



Neural Labyrinths: A Performance Installation



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Neural Labyrinths is inspired by the threads running through David Tudor's live electronics works, in particular, the balance between the deceptive technical simplicity of the networks, and the subtle richness of their sounding behaviors. Much of the technical setup stems from Tudor's working methods: modular processing chains, tuned transducers, and people who "could only hope to influence ..." the resulting system. *Neural Labyrinths* is a network of six nodes/stations, each of which consists of: an embedded computer running an audio feedback network loosely modeled on neural influence paths as a synthesis program; audio inputs to the feedback network from an air microphone, a vibration sensor, and two audio lines from other nodes; processing by a modular FX program as complex feedback/resonator; acoustic output via loudspeaker, and vibration transducer via a chosen object; and two channels of audio output to feed into other nodes. Each node/station is individualized by different choices of resonating objects, and transducers. The overall assemblage of nodes is cross-connected by all acoustic signals traveling through air to all listening microphones and transducers, a fixed topology of electronic audio connections (hardwired), and their tunable connection strengths. This network is both an installation and a multi-player performance environment, and new individualizations can optionally be created in a workshop with xCoAx participants.

Keywords: Feedback Systems, David Tudor, Cybernetics, Live Electronics, Participative Works.

Description



Figure 1: Opening performance of *Neural Labyrinths* at the Unexpected Territories Festival, Meinblau Gallery Berlin, July 2, 2022. Photo by Daniel Pepper.

Neural Labyrinths is inspired by the threads running through David Tudor’s live electronics works, in particular, the balance between the deceptive technical simplicity of the networks, and the subtle richness of their sounding behaviors. Much of the technical setup stems from Tudor’s working methods: neural synthesis,¹ modular processing chains, tuned transducers, and people who “could only hope to influence ...” the resulting system.

While Tudor and Gordon Mumma did not seem to refer to second order cybernetics explicitly, the ideas of adaptive systems, meta-systems subsuming systems and their observers, and circular causality, seem perfectly suited to assembling complex setups that may equally be called composed instruments or networks, and that show the sense of aliveness that can come from letting the systems “reveal their personalities”.

The setup of *Neural Labyrinths* is a network of six nodes/stations, which are best distributed in a multi-level open space, for example, as shown in Figure 1.



Figure 2: One node/station consisting of a Raspberry Pi running SuperCollider, an influence interface, a mixer/audio interface, and microphone. Photo by Udo Siegfried.

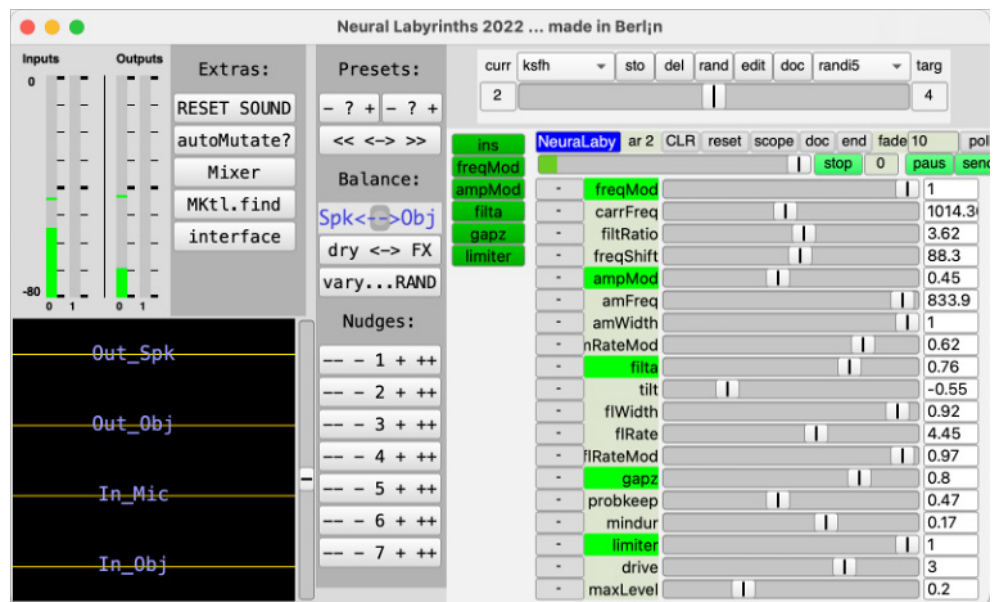
As shown in Figure 2, each node/station consists of:

- an embedded computer running a audio feedback network as synthesis program;
- audio inputs to this feedback network from an air microphone, vibration sensor, and audio lines from other nodes;
- processing by a modular FX program as complex feedback/resonator;
- acoustic output via loudspeaker, and vibration transducer into a chosen resonator object;
- and two channels of line audio output to connect to other nodes.

