CONVERTING A HISTORIC CHAPEL TO A PERFORMANCE SPACE BOTH GRAND AND INTIMATE

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1 EXECUTIVE SUMMARY

The Emma Willard School Chapel in Troy, New York, USA, was built as a gym in the early 1900s, converted to a chapel in the 1950s, and was recently renovated into a multipurpose auditorium for theatre rehearsal and performance, dance, music, lectures, and gatherings. The chapel floor was dropped to basement level, a mechanical room tucked below tiered seating, and the ceiling opened up above the stage for rigging and fly space. The soaring volume of the chapel contributes to overall reverberation and loudness control, with suspended reflectors over much of the extended stage and front audience area carefully designed to send strong early reflections back to performers and audience for excellent clarity, intimacy, and ensemble hearing. There was much negotiation during design regarding adjustable sound-absorptive features besides the theatrical curtains onstage, and whether we could achieve a suitable acoustical compromise for the range of programming using a relatively small amount of fixed acoustical absorption. We faced challenges with our reverberation time estimations due to the existing material covering the chapel ceiling. After a long design and construction process, the design is realized and functioning well, similar to our predictions: speech and music are clear and intimate, with gently enveloping reverberation.

Acentech was the acoustical consultant on the project, with Annum Architects as the architect, Nextstage Design as the theater consultant, and Kohler Ronan as the mechanical engineer. The project was completed in early 2025. Many thanks to Kelsey Rogers, who led the project for Acentech during much of its life.

1.1 Site Overview

The overall project included a transformation of the Chapel into a performance hall, as well as a new Arts Wing addition. The Chapel stands tall and prominent from the exterior, while the Arts Wing was designed mostly below grade. The Arts Wing gently pushes up from the earth, just enough to allow for some clerestory-level natural lighting. The slight hill formed in the landscape, with green roof over the top, preserved much of the useable outdoor space that was previously there. The Alice Dodge Wallace Center for the Performing Arts (as the Arts Wing has been named) includes several arts education spaces: dance and music rehearsal studios, as well as a black box theatre. We will recount the project story of only the Chapel renovation in this paper.

Figure 1. Completed Arts Wing and Chapel at Emma Willard School (photo credit: Chuck Choi).

2 HISTORY OF THE CHAPEL

The Alumnae Chapel at Emma Willard School was constructed in 1910, to serve as the school's gymnasium. Designed by architect Fredrick M. Cummings, it originally had a swimming pool and bowling alley in the basement, a gym on the main level above, and even a suspended running track above that. The building is included on the National Register of Historic Places.

Figure 2. Gym from 1910-1950 (left), chapel from 1950 until pre-renovation (right). (Photos provided by the school.)

The gym on the main level was converted into the school's chapel in 1950, but the basement spaces remained intact. As of the start of the project in 2021, the basement areas were just used as storage spaces.

