FUNCTIONALITY AND HISTORY OF ELECTRONICS IN REGARDS TO THE PERFORMANCE PRACTICE OF THE FOLLOWING WORKS:

Temazcal (1984), Javier Álvarez, and *Memory Palace* (2012), Christopher Cerrone

By

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A

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Abstract

The Electroacoustic pieces; *Temazcal* (1984), by Javier Álvarez (b.1956), and *Memory Palace* (2012) by Christopher Cerrone (b.1984), each employ different types of electronic technologies in their realization through performance.

This paper will discuss the origin and history of the technology applied respectively in the works. I will examine the role of percussion within the works, specifically in regards to learning and problem solving through technological challenges in order to effectively perform the compositions. By looking at *Temazcal* and *Memory Palace* through the context of their historical significance as electroacoustic works, the inherent functionality of the technology employed in each, and the resultant performance practices that have subsequently developed, a greater musical appreciation and understanding of electroacoustic works, in general, is possible.

Introduction

"I can't understand why people are frightened of new ideas. I'm frightened of the old ones." - John Cage.[1]

The use of percussion instruments in music has evolved from an ornamental role (as found throughout orchestral music), to a more substantive role. It is the seminal work *Ionisation* (1921) by Edgard Varése (1883-1965) where we first see the extrapolation of percussion instruments from a subservient role to becoming the only instruments used in a critical work. While defining percussion compositions in music can be difficult, the composer and musician John Cage (1912-1992) sums up the idea very eloquently in his credo regarding future of music:"Percussion music is revolution. Sound and rhythm have too long been submissive to the restrictions of nineteenth-century music. Today we are fighting for the emancipation. Tomorrow, with electronic music in our ears we will hear freedom."[2]

Analogous to percussion, electronic music has wholly developed within the last century. The genre has evolved at such a quick pace that technology's role in music is in a constant state of flux. Composers are redefining electronic music with every advance of technology, via the gramophone, magnetic-tape, synthesizers, sequencers, and digital audio workstations amongst other mediums.

In the last century, the use of electronics as a component in contemporary music has greatly increased. Electroacoustic works for percussion are becoming one of the more

[1] Richard Kostelanetz, *Conversing with cage*, (Routledge, 2003).
[2] John Cage,"The future of music: Credo." *Silence: Lectures and writings* 4 (1937), 87.

widely explored compositional genres of the 20th and 21st centuries. It is therefore relevant to examine these electroacoustic compositions with an evolved set of values; a point of view that considers their place in history, as well as their aesthetic role in composition regarding interactions with live performance. This point of reference is important as it gives historical and medium based context, helping to explain why composers chose to use specific electronic mediums within their compositions.

Temazcal (1984) in particular utilizes analog tape methods associated with *musique concréte*. *Memory Palace* (2012) employs electronic synthesis techniques engineered from the *Elektronische Musik* movement, as well as influence from *musique concréte* for its use of sampling. Additionally *Memory Palace* uses a digital process which involves live musical interaction with computers, a process using computers which was developed in the wake of *musique concréte* and *Elektronische Musik* from a group at IRCAM, Institute for Research and Coordination in Acoustics/Music.

In the 1950s, two basic electronic techniques for composing sounds existed: *Elektronische Musik* and *musique concréte.* Their division was initially categorized by the source material used and the respective countries where the musical processes originated.[3] *Musique concréte,* developed in France, primarily dealt with purely ambient sounds and natural sounds, while *Elektronische Musik,* from Germany, basically encompassed everything else that composed electronic music, i.e. oscillators (tone generators) synthesizers, and early computers. With the advent of computers, two major means of developing electronic sound evolved, these being analog and digital.

[3] The countries where each art originated played a large role in the division. Composers from France and Germany both looked to separate themselves from each other as ideological differences between the countries in the 1950's were quite strong.

While both analog and digital are parts of electronic music, the difference between them is an important one. Analog is continuous, non-interrupted magnetic information, sound, such as singing, breathing, and so on. Most of the activities of life, are analog. Digital, on the other hand, refers to information stated and stored in numbers; that is, discrete, non-continuous digits, or bits of information. Unlike tape processes, analog synthesizers, and tone generators, associated with *musique concréte,* computers are digital, working exclusively in numbers and data. Digital music on computers exist as numbers and rather than physical sound waves, the music in represented by ones and zeros marking the beginning and end of a sound wave, then another program converts the digital information into an audio for playback.

The term *Elektronische Musik* faded, transforming into 'electronic music' as technology advanced, while *musique concréte* became a broader style - no longer exclusively using natural sound sources, but as a definition of the analog process of using magnetic tape for composition or performance. Although both movements are vitally important to electroacoustic music, I will explore *musique concréte* in the *Temazcal* section of the paper, since the piece is more exclusively associated with tape music and *Elektronische Musik* in the *Memory Palace* section of the paper.

I: *Temazcal*

Temazcal was composed by Javier Álvarez in 1984. The composition is written for maracas and electronic tape playback. In *Temazcal*, Álvarez instructs the performer to use the score: "as a mere map of possible realization." His initial instructions shed light on the nature of the performance for the piece:

Temazcal (Álvarez, 1984) stems from the Nahuatl (ancient Aztec) word literally meaning "water that burns." The maraca material is drawn from traditional rhythmic patterns found in most Latin – American musics, namely those from the Caribbean region, southeastern Mexico, Cuba, Central America and the flatlands of Colombia and Venezuela. In these musics in general, the maracas are used in a purely accompanimental manner as a part of small instrumental ensembles. The only exception is, perhaps, that of the Venezuelan flatlands, where the role of the maracas surpasses that of mere cadence and accent punctuation to become a soloistic instrument in its own right.[4]

Hence, the role of the soloist is to become a virtuosic maraca player referenced in Venezuelan music, and to construct a realized solo during electronic accompaniment. The electronic sounds featured in the piece are made from natural recordings which are manipulated using the tape techniques made popular during the *musique concréte* movement.

The idea of using sampled recordings in composition in the western world came about after World War II; there was a revival of arts and a more open-minded audience for listening to experimental and electronic music. Technological advances during the war, an increase of interest from chamber groups for new sound, and a generally expansionist economic climate where institutions had funding for new musical research helped create a fertile environment for the creation of new sounds and techniques.[5] All that was needed next was a musical seed of thought which would be provided by the French composer and engineer Pierre Schaeffer (1910-1995).

In 1948, the Frenchman presented a "Concert of Noises" over the French national radio. The music consisted of natural and industrial sounds taken from field recordings and then experimentally re-recorded on to long-play records (LPs) to form short, musical,

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[4] Javier Álvarez, *Temazcal,* Self Published, 1984.

[5] Peter Manning, *Electronic and Computer Music,* (Oxford University Press, 2013), Kindle Edition: 404 of 12531.

sonic collages. Schaeffer coined the term *musique concréte* because the sound is sourced from concrete material (acoustic or from nature, and or man-made, no electronics)[6] which is then artistically and/or experimentally arranged: "Whereas ordinary music is created abstractly, written in symbols, and results in instrumental sound only when it is performed."[7]

In the 1940's, Sheaffer worked as a technician for *Radiodiffusion Française*. It was there that he developed a music lab supplied with resources provided by the French government for using new technology to experiment with sound. In many ways, Schaeffer was more of an engineer than a musician and his experimentation was driven by the possibilities opened up by the new technology rather as pure aesthetic insight[8]. Additionally, it is important to note that composers were using phonographs (and sound samples) in compositions prior to Schaeffer's *musique concréte*. John Cage composed *Imaginary Landscapes No. 1* in 1939, scored for piano, percussion, and turntables. Cage orchestrated for long play records of oscillator tones which are pitch adjusted using the variable speeds of the turntable itself.[9] Schaeffer's *musique concréte* distinguished itself by its use of natural sounds as source material.

In 1948 Schaeffer was joined by the engineer Jacques Poullin who subsequently played a significant role in the technical evolution of tape music. The composer Pierre Henry (b. 1927) subsequently joined forces with Schaeffer and Poullin in 1949. Together

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[6] Concrete, as a musical term, refers to the material sampled from real, acoustic, natural sources, as opposed to synthesized or electronically generated sounds.

[7] Otto Luening, "An Unfinished History of Electronic Music", *Music Educators Journal,* (November 1968), 11.

[8] Ibid, 12.

[9] Nicholas Collins, Margaret Schedel, and Scott Wilson, *Electronic music*, (Cambridge University Press, 2013), Kindle Edition: 493 of 5862

they composed the *Symphonie Pour Un Homme Seul* (Symphony for one man alone), a true classic of early tape music. Amazingly, the work was completed before they had access to tape recorders, instead they used phonographs to record which was then transferred to tape.

The groups important breakthrough, which in reality is another testament to Schaeffer's engineering pedigree, concerned the technique for altering the recorded sounds.[10] This aspect is what set *musique concréte* apart from previous compositional styles. Schaeffer found that by cutting off the initial attack of a sound, he could remove the identifying feature of the source and create pure building blocks of noise, while still using acoustic sounds. Schaeffer would drop the needle at precisely the right point while recording onto a new acetate (record) on a disc cutting lathe."[11]This enabled him to create new sounds and construct layers upon layers of new timbral material. His first concrete study, *Étude aux chemins de fer* (1948) (Study on The Paths of Iron), consisted of sounds recorded from a Paris train station. Noises including locomotive whistles, wheels, and brakes were manipulated and arranged in semi-rhythmic patterns to create the study.

