

Key Terms and Definitions

1. **EEG (Electroencephalogram):** A non-invasive method to monitor electrical patterns in the brain. Used in this project as a real-time data source for interactive art.
2. **HCI (Human-Computer Interaction):** The study and practice of designing interactive systems that are usable and effective for human users.
3. **Data Visualization:** The graphical representation of information and data, often used to help people understand the insights in the data.
4. **Immersive Installation:** An art installation designed to envelop the viewer's senses, often incorporating elements of interactivity.
5. **OSC (Open Sound Control):** A protocol for networking sound synthesizers, computers, and other multimedia devices. Used here for data communication between EEG devices and the computer.
6. **Unreal Engine:** A real-time 3D creation tool commonly used in game development, simulation creation, and other 3D visualizations.
7. **SpeedTree:** A software suite used to create 3D animated plants and trees for games, animations, and architectural renderings.
8. **Blender:** An open-source 3D computer graphics software toolset used for creating animated films, visual effects, art, 3D printed models, and more.
9. **BCI (Brain-Computer Interface):** A direct communication pathway between the brain and an external device. For this project, the Bluetooth EEG headset will serve as the BCI.



preliminary concept art



preliminary concept art

Summary

This project proposes an interactive and immersive virtual forest where connection is formed between the gallery audience and their environment by allowing brain-wave data to influence and evolve the experience. Participants, wearing non-invasive EEG headsets, engage in a symbiotic interaction where their neural activity becomes a variable, processed by software used in game development, to create change in the environmental elements within the projected forest, such as wind, rain, light, and sounds with the goal of generating emotional impact. As the human experience continues to be marked by data overload and a collective numbness to pressing issues such as ecological sustainability, fresh modes of meaningful engagement are needed to confront apathy.

Situated in the overlap of Human-Computer Interaction, Data Visualization, and New Media Arts, this creative project seeks to broaden academic and public discourse by integrating emotional resonance and psychological engagement as essential layers of utility. Over the one-year grant period, the project will undergo iterative development and then ultimately be submitted for exhibition at national and international festivals, conferences and venues including the International Symposium on Electronic Arts (ISEA), Ars Electronica, and SIGGRAPH, targeting both scholarly and general audiences.



Purpose of the project

a. A statement of the problem.

Our lives are saturated with streams of data and information which seems to generate numbness or indifference to critical issues, such as our complex relationships with nature and its systems. This desensitization is exacerbated by the sheer scale of data, which often transcends human comprehension. Traditional methods of experiencing this information, such as charts or news reports, have lost their impact due to overexposure and lack of relatability. There's a pressing need for alternative approaches that can re-engage the person, making them not just consumers of information but active participants in interpretation and change.

The proposed project aims to disrupt this status quo by leveraging the intersection of art, technology, and neuroscience. Through an immersive installation that utilizes real-time EEG data as a form of interactive narrative, the project seeks to create a more intimate connection between individuals and the world(s) they impact. This approach will re-contextualize available data streams by re-humanizing the connection to it, making the abstract tangible and the impersonal personal.

b. Significance of the creative work to the academic discipline.

Interdisciplinary Impact

This project relies upon synergy between the disciplines of Human-Computer Interaction (HCI), Data Visualization, and Art / Aesthetic Experience. While HCI and Data Visualization often prioritize functional utility, this project introduces a nuanced perspective by considering emotional and psychological engagement as additional forms of utility. This expands the scope of what is traditionally considered “useful” from an academic perspective to integrate the emotional activation created through an aesthetic experience.

Innovation in Art + Technology

The incorporation of EEG data as a dynamic and self-reflexive data source is an innovative approach that enriches the field of New Media Arts. It opens dialogue around the ethical and aesthetic dimensions of information and its impact. The EEG data not only serves as an input but also as a reflection of the participant’s real-time emotional and cognitive state, making the data both the medium and message. The

project, and its exhibition, will contribute to broader discussions of how art can serve as a catalyst for social or environmental awareness and engagement.

