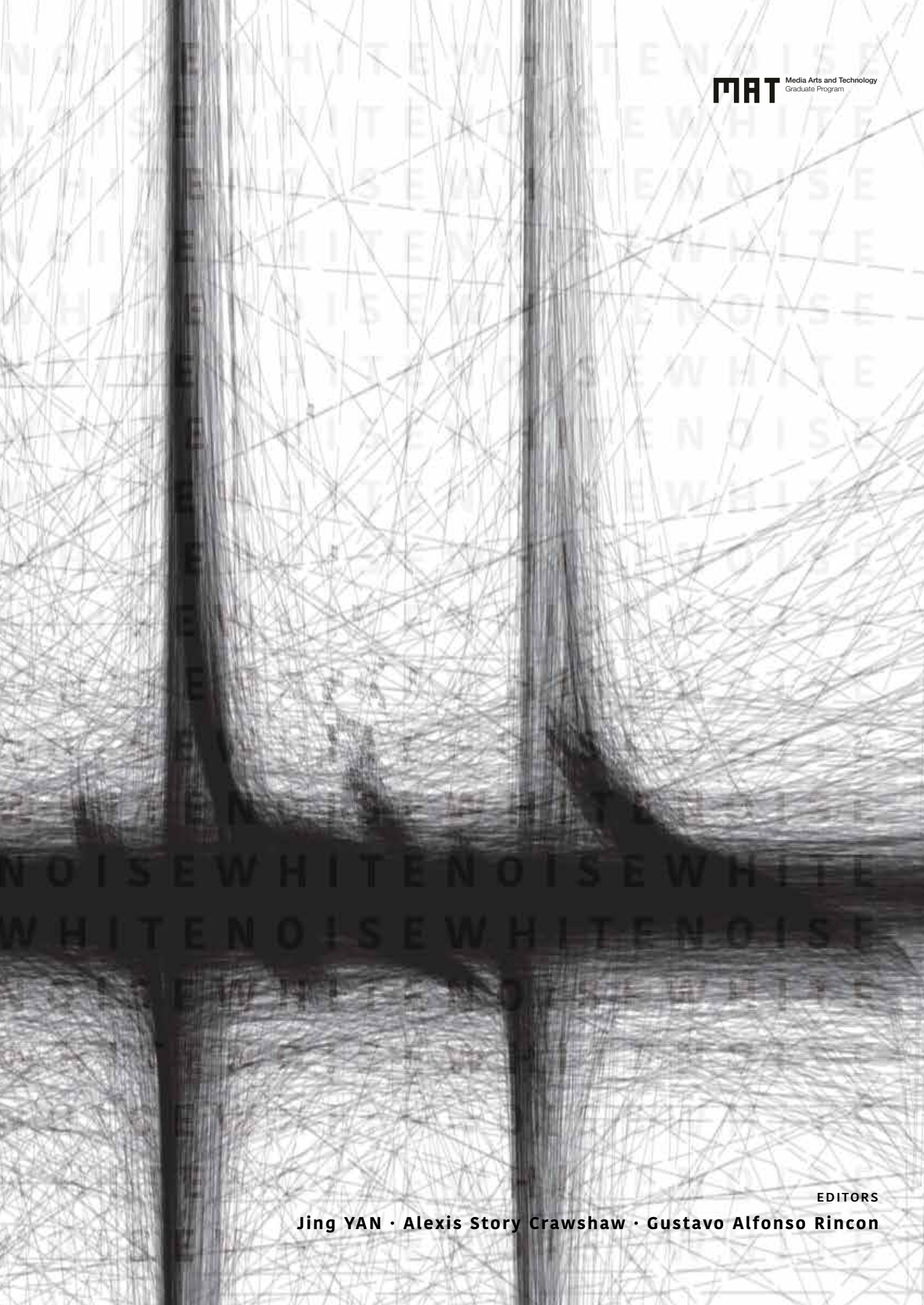

EDITORS

Jing YAN · Alexis Story Crawshaw · Gustavo Alfonso Rincon

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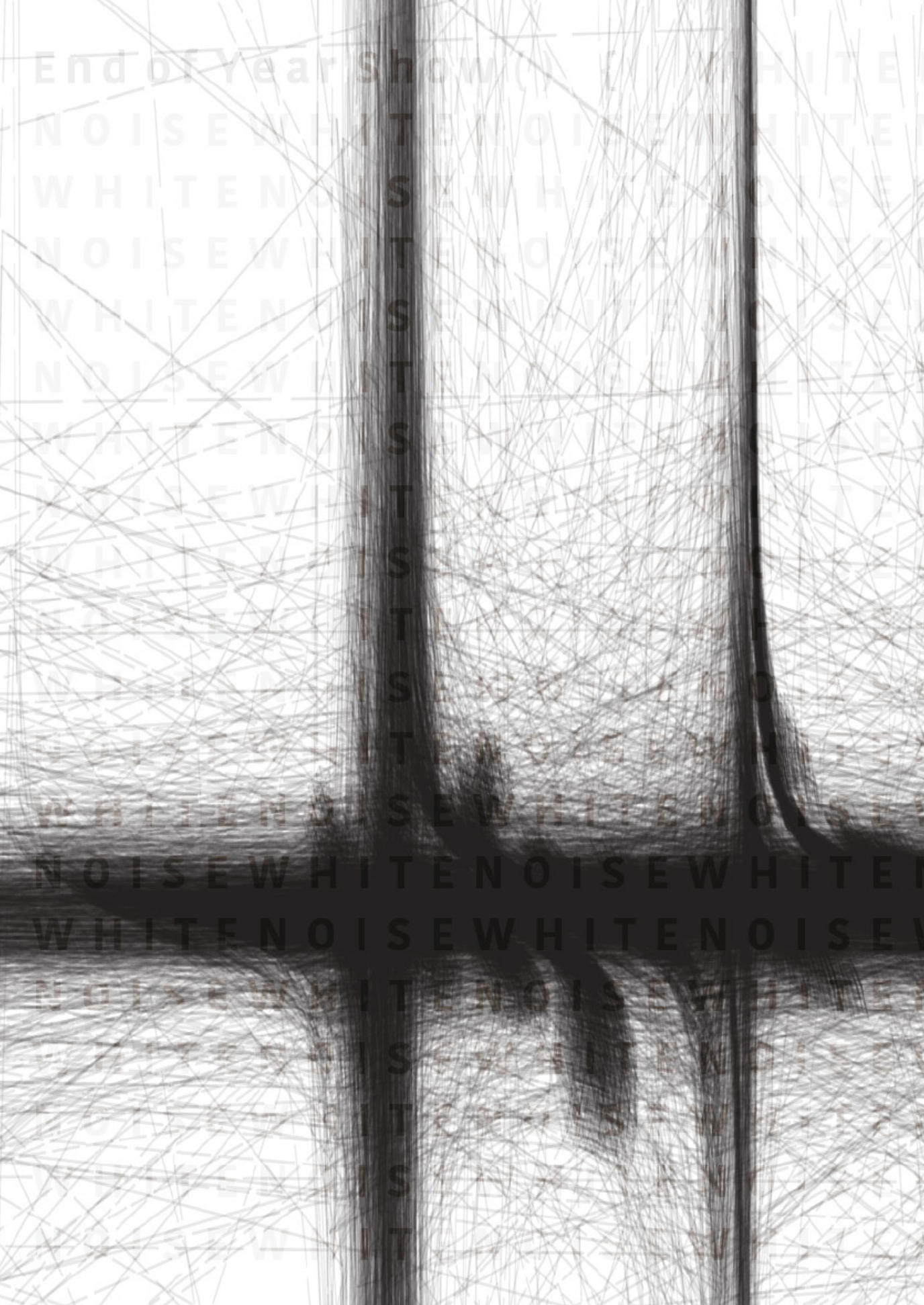
White Noise Media Arts and Technology Program 2016 End of the Year Show (EoYS) Catalog

EDITORS Jing **Yan** · Alexis Story **Crawshaw**· Gustavo Alfonso **Rincon**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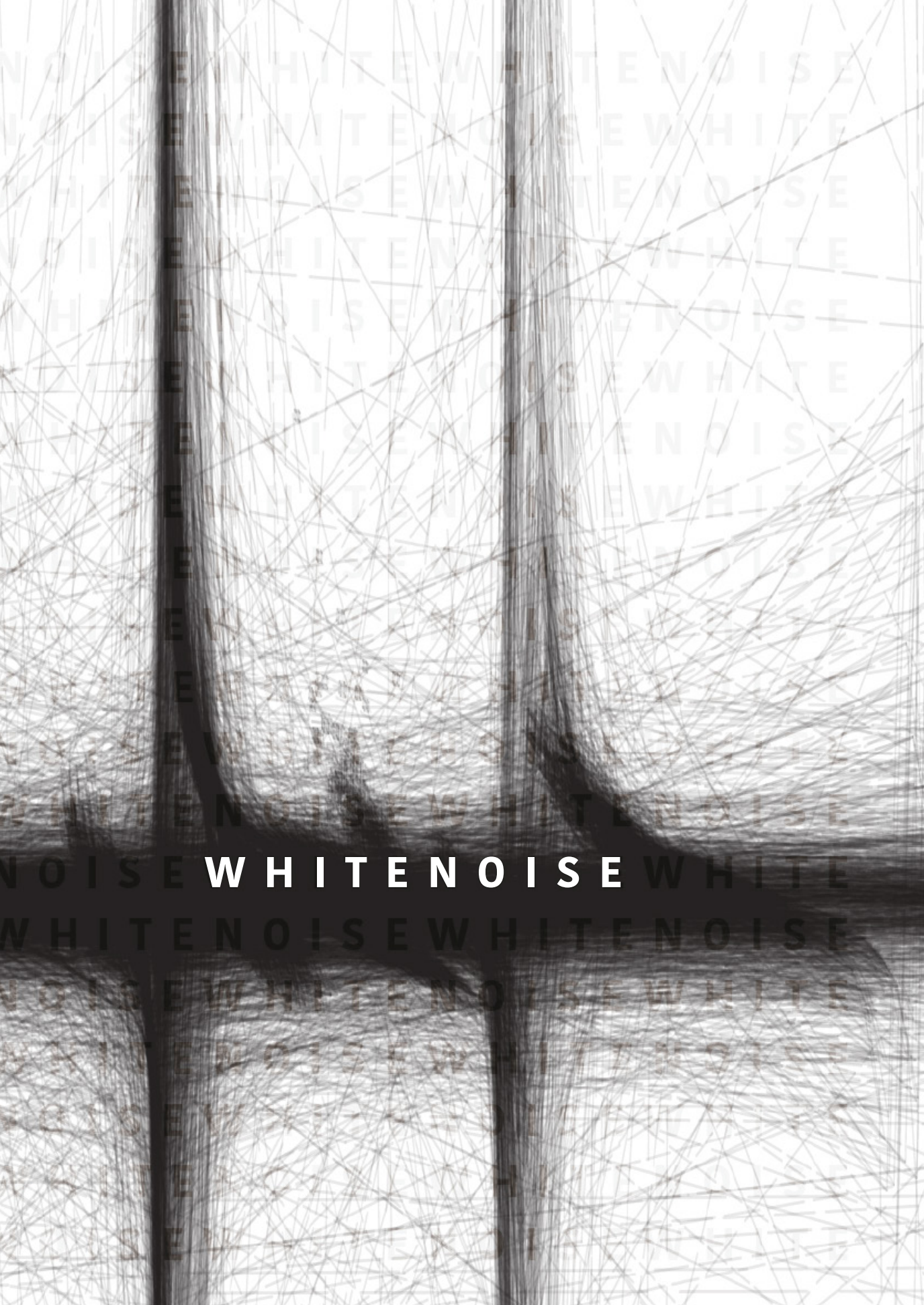
WHITENOISE

End of the Year Show (EoYS) Catalog Series
Media Arts and Technology Program, University of California, Santa Barbara

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UCSB MAT Media Arts and Technology Graduate Program

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Chair's Foreword

It is with great pleasure that I have the opportunity to introduce “White Noise,” the Media Arts and Technology Graduate program’s 2016 End of Year Show exhibition and catalog, featuring cutting-edge art and research-based projects created by students this academic year.

The Media Arts and Technology Program (MAT) is an interdisciplinary graduate program founded in 1999 to pursue emerging opportunities for education and research at the intersection of art, engineering, and science. MAT paved the way in digital media arts-engineering in the University of California, introducing the Master’s degree in 1999 and the Ph.D. in Media Arts and Technology in 2005, resulting in a major international presence in digital and new media fields.

MAT’s contribution to research and education is through fostering an interdisciplinary approach, by exploring questions that cannot be answered by the individual disciplines alone, and preparing new kinds of hybrid researchers who are fluent in traditionally separate knowledge domains. Our faculty provide knowledge and standards through their joint appointments with Art, Computer Science, Electrical and Computer Engineering, and Music.

MAT students come from a variety of backgrounds with undergraduate degrees in a wide range of disciplines such as computer science, media art, design, architecture, electrical and computer engineering, music, and audio engineering. Many have hybrid backgrounds, with experiences and interests in both technical and aesthetic aspects of scholarship and creative work. The critical element, however, is a passion for thinking and working out of the box, beyond the traditional disciplinary boundaries, to create new media, new ideas, and new disciplines. Our students engage in experimental prototyping in sonification, visualization, spatialization, time-based studies, control sensors and devices, and collaboration opportunities with most engineering and scientific fields as we can work with any form of data be it scientific, economic, or artistic.

The production of this exhibition catalog is an important step towards chronicling our activities. It has taken much effort, passion, focus, and commitment. Much appreciation goes to this year’s End of Year Show team. Gustavo Rincon did an exceptional job of organizing and facilitating the exhibition and catalog. Significant credit for design goes to Jing Yan and Ambika Yadav, with an algorithmically defined background pattern by Weihao Qui. We are greatly indebted to Alexis Crawshaw, Pablo Colapinto, and Hannah Wolfe for painstakingly editing all of the texts.

George Legrady
CHAIR · Media Arts and Technology Graduate Program

Editor's Foreword

Lead Editor · **Alexis Story Crawshaw**

White noise — a noise containing all frequencies presented in equal proportion— represents all possibilities in equal likelihood. As this year's theme, it represents the blank canvas, the marble awaiting the sculptor — requiring subtractive strokes to distill such possibilities into the tangible and the definite. At MAT, our transdisciplinary research is like white noise in that it contains “signals” from every field. As media artists and technologists, our task is to navigate and filter through this diverse aggregate of information in novel ways to sculpt new signals — deriving new art, new knowledge, and new questions that transcend the present paradigm. Our show and this present catalog are the fruits of this process. We invite the reader to celebrate with us this documentation of our efforts.

Designer's Foreword

Lead Designer · **Jing Yan**

Years ago, the words “white noise” first settled in my mind as the title of a song by the post-rock band, Mogwai. The repetition, randomness, and complexity of this music genre formed my initial impression of white noise. The term itself struck me with its contrasting beauty and simplicity.

Combining these associations with its origins in signal processing as a collection of all frequencies, I interpreted white noise both as a state between order and chaos, and as a possibility between meaning and nonsense. It is at once a womb for new signals, and a graveyard of broken pieces. Thus, the visual identity design of this show presents white noise as a composite notion, a fusion of three parts: 1. an assemblage of basic elements evolving from points, to lines, to squares, to cubes, 2. a distortion of the three-dimensional world in relative perspective, and 3. an overlay of micro- and macro-scale points of view.

The whole visual identity underwent a long, evolving design process, balancing software development with design strategy. It was not built all at once with a blueprint; instead, an algorithm was constructed to generate a collection of designs with unexpected aesthetic shifts between them.

The process of the design began with a basic state of the words “white noise.” This first state was built by transforming pixels to cubes with random, dynamic movements. Next, shaders were used to represent these cubes, distorting the perspective of the cubic geometries. These shaders were then converted into vector lines to provide the graphic’s foundational layer. The design was finally patterned with text to immerse the background with additional texture.

An accompanying video illustrates the algorithmic process and its complexity, animating through these states in an infinite pattern space, at different levels of viewer proximity to the design. The viewer’s gaze and curiosity explores

this distorted environment at different scales and navigational points of view. Thus, this dynamic spatial image conveys the multitude of micro and macro structures found within this white noise world.
This process of generated and superimposed images created the design source material for the show, including posters, postcards, wall signage, labels, this catalog cover, and our web design.

For this catalog design, the concept of white noise is embodied in the general layout of text and images, breaking the grid. The text breaks into smaller pieces and is arranged sparsely to create a design aesthetic of fragmented randomness. An additional layer of vector elements is distributed randomly throughout the entire catalog and overlain as background. This provides conceptual unity with a distinctive rhythm and adds multi-layered depth to the two-dimensional manifestation of our graphic identity.

I want to thank Professors Marcos Novak, George Legrady, and Marko Peljhan for their guidance throughout the entire process. Special thanks to my colleagues Donghao Ren and Zhenyu Yang for their generous help on the algorithm design of the visual identity, Ambika Yadav for her contributions as a member of the design team, and Gustavo Rincon for all the design support. All the photo credits of this Catalog go to Weihao Qiu and Zhenyu Yang.

Background Algorithmics

Weihao Qiu

Noise is perceived as chaotic, but is fascinating for its integrity of unity, as a collection of all possibilities occurring with uniform probability.

The design of the catalog embodies white noise, with noise permeating the whole catalog, particularly the background design of the pages. Instead of manually simulating randomness to evoke noise, I chose to engineer an algorithm to generate a more exact “randomness,” assuring equal probability of occurrence so that this unity inherent in noise is retained, assuring the beauty of the design through this algorithmic cohesiveness.

The background of the majority of the pages contains elements of vertices, lines, and rectilinear panels. The main design principle distributes the placement of these design elements across the pages by average, thus ensuring the equal probability of a noise element to be placed at any particular position of any particular page, in this way mimicking white noise. The distribution and placement of these elements on the pages is calculated by the algorithm so that if all the pages of the catalog were to be collapsed down into only the design elements, the resulting stack would be of equal thickness across its area. Also, the degree of noisiness (the density of the elements) fluctuates from page to page, manually composed like the notes of a melody, with a different melodic envelope shaping each section, relating to how the sections are distributed. Therefore, this catalog is not only designed to show the unified beauty of noise, but also how from noise, one can make music and form.

Acknowledgments

Lead Coordinator and Organizer • **Gustavo Alfonso Rincon**

On behalf of the EoYS 2016 team, I want to thank all of the artists, researchers, faculty, and community members that participated in this year's EoYS White Noise exhibition and series of events.

The EoYS 2016 was a four-day series of events that launched our first ever educational outreach exhibition Preview Day featuring the Media Arts and Technology (MAT) Program and affiliates led by Dr. JoAnn Kuchera-Morin with the help of Wendy Ibsen, Associate Director of the Center for Science and Engineering Partnerships (CSEP). Student participants included ninth grade girls from the Dos Pueblos Engineering Academy (DPEA) and students from the Santa Barbara High School Computer Science Academy (SBHS-CSA).

Our exhibition events included a kickoff lecture, panel discussion, AlloSphere tours, a main exhibition on all three floors of the California NanoSystems Institute, a concert in collaboration with the Center for Research in Electronic Art Technology (CREATE), a day-long critique session with visiting critics, and a satellite, two-evening exhibition at the Santa Barbara Center for Art, Science, and Technology (SBCAST). This exhibition at SBCAST featured three galleries and included a parking lot concert with visual projections. This two-part SBCAST event also consisted of two firsts for the EoYS: a closing event and an inaugural EoYS 2016 First Thursday community event, featuring a live performance by Professor Curtis Roads, archival radio shows by Professor Yon Visell and Katja Seltmann, and a sound installation by Professor Clarence Barlow.

The main EoYS exhibition day and evening featured demonstrations, installations, performances, and concerts by over fifty student and faculty works from the MAT program, AlloSphere Research Facility, Experimental Visualization Lab, Four Eyes Lab, MIRAGE Lab, RE Touch Lab, Systemics Lab, and transLAB. We want to thank Professor Tobias Höllerer for leading the coordination of the Four Eyes Lab's first ever exhibition on the entire third floor. We also thank Professor Theodore Kim for his generous support of the opening event and Professor Pradeep Sen for facilitating the MIRAGE Lab exhibition.

The media and research works represented transdisciplinary subjects that spanned the areas of computational perception, computer vision, computer graphics and imaging, haptics, robotics, virtual reality, augmented reality, conceptual art, digital humanities, mechanics of touch— real and virtual, human-robot interaction, data visualization, generative sound, generative design, scientific visualization, field research, sensor networks, remote sensing, and experimental music.

The EoYS also featured several guests. Our keynote lecture was given by Zhang Ga (CN/US), a Professor of Media Art at CAFA, China Central Academy of Fine Arts, and an Associate Professor at the School of Art, Media, and Technology, The New School, Parsons. Andreas Schlegel, Coordinator of the Media Lab at LASALLE College of the Arts in Singapore, was a guest critic, giving a lecture earlier in the week.

For the first time, MAT faculty participated in a EoYS panel discussion, which featured the themes of "White Noise" and the "Future of Media Arts Research: Education, Practice, and Scientific Discovery." The panelists included international guests Zhang Ga and Andreas Schlegel, along with MAT Professors JoAnn Kuchera-Morin, George Legrady, Marcos Novak, Marko Peljhan, and Matthew Turk. The panel was moderated by first-year MAT Professor Yon Visell.

The opening remarks of the White Noise exhibition were given by the MAT Program Chair, Professor George Legrady, recipient of the 2016 John Simon Guggenheim Memorial Fellowship.

We thank Professors JoAnn Kuchera-Morin, George Legrady, Marcos Novak, and Marko Peljhan for their invaluable assistance with the EoYS events and this catalog.

The 2016 MAT EoYS was supported by Rod C. Alferness, Dean of the College of Engineering, and John Majewski, Dean of Humanities and Fine Arts. Special thanks to the Office of the Executive Vice Chancellor David Marshall.

Our educational outreach was made possible by the generous support of the Robert W. Deutsch Foundation and the Mosher Foundation. We thank Alan Macy, Founder of SBCAST (the Santa Barbara Center for Art, Science, and Technology). Special thanks also to Craig J. Hawker, Director of CNSI (the California NanoSystems Institute) and Dow Materials Institute, as well as
Faculty Director of the UCSB MRL (Materials Research Lab).

Interviews

GEORGE **LEGRADY**
MARKO **PELJHAN**
MARCOS **NOVAK**
JOANN **KUCHERA-MORIN**
CURTIS **ROADS**
ANDRES **CABRERA**
MATTHEW **TURK**
TOBIAS **HOLLERER**
CLARENCE **BARLOW**
YON **VISELL**

George **Legrady**

Department Chair • Director of the **Experimental Visualization Lab** • Professor

Q : MISSION STATEMENT OF THE LAB

The Experime one of 5 dedicated research labs in the Media Arts and Technology arts-engineering program at UCSB. The lab focuses on computational-based creative explorations in the fields of data visualization, visual language, machine vision, computational photography, interactive digital installations, and related directions addressing the impact of computation on visualization. The experiments, projects, and courses we do and offer contribute to the arts-engineering/scientific community in the following ways: 1) Exploring new forms of visualizations through implementation of advanced knowledge of visual language, image syntax, and semiotics, 2) Rapid testing of concepts through visual/spatial/interactive means, and 3) Addressing image-based research that is on the fringe of engineering/science research and exploring opportunities for artistic exploration.

Q : HOW DO YOU DEFINE MEDIA ARTS AND TECHNOLOGY?

Media Arts and Technology is the integration of the application of media and technology to experimental prototyping approaches as in the arts. Over the years, the term has shifted meaning, and today it may make more sense to say "media
arts and computation" or "computation, research, engineering, science, and arts." The underlying core focus is that it is computational-based. There is an experimental, applied and research approach, suggestive of the open systems in the arts in comparison to the systematic-procedural approaches specific to the sciences and engineering.

Q : WHERE DO YOU SEE YOURSELF OR YOUR LAB WITHIN THE CONTEXT OF BOTH THE EDUCATIONAL AND RESEARCH CONTEXTS OF THE MAT PROGRAM AND ITS OTHER LABS?

The lab has gradually transitioned over the years and continues to do so. There is a strong computational foundation as students are expected to explore the intersections of visualization, conceptualization, and cultural investigation through software development. Over the past 4 years, we have had to design custom camera hardware systems to realize certain projects.

The output of our work crosses multiple disciplines and institutional contexts at the international level. Some result in collaborations with students. We have presented papers and installations in Engineering contexts (ACM Multimedia, NIME), Arts-Engineering (Siggraph), humanities-based academic conferences (CAA, ISEA), academic museums (Beall/UC Irvine), Fine Arts museums (SBMA, SFMMA), media festivals (Fotofest), Fine Arts galleries (Nadimi Gallery/Toronto, Nature Morte/Berlin, Cella Gallery/LA), public facilities (Seattle Central Library), corporate clients (CEB, Arlington), and a related range of publications in diverse conference and arts-engineering venues.

Q : WHAT ARE YOUR FUNDAMENTAL RESEARCH QUESTIONS AND WHERE DO YOU SEE YOUR RESEARCH EXPANDING OVER THE NEXT 10 TO 20 YEARS? WHAT NEW FIELDS ARE ON THE HORIZON?

The fundamental focus is the study of the image, both 2D and 3D. The approach is to explore the syntactic nature of how images function, the impact of computation on visualization, and to articulate and analyze the complex cultural underpinnings of how and why the culture believes in the machine-generated image, when in fact it is the result of a construction through optical-mechanic and computational means. Interactivity has been at the core of my own personal artistic work since the early 1990s and in the past few years, we have explicitly studied research methodologies between various disciplines by visiting scientific and engineering labs and engaging with the researchers.

Q : WHAT QUESTION WOULD YOU LIKE TO ASK YOUR MAT COLLEAGUES? HOW WOULD YOU ANSWER YOUR OWN QUESTION?

“That’s cool! How did you do it?” My answer would obviously depend on the project. Given the artistic nature of some of the projects, the questions I sometimes get are “What does it mean?” and/or “Why did you do it?”

Marko **Peljhan**

Department Vice Chair • Graduate Advisor • Director of the **Systemics Lab** • Professor

Q : MISSION STATEMENT OF THE LAB

The Systemics Lab is devoted to the creative exploration of the edges of art, science and technology research with a special focus on robotics, interface design, signal processing, embedded systems, sensors and sensor networks, communications, applied aerospace systems, biological computing paradigms, sustainable computing paradigms, and cybernetics and systems theory in general. We got our name from the definition of “Systemics” by the late cybernetist Heinz Von Foerster. Systemics is integrated and that’s what we are aiming for, an integrative approach to creation, questioning, and intervention in multiple domains.

Q : HOW DO YOU DEFINE MEDIA ARTS AND TECHNOLOGY?

A creative clash of multitudes, reflecting contemporary technological and artistic research through the use of known and undiscovered media. A complex techno-spiritual endeavor. I find reflection and understanding of the work of our predecessors, be it in science, engineering, and the arts as the cornerstone of moving forward.

Q : WHERE DO YOU SEE YOURSELF OR YOUR LAB WITHIN THE CONTEXT OF BOTH THE EDUCATIONAL AND RESEARCH CONTEXTS OF THE MAT PROGRAM AND ITS OTHER LABS?

Systemics is space for the pursuit of unknown unknowns. We think, analyze, build, break, connect, and project. In the end, we simply try to understand existing micro and macro systems and build new ones, both for the reflection and projection of ideas.

Q : WHAT ARE YOUR FUNDAMENTAL RESEARCH QUESTIONS AND WHERE DO YOU SEE YOUR RESEARCH EXPANDING OVER THE NEXT 10 TO 20 YEARS? WHAT NEW FIELDS ARE ON THE HORIZON?

The building of observatories for the meta-analysis and reflection of world systems with the help of technological machines and different categories of knowledges and the building of “generators” for future synthesis and projections. It is a systemic, recursive path. Sometimes it resides in the arts, sometimes in engineering.

Q : WHAT QUESTION WOULD YOU LIKE TO ASK YOUR MAT COLLEAGUES? HOW WOULD YOU ANSWER YOUR OWN QUESTION?

Let’s change this world. Would you teach me? Can I teach you?

Marcos **Novak**

Director of the **transLAB** • Professor

Q : MISSION STATEMENT OF THE LAB

What is a world? In fact? In fiction? In action? How can emerging technologies help us create new worlds or improve existing ones?

The mission of the transLAB is to study “worldmaking” through “transformation that leads to speciation,” and to use this knowledge to create not only tools, but also works: new transmodal worlds-as-works.

For our purposes, a “world” can be the actual world itself, an ecosystem within it, an organism within the ecosystem, a living cell within the organism, and so on, or a simulation of these. It can also be a society of minds, a single mind, or a simulation of these: an artificial life, artificial intelligence, or artificial consciousness. It can also be a work of art, music, architecture, static or dynamic, or it can be what a mind imagines in response to a work, as a reader imagines a world while reading a novel.

In all of these cases, the “world” in question is a complex dynamical system held together by rules that govern being and becoming. The rules can be mathematical, computational, generative, linguistic, biological, physical, and so on, and can be factual or fictional, objective or subjective, data-driven or imagined, pragmatic or poetic. Our method is to transpose knowledge across domains: for instance, to study biological morphogenesis and to use it to generate worlds that combine architecture, music, future cinema, and immersive spatial narrative.

The interests of the transLAB grow out of concepts such as “liquid architectures,” “transarchitectures,” “habitable cinema,” and, overall, “transvergence.” As such, it has a special interest in space, form, and fabrication, and also, at the other end, ideas about society and civilization, as these are expressed in art and science.

Q : HOW DO YOU DEFINE MEDIA ARTS AND TECHNOLOGY?

“Media Arts and Technology” studies the balanced mediations between disparate elements unlike enough to be distinct, and similar enough to be bridged; its tools are new technologies; its purpose is Art. Sometimes, those mediations require the invention of new tools, new technologies; then those innovations are subsumed into Art, too.

A definition is not a slogan. A definition makes something indefinite more definite. It is the conclusion of an evolving thought process, a consideration that is dynamic and ongoing, adjusting to new circumstances and new information.

Regarding the definition of “Media Arts and Technology,” my present thought process is as follows:

Every serious investment of human effort and resources answers to some corresponding human need or desire. “Law” answers to the need for justice, “medicine” answers to the need for health, and so on. What needs or desires does a new field such as MAT answer to?

At a first approximation, we could say that the pursuit of “media arts and technology” simply aims to advance the so-called “media arts,” apparently using “technology.” Perhaps, but this simply postpones the definition, since it

sheds little light upon any of its component terms or upon the sum of them.

At a second approximation, we could try to make more definite those component terms (media, arts, technologies) and their concatenation. “Media” could refer to advancing “new media,” and “technologies” could refer to the hardware and software tools pertinent to new media. “Media arts” would then just be arts employing new media, and technologies would be the substrates that enable such new media. The fundamental needs and desires they addressed would be whatever needs and desires art-making and tool-making, in general, already address, in conventional usage, without much more thought or elucidation.
This articulation is too tautological, and isn’t really much better than the first.

A third approximation is to inquire into each term more vigorously.
In reverse order (technology, arts, media):
“Technology,” instead of referring to tools as disjointed objects, would address the logic of techne, or artful craft, that is to say, tools functioning not as isolated machines independent of their users, devoid of intent or sensibility — but tools as evolving ecosystems — complex aggregates that include materials (including processes), devices that modulate those materials, device-makers, device-users, and device-audiences, as complex systems: not the chisel alone, but the whole system: the quarry, the stone, the chisel, the sculptor, the guild, the city, and the viewer, the planet, all as one cluster, across space and time. Implied here is also the continual refinement brought about by advancing theory and practice steadily over time.

The “Arts,” instead of being confounded with the provision of pass-time entertainment (or the selling eye-candy to the addicted eye of the beholder, or the serving to the visible hand whatever only the invisible hand’s semi-visible market “wisdom” can discern, or the shocking of the ever-shrinking petite-bourgeoisie, already stunned into indifference after a century of electro-art-shock-therapy, or any such 20th century remnant), the arts, we repeat, would answer to the ancient and fundamental human need for making “exemplars,” communications by which past and present generations communicate to future ones their best and most sincere advice about what is important to emulate or avoid, to disdain or to admire.

“Media,” finally, would refer not only to the material of expression (brushstrokes, chords, pixels), but to the intent of expression: the bridging between a “here” and a “there,” a “this” and a “that,” a “you” and an “I.” A “medium” is never a single entity, but is, as was observed earlier, the central element of a triad, a mediation between two things unlike enough to be distinct, and similar enough to be bridged. Moreover, in this context, the mediation is a message between the transmitter (who actually has something to say) and a receiver (who wants to make sense of — not just receive — that message).

But we are not done yet — because a medium is not just a midpoint — it is a mean, the right mean, the balance that maintains a balance. The message is conveyed through mediation, yes, but the message is itself a mediation. I write in English — written English is my medium — but I write “this,” and this “this,” whatever it may be, pinpoints a specific balance, the specific mediation, between too much and too little, that I am trying to convey to you.

Notice the nesting of codes of mediation — decoding this text requires knowing the code of English — but it also requires sharing numerous other codes of shared assumptions and values. Mediation is, implicitly, plural: mediations — already closer to “media.”

This specific mediation to be conveyed is not simply “content” that fills vessels called “media” — it is, rather, the embodiment of what is to be conveyed: it is not a label called “bravery” attached to an avatar; it is the communication of a brave act in a brave act of communication: it is having something to say, and saying it well by living it well.

And so, finally, we come to something fundamental and worthy of being called a “field”: the discipline and science of seeking not merely to connect unlike things, but to connect them with fine, wise, sustainable, and meaningful balances.

Reading the terms in order, we can now assemble a definition of “Media Arts and Technology” that applies to past, present, and future, to advanced research and avant-garde creation and critical reflection on the sum of human accomplishment:

Media Arts and Technology is:
— a discipline and
— a field of advanced research and creative practice
— that studies the conveyance of balanced meanings
— across individuals and generations
— put forth through exemplary works
— employing nested mediations
— created using evolving technological ecosystems
— refined continually by theory and practice over extended time
— toward the goal of making a better world.

These mediations, of course, provide what Aristotle called μεσότης/mesotes, the Golden Mean, the perfect point between excess and deficit. They help bring about the philosophical stance that builds a well-balanced society of well-balanced individuals in cities that aim to increase the happiness and well-being of their citizens. Here we are finally faced with the fundamental human needs and desires that are the foundations of fields of extended and durable human effort.

Q : WHERE DO YOU SEE YOURSELF OR YOUR LAB WITHIN THE CONTEXT OF BOTH THE EDUCATIONAL AND RESEARCH CONTEXTS OF THE MAT PROGRAM AND ITS OTHER LABS?

In a narrow sense, the transLAB complements the other labs at MAT by focusing on space, form, and inhabitation. New technologies are constantly changing how we conceive of space and interact with and within it; of course, after relativity, “space” is now “spacetime,” and what was once conventionally understood to be local, empty, passive, and inert, is for our time global, full, active, and alive. In addition, we now have the vast, unexplored territory of virtual space, and of the intermediate sensor/effector spaces that connect actuality to virtuality.

In a more extended sense, though, because the transLAB grows out of advanced architectural research and avant-garde production, there is a concern for how architectures, liquid architectures, transarchitectures, are formed by and inform civilization. A work of architecture is never isolated: it is either in direct negotiation with nature, or it is part of the fabric of a city; its success depends on both its relation to what surrounds it, and on what it contains, namely its citizens. Of the arts, architecture is the most demanding of resources, and thus it is constantly aware

of the social, economic, and political determinants of human effort. It is also an ancient and durable art, and must therefore be aware of its past and must anticipate the future.

From their ancient origins, architecture and music have been connected through mathematics and philosophy. Now fused into “archimusic” (corresponding to “spacetime”), they both seek to recognize, generate, and transform complex patterns that affect humans in positive ways. The transLAB generalizes these concerns to the ultimate degree: it approaches the study of complex spatiotemporal pattern generation and transformation in an n-dimensional way, allowing any data source to be translated from any modality to any other modality, not by abstracting everything that is of human interest away, but by reintegrating everything into a new “transmodal continuum” that includes cultural and humanistic concerns along with technological and scientific ones.

The most complex pattern-generator in the world is life itself. Thus, the transLAB has a special interest in computational biology and algorithmic morphogenesis.

Unifying all these interests is made possible by concentrating on “worldmaking,” as fact and fiction. Thus, the transLAB also functions as a studio for worldmaking.

In the context of MAT and of a research university in general, we provide important connective tissue. Our culture tends to divide and specialize. This is a very effective and powerful method, but sometimes there is no one left to consider the big picture, the sanity of the whole. We make it our point to remain holistic even as we specialize. It’s more work, but it’s more satisfying, too.

Q : WHAT ARE YOUR FUNDAMENTAL RESEARCH QUESTIONS AND WHERE DO YOU SEE YOUR RESEARCH EXPANDING OVER THE NEXT 10 TO 20 YEARS? WHAT NEW FIELDS ARE ON THE HORIZON?

…ὣς ἄρα οἱ εἰπόντι ἐπέπτατο δεξιὸς ὄρνις, κίρκος, Ἀπόλλωνος ταχὺς ἄγγελος…
…even as he spoke a bird flew by upon the right, a hawk, the swift messenger of Apollo…
(Homer, Odyssey, 15:525)

What is “research”?
Have you ever noticed a hawk wheeling overhead, scanning for prey? We call the flight “wheeling” because the hawk flies in circles, great wheels in the sky. In Homeric Greek, such a hawk is called a “κίρκος”/“kirkos.” The word “kirkos” is related to “kyklos,” from which we get “cycle.” Latin borrows “kirkos” to make “circus,” “circulus,” and the verb “circo,” “to wander in circles,” “to circulate,” from which music derives the “ricercare,” the re-circling around a theme, from which, finally, we derive “search” and “re-search.”

