Isabella Stewart Gardner Museum - Calderwood Performance Hall's Acoustics

By Motoo Komoda

In our March, 2012 newsletter, I wrote about the opening of the Isabella Stewart Gardner Museum's new wing and mentioned that we were waiting until the museum hosted Calderwood Performance Hall's opening series of concerts to take acoustical measurements in the new hall. In this article, I will discuss key features of the hall's acoustical room design and some particularly memorable highlights of the hall's first concerts.

As can be seen on the accompanying architectural drawings, the basic shape of the new hall is a cube that measures 14 m. on each side, a configuration that posed several difficult challenges from the acoustical design perspective. Because of the acoustical obstacles inherent in a cube-shaped hall configuration, most standard acoustical engineering textbooks categorically advise against adoption of the cube shape when designing a concert hall.

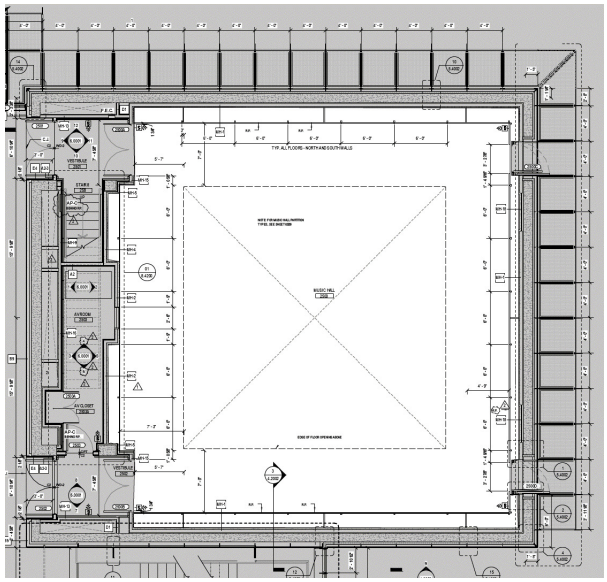

Figure 1: Calderwood Performance Hall plan

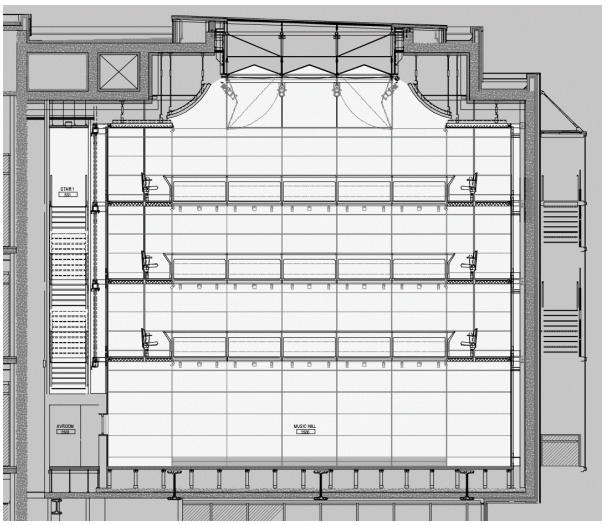

Figure 2: Cross-section drawing

Mitigating the Acoustical Challenges of a Cube-shaped Hall

Parallel floors and ceilings can cause a hall to have flutter echoes. To prevent this undesirable phenomenon from occurring in Calderwood Performance Hall, we negotiated the use of pyramid shapes in the glass of the hall's skylight, thereby creating surfaces in the ceiling that are not parallel to the hall's floor.

The hall's balcony tiers also have parallel side walls. On most of these wall surfaces we installed 2.5 mm. wood panels with 40 percent open perforations. These panels are acoustically transparent and promote diffusion of high frequency sounds. The three layer gypsum board wall behind the panels has sufficient rigidity to produce

excellent sound reflections while the perforated wood panels ensure the prevention of flutter echoes. In addition, each balcony underhang connects to the hall's walls at 90-degree angles. We pursued an iterative design process for this part of the hall and achieved a design that also effectively produces sound reflections from each of these corners.

Figure 3: The ceiling's skylight with pyramid-shaped glass

Figure 4: Perforated wall panels and waffle-patterned panels attached to balcony underhang

Testing in Scale Models

Our room acoustical design process for this project included building a 1/24 scale model and conducting acoustical testing of the hall's configuration in the scale model. In addition, we decided to do additional testing of one element that we wanted to install at the concrete balcony underhangs. We had developed a plan to use waffle-patterned ceiling panels at the concrete balcony underhangs to promote sound diffusion, but this kind of repetitive pattern (a diffraction grating) can sometimes be the source of undesirable acoustic phenomena (as explained in our September, 2005 newsletter). To best understand how the waffle-patterned panels would perform as acoustical elements in Calderwood Performance Hall, we built a 1/10 scale model of a balcony with a waffle-patterned panel attached to the balcony underhang and conducted tests. By testing in the scale model, we checked that these panels would achieve the desired sound diffusion result.

