Acentech Incorporated
33 Moulton Street
Cambridge, MA 02138

Telephone: 617-499-8000
Facsimile: 617-499-8074
E-mail: postbox@acentech.com

Acentech

May 21, 2013

Mitchell Goldman
Goldman Reindorf Architects
427 Watertown Street, Suite 102
Newton, MA 02458
By email: grarch@comcast.net

Subject: Acoustics and Audiovisual Conceptual Recommendations
War Memorial Auditorium and Aldermanic Chamber
Newton City Hall, Newton, MA
Acentech Project No. 623108

Dear Mitchell:

On May 1, 2013, Richard Closs and Jonah Sacks visited the War Memorial Auditorium and Aldermanic Chamber at Newton City Hall. We met you there, and also Miriam Tuchman of the City of Newton. We discussed the uses of the rooms and their difficulties, and we made various measurements and observations. This letter presents our initial conceptual recommendations for acoustical and audiovisual systems improvements to these rooms. We look forward to working with you to implement these recommendations within an integrated architectural design.

War Memorial Auditorium

The War Memorial Auditorium is a visually striking space, tall and brightly painted and daylit by large windows. The main floor is flat with loose chairs, and there is a small balcony; total seating capacity appears to be around 200. All major surfaces in the room are hard and sound-reflective, making speech intelligibility difficult.

Typical uses include spoken presentations, and choir rehearsal and performance. The room will be used as swing space for Newton North High School theatrical activities in the near future. On at least one occasion, the room has been used in a service tent configuration, with tables set up for members of the public to visit and learn about city services. A larger range of uses would likely develop if the acoustical conditions improved. The current highly reverberant acoustical conditions are favorable for choir use, but make other uses difficult.

Measurements

We measured reverberation time in the room. For our measurements, all chairs were stacked at the sides of the room, exposing the stone floor. Reverberation time is a property of a room that indicates the length of time, in seconds, that sound lingers within the room; long reverberation times indicate live, sometimes loud rooms, while short reverberation times indicate dry or dead sounding rooms.

The reverberation time in the War Memorial Auditorium, unoccupied and with chairs stacked, was 2.6 seconds (mid-frequency). We estimate that, in a more typical unoccupied configuration with loose chairs laid out in rows as in the photos on the next page, the reverberation time would

drop to 2.2 seconds, and with a full seated audience, the reverberation time would fall to 1.8 seconds. These reverberation times are very long indeed for a room of this size. For comparison, the much larger Symphony Hall in Boston has a reverberation time of 2.5 seconds when unoccupied, and 1.9 seconds when fully occupied. The long reverberation times in the War Memorial Auditorium indicate muddy and unclear speech during lecture presentations or panel discussions, and excessive loudness during social gatherings or service tent uses.

Background noise in the room was very quiet, 30 dBA and NC-22, primarily from street traffic. There was no perceptible building mechanical noise.

Several photos of the War Memorial Auditorium in a typical configuration.

Acoustical Goals of Renovation

The primary goal of any acoustical renovation should be to incorporate acoustically absorptive material into the space, thereby reducing its reverberation time, improving the clarity of speech, and reducing loudness of activity noise. It would be useful to provide some variability of acoustical conditions to allow more reverberation for choir performances, and greatest clarity for lecture presentations. Ideally, it would be possible to vary the reverberation time between around 1.0 seconds and around 1.4 seconds, with seated audience.

An equally important goal of any renovation should be to maintain the current very low background noise conditions. Any increase in background noise from the planned elevator or

future installation of HVAC equipment will work against the gains in speech intelligibility that the current recommended modifications will achieve.

Recommendations

We recommend incorporating new sound absorbing finish materials totaling approximately 1,700 square feet, half or more of which should be retractable window treatments, such as curtains or roman shades. Select materials with Noise Reduction Coefficient (NRC) of 0.80 or higher.

We propose the following approximate breakdown of materials and locations:

125 square feet of fabric-wrapped wall panel on upper-level rear wall

560 square feet of 1-inch fiberglass core ceiling panel at side ceilings

1,000 square feet of AcouStac or similar acoustical window treatments

This combination of materials will provide useful reverberation control for all uses of the room, and will allow users flexibility to reduce reverberation quite significantly for speech presentations, theatrical rehearsal and performances, and service tent uses simply by extending (lowering) the window coverings. During choral or other music uses, users may choose to retract (raise) the window coverings to restore a flattering level of reverberation to the room.

