

# Self-Regulatory Feedback Systems as Sound Installations

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**Abstract.** *This paper examines the development of two recent sound installations, Filling Vessels and circadia, and their method for exciting and controlling feedback through adopting techniques associated with a-life. The evolution of these installations is traced, while examining the decentralized performance encouraged within them.*

## 1. Introduction

*Filing Vessels* and *circadia* are two related sound installations developed in order to examine ways in which people interact with an acoustical space and subtly impact the sounds within it. Of particular interest and influence was Alvin Lucier's work as detailed in *Reflections* (1995), and especially his sound installation *Empty Vessels* (1997) in its striking manner of generating feedback. In this installation, Lucier inserted microphones into jars, and vases that were distributed throughout the space. The input on the microphones was then amplified such that they were on the cusp generating feedback. This extremely delicate balance was navigated by the visitors to the sound installation, as their movement through the space affected resonances within it.

*Empty Vessels* provided an initial impetus to experiment with feedback in a similar manner; that is, using feedback as a means of exploring the acoustical qualities of a particular space and the impact visitors have on it through their presence and movement. This interest aligned with the goal of making a feedback-based sound installation self-regulatory, cajoling itself towards producing various tones, and curtailing itself from spinning wildly out of control. Of particular interest was how a sound installation might acquire a unique sonic identity based on the self-regulatory mechanism employed. This paper traces the evolution and gradual merging of *Filling Vessels* and *circadia*, discussing the manner in which both systems regulate themselves.

## 2. Filling Vessels

The development of *Filling Vessels* began during the Fall of 2005. The title chosen pays homage to Lucier's pioneering work with feedback and the pivotal role *Empty Vessels* had in inspiring this work. *Filling Vessels* began by experimenting with generating feedback by amplifying microphones placed in jars until they were at the threshold of generating feedback. The sensitivity of the microphones to the acoustical properties of the space and one's location within it were immediately evident. Feedback would at times emerge and then cease if one walked to a different part of the room upon excitation. One could also easily hear how specific pitches and tones became excited simply talking, clapping, and singing. At times, the feedback could begin, and then

crescendo to nearly unsafe volume levels. Utilizing “adaptive games,” as discussed by Eduardo Miranda (2003), served as a model for reigning in the feedback.

Adaptive games utilize agent-based behavior in systems drawing on tenets of a-life that do not specifically involve cellular automata or genetic algorithms, but instead employ algorithms related to the interaction of multiple agents with a bottom-up emphasis, such as flocking and swarming. In particular, I was interested in what I call *decentralized performance*—that is, the specific actions and performative responsibilities of agents within systems that involve the aforementioned techniques.

The goal was to develop a system that could keep track of itself in a bottom-up manner. Instead of having a global control of amplification, each individual feedback-generating vessel is treated as an independent agent. Four vessels are located at the center of the room, with a microphone inserted in each jar. The signal feedback generated is routed to four different speakers located at the edges of the installation space. Each vessel is assigned its own speaker. The feedback signal passes through a Max/MSP patch tracking the overall volume and pitches produced by each of the four vessels. Each vessel tracks its own activity in relation to the others, making sure that each vessel has a chance to generate its own, unique feedback. Large cascading waves of feedback emerge with tones arising from one vessel while another decrescendos.

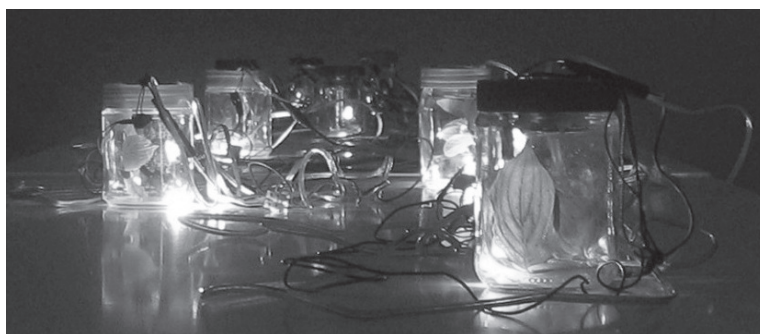
Most crucial in this particular feedback scenario is determining the rate at which the amplification is gradually decreased and increased. This calibration changes wildly from space to space, depending on the shape and resonance of the room and the number and location of people within it. The overall tones produced depend on the resonance of the jars, the room, the equipment mediating the feedback, and a shifting filter system that changes every time a pre-specified volume level is exceeded. Another element introduced to the system was to have it constantly recording and cataloging recorded tones based on register. These samples are reheard occasionally as shifting, discrete rhythms that are selected based on the frequencies present in the room. This lends the space a memory of the sounds that have occurred within it, and provides small perforations of the larger waves of sound from the four vessels. *Filling Vessels* later acquired a video element in collaboration with Tom O’Doherty, consisting of images of light reflected in the performance space. After working with the large waves of sound in *Filling Vessels*, I was interested in exploring smaller, waves of sound. This interest fueled the development of *circadia*.

