AND DROPS OF RAIN FALL LIKE TEARS: A COMPOSITION FOR ELECTROACOUSTIC MUSIC AND VIDEO

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And Drops of Rain Fall Like Tears is a composition for electroacoustic music with an optional ambient video component. The composition consists of a single movement electroacoustic work twenty-two minutes in duration. The piece creates an immersive sonic environment within the confines of a typical concert space, thereby recreating the powerful temper and subtle beauty of nature from different sonic perspectives.

The paper is divided into four chapters, each discussing an element of the piece in detail. The introduction presents background information and compositional approach for the composition. Chapters 1 through 4 present detailed information related to the creation of both the electroacoustic music and video elements of the piece. Chapter 4 contains relevant information to the performance of the piece.

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INTRODUCTION

And Drops of Rain Fall Like Tears is an electro-acoustic composition with an optional ambient video component. The composition consists of a single movement electroacoustic work twenty-two minutes in duration. The piece creates an immersive sonic environment within the confines of a typical concert space, thereby recreating the powerful temper and subtle beauty of nature from different sonic perspectives.

And Drops of Rain Fall Like Tears' compositional aesthetic is based on a mix of French and Canadian electro-acoustic ideals that exist in parallel and in contrast to other electronic music movements pioneered in Germany, the United States, and else where. The compositional focus of this piece lies in the fusion of acousmatic[1] and soundscape[2] electroacoustic musical elements. Taken from the Fench word *Acousmate*[3] meaning sound for which the cause is not seen, acousmatic music is composed with recorded sounds that are developed in the studio and projected in concert halls without the use of visual stimuli. Primarily practiced in Europe and parts of Canada, the roots of acousmatic music date back to the Musique Concrète tradition. As such,

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[1] Dhomont, Francis. Les dérives du signe (liner notes) (Compact Disc IMED 9608. Diffusion i Média 1996) 26.

[2] Trux, Barry, ed. Handbook for Acoustic Ecology. (Canada: A.R.C. Publications, 1978) 126.

[3] A French word derived from the Greek noun Akousma that translates as what is heard.

acousmatic music adopts and extends the Musique Concrète aesthetic as presented in Pierre Schaeffer's Traité des Objets Musicaux[4].

Beyond the obvious use of recorded sounds and compositions existing on fixed media, Musique Concrète provides a physical connection to the compositional process by defining a 'concrete' or direct approach in working with and modifying sound materials. The fundamental difference in Schaeffer's musical revolution and that of other electronically based musical trends is found in the compositional use of perceived musical qualities contained within the sounds themselves rather than the use of measurably preconceived instrumental thinking. As such, Schaeffer's new music stands in aesthetic contrast to the concepts presented by John Cage's ideas involving the inclusion of all possible sounds as valid compositional material illustrated and exemplified in both his electronic and acoustic compositions. Musique Concrète is also at odds with the de-rationalization (indeterminacy) of musical ideas imposed on these sound sources as found in the works of Innas Xenakis, as well as the aesthetic practice of pre-compositional techniques found in music of the Elektronische Musik serialists such as Karlheinz Stockenhausen.

By extending the sonic palette to include the recording of any sound source, the ideals intrinsic to Musique

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[4] Schaeffer, Pierre, Traité des Objets Musicaux. 2nd ed. (Paris. Editions du Seuil, 1977).

Concrète also provide for an engaging compositional environment that encourages creative and improvisational collaboration between the composer and the sound materials. It is this important aesthetic view that dramatically differs from the accepted traditional musical thinking of imposing one’s will, or in the case of Cage and others, an external organizational process on so-called ‘neutral’ sound material.

In acousmatic music, combining recorded sounds subsequently creates musical gestures that are conceptually similar to the ideas of motive or phrase found in acoustic compositional practices. The acousmatic gesture creates motion, builds climaxes, facilitates transitions, and promotes formal development within a composition and functions, at least superficially, much like melody, harmony, and phrase do in acoustic music. Regardless of this analogy, it is important to point out that there is no direct link or consensus among practitioners representing acousmatic music as a descendant or even an extension of traditional acoustic compositional thought.

Soundscape composition, in contrast, usually represents a less active presentation of sound materials, and is distinguished by its sole use of environmental sounds. A type of music fostered in Western Canada and evolving from the World SoundScape Project of 1973, electroacoustic soundscape composition shares more aesthetic influences with photography and documentary than with traditional musical thinking. A definition of the term soundscape is found in the *Handbook for Acoustic Ecology* that states:

> Soundscape[5]: An environment of sound (sonic environment) with emphasis on the way it is perceived and understood by the individual, or by society. It thus depends on the relationship between the individual and any such environment. The term may refer to actual environments, or to abstract constructions such as musical compositions and tape montages, particularly when considered as an artificial environment.

Soundscape utilizes environmental recordings to create a sonic motion picture of an environment or a mix of different environments with emphasis on the perception and understanding of the soundscape to the individual experiencing the piece. While this aesthetic approach is used to accurately recreate a sound environment, it also presents the potential to create a virtual or almost surreal environment based on realistic recordings. This duality prompts a delicate balance between abstraction and representation in soundscape electroacoustic composition. It is important to note, however, that Soundscape's cohesion relies primarily on the social context from which the sonic environment is taken. Figure 1 depicts the functional, albeit superficial, elements that characterize soundscape design and some conceptually analogous traditional musical elements.

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5 Trux, Handbook for Acoustic Ecology. 126.

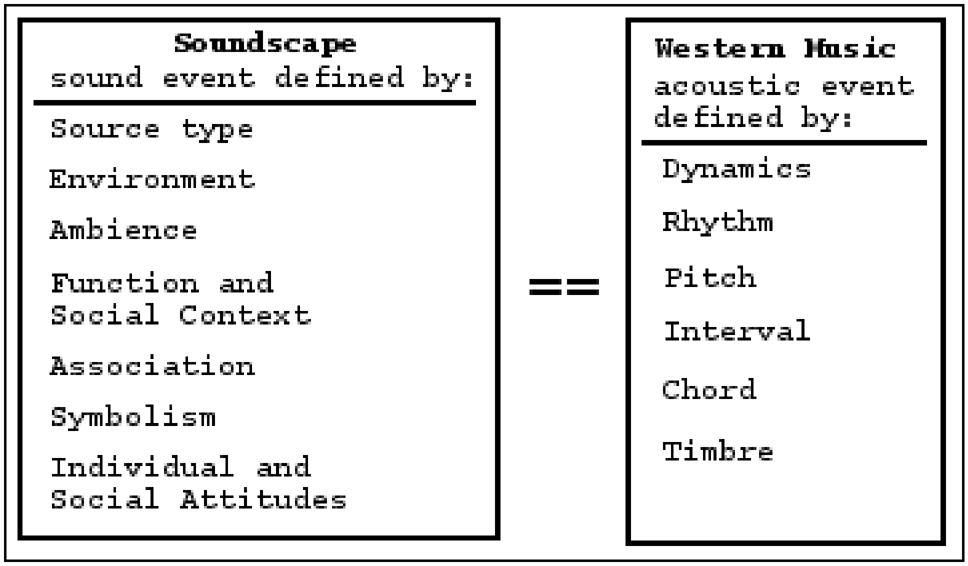

Fig. 1. Soundscape elements and conceptually analogous musical elements.