“Research” thus means encircling and re-circling, cycling and recycling, wandering in search for prey, scanning from the highest vantage point and with the sharpest vision. We cannot foretell what may come across our field of view, or when, but we can be prepared to encircle our fields, scan for differences, notice patterns, recognize anomalies, propose theories, act on hypotheses, and, ultimately, capture knowledge.

I’ve already alluded to my main research questions. Like the hawk’s flight, my research proceeds in ever expanding circles. New questions do not cancel old ones, but expand them. Core ideas persist, drawing on the past and

present, but aiming for the future.

At the very center is a quest for objective beauty, not opinion, and for using technologies as “alloscopes” that allow us to peer into worlds previously beyond our perception and even our conception. Since biological morphogenesis and noogenesis are the most powerful generators of complex (indeed living, conscious) pattern that we know of, I am interested in how we can leverage their power by digital and physical computing.

In the middle ground are more immediate developments, made possible by emerging and enabling technologies. All my previous concerns persist, and new ones are added. I’m particularly intrigued by something I call “media field navigation,” combining VR and autonomous vehicles, for instance, and by social VR, and by VR as the future of cinema.

Extended to its logical conclusion, research toward artificial intelligence and artificial life, and increasingly life-like robotics, culminates in the quest for the development of quasi-living artificial consciousnesses in actual and virtual spaces. We will make virtual worlds that overlap our actual one, and bring to life n-dimensional life forms that we will interact with. Science and technology may make these possible, but engineering alone cannot civilize them without the nurturing wisdom of art and philosophy. Thus, the research into tools and means must be balanced with research toward ends and works.

Q : WHAT QUESTION WOULD YOU LIKE TO ASK YOUR MAT COLLEAGUES? HOW WOULD YOU ANSWER YOUR OWN QUESTION?

Paraphrasing Plato:
Where are we heading, and do the paths we’re on actually lead us toward there or away from there?
By implication, therefore:
We can build nearly any shape we wish, but are our cities really better places to live in?
We can synthesize any sound we wish, but is our music better to listen to?
We have media arts, but do we have more powerful or more meaningful art?
Sciences and technologies have criteria; what criteria do the media arts have?

How might these questions be answered? The conventional response is to deflect or postpone questions having to do with art and meaning, and to say something trivial about how relative everything is— in short, to avoid any difficult thought by pretending that the question is unanswerable or irrelevant. Perhaps such a stance was useful, or even necessary, for a short period last century. Perhaps it will be useful or necessary again if ideas become stale and oppressive. At the moment, it isn’t. Quite the contrary: globalization’s collective disregard for meaning is damaging the environment, the species we live with, and our societies.

I propose that the twentieth-century attitude of systematically dismantling all criteria for what is good for humans has served its purpose and is no longer useful in the twenty-first century. I observe that the fascination with “noise,” trumpeted by the Futurists, is already over a century old. Then, noise was a fresh and revitalizing resource. Now, we are drowning in it. I point out that the world “noise” itself comes from the Greek word “νόσος/nosos,” meaning illness or disease. I propose that, for our century, putting science and technology at the service of a more directly humanistic art that aims at helping people thrive must take priority.

JoAnn Kuchera-**Morin**

Director of the **Allosphere Research Laboratory** • Director of the **Center for Research in Electronic Art Technology (CREATE)** • Professor

Q : MISSION STATEMENT OF THE LAB

The AlloSphere's mission statement: To lead the way in immersive, interactive visualization, and sonification of complex data, defining a unique computational language for discovering new patterns in this complex information, while building one of the largest interactive immersive display instruments in the world to work with this information at human scale. Research questions in the group encompass new interactive immersive art forms that are informed by ground truth principles of science, hence leading to the possibility of new scientific discovery through artistic exploration.

Q : HOW DO YOU DEFINE MEDIA ARTS AND TECHNOLOGY?

The evolution and intersection of the traditions of music and the visual arts with electrical engineering and computer science— these traditions can be traced back to the ancient times of musical instrument design (mechanical engineering, acoustics, frequency vibration), visual arts (geometry, design, printing, architecture), viewing the evolution in the 1800s of primarily music and art with mechanical engineering. With the invention of electricity and the industrial revolution in the 1900s, one sees the evolution of the field encompassing analog electronics and the exploration and invention of the amplifier and other electronic components establishing the field of analog electronic music and art in the mid 20th century. The intersection of the arts with engineering in the mid 20th century encompasses electrical engineering (audio/visual signal processing) as well as mechanical engineering. In the mid to late 20th century with the invention of the computer, one sees the evolution to digital technologies, first with audio, then visual, and haptics, now in the early 21st century (having its roots in mechanical engineering). This now ties together and defines our formal field of media arts and technology education and curriculum in history, theory, and practice as well as research— **music, visual arts, computer science and electrical engineering**. We take our research and practice now a step further by tying in the sciences with bio-art (fluid dynamics, bio-genetic algorithms), interactive visualization of complex mathematical equations for exploration into higher dimensions (fractals, quantum mechanics, etc.) as well geometric principles of architecture and design. This will begin to formalize other areas of curriculum as our field evolves into a discipline.

From Curtis Roads, former Chair, in his 2011 response to our external program review (agreed upon by the MAT faculty):

> MAT is a transdisciplinary Graduate Program combining the arts, engineering, and the sciences. At our core, we apply design skills and aesthetic insight to (a) solve engineering problems in data visualization and sonification, and (b) push the limits of creative expression. The specific type of data being processed can be drawn from any source: scientific, economic, cultural, or artistic. Because of this, the scope of MAT's current and potential future research partnerships is extremely broad. MAT researchers implement these projects in a variety of physical and software media, from the macro scale (e.g., AlloSphere) to increasingly sophisticated mobile media devices. This unique combination of scientific and engineering practice informed by artistic criteria (perception, affect, and aesthetics) introduces new transdisciplinary forms of problem solving, practiced in both the laboratory and the classroom.

Q : WHERE DO YOU SEE YOURSELF OR YOUR LAB WITHIN THE CONTEXT OF BOTH THE EDUCATIONAL AND RESEARCH

CONTEXTS OF THE MAT PROGRAM AND ITS OTHER LABS?

In keeping with my statement of the evolution and current definition of Media Arts and Technology and the mission statement as defined by the former MAT Chair and agreed upon by the faculty during our first external review, (information listed above), I believe that the AlloSphere and the AlloSphere Research Group encompass and intersect the research and educational missions of the MAT labs and hence every lab and course is essential. The AlloSphere is a unique immersive multi-user instrument designed for performance of complex multidimensional immersive, interactive data sets for new art forms and new scientific discovery. The user interface is dependent upon gestural control and interaction at the most subtle nuance so HCI with sophisticated studies in human body movement from musicians as well as dancers is one area of research and practice that intersects the CS Four Eyes Lab with the AlloSphere Research Facility and Research Group. In the design of AlloSystem software as an n-dimensional visual/aural compositional/performance platform, immersive VR research for psychological analysis of sensorial perception completely ties together CS and psychology. With visual and aural content, the ExpVisLab's information visualization and computational photography are two areas that have explored this type of research in the AlloSphere. The transLAB's environment of morphogenesis and world-building research creates a space for movement that complements the AlloSphere as an immersive instrument. CREATE's spatial audio composition and musical instrument design, the Mirage Lab's graphics research, and our new RE Touch Lab's haptic research all tie into the AlloSphere's arts/science research, practice, and educational mission.

Q : WHAT ARE YOUR FUNDAMENTAL RESEARCH QUESTIONS AND WHERE DO YOU SEE YOUR RESEARCH EXPANDING OVER THE NEXT 10 TO 20 YEARS? WHAT NEW FIELDS ARE ON THE HORIZON?

My fundamental research question has always been one on the side of quantum mechanics and how I go about expressing these concepts both artistically and with the help of my physicist colleagues, scientifically, to engage in a dialogue that creates a new field, one that completely blurs the boundaries among arts, science, and engineering and elevates the Arts to an advanced-level STEM discipline. I see my research expanding to include all of the senses and to move seamlessly from the virtual to the material, composing and performing out complex systems visually and sonically in real-time with large groups of researchers interacting from remote locations as if they were right next to you.

Q : WHAT QUESTION WOULD YOU LIKE TO ASK YOUR MAT COLLEAGUES? HOW WOULD YOU ANSWER YOUR OWN QUESTION?

What are the most significant issues that are important to you and how do you believe what you do can make a difference in transforming this society?

My answer is to try to make a new transformational community based on kindness, compassion, and caring. One that uses the arts to express and uncover beauty in all fields so that we can have a common dialogue and dream about our future together as "**humane**" beings!

Curtis **Roads**

Associate Director of the **Center for Research in Electronic Art Technology (CREATE)** · Professor

Q : MISSION STATEMENT OF THE LAB

The Center for Research in Electronic Art Technology (CREATE) serves the Music Department and the Media Arts and Technology (MAT) program at the University of California, Santa Barbara (UCSB). The Center provides a dynamic environment for students, researchers, and media artists to pursue research and realize a wide array of works. We serve a community of about 55 graduate students in Music and MAT.

Q : HOW DO YOU DEFINE MEDIA ARTS AND TECHNOLOGY?

Media Arts and Technology at UCSB is a transdisciplinary graduate program that fuses emergent media, computer science, engineering, electronic music and digital art research, practice, production, and theory. In MAT, we seek to define and to create the future of media art and media technology. Our research explores the limits of what is possible in technologically sophisticated art and media, both from an artistic and an engineering viewpoint. Combining art, science, engineering, and theory, MAT graduate studies provide students with a combination of critical and technical tools that prepare them for leadership roles in artistic, engineering, production/direction, educational, and research contexts.

Q : WHAT ARE YOUR FUNDAMENTAL RESEARCH QUESTIONS AND WHERE DO YOU SEE YOUR RESEARCH EXPANDING OVER THE NEXT 10 TO 20 YEARS? WHAT NEW FIELDS ARE ON THE HORIZON?

The field of Visual Music is clearly emerging as a major artistic opening. My book Composing Electronic Music: A New Aesthetic (Oxford 2015) outlines many potential opportunities for research and exploration in the domain of sound. Multichannel spatialization and automated upmixing are also important topics. Our paper on spatial audio in the AlloSphere has been accepted for publication in Computer Music Journal.

Andrés **Cabrera**

Research Director of the **Center for Research in Electronic Art Technology (CREATE)** · Media Systems Engineer of the **AlloSphere Research Group**

Q : RESEARCH STATEMENT

As a musician turned programmer I am drawn to applying craft of programming to artistic creation. Programming is the entry point to the medium, and knowledge of programming languages is part of the artistic craft. I look for creative use and abuse of programming. I strive to narrow the gap between creating and creation through software.

Q : HOW DO YOU DEFINE MEDIA ARTS AND TECHNOLOGY?

The name Media Arts and Technology poses a conundrum that would make a computer language designer cringe. The operator precedence hasn't been properly defined in the spec. What does Media Arts and Technology actually mean? Which one is it?

Media (Arts + Technology) | Media + Arts + Technology | (Media Arts) + Technology

Because the word Art is in there we can take license and say it's the three of them, which then begs for more definition. What is Media? What is Art? What is Media Arts? What is Art and Technology?

Without going there I can venture to say that I understand Media Arts and Technology as the field where concepts and expression can exploit new technological media, and where new media itself becomes the source of artistic expression. Just as the medium has always defined, enabled, and shaped artistic expression. So, apart from being the messenger, technology can open new paths for exploration and the creation of rich experiences and eventually common practices and shared language.

Q : WHERE DO YOU SEE YOURSELF OR YOUR LAB WITHIN THE CONTEXT OF BOTH THE EDUCATIONAL AND RESEARCH CONTEXTS OF THE MAT PROGRAM AND ITS OTHER LABS?

As a programmer, I have always understood myself as an enabler, a builder of tools. I hope that through my interactions I will shape my interests and directions towards tools that are both expressive but also frictionless. I feel that tools need to become "second nature" to practitioners, and that means reducing the "friction" of their use. This reduction of friction, is not a dumbing down of tools to simplify processes by making assumptions and constraining to specific models, but by making processes simpler. Add a little grease here and there, put a pivot to help move the rock. You are still moving the rock where you wanted, but it's been simpler.

Q : WHAT ARE YOUR FUNDAMENTAL RESEARCH QUESTIONS AND WHERE DO YOU SEE YOUR RESEARCH EXPANDING OVER THE NEXT 10 TO 20 YEARS? WHAT NEW FIELDS ARE ON THE HORIZON?

What new paradigms in computing can accelerate and enable artistic exploration? How can these paradigms be applied to general purpose computing and what does that tell us about the nature of human endeavor and interests?

Q : WHAT QUESTION WOULD YOU LIKE TO ASK YOUR MAT COLLEAGUES? HOW WOULD YOU ANSWER YOUR OWN QUESTION?

Have you experienced the creation of a "field" in your own work? Have groups of practitioners gathered around this "field" and developed a common language and practices that are specific, distinct, expressive, and novel?

Matthew **Turk**

Co-Director of the **Four Eyes Lab** · Professor

Q : MISSION STATEMENT OF THE LAB

The Four Eyes Lab pursues research in the "four I's" of imaging, interaction, and innovative interfaces, including areas such as computer vision, human-computer interaction, augmented and virtual reality, computer graphics and visualization, intelligent interfaces, novel displays, and wearable and pervasive computing. We investigate fundamental issues in developing robust, real-time interactive technologies, providing compelling new capabilities in a variety of computing environments and application areas, to support the creation of new media devices and experiences. The lab's expertise combines core computer science approaches with human factors and usability to consider the broader user experience in the context of media systems. One of the most active areas of the research in the lab is augmented reality, aiming to deliver rich, compelling experiences that provide digital information appropriately situated in the physical world.

Q : HOW DO YOU DEFINE MEDIA ARTS AND TECHNOLOGY?

Media Arts and Technology describes the dynamic space where new media technologies are invented, developed, and utilized for a wide variety of human expression and exploration— joining backgrounds, methods, and practice from the perspectives of both art and technology.

Q : WHERE DO YOU SEE YOURSELF OR YOUR LAB WITHIN THE CONTEXT OF BOTH THE EDUCATIONAL AND RESEARCH CONTEXTS OF THE MAT PROGRAM AND ITS OTHER LABS?

Work in the Four Eyes Lab can provide new tools and methods for others in MAT, and other areas in MAT can impact the lab's research by introducing new perspectives, contexts, use-cases.

Q : WHAT ARE YOUR FUNDAMENTAL RESEARCH QUESTIONS AND WHERE DO YOU SEE YOUR RESEARCH EXPANDING OVER THE NEXT 10 TO 20 YEARS? WHAT NEW FIELDS ARE ON THE HORIZON?

How can computers see and understand the world around them? How can information be presented to people to maximize its value and utility? How can we create new human experiences based on ever-advancing technologies? Areas like computer vision, augmented and virtual reality, and intelligent interfaces are poised to make huge impacts in the near future.

Q : WHAT QUESTION WOULD YOU LIKE TO ASK YOUR MAT COLLEAGUES? HOW WOULD YOU ANSWER YOUR OWN QUESTION?

There's so much interesting work to be done— how do you choose your priorities and problems? For me, it's a combination of being opportunistic and idealistic.

Tobias **Höllerer**

Co-Director of the **Four Eyes Lab** • Affiliate Faculty in MAT

Q : HOW DO YOU DEFINE MEDIA ARTS AND TECHNOLOGY?

Media Arts and Technology provides a transdisciplinary approach to new media creation and dissemination, incorporating perspectives from, in no particular order, fine arts, engineering, computer science, performing arts, social sciences, and the humanities. These different perspectives come together in a scholarly research program that enables its participants to envision, design, implement, perform, and evaluate novel media artifacts and experiences, and establishes these within the rich context of existing and imaginable works and capabilities.

Q : WHERE DO YOU SEE YOURSELF OR YOUR LAB WITHIN THE CONTEXT OF BOTH THE EDUCATIONAL AND RESEARCH CONTEXTS OF THE MAT PROGRAM AND ITS OTHER LABS?

As a Professor of Computer Science, working in the field of human-computer interaction (HCI), I see my research within the Four Eyes Lab's agenda pushing the boundaries of computer science and engineering methodology for defining future generations of human-computer interaction. Our lab's agenda is purposefully broad. We pursue research projects in augmented and virtual reality, in computer vision (off-line and real-time), machine learning, analysis and modeling of cognitive crowd phenomena, such as trust, credibility, and civic engagement, interactive network science, visualization, and interactive computer graphics. All of these have considerable overlap with MAT's educational and research mission. All it takes is interested and motivated individuals with some background in algorithmic formalisms and information technology to realize and reinforce the connections.

Having been brought up in a family deeply involved with questions of literature and the visual arts, my personal interest is keenly aligned with bridging perspectives from the arts and engineering. From my computer science HCI background, I'd like to contribute an unabashedly utilitarian perspective on computing literacy. I am convinced that individuals who are prepared to shape the information technology landscapes of the future hold the keys for the well-being of future generations.

Q : WHAT ARE YOUR FUNDAMENTAL RESEARCH QUESTIONS AND WHERE DO YOU SEE YOUR RESEARCH EXPANDING OVER THE NEXT 10 TO 20 YEARS? WHAT NEW FIELDS ARE ON THE HORIZON?

My group normally defines research questions, even fundamental ones, on a per-project basis, since the project context usually heavily influences the type of research question pursued and the research approach. However, some broad overarching fundamental research questions include:

- How can we improve human-computer interaction for the benefit of mankind?
- How can computer and information technologies be used to offer people important new perspectives and learning experiences?
- How do we provide more people the needed computer literacy to positively influence future technologies?

My group's research will likely expand from a current focus on technological solutions to even more human-centered perspectives than we already cover. I imagine an increased focus on personal technologies that protect privacy while fostering human-human relationships, and on methodologies that support human creativity, an increasingly important resource.

Q : WHAT QUESTION WOULD YOU LIKE TO ASK YOUR MAT COLLEAGUES? HOW WOULD YOU ANSWER YOUR OWN QUESTION?

Q: How do we most productively bring together our different perspectives and expertise?
A: I think we have an abundance of reasons to have a lot of trust in, and respect for, everyone's contributions to Media Arts and Technology. No single approach is sufficient as a unifying strategy. The Program thrives from the curiosity of all its members and the intricacies of their backgrounds.
Media Arts and Technology. No single approach is sufficient as a unifying strategy. The Program thrives from the curiosity of all its members and the intricacies of their backgrounds.

Clarence **Barlow**

Corwin Endowed Chair • Head of Composition in Music • Affiliate Faculty in MAT

Q : RESEARCH STATEMENT

My main interests revolve around the algorithmic composition of instrumental and electronic music as well as digital sound processing and spatialization. Further interests are the relations between music and the fields of language, mathematics, computer programming, visual images and field recordings as well as between individual pieces of music and between music cultures.

Q : HOW DO YOU DEFINE MEDIA ARTS AND TECHNOLOGY?

I follow standard definitions— see for instance <http://www.dictionary.com/browse/media>, <http://www.dictionary.com/browse/arts> and <http://www.dictionary.com/browse/technology>. Taken together, the three form a powerful combination capable of unbounded creativity.

Q : WHERE DO YOU SEE YOURSELF OR YOUR LAB WITHIN THE CONTEXT OF BOTH THE EDUCATIONAL AND RESEARCH CONTEXTS OF THE MAT PROGRAM AND ITS OTHER LABS?

A keyword here in these contexts is interdisciplinarity. An example could be the development of computer programs to generate music for player pianos or multi-channel audio in combination with video.

Q : WHAT ARE YOUR FUNDAMENTAL RESEARCH QUESTIONS AND WHERE DO YOU SEE YOUR RESEARCH EXPANDING OVER THE NEXT 10 TO 20 YEARS? WHAT NEW FIELDS ARE ON THE HORIZON?

The main thrust of my research for over thirty years has been in the field of computer music, which is expanding by itself and can be expected to continue to do so in my work in future.

Q : WHAT QUESTION WOULD YOU LIKE TO ASK YOUR MAT COLLEAGUES? HOW WOULD YOU ANSWER YOUR OWN QUESTION?

Question: Can we work together in some way? Answer: Let's try.

Yon **Visell**

Director of the **RE Touch Lab** · Assistant Professor

Q : MISSION STATEMENT OF THE LAB

We are investigating the tangible nature of reality, especially aspects related to how we interact with the world using the sense of touch. Our work is motivated by a few simple questions that turn out to be very difficult to answer, such as: What is it that we feel when we touch and manipulate objects in the world? How do the conscious percepts of touch arise from contact with matter, and how are the processes involved enabled through specializations in the body?

Q : HOW DO YOU DEFINE MEDIA ARTS AND TECHNOLOGY?

Media, in the broadest sense, suggests matter and energy, the substance of the physical universe. Arts and Technology casts our endeavor as activity of inquiry into the nature of matter and energy through practices that integrate the spirit and the intellect.

Q : WHERE DO YOU SEE YOURSELF OR YOUR LAB WITHIN THE CONTEXT OF BOTH THE EDUCATIONAL AND RESEARCH CONTEXTS OF THE MAT PROGRAM AND ITS OTHER LABS?

In the center. That is, everywhere.

Q : WHAT ARE YOUR FUNDAMENTAL RESEARCH QUESTIONS AND WHERE DO YOU SEE YOUR RESEARCH EXPANDING OVER THE NEXT 10 TO 20 YEARS? WHAT NEW FIELDS ARE ON THE HORIZON?

Our main scientific line of inquiry concerns the fundamental mechanisms of touch perception and action, and their relation to the mechanics and dynamics of materials, with special attention to biology. We are developing a view of haptic function in which the body is regarded as an integrated system for sensing the world through touch. We are excited about a concept, expressed in our current work, of touch sensing as a wave-like process in the body [1].

Q : WHAT QUESTION WOULD YOU LIKE TO ASK YOUR MAT COLLEAGUES? HOW WOULD YOU ANSWER YOUR OWN QUESTION?

How can I help you?

[1] a Y. Shao, V. Hayward, Y. Visell, Spatial Patterns of Cutaneous Vibration During Whole-Hand Haptic Interactions. Proceedings of the National Academy of Sciences, 113(15), 2016.

Articles

JOSEPH **TILBIAN** / ANDRES **CABRERA**
KON HYONG **KIM**
JOHN **O'DONOVAN** / DONGHAO **REN**
GUSTAVO ALFONSO **RINCON**
CLARENCE **BARLOW** / AKSHAY **CADAMBI** / MATTHIAS **WAGNER**
F. MYLES **SCIOTTO**
HANNAH **WOLFE**
ALEXIS STORY **CRAWSHAW** / MAUD **WATEL-KAZAK** / TIMOTHY **WOOD**
KURT **KAMINSKI** / KENNY **KIM** / HANNAH **WOLFE** / TIMOTHY **WOOD** / KARL **YERKES** / KEE **YOUN**

The Stride Manifesto
Software, Hardware and the Strides in between

Joseph **Tilbian** / Andrés **Cabrera**

Today, there is a fundamental disconnect between programmable hardware and the software that drives it. There are “hardware people” and “software people” and this distinction is as stark as when describing two related disciplines like economy and sociology. Software and hardware share many core concepts, however they tackle and define their various problems in fundamentally different ways. This divide in a field where the players strongly depend on each other is a bit of a mystery.

Is this disconnect due to the fact that software engineers, because of the fluid nature of software that allows for a more iterative process, can explore and experiment through different variations whereas hardware engineers need to get it right in a few tries to make the effort worthwhile? Is it perhaps the fact that software grew out of Babbage’s mechanical tradition and Turing’s abstract mathematical foundations, while hardware grew out of Maxwell’s equations?

Today, in the age of embedded devices, we find ourselves looking for programming paradigms that can help us create quickly and in a simple manner the “intelligent stuff” to do work for us, and we are often stopped by this disconnect. It seems as if we have been getting it all wrong. On the one hand, programming languages (except for those like Assembly that target hardware directly) have been designed around abstract paradigms like functional, procedural, and object-oriented in an effort to simplify programming and to get away from the complexities, variability, and intricacies of hardware. On the other hand, hardware has been built to efficiently perform computations, with little thought about the software interface that programmers will ultimately use to drive it. Software and programming languages are an interface after all.

The way code is written impacts performance. It is often the case that cleaner and more organized code tends to run slower and less efficient on the hardware, as it relies on constructs that introduce overhead. And conversely, code that is very efficient is often hard to understand and tied to deep knowledge of the hardware platform, the operating system, or the compiler’s specific optimization strategies. There is almost a tug of war between the code and the programmer.

In the past two decades we have witnessed the rise of multiple open-source electronic platforms based on embedded systems. One of the key factors for their success has been in the simplifications made to programming the hardware. By the nature of their hardware design, they have mainly targeted physical computing and graphics applications. As digital audio programmers we wanted to create a full-featured audiocentric multi-channel embedded platform capable of high resolution, high bandwidth, and low latency sound synthesis and processing. We ventured on the same path other platform designers had taken before us. We soon realized why a microcontroller based audiocentric platform had not been created yet and we attributed this to the lack of a high level domain specific programming language targeting such a platform. We then attempted to bring hardware and software closer by designing a new domain-specific programming language called Stride. The Stride programming language began as an idea to provide a simple programming language for sound synthesis and processing on bare metal embedded devices.

While Stride was born out of audio processing needs, as the project evolved, we realized the design was suitable not only for audio but also for general purpose programming. Digital audio in a computer is a complicated beast. Information processing needs to happen very quickly and be updated on time. If deadlines are missed, unpleasant clicks are heard. For improved performance, frequent computation of parameters are avoided when the delays incurred by them can not be perceived. This is known as “control rate” or the “buffer size.” Additionally, control information is injected into the audio process asynchronously to change audio parameters. This should occur in a

manner where the flow of sound is not interrupted. Finally, at the slowest time scale, there often needs to be some form of a scheduler that can initiate events. Stride was designed to handle these cases in elegant ways, and as the work progressed, the solutions for our particular issue also seemed to encompass most issues found in general purpose programming.

Stride is a declarative and reactive domain specific programming language for real-time sound synthesis, processing, and interaction design. Through hardware resource abstraction and separation of semantics from implementation, a wide range of computation devices can be targeted such as microcontrollers, system-on-chips, general purpose computers, and heterogeneous systems. With a novel and unique approach at handling sampling rates as well as clocking and computation domains, Stride prompts the generation of highly optimized target code. The design of the language facilitates incremental learning of its features and is characterized by intuitiveness, usability, and self-documentation. Users of Stride can write code once and deploy on any supported hardware.

A central consideration during the design of Stride was to treat the language as an interface and trying to make it as ‘ergonomic’ as possible. Two other criteria were readability and flow. That is, users should not need to read documentation to understand code and should be able to write code with as little friction as possible as the language works in an "intuitive" way. The syntax of Stride is easy to learn as there are very few syntactic constructs and rules. Entities in the language are selfdocumenting through their properties, which expose the function of the arguments they accept. The choice of making Stride declarative was to separate semantics from implementation, and the trick here is to keep this versatile and simple at the same time.

The novel and unique aspect of Stride is making rates and hardware computation cores an intrinsic part of the language by introducing computation domains and synchronizing rates to them. This concept, that models the inner workings of microprocessors with their clocks and interrupts, enables the distribution of various synchronous and asynchronous computations, encapsulated in an entity, to execute in different domains, potentially part of a heterogenous architecture. In other words, for Stride all platforms are equal, no matter if one is talking about an audio board, a computer with an operating system, an Arduino/Wiring board or a GPU cluster. The code will look the same and Stride will seamlessly connect and interface between them, bridging the gap between hardware and software. The programmer’s only worry is telling Stride which platform should run which part of the code and how often.

```
# Stride Language Block Declaration
language Stride {
  paradigm:     [ 'declarative',
                  'reactive' ]
  purpose:      [ 'sound synthesis',
                  'signal processing',
                  'interaction design' ]
  target:       [ 'microcontroller',
                  'system-on-chip',
                  'general purpose computer',
                  'graphics processing unit' ]
  designer:     [ 'Andrés Cabrera',
                  'Joseph Tilbian' ]
  web:          'http://stride.audio'
}
```

```
Stride
>> Compile ( toolchain: 'GCC ARM Embedded' )
>> Load ( targetDevice: 'AudioCore' )
>> Run ( reset: on );
```

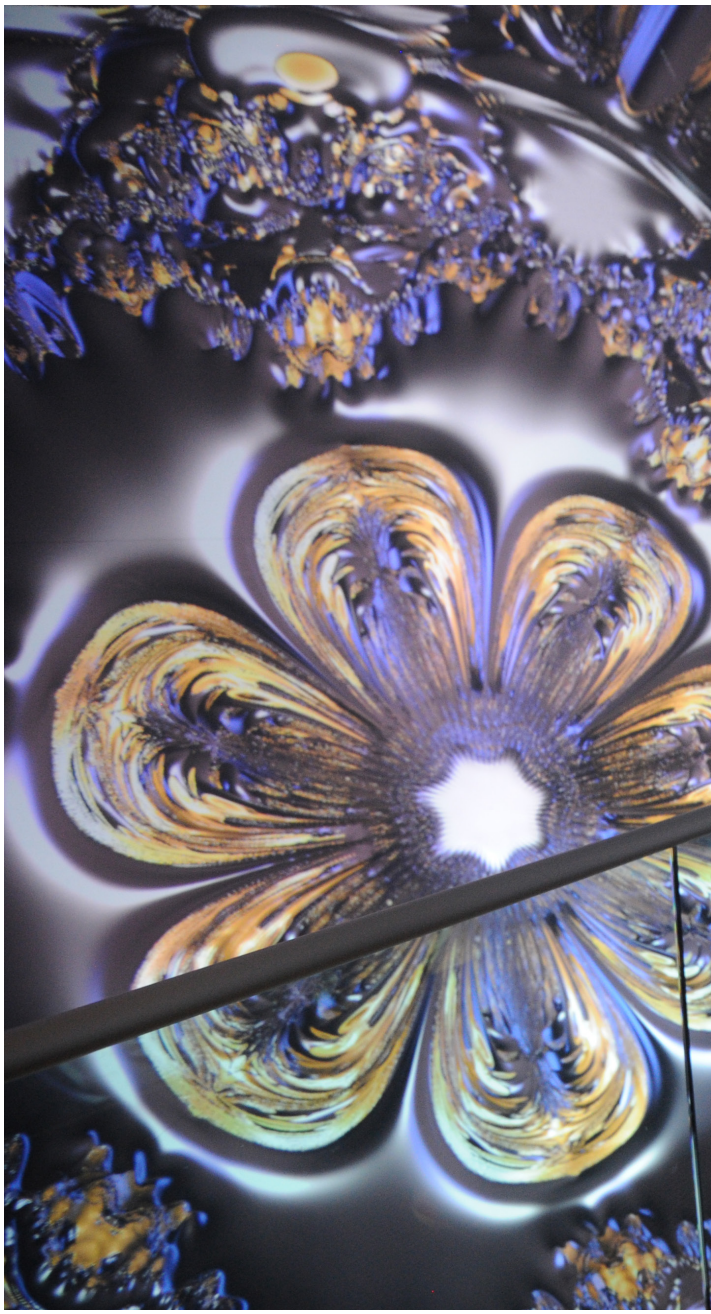
Fractal

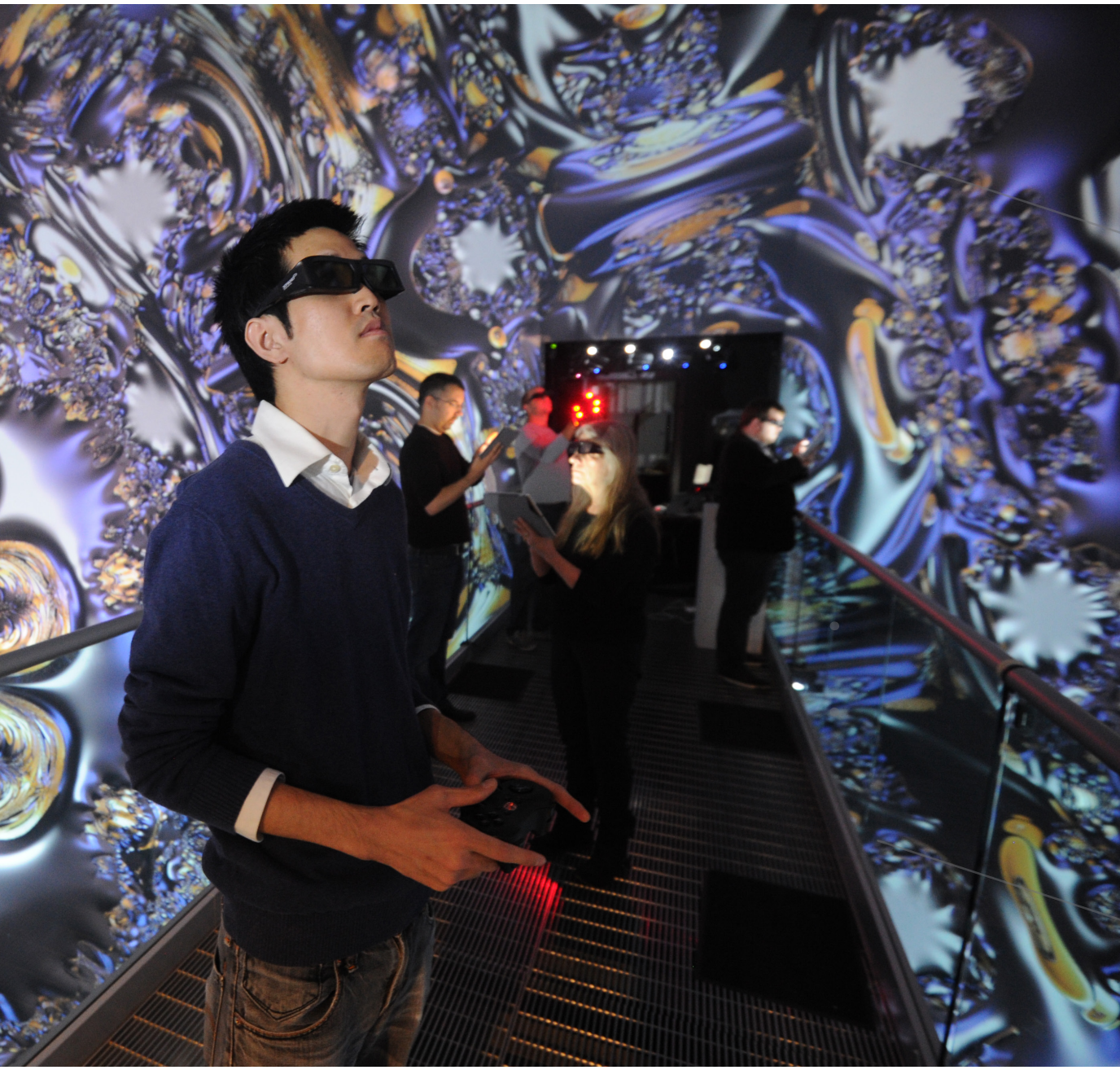
Kon Hyong (Kenny) **Kim**

Fractal is a real-time simulated artwork of hypercomplex deterministic fractal systems shown in full surround 3D. Users can interact with the system using various devices inside the AlloSphere, allowing them to easily create and transform hypercomplex deterministic fractals that are rendered using ray-casting inside the AlloSphere.

The artwork is based on the artist's application of the same name, which was designed to allow artists to easily create deterministic hypercomplex fractals. Deterministic fractals, such as the Mandelbulb, Julia Sets, and the Mandelbox, gained popularity since the late 2000s due to their ability to generate amazingly detailed structures from just a series of simple transformation algorithms. Due to the chaotic nature of fractals, even the smallest change in a parameter can result in a drastically different scene.

However, the users needed deep knowledge on the required math to manipulate the algorithm, and advanced programming knowledge on graphics hardware to freely create such fractals in a timely manner due to the high computation cost. This application aids the user by providing a backend that handles the graphics hardware so the user can focus on the algorithms, which are easy to learn by exploring the application's interface. The backend system uses GLSL to achieve real-time ray-casting by allowing most of the required computation to run on the GPU, taking advantage of the high parallelization inherent in the algorithm. By allowing the rendering to happen in real time, the user can instantly see the changes they make. The artwork is a modified version of the application, which connects the interaction devices inside the AlloSphere, and tries to constantly provide an aesthetically interesting experience during the various interactions. The ray-casting algorithm also gives a much crisper image of higher resolution than the other artwork inside the AlloSphere, which allows a better immersive experience while the user freely explores the endless possibilities of deterministic hypercomplex fractals.





Trajectory Fluid

John **O'Donovan** / Donghao **Ren**

Network data is ubiquitous. Visual representations can help people gain insights about the underlying data. This installation presents an artistic approach towards understanding how people perceive and analyze network data in different visual representations.