We recommend using (if possible) AcouStac acoustical banners at the windows, because these banners retract vertically into discreet head boxes and provide maximum acoustical flexibility. Horizontally tracking drapes are another acceptable option, though these will likely remain somewhat exposed to the room even when retracted, thereby reducing acoustical flexibility.

By retaining the hard, sound-reflecting rear wall at the lower level, this arrangement ensures that presenters speaking from the front of the room will hear themselves well without amplification. It is our hope and expectation that for most uses of the room amplification will not be necessary, except perhaps to present pre-recorded material such as theatrical sound effects or music to accompany dance. Speech should typically not require amplification.

Because amplification will generally not be needed, we recommend continuing to use a portable sound system, which may be of use elsewhere when it is not needed here.

Recommended materials and products

AcouStac is manufactured by AcoustaCorp and represented locally by Ed Hyatt of Boston Illumination Group: 508-653-2144, edhyatt@bigconnect.com. If using horizontally tracking drapes, use heavy theatrical fabric, minimum 27 ounces per linear yard, pleated for at least 50% fullness.

For the walls and ceilings, there is a wide variety of acceptable choices. We recommend considering a stretched-fabric system such as Clipso, which can cover long spans without seams for a clean, monolithic appearance. A lower cost alternative would be to use pre-manufactured fabric-wrapped panels, which would result in visible seams or reveals. Any of these materials must be factory colored and cannot be painted on site. Clipso and various fabric-wrapped panel options are represented locally by Alison Carrig of Hamilton Associates: 781-648-7300, alison.carrig@hamiltonrep.com.

Aldermanic Chamber

The Aldermanic Chamber is the home of the Alderman of the City of Newton. The Aldermen's desks are arranged in semicircles around a raised rostrum at the front of the room. Public gallery seating is behind the Aldermen's desks and in a small balcony seating area. The room is excessively reverberant, and the sound system does not function well. We have been told that Aldermen hear one another acceptably well, for the most part, but that the public have great difficulty understanding what is said.

The finish ceiling is apparently 1'x1' glue-up mineral fiber ceiling tiles between expressed beams, which appear to have been painted. The acoustical effect of these tiles is likely small. There are 6 large windows on the right and left sides of the front half of the room.

The Aldermanic Chamber

Measurements

We measured reverberation time in the room. For our measurements, the room was unoccupied, but all furniture was in place, and many Aldermen's desks were piled with papers. As explained above, reverberation time is a property of a room that indicates the time over which sound lingers within the room, with long reverberation times indicating live, sometimes muddy-sounding rooms.

The reverberation time in the unoccupied Aldermanic Chamber was 1.7 seconds (mid-frequency). We estimate that, with a full seated audience, the reverberation time would fall to 1.5 seconds. These reverberation times are rather long for a speech room of this size, particularly one used primarily for amplified speech. Such long reverberation times are likely to result in muddy and unclear speech, particularly at seats that are farther from the front of the room, and particularly when the speaker is not facing toward the listener. In these locations, the listener relies almost exclusively on the sound amplification system, and the room's reverberation makes the amplified sound less intelligible as well.

Background noise in the room was fairly quiet, 35 dBA and NC-30. The small amount of audible noise was from unknown building mechanical sources; there is no mechanical ventilation to the room. As this room is used entirely for amplified speech, this level of background noise is acceptable.

Acoustical Goals of Renovation

The primary goal of any acoustical renovation should be to incorporate acoustically absorptive material into the space, thereby reducing its reverberation time, improving the clarity of speech and the function of the sound amplification system. Our goal is to achieve a reverberation time of around 1.0 seconds with seated audience. Variable acoustics is not a goal here.

An equally important goal of any renovation should be to avoid introducing new background noise into the space, such as from a future installation of HVAC equipment. An increase in background noise will work against the gains in speech intelligibility that the current recommended modifications will achieve.

Recommendations

We recommend replacing the existing ceiling tile with sound-absorbing material such as fabric-wrapped fiberglass panels, as recommended above for the War Memorial Auditorium. Select panels with Noise Reduction Coefficient (NRC) 0.80 or higher, approximately 1-inch thickness. Such panels are probably also the best choice for the ceiling of the upper gallery seating area.

