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Creating an Anechoic Choral Recording

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ABSTRACT

Auralization continues to grow as a tool for acoustical analysis and comparative listening during the planning and design phases of new construction or renovations. Expanding the library of anechoic source material to use in convolutions improves the modelling of impulse response from different architectural designs by providing demonstrations better suited to particular clients and projects. Realizing that choral anechoic source material was not readily available, the Wenger Corporation partnered with St. Olaf College and 3M to create an anechoic choral recording. The paper describes the challenges of the recording project from technological, logistical and musical standpoints and the successful solutions. A unique aspect of the project was the concurrent use of numerous microphone techniques (spaced pairs, XY, ORTF) and various microphone types. All recordings were made available in an "un-mixed" version on a DVD accompanying the CD for those who preferred an alternative to the audio recordings mixed to the CD. In total six choral arrangements were recorded in this project.

BACKGROUND

Wenger Corporation has been involved in auralization work dating back to the mid-1990s working with CATT-Acoustic and utilizing Lake Hardware FIR filters for convolutions of created impulse responses related to rehearsal room acoustics. At that time the Denon Anechoic Orchestral Music Recording CD was used as the primary source material for convolutions. The time required for convolutions to be done on PCs was very lengthy, hence the use of the hardware FIR filter. Wenger realized that the number of source material recordings was quite limited especially for larger musical ensembles or groups. The most commonly known recordings were the Anechoic Orchestral Music Recording by Denon, JVC Impact Disks and Music for Archimedes by Bang and Olufsen. There were a number of well-done recordings of solo instruments and voices available, but few orchestral and band recordings. No large-group choral recordings could be found.

ANECHOIC RECORDINGS

The ability to listen to designed architectural spaces during the design phase of new construction has obvious benefits in ensuring the outcome of the project is as desired. Although absolute accuracy in auralization is very difficult to achieve, it does provide a good tool for highlighting areas of concern that may deserve closer analysis. The ability to use the hearing perception along with the visual also provides a more complete sense of how a space will perform once constructed. One of the limitations of this process is the limited number of specialized anechoic recordings available as source materials for these auralizations[1,2]. The unique requirement of a reflection-free recording limits the number of available choices especially as the size of the musical groups being recorded increases.

EXPANDED USE OF AURALIZATION

In the late 1990s interest increased internally at Wenger to utilize auralization for assessing the impact orchestral shells, overhead panels and clouds above the audience area had on the onstage acoustics as well as the audience area. As this became a focus for research, it was noted again that there were full anechoic recordings of large instrumental groups but none of choral groups. This led to discussions about creating an anechoic choral recording to use for further research and to share with others in the architectural acoustics community who could benefit from this source material in their auralization work. It was estimated that a project of this scope would present a considerable expense to the company – approximately $25,000. After much discussion, Wenger decided to move forward with this project.

WHERE CAN THIS BE DONE?

Recording a large choral group is challenging in its own right. Adding the requirement of a reflection-free recording makes the challenge considerably more difficult. Through prior work with 3M in St. Paul, MN, USA, Wenger knew of a larger anechoic chamber that might be able to provide the size and support needed for a large choral group (Figure 1).

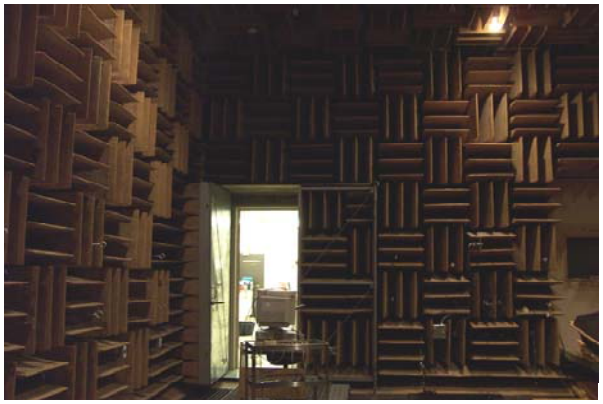

Figure 1. 3M Anechoic Chamber

The chamber and nearby reverberation rooms are now used to support material research and application development activities for Thinsulate Acoustic Insulation and 3M's worldwide acoustics businesses. 3M generously donated the use of these facilities, along with support personnel to assist the project. The chamber measures 7.6m (25ft) by 9.1m (30ft) by 6.1m (20ft) with a suspended grid 1.5m (5ft) above the absorptive wedge floor.

