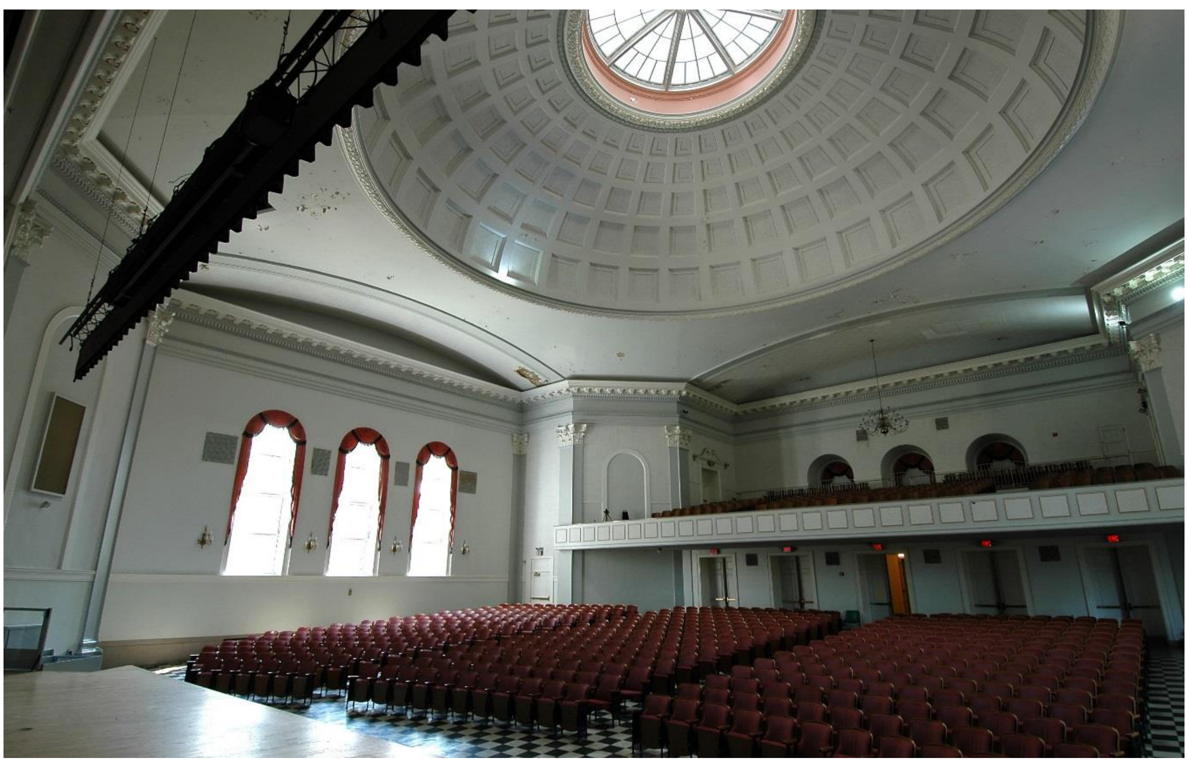
BALDWIN AUDITORIUM AT DUKE UNIVERSITY, DURHAM, NC

A Domed Homecoming

Building Blocks

My first encounter with Baldwin Auditorium was in 1977 as a Duke undergraduate student when I was working for Student Services, the in-house AV group at the university. I was sent there with a couple of Shoeps microphones and a Nagra reel to reel tape recorder to record a string quartet performance. I can't vouch for the recording quality, but I do recall the hall was worn and in poor condition. The acoustics of the room were boomy, with a very high BR and low mid frequency RT probably due to the vintage acoustic tile glued to the walls and ceiling. The air conditioning was so noisy it had to be shut off during the recording session.



Baldwin Auditorium, Duke University, NC, 1930. East Campus's Baldwin Auditorium, pre-renovation. This photo was taken in 2009 and the hall is unchanged since a 1960's renovation. Note the wood seats, single pane windows to the exterior, peeling paint, and large domed ceiling.

I returned to Baldwin in 2010 to conduct an acoustic survey of the hall as part of a new commission to evaluate the Nelson Music Room and the auditorium for a possible renovation of the music department. The room looked and sounded very much as I remembered, but a new stage extension had been added to grow the performance platform. I observed the Duke Symphony Orchestra tightly crammed onto the stage, surrounded by rolling shell towers only 12 feet (3.5 m) high. Overhead in the small stage house were three acoustic ceiling shell pieces that were oddly angled, sending all sound out to the hall.

Measurements confirmed the reported dryness of the hall which was less than 1.5 seconds RT mid frequency and even less at the high end. The walls under the acoustic tile were thick plaster on masonry and the ceiling was made of plaster on suspended metal lathe. In the center of the hall was the iconic coffered dome. The dome was huge, encompassing almost all of the ceiling area, and was formed of thin plaster in a structure similar to an egg shell. The dome was extensively coffered with ribs that provided mid and high frequency diffusion, however acoustic tile had been affixed to the center of each coffer with asbestos glue. The hall's poor acoustics was often blamed on the dome. I heard a number of comments about how the sound was "lost" in the dome and how it focused the sound in undesirable ways. However, I was not so sure the dome was the real issue here. Perhaps it was an opportunity.