By 1950 Schaeffer and Henry were working with magnetic tape and the evolution of *musique concréte* proceeded at a fast pace. Their first public performance was given in that same year at the *École Normale de Musique*. In the following year, the French National Radio installed a sophisticated studio for the Group for Research on *musique concréte*. During the following years many significant composers began to be attracted to the studio including Pierre Boulez (1925-2016), Michel Philippot (1925-1996), Jean

[10] As opposed to the idea of using sample music which he certainly was not the first to come up with.

[11]Nicholas Collins, Margaret Schedel, and Scott Wilson, *Electronic music*, (Cambridge University Press, 2013), Kindle Edition:508 of 5862

Barraqué (1928-1973), Phillipe Arthuys (1928-2010), Edgard Varèse, and Olivier Messiaen (1908-1992).[12]

Gesang der Jünglinge (Song of the Youth) composed by Karlheinz Stockhausen (1928-2007) in 1955, is another widely accepted and popular modern tape music piece. This piece blends the *musique concréte* technique using samples of children singing with electronically produced sounds of *Elektronische Musik*. Stockhausen's work highlights the development of playback considerations in the solo performance of electronic compositions. The score for *Gesang der Jünglinge* calls for five loud speakers to surround the audience. Using the spatial direction and movement of sounds, Stockhausen adjusted the placement of the speakers to enhance the auditory experience for the audience. [13] He became an active voice in the importance of acoustics and live electronic music, often having specific locations for pieces. This trend was continued by composers such as Varése in his *Poème électronique* (1958), where he had architects build a special building, the Phillips Pavilion, to house the 350 speakers for the live performance of the piece. Álvarez also had specific directions concerned with the sound in *Temazcal*, which will be addressed in the next section.

Although using tape and electronics presented composers with a new palette of sonic resources, the general audience suffered from a lack of visual appeal during live performances. Composers such as Stockhausen and Varése took into great consideration the importance of visual space and the locations of the speakers, but the success of the performances still relied upon external factors to provide visual interest for an audience.

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[12] David Dunn, "A History of Electronic Music Pioneers," *ders.(Hrsg.), Eigenwelt der Apparate-Welt,(Katalog), Linz* (1992), 11.

[13] David Cope, *New Direction In Music, (*Brown and Benchmark: Madison, WI, 1993), 228.

As a remedy to this issue, live instrumental performers combined with tape was inspired as a medium for composition. Just as Varèse was a pioneer for percussion in regards to *Ionisation,* Stockhausen was a trailblazer for electroacoustic works in general.

Déserts is the first piece where live performers play with prerecorded tape. In 1954 Varèse composed the first version of the tape part to *Déserts* at Shaefer's studio.[14] The piece saw its infamous premiere in December of that year due to the unaccustomed and conservative audience. A major musical concern for this piece was the need for synchronization between the musicians - a wind orchestra, and the tape piece - two monophonic tape players with individual speakers placed at opposite sides of the stage. The tape and orchestra sections are alternated so to avoid the synchronization problem. *Déserts* was composed for a 14 piece chamber group, featuring brass, woodwind, percussion, and electronic tape. Paul Griffiths describes the monumental feat: "The plan of *Déserts,* unprecedented, was that electronic and orchestral music should be brought face to face: three sequences of 'organized sound' on tape are interpolated into a composition for an orchestra of wind, piano, and percussion."[15] The mental framework of an "organized sound" used in this piece would form the basis of Varése's *Poeme Electronique* at the Brussels World Fair.

Other early examples of *musique concréte* include Henri Pousseur's (1929-2009) composition *Rimes Pour Différentes Sources* (1959), which is scored for orchestra and tape and treats the sound sources like antiphonal bodies with contrasting materials for

[14] Peter Manning, *Electronic and Computer Music,* (Oxford University Press, 2013), Kindle Edition 692 of 12531.

[15] Paul Griffiths, *Modern Music and After*, (Oxford University Press, 2011), 129.

each. Otto Luening (1900-1996) and Vladimir Ussachevsky (1911-1990) collaborated to create *Rhapsodic Variations for Tape Recorder and Orchestra* (1954)[16].

The early composers of *musique concréte* mostly worked with analog sources including records, tape decks, tone generators, mixers, reverbs, and delays. While the technology available to the early composers of *musique concréte* was fairly primitive, composers utilized creative methods to change the recorded sounds by manipulating and preparing the tape. Some standard techniques, as well as those used in *Temazcal* include:

–**Vari-speed**: changing the speed of the tape to change the pitch of the sound.

–**Reversal**: playing the tape backwards

–**Comb Filtering**: playing a sound against a slightly delayed version of itself various resonant frequencies are brought in or out.

–**Amplitude modulation**: Often done by periodically varying the amplitude of a sound or applying a different amplitude envelope over it.

–**Frequency Modulation**: Isolating frequencies and either boosting, or subtracting the signal, this is used to create vibrato effect, popularly called LFO (low frequency oscillator).

–**Tape loops**: in order to create loops and ostinatos out of otherwise non rhythmic material, composers would repeat certain portions of a recording.

–**Expanded-compressed time**: by slowing down, or speeding up then reversing the direction of a sound.

[16] Ibid, 232.

–**Splicing**: involves cutting and pasting the physical tape in order to change the order of the musical events and or insert new sounds within a recording

–**Filtering**: to bring in or out different frequencies of a sound and change its quality and texture

–**Layering**: recording multiple sources down to a new reel or by mixing them in real time via a mixing board.

–**Analog Synthesis**: inserting tones and sweeps from oscillators in their compositions.

–**Reverberation, delay**: used to create a sense of unity, or fusion between sound sources coming from different origins, and a great way of superimposing a new sense of space on an existing recording.

–**Panning**: allowing the composer to place the sound within a stereo or multichannel environment.[17]

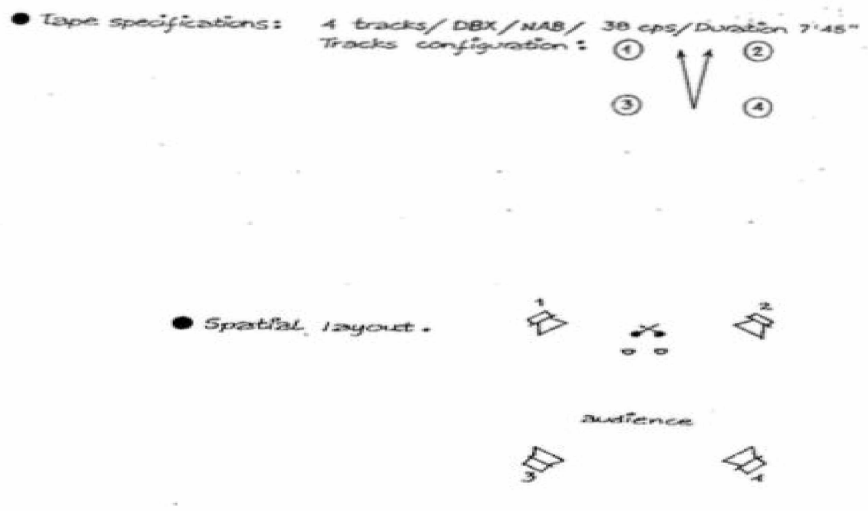
The definitive use of analog *musique concréte* techniques in *Temazcal*, rather than a digital process, can be determined in two ways: The overall sound characteristics of the tape part, and the year it was composed. Compared to the tools available to the composers today in 2016, digital music technology was quite limited in 1984. Computers during the 1960s-1980s served elementary functions such as processing information, storing data, and counting. The physical space that a computer occupied would often fill an entire floor of a large building. Although various music programs were being created in the same time frame as *Temazcal*, computers presented a steep learning curve as well

[17] Jean-Luc Sinclair, Organizing Sounds: musique concréte, Part I, *Codehop,* September 29, 2011, accessed 1/28/2016, http://codehop.com/organizing-sounds-musique-concrete-part-i/.

as many physical limitations, usually pursued by hobbiest rather than composers. The majority of computers during the 1980s did not have screens or an interphase that could be understood by the typical composer or layman, just hardware that performed a single function for each circuit board. The technology for smaller computers did not become readily available until the mid-late 1980s. Tape technology, on the other hand was readily available for composers and relatively cheap. Tape allowed Álvarez to structure time in *Temazcal* without need of meter or even discernible rhythms.

A feature of *Temazcal* reminiscent to Stockhausen's attention to acoustic detail is the treatment of sound with regards to amplification. Stockhausen helped bring attention to special considerations for acoustics and speakers placement for live performance of electroacoustic works. These considerations are highlighted in works like *Gesang der Jünglinge,* and *Kontakte* (1958-60) where Stockhausen treats the speakers as musical sound sources, just as important as the placement of musicians and audience. A significant component of the live performance relies on these directions for presentation as shown in Example 1. Álverez's program notes includes a diagram for microphone locations, speaker placement, and tape specifications.

Example 1: Tape specification. Javier Álvarez, *Temazcal*, program notes:



Like many *musique concréte* works, Álvarez's used recorded samples of real instruments to compose the piece. Additionally, many of the electronic sounds heard on the tape part of *Temazcal* are traditional Venezuelan instruments. These include The *cuatro* and *bass cuatro*, traditional Venezuelan Maracas, and *quitiplás*, small bamboo drums which can be seen below in (figure 1).

