

Sound Advice

Helpful Information from *Stewart Acoustical Consultants*

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Acoustical Considerations in

Worship Spaces

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The acoustical design of a worship space begins with making the room acoustics match the musical program of the service. Sound systems must be carefully designed for speech clarity in rooms optimized for classical religious music. For contemporary music, the room must be friendly to a variety of sound sources. Some ideal goals present conflicts requiring compromises. The relative importance of various issues must be established based on discussions with the congregation.

A major acoustical factor describing most worship spaces is the reverberation time. This is a measure of the room liveliness resulting from multiple sound reflections from walls and ceiling. More reverberation is desirable for traditional, classical, and organ music than for speech or modern music. Reverberation increases with room volume, which may be desirable to a point, but it limits speech clarity. Reverberation is reduced by adding sound-absorptive materials to the room. People in the room absorb sound and reduce reverberation. This variation due to the number of people present is reduced by using pew cushions (covered by people) or making the room larger with added absorption. However, this can hurt the loudness of congregational singing.

Most but not all worship spaces will be in one of three categories, characterized by reverberation times appropriate for different music styles. A congregation should first consider where it fits among these styles.

Contemporary Music. - These spaces often seat a large congregation in a fan shape. They will have a reverberation time in the range of 1.0 to 1.5 seconds. A primary goal is to make the room friendly to the sound system. All speech and music are usually amplified with electronic instruments frequently used. The preachers often employ a wide dynamic range in their voices. This system is designed to provide powerful music. The sound of the music is controlled more by the audio system than the room. The room is designed to avoid harmful reflections, which often requires significant wall treatment. The room volume should be limited to prevent the need for excessive added absorption that could hurt congregational singing. The sound system is often expensive because of many sophisticated production features and powerful music capabilities.

Classical Music. - These spaces place a strong emphasis on classical music and organ. A reverberation time in the range of 1.7 to 2.2 seconds requires careful design of the sound system for clear speech. Some rooms may have longer reverberation times, making it very difficult to achieve clear speech. The most successful of these rooms are usually arranged in the classical "shoe box" shape with a moderately high to high ceiling. Those congregations planning to invest in a pipe organ should consider this style. To preserve loudness of congregational singing, the room should be optimally sized to reduce the need for added absorption. This means the sound system must be carefully designed to aim the sound into the people and minimize wall reflections and reverberant sound. The system designer should be selected carefully. The sound system may be expensive because of the speakers needed to control the placement of sound for speech. Supplementary stereo music loudspeakers may be desirable.

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Balanced. - Many worship spaces in our region are this compromise style. Reverberation time is in the range of 1.3 to 1.8 seconds. These spaces provide both clearly understood speech and acceptable conditions for both contemporary and traditional church music. The sound system is usually simple and less expensive unless the space is very large or features are provided for a strong contemporary music element.

Notice that higher ceilings are required for the more reverberant styles. Even evangelical and balanced spaces should have enough ceiling height to allow sound from a speaker cluster to cover most of the room. Otherwise, a distributed speaker system is needed. Extra height will require more absorptive wall or ceiling treatment to limit reverberation. This adds some cost. A benefit is that the room acoustics will not vary as much with the number of people present. A problem is that the extra absorption will reduce the loudness of congregational singing.

Materials for the walls, floors, and ceiling must be carefully selected. It can be difficult to both get the room right at the speech-frequencies and assure balanced reverberation at low and high pitches of music. Carpet and other sound absorptive treatments should be minimized in the livelier rooms unless they are very large. Carpet deadens any room, especially at higher pitches. However, it cushions footstep noise. People add absorption to the room. Thus, the acoustics will vary with the number present. Pew cushions are preferred to reduce this variation. Carpet under the pews can help to a lesser extent. However, either will deaden the room more when the congregation is standing. Some gypsum or wood paneling with airspaces behind it is desirable to control bass boominess. However, too much of this can leave a room without "warmth." Sometimes we must double-layer some gypsum to control this.

Initial reflections from the rear wall behind the congregation, or from the front side walls of rooms more than 55 feet wide, can be a problem. Such reflections can arrive at a listener delayed just enough in time to cause difficulty in understanding speech. We control these problems in livelier rooms with room shape and sound scattering surfaces. Sound-absorptive materials can control both reverberation and bad reflections in rooms for contemporary music. Where concave walls or ceiling surfaces are necessary, focal points that are within the listening space must be carefully avoided. It is most important that focal points not be where there may be a listener or speaker.

Musical elements, other than antiphonal choirs and organs, should be carefully located as close together as possible, within a 40-foot circle. The choir should face the congregation on a raised platform, with the organ pipes above and behind them. If possible, the walls and ceiling should be carefully shaped around the choir. The ceiling should be 20 to 30 feet above the choir. Acoustical design of rooms with pipe organs should be carefully coordinated with the organ maker.

Good, trained speakers should be understood throughout many rooms without amplification. However, most congregations will want a sound system anyway, especially for lay speakers and to achieve special effects. Livelier rooms present more difficulty for speech. A speaker cluster over and a little forward of the pulpit usually provides the best results. Additional speakers for the choir and under balconies may be needed. Widely split speakers on each side at the front can be useful for music, but should be avoided for speech. Systems for the hard of hearing should be considered.

It is very important that noise from the ventilation system and other sources not be distracting, and be quiet enough to allow the congregation to hear. The larger the room, the quieter the background sound needs to be. Mechanical rooms should not be immediately adjacent, and equipment should not be mounted on the roof directly over the room. Fan noise must be carefully silenced before it enters the room through the ducts. Airflow through diffusers must be sufficiently slow to avoid generating excessive noise at those diffusers. The noise of the outdoor components of the air-conditioning system should be considered for new or expanded facilities in residential communities.