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Vocal Synthesis and Deep Listening

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VOCAL SYNTHESIS AND DEEP LISTENING

A thesis submitted in partial fulfillment of the

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by

Chelsea Anna Bruno

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To: Dean Brian Schriner
College of Arts and Sciences

This thesis, written by Chelsea Anna Bruno, and entitled Vocal Synthesis and Deep Listening, having been approved in respect to style and intellectual content, is referred to you for judgment.

We have read this thesis and recommend that it be approved.

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Orlando Garcia

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Jacob Sudol, Major Professor

Date of Defense: March 25, 2014

The thesis of Chelsea Anna Bruno is approved.

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Dean Brian Schriner
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ABSTRACT OF THE THESIS

VOCAL SYNTHESIS AND DEEP LISTENING

by

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Professor Jacob Sudol, Major Professor

My composition, Maitreya, combines vocal synthesis techniques with the theoretical concept of Deep Listening. This essay discusses developments in vocal synthesis and digital signal processing (DSP) software that can be performed in real-time and contributed to my composition. Deep Listening involves meditative practices to make one more aware of sounds that are both audible and inaudible. The composition utilizes recordings of male and female voices that recite poetry, chant, and are phase-vocoded. The composition also features various DSP techniques, and a custom-built modular synthesizer. The composition has three sections that were compiled and edited in Ableton Live 8.2.2.

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I. INTRODUCTION

I hear the guitarist playing next to me; I hear the water drops falling from the leak in the roof. I especially hear the steady mating call of the amphibians in the canal that strongly resembles a sound that is easily and readily synthesized. It is that the frogs are modulating their vocal chords. However, the fact that the other frogs further away in the canal are also echoing the same sound makes it worth interpreting. Their chirping entrains; these frogs are naturally echoing, by a deep communication within their primal expression, which we, as humans, do not have anymore.

(Personal Deep Listening notes, Spring 2013)

My thesis composition, *Maitreya,* aims to embody a unity between Eastern and Western cultural traditions with a combination of vocal sampling, phase vocoding, Deep Listening, and modular synthesis techniques.

I have Pauline Oliveros to thank for my awareness and initiation to becoming a deep listener. Her theory, known as Deep Listening, is a metaphorical meditative practice that trains one to be a deep listener. It states that one should always be listening to all sounds in the surrounding environment and always remind oneself when he or she is not listening. Being a deep listener requires a novel hypersensitivity to sounds that happen all the time and therefore makes one more sensitive and appreciative of sound. After my research into Deep Listening, I find that I spend a large amount of time sitting in silence developing a more thorough appreciation of music and all sounds.

I strongly believe that because Deep Listening opens the listener's awareness and sensitivity to sounds, that it has the power to allow for a sacred listening experience. The New Oxford American Dictionary defines the adjective, "sacred," as how something is "regarded with great respect and reverence by a particular religion, group or individual." Expanding from this definition, I consider sacred music to be a sequence of

vibrations, which create a desirable and harmonious audible structure that is pleasing to my ears and other senses. These sequences of vibrations and melodies provide me with a sense of peace during my compositional processes. I aim to create a new form of music that through its own personal meaning does not have to be religious in order to be something that I consider sacred. I view this approach of utilizing sounds that have a personal sacred meaning to produce a sacred music as something similar to the technique found in other sacred musics, such as *raga*. For example, when describing the significance of deep personal meanings in raga, Ravi Shankar states – "the highest aim of our music [i.e. raga] is to reveal the essence of the universe it reflects, and the *ragas* are among the means by which this essence can be apprehended" (Schwartz 82).

Following this idea, my thesis project aims to yield a composition that I myself will consider sacred and, as such, hopefully communicate a message with the listeners. To do this, I aim to transmit attributes of Deep Listening experiences that portray sound as a form of alchemy such as horripilation, which is known as the sensation of chills or tingles during a powerful conscious experience. I equate this feeling with a personal awareness of something sacred. I have found that horripilation is most possible in our present day while watching a film because the viewer is engaged in a story that builds up to a certain point and is accentuated by the musical score. Horripilation can occur almost as if on trigger because of the music that is paired with a peak point in a film's plot. I can verify this of my own experience in two recent films: "Batman: The Dark Knight Rises," the score composed by Hans Zimmer, and "The Hobbit: An Unexpected Journey," the score composed by Howard Shore. I noticed, while experiencing these films at certain critical moments, chills ran through my whole body. The movie theater going experience

is a sort of modern or contemporary cathedral whereby a large group of people and loud amplitudes heighten the effects of sounds. This is similar to the historical experience of listening to chorales and sacred music in a cathedral where the architecture's natural reverb would amplify the music and potentially send chills to the listeners, thereby creating a feeling of union with the divine.

The world of music has been transformed entirely since the developments of technology. Charles Dodge used vocal synthesis as a unique instrument to provide a different perspective on how this technique could be utilized in experimental music. The quality and density of Dodge's *Speech Songs* encourages me to enter an empty listening state that does not evoke any emotions. They are not, in fact, songs, but expressions of the somewhat limited technological capabilities at the time. I realize that vocal syntheses are amazing technological developments that have been made mundane in our society. This composition on the other hand, points to artificial nature of vocal synthesis and is something I desired to highlight anew in my composition.

With Deep Listening, Oliveros attempted to bring back the divine nature and freedom of music by demanding that individuals develop a deep awareness and sensitivity to sound. The perpetuation and expansion of technology makes this difficult, because it has constantly increased the number of sounds present. The technological age for this reason is a difficult one for yielding music of sacred substance. Despite this, I have attempted to bring back the sacred relevance of ancient music by using textural and sonic materials that personally trigger horripilation. This requires a combination of technology, chanting, drones, and texts for spiritual healing.

I continue to state the importance of what I have discovered as being a Deep Listener. We can hear beyond the deep rumble of the airplanes, or the earth quaking, and the deep sounds that surround us throughout our everyday lives. I believe that music can assist with the meditation and healing process. Sound can provide a sense of guidance and the insight that one may seek if they desire to listen to music.

II. HISTORY OF VOCAL SYNTHESIS AND RE-SYNTHESIS

> The history of computer-synthesized speech begins in the 1950s at Bell Telephone Laboratories, where scientists and engineers were working to replicate the human voice in telephone systems. Musicians soon became interested in the possibility of using the synthetic voice as a musical instrument that could surpass the human voice in plasticity and range of capabilities. The element of intelligible language was thus introduced to computer music, bringing with it a broad range of theatrical, intellectual, and poetic possibilities. (Dodge 220)

Homer Dudley began experimenting with electronics in Bell Labs in 1928 intending to imitate human speech sounds. Physiologists had previously concluded that the sonic complexities achieved by vocal cords lay in their mechanical structure and in the formants they produce. He applied these discoveries in his invention, the VODER (Voice-Operating Demonstrator), in 1939. This machine required external kinetic motion to mechanically produce synthesized speech.

Vocal synthesis has undergone a vast amount of research since its invention. One of the first songs to use digital vocal synthesis, *Daisy Bell* (1962) involved programming designed by Max Mathews. This work has been an inspiration for my thesis. Unlike Dudley's VODER, digital vocal synthesis only required a computer and a digital audio converter.

Charles Dodge used the computer-synthesized human voice creatively in his tape compositions, *Speech Songs* (1973), to create a dichotomy between the real and the unreal. Although the synthesized voice in Dodge's music is at times presented realistically, it also speeds up, slows down, and gets broken down into syllables and speech fragments in a way that no human voice can.