While *And Drops of Rain Fall Like Tears* is based on principles borrowed from acousmatic and soundscape music, any attempt at explaining the piece in exclusively acousmatic or soundscape terms or concepts will not hold true for either case. However, there is significant overlap where both musical ideals share the conceptual guise of referential material. *And Drops of Rain Fall Like Tears* fuses these two musical approaches by utilizing the common element of recorded sound sources capitalizing on the power of communication in the form of referential material.

While Schaeffer's Traité des Objets Musicaux refers to the concept of reduced listening manifested in the idea of the sound object, I prefer to call this idea abstract listening. Abstract listening taps into the referential idea by asserting that as long as a sound is recognizable it continues to retain certain contexts even when removed or ‘abstracted’ from its original environment. For example, the sound of the tide at a beach, a train, a thunderstorm, or a running stream contextualizes and includes certain personal meanings or experience that cannot be completely separated from the sound. Although the context or setting of the sonic element may change when presented compositionally, it is still recognizable as a train or thunderstorm. At most, the sounds take on additional meaning but they never fully shed their real-world contextual associations.

In another example more closely related to this piece, consider a concert situation where the sonic materials are sounds of a thunderstorm. In this context, each person listening to the sounds of a thunderstorm recognizes it as such. During the listening process, the mind auditions the recognizable event of a thunderstorm and automatically recalls memories relating to past personal experiences in which such a storm created a memorable impact. At this point the ability to recall the different experiences and associations that the sonic materials evoke intimately transcends the communication barrier between the listener and the composer.

This dissertation examines each element of the piece and provides insight into the compositional and technical challenges encountered during the creation of the piece. In addition, topics related to sonic sources, formal design, and presentation will also be discussed with regard to the construction of an immersive listening experience.

CHAPTER 1

ELECTROACOUSTIC MUSIC

Approximately two years ago, I became interested in composing electroacoustic music based on sounds from thunderstorms and raindrops while lying in bed one night as a particularly bad storm passed through the area. With the windows open, I heard the beginnings of a storm out in the distance. Gradually, the storm became stronger and moved closer to town. The intensity of the storm continued to build to a climax of extreme force before slowly disappearing into the distance once again. Listening to the sounds of the storm's different layers as it made its way through town inspired me musically by creating a sonic tapestry from the raindrops hitting the roof, window, and finally dropping into a puddle of water outside my window. While not necessarily programmatic, *And Drops of Rain Fall Like Tears* is closely embedded within the fabric of extra-musical ideas experienced during the storm.

Composing the electroacoustic music portion of *And Drops of Rain Fall Like Tears* occurred over a six-month period. However, the source materials that form the foundations of the piece were recorded and collected over a two-year period, amounting to over three hours of recordings. This collection of sounds includes a complete forty-five minute storm captured from beginning to end in addition to other rain and water-related sounds. All sounds were recorded using a Sharp MD-MT 15 portable MiniDisc recorder with omni-directional and cardioid portable stereo microphones. Macintosh[6] computer systems account for all of the processing and postproduction power utilized for this piece. Digital signal processing software used includes: Emagic's[7] Logic Audio, Emagic's VST equalizer, spectral gate, and compressor/expander plug-ins, Digidesign[8] Protools, GRM Tools[9], TC Electronics[10] reverb, graphic and parametric equalizers, Digidesign's DINR, Waves[11] S1 stereo imager, and my own stereo VST processor Shimmer.

Although *And Drops of Rain Fall Like Tears* exists as one continuous movement, the piece contains six different sections identified by changes in sonic perspectives and activity. Formally, the duration of a naturally occurring thunderstorm influenced the structure of the piece, outlining a simple arch form. *And Drops of Rain Fall Like Tears* follows the same unfolding pattern of a storm from distant soundings culminating with the first climax about midway through the piece. At this climactic point, the arch form is broken and a tranquil sonic scene emerges from a lull in the storm's activity. Over time, the piece gradually gathers more activity evolving into new soundscapes that present different perspectives of the storm before dying

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[6] Apple Computer, Inc.<http://www.apple.com> [Accessed 7 Dec. 2001].
[7] Emagic Soft-und Hardware GmbH. <http://www.emagic.de> [Accessed 7 Dec. 2001].
[8] Digidesign. <http://www.digidesign.com> [Accessed 7 Dec. 2001].
[9] GRM Tools. <http://www.grmtools.org> [Accessed 7 Dec. 2001].
[10] TC Electronic. <http://www.tcelectronic.com> [Accessed 7 Dec. 2001].
[11] Waves. <http://www.waves.com> [Accessed 7 Dec. 2001].

away peacefully with wind chimes ringing in the distance. Figure 2 outlines the formal structure, density levels, and activity levels of the composition.

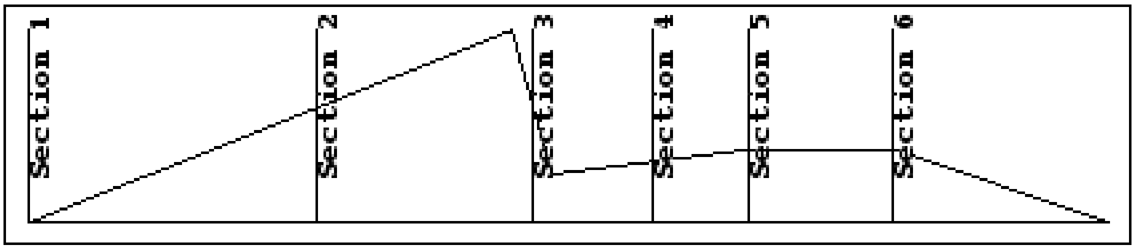

Fig. 2. Formal Structure

Most of the source material for this piece originates from field recordings of rain showers and thunderstorms collected throughout the United State, United Kingdom, and Europe. Materials were recorded to create an immersive sonic environment. This environmental need led to the selection of a cohesive group of sounds that share similar sonic qualities and greatly contributed to the temporal unfolding of the piece. Recordings of other sonic materials facilitated the creation of transitional segments that link the larger musical sections together and enable the development of acousmatic gesture that holds the momentum and development of sonic materials within the piece. These additional sound sources included recordings of water drops, creaking wooden chairs, a door opening and closing, and wind.

