

# REVERBERATION - SERVING SOUND OR SERVING MUSIC?

## An Heretical View of Acoustics

By

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(Article reprinted with corrections from *The Diapason*, November, 2000)

In the world of music at large the organ is often considered an outcast, a curiosity, or at best an antique. One reason is that much of the organ world is thought to be more concerned with sound for its own sake than with music. This characterization may be unfair, but it is partly our own fault. Organ builders and organists are notorious for demanding acoustics with exceptionally long reverberation times. True, much choral and organ music (often that written for the church) sounds best in a resonant environment, but this fact has often clouded our thinking . . .and the music! A great deal of music played on the organ is not served well by overly long reverberation because clarity is lost. Too much reverberation can blur form, harmonic structure, rhythm, articulation, and dynamic contrasts. Although it is hard for organ devotees to admit it, a resonant acoustic that is excellent for orchestral and other music can also serve the organ well.

There are two reasons for the dogmatic insistence on long reverberation times. First, it is a natural reaction to the discouraging trend toward studio-like acoustics in modern church architecture. In order to gain any reverberation at all, we have become used to asking for the moon. Ask for five seconds and be happy with one and a half is the usual formula. Unfortunately, however, this strategy often backfires, leaving organ advocates with little credibility among architects, acousticians and those who pay for buildings.

The second reason is that organs in highly reverberant rooms make a spectacular sonic effect. It is said that any kind of noise sounds well in a stone cathedral. But what does this mean? Does it mean that the overall result is musical? Or does it mean only that the sound itself is exciting, dramatic, rich with color? All too often the latter is the answer. Likewise, amateur singing sounds fine in the shower as does student trumpeting in an empty gymnasium. But these, of course, are illusions. What is being perceived as music is often nothing more than exaggerated sound. More is required of an acoustical environment to make satisfying music.

### What Is A Good Acoustic For The Pipe Organ?

It is commonly believed that all organs are enhanced by a very long reverberation time. We must differentiate among general types of organs (and the music played on them) and their acoustical environments. First, consider the cathedral organ. Although no music is successful when all clarity is lost through excessive reverberation, certain branches of the organ and choral repertoire – particularly that written for grand churches – require a reverberation time that is greater than that required for other forms of music.

At the other extreme is the high pressure theater organ. This type of instrument is far more successful in a studio or heavily draped theater. Otherwise the detail is lost. Their unique ability to create accent and to carry complex rhythmic patterns is partially defeated if reverberation is too great. Special purpose venues for these two extremes of the spectrum are not our concern here. This article deals instead with acoustical requirements for organs in the middle ground that are required to perform an *eclectic repertoire in typical American churches and in multi-purpose concert halls*.

### **Amount of Reverberation**

Too much is just as bad as too little. The lower limit of reverberation is easy to determine. It is the point at which music sounds dry, dull, and lifeless. This lower limit is higher for organ than for other instruments primarily because organ pipes are simply on or off. There is little that can be done to shape their tone. Some organ builders strive to improve the flexibility and responsiveness of the pipe organ; however, it seems unlikely that this can be achieved to the degree it is found in other instruments or in the human voice. Therefore a reasonably resonant acoustic is necessary for the church or concert pipe organ.

It is more difficult to determine the upper limit of reverberation. When does reverberation stop adding warmth and grandeur and start adding confusion? There are five determinants:

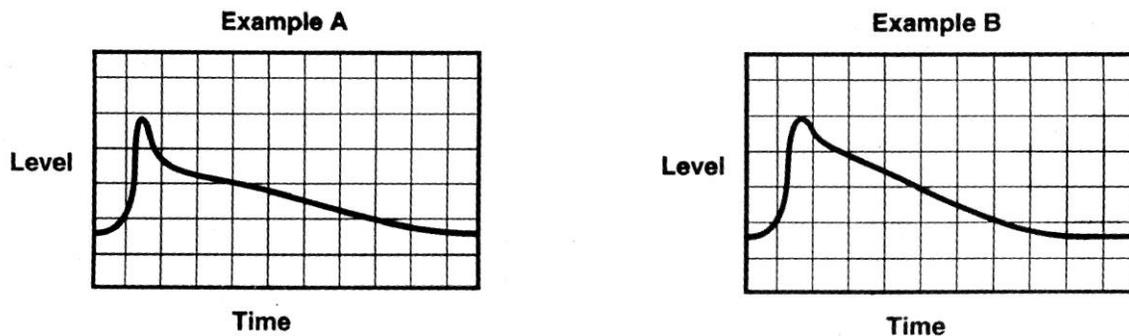
- When there is so much overlap of sequential sounds that musical line and structure lose definition despite the most careful articulation by the player; in other words, when the player's ideas get lost in the process of transmission to the audience. At that point the performance becomes an impression of sounds rather than a projection of musical ideas. (Those satisfied only with impressions of sounds are much like the early Hi-Fi enthusiasts who favored recordings of locomotives!)
- When the player loses control of rhythm.
- When it becomes impossible to create accent, which on the organ is accomplished more through durations of silence and sound than it is by increase of loudness.
- When sudden changes of dynamic level are obscured.
- When sharp contrast in tone color is clouded.