Paul Lansky also composed with vocal syntheses. I believe that the vocal transformations in "Her Reflection" from *Six Fantasies on a Poem by Thomas Campion* (1979), embody a sense of musical mysticism. In this piece, a phase vocoder temporally stretches the human voice to produce prolonged tones. Dodge wrote about this composition stating that the "prolonged tone is of the same vowel timbre as the syllable of the text it prolongs" (Dodge and Jerse 240). Therefore, the processing obscures the speech and places emphasis on the sound, thereby giving it a new dimension.

The juxtaposition of male and female vocals is an area that has been explored by past researchers. Dutch researcher Hannah Bosma has "identified a variety of issues surrounding the compositional choices of those utilizing spoken and sung text in their work and illustrated the differences of use in relationship to the vocalist's gender" (Elizabeth Hinkle-Turner 122). Whereas Lansky utilized the voice of Hannah McKay reciting poetry in *Her Reflection*, and Dodge synthesized a male voice reciting poetry in *Speech Songs*, I have synthesized a droning digital male voice to contrast it with recordings of my own female voice as well as recordings of a male voice, that of my friend Thomas Ashley.

III. UTILIZED TECHNOLOGY

III-A. SOFTWARE COMPONENTS

The most important aspect of *Maitreya* is the sampling, transformation, and synthesis of human vocal sounds. For *Maitreya,* I programmed a Max/MSP patch that serves multiple functions (see Figure 1). It has within it seven subpatches: four phase vocoders, a vowel generator, a noise filter sound source, and dual-carrier frequency modulation (FM).

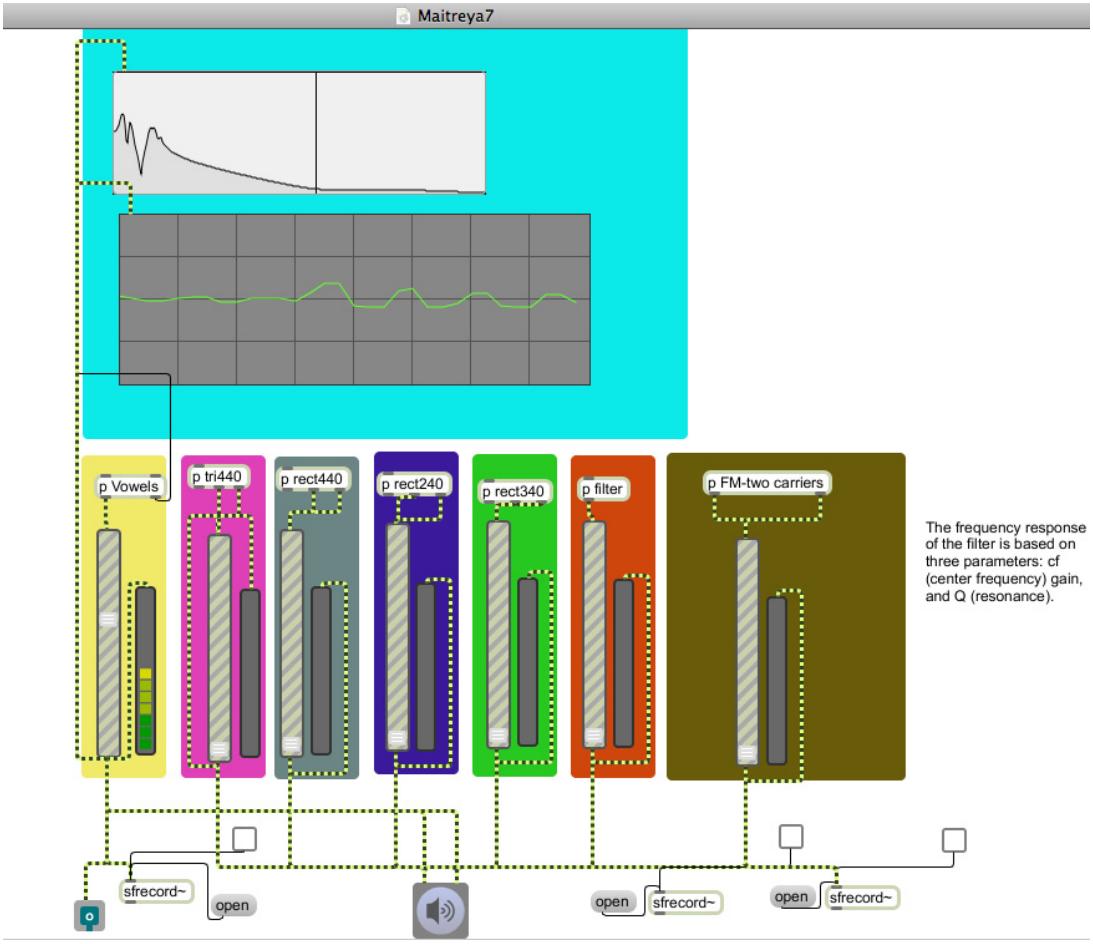

Figure 1: Screen shot of the main Max/MSP patch that generated sounds for *Maitreya*

One subpatch synthesizes the vowel sounds (see Figure 2). The resulting sound resembles a voice that does not breathe or vary in amplitude or pitch as a human voice would. To achieve this, I used an external DSP object for Max/MSP called synGranul~ that I found on the Max Objects Database (GMEM). This object performs sinusoidal granulation around specific bands of frequencies or formants. It specifically has the capability to synthesize any of the five vowel sounds (A, E, I, O and U) at different pitches; additionally, it generates the vowel sounds by drawing upon fixed formant frequency values that are stored in a Max/MSP collection object. I retrieved the formant frequencies for soprano, alto and tenor from a table of formant values in CHANT (see Figure 3). This software synthesizer was developed by Xavier Rodet in the early 1980's at IRCAM (*Institut de Recherce et Coordination Acoustique/Musique)* to produce voice-like sounds. The theoretical basis of this technique relies on formant wave functions, or *Forme d'Onde Formantique* (FOF). A formant is a peak of energy in the spectrum (Rodet, Potard, and Baptiste-Barriere). After programming this process in Max/MSP, it is evident that the combination of FOFs is a successful method for vocal synthesis.