In addition to the structure of a thunderstorm, pitch organization based on the sounds themselves helped define the overall spectral morphology[12] of the piece but followed no formal organizational process. Sound groupings were constructed based on families of sounds with similar resonant frequencies and spectra. The groupings were mainly organized based on perceived pitch similarities between the sounds. The sounds' inherent frequency content dictated much of the perceived 'pitch' organization. In some cases, reinforcement of the frequency components by external processing techniques such as equalization, comb filtering, and vocoding were employed. These new families of 'pitched' sounds were then used to compose sections and subsections of the piece. However, it is important to state that all references to 'harmonically' oriented material used in the piece were purely coincidental. There was no pre-conceived notion of traditional harmonic procedure used within the piece. An example of a section constructed from pitched materials and having strong 'harmonic' qualities is found at approximately ten minutes into the piece where a pitched chordal drone section emerges from the climax of the storm. Other pitch-based modifications, such as transposition and resonant filtering, allowed sounds in different pitch families to conform 'harmonically' to other pitched elements found in the piece.

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[12] Smalley, Denis. "Spectro-morphology and Structuring Processes."In The Language of Electroacoustic Music, ed. Simon Emmerson, (London: Macmillan Press, 1986) 61-93.

CHAPTER 2

TECHNICAL USAGE

Microphone Techniques

The desired type of recording, either environmental or directional, influenced the selection of microphone used. Throughout the compositional process, all recordings remained in the stereo format. Two types of microphone polar patterns were used, omni directional and cardioid. The two principle stereo recording techniques used include the 3:1 principle[13] and the xy technique[14] explained in detail below.

The omni directional microphone responds equally to sound pressure at its surface without regard to the sound source location as seen in figure 3. Therefore, omni directional microphones are best suited for recording environmental sounds due to their larger polar pattern. Generally, larger polar patterns equate to a larger environmental pickup area around the microphones. This strength allows the recording to keep certain spacious qualities inherent in the natural environment and in turn enable one to reproduce them, as closely as possible, in a stereo loudspeaker environment.

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[13] David Miles Huber and Robert A. Runstein, Modern Recording Techniques, 3d. ed. (Indiana: Howard W. Sams & Company, 1989) 83.
[14] *ibid*.

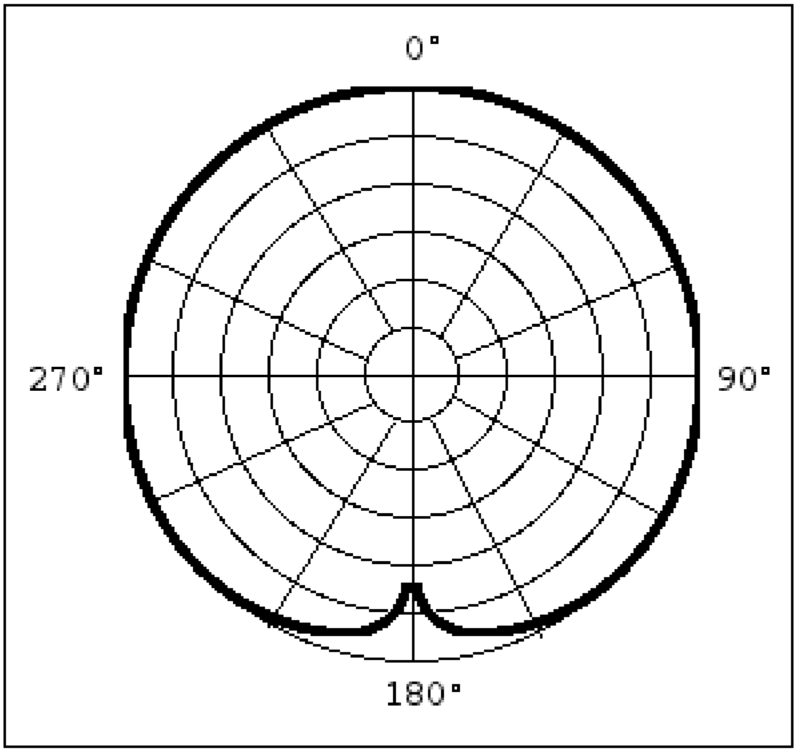

Fig. 3. Omni directional polar pattern

Two types of mounted omni directional microphones were used to record sounds for this piece, Audio Technica[15] headset and handheld. Headset based microphones are designed for making binaural recordings. Binaural recordings are recordings specifically used to capture the listening area of a human by using the head as a natural filter for directional cues and other naturally occurring phenomena. This filtering in turn makes its way onto the recording. Binaural recordings, therefore, create a type of natural encoding of audio data representing the human hearing experience. The omni-directional stereo microphone was mounted on a portable handheld microphone stand. This allows

[15] Audio Technica. <http://www.audiotechnica.com> [Accessed 7 Dec. 2001].

fast and easy microphone adjustment in order to expand or contract the stereo field, and thus facilitates changing the stereo image for any particular recording situation. The result of these adjustments provides different stereo images, each with varying levels of frontal stereo focus.

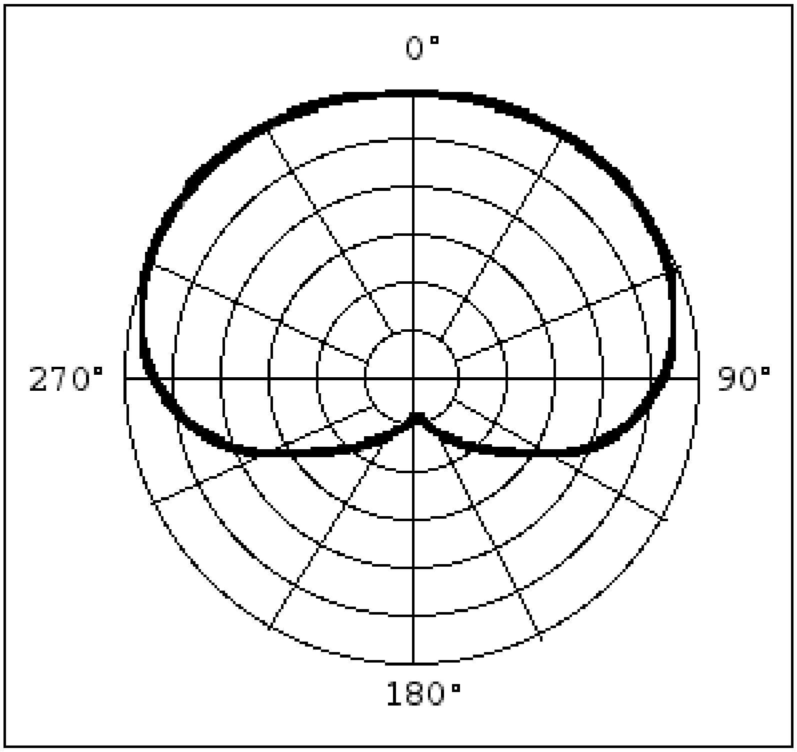

Fig. 4. Cardioid polar pattern.

