The Organ and its Acoustics

by Glenn White, acoustician

The organ, as every organist knows, requires a room with proper acoustics to be a completely satisfactory musical instrument. The instrument itself, voiced and tuned, cannot generate the exciting sounds that a sympathetic acoustical environment provides.

What acoustical requirements enhance the sound of an organ? First, the room must be large enough to accept the organ's sound and blend it together, then cloak it in an aura of reverberant energy, which is more a characteristic of the room than of the organ. The reverberant sound must not be too loud compared to the direct organ sound, which would detract from the clarity of the musical line, and it should have a non-directional quality which seems to come from everywhere. The listener needs the impression of being immersed in a field of sound within a diffuse reverberant blanket, but with a true sense of directionality for the direct sounds from the instrument itself.

The quality of subjective directionality combined with diffusion is sometimes called “envelopment,” and can be elusive and difficult to achieve. Envelopment, simply, is achieved by suppression of echoes or discrete strong sound reflections, while providing reflecting surfaces that assure the listener hears sounds arriving from the sides of the room rather than from the ceiling or straight ahead.

Sounds reflected from the ceiling should be diffuse, with no discrete reflections to any location in the room. The room must have no “right tri-corners,” which send strong discrete reflected sounds in unwanted directions. The reflected and reverberant sounds must contain the correct blend of high and low frequency energy to complement the sound produced by the organ without placing any false emphasis in any musical register.

When Lola Wolf asked me to design this room's acoustics, I was exhilarated to work on a project that was yet unbuilt. Then, recalling frustrating experiences with some architects, I asked what conditions and requirements would be imposed.

“How big is the room to be?” Lola answered, “You tell me how big it should be.” I asked what kind of interior finish she had in mind. “She said, “You tell me what it should have.” As we conversed, I realized I was about to live an acoustician's dream – a commission with no restrictions or preconceived ideas. Adding to the delight, Dale Kowalchuck, the contractor, made the most complex shapes without question, and with no technical difficulty at all.

What determined the size and shape of this room? Starting with the size and shape of Martin Pasi's already designed organ case, I chose the square root of three as an appropriate irrational ratio to use as an integrating design factor. An irrational ratio is no common integral factors, root 3 being close to 1.7320508 ... Other irrational ratios have been used in art and architecture for centuries, but the house and lot seemed, to my eye, to incorporate a ratio of about root 3. (Not wanting to appear weird at the time, I did not confirm this with measurements.)

After selecting the ratio, it became a fairly simple matter of scaling from the dimensions of the organ itself to arrive at the height, width, and depth of the room, balcony height and depth, etc. The fun began when we designed the wall and ceiling shapes. The walls are convex to achieve proper diffusion, but no so much as to prevent lateral reflections. Root 3 again came into play for the fadii of curvature, which

are nearly – but not quite – equal to each other. The inward, upward tilting of the walls is imperative for proper envelopment. The amount of tilt was a compromise, being a little less than a root 3 ratio to the curvature radius and width at the ceiling to preserve architectural integrity.

The walls look simple and, I hope, elegant, but they are very complex in design and structure. The surface density is six pounds per square foot to get the correct bass reverberation. The curves have many strategically placed stiffeners inside which prevent too much wall vibration. The ceiling provides complete diffusion to prevent echoes or reflections that would call the listener's attention to the ceiling. There are many small design details that are not very evident but assure that no echoes or false tonal responses creep in.

I would like to thank Lola ... for giving me the rare and exciting opportunity to design a recital hall from scratch, and Martin Pasi for recommending me to then. I have seldom if ever worked with a more harmonious and dedicated group of people.

In the words of a long forgotten Roman punster, ***NE IMPEDIATUR MUSICA***.