Soundscape

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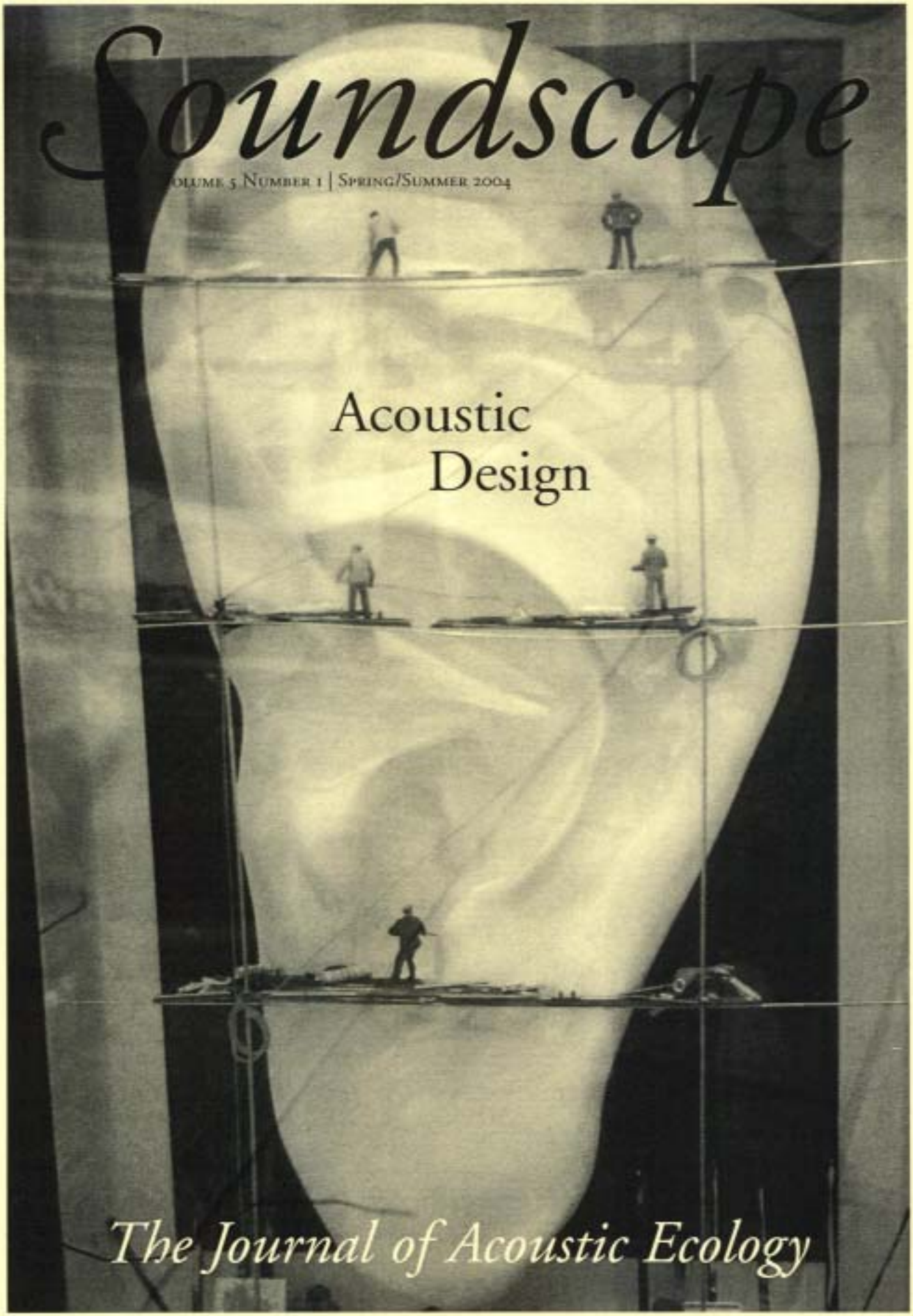

Acoustic Design

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Active Acoustics: Defining One's Private Acoustic Environment

By Steve Haas

Imagine if you could not only escape from your everyday acoustical environment but also be instantaneously transported to any conceivable acoustic space—all without leaving an ordinary home environment. New technology now is able to offer private residences this escape into a new acoustical world with a process known as "active acoustic enhancement."