Figure 1: *Cuatro,* Maracas, *quitiplás.*[18]

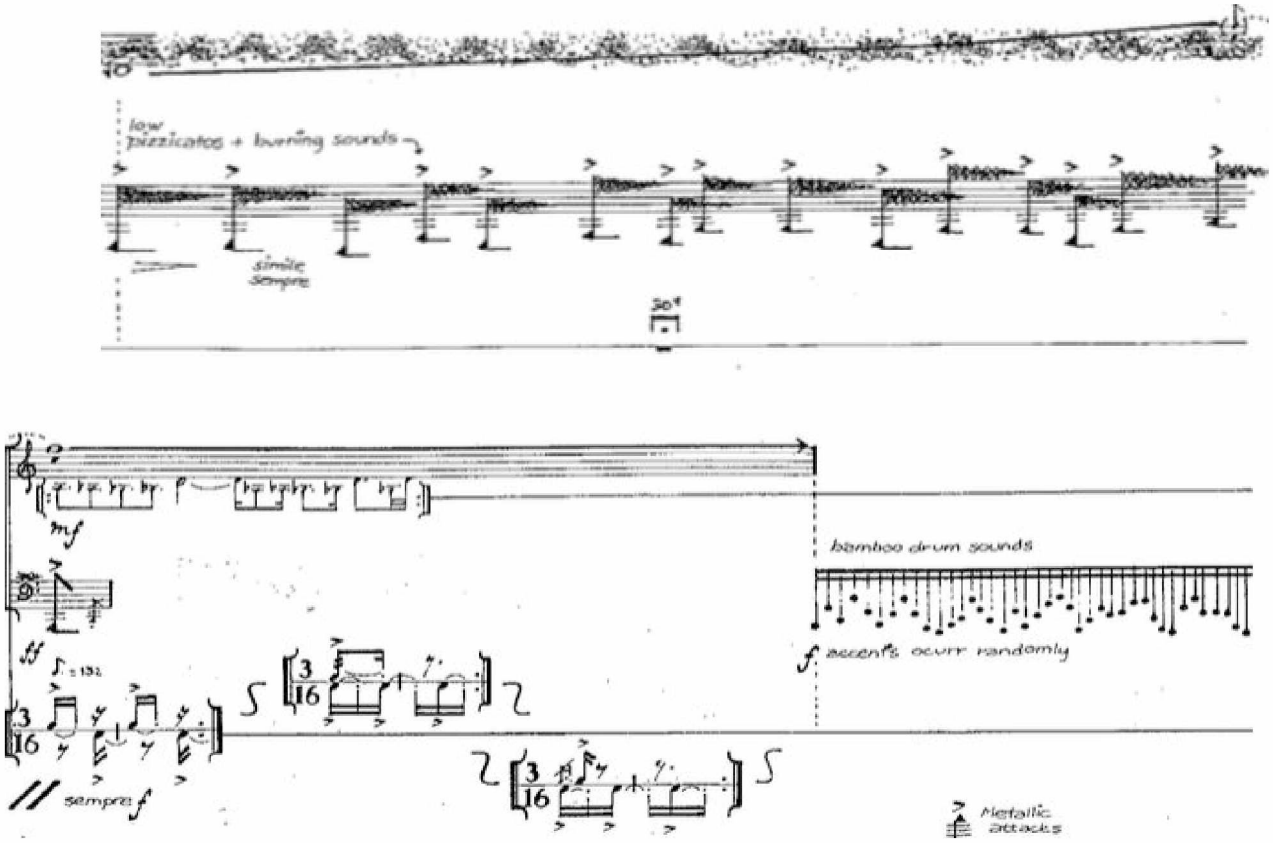
[18] Bartolomé Duijsens, "Afro Venezuelan Music", *Fundación Interchange,* Last modified 4/1/16, http://www.lameca.org/dossiers/afro_venezuelan_music/eng/p4.htm.

Temazcal also uses samples from nature such as burning sounds, breaking wood, birds, and cicadas. These sounds are manipulated using classic tape music techniques such as ring modulators, pitch adjusting, and band pass filters (a type of frequency modulation that isolates a range of decibels). Although the piece was written in 1984, *Temazcal* stays true to Schaefer's original concept of *musique concréte,* using only sounds found in the real world.

From a personal standpoint playing live with a tape has both advantages and disadvantages. One advantage is that because the piece is an improvisation, the aspect of improvisation allows for a great degree of changeability. *Temazcal* is a piece that can grow and progress with a performer as new maraca techniques are learned over time and as insights are made about the intricate tape part.

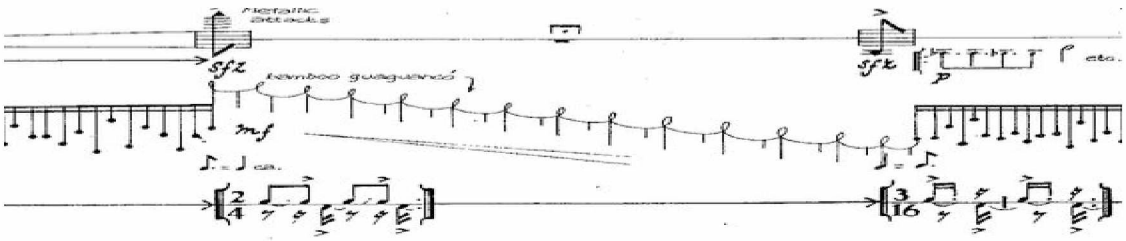
A disadvantage concerning *Temazcal is* rather than having notes to read in a linear order, the piece relies on specific sound cues throughout its duration to differentiate themes and signal changing patterns. These must be memorized as the score shows limited visual mapping as far as precise locations and timings are concerned. Each thematic section of the piece includes suggested serial rhythms that fits within the tape part to some degree. These patterns help give a framework for the structured improvisation. The first maraca patterns enters after a series of low pizzicato burning sounds, these sounds must be memorized as they are not rhythmically placed in time and as shown below, the maracas enters quite suddenly, creating a dramatic musical effect (Example 2).

Example 2: Javier Álvarez, *Temazcal*, page 1.



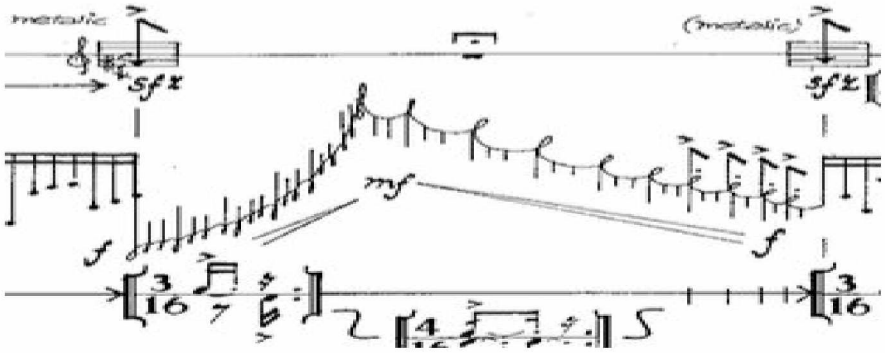
To learn *Temazcal* effectively, it is important to not only memorize the cues that signal the musical changes within the tape, but also to make a system in order to internalize each different pattern. There are sections that seem to be in a regular meter but then suddenly cut out, or change in tempo very subtly. Example 3 includes of one of the "Metallic" sonic cues that signals a metric modulation and quick series of musical changes.

Example 3: Javier Álvarez, *Temazcal*, page 1:



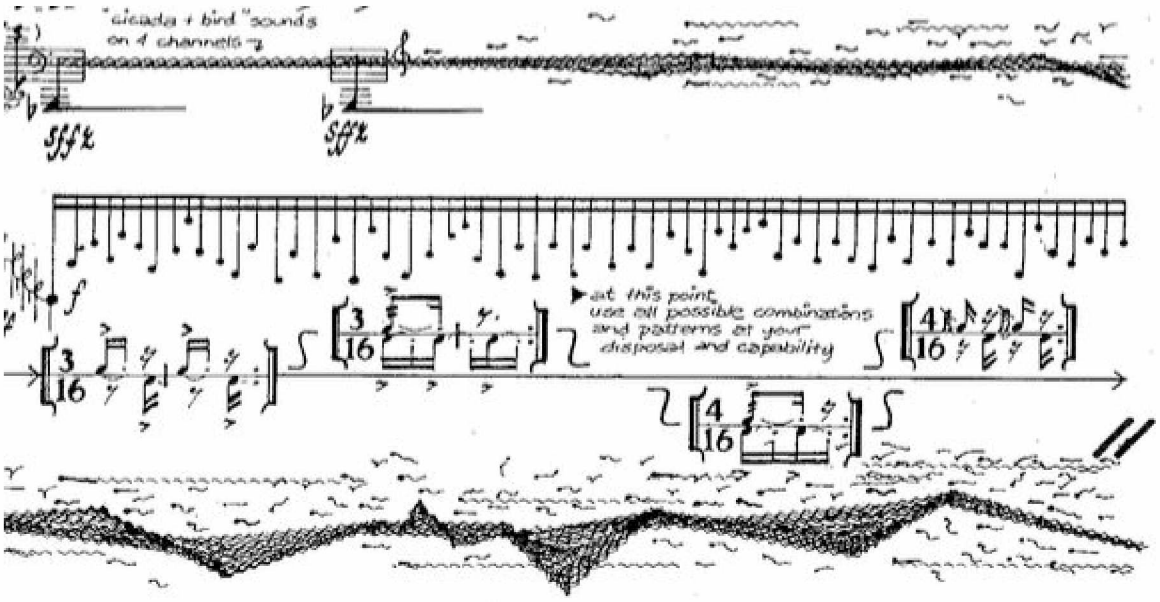
As previously mentioned, the visual score, does not reliably convey the exact rhythm in the *bamboo guanguancó* section. Not to mention this *guanguancó* returns throughout the piece, and each time it is slightly different in timing, length, and meter. This is an inherent quality of tape music. Because the tape is usually cut by hand, and produced by ear, small imperfections occur. Although this imperfection makes for an interesting sound, it is complicated to learn as each pattern requires a slightly different maraca rhythm to synchronize with tape rhythm. Example 4 is another variation of the *bamboo guanguancó*.

