Creating an Audio Experience that Meets Guest Expectations

by Dan Digre

As in all engineering projects, the approach to any one element of audio system design can be expected to influence other engineering decisions. The creation of audio systems that generate articulate and immersive sound from within a casino game cabinet, now critical to the delivery a truly exciting multi-media experience, is a multifaceted challenge. The following is a basic primer for audio system design in the pursuit of compelling pro quality audio that keeps the guest in the casino.

How Loud Does the System Need to Play?

The simple answer is, loud enough to have the system clearly heard over the sound level of everything else. From recent research, volume levels inside casinos average 77 decibels (dB). What are dBs? Some points of reference are:

- The average home interior is 50dB
- A conversation across your dining table is 60dB
- Rock concerts typically measure at 115 dB

With 77dB as the sound level to overcome, what do we need to be clearly and reliably heard? Psychoacousticians are the experts and due to multiple factors confirm that we each hear volume changes slightly differently. For many to hear double the volume takes an increase of 10. That gets us to 87 dB. Is that loud enough? Not quite. While 77 is the average sound level of casinos, some can be as much as 7 dB louder at 84. Working with what we think is worst case of 84 and doubling (an increase of 10) moves the target to 94 dB. Add 3 to overcome the occasional louder noise and the goal changes to 97 dB. That might sound like a lot. But, if we add 10 and double the perceived volume of our target, that volume is still way under the volume of a rock show.

How Many Speakers are Needed and What Types?

This depends on the sound presentation called for by the sound designer. The base line today is full-range stereo. "Full range" means the system can produce the lowest and highest tones we hear. The generally accepted hearing range is 20 to 20,000 cycles per second, or Hertz (Hz). The fundamental notes of a piano cover between 27.5 Hz (double pedal A) and 4186 Hz for C 8th. Middle C is 261.6 Hz. Pipe organs range from 16 Hz to 7,040 Hz. We pretty much feel 16 rather than hear it.

Full-range stereo is often achieved in gaming equipment using a design, familiar to many home stereo systems, called a subwoofer/satellite system or 2.1 system. These systems use one subwoofer enclosure to reproduce the bass sound (below about 100 Hz) from both stereo channels. The sounds above 80 or 100 Hz are reproduced by what are called satellites or main speakers. Occasionally, to simplify gaming equipment assembly, all the speaker components of a 2.1 system may be housed in a single enclosure called a sound bar. Some gaming equipment sound system designs use a single full range speaker in each channel to produce all of the frequencies higher than the sub. But, like a home or car audio system, we get better sound when the duties of the main speaker are divided. The dividing of signal into higher and lower frequencies is done by what is called a "crossover." Higher frequency sounds like cymbals and piccolos are fed to a tweeter. The frequencies that occur between the tweeter and sub are handled by what is called a mid-range driver [driver = speaker element]. For a bigger sound and ability to play louder, some designs may rely on a pair of mid range drivers with one tweeter for each of the left and right main speakers.

Sound design for gaming is beginning to take advantage of the immersive effects of surround sound. This requires the addition of two more speakers, similar to the main speakers, to reproduce surround channels. The surround speakers work best behind and to the sides of the player – most often installed in the headrest area of a dedicated chair. The chair can also be fitted with a device called a shaker or actuator to enhance the low frequency sounds with tactile sensations. If a dedicated seat isn't practical, surround speakers might be placed high in the game cabinet. When done properly, it can provide some sense of space and surround sound.

It is important for casino gaming sound to keep pace with other entertainment media. Advances in audio technologies for the theater, family room, home computer/console game platforms and DVR programming are constant, although it's challenging to properly implement multiple speakers within the confines of gaming machine cabinets. Like the consumer audio industry has learned – consumer demand for new technology drives revenue.

How Much Amplifier Power is Needed?

What's needed depends on the interaction of some variables. We've touched on the level of sound we need for the sound to be fully heard and enjoyed. For an amplifier to get the speakers to that level at the listener, we need to know if we lose anything on the way to the listener, how much sound comes out of a speaker for a given amount of signal, the amount of power we need to get to the volume we want and what we need to have for something called headroom.

The volume of sound made by a speaker when it gets 1 watt of power from the amp is called its sensitivity. This is measured at a distance of one meter from the speaker and stated in dBs. 86 dB is a fairly common sensitivity for the kind of speakers often

used in casinos. With that we're close to being on target with one watt from our amp. Every doubling of amplifier power gets a 3dB louder sound from a speaker. So a 2-watt amp will motivate our speaker to make 89. We'll need 16 watts to get us 97 dB.

Figure for a little extra power – called headroom. The numbers previously noted are average constant signals, but the sound we want to reproduce is anything but constant. Think of it like horsepower in your car – you don't need much day to day. But, there will be a moment when you'll need some extra. Fortunately, today's digital amplifiers are notably less expensive, smaller and run much cooler than traditional analog designs. Amplifier power ratings of 20 watts per satellite speaker and around 50 watts for subwoofers will do the job in most cases.

Should the Design Include Digital Signal Processing?

Digital Signal Processing or DSP can provide notable gains in electrical efficiency and audio system performance accuracy when used to eliminate traditional crossovers to divide the signal before amplification. This is called bi-amping. With DSP, sound designers gain compression and equalization tools for shaping, contouring and enhancing the sound experience. Like all digital technologies, we enjoy continually decreasing cost with increasing processing power. This makes DSP based designs increasingly more powerful and surprisingly affordable.

How Much Space Needs to be Allowed for the Audio System in a Casino Gaming Machine?

Speakers and audio electronics have been shrinking in size while maintaining or improving performance. Careful consideration needs to be given to the space, air movement (sound is modulated air/thermal management for electronics) and location of speakers and audio electronics. These requirements vary with system design. But, keep in mind that speakers need air space within their enclosures to perform well. Generally, more is better. The higher frequency sounds from satellite and surround speakers should be at or as close to the listeners' ear level as possible to deliver the full sound experience. The position of subwoofers isn't nearly as critical, but subs must freely move notable amounts of air. All speakers need clear and unrestricted path to move sound from the gaming cabinet to the player. Speakers should be placed at or close to the exterior surface of the cabinet. Decorative and protective grills need as much open space as possible to be acoustically transparent. If the working surface of a speaker must be set back into the cabinet, the route the sound must follow needs to be properly designed. To understand the negative effects of moving sound through cavities, cup your hands around your mouth while speaking, or try singing through a rolled up newspaper.

A Few Other Items to Note

The task of designing high quality, pro grade audio systems in casino game cabinets and fitting them into limited space is always challenging. But, understanding what it takes to do it properly can help deliver great results. It's important to understand that the way we hear sound from a speaker is affected by the physical relationship between the speaker and our ears. Speakers don't radiate all frequencies in the same pattern. The simple way to deal with this is to position the speaker so it will be as close to the player's ear level as possible and aimed toward the player. Space is needed between speakers for the best stereo effect. Also, keep in mind that, like the sound of your voice being reliant on the air inside your mouth and throat, speakers need the help of a specific air cavity behind them. Design considerations for both the size and construction of speaker enclosures are important to the performance of audio systems.

Armed with these fundamentals, you now have the basic knowledge needed to make good audio decisions. Whether defining audio system parameters for your next gaming machine build, searching for design support or seeking to purchase some great sounding machines, keeping this info in mind will help you deliver an exciting and compelling gaming experience. ♣

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