For centuries, opera singers, musicians and even entire orchestras performed in royal palaces and the parlors of the aristocracy. The support of new musical works from these same sources were also filling fine, dedicated concert halls with great acoustical success, even though "acoustical science", as we know it today, was largely undefined. Practically speaking, this was largely due to such spaces being architecturally treated as large volumes with hard, ornate surfaces and narrow widths–resulting in an acoustically live, diffuse sound environment, suitable to the music of the age.

Fast forward to the late 20th century/early 21st century. Today, it is rare that private home environments are built with such acoustically-conscious consideration, let alone any live music played in the home. We have almost entirely given away our traditions of sharing "live" performances to newer forms of electronically-based entertainment—movies, TV, video games, etc. Yet even listening to the best *recording* of a chamber orchestra on a fantastic system cannot re-capture the intimacy, depth and freshness of a real living ensemble playing before you—not to mention the interaction of audience and performers. This was part of the inspiration for the development of a new type of technology to return a more balanced perception of musical and/or theatrical performance to private home environments within an acoustically-pleasing architecture.

Active Acoustic Enhancement (AAE) is not something new; as early as the 1930s, acousticians have been developing and applying technologies to enhance deficient acoustic environments via electronic means. RCA was one of the earliest experimenters—attempting to energize the reverberant stairwells adjacent to the Philadelphia Academy of Music's main concert space in order to increase the perceived level of reverberation within the hall. Since that time, AAE has gone far beyond the experimentation phase and has been successfully integrated into concert spaces, cathedrals and multi-purpose halls for decades. The advent of digital signal processing, better computing power and highly-transparent loudspeakers have made the variety of AAE platforms and approaches much more palatable to the ear.

The concept of AAE is fairly straightforward: the electronic recreation of specific sound reflection patterns that would normally occur in a performance or presentation space. This might mean adding or enhancing certain aspects of a hall—such as on-stage hearing or low-frequency reverberation in the audience chamber—or it could be a total redefinition of the acoustic environment through the space. While there are differences in the various AAE technologies, most follow a basic method: Microphones situated above the performance area and, in some cases, throughout the audience areas as well sample the physical acoustical environment. Cardioid microphones are used near the

Photography by Steve Haas

Sarah Koo and Heidi Torvik perform for guests in an acoustically-enhanced listening room. As the active acoustic enhancement system is embedded in the architecture of the setting, to preserve the aesthetic integrity the architect had intended, there is no "hardware" to view. The point is "the return of the concept of 'house concert' to people's homes again."

performers to "listen" more to the source while omni directional microphones pick up the ambience (or lack of) that is present in the audience area. These signals (typically 2-8 in number, but could be as many as 32 in a very large space or outdoor environment) are sent to a proprietary digital signal processing system which then adds to each signal a certain amount of early reflected sound energy and reverberation. The early reflections provide the presence and clarity to music and speech while the (frequency-variable) reverberation defines the liveness, envelopment and "warmth" in the room. These processed signals are then sent in specific amounts and ratios to a complex network of loudspeakers and other types of transducers installed in all walls and the ceiling of the room. The quantity of loudspeakers could be anywhere from 12-14 in a small residential space to hundreds in a large concert hall or cathedral.

It should be stated that this is *not* a PA system closely micing a performer and then patching in a reverb unit to simulate an environment. Rather, AAE still allows the direct sound—whether it is a cellist, vocalist, or even someone coughing in the audience—to emanate into the space naturally and unaltered. The AAE system then "takes over," just as a real room would, to enhance the intimacy, intelligibility and fullness of the sound.

Having spent 14 years as an acoustical consultant with Jaffe Acoustics—one of the pioneering firms developing and applying AAE systems—I was exposed first hand to the design and integration of enhancement systems for many venues, including the main performance halls for the Nashville, Milwaukee, Indianapolis and San Diego symphonies. The earliest analog systems integrated in the late 70s/early 80s often received mixed

reviews, since the delay and reverberation algorithms simply couldn't maintain the processing speed necessary to deliver undistorted, uncolored sound to the audience as well as back to the musicians. Since then, though, the newest DSP-based technologies have come a long way to deliver very natural, transparent acoustic fields.