Directional recordings were captured using stereo cardioid microphones. A cardioid polar pattern combines bi-directional and omni directional polar patterns to produce a directional polar pattern as shown in figure 4. The stereo cardioid microphone was employed to isolate a specific characteristic of the environment through helping to focus the recording of that characteristic towards the center of the stereo image. A CMC-1, manufactured by The Sound

Professional[16], stereo cardioid microphone was mounted on a portable handheld microphone stand, allowing each pickup a full range of adjustability within the stereo field.

The typical stereo placement technique used for the cardioid-based recordings of this composition is the xy technique. The xy technique allows the creation of a tight frontally oriented stereo image with less ambient leakage from the areas around the pickups. This image is achieved by placing the microphones at right angles to each other in which the grills of the microphones sit as closely together as possible without touching. This placement allows for increased detail in the recording as well as provides an excellent stereo image exhibiting a focused central source and broad width within a moving stereo field.

Other microphone placement patterns employed the widening of the distance and angle between the two pickups resulting in larger stereo images and increased amounts of outside environmental ambience in the recording. In addition to microphone adjustments, recording in closer proximity to the sound source also allowed for tighter stereo images and less ambient leakage (background noise) in some of the recordings.

The other microphone placement technique employed during the recordings is the 3:1 principle. The 3:1 principle attempts to maintain phase integrity for every

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[16] The Sound Professionals. <http://www.soundprofessionals.com> [Accessed 7 Dec. 2001].

unit of distance between the microphone and its source. Interestingly, some environmental recordings used the 3:1 principle with cardioid microphones. This use yielded acceptable results, demonstrating that there is no hard and fast rule involved in utilizing both types of microphones for any one type of recording situation.

Noise Reduction Techniques

Given the environmental variables involved in field recordings, it is impossible to achieve a focused naturally occurring event without picking up some unwanted elements. In a number of situations during the collection of materials for this piece the recordings also exhibit additional, potentially unwanted elements such as city, car, and neighborhood noise. The inability to control the inclusion of these additional elements required them to be controlled and/or suppressed via noise reduction techniques.

Because of the practical issues surrounding field recording explained above, outside noise and artifacts did make their way onto the recordings. Minimizing the sonic presence of these extra elements was problematic and compounded by the inherent delicate nature of the sonic materials being recorded. In an attempt to isolate sonic elements and remove excess noise that compromised the sonic quality of the piece, I utilized three types of noise reduction processing techniques. These processes included spectral, amplitude, and masking-based techniques.

Spectral processing of sound involves the use of both time and frequency domain processing. This processing centers on the use of filters and banks of filters normally referred to as equalizers. The four main types of digital filters are high pass, low pass, band pass, and band reject (notch). A filter functions by attenuating or boosting the frequencies above, below or within a certain frequency range. High pass filters, for example, attenuate, or reduce the amplitude of frequencies below a given cutoff frequency. Conversely, low pass filters attenuate, or reduce the amplitude of frequencies above a given cutoff frequency. Therefore, the use of these filters can help control excess noise as well as unwanted frequency content. For example, the environmental insect sounds in the opening section of *And Drops of Rain Fall Like Tears* utilizes a high pass filter attenuating frequencies below a given cutoff frequency. Before processing, this spectral area was very problematic in that it contained low ambient noise from nearby industrial air conditioning units, highway noise, and wind rumble. Applying the filter to the sound removed these types of noise.

In most modern computer-based digital audio workstations (DAWs), the band pass and notch filters combine to form a peak/notch filter known as a peaking filter. A peaking filter has the ability to boost as well as attenuate a group of frequencies within its bandwidth. The peaking filter design is at the heart of two of the most powerful tools in spectral shaping and noise reduction, the graphic and parametric equalizers.

A graphic equalizer contains a bank of peaking filters arranged in parallel across the spectral range. These banks usually occur in groups of seven, fourteen, or thirty-two bands spaced according to musical intervals or octaves. Graphic equalizers are powerful in that they allow independent control over the complete spectral range of a sound. The user of a graphic equalizer could, for example, attenuate frequencies in the eight-kilohertz range while simultaneously boosting frequencies centered around one hundred fifty hertz. On many occasions throughout *And Drops of Rain Fall Like Tears*, the need to suppress noise and unwanted frequency resonance in the source materials dictated the use of this type of equalizer.

The insect environment of the opening section of *And Drops of Rain Fall Like Tears* is processed with a high pass filter and a graphic equalizer to remove high frequency hiss in the twelve-kilohertz range while slightly attenuating the frequencies centered on and around eight hundred hertz and one kilohertz respectively. These filter settings effectively removed high frequency hiss from the recording as well as reshaped the mid range frequencies.

In addition to the graphic equalizer, spectral control can be accomplished through using a parametric equalizer. A parametric equalizer is most frequently comprised of three types of filters (low shelving, peaking, and high shelving) daisy chained in a series. The shelving filters are similar to the high and low pass filers but exhibit additional control over the amplitude of the frequencies above or below a given cutoff frequency depending on the filter. A typical parametric equalizer has at least one peaking filter but may contain more. In a standard parametric equalizer configuration, the cutoff frequency is adjustable as well as the bandwidth. Frequencies centered on the bandwidth of the chosen center frequency parameter are also adjustable through boosting or attenuation.

During the creation of *And Drops of Rain Fall Like Tears* equalizers were most frequently used in combinations. The setup for these configurations utilized the inserts on a mixer strip in software. For example, the main mixer strip of a channel in any high-end digital audio workstation software package contains inserts that allow a signal to pass through various outboard digital signal processor plug-ins such as delays, equalizers, and compressors. Most software allows at least five inserts to route a signal through multiple plug-ins. The signal is then processed in real-time before routing back into the channel strip and routed to the master output stage. Figure 5 illustrates channel strip inserts containing plug-ins.

Fig. 5. Inserts configured with plug-ins used for noise reduction.

In some instances during the compositional process, a graphic equalizer employing extreme frequency attenuation helped reduce noise found at a particular frequency or group of frequencies. With extreme graphic equalization adjustments, spectral degeneration can occur and in some cases may destroy the spectrum of a sound altogether. If this happens, additional stability issues may arise within the stereo image of a sound. To work around this dilemma, I experimented with the addition of a parametric equalizer directly after the graphic equalizer to combat spectral deficiencies created by the first stage of equalization. I discovered that making small amplitude changes in the parametric equalizer around the defective frequency ranges helped smooth out and stabilize the spectral integrity of a processed sound.