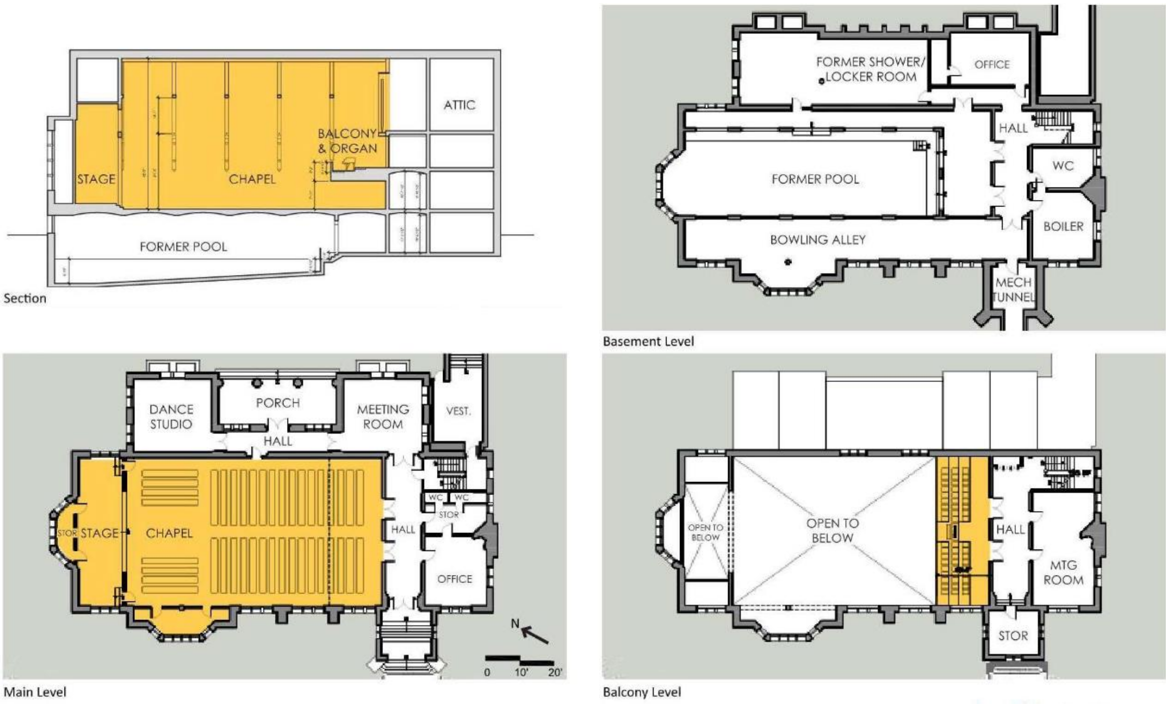

Figure 3. Previous plans of the chapel (highlighted), with the pool and bowling alley below. (Drawings by Annum Architects)

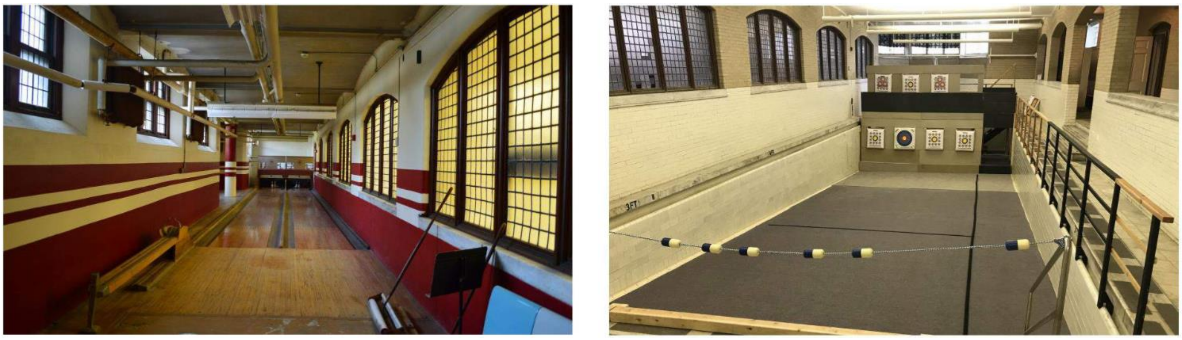

Figure 4. Images of the bowling alley (left) and former pool (right) in the basement pre-renovation.

The chapel (main level) had a relatively small, proscenium style stage, with wooden pew seating on the main floor and 3 rows of loose seating in the balcony at the rear. A tracker organ was installed in 1970 in the balcony, its design based on a typical 18th-century North German pipe organ. Being the first modern tracker organ of baroque style built in the Capitol Region and one of very few in upstate New York, it was decided that the organ would be protected and preserved in this project.

Figure 5. Chapel view towards the stage (left) and towards the organ/balcony (right) pre-renovation.

3 PROJECT DESIGN OPPORTUNITIES

The unused basement spaces presented an opportunity to transform the space by removing the former Chapel floor. The entrance at the rear of the orchestra seating is still at the original floor level. The new seating slopes down to meet the stage at the former basement floor level. This creates a dramatically tall space and excellent sightlines to the stage. The former swimming pool basin created a convenient niche for under-floor ductwork and supply air plenums, to serve the Chapel quietly.

The former proscenium wall was removed to create a much wider usable stage area. The new stage location at the former basement level created space above the stage for theatrical rigging and lighting. A stage extension was included to create more space for certain performances, particularly dance. The balcony was rebuilt in roughly the same position, with re-raked seating. Side boxes were added to create unique audience positions and double as technical galleries.

