Technical Note

Note: Technical notes are aimed at promoting discussion. The views expressed are not necessarily those of the editors or the Australian Acoustical Society. Contributions are not formally peer-reviewed.

ACOUSTIC REDESIGN OF BRISBANE CITY HALL AUDITORIUM

Derek Thompson
AECOM, Melbourne, VIC, Australia

Prompted by a need for urgent structural repairs, a $215 million project was initiated by Brisbane City Council in 2009 to restore Australia's largest town hall. AECOM was commissioned through the architects to provide acoustic advice for the overall building, including Council Chambers, staff offices, and a new rooftop gallery for the Museum of Brisbane. AECOM was also engaged to provide specialist architectural acoustic design for restoration of the main Auditorium.

A BRIEF ACOUSTIC HISTORY

The size and geometry of the Auditorium at Brisbane City Hall creates an imposing space and distinctive ambience of grandeur. However, the large size of the space, its circular form, and geometry of the domed ceiling all contributed to acoustic issues that have affected events and activities taking place in the Auditorium since its original opening 83 years ago.

Previous refurbishments of the Auditorium had attempted to address some acoustic deficiencies, primarily through introduction of acoustic absorption. In the 1970s the solid dome ceiling was replaced with expanded vermiculite, applied to chicken-wire on a timber frame. In the 1980's large fabric-faced wall and ceiling absorber panels were applied liberally throughout the auditorium. While such treatments were clearly well-intentioned modifications to control the issues of focusing and poor intelligibility, these treatments had not addressed the underlying room geometry, and as a result never truly tamed the problems of focused sound.

Conditions for a variety of contemporary uses – including banquet dining, speaking events, trade shows and amplified music concerts – were still compromised. Indeed, with absorptive treatments only, the acoustic character of the auditorium had been substantially altered and the reverberation time reduced to such an extent that the City Hall was unsatisfactory for orchestral or chamber music – and wholly unsuited to performances on the historic Henry Willis & Sons pipe organ. To support the ongoing viability of the auditorium both as a commercial venue, and as a community space, the renovation plans necessarily had to address these acoustic issues.

FEATURES OF THE ACOUSTIC REDESIGN

The old vermiculite dome facing has gone, replaced with transondent membrane which replicates the dome shape visually (with subtle adjustment to the geometry – as shown in Figure 1), while concealing acoustical reflector arrays and allowing the architects and specialist lighting designers to provide theatre systems and integrated lighting displays. This system incorporates two layers of lightweight and micro-perforated stretched membranes. A concealed ceiling reflector array was then designed to meet the exacting structural constraints of the historical building structure. Even very small increases in weight, multiplied across dozens of repeating elements would affect the ability of the building structure to support temporary event rigging systems.

The outer dome was restored and treated with a sound-deadening composite foam lining, incorporating a fire-resistant facing and an embedded limp-mass layer. This treatment provided the necessary balance of sound insulation and absorption whilst being relatively lightweight.

Figure 1. The newly installed dome, incorporating heritage central lantern

Another critical design feature was the introduction of new acoustic diffusers to replace the existing wall panels, as shown in Figures 2 and 3. These were developed specifically to combat acoustic deficiencies in the base auditorium geometry. The diffuser panels are moulded in glass-reinforced plaster, recessed up to 600 mm into the auditorium walls to minimise visual impact. The design also allowed for modular construction, aiding manufacture, delivery and installation on site.

Figure 2. Installed acoustic diffuser panels and displacement air grilles, with architectural facings