In specific instances, Digidesign’s Broadband Noise Reduction (BNR) was used to help remove unwanted noise. BNR is a frequency domain based noise reduction system that utilizes Digital Signal Processing (DSP) techniques such as the Fourier Transform to analyze an input signal, create a noise map, and effectively mix the noise map with the original signal to cancel out the noise elements. This type of processor excels at removing broadband noise such as high frequency hiss. BNR was not used extensively in *And Drops of Rain Fall Like Tears* since it does not effectively reduce noise in recordings that have strong and frequently changing background noise properties. Since the majority of sound materials used in *And Drops of Rain Fall Like Tears* contain these properties, BNR proved to be an ineffective tool for de-noising as it produced additional unwanted artifacts after processing. However, BNR successfully removed unwanted background noise from droplet samples found throughout the piece that were recorded in a more controlled environment.

Amplitude domain noise reduction techniques were also utilized to help control noise levels of many recordings and included the use of compression, expansion, limiting, and noise gating. These processes involve tracking the amplitude of an incoming signal and applying a process to control or shape the amplitude of the output signal. These processors were used for noise reduction and usually employed in various combinations with each other as well as with the equalizers mentioned previously.

Compression reduces signal levels that exceed a selected threshold by a specific amount. Limiting occurs in a compressor when the compression ratio is set extremely high. The typical application of limiting controls short-term peaks in an audio stream that could cause amplitude clipping. When processing sounds for *And Drops of Rain Fall Like Tears*, an expander was occasionally added to the processing chain directly after the compression or limiting stage.

An expander increases the amplitude of louder signals while attenuating the level of softer signals. This increases the dynamic range of a signal, allowing amplitude peaks to break through a mix. Applying additional equalization after the compression and/or expansion stage frequently, as see in figure 6, helped shape the sound’s spectrum and remove excess noise.

Fig. 6. Combination of compressor, expander, and equalizers plug-ins used for noise reduction.

A noise gate was frequently employed as the final stage in noise reduction processing. Basically, a noise gate is an amplitude tracker that does not allow a signal to pass through until the amplitude of the signal is greater than a given threshold value. When a signal’s amplitude is less than the threshold, the gate then closes blocking the sound and effectively turning off the output of the signal. In addition to threshold, the user can also control the rate at which the gate opens and closes. Careful adjustments to these parameters helped to attenuate the remaining background noise in some of the sound samples of *And Drops of Rain Fall Like Tears*.

Lastly, the extensive use of the technique of masking noise during the compositional stage of mixing helps control noise perception. By effectively blending multiple sound sources containing similar frequency content, masking sonically hides the less desirable qualities by incorporating the noise into the piece in a non-intrusive fashion. Various combinations of mixing, equalizing and amplitude processing helped control noise encountered during the compositional process.

Sound Spatialization Techniques

Spatialization of sound sources is immensely important when creating immersive sonic environments. In nature, humans hear sound emanating from many directions. Overcoming the challenges associated with reproducing this sense of space in an indoor concert situation is paramount to the success of an environmentally based piece. It is widely understood and accepted that an immersive environment can be created for performance in a concert hall through the employment of multiple sets of loudspeakers. However, a piece must be composed in such a way that it creates such an environment regardless of the sound system provided for performance. In a stereo loudspeaker listening situation, the task of expanding the depth and spaciousness of a piece is carried out by strategically placing sound sources within the stereo field. In some cases, depth and realism can be enhanced via adjustments in tonal color, amplitude, and the addition of reverberation. Since all of the source materials for *And Drops of Rain Fall Like Tears* were recorded in stereo, only minimal positioning and panning adjustments were needed. However, more complicated adjustments, including the re-imaging of original sounds and correcting deficiencies after signal processing, utilized the software-based Waves stereo imaging plug-in S1 and my own VST plug-in, Shimmer.

The S1 imager, as seen in figure 7, has the power to not only adjust the placement of the sound within the stereo field, but it also has the power to refocus a pre-recorded stereo image.

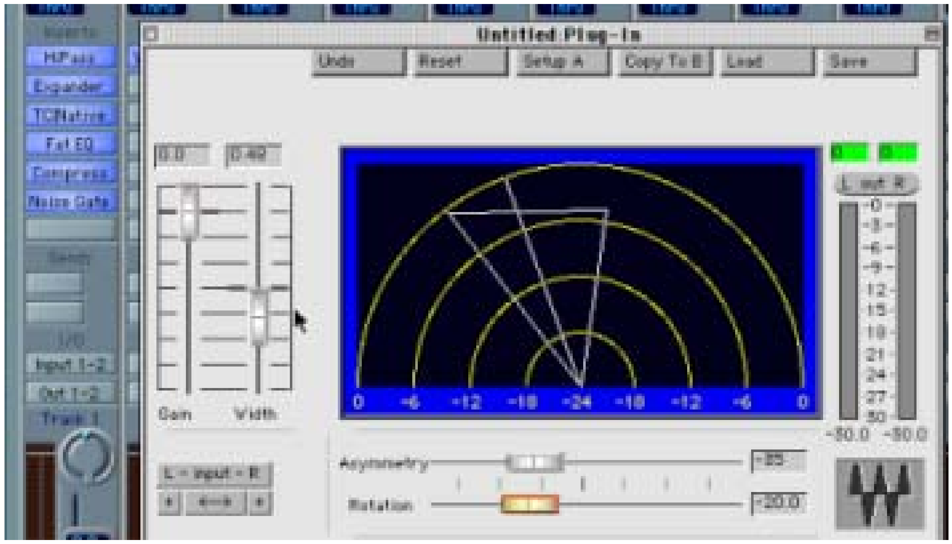

Fig. 7. Waves S1 Stereo Imager

Deficiencies in the original recordings or weakening of the stereo field by extreme processing techniques were corrected and/or adjusted when processed through the S1 Imager. The decision to employ S1 was based on my desire to utilize three main processes: increasing the width of an image, narrowing the width of an image, and repositioning the location of a sound source within the stereo field. Automating various parameters of the S1 plug-in created truly dynamic sound fields with the ability to expand, contract, pan left and pan right over time. With this power to refocus an image came the flexibility to take a wide stereo image recording, like rain hitting a tin roof, and narrow the width of the image while simultaneously repositioning the stereo location of the sound.

My own programmed VST plug-in, Shimmer, is also used to modify the stereo characteristics of a sound. Shimmer's development is inherited from the auto panner family of stereo processors popular in commercial music production studios. However, Shimmer's signal processing design differs significantly from other panners. One distinction between Shimmer and its commercial counterparts is its function as a random auto panner. This means that the stereo placement of a sound at any given time interval is determined randomly, distinguishing it from other auto-panners that generally utilize a low frequency oscillator (LFO) to pan sounds cyclically. The calculated rate of change occurs from one random position to another in samples via interpolation and moves from one value to another as smoothly as possible, eliminating discontinuities in the signal output.

