Volume 26 • THE COMPUTER MUSIC AND DIGITAL AUDIO SERIES

THE ART AND TECHNIQUE OF ELECTROACOUSTIC MUSIC

Peter Elsea

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A-R Editions, Inc.
Middleton, Wisconsin

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Find a Quiet Spot . . .

Sound quality is the top priority for an electroacoustic studio. The acoustical requirements are not as stringent as those for a recording studio, but they cover the same ground. There should be no intrusive noise, sounds made in the studio should not bother others, and the ambience of the space should be natural and comfortable. These features require solid construction of the room, well-fitted doors and windows, some consideration of the shape of the room, and thoughtful treatment of surfaces.

Few composers have the luxury of working in acoustically designed spaces. Some may have access to such places at a school or commercial studio, but most of us work in a house or an apartment. Luckily, a spare bedroom usually provides all we need. In warmer climates a garage might be a workable location, but most are so flimsy you are essentially outdoors, subject to traffic noise and close to the neighbors. Basements often offer excellent isolation, but low ceilings produce an odd ambience and any dampness will play hob with the electronics. When considering any space, pay attention to sound coming from the adjoining rooms. The main noisemakers in a house are refrigerators, laundry facilities, air conditioners, and plumbing, all of which produce low-frequency sounds that easily pass through walls. No surface treatment will have a significant effect on this problem. You must also consider human activities. Sound intrusions from TVs, stereos, and games may be controlled by negotiation, but it's less tiresome to avoid the possibility altogether. Of course, the studio must possess the amenities any room needs: adequate ventilation, decent light, and a comfortable temperature.

The room need not be particularly large as long as there is space for the planned equipment. I've worked for years in a room about 8 feet by 10 feet, which I consider a practical minimum. This is big enough for a basic setup, but I can't bring anyone else in to hear work in progress. You will need a bigger space if you play an acoustic instrument or if others are going to join you. The equipment layout will be about the same in any size room, but the ideal situation allows for placement in the middle of the room with comfortable access to the back of the gear.

The precise shape of the room isn't likely to be much of a problem. Most houses are designed with some attention to the proportions of rooms. Rooms should not be round or perfectly square, but you seldom encounter these. The main exception is old houses where large rooms have been divided. There you might find some peculiar spaces, generally long and narrow. You can test for shape problems by clapping your hands in the empty room. A badly proportioned room will respond with a definite pitch, or perhaps a flutter echo, which is a series of rapid pulses of sound. Mild cases of these symptoms are treatable, but if the effect is severe, choose another room.

AUDIO EQUIPMENT

The heart of any studio is a high-quality sound system. This typically consists of mixing console, amplifier, and speakers and can be augmented by synthesis and processing gear. The size and complexity of these are related to the types of music and processes you are interested in. Most electroacoustic studios are modest in size compared to commercial recording facilities, but sonic quality is another story. There is no reason a composition studio cannot match or even exceed the best professional operation in quality. All the composer needs is some understanding of audio specifications and the skill to hear flaws when evaluating products.

Signal Quality

The electrical representation of sound is called the signal. Electroacoustic music is produced by modifying signals. We amplify a signal with the understanding that this will make the sound louder, we equalize a signal knowing that the result will affect the tonal balance, and so on. The concept of signal quality comes down to the sound that will result. Are there any changes that we did not intend? This can be tested by recording the signal with no deliberate changes. A perfect system would reproduce a sound identical to what went into the microphone in the first place, but that is impossible. Microphones do not do a perfect job of converting sound pressure to electricity, and speakers are even worse in converting it back. Even so, the human hearing mechanism is quite forgiving, and listeners are often pleased with the results, denying any difference between the original and the reproduction. This was true even in the early days of recording, when sound was reproduced by a cactus needle following the groove of sound waves scratched in shellac. What we are actually considering when we talk about signal quality are changes that will not be acceptable to listeners. The most prominent offenders affect frequency response, distortion level, and noise.

Frequency Response

Humans can hear sounds that range in frequency from 20 to 20,000 Hz. If an audio system does not reproduce this entire range, listeners will be aware they are missing something. For an example of restricted frequency range, listen to a telephone,

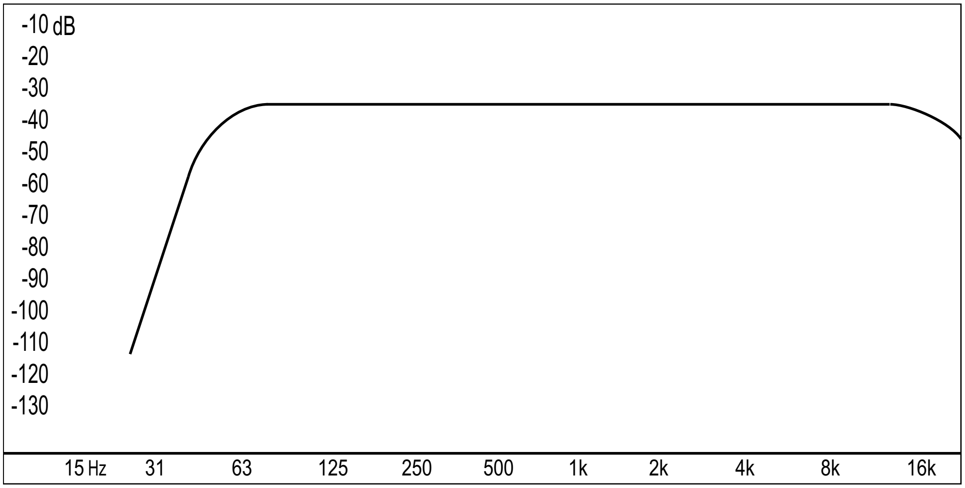

FIGURE 1.1 Typical frequency response graph.

which covers about only 20 percent of the audible spectrum. Further, if an audio system favors some frequency bands over others, the quality of the sound changes—this is called coloration. Some people have a taste for certain types of coloration, such as turning up the bass on their stereos, but this should be a deliberate choice. Frequency response is usually displayed as a graph of amplitude across the entire audible range, as shown in Figure 1.1. The graph shows change in amplitude at each frequency. If there is no preference for one frequency over another, the graph is flat. Good equipment has flat frequency response.

