Clear debate

The audiovisual systems within Australia's Northern Territory Parliament have been redesigned for a new age, solving a host of problems along the way

WHEN IMPLEMENTED IN 1993, THE video and audio systems in the chamber of Darwin's Northern Territory Parliament were among the most sophisticated in Australia. Installed under watchful eye of Rod Louey-Gung (principal of Integrated Media), the installed system incorporated a broadcast vision and audio system that enabled a single non-technical operator to take full control via a touchscreen. The system supported dual operation, for those occasions when more sophisticated video switching and high level production values were required. In these situations, a producer would take over the production and operation using the broadcast vision mixing and camera titling system.

Eighteen years almost equates to a geological epoch in audiovisual history. With equipment exceeding its recommended life and components showing signs of deterioration, it was clear that an upgrade was required. To address the requirement for highly intelligible speech reinforcement and higher user expectations for vision quality in such a prominent place as the chamber, the Northern Territory Parliament identified the need for a high-performance technology solution that offered high-performance sound reinforcement for Parliamentary

The former control room

The Northern Territory Parliment now has a customised loudspeaker installation

Members and the public to better hear and understand chamber proceedings. It also stipulated the need for system redundancy in case of equipment failure in addition to high quality sound-processing for use in broadcast, house distribution and internet streaming. Furthermore, a fulfilment of high video production values to allow the client to remove broadcasters from the chamber was required, whilst future proofing for the transition to digital broadcasting and 16:9 video format was also recommended.

Having identified these criteria, the clerk of the Parliament contacted Rod Louey-Gung in 2009 to seek guidance on the replacement of the chamber's audiovisual systems. As one of the founding directors of ICE (Integrated Communication Environments) Design Australia Pty Ltd, Mr Louey-Gung introduced the clerk to ICE Design's expertise and experience in designing solutions for difficult, high profile spaces. ICE Design is the only consultancy in the Asia Pacific region that focuses on the holistic design of environments and technical systems for spaces such courtrooms and parliaments. As a result, the company was commissioned to undertake the design and commissioning of the replacement broadcast and audio systems and oversee their installation. A comprehensive consultancy process was then undertaken to meet the project's schedule of successful implementation and handover of the new systems in time for the May 2011 parliamentary sessions.

Common shortcomings in parliamentary systems

Over the years, the Northern Territory Parliament identified a number of shortcomings in its existing systems. The inappropriately placed small desk-mounted loudspeakers, for example, were incapable of producing the SPLs required for robust debate and could only provide limited coverage of each Member's personal space. In addition, the positioning of the loudspeakers in the public gallery itself was poor, resulting in significant sound spill back into the chamber, further degrading the speech intelligibility for all listeners on the chamber floor and in the public galleries.

The entirely automatic audio system created excessive room noise when too many microphones became active, which in turn affected all system outputs, making transcriptions difficult, whilst compromising audio quality on the internet and for broadcast. The automatic switching of microphones also meant that as the chambers became rowdier, with more microphones opening, the audio level of the speaking Member remained constant but inadequate and easily overcome by the interjections. As a result, acoustic feedback occurred on a regular basis. Furthermore, the microphones were generally situated far away from the speakers and were inappropriately located, thereby limiting the clarity and intelligibility of amplified speech. When addressing the chamber the Members could

SOME TECHNOLOGY REVELATIONS: MICROPHONES

Rod Louey-Gung explains microphone placement within the Northern Territory Parliament

NO MATTER how good the microphone, poor placement can destroy the sound quality. The Northern Territory Parliament's original microphones were mounted on short fixed stems, placing the capsule at best 1m away from the person speaking. When designing the custom gooseneck for the new microphone, considerable thought went into appropriate placement, particularly regarding desk reflection on the frequency response of the original microphones in-situ.

Meanwhile, whilst the chamber sound was manually switched, this process did not provide all signals for Hansard recording. As the Hansard system was upgraded from four-channel to eight-channel recording as part of the system upgrades, we had great flexibility in recording channel assignments. However, how where we to get the appropriate channels out of the system without an automixer mess?