Fig. 8. Shimmer plug-ins

Shimmer comes in two versions, one version using a purely random value for stereo positioning and another, called Shimmer2, whose stereo position values are randomly centered around the true center, or mean, of a stereo mix. Figure 8 displays the parameters of both Shimmer plug-ins. Another difference between Shimmer and Shimmer2 is that Shimmer has an adjustable width parameter allowing control over the output width of the stereo Shimmering effect. Both plug-ins have additional gain control as well as the ability to mix the original signal with the processed signal. One striking feature shared by both Shimmer plug-ins is the addition of a high pass filter before the panning stage. Figure 9 traces the signal path through the plug-in.

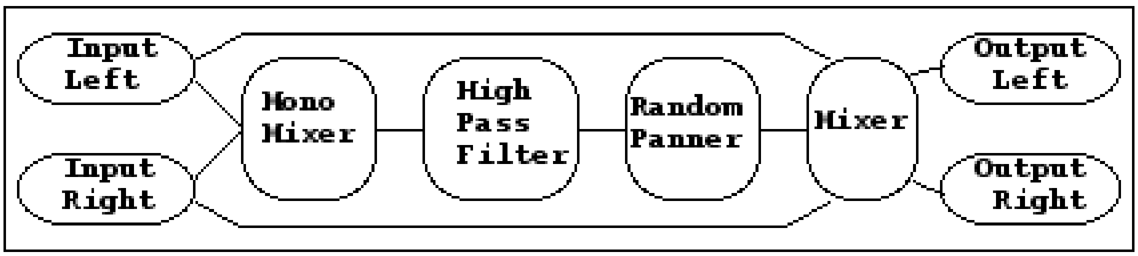

Fig. 9. Shimmer signal flow.

An input signal passes through the first stage of the plug-in creating a mono signal from both channels of the stereo input. Next, a high-pass filter processes the mono signal. The reason for the use of the high pass filter is two fold. Firstly, it enables the sound to shimmer more perceptibly across the stereo field when filtered and then remixed with the original sound. Secondly, the high-pass filter helps to achieve the shimmering effect at reasonably small sample intervals without producing amplitude modulation artifacts that can occur from the lower range of frequencies. After filtering the mixed mono signal, a random pan location is calculated. If Shimmer is the selected plug-in, the width of the output stereo field is modified to coincide with the width parameter, in which zero exhibits no stereo spread and a value of one allows the full range of the stereo field. If Shimmer2 is selected, the signal-flow proceeds directly to the panning algorithm stage of processing. At this stage of the processing chain, the plug-in interpolates between the previous stereo location and the newly calculated stereo location, moving the sound to the new position over the time interval designated by the samples parameter. After generating a pan location, the panning high pass signal and the original unprocessed signal are combined before exiting the plug-in and returning the signal back to the channel strip.

CHAPTER 3

VIDEO

Traditionally in video and film, audio has played the supporting role of enhancing the visual element of a work (audio->video). In *And Drops of Rain Fall Like Tears*, the roles of the audio and video components are reversed and the primary role of the visual element is to support and enhance the audio experience (video->audio). As explained earlier, the video is design to function as an optional element in performance. While there is no low-level interaction between the video and audio, the relative synchronization of both elements is implied and functions as a visual backdrop when the video element is used during performance. Therefore, the synchronization of both elements is determined through the pacing of each audio section with a corresponding visual sequence adding to and further promoting the sensations of an immersive sonic environment.

All visual elements in *And Drops of Rain Fall Like Tears* were developed using the cross platform modeling and animation software package Blender[17] running under SuSE Linux[18] 7.1 for PowerPC on Macintosh computers. All of the visuals were created with three-dimensional modeling and animation techniques. Physical properties resembling moving

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[17] Not a Number. <http://www.blender.nl> [Accessed 7 Dec. 2001].

[18] SuSe Linux. <http://www.suse.com> [Accessed 7 Dec. 2001].

water, rain, refraction, rippling, and lightning were key in complementing and visualizing the audio component. The reason for using three-dimensional animation instead of captured video lies in the purposeful modification and abstraction of real life environmental phenomena is to simulate physical properties of the objects portrayed in each sequence. An example taken from the video sequence presents an extreme close-up shot containing a water droplet falling while refracting an unseen environment abstracted against a pure black backdrop.

Made up of five animation sequences, the video contains images of rolling clouds, rippled water, falling rain, an underwater view, and a water droplet. Each video scene incorporates different combinations of modeling and animation techniques and procedures. In order to explain the development of the scenes, it is important to understand the basic modeling and animation techniques used, which include metaball[19] modeling, mesh[20] modeling, lattice[21] deformation, particle[22] systems, and wave effects.

Metaballs are spherical or tubular mathematical formulae that perform logical operations on one another through addition and subtraction and are also referred to as

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[19] Michael O'Rourke, Principles of Three-Dimensional Computer Animation: Modeling, Rendering, and Animation with 3D Computer Graphics. (New York: W. W. Norton & Company, Inc., 1995) 191.
[20] ibid., 17.
[21] ibid., 163.
[22] ibid., 195.

Constructive Solid Geometry[23] (CSG) objects. They produce amorphous objects that can merge and separate in ways similar to water and other liquid like substances. In contrast to the amorphous metaball, a mesh is a triangle or quad data type that forms an object represented by vertices, faces, and normals. Lattice deformation employs a three-dimensional grid containing moveable vertices that can deform a child mesh, surface, or particle object contained within its grid.

In Blender, effects are processes applied only to meshes. Blender provides three types of effects: build, particle, and wave. *And Drops of Rain Fall Like Tears* utilizes only two of the three effects, the wave effect and the particle system. The wave effect adds an animated wave to a mesh while a particle system is created from a vertex or series of vertices that can emit, either sequentially or randomly, a two-dimensional or three-dimensional mesh-based object. In addition, the individual particles can be subjected to force, emulating physical effects like gravity or wind.

The cloud animation segments were created by combining three of the techniques describe above. The first element in creating a cloud was the creation of a mesh surface to act as an emitter for the particle system. After the creation of the emitter and the addition of the particle effect to the mesh, each particle generated by the particle system was

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[23] ibid., 56.

assigned a global material, also referred to as a texture. The material was created using a Blender preset material generator called Cloud. Cloud generates random two dimensional fractal noise patterns that visually resemble cloud patterns. Once attached to each particle generated by the emitter, the material underwent fine adjustments allowing for shape, color, and transparency modifications to create a halo like appearance. The particle system was also configured to randomly emit the particles along the x, y, or z-axis where applicable for each scene.