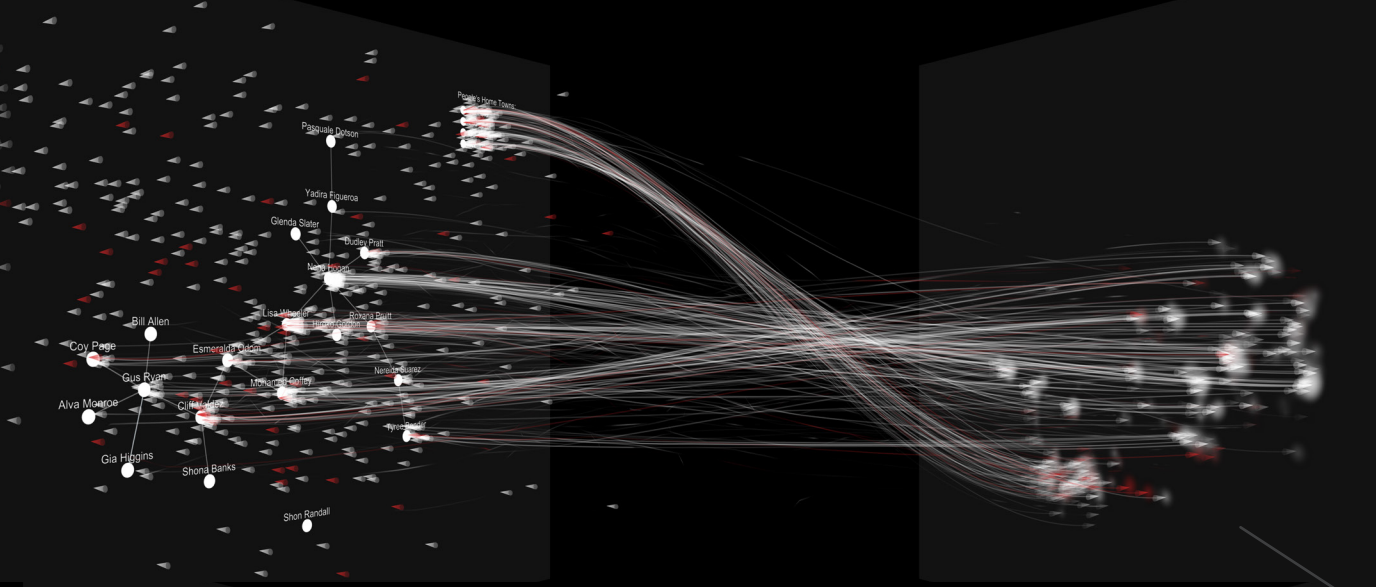
The fundamental data units of the installation are mouse trajectories. Each trajectory is a sequence of mouse movements and annotations performed while a person interacts with a network visualization to complete a given task, such as finding the shortest path between two nodes. Mouse trajectories can provide insights into the mental processes of people making decisions regarding workflow or trying to comprehend the structure of networks. A dataset of 9,600 mouse movement trajectories from a large-scale cognitive experiment comparing the node-link and matrix visualizations [1] with 600 Amazon Mechanical Turk participants was used. In the experiment, each participant was asked to perform 16 question-answering tasks on one of two networks of different sizes and one of three visual representations. Specifically, these were a node-link graph, a matrix ordered by group and a matrix ordered by node degree.

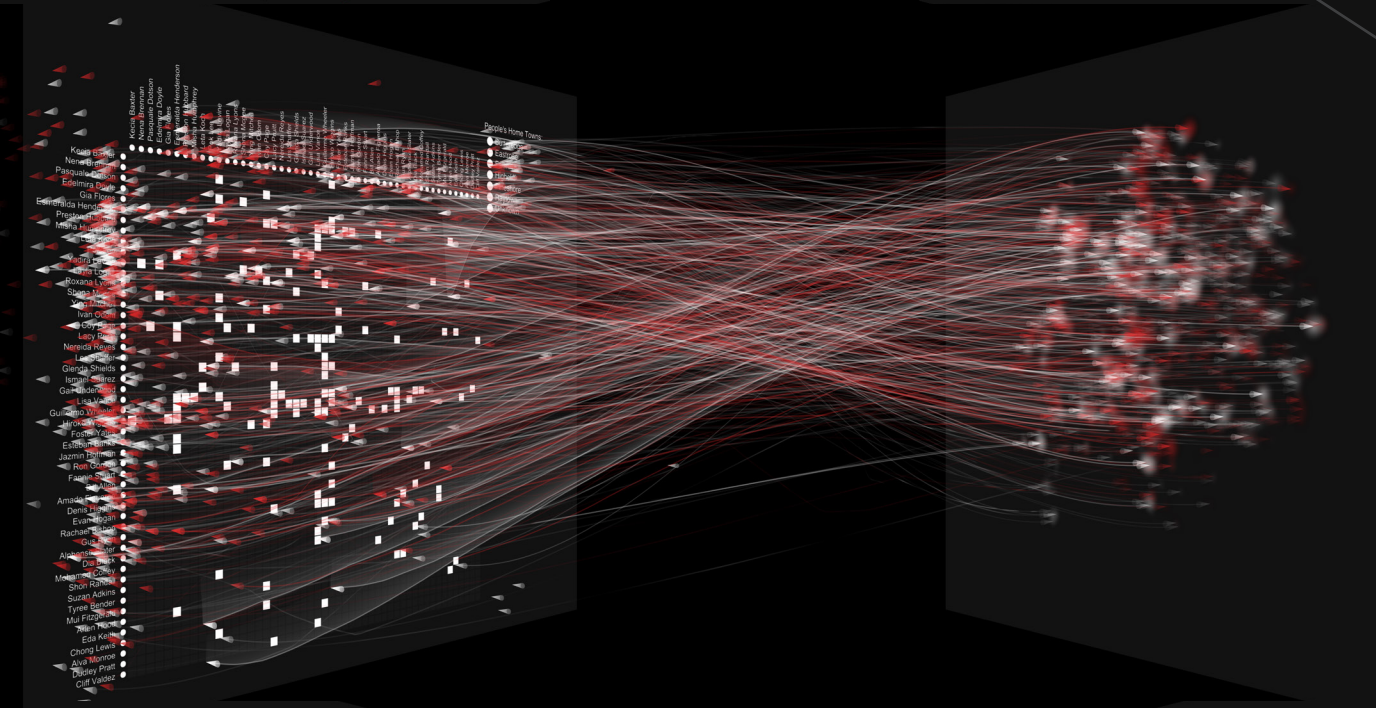
In this installation, the trajectories are revealed in two spaces: the screen space and the abstract space. In the screen space, the trajectories are presented on the visualization in real time. Each moving cone represents a single trajectory. The abstract space, which maps each trajectory to a single point, aims to capture the similarities and dissimilarities between trajectories. It is computed using Laurens van der Maaten and Geoffrey Hinton's t-SNE (t-Distributed Stochastic Neighbor Embedding) algorithm with the DTW (Dynamic Time Warp) distance. Three-dimensional Hermite splines are drawn to connect the screen space and the abstract space. The visual encoding maps correctness to color (red means incorrect) and the information of the visualization to luminance. Annotation actions are rendered as semi-transparent bands alongside the splines. Mouse movements and annotations in the screen space generate turbulence that propagates to the abstract space among the lines, which resemble a "fluid" from the screen space to the abstract space.

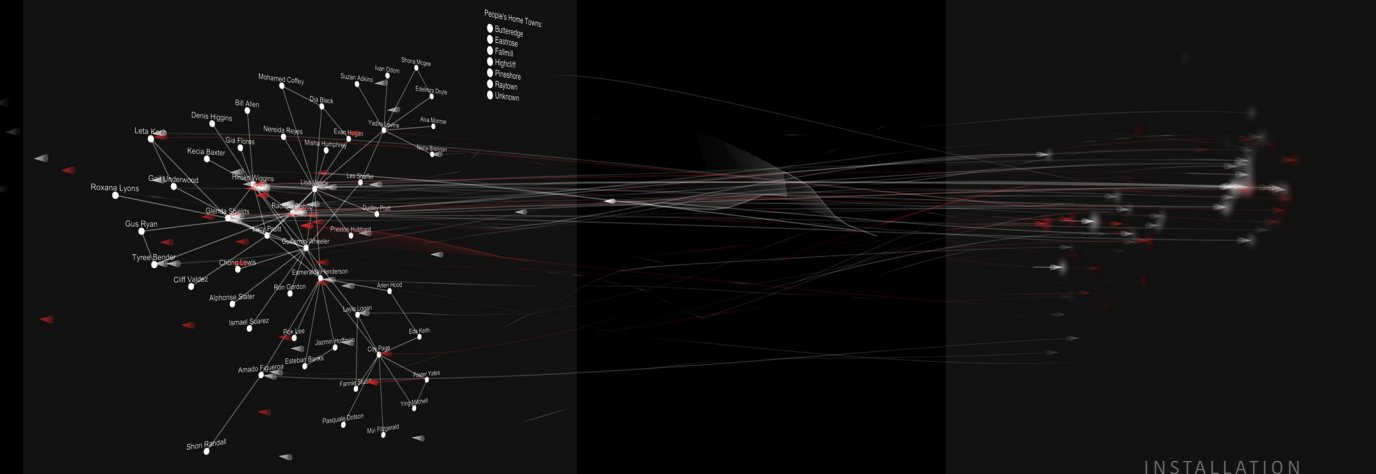
The audience can interactively explore each of the 6 combinations of visual representations and network sizes on all or specific task types. Various patterns on these combinations manifest the differences between the nature of these visual representations, network sizes, and tasks.

Left top: Node-link visualization, 50-node network, all 16 questions.
Left middle: Matrix visualization (group order), 50-node network, all 16 questions.
Left bottom: Node-link visualization, 50-node network, a single question.
Next page: Node-link visualization, 20-node network, all 16 questions.

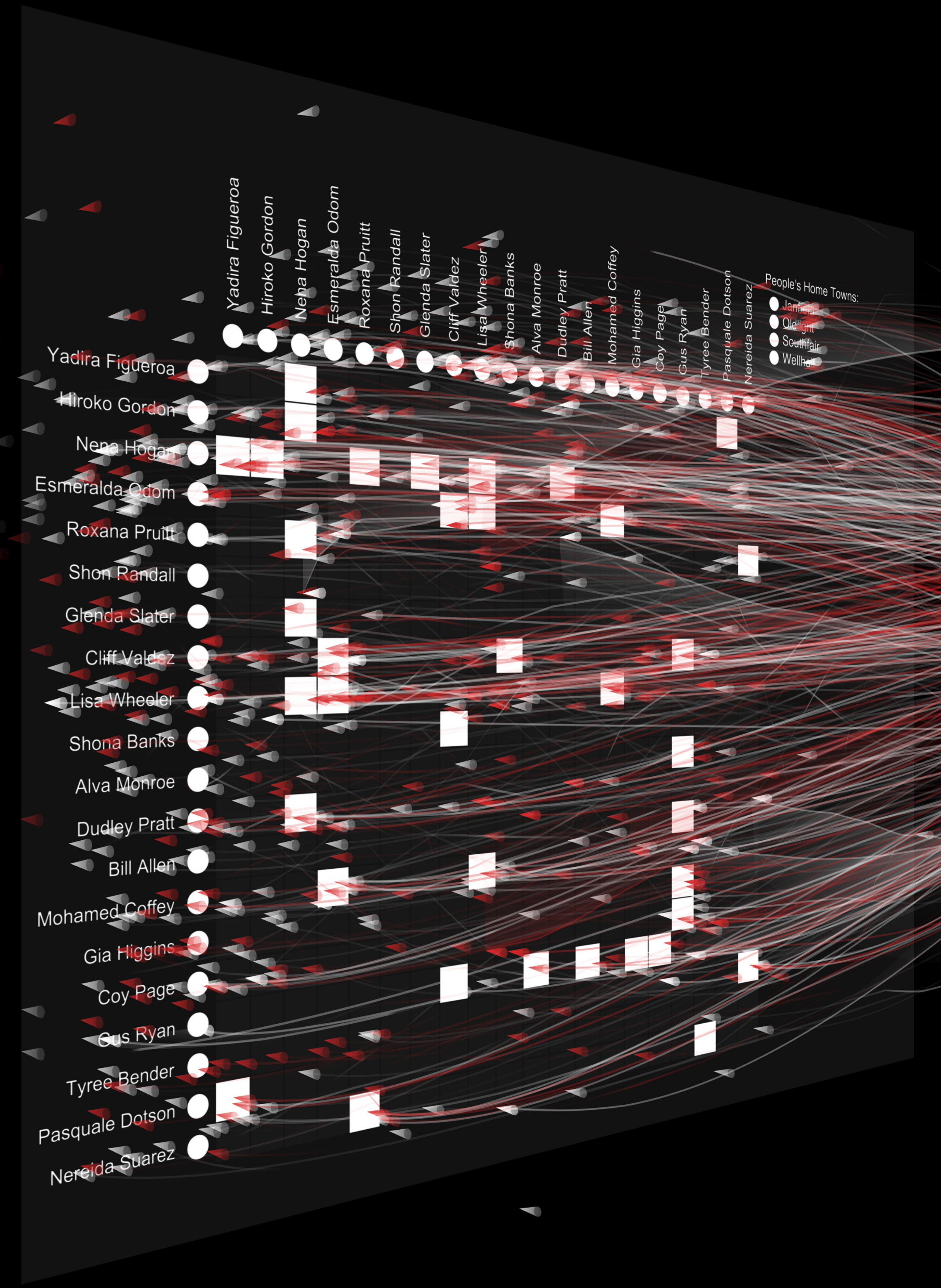
[1] Ren, Donghao, Laura Marusich, Jonathan Z Bakdash, John O'Donovan, Heather Roy, Sue Kase, Daniel Cassenti, James Schaffer, Wan-Yi Lin, and Tobias Höllerer. 2016. "Understanding Nodelink and Matrix Visualizations of Networks." Open Science Framework. May 25. osf.io/qct84.



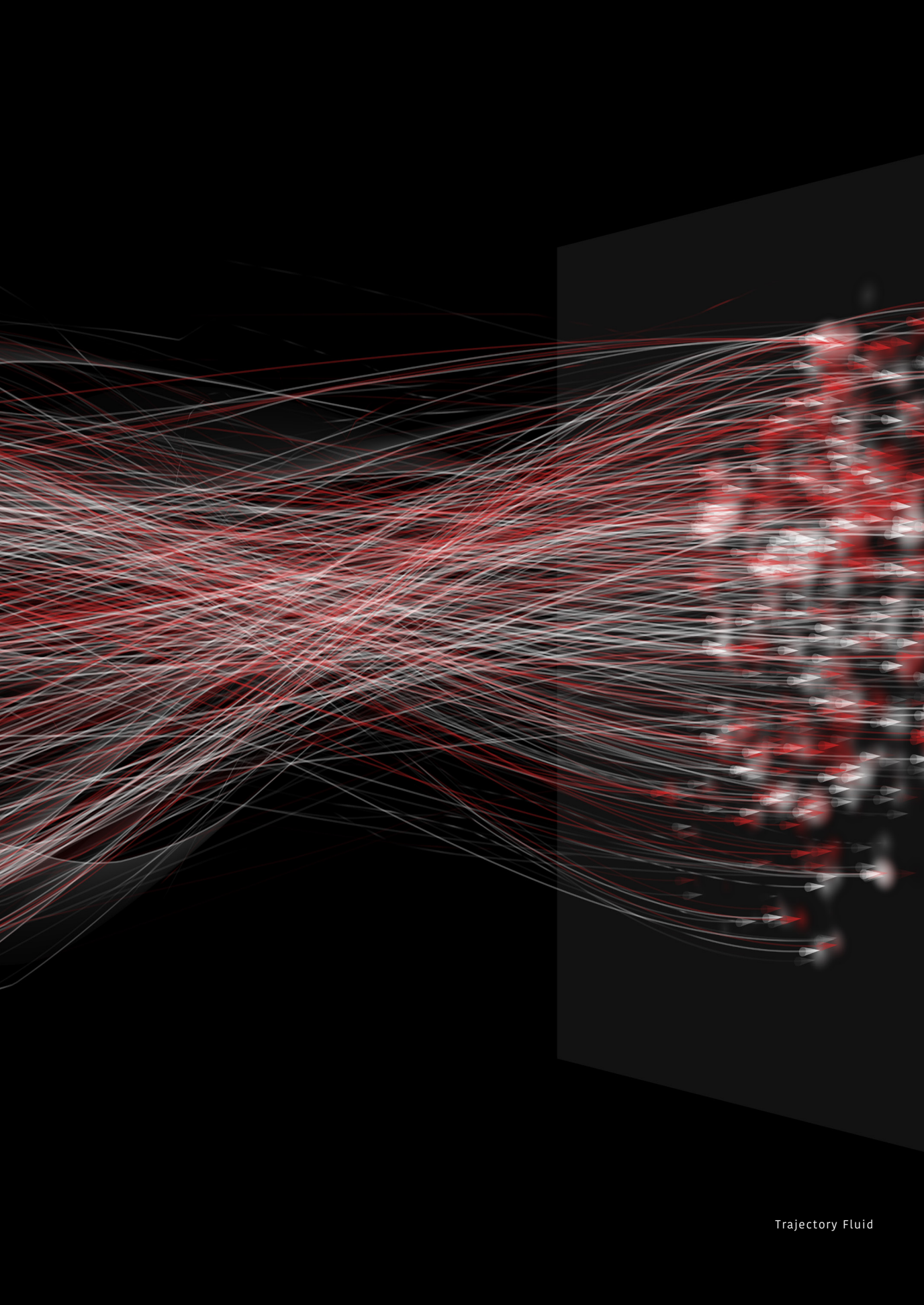




INSTALLATION



Yadira Figueroa
Hiroko Gordon
Nena Hogan
Esmeralda Odom
Roxana Pruitt
Shon Randall
Glenda Slater
Cliff Valdez
Lisa Wheeler
Shona Banks
Alva Monroe
Dudley Pratt
Bill Allen
Mohamed Coffey
Gia Higgins
Coy Page
Gus Ryan
Tyree Bender
Pasquale Dotson
Nereida Suarez
People's Home Towns:
Southfair
Wellhall



Trajectory Fluid

Una Ráfaga Amante de las Voces de Una Multitud de Recuerdos - **A Loving Rush of Voices in a Flock of Memories -**

Gustavo Alfonso **Rincon**

“Una Ráfaga Amante de las Voces de Una Multitud de Recuerdos” is a media arts and design work that explores a flocking and swarming algorithm as a research subcategory within the conceptual framework of complexity science. “Una Ráfaga Amante de las Voces de Una Multitud de Recuerdos” investigates agent-based behavior for the creation of generative structure and form. This media arts sculpture is a prototype that demonstrates generative design with a flocking and swarming algorithm, using an agent-based model (ABM).

I. BACKGROUND:
The prototype combines various media, a fabricated object, software simulation, computer renderings, and sound created with modular analog/digital synthesizers. The ABM is a computational, biological representation that combines computer simulation and model validation. An ABM can be defined as a computational model simulating autonomous agents with the goal of identifying patterns of emergence within a system. The computational, conceptual, and educational framework behind ABM can be credited to Seymour Papert, one of the creators of Logo (1968) and one of the founders of the Epistemology and Learning Research Group at the MIT Architecture Machine Group (1981). His educational Constructionism learning theory was influenced by Jean Piaget’s work on cognitive development. Body-syntonic awareness of agents and Turtle graphics are traced to the pioneering work of the Logo programming language at the precursor lab of MIT Media Lab. Uri Wilensky evolved the Logo language to a multi-agent paradigm of NetLogo (1999). In collaboration with Bill Rand, Uri Wilensky co-published a book for NetLogo through MIT Press (2015) that gives an overview of the language, examples of projects, and formulates a history of the field in ABM.

As a field, ABM originated through the social sciences with the work of Nobel Prize winner Professor Thomas Schelling‘s “Tipping Model” (1972). John Holland is credited to have originated the research area of complexity with his work on genetic algorithms and complex adaptive systems (CAS) in 1975. Melanie Mitchell, a student of Holland, published “Complexity: A Guided Tour” in 2011, giving a conceptual framework of complexity as a field of research.

ABM is one of the research methods used in complexity science to explore natural and manmade phenomena. It has evolved to be the foundation of multi-agent systems (MAS) that explore the intelligence of problem-solving agents.

II. PROBLEM:
The problem addressed is that contemporary Generative Art and Design that uses simulated agents is void of living complex systems. This subcategory of works will need to be defined within the larger movement of agent-based modeling in the Media Arts. As a new territory of research, this knowledge will allow new works to be theorized based on the level of detail simulated.

Depending on the constraints of the computational agent system, this leaves a vacuum of artificially constructed worlds without drivers for evolutionary imperative. This condition of ecological detachment is both an opportunity and an area of research with a lineage of history that can be traced back to origins in both arts/design and engineering/sciences. The reformulation of the agents’ computational objective transforms and limits the artistic objectives. The study of living systems is an opportunity to reveal novel computational formulations.

The overall objectives are key to the realignment in a metaphor of an agent in an environment to create simulations that have expansive territorial levels of research yet to be explored. The ecology is a vital part that biological agents use to inform movement and survival behaviors in virtual space defying conventional computational models. Unless a library is used to replicate the random nature of such movements and Darwinian evolved senses, this will need to be considered as an obstacle to further discover novel connections.

The separation of the sciences and engineering creates an opportunity to redefine agent movement as information (data). The metaphor reveals unexplored territory through complexity in the media arts. The discourse is not inherently binary or linear in nature; however, a dynamical complex system engages the physical and virtual simultaneously. The spatial narratives found in architecture and arts evolve through information as mathematical patterns of code. This work is an opportunity to engage art and design practice with computational science methods that are non-statistical or equation-based and engage all of the senses.

III. MOTIVATION:
The overall motivations of the research are to identify and begin to formulate a codified language of media art-making through synchronous and asynchronous behavior of computational agents. This time-dependent work speculates on a new experimental approach to generative and aural media design. The composition illustrates various timescales of embedded memory and visual/aural states through a multi-agent system.

The investigation critically engages media art works through a complexity science research framework. ABM is used as a strategy to formulate a taxonomy of research that simultaneously encapsulates aesthetics, computation, education, space/form, and time. The experimental, performative aspects of the work are inspired by the collaborative experiments with perceptual deprivation of James Turrell and Robert Irwin in 1969. The poetics of computational geometry, cyberspace, and virtual space research are greatly influenced by Marcos Novak's concepts of "Liquid Architectures" (1991) and "Worldmaking" in the Transvergence seminar series at the University of California, Santa Barbara (UCSB).

IV. TECHNICAL DESCRIPTION:
The sculpture presented is a geometric model from a modified predator/prey Boids model inspired by Robert Hodgin's work in the creation of Cinder for computational arts (2010) and Craig W. Reynolds's original artificial life program (1986). The algorithm is modeled in a C++ program in the AlloSystems framework and the 3D point position data is extracted through a multistep process using Unix and Rhino 3D to create the digital form. NetFabb is used to heal any imperfections in the geometric polygonal surface data for fabrication viability. The objects' alternative surface treatments were constructed in Grasshopper and Mathematica. The experiment ran transformations of flight trajectory agent point data produced by the algorithm. Stephen Wolfram's 2002 book "A New Kind of Science" inspired the investigation: an inquiry into the journey of following complexity science through computational experimentation.

V. MEDIA ART/DESIGN FORM TO ALGORITHMIC COMPOSITIONAL SPATIAL FORM:
The computational model consists of agents divided into two types of predator and prey, producing murmurations. The virtual world is governed by rules of separation, alignment, cohesion, and evasion. The inspirational seed for the computational form-making process of ABM behaviors is the tension of simulating nature through computational data generation and analysis. The fabricated form is a result of an intensive study of the computational model's behavior. The program ran for days; results were observed, aggregated, and analyzed. The resulting patterns are based on a design selection process filtering types of movements that maximized 3D fabrication success.

The creation of computational agents and their behavioral pathways as sculpture is an area of research that engages a spatio-temporal phenomenon. The disciplines of media arts, architecture, design, and complexity science are simultaneously engaged through this series of generative modeled worlds. Influences include Gaston Bachelard, Hans Haacke, Iannis Xenakis, and Nicholas Negroponte.

VI. GEOMETRIC TOPOLOGICAL DATA VOCABULARY:

The data produced from the system is point cloud data, fabricated from a computational visual language and created by the modified flocking and swarming algorithm. An additional layer of sound was added, inspired by re-conceptualizing the generated visual language as music.

The work investigates the transformation of forms, textures, patterns, and surface through the parameters of the program. Technical experimentation demonstrates how data points in a computational, three-dimensional space can be expressed in a single form. Variations in process and data reconstruction led to further experimentation and form selection of the final prototype design. The rendered images reflect an investigative analysis that reveals the geometric qualities of the data through virtual photography. The curvature, folding, and outlier characteristics of the geometry were privileged over surface texturing to formulate an alternately constructed synthetic form.

VII. AESTHETIC, CONCEPTUAL, AND NARRATIVE VOCABULARY:

The aesthetics, language, and techniques used in the work are a poetic attempt at an artistic, structural, and multimedia arts-driven narrative. The analytical and historical work of Edward Shanken and Jack Burnham (1971) help reveal the interrelated nature of systems art, cybernetics, and media arts. The story presented is an internal struggle that engages the limits of abstraction to balance a formal scientific logic in a fabricated form and soundwork.

An experimental sound work, inspired by the process, is an evolution of the artistic process that further investigates synchronous and asynchronous granulated sounds based on "Microsound" (2001) by Curtis Roads. The soundwork is structured as a performance, recorded live, and composed to emote an alternative surface layer of sound. The technology includes modular analog/digital synthesizers with source material. The found audio material is a layered synthesis of speeches, songs, and commercial advertisements as source data controlling a granular synthesis module. The experimental sound compositions were edited together in a digital audio workstation to produce a final directed sound narrative.

VIII. CONCLUSION:

The theme of this work describes a synthesized emotion that is constructed from a moment in time: a moment where dreams and emotions flutter through the space of loss. A virtual form is transformed into a fabricated object created to dimensionally freeze that moment in time. The form, as an ephemeral virtual object, becomes a representation to be pushed into the future as a trace of matter that transcends the lifespan of a human being.

Navigating and analyzing the generated form with sound builds a bridge to a synthetic natural experience within the boundaries of form and space. The movement captured by this process is a metaphoric exploration of all simultaneous parts of the self as media sculpture. My performance as a media artist is computationally filtered, transformed, and reconstructed into this sculptural research prototype.

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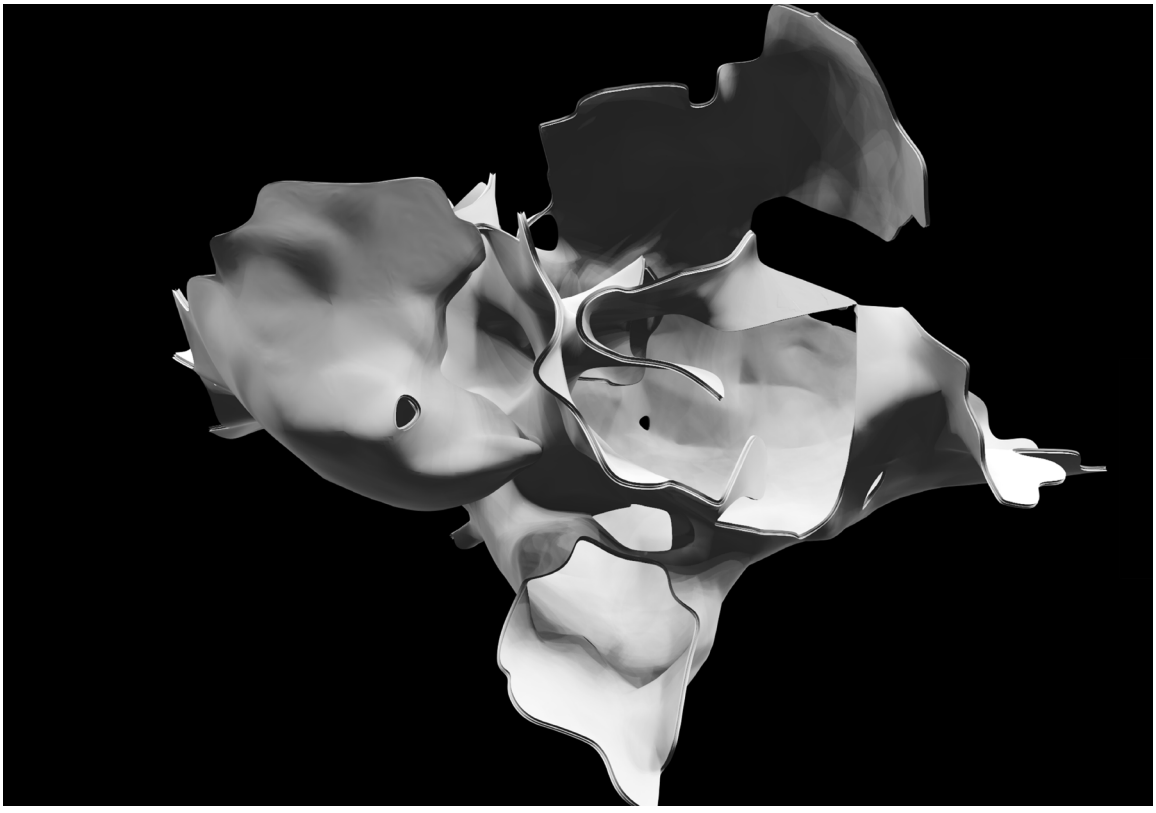


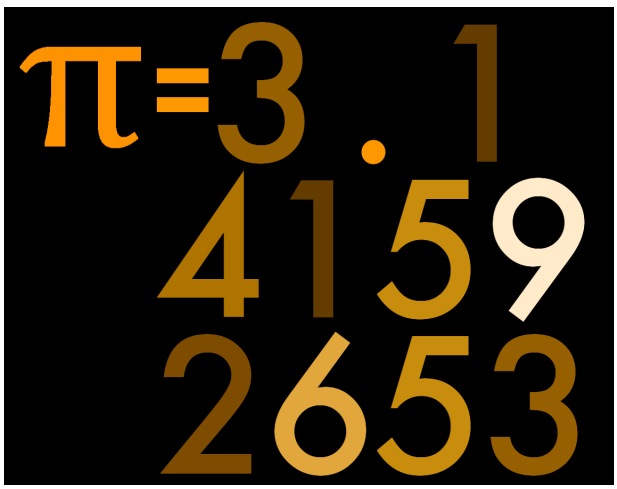
Approximating π

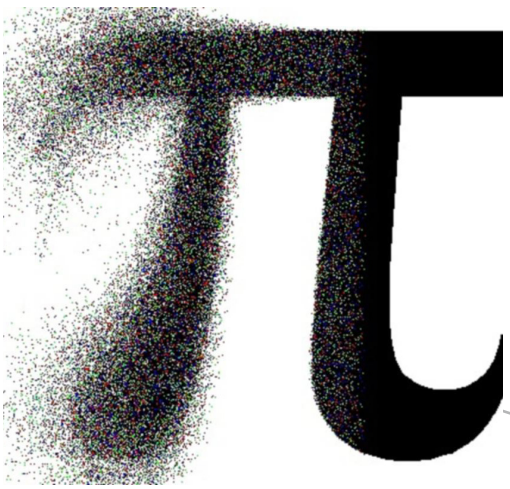
Clarence **Barlow** COMPOSITION
Akshay **Cadambi** / Matthias **Wagner** SOFTWARE

Approximating π is an audiovisual installation of a multi-channel electroacoustic composition by Clarence Barlow, presented here with multi-channel visuals.

The work is a sonification of the digits of π, based on a series approximation detailed further below. The whole piece is conceptualized so that it can be flexibly played on up to 16 A/V channels, and for any duration up to 1.5 years. However, in this implementation, it ran for 2 hours, with 6 channels (6 monitors + 6 speakers).

Construction Method
Point of departure: the converging series $\pi = 4(1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \frac{1}{9} \ldots)$
Each convergence gets a time window of 5040 samples (twice the lowest common multiple of the numbers 1-10), in which ten square wave partials of frequencies $8\frac{3}{4}n$ Hz and amplitude 2^{d_n} are set up, '$8\frac{3}{4}$' deriving from the 5040 samples, 'n' being the partial number and 'd_n' the n^{th} digit in the convergence's decimal representation; e.g. for '3.141592654', the ten partials' amplitudes are 2^3, 2^1, 2^4, 2^1, 2^5, 2^9, etc., thereafter rescaled by the arbitrary sawtooth-spectral factor $\frac{2\pi}{n}$, where 'n' is still the partial number. The convergences make the digits stabilize from left to right to a value approaching π, the resultant timbre moving from turbulence to constancy over $4 \times 10^9 \times 5040 = 20.16 \times 10^{12}$ samples or ~ $14\frac{1}{2}$ years. The installation can be pitch-shifted (by sample-dropping) and/or time-truncated. Here the sixteen sound channels are transposed from $8\frac{3}{4}$ Hz to frequencies ranging from 9 to 402 times higher (according to the expression $[9 \times \pi^{(1+\frac{1}{2}+\frac{1}{3}\cdots\frac{1}{\chi})}]$, where χ is the channel number plus one); the duration is truncated to a millionth of the total, i.e. $7'37\frac{1}{7}''$, the highest transposition thereby reaching the 1,608,000th approximation of π, where the first six digits are already stable.





Sound and the HollyHock House

F. Myles **Sciotto**

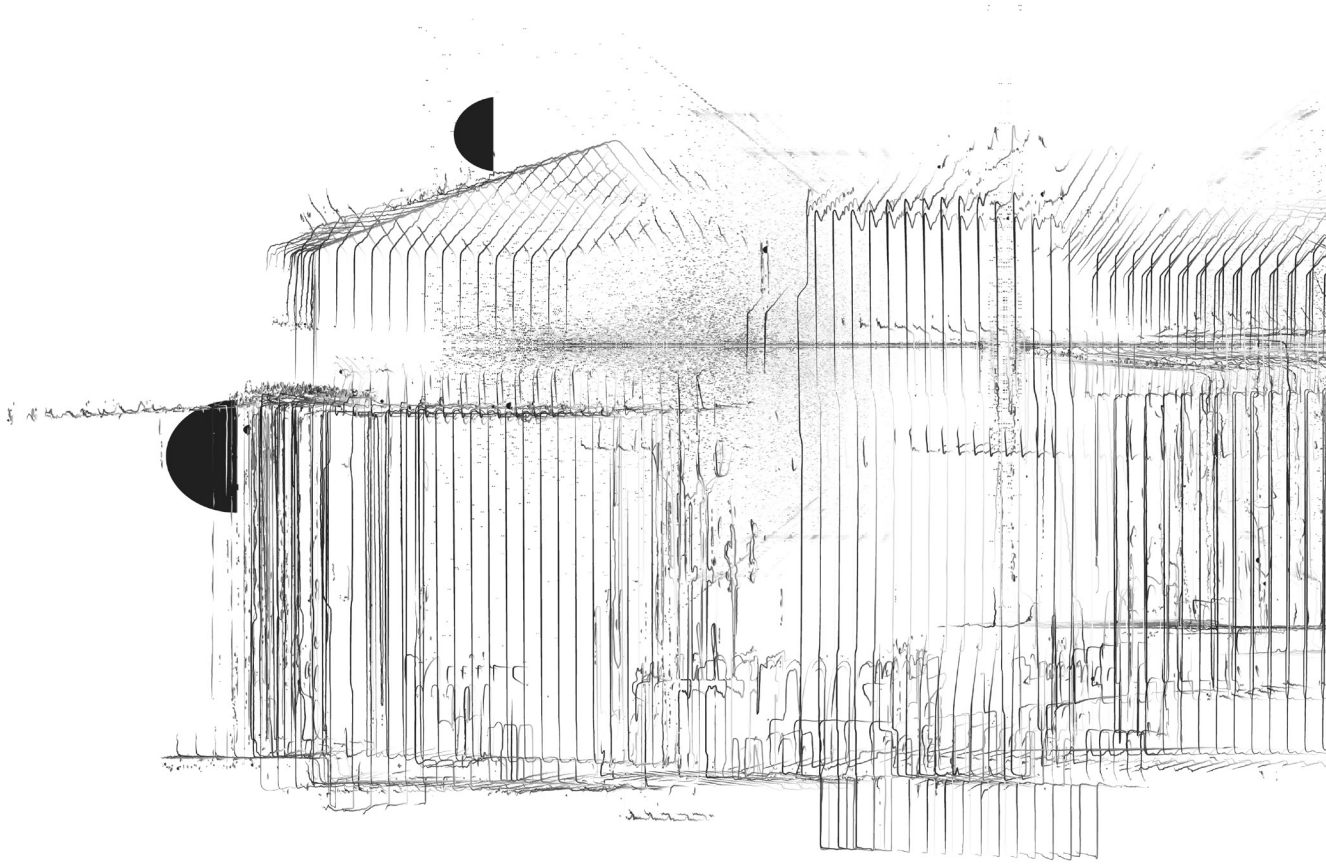
Sound and the Hollyhock House is an archimusical work that examines the characteristics of Frank Lloyd Wright's Barnsdall House in Los Angeles. The Hollyhock House is an exemplar of modern architecture whose design is heavily influenced by nature and Wright's practice of organic architecture. Music was an important aspect to Wright, who said, "The symphony, as my father first taught me, is an edifice of sound. I now felt Architecture not only might be but ought to be symphonic in character." This quote from his autobiography embodies the very point that strikes to the heart of how music and architecture are different modalities of the same principle dealing with the built elements, their structure, and purpose.

