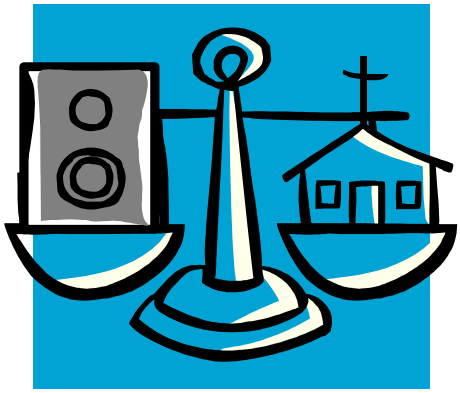
Acoustical Balance for Worship Spaces

By Vance Breshears

Acoustical Requirements for Worship

Acoustics is often perceived as more an art than a science. I've heard people refer to various rooms as being "acoustically perfect," but have never figured out what that means. I've also been asked what the perfect acoustic space is. My response is always "perfect for what?" I don't believe there really is a perfect acoustic space, even for any one specific function or program. While a few concert halls might be very good for a specific application, I don't know that any room could be called perfect.



If you search, you will find that much has been written about the natural room acoustics for performance spaces – concert halls, opera houses and the like. But lately, the natural acoustical environment as applied to worship spaces has become the object of greater interest as worship program styles change and a greater number of worship spaces are constructed. This increased interest is understandable. After all, there are many more worship spaces attended by more people than there are performance spaces.

The acoustical requirements for a worship environment are generally very different from a performance room. In a symphony hall, for example, the acoustical requirement is to support and enhance orchestral music. Sometimes the room can musical programs, but orchestra performance is the main focus. In contrast, one of today's contemporary worship spaces will most likely require a wide variety of program functions and their correspondingly varied acoustical requirements. For example, in a contemporary church today, there may be musical styles that include choir, organ, rock and roll, and everything in between, sometimes one musical style right after the other. Rarely will you find the requirement for such varied musical styles within the same short timeframe in any other type of function or facility.

While these varied musical styles place a great demand on the acoustical performance of the space, there is an additional requirement not found anywhere else. Unlike performance auditoriums or theaters, a worship space also has a requirement for the acoustical support of congregational participation in worship. The need to meet all these acoustical requirements is huge and is rarely achieved.

Acoustical Characteristics

The behavior of sound in any space can be described in terms of three different aspects: direct sound, reflected sound and reverberation. Simply enough, the direct sound is the sound that travels directly from the source to the listener. Reflected sound is the sound energy that follows a distinct path through a room bouncing off various boundary surfaces to arrive at the listener. Much like a light reflecting off a mirror, reflected sound is well defined and travels in a discrete path. Reverberation, on the other hand, is the diffuse acoustical energy in a space that has little apparent direction. The sounds we hear can be broken down into these three components and can be defined, measured, analyzed and even simulated.

A worship space that has acoustical problems is usually found to have excessive reverberation or late arriving reflections that are perceived as an echo. The really problematic rooms will have both. And while both of these problems involve too much acoustic energy, it is not always the problem. Sometimes a room can be too "dry" where there is a lack the adequate sound energy that would otherwise be pleasing for the style of music being played. A movie theater would be a good example of a room lacking in acoustic energy.

Some worship spaces are so dry and have so little reverberant sound energy that the reflections off doors or other small surfaces are noticeable. A worship space that is too dry will be unfavorable for congregational participation. When the congregation sings, they don't hear themselves or anyone else. But regardless of which side of the scale you are on – too much or too little sound energy – there usually is a combination of acoustical problems in any given room.

Reverberation Time

The acoustical value of reverberation time is often overused and has tended to become an oversimplification of the subjective acoustical performance of a room. For example, given any two rooms with similar cubic volume, it is often thought that the room with the longer reverberation time will have greater problems with speech intelligibility and clarity of music than the room with the lower reverberation time. While excessive reverberation is often a primary problem it is not always the case. The *level* of reverberation (not just reverb time) will have a substantial impact on the performance of the room. The relationship between the three aspects of the room, direct sound, reflections and reverberation, will all contribute to the room performance.

A better indicator of intelligibility or clarity in a room would be the ratio of the direct sound to the reverberant or reflected sound. This value is often calculated or measured when talking about sound reinforcement systems, but can apply to natural acoustics as well. In general, the greater this ratio, the better intelligibility and clarity will be. For example, you can have a very reverberant room with a long reverberation time, but still achieve good intelligibility by increasing the ratio of the direct sound to reverberant sound.

Another method to evaluate the acoustical environment of a room would be to measure the ratio of early acoustic energy as compared to late acoustic energy. This "early to late ratio" is evaluated at various different time split values (for determining what is early and what is late) and is very beneficial in determining how well a room works for worship related functions. For congregational participation, early energy is very beneficial in enhancing the experience. Ideally, people want to feel like they are singing in the shower. This "singing in the

shower" effect is created by early sound energy coming from reflective surfaces in close proximity to the listener.

Acoustical Balance

All of this discussion of acoustics provides a foundation to address the issue of acoustical balance. For purposes of this discussion, balance can be defined as the relationship between listeners and various surfaces and their finishes (reflective or absorptive materials) throughout a room.

As an illustration, let's take two very similar rooms that have identical cubic volumes and very similar amounts of absorptive materials. By definition, these two rooms will also have very similar reverberation times. The primary difference between these rooms is the distribution of absorption within the room.

One room has most of the absorptive surfaces close to our listener and the reflective surfaces further away. This happens naturally in a room with carpeted floors, padded seats and hard reflective surfaces on the furthest walls and ceiling. The other room has hard reflective surfaces close to the listeners and absorption on the surfaces furthest from the listeners. This happens in a room where the floor under the seats is reflective, the backs of the chairs or pews are reflective, and there may be short vertical wall surfaces that separate seating areas.

The first room will have very little early energy and most of the reflected sound energy will be late in time since the reflective surfaces are the furthest away. The second room will have more early reflected sound energy since there are reflective surfaces close to listeners. The room with more early energy will work much better in terms of intelligibility and clarity and will be much more enjoyable for congregational singing. Again, the two rooms can have identical reverberation times (which is a function of the amount of absorption in the room). However, the distribution of that absorption is quite different.

If we were to turn the first room upside down (in acoustical terms) and have the reflective surfaces close to our listener, then the reflected and reverberant sound energy in the room would arrive much earlier in time or closer to the direct sound. Think of it in terms of the density of early energy in the time domain.

A room that is balanced well in acoustical terms will not only be better for performance functions but also for worship purposes as well. Such a room would have a tendency towards more early acoustical energy. Planning for a good acoustical balance is best done in the architectural design phase with the idea to address not only surface finishes and construction materials, but also the physical architecture of the room itself. Architectural elements such as ceiling clouds and shaped wall surfaces will be useful in achieving proper acoustical balance. Also, by splitting up seating areas into smaller seating pods or trays, a small intermediate vertical surface can be introduced into the space. These short walls will help to make the room acoustically smaller and provide more early sound energy.

Careful planning in the design phase can make a dramatic improvement in the acoustics for worship. Observing the elements needed to maintain acoustical balance is one of the key ingredients to a good design. Singing in a good acoustical worship space can be a wonderful experience – almost as good as in your shower. ■

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