



ARCS OF IMPACT

RELATING SYSTEMS THINKING & DESIGN
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Entangled Harmonies: Exploring connection to the more-than-human through interactive bio-generated sound and the inner life of plants

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Entangled Harmonies is an interactive sonic ecosystem that explores human entanglement with the more-than-human world through live bio-data sonification (biosonification) and field recordings. Biosonification involves portraying processes within organisms as music or sound. Electrodes and a MIDI-data biosonification device convert fluctuations in microconductivity in organisms to MIDI notes, which "play" an ever-changing soundscape with digital instruments. Elements of the display invite viewers — I will call them participants, as their interaction co-creates the exhibit — to interact with organisms, to touch, to "play," and experiment with shaping sound. As both an artistic and cultural medium, technology can augment the ways in which we interact with, experience, and understand non-human organisms like plants and fungi. With Entangled Harmonies, I utilise biosonification as a creative means to translate an organism's "aliveness" and internal rhythms of beings like plants that are oft-seen as static or mere objects by the human observer. The installation presented at RSD is part of a growing body of work designing sound experiences, song-craft, and performance co-created with the more-than-human. My goal with this project is to uncover the hidden web of connections that build our world and inspire participants to reflect on how they are affected by—and affect—the surrounding environment, both now and in the future.

KEYWORDS: systemic design, entanglement, more-than-human realm, more-than-human intelligence, semiotics, translation, inter-species creativity, biology, plants, fungi, biosonification, acoustic ecology, sound installation, immersive art, interactive sound art

RSD TOPIC(S): Learning & Education, Society & Culture, Socioecological Design

Statement of Work

In a conversation for *Emergence Magazine*, Robert Macfarlane says, "It wasn't written in the forest, it was written with the forest." (*Song of the Cedars - a Conversation with Giuliana Furci, Robert Macfarlane, César Rodríguez-Garavito, and Cosmo Sheldrake*, 2025).

This is how I view my work. I do not make music and art from plants, fungi, and other nonhuman organisms. I collaborate with them. I think it raises interesting questions — how is my relationship a partnership? My work draws me closer to the world around me; I see and notice the action of ecology and my place within the ecosystem. Through interactive installations that encourage physical touch and where connection between people and plants co-creates the soundscape, I hope to inspire others to do the same: to reconnect people with the ecologies both within and around us. We are active participants in ecosystems. Like a forest, our lives, society, and world is a messy, interconnected system of life happening and influencing other life. Everything we touch we change: everything we change changes us. We must see nature not as