I was more concerned with the extensive width of the seating area. The hall was a good deal wider than it was deep, which is not good for acoustics. We wanted to provide early lateral reflections for the seating areas, but the 120 feet (36.5 m) wide room would be an issue for any renovation. Many rows under the balcony suffered from the low ceiling, and worse still, outdated and noisy blowers were located in the plenum below the seats. These units were so noisy they needed to be shut off during symphony performances or recording sessions, which prevented ventilation. The final flaw were the lovely arched windows that flooded the room with natural light – they let in a lot of noise from the outside.

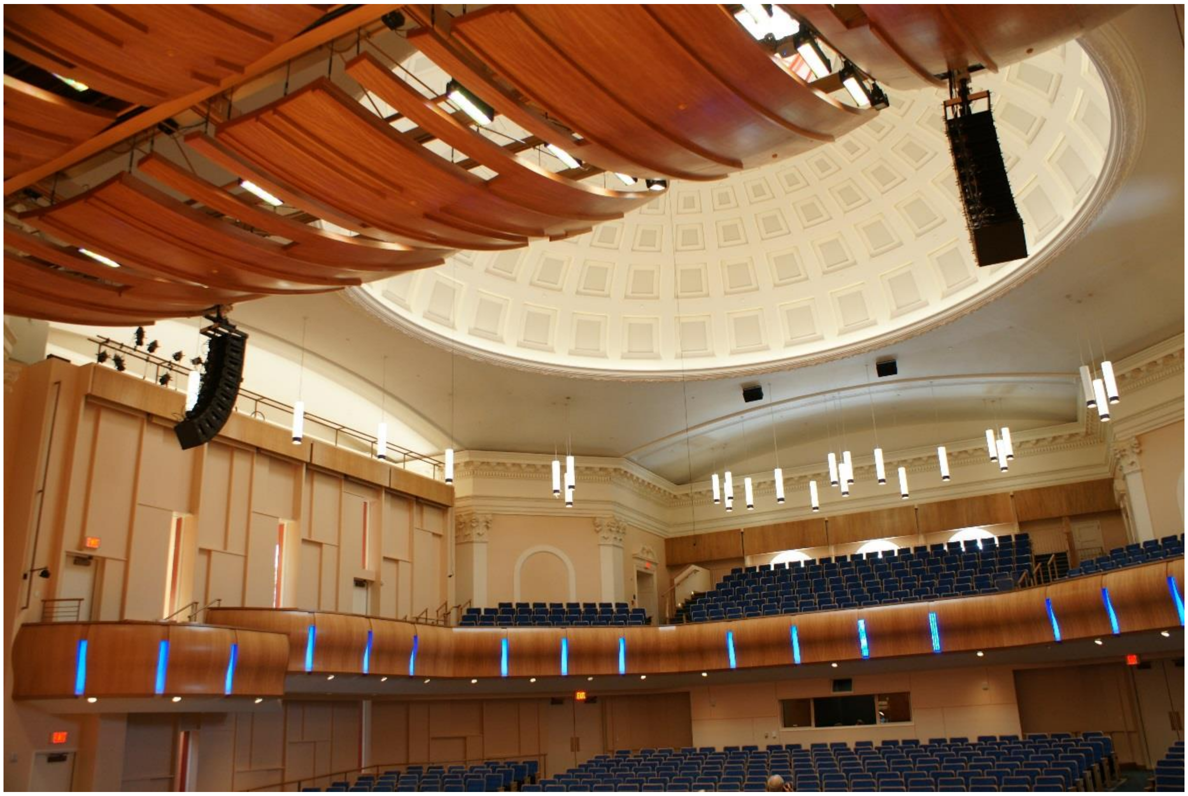
The university's goal was to transform the outdated auditorium into a modern multi-use concert hall that would serve as a home to the renowned artists of Duke Presents and the school's music department. The Emerson String Quartet was a regular visitor, as was leading solo artists like pianist Emanuel Ax. Amplified events such as jazz concerts, and large lectures using a projection screen were also part of the programming mix. Any event but fully staged opera or musical theater was possible, although music events would dominate the program.

Challenge

How to preserve the wonderfully historic dome and yet significantly improve the acoustics for the full range of uses? Also, the stage was partially in the stage house and the hall. How could they be acoustically coupled with a unifying acoustic shell?