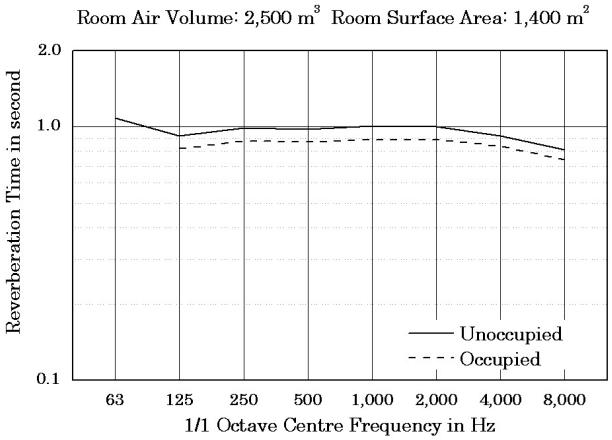

Figure 5: Calderwood Performance Hall's reverberation time characteristics

As a result of our final acoustical testing, we further confirmed that echoes cannot be detected in the new hall. The reverberation time measures 1.0 seconds (at 500 Hz, in an unoccupied hall), from which we calculate that the reverberation time measures 0.9 seconds when the hall has a full audience. The reverberation characteristics

are mostly consistent across the entire frequency spectrum. Based on the results of our measurements, our design achieved the quantitative acoustical physical properties that we set as the objectives for this hall.

Concerts in Calderwood Performance Hall

As I mentioned in the March article, one of Calderwood Performance Hall's most distinguishing characteristics is the placement of the audience seating. The 300 seats entirely surround the stage, starting on the ground level and continuing in single-row balconies that rise vertically on all sides of the hall. When I sit in this hall, the sense of intimacy is so strong that I feel as if I could touch the performers merely by extending my arm. The single-row arrangement of 80 percent of the seats means that almost all of the audience enjoys unobstructed "VIP" seating. (Only the ground level audience section has two rows of seats.)

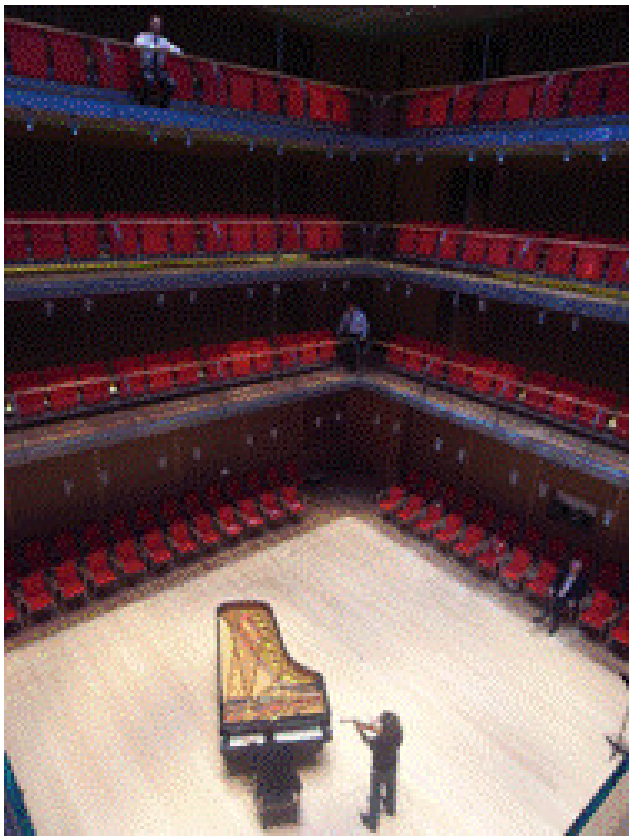

Figure 6: Paavali Jumppanen's piano with the lid removed

However, the equal proximity of the audience from all sides of the hall also means that the hall has a square stage, which creates a totally different stage environment compared with the stages of most other performance venues. There is no directionality from the stage to the seating and, not only does the audience surround the performers for 360 degrees in the horizontal dimension, but much of the audience looks down on all sides of the stage from the balconies. For both solo and ensemble performances, the performers need to think carefully about how they configure their seating on this hall's stage.

When Paavali Jumppanen gave his solo performance, he tried removing the lid from his piano. He found that the piano's notes rose toward the ceiling and that the reverberations blended well throughout the hall. Soprano Kiri Te Kanawa deftly and slowly turned to face each side of the audience as she sang, greatly impressing me by her attention to connecting with each and every member of the audience. It was truly a wonderful experience to listen to her beautiful voice at such close proximity.

Figure 7: Circular ensemble seating configuration of Yo-Yo Ma's cello concerto performance

When Yo-Yo Ma began to rehearse the Haydn Cello Concerto, he placed his cello riser in front of the en-

semble and sat with his back to the other musicians. This was not a perfect configuration and he decided to both abandon the riser and to sit together with the ensemble in a circular configuration. This enabled the musicians to have eye contact with each other as well as with Mr. Ma and improved their ease of playing.

I watched and listened to these and other rehearsals and concerts that celebrated the hall's opening. Each musician and group of performers brought a creative approach to performing in the hall's unique environment. I look forward to learning about how other musicians creatively adapt to this intimate and delightful new venue at the Isabella Stewart Gardner Museum.

You can read more about the museum's music program or listen to a podcast at the music page of the museum's website.