

Kansas City's New Concert Hall Specifications Tested in 1/10 Scale Model

By Kayo Kimotsuki-Kallas

Soon, the under-construction Kauffman Center for the Performing Arts (<https://www.kauffmancenter.org/>) will re-define the cultural landscape of Kansas City, Missouri, a city famous for its many beautiful fountains and for the fine “Kansas beef” steaks that can be enjoyed in its restaurants. The new Center comprises a 1,600-seat concert hall that will be the home hall of the Kansas City Symphony, and a 1,800-seat proscenium-stage theater, primarily intended for ballet and opera performances. The Center's architect is Moshe Safdie and Associates (<http://www.msafdie.com>). Nagata Acoustics is the project's acoustical consultant, providing the entire range of services from acoustical design and related construction management to acoustical measuring and testing at the project's completion.

In the November, 2006 issue of this newsletter we shared an overview and news of the ground-breaking milestone of this project with our readers. In this article, I will focus my discussion on the two rounds of testing performed in the 1/10 scale model we built for the project. The scale model testing took place last winter and again in the summer of 2007.

The Hall's Shape, the Design in the Details and the 1/10 Scale Model

The seating of the Kauffman Center's concert hall surrounds the stage in a vineyard configuration. As shown in the plan and 3D cross-section views of the hall that accompany this article, the hall's footprint has an oval shape and the front wall of the hall forms a sweeping arc in the vertical direction. Overall, the hall's interior architectural design includes many concave surfaces.

While concave surfaces figure prominently in the hall's architectural design, from an acoustical perspective, the use of concave surfaces is always approached with caution because they unfortunately raise concerns about undesirable sound focusing and echo phenomena. In order to maintain the integrity of the architect's concave design, we prevented sound focusing problems by using latticework and metal mesh materials with a large percentage of open area for the front wall's concave surface, building sound diffusing elements behind the mesh wall. In addition, we specified precisely determined angles for the sidewalls of the hall so that they function as effective sound reflecting surfaces, proactively incorporating sound diffusing elements that visually blend well with the hall's architectural design. Throughout the room interior, in every detail of the design, we successfully emphasized and implemented the acoustical design needs of this concert hall.

Keeping all of these carefully devised detailed plans in mind, in the 1/10 scale model we aimed to reproduce as faithfully as possible all of the acoustical design specifications of the actual concert hall. To achieve this end, we adapted our choice of materials and used creative scale-model building techniques. To the eye, the scale model appears to be constructed with elaborate detail and precision. Even the architect's and general contractor's project

managers found that the scale model aided them greatly in understanding the hall's configuration.