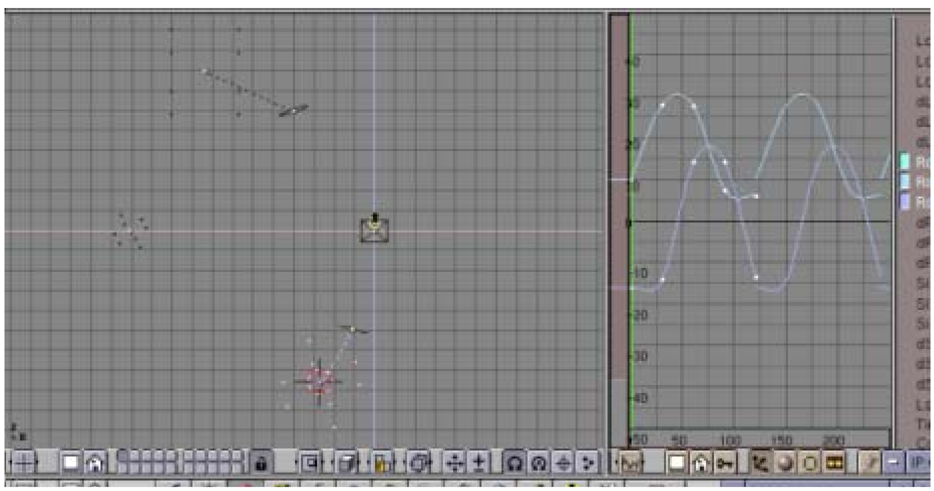

Fig. 10. Clouds with animation control.

Additional cloud animations emitted cubes, seen in figure 10, that were texture-mapped with the same cloud-based halo material from above. Rotation of these cubes around the x, y, and z-axis created a tumbling effect. Figure 9 shows the cubes attached to the emitters on the left side and the animation of the cube on the right.

Some cloud sequences also used lattice deformation on the cubes to deform them along a path adding control to the tumbling and churning cloud-like effect. In figure 11, the wire-frame shape of a lattice deformation object is behind the cloud render window. As the piece opens, the electroacoustic soundscape fades in as the storm is heard off in the distance. Visually, the clouds rolling in signify the beginnings of a storm.

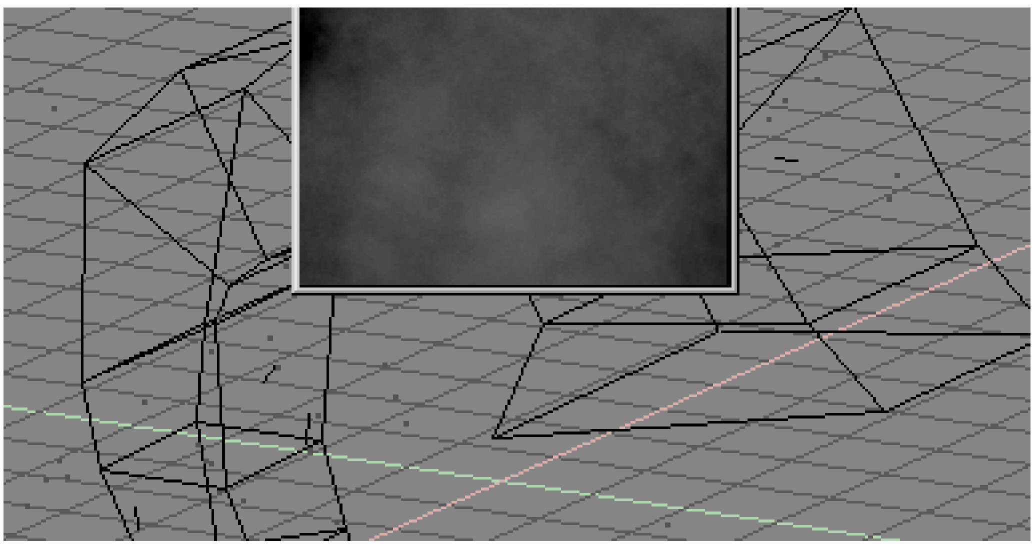

Fig. 11. Cloud with lattice deformation.

The rippled water sequences, as seen in figure 12, coincide with the musical sections found approximately five minutes into the piece where raindrops become apparent as separate events from the wash of sound in the background sound event. As the drops begin to stand out from the sonic wash of background rain, the video component fades in with animations of droplets. This complementary visualization of the droplets falling onto a liquid surface enhances this audible event. The rippling water scene utilizes the wave effect in Blender that contains randomly applied waves simulating raindrop ripples on the surface. The mesh-based surface refracts (also referred to as environmental mapping) the scenes environment.

Fig. 12. Rippled water with light energy animation.

The rippled water scene contains additional light sources as well as a plane with a texture-mapped surface of a skyline at night. Throughout the sequence, the actual raindrops have been removed with visual focus directed at the ripples, bringing them into the forefront of the scene. Animating the energy emitted by a light source produced the lightning flashes refracted off the surface of the water seen as the sequence progresses.

In order to create the feeling of viewing the storm from under a puddle of moving water, I modified the rippling water scene by adding more wave effects along with more lighting and animation of the light sources. Moving the light sources creates bursts of color that show through to the surface. Moving the lights across the surface of the mesh and animating the energy and color emitted by these lights adds to the appearance of the sequence. Removing the environmental mapping from this scene created a transparent background from which the sparkles of light were able to shine through, as seen in figure 13.

Fig. 13. A frame from the underwater sequence.

The first falling rain sequence appears at approximately five minutes and thirty seconds into the piece, where the electroacoustic music consists of sounds of rain striking surfaces. Again, the idea was to enhance the audible environment with related visual stimuli. Throughout the piece, there are two visual sequences of falling rain. Both of the falling rain scenes stem from a single Blender scene file shot from different camera angles.

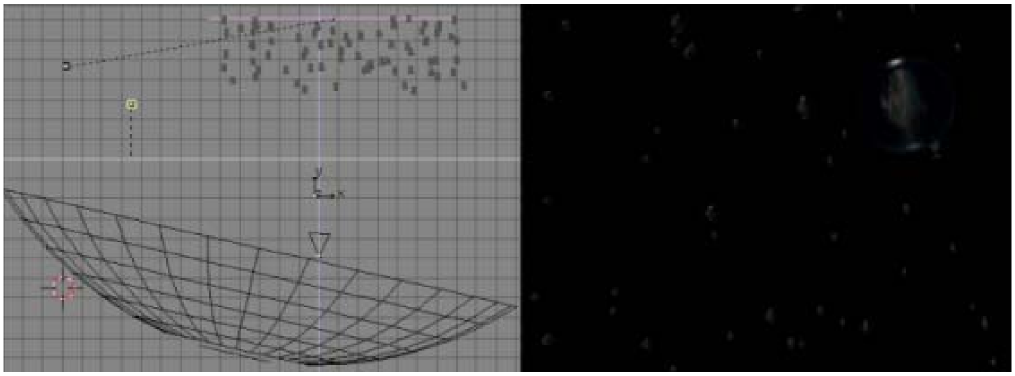

Fig. 14. Falling rain.