Solutions

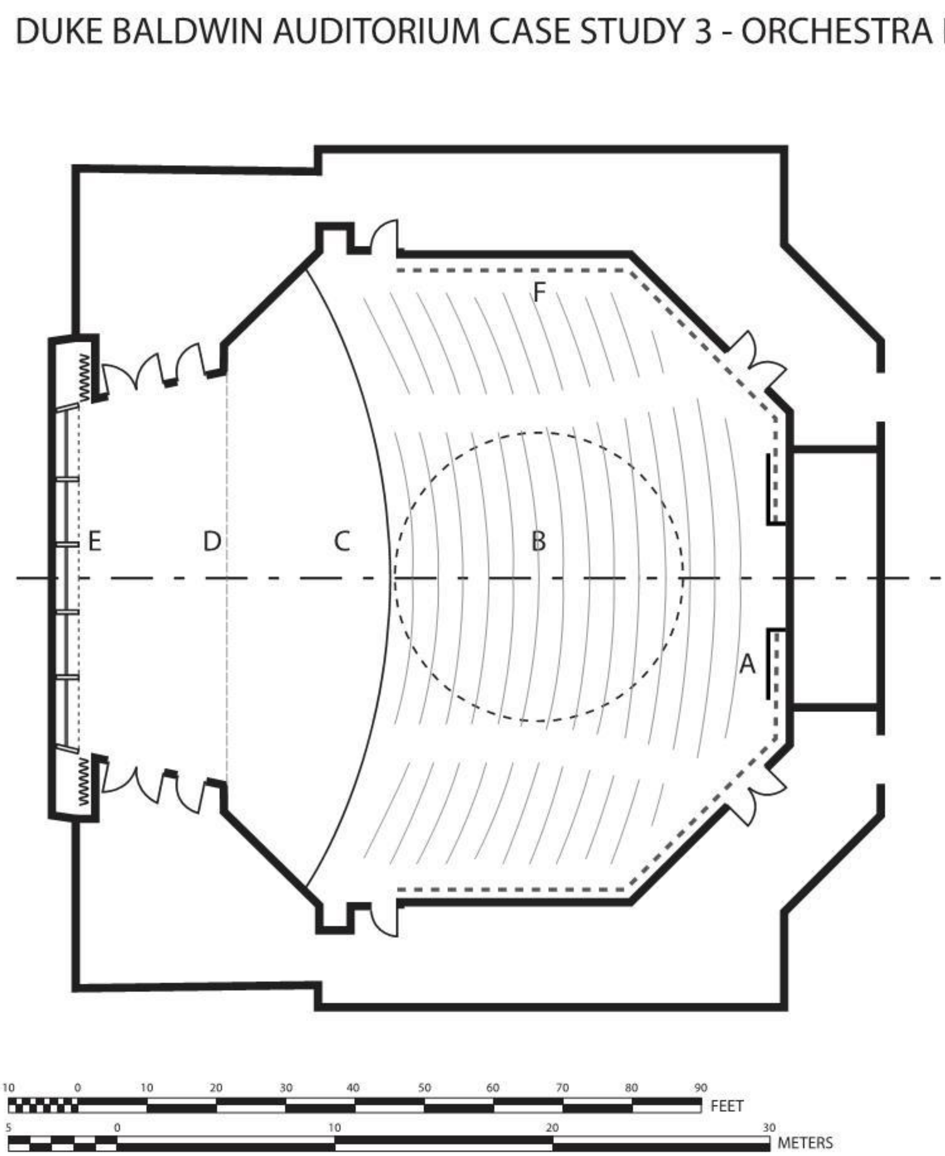
The dome was treated with diffusive panels to transform it from a liability into an asset, while a dynamic new wood shell surrounded the stage and extended dramatically into the hall. Both rolling acoustic banners and horizontally tracking acoustic drapes were utilized.



Baldwin Auditorium, Duke University, NC, renovated 2013. This renovation preserved the character of Baldwin Auditorium and enhanced intimacy, comfort, and acoustics.