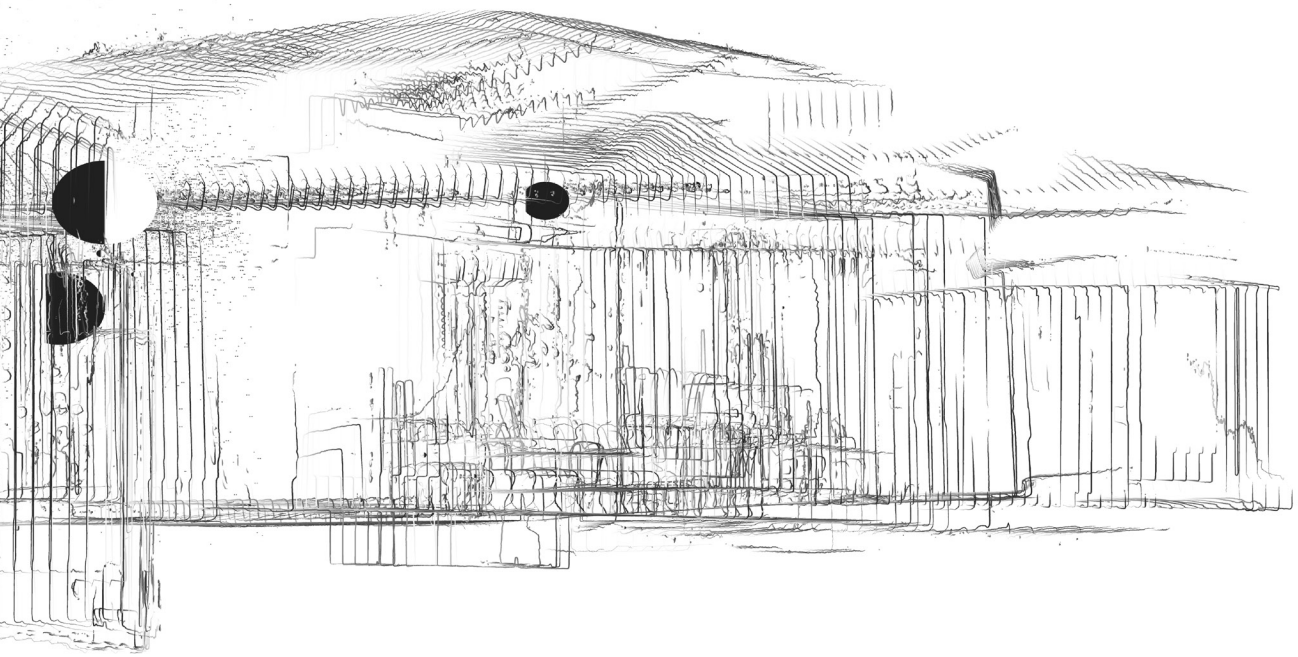
This project is a continuation of a previous study called Sound and the Schindler House conducted in 2014 and 2015, whereby the Rudolf's Schindler Kings Row house was reimagined using the modality of sound. Schindler came to be in the Los Angeles area because of the opportunity that W right presented to help manage and oversee the construction of the Hollyhock House, which was built for Aline Barnsdall. Both houses exhibit a beautiful quality of architecture's place within and amongst nature, but the Hollyhock house exhibits an exceptional kind of quality. The ways Wright embodied and unified the natural and artistic principles relating to its inspiration of the Hollyhock flower (Alcea), the site (Olive Hill), and surrounding elements (views of Griffith Park) are proof to the natural instinct and posture of this place.

Sound and the Hollyhock House pays particular attention to these unique design elements including the compression and expansion of the interior spaces, the graphic composition of the art glass and the symbolic formal abstraction of the Hollyhock flower found in the rhythmic ornament of the facades and interior details. Together these formal components create a unique and holistic assemblage, each architectural element being an integral part of the whole composition. This holistic approach is exhibited throughout the house and is achieved by the integration and composition of its generated motif and the architectural and geometric equivalent to the musical concept of theme and variation (details, cast elements, furniture, and art glass). This unique quality is beautifully displayed and reaffirms the impressions of the Hollyhock House's musical nature and the symphonic spaces of Wright's work.

A series of drawings with an accompanying sound composition illustrate different modalities of the same forms by using an archimusical technique called spatial sampling. The above-mentioned elements are examined by sampling the sounds of each space of the house with an array of contact and condenser microphones, and through spatial data collected with the use of a 3D scanner. Together this spatial and sonic data is integrated within a computational compositional program that uses the sonogram as translational mediator. This is done in order to unify the spatial and sonic characteristics and provides the components for generating new architectural, musical, and archimusical material.

The soundscape and drawings are made to exemplify known qualities of this unique place in a new way, emphasizing Wright's mastery of the craft and the capability for music and technology to create new integrations and transformations within the discipline of architecture. Reimagining new forms using the sonic and musical qualities will enable a deeper understanding of the trans-disciplinary relationships between music and architecture and promote a multimodal method of exploring sonic, visual, and physical forms.





Les Colonnes Sonores

F. Myles **Sciotto**

Les Colonnes Sonores (The Sonic Columns) is an archimusical exploration. Archimusic is the trans-disciplinary practice at the intersection of architecture and music whereby the relationships and integrations between these two fields are combined into one discipline and towards a new end.

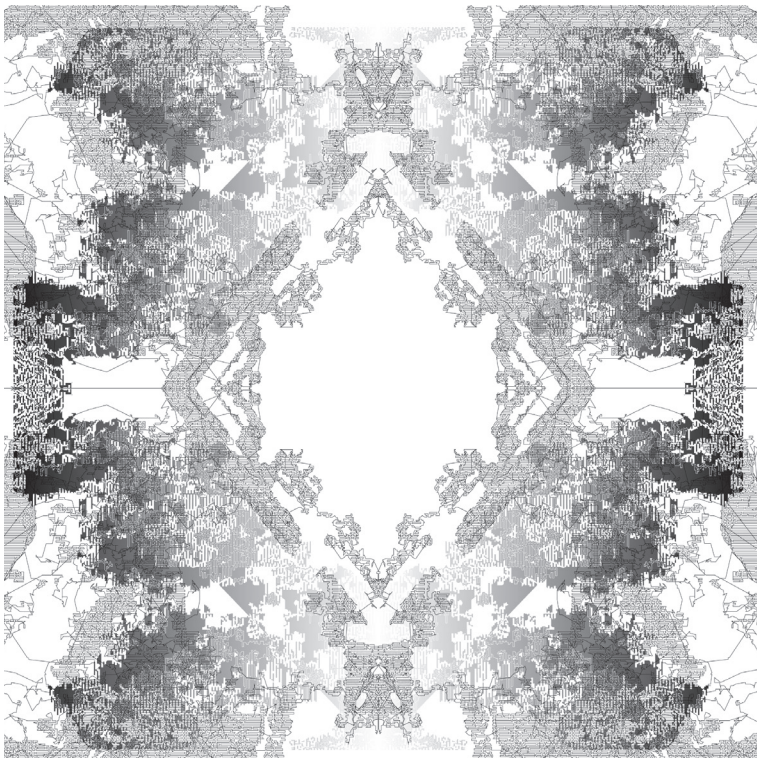
Historically, architecture and music have shared a unique past and have created both architectural and musical works that have explored interdisciplinary relationships in a myriad of creative ways. These works have explored notational and representational connections, structural and material relationships, and methods of instrumentation and synthesis as a temporal and spatial construct. One of the way these two disciplines have not yet been examined is the ancient ways in which architecture has embodied certain principles of proportion and the potential relationship to the concept of musical harmonics.

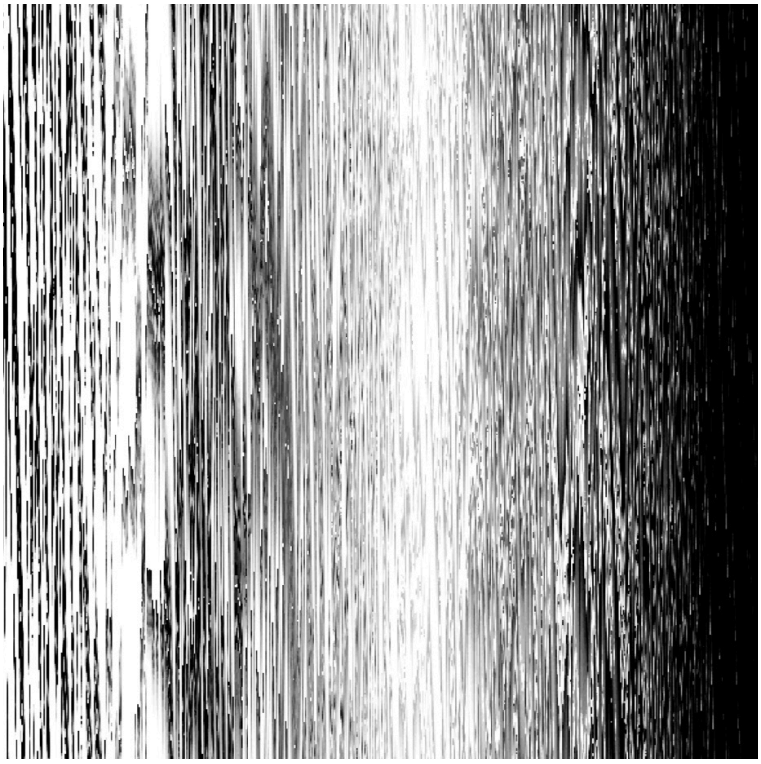
Harmonics is a common term in the discipline of music and its parallel in the discipline of architecture is said to be proportion. Together these two terms, harmonics and proportion, refer to the qualities of beauty and elegance within the composition of sculptural and sonic form. As sounds can be both composed and analyzed in terms of their harmonics and/or partials, architectural forms can be described in terms of proportion and balance. Les Colonnes Sonores is an archimusical study that investigates the relationships between these two separate yet parallel worlds and aims to reveal new and innovative work by integrating these two spheres of knowledge towards a new end.

Les Colonnes Sonores is a series of drawings with accompanying sound composition. These drawings and soundscapes are an integration of the classical Greek Corinthian order that is understood to be the most beautiful and ornate of the three Greek orders (Doric, Ionic, Corinthian). Sound is integrated into the architectural and geometric process by translating a 3D scan of a Corinthian column and its resulting point cloud into a sonic counterpart. This is achieved by synthesizing sound using the spatial data (position, vector orientation and color data) from the point cloud. The outcome of this sound synthesis is then analyzed using spectral analysis and finally translated back into a new spatial point cloud that results as an archimusical transformation.

This work explores the spatial relationships of the Corinthian order using sound rather than a purely geometric relation. The resulting geometric figures are embedded with a sonic quality not present in the original built form. The soundscape illustrates the transdisciplinary sonification of the Corinthian proportions that can now be heard instead of only seen. The drawings illustrate a formal modulation of the original point cloud using sonic elements that result in a form that can now be visualized as well as heard.

The making of new archimusical elements that explore new formal harmonics and proportions that can be both seen and heard simultaneously offer an innovated level of understanding due to the transdisciplinary relationships and the use of multiple modalities. Future explorations of this study will investigate the Doric and Ionic Orders in the same manner and a comparative analysis will be conducted of all three as a holistic study.





ROVER

Hannah **Wolfe**

1. Introduction

Robots are now moving out of industry, where they have worked with trained engineers, and into more domestic settings, like the home, healthcare, and entertainment [44]. Asimov's Laws describe the three laws of robotics that allow robots to interact with humans. The primary law is to keep humans safe, the second is to obey humans, and the final law is to keep itself safe [4]. In order to fit within the first and second laws, robots need to be easily usable, trainable, accessible, and pleasant. For technology to be accessible, information should be conveyed in a variety of forms including visual, aural, and tactile. Multimodal interaction, "interaction with the virtual and physical environment through natural modes of communication" [11], is needed because it allows for universal access, and people prefer it [40, 39].

A majority of the research in human robot interaction focuses on emotive visual communication. Yet sound in particular is a critical element of interaction, as people react 10 times quicker to sound than to visual cues [26], and one of the fastest triggers for emotion is sound [27]. Emoting vocally is an important part of how animals (humans included) interact with one another [17]. One of the earliest references to this in science is in Darwin's "The Expression of the Emotions in Man and Animals" where he states, "With many kinds of animals, man included, the vocal organs are efficient in the highest degree as a means of expression" [17]. Vocal communication is the primary focus of this project for these reasons and because it is less explored in research and simpler in some respects than visual communication. Visual communication either via body language or physical appearance has already been extensively explored in research [12] and introduces many layers of complexity, particularly concerning the construction of the robot when implementing its design.

While natural conversations and emotions are difficult to express through robots, they make robots more relatable and predictable. I believe that in order to navigate uncontrolled environments with untrained users who may or may not even speak the same language, it is important to find a universal language so that robots can communicate. The importance of affording the system the capability of interpreting human intention is essential for seamless interaction between the person and the machine. It has been shown that people treat computers like people, so computers need to be able to respond like people [46]. If technology follows human social expectations, people will find the interaction enjoyable and empowering [46]. To achieve this goal, several considerations in vocal and visual communication should be kept in mind.

The concept of the uncanny valley poses a particular problem in designing robot communication. The uncanny valley, an aesthetic argument about the discomfort caused to the viewer when something seems mostly but not quite human, is an issue in all forms of emotive communication [35]. The quality of synthesized speech is worse than synthesized facial expressions with the present technology [8]. While trying to line up words with expressive audio factors, the voice typically falls into the uncanny valley. Therefore, it is important to look for a way to convey emotion and create an emotional response in the viewer purely through non-linguistic auditory cues, paralanguage, and prosody. To create the most comprehensive way to communicate and create expressive responses, research was conducted in music, linguistics, and psychology.

A crucial visual consideration is the way that a robot moves, which affects a person's emotive response [49]. Feature cues and movement are the two main pieces of information that children use to define the difference between an inanimate and animate object [36]. Since movement would create a stronger sense of embodiment, participants relate to a mobile robot more readily than to a non-mobile robot.

Without interaction with its environment, a robot is not a robot; it is just an object. This interaction could be in any form: audible, textual, visual, or physical. The concept of entitativity— where people subconsciously determine

whether or not an entity is part of a group based on certain perceptual cues— was coined by Campbell in 1958 [13]. This was expanded upon by Ip to include physical similarity and goal/behavior similarity cues [28]. Robots create entitativity through behavioral cues such as emotive sound and movement.

Addressing these issues, this project is the exploration of emotive reactive systems through the design of ROVER the Reactive Observant Vacuous Emotive Robot, an interactive sculpture and experimental platform for human-robotic interaction. This artwork can also be used to collect data from users to learn about human and robot interaction. The project was initially motivated by the 2nd floor hallway of the California NanoSystems Institute building (Elings Hall) designed by architect Robert Venturi at the University of California, Santa Barbara. The space is poorly lit, desolate, antiseptic, and windowless. The project was a way to bring warmth and joy into the space. The first iteration of ROVER detected heat and moved toward people, looking for warmth and attempting to make them happy through song. ROVER learned through operant conditioning, an incredibly effective way to modify dog and other animal behavior. ROVER gained his traditional canine name due to this dog-like capacity.

2. Context

ROVER takes inspiration from the early robots of cybernetic art as well as from more contemporary robotic and other automated artworks, particularly those emulating creative human behavior and speech. The works of artists Simon Penny and Ken Rinaldo have been especially crucial in the shaping of ROVER.

2.1 Cybernetics

ROVER references many early works of cybernetic art. By using an iRobot CREATE, ROVER references Grey Walter's tortoises and Robert Breer's sculptures at Pepsi Pavilion. Some of the first autonomous robots were these tortoises by Grey Walter, named Elmer and Elsie, constructed in 1949. They were called tortoises because of their slow speed and shape. Their functionality is similar to today's Roomba, with bump sensors to avoid obstacles, and Elsie's ability to return to a docking station to recharge when running low on power [57]. Robert Breer's 1970 sculptures were 6 feet high and emitted sound while moving around at less than 2 feet per minute [45]. ROVER is particularly reminiscent of these sculptures as a 6-foot tall robot moving slowly and emitting sound himself. However, these early autonomous robots differ from later projects including ROVER in that they did not interact with the public.

ROVER was additionally inspired by more engaging robots. Many early robots were remote controlled and were used for disruption, like Bruce Lacey's ROSA BOSOM (Radio Operated Simulated Actress – Battery Or Standby Operated Mains) with Mate [47] and K-456 by Nam June Paik and Shuya Abe. K-456, built in 1964, was a 20-channel radio controlled robot originally considered "androgyne" but cast as female in the United States. "Robot-K456 can bow, walk, give a speech (recorded by the then Mayor-elect of New York, John Lindsay), lift each arm independently and wiggle its representational torso. It also defecates on the floor of the gallery by remote control. Paik's robot looks mechanically unreliable and he admits that it needs constant attention" [1]. Rosa Bosom was originally designed as an actress to play the Queen of France in the production of the Three Musketeers, at the Arts Theatre 1966 [47]. These robots were shown at Cybernetic Serendipity along with Gordon Pask's Colloquy of Mobiles, robotic mobiles which had very simple interaction tasks to interact with each other using light. The viewers were also given flashlights so that they could interact with the robots [47].

ROVER, however, is computer controlled, not remote controlled. In 1970, The Senster by Edward Ihnatowicz became the first computer-controlled robotic sculpture that was also interactive with the public, using 4 microphones and 2 doppler radar arrays. It was an 8ft tall and 15ft long hydraulically activated sculpture that followed the sound and motion of the spectators. It was attracted to sound and movement but avoided loud noises and quick movement. As an artwork with 5 degrees of freedom, it was a novelty at the time [9].

2.2 Contemporary Art

2.2.1 Robots Emulating Humans

With respect to contemporary art, ROVER references many approaches to create robots with more human-like cognitive abilities, such as analysis, creation, and performance, as well as ones emulating other qualities, such as basic bodily functions and speech.

Berenson, named after Bernard Berenson, is a robot art critic by anthropologist Denis Vidal and robotics engineer Philippe Gaussier. The critic observes viewers' reactions to art and learns what is "good" and "bad" art. Then, he moves towards art works that are "good" and smiles at them, and frowns at "bad" art. This robot uses a neural network to learn [41].

While there are few robots that compose music, drawing robots and machines are pervasive in art and have been explored by Shih Yun Yeo, Balint Bolygo, Patrick Tresset, Nils Völker, Jen Hui Liao, Brian De Rosia, Guy Ben-Ary, Harold Cohen, Jürg Lehni, Jeff Badger, and Fernando Orellana [58, 54, 55, 56, 18, 20, 7, 15, 32, 6, 37]. With respect to dance, the art of movement, Louis-Phillipe Demer's Tiller Girls is a live interpretative performance with simple robots that can only move their necks and waists [19].
Composing robots aside, robotic instruments are more common and have existed since the 14th century with automated carillons [34]. Mechanical music was part of the Dadaist movement— an example is the Ballet Mecanique Dadaist film by George Antheil [31]. This music was later performed by LEMUR (League of Electronic Musical Urban Robots) at the National Gallery in 2005 with a computer driven robotic ensemble [33]. Additionally, Peter Ablinger made a piano speak by automated means in "Speaking Piano" [2]. As a nod to this, in the pilot study for this project, ROVER's final frequency range was based on that of a piano.

The relationship between sound and the human body is explored in CodAct's Pendulum Choir, where the performers work with a system to create sound [14]. Stelarc explored the relationship between man and machine in many of his works, both augmenting and extending his body [5]. Robots have been built that reproduce bodily functions like Kevin Grennan's robot that sweats [24] and Alexitimia, Paula Gaetano's sweating robot [3]. Another example of this is Cloaca, Wim Delvoye's machine that defecates, and the previously mentioned K-456 by Nam June Paik [16, 1].

The first speaking machine was designed in 1769 by Wolfgang von Kempelen. This machine was a human-controlled mechanism with bellows, only able to say a few words [30]. Around the same time, C. G. Kratzenstein constructed various shaped tubes that produced five vowel sounds. The first electrical speaking machine was the Voder, designed by Homer Dudley in 1939 [21]. Research has continued to the present with work like the Waseda Talker Series from the Humanoid Robotics Institute at Waseda University [23] and Hideyuki Sawada's KTR-2 which sings [50]. The first computer to sing was the IBM 7094 in 1961, singing the song "Daisy Bell." These vocals programmed by John Kelly and Carol Lockbaum famously inspired a scene in 2001: A Space Odyssey [52].

2.2.2 Autonomous Robots

Autonomy was an important drive when creating ROVER. Jed Berk's ALAVs (Autonomous Light Air Vessels) are a flock of floating, sheep-like balloons with lights that can communicate with lights and movement. In the first version, viewers could befriend the ALAVs and change the flocking behavior by feeding them. In later versions, viewers could communicate with the ALAVs via cell phone and their choices of being friend or foe affected the ALAV flock's actions [10]. Robots have moved outside of the gallery with Theo Jansen's Strandbeests, which he is trying to make completely self-sufficient on the beach [29]. Fernando Orellana's work Elevator's Music, 2007, has robots driven by sound that hide in the elevator [38]. Gilberto Esparza's Urban Parasites' "intention is to create life forms

that exist at the expense of energy sources generated by the human species, which can be found in the urban environment" [22]. Robots also offer the opportunity to extend art to remote environments, to explore places where there is little to no human intervention. Michael Snow's film La Région Centrale was created completely with a mechanical camera surveying a remote area of Canada [53].

2.2.3 Case Study: Simon Penny

Simon Penny explores human interaction with technology and robotic recreation of human behavior. His first work on these topics was Stupid Robot in 1985. Stupid Robot was designed to be reminiscent of a legless beggar, and it shook a can of metal scraps when approached. In 1990, he created a heat-seeking anti-personnel sculpture called Pride of Our Young Nation. Pride of Our Young Nation was designed to look like an artillery cannon and use an infrared heat sensor to aim at its victims. Once it found its victims, it would "fire" by rotating a large metal cone covered in spikes towards them. Petit Mal, is an autonomous interactive robot, designed to be more simple than functional. Its basis is a pendulum and two bicycle wheels. It uses ultrasonic and piezoelectric sensors to navigate the space and find people, which it follows. Its clunkiness could be described as adorable. In Phatus, Penny works with the idea of trying to reproduce how people make noises by creating artificial vocal cords and lungs. He is still currently working on this project another form of interaction, speech, but instead of just using electronic forms of synthesis, this speech is purely mechanical [43].

2.2.4 Case Study: Ken Rinaldo

Ken Rinaldo explored sound as communication for robots and autonomous robots that photographed and interacted with the public in a way similar to ROVER. Ken Rinaldo's early sculpture Cyber-squeaks, 1987, was a series of small hanging sculptures that reacted to touch and light by emitting sound. Ken Rinaldo continued to explore sound and interaction with the Flock in 1994. Flock was three robotic hanging arms that interacted with the public through movement and communicated with each other using telephone tones. They sensed the environment with microphones and infrared sensors. This was later expanded into Autopoiesis, whose actions evolved based on interactions. Rinaldo first started exploring autonomous robots with Augmented Fish Reality, where Beta fish could control mobile tanks that moved around the space. This is similar to Garnet Hertz's Cockroach Controlled Robot in 2008 [25]. His next autonomous robot was the Paparazzi Bots, a series of human-height robots that would move toward people and take pictures of them like paparazzi. They moved at human speed, avoiding obstacles using multiple microprocessors, cameras, sensors, and a custom rolling platform. [48]

3. Conclusion

ROVER was greatly informed by both cybernetic and contemporary art. When looking forward in creating interactive robots for the home, the arts are a valuable inspirational source, where the history of interactive robotics itself has deep roots.

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ROVER

Excerpts from Psychagogy: **The Dance of the Fulcrum and Kroumatograph**

Alexis Story **Crawshaw** CONCEPT, COMPOSITION, LYRICS, PIANO, AND VOICE
Maud **Watel-Kazak** / Timothy **Wood** CHOREOGRAPHY AND DANCE

Sponsored by the following UCSB entities: the Division of Humanities and Fine Arts, the Graduate Division, the Interdisciplinary Humanities Center, the Media Arts and Technology Program, the College of Creative Studies Music Composition, the College of Creative Studies Computing, the Department of Music, the Department of Theater and Dance, and the Classics Department

The Dance of the Fulcrum and Kroumatograph are two components of a larger project in progress, Psychagogy. The overall work, Psychagogy, meaning "the leading of souls" in ancient Greek, is a transmedia mini-epic song cycle. It will eventually be comprised of 24 two-part song/installation chapters, with original lyrics written and sung in ancient Greek. The Dance of the Fulcrum is a song/performance excerpt and Kroumatograph is an installation excerpt from this effort. The whole work explores both 1) the ancient Greek notion of paideia, looking at the potential of art to educate through an embedded value system, and 2) spatiotemporal music, musical experience and form as a function of both time and space.

In terms of its layout and technical aspects, The Dance of the Fulcrum (the song/performance portion) consists of three performers (two dancers and one pianist/vocalist), a stage area, a virtual reality (VR) head-mounted display and hand controller, a piano, a spatial-tracking system, a sound system, and a visual projection. The visuals from the VR display are projected onto the wall behind the stage area and dancers for the audience to see. The set-up for Kroumatograph (the installation segment) consists of a subwoofer, a spatial-tracking system, three driftwood tripods holding bowls of different scents, and three accompanying thermal/cooling devices— one per tripod.

In The Dance of the Fulcrum, the actual and the virtual actively mold one another. The live instruments and live dancers mutually shape electronically generated sound and visuals. While a more constant instrumental composition seeds the whole piece, the dancers remain in fluid, transactive dialog with the virtual elements. Within this loop, the two spatially-tracked dancers— Maud Watel-Kazak and Timothy Wood— engage in the art of sculpting music both sonically and visually with the body. On the visual end, one dancer, Wood, wears the VR head-mounted display while the other dancer, Watel-Kazak, wields the VR hand controller. This controller serves as a real-time 3D spatial virtual drawing tool. As Watel-Kazak dances and interacts directly with the audience members, her gestures are visually recorded in virtual 3D space. These traces are gradually revealed to the audience through the virtual gaze and viewpoint of the other dancer, Wood. Sonically, through the input of both 3D spatial trackers and sensors on the piano, the movements of the dancers and the displacement of strings algorithmically modulate the audio parameters of the environment. In this way, the two dancers explore the continua between music and sculpture, audience and performer, the temporal and the spatial, the actual and the virtual, and the permanent and the ephemeral.

In Kroumatograph, the audience is invited to explore a 3D-tracked environment brought alive with both a grid of interacting standing waves and a grid of different thermal and olfactory currents. The thermo-olfactory composition includes a spectrum of scents, changing in balance according to spatial position. Certain scents are employed as sensorial cues to encourage more tranquil emotional responses against the sometimes highly intense audio-tactile stimulus of the standing wave anti-nodes. Scents evoking physiological calm intermingle with scents that semiotically evoke psychological calm. As a whole, this navigable space of sonic, tactile low bass, thermo-tactile, and olfactory components further serves to unite spatial and temporal elements into a more continuous and multisensory spatiotemporal musical expression.

Transdisciplinary paideia: blending mythology, philosophy, and the avant-garde through algorithms
Thematically, Psychagogy extensively explores social relationships and spatiotemporality by means of a poetic interpretation of the mythological exchange of gifts between Apollo and Hermes in the "Homeric Hymn to Hermes." Hermes gifts Apollo the lyre, an instrument of the temporal art, music. Apollo gifts Hermes the caduceus (a messenger staff, consisting of either three branches or two snakes), carrying associations with spatial travel. Each gift comes to define a new domain for the receiver, with Apollo becoming the god of music and Hermes, the god of messages, respectively. These connections are particularly articulated in the overarching original story of the song cycle.

With respect to the particular social values that are emphasized in the work, Psychagogy examines bonds of friendship as a means 1) to better "know thyself" through the contrast of the self and other and 2) to co-encourage ethical growth, as per Aristotle's chapter on friendship in his Nicomachean Ethics.

In The Dance of the Fulcrum, one way that these values are expressed is through a spatially-tracked dance in which the spatial movements of the dancers have the potential to algorithmically generate more or less interesting musical changes to an electronic musical component. These changes depend on the proximity of the dancers, how closely they complement the movements of one another, and how ambitious they are in experimenting with their movements. In this way, through this algorithm, the dancers are musically guided and incentivized to strengthen their bond to one another as well as to strengthen their individual abilities as dancers.

Spatiotemporal cross-modal composition
As a general note, spatiotemporal music entails both temporal variation and spatial variation, changing over time with respect to a displacement in a physical space.
The Dance of the Fulcrum and Kroumatograph both represent two distinct approaches in spatiotemporal composition with respect to electronic sound, and both engage other sensorial material spatiotemporally as well.

Regarding electronic sound, The Dance of the Fulcrum employs virtual space, using the spatial tracking of two individuals in a physical space to computationally create a new virtually constructed audio environment, as described earlier. In contrast, Kroumatograph entails a direct manipulation of physical space itself, primarily employing acoustic principles to create a spatiotemporal environment. The work combines the acoustic phenomena of standing waves and frequency beating, using measurements of the room with a modified standing wave equation to map pitch and rhythm to different locations in the space. In part, the work is a dynamic, unfolding sound sculpture— a curated composite of standing wave harmonics. Each harmonic is itself a composite of waves, comprised of slightly offset versions of itself, which beat rhythmically. Thus, each harmonic carries its own frequency-beating polyrhythmic identity. In this way, both distinct pitches and rhythmic patterns are spatialized, creating a topography for participants to walk through and be guided through to experience musical variation and thus, musical form, depending on the trajectory of movement and physical displacement.

The spatiotemporal composition of these two works is inherently cross-modal and extends to several senses as well. The spatial nature of the works necessarily entails kinesthesia (the sense of movement), experienced by both performers and/or spectators. In The Dance of the Fulcrum, through the real-time VR drawing tool, 3D spatiotemporal visual music is generated. In Kroumatograph, the low frequencies needed to create the standing waves simultaneously engage both hearing and vibrational touch, particularly activating a known resonance in the chest. Additionally, olfaction and thermal touch are mapped in space and experienced in different combinations and balances depending on a spectator's spatiotemporal trajectory.

As such, the work serves in a broader context as an ontological exploration of music— particularly investigating whether music exists beyond hearing and whether, in the Platonic sense, it can be united with gymnastics, to merge into a more pedagogically holistic practice. As such, the work serves as an ontological exploration of music— particularly investigating whether music can be separated from sound and whether, in the Platonic sense, it can be united with gymnastics.

Excerpts from Psychagogy: The Dance of the Fulcrum and Kroumatograph

TEM/AP Project

Kurt **Kaminski** / Kon Hyong (Kenny) **Kim** / Hannah **Wolfe** /
Timothy **Wood** / Karl **Yerkes** / Keehong **Youn**

The TEM/AP project is a collaboration between the AlloSphere Research Group and research scientist Dr. Stephan Kraemer to visualize the datasets from two different imaging techniques in the AlloSphere, a fully immersive stereoscopic environment. The goal of this research is to help scientists understand the nature of nanoscale imperfections in steel, which could lead to more stable fusion reactors. TEM/AP stands for the two imaging techniques being employed: transmission electron tomography and atom probe microscopy.

The datasets were sampled from the same material, a small piece of steel, which contains various microstructural details that experimentalists can intuitively navigate and analyze. The key features of the data were Helium bubbles and oxide nanoclusters, which clearly showed a 1:1 association. To further analyze this association, superimposing the data was imperative. Visualizing the two datasets simultaneously presented a number of challenges. Foremost, the transmission electron tomograph produces data in the form of a density field along a regular grid whereas the atom probe is a point cloud of positions representing elements that compose the material. Initially, we forced these two types of data into the same domain by constructing isosurfaces of their respective components. Isosurfaces represent a constant value within a volume, and by changing this value, internal features are revealed as three-dimensional geometric contours. Isosurfaces are generated using the "Marching Cubes" algorithm by Paul Bourke (1994). The algorithm finds contours by iterating through a scalar field, repeatedly searching for intersections within eight neighboring locations, hence the cube. Polygons are drawn as representations of the intersections given a certain threshold (the iso-value) and eventually fused together to form the final surface. Since the atom probe data was a point cloud and not a volume, density was inferred by measuring concentrations of points to produce a density field, which was subsequently turned into an isosurface. In this way, the voids left by Helium bubbles measured using transmission electron tomography are clearly correlated to oxide clusters seen by the atom probe.

Going further, experimentalists wished to see the raw atom probe data inlaid with the TEM volumetric isosurface data. Such a rendering implies making the isosurfaces partially transparent, introducing a number of graphical programming considerations. In computer graphics, the concept of ordering, or how triangles overlap one another, increases in complexity when transparency is introduced. With a static viewing angle, ordering can be solved with simply organizing the code to execute in a sequential way that mirrors the drawing order of the application, which is usually a back-to-front scheme. Since this is an interactive application with a mobile, 360-degree omni-stereographic view, an order-independent transparency algorithm was implemented to decouple the order of the code with the order of the geometry rendering. The algorithm, originally developed by Morgan McGuire (Williams College), stores individual passes of opaque and transparent objects, then calculates how much color is obscured or transmitted by overlapping triangles. All of this information is composited together using a weighted blending operation that avoids artifacts while correctly reproducing color values. Finally, the order-independent transparency algorithm was adapted to the AlloSphere's omni-stereo pipeline to complete the immersive visualization rendering.

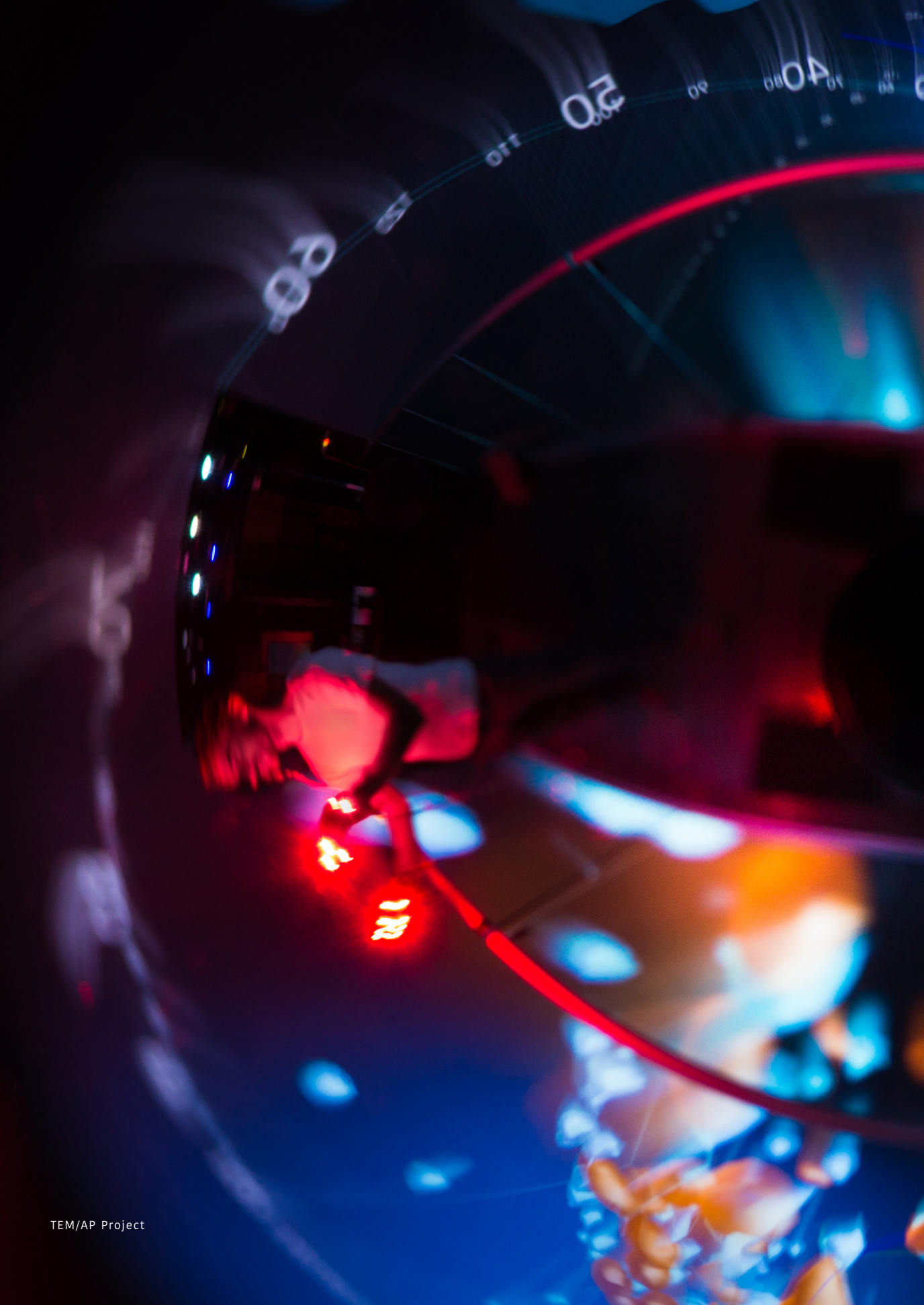
In order to create a multi-user instrument that is flexible, it is necessary to have many different ways of interacting with the data in the sphere. For this project we focused on two main user interfaces: a 2D tablet interface, and a 3D gestural interface using LED gloves.

A tablet interface provides familiar two-dimensional control of parameters of the system. The tablet interface uses Interface.js, a library built by Dr. Charlie Roberts (RIT), communicating over Open Sound Control (OSC). An intuitive interface was created through familiar widgets and touch screen gestures. The tablet interface allows for users to change datasets, move to preset camera poses, navigate with the camera, and adjust the atom probe data's position and orientation. Users can also modify how the data is shown, allowing the user to change the isosurface

value, color and opacity. The iPad displays real-time information to the scientist about the current state of these variables. A slice viewer was implemented, allowing the viewer to create a plane through the data at any angle and view the raw data that the plane intersects. The user can control the position and orientation of the plane using LED gloves or the iPad's accelerometer data.

Because of the immersive three-dimensional quality of the AlloSphere, there is an immediate instinct to reach out and touch what you see with your hands. To fulfill this instinct we created a gestural-based interaction mode using active marker motion tracking, head tracking, and a pair of LED gloves. This mode of interaction lets the user use their body to naturally interact with the environment in three dimensions. One of the gloves is used for navigating space, the other for interacting with the data sets. The user navigates by dragging space with their left hand while the index finger is held close to the thumb in a pinched gesture. This enables fine grain control over the camera's position in space. The user can also reach out with the right hand and grab data sets in order to change their positions and orientations in space.

By using the AlloSphere to visualize 3D data from two different instruments, a transmission electron microscope and an atom probe microscope, complex structural information can be rapidly conveyed and scrutinized in an architectural-scale setting. This unique environment allows for scientists to envelop themselves in their data while physically distancing themselves from it, leading to new modes of collaboration and communication.



