An Initiative in Embedded Sound Art with Found Objects: "What's Old Is New"

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ABSTRACT

"What's Old Is New" is an initiative in embedded sound art with found objects. After reviewing some history of found objects being used in experimental music, this paper proposes the idea of embedding powerful digital computation inside of found objects. It is further suggested that it can be fruitful to integrate audio amplifiers and loudspeaker drivers/transducers into found objects to create Embedded Acoustic Sound Art. These ideas are illustrated using some recent sound art projects by the authors.

1. INTRODUCTION

1.1 Early History

For millennia, people have sought to make musical sounds using found objects from their environment. This includes immediately creating sounds, such as by blowing air across a drinking vessel, bamboo reed, or a fixtured leaf or blade of grass. People have also found ways to create simple musical instruments out of found objects. For example, pan pipes have been made out of groups of bamboo reeds, drums have been made out of hollowed-out logs, and various other instruments have been made out of modified gourds, bones, etc. [1, 2, 3].

1.2 20th Century History

1.2.1 Found Objects and Ready-Mades in Art

In the history of art, found objects have also been important. While found objects have sometimes been juxtaposed with other artistic objects [4], found objects have alternatively sometimes been presented as art objects on their own. Such artworks have been referred to as *ready-mades*, a term taken from the distinction, at that time, between hand-made products and ready-made (e.g. manufactured) objects [5]. Marcel Duchamp created a series of ready-mades and introduced the term for them.

One of the most notorious ready-mades titled *Fountain* (1917) was a urinal mounted upon a pedestal. This ready-made tends to be attributed to Marcel Duchamp, although there is some question about that [6]. In any case, *Fountain*'s consideration as an artistic object made a controversial and lasting impression on the art community, and it became part of a trajectory of a series of found objects used by many artists over the years.

Trash has also been used as found objects in art [4]. This kind of art questions assumptions about modern life and how people interact with their environment. Along a similar vein, in a variety of projects, musical instruments and musical instrument components have also been made out of junk, trash, and surplus parts [7, 8].

1.2.2 Non-Electronic Found Objects in John Cage's Experimental Music

In the context of this paper, it is important to think about how found objects have been used in experimental music. Since John Cage played a leading role in popularizing the usage of found objects in experimental music, some of his notable works will be described here.

Already in 1939, Cage's *First Construction in Metal* specified the usage of brake drums and scrap iron [9]. Later in 1959, Cage performed *Water Walk*. For this performance, the "materials required [were] mostly related to water, i.e. bath tub, toy fish, pressure cooker, ice cubes (and an electric mixer to crush them), rubber duck, etc., but Cage also [called] for a grand piano and 5 radios" [10]. Also notably, John Cage composed *Child of Tree* (1975) and *Branches* (1976), which particularly emphasized the audio amplification of the sounds of found objects. For those compositions, plant matter-based instruments were utilized [10], including a dried cactus, whose spines produced music-like tones upon being plucked.

1.2.3 Electronic Found Objects in John Cage's Experimental Music

Cage also called for the usage of electronic found objects. Already in 1939, in one of the earliest works involving live electronics, John Cage specified how two turntables should be used in the performance of *Imaginary Landscape No. 1* [11]. Later, for *Imaginary Landscape No. 4 (March No. 2)* (1951), John Cage dictated that 24 performers should use 12 radios to tune across local radio stations [1]. Further examples abound [10].

Generally speaking, electronic found objects have been used in a wide variety of ways by many composers and sound artists to create music. Some of these have been documented in books by Nicolas Collins and Reed Ghazala [9, 12]. In general, a lot of the approaches involve subverting the original design of electronics in order to create strange sounds.

1.3 Embedded Computation for Sound Art

Up until recently, found objects and other artistic objects have been able to have analog or very simple digital electronics embedded inside of them. In this way, it has been possible to give them an electronic voice. However, the possibilities have been somewhat limited by available technology.