Community and Academic Relevance

This project's significance extends beyond academia. By offering a novel way to engage with a complex issue such as the relationship between humans and the environment, the project contributes to broader academic and community conversations. It serves as a localized intervention with the potential to influence personal perceptions and scholarly inquiry alike.

c. Objectives of the proposal

1. **Hardware Acquisition and Testing:** To acquire and test EEG headsets, including the Muse S and Emotive Insight models, to determine the most effective hardware to prototype and then capture the data in a gallery exhibition or festival setting.
2. **3D Asset Development:** To create high-quality 3D assets for the forest environment, potentially utilizing specialized software like SpeedTree to enhance realism and aesthetic impact.
3. **Interactive Platform:** Develop an Unreal Engine project that integrates the EEG data and 3D assets into an interactive, immersive experience for projection.
4. **User Experience Design:** Design the interaction in a way that is intuitive and engaging, ensuring that participants can easily navigate the experience and meaningfully interact with its content.
5. **Exhibition and Dissemination:** Showcase the completed project at festivals and events such as ISEA, Ars Electronica, and SIGGRAPH, aiming for both academic recognition and public engagement.
6. **Future Scalability:** Design the project in a way that allows for future expansions, both in terms of content and technological capabilities.

d. Outline of existing work in the field

New Media Art

Artists like Rafael Lozano-Hemmer have used interactive technologies to create

participatory experiences, such as "33 Questions per Minute," which generates questions based on real-time audience input. Jenny Holzer's text-based art often incorporates technology to display provocative statements in public spaces. Ryoji Ikeda uses data as a material, transforming it into sensory experiences. However, the incorporation of EEG data in art is still a burgeoning area, offering a unique opportunity for innovation.

Human-Computer Interaction (HCI)

HCI has been a subject of academic research for decades, but its intersection with art is a burgeoning field. Works like "The Machine to be Another" by BeAnotherLab explore the boundaries of empathy and identity through immersive experiences. Chris Harrison's work at Carnegie Mellon focuses on touch interfaces, expanding the vocabulary of HCI. The "Reactable" by Sergi Jordà et al. turned HCI into a collaborative musical experience, showing the field's versatility.

Data Visualization

Jer Thorp's work often explores the aesthetic dimensions of data, making it more relatable and engaging. Ben Fry, co-developer of Processing, has been a pioneer in using data visualization in artistic contexts. Casey Reas, another co-founder of Processing, has explored generative art, which could be considered a form of data visualization. The use of real-time, biometric data for interactive art remains an underexplored area, ripe for innovation.

Neuroscience

Marina Abramović's "Measuring the Magic of Mutual Gaze" used eye-tracking and brainwave monitoring to explore human connection. Olafur Eliasson's "Your embodied garden" used VR to explore the neurological experience of space. These works hint at the untapped potential of incorporating real-time brain activity into interactive experiences.

Environmental Art

Olafur Eliasson's works often engage with environmental themes, like "The Weather Project," which simulated the sun and sky inside the Tate Modern. Agnes Denes' "Wheatfield" turned a landfill into a wheat field, directly engaging with land use and environmental impact. However, the direct link between human activity (via EEG data) and environmental impact is a novel approach in this field.

Research design and methods

a. Procedures

Real-Time Interaction

The core of this project is an immersive, interactive installation where participants' EEG data directly influences a virtual forest environment in real-time. The EEG headsets will be connected to an Unreal Engine project hosted by a computer which will interpret the data to modify various elements of the projected forest, such as weather and sound.

Ethical Considerations

It's crucial to note that the EEG data is solely for real-time interaction within the installation. No personal or sensitive data will be stored, eliminating the need for long-term secure storage and ethical review for data retention.

User Experience Design

The interaction design will be developed to be intuitive and engaging. Usability tests will be conducted during the development phase to refine the user interface and experience.

Qualitative Feedback

To gauge the impact and effectiveness of the installation, qualitative feedback will be collected from early participants. This could be in the form of post-experience conversations, interviews or creatively designed digital questionnaires that serve as an extension of the art experience.

Phase 1: Conceptual Design

- Activities: Initial sketches, mockups, and wireframes to visualize the forest environment and types of interactions.

Phase 2: 3D Asset Creation

- Activities: Develop 3D models for the forest environment, including trees, foliage, and terrain.

Phase 3: Unreal Engine Integration

- Activities:
 - Import 3D assets into Unreal Engine.
 - Write custom scripts to stream EEG data to the Unreal Engine.

