Live Sound For Musicians --by Rudy Trubitt

Contents

Purpose of a Sound System

What is a sound system for?

The function of a sound system is to make soft sounds louder and projects them to listeners who would otherwise be too far away to hear them comfortably.

This purpose is at the root of the name “public address system,” or PA, as sound systems are often called—a person can stand up and “address the public” with a sound system that amplifies their voice.

The same holds true for music. A PA allows you to play for a much larger audience than you could reach without amplification.

However, the needs of each performance vary. For example, dance bands use amplification to motivate their audiences to get up and move. In this case, the sound system becomes an integral part of the act—No PA? No show. On the other hand, a string quartet may need a little volume boost in a large hall, but they’d be fine without a PA in a smaller room.

This brings us to an important point: The use of a sound system should always complement the performance. Every performance is different, and it’s very important to adopt a flexible attitude when it comes to dealing with each event. There is no “right way” to do sound, just the best choices (or compromises) for the circumstances at hand.

Think of live sound as a three legged stool. One leg is the needs of the audience, one is the needs of the musicians, and the third leg is the demands of the room. For best results, all three different needs must be met. Ignoring any one of these three areas can result in a performance that falls flat!

Related tasks

Operating a Sound System on page 3
When using a sound system, projecting a louder sound to an audience is our goal. But how can we break this up into individual steps?

Related reference

Sound Waves vs. Electrical Signals

Operating a Sound System

When using a sound system, projecting a louder sound to an audience is our goal. But how can we break this up into individual steps?

All sound systems must perform the same three basic tasks:

1. Pick up the original individual sounds (usually with microphones).
2. Combine, or “mix,” these sound sources and amplify them.
3. Play the mix through speakers for the audience, or “house.”

The result is the audience can comfortably hear the preseter talking or the musicians playing.

Related concepts

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Level on page 6
A sound’s level, or percieved loudness, is directly related to how vigorously it is vibrating.

Picking Up the Original Sounds

The connecting of input sound sources is the first and most fundamental task of any sound system.

If the purpose is to make an existing sound louder, we must begin by capturing the original sound. The most common tool used to capture sound is the microphone. The mic hears sounds in the air (sort of like your ear does), and converts the sound into an electrical signal.

Not all instruments require microphones—some produce an electrical signal themselves. For instance, you can hear the plinking strings of an unplugged electric guitar, but the main sound from that instrument comes from pickups, which generate their own electrical signal from the strings' sound. Other instruments, like electronic synthesizers directly, create their "sound" as an electronic signal.

So, depending on what kind of instruments you are involved with, you may be using more than just microphones. However, almost every amplified performance uses at least a few mics, so we'll focus on them in the first part of this book.

Mixing Sounds

A sound system must usually accommodate more than one sound source.

Even if you're a solo guitarist/singer, you must be able to blend, or "mix," two sounds: your voice and instrument. For larger groups, the number of sounds to be mixed will be many more.

Combining the electrical signals of the individual sounds is done by a mixing board, or mixer. A mixer's knobs are used to balance the volume of all the different sounds connected to it, so that the desired musical blend is heard by the audience.

The mixer doesn't produce sound waves—just another electrical signal that represents the blend of all the connected microphones or other instruments. But before this signal can be connected to speakers, its power must be substantially boosted, which is the job of the amplifier.

Amplifying Sounds

A sound system must usually accommodate more than one sound source.

Boosting the signal which comes from the mixer is the task of the amplifier. Also called a power amp (or just "amp"), this device takes the low-power signal that comes from the mixer and boosts it enough to operate the speakers.

While the microphones, mixer and speakers are always easy to spot in any sound system, the power amplifiers may not be so apparent. While some power amps are housed in their own cases, amps are sometimes built into to the mixer (creating a "powered-mixer"). Often, manufacturers will build the amp right into speaker cabinets, creating "powered speakers." Regardless of where the amplifier is physically mounted, its function in the system is the same: create a strong enough electrical signal to cause adaquate physical motion of the loudspeaker to create the sound waves we hear.

Turning the Mix Back Into Sound

The final task of the sound system is to turn the electrical signal back into sound that the audience hears.

This is done by loudspeakers. Within the speaker enclosure, the speakers themselves move back and forth in response to the amplifier's output signal. This physical motion creates ripples of air pressure, and we perceive the result as sound. And, thanks to the amplification provided by the sound system, the results can be much louder than the original sound was.