Example 4: Javier Álvarez, *Temazcal*, page 2:



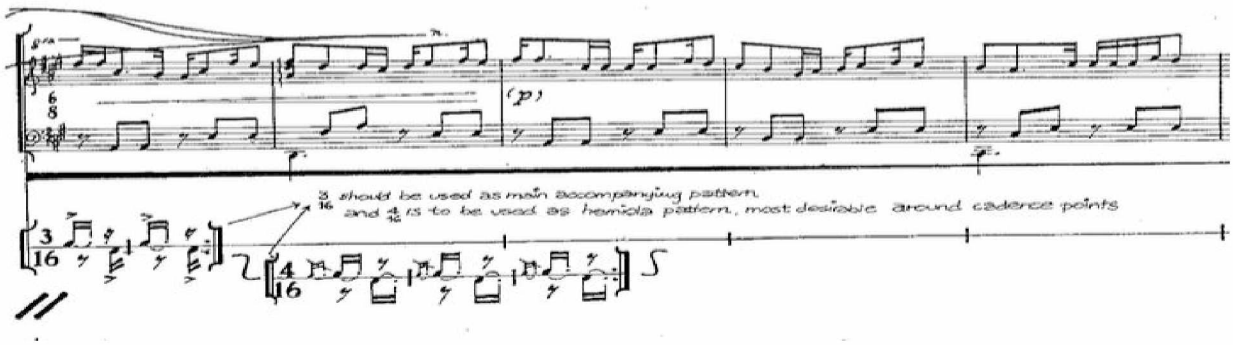
Temazcal gradually builds in complexity and intensity leading to a frantic soloistic climactic section (Example 5) where the performer is asked to combine all previously played rhythms, and demonstrate their maraca skill at the highest capability.

Example 5: Javier Álvarez, *Temazcal*, page 6:



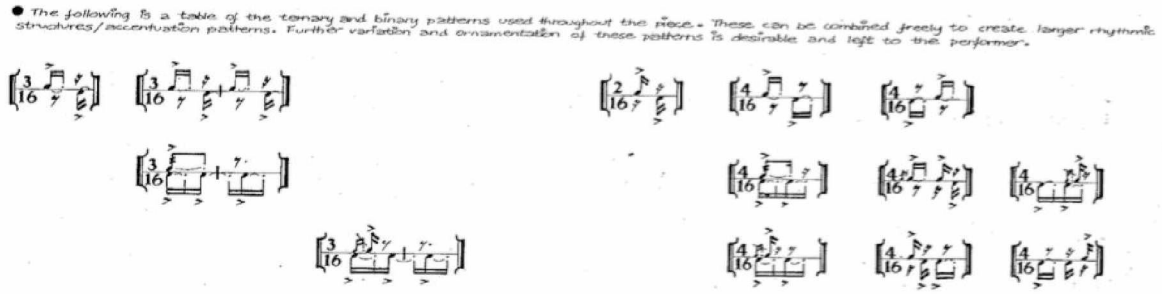
Following the climax, the piece quickly diminishes in complexity. As an homage to the Venezuelan folk music which inspired the piece, there is a final slow section that is a direct reference to the music which inspired the piece. It represents a reminiscent history of where the sounds of the piece originated. This final section (Example 6) illustrates a metaphorical cadence, meant to remind the performer and listener alike the roots of traditional music for the maracas.

Example 6: Javier Álvarez, *Temazcal*, page 7:



Another fundamental disadvantage to early tape pieces such as *Temazcal,* is the inability to effectively practice the piece. When learning traditional western music, a musician can progress through a piece by reading notes, learning and perfecting one bar of music at a time,gradually working through the composition at a relative pace. With tape music, the whole piece is laid out for the performer in non-stop-linear fashion. The tape part exists as an audio track and when activated, the tape plays through the entirety of the piece. This does not allow the performer to learn the work in a more traditional manner. Although the score provides a helpful visual aid, it does not convey precise rhythmic locations that can be practiced in isolation of the tape. Álvarez does however give a guide to common rhythmic motifs used. Example 7 is a table of common binary and ternary patterns found throughout the piece. These rhythms are to be combined to create larger rhythmic structures and accentuation of patterns. Further variation and ornamentation if desirable is an optional decision left up to the performer.

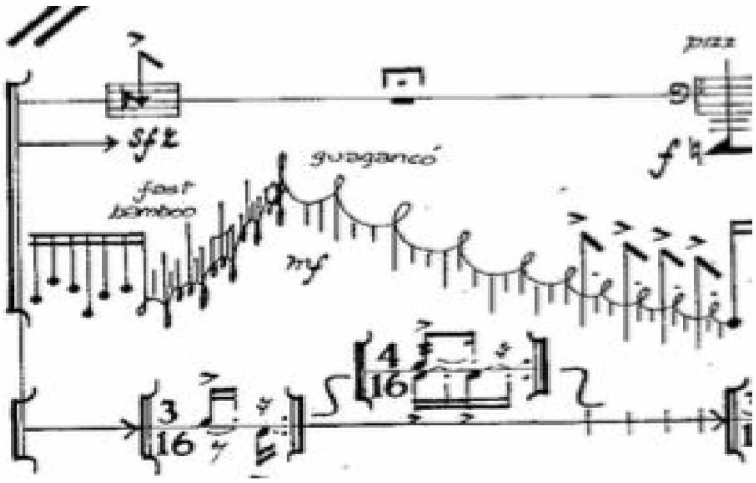
Example 7: Javier Álvarez, *Temazcal*, program notes:

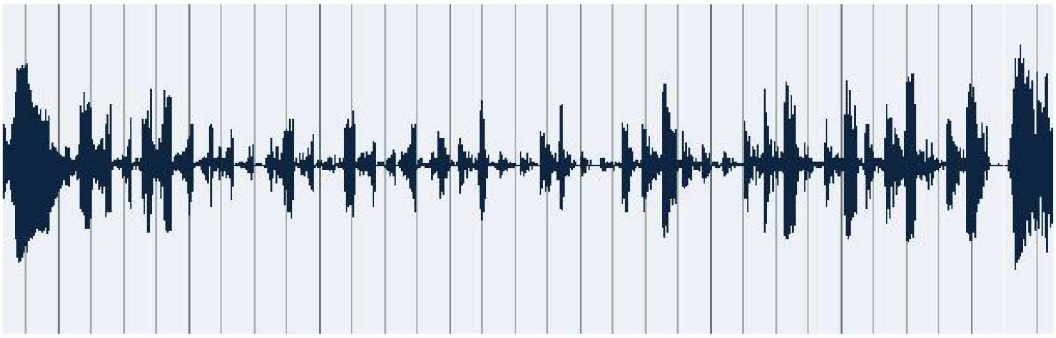


Generally, when learning a piece of percussion repertoire, it is important to isolate, repeat, and slow down complex passages. In order to ease this difficulty, I have elected to use modern technology to aid deciphering and problem solving the tape part.

Using a computer program called Ableton Live, I can digitally analyze and manipulate the audio signal. Therefore sections that require repetition can be slowed down and looped to repeat the specific section. Example 8 shows difficult section in *Temazcal.* I have isolated the same section of audio in the program Ableton for comparison.

Example 8: Javier Álvarez, *Temazcal*, page 2:





To decipher the sound waves above-observed in Ableton, the score of *Temazcal* actually provides useful information. The waves with the largest amplitude (height and density shown in black), which sound dynamically loud, appear at the beginning and the end of the phrase shown. In the score, we can see that there are two "metallic pizzicato"cue sounds marked with a *sfz* that correspond to the waves seen in Ableton.

The last four accentuated notes also appear as bolder sound waves and correlate to the visual score as well. The similarities found in the two parts are helpful in order to locate exact passages that need more attention in practice.

Using this process of isolating difficult passages in Ableton, I have created a custom practice audio track that contains loops of the various sections and metric modulations. These sections would be quite difficult to decipher without the aid of software.

Another helpful digital feature that I utilized in Ableton for practicing *Temazcal* is the ability to slow down passages without affecting the pitch. It allows the ability to practice the entirety of the piece at a slower tempo and gradually speed up as necessary. The pitch of the piece actually affects the memorization process, whereas the tempo does not, in fact it makes the system of memorization easier as it allows more process time for the brain to analyze each passage. Using the same speed changing technique, the piece can then be slowly sped up to the actual tempo - this process is much closer to working on non-electronic music and therefore is more familiar can be effective in learning a composition. Using current technology to help decode and analyze tape pieces is amazingly helpful in learning a piece like *Temazcal.*

II: *Memory Palace*

Memory Palace was composed by Christopher Cerrone in 2012. The piece is scored for percussion and electronics. The majority of the instruments in *Memory Palace* are to be constructed by the percussionist. This includes restringing and re-tuning a

guitar, cutting and tuning 17 slats of wood and 10 metal pipes, and tuning glass bottles by filling them with varying amounts of water. In addition, a few traditional percussion instruments are used: three crotales, two glockenspiel bars, and a bass drum. Regarding the constructed sounds, Cerrone notes: "Ideally, the instruments should not be expensive to make; simple household items (and maybe a trip to your local hardware store) should suffice."[19]

The instrumentation for *Memory Palace* is orchestrated so that a percussionist can build and perform the setup anywhere. This feature of the piece reflects a growing movement in percussion composition that moves away from orchestration for huge set-ups that rely heavily on big and or expensive instruments; usually only institutions such as colleges and universities can provide such instruments. In my experience, *Memory Palace* was quite difficult to set-up, needing much more than a trip to a local hardware. Additionally, because the use of crotales and glockenspiel notes, I still needed institutional resources to play this piece. Apart from non-traditional instruments, *Memory Palace* also employs a sophisticated technological setup to create a unique performer controlled electronic sound.