4 ROOM ACOUSTICS DESIGN

4.1 Opportunity as Challenge

This transformation created a large volume and generous height, presenting both an opportunity and a challenge for the room acoustics design. The effective acoustical volume of the renovated Chapel is about 4,250 cubic meters (150,000 cubic feet), for about 8.5 cubic meters (300 cubic feet) per audience seat. This volume is extremely helpful for controlling loudness of large ensembles and achieving appropriate reverberation for many music uses.

This transformation also presented a risk, that the tall height above the stage and peaked roof profile would result in a lack of clarity and ensemble hearing, a particular challenge for young performers.

4.2 Programming & Variable Acoustical Goals

The Chapel programming includes:

- all-school morning meetings
- music performance – orchestra, choir, chamber ensembles, and soloists

- theatrical rehearsal and performance – speech theater productions and instruction, annual musical theatre production with live instruments, and annual medieval pageant Revels production
- dance performance, including high impact stepping
- lectures and film screenings
- social gathering events

The intent of the acoustical design was to provide a clear, supportive sound for dramatic speech without the need for amplification; a warm, reverberant, and highly present sound for orchestra, choir, chamber music, and soloists; a clear, strong sound for amplified speech, such as for school meetings, lectures, and amplified drama; good self- and ensemble-hearing conditions on the performance platform. Amplified music uses, while they may sometimes occur here, have other spaces available and were de-prioritized for our design.

Our design response was to minimize sound absorptive material in the room during music performance to support reverberation and envelopment. The layout of seating, with its steep rake, balcony, and side boxes, provided an appropriate level of absorption for these uses.

Initially, we suggested that sound absorbing drapery or similar features be considered to control reverberation for clarity of amplified speech and music.

4.3 Adjustable Drapery & a Fixed Treatment Alternative

We worked closely with the architect and theater consultant to balance acoustics with aesthetics, budget, and constructability. The acoustical design evolved through a number of challenges.

We first recommended about 153 square meters (1,650 square feet) of adjustable drapery on the upper side and rear walls, in addition to the approximately 130 square meters (1,400 square feet) of theatrical drapery onstage (upstage curtain and shallow side legs). There was not enough space to incorporate header boxes or side pockets to be able to fully retract the drapery out of the room. Vertically tracking banners were expensive and unfriendly to the room’s geometry. Horizontally tracking curtains conflicted with the seating configuration. We explored the possibility of extending curtains along the sloped underside of the peaked roof, but this was determined to be impractical.

This effort was further complicated by uncertainty regarding the acoustical characteristics of the material at the underside of the roof, which was to remain undisturbed. Our measurements of the existing space and reverberation analysis led us to believe that this material was somewhat absorptive, likely an early 20th-century porous material covered with layers of paint. Our proposal to measure its absorption directly using an intensity probe method was not accepted, but further information from the design and construction team assured us that the material was indeed a somewhat acoustically absorptive material.

Meanwhile, the design of overhead reflectors was taking shape, and gave us confidence that we could achieve the desired clarity and reverberation together, without variable absorption in the audience area. We put aside our wish for variable acoustics features in the audience area and settled on a fixed design that included 46 square meters (500 square feet) of sound absorbing material at the underside of the roof in the rear-most structural bay, above the last rows of the balcony.

A degree of variability is achieved with theatrical drapery, which is hung by the school for specific events, typically speaking events, drama, and dance. (Visible in Figure 9 below.) This aligns conveniently with the uses that benefit from greater control of reverberation.

4.4 Intimacy, Clarity, and Reflectors

A primary acoustical goal for the project was to create an environment that was intimate, yet grand. Clarity for ensemble hearing and speech intelligibility was also important, especially since some other halls on campus struggled with these issues. The height and pitched geometry of the roof structure do not provide acoustically useful and uniform early reflections, but they contribute very positively to the overall reverberation and loudness control for the larger ensembles.

We proposed an array of overhead reflectors to cover the performance platform and its extension, located to send strong early reflections to audience and performers, while keeping the upper volume of the hall engaged acoustically.

We worked closely with the architect and theater consultant to coordinate the reflectors around rigging, lighting, ductwork above stage, and other elements at the ceiling. We modeled the reflectors using CATT Acoustic software to adjust their locations, curvature, and angles to provide the desired coverage.

5 HVAC DESIGN

An excellent performance environment starts with silence. We measured a background noise level of NC-15 in the pre-renovated Chapel, which lacked air conditioning. An important project goal was to maintain this very low background noise level with the new HVAC system.