What's the Catch? The problem, as was hinted before, is in the conversion to and from air, a task performed by *transducers*. Sound waves have so much subtle detail that it's very difficult to design a mic that captures all their

nuances. Also, microphones don't really "hear" sounds the way our ears do—even good mics can "color" the sound of an instrument, especially if the mic is not properly positioned.

The flip side of the coin is the speakers. Again, the task of translating the complex electrical signal into an accurate motion in the air is demanding. The loss of accuracy in the translation can result in bad sound. And, just as microphones don't pick up all sounds the way they originally occur, loudspeakers don't necessarily project sound the same way that the original instruments do. The result can be "uneven coverage," meaning that the final sound may be good for those sitting in front of the speakers but not-so-good for the audience off to the sides.

Review 1

The purpose of a sound system is to make one or more a quiet sounds louder.

To do this, you must first capture the original sound (your voice or instrument). This is usually done with a microphone, although some instruments have pickups instead.

The mics or pickups translate the original sound into a faint electrical signal. This is connected to a mixer, which boosts that signal and then lets you balance the levels of all your individual mics. The electrical signal created by the mixer is sent to a power amplifier, which boosts the level of the signal again. This high-power electrical signal is then connected to loudspeakers which turn the signal back into sound for the audience.

Converting sound to and from an electrical signal is difficult; therefore, most of the problems associated with live sound are related to *transducers* (microphones and speakers), and their interaction with the room and the musicians.

Fundamental Concepts and Terms

Pitch and Loudness

Two fundamental properties of a sound are its pitch and loudness.

As you've probably guessed by our casual tone, we're not going to plunge into the icy waters of mathematical formulas to explain how sound systems work. However, you are going to have to come to grips with a few basic concepts. But fear not! This text is certified Musician-Friendly, 100% math-free.

Sound is pretty simple: An object vibrates. This movement pushes air back and forth, which sends out little ripples of changing air pressure. As these little waves wash up against your ears, your eardrums wiggle back and forth in sympathy. The resulting motion is converted into nerve impulses, which in turn are perceived by your brain as sound.

What makes one sound different from another? Two important things: How fast the vibration is and how vigorous it is. The faster the motion, the higher the pitch we percieve. And the greater the back-and-forth motion, the louder the resulting sound.

The technical terms for these two fundamental properties of a sound are *amplitude* or *level*, which describes how loud something is, and *frequency*, which is related to pitch, where higher frequencies are percieved as higher notes.

Related reference

Level on page 6
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Frequency on page 6
In musical terms, a sound's frequency is closely related to pitch. The higher a note's pitch, the higher its frequency.

Midrange Frequencies on page 7
Humans ears are especially sensitive to mid-frequency sounds.

Low Frequencies on page 7
Bass or low-frequency sounds add impact or "oomph" to music, especially modern pop or dance music.

High Frequencies on page 7

High-frequency sounds, in moderation, add a pleasing, open or “airy” quality to the listening experience.

Level

A sound’s level, or percieved loudness, is directly related to how vigorously it is vibrating.

If something’s barely moving back and forth, it will make very little sound. But if you really whack it, it will vibrate a lot harder. This will move more air and the result will be a louder sound. Most discussions about volume are relative. For example, “We sound great, but I should be louder!” But how loud is loud?

Sound engineers measure the absolute level of a sound, or the difference in level between two sounds, using the “decibel.” You may have seen charts showing the range of human hearing for sounds of different loudness, starting with a quiet room and progressing to lawnmowers, rock concerts, gunshots and jet-plane take-offs. Next to each of these example sounds is a number that shows approximately how loud that particular noise is in decibels.

While you probably won’t be asked to adjust your band’s volume to "96 dB sound pressure level," professional sound system engineers often work under these restrictions, especially when concerts are held near residential neighborhoods. Using a device called a sound pressure level (SPL) meter, the actual level of sound can be measured. Although not a replacement for a callibrated, professional measurement device, you can find inexpensive or free "sound level meter" apps for your phone. These will give you a much better idea of how loud "loud" is!

Related concepts

Pitch and Loudness on page 5
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Related tasks

Operating a Sound System on page 3
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Frequency

In musical terms, a sound's frequency is closely related to pitch. The higher a note’s pitch, the higher its frequency.