The piece uses a series of 92 sound cues that advance through the 5 movements. Each movement is described by Cerrone as a distinct memory location. Cerrone writes about the locations in the program notes:

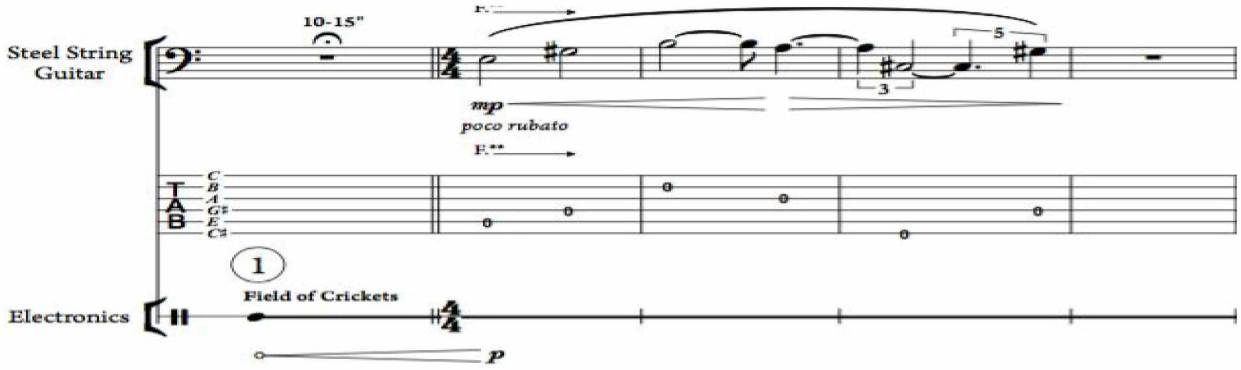
"Memory Palace is a kind of paean to places and people that have deeply affected me. The title refers to an ancient technique of memorization that helped orators remember very long speeches by placing mental signposts in an imaginary location and 'walking' through it. In this piece, the palace is my life. The crickets in the first movement,

[19] Christopher Cerrone, *Memory Palace,* Outburst-Inburst Musics: Brooklyn, NY, 2012, 2.-Although from personal experience, constructing the instruments for the first time was one of the major challenges of undertaking this piece.

"Harriman," were recorded with on a camping trip with two old and dear friends. The recording of windchimes in the third movement was recorded at my parent's house in their backyard. The sounds in the piece are signposts; they help me remember—and more important, understand, who I am."[20]

The electronics used in *Memory Palace* take the form of a series of samples that blend seamlessly with the live percussion. The samples include both live recording and electronically generated sounds. These natural sounds help to conjure vivid imagery corresponding to the piece. These samples are activated manually by the percussionist and are notated by circled numbers in the score which correspond to the cues in the program (Example 9).

Example 9: Christopher Cerrone, *Memory Palace*, *I. Harriman,* mm.1-4.



The samples are triggered via a MIDI (Musical Instrument Digital Interface) foot pedal connected to a computer application built in the program MAX. In addition, the program provides amplification and audio processing which adds adjustable reverb to create the appropriate ambience during live performance. The electronics in *Memory Palace* are directly related to developments in *Elektronische Musik* and IRCAM. Because the history of *Elektronische Musik* had such an effect on music technology and led to the

[20] Ibid, Program Notes.

forming of the important institution IRCAM, this section of the paper will discuss the history of both topics.

Elektronische Musik, in contrast to *musique concréte,* was developed not by a single inventor, but by a group of collaborators, drawn together by both musical and technical backgrounds.[21] Werner Meyer-Eppler (1913-1960) was a Leading German Physicist and director of the Department of Phonetics at Bonn University. In 1948, Homer W. Dudley (1896-1987) from Bell Telephone Laboratories showed Meyer-Eppler a device called the Vocoder, a machine that could analyze and synthesize speech electronically.[22] Although the fidelity was limited, as it was designed for processing speech rather than music, Meyer-Eppler was quite impressed with the devices potential for music production. In 1949 he published a historical account regarding the design of electronic instruments, which included the Vocoder, titled *Elektronische Klangerzeugung* (Electronic Sound Generation). The term *Elektronische Musik* originated during the ensuing lectures giving by Meyer-Eppler, describing any kind of music that could be produced by electronic instruments. After one of his lectures on electronic sound production at the Music academy in Detmold in 1949, Robert Beyer (1897-1972) of the Northwest German Radio Cologne, was moved by the ideas and decided to join forces with Meyer-Eppler. Beyer had already shown an interest in electronic music as early as 1928 in an article he wrote for *Die Musik*: "The Problems of the Coming Music." The

[21] Peter Manning, *Electronic and Computer Music,* (Oxford University Press, 2013), Kindle Edition 784 of 12531.

[22] Otto Luening, "Origins", In *The Development and Practice of Electronic Music,* 1975, ed. Jon Appleton, and Ronald Perera, (Prentice-Hall, Inc. Englewood Cliffs, New Jersey, 1975), 12.

article includes a discourse on the use of electronics in composition and public reaction to the inclusion of new media in music.[23]

After the Detmold meeting, the two men felt positive about the public interest shown in the subject and decided further exposure would generate wider academic support. In 1950, Beyer and Meyer-Eppler developed their ideas in a series of lectures called "The World of Sound of Electronic Music." They presented the lecture at Darmstadt during a summer music festival in 1950, among the attendees were composer Edgard Varése and music theorist and critic Herbert Eimert (1897-1972).[24]

The lectures gathered support among scientists and composers and in 1951 a radio broadcast of the Beyer and Meyer-Eppler lectures along with a forum which included Eimert was aired over the Cologne public radio station. After the program, the station installed its own music studio for making and recording *Elektronische Musik.* More lectures and radio broadcasts exposed the general public to the ideas of Meyer-Eppler, Beyer, and Eimert. By 1953, lectures halls were being filled by the thousands and notable audience members included composers such as Pierre Boulez, Karel Goeyvaerts, Bengt Hambraeus, Gottfried Michael Koenig, and Karlheinz Stockhausen.[25]These composers all subsequently became involved with composition of *Elektronische Musik* at the Cologne studio.

The important distinction during the early 1950s was *Elektronische Musik* being composed strictly with electronically generated tones as opposed to "natural"- acoustic

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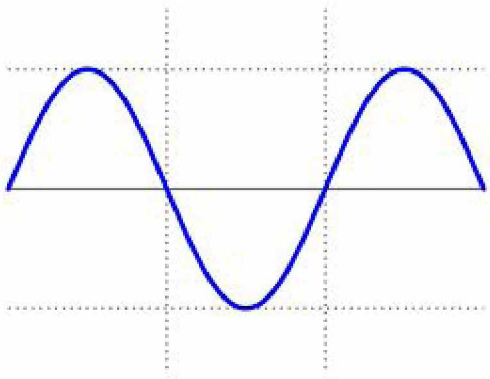
[23] Ibid.

[24] Peter Manning, *Electronic and Computer Music,* (Oxford University Press, 2013), Kindle Edition 796 of 12531.

[25] Otto Luening, "Origins", In *The Development and Practice of Electronic Music,* 1975, ed. Jon Appleton, and Ronald Perera, (Prentice-Hall, Inc. Englewood Cliffs, New Jersey, 1975), 13.

sounds found in *musique concréte* at the time. Germans championed the serialistic process of composition linked to the Second Viennese School, specifically Anton Webern as well as integral serialism (1883-1945) and idealized the works. The increasing desire to control every aspect of composition led to an eager interest in the possibilities of electronic music production. The early advocates of *Elektronische Musik* such as Beyer, Stockhausen and Meyer-Eppler, not only restricted themselves to completely synthetic sound but also went through great measures to dissociate themselves from imitating acoustic instruments with electronics.[26]

Stockhausen's *Studie I* (1953) *and II* (1954) are produced solely from electronic tone generators, specifically sine waves.



He produced these works at the Cologne studio and represent clear examples of *Elektronische Musik* in its pure form, ie: portraying serialized techniques and using electronic sound source. Other composers who explored this format include: Eimert, *Etude über Tongemische* (1953–4), *Fünf Stücke* (1955–6); Igor Stravinsky (1882-1971), *Variante einer Variation von Anton Webern* (1958), *Selektion I* (1959–60), *Epitaph für*

[26] Referring to electronic sounds that imitated actual instruments, similar to an organ or electronic keyboard with preset sounds.