Today, recent developments make it possible to embed powerful computation inside of found objects. For example, now it is possible to run common computer music programming languages such as Pure Data or SuperCollider on Raspberry Pi or Beagle Bone-based embedded computers [13, 14], which can be embedded inside found objects. This can potentially result in a whole new way of conceptualizing of and realizing sound art, in consideration of the futuristic paradigm that eventually maybe even almost all commonplace objects will someday have computation embedded inside them.

1.4 Embedded Acoustic Sound Art

By further integrating loudspeaker drivers and amplifiers into sound art, it becomes possible for sound art to directly radiate digitally computed sound and become standalone, digital sound artifacts. A diagram of this scenario is shown in Figure 1. The authors refer to this as Embedded Acoustic Sound Art, which will be exemplified through the projects documented in this paper.

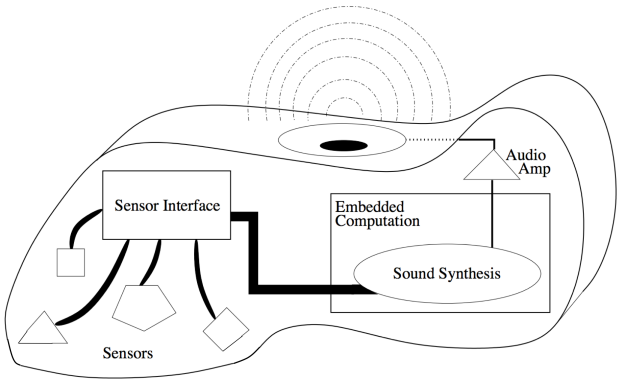

Figure 1. Diagrammatic representation of Embedded Acoustic Sound Art.

2. WHAT'S OLD IS NEW

Combined with advancements in digital fabrication, an infinite range of possibilities is enabled today for embedded sound art. However, an infinite range of possibilities can also present a challenge for designers: if there are too many possibilities, then it can be hard to get down to business and make the project specific enough to have a strong artistic meaning or metaphor [15].

Accordingly, the incorporation of found objects into embedded sound art can be a boon. The present paper investigates this topic using a series of embedded sound art. The authors have found it interesting to explore the boundaries between old and new objects, which has resulted in the creation of an initiative called *What's Old Is New*.

Beyond exploring the possibilities of Embedded Acoustic Sound Art, the following discussion aims to describe the interface between old and new objects, as this relates to embedded sound art. Indeed, many messages that old objects communicate are still relevant today. But with embedded technology, sound artists can put a new spin on the messages that these objects communicate.

3. HANG-UPS

3.1 Description

Hang-ups is a sound art installation made by integrating audio DSP into an antique candlestick telephone, which is displayed as shown in Figure 2. Visitors are instructed to do the following:

"Cast off your hang-ups! Speak one of your hang-ups into a modified antique telephone, and listen as the sound decays away into the ether. Wait until the environment is quiet, and then follow this procedure:

1) Pick up the earpiece and hold it to your ear. 2) Speak one of your hang-ups as a sentence or a phrase. 3) Hear the sound of your hang-up as the telephone conveys it back to you through the earpiece. Then listen to the rhythms of your hang-up decay away as the response gradually grows softer. 4) Hang up the earpiece to lay your issue to rest. 5) Repeat with another hang-up."

Visitors are suggested to consider hangups like

- Trying to make everything perfect.
- Wanting to always have good coffee.
- Having difficulty being satisfied.

An example of *Hang-ups* in use can be heard at the link below. [1]

3.2 Technical Realization

A Raspberry Pi 0 was used to implement the audio DSP. It was installed inside a cavity created in the base of the phone, which is shown opened up in Figure 3. A Speaker pHAT shield was plugged onto the GPIO pins of the Raspberry Pi 0, which provided a DAC and audio amplifier to

[1] `http://edgarberdahl.com/%20listen/2018/11/01/Hangups.html`

Figure 2. For *Hang-ups*, a visitor is asked to speak one of his or her hang-ups into a candlestick telephone and then to listen while the rhythms created from the voice signal decay away into the ether.

power the telephone's earpiece. To get audio input, the telephone microphone was connected into a line-level audio input provided by a USB audio adapter from Adafruit. Despite the potential impedance mismatches between early 1900's-era electronics and electronics from 2017-2018, the system worked without any additional required electronics. The only electrical connection from *Hang-ups* to the outside world was via a simple 5V power connection.