TEM/AP Project

Projects

AMBIKA **YADAV**
JING **YAN**
CHANG **HE**
LU **LIU**
WEIHAO **QIU**
JUNXIANG **YAO**
OWEN **CAMPBELL**
PABLO **COLAPINTO**
PAUL **JACOBS**
KURT **KAMINSKI**
SOLEN **KIRATLI** / AKSHAY **CADAMBI**
RODGER **LUO** / KEEHONG **YOUN**
RYAN **MCGEE**
NATALY **MORENO** / SAMUEL **DONG**
SAHAR **SAJADIEH** / NATHAN **WEITZNER**
JUNGAH **SON**
TIMOTHY **WOOD**
DAVID **GORDON**
MARK **HIRSCH**
MOHIT **HINGORANI**
AARON **JONES** / PRADEEP **SEN** / THEODORE **KIM**
STEVE **BAKO** / YUXIANG **WANG**
CHIEH-CHI **KAO** / PRADEEP **SEN** / YUXIANG **WANG**
MATTHIAS **WAGNER**

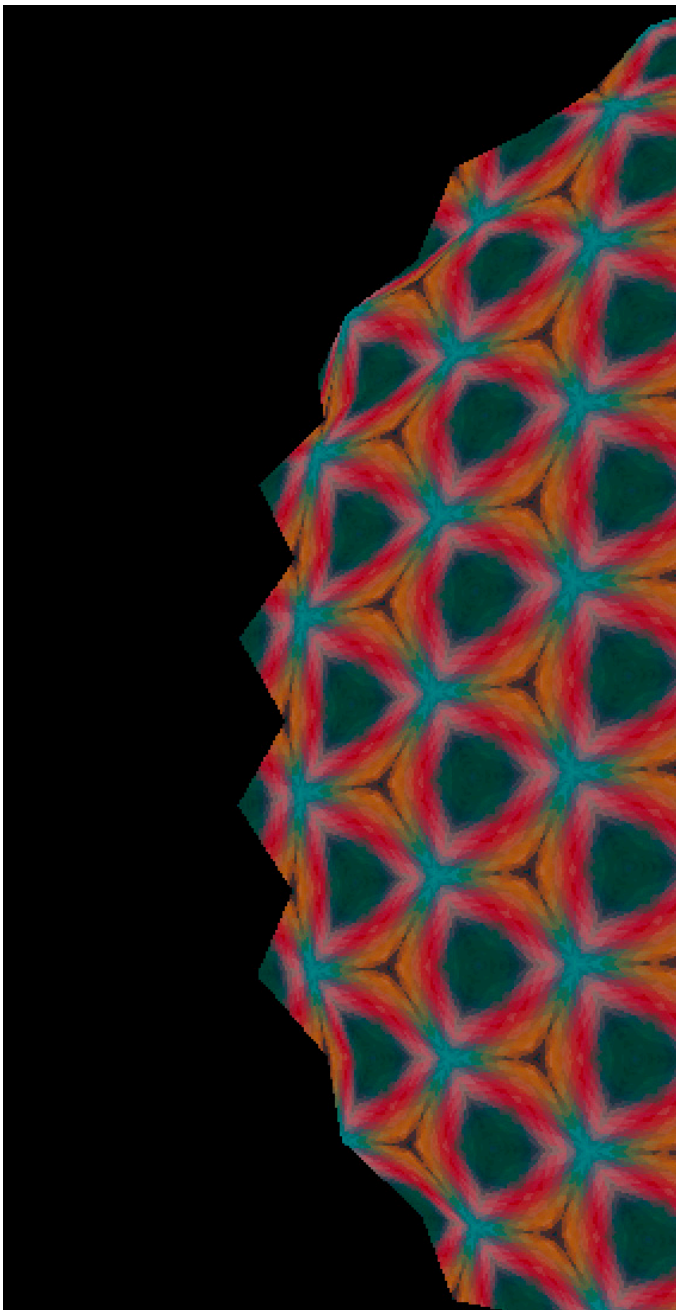
Kaleidoscopic Geodesic Dome

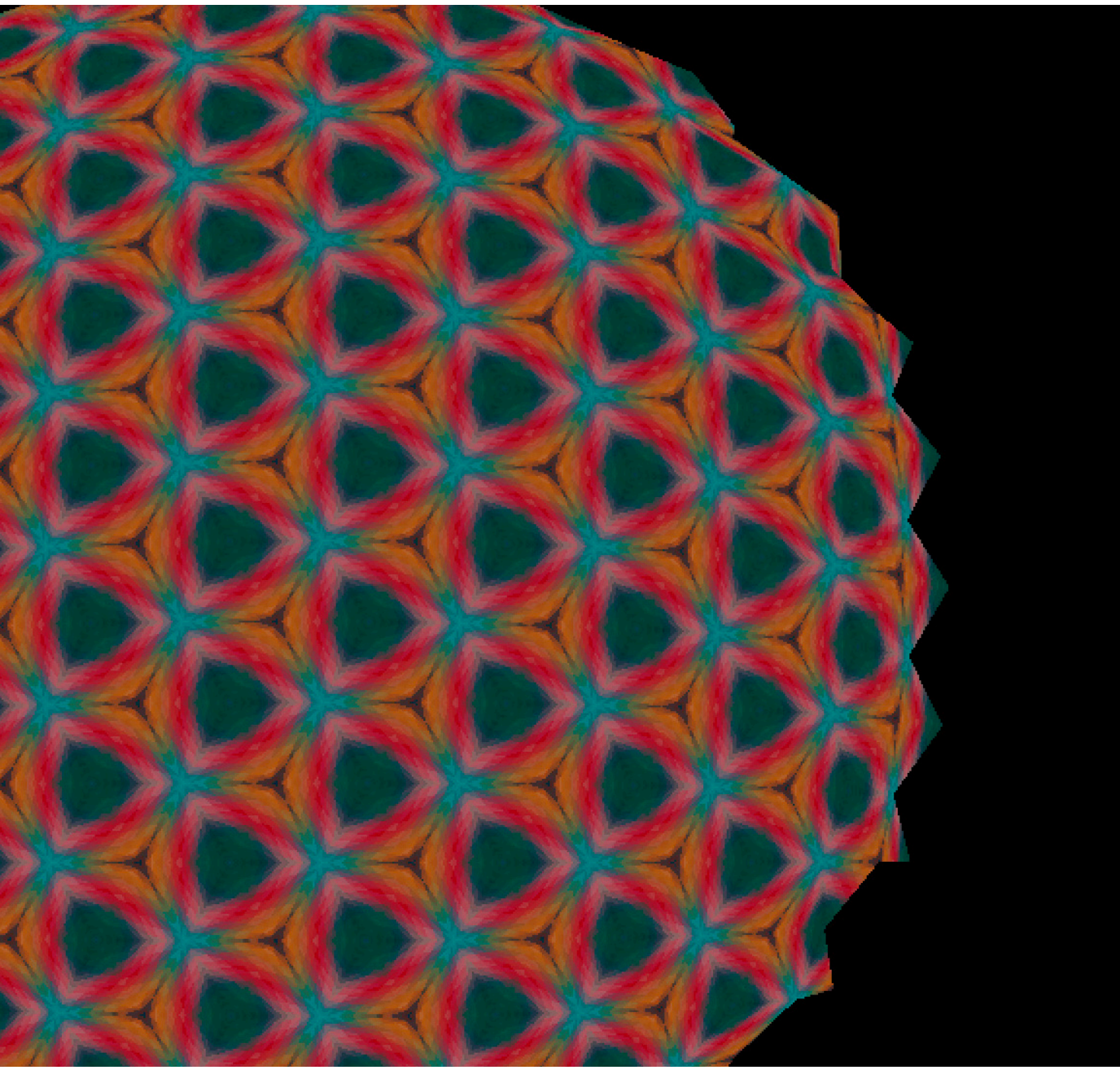
Ambika **Yadav**

Kaleidoscopic Geodesic Dome is an interactive audiovisual piece made for the Allosphere. As a digital simulation of a spherical kaleidoscope, the work evokes the experience of a geodesic dome as it is presented within the immersive environment of the Allosphere.

Concerning the construction of this kaleidoscope, the spherical effect is achieved through a tapering of the traditionally rectangular mirror components of a kaleidoscope's geometry.

Additionally, the work has three main interactive components. Firstly, the user can select from six different input images to feed into this system of virtual mirrors. Secondly and thirdly, the user can move the 3D position of both the input image and of the position of the spherical kaleidoscope itself. Given these variables, the system is always dynamic with minimal repetition.





Code of Red

Ambika **Yadav**

Code of Red is an interactive visualization that examines the impact of war on artistic creation over the last century. Specifically, it enables the audience to explore the ways in which wartime affects artists. Does war always oppress or can it have the opposite effect, provoking an outpouring of thoughts and ideas into the world? This visualization is intended to evoke questions about why artistic creation may be important in the context of war, how it may be serving as a coping mechanism or as a tool to elicit new perspectives that may help present and future generations reflect on the power of their actions to bring about good instead of ill.

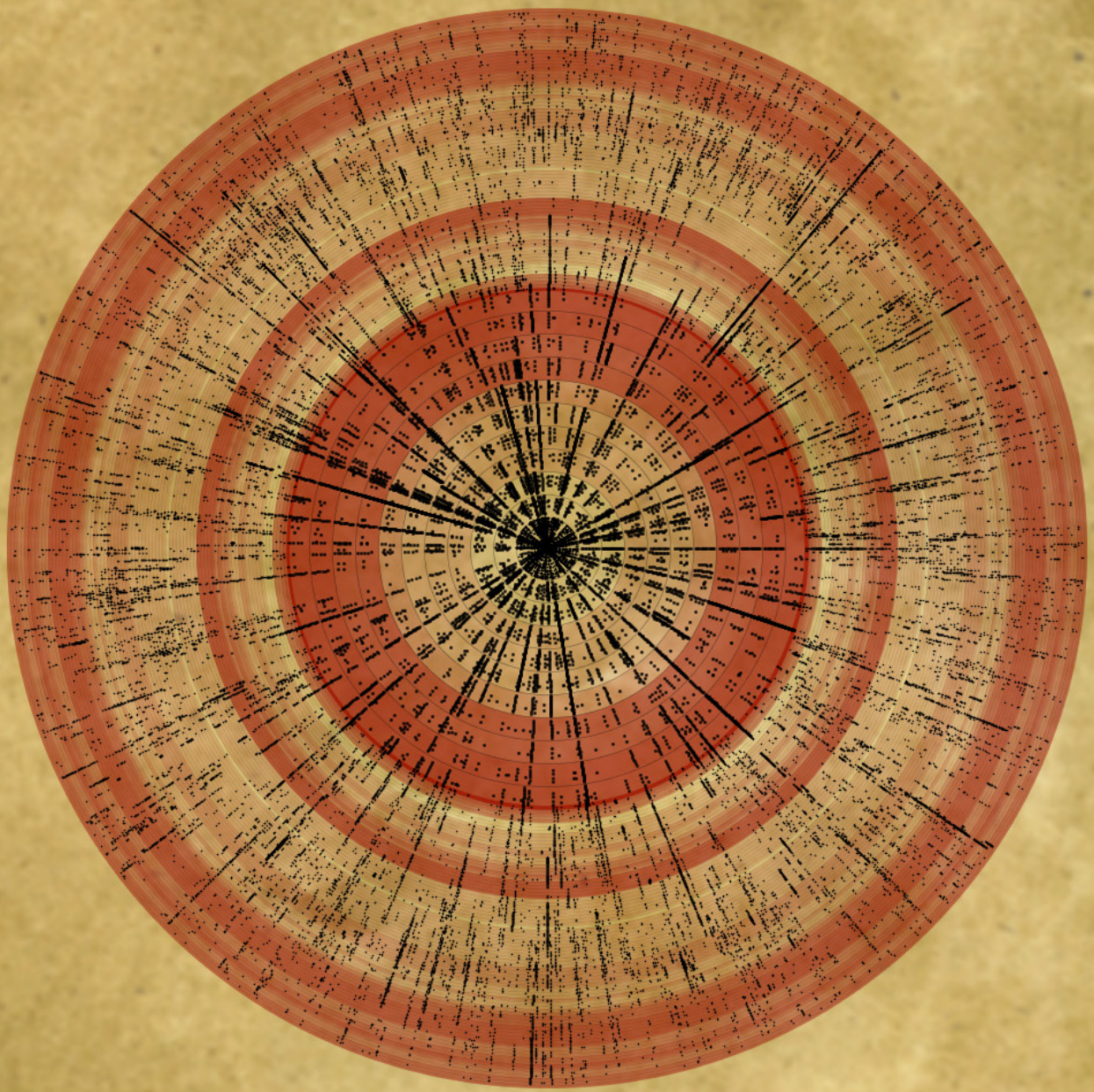
Regarding the design, users can observe trends of artistic output for groups of artists both as a whole worldwide and within certain countries. The layout is organized like the cross-section of a tree, with each year represented by a ring, 1900 being the innermost layer and 2000 being the outermost one. The user can scroll through any 10-year period for a more detailed examination. Each artist is represented by a unique, invisible line that radiates out from the center of the work. Each of their artworks delineate this line with a black dot placed according to the year of the given work's creation. Wartime year rings are tinged with red.

Thus, like with the tree, one can easily read the responses of the societal organism to years of extreme duress. Although the individual tree may be powerless to change the weather it endures, as a society, through art, we may seed winds of change. Knowing this, we may reduce the number of bloodstained rings to come, learning from the past to fortify the future health of the whole.

CODE OF RED

A PALLETE OF WAR AND ART

| Visualizing the dependency of artwork on war periods |



1909 - 1919

1900 1910 1920 1930 1940 1950 1960 1970 1980 1990 2000

WORLDWIDE

WARS

World War II 1914-1918
Russian Civil War 1917-1921
Armenian Genocide 1915-1923
Mexican Revolution 1911-1920
Greek Genocide 1915-1923
Assyrian Genocide 1915-1923

INSTALLATION

Inner

Jing **Yan**

The idea for this AlloSphere project emerges from the story of an anterograde amnesia patient, K.C. Anterograde amnesia is a condition in which a person cannot hold new memories for long, eventually forgetting everything new that happens in their life. After watching a strongly depressing interview series of K.C. doing a memorization test, I started to construct a piece of work about the persistence of people's memories— the storage of memories, the general process of oblivion, the visualization of memories, as well as the interaction with memories.

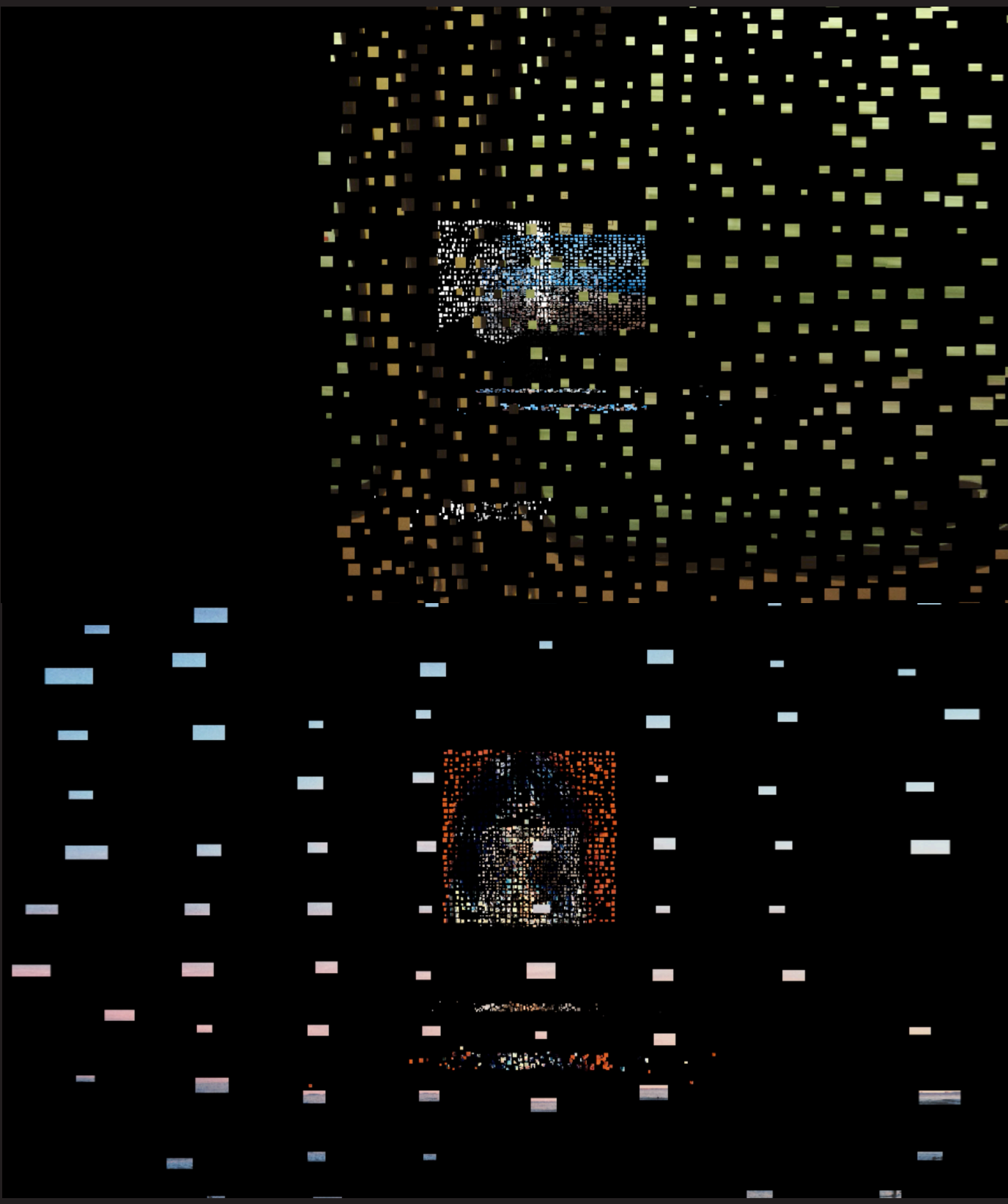
My work is analogous to the low-resolution work of Jim Campbell, who is famous for his sculptural LED light installations. We live in a high-resolution world and strive to make the image of entities clearer; the real impression, however, stays shattered in our minds. In memory, we grasp the silhouette and feeling, and let the details elude us and fade.

My work conveys the idea of memory through the dynamics of image fragments. These fragments form an image tunnel. When an image breaks into fragments, some part of the information is lost. The resolution further degrades when some of the fragments plummet, and leave behind blank spaces. Compared to a higher resolution photo album, fragmented images more closely capture the feeling and actual experience of memory.

I deem memory an inner creature. Therefore, in my work, this aliveness is communicated via a beating motion resembling that of the heart. This creature of images gradually dies as the pieces drop. Additionally, when a viewer goes through the image tunnel, they can interact with the images by pressing a key on a keyboard. This process aims to illustrate the recollection of memory. When the audience interacts with the broken pieces that have not yet fallen, they can try to suture together these remaining fragments and reconcile the original images. However, the warped, collective result will be far removed from the images that these shards once composed; there will be a reduction of perspective, like reverse Cubism. This serves as a metaphor for remembrance.

The framework for this project is left open for further possibilities as it can be filled with various components. In the current iteration, the images are all related to my own life, in the manner of a personal memory gallery. However, it might be more interesting if the audience can upload their own images. In this way, it could become the personal memory of one audience member or the collective memory of a group of people. Thus, the work is a way of reminiscing in ceremony, standing together in the long hallway of this inner world, gazing and participating in the breaking and reconstruction of memories.

The program is written in C++ code using AlloSystem with Cuttlebone.



AUDIO/VISUAL COMPOSITION

David Bowie: Blackstar

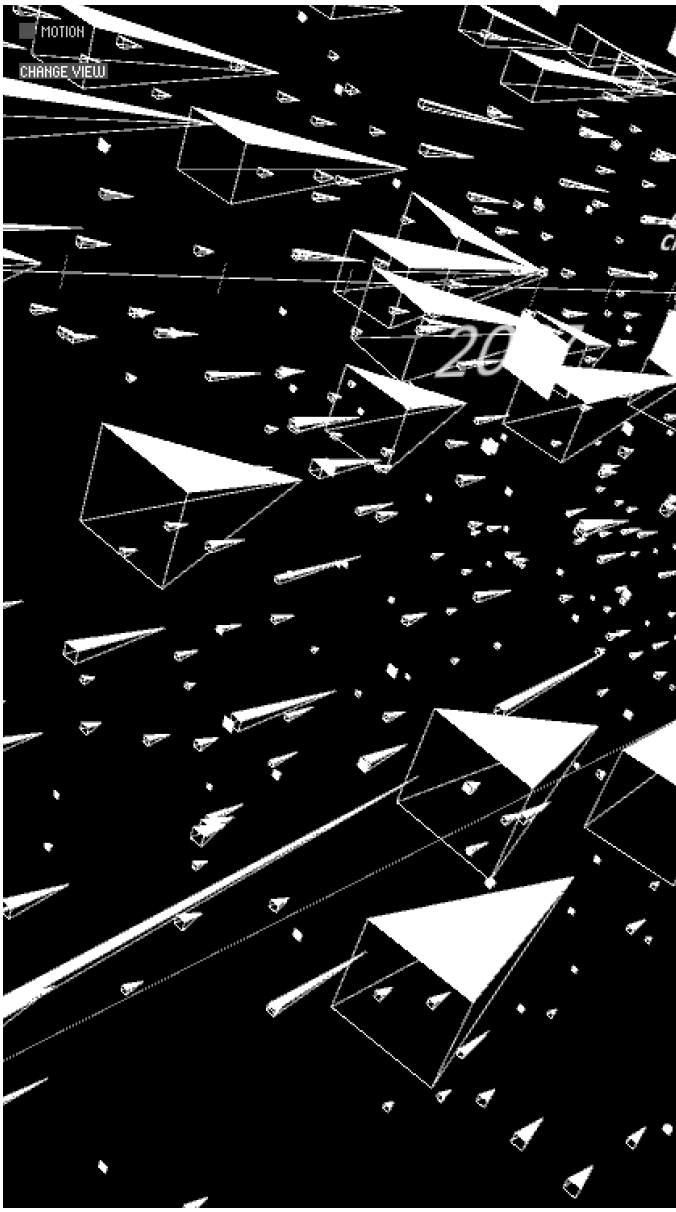
Jing **Yan**

When rock stars die, they are never truly gone. They continue to be memorialized by millions of their fans, music lovers, and the public. Their songs are played again and again, and as cultural icons, their life stories are rediscovered, passed on, and exaggerated year after year.

In this project, I explore the aliveness of David Bowie in the Seattle Public Library, in a quantitative capacity, by examining both the checkout times and checkout durations for David Bowie's CDs and related books, from 2006 to 2015.

This visualization is based on an event-river model, which regards each event as a distinctive creature in a river of time. I find these metaphors of river and fish have a lot of imaginative potential for dynamic visualizations, particularly for investigating this concept of "aliveness." Thus, I've adapted this 2D model into a dynamic and interactive 3D interface.

Regarding the implementation, the river serves as the field for all the events. Its x-axis is a timeline, and the titles of all the relevant works are displayed along the y-axis. Multiple checkout events occurring on the same day for the same titled work are displayed along the z-axis. Each creature is shaped by two parameters: the checkout time and checkout duration. These parameters affect the creature in two ways: its size and its motion. Regarding the creature's size, the checkout duration is mapped to tail length, and the checkout time is mapped to body size. Regarding the creature's motion, the checkout duration is mapped to the tail's swishing angle, and the checkout times are mapped to the frequency of this fluctuation. Though it may seem redundant to map the same information to two sets of attributes, I find that it provides the viewer with a livelier and more intuitive experience of the data.



INSTALLATION

Life is Elsewhere

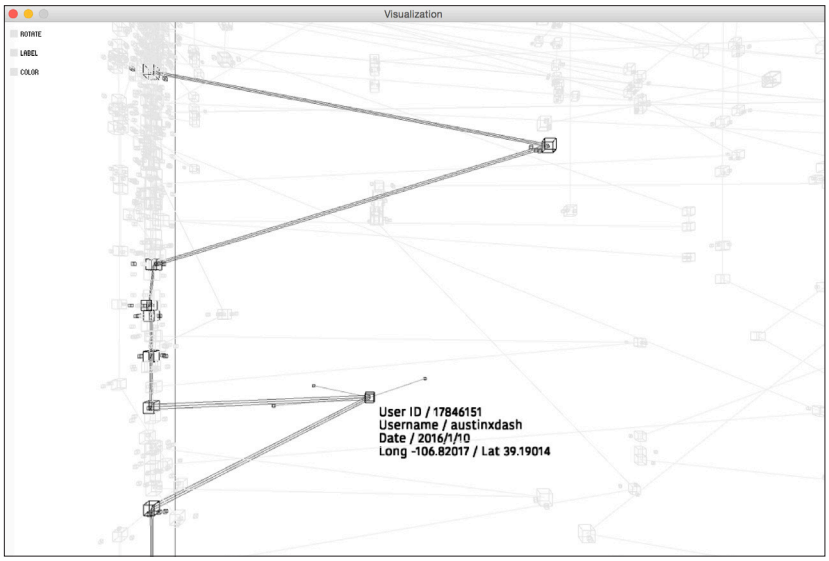
Jing **Yan**

Life is Elsewhere is a data visualization project that aims to explore the relationship between people's spatial trajectories and their social interactions, using the Instagram API. The “elsewhere” represents the remote areas we visit: both changes in geo-location and specific points in time— those “frozen moments” we keep as photos, as some retainable material in the digital world. “Elsewhere” also represents a reflection of ourselves in someone else’s eyes, the trace of our existence in the social world.

This project is based on a three-dimensional space-time cube model to present this temporally dynamic data. The horizontal plane represents geo-location, and the vertical axis represents time, with a map of the United States on this bottom plane and a timeline from 2015.12.01 to 2016.3.14 along the vertical axis. This project follows the activity of around 100 Instagram users within this space-time window. A box/cube is used to represent each Instagram image uploaded by these users, mapped according to the certain location and time at which the image was posted. All the images from a particular user are connected along a single path in order to show the users’ spatial trajectories over time.

Additionally, I combined the space-time model with a galactic metaphor of orbits to represent the virtual social worlds of each user for specific space-time locations. Smaller cubes, rotating around the larger image cube, each represent one comment the user has received on that photo. The radius of the orbit corresponds to the elapsed time between when the photo was posted and when the comment was given. The speed of the orbiting comment box corresponds to the text length of that comment.

As such, one has an almost omniscient view of the virtual and actual experiences of all of these users. Future work could look more closely at the ways that these two types of experiences might influence each other.


Visualization
ROTATE
LABEL
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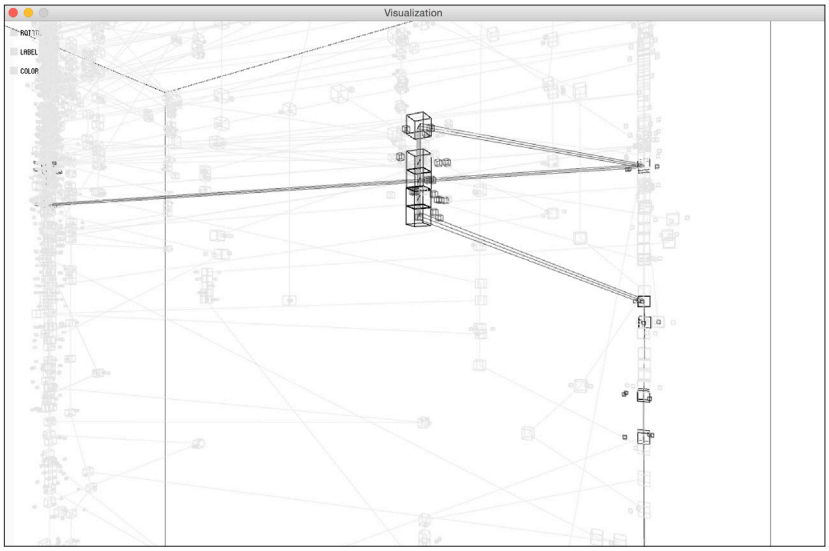
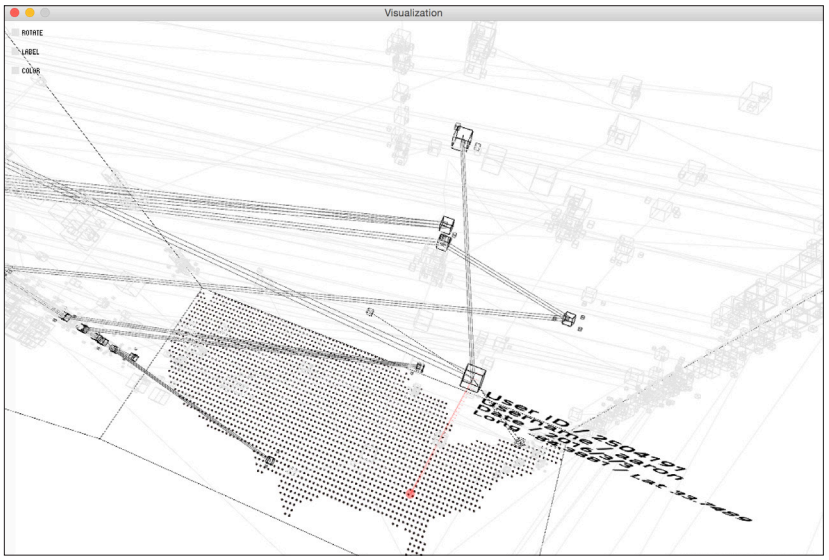
Date / 2016/1/10
Long -106.82017 / Lat 39.19014


Visualization
LABEL
COLOR


Visualization
ROTATE
LABEL
COLOR

Rubik

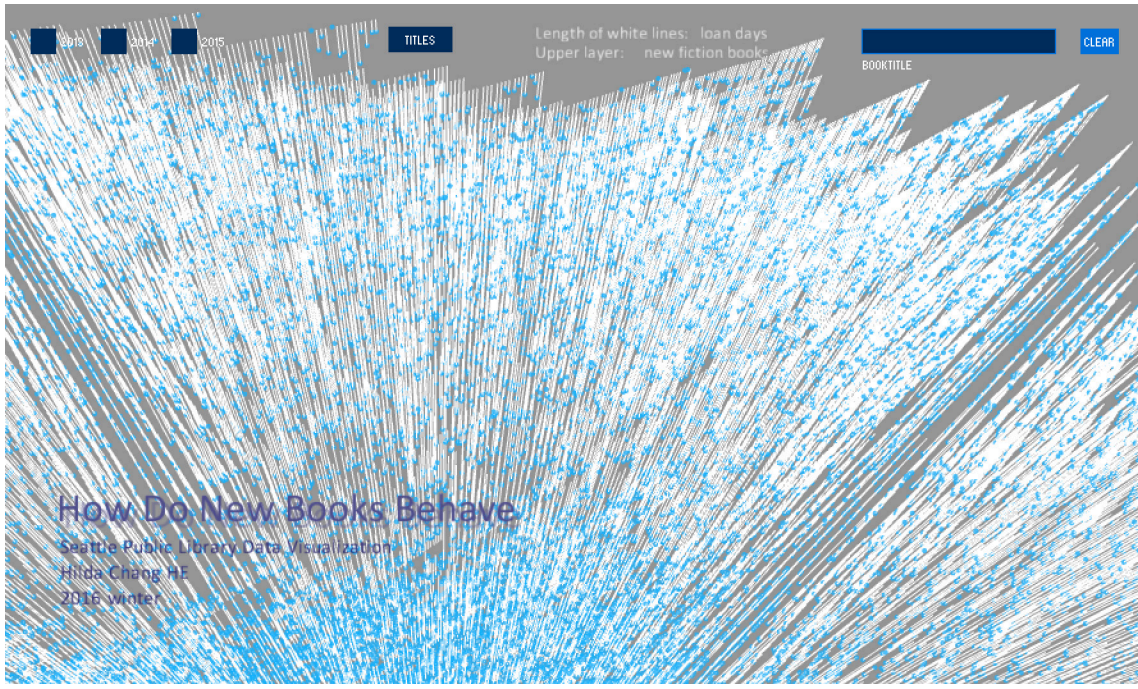
Hilda (Chang) **He**

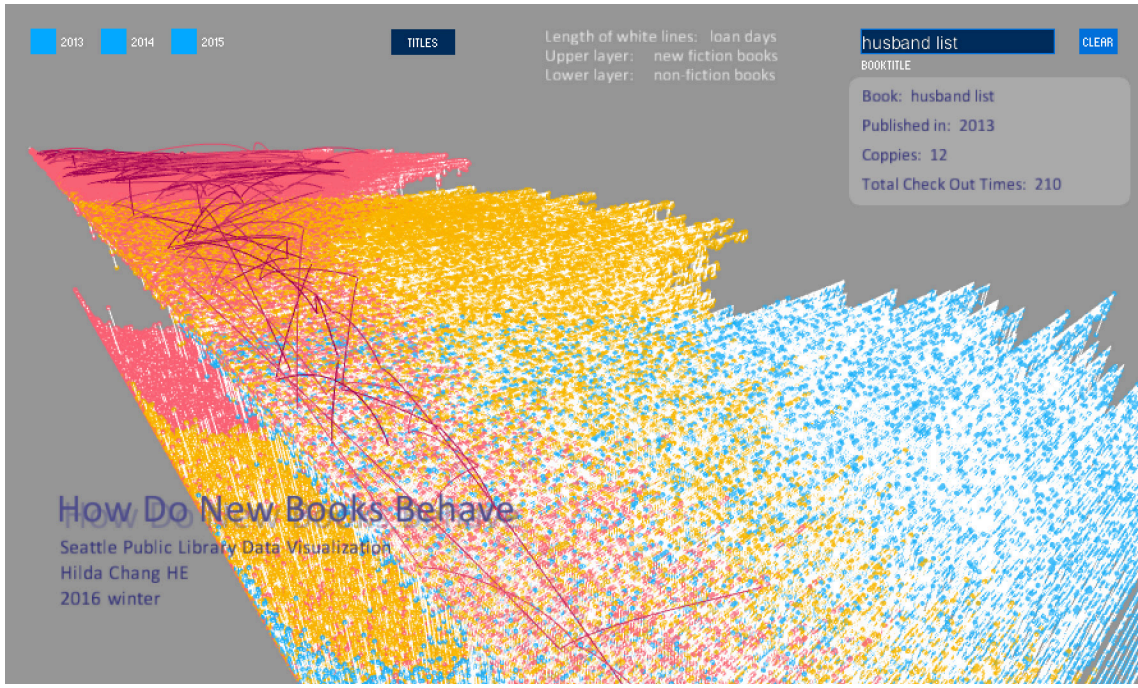
How often should a library buy new books? How many copies of each new book should be acquired? How long should a new item be seen as new? All of these questions are difficult to answer. However, data mining accompanied by a corresponding visualization can provide crucial insight for decision-making, and this is what I try to explore in this 3D data visualization
project, Rubik.

This project not only helps to answer the above questions, it also explores hidden patterns and potential valuable information among the SPL dataset. Additionally, I try to apply a core concept from business intelligence, called an OLAP Cube, to data visualization. An OLAP Cube provides multiple perspectives with different focuses on the same dataset in order to convey more information. I visualize this geometric multi-dimensional notion with real time interaction. This is a relatively novel experiment.
First, I extract all the checkout records of new items from the Seattle Public Library database and represent each item by a white line with a color point at its end. The line's length is determined by the loan duration in days. The line's position is affected by its checkout date and corresponding sequence in that day. I also divide new books based on type (fiction or non-fiction) for clustered analysis and better pattern visualization.

In this way, shapes are formed automatically based on the actual data. Valuable patterns and information can be shown directly and visually. The total data size used in this project is about 56 Mb, which includes over a half million records. Such a big dataset is usually hard to handle in terms of creating a good visualization design. It is also subject to computational limits, especially when dealing with real time interaction and high dimensionality. Because the data set is rather large, the user could get lost in high-level information more easily (from looking at the patterns). Therefore, I implement a searching feature for the user to explore detailed information about each individual book, which makes information about every single book independently meaningful. When a user types in a book title, the system returns all the corresponding records. The user can see how the particular book was checked out by different readers after publication based on the curves shown above the basic shape. Additionally, related information about this book will be shown at the top right corner under the searching text
field.

The results can illustrate valuable information to support decisions for librarians in SPL, such as what proportion of their budgets should be spent on buying different kinds of new items. It gives reasonable predictions with good visual presentation about possible trends for fiction books and non-fiction books. With more data provided from SPL, such as a budget plan and buying behaviors, this project can be further extended in many directions, all of which can reveal hidden information of real worth to support better decision-making.

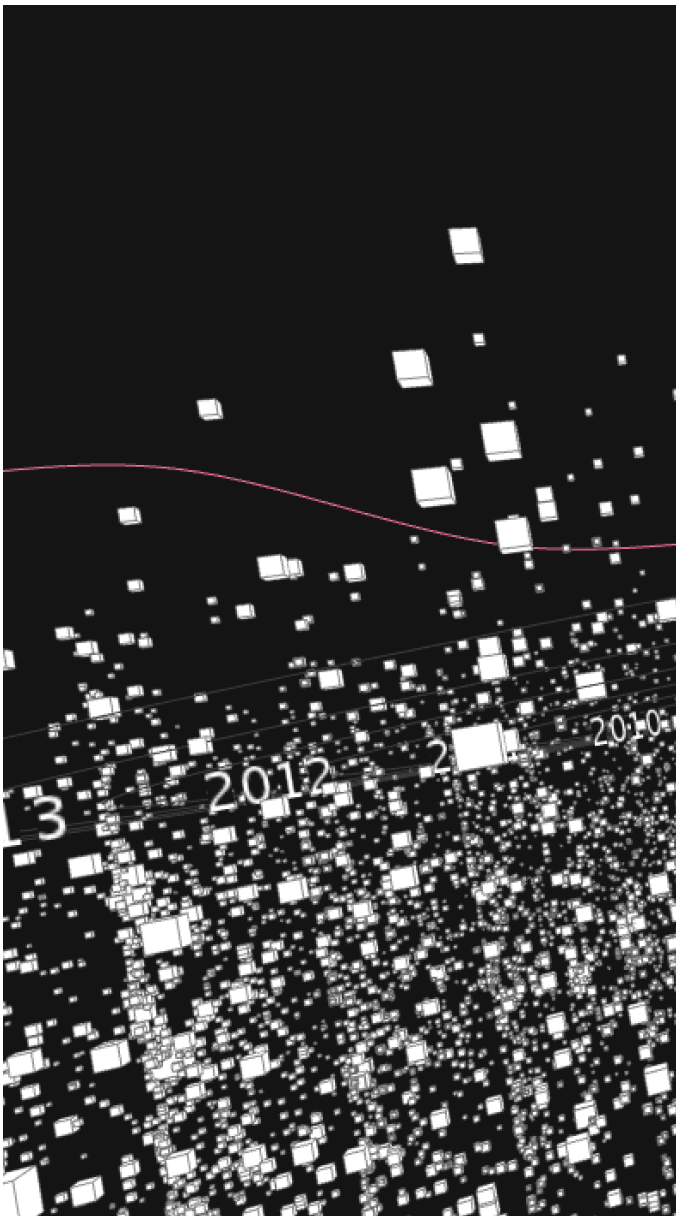

2013
2014
2015
TITLES
Length of white lines: loan days
Upper layer: new fiction books
BOOKTITLE
CLEAR
How Do New Books Behave
Seattle Public Library Data Visualization
Hilda Chang HE
2016 winter


2013
2014
2015
TITLES
Length of white lines: loan days
Upper layer: new fiction books
Lower layer: non-fiction books
husband list
BOOKTITLE
CLEAR
Book: husband list
Published in: 2013
Coppies: 12
Total Check Out Times: 210
How Do New Books Behave
Seattle Public Library Data Visualization
Hilda Chang HE
2016 winter

Film Adaption Influence

Lu **Liu**

Film Adaption Influence is an interactive data visualization that explores the library check-out trends of selected fiction novels following the theatrical releases of their film adaptations. This three-dimensional visualization draws from over 20,000 check-out records from the Seattle Public Library over the past ten years, focusing on four books adapted into films released in 2006, 2009, 2012, and 2014, respectively. This project conveys the remarkable impact that adapted films have in promoting the popularity of their corresponding books.




