Auditorium Acoustics Considerations

BY NICK COLLERAN

When acoustically treating a performance space or auditorium, there are several considerations. Some are often obvious, but nevertheless often ignored.

WHAT'S GOING ON?

First among these is the type of performance. This can range from natural acoustic to high-powered reinforced electric. Is it music that is traditional or a cappella? Is it to be speech only, music only, or a compromise of acoustical ambiance to allow both? One size doesn't fit all.

A well-designed theater from the vaudeville era will project an unamplified performance but is easily overwhelmed and acoustically overloaded in the age of today's high-powered line arrays.

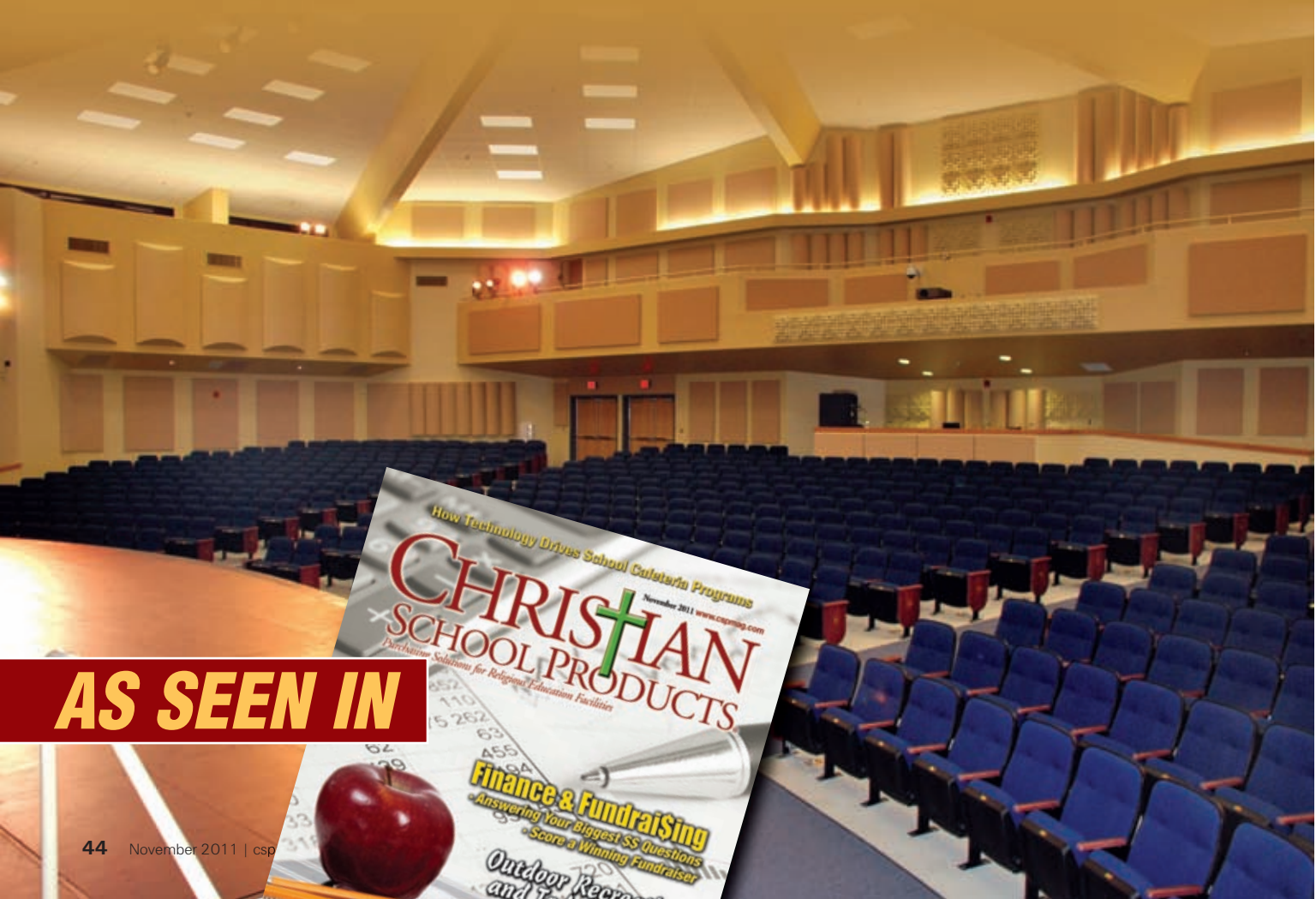
Sound that did not reach to back wall, back in the day, now hits it with storm force, producing annoying slap-back to interfere with the musician's timing and the speaker's concentration. If an existing space is to be a natural acoustic venue, little treatment and less sound reinforcement will be necessary.

