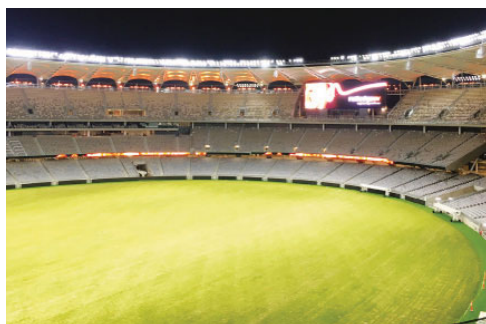# Field of dreams

Hard to ignore, Perth's new multipurpose stadium is a testimony to both Multiplex' thorough research and Rutledge AV's design skills. **Richard Lawn** takes a tour

The stadium incorporates two Daktronics 10m high x 34m wide 15HD pixel displays

Optus Stadium takes shape during the final phases of construction

15,000 LED lights can project team colours around the stadium's seating area and on the roof

THE 60,000-SEAT OPTUS STADIUM RESIDING BY THE easterly bank of the Swan River has captured many headlines since opening its gates to spectators in January. It is the third largest in Australia after the Melbourne Cricket Ground and Sydney's Stadium Australia. Having relocated from Subiaco Oval, Optus Stadium is now home to two Australian Football League (AFL) teams – the Fremantle Football Club and the West Coast Eagles – plus hosts international and domestic cricket, soccer, rugby union and rugby league games.

Its multipurpose credentials have been further extended with entertainment events, as booking western Australian dates as part of a world tour now becomes a viable proposition for concert promoters. Previously, nib Stadium's 22,000-capacity represented something of a risk for international artists, but Optus Stadium's 70,000 capacity makes it a lucrative stopover between South East Asia and Australia's east coast, as Taylor Swift's promoter has demonstrated by booking it for October.

In an attempt to maximise the stadium's commercial appeal, the Westadium Consortium led by Multiplex has delivered additional facilities that attract a regular revenue stream. Behind the field of play, multiple function rooms providing a high degree of flexibility are capable of hosting various scales of corporate events, exhibitions, weddings and celebrations for up to 2,000 guests.

The Design Development phase consulted with nine User Groups that would ultimately create a Project Definition Plan together with ongoing design development elements. Created in early 2013, the Sports Fans User Group aimed to deliver a 'fans-first' aspiration into planning and design. This group constituted 30 western Australian fans selected from a wide range of demographics and sports to provide ongoing advice relating to the fan experience during events. Using their experiences from attending events at other stadia, the group highlighted the need for wider concourses, a larger number of food and beverage outlets and toilets to reduce queuing and wait times, cup holders in seats and a need for a consistent connection to the field of play. As a result of their collective input, these requests have all been delivered in the Optus Stadium design.

The delayed design and procurement of stadium technology ensured that the Optus Stadium integrated the latest equipment, including the largest stadium video screens to date in the southern hemisphere. In addition, over 1,000 TV screens have been integrated throughout the interior to ensure fans don't miss any of the action. Nor has the lighting been sacrificed as the stadium's 891 LED floodlights together with the 650 RGB (red, green and blue) lighting fixtures that light up the fabric roof combine to make it the largest sports installation in the world. With over 1,000 permanently fixed loudspeakers connected via a digital management system, the stadium houses the largest sound system in Australia.
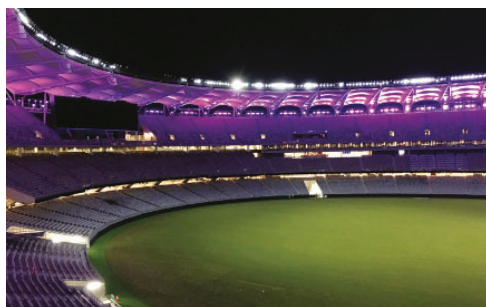
Rutledge AV

Officially founded by Michael and Sandy Rutledge AV in 1979, Rutledge AV initially established its brand by building, installing and monitoring live and recorded sound technologies for recording studios, venues and broadcast media. With an employee count of over 300 across all eight Australian states, Rutledge AV has merited its status as the country's number one A/V systems integrator. It has consistently created cutting-edge A/V infrastructures in all manner of educational institutions, government offices, legal facilities, defence headquarters, airports, retail developments, transportation services and entertainment and sporting venues.