The problem for Hansard is that Member interjections in the

Rod Louey-Gung

chamber must also be recorded in case they need to be included in the Hansard record. So, a special recording side-chain was developed.

Having previously had great success with the automixer in the Biamp Audia, we utilised the adaptive gate threshold, and the ability of the automixer to discriminate to the most appropriate microphone.

Firstly, dividing the chamber into five logical sections for the purpose of recording channel assignments allowed the use of smaller channel counts for each automixer. Secondly, when a channel was manually selected for sound reinforcement it was 'removed' from the automixer mix. However, turning the microphone off still allowed it to be part of the adaptive threshold. This provided a more stable reference for the automixer, and has resulted in high quality interjection recording across four channels. Channels One and Two are specifically for the executive mics and switched Member.

A variation of these signals has been mono mixed for broadcast and internet streaming. Where before there was great variability in sound quality as the number of open microphones increased, the new broadcast and internet sound is very clean and natural.

Loudspeakers are hung high in the parliament

not hear themselves, with many developing a habit of speaking away from the microphone, resulting in poor quality audio pickup.

The design approach and new features

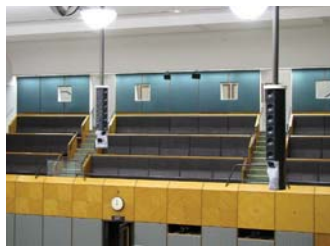
At the commencement of this project ICE Design had completed a similar job for the New Zealand Parliament. Whilst the Northern Territory Parliament shared a number of common requirements with the New Zealand Parliament, there were also significant differences. One of the most important related to the control room location and the sophistication of its user operations. In the Northern Territory Parliament, the control room does not have line-of-sight viewing directly into the chamber. Furthermore, Darwin does not have ready access to operators with a production background. These two situations heavily influenced important design decisions aimed at simplifying the system operation.

The integrated design approach looked at all aspects of the original system design to understand the shortcomings that needed to be addressed to meet the new performance requirements. Using the performance parameters and design process undertaken for this project, it was decided early on that a sound reinforcement system similar to that used in the NZ Parliament would be suitable for implementation into Darwin. Similarly, it was deemed that the user button panel interface from New Zealand provided a good basis for the design of customised control surface for Darwin.

One of the major design features arising from this process was the customisation of loudspeaker systems for both the Chamber and the public galleries in order to provide robust speech intelligibility under difficult conditions. The downward-aiming loudspeakers now allow Members to hear themselves when speaking. The new microphones have been installed on custom rigid goosenecks to optimise the distance between the microphone and the member speaking, thus maintaining a consistent position with respect to the loudspeaker system for reliable, natural sounding reinforcement of Members' voices.

Audio-Technica microphones have been desk-mounted

By changing the operation of microphone switching to manual, meanwhile, all the unused microphones could be muted in the sound reinforcement and broadcast systems, thus maximising system gain before feedback and signal to noise ratios. Additionally, the availability and integration of newly available digital signal processing technology ensured interjections could be captured for transcription by Hansard. The resultant system with its network redundancy ensures that the installation will continue to operate following a failure of any major component. In addition to new sound absorbing panels being added, a calibrated control room has also been created to monitor and control the system, ensuring the operator hears a true representation of sound levels on the floor of the chamber through the monitoring environment.



Customised loudspeakers provide high intelligibility

Key sound system requirements

ICE Design lists its parliamentary audio solutions on the basis of meeting several key requirements for Members, parliamentary staff and public present in the debating chamber. Firstly, speech intelligibility must be excellent. Secondly, amplified speech must overcome noise from Members' interjections. To do this the system must deliver sufficient amplification before the onset of acoustic feedback, have sufficient capacity to accommodate the speaking styles used during Question Time and sound very natural. The amplified sound should appear to come from the direction of the talker so that there is reasonable matching of the visual and aural cues for listeners, thereby improving naturalness of human communication between Members.