WHAT'S THE PROBLEM?

Next, is there a sound problem or a noise problem, with noise being the sub-category of sound that is unwanted? If there is a noise issue, is it noise coming into the auditorium or leaving it to disturb neighbors or others in the building?

Higher-pitched noise will generally be less intense, with lower energy content and more easily controlled with dense, heavy barrier materials, such as gypsum board and mass loaded vinyl layers.

Low frequencies have longer wavelengths and generally have more power. The longer wavelengths take a greater distance to fully develop and may explain why the neighbors perceive a sound as louder than the folks close to the source. Low frequencies tend to be structure borne and usually



require decoupling from the source with resilient isolation. This treatment is lower cost if implemented at the start of construction where it is easier to split a concrete slab or float a floor on pads..

IS COMPROMISE REQUIRED?

The discussion of noise pollution, especially the long waves, is also a long discussion, best reserved for a more in-depth article. The primary consideration for an auditorium is almost always its sound quality.

Again, sound quality is not the same for every source or every listener. A typical space will sound best for spoken word if the reverberation time, RT60, is between 0.90 second and 1.00 second. (Reverberation time is the interval between when the sound is made and its decay becomes inaudible, 60 dB down.) Traditional music may want to hear the reverberation in the same room at between 1.5 seconds and 1.6 seconds, while electronic music may want to be "dry" with no reverberation or echo other than what is added artificially by the sound engineer.

These situations require compromise at perhaps 1.25 seconds for a traditional performance, while electronic music allows speech to be clear by using a dry room with artificial ambiance added to taste for the music.

PEOPLE COUNT

Acoustical taming of a performance space is most often achieved by adding sound absorption to room surfaces, usually on walls and ceiling. Some added sound control can be accomplished with padded seats and carpet on the floors. In general, the thicker the material, the more absorption is achieved, provided it is fluffy and porous.

When adding material, it should be noted that the difference in sound absorption may not equal the specifications of the product, depending upon the surface being covered. The full rating of an acoustical material could be "as advertised" over rigid gypsum drywall but may only equal the difference in absorption between an existing acoustical surface and the added acoustical panels (for example, if the existing walls are porous or covered with materials already providing some acoustical properties).

People count in this cover-up as well. Padded seating will add to the acoustical absorption of an empty room and allow the space to be similar in sound with a full or partial audience.

However, if the seating is hard, the acoustics will change as the seats are filled with people. The ambiance will dry up drastically in winter, when those attending wear heavy, fluffy coats.

Failure to account for this has produced acoustical difficulties in some well-known venues.

FORM, FUNCTION, FIRE, AND FINISH

While symmetry of acoustics left-to-right is desirable, even multiples in the stepped increments of a theater's rising listener area may not. The ancient outdoor amphitheaters were not spaced on even multiples.

At least one recent outdoor "bowl" has uniform math and equally uniform bad sound due to the commonality of wavelengths, reinforcing or canceling the same frequencies, rather than disbursing them over the full range of hearing. Good looks can have, but do not necessarily produce, good acoustics.

This leads into the topic of "form function, fire and finish." If form is the principal consideration, good looks can lead to trouble and are almost always the path to greater expense, if acoustical function is not an equal consideration. Both may be achieved if given equal weight at the start.

The sound absorption function alone can be achieved with a bale of hay, but there are allergy and fire considerations. Once fire specs are met, the final consideration driving price will be finish. A $20 panel can meet these minimum requirements and perform as well as the panel costing six times as much.

LAST IS FIRST

Sound absorption placed anywhere open to the air in a room will reduce reverberation time. Acoustical panels have been mounted under seating in places where there is not enough open wall area.

However, absorption lowering reverberation alone will not solve all problems. Once reverb is reduced, annoying direct reflections are more easily heard.

The most troublesome of these reflections are those bouncing back from the rear wall that are out of time sequence with the musicians and cause the person speaking to repeat himself involuntarily, reducing intelligibility and increasing distraction from the subject of the presentation.

Following second is treating the stage wall, if there are floor monitors aimed toward it, and the sound reflects to interfere with the main source. This can confuse the performers and be more annoying to the audience listening.

SCIENCE TO ART

Beyond controlling and containing sound is the shaping of it. This is achieved by spreading sound uniformly with diffusion that lowers intensity without eliminating the sound by absorption. Boom can be controlled with bass trapping that requires size and depth for low frequency control.

Once the sound is tamed, it can be trained by these methods, but that is an art requiring a more in-depth discussion exceeding the space of this article. **CSP**

Nick Colleran is a principal of Acoustics First Corporation, www.acousticsfirst.com.