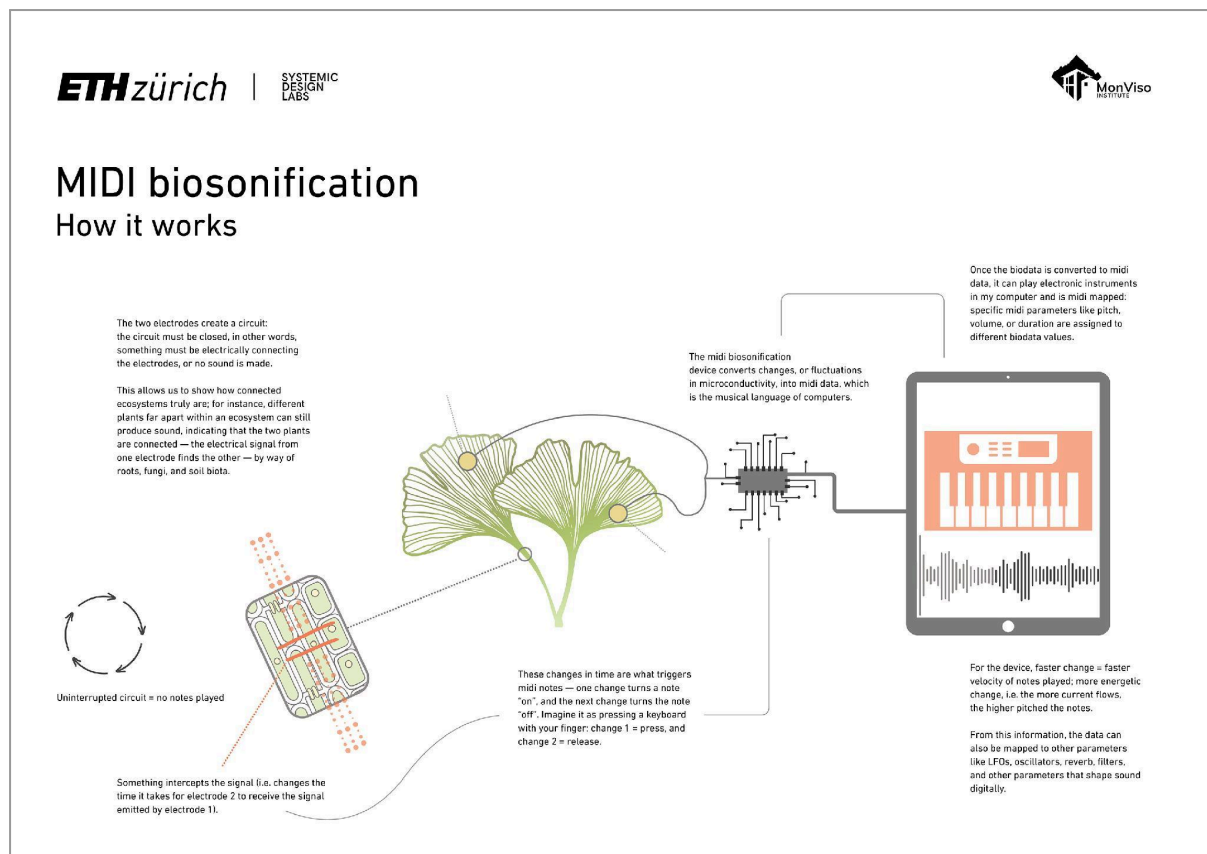


Image 1: Electrodes on plants during Entangled Harmonies installation at the Delaware Valley Arts Alliance, 2025. Source: Willow Gatewood.

separate, but as part of us. It is only then can we mend our relationships. It is only then can we live within the gifts of the world and learn to give back.

Methods of Tuning-in: Biosonification

Humans have a great capacity to recognise auditory patterns; therefore, sonification has been used to analyse data and to add dimensionality to data interpretations or



representations across disciplines (Bornmann, 2024). Coupled with visualisation and other methods of analysis or portrayals, sonification helps preserve richness and complexity while providing a different way of experiencing, thus understanding, information. It is particularly useful for portraying non-linearity and emergent properties of biological data (Choi, 2018). Sonification has diverse applications in the realms of arts, science, and science or environmental education or communication, with an equally great potential to connect disciplines through artistic representation of data.

Image 2: How MIDI Biosonification works. Source: Willow Gatewood, Sylwia Orczykowska

Biosonification involves turning biological processes within organisms into music or sound. My interest in biosonification lies both in producing rich sonic landscapes that intrigue and connect viewers to the world around them and as a novel method for researching processes that influence micro-conductivity, including rhythmic ion transport, water transport, and electrical activity in the body of the organism.

Electrodes and a MIDI-data biosonification device convert changes in micro-conductivity in plants and fungi to MIDI notes, which "play" digital instruments. For my process specifically, each time a fluctuation is registered, this sends a "note on" message; the next fluctuation equals "note off". How rapidly changes occur determines velocity, while pitch is influenced by how energetic the changes are. The MIDI biodata device is adapted from Samuel Cusumano's MIDI Sprout design (Cusumano, 2016). The build includes an ESP32-WROOM-32 module for MIDI over Bluetooth, custom printed PCB, and LiPO battery pack and is coded using the Arduino IDE. For this project, I use Logic Pro, although the device can be used with other Digital Audio Workstations (DAWs) or



programs that speak in MIDI information. Additionally, biodata can be "mapped", or routed, to any MIDI-controlled parameter, such as filters and LFO's on digital instruments or synthesisers, code and patching programs like Max/MSP/Jitter, and visual or lighting effects using environments like Touch Designer or DMX lighting. I often map biodata to other parameters on the digital instruments played to create wandering, ever-changing soundscapes: the non-linearity of input data has the capacity to shape the instruments' sounds in complex, unpredictable ways that add to the richness of music co-creation with non-humans.