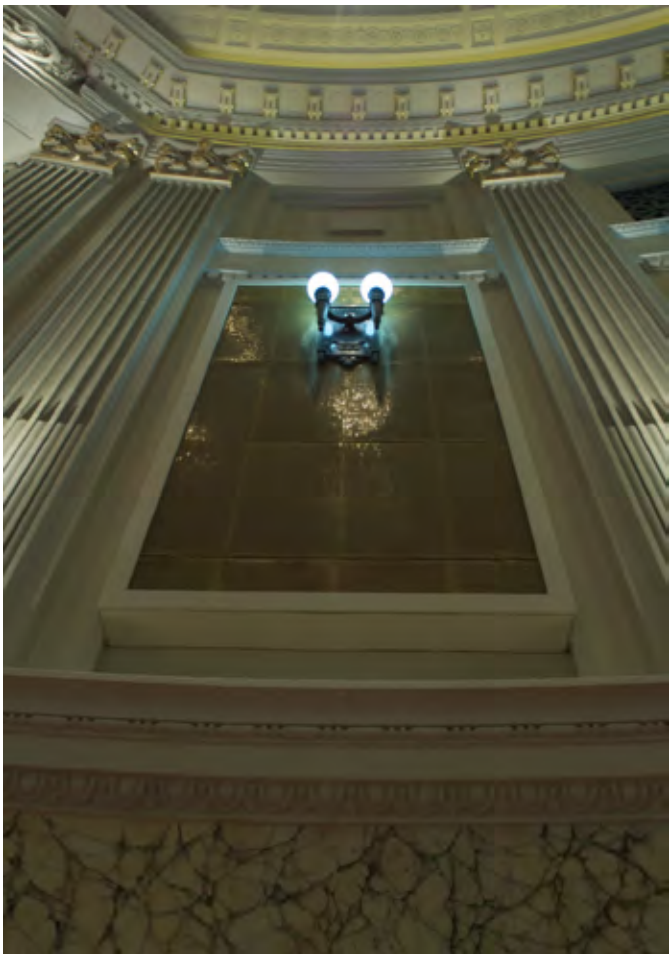

Figure 3. Acoustic diffuser panel with integral variable absorption, architectural facing and heritage light fitting

Variable acoustic control has been incorporated into the space through automated acoustic banners to provide subtle control over reverberant conditions in the space, allowing conditions to be matched to a variety of uses from meetings and exhibitions to organ recitals. The banners and diffusor panels have been concealed with architectural facings to integrate with heritage details.

Figure 4. Prototype panel testing at RMIT

The panel designs were extensively tested prior to manufacture via 3D acoustic ray tracing. Prior to installation full-scale prototypes were constructed and tested in the reverberation chamber at RMIT in Melbourne to verify absorptive properties, as shown in Figure 4.

Additional measurements of the directional diffusion coefficient were conducted at full-scale, in a temporary testing facility established specifically for the tests at Jands' factory in Sydney. This testing applied the newly published standard for testing of directional diffusion coefficients [1].

RESTORATION RESULT

Figure 5 shows the acoustic result for the auditorium is an improved reverberation time – extended by over one second – much more consistent with the room's original grandeur, and enabling the Henry Willis organ to be featured. The auditorium also enjoys variable acoustics for fine-tuning of the space according to the type of event being held.

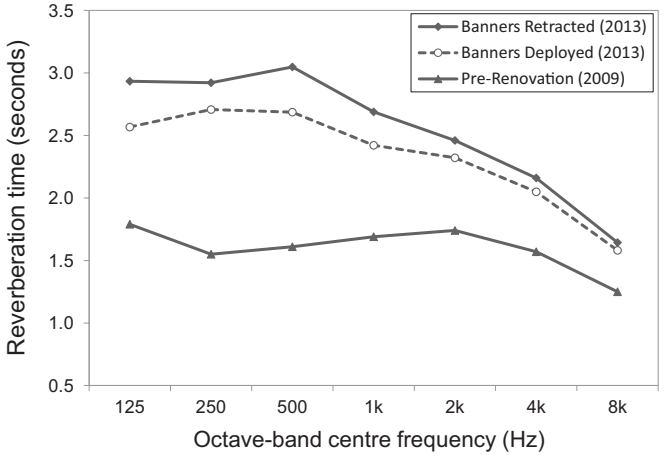

Figure 5. Reverberation times (unoccupied) pre- and post- renovation works

RESTORATION FACTS

New building elements critical to creating the new acoustic conditions in Brisbane City Hall's main auditorium include:

- Dome array consisting of 70 acoustic reflector panels, concealed above the visible dome face
- New visible surface for the dome made from a transondent tensile membrane
- Modified geometry and radius for the visible face of the ceiling dome
- Restored external copper dome has had a multi-layer limp-mass lining added to provide absorption within the dome and boost the transmission-loss
- 16 custom profiled 2D acoustic diffuser panels, moulded from glass reinforced plaster and recessed into the auditorium walls at the stalls level
- 18 custom profiled 3D acoustic diffuser panels, moulded from glass reinforced plaster and recessed into the auditorium walls above the balcony
- Variable acoustics provided by 46 operable acoustic banners integrated with new architectural elements
- Programmed control system providing automated setting of acoustic banners for different events
- New low-noise displacement air-conditioning system
- New seating throughout
- Original hardwood flooring reinstated
- Original plaster surfaces and detailing restored.

ACKNOWLEDGEMENTS

AECOM acknowledges the work of Brisbane City Council, Tanner Kibble Denton Architects (in particular Megan Jones and Scott MacArthur), and Jands (Peter Grisard and Chris Clegg), contributing to the acoustic success of this significant public project.

REFERENCES

[1] International Organization for Standardization ISO 17497-2: 2012, *Acoustics – Sound-scattering properties of surfaces – Part 2: Measurement of the directional diffusion coefficient in a free field*, 1st edition