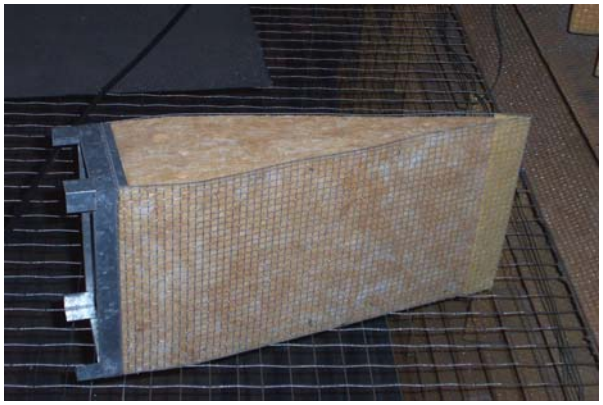

Figure 2. Fiberglass wedge

The fiberglass wedges providing internal absorption in the room are 91cm (36in) in depth (Figure 2). A unique and essential feature of this chamber for this project was a curved support track installed at grid level, enabling heavy items to be rolled out into the chamber (Figure 3). The center part of this track is 91cm (36in) wide, with 25cm (10in) of grid spillway on either side. How well would this track support a large number of singers and the risers? The track was eventually judged capable of supporting an 80-member choir on risers, estimated to have a total weight of nearly 6000kg (6.5 tons).

Figure 3. Support track & riser sample

There were logistical issues that would have to be addressed. One of 3M's primary concerns was corporate security. The chamber was located in one of 3M's core research and development labs, which have heightened security and generally very few visitors. Its central location in the building meant there was no shortcut or easy way to bring in a large group of singers. 3M decided to pre-register all singers, issue event-specific personalized name badges and provide escorts. Meetings between 3M and Wenger started concurrently with the search for a choral group willing to participate in this recording.

WHO WILL SING?

Due to the long relationship between Wenger and St. Olaf College in Northfield, MN, this college's internationally acclaimed music department was chosen as the best possible option for finding a choral group. Contact was made with the choral professors at the college and Dr. John Ferguson expressed enthusiasm in having his students be part of this project. Dr. Ferguson directs the 80-voice St. Olaf Cantorei made up of men and women. Challenges for this group would include performing musically despite the extremely dry acoustics of the chamber. Two principal ideas were discussed and implemented to help address this issue. First was changing the arrangement of the singers from the normal Soprano, Alto, Tenor, Bass (SATB) configuration. Instead, small groups within the choir would be made up of each vocal part, thus assisting members in hearing the overall sound. In an anechoic chamber, this hearing would be difficult due to the lack of reflections. The second part of the discussion involved how best to rehearse for this event. Initially the discussion centered on using headphones during the recording session to provide some sensation of a reverberant space to support a more musical environment. However, logistical considerations and unfamiliarity with this type of recording technique led to the decision that the best replication of an anechoic environment would be rehearsing outdoors away from buildings and other reflective surfaces. Three outdoor rehearsals were held on the St. Olaf campus, away from buildings, roads and other reflective surfaces. This did elicit a number of inquiries from passersby ("What are you doing"?) who noticed this unusual rehearsal venue.

For the actual recording, the plan was developed for two, two-hour recording sessions, one in the afternoon and one in the evening, with a break in between for a short rest. Discussions were held with Dr. Ferguson about the purpose of the recording and its focus on choral music, specifically *a cappella* arrangements because there were already other anechoic recordings with instruments. It was decided to limit the number of songs to six due to the challenging performing environment of the anechoic chamber. Four songs would be *a cappella*, one with a solo violin accompaniment, and one

with handbells to provide some variety in the recording. The songs were: Beati Quroum Via, Alleluia, Almighty and Everlasting God, Who Is This, Psalm 150 and Kyrie from Missa Brevis #4.

THE RECORDING

Recording Equipment

Selection of the recording equipment was driven by the desire to capture as much high-quality information as possible, since the likelihood of replicating this event in the near future would be difficult. The recording session was captured on 24 tracks of 24-bit digital audiotape. Eight different microphone configurations were used concurrently for the recordings (Figure 4). These included: A-B spaced pair of matched DPA 4003 omni-directional microphones spaced 61cm (24in) apart; A-B spaced pair of B&K 4007 omni-directional microphones spaced 91cm (36in) apart; ORTF method Neumann KM140 pair of cardioid directional microphones; ORTF method Schoeps CMC5-MK5 pair of cardioid directional microphones; A-B spaced pair B&K 4011 cardioid directional microphones spaced 122cm (48in) apart; A-B spaced pair Neumann KM184 cardioid directional microphones spaced 61cm (24in) apart; Four "shotgun" Audio Technica AT4073A microphones spaced in pairs at 91cm (36in) and 122cm (90in) with each microphone aimed at one quarter of the choral group; X-Y method Schoeps X/Y CMXY cardioid stereo microphone at 90 degrees. Installed but not used due to technical issues were X-Y method Neumann SM69 and ambisonic method Calrec Soundfield MKVI microphone.

Figure 4. Microphone Bar

Other equipment used for the recording session were 24 channels of Millennia Media-3D HV preamps and 3-Tascam DA98HR 8-track/24bit digital recorders for 24 tracks of recording. For monitoring, Genelec Model 1030A near field monitors and Soundcraft Spirit M series and FX16 mixers were used (Figure 5).

Figure 5. Recording and Monitoring Equipment

Ideally it would have been preferable to have an individual microphone for each person, allowing for the maximum flexibility when mixing, however the practical limitations of this implementation caused this approach to be abandoned. The microphone selection made allowed for some discretion/experimentation with the various configurations.