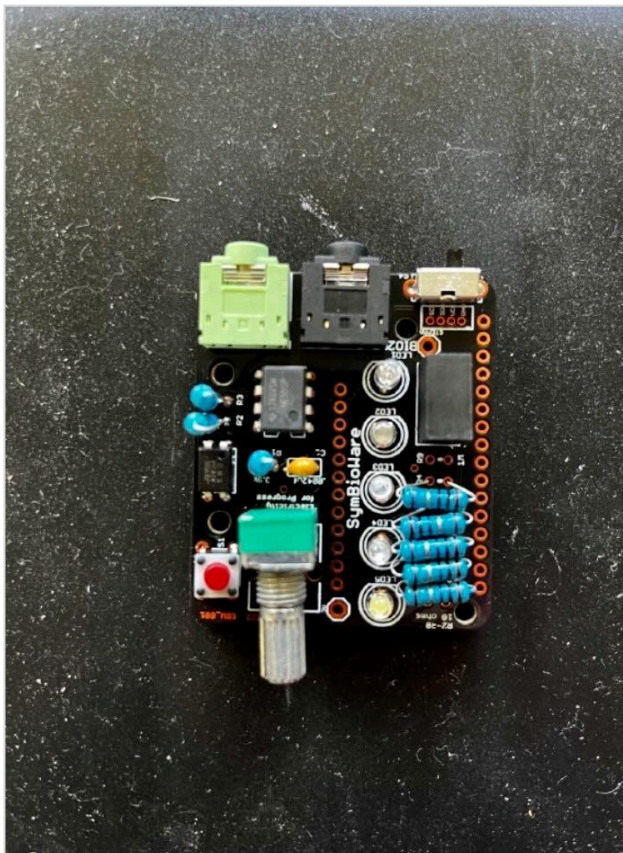


Image 3, top: Arduino Uno biodata device. Source: Willow Gatewood; Image 4, bottom: Bluetooth wireless biodata build for ESP32- WROOM-32 module. Source: Willow Gatewood.

A common criticism of data sonification is ambiguity of what is being sonified and why. For instance, similar MIDI biosonification devices like *PlantWave* and *PLANTChoir* have been marketed so that users can "listen to the music of plants" — while often well-intending, language such as "voice", "music", and non-specific terms like "biofeedback" and "biosignals" can make users believe they are hearing

actual sound produced by plants or misinterpret claims of what insights the data can actually provide (*PlantWave*; *PLANTChoir*). Therefore, I believe it is critical to keep language clear and unambiguous, emphasise *co-creation* — that a human plays a large role in what the listener hears — and clarify the intent and purpose of using sound as a method for translating data.

While transparency is important, one can argue that within an artistic activation it is vital not to alienate listeners and participants by focusing too heavily on data; additionally, in my work I wish to draw participants into the world of more-than-human entanglements of which they may not be accustomed within the set space and time of an installation setting lacking verbal explanation. With *Entangled Harmonies*, instruments within the DAW include familiar instruments like piano or string pads that slowly morph or are cushioned by surreal sounds that might be considered more "alien" to listeners. My intent is to draw participants in with something familiar enough not to be off-putting, yet intriguingly fresh and not downplay the extraordinary "otherness" of plants. While instrument choice is meant to be sonically pleasing, I map MIDI data to other parameters within my digital synthesiser, such as LFO's and filters (tools for shaping sound), so that sound wanders and fluxes between recognisable and alien to keep the installation approachable. Here, I wish not to depict the *other* as lesser than; rather, invite participants to enter the space with curiosity and humility.

Reflections and Future Exploration

The installation presented at RSD is part of a growing body of work designing sound and performance experiences co-created with the more-than-human, including *Symbiotic Symphony* (School of Visual Arts Bioarts Lab, 2023), *Planetary Listening: a deep listening series exploring kinship to the living Earth through more-than-human songcraft* (Refreshers Laboratory, Immersive Sound residency, 2025-ongoing), and *Entangled Harmonies* workshop series (2023-ongoing).

Entangled Harmonies and similar sound art activations serve as an ongoing platform for experimentation, ever-growing and morphing from audience participation, inputs, and feedback. I hope to continue to weave sonification and soundscapes into my creative pursuits to serve as a translator for unrecognised intelligences, and for connecting audiences and participants with the living, breathing Earth.

Image 5: Installation view of Symbiotic Symphony at the School of Visual Arts, Bioarts Laboratory Residency, 2025. Source: Willow Gatewood.

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PLANTChoir. <https://plantchoir.com/>

PlantWave. <https://plantwave.com/>

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For information about building a MIDI biosonification device based on my build, please see the linked Google Drive folder for open-source code, diagrams, and build information.

LINK

<https://drive.google.com/drive/folders/1iYSQHLLTaMRZt1LQ5vwRjX0XFy1AC4tHX?usp=sharing>