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Designing for sound

How to achieve worship-worthy sound through good acoustics

By Carolyn Heinze

When it comes to church construction projects, there can't be enough said for planning. By investing time and careful thought on the front end, facilities can avoid futile efforts, wasted money and a lot of blood, sweat and many, many tears.

This especially rings true when it comes to acoustics: if taken into account in the beginning, chances are that first service you celebrate in your new sanctuary will sound close to how you imagined it. If you wait until you've moved in the equipment to test out how the room's physical characteristics weigh upon audio quality, however, you're likely to set yourself up for disappointment.

New Construction

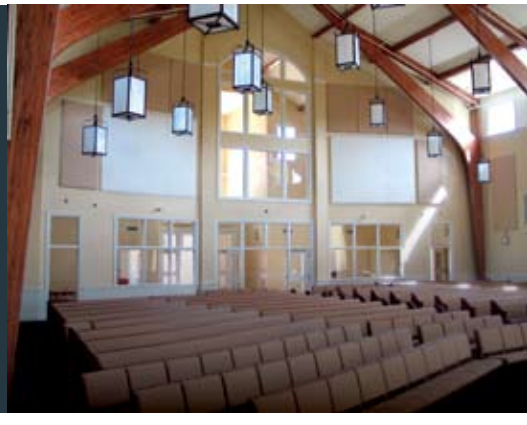
The best time to think about acoustics is long before the tradespeople arrive: because acoustics is determined by the size, shape and configuration of a space, the design thereof should take place when a construction project is still in the blueprints stage. Beware, however, of taking a cookie-cutter approach. Even though your building may be similar to another, your acoustical needs can differ greatly from the church down the street. Every congregation worships differently, and this factor plays a significant role in acoustical design.

"When designing a sanctuary, a church needs to take into account the style of worship that will be applied in the space," says Ben Davenny, senior consultant at Acentech, an acoustical consultancy based in Cambridge, Mass. Do you practice contemporary worship, which necessitates the amplification of music and performances? Or are your services more traditional, which means that sound remains unamplified? "Whether the space will have one or the other, or both, should determine the acoustical direction of the design."

Wall and ceiling construction is also paramount when it comes to acoustics. Thick, heavy materials, such as solid concrete, masonry block or several layers of gypsum board, reflect bass sounds back into the space, which contributes to good acoustics for unamplified services, Davenny explains. On the flipside, this isn't ideal for amplified music, where "thin" construction materials such as several layers of gypsum board backed by stud cavities, absorb bass frequencies, which brings clarity to the sound. Contemporary worship spaces also require sound absorptive materials such as acoustical panels to reduce slap-back. "These are generally placed at least on the rear wall, so that slap-back echoes are reduced, and on the stage platform to reduce noise build-up on the stage," he says.

This scenario was a challenge for Houston-based Lakewood Church when it began converting a 16,000-seat basketball arena into a worship space. Reed Hall, director of audio and technical production, explains that the church had to solve the problem of a reverberation time that lasted 11 seconds. "We installed panels for sound isolation and absorption," he says. "Because we are very contemporary with our music, we really wanted our reverb times way down because of the high intensity music and sound pressure level."

Sound absorption also has an impact on congregational singing: in traditional spaces, reverberation helps worshippers to feel like they are singing with others. Contemporary spaces, however, sound "dryer," making members of the congregation feel alone when they are, in fact, singing as part of a group. To counter this, many acousticians specify sound reflective and diffusive surfaces on ceilings and walls, which help to reflect the sound back into the audience.



SNUG INSIDE Worship spaces often provide a myriad of sound considerations for designers and acousticians. One simple and inexpensive way that churches of all sizes can help ensure good acoustics is by properly insulating walls. Nick Colleran of Acoustics First Corp. in Richmond, Va., says the insulation doesn't have to be the highest grade on the market, but that it should be installed during construction or renovation. Shown here, Avery Street Christian Reformed Church, Windsor, Conn. *Photo courtesy of Acoustics First Corp.*

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—Ben Davenny, senior consultant, Acentech, Cambridge, MA

Isolation

Isolation serves a dual purpose: it keeps sounds from escaping the sanctuary into other parts of the church, and it prevents noise from entering the worship space.

"There are two elements to controlling sound going through walls: you need things that are heavy, dense and massive, such as drywall or sheetrock, to block the sound," explains Nick Colleran, co-owner of Acoustics First Corp., a provider of acoustical materials based in Richmond, Va. "However, if the wall cavity is hollow, it acts like a drum: if you tap one head, the other head rings. If one wall is vibrating from sound, the sound will travel through the air and vibrate the other side of the wall and be heard in the next room."

This necessitates insulation: while it won't block the sound entirely, it will keep the air from moving between the wall. Colleran emphasizes that the insulation doesn't have to be the highest grade on the market, but that churches should install it during the time of construction. "It's really, really cheap to insulate walls while you are building," he says. "It gets very expensive to retrofit."

Davenny notes that the weakest sound transmission path is often through the doors. "A good way to improve the sound isolation at the entrances to the sanctuary is to create vestibules with two sets of doors, and to seal the gaps around the other set of doors with gasketing," he says.

The Electronic Factor

One false assumption that many fall victim to is believing that bad sound is the fault of the audio system, leading to expensive technological upgrades without taking acoustics into account. While it's possible that tweaking the system will result in some improvements, it's necessary to first analyze if the problem is rooted in acoustics.