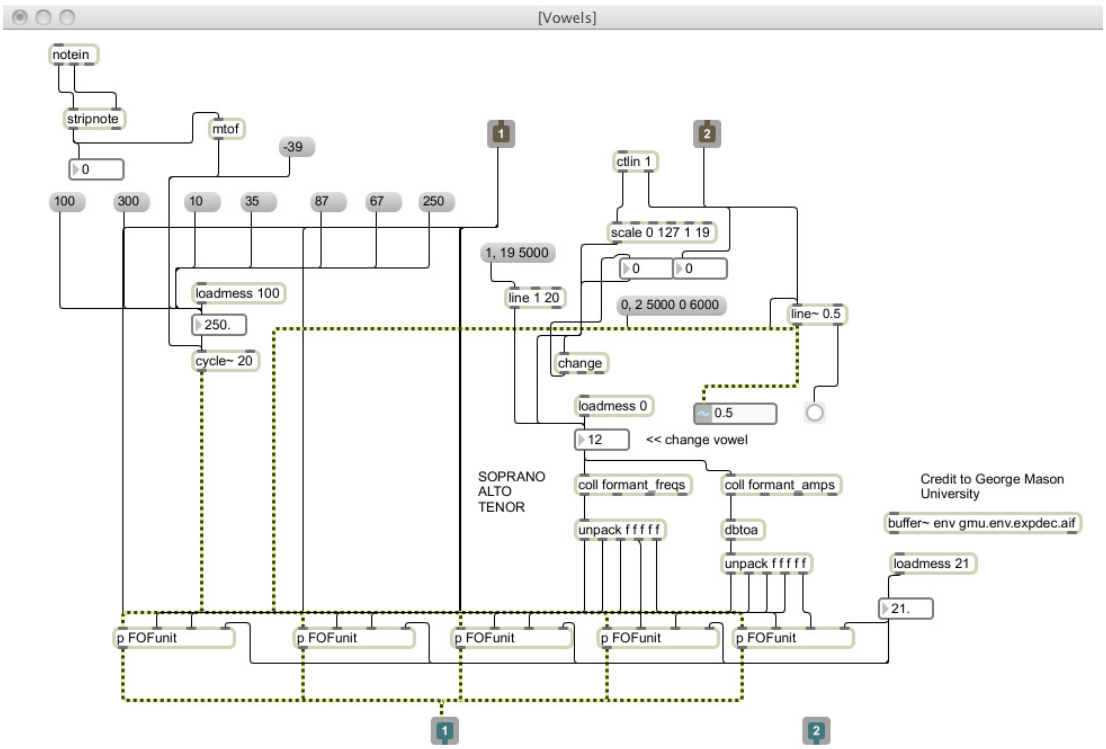

Figure 2: Vowel Generator Subpatch

The phase vocoder, introduced to computer music by J.A. Moorer, "offers the opportunity to make musically interesting changes to the spectrum of a natural tone before resynthesizing it" (Dodge 253). Additionally, it can change pitches or the spectral content of a sound without affecting its duration. The phase vocoder is defined as "a channelized analysis tool that measures the amplitude of the spectral components of a signal in frequency bands" (Dodge 251). Following this analysis, one can make transformations to a sound before the phase vocoder resynthesizes it. Curtis Roads, author of the *Computer Music Tutorial*, explains it as follows:

> The phase vocoder applies Fast Fourier transforms to short segments of incoming sounds. The FFTs result in a series of spectrum frames that capture the frequency domain evolution of the sound over time. Based on these data, the original sound can be re-synthesized by additive synthesis; each sine wave oscillator's frequency corresponds to an analyzed

frequency component. (Roads 445)

Table of formant values for vowel sounds in CHANT: alto

	f_1	f_2	f_3	f_4	f_5
[a]					
Frequency	800	1,150	2,800	3,500	4,950
Amplitude	0	−4	−20	−36	−60
Bandwidth	80	90	120	130	140
[e]					
Frequency	400	1,600	2,700	3,300	4,950
Amplitude	0	−24	−30	−35	−60
Bandwidth	60	80	120	150	200
[i]					
Frequency	350	1,700	2,700	3,700	4,950
Amplitude	0	−20	−30	−36	−60
Bandwidth	50	100	120	150	200
[o]					
Frequency	450	800	2,830	3,500	4,950
Amplitude	0	−9	−16	−28	−55
Bandwidth	70	80	100	130	135
[u]					
Frequency	325	700	2,530	3,500	4,950
Amplitude	0	−12	−30	−40	−64
Bandwidth	50	60	170	180	200

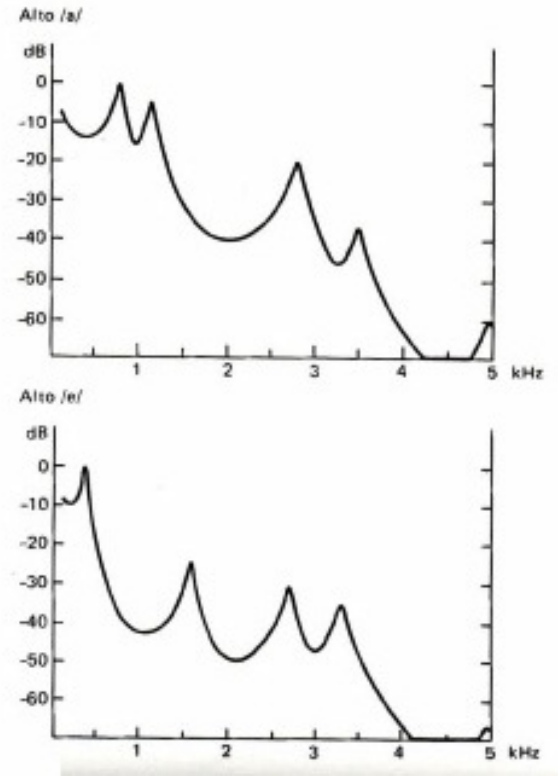

Figure 3: Example of Table of Formant Values (Frequency measured in Hz, Amplitude in dB)

(Mathews and Pierce 36)

Roads asserts that “a musician’s use of the phase vocoder inevitably involves modification of the analysis data before re-synthesis. For what the composer seeks in the output is not a clone of the input, but a musical transformation that maintains a sense of identity of the source” (Roads 566).

There are four phase vocoders programmed within the patch. Figure 4 shows one of these phase vocoders.