A displacement air system was planned for the audience areas, with an underfloor supply air scheme at orchestra and balcony levels. Air-handling units, ductwork, and plenums are located below the main seating rake. Large ducts deliver air at low velocity, sound attenuators control fan noise, and internal duct liner helps to control air flow noise. A mechanical room located below the sloped orchestra level seating was constructed with a carefully decoupled enclosure including sound barrier ceiling. All penetrations were tracked, stuffed, and sealed. The coordination effort was significant and required communication and flexibility from all parties.

The stage is served by overhead ducts that were carefully coordinated with acoustical reflectors and many theatrical features in the same area, with many adjustments during construction.

6 OUTCOME

Our acoustical commissioning took place over a series of visits when the building was not quite complete. Chapel doors were not yet installed. HVAC was operational, but balancing was incomplete. The front-of-house control desk, built into a handsome piece of wood furniture, was not yet enclosed. As of this writing, we believe these issues have been resolved, but we have not yet witnessed and documented them.

Despite these obstacles, we were able to document the room acoustics of the new Kingenstein Concert Hall in music configuration (no stage curtains). We also observed that the floor supply air diffusers were delivering air silently.

No final measurement is more important than simply speaking, playing music, and listening in the space. We were pleased to find that, to our ears, the space sounded great and as we had intended: speech and music are clear and present, and reverberation is gentle and embracing. We measured a mid-frequency reverberation time of 1.4 seconds. This will drop a bit at times when theatrical drapery is deployed.

We collected impulse responses using a dodecahedral loudspeaker (NTI DS3) on stage and a 4-channel ambisonic array microphone (Sennheiser Ambeo). Preliminary analyses seem to align with what we heard in the space and with the design intent. (See Figures 6 and 7 below.)

The school held a grand opening event in late spring to welcome and thank their community. We received very positive feedback from participants. The new building opened for school use in August.

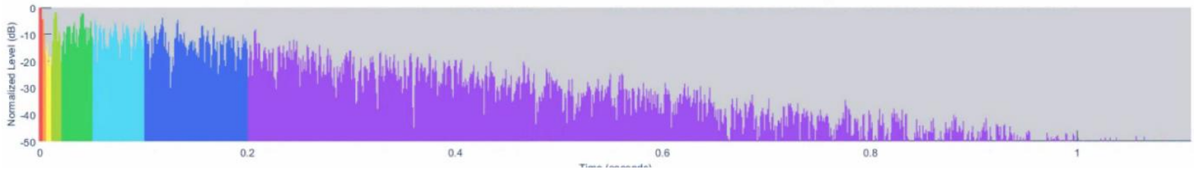

Figure 6. Energy-time curve measured in rear orchestra seating. The dense array of early reflections followed by smooth reverberation matches what we heard.