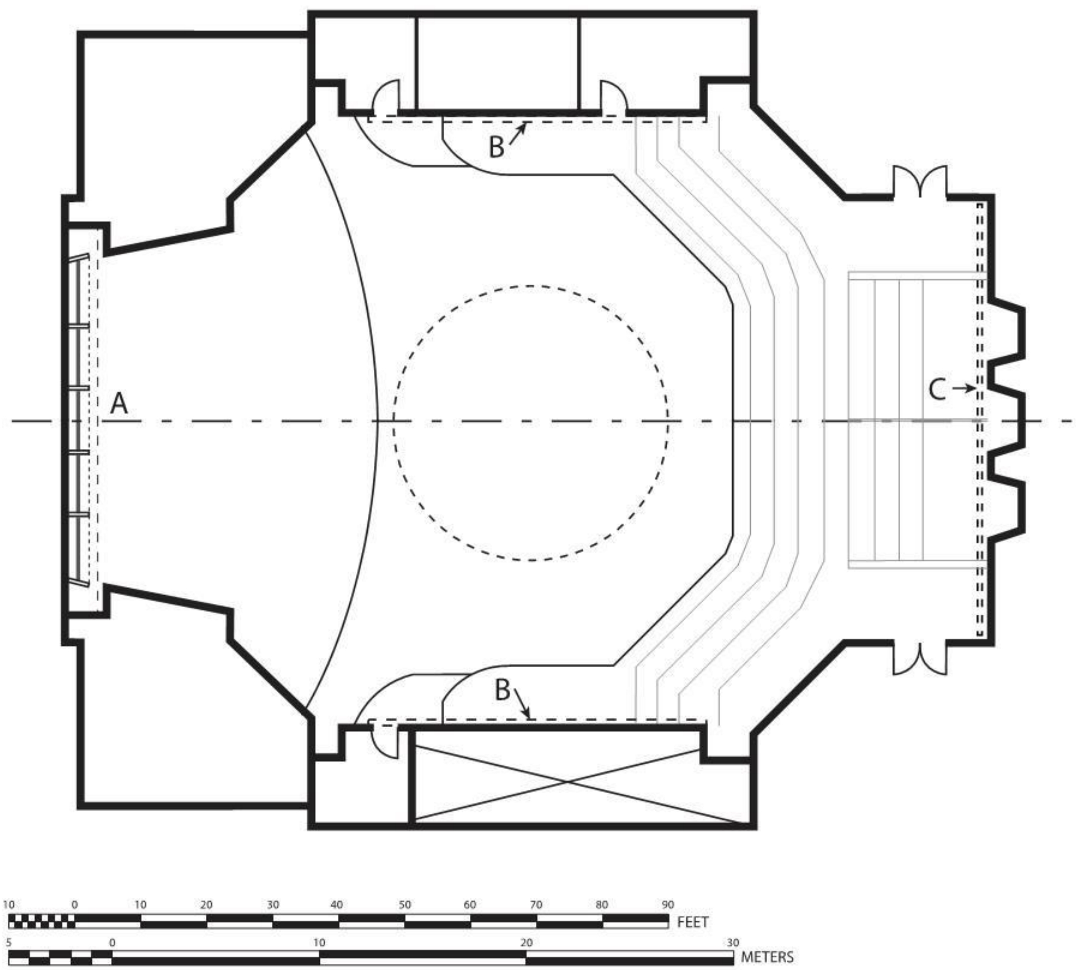
Creating the Building

The design team featured Bill Murray from Pfeiffer Partners, Robert Long of Theater Consultants Collaborative, and myself. Our initial acoustic design was a significantly smaller beautiful new 685 seat hall within the Baldwin interior. Downsizing the seating was critical to the success of the design. The volume of the hall was low for symphonic reverberation at over 1,000 seats, but could be workable with a smaller number. This reduction allowed the width of the hall to have much improved C80 reflections. A shallow wrap-around balcony with soffits would direct the reflections downward into the orchestra seating area (see Chapter 11 for information on balcony reflections), add intimacy and interest to the very wide room, and would provide diffusion opportunities.



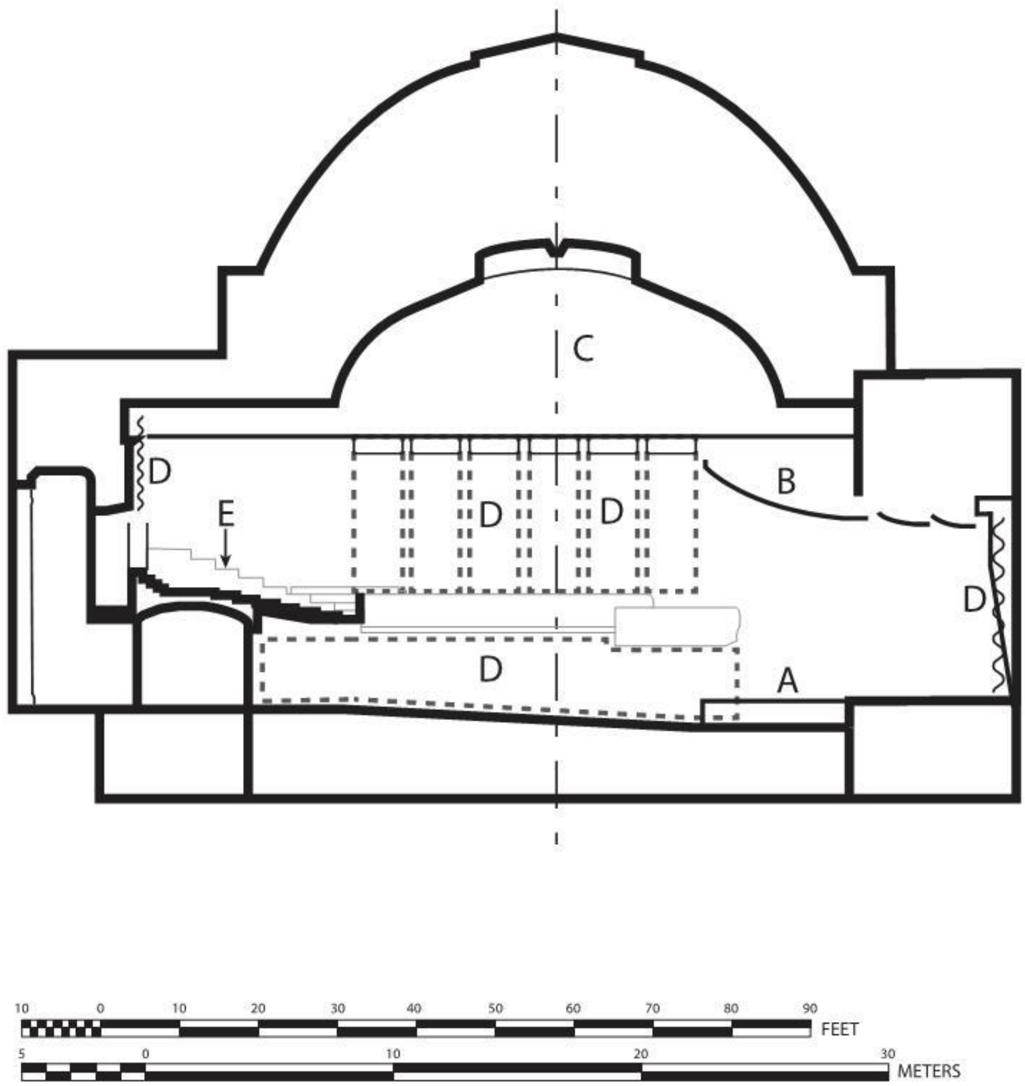
Baldwin Auditorium, Duke University, NC, renovated 2013. Orchestra Plan. A: Motorized acoustic drapes pockets near control booth B: Location of domed ceiling overhead C: Stage extension with perforated floor D: Line of proscenium opening E: Shaped wood rear wall with acoustic drape F: Acoustic drapes on side walls have cut-outs for exit doors.