Engineering of the recording sessions was handled by Tom Mudge and Craig Thorson, both contracted from Minnesota Public Radio (MPR). They had extensive backgrounds in recording choirs and other live events.

Live Recording

All recording was done directly from the microphones to a dedicated preamp to the digital recorder. No mixing was done during the recording session. Previous discussions with the recording team and the choral director had concluded that there would be no overdubs during the recording session. Each song was complete from start to finish as performed (Figure 6). Due to ventilation background noise in the chamber, the system was stopped for each recording and switched back on during the breaks between songs. Gradually the temperature increased in the chamber, even with the ventilation between songs. Eventually, some students became overheated and experienced symptoms of claustrophobia.

Figure 6. St. Olaf Cantorei Choir

Monitoring of the recording session was conducted in an adjacent reverberation chamber. Walls were treated with Thinsulate absorption to reduce the reverberation time to acceptable levels for monitoring. A video link was installed to provide a visual link to the anechoic chamber, choir and director (Figure 7).

Figure 7. Tom Mudge engineering

The actual recording session of the six songs was completed in 1.5 hours due to the extensive rehearsals conducted by Dr. Ferguson and the St. Olaf Cantorei Choir; the planned evening recording session was unnecessary (Figure 8).

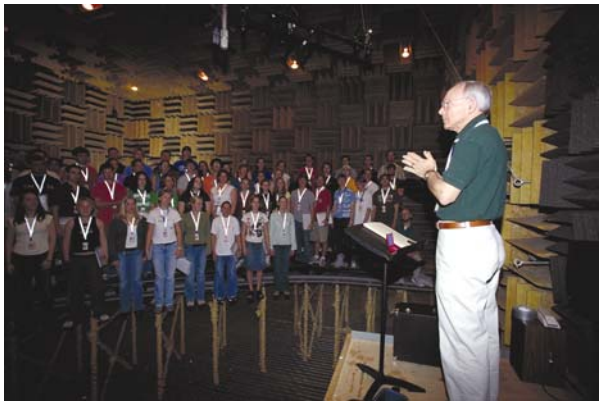

Figure 8. Dr. Ferguson and the St. Olaf Cantorei Choir

Upon completion of the recording session, a dodecahedron speaker was placed on the middle step of the center-most riser as close as possible to where the center of the choir had been. This was to provide a reference level for the recording. A 60-second selection of pink noise was recorded on all 24 tracks. The SPL at the microphone array was measured using a Larson-Davis 2900B analyzer.

Post Production

It was decided that the information from the recording session would be provided in two formats with two distinct purposes: 1) an audio CD for use in auralization or any other applications requiring an anechoic choral source; 2) a DVD that would contain the digital data as recorded on the 24 track recordings in .wav file format allowing for other choices in microphone methods, types and mixed levels (the raw, unmixed tracks from the recording session). Six of the 24 tracks were not usable due to technical issues with the Neumann SM69 and Calrec Soundfield microphones.

To create the audio CD, the tracks were played back at MPR's Studio M, which offered an excellent critical listening environment. Tom Mudge and Craig Thorson provide engineering on the selections for the audio CD (Figure 9).

Figure 9. Craig Thorson mixing at Studio M

Three microphone sets/methods were selected as providing the best potential for use with auralization programs. The main perceptual differences were in the apparent source width, which translated somewhat differently in the auralization process. These were later evaluated through auralization using CATT-Acoustic software and convolution of impulse responses through a Lake Technologies FDP-1 convolver used for near real-time evaluation. The six songs from the three microphone pairs were then mastered for an audio CD. Endings for each of these songs were also mastered for the audio CD for those who just need short song segments for auralization comparison.

The DVD included all usable tracks from the recording session, allowing others to experiment with other microphone/methods/mixes for auralizations. The DVD contains both 16bit and 24bit .wav file formats recorded at 44.1kHz (Figure 10).

Figure 10. Mastering Audio CD

SUMMARY

The anechoic choral recording event required approximately a year and half of planning to successfully coordinate the activities necessary to accomplish this recording session. Due the unique requirements of the recording, many logistical issues had to be addressed. The resulting recording adds to a relatively small body of anechoic source material that is available for auralization, which until this time included no choral selections.

Wenger has been able to utilize the anechoic choral recording in proscenium auditoriums and secondary-school rehearsal rooms using binaural recordings to assess perceptual and

objective differences in room acoustics from acoustic wall treatments, ceiling clouds, orchestral shells, etc.

Wenger Corporation hopes the availability of this CD/DVD set will facilitate ongoing improvements in auralizations, and resulting advancements in acoustical design and facility construction. The CD/DVD set is available at no charge from Wenger; please contact Ron Freiheit at ron.freiheit@wengercorp.com.

REFERENCES

1 Denon, Anechoic orchestral music recording. Audio CD, Denon Records, 1995
2 Bang & Olufsen, 'Music for Archimedes', Audio CD, Bang & Olufsen records, 1992