For the past 10 years I have also operated an independent consulting practice designing acoustic spaces for high-end residences (home theaters, ballrooms, music listening rooms, etc.). I was pleasantly surprised to find out how many of my clients were actually amateur musicians playing in their homes. Some even hired musicians for parties and other special events to perform. A little research revealed that "house concerts" have become popular again—especially as people are investing more into having their homes be virtual sanctuaries that meet all of their needs for entertainment and leisure.

Many home theaters also are being architecturally designed by the likes of Theo Kalomirakis and others to look like miniature performance halls—containing stages, prosceniums, fixed audience seating and even balconies in some of the larger theaters! People are naturally trying to use these grandiose spaces for a variety of activities, including live performances. I have watched as several clients played their instruments or their children nervously got on the stages of their home theaters and gave their first recitals. One homeowner even built a dedicated organ room 30 feet high by 60 feet long in his home and commissioned a quarter-million dollar organ for the space.

After witnessing all of this, I began to query some homeowners hosting house concerts and especially the musicians who play in these homes on a regular basis. One of the biggest complaints has been the uninspiring acoustic environments in which the musicians are forced to play. Visiting musicians usually end up getting cramped into a corner and sometimes have to try and contend with the noise of several hundred guests (in large mansions), that of other activities in the home (e.g. cooks and caterers preparing and serving food) and even outside sirens and other vehicular sounds when they play in urban penthouses.

This investigation led me to find a way to marry my two worlds (performing arts and luxury homes) to turn these ornate residential architectural spaces into acoustical jewels for just about any type of performance. Of course, there are those who have created moderately successful home recital halls the natural way. But, even for the rich and famous, having a 40-50 foot high room and a large footprint just to give the sheer volume necessary for balanced recital acoustics is almost never a desirable solution. In addition, there is a practical limit to the adjustability that the acoustics of these types of physical spaces can have for different genres and music types.

Enter active acoustics as a solution. AAE has been done in limited forms with reasonable success in prefabricated music practice rooms and studio rehearsal booths by Wenger Corp. and others. We wanted, though, to go beyond the prefabricated environment and promote the use of AAE in smaller, more intimate environments on a highly customized level. Utilizing a technology platform that allowed for complete flexibility in the assignment of each input signal to one or more output devices, we sought to design and integrate AAE experiences into luxury homes and other high-end small commercial spaces. We began working with a technology platform that had been created primarily for larger commercial spaces where certain I/O configurations, networking functions and algorithms were optimized for major concert venues, Broadway theaters and houses of worship. To be effective in the smaller residential settings, we needed to work with the technology to scale down and adapt its hardware and software architecture so it would apply more (and be more affordable) to the home clients.

The first attempts at implementing the optimized AAE system were even better than we expected. Unlike most commercial applications, where the systems have been used to augment existing natural acoustics, the spaces that we first tried basically were dry, lifeless rooms. Therefore, the entire acoustic impression was created electronically. We spent many hours listening with a variety of sources and using our background in concert hall natural[1] acoustic design to simulate the multitude of parameters—subjective and objective—that go into the design of most excellent halls. Once again, with the flexibility of the system we have been using, we have been able to correlate the relationship of software settings for initial time delay gap (ITDG), early decay time (EDT20 and EDT 30) and clarity (C80) as well as a number of minor parameters to the perceived listening experience.

The real test, of course, came with the evaluation from our first musicians and audience members. We set up a temporary system in a New York City-based home theater showroom and proceeded to bring in a variety of performers—mostly classical and jazz musicians from Juilliard. We figured that these young musicians have already had quite a bit of experience performing and rehearsing in good and bad acoustic spaces, and would really be able to give us some great feedback on the playing experience in the AAE environments.