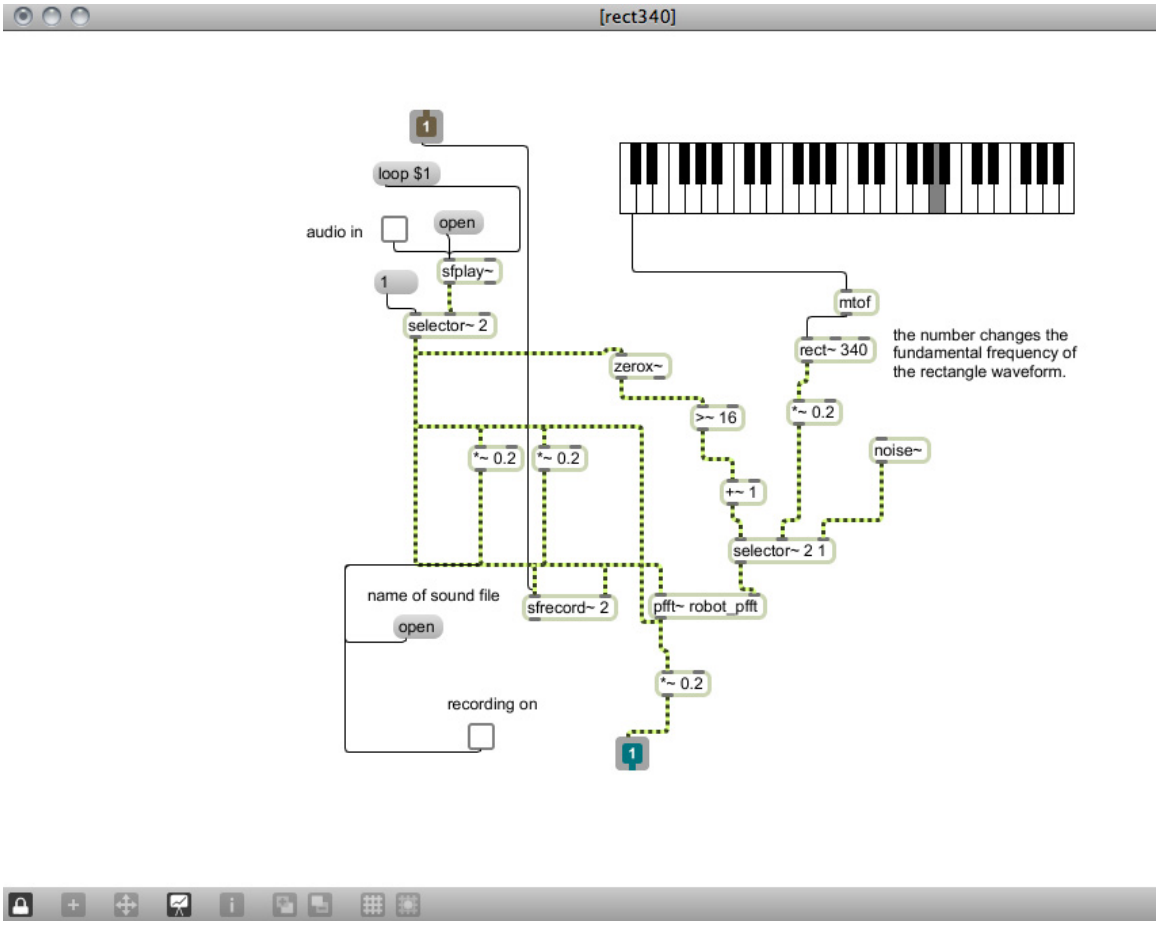

Figure 4: Phase Vocoder Subpatch

I used these to change some of the timbres of the pre-recorded human vocal sounds for the composition. These phase vocoders change the vocal sounds by convolving them with either triangle and rectangle waveshapes that can have changing fundamental frequencies. Convolution consists of applying the amplitudes of specific frequencies to the amplitudes and/or the frequencies of another sound (Rossing, Moore, and Wheeler 642). A Max/MSP keyboard slider object provided me with the ability to change the fundamental frequencies of these convolving waveshapes, and thereby change the

resultant of the phase vocoded vocal recording. For *Maitreya*, I also convolved speech sounds with recordings of my modular synthesizer.

I used filtered noise in my composition as an audible medium in lieu of consonant sounds as a transitional material. The filtered noise aims to resemble the wind-like texture of breath and the fricative sounds. In speech, these sounds with teeth and tongue, where the shape of the mouth acts as a filter. The filter was programmed in Max/MSP using a biquad~ object and noise generator. The affected parameters (frequency and band-width) of the band-pass filter were then recorded to create noise sweeps that I used in the composition. The brevity and sonic novelty of the filtered noise sound in the composition allows another element of the Deep Listening experience by providing a strongly contrasting sonic texture.

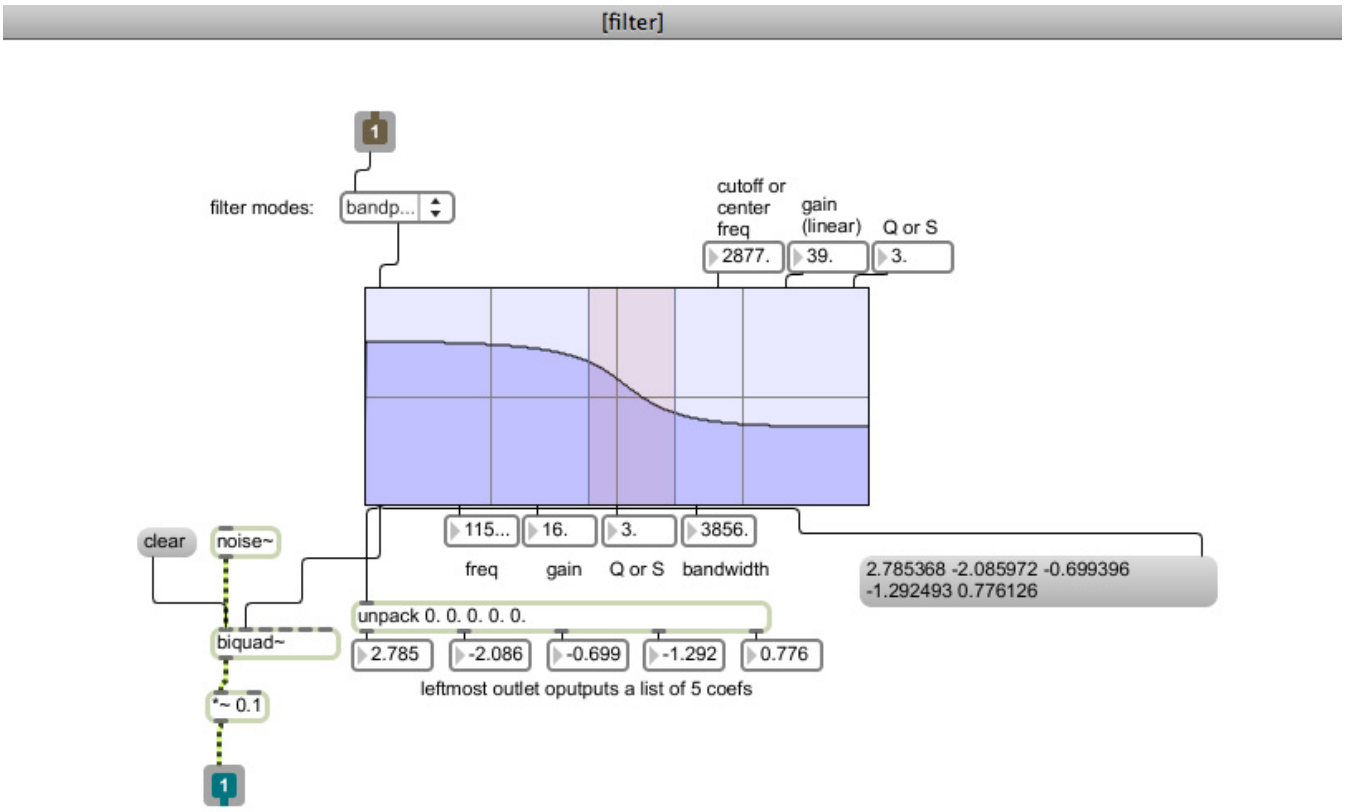

Figure 5: Noise Filter Subpatch

A dual-carrier frequency modulator creates the ending of *Maitreya*. Frequency modulation occurs "when a modulating signal is applied to the frequency input of a carrier oscillator" (Dodge and Jerse 94). The two carriers of the frequencies allow them to modulate at different ratios depending on how the parameters are affected, by changing the index of modulation, the randomness of frequency, and the vibrato width to potentially create a spectrally dense sound. I used the dual-carrier FM in order to achieve the conclusive droning sound at the end.