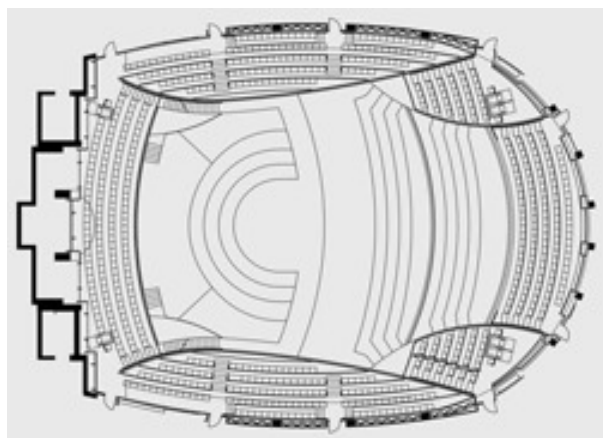


Figure 1: Plan View of KCPA Concert Hall

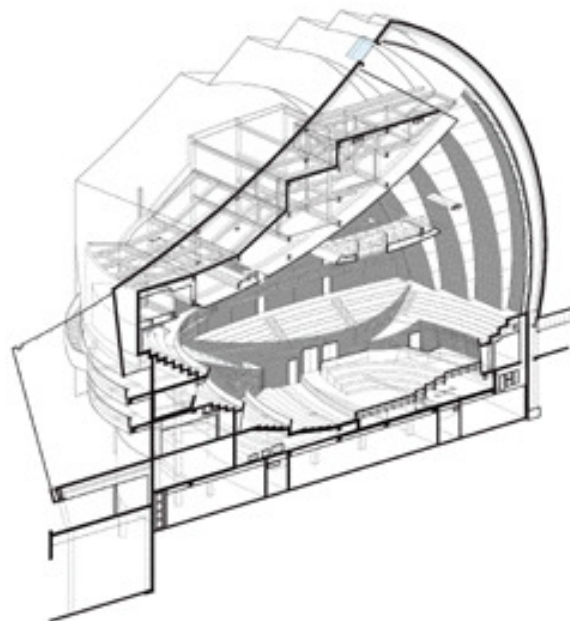


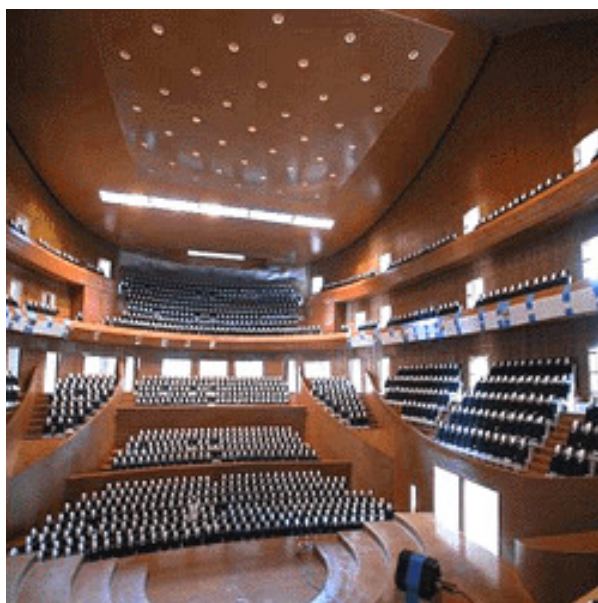
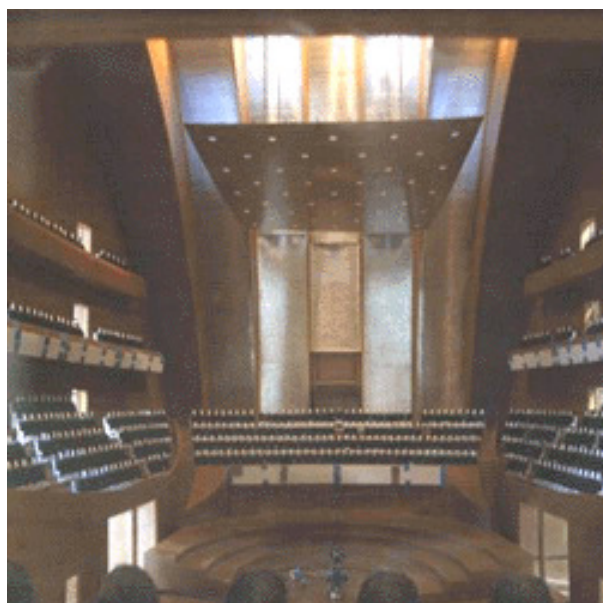
Figure 2: 3D Cross-section View of KCPA Concert Hall (Courtesy of Moshe Safdie and Associates)

Testing in the 1/10 Scale Model

Prior to performing tests in the 1/10 scale model, we scrutinized the design for the hall's configuration using computer simulation technology. For concert halls such as the Kauffman Center project that have unique architectural configurations, the scale model is a powerful tool of the acoustical consultant during the design phase of the project. This tool is powerful because, by generating sound in the scale model and measuring how it interacts with the hall's design, we can hear how the concert hall would sound if built to design specifications matching those of the scale model.

Our February, 2007 newsletter, carried an article that outlined the benefits of scale model testing in general, and I would like to underscore one of the points made in that article that is particularly relevant to the Kauffman Center project. As mentioned in that article, "we test for undesirable echoes, find their root causes and test echo mitigation remedies, and we measure the impulse responses and compare the physical data derived from those responses with data from existing halls."

To maximize the value of testing in the Kaufmann Center Concert Hall scale model, we checked the acoustics in every section of the hall, including multiple locations in the audience and stage areas. To do this, we set up sound measuring devices in a total of 38 locations in the scale model.



1/10 Scale Model of KCPA Concert Hall

In the first round of testing, we began by looking for echoes, the most likely sound problem. After identifying the location of an echo, we judge the distance to the originating location from the response waveform. Using this distance as a guide, we determine the expected root cause of the echo, apply sound absorbing material to that location and conduct a retest to learn if the echo no longer occurs. This iterative testing requires steady perseverance. Because it is a sure way to identify the locations in a hall that would cause echoes and enables us to suppress these unwanted phenomena, it is a very important process.

With the results of our scale model testing in hand, we met with the Kauffman Center Concert Hall's architectural team to discuss the various options at each location identified as causing an echo. Depending on the location, the solution options included strategic placement of sound absorbing material, using or altering planned sound diffusing elements and adjusting the angle of certain wall surfaces. Thereafter, we updated the 1/10 scale model to reflect the design decisions and entered the second round of testing, which began with using our measuring devices to confirm that the echoes had been eliminated. When our testing passed this milestone, we proceeded to the final validation of obtaining impulse response data from the scale model, calculating the acoustical properties that can be derived from the data and analyzing the data in comparison to data for existing concert halls. At the end of these efforts, we successfully concluded the scale model testing.

In these few paragraphs, I hope to have provided the reader with an overview of the process we used to perform scale model testing for the Concert Hall at the Kauffman Center for the Performing Arts site in Kansas City, Missouri. Our testing resulted in modifications that have been incorporated into the project's design. Currently, the project is in the midst of the construction phase.