We recommend adding new window curtains of heavy fabric. When retracted, these curtains may simply gather at the sides of each window bay, so that they will provide some acoustical benefit even when retracted to allow natural light into the room.

We recommend adding sound-absorbing panels at the rear wall, perhaps within the framed areas below the upper gallery seating and above the main entrance doors. Select fabric-wrapped panels or other materials with NRC 0.8 or higher.

Alison Carrig of Hamilton Associates can help you select and procure appropriate finish materials: 781-648-7300, alison.carrig@hamiltonrep.com.

Rear wall with framed areas, and upper gallery seating area.

Sound System

We used the NTi Audio XL2 platform to evaluate the performance of the installed sound system in the chamber. The analyzer was used to record the Speech Transmission Index-Public Address (STIPA) and Frequency Response of the existing sound system. The existing sound system consists of the following:

- Four Bose Panarray loudspeakers (two on the north wall and two on the south wall of the alderman area),
- A small loudspeaker on the north and one on the south wall of the balcony,
- An equipment rack located in the rostrum desk that houses the audio processing (Biamp Nexia) and amplification (QSC CX404 and Peavey IPA 150 T) ,
- 13 Audio Technica ES917S wired microphones with on/off switches,
- A wireless microphone (Shure ULXP4), and
- An assistive listening system.

Measurements

STIPA measurement was used to evaluate the intelligibility of speech delivered through the sound system in the chamber. The STIPA measurement accounts for all of the acoustic and electronic portions in the talker-to-listener transmission path that directly affect speech intelligibility. During the testing, speech is replaced with a repeatable signal with speech characteristics that are of concern for clear understandable speech. The STIPA measurement process returns a single number between zero and one that represents the intelligibility of the sound system measured. The STIPA scale and the associated subjective intelligibility are below. The targeted goal for STIPA in the chamber should be in the "Good" range of 0.60 to 0.75 or higher.

STIPA	1.00-.75	**.75-.60**	.60-.45	.45-.30	.30-.00
Subjective Intelligibility	Excellent	**Good**	Fair	Poor	Bad

The chart below shows the STIPA measurement results for the Gallery seating area, the Aldermanic desks, and Balcony seating areas of the chamber. There were four measurements recorded in the Gallery, five at Aldermanic desks, and two in the Balcony section of the chamber. Since the chamber is symmetrical, the measurements recorded are from the southern half of the chamber.

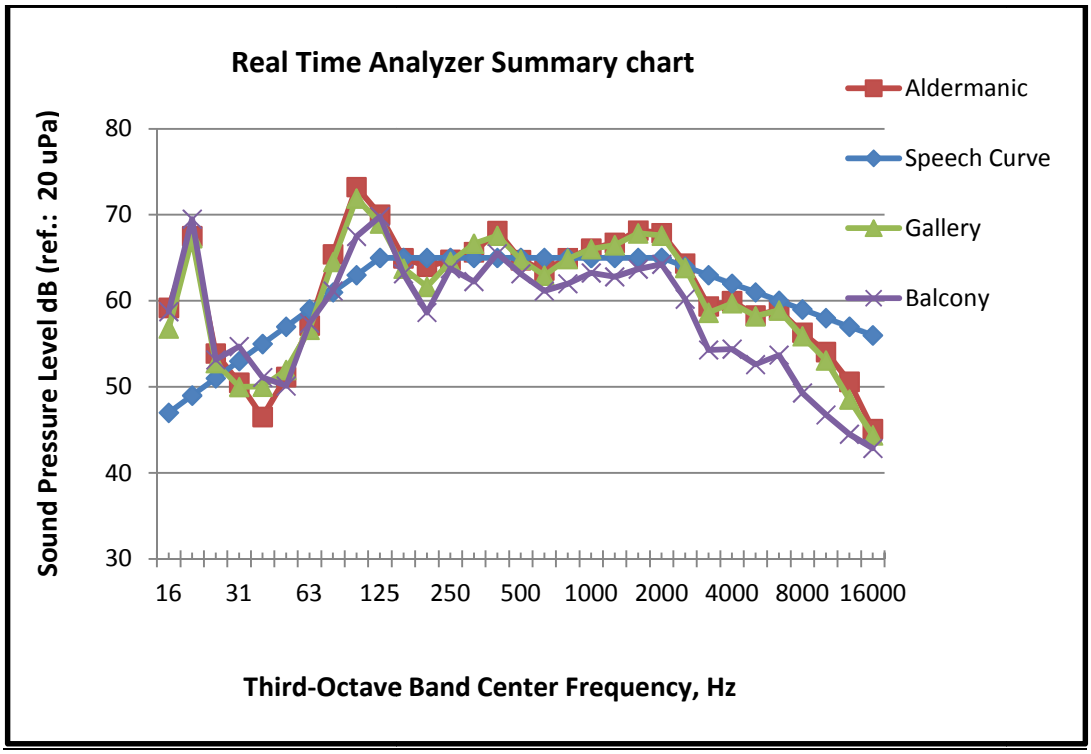
Chamber Area	Measurement No.	STI-PA
Gallery	1	0.50
	2	0.50
	3	0.55
	4	0.48
Aldermanic	1	0.57
	2	0.55
	3	0.58
	4	0.57
	5	0.48
Balcony	1	0.41
	2	0.41