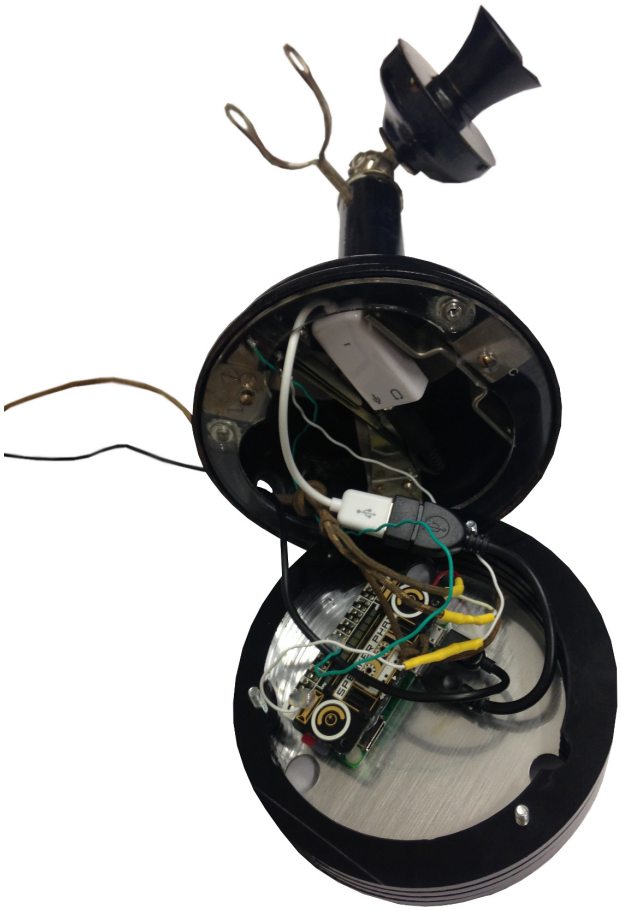

Figure 3. Inside the base of the candlestick telephone for *Hang-ups*.

3.3 What We Learned

In present day, most young people have never used a candlestick telephone before. Upon first approaching the telephone, young people sometimes needed a few tries in order to figure out how to use it.

The original candlestick telephone microphone and earpiece caused the sound quality to be particularly lo-fi. Moreover, the microphone connected to the line-level input somehow had a very strong resonance frequency just above 1kHz. To mitigate this effect, a notch filter was applied in Pure Data. The otherwise originally lo-fi aspect of the sound was charismatic and enhanced the experience of interacting with *Hang-ups*.

Several challenges were discovered when attempting to integrate new electronics with an old telephone. One of them was that the size of the base needed to be increased in order to house the extra electronics. Figure 4 shows the old part of the metal-enclosed base and the new part, which was made out of a stack of laser-cut black acrylic rings.

Figure 4. For *Hang-ups*, the old telephone base needed to be extended with some new acrylic discs in order to house the additional electronics.

Additional work was needed to be able to screw the new part of the base onto the telephone. The old screw (see Figure 5) was incompatible with the laser-cut rings, so a new bracket was created out of transparent acrylic. This bracket had holes that allowed attachment to the old screws, and the bracket also had three instances of a new nut (see Figure 5), which were epoxied onto the acrylic bracket in order to enable the new rings to be screwed onto the base.

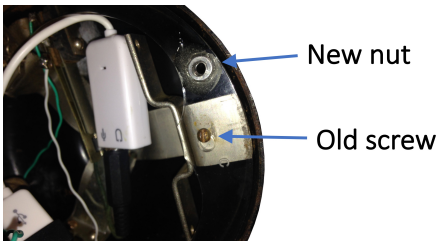

Figure 5. For *Hang-ups*, each of the old screws in the base needed to be adapted with a transparent acrylic disc to provide a new nut. Because the acrylic disc press-fit against the old screw, it was challenging to laser-cut the disc as precisely as needed.

