

“... AND WHAT EXACTLY DO YOU MEAN BY ‘GOOD ACOUSTICS’?”



Singing in the shower . . .

The interior of a Rolls Royce Silver Cloud? What’s your idea of good acoustics?

As an acoustical consultant, I have heard many descriptions of church auditorium acoustics. There is the very reverberant church in which the pastor cannot be understood from the rear seats on the main floor, let alone the balcony, but where the organist was adamant that they not do anything to hamper the “good acoustics” of the church. There was the church with wood-paneled walls and ceiling with a really warm, musical acoustic, whose pastor complained about the echoes. But by far most of the churches I visit – ranging from excellent to horrific acoustically – are described by their staff and members as having good acoustics.

First, let’s discuss what is involved when we refer to the acoustics of a room. Probably the best-known characteristic is the reverberation time RT_{60} , which is the time required for a sound about the level of conference-table conversation to decay to inaudibility. Although probably the most familiar acoustical measure, RT_{60} certainly does not tell the whole story. A room may have an ideal RT_{60} and still have obtrusive echoes. The difference between echoes and reverberation is that echoes are discrete repetitions of a sound from one or two surfaces, while reverberation is a more-or-less continuous wash of sound bouncing off multiple surfaces.

Besides reverberation and echoes, there is background noise. This can come from outside (highways, etc.) or from inside (usually heating/ventilating/air conditioning -- HVAC). If it is too loud, speech intelligibility and enjoyment of music are both diminished.

There are several acoustical parameters that relate specifically to listener satisfaction and comfort. In a church, it is uncomfortable for a listener if the sound comes from a direction noticeably different from the location of the person speaking. This is the issue of *acoustical imaging*. The all-too-common 4-corner speaker location practice among amateur-installed sanctuary sound systems is famous for acoustically dismembering pastors, not to mention the muddling effect of artificial echoes created by sound sources at various distances from the listener.

Music sounds better if the sound at the left and right ears is significantly different. This is measured as *inter-aural cross-correlation*, or IACC. IACC is affected strongly by the presence of lateral reflections (reflections of sound from the walls of the auditorium), measured as *lateral energy fraction*, or LEF. Certainly these reflections need to be diffuse, rather than discrete, so that we hear a unified sound, not echoes.

The strength of arriving energy, or G , is a measure of how much louder a given sound source sounds in the room than it would at the same distance outdoors. G is sometimes called *room gain*. There are very few churches in which everything is amplified, so room gain is always important, even in contemporary worship spaces using predominantly amplified sound. An example of this importance is the Christmas pageant in which one of the children forgets to turn on the wireless mic, or accidentally knocks it off his/her clothing. There is also the person who uses a mic, but not correctly (the famous belly-button mic position), so that person is only nominally amplified.

The ability of worship leaders and musicians to hear themselves is crucial to their comfort and ability to speak/sing/perform well. While stage or in-ear monitoring can go a long way in improving this ability, a properly designed auditorium will support these worship leaders' acoustical communication. This support is particularly crucial for choirs, since there is no good way to assist choir members in hearing one another via the sound system, promises of certain overzealous salespersons notwithstanding.

Although it is affected by reverberation, echoes, and noise levels, speech intelligibility is a sufficiently important criterion that it deserves specific mention on its own. The original speech intelligibility tests used people reading carefully chosen word lists with listeners trying to identify what word has been spoken. In the last half-century, much research has gone into developing electroacoustical ways of measuring speech intelligibility with a reasonable expenditure of time and resources. The two most common of these measures are called "*percentage articulation loss of consonants*," or $\%AL_{\text{cons}}$ and "*speech transmission index*", or STI.

Now let's get back to the question in the title of this column: What exactly do you mean by "good acoustics"? In fact, each of the parameters discussed above has a range of values that defines "good" from specific points of view. Different members of the congregation – the young, the middle-aged, the elderly, the choir, the praise band, the pastor, the organist/pianist – will often have different points of view. Thus the acoustical design of worship spaces is far from a one-dimensional problem. Yet far too often the organ builder is given final say about the acoustics ("the more reverberation, the better"),

or that dubious honor is passed to the sound company (“the less reverberation, the better”). And equally often, the only answer considered for acoustical problems is thought to be a new sound system or some fuzzy stuff glued to the wall. If your only tool is a hammer, every problem looks like a nail.

A church with any dimension that exceeds 60 or 70 feet should involve an acoustical consultant in the design phase. Certainly an acoustical consultant – not the architect or the organ builder or the sound company -- is the person to call to deal with acoustical problems in an existing facility. “Acoustical consultant” does not mean “anyone who knows how to operate, or even design, a sound system”. A consultant’s specific training and experience in acoustics should be documented. Membership in the relevant professional societies, such as the Acoustical Society of America and the Audio Engineering Society, is also important.

Objections to using qualified acoustical consultants are often raised on the basis of cost. A good consultant is expensive. But so is heat and air conditioning for the church building. Given that churches with good acoustics average 5% to 20% higher attendance than similar churches with poor acoustics, and that a church’s ability to minister through worship services is significantly affected by its acoustics, the cost of a good consultant may well be an investment rather than expense.



The Organ Designer and the Sound Guy Discuss Acoustics