Aikichi Kuboyama (1960–2), *and Sechs Studien* (1962); Bengt Hambraeus (1928-200), *Doppelrohr II* (1955); *Hermann Heiss, Elektronische Komposition 1* (1954); Mauricio Kagel (1931-2008), *Transición I* (1958–60); Gottfried Michael Koenig (B.1926), *Klangfiguren I* (1955), *Klangfiguren II (*1955–6), *Essay* (1957–8), *Suite* (1961), *and Terminus I* (1961–2); György Ligeti (1923-2006), *Glissandi* (1957) and *Artikulation* (1958); and Henri Pousseur, *Seismogramme I und 11* (1954).[27]

During the early stages of development, the possibilities of *Elektronische Musik* for use in serialized music composition eliminated both the human element of physical performance and the inherent 'flaws' of acoustic sound sources. This step towards absolute control of musical parameters proved ineffective in actual practice. Peter Manning explains, "The acquisition of such power, however was to precipitate a major crisis in this (*Elektronische Musik*) movement toward total determinism, for it proved extremely difficult to create culturally acceptable alternatives for these essential characteristics (of live instrumental performance) of traditional music."[28] Therefore, due to the growing interest in the manipulating live sounds and the use of electronic synthesizers by composers such as Otto Luening, John Cage, Vladimir Ussachevsky, Edgard Varése, and Karlheinz Stockhausen, the integration of *Elektronische Musik* and *musique concréte* became an accepted practice starting in 1954. By 1960, the Cologne studio that produced exclusively *Elektronische Musik* was outfitted with recording and playback facilities that were previously and exclusively used in the creation of *musique concréte*. This conglomeration of technology reflected the change in ideology regarding

[27] Peter Manning, *Electronic and Computer Music,* (Oxford University Press, 2013), Kindle Edition 839 of 12531.

[28]Ibid.

the studio's output of music. Thus in practical terms, the techniques of *Elektronische Musik* and *musique concréte* both became widely recognized equally as integral facets of electronic music.

One of the very important compositions to come from the later electronic music genre, using both *Elektronische Musik* and *musique concréte* techniques, was Stockhausen's *Kontakte* (1959/1960) written in Westdeutscher Rundfunk, Köln (Cologne) for electronics, piano, and percussion. This piece was not only important for its use of the latest electronic technology, but also percussion, which plays a very central role. Even the pianist is required to play a number of gongs, cymbals, and bells. In this piece, Stockhausen uses the four sound sources (loud speakers being 2 of them) to create compass points where screens of sound and sonorities swirl in space.[29] *Memory palace* takes the idea from *Kontakte* regarding changing locations of electronic and acoustic sound to create controlled sonic collages of specific sounds sources.

Across the Atlantic in America, the advancement of electronic music progressed differently during the early 1950s. Much of the electronic music during the post-WWII U.S. was small-scale and experimental. This is due in part to the lack of institutional support. It was not until the mid-1950s when major computer systems dedicated to sound production were constructed in the United States. Due to the lack of academic support, composers had to rent commercial recording studios for sound experimentation and to access tape recorders, the majority of which had limited technology, .[30] However the movement of electronic music continued. One group called *The Music For Magnetic*

[29] Paul Griffiths, *Modern Music and After*, (Oxford University Press, 2011), Kindle edition, 3305 of 9619.
[30] Ibid, 1477 of 12531.

Tape Project, made up of John Cage, Earle Brown (1926-2012), Christian Wolff (b.1934), David Tudor (1926-1996) and Morton Feldman (1926-1987), created works of electronic music despite the lack of institutional support.[31]One of the major pieces conceived by Cage with collaboration in realization from the group was *Williams Mix* (1951). Scored for eight tracks, each through a separate speaker channel, and comprised of over 600 samples cut and spliced meticulously, with sounds ranging from natural to electronic. *Williams Mix* was premiered in 1953.

In the same year that *The Music For Magnetic Tape Project* was creating *Williams Mix*, Vladimir Ussachevsky gave a public demonstration of his tape music experiments at Columbia University in New York. An engineer at Columbia showed Ussachevsky the process of creating tape effects such as reverb, echo, and delay.[32] As a result the composer became extremely interested in composing with the new technology. [33] Working in almost complete isolation from the other composers in Europe and the United States, Ussachevsky began to explore tape manipulation with both electronic and instrumental sounds with very limited resources. Otto Luening attended Ussachevsky's tape concert in 1953 and was immediately interested in collaborating in the electronic music field. The two began to compose some of the first tape compositions in the United States. Because at the time, the facilities at Columbia were limited and not suited for serious music making, they composed at the home of Henry Cowell (1897-1965) in New York, where the pieces *Fantasy in Space* (1952), *Low Speed* (1952), and *Sonic Contours*

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[31] David Dunn, "A History of Electronic Music Pioneers," *ders.(Hrsg.), Eigenwelt der Apparate-Welt,(Katalog), Linz* (1992), 15.

[32] Ibid.

[33] Nicholas Collins, Margaret Schedel, and Scott Wilson, *Electronic music*, (Cambridge University Press, 2013), Kindle Edition: 1300 of 5862.

(1952) were conceived.[34] The group eventually publicly presented their works at the Museum of Modern Art in October of 1952. In 1955 they returned to Columbia University and established the first tape studio in the United States. In 1958, with the aid of Milton Babbitt (1916-2011), who worked as music faculty at Princeton University, the group founded the Columbia-Princeton Electronic Music Center.[35] These institutions helped precipitate the rise in computer based music and the composition of countless electroacoustic compositions including *Memory Palace*.

The first electronic music that was fully composed using computers was written by engineer Max Matthews (1926-2011) in 1957. Mathews, who is known in the vernacular as the "father of computer music," famously developed the first music computer coding language called *MUSIC 1* while he was an engineer at Bell Labs.[36] This early process of rendering digital samples into audio with *MUSIC 1* took twenty minutes per one second of real time audio.[37] Mathews arduously created two notable works with support from Bell Labs: the *Silver Scale* (1957), which was the first fully computer generated music, and *Bicycle built for two* (1961) which used a speech synthesizer that modifies vowels with melody. The same speech processor would famously be used for the voice of HAL in Stanley Kubrick's *2001 Space Odyssey* (1968).[38] Matthews would go on to become a scientific musical advisor for an important organization: IRCAM.

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[34] David Dunn, "A History of Electronic Music Pioneers," *ders.(Hrsg.), Eigenwelt der Apparate-Welt,(Katalog), Linz* (1992), 15.

[35] Nicholas Collins, Margaret Schedel, and Scott Wilson, *Electronic music*, Cambridge University Press, 2013, Kindle Edition: 1613 of 5862

[36] Georgina Born, *Rationalizing culture: IRCAM, Boulez, and the institutionalization of the musical avant-garde*, (Univ of California Press, 1995),66.

[37] Nicholas Collins, Margaret Schedel, and Scott Wilson, *Electronic music*, (Cambridge University Press, 2013), Kindle Edition: 1586 of 5862

[38] Ibid.

This organization played a major developmental role in the creation of new technology and music software including Max, the program used by Cerrone to create and perform the electronics employed in *Memory Palace.* Max allows the performer to more directly interact with the music. As opposed to playing with tape, or a fixed medium, the program can be manipulated in real time making the electronics have a intuitive user interface.

Another critical component of the development of electronic music is IRCAM. The institute is one of the world's largest public research centers dedicated to both musical expression and scientific research. Founded by Pierre Boulez in 1977, IRCAM, is a unique institute where artistic sensibilities collide with scientific and technological innovation. The three principal activities at IRCAM include creation, research, transmission.[39] Boulez founded the center to help create an active dialog between, musician, composer, scientist and engineer. He believed passionately that the future of music depended understanding of avant garde music ideals and the embrace of large scale collaboration between the music and scientific fields of study, embracing technology to change the way music was created. Boulez writes about this importance in relation to the collaborative aims of IRCAM:

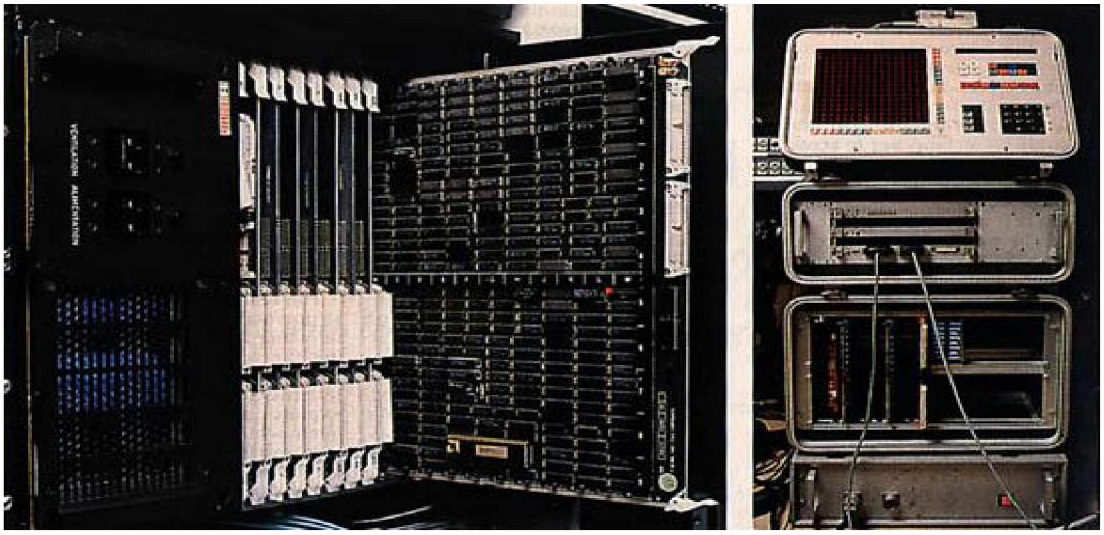
> "The musician must assimilate a certain scientific knowledge, making it an integral part of his creative imagination. As to the scientist, we are not of course asking him to compose, but to conceive with precision what the composer, or instrumentalist, expects of him, to understand the direction contemporary music has taken, and to orient his imagination along these lines. At educational meetings scientists and musicians will become familiar with one another's point of view and approach. In this way, we hope to forge a kind of common language that scarcely exists at present."[40]

[39] "Who We Are," Acceseed March 15 2016, http://www.ircam.fr/ircam.html?&L=1.
[40] Ibid.