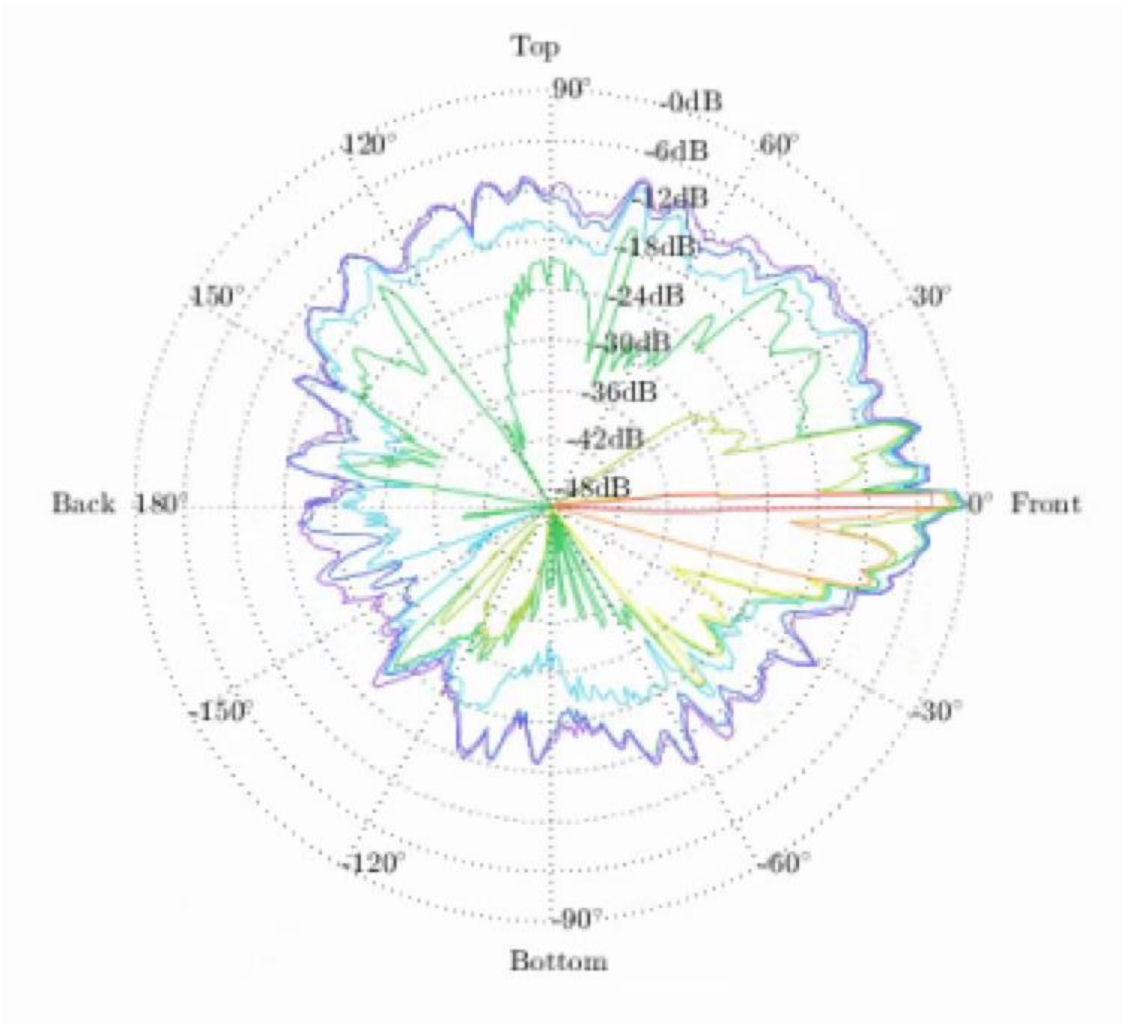

Figure 7. A sound rose analysis shows significant early reflected energy (<50 ms, green line) from a forward-and-above angle, corresponding with the overhead reflectors. Late reflected energy (<200 ms, dark blue line) is relatively uniform spatially.