In musical terms, frequency is closely related to pitch. The higher a note’s pitch, the higher its frequency. For instance, hitting a bass drum has a completely different result than hitting a triangle. Since the bass drum vibrates more slowly than the triangle, we hear its sound as being lower in pitch.

Note that every vibrating object wiggles at more than one single frequency. This explains why you can hear two people singing the same note, yet still be able to tell the performers apart. Both singers produce the same root, or fundamental, frequency when they sing the same pitch. However, every person (or instrument) creates its own blend of other, related frequencies called harmonics. These harmonics are what let us differentiate one singer from another. There are many instrumental examples of harmonics; an exploration of these is left to you as an extra-credit assignment!

Frequency is measured according to how many vibrations (or cycles) are completed in one second (a cycle is one complete vibration, for example, bending outward, bending inward and then bending outward again).

Sound frequency is measured in cycles-per-second or Hertz, abbreviated Hz. The open A string of a guitar (in standard tuning) will vibrate back and forth exactly 110 times in one second.

While you can translate between musical pitch and specific frequencies, you’ll normally use one or the other. When talking about music, you’ll just say “open A,” not “110 Hz.” Similarly, only frequency is used when discussing sound equipment. You will find controls that apply to specific sound frequencies, but these will never reference musical note names. However, you can use your trained musical ear to identify different frequencies by ear. This will be especially important when trying to control *feedback* (more on this later).

Our Range of Hearing

You know from experience that we can hear very low and very high-pitched tones. The typical range of human hearing (in younger people) is from 20 cycles per second to 20,000 cycles per second (which is often abbreviated 20Hz-20kHz).

It is convenient to break this “frequency spectrum” into smaller ranges or “bands” to help us talk more specifically about what we are hearing. The simplest division is to split our range of hearing into three parts: bass or “lows,” midrange or “mids,” and treble or “highs.” Your sound system must be able to reproduce each of these three frequency bands with reasonable accuracy.

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Midrange Frequencies

Humans ears are especially sensitive to mid-frequency sounds.

Humans rely heavily on midrange frequencies for understanding speech, because this is where the consonant sounds reside. If you can’t hear consonants, it’s very hard to tell the difference between, for instance, “cake” and “ache.”

So, you would be correct to assume that good midrange response is important for a sound system used for the spoken word, or if you want people to understand the words you are singing.

Midrange is important for more than just speech. Many instruments produce a lot of sound in the midrange. Playing these instruments through a sound system lacking mids will not seem very energetic. However, this is rarely a problem: most smaller sound systems tend to have too much midrange response and produce a sound that is abrasive and tiring to listen to for extended periods.

Just remember that our ears are most sensitive to midrange sounds, so it doesn’t take much midrange to wear us out, especially as we get older. Perhaps this is why parents can’t understand why their kids like such loud, braying music.

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Low Frequencies

Bass or low-frequency sounds add impact or "oomph" to music, especially modern pop or dance music.

I’m sure you are familiar with the types of instruments that generate lots of low-frequency sound, including bass guitars, upright basses, electrical keyboards, larger drums and so on.

A sound system that has good low-frequency response will help motivate an audience to dance. However, this will require a sound system with larger speaker cabinets and more powerful amplifiers.

So, a sound system with poor low-frequency response isn’t a good choice for an amplified dance band trying to beef up their low end. However, for sound systems that are primarily for speech, lack of extended low frequency “thump” won’t be missed.

Related concepts

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High Frequencies

High-frequency sounds, in moderation, add a pleasing, open or “airy” quality to the listening experience.

Finally, there are the treble or high frequencies. Remember when I said that most instruments generate sound at more than one frequency at a time? While the fundamental pitch of a guitar's open A string is a relatively low 110 Hz, that sound is rich in harmonics, additional frequencies in the octaves above the fundamental. The high-frequency range of your PA system will mostly be busy reproducing these harmonics.

A sound system with good, smooth high-frequency response will have a pleasing, open or "airy" quality. One might also call it "hi-fi." A lack of highs will leave your system sounding somewhat dark, closed or veiled. Most PA speakers don't have the extreme high-frequency response found in good home-stereo systems, but most will do an adequate job. As always, too much of a good thing is too much of a good thing. Excessive highs can make your system more prone to feedback (more about that later) and also make any background hiss generated by your equipment more obvious to listeners.

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