8:00
9:00
10:00
11:00
2009
2008
2007
2006
13:00
14:00
20:00

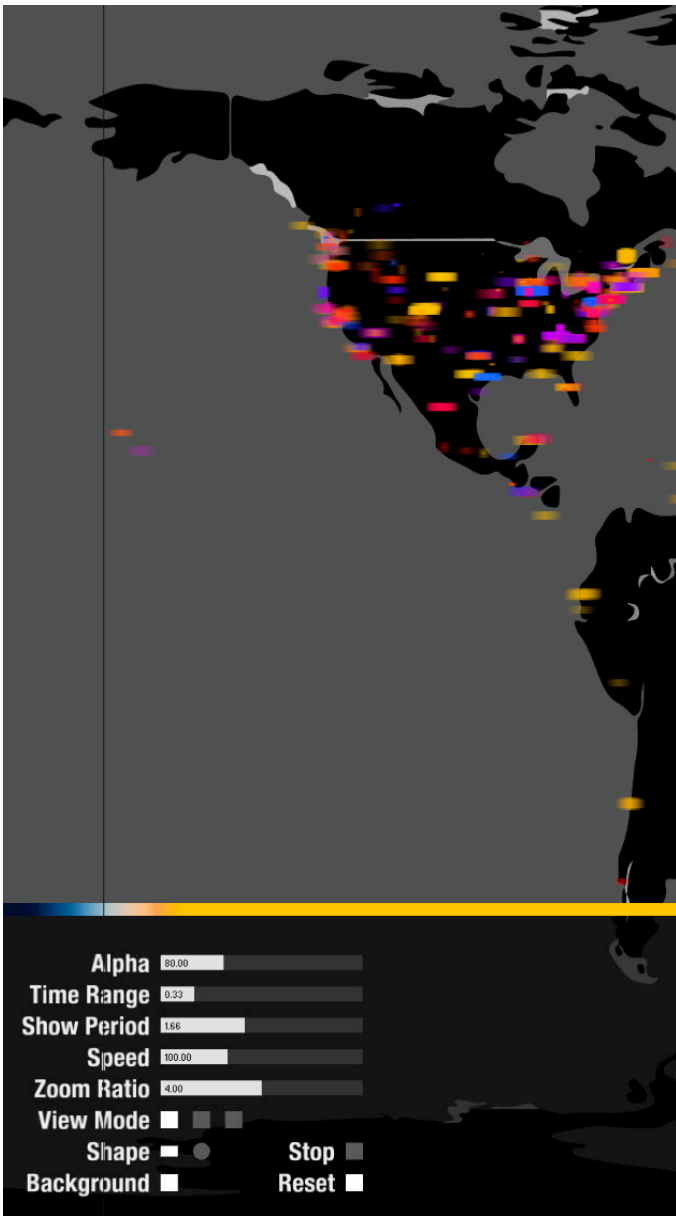
Exposure & Light

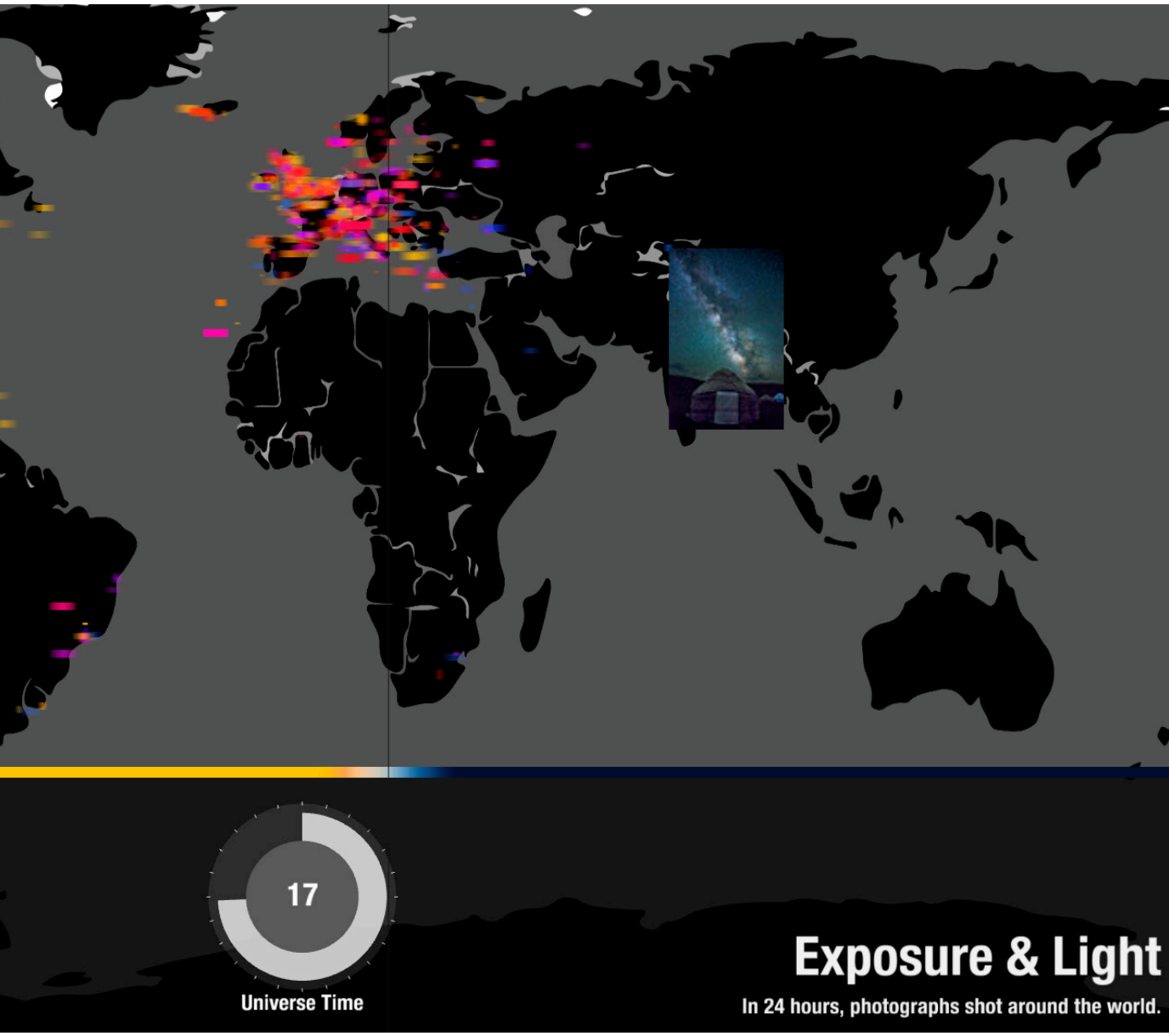
Weihao **Qiu**

Taking photos has become so habitual in modern society since the introduction of digital photography that it has resulted in countless images posted online. This global engagement with image-making made me curious about how those photographs were distributed spatially (over the globe) and temporally (over the day). I also wondered about how lighting condition changes impacted photo-taking frequency, especially at sunrise or sunset when the most dramatic visual scenes occur.

"Exposure & Light" is a data visualization project consisting of 200,000 photographs retrieved from Flickr taken over a 24-hour period. The photographs are arranged on a world map based on their EXIF data including geographic location, shooting time, and camera settings such as aperture, exposure time, and ISO. Each photograph is represented as a colored rectangle, placed according to its geographic location. A rectangle's color is determined by the photograph's exposure value, ranging from blue to red to yellow. Images with low exposures are colored blue, increasing through to red, to orange, and to yellow for high exposures. An animation cycles through the hours of the day. Photographs become visible based on their specific time-zone stamp. Users can control a time wheel to switch between different times. Also, users can see the actual photos by rolling over each colored rectangle.

Through the panorama of worldwide photography activity, and based on the images I have collected, I have found that more pictures are taken during free time, such as lunch and after-dinner, and taken in more developed areas such as Europe, Japan, and the East and West Coasts of the United States. Furthermore, the changing colors throughout the day reveal the intimate relationship between photography and light: cameras are usually set to shoot with exposure values proportional to lighting conditions, except at midnight, when pictures are taken with high exposure values to brighten dark scenes.



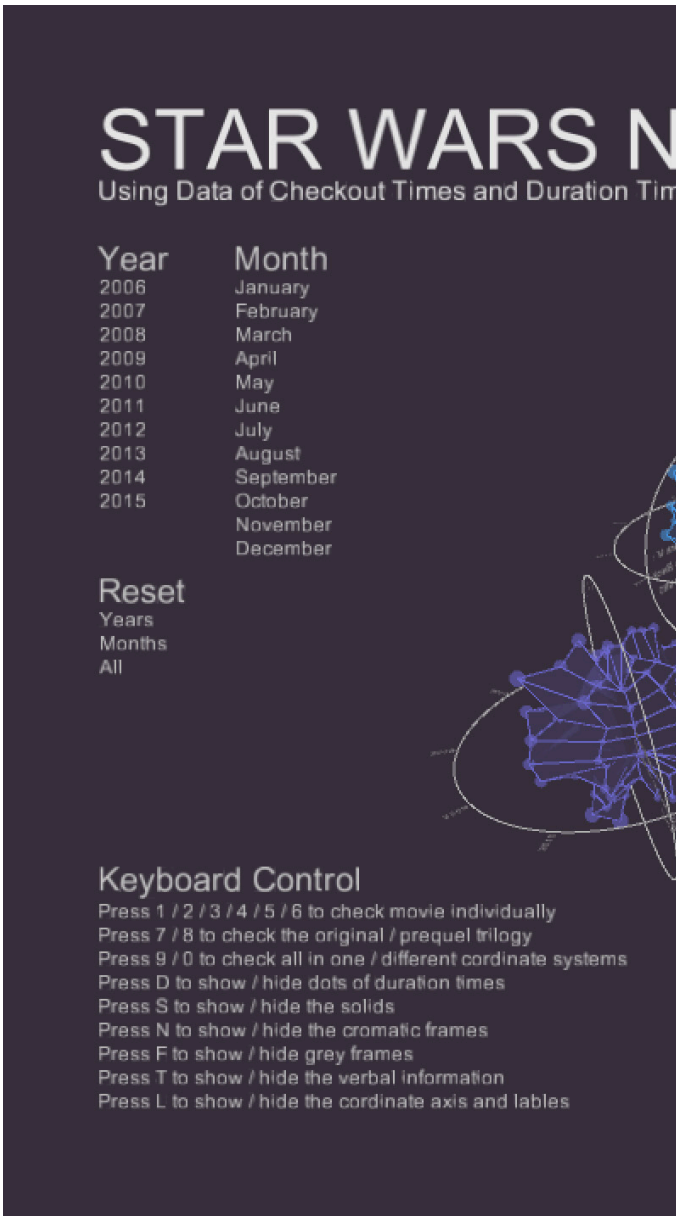

17
Universe Time
Exposure & Light
In 24 hours, photographs shot around the world.

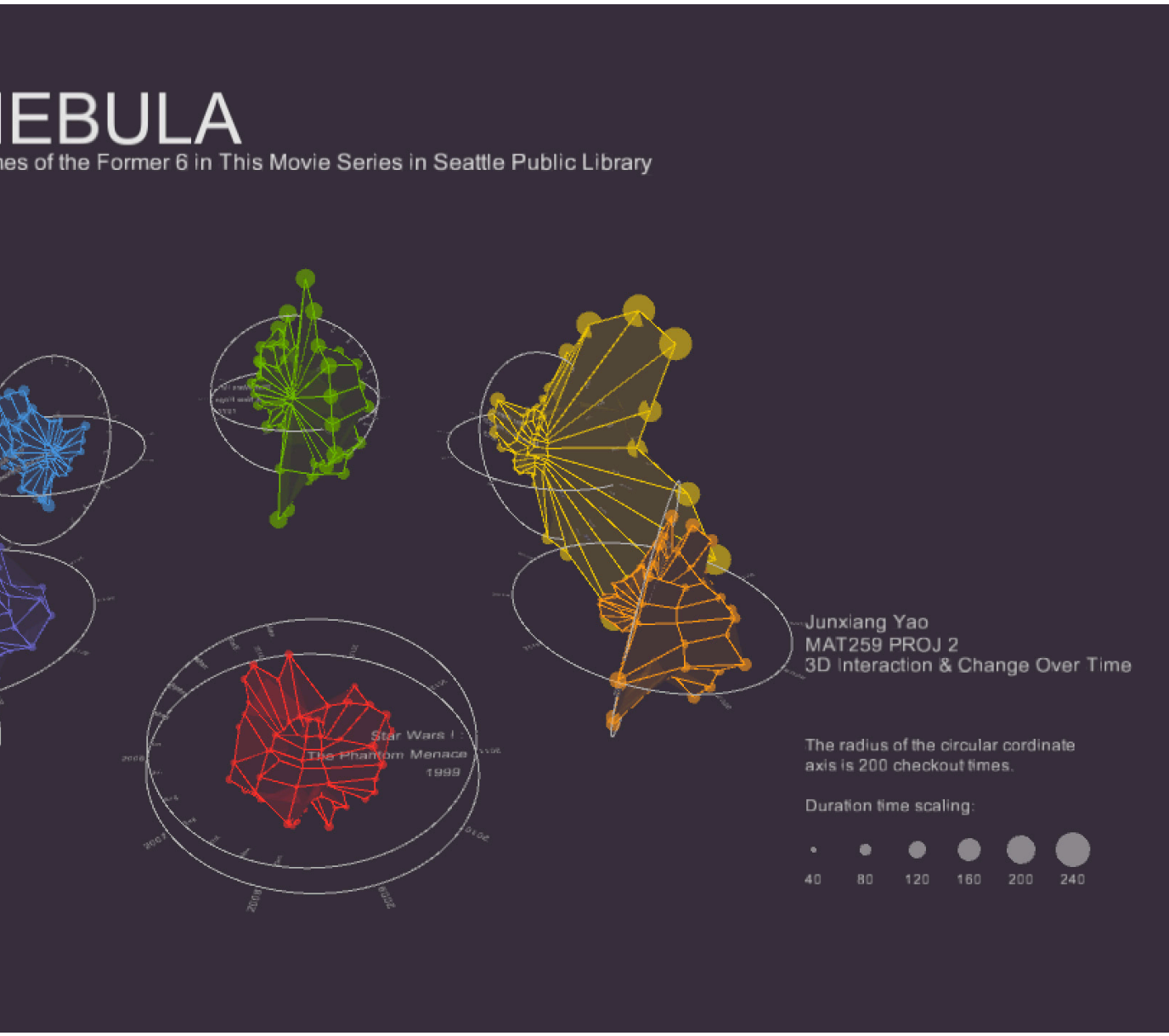
Star Wars Nebula

Junxiang **Yao**

This project visualizes Star Wars checkouts from the Seattle Public Library (SPL). I was curious about the patterns of the checkout times of the former 6 movies in this movie series, and to present this data in a new way. I chose years, months, movie titles, checkout times, and duration times as the columns I used in the visualization, and I tried different ways to visualize this data.

I wanted to create a sphere-like structure. The latitude of the structure represents the month, and the longitude of the structure represents the year. The two axes of a rectangular coordinate system are mapped into two circles drawn on two perpendicular planes. The months are aligned vertically along the left half of the vertical circle, and then rotated ten times horizontally to display information about ten years. I drew dots to display the data of each month in the data set. The dots in the same year have the same longitude, and the dots in the same month but in different years have the same latitude. The distance between dots and the center of the sphere shows the checkout times in that month, and the radius of the dot shows the total duration time of the item in that month. To clarify the pattern, I drew lines to connect the dots and its neighbors. And to distinguish the 6 movies, I used 6 different colors. Warm colors were used to present the data of the prequel trilogy, and cold colors were used to display the original trilogy.




EBULA
es of the Former 6 in This Movie Series in Seattle Public Library
Star Wars I :
The Phantom Menace
1999
Junxiang Yao
MAT259 PROJ 2
3D Interaction & Change Over Time
The radius of the circular cordinate
axis is 200 checkout times.
Duration time scaling:
40
80
120
160
200
240

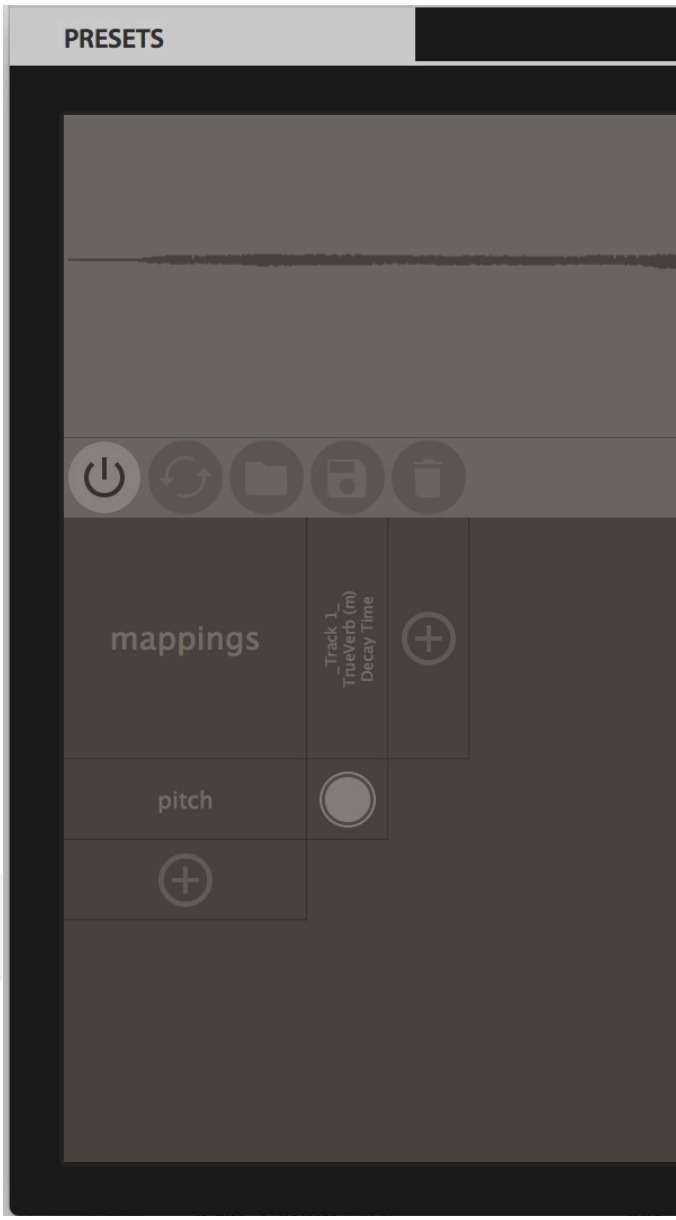
DEMO

ADEPT

Owen **Campbell**

ADEPT (Adaptive Digital Effects Processing Tool) is an audio analysis plugin created to facilitate adaptive digital effects processing within digital audio workstations (DAWs). It allows the user to create arbitrary mappings between musically salient audio features (such as pitch) and the parameters of other audio processing plugins (such as the decay time on a reverb plugin). Intended use cases are automated mixing and sound design. ADEPT was built to operate in real time, making it useful for both studio production and live performance.

Aside from simply offering mixing engineers an additional means of automating certain tasks, ADEPT aims to open up a world of new sonic possibilities for musicians, producers, and sound designers. Techniques that would otherwise require the active manipulation of MIDI controllers can be executed automatically, thus freeing hands, feet, and attention during musical performance. It affords users a level of control over their effects processing and digital synthesis modules impossible to achieve with conventional tools.



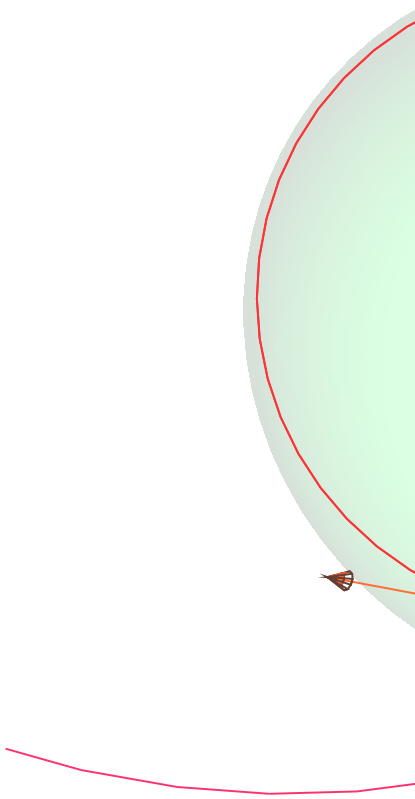

(ADEPT
pitch
Track 1
TrueVerb (m)
Decay Time
520.17
0.69
44.48
0.0
Skew
Polarity
Skew
0.2
0.2
Steps
Smooth
–
0.82

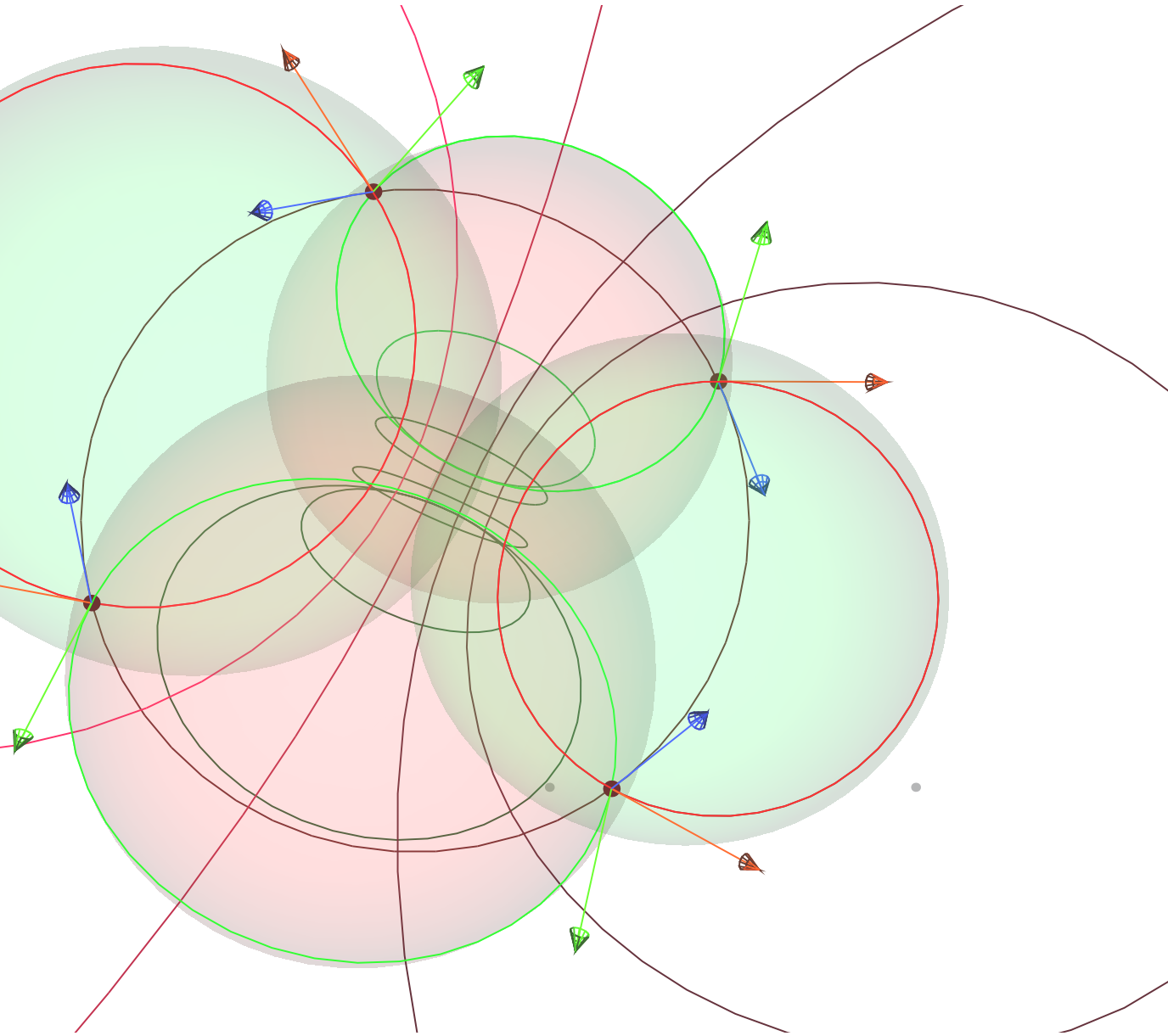
DEMO

The Knot

Pablo **Colapinto**

A sequence of hyperdimensional transformations, The Knot is an AlloSphere composition that utilizes at least six distinct MAT-grown software frameworks for audio-visual design that contribute to the AlloSystem software archipelago. The first is VERSOR, an optimized geometric algebra engine for spatial computing designed by Pablo Colapinto. The second is his OHIO, a functional reactive engine for combining events and behaviors into a expressive system. The third is OMNIRENDER, the AlloSphere's immersive 3D graphics visualization pipeline based on work by MAT student Graham Wakefield. The fourth is GAMMA, MAT student Lance Putnam's audio synthesis library. The fifth is CUTTLEBONE, MAT student Karl Yerkes' state-synchronization library. The sixth is INTERFACE SERVER, MAT student Charlie Roberts' scriptable controller model. The result is an immersive and interactive real-time audio-visual work that allows us to enter cryptic spaces. This work is supported by Robert W. Deutsch Foundation, via the AlloSphere research lab, directed by Dr. JoAnn Kuchera-Morin.





AUDIO/VISUAL COMPOSITION

Forces of Nature 2.0

Paul **Jacobs**

Forces of Nature is a reusable platform of custom-built hardware and software for creating software-defined kinetic sculpture. A two-dimensional array of high-energy electromagnets synchronized by a micro-controller project an animated electromagnetic field, visualized in ferrofluid. The complex beauty of physics is revealed by combining the effects of the processed human inputs driving the magnet array, gravity, the effect of the magnetic field on the ferrofluid, and fluid dynamics.

Timing is a composition written for Forces of Nature, a short story of love and loss told in magnetic field timings and interaction with gravity. An exploration of human-machine-artwork-human interaction, starring ferrofluid as the cast of lead and supporting actors, as it makes visible the hidden script of magnetic movement with a high-level elegance that twerks the imagination. Audio refreshment may be provided.

Special thanks to CZFerro for donation of ferrofluid vessel materials and technical assistance.

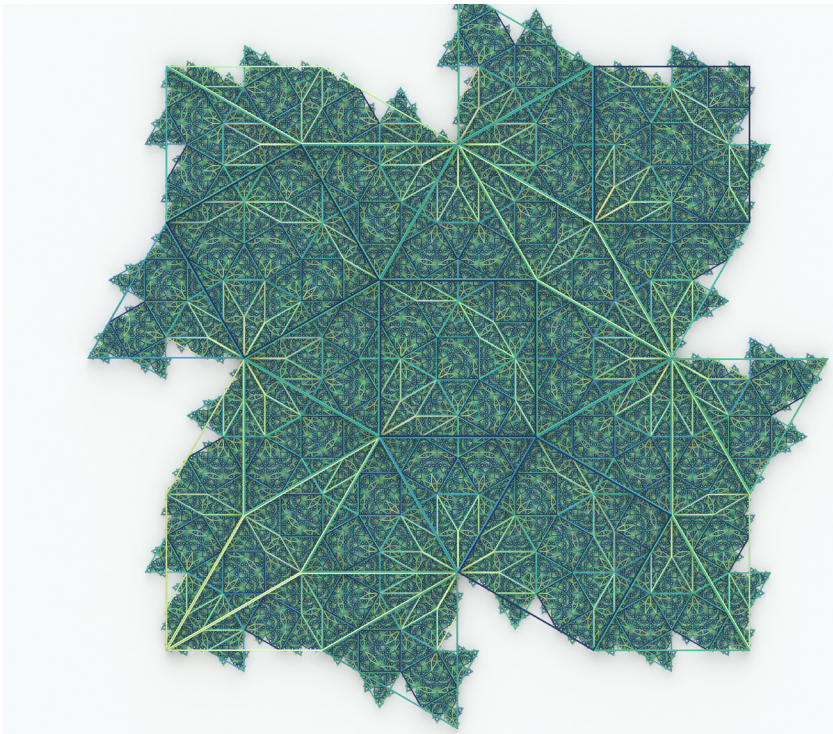
Folded Wires

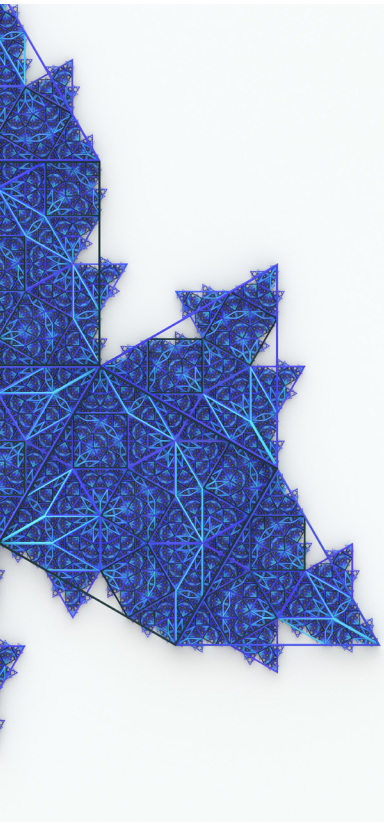
Kurt **Kaminski**

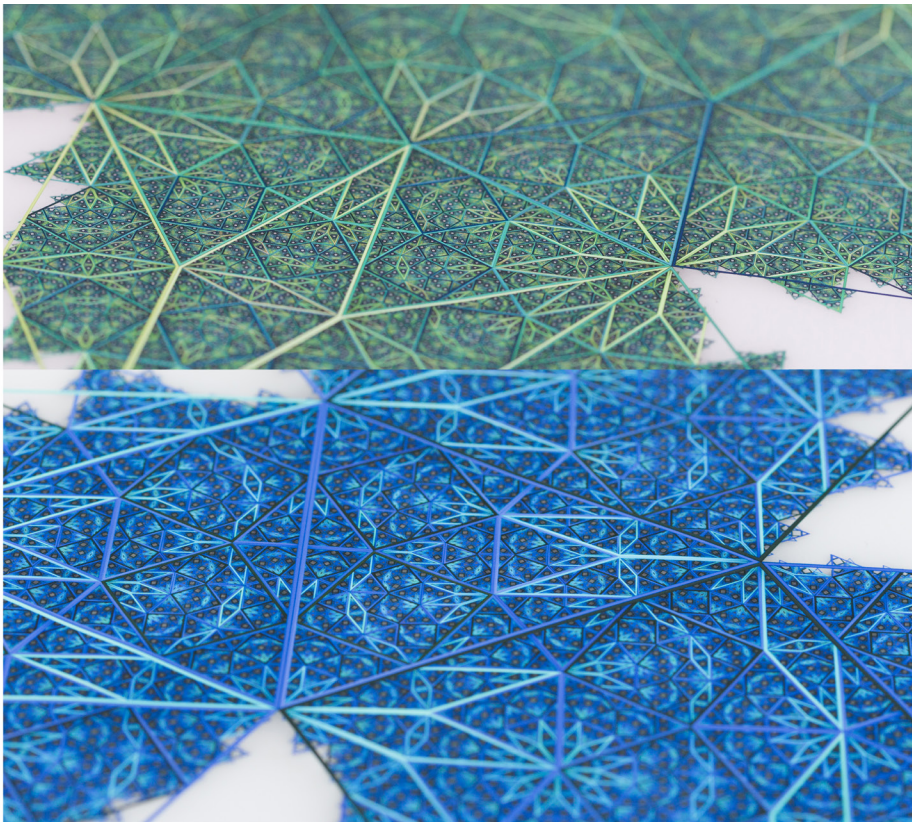
Aperiodic tilings are geometric subdivisions of a surface with no large scale repetition. The most famous example is the Penrose tiling, but many more exist through substitution rules and cut-and-project methods. The process of substitution requires that a set of initial shapes, or prototiles, can be reconstructed by scaling, translating, and rotating combinations of other prototiles. Simply, a rule is a tile that is made up of smaller tiles. This rule becomes a replacement, or is substituted for, shapes in other rules, ad infinitum, thus producing the aperiodic tiling. Each iteration can be thought of as equivalent to a fractal dimension.

I became interested in aperiodic tilings after learning of their presence in both Islamic architecture and the quasicrystalline atomic lattice of certain materials. The large corpus of tiling rules begs aesthetic study, many seeming to synthesize medieval motifs with the complexity of CAD software. Aperiodic tiling has many artistic applications including textile design, sonification, texture synthesis, digital sequencing, and algorithmic art.

These pieces are based on the Watanabe Ito Soma 12-fold tiling and its three prototiles: a square, an equilateral triangle, and a diamond. By overlaying tubular frames derived from 4 iterations of a single prototile, the initial rule hovers above an array of increasingly granular interrelationships, guiding the eye in discovering new patterns and connections. In the Watanabe tiling, its rules do not match the silhouette of the affiliate prototile, leaving some vertices outside the original window. This excess aligns and overlaps perfectly on the internal structure, but produces interesting jagged borders when iterated. The visual effects software Houdini was used to generate the geometry and render the images. Careful use of color and lighting, with a touch of stochasticity, highlight multilayered rhythms and harmonies produced by the algorithm. Folded Wires will be on display at the 2016 Bridges Mathematical Art Exhibition in Jyväskylä, Finland.







HIVE

Şölen **Kiratli** / Akshay **Cadambi** [**RE Touch** Lab]

funded in part by Interdisciplinary Humanities Center

HIVE is a sculptural sound instrument, in which the sound design and spatial geometry are approached as a unified notion. By creating a harmony between the structural features, physical acoustics, and the sound design, the object simultaneously contains, emanates, and is, in fact, a soundscape. This hybrid system uses embedded multi-channel audio and digital fabrication techniques to create a 360° divergent sound field, and further morphs it using acoustical waveguides. The sound design adds a layer of sonic choreography that serves to accentuate the structure of the object, imploring the viewer to explore it— as one would while exploring a real-world soundscape.

FRAGMENTS

Jieliang **Luo** / Keehong **Youn**

This project provides a unique experience for the audience to observe cubism in real-time multi-viewpoint video, which is produced by mixing three different scenes using OpenGL fragment shader functionality. Pixel columns from each scene alternate horizontally, aligning like a lenticular film. Because each frame of each scene only presents 1/3 of the information, proper pixel sampling with filters are needed to smoothen the image. The whole part of this process is done in real time, including the three-dimensional rendering of each scene. The rendering of each scene involves capturing one common object from many different configurations, using different camera positions with different lens simulations. These captured views are stitched together into three scenes to introduce a method in cubism: combining different perspectives into one view.

In terms of content, the process begins with randomly taking portions of several featured cubism paintings and reconstructing the segmentations in 3D space following a modified Convex Hull algorithm to create an asymmetric structure with different regions of cubism paintings textured on each panel. This 3D structure is later used as a model for re-creating 2D images in a new sense of cubism.