The loudspeakers were specifically developed by ICE Design and manufactured by Acoustic Technologies in Brisbane to meet the requirements of the NT Parliament. Similar to those used for the NZ Parliament, they were modified to suit the NT Chamber requirements.

Three 'Croc Tube' 23-element beam steered arrays were installed to achieve the resultant performance, incorporating multi-channel audio processing and amplification. To bring the performance of the loudspeaker and associated system to its operational potential, ICE Design undertook a detailed and extensive commissioning process. Bespoke ALA07 beam steered array loudspeakers, again from Acoustic Technologies were also designed for the public galleries and were flush-

THE MANUFACTURER'S VIEW

QSC's vice president of systems strategy, Richard Zwiebel, offers his thoughts on the Northern Territory Parliament.

'I HAD the pleasure of visiting the Northern Territory Parliament in Darwin this year. One area that I have especially focused on over the last 23 years is legislative facilities, having designed and set up many chambers ranging from a small city council all the way to the United States Senate Chamber.

As the VP of systems strategy at QSC my main area is with the Q-Sys product. QSC developed Q-sys to be a very powerful, configurable, yet easy to use product that could be applied to many applications.

Richard Zwiebel of QSC

During the design phase of the Northern Territory Parliament we received many inquires and requests from the designers at ICE. The questions were always the type that showed a deep understanding of signal processing, acoustics, loudspeakers and most importantly the interaction between them. I work with people throughout the world on a wide variety of project types and this is one that really caught my attention, so when I was invited to come visit the Parliament, I was quite excited. I knew it was going to be a very interesting project.

What I knew was that it was fairly large, live room. Typically, in that type of room, I would recommend that the loudspeakers be placed very close to the person who is speaking. This type of 'distributed loudspeaker' approach is able to get good gain before feedback and intelligibility since the speakers are so close to the listener. By being so close, the volume does not need to be very loud, which in turn avoids exciting the room.

But I knew that the people at ICE had done something quite different. When I first saw the room, I looked at the surfaces, microphone placements, and the speaker locations. The system uses large steerable arrays hung high above the chamber floor. This is not an approach I would have recommended for this room, as it looked like intelligibility would be low and the potential for feedback would be high. Looking at the system made me nervous that it would not sound especially good.

The system was turned on and we started to speak through it. I purposely went to the areas that should sound the worst. I listened carefully and boy, was I wrong! The system was very intelligible and there was no feedback issue at all. I kept going from location to location, and it just kept sounding exactly the way you would want it to. The best compliment a legislative system can get is that you hardly notice it is there – you just clearly hear each and every word. This system easily achieves that goal.

I reviewed the Q-Sys design file and realised just how much effort had gone into creating a design that could be fine tuned so well. Here was an example of highly skilled practitioners using the power and flexibility that we designed into Q-sys in a very creative way that took full advantage of those capabilities. They were able to create all of the filters and delays, along with other processing and mixing elements to tune the steerable arrays to exactly meet their needs.

The loudspeakers really impressed me a lot too. I had never seen or heard these speakers before and they are certainly unique looking units. By placing these well-designed speakers correctly and carefully tuning them, the desired result was totally achieved.

If I had just seen photos of this room and system I would have assumed that it sounded okay at best, but once I heard it I was very impressed. I realised that there is more than one way to achieve a great result and that I had a lot to learn still. I have a passion for this industry and hearing this system work so well really made my trip extra special. I realise that pulling this off took great products, a lot of knowledge, a lot of skill and I have to believe that it took a lot of time in tuning to get it to work that well. In fact, since returning to the US, I have told many leading consultants and integrators about this great project far away in the Northern Territory of Australia.

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mounted with the ceiling. The beam steering minimises the sound radiated directly back into the chamber and also directs sound towards the public seating areas and the acoustic panels where it is absorbed, minimising detrimental spill back into the chamber floor. The aesthetic aspects of all loudspeakers were addressed collaboratively with Darwin-based Jackman Gooden Architects, to ensure that they integrated with the Chamber architectural features without compromising the design performance.