### 3. *circadia*

*circadia* began as an outgrowth of *Filling Vessels*, utilizing a similar manner for producing feedback. The focal interest shifted to creating small waves of sound by using eight glass jars of various sizes as the feedback-producing vessels that doubled as the resonating bodies for speakers mounted on top of the jars. The speakers, in this case, are actually the lids to the jars, enclosing a small condenser microphone and LED inside the vessel. The microphones are amplified such that feedback emerges out of each jar, and is routed out its own speaker-lid. Thus, one can listen to the unique feedback each vessel generates.

Each vessel in *circadia* is treated as a separate agent as well. In contrast to *Filling Vessels*, these vessels work towards synchronization. The amplification of each microphone is controlled through a Max/MSP patch specifying different envelopes that determine the gradual increase and decrease of the amplification. A series of 12

different envelopes are possible, and each one can be triggered at different rates. A vessel is randomly assigned one envelope and pulsation rate at the beginning of the synchronization process. The vessels work towards synchronization by finding a common rate of pulsation; that is, how often the envelopes are triggered, and then by converging on a common envelope. No single vessel acts as a leader. Instead, each one takes on the pulsation rate of a neighboring vessel depending on whether or not it is more active than itself, resulting in shifting pulsations of subtle feedback until finally coalescing into one shared pulse. The LEDs within each jar are controlled by the amplitude of the signal, reflecting these pulsations with light. The overall look resembles fireflies flickering in the night, referencing the childhood experience of watching the visual dance of these insects.



**Figure 3. Image of *circadia*.**

*circadia*, like *Filling Vessels*, is impacted by the acoustic properties of the space as well as the audience's interaction with it. Frequently, visitors to the installation would talk and sing into the vessels. By exciting resonances within the jars in this manner, the tones of the feedback would often change based on what frequencies were excited. Intriguingly, by working with the synchronization algorithm, the vessels would often excite different frequencies in one another. This was a completely acoustic phenomenon, and one that occurred only through multiple feedback-producing agents interacting in this decentralized manner. Different combinations of tones emerged over time based on the frequencies each vessel excited in one another.



**Figure 4. Image of *Filling Vessels* and *circadia* combined.**

After developing these two interrelated sound installations, the idea of combining them became enticing. *Filling Vessels* and *circadia*, merged, forming a

complex feedback-based environment. The small pulsations of *circadia* excited frequencies in the jars for *Filling Vessels*, coaxing unique balances between the small and busy activity of *circadia* and the enormous waves of sound emerging from the larger speakers in *Filling Vessels*. Images of light reflected in the installation space photographed by Tom O’Doherty were used for illumination, and processed based on the activity of the four vessels in the space. The contrasting amounts of both light and sound affected the sense of the depth of the sound in space, making it seem both vast and localized.

#### 4. Conclusion

*Filling Vessels* and *circadia*’s development utilize different implementations of self-regulating feedback systems. Both monitor the amount of amplification of the microphones inserted in the vessels as a way of controlling the amount of feedback that emerges. However, each utilizes adaptive games differently. One defines the responsibilities of the feedback-producing agents such that they have the goal of generating feedback, but only so long as it refrains from overpowering the other agents, while the other endows the agents with the task of synchronizing with one another. The self-regulating mechanism employed in both installations enabled their contrasting sonic characters. One criticism of both installations relates to the nature of the oblique interaction with the audience. Many visitors could sense some sort of influence on the system, but the immediacy of a cause and effect relationship was often difficult to pinpoint. This, however, is one of the aspects of interaction that *Filling Vessels* and *circadia* is concerned with. There are no knobs to turn, no buttons to push, no switches to throw. It is simply by being there that one affects the space, becoming part of it and the resonating environment.

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#### References

- Lucier, A. (1997) “Empty Vessels”, <http://www.ps1.org/cut/volume/lucier.html>, July.
- Lucier, A. *Reflections: Interviews, Scores, Writings*, MusikTexte, 1995.
- Miranda, E. 2003. “On the Music of Emergent Behavior: What Can Evolutionary Computation Bring to the Musician?” *Leonardo*, 36(1): 55-59.