One final surprise was the difficulty of soldering to wires from early 1900's electronics — although the wires themselves were still in good condition, for some reason it was necessary to add a lot of solder flux to joints while soldering.

4. RE-SOUNDING WILD

4.1 Description

Re-Sounding Wild is a demonstration of the actual soundscapes of national parks in real life. *Re-Sounding Wild* consists of a piece of driftwood (see Figure 6) with embedded electronics for interactivity. Emerging directly from the wood, nature sounds entice participants to examine the installation. As participants get closer, however, the natural soundscape changes to a human-made soundscape. This interaction is meant to mirror the effect that humans have on natural environments. It also emphasizes that we cannot enjoy nature without changing it.

All of the recordings are from Yellowstone National Park. The few sounds of nature include rivers, streams, geysers, and birds. The many sounds of people interrupting nature include footsteps, families taking photos, people discussing trail routes, talk of bear sightings, international tourists, vehicles, and a father scolding his son.

Figure 6. *Re-Sounding Wild*.

An example of *Re-Sounding Wild* in use can be seen at the link below. [2]

4.2 Technical Realization

Re-Sounding Wild has a Raspberry Pi 3 glued onto the underside of the driftwood. A Pimoroni pHAT BEAT is plugged into the GPIO pins of the Raspberry Pi 3 for stereo output to left and right channel transducers [16] which are attached directly to the driftwood to actuate the wood's resonant frequencies. An Arduino UNO is connected via USB to the Raspberry Pi 3 and mounted onto the pHAT BEAT with a laser-cut piece of cardboard and plastic screws. Two distance sensors are connected to the Arudino UNO and mounted under the driftwood with velcro for flexibility.

The distance sensors use Firmata to communicate with Pure Data running on the Raspberry Pi 3. In Pure Data, a collection of natural sounds recorded in Yellowstone National Park are on loop in an irregular pattern. As participants move closer to the distance sensors, Pure Data cross-fades from the natural sounds to the human-made sounds found in Yellowstone National Park looping in an irregular pattern.

4.3 What We Learned

Semi-permanent, non-invasive methods were used to embed *Re-Sounding Wild*'s electronics to maintain the driftwood's structural integrity. Given the unique nature of the driftwood, it is undesirable to potentially destroy the piece by drilling or carving into it. A variety of non-invasive materials are used instead to embed electronics onto the driftwood. The Raspberry Pi 3 is connected to the surface of the driftwood with wood glue, the distance sensors are connected with velcro, and the transducers require epoxy to accurately actuate and to stay mounted to the wood.

Found objects don't always offer a place to hide electronics. *Re-Sounding Wild*'s electronics are embedded, but are still plainly visible sitting on the surface. By determining the driftwood's front and sides, the back and underside of the wood was able to be used to hide the electronics, with the exception of the distance sensors. The distance sensors need to have a clear path to the user, so they are visible, but their wires are wrapped in black cloth. Putting the wood onto a black cloth-covered surface to have the sensors blend into the background even though they were in plain sight.

Using found objects for their meaning, not their sound properties is a challenge when developing a sonic installation. Driftwood is not an amazing material to use with transducers, so sound fidelity is low and noisy. To counteract the noise, bandpass filters were used on the audio to remove any low rumbling or high hissing that was causing the wood to rattle and interfere with the desired output.

5. ZEN GARDEN

5.1 Description

The goal of the *Zen Garden* installation is to sonify the private experience of a larger zen garden, but have it be in a location inside the house or office. As a user rakes the sand shown in Figure 7, the sound of zen bells adds a restful sound as they are triggered in an indeterminate order, as if the wind is peacefully blowing through. To add to the healing aspects of the meditative state that's possible to reach during usage of the zen garden, the volume of the sound files is dependent on the speed at which the user pulls the rake through the sand; i.e. the slower someone pulls the rake through the sand, the softer the sounds, and the faster someone pulls the rake through the sand, the louder the bells will toll. A demonstration of *Zen Garden* can be viewed at the link below. [3]

5.2 Technical Realization

A desktop-sized zen garden is placed on top of laser-cut box (see Figure 7), which has speakers placed beneath the surface. The speakers are connected to a Raspberry Pi. We utilized Pure Data to program the sound files and the response thresholds. We attached a piezo pickup to a rake that is connected to the Raspberry Pi through an auxiliary cord. The only electrical connection that the Zen Garden has is via a simple 5V power connection. There is also a turnable switch that is attached to the Raspberry Pi that can give the operator a manual volume control and to switch the power supply on.