Each node/station has fixed aspects, which are individualized by choice of audio equipment used, such as different choices of loudspeaker, microphone, transducer, and first and foremost, resonator object in the vibro-acoustic feedback path. The overall assemblage of nodes is cross-connected between all nodes by all acoustic signals traveling through air to all listening microphones and transducers, and by the electrical audio signals through a fixed topology of audio connections.

1. Initial plans included a small simulation network of firing nerve cells as audio signals following the common Fitzhugh-Nagumo model, which were to be excited by incoming audio signals. As the feedback system itself turned out to be such a rich sound source already, the neural synthesis module was not considered essential for the first realization and relegated to an option in later editions. Nonetheless, we felt the role that feedback paths play in nerve cell assemblies and in our system are structurally identical, and thus justify keeping the name as is.

Figure 3: The graphical interface shown on the touchscreen of each Raspberry Pi node. Screenshot by Alberto de Campo.



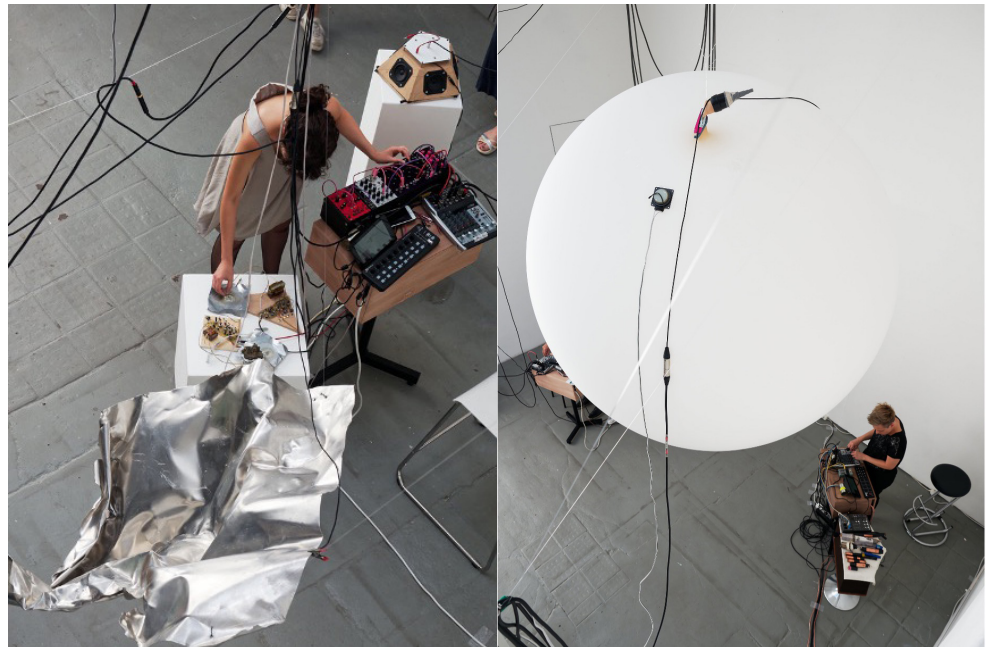
On each station, the inputs, air mic, contact mic and the two lines from other nodes are mixed to a stereo sum which goes through two-channel processing; then the left output goes to a speaker, and the right goes to a shaker or string amplifier. The processing patch is inspired by the Pepsi Modifier Board that Gordon Mumma built for Tudor and the Pepsi pavilion project (Nakai 2021, chapter 5).

It consists of four modules:

- *frequency modulation* which uses pitch shifting similar to the Pepsi board;
- *amplitude modulation* continuing into ring modulation, with amplitude following rate modulation;
- a *tilt filter* going from lowpass 200 Hz to hipass 5000 Hz, with amplitude following modulation;
- and a *gapz* module which decides by probability at zero-crossings whether to pass the next waveform segment or not. This is a digital variant on the pulser modules Tudor used very often.²

Each node also has tunable aspects, which can be influenced by performers in order to activate or animate the system; the nodes can also listen to themselves and to each other and their environment, and adjust their tunable aspects based on their “observations”, thus adapting by influencing themselves and each other.