All of these musical situations, and others, caused by excessive reverberation are not tolerated by most musicians. Unfortunately, however, they are sadly disregarded by many in the organ profession, much to the detriment of their credibility in musical circles. We are sometimes willing to sacrifice ten minutes of music to get five seconds of sound at the end of the last chord!

## Quality of Reverberation

Frequently, the total amount of reverberation time is the only consideration in specifying ideal organ acoustics. But we should be far more interested in the quality of reverberation than in its duration. There are three qualitative elements that seem most important to me as an organ designer:

- The intensity (power curve) must be as high as possible. I was first made aware of this in visiting some of the great churches of France. There was a quality of reverberation there quite different from even the best reverberant rooms in this country. Why this is so must be the subject of another enquiry; however, the nature of this quality is vitally important. What I found was that the intensity of sound stayed quite high throughout the reverberation period and then trailed off rather quickly. This produced a most satisfying, rich, warm sound. In other buildings with an equal duration of reverberation, but with quickly decreasing intensity, the result is a disturbing confusion. I attribute this to the changing nature of the sound during the reverberation period. My conclusion, based upon much observation, is that it is far better to have a short, intense reverberation period than to have a long, weak one. The charts below show this concept.



While the curve at left illustrates a longer reverberation time, the one at right shows a higher reverberant level and hence produces a richer acoustic.

A measurement which may be more valuable than reverberation time (RT) in expressing this quality of intensity is early decay time (EDT). This is the time it takes a sound to decay by 15 decibels, whereas RT measures the sound until it decays by 60 decibels. Obviously EDT is measuring the first and most intense part of the reverberation. A high sound level during the first seconds and a total reverberation period extending very little longer than the EDT describes my ideal reverberation characteristic in a more precise way. Exact numbers, of course, vary with each situation; however, the idea of a high ratio of EDT to RT is true in all cases.

- The decay of sound should be smooth. A series of fast echos (much like clapping one's hands at the top of a deep well) are called flutter echos. These often occur in buildings with parallel walls located close together or with domes and barrel vaults which have a focal point at a sound source. These are extremely deleterious to musical effect. They can be so serious as to confuse performers while irritating the listeners. Sometimes they can be sensed throughout the room, but often they are localized. This characteristic of reverberation, a yodeler's delight, is ruinous to music, or for that matter, clarity of speech. The quality of reverberation that we seek is a sound dying away, not a sound being reiterated.
- The room should sound the way it looks. The eye leads the ear to expect a certain amount of reverberation. When it is either more or less, even the amateur listener detects that something is wrong.

### **Frequency Response**

Reverberation time is such an issue that other related characteristics are sometimes overlooked in specifying acoustical design. Frequency response is one of the most important of these. I find it far easier to work in a building with a smooth frequency response than one where there are peaks and valleys along the spectrum. The amount of reverberation should progress evenly through each frequency range. The bass should have slightly more reverberation than the mid range and the treble should have slightly less in order to avoid shrillness. One of the great faults of most buildings is the inability to support the deep bass of the organ. The unfortunate tendency of many buildings to also exaggerate treble makes bass seem even weaker. Bass is, after all, one of the characteristics that makes the organ the king of instruments. However, if low frequency reverberation is overemphasized, the heavy, often slightly slow speaking bass of the pipe organ becomes ill-defined.

### **Dispersion**

The sound producing area of a pipe organ is large. Sounds of different color and intensity emanate from various places within the organ case or chamber. If a room is shaped in such a way that sounds coming from different points are focused to particular listening areas, it is impossible to achieve good ensemble. The ideal acoustic disperses sound evenly throughout a room. Acousticians and architects can achieve this through the application of various shaped dispersion elements.