These different camera angles included a shot positioned to the right-hand side of the scene and a shot positioned from below looking into the falling rain, as shown in Figure 14. The basic scene consisted of a sphere deformed by a lattice to simulate the force of gravity on a falling amorphous object. By parenting this object to the mesh object, the particle system was able to emit the raindrop object from the mesh’s vertices. Based on the same environmental mapping of the water surface from the rippled water scene, each individual raindrop also refracted the surrounding, but unseen, environment.

I refer to the final sequence of the animation of *And Drops of Rain Fall Like Tears* as the droplet scene. At approximately sixteen minutes into the piece the sonic scenery changes. Raindrops hitting a tin roof fill the sonic environment. The product of the single droplet relating to rain falling leads to the accumulation of a small reservoir of water that, when placed under gravity, eventually gives way and falls as an accumulated droplet.

This scene used metaball modeling to animate water coagulating together before being overcome by gravity and falling to the earth. As stated previously, metaballs have the ability to create smooth, flowing three-dimensional objects that can seem to pull apart or absorb into one another when confronted with simulated gravitational forces or when moving in close proximity to one another.

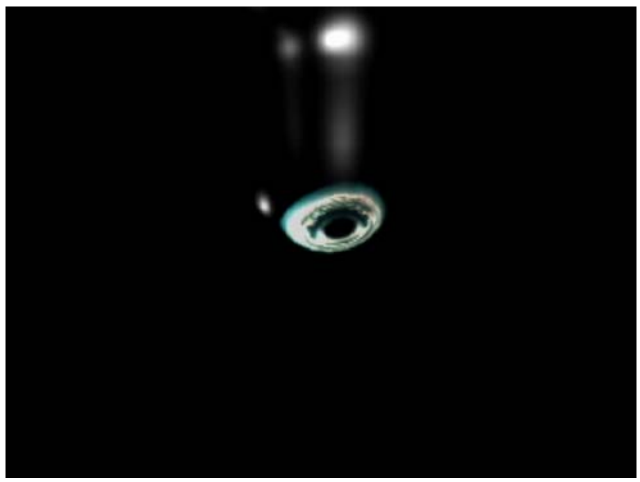

Fig. 15. Droplet created with metaballs.

Environmentally, the metaballs were created to refract their environment like the water surfaces and raindrops from previous sequences. Figure 15 illustrates a droplet falling and refracting its environment.

CHAPTER 4

PERFORMANCE

One of the most crucial elements of any electro-acoustic piece is its presentation in a concert setting. Simulating an immersive sound environment is essential to the successful presentation of this work. In tradition with Musique Concrète, the performance aspect of this work is considered an extension of the compositional process. Although *And Drops of Rain Fall Like Tears* is a two channel composition, the optimal live performance configuration is a multi-speaker environment. A minimum of eight speakers is suggested for medium to large performance spaces; however, the use of more than eight speakers is preferred. The optimal placement of the speakers for *And Drops of Rain Fall Like Tears* is an expanded stereo format, illustrated in Figure 16.

The expanded stereo format consists of stereo pairs arranged in a performance space to enhance the spatialization already composed into the piece and simulate distance, focus, width, motion, and surround. A pair of speakers placed at center stage are referred to as mains and should be placed as far apart as possible while maintaining a strong and stable stereo image.

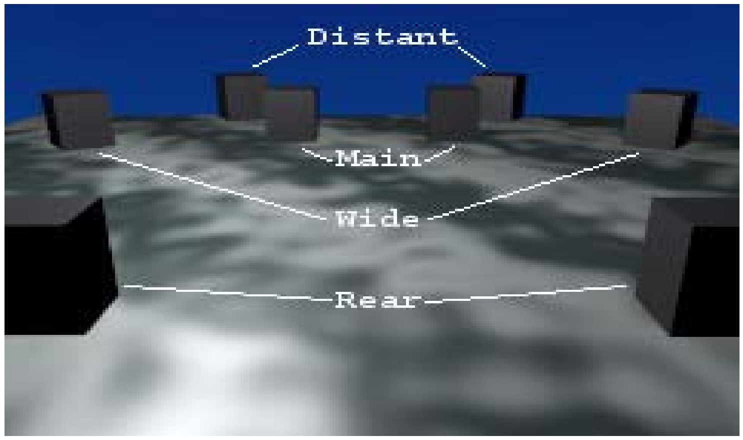

Fig. 16. Basic expanded stereo speaker setup using eight loudspeakers.

The pair of speakers placed wide out to the sides of the audience is used to enhance all stereo lateral movement composed into the piece. The mains and wides should be placed in a arch and balanced to carry most of the piece’s focus. Distance is simulated by placing a pair of matched speakers upstage behind the main stereo pair. This pair of distant speakers should be placed at a width greater than the main pair of speakers, and focused facing inward toward center stage. A pair of speakers placed to the rear of the performance space is used to enhance the surround effect. If more than eight speakers are used, primary sound reinforcement should be directed to the left and right sides of the space to be used as side fill. In addition to side fill, extra speaker groupings should be utilized to further enhance height and depth within the space.

The video is mastered to MiniDV, VHS and S-VHS formats. An S-VHS version with audio is also available. CD audio playback is recommended for optimal audio fidelity.

If the video is used in performance, it must be projected on a large screen placed upstage without blocking any loudspeakers. Technically, the video need not be centered to further obscure the ambiguous role of the video. Projection of the video in multiple locations around the audience is encouraged if resourses exsist to do so. However, special consideration must be taken to both avoid obscuring the sound field and also disallow the video's visual presence to overpower that of the audio.

Ultimately, a successful performance is directly related to a careful balance of the sound within the performance environment as well as tasteful use of the video component. Sound projection or diffusion is the desired performance realization for the piece, keeping in mind that the electroacoustic music must always be diffuse and appear to surround the audience. Sounds should never be directed at individual speakers nor serialized into patterned movements but rather positioned in a way so that the space is perceived as a large environment.

And Drops of Rain Fall Like Tears combines visual and audible elements in non-traditional roles emphasizing the power of the audio to create an immersive environment. This piece can be performed with or without the video element using many loudspeaker configurations. Through the combination of soundscape and acousmatic compositional practices, I hope that each listener is transported to another time and place while experiencing some of the same feelings and emotions that I experienced that night during the storm.

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