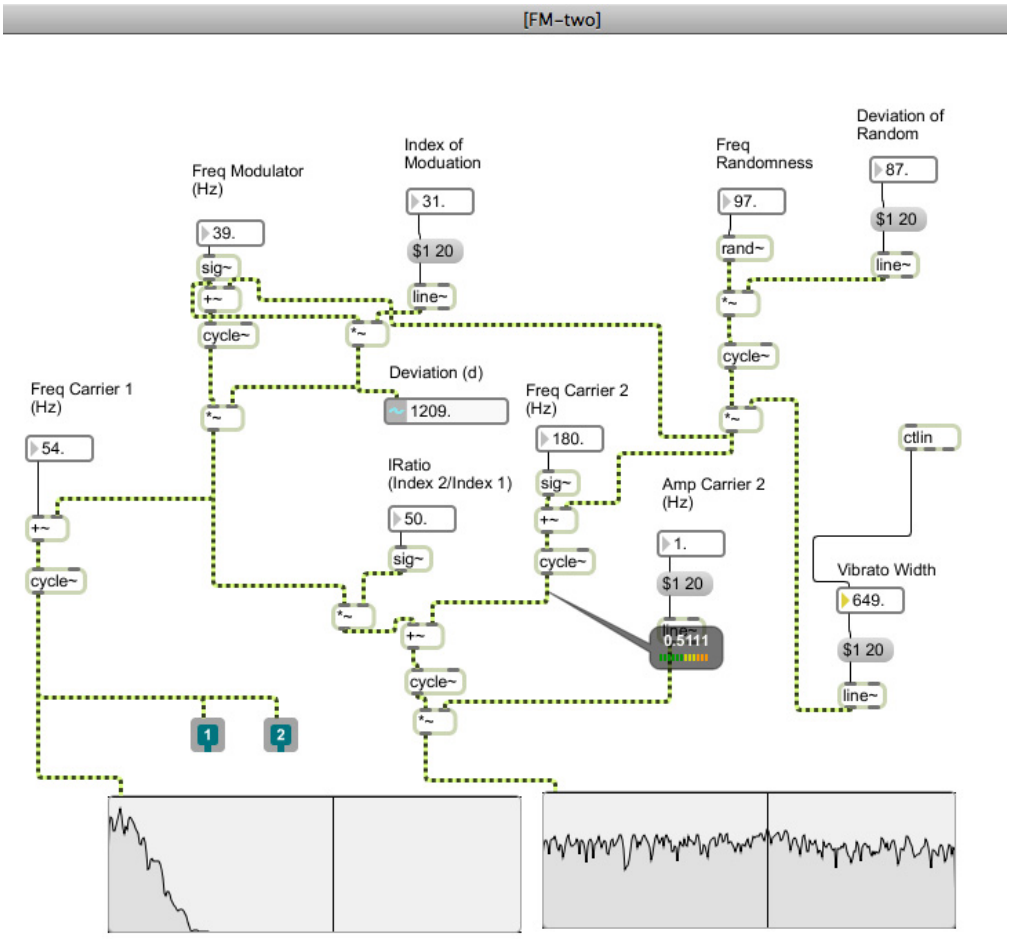

Figure 6: Dual-Carrier FM Subpatch

Ableton Live is a software that I used to arrange the composition as well as apply digital effects, such as reverb, delay, and panning. It is a digital audio workstation designed for the recording, arrangement of sounds, and specifically to assist with live performances. All of the sounds I used in *Maitreya* were recorded in either Max/MSP or Ableton. I then used Ableton to arrange all recorded material. These consist of 22 separate channels, which each have multiple effects.

In Ableton, I added reverb to prolong the sounds and imitate the spaciousness of a sound that can be heard in a large reverberant space to create that visualization for the listener. I also use a Ping Delay that is built into the Ableton software. This delay has a control over the percentage amount of delay feedback. It also includes a Dry/Wet signal to change the sound's spatial distribution and texture. I also used Ableton to master the phase vocoder recordings by adjusting their amplitude and occasionally layering them over the original unmodified sounds. I layered the recordings of the modular synthesizer on two channels and panned each to left and right speakers in Live to create a full distribution of the sound. Figure 7 shows the Arrangement View in Ableton for *Maitreya.*

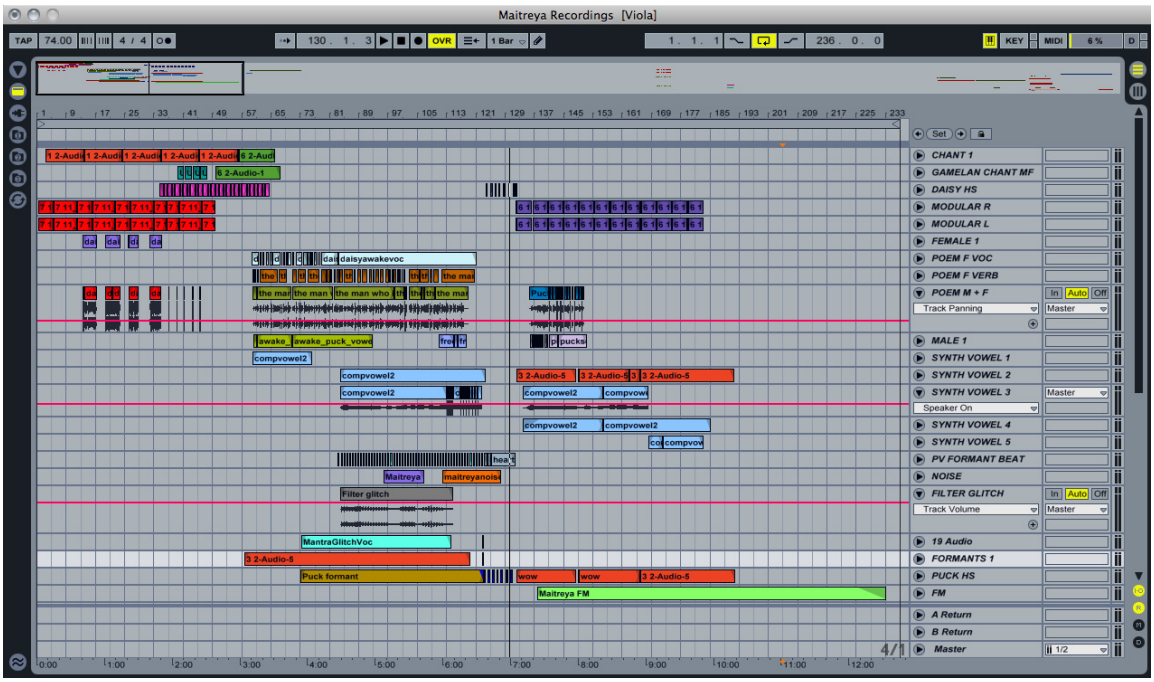

Figure 7: Ableton Live Composition Arrangement View

III-B. HARDWARE-BASED ANALOG SYNTHESIS

As a main sonic component of *Maitreya,* I used a unique voltage-controlled modular synthesizer. This modular synthesizer has the capability to create droning, laser-like pulses, noise pitch frequency bends, and other analog sounds. I built this synthesizer in the summer of 2014 while doing an internship with 4ms Company, a company that invents and builds various analog modular units (or modules) and kits to build these modules.

A modular synthesizer is an analog device that is patched externally to change its functions. Unlike digital synthesis of sound, an analog synthesizer does not rely on computer processing or digital audio converters in order to output sounds; in other words, analog synthesizers can connect directly to a speaker. The electrical pulse signals differ greatly from analog to digital, because digital technology relies on binary codes, consisting of ones and zeroes, and analog relies on the flow of electricity through circuitry. Because of this distinction, analog equipment produces frequencies with broader spectrums and greater frequency resolution than computers (Dodge and Jerse 62).

Every function in the modular synthesizer can be potentially connected and each pathway, from in to out, serves a different function. The control voltage distribution to the modules in the synthesizer changes the pitch, envelope, timing, etc. Roads states, "In a voltage-controlled synthesizer, the pitch, amplitude, filter center frequency and many other parameters can be varied by applying a changing voltage to a control input jack on a synthesis module" (623). Low frequency oscillations when passed through the timing

devices are rhythmically affected. "For example, by patching the output of one VCO module into the frequency control input of another, we can modulate the frequency of the second oscillator with the signal of the first" (Rossing, Moore, and Wheeler 621).

When encased together, the modules that complete the synthesizer are sometimes referred to as a eurorack. The oscillator module is the one module that needs to be patched in order to create sound. My oscillator module has four oscillator outputs, two square waves and two saw waves. The mixer on my eurorack, built by Pittsburgh Modular. has 4 channels (See Figure 8).