When Alistair Dick set out from his native Melbourne to pioneer the Rutledge AV office in the western Australia capital, he was employee number one. He must have done something right over the last decade, as senior project manager Elijah Steele is one of 60 now employed directly by the Perth office. Mr Steele was charged with the enormous responsibility

of managing Optus Stadium's A/V services design and installation over several years.

Having been awarded the contract to design, install and supply the A/V systems throughout, Rutledge AV never underestimated the scale of what it was taking on. The company's vast experience led it to conduct multiple high-level briefings to the various teams working on the design philosophy. 'Different sporting teams now call the stadium home,' explains Mr Steele. 'As such, they all had to be consulted and we had to incorporate their specific A/V requirements such as OB facilities, in-house broadcasting and team bench communications.'

During all phases, workshops were conducted with the various stakeholders, coordinating all the build technology. From this, a 3D model of the stadium was created using Building Information Modelling depicting the 2,000 speakers that would be installed on the roof, L1, L3 and L4 fills, premium A/V spaces and back of house areas. 'By taking a look at the detail we incorporated, it was easy to envisage the completed rooms,' continues the project manager.

Crucially, before any plans could be drawn, Rutledge AV had to fully understand the strict aesthetic guidelines that the interior designers and architect had put in place. 'We had to convince the architectural team that the sleek, compact structures of our proposed designs would seamlessly integrate into the application without any distraction to the eye,' he says.

The proposed works raised health and safety concerns so structural engineers were also widely consulted in advance. 'Structurally, any installed materials have to be durable for the length of an infinite fatigue lifetime span for the main line array speakers. You also need to factor in 1-in-100-year extreme storm occurrences such as a major typhoon. Enduring such an environment close to the Indian Ocean and a desert with such a large structure is very challenging.'

Main stadium PA

Stadium PA systems are traditionally plagued by echo due to the long reverberation times associated with the architectural acoustics of such expansive spaces. Putting the fan first had become an all-encompassing mission for the State Project Team and Westadium Consortium, which demanded speech intelligibility on par with that of a modern classroom setting. As such, Rutledge AV was challenged to create a PA system that would deliver an ambitious 0.6 STi or above for the entire stadium seating area, referred to as the Main Bowl PA. Additionally, a nominal SPL of 102dB (±3dB) for all the 60,000-seated visitors was stipulated.

Creating high-fidelity audio for what is essentially a PA system under a lightweight fabric roof severely tested the capabilities of Rutledge AV. 'At that point in the 3-year design

Relax in your cinema style seat and watch the game

One of the Nexo line array sub structures is tested

period, the roof structure and all the physical aspects of the design were already being manufactured,' explains Mr Steele. 'We favoured a line array solution, but knew we had to work within the existing design constraints. In addition to weight restrictions, there were limited locations for suspending the speakers owing to the fabric roof. Ultimately, we suspended arrays from the very tip of the roof structure.'

Based on three main criteria – capability, price and performance – Rutledge AV set about evaluating five loudspeaker systems. 'Networking abilities, service support and rigging hardware capabilities were other paramount factors in making our decision,' furthers Mr Steele. 'From the outset, Nexo was the clear winner for a variety of factors and, over the course of the project, the manufacturer proved themselves as great partners providing support whenever we required it. We've worked with their distributor, Group Technologies, many times before and knew we could fully rely on their support.'

Eighteen arrays, each combining 12 Geo S12 elements together with three LS18 18-inch sub bass cabinets, now provide the bulk of the stadium's SPL punch. Largely dictated by simulations using Nexo's NS-1 software, the special Geo S1210 and S1230 modules provide long-throw capabilities to ensure even coverage down to the L1 seating areas. Vertical and horizontal control is further enhanced by the incorporation of the Geo S12's Hyperbolic Reflective Wavesource, while a Directivity Phase Device extends coherency below normal LF-HF coupling limits. The presence of three additional LS18 sub bass units within each array extends the LF response to 32Hz at –6dB.