Keeping with the objective to customize a number of presets, we spent hours working on optimizing a number of different hall sizes, apparent proportions (e.g., narrow width/tall ceilings vs. wide width/short low ceilings) and even the amount of acoustic feedback to the musicians from the rear of the "hall". We also experimented with the creation of environments that accentuated certain tonal characteristics of particular instruments—something that would never be done on purpose for economic and artistic reasons in a commercial venue, but could easily be done in the electronic domain and saved as a preset.

We and the musicians have been very pleased with the results. The subjective impressions from the musicians have all supported how well AAE helps them hear themselves and other performers, and the "return" from the simulated halls has strengthened their playing ability. One performer actually utilized one of the AAE environments to prepare for a solo recital at a major hall in New York City and remarked on how confident she felt after doing so. Soloists and small ensembles ranging from chamber groups to jazz combos to Top 40 guitarists to a bluegrass quartet have now spent hours playing for audiences and rehearsing in our new AAE enhanced demonstration facility. Utilizing not only the enhancement technology, but also new types of flat panel radiators in lieu of traditional loudspeakers, we have been able to create very non-localizing and enveloping results that are now being designed for about a half-dozen luxury residences around the United States.

Of course, for a residential space to be transformed with active acoustic enhancement into Carnegie Hall or Birdland or Notre Dame Cathedral, one must create an infrastructure that completely nullifies any outside or inside acoustic interference. Such spaces must be absolutely silent at all times, otherwise the whole suspension of disbelief goes out the window. Imagine listening to an oboist play a quiet passage in the recreated environment of Boston Symphony Hall, and all of a sudden you hear pots and pans dropping from the adjacent kitchen, the heating system turning on and a fire truck roaring by outside. Hardly, the intimate escape to the concert hall! Before even beginning to

Photography by Steve Haas

One of Denver's hottest jazz trios enthralls the audience in a high-end home theater outfitted with active acoustic enhancement.

integrate the enhancement system, all walls, floors, ceilings, doors and windows are acoustically upgraded to the most practical level of isolation possible, while noises and vibrations from home climate systems, plumbing and lighting systems are eliminated.

Now, for the physical environment in the listening room: this also must be "tamed." Active acoustic systems can not "deaden" an overly reverberant room (a large Great Room, Foyer, etc.). For example, one can not hope in a Ballroom to simulate a jazz venue that is intimate and present when the natural[1] room itself might have a mid-frequency reverberation time of 3.0-4.0 seconds! Therefore, passive sound absorbing treatments must first be introduced as a way of neutralizing the effects of the physical space. This also comes into play with the multi-purpose function of many large home spaces. One anonymous homeowner, who is in the process of integrating active acoustic systems into two rooms in his new home, describes the following:

> We have a very large Ballroom that my wife and I wanted to be able to entertain in on a regular basis for up to 300 guests. Yet we also wanted to simply enjoy the space on a regular basis for leisure activities and also live music performances. Our acoustician's analysis of the space told us that our proposed interior finishes would give us a liveness of almost six seconds, which we knew would be unbearable once our many guests were all in there conversing. Discovering active acoustic enhancement was a blessing, because it will give us the ability to first lower the liveness of our Ballroom with some high-end acoustic finishes so that we can all talk comfortably at any time. Then, when we want to bring out the Steinway or have a chamber group in there, we'll just press a button and, voilá, we have our liveness back.

The integration of active acoustic enhancement is not an inexpensive proposition due to the raw costs of the technology, the amount of supporting equipment and the design and tuning time required by qualified acousticians. It is, though, for a number of homeowners and even commercial venues (where no one wants to deal with unsightly microphones or playback equipment), the ultimate way to escape the reality of their numb aural surroundings and embark on a voyage into new and exciting listening experiences.

Steve Haas is the founder and president of SH! Acoustics —an internationally recognized acoustical and audio consulting firm. He is also the creator of Concertino™, an active acoustic enhancement system being integrated into luxury homes, yachts, hotels and recording studios. For more information, visit http://www.shacoustics.com.

[1] 'Natural' is referring to the acoustical state of the space or room and not to any 'organic' sense of the word. In the world of acoustical jargon, this word is befitting.