DUKE BALDWIN AUDITORIUM CASE STUDY 4 - BALCONY PLAN



Baldwin Auditorium, Duke University, NC, renovated 2013 Balcony Plan. A: Manual pull acoustic drape on upstage wall stores in side pockets. B: Roll down acoustic banners on side walls cover diffusive wall with small glazed areas. C: Rear wall acoustic banners pull up from banner boxes.

DUKE BALDWIN AUDITORIUM CASE STUDY 5 - SECTION



Baldwin Auditorium, Duke University, NC, 2013. Section. A: New wood stage extension with air perforations B: Wood forestage reflector (see detail 13.6) C: Domed ceiling with applied diffusion panels D: Adjustable acoustic drapes and banners E: Balcony build-up similar to detail 14.5.

Architectural Details

The Ceiling

The existing dome was to remain, but the university and its project manager were concerned about negative acoustic effects. We believed that the dome, minus the glued-on tile, would be a good diffusive device and would add critical acoustic volume and diffusion in the otherwise plain room. Standing directly under the dome, there was certainly some focusing effects, but we advocated that the dome was a good thing that should remain. If direct sound from the stage could be blocked from impacting the dome with a large forestage ceiling, it would add reverberation and diffusion. The remaining flat plaster areas of the ceiling that was covered in mineral acoustic tile would be stripped back to the original plaster for full frequency reflections. The challenge remained of how to utilize the beneficial volume of the dome and its diffusion properties, while eliminating the focusing effects.

Careful analysis of the dome's geometry and ribs convinced us that the best direction would be to strip the tile back to the plaster and add thin RPG BAD diffusive panels to the rear focusing areas coffers. To block direct sound from the stage from ever reaching the dome, we proposed an extensive wood acoustic forestage reflector covering the new enlarged stage extension. This reflector faithfully followed our acoustic guidelines for sound projection, sound diffusion, and onstage hearing. It included openings and gaps between sections that would allow sound to reach the upper reverberant volume of the hall. A newly designed, gorgeous wood ceiling and walls extended into the stage house volume.

Baldwin Auditorium, Duke University, NC, renovated 2013. Stage Enclosure. Wood veneer plywood and MDF walls and ceilings are shaped for acoustic reflections, diffusion and blending. Openings in the ceiling reflectors are precisely positions for acoustic coupling to the volume above them.

The wood stage enclosure features double doors that allow for the free movement of performers, openings for stage air distribution, stage lighting, and line array speaker suspension points. The complex diffusive geometry was built of one inch (2.5 cm) thick double curved wood by a local furniture maker. It was built in large sections, then delivered and hoisted into position. The tight budget would not allow the inclusion of motorized winches to allow adjustability of the angle or height of the ceiling elements. We would have one shot at getting the angle right and it would need to be in the design phase.

Adjustable Acoustics

The location of the acoustic banners and drapes presented a challenge, as we did not want to penetrate the ceiling with banner boxes on account of access issues and limited space for the mechanisms above the ceiling. Therefore, the banners were placed on the side and rear walls in visually exposed banner boxes. The new side walls held more than just the banners. They also narrowed the hall to 90 feet (27.5 m) for improved C80 reflections and diffused sound with applied painted wood panels, vision lites and moldings. The banners are double layer wool serge (as described in Chapter 15) and drop down on double rollers to minimize the size of the exposed storage enclosure. The rear wall velour drapes pull up from floor mounted banner boxes.

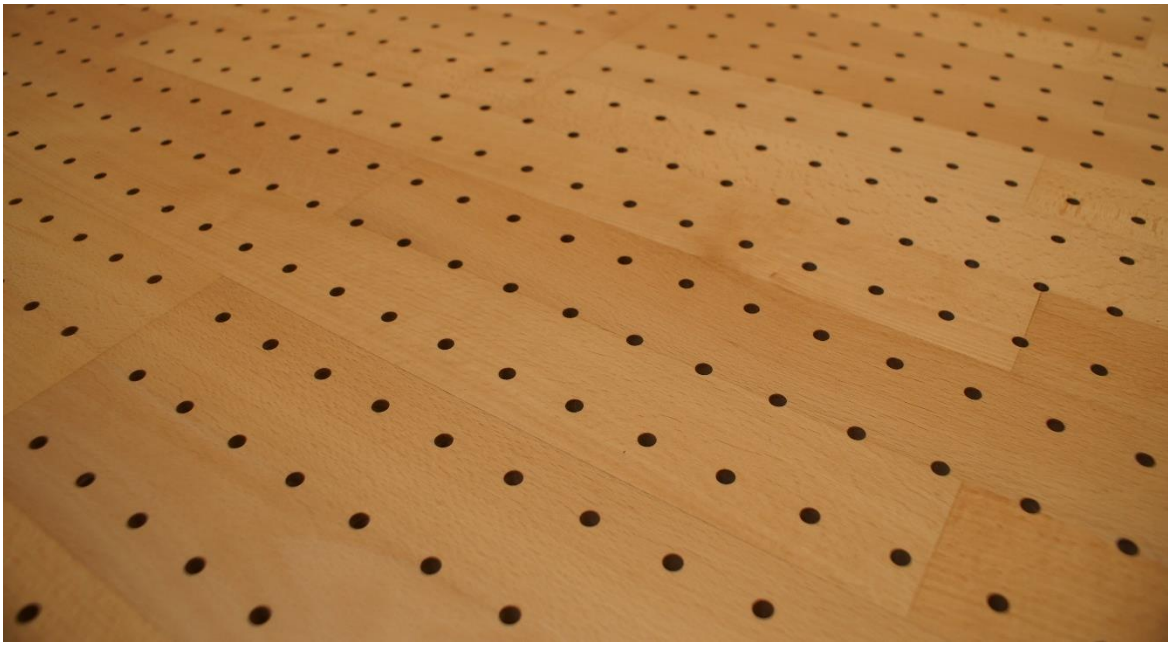
Baldwin Auditorium, Duke University, NC, renovated 2013. A view of the acoustic banners deployed on the upper side walls and tracked drapes under the balcony.