Having first sourced a specialised metalwork shop to create customised array casings for the 18 IP65-rated weatherised arrays, Mr Steele then set about hiring professional subcontractors to conduct the works. Then there was the tricky obstacle of occupational health and safety to overcome. 'Multiplex red-flagged the 18 line array hangs as high-risk work,' continues Mr Steele. 'This was a process in which I had to provide a presentation to the executives, highlighting each stage of the works and who we had sub-contracted to conduct them. They had to be convinced that our plans were watertight and would not fail or endanger anyone. However, this is an environment where we have extensive expertise dating back 30-plus years.'
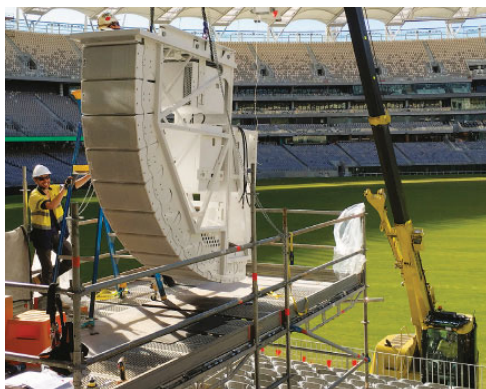

200 Nexo ID24 cabinets have been installed into the shadow areas below the L1, L3 and L4 balconies

From a temporary scaffold built above the seats, the line array sub-structures were individually created. A specialised super crane was placed onto the pitch to hoist the array – initially without its 15 cabinets – to each of the 18 equally spaced suspension points. In each case, a qualified sub-contractor on the roof structure created temporary mechanical attachments to suspend the sub-structure above the temporary scaffold. The Geo S12s and LS18 subs were then loaded, splayed, connected, tested and calibrated before attaching the side panels and raising them into their final position by the custom-built mobile dolly.

'The first array took some perfecting, but we soon got into a good rhythm of installing one array per day,' recalls Mr Steele. 'We also integrated a customised mobile dolly that permanently lives on the roof gantry. It can then lower the line arrays from the catwalk to L1 for periodical servicing, cleaning and maintenance.'

18 Nexo Geo S12 arrays suspended from the lip of the 53m-high roof provide 104dB SPL contributing to an STi of 0.6

One of the line array sub-structures is assembled on a temporary scaffold above the L1 seats

To attain an STi of 0.6 for the under-balcony seating areas on L1, L3 and L4, a further 200 Nexo ID24 cabinets have been installed. Each delayed ID24 incorporates dual 4-inch drivers in a dipole arrangement, providing coverage in those spaces out of the full Geo S12 range. 'These deceptively powerful boxes allowed us to fulfil the 100dB SPL handling in what we term the shadow areas, while their compact footprint provides discretion,' explains Mr Steele.

Cabling conduits from each of the Geo S12 and LS18 arrays run to a number of L5 control room racks housing the Nexo NXAMP4x1 and NXAMP4x4 amplifier racks located within 85m. Equipped with processing presets, the NX amplifiers receive their signal from a Yamaha CL5 console with four MY8-ADDA96 cards located in a lower-level broadcast suite.

Operating over a digital Dante signal transport network, the integrated PA system is broadcast to all zones via the Q-LAN network. 'In terms of monitoring and zone control, the Q-Sys platform had to fully integrate with the Nexo loudspeaker system, which ultimately required custom interfacing between two different protocols,' explains Mr Steele. 'Both manufacturers had to work together to create bespoke software scripts and commands to provide compatibility, so that the operator can monitor or mute the PA, for example.' Mobile configuration and monitoring has been added in the form of Yamaha's Stage Mix app on an iOS touchscreen.