Phase 4: Hardware Profiling

- Activities:

- Pass EEG data stream via OSC to the computer.
- Set up the computer to provide rendered video signal optimized for the color and light capabilities of the projector.

Phase 5: Data Interpretation

- Activities:
 - Real-time EEG data will be processed via scripts in the Unreal Engine to influence the virtual environment.
 - Testing and Iterative design process for fine-tuning custom scripts.

Phase 6: Tech Demos

- Activities:
 - Full project installations to test the entire projected experience.
 - Capture documentation images for instructional documents.

Phase 7: User Testing

- Activities:
 - Conduct usability tests as trial run installations.
 - Refine the user interface and experience based on feedback.

Phase 8: Feedback Collection

- Activities:
 - Collect post-experience qualitative data and anecdotal information.
 - Provide optional digital questionnaires via a web submission form.

b. Method of data collection and procedures proposed for data analysis.

On Data Collection

- Real-Time Interaction: EEG data will be streamed to the Unreal Engine software in real-time during the installation to influence the virtual forest environment. This data is monitored as a received stream of floating point numbers solely for real-time interaction and will not be stored.
- Qualitative Feedback: Post-experience interviews or digital questionnaires will be used to collect anonymous qualitative data from participants during the

development of the project. This could be in the form of open-ended questions or Likert scale questions to gauge emotional and cognitive responses.

Data Analysis

- Real-Time Interaction: Given that EEG data is used only for real-time interaction, no long-term data analysis is applicable.
- Qualitative Feedback: Responses from interviews and questionnaires will be analyzed to identify recurring themes, emotional impact, and cognitive engagement. This information will be used to refine the project experience.

c. Previous experience of the individual related to the proposed project.

I have a robust foundation in New Media Arts, with a particular focus on interactive installations and data-driven art. This proposal is a natural evolution of work initiated during a Fall 2019 Sabbatical. During that period, preliminary investigations were conducted using off-the-shelf EEG BCI devices to explore the utility of brainwave data in aesthetic experiences. While the hardware and software environments of these devices were limited, the early work provided valuable insights and received positive feedback during Visiting Artist stays at Washington State University and the University of Colorado – Boulder.

Prior to the 2019 Sabbatical, I have worked with visual patterns in data and alternative human-computer interfaces. Notably, custom Java software was developed to reveal patterns in GPS location data from domesticated animals. The resulting visualizations were exhibited at Meyer Library on the Springfield MSU campus (still on display) and were also featured in the TechnOzarks publication from the Ozarks Studies Institute in 2019.

The multidisciplinary approach, combining art, technology, and neuroscience, has been a cornerstone to my work. I have a proven track record of successful interdisciplinary collaborations and academic contributions, making me uniquely qualified to develop this innovative project.

d. Dissemination of Results

The primary mode of dissemination for this project will be through its submission for inclusion in national and international festivals, exhibitions, and events, such as ISEA, Ars Electronica, and SIGGRAPH. These platforms not only offer a broad audience but

also provide a space for interdisciplinary dialogue, making them ideal venues for showcasing the project's innovative approach to data visualization and interactive art.

In addition to exhibitions, the project aims to contribute to academic discourse through conference papers and presentations. Given the project's interdisciplinary nature, it has the potential to be presented at conferences focusing on New Media Arts, Human-Computer Interaction, and Data Visualization. These academic contributions will serve to extend the project's reach within scholarly communities and could potentially lead to publications in peer-reviewed journals.

By employing a dual strategy of public exhibitions and academic contributions, the project aims to maximize its impact, reaching a diverse audience that spans both the general public and the academic community.

Below is a list of potential exhibition or festival opportunities along with a brief description of relevance to the project.

EVA London (Electronic Visualization and the Arts)– Held annually in July, this international conference focuses on supporting new technologies within the arts and culture.

ISEA (International Symposium on Electronic Arts) – This symposia's goals are "...fostering interdisciplinary academic discourse and exchange among culturally diverse organisations and individuals working with art, science and technology."¹

Currents New Media – An annual festival / exhibition, this event "...showcases interactive and non-interactive installations, multimedia performances, VR and AR environments, single channel video, animation, and experimental documentary, robotics, wearables and 3D printing."²

Ars Electronica – This organization, based in Linz, Austria, supports research and collaboration from artists, scientists, technologists, designers, developers, and entrepreneurs and activists from all over the world through year-round programming and the annual Ars Electronic Festival.