A motorized traveler drape can cover the walls under the balcony on either side of the control booth. This is useful for controlling reflected sound from amplified events. A large manual acoustic drape covers the upstage wood wall for amplified productions and lecture use and can be stored inside pockets when not needed.

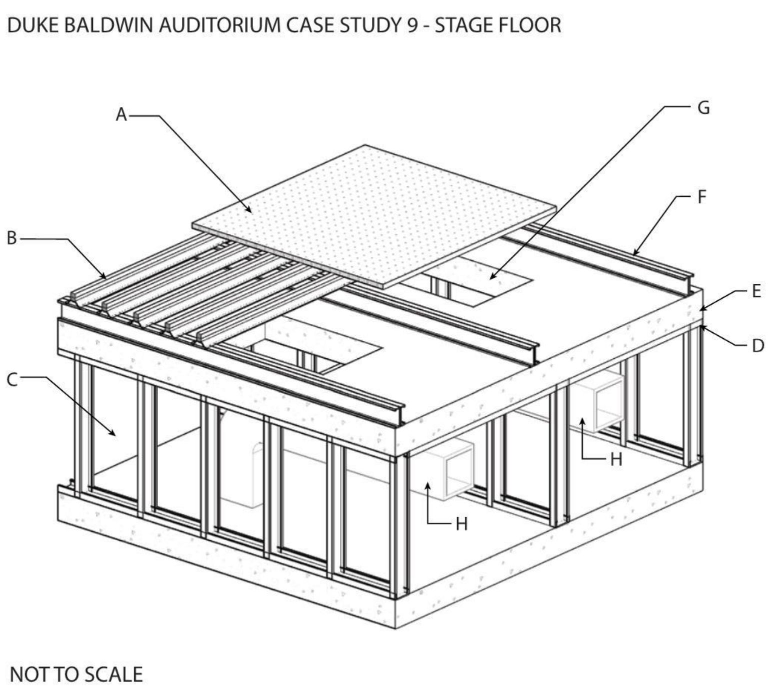
Stage Floor Air

The HVAC engineers were concerned that the under floor air supply in the auditorium seating area needed to continue into the stage in order to provide appropriate comfort on stage. Typical round metal floor supply registers that could be readily hidden under the audience seats was rejected for use in the stage floor as they were unsightly and got in the way of performances.

Our innovative solution was to drill 75,000 small air holes in the stage floor, small enough to be virtually invisible, but large enough for the air to filter up and cool the musicians above. An air plenum was built below the stage floor and was pressurized by slow moving, muffled conditioned air. Mock-ups proved the systems feasibility mechanically and acoustically. The system is rated below NC-15, and the final result is detailed in the drawings below.



Baldwin Auditorium, Duke University, NC, renovated 2013. Air conditioning on stage extension is provided by an innovative perforated wood floor. Cello players remarked that the holes are ideally sized for their pegs.



Baldwin Auditorium, Duke University, NC, 2013. Stage floor detail. A: Perforated T&G wood floor on subfloor B: Support channels C: Acoustic air supply plenum D: Acoustic duct liner E: Structural floor slab on metal decking F: Back to back metal studs G: Air openings H: Supply air ducts.

Measuring Results

The design team’s approach for the renovation of Baldwin Auditorium was an acoustic triumph for all types of programs, ranging from amplified jazz and African drumming to solo piano and voice recitals. Praise from artists, audiences, and presenters was unanimous. Besides being visually stunning, the strength of the RT, especially at low frequencies, is excellent. We were concerned that the thin plaster of the dome would lower the BR through diaphragmatic absorption. However, this did not turn out to be the case, probably because of the dome’s rigidity and balance of massive materials on the remaining surfaces.

Settings for Adjustable Acoustic Systems

We provided an acoustic manual for this project to outline recommended settings of the adjustable acoustic elements for various types of programs in the auditorium. Note that all of the settings for the acoustic drapes and banners listed here have been recorded as presets in the rigging control module and are labeled accordingly for ease of use. In addition, performer stage locations were experimented with throughout the tuning process and the approximate recommended locations are described. For programs not included, the variable acoustic elements would be set and the performers located according to the event type they most closely resemble.

Baldwin Auditorium, Duke University, NC, renovated 2013. Adjustable acoustic control system has presets predetermined during our acoustic tuning. This allows users to easily access our preferred settings by performance type.