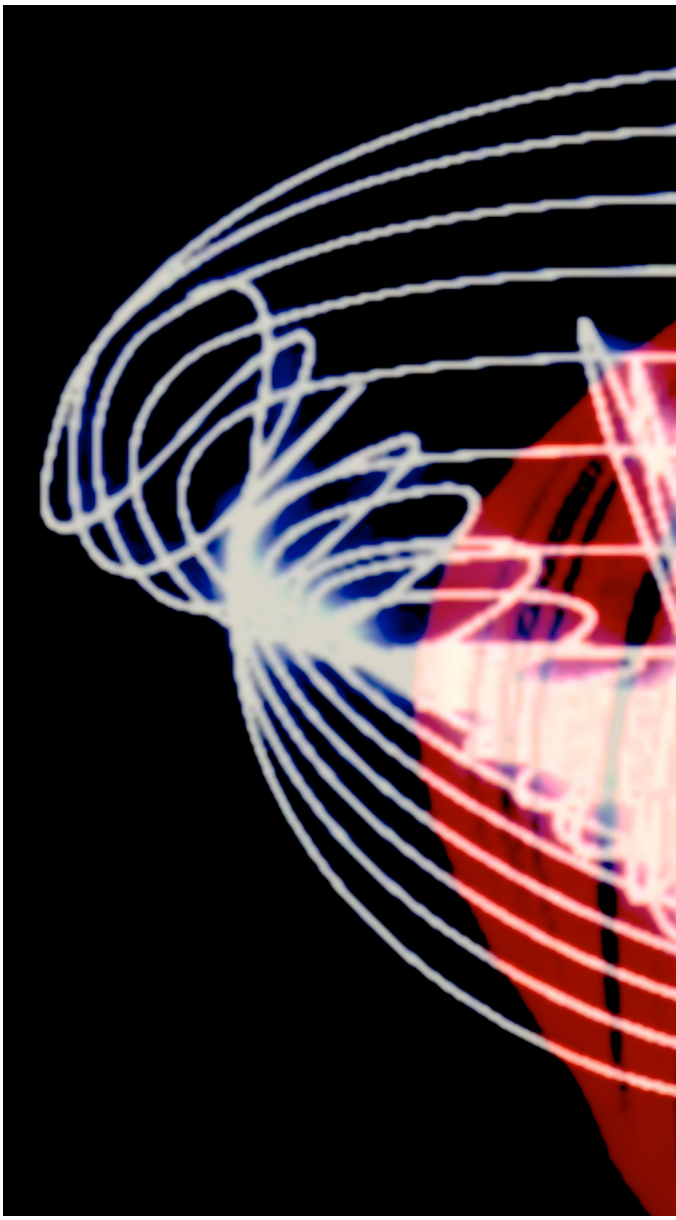
INSTALLATION

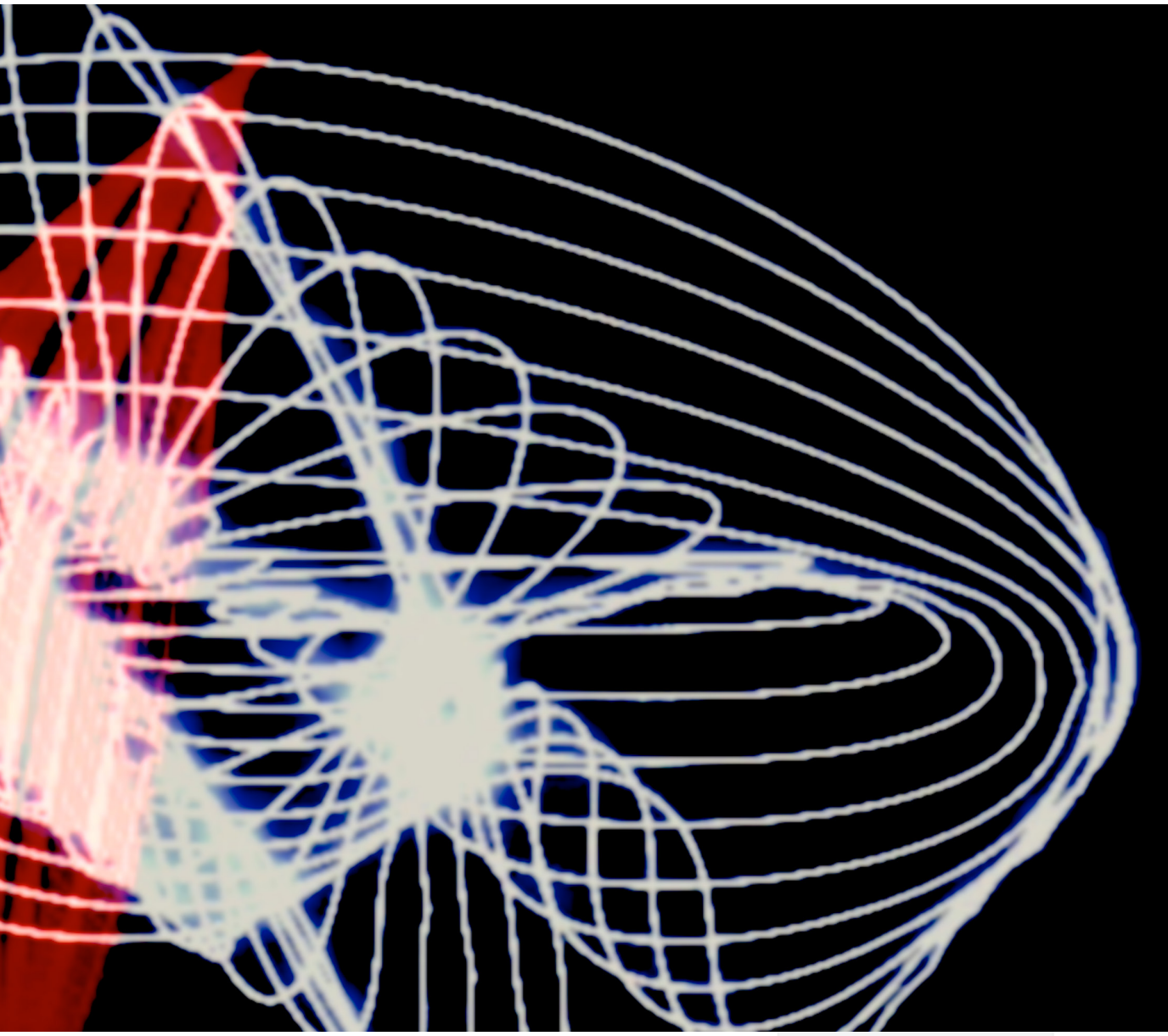
Kinetic v3

Ryan **McGee**

In 1962, Karlheinz Stockhausen's "Concept of Unity in Electronic Music" introduced a connection between the parameters of intensity, duration, pitch, and timbre using an accelerating pulse train. In 1973, John Chowning discovered that complex audio spectra could be synthesized by increasing vibrato rates past 20Hz. In both cases, the notion of acceleration to produce timbre was critical to discovery. Although both composers also utilized sound spatialization in their works, spatial parameters were not unified with their synthesis techniques. Spatial Modulation Synthesis is a novel, physically-based control paradigm for audio-visual synthesis, providing unified control of spatialization, timbre, and visual form using high-speed sound trajectories.

Kinetic v3 is the third study of Spatial Modulation Synthesis in the AlloSphere. Focusing on contrast between polyphonic audio-visual harmony and granular noise, spatial sound timbres and their visualized trajectory orbits immerse the listener to create a 5 minute work of immersive visual music.





AUDIO/VISUAL COMPOSITION

The Exorcism of Elings Hall

Samuel **Dong** / Nataly **Moreno**

The Exorcism of Elings Hall is an augmented reality installation set on the third floor of Elings Hall. Ghosts have possessed some of the objects on the third floor. The player is to investigate the situation and exorcise all of the ghosts from Elings Hall. Once they have found all of the clues, the player will discover the true purpose of the ghosts and their mysterious leader. Through this game, techniques in designing effective augmented reality experiences are demonstrated. The installation focuses on increasing immersion, even on a personal smartphone or tablet. It does this by taking the weaknesses of current augmented reality libraries and integrating them into the game mechanics. By designing the installation around these limitations, the experience seems more engaging and avoids breaking the player's suspension of disbelief.

INSTALLATION

Hello, My Dear

Sahar **Sajadieh** / Nathan **Weitzner**

In our daily interactions with technology, we have accepted digital reproductions of others' voice and image as alternatives to the real ones. Hello, My Dear is a participatory durational performance piece, which explores the new dynamics of human interaction in telecommunication and the significance of the co-presence of another human on the other side of the telematic medium. The piece examines human perception and sensitivity to detect the immediacy of interaction and physiological responses during encounters mediated by telecommunication.

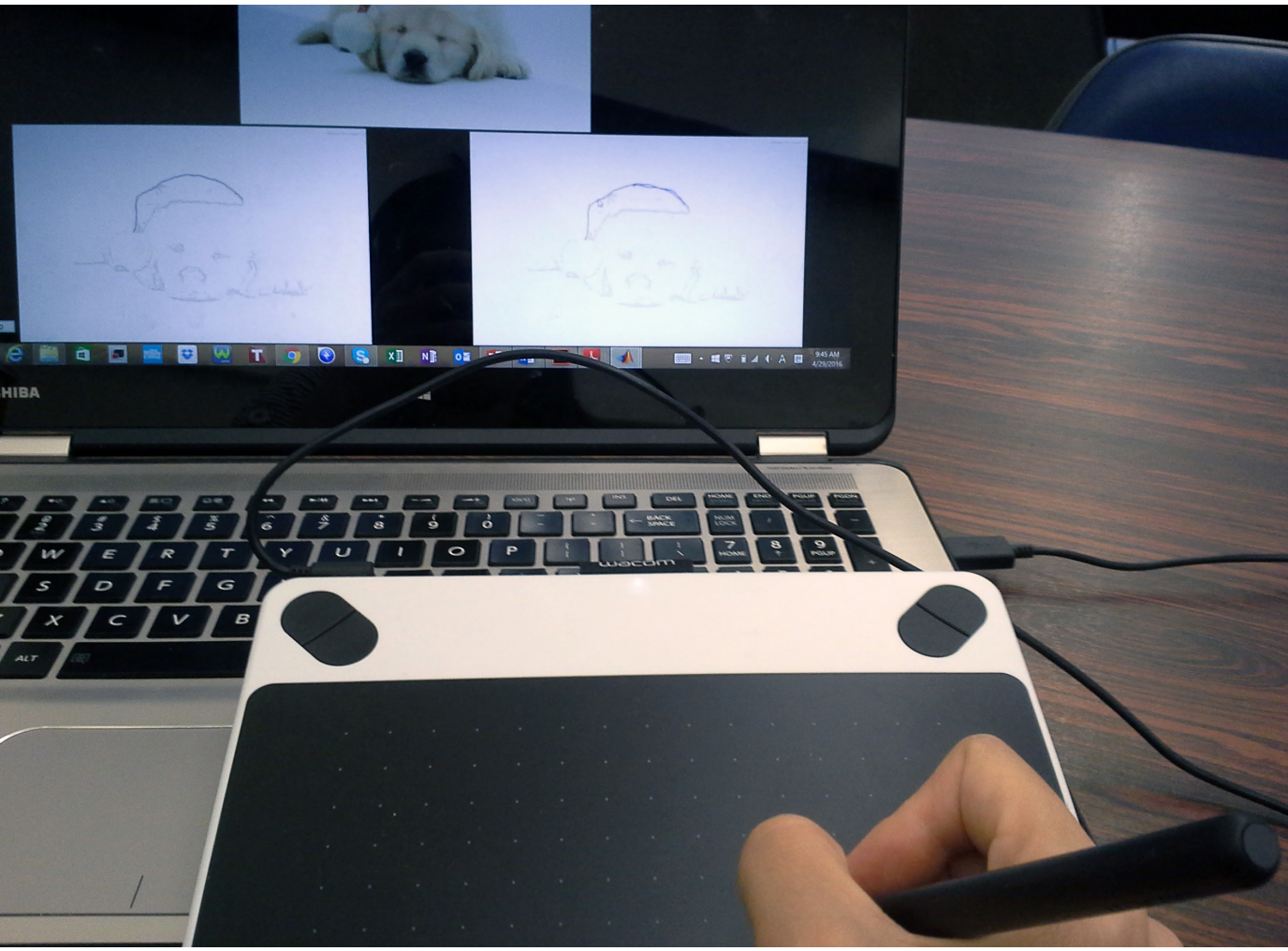
Hello, My Dear is a theatrical Turing Test, which interrogates the notion of liveness in telepresent interactions by challenging the boundaries between recorded and live, presence and absence, and private and public. In this piece, participants enter separate rooms at the same time, sit behind the computer stations, and follow the main instruction: "sit silently and maintain eye contact with the person on the screen in front of you." They go through various modes of liveness, in interaction with each other and the artist. The interactions are solely non-verbal, since there is no audio in the video-mediated communications. This interactive performance piece seeks to simulate digitally-mediated liveness in video communication and examine the spectator's perception of the presence of the other body on the other side of the digital medium.

Draw Objects

Jungah **Son**

Our brain is known to be more dedicated to processing vision than to any other mental task. As such, expressing ourselves visually can be a compelling and engaging means to convey ideas and thus expand our perception of the world. The ability to draw is useful to this end [1]. The artist Joshua Bienko states that in order to make drawings look realistic, a novice drawer should learn how to draw what s/he sees over what s/he perceives. One of the challenges novice drawers face is in drawing the outline. The main objective behind this project is to produce a drawing assistance system that assists the contour drawing of objects for such novice drawers. The user interface of the system consists of three components: two reference images, of the original image and its edge-detected version with the reference stroke as a guide, and a drawing area. The system gives assistive feedback or guidance on drawings by the stroke-correction algorithm [2]. The algorithm first re-samples the user's stroke so that it contains the same number of vertices as the reference stroke. Then, a new stroke, which is defined as linear interpolation between each pair of corresponding points of the reference and user strokes, is generated. The ultimate goal of designing an assistive interface is to design a realistic learning environment, perceived as a digital teacher, that reduces frustration with the technology and that helps users gain immediate confidence in learning to draw.

[1] D. Dixon, M. Prasad, and T. Hammond. iCanDraw?:using sketch recognition and corrective feedback to assist a user in drawing human faces. In. Proc. Int'l. Conf. on Human Factors in Computing Systems, 897-906, 2010.
[2] J. Fernquist, T. Grossman, and G. Fitzmaurice. Sketch-sketch revolution: An engaging tutorial system for guided sketching and application learning. ACM User Interface Software and Technology, 373-382, 2011.



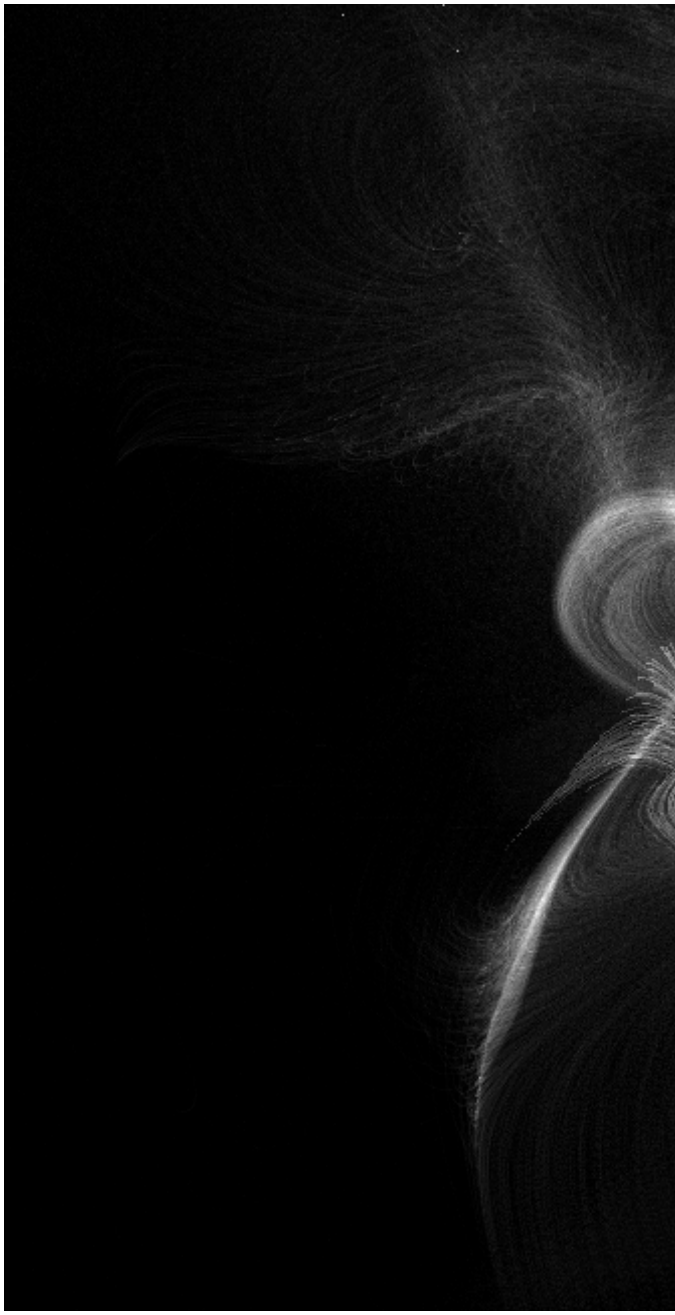
DEMO

Becoming Light

Timothy **Wood**

Becoming Light is an immersive world made for the transLAB. As a performance, a solo dancer explores a world of light and sound on a path through memory and dream-like space. The motions of the dancer are remembered and re-encountered as ghost-like storytellers along the journey. It is the movement of the body that reveals recorded words and poetry. The shape, timing, and velocity of the body changes the way the story is told. I also plan to run it as an installation, where multiple participants work together to navigate the world.

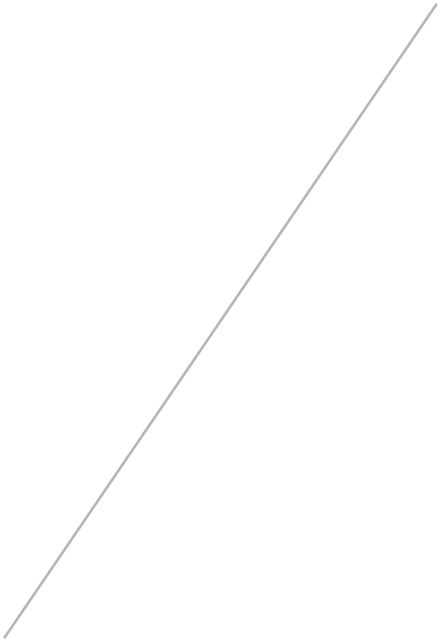
This project is an exploration in performance worldmaking, a practice of sharing digital worlds through performance and interaction with an audience. The goal is to create a bridge between our reality and our bodies into a virtual world of personal stories. What does the body know? What stories and what secrets does the body keep inside its cells? How do we create and remember these stories with our bodies? How do we change our reality with our bodies? How do we share secrets that may be beyond words?

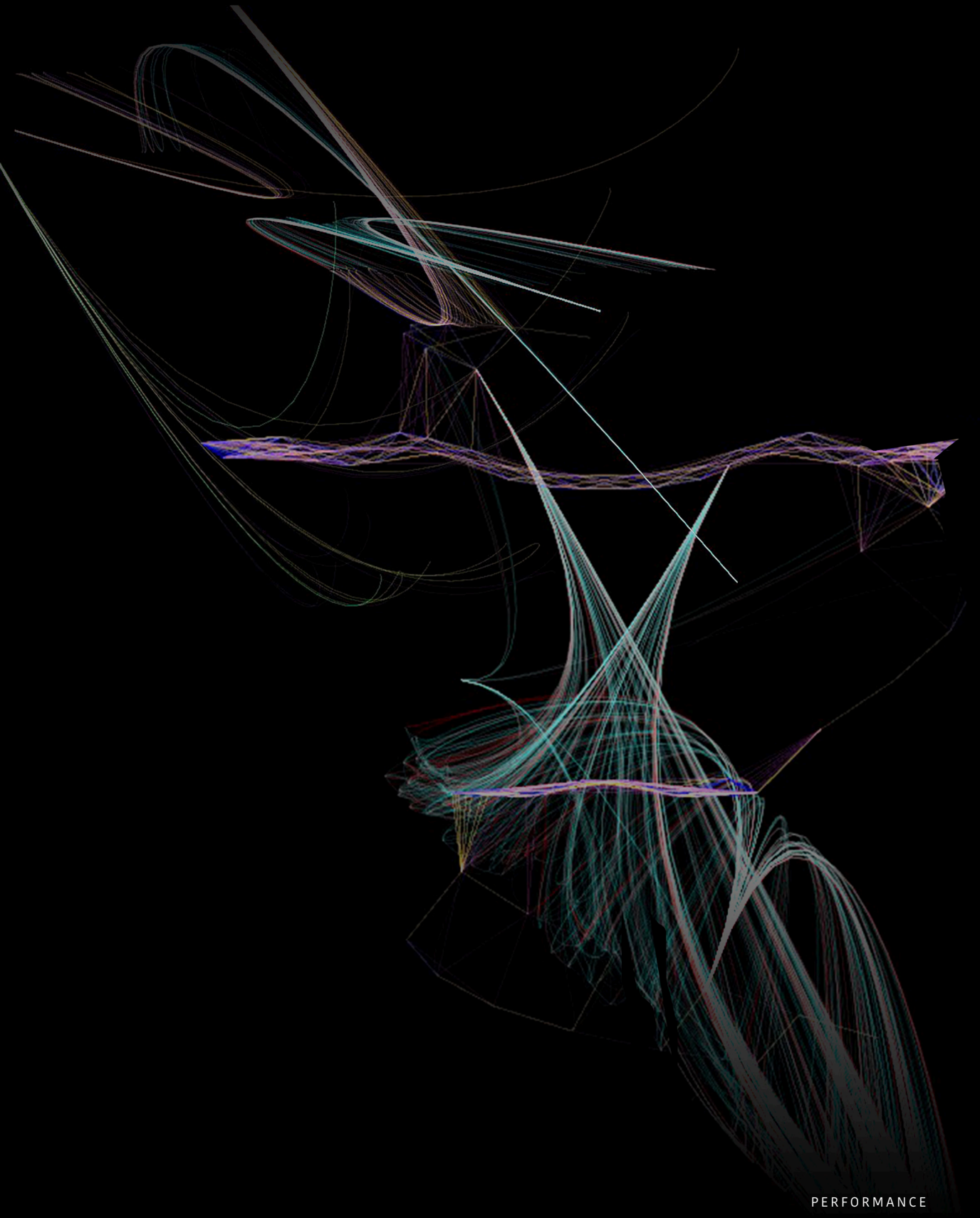


Matrix

David **Gordon**

Matrix is an 8-minute performance of live-generated electronic music and visuals. The performer chooses a scale, rhythm and number of voices to begin. Then, the software then generates a set of short melodic cells. During the performance, using a graphical interface, the performer triggers the melodies and shifts between scales, rhythmic patterns and contrapuntal textures. The sound is accompanied by live visuals that associate the motion of abstract shapes with the harmonic ratios between the notes, an approach influenced by John Whitney's theory of digital harmony.





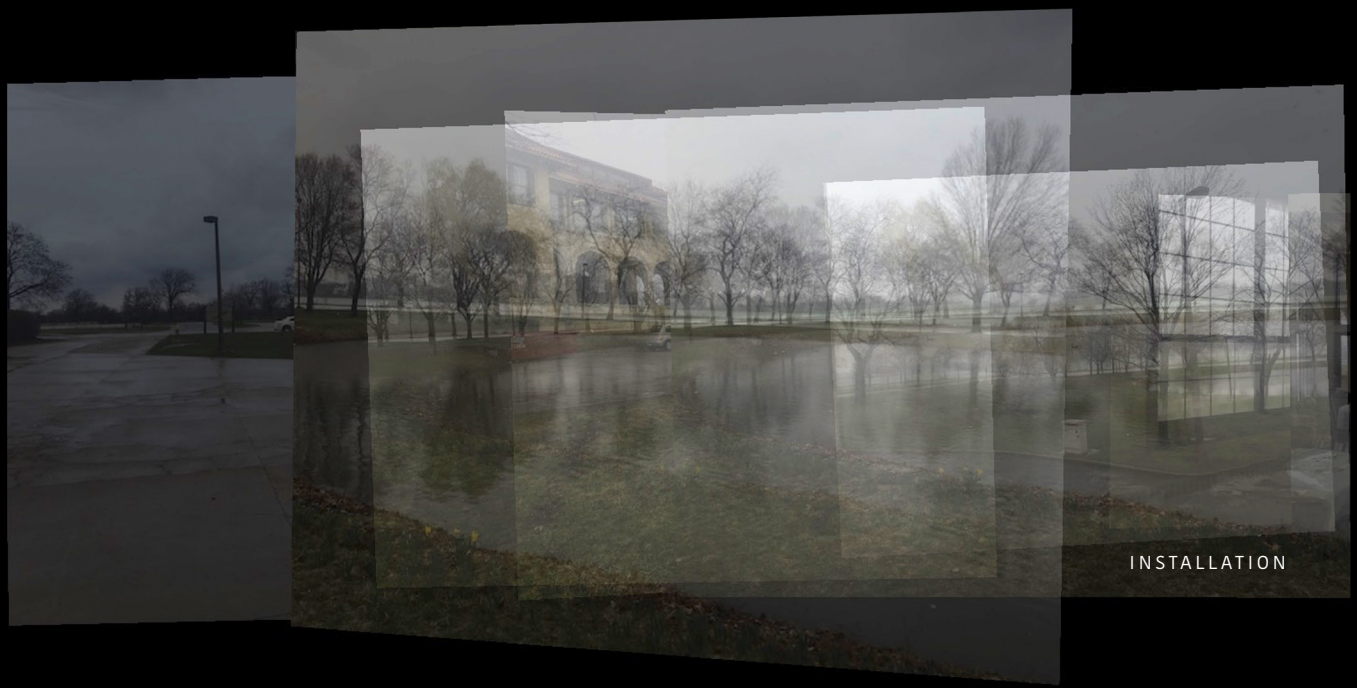
PERFORMANCE

GeoMultimediaViewer

David **Gordon**

PhotoScene is a program for interactively browsing photo and video collections as 3D virtual scenes, using embedded GPS and other image metadata to present digital photos and videos in virtual space according to the spatial locations where they were taken. The project reflects an interest in data visualization, virtual worlds, digital collage, and Cubist painting. Many smartphones and some digital cameras already record longitude, latitude, altitude, and compass direction. In addition, the popular iPhone photography and navigation app, Theodolite, can embed rotation and elevation angles, not yet a part of standard EXIF metadata. These metadata allow PhotoScene to create virtual environments from collections of photos and videos, which viewers can navigate using several different modes.

While the popular panoramic photo-stitching and 3D modeling programs PhotoSynth and 123D Catch use image matching algorithms to merge photos, in contrast, PhotoScene uses geographic proximity to cluster images into panoramic collages, where the original photos are unaltered. By preserving, rather than smoothing out, image boundaries, the program's hybrid panoramic collages offer a window onto a photographer's working process. This format also allows fast navigation of large collections of images spanning geographic areas of different sizes and dimensions, while providing the flexibility to modify parameters of the scene, such as changing which photos are visible based on date or keyword, while seeing the results in real time.



INSTALLATION

ID/id

Mark **Hirsch**

Within America's gun culture, the concept of identity is in a state of confusion. CEOs and politicians stake their identities on the people's right to bear arms without restriction, supporting a machine that throws money at gun rights with uzi-like frequency and dispassion. In doing so, the sheer mass of this pro-gun machine subsumes their individual identities and provides a shelter of anonymity and a degree of removal when tragedy unfolds.

There is a confusion of identity for the victims and families affected by gun violence as well. On the national stage, as more and more violence occurs, each identity transforms from a clear face of the horror wrought by gun violence to just one more number in a grand statistical framework.

A confusion—or perhaps clarity—can be experienced when considering one's ID (identification) and one's id (from Freudian psychology).

The id "contains the psychic content related to the primitive instincts of the body, notably sex and aggression. It is oblivious to the external world and unaware of the passage of time. Devoid of organization, knowing neither logic nor reason, it has the ability to harbor acutely conflicting or mutually contradictory impulses side by side" [1].

Within the gun culture of America, the ID and the id seem to be one and the same.

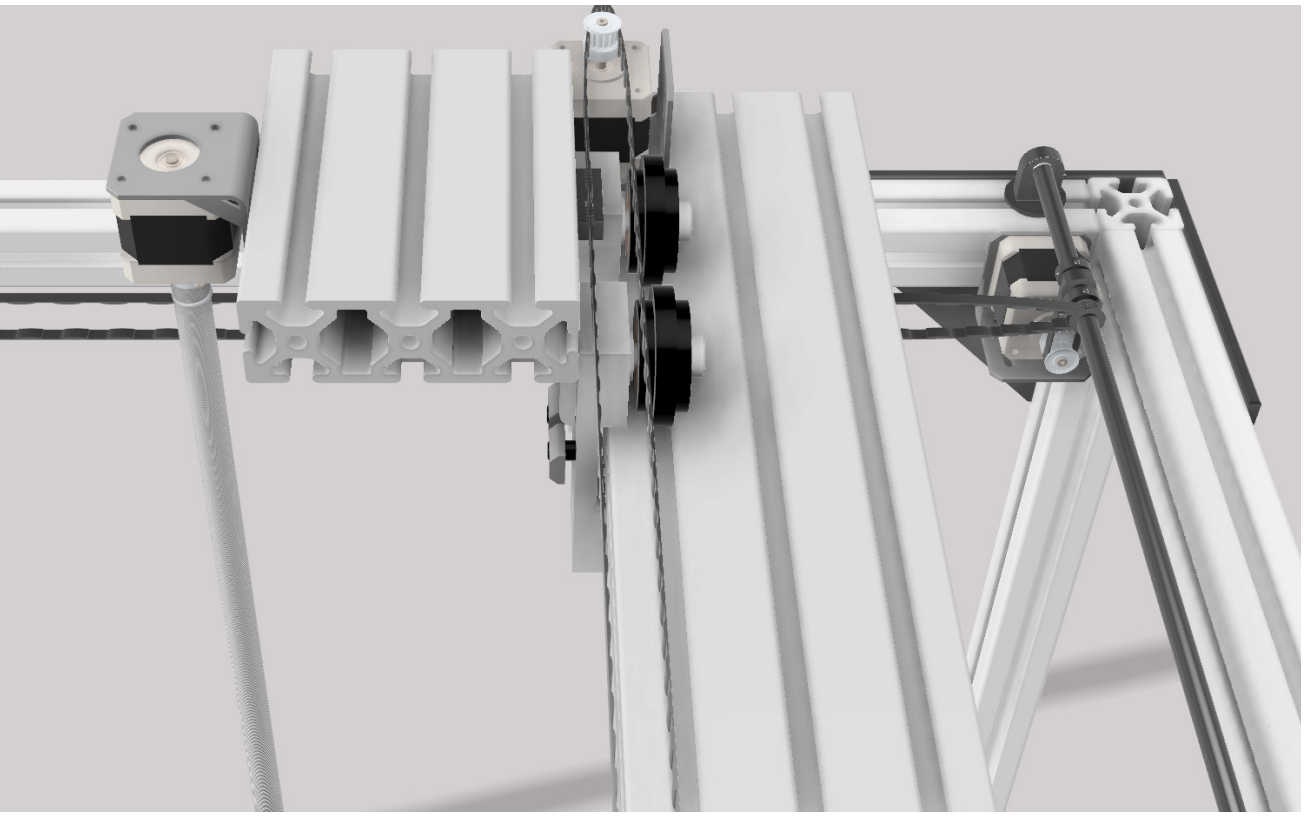
ID/id is an installation representing this conflation of the ID and the id.

ID/id is a performance by a machine. This machine functions similarly to that of a 3D printer, with a system of stepper motors, timing belts, extruders, and control hardware/software. Unlike a 3D printer, the machine deposits a dark powder that freely falls and collects on the floor. Over the length of the installation, the image of a large-scale fingerprint slowly emerges.

Through its operation, this machine—the id of pro-gun America—performs its task efficiently, without conscience or responsibility. What this task produces, a powder fingerprint—the ID of our culture, is a design that articulates the idea of our individuality. Yet, in our society, this design is then institutionalized, aggregated, and lost to the white noise of our cultural background.

The machine and the fingerprint embody the confusion of our gun-ridden reality. They embody the conflict between anonymity and responsibility— between the base instinct and the conscience, between the ID and the id.

[1] www.britannica.com



Musicians of Central Park Photo series

Mohit **Hingorani**

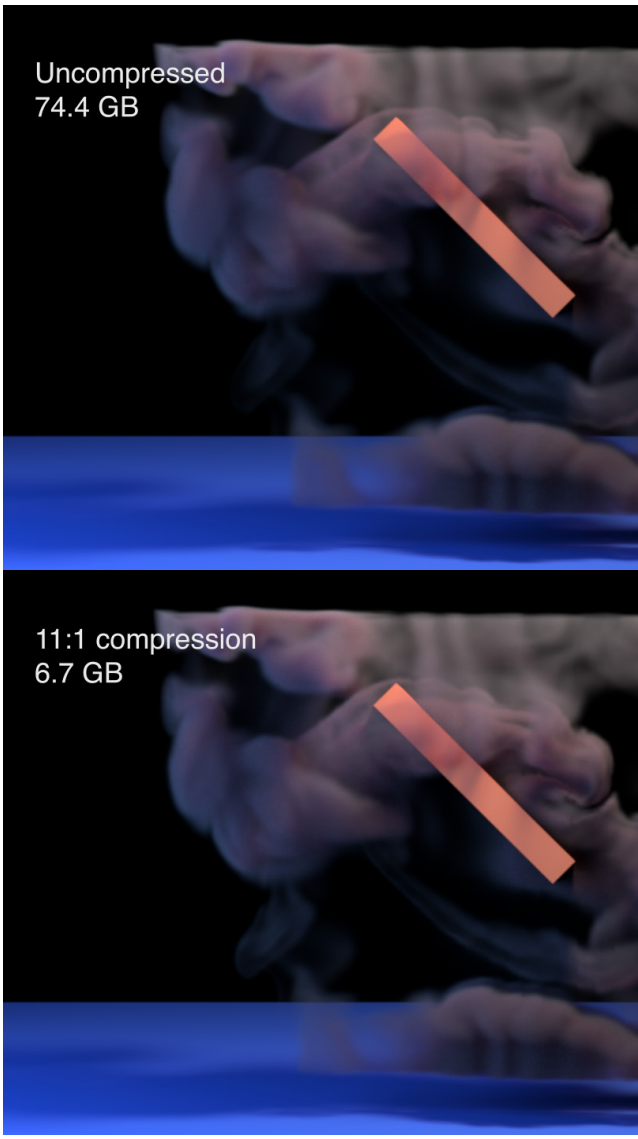
Digital photography is considered a type of visual art where images are represented by an array of pixels. Over a period of time, a photographer evolves and adopts a certain aesthetic preference. These image aesthetics depend on visual aesthetics (composition, color, etc.) as well as technical aesthetics (depth of field, perspective, blur). An important learning tool available to photographers is image metadata (also referred to as EXIF): camera settings that show how the image was created. My research is focused on understanding the technical aesthetics of photographers by visualizing this image metadata. This research has led to the creation of web-based tools for photographers to understand and correlate technical aesthetics with EXIF parameters. My own research has informed my photography and enabled me to create consistent work.

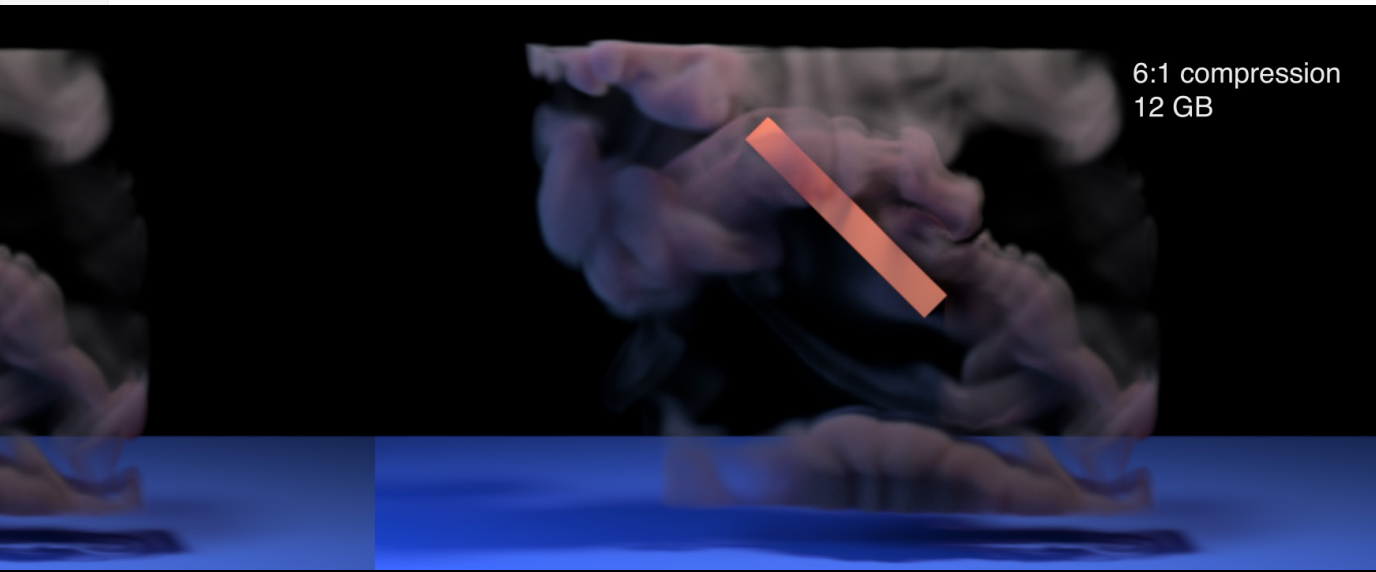
Musicians of Central Park is a photo series that exemplifies this. The images were taken at the Central Park during my first visit to New York. Everyday, Central Park comes to life with musicians and entertainers playing their tunes at every corner. Each one of them is immaculately dressed, lost in their own music. This photo series is a documentation of these musicians who remain unrecognized and usually underappreciated. The images presented here have a common story, common visual aesthetics, as well as similar technical aesthetics. They were captured with a 24 mm prime lens, high apertures, high ISO values and fast shutter speeds. This resulted in the creation of highly detailed images with both the subject being put into context with their surroundings and a hint of grain to invoke a sense of old-time nostalgia.

