Monitors

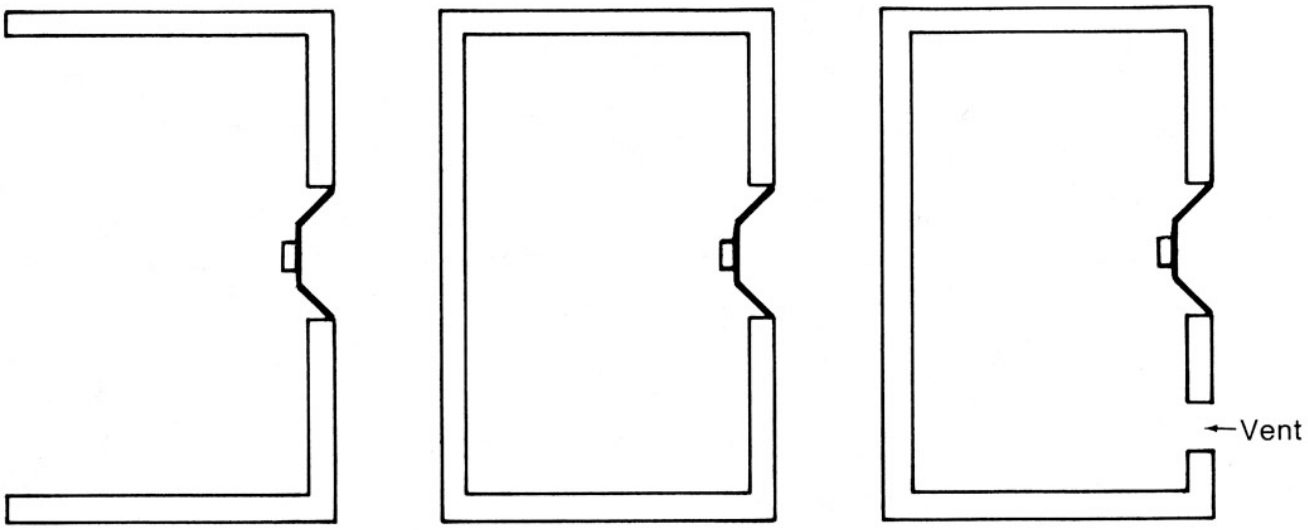
One of the most confusing aspects of audio reproduction involves loudspeakers and their effect on how we perceive the sound of our work. Just as microphones each have a characteristic sound, speakers have distinct colorations that they impart to the sound we play through them. The similarities are not coincidental: both microphones and speakers are physical transducers, with mechanical properties that directly affect how they perform the task of converting energy to and from mechanical and electronic representations.

Since we cannot hear electronic signals directly, we need some form of transducer to convert them back to mechanical vibrations that we may hear. Like microphones, loudspeakers come in a variety of types; however the main type is similar to a dynamic microphone in reverse: applying an electronic signal to a coil attached to a diaphragm causes the coil and diaphragm to move in a fixed magnetic field. There are also electrostatic loudspeakers which may be thought of as more similar to a condensor microphone and even plasma speakers, which use high-voltage discharges to move the air, but these types are not commonly found in the studio and will not be discussed further here.

What we need to understand is how the dynamic loudspeaker and its enclosure interact with the surrounding environment and convey sound information to our ears. Not only does this involve the speaker itself, but it also involves the room in which we are listening and the interaction of the speaker with the room. Just as no two pianos or guitars sound exactly alike, so it goes with loudspeakers. So how can we deal with this dilemma?

In order to understand what we hear from the monitor loudspeaker, we need to appreciate how the speaker works and how it interacts with the room in which it is placed. Most loudspeakers are actually composed of two or three separate elements that divide up the frequency range from 20 to 20,000 Hz. This is because no single driver is capable of producing precise transduction across that wide a frequency range. Instead, the monitor divides the signal into separate frequency bands with filters called crossovers and each frequency band is fed to the appropriate speaker element. These filters are passive in the case of unpowered monitors and active in the case of powered monitors. Powered monitors contain their own power amps and these may be carefully tailored to produce controlled sound reproduction with the exact speakers and geometries used. Unpowered monitors require external amplification and divide the frequencies after the amplifier output as opposed to the active crossovers found before the amplifiers in powered speakers. Powered monitors have the advantage of separate amplifiers for each element, which eliminates intermodulation distortion that occurs when high and low frequencies interact in the power amplifier circuitry. Powered monitors have become very widely used recently.

