Coverage And Feedback

More about factors of a "good" system

By Bob Thurmond

A common complaint of audience members who have become familiar with a particular sound system, typically in a venue with a permanently installed system and which they visit repeatedly (such as a church) is that there are locations where sound is obviously better than at others.

In other words, sound is not uniform throughout the audience area. In fact, this is a common problem with all systems, but in many cases, such as a one-time concert, the audience has no opportunity to compare the sound quality at different locations.

The only evidence of the problem may be that various audience members disagree significantly on how good or bad the sound was.

It's remarkably difficult to provide uniform sound coverage throughout an audience area from a configuration of loudspeakers. The audience layout is often irregular and complex, and just as often, the dispersion from the loudspeakers is poorly delineated and frequency-dependant.

Add the necessity for multiple loudspeakers and physical restrictions on their locations and orientations, and it's surprising that reasonably uniform coverage can ever be achieved!

ADDING COMPLEXITY

These facts of life beg some questions: How uniform does coverage need to be? What variation limits are acceptable and what are desirable? Variations with frequency add another dimension of complexity.

Program material may add another variable; perhaps the coverage uniformity requirements for speech are different from those for music. Almost no research has been carried out on these important questions.

As with other performance characteristics, there is no accepted method for measuring coverage uniformity. Worse, it's not clear how it even might be measured subjectively.

One fairly obvious possibility for an objective technique is to feed a constant-level broadband signal over the system and sample it in many audience locations, or record it via microphone traverses through the audience area. Such samples can then be analyzed for uniformity in various frequency bands.

Let's have a look at **Figure 1**, where broadband pink noise was played through a system, with the resulting sound recorded on a traverse through the audience area. The recording was fed through filters centered at various frequencies and plotted on chart paper, so that the x-axis indicates the location within the traverse in every frequency band.

Again in **Figure 1**, we can see that there are significant level variations within each frequency band at different locations, and that these variations are different at each frequency. Thus, not only is the level different at each location, but so is the frequency balance.

It should further be noted that these measurements were made on a system that was carefully designed, installed, and adjusted to produce the best possible results in this situation.

Further, the room was rather reverberant, which might have reduced the level variations. The subjective impression was that the coverage was quite uniform, which suggests that this measurement technique might be sensitive enough to reveal any audible variations.

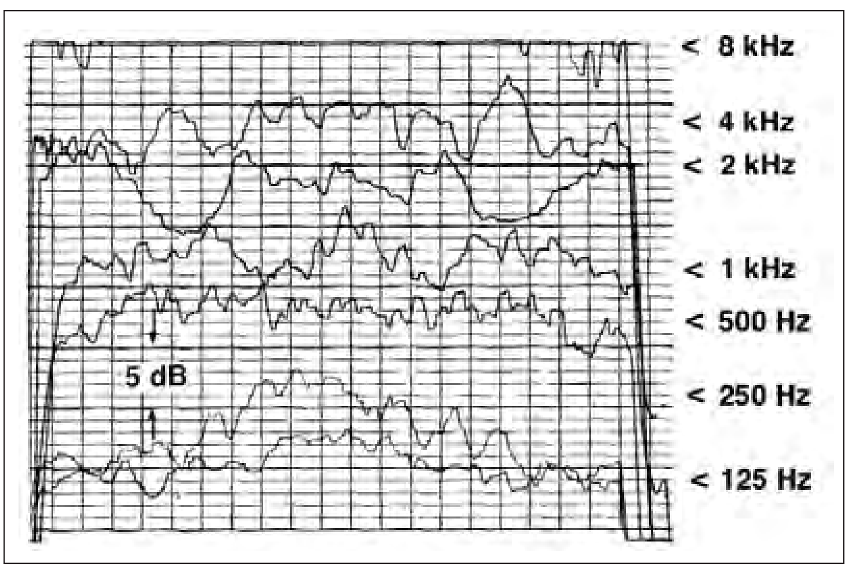

Figure 1: Variations across a seating area in the level of sound from a loudspeaker system displayed at several frequencies.