Figure 4: Left: Ioana Vreme Moser with a warped metal sheet as sound object, and self-made 5-channel loudspeaker, and for the performance, a self-made electronic circuit. Right: Liz Allbee with weather balloon and a hybrid electroacoustic wind instrument setup. Photos by Anne Wellmer.



Collaborative Process for Version Meinblau 2022

The starting point for the creation of the piece was an invitation by curator Carsten Seiffarth to propose a contribution for the Festival Unexpected Territories – David Tudor. After reading the newly released major analysis of Tudor’s music and working processes (Nakai 2021), we decided to build a system that attempts to embody several central aspects of Tudor’s work:

- inviting a group of participants to co-create the instance of the work together,
- choosing or creating sculptural objects for the sound-coloring properties,
- synthesizing sound by (acoustic, vibrational and electronic) feedback,
- applying neural concepts such as networks of feedback paths,
- deploying modular effects processing chains for real-time playability of all sounds.

Figure 5: Left: Hannes Hoelzl designed a construction with six suspended metal strips. Right: Anne Wellmer chose an electro-magnetic string setup (from our *Six Strings* project) as her feedback-filter object. Photos by Anne Wellmer.

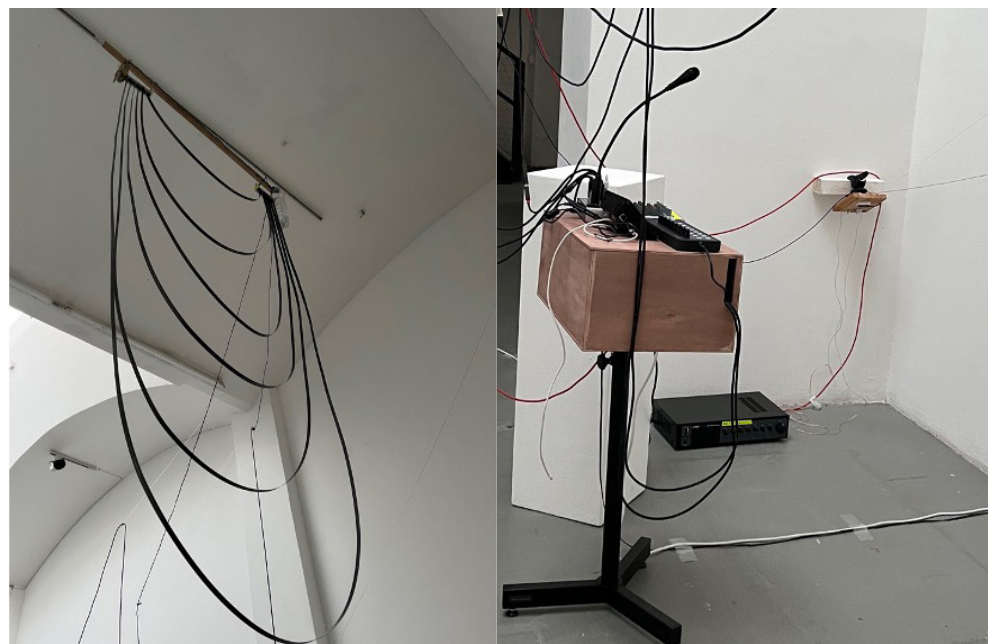


Figure 6: Left: Alberto de Campo chose a bottle drying rack with a diverse collection of bottles and cans as rattling objects. Right: the anonymous 6th station consists of a shaker and a contact mic attached to a drywall, including the architecture of the exhibition space as a resonant object. Photos by Anne Wellmer.



The participants for the first version of *Neural Labyrinths* were Anne Wellmer, Liz Allbee, Ioana Vreme Moser, and ourselves. We brought the basic setup and our object prototypes together in a basement room at UdK Berlin Medienhaus, and played multiple rehearsal sessions in different combinations, learning to play the processing patch, and refining the objects in multiple iterations. The sound-coloring objects were fitted with a shaker for sound input, and a piezo pickup for output of vibro-acoustic sound.

References

Nakai, You. 2021. *Reminded by the Instruments: David Tudor's Music*. Oxford University Press.