Explanation of Acoustic Settings

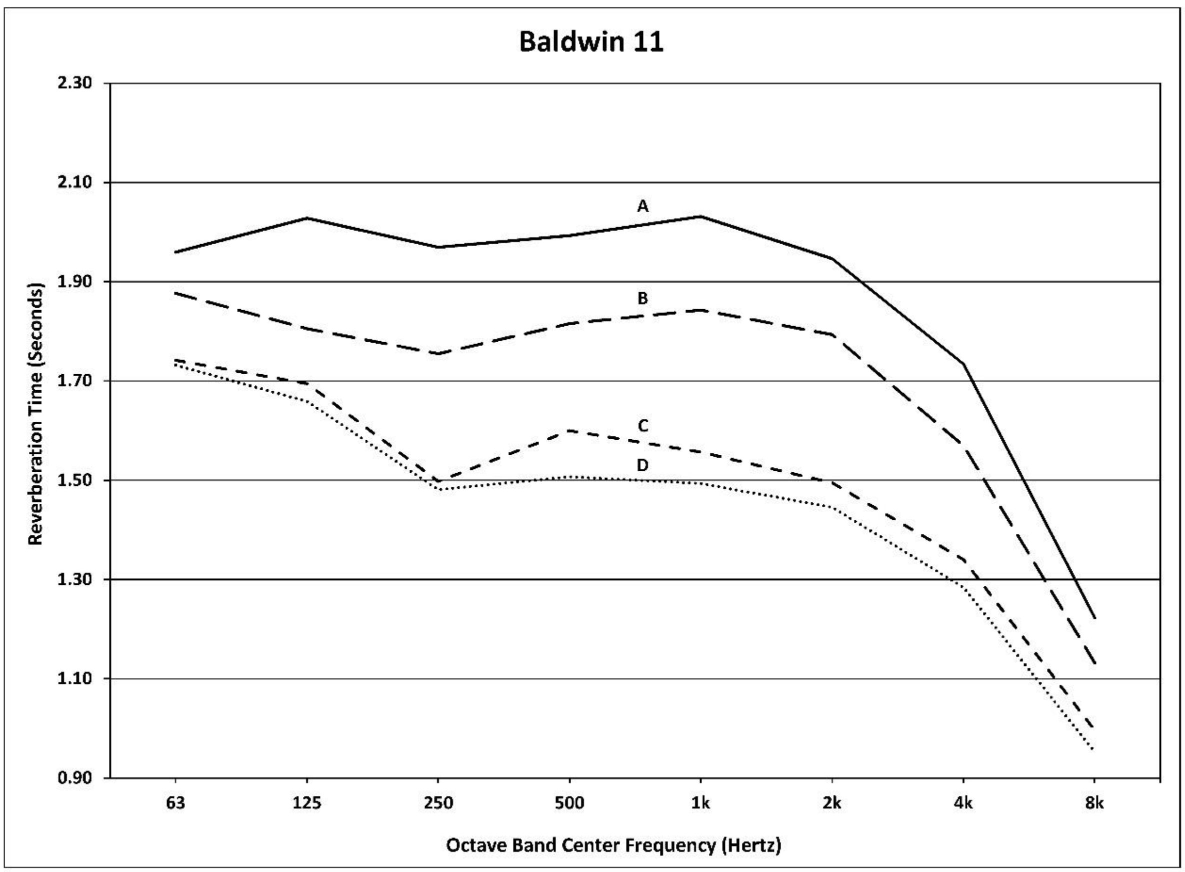
The following excerpts are from the actual user's manual for Baldwin Auditorium. The images of musicians' recommended positions on stage have been omitted.