In the 1980s, IRCAM became a major center for computer music research and composition. A major development at IRCAM was of the Sogitec 4X computer system, featuring revolutionary real-time digital signal processing. This was the first signal processing musical computer and was an integral part of Pierre Boulez's *Répons* (1981).

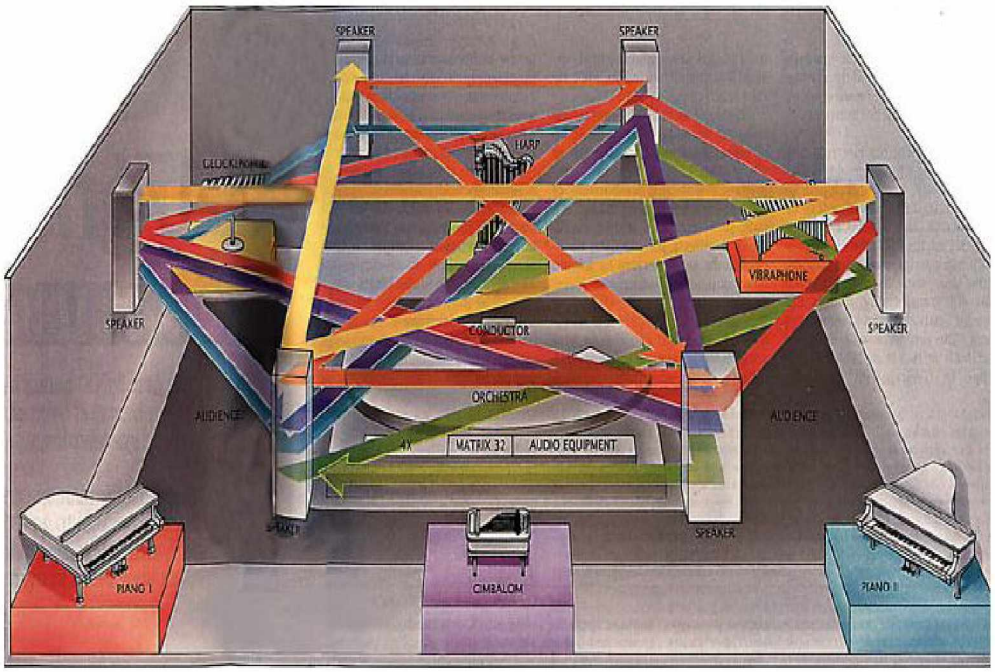
The massive piece was written for a 24 musician orchestra including 6 soloists: vibraphone, cimbalom, harp, glockenspiel, 2 pianos, and an arsenal of speakers linked to Sogitec 4X. The computer was used to manipulate the sounds of the soloist and pan their affected acoustic sound through a multi channel speaker system in real time. A visual illustration helps show the size of the Sogitec 4X as well as the complexity of the sound (Figure 3) setup used for the audio routing process performed by Sogitec 4X in *Repons* (Figure 2).

Figure 2: The Sogitec 4X.[41]



[41] Pierre Boulez, and Andrew Gerzso, "Computers in Music," Scientific American, avril 1988, vol. 258, # 4, Accessed 3/18/2016, http://articles.ircam.fr/textes/Boulez88c, section 1.

Figure 3: Sound diagram for *Repons.* [42]



Live interaction based hardware and software became a main component of the IRCAM musical production, which eventually led to the development of MAX. The program was first developed for the Macintosh in the mid-1980s at IRCAM by Miller Puckette (b.1959), a mathematician and programmer who worked at the institution through the late-1980s. The software was named after Max Mathews in honor of his important achievement in musical software: *MUSIC 1*. Puckette continued developing the features of MAX and by 1989, the program was widely used at IRCAM and 30 other institutions and individual studios around the world. At this time the cost of the program alone, which came with 2 audio processors, was $12,000, not including the actual computer.[43] The program Max was first released commercially by Opcode Systems, Inc.

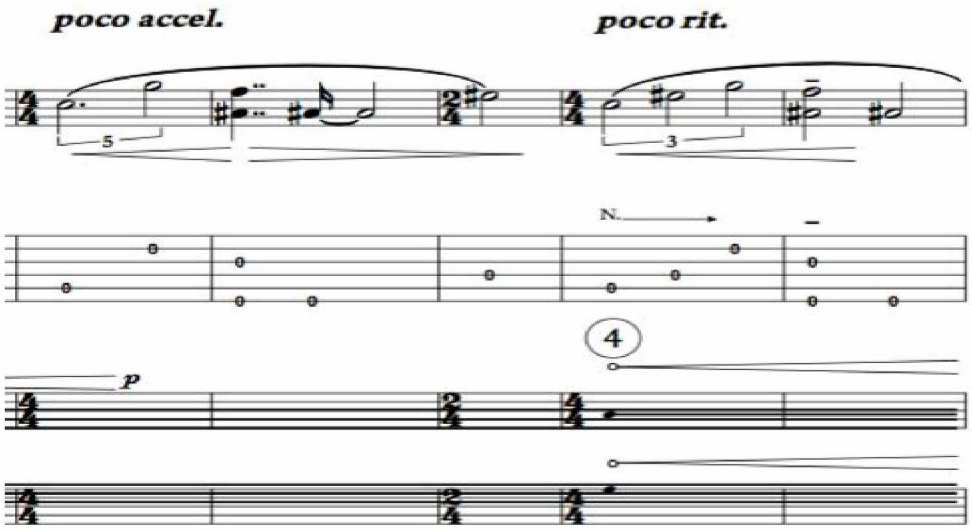
[42] Ibid.

[43] "Where did MAX/MSP come from?", *www.cycling74.com*, Last modidied 4/25/2008, http://web.archive.org/web/20090609205550/http://www.cycling74.com/twiki/bin/view/FAQs/MaxMSPHistory.

in 1990. It was chosen as Software Innovation of the Year by the readers of Keyboard Magazine in 1991. Since 1999 it has been published and supported by Cycling '74.[44] As stated previously *Memory Palace* uses Max software as the core component for operating the electronics within the piece.

The first movement of *Memory Palace, Harriman* is scored for guitar which is to be played like a percussion instrument. The part is written in guitar tablature as well as standard notation in treble clef and the notation specifies techniques include: plucking with finger, the nail, and activating harmonics. The first notated electronics trigger a sample of crickets, the remaining cues slowly build up a series of electronic sine wave tones that create a minor pentatonic E chord. The *Harriman* electronic part is reminiscent of Stockhausen's *Gesang Der Jünglinge*, using both samples of natural sound as well as electronic tones to create an atmospheric background (Example 10).

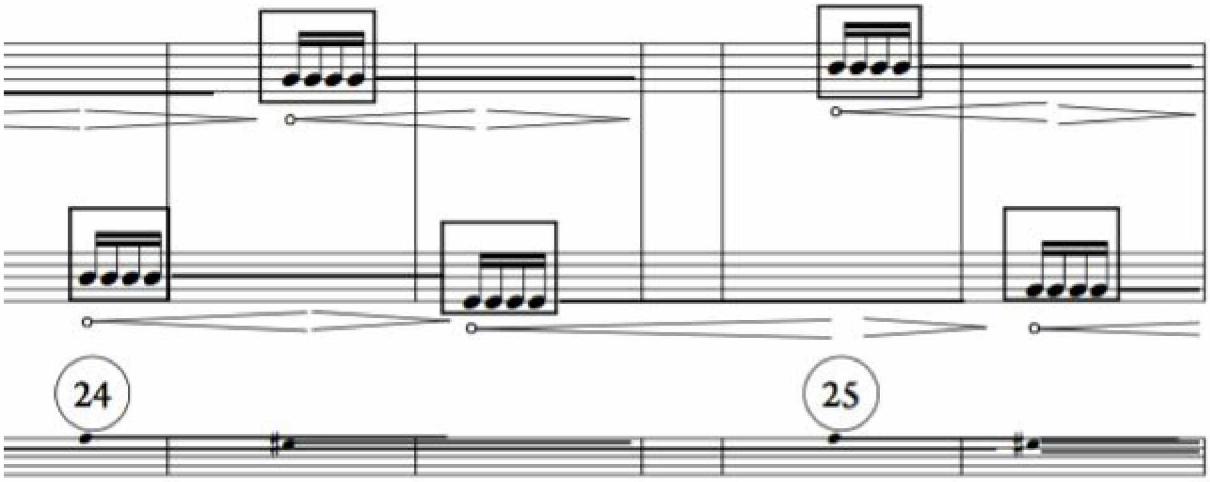
Example 10: Christopher Cerrone, *Memory Palace*, *I. Harriman,* MM.42-46.



[44] Ibid.

The second movement, *Power Lines,* is played on the seven lowest notes of the tuned wooden slats. The percussionist plays mandolin rolls[45]on the slats in metered sixteenth notes. Similar to the first movement, the electronic sounds build in amplitude throughout, although, the rhythmic density become much more intense in this movement. As shown in Example 11, each time a note is played by the percussionist, a corresponding triggered electronic tone is introduced and short melodic passages are intertwined between the live player and activated electronics.

Example 11: Christopher Cerrone, *Memory Palace*, *II. Power Lines,* MM.114-118.