### **Distribution**

Sound should be distributed evenly throughout the listening area. Organ builders encounter many rooms which have hot spots and dead spots. Some of these may involve overall loudness, others may emphasize certain frequencies. The first concern in good distribution is correct placement of the organ. Whether free-standing or in a chamber, an organ must have adequate communication with the listeners. Once that is achieved, the architect and acoustician can eliminate sound traps and provide proper reflective surfaces.

## **Presence**

Reverberation that appears to be happening at a distance is not very satisfying. The listener should be immersed in the reverberant field, otherwise the effect is similar to listening to music coming from the next room. It is most often desirable for the organ to sound as though it is located in the same room as the listener, even if it is in a chamber. Many points of organ design are involved in this issue but acoustical factors are important as well. The chamber opening to the listening room should be as large as possible. The chamber should not be overly deep nor wider or taller at the back than it is at the front. Finally, the organ should occupy enough space so that the chamber does not possess its own reverberant field. If the sound being projected into the listening room comes with a built-in echo or hollowness, the result is more confusion. It must be noted that in some liturgical settings the opposite of presence, a sense of mystery, is valued. It is much easier to produce this quality in a chamber than in a free-standing case. Thus, a chamber can, in some circumstances, be very advantageous.

## **Background Noise**

Because the organ is a “sostenuto” instrument lacking the percussive attack possibility of most other instruments, control of background noise is especially important since most background noise is also of a sustained nature. I refer especially to air handling equipment. Many types of organs have as one of their great virtues an extremely wide dynamic range. If background noise is not under control, the softer end of the organ’s tone is lost.

## **Loudness**

Obviously, all of the qualities listed above which contribute to a warm, resonant sound require adequate loudness. This is a question of organ design. If an organ does not have the sonic energy to excite the reverberant field of the room, all of the efforts of acousticians and architects will be to no avail. The organ builder must design the instrument to fit the acoustical size of the listening room without being overbearing. All too often acoustical size is confused with the number of stops. Sound output has a great deal more to do with stop selection, layout, scaling, wind pressure, voicing, and finishing. In most cases, it is best to keep the organ as small as possible to achieve the musical and acoustical results desired.

## **Placement of the Organ**

Placement of organ pipes is a critical element in acoustical design. If sound is not projected properly from its source, even the finest acoustic will not save the instrument. Proper placement and the tonal design of organs to fit various placement situations should be the subjects of a lengthy article, however a few summary comments are in order here. Although high, side organ chambers are often very successful in churches where the organ’s role is primarily accompanimental, it is generally true that the best placement for an organ is directly behind and above the other performing forces. The organ should speak down the central, long axis of the room. This often poses a problem especially when inserting a pipe organ into an existing space. Usually, the difficulty is finding height for the organ. The lowest point of the sound opening should start one to two feet above the heads of the farthest “upstage” row of choristers when standing. This is often as much as 15' above floor level. The top of the tone

opening should be a minimum of 18' above that. For some types of organs it should be more. If adequate height is not available, there arises the challenge of how to present the organ visually. Traditionally, organs are narrow and tall. Short, squat ones tend to look ridiculous. Since the organ is known as the king of instruments and produces a fittingly noble sound, a "Punch & Judy" pipe display is inappropriate. There are no easy solutions. If a compromise must be made, the musical result must always be favored over the visual one. Sometimes it is best not to show pipes at all and let the instrument speak through grilles. A smaller instrument is often the best solution. It will open far more options for good placement than a larger one. A well placed organ is an acoustically efficient organ.

## Summary

Over the years I have found it most comfortable to work in buildings with a moderate acoustic. It is depressing to face a totally dry environment where the organ's tone is given no help at all; however, it is equally frustrating to deal with an overly live building where all of one's efforts in careful tone regulation are lost in a musical muddle. Approximately two and one-half to three seconds of intense, smooth reverberation (when the room is occupied) combined with even frequency response, good dispersion, distribution, presence, and low background noise as well as adequate loudness yields the ideal atmosphere. A few examples from my experience that come quickly to mind are Old South Church in Boston, First-Plymouth Congregational Church in Lincoln, Nebraska, the University of Arizona (Holsclaw Hall) in Tucson, Severance Hall in Cleveland, the Boston Symphony Hall, and many of the famous 19th century town halls throughout England. In other words, this writer's ideal for organ sound is the same as that for a first class symphony hall of the more reverberant type. Such an environment provides warmth for organ tone combined with clarity of musical line.



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