In addition to the mechanical and electronic components, the physical enclosure of the monitor contributes significantly to the sound produced. There are two basic enclosure types: bass reflex, in which the enclosure is “ported”, or open to the outside, and acoustic suspension, in which the cabinet is sealed. The bass reflex type allows the designer to extend and shape the low frequency performance of the speaker by tuning the port to resonate with the speaker components. Acoustic suspension speakers may have less low frequency output for a given size, but they have a tight, defined bass sound. Because they are less efficient than bass reflex speakers, it often takes a significantly larger power amp to properly drive acoustic suspension speakers. Simple open-back cabinets popular for guitar amps are not found in studio monitoring. They result in dipoles, with sound radiated out the rear out of phase with the sound from the front, a condition not desirable when we are trying to generate the best imaging and clarity from our loudspeakers. They may be more efficient but do not give the controlled sound radiation pattern we want from studio monitors.



(A) An open-back (folded baffle) cabinet.

(B) A closed-back cabinet.

(C) A vented cabinet.

Used in guitar amps

Acoustic suspension

Bass reflex

Figure 1 Speaker cabinet types

In addition to the speakers' design, their placement in the room will have a profound effect on what we hear. Low frequencies tend to "build up" near walls and especially in corners. Therefore, the placement of the speakers should minimize these problems. They should also be positioned so that reflections will not bounce back and interfere with the direct sound radiation. People often think they can fix bad room sound by equalizing the sound system: this is a mistake. The effects that tend to ruin the sound are time-domain problems, involving sound bouncing off of surfaces and creating interference patterns in the room. No amount of equalization will fix this except possibly for a tiny spot in which the measurement microphone is positioned. Standing waves must be addressed by absorbers and diffusers built into the room to break up reflections and absorb unwanted accumulations of bass frequencies.

Speakers are also classified according to the distance at which they are designed to focus their sound output: near field, mid field, and far field. These terms refer to the listener's relative perception of the direct to reflected sound ratio. Near-field speakers are designed to be heard in the near field, where the direct sound far exceeds the reflected sound intensity. Near field monitors are desirable in part because their sound is largely independent of the room, hence their popularity for home and project studios where acoustics are often less than perfect. Mid field monitors are designed to be heard from a longer distance, where the reflected sound and direct sound are about equal. Far-field speakers are designed to "throw" the sound a longer distance from the speaker, where the reverberant field may be stronger than the directly radiated sound. Far-field speakers are often soffit or wall mounted in large control rooms.

Finally, there are the very near-field speakers we call headphones. Headphones are small speakers mounted for direct-to-the-ear delivery of sound. While they are often used for monitoring during recording, for overdubbing, for example, they are generally not designed for use in critical tasks like mixing. Although some headphones are designed as free field, they produce effects quite unlike speakers since they are directly coupled to our ears with little air to intervene. Headphones are often useful in examining panning (spatial placement in a mix) and for hearing effects like reverb which may tend to get lost in a room's acoustic field, but they are not likely to represent the sound any loudspeaker is going to produce very accurately. The center image created by

loudspeakers for sounds emanating from stereo speakers does not sound the same in headphones. And a caution: it is quite easy to deliver dangerously loud sounds via headphones and ear fatigue can soon be a problem. It is strongly recommended that prolonged headphone use be tempered by frequent rest periods.

Just as with microphones, we must practice and experience the results over time in order to fully appreciate how the monitors we use affect the sound we produce. Fortunately, CCRMA has several different sets of monitors in different studios that can be used to evaluate the contribution of the loudspeaker to the final sound of our recordings. While we must mix on a single set (or at most a couple of sets) of monitors, we can take our mixes around to the other studios and listen on the other speakers. This often reveals some problems we might not have heard on the Westlake BBSM-10 monitors that are the main loudspeakers in the control room. For example, the Genelec 1030A speakers in Studio E are very detailed and bright sounding and will emphasize problems with high frequency content and imaging. The JBL LSR-28P monitors in Studio C have stronger bass performance and reveal problems with the low frequencies more easily. Although the BBSM-10s present the midrange and higher frequency sounds very accurately, we sometimes have trouble adjusting the low frequency content using just the Westlakes and have also installed a pair of JBL 4206, which have an exaggerated, rather boomy low end. It is possible to create mixes which sound good on all of these systems after several experiences of listening on the varied systems we have available and making appropriate adjustments to the mix. You will find that the more time you devote to evaluating your mixes on the different monitor systems, the less mastering will be required for your final product.

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