



Digital Reverberation--Beyond the Technology

Application Note AN-9

by Christopher Moore

Introduction

While much has been published about reverberation and its digital implementation, to my knowledge there has been little written about its underlying *raison d'être*, about the aesthetic of reverberation.

During a memorable late night conversation at an Audio Engineering Society Convention in 1980, Stephen Hill and I exchanged ideas and explored new insights into reverberation. Years later, I have fleshed out these ideas for you in this short note.

Reverberation is universal

The word reverberation has its roots in Latin, meaning to beat back again. It encompasses the echoes, the spatial unfolding, the early temporal detail, and the later decaying tail where all detail is lost. Reverberation, whether occurring naturally or created digitally, is everywhere in our daily lives, so that most of us, most of the time, take it for granted. Yet if we were to enter an anechoic chamber, we would be shocked by the starkness of sounds heard only in the gestalt instant of time, devoid of echoes or reverberation. Similarly, standing outside in an open field, we hear a nearby friend's voice as thin, pure, dry. We are so used to hearing reverberation that we require it in virtually all of our recordings. Reverberation is a universally used tool in all areas of audio.

The artist and recording engineer can use music as a probe, like a sonar pulse, that allows us to interpret space. The music is like an explorer who ventures to places beyond our reach and returns with an impression of larger, grander spaces. First, our binaural hearing pinpoints the location of the direct-arriving source, then it maps the room boundaries by the early reflections, and finally estimates the size of the space by the reverberation tail.

Music, reverberation, and the time dimension

Music and reverberation have been intimate partners for hundreds, perhaps thousands of years. The tempo and flow of Gregorian chant were shaped by the long decay time of the large stone spaces of early abbeys and cathedrals; chamber music was adapted to the shorter decay times of smaller spaces in courts and palaces; while romantic classical music led to the design of concert halls with more absorptive surfaces and medium decay times.

Unlike painting or sculpture (which can be taken in at a glance, then explored in detail with random access), music flows by us in time and requires our participation over time. Music unfolds

along the "horizontal" dimension of time metered by rhythm and tempo, varying in melody and harmony along the "vertical" axis of pitch, and enveloping us along the way in the three dimensions of reverberating acoustic space.

As living, mortal creatures, we can neither stop time, speed it up, nor slow it down; we are chained to it. But for a time, while listening to music, the combined creativity of composer, artist, and recording engineer can seduce us into the musical experience and lift us out of our own time line. Reverberation can play a powerful role in this seduction, for with it we not only have the present instant, the little gestalt moment of direct sound, but the sweeping extension of past sounds, each dying away while new sounds constantly arrive. Reverberation modifies our window onto time; instead of a narrow slice of time, reverberation offers us an extended, widened perception of sound.

"Spectral Plasma"

Reverberation further enhances music by creating a kind of a "spectral plasma." Melodic sequences turn into complex "Space Chords" (Stephen Hill), while chordal sequences merge into a vaguely tonal decaying noise. Eventually, notes and chords all enter the reverb tail, where they are melded into an incoherent spectral stew.

Reverberation also works its effects on temporal detail. The attack of individual notes and percussive sounds vanish into the fading reverb tail. The crack of a hand clap turns into the "whoosh" of the noise-like reverb tail. Reverberation serves as a glue, an interstitial bonding force, joining each prior note to the present notes, smoothing out transients and staccato notes, softening and rendering palpable the passage of time.

Music and the psyche

We live in confining houses or apartments, work in even smaller cubicles, and move about in crowded, noisy urban landscapes of concrete and glass. The demands of work, family, and the world often seem to press in upon us, filling us with a longing to get away from it all. A richly reverberant recording frees us emotionally and projects us into the space and time continuum represented in the recording. Large spaces carry us out of ourselves, expand our boundaries without drugs, and enlarge our psychic space.

Perhaps we find music in large spaces expanding because it puts us in touch with our own smallness, the humbleness of our little place in the universe. Or perhaps the experience is profound because we feel expansive in the large space projected by the

recording. Just as the reverb tail blends notes and destroys detail, so too does time diffuse memories of the days and years of our lives.

Digital reverberation

Decay times in architecture extend to perhaps six seconds in rare cases, but with digital reverberators they can reach 100 seconds or even infinity. Long decay times are only useful in certain kinds of music, "Space Music" in particular, music with reduced tempo, open spaces between notes, and percussive sounds allowed to ring out into silence. Digital reverberation can also produce decay tails where the decay time alters itself, creating effects beyond anything in architecture or natural outdoor spaces such as canyons, cliffs, lakes, or valleys.

However, unlike the experience of "real" reverberation, which envelops us with arrivals from all directions, reverberation embedded in recordings comes only from the two speakers, seriously limiting its spatial impact. In the years to come, surround sound systems may help overcome this limitation. Digital reverberators are now so widely available and inexpensive that many of them can be used, simultaneously or sequentially, to place, as Suzanne Ciani once said, each instrument into its own "little reverberation suit."

Parallels in vision

It would be interesting to search for analogies to reverberation in vision. Maybe the use of perspective and mirrors in paintings or of fades, montage, and cross fades in cinema have something in common with reverberation. In the human sensory realm, persistence of vision and *deja vu* may be cousins of reverberation.

My professional involvement with digital reverberation

Starting in about 1976, I began to design digital reverberators. From 1978 to 1986, the company I founded, URSA MAJOR, designed and marketed digital reverberators--the Space Station, 8X32, StarGate, and ADR-68K. During those years, I lived and breathed digital reverberation and enjoyed the rapport of some of its pioneers--Barry Blesser, David Griesinger, Tony Agnello, Julius Smith, and Wolfgang Schwarz. Later, working in the mid-1990's with Bob Chidlaw of Kurzweil, I contributed four reverberation programs to the Kurzweil KDFX effects option for the K-2500 synthesizer.

Acknowledgement

I'm particularly grateful to Stephen Hill, founder of Hearts of Space, for stimulating conversations and pioneering work in reverberation--and for giving me the name "Space Station" for my first digital reverberator. Stephen's long championing of "Space Music" has had a major impact on the world of recorded music. Many people have found pleasure and escape listening to his radio program or to CDs from his label. Explore Space Music at the Hearts of Space web site, <http://www.hos.com>.

Bibliography

Hill, Stephen, "Toward Spatial Synthesis," personal communication, May 1981.

"Flamenco Mystico," by Gino D'Auri, Hearts of Space CD.

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