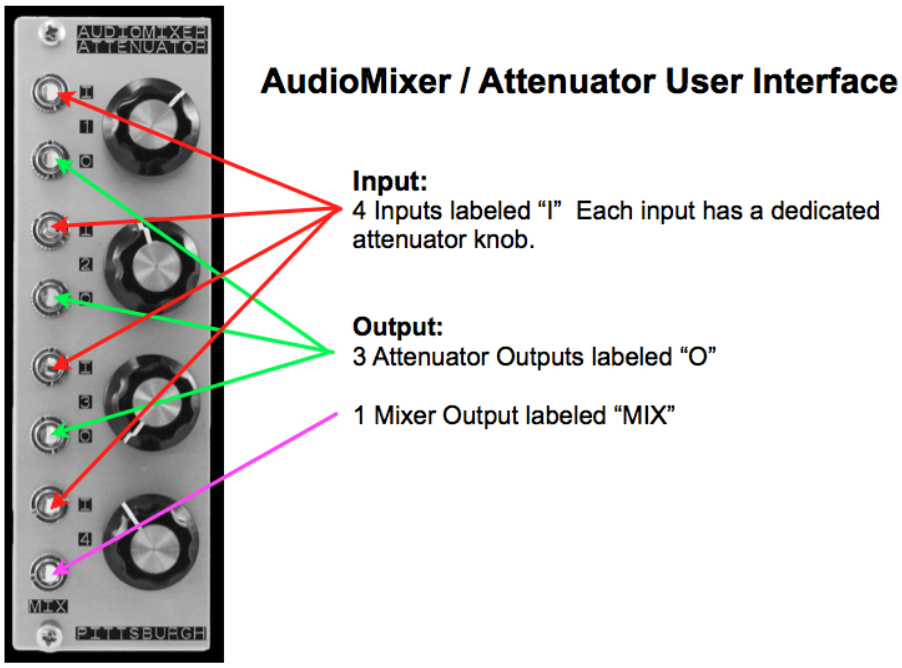

Figure 8: Diagram of Pittsburgh Audiomixer

(from the Pittsburgh AudioMixer/Attenuator Manual)

This module can output four oscillators through each of the inputs on the mixer simultaneously or separately. When connecting a patch, I begin from the mixer module input, patched to the filter or oscillator out, depending on if I want to hear the pure

waveform or affect it with the various parameters of the filter. The mixer module acts just like a regular audio mixer, providing ins, outs, and volume controls. From the mixer module, one of the oscillator inputs is patched with one of the PEG outputs. The oscillator inputs (FM, VCA-FM, Sync, and 1v/oct) can be connected to any of the PEG outputs, which are envelope (ENV), end of fall (EOF), end of rise (EOR), and +5v/oct. These alter the sound's envelope shape and duration. Alternatively, I can patch the mixer or oscillator output to any filter output or input. I have two filters on my synthesizer. One is the Borg filter made by Malekko, and the other is a multimode filter made by Doepfer.

The dual-Pingable Envelope Generator (PEG) module made by 4ms Company is a dual envelope generator whose envelope lengths are set by incoming clocks or "pings." The PEG reference manual explains that the "total envelope time is set by time between pulses (which are referred to as 'pings')" (4ms Company). An oscillator can be patched through one or two envelope generators.

> A "trigger" input detects when a control voltage exceeds a preset value, thus initiating—or triggering—the envelope function. The envelope proceeds through its attack and decay phases and remains at its sustain level until the trigger input goes below the preset value, thus initiating the release phase. (Rossing, Moore, and Wheeler 623)

The timing of the envelope is determined by the multiplication or division settings that the Div/Mult knob controls. The division of the control voltage input allows the sound to travel at a slower pace.

The Rotating Clock Divider (RCD) made by 4ms Company is another important module in the timing section of my eurorack. It has the capabilities to output note values when patched. The eight output jacks are labeled Divide by 1-8.

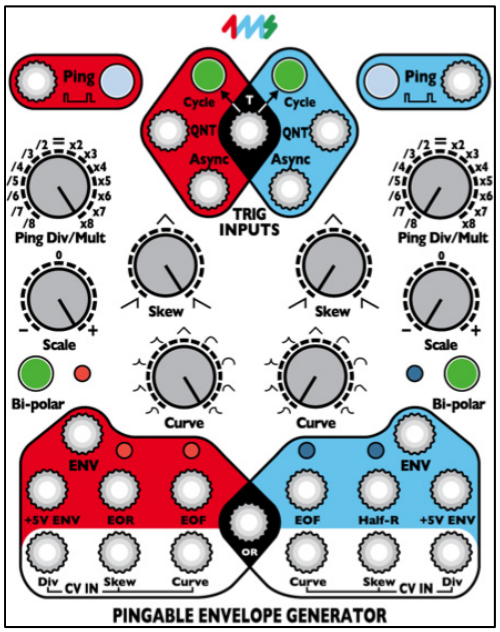

Figure 9: Dual-Pingable Envelope Generator Diagram

(PEG reference manual)

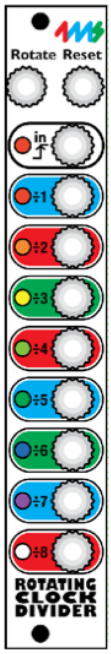

Figure 10: Rotating Clock Divider Module Diagram

(RCD reference manual)

IV. DEEP LISTENING

Pauline Oliveros is a conceptual American composer and pioneer of early electronic music who founded the theory of Deep Listening. She is concerned with audience participation and awareness during performances of her works. Oliveros defines Deep Listening as her compositional process; she also describes consciousness as "awareness of stimuli and reactions in the moment," and/or as "acting with awareness, presence and memory" (Oliveros xxi). She strongly emphasizes consciousness in her compositions, specifically existence in the present moment, which I believe lends itself to the ideas of Eastern mysticism. Oliveros theorized listening states in a way that can be used to enhance the interpretation of experimental music composition.

Deep Listening is broken into focal attention and global attention. Oliveros describes these states of awareness as "complementary opposites operating in each of the human sensory modes" (Oliveros 217). "The theory generates complex sound masses possessing a strong tonal center—these are normally conflicting terms, but it is still an adequate description of the functions of focal attention, which is tonal (single), and global attention, which registers surrounding material (the mass)" (Gunden 106).

Focal attention is the sound being directly observed by the listener, who is at the center of an abstract circle that represents the listening environment. Focal attention relates to thought, memory, and the individual experience of direct sounds, whereas global attention considers the whole environment of collective listening. Focal attention involves attention towards four classifications of sounds: direct and implied sounds, sounds intentionally placed in a composition, and unintentional sounds in the listening environment. *Global attention* takes the listener beyond their normal state of listening to

a place deep within their minds. Global attention is a nonlinear exploration of space-time. It registers information stored in the senses, imagination, and memory during the listening process.

Oliveros's *Sonic Meditations* are exercises that require the continuous awareness of sound and the surrounding space. They also champion bodily energy in its relationship to being at the center of the listening environment and observing all sound that surrounds in the exterior world. The Sonic Meditations are twenty-five compositions "for musicians of all ages and skill levels, to help them learn how to focus on, listen to and produce sound naturally" (paulineoliveros.us). The Sonic Meditations involve (1) actually making sounds, (2) actively imagining sounds, (3) listening to present sounds, and (4) remembering sounds. In these works, Oliveros composed for multiple performers, including the audience members, who were not always aware they were part of the performance. She found that the more the audience participated, the deeper the piece became. This is because the performance focused the participations on her notion of focal and global attention.

Deep Listening applies influences from Eastern traditions to electronic music and consciousness exercises, promoting the development of what Oliveros calls sonic awareness. *Sonic awareness* is a key aspect to focal attention, which stresses the importance of sound throughout one's conscious experience. Sonic awareness "is a perceptual theory about how we hear and make sounds" (Gunden 105). It instructs the listener to be aware of the ambient sound in the atmosphere, even when it is not conventional music or meant to be listened to as music. Heidi von Gunden states, "Sonic

awareness is ideally characterized by a continual alertness to sound and an inclination to always be listening" (Gunden 105).