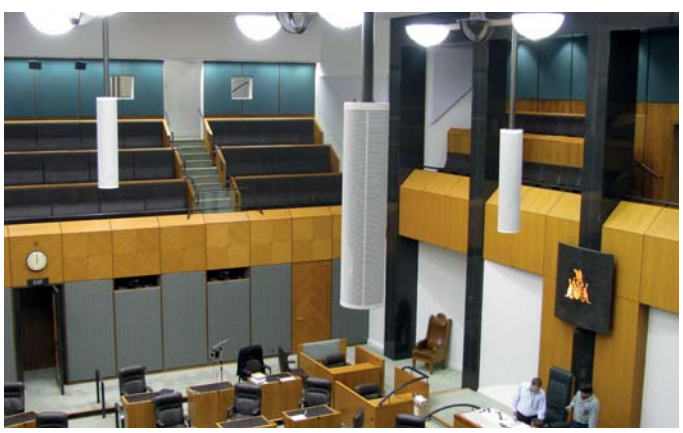
ICE Design undertakes a thorough testing of various microphones, involving acoustic and electronic measurement and listening tests, every three to four years in order to select an appropriate model for court and parliament projects. An additional test was conducted for the NZ Parliament, where the selected microphone from Audio-Technica was compared to a respected broadcast microphone and found to be more than acceptable and therefore selected for the NT Parliament chamber. Custom rigid gooseneck designs were made to place the microphone capsule in the best location for voice pickup on each of the Members' desks, Despatch Boxes, Speaker and Clerk's positions.

One of the major challenges with the new system was to allow non-broadcast operators to control a sophisticated A/V system. From ICE Design's experience on their New Zealand project, a mechanical push button panel provided the necessary tactile interface not available to more high-tech designs such as touchscreens. Designed and manufactured by FutureWorks of Wellington, the same control interface and software for the New Zealand Parliament was adopted for the Darwin system. The major difference between the two was the tight integration of audio and video in Darwin, with the control panel simultaneously controlling both the on/off function for the microphone channel and the camera positioning to capture the most appropriate shot of the Member. The setup allows the camera selection to be previewed prior to switching the camera to air.

The control room for system operations in the NT parliament is located on the fourth floor, which is physically separate from the chamber. The lack of direct visual and audible connections between the two prevents the operator from directly experiencing the sound heard within the chamber. To address this issue, ICE Design provided a calibrated mix of sound levels of both speaking Members' microphones, interjections, and other microphones, in order to mimic the sound field present in the chamber for the operator in the control room.

An ambient mix provided the operators with a natural soundscape resembling the levels in the chamber, while live microphones were directed to either left, centre or right monitor loudspeakers to approximate the seating layout of the chamber and match the default wide-angle camera view used. The Speaker and executive microphones appeared in the centre channel. Sound quality in a high-resolution monitoring situation is dictated as much by the acoustic environment of the listening room as it is by the sound produced by the monitor loudspeakers. Considerable design work went into modifying the acoustic performance of the control room using both broadband and tuned, low-frequency sound absorbers.

The combination of acoustic measurements and listening tests conducted in the chamber and an understanding of the difficulties with the original sound system resulted in some acoustic issues requiring treatment before proceeding with the sound system design. Four critical aspects of the acoustical properties of the chamber and the public galleries were assessed including the ambient noise levels from building services, reverberation time, acoustic reflection arrival patterns and structure of the existing acoustic treatment on the walls of the chamber.



Intelligibility has dramatically improved

Significant work was undertaken to replace and supplement the acoustic panels in the upper galleries that were more suited to the critical requirements of the loudspeaker system. High-performance sound absorbing panels were fitted to the rear and side walls of each gallery to minimise the amount of acoustic spill from the three open galleries onto the chamber floor and to reduce the reverberation times of the enclosed gallery. Existing panels on the lower levels of the chamber were also refurbished and finished with a carefully selected fabric, resulting in improved speech intelligibility and acoustic-comfort in both the chamber floor and the public galleries.