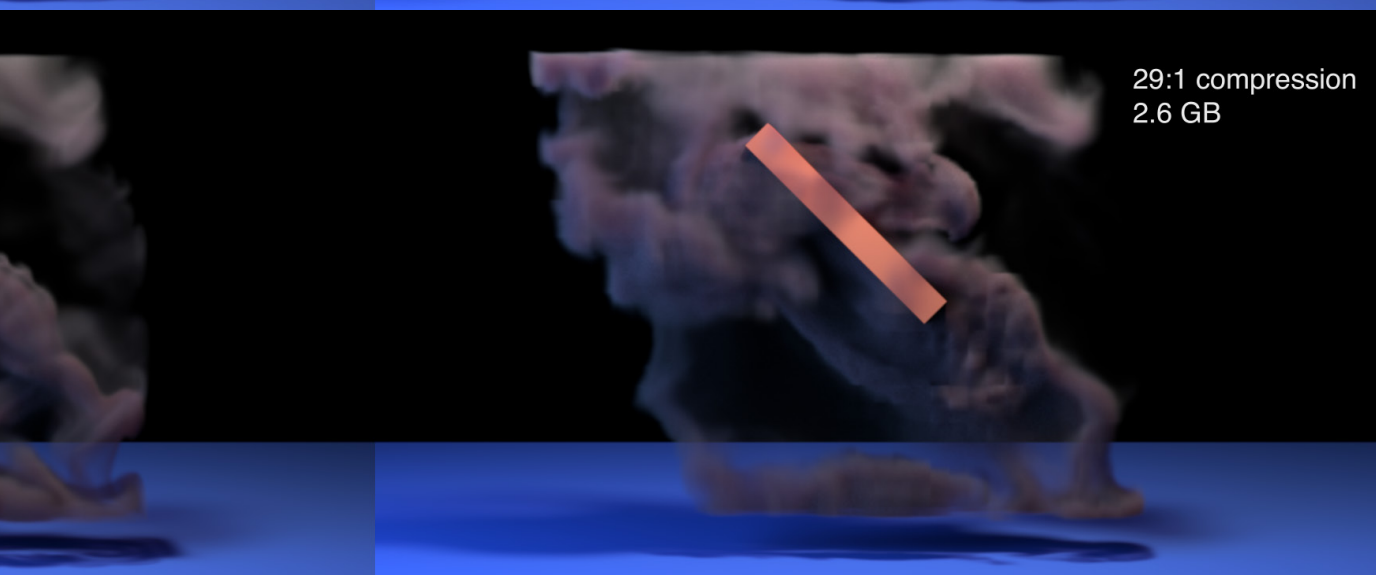
Compressing Fluid Subspaces

Aaron **Demby Jones** / Pradeep **Sen** / Theodore **Kim**

Subspace fluid simulations, also known as reduced-order simulations, can be extremely fast, but also require basis matrices that consume an enormous amount of memory. Motivated by the extreme sparsity of Laplacian eigenfunctions in the frequency domain, we design a frequency-space codec that is capable of compressing basis matrices by up to an order of magnitude. However, if computed naïvely, decompression can be highly inefficient and dominate the running time, effectively negating the advantage of the subspace approach. We show how to significantly accelerate the decompressor by performing the key matrix-vector product in the sparse frequency domain. Subsequently, our codec only adds a factor of three or four to the overall runtime. The compression preserves the overall quality of the simulation, which we show in a variety of examples.




6:1 compression
12 GB


29:1 compression
2.6 GB

Improved Variance Reduction Techniques for Ray-Traced Images

Steve **Bako** / Yuxiang **Wang**

Modern day films, TV shows, and video games are filled with sequences containing spectacular and sophisticated special effects and animation. These videos are typically generated using physically-based renderers that simulate light rays bouncing around in a scene and falling on a virtual camera sensor. Unfortunately, many costly samples are typically needed to accurately synthesize an image, resulting in lengthy render times and costly production schedules for studios. When fewer samples are used, render times are shorter, but unacceptable noise begins to appear in the final image. There have been successful approaches proposed previously to reduce the color variance of these images. First, Metropolis Light Transport (MLT) is able to reduce noise by distributing rays in a way that more efficiently evaluates the amount of light received at each pixel. However, even with MLT, there can still be noise present if not enough samples are used. Another solution is to filter the image as a post-process to generate a noise-free result that is close to the reference image generated with many samples. In our work, we propose two novel noise reduction techniques. The first parallelizes standard MLT to allow for efficient parallel exploration of light paths to more effectively reduce noise in the rendered image. In our second technique, we developed the first machine learning approach to filter noisy rendered images. Our Learning-based Filtering (LBF) algorithm utilizes a neural network that is trained in combination with a back-end filter in order to appropriately denoise the image.

Here we illustrate results from our two proposed approaches. The first row shows an input image rendered with severe Monte Carlo noise [upper left] and the results of our machine learning denoising algorithm [upper right]. In the bottom row, we show the results of a previous serial light exploration technique [lower left], our parallelized version [lower middle], and the ground truth rendered with many samples [lower right].

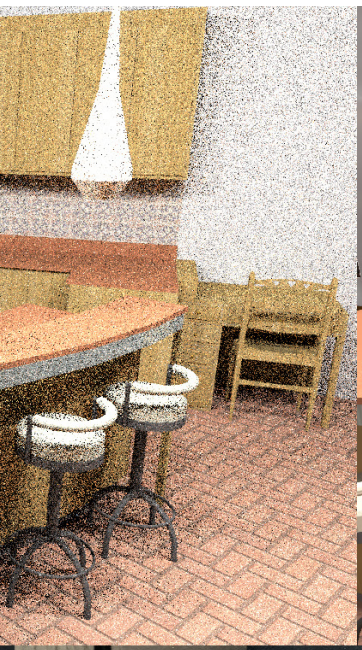
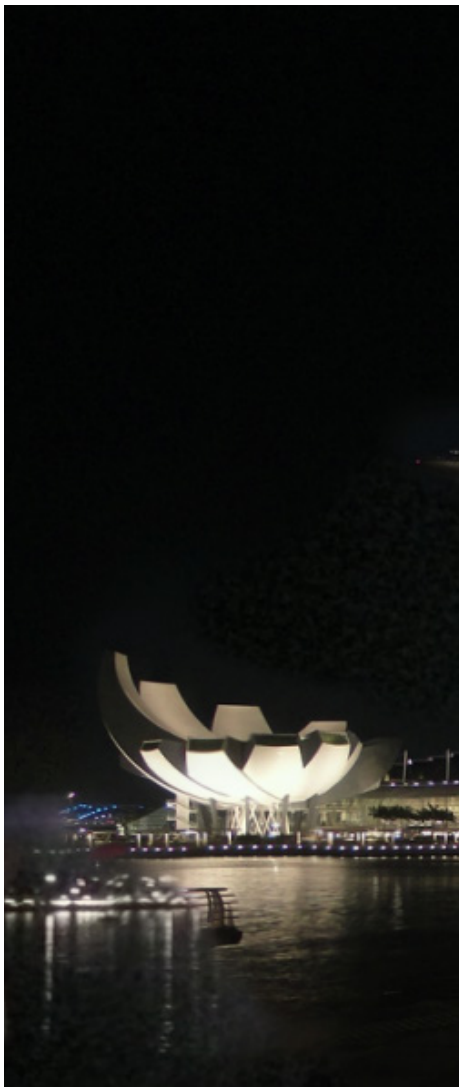


Image Enlargement by Example Images

Chieh-Chi **Kao** / Pradeep **Sen** / Yuxiang **Wang**

Nowadays, applications in image processing require high-resolution images for better visual quality and more accurate analysis. The goal of image super-resolution and hallucination is using information from a single image, from multiple images, or from large image databases to generate a high-resolution image. The super-resolution is an ill-posed problem due to many factors: insufficient information from low-resolution image, unknown down-sampling kernel, etc. Most of the previous works have focused on low magnification factors. In this project, we present an algorithm that can hallucinate high-frequency details into the super-resolved image. Given a small input image, the super-resolved result can be generated by utilizing the information extracted from a large image database. Moreover, unlike some of the other state-of-the-art learning-based methods, the proposed method does not need any training process in advance. The proposed method also shows considerable improvement in visual quality over standard super-resolution approaches at large magnification factor.

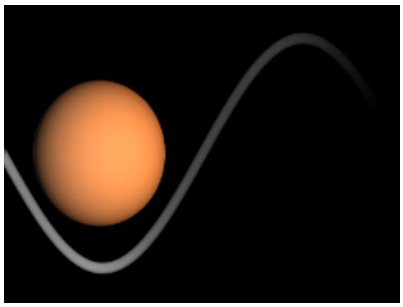
Original image



other

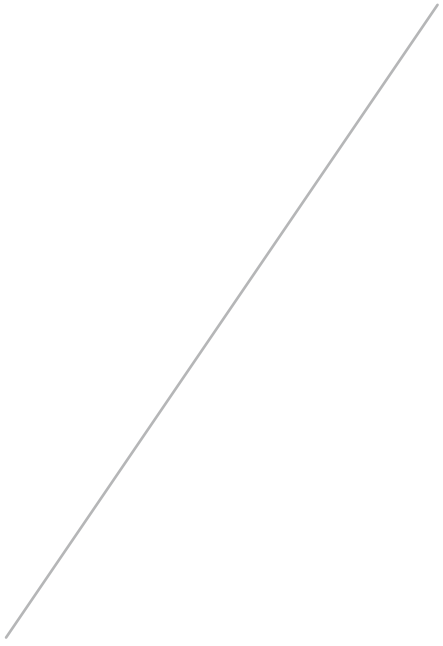
Matthias **Wagner**

other explores the threshold between oneness and multiplicity of what we hear and see. In the real world, sounds are broken up into frequency components that become new sound objects themselves. Spatial and temporal separation create the effect that what we thought of as a whole ceases to exist and gives way to new entities. Conversely, seemingly unrelated parts merge into something that is both definite and familiar. What motivated me to create this piece is the question of how our mind constructs identities and under what conditions they disintegrate.

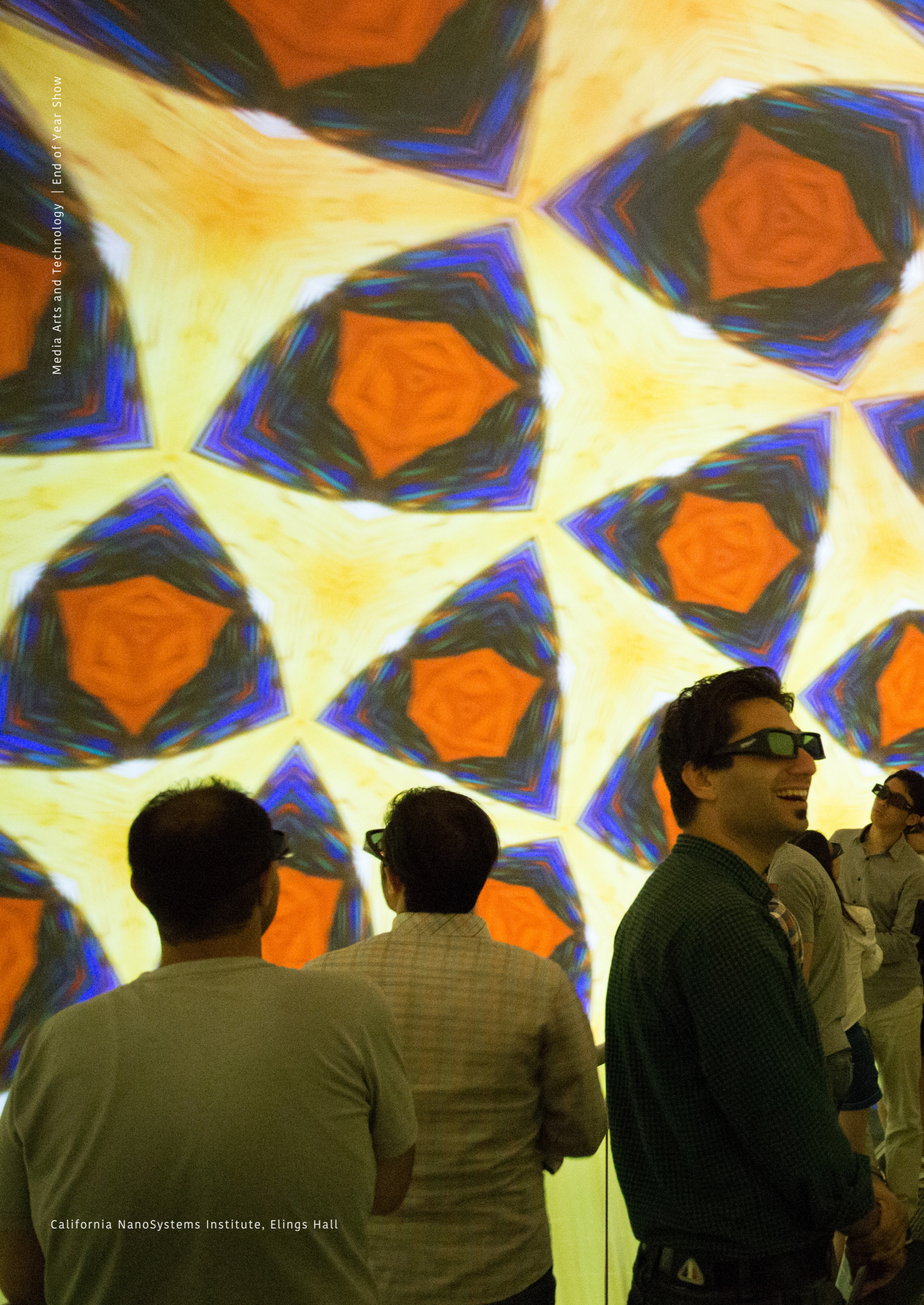


The technical aspect is realized by analyzing the spectrum of a sound and resynthesizing it as a sum of sine oscillators whose frequency and amplitude vary over time. Separating these objects spatially allows for the simultaneous exposure to all the particular parts, so as to be able to slip into a sound and immerse oneself in it. This enlargement and the capacity to rearrange the partials at will make the source material and its surrounding space uniquely malleable. The different configurations and movements establish a dynamic order that articulates diverse characters of the original source, generating many sounds from one. When multiple sources interact, their boundaries slowly dissolve and once distinct bodies of sound morph in and out of each other.

It is a playful and artistic way to engage with questions that are central to Gestalt psychology and inquire about meaningful perceptions of our environment. The title of this project stems from Kurt Koffka's famous statement that "the whole is other than its parts."



California NanoSystems Institute, Elings Hall



California NanoSystems Institute, Elings Hall

California NanoSystems Institute, Elings Hall

Credits

CATALOG TEAM

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Jing YAN
Lead Designer

Weihao QIU
Algorithm

TEXT

Alexis Story CRAWSHAW
Lead Editor

Gustavo Alfonso RINCON
Managing Editor

Pablo COLAPINTO
Assistant Editor

Hannah WOLFE
Assistant Editor

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Events Organizer and Curator

Atakan GUNAL
CREATE Equipment Coordinator

Hannah WOLFE + Larry ZINS
Curatorial Website Infrastructure

Joseph TILBIAN
Web Developer

Ryan MCGEE
Lead Concert Coordinator, CNSI and SBCAST

F. Myles SCIOTTO
Concert Coordinator, SBCAST

Sahar SAJADIEH
Educational Outreach Lecturer

Jungah SOH
Event Assistant

Jing YAN
Lead Event Designer

Ambika YADIV
Assisting Event Designer

CATERING

Laura CHEUNG
Marko PELJHAN
Gustavo Alfonso RINCON
Jungah SOH
Lisa THWING
Food Runners

Theodore KIM
Wine Fund Purveyor

Marko PELJHAN
Sommelier

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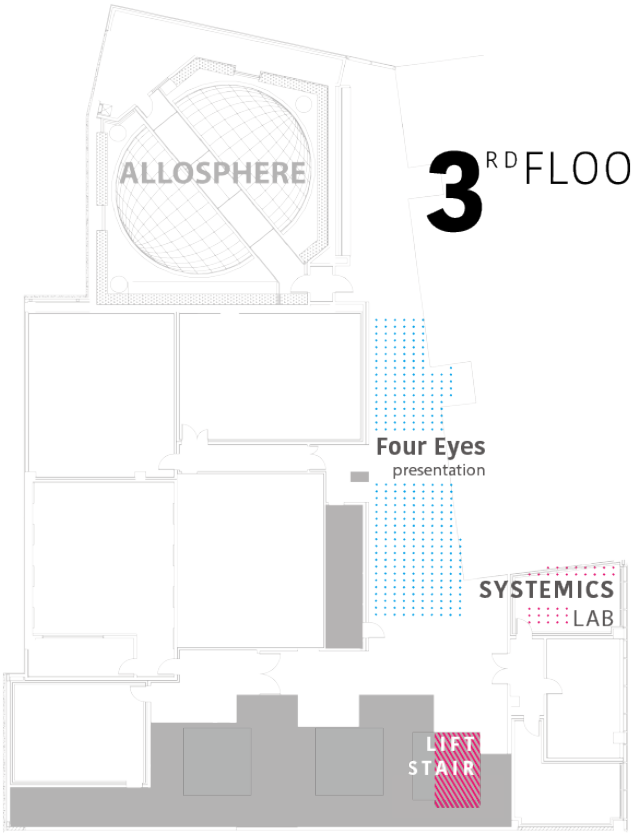
Marcos NOVAK
Marko PELJHAN



SYSTEMICS LAB
MARKO PELJHAN
KARL YERKES
DANNY BAZO

Four Eyes LAB
Presentation

MIRAG
ABHISHEK
CHIEH-CH
STEVE BA

ExpVis
DATA VIZ
AMBIKA Y
CHANG H

Allosp
DENNIS A
MATTHIAS
TEM/AP -
DONGHA

0 - (WHIT
JING YAN
1 - HANNA
2 - KURT K
3 - SAHAR
4 - NATHA
5 - DONGI
6 - PABLO
7 - KARL Y
8 - AARON
9 - NATAL

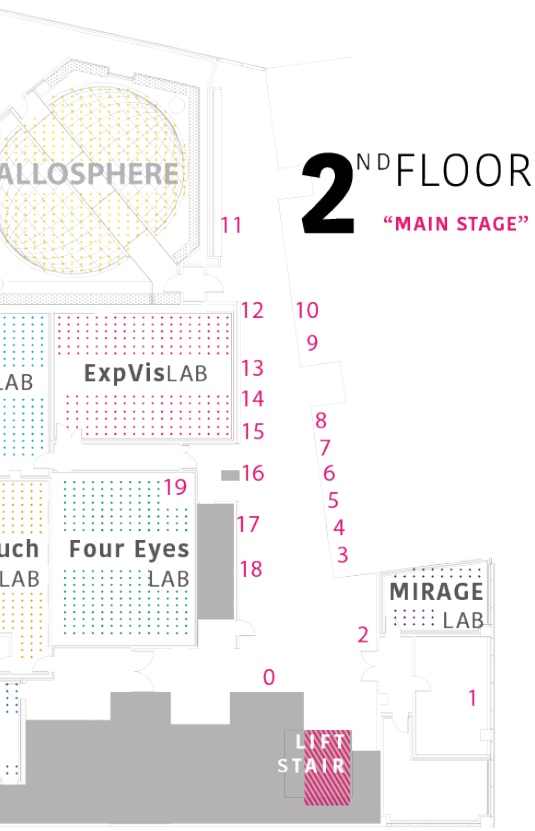
WhiteNoise( ){

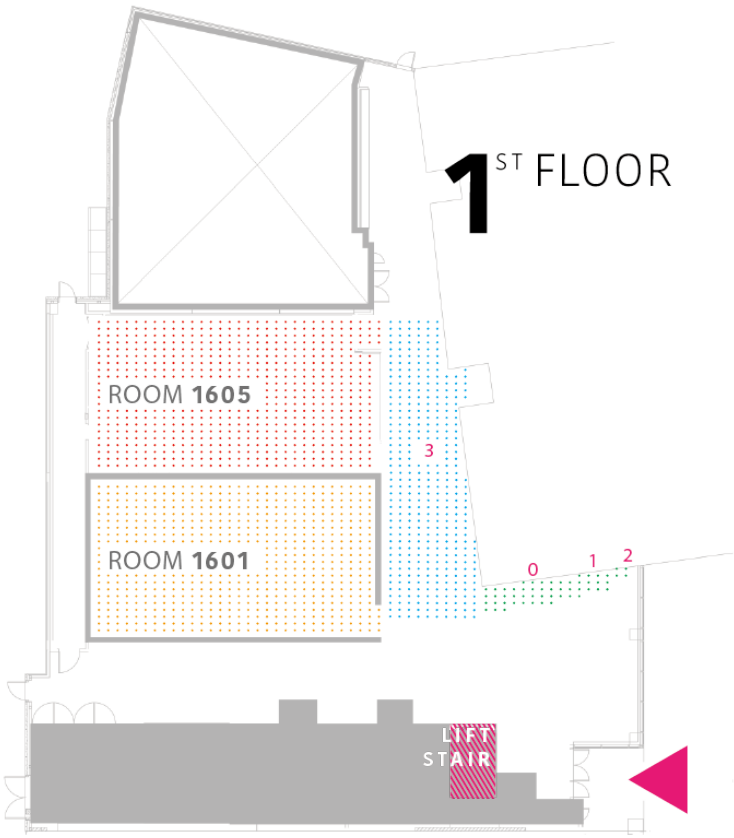
Location One
California NanoSystems Institute, Elings Hall
University of California, Santa Barbara

Thursday, May 26th, 1pm – 4pm | **Educational Outreach**
Friday, May 27th, 1pm – 4pm | **Opening Lecture and Panel Event**
Friday, May 27th, 5pm – 9pm | **WHITE NOISE End of Year Show Exhibition**
Saturday, May 28th, 9am – 12pm, 1pm – 4pm | **Critique Sessions**

Location Two
SBCAST - SANTA BABARA CENTER FOR ART, SCIENCE AND TECHNOLOGY
513 Garden Street, Santa Barbara, CA, 93101

Saturday, May 28th, 6pm – 9pm | **End of Year Show at SBCAST**
Thursday, June 2nd, 5pm – 10pm | **End of Year Show "First Thursday" at SBCAST**





E LAB
BADKI /
I KAO + PRADEEP SEN /
KO + YUXIANG WANG

LAB
2015 GEORGE LEGRADY
ADAV / LU LIU / JING YAN
E / WEIHAO QUI / JUNXIANG YAO

here
DDERTON / JING YAN / AMBIKA YADAV
S WAGNER / KENNY KIM / PABLO COLAPINTO
THE TEAM / RYAN MCGEE
O REN / TIBOR GOLDSCHWENDT / YUNSUK CHANG / TOBIAS HÖLLERER

E NOISE Theme)
+ AMBIKA YADAV
AH WOLFE
KAMINSKI
SAJADIEH
N WEITZNER
HAO REN + JOHN O'DONOVAN
COLAPINTO
ERKES
N JONES
Y MORENO + SAMUEL DONG

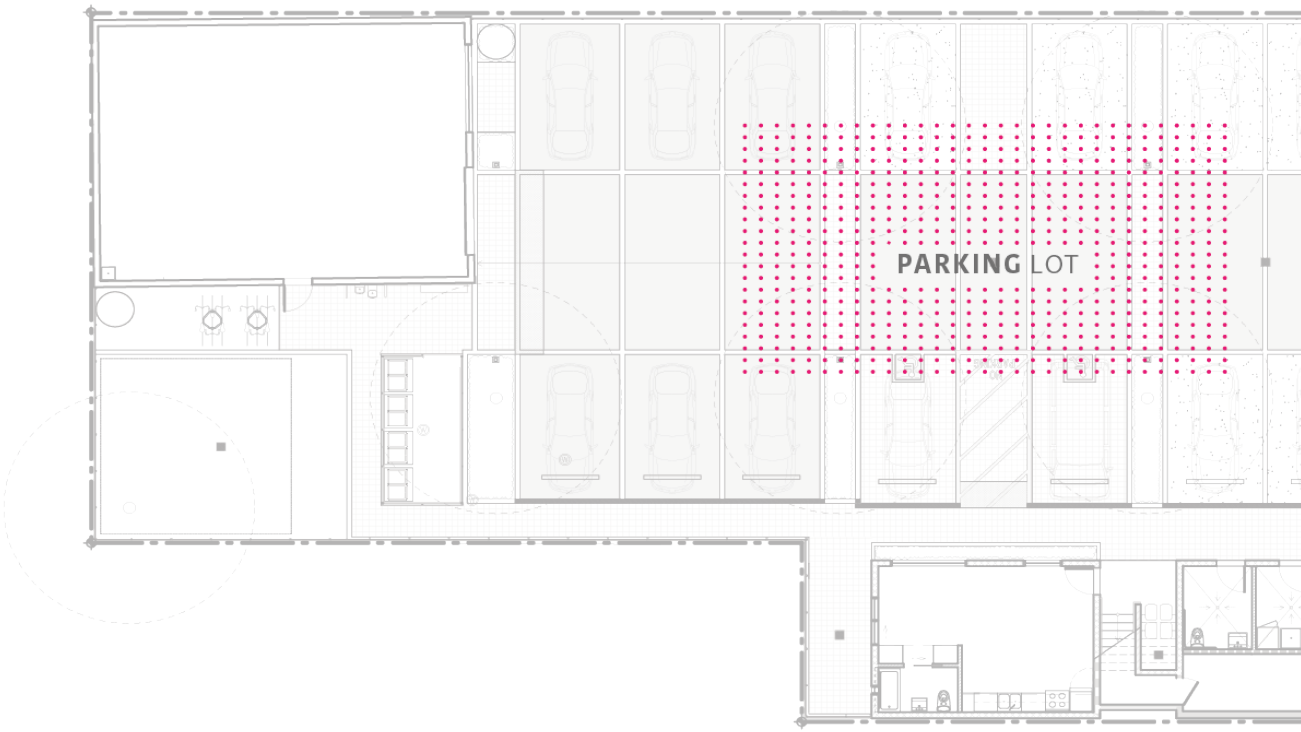
10 - MYLES SCIOTTO
11 - DENNIS ADDERTON
12 - PABLO COLAPINTO
13 - MARCOS NOVAK
14 - KURT KAMINSKI
15 - JUNGAH SON
16 - DAVID GORDON
17 - MOHIT HINGORANI
18 - JIELIANG LUO + KEE YOUN
19 - SAHAR SAJADIEH

0 - JING YAN + AMBIKA YADAV (Theme Graphic)
1 - ROSLI WAN + MUHAMMAD HAFIZ
2 - ANDREW PEPERDINK
3 - Exhibition CNSI

ROOM **1605** 5/**27** **1-4**PM
Lecture | Panel Discussion
PAUL JACOBS / DAVID GORDON
MARK HIRSCH / AKSHAY CADAMBI /
MATTHIAS WAGNER / RYAN MCGEE /
CLARENCE BARLOW

ROOM **1601** 5/**27** **8:30**PM
Concert | Live Performance
CLARENCE BARLOW
AKSHAY CADAMBI / MATTHIAS WAGNER

UCSB MAT Media Arts and Technology Graduate Program



WhiteNoise( ){

Location One
California NanoSystems Institute, Elings Hall
University of California, Santa Barbara

Thursday, May 26th, 1pm – 4pm | **Educational Outreach**
Friday, May 27th, 1pm – 4pm | **Opening Lecture and Panel Event**
Friday, May 27th, 5pm – 9pm | **WHITE NOISE End of Year Show Exhibition**
Saturday, May 28th, 9am – 12pm, 1pm – 4pm | **Critique Sessions**

Location Two
SBCAST - SANTA BABARA CENTER FOR ART, SCIENCE AND TECHNOLOGY
513 Garden Street, Santa Barbara, CA, 93101

Saturday, May 28th, 6pm – 9pm | **End of Year Show at SBCAST**
Thursday, June 2nd, 5pm – 10pm | **End of Year Show "First Thursday" at SBCAST**

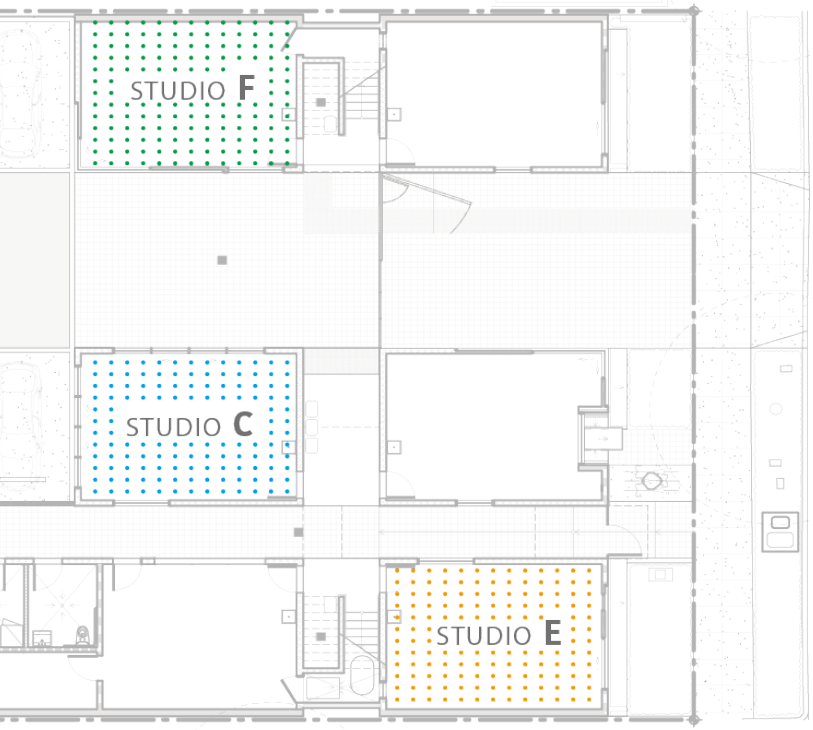
}

Artist

STUDIO
Hirsch, Ma
Kirati, Sole
Kim, Kenn
Luo, Roge

STUDIO
Wood, Tim
Barlow, Cl
Marko Pel

STUDIO
Yon Visell
Sciotto, M
Pablo Cola
Mohit, Hir



Exhibition

F

rk id
n & Cadambi, Akshay- HIVE
y - Fractal (T.B.D)
r & Youn Kee(T.B.D)

C

arence, (Cadambi, Akshay & Wagner, Matthias)
jhan

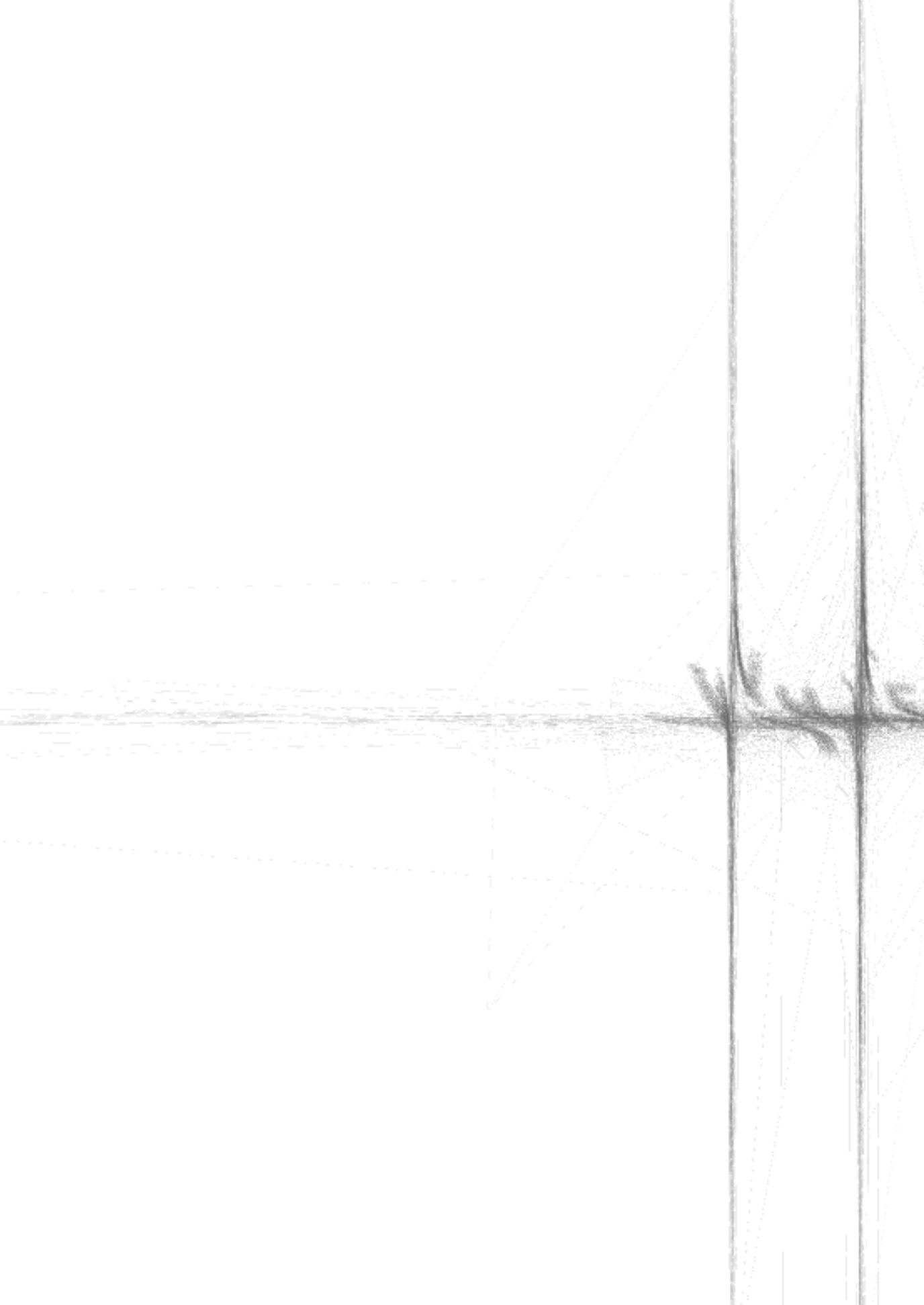
E

yles
pinto (T.B.D)
gorani (T.B.D)

Concert | Live Performance

PARKING LOT

McGee, Ryan
Hirsch, Mark (T.B.D)
Myles Sciotto
Barlow, Clarence, (Cadambi, Akshay & Wagner, Matthias)
Roads, Curtis
Kuchera-Morin, JoAnn



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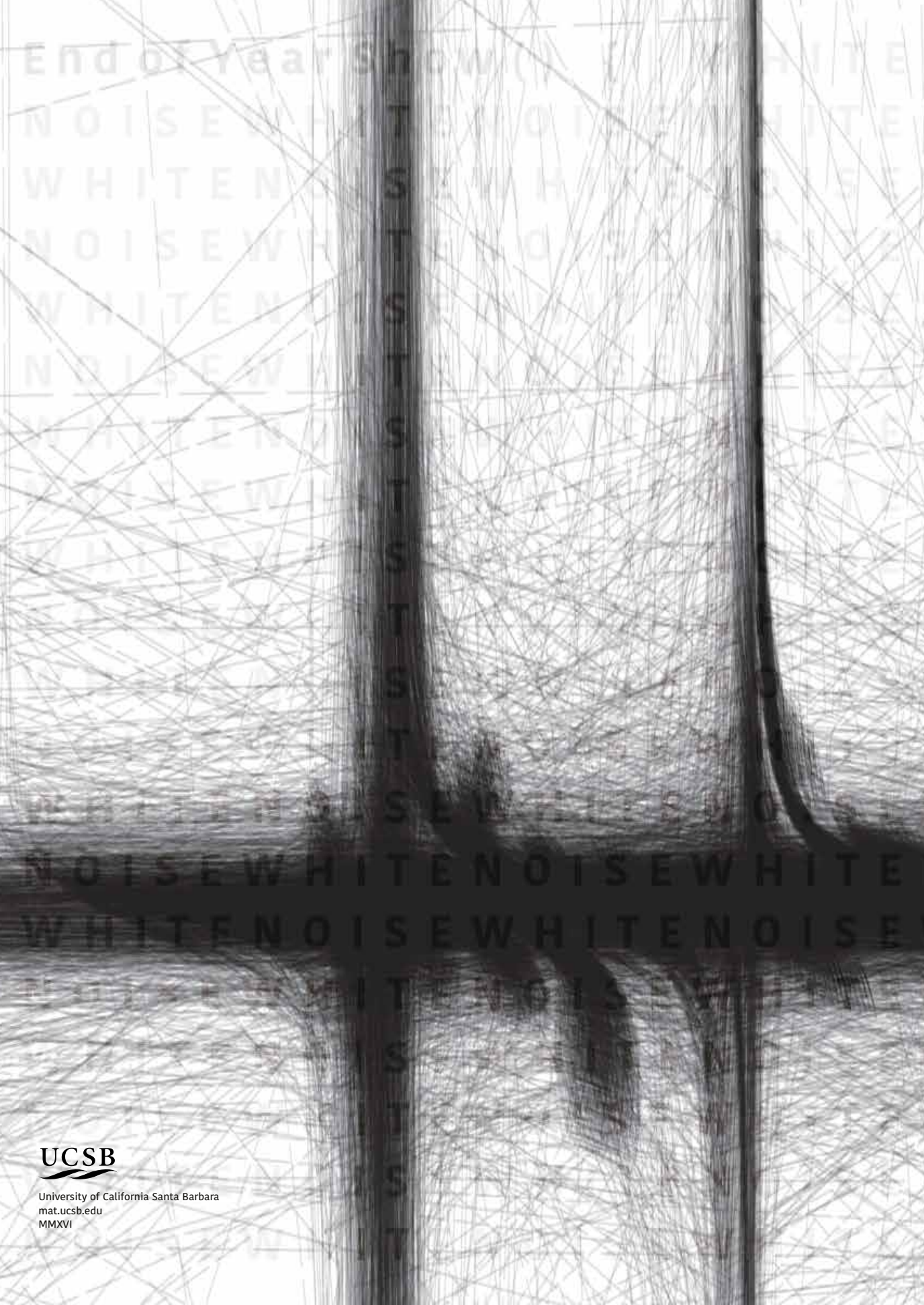

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