Deep Listening can have a profound effect on the listener if the listener is aware that he/she is practicing the art of Deep Listening. For example, listening to music in certain settings can transmit certain frequencies that are inaudible and can potentially cause bodily reactions. These bodily reactions, such as horripilation, can contain personal sacred meaning. Echoing this idea, Judith Becker describes Deep Listening as "a kind of secular trancing, divorced from religious practice but often carrying religious sentiments such as feelings of transcendence or a sense of communion with a power beyond oneself" (2).

When used in ritualistic and religious situations, different forms of music can provide some listeners with enhanced states of being, which leads to the concept of epiphenomenalism. An epiphenomenon is defined as "a mental state regarded as a byproduct of brain activity" (Oxford). In order to prove this concept, Oliveros included poetry and other references to literature in her compositions. For example, in her program notes for Crone Music, she utilized the writing of 16th century Japanese poet Matsuo Basho in *Dialogue*. Music and poetry, as portrayed in this particular work, evolve into a fascinating phenomenon that becomes song and may convey a mystical experience.

The mystical experience of Deep Listening also involves the concept of entrainment through performance and interaction. The biological definition of entrainment "is a process in which one rhythmic pattern achieves and maintains synchrony with another pattern. According to this view, the listener synchronizes

internal rhythms with external rhythms, engaging in a kind of internal dance with music" (Tan, Pfordresher and Harré 105). In Oliveros' *Tuning Meditation*, some of the players will end up synchronizing the improvised sounds they are playing unintentionally. There is currently research occurring about brainwave entrainment, which is possible because of sound. Through the compositional process of Deep Listening, sound can be used as a tool to assist in the entrainment of an audience's breathing and focal attention, and through the use of words that can trigger something in an individual's memory. "The basic idea is that people are inherently rhythmic, with internal rhythms that adapt to the rhythms of music" (Tan, Pfordresher and Harré 105).

Musical trancing is similar to entrainment, but the difference is that it arouses a state of heightened consciousness. Trancing for individuals occurs in religious musical experiences but Oliveros proved it to be possible in secular music. Music has been known to allow characteristics of transcendence to listeners who fall into a musical trance. Judith Becker states in *Deep Listeners:* "The arousal of emotion within the trancer, in part inspired by music, links trancers and deep listeners: trance consciousness and the transcendental experiences of deep listeners both rest on powerful emotional excitement" (45). Steadfast emotion can also place the listener in a trance with meditation and repetition. Becker defines trancing as "a learned bodily behavior acted out within a culturally pregiven religious narrative" (42). These concepts of trancing, entrainment, and Deep Listening have largely contributed to and provided direction for my thesis composition.

V. *MAITREYA*

V-A. POETIC IDEAS AND MATERIALS

I titled my composition *Maitreya* to signify its relation to Buddhism on various levels. I composed this work after considering what I perceive to be the spiritual elements in Deep Listening. Following this, the composition aims to imitate a form of Sonic Meditation by experimenting with the combining of phase vocoded vocal recordings, computer generated vocal sounds, and natural unmodified vocal sounds. I also used Buddhist text, as they reference Eastern religion and philosophical traditions that I have been similarly drawn to.

The main materials for *Maitreya* are the chanting of mantras and the recitation of poetry. "The term *mantra* is derived from a verbal root *man-,* which means think, and the suffix *-tra*, which often expresses instrumentality. The etymology therefore suggests the meaning, 'instrument to think'" (Staal 192). The recitation of mantras involves blank facial expressions and absence of emotion and thought.

> Facial expression and emotional content of vocalization are closely related, with particular orofacial musculature configurations resulting in particular vocal qualities, and the production of certain vocal tones and contours being dependent upon the instigation of certain facial expressions. (Rossing, Moore, and Wheeler 115)

In contrast, reciting poetry typically involves emotions and prosodic features. "*Prosodic* features are characteristics of speech that convey meaning, emphasis and emotion without actually changing the phonemes" (Rossing, Moore, and Wheeler 352). These are the qualities that indicate the vocalist's emotional state. Prosodic features are heard in the

second section of the piece during the recitation of "The Man Who is Awake." On the contrary, the computer-generated vocal sounds that I programmed for this piece are emotionless and incapable of prosody except when convolved with actual human vocal sounds.

The use of the Universal Healing Mantra *Ra Ma Da Sa Sa Say So Hung* provides a rhythmic element, allowing multiple forms of entrainment. This Mantra is commonly used in Kundalini yoga and healing meditative practices. The recitation of these eight syllables figuratively entrains with the modular synthesizer. In addition, the male and female vocal recordings entrain at certain points, and, as well, the audience may find themselves entraining during the listening experience.

The Heart Sutra is a sacred text that is commonly recited in many Buddhist sects (See Appendix 3). During the composition, each line of the short excerpt of the Heart Sutra that I selected is recited by the male and then echoed by the female voice. This section is transitional to the ending of the piece and allows a rest between the second and third sections. Both male and female voices are phase vocoded at the same frequency to symbolize a unity between the two and highlight the textures of each voice. I phase vocoded the recitation of the Heart Sutra excerpt to create the abrupt interruption of the final section.

Rabindranath Tagore (1861-1941) has been an influential and inspirational figure to me throughout my collegiate experiences. Tagore was a prolific poet, philosopher and musician from India who was an important figure in the merging of eastern and western cultures. This composition includes two excerpts from Tagore's *Gitanjali*, which is a collection of prayer songs or "Song Offerings." The female recites Tagore's poem

Threshold (see Appendix 1) in the first section. Both male and female voices recite "The Man Who is Awake" from the *Dhammapada* (a collection of the sayings of the Buddha in verse form) in the second section (see Appendix 2). The male recites *Senses* from the *Gitanjali* in the third section (see Appendix 4). I selected these three poems in order to give the composition a progression through the beginning, middle, and end comparative to a journey. Since so much of my material is textual, the composition is densely packed with words and vocals.

This composition also embodies Oliveros' mandala structure (see Figure 11) for the performance, with the listener being at the center of a circle with the speakers surrounding to envelop the listener in sound. The use of Oliveros' Archetypal Mandala structure is the layout for audience and speaker placement to further achieve the Deep Listening experience. The dot in the middle of this circle represents the listener's attention, and the circle is representative of awareness.

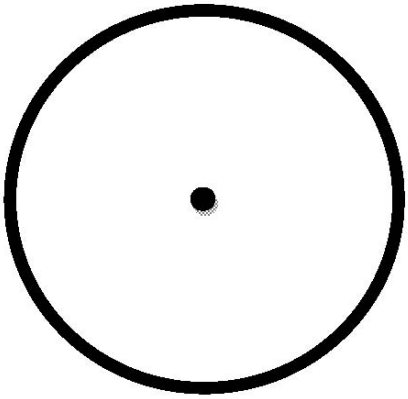

Figure 11: Archetypal Mandala Structure (Gunden 106)

V-B. STRUCTURE AND FORM

The structure of *Maitreya* consists of three sections. Tagore's poems are phase vocoded in conjunction with the same tones of the modular synthesizer for the first and third sections. This phase vocoding process is recorded in Max/MSP and then arranged to match the recorded tones of the modular synthesizer. For these recordings, the voltage distribution from the oscillator output was divided equally in both the first and third sections to provide a consistency of a rhythmic harmony. The Ping Div/Mult knob on the PEG was also set to /2 in order to achieve the slow, rhythmic drone.