A major disadvantage of most DSP based audio systems prior to this implementation was the difficulty in providing resilience to a major component or network failure. The availability of QSC Audio's Q-Sys platform provided full redundancy by hot swapping the duplication of critical components. The system was designed and implemented with dual redundant networks, system Core processors and peripheral devices, for which dual redundant Gigabit networks carry the Q-Sys audio and control traffic. Should one network component fail, there is an immediate switch to the redundant network. Similarly, failure of one of the Core processors will result in a redundant Core taking over the entire operation within 7s.

Control and cabling

Another critical part of the system is the recording feeds, which differ from the sound reinforcement feeds in so much as they must record all interjections. To achieve this ICE developed a secondary DSP system based on the Biamp Audia, which took a split of the Members microphones to provide automixer switching specifically for Hansard and broadcast audio.

Results

The new sound system has been proven to provide excellent speech intelligibility at a world-leading standard to all listeners on the chamber floor and in the galleries. Excellent gain before feedback was achieved and ultra-natural tonal balance is achieved for all listeners. The new system provides a platform for Members to appropriately address the house, knowing that all orations can be heard throughout the chamber and public galleries, online and with accurate recording by Hansard. Visitors addressing Parliament can also be heard in the same manner.

As the implementation of the system has been undertaken in two separate phases, ICE Design was able to qualify the outcomes. The first stage witnessed the installation of custom manufactured microphones from Audio-Technica for which on-site measurements were completed to ensure appropriate placement of the microphone when the Member speaking was standing at their desk. The replacement of the microphones saw an immediate rise in quality of the recorded Hansard, making transcription easier, and resulting in a significant productivity increase.

The second stage saw the completion of the loudspeakers and control system, resulting in a change in the speaking behaviour of Members. Previously, as Members wandered around their seating positions, inadequate sound pickup had become the norm. The provision of effective monitoring, enabling each Member to hear themselves when speaking has resulted in Members standing more directly in front of the microphone, ensuring other listeners understand them. This change in behaviour has further increased the audio quality of Hansard, sound reinforcement and broadcast, and web-streaming.

The original system's audio operation provided a poor broadcast signal due to multiple microphones being active during robust debate in the chamber, and the inability to prioritise the recognised Member. This resulted in poor sound quality due to low signal to noise ratio, reverberation and a high level of background noise. The new operating procedure with only required microphones being active resulted in a major improvement to the broadcast audio quality. This is most noticeable on the internet streaming, where the signal received by the user often suffers from limited bandwidth and compression.

When first opened in 1995 the Northern Territory Parliament had one of the most sophisticated and highest performance Hansard systems in Australia. Built to meet the needs of the day, the original system lasted for 15 years. This project has enabled the NT to once again take leadership with a system that is designed to meet the needs of a new age. How obsolete this will have become by 2029 is open to speculation and debate depending on how technology advances over that time frame.

www.icedesign.net.au
www.futureworks.co.nz
www.broad-perspectives.co.nz
www.redfishtechnologies.com.au
www.ozemail.com.au

Equipment (Main Components)

QSC Audio Q-Sys Core 4000 processor x 2
QSC Audio Q-Sys I/O frame x 22
QSC Audio CX168 amplifier x 17
Biamp Audia Flex x 2
Acoustic Technology Croc Tube 23-element beam steered array x 3
Acoustic Technology ALA07 8-element beam steered array x 12
Audio-Technica custom gooseneck microphone based on the U857 with UE-H capsule x 40
AMX control system with custom push button interface by Future Works (NZ)
Emes Black TV studio monitor loudspeakers x 3
FTR "For the Record" software - 8- channel recording x 2
Cisco 3560E-48 switch x 2
Martini Industries PolyMax XHD100 polyester insulation