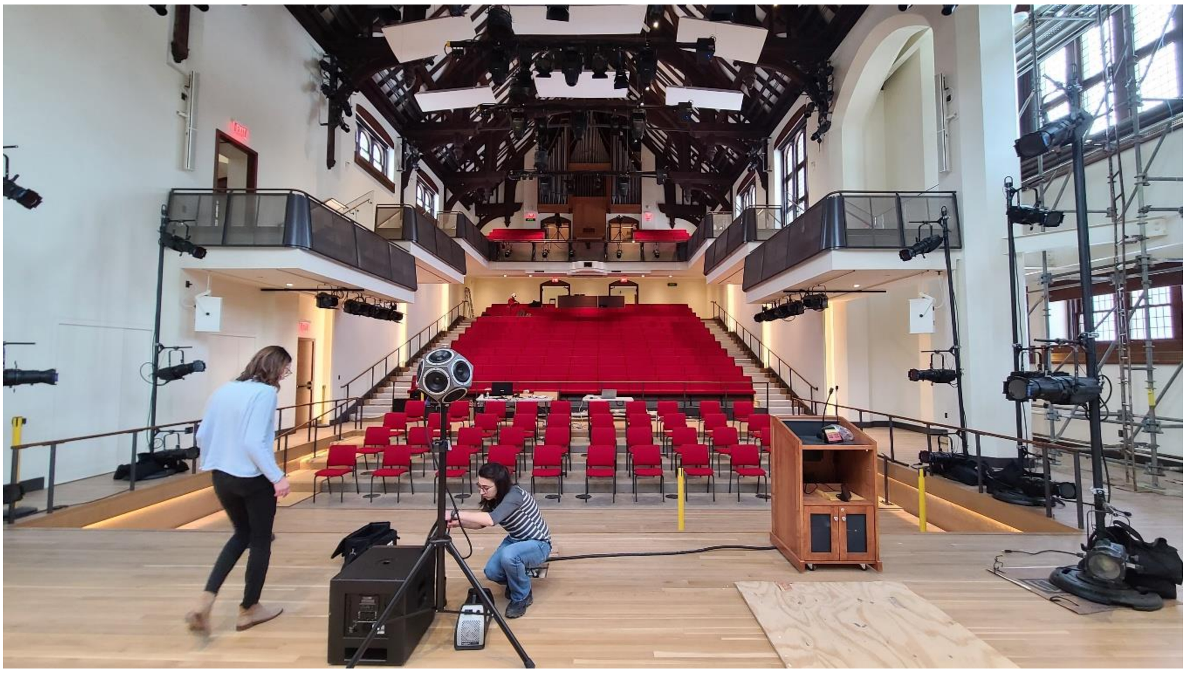

Figure 8. Measuring the new Klingenstein Concert Hall. (author photo)

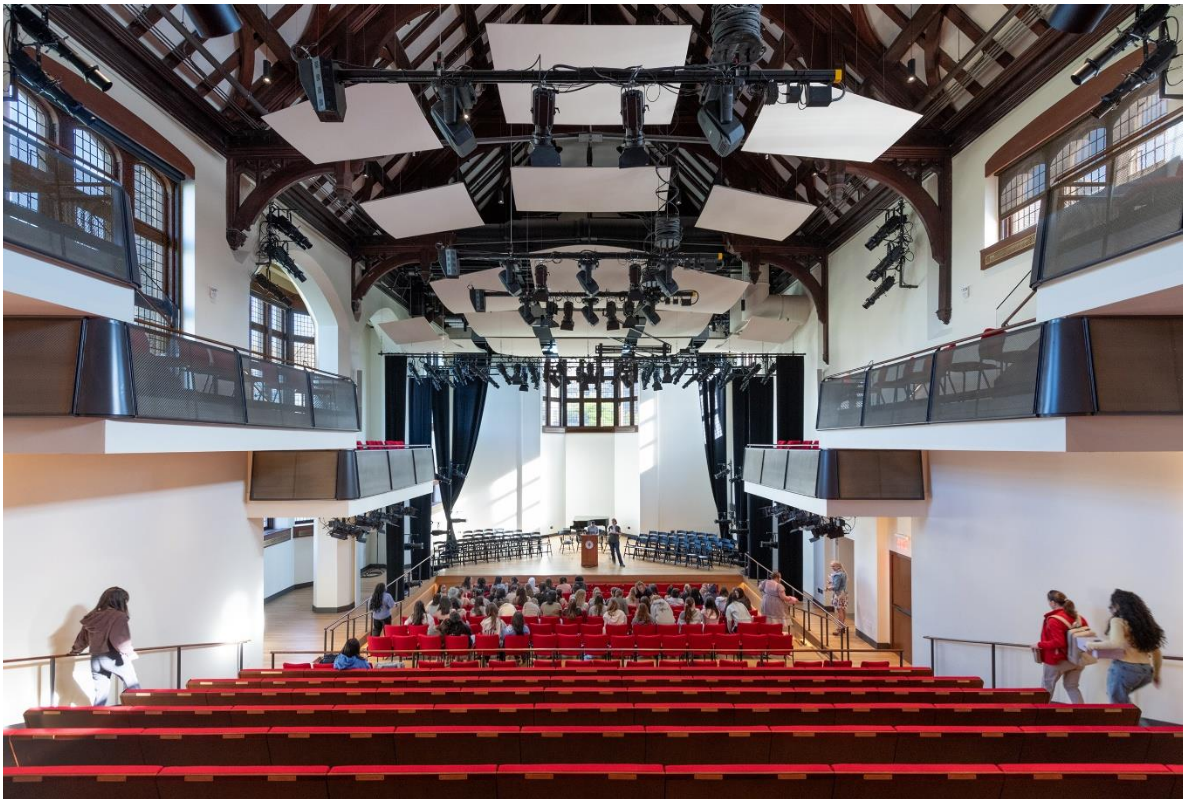

Figure 9. Chapel post-renovation, with theatrical drapery installed (photo credit: Chuck Choi).