User's Manual

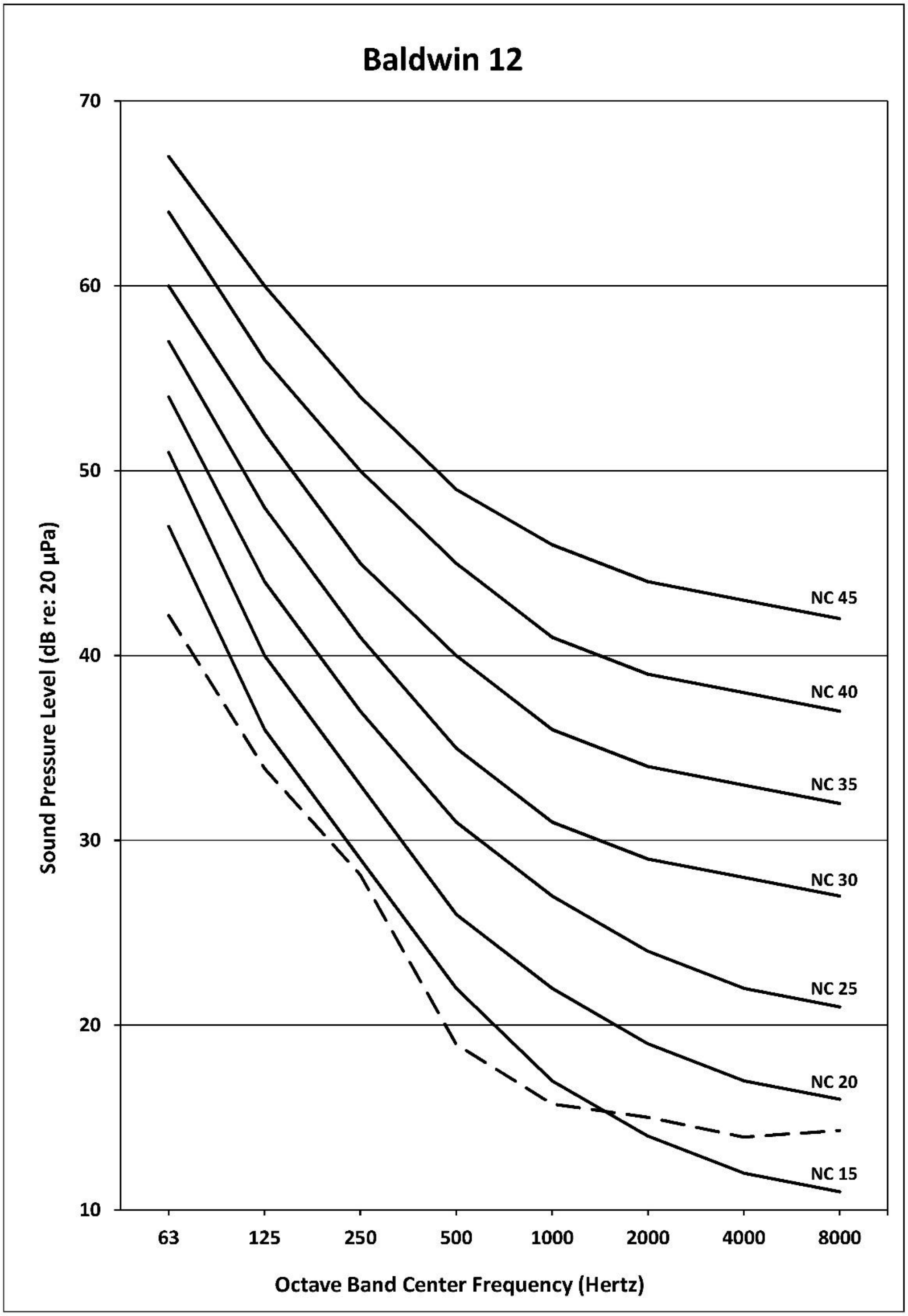
1. Symphony/Chamber
   a. This setting would be used for most large acoustic ensemble performances including the university's symphony orchestra, wind symphony, choral, and chamber ensembles.
   b. Acoustic Banners and Drapes
      i. All banners and drapes stored.
   c. Example Choir Layout and Drape/Banner Configuration (not included here)
2. Symphony Rehearsal
   a. This setting would be appropriate for rehearsals with the same ensembles mentioned above. The purpos of the partially deployed banners is to simulate audience absorption in an unoccupied auditorium.
   b. Acoustic Banners and Drapes
      i. Upper side wall banners (5 and 6) halfway deployed
      ii. All other drapes and banners stored
   c. Drape/Banner Configuration (not included)
3. Small Ensemble
   a. Typical programs appropriate for this setting include string quartets, piano trios, saxophone quartets, and woodwind quintets.
   b. Acoustic Banners and Drapes
      i. Upper side wall banners (5 and 6) 100 percent deployed
      ii. All other drapes and banners stored
   c. Example String Quartet and Trio Musician Layouts and Drape/Banner Configuration (not included)
4. Amplified/Lecture
   a. Typical programs appropriate for this setting include amplified ensembles, films, lectures, and panel discussions
   b. Acoustic Banners and Drapes
      i. All drapes and banners 100 percent deployed
   c. Example Big Band Musician Layout and Drape/Banner Configuration (not included)
5. Percussion
   a. Loud acoustic ensembles that require a high degree of clarity would benefit from this setting. Typical ensembles include the University Djembe Ensemble and Percussion Ensemble.
   b. Acoustic Banners and Drapes
      i. Lower side wall drapes (1 and 2) stored
      ii. All other drapes halfway deployed
   c. Example Djembe Ensemble Musician Layout and Drape/Banner Configuration (not included)
6. Piano/Vocalist
   a. Typical programs appropriate for this setting include solo piano and vocalist performances.
   b. Acoustic Banners and Drapes (not included)
      i. Upper side wall banners (5 and 6) halfway deployed
      ii. All other drapes and banners stored (identical to symphony rehearsal)
   c. Example Musician Layouts and Drape/Banner Configuration

Acoustical Measurements Data and Analysis Summary

The maximum RT mid-frequency (RT_{mid}) of the auditorium, unoccupied, was measured to be approximately 2.1 seconds, and the minimum RT_{mid} was approximately 1.5 seconds. The adjustable absorptive banners are providing 0.6 seconds of variability in the room's response. When the room is fully occupied, it is anticipated that the reverberation times will be about 0.2 seconds shorter depending on the number of audience members present.



Baldwin Auditorium, Duke University, NC, renovated 2013. RT Measurements. A: Banners 100% stored B: Banners 25% deployed C: Banners 75% deployed D: Banners 100% deployed.



Baldwin Auditorium, Duke University, NC, renovated 2013. NC measurements show NC-15 levels were achieved in the renovation, low enough for professional recording. The perforated wood floor air system is inaudible.

Press

"Duke orchestra and chorale doing Beethoven's 9th… with the stage full of musicians the sound and the acoustics are perfect. Can't ever thank you enough."

Tallman Trask III, Executive Vice President, Duke University

Project Information

Design Team

Architect: Pfeiffer Partners Architects
Theatre Consultant: Theatre Consultants Collaborative

Details

Size: 42,000 SF
685-seat Performance Hall

Budget

$15 Million

Scope of Work

Architectural Acoustics
Sound Isolation
Mechanical System Noise Control
Audio/Video Design

Client

Duke University

Completion Date

2013

LEED Rating

Pursuing Silver