5.3 What We Learned

In a modern-day lifestyle, filled with stresses, pressures, and responsibilities, there usually is not much time for an individual to relax. At first glance, this seems like a kitsch desktop gift one might find at an oddity store. But once the individual interacts with the *Zen Garden*, she or he soon discovers that it is not only peaceful and relaxing, but it is also fun.

Initially, the most difficult thing to do was to figure out not just the dimensions of the box on which it sits, but also the placement of the speakers, Raspberry Pi, and where the power cord and the connection to the rake might enter/exit the housing without getting in the way. From there, we were able to build an instrument in which we were able to create a world that could be implemented on a small scale.

[2] `https://drive.google.com/open?id=1XbMyx1x7Q9xjkaCnJavf4J29O-E1mvLV`

[3] `https://drive.google.com/open?id=15pJ0uGoF5n5RW5xgtMh8FlDs_EMXmbF3`

One challenge encountered was that it was tricky to interface the rake (and old object) with the piezo disc (a new object) in order to measure the vibrations. Nonetheless, we were able to do so and achieve a good sound quality by gluing the piezo disc to the handle of the rake (see Figure 8).

The most pleasant surprise from the entire experience was that we could recreate the experience of being at a zen garden but we were protected from the elements by being inside, and that the piece reacted like an instrument, regarding pressure of the movement of the rake and the volume of the bell chimes. This piece can evoke the ancient practice of zen gardens with the practical needs of someone living in the city and the technical advancements to nearly bring the entire outdoor experience inside. By bridging the ancient and the modern, an experience is created that more people can enjoy.

Figure 7. *Zen Garden* is an installation that takes the vibrations from raking a zen garden (see sand box above) and converts them into musical sound.

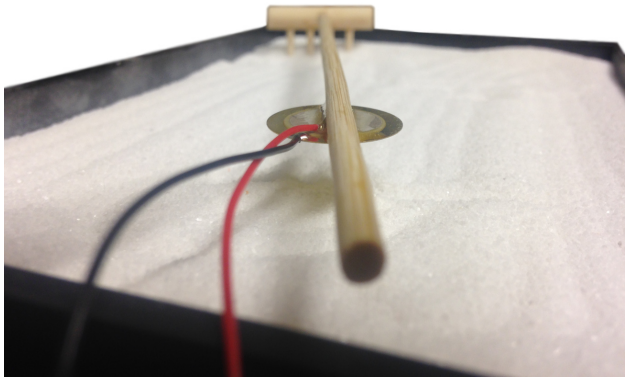

Figure 8. A piezo disc (see above) is attached to the rake of *Zen Garden* in order to measure its vibrations.

6. CONCLUSIONS

Above, some works have been discussed that integrate electronics (new objects) into found objects (old objects). In this way, the initiative "What's Old Is New" is being proposed.

One perspective on this initiative is that some objects just need to make sound! Aspects of modern life can be mundane, but with music, and its integration into found objects, sound artists can contribute an air of whimsy and delight.

Even though embedded electronics are continuing to get more advanced, it's still somewhat challenging in practice to hide powerful embedded systems inside found objects. One way to address this issue is to use digital fabrication to help interface the old parts with the new parts. Nonetheless, challenges will be encountered: press-fitting is hard to work with, screw holes may not be located in a workable arrangement, additional soldering flux may be needed to solder to 1930's-era wires, and the look of the old objects being integrated with the new objects may be incongruous. Yet perhaps this is what makes Embedded Acoustic Sound Art intriguing. Moreover, approaches for integrating old objects together with new objects, such as using transducers to actuate works instead of simply installing loudspeaker drivers, can be important. More works and approaches are needed for learning more about this research area, and how to use new technology to help embrace old objects. The authors hope that their works are providing a good start in this direction.

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