"People assume that they can fix the acoustics with electronics—it cannot be done," Colleran says. "You can pull things out with electronics, but the distance to the wall is going to determine what sound cancels at what frequency." If the wall is half a sound wavelength away, the sound will reflect back onto itself and cancel out, no matter how fancy your gear is.

Background Noise

A church's heating, ventilation and air conditioning system can play a large role in contributing to the level of background noise in sanctuaries, which can distract from the worship experience. How noisy your HVAC system can be without presenting a problem depends, again, on your worship style. Traditional-style services, for example, require very low background noise levels—Davenny favors those below NC-25 (or Noise Criteria 25)—while contemporary worship, because it is amplified, can withstand levels up to approximately NC-30 or NC-35. "The appropriate background noise target should be established early in the design, because low noise HVAC systems are typically more expensive than the higher noise systems," he advises. Other variables affecting HVAC noise include the location of the mechanical rooms and rooftop equipment in relation to the sanctuary, the vibration and isolation of this equipment, the installation of duct silencers and duct lining—which reduces fan noise—and ducts that are sized to reduce airflow noise in general.

Mechanical noise was one of the biggest issues facing Lakewood Church, Hall relays. The church worked with Houston-based Studio Red Architects and the acoustical consulting firm Russ Berger Design Group in Addison, Texas, to isolate the mechanical systems by jacking them up and placing them on spring-loaded shock pads, which minimize vibration when the system starts up. This machinery is located in the four quadrants of the arena, and to further isolate the sound, the church constructed cinderblock enclosures around them.

Retrofits

What if your church purchased an existing building, or you are conducting a retrofit of your current premises? Is it possible to fix poor acoustics long after the walls have been erected?

Colleran replies that the answer is a qualified, yes: "If the geometry is reasonable, we can work with the wall surfaces to either make them more absorptive or more acoustically diffuse," he explains. Poor geometry—the angles of the walls, the height of the ceiling, and so on—is, however, difficult to fix.

Outside the Sanctuary

While acoustical issues outside the sanctuary will be more basic, churches should take a few factors into consideration, especially in spaces where a number of people will be congregating for meetings, classes and choir practices. Colleran advises that if you are using a space other than the sanctuary for rehearsals,

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— Pete Garrett, partner, Studio Red Architects, Houston

QUICK-LINKS

Acentech
Acoustical consultancy
(617) 499-8000 • www.acentech.com

Lakewood Church
Houston
(713) 635-4154 • www.lakewood.cc

SOUND ADVICE The acoustics inside fellowship halls, cafes and other public spaces at a church must also be considered during design. Groups of people having conversations at the same time can allow noise to build up, and sound absorptive materials in the ceiling can help. Shown here, Champion Forest Baptist Church in Houston. *Photo courtesy of Studio Red Architects.*

ensure that the walls extend all the way up to the ceiling deck. "With drop-tile ceilings, such as those you would see in an office space—where they put it in first and then build walls between cubicles or offices—the sound will flank; it goes around the wall," he warns.

Davenny notes that churches should also pay special attention to gathering places, such as fellowship halls, which often host large groups of people having different conversations at the same time. "The noise level can build up without sufficient sound absorption," he says. In these spaces, the ceiling should be treated with sound absorptive materials having a high Noise Reduction Coefficient, or NRC.

The Acoustician's Role

Acoustical consultants—or acousticians—offer advice throughout the construction design process, often consulting with both the facility's personnel and the architect to provide recommendations concerning the acoustics. Because they do not sell product, the input they provide is unbiased. As members of a service industry, acousticians' fees vary, and are usually based on the level of involvement the client requires. A single design review may run between $3,000-$5,000, while a project requiring several design reviews and client meetings could cost anywhere between $15,000-$30,000. While these numbers are far from small, churches must weigh the return on investment: sometimes, paying a little more up front for solid advice can save a lot of money down the road.

Colleran notes that for smaller projects, his company will create a basic acoustical review of the facility. He acknowledges that for churches requiring more in-depth acoustical consulting, it's necessary to work with someone that can explain the science in laymen's terms. "Einstein could explain relativity to someone that was intellectually competent, even if they weren't a physicist," he says. "The same thing applies to scientists and engineers: if you don't understand what they are saying, it may be that they don't know what they are doing. If they can't put it into terms that you understand, don't spend the money."

Identifying Priorities

Hall relays that no matter the size of the church, all facilities must work within a budget. Even Lakewood Church, he notes, must abide by certain financial criteria. Once they have laid out their plan, churches should draw up a list of priorities to determine what must be done at the outset of the project, and what can be delayed. "We had created a list of items that were prioritized according to money and significance," he recounts. "There were things that could be done later at no great expense. If it's just wall treatment—that's something that we can do later. If it takes scaffolding and creates dust in the arena—that's something that needs to be done now."

At the same time, churches need to have the big picture in mind when projecting budgets for the future, notes Pete Garrett, partner at Studio Red Architects. "Once they have designed the acoustics, there is often not enough consideration for the electronic sound systems and video screens," he says. "Usually, there are budgets that the church has created, and there isn't enough money to buy what they need to install."

The highest priority, however, should be the building itself. "You get one shot at your building," Hall says. "PA systems come and go, but with acoustics, you need to get them right the first time. Spend the money to get the acoustics right the first time you do it, because you don't get another shot at it."

Carolyn Heinze is a freelance writer/editor.

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