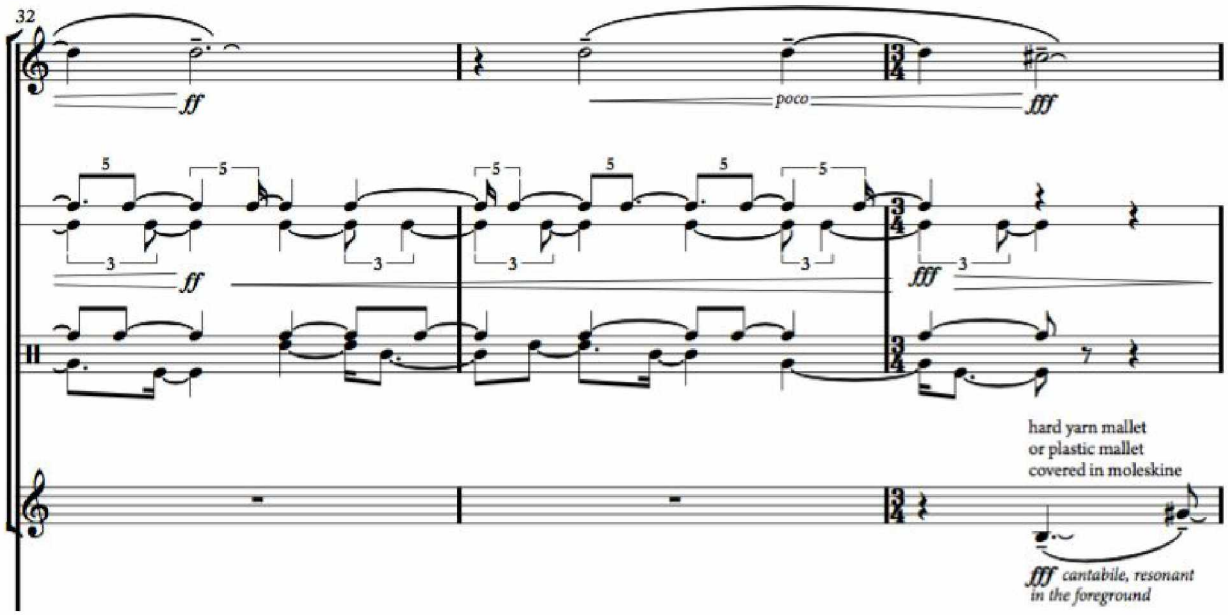


This movement begins to highlight the complexity in dexterity for the live player. The percussionist must employ all four limbs: two hands playing mandolin roles as notated by the top and bottom lines, MIDI foot pedal activation, and not to mention a series of page turns. In order to facilitate the difficult page turning, I used an electronic PDF reader and a bluetooth foot pedal to activate page turns.

[45] An extended percussion technique where two mallets are used in one hand to strike the top and bottom of an object to create a roll effect.

The third movement, *Foxhurst,* uses the least amount of electronic triggering but is the most rhythmically challenging in *Memory Palace*. The last electronic cue from *Power Lines,* carries through this movement and consists of a sample of outdoor wind chimes. The wind chimes play ambiently throughout the entire movement, symbiotically echoing and adding levity to intensely rhythmic acoustic part. *Foxhurst* is played on all the metals: suspended pipes, mounted pipes, bells, and crotales. Interestingly, the mounted pipes, crotales, and bells, play independent rhythmic ostinatos. These patterns are introduced one at a time, first entering with the mounted pipes, then following with glockenspiel notes, and finally crotales. The suspended pipes play the melody and the musical entrance is met with a gradual reduction of complexity with the other metals sound sources.

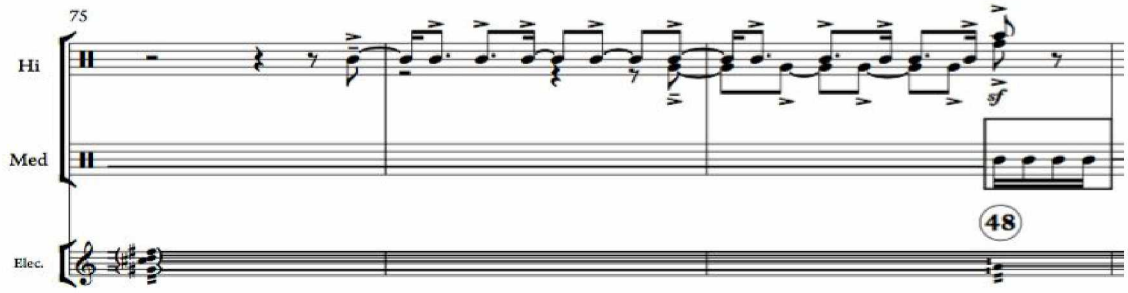
Example 12: Christopher Cerrone, *Memory Palace*, *III. Foxhurst,* MM.32-34.



Looking at the rhythms in the Example 12 , from top down, the crotales play in increments of half notes. The top bell part plays once every six quintuplets. The bottom bell plays once every four eighth note triplets. The mounted pipes play a polyrhythm of five against four in sixteenth notes. In order to accurately play the compound polyrhythm, a process known as gridding is utilized. Using math to calculate the lowest common denominator of all the rhythms present gives the key to the rhythmic equation. Thus, the found denominator becomes the subdivision used to grid an accurate relationship between each note.

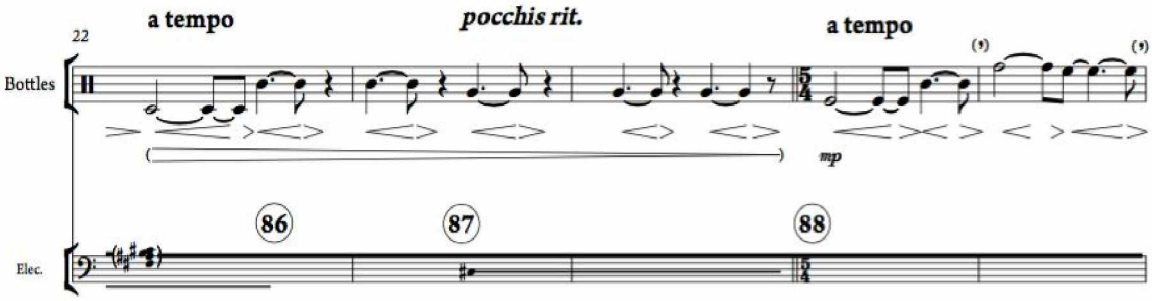
The fourth movement: *L.I.E.,* is fast paced and combines elements from second and third movements. The percussionist plays a mandolin role in sixteenth notes on the medium and low wooden slats with the left hand while playing serialized offset ostinatos in the right hand on the high wooden slats and crotales. The electronic samples, similar to the second movement, are tonal and interact melodically with the changing of pitches played by the performer. The texture of the electrics sounds pulses and blends with the live performance to create rhythmic unisons and ambient harmonization with the notes played by the percussionist. Example 13 shows the ostinato played in the right hand along with corresponding cue that changes the harmony in the electronic part.

Example 13: Christopher Cerrone, *Memory Palace*, *IV L.I.E.* MM.75-77.



The final movement: *Claremont* serves as musical coda, tying in the melodic content found throughout the entire piece. This movement is played on tuned glass bottles. The performer blows on the top of the bottles to create pitched whistling tones. The electronics are triggered in concurrence with the melodic phrasing of the bottles and provide a modal harmonic texture which highlights the changing pitches of the bottles. Example 14 demonstrates the melodic phrasing between the blown bottles and triggered electronics.

Example 14: Christopher Cerrone, *Memory Palace*, *V. Claremont,* MM.22-26.



III: Conclusion

"Composers have had essentially one medium through which to express their musical ideas in forms that an audience can appreciate: the sounds that musicians can elicit from traditional instruments. With the advent of computers and other equipment for processing...an entirely new means of musical expression has become available. A composer who applies these electronic devices is bounded only by imagination in creating an "orchestra" of sounds."-Boulez.[46]

The history of technology in music, specifically *musique concréte,* and *Elektronische Musik* is important for understanding and appreciating the evolution of the electroacoustic pieces. This is especially true considering the creation and use of tape,

[46] Pierre Boulez, and Andrew Gerzso, "Computers in Music," Scientific American, avril 1988, vol. 258, # 4, Accessed 3/18/2016, http://articles.ircam.fr/textes/Boulez88c/, section 2.

analog, digital, and computer technology used in electroacoustic works such as *Memory Palace* and *Temazcal* was developed within the last century. The research of early electronic music provided explanation regarding the types of technologies used in these compositions as well as the origins of their development. The material provided in this paper allows electroacoustic compositions to be better understood, appreciated, and analyzed.

Musique concréte, and *Elektronische Musik* form the initial building blocks that created electroacoustic compositions which represent a growing section of standard percussion repertoire. Institutions such as Columbia-Princeton Electronic Music Center, Bell labs, and IRCAM, in turn developed technologies and software that is being used to create present works.

The major electronic and electroacoustic works discussed throughout this paper such as *Symphonie Pour Un Homme Seul, Gesang der Jünglinge, Poème électronique, Déserts, Studie I* and *II, Kontakte, Williams Mix, Silver Scale,* and *Répons,* serve as historical bookmarks in their important technoligical developments. Each of these works are linked to each other by their ever evolving technology. The ideas expressed in these groundbreaking pieces forever helped shape the compositions that followed. Neither *Temazcal* nor *Memory palace* would have been composed if not for the important works and technology discussed in this research paper.

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