In order to understand the words being phase vocoded, the listener is forced to listen closer. The recitation of verse 14 from the *Dhammapada*, "The Man Who is Awake", in the second section has prosodic features evident in both male and female vocalists. Both recitations were processed through the phase vocoder with the digitally generated vowel sounds. This recitation is improvised upon by the vocalists' interpretation of the words. The vocalists' recitation entrains at certain points, and at other points the voices are staggered. Each vocalist recited the poem at his or her own pace, which was then arranged to correspond with each other in the software.

The isolation of the formants and consonant sounds is possible because of the time stretching capability in Ableton Live. The vocals were recorded at a tempo of 74 beats per minute, then stretched to a value of 322. This creates a stuttering pattern that allows one to clearly hear every consonant of the eight-syllable chant.

The use of reverb on the channel with the modular synthesizer can give the listener the sensation that he or she is in a cave or a cathedral. I believe reverb also adds

to the spacious quality of sounds and creates a nostalgic and powerful feeling of drama. Playing off this belief, at the conclusion of the composition, there is no more reverb. Instead, there is FM synthesis at the end of the piece. I recorded this sound in Max/MSP to give a feeling of depth to the finale. In a concert hall, these low frequencies would add a great deep listening affect.

The composition begins with the first modular drone and the natural female voice begins the chant at 00:10. The phase vocoded recording of the female recitation of *Threshold* begins at 00:41. After the poem is finished, the male phase vocoded chant begins at 1:50, joining the female chant; the male's voice is phase vocoded in combination with the modular synthesizer. The male's natural vocals begin the chant at 2:05. The fourth beat change of the modular drone pitch begins at 1:57. I changed the pitch of this count in Ableton to provide a transition. At 2:39, the first section is concluded when the modular drone stops.

At 3:12, the second section begins as the male and female begin the recitation of "The Man Who is Awake." The voices alternate, with natural and phase vocoded echoing between both voices. Both male and female voices were phase vocoded using the computer vowel sounds. At 4:27, the male consonant rhythmic kick begins with the recording of the filter effect applied. At 4:29, the computer generated vowel sound drone is introduced. At 5:04, the female phase vocoded voice is isolated when reciting the line, "But how can he hide there from his sorrow?" At 5:09, the filtered noise recording begins and continues fading in and out. The noise drops out abruptly at 5:43, while male and female voices entrain in the recitation.

At 6:37, the Heart Sutra is introduced, which is also a brief transitional section. Both voices were phase vocoded at the same pitch and have different amounts of delay applied. There is reverb added to the last syllable spoken by the female to provide a smooth transition to the last section. The noise drops out at 6:51 to accentuate the male saying, “All past, present and future Buddhas.”

At 7:06, the modular drone of the third section pairs with the formant syllables of the chant of the male voice. At 7:19 begins the male recitation of *Senses*. There are two recordings of the male voice reciting this poem, one natural with reverb applied and one that is phase vocoded. At 8:06, the computer vowel drone begins. The dual-FM recording begins to fade in at 7:30 and becomes audible around 8:20. The modular drone finally drops out at 9:51, leaving only the dual-FM recording and the formant analysis of the male chant that continues until 10:17. The dual-FM recording continues and changes vibration throughout the conclusion of the piece. It fades out completely by 12:30.

VI. CONCLUSION

After my research of Pauline Oliveros' theorization of Deep Listening, I now consider myself to be a Deep Listener. Deep Listening is a conceptual theory that provides a different perspective on the cognition of sound and allows a sense of creativity to be explored in sounds that are not typically considered musical. If the listener is familiar with Deep Listening, he/she can become aware and identify the vocal expressions that are being portrayed. In my conclusion, I can strongly agree with the following statement that "music clearly has 'affective' or 'connotative' meaning. Indeed, the extraordinary power of music in this regard, clearly a universal aspect of musical experience, suggests that music may interface with some facet of emotional psychology" (Rebuschat et al. 62).

The modular synthesizer in this composition proves to be an advocate for Deep Listening. During the compositional process for this piece, I have experienced what musical trancing can be. I have experienced horripilation and other physical effects while listening to this composition. Placing myself in a musical trance and entraining my breath with the modular synthesizer while working on this composition has been a unique listening experience, as technical as it is deep. The modular synthesizer can be viewed as a tool for meditation and entrainment, which I plan to expand upon in further research.

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APPENDICES

APPENDIX 1

THRESHOLD (from the *Gitanjali* by R. Tagore)

I was not aware of the moment
When I first crossed the threshold of this life
What was the power that made me open out into this vast mystery
Like a bud in the forest at midnight!
When in the morning, I looked upon the light,
I felt in a moment that I was no stranger in this world.
That the inscrutable, without name and form,
Had taken me in its arms in the form of my own mother.
Even so, in death, the same unknown will appear as ever known to me.
And because I love this life, I know I shall love death as well.
The child cries out, when from the right breast, the mother takes it away,
In the very next moment, to find the left one in its consolation.

APPENDIX 2

THE MAN WHO IS AWAKE (from the *Dhammapada*)

He is awake.
The victory is his.
He has conquered the world.
How can he lose the way
Who is beyond the way?
His eye is open
His foot is free.
Who can follow after him?
The world cannot reclaim him
Or lead him astray,
Nor can the poisoned net of desire hold him.
He is awake!
The gods watch over him.
He is awake
And finds joy in the stillness of meditation
And in the sweetness of surrender.
Hard it is to be born,
Hard it is to live,
Harder still to hear of the way,
And hard to rise, follow, and awake.
Yet the reaching is simple.
Do what is right.
Be pure.
At the end of the way is freedom.
Till then, patience.
If you wound or grieve another,
You have not learned detachment.
Offend in neither word nor deed.
Eat with moderation.
Live in your heart.
Seek the highest consciousness.
Master yourself according to the dharma.
This is the simple teaching of the awakened.
The rain could turn to gold
And still your thirst would not be slaked.
Desire is unquenchable
Or it ends in tears, even in heaven.
He who wishes to awake
Consumes his desires
Joyfully.

In his fear a man may shelter
In mountains or in forests,
In groves of sacred trees or in shrines.
But how can he hide there from his sorrow?
He who shelters in the way
And travels with those who follow it
Comes to see the four great truths.
Concerning sorrow,
The beginning of sorrow,
The eightfold way
And the end of sorrow.
Then at last he is safe.
He has shaken off sorrow.
He is free.
The awakened are few and hard to find.
Happy is the house where a man awakes.
Blessed is his birth.
Blessed is the teaching of the way.
Blessed is the understanding among those who follow it,
And blessed is their determination.
And blessed are those who revere
The man who awakes and follows the way.

They are free from fear.
They are free.
They have crossed over the river of sorrow. (3x)

APPENDIX 3

HEART SUTRA (excerpt)

With no hindrance of mind—no hindrance therefore no fear,
Far beyond all such delusion, Nirvana is already here.
All past, present and future Buddhas live this Prajna Paramita
And attain supreme, perfect enlightenment.

APPENDIX 4

SENSES (from the *Gitanjali* by R. Tagore)

Deliverance is not for me in renunciation
I feel the embrace of freedom in a thousand bonds of delight
Thou ever pourest for me
The fresh draft of thy wine of various colors and fragrance
Filling this earthen vessel to the brim
My world will light a hundred different lamps of thy flame
And place them before the alter of thy temple
No, I will never shut the doors of my senses
The delights of sight and hearing and touch will bear thy delight
Yes, all my illusions will burn into illumination of joy
And all my desires ripen into fruits of love.