¹ "ISEA International Website." *ISEA International Website*, <http://www.isea-web.org/>.

² "About Us." *Currents New Media*, 31 July 2021, <https://currentsnewmedia.org/about-us/>.

IMPAKT Festival – The IMPAKT Centre for Media Culture in Utrecht, Netherlands holds an annual “...five-day multimedia event that includes exhibitions, film screenings, lectures, panels, performances, presentations, and artists talks...”.³

CICA New Media Art Conference – The Czung Institute for Contemporary Art (CICA) hosts an annual conference “...to celebrate art in the digital age and share thoughts and ideas on new forms of art and culture in relation to emerging technologies and trends including artificial intelligence, virtual / augmented reality, social media, and art in the time of pandemic.”

e. Plans for extending the investigation beyond the immediate project.

While the Faculty Research Grant (FRG) provides a one-year framework for the project, the intention is to extend its life and impact well beyond that timeframe through its exhibition and festival or conference inclusion. The immediate goal post-FRG is to continue submitting the project to various international and national venues, thereby expanding its reach and influence. It is expected that this project will be submitted to opportunities for years to come.

In terms of research and development, there's a potential roadmap for evolving the project into a Virtual Reality (VR) experience. This would allow users to navigate the forest environment, adding another layer of interactivity and immersion. Transitioning to a VR format would not only enhance the user experience but also open new avenues for research in spatial cognition and environmental psychology. However, this extension would require additional funding and resources, making it a longer-term goal that would likely necessitate external grants or collaborations.

By setting these extended objectives, the project aims to sustain its relevance and adapt to emerging technologies and research questions, ensuring it remains a dynamic contribution to the fields of New Media Arts and Human-Computer Interaction.

f. Beginning and ending dates for the project.

This project will begin as funding is secured, or by January 1, 2024 and continue until the end of December, 2024.

³ “About Impakt.” *IMPAKT*, <https://impakt.nl/about/>.

Other sources of funding:

a. *List internal or external cost-sharing funds that can be applied to this project.*

The proposed equipment will be in high demand for the duration of the research project. The hardware could also facilitate future research projects. This makes it difficult to predict cost sharing in the equipment. Beyond using equipment available in Art + Design department to document the project during development, there are no external cost-sharing funds identified at this time.

b. *List applications to external grants since last Faculty Research Grant.*

2018, Working Artist Grant, WorkingArtist.org (\$1000)

2018, Creative Capital Grant, Creative Capital (\$7,500 - Finalist) – Not Funded.

2018, Prototype Fund, Knight Foundation (\$15,000 - invited to apply after Letter of Interest) – 2nd round, Not Funded.

2017, Working Artist Grant, WorkingArtist.org (\$1000) – Not Funded.

2017, Artistic Innovations Grant, Mid America Arts Alliance (\$9000, finalist as of Feb. '17) – Not Funded.

Previous MSU faculty support:

2017 – Summer Faculty Fellowship – This support provided dedicated time to investigating interactive installation and data driven imagery. I utilized motion tracking, infrared data capture, and physical computing. This process led to natural evolutions which propelled me to use VR / AR as a medium as well as Creative Code in general. This work led to three Visiting Artist stints, all of which are occurring during the Fall of 2019. I also presented a paper which included findings from this research as part of a panel at the 2017 FATE (Foundations in Art: Theory and Education) Biennial Conference. This work was exhibited in National and International venues as well.

2015 – Curriculum Innovation Grant – This grant provided support to purchase new printing equipment which has allowed for greater cross over between the Digital Art and Printmaking areas in the Art + Design Department at Missouri

State University. The equipment has had a positive impact in those areas for both student and faculty.

2014 – Faculty Research Grant – This grant was crucial in developing a body of work that helped propel me toward Tenure & Promotion. The research supported by this grant was exhibited at seven national and international group exhibitions, as well as two solo exhibitions. From this work I also developed papers and presentations that were included in three international conferences