STIPA Chart

The majority of the measurements fall between .45 and .57, which is "Fair" on the STI scale. Speech intelligibility is less good in the gallery and balcony areas than at the Aldermanic desks. These areas measured an average of 0.1-0.2 below the Aldermanic area with the balcony intelligibly "Poor" at 0.41.

The two main impediments to speech intelligibility in the space are loudspeaker placement and the relatively long reverberation time of 1.7 seconds in the chamber.

The frequency response of the sound system was measured to determine the magnitude or level of each frequency band within the audible bandwidth. The frequency response of a speech system, similar to the one in the chamber, should have a smooth frequency response of at least 250-4,000 Hz. The target goal for a system similar to the one in the chamber is shown in cyan in the graph below and labeled "Speech Curve". The other response curves are an average of measurements recorded in the Aldermanic, Gallery, and Balcony areas. The same 11 measurement points used for the STIPA measurement were used for the frequency response with an addition of a measurement at the center of the rostrum, for a total of 12 points.



Frequency Response curve

Response curves for the chamber do not follow the recommended "Speech Curve" as indicated above. The similar response curve and uniformity of coverage for the aldermanic, gallery, and balcony areas is an indicator of the long reverberation times in the chamber.

Sound System Goals for the Renovation

The goals of the sound system renovation should be to improve speech intelligibility and directional realism in the chamber. The first step in the process would be to optimize the loudspeaker types and locations. By optimizing the type and location of the speaker systems, the listener senses that the sound originated at the talker and not from a loudspeaker system mounted on the wall or in the ceiling. The optimized speaker system also provides uniform coverage and improved frequency response and sound levels in the chamber.

Recommendations

In the aldermanic area, we would recommend conferencing units (pictured below) at each of the aldermen's desks that include a speaker and microphone. The conferencing system provides for a personal conversation between the alderman, the rostrum, and the gallery/balcony. The system can be configured to operate in the same manner as the existing microphone system. If required, the conferencing units can be purchased with a voting option.

Typical Conferencing Unit.

To provide coverage in the gallery we would recommend using either:

- A set of loudspeakers suspended from above at the front of the gallery seating area at 12 to 14 feet above finish floor, or around the same height as the existing chandeliers. This is acoustically the preferred approach.
- Alternatively, a steerable array loudspeaker system could be mounted vertically to the side walls (does not need to be tilted down), probably at the second column from the front of the room (between the second and third windows). The steerable array can be mounted flat against the wall and painted to match the surrounding area or recessed in a niche. Sound from the array is steered or aimed electronically at the listeners in the gallery by using digital signal processing.

Finally, to cover the balcony area, we would recommend moving two of the existing Bose speakers up to the balcony and mounting them on the soffit in front of the balcony.

Choosing optimal loudspeaker locations and coordinating them with the architecture will be a major focus of the design effort yet to come.

The recommended acoustical and sound systems improvements will complement one another to provide greatly improved speech intelligibility and accessibility for members of the public.

* * * * *

We trust this acoustic and sound system report provides the information that you need at this time. If you have any questions about the contents of this report, please feel free to contact Jonah Sacks (acoustics) at 617-499-8079 (jsacks@acentech.com) or Richard Closs (sound system) at 617-499-8029 or rcloss@acentech.com.

Sincerely,

ACENTECH INCORPORATED

Jonah Sacks
Senior Consultant in Acoustics

Richard I. Closs
Director Systems Group

J:\623108\2015_05_21 Acoustic and Sound System Report.docx