FEEDBACK AND SUPPRESSION

When a system's microphone can pick up any sound from the system's loudspeakers, which is almost always the case, feedback is possible. The characteristics of this phenomenon - and ways to suppress it - are fairly well understood, if only modestly effective.

However, note that some audible effects of the typical suppression techniques have not been well studied.

Feedback frequencies are typically suppressed by means of narrow band-reject (notch) filters added to the system electronics, with each filter tuned to a primary feedback frequency. Such filters ring measurably, with the decay time of this ring varying according to the filter characteristics.

Some listeners claim that this ringing is audible and objectionable, even though the ring decay time is almost always much shorter than that of the system feedback which the filter suppresses.

Others observe that wisely used notch filters can suppress the apparent room reverberation as excited by the system, thus improving its sound quality. In many cases, feedback suppression can allow the system level to be turned up enough to make a very desirable improvement in performance.

But always keep in mind the key portion to this approach: notch filters must be wisely used or they can have a highly negative impact.

CHALLENGES AHEAD

In the March 2004 issue of Live Sound, we began the discussion that has continued here, regarding factors that define a "good" system. Note that with regard to all of them, as a group, the professional audio industry has a long way to go before reaching many concrete solutions.

Why is that?

Our problems are interdisciplinary, and require "in-situ" measurements of many factors in both subjective and objective domains. This requires proficiency in several rather complex disciplines. To this point, very few in our industry possess these specialized skills, and further, as a group we're not prepared to fully understand this information.

Don't get me wrong - we're not stupid, it's just that the issues are highly complex. Multiple variables can be involved, but not readily apparent. A major problem is simply isolating the variables from one another. At this current point in time, it's a huge challenge.

Further, the parameters involved are poorly defined. In fact, a major goal of research in this area is simply to isolate, identify, and define the significant parameters. It would seem that this is the obvious starting point, but many issues are so poorly understood that such is not yet possible.

Plus, we're all human, with significant opinions and prejudices. This is always a danger in any type of scientific investigation, but it may be even more significant here because of widespread prior experiences, good and bad, with sound systems.

Finally, sound reinforcement professionals often respond to the research results that do exist with skepticism or outright rejection. It seems that many of us like to feel that our knowledge and understanding of the craft is more than adequate, and to be honest, we can feel threatened by any challenge to our competence.

And now we've come full circle! The key problem is the lack of understanding of the relationship between objective and subjective factors. Until we reach some sort of consensus, real progress on the true definition of a good system, let alone the application of what we learn, still seems a long time coming.

Editor's Note: This paper was originally presented at the 146th Meeting of the Acoustical Society of America, Session 4aAAa. For a full bibliography of materials referenced, see ProSoundWeb.com.

Bob's Sound System Performce Evaluation

SYSTEM CHARACTERISTIC	OBSERVATION TECHNIQUE	BASIC MEASUREMENT	ADVANCED MEASUREMENT
Component Performance	Listen to system	Frequency response, noise, distortion	Plot response, noise, and distortion on graph
Interconnection	Inspect	Trace signal flow	Measure signal levels
Transducer Polarity	Listen to two units close together	Polarity tester	Delay times between units
Loudspeaker Impedance	Check manufacturer's ratings	Impedance meter	Plot impedance vs. frequency
Audience Coverage	Listen to pink noise while walking through audience	Read sound levels in audience with pink noise over system	Record through audience with noise over system; analyze and chart recordings
Response Uniformity	Listen to program in various audience	Analyzer readings at several audience locations	Chart level vs. frequency at many audience locations
Average Response	Estimate from above observations	Visually average analyzer readings	Draw average of response graphs
Feedback	Listen to feedback	Frequency counter on feedback	Plot feedback potential vs. frequency