Distortion

Audio systems usually adjust the amplitude of the signal at some stage. This process is called amplification or attenuation and has the effect of multiplying the currents of the signal by a constant factor called gain. Volume knobs are an obvious example of amplitude adjustment, but electronic systems constantly manipulate amplitude for reasons best known to the design engineers. We expect such adjustments to be perfectly linear, the same whether the signal is loud or soft, but this does not always work out. Many electronic parts are actually linear only over a small range of current and will distort the signal when the current gets beyond that range. Some circuit designs do not react well to sudden changes in amplitude and smear the attacks in the signal. Problems like these can be solved by careful design and precise manufacturing techniques, but these techniques add to the cost of the circuit.

Distortion adds extra components to the signal. It may be specified as a total percentage or divided into harmonic and inharmonic portions. The components of harmonic distortion occur at simple multiples of the frequency of the original material. Since most musical sounds already contain multiples of a fundamental frequency, a bit of harmonic distortion may be acceptable. The components of inharmonic distortion follow other patterns, such as the sum and difference of the frequencies of the signal. Harmonic distortion becomes audible when the amount exceeds 1 percent but even 0.1 percent inharmonic distortion may be objectionable. Digital systems are not immune to distortion. In fact, the digital revolution has introduced several new types of distortion. The sound of distortion is difficult to describe, but it's usually grating or rough. Some types of distortion give the impression that the sound is louder than it actually is, other types make it hard to identify the sound. Distortion is not always unpleasant. After years of exposure, many people have developed a taste for distortion, at least for certain types such as that associated with tube amplifiers.

Noise

Audio noise is anything added to the signal that didn't go into the microphone. Noise can sound like a lot of things: a low-pitched hum, a hissing sound, random pops, even music if it is somewhere it's not supposed to be. Noise is measured by comparing the amplitude of the loudest possible signal to what the system produces when there is no input signal at all. This ratio is converted to decibels, a measurement discussed in chapter 2. Signal-to-noise ratios of 60 decibels were once considered satisfactory, but in the digital age they should be in the 80s or even 90s. The most common source of noise in the modern studio is the computer that makes so much of our work possible. The multitude of high-frequency signals associated with bit crunching and running displays often leaks into the audio signal, producing strange buzzes and whistles. The physical noise of the computer is a double-barreled problem. The whirr of fans and disc drives is easily picked up by microphones and will prevent you from hearing similar problems in the music you are trying to create.

Speakers and Amplifiers

Accurate playback is as important to the composer as northern light is to a painter, and for much the same reason. The speakers will color the sound of everything produced in the studio, so if they are not accurate the music will sound different in other locations. The playback system may consist of an amplifier and speakers or the amplifiers may be built into the speakers, but the system must have balanced frequency response, an extended low end, and low noise.

Headphones

A set of quality headphones is an essential adjunct to the speaker system. You can't make up for poor speakers with good headphones, but there are times when you need to keep the sound in your head. Look for headphones that fit comfortably. Some are designed to sit lightly on the earlobe (supra-aural), while others surround the ear with seals resting on the side of the head (circumaural). The latter are better for studio work because there is less sound leakage. In either case they must work with the unique shape of your ears. Headphones have the same quality criteria as speakers. Wireless headphones are not appropriate for studio use. They employ signal processing that will obscure the details you are listening for.

The Mixer

Mixers range from pocket-sized portables to room-filling behemoths, but the needs of the electroacoustic musician are relatively modest. The mixer will be used primarily for listening to audio sources, with the occasional recording project thrown in. A model with twelve to sixteen inputs will usually be sufficient. The following considerations are important.

Digital or Analog?

The best high-end mixers are digital these days, but the low-cost digital models are no better than simple analog machines. There's a lot of analog circuitry in any mixer, so the cost and performance benefits of digital systems do not appear until the board is fairly complex. The cut-rate effects found in the cheaper digital mixers can even limit the quality of the signal. For now the best choice is analog, but in the near future this is likely to change. (If you do decide to go digital, look for a desk with plenty of digital inputs. Surprisingly, most of the inputs on small digital mixers are analog. There are usually only two or three digital connections.)

Preamplifiers

Unless you make complex live recordings, the mixer does not need fancy microphone preamplifiers. The basic preamps in a low-cost mixer or field recorder will be adequate for recording source material, since you are going to modify the sounds anyway. If you need high-quality recording, buy a separate premium preamp. Such a preamp costs about the same as a basic sixteen-input mixer. Imagine the price of a mixing board with high-performance preamps in every channel.

Monitoring Controls

The most important feature on a mixer is a control-room monitor section with a master volume control and switches that include an external input. (This is often marked "tape," a vestige of that technology in the modern studio.) This will become the central control of the studio. The input switches allow you to choose to listen to studio hardware directly or by way of the mixer. A master volume control will help you keep signal levels consistent because you will always grab the same control when surprised by a loud sound.