In addition to announcements and BGM, the Bowl PA also serves as a relay system during special events supplementing field sound systems. Furthermore, the Bowl PA can be isolated to individual tiers and seating areas, minimising acoustic reflections that are heard particularly during lower-capacity events. The lower tiers can be reduced or muted, allowing an even transition from the on-field system to the Bowl PA upper areas.

Broadcasting

The broadcast systems running throughout Optus Stadium comprise multiple cabling networks and interfaces that meet the major sporting codes' technical briefs outlined at the commencement of the project. While integrating the in-house A/V production facilities, the stadium-wide cabling backbone interlinks the OB compound, studios and live-to-air camera position in addition to the radio frequency systems used for microphones and communications.

'As it supports current broadcast practices and sporting codes, single mode fibre (OS1) was selected as the primary transport,' explains Mr Steele. 'OS1 operates over significant cabling distances, providing high bandwidth broadcast services that should future-proof the stadium against foreseeable technological advancements. Not only does this backbone ensure 4K and 8K future requirements are met, but it will also maximise venue flexibility for special events.'

The main broadcast, mobile and remote broadcast cameras are channelled to the broadcast patch for the OB vehicles via respective SMPTE 311M and 3G-SDI/fibre cabling infrastructures. From here, the signals can be fed either to the L4 production suite or an external TV studio. 'This is fundamentally a major cabling backbone integrating the various camera and production points to the OB truck patch location,' explains Mr Steele. 'Ultimately, we have created a

really robust setup for the benefit of incoming broadcasters.'

Supporting both active signal extension and OB productions in addition to integrating the in-house production systems, Rutledge AV provided a Riedel MediorNet multicore fibre backbone. The MicroN 80G media distribution network runs from the OB compound to the production studio patch and main control room (MCR). Connected to a core fibre router, the high-density signal interface provides point-to-point functionality for up to 12 bidirectional 3G-SDI video I/Os, two MADI audio I/Os and a Gigabit Ethernet link from all the pre-planned points in the network. These include the media interview rooms, players' benches, players' entrance and team arrivals area, for example, to the OB patch panels.

SMPTE 311M connections have been laid to all the operated camera positions. These are interfaced with 3K93C panel mount connectors that breakout to both OS1 fibre and auxiliary copper, thus ensuring cabling distanced over 400m can be supported. The OS1 infrastructure has been extended to all the camera and auxiliary positions including unmanned and supplementary cameras such as virtual eye and goal post cameras.

Following the initial technical briefings, both AFL teams and Cricket Australia selected precise camera positions, which can be referenced in the technical panel floor plans. In addition, Cat-6a cabling was laid to 10 cricket wicket positions to support enhanced stump vision and microphones, with external connections housed in IP65-rated enclosures.

The heavy schedule of cricket, AFL, rugby and soccer games together with other live events ensures the production suite within Optus Stadium is put through its paces. Having successfully installed the broadcasting production suite into the Adelaide Oval, Kojo was contracted to provide all game-
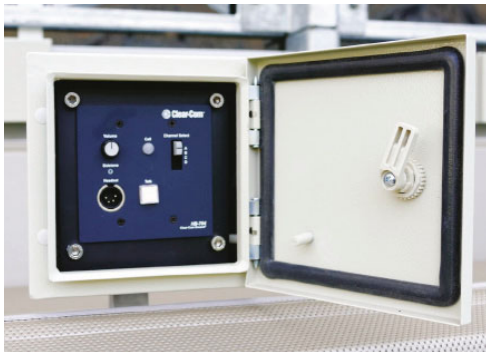
The team benches by the playing field are equipped with Clear-Com HB-704 headset stations

A Ross Video openGear 3.0 server lies at the heart of the video production operations

day production for Optus Stadium, including the Ross Video Carbonite production switcher at its core.

Supporting integration to both the IPTV and Daktronics large LED and ribbon screen networks required further fibre cabling to be laid between the production suite and the MCR. Located at the east and west ends of the stadium and approximately 10m high x 34m wide, Multiplex oversaw the installation of two 15HD pixel layout main displays hosting live videos, instant replays and event statistics during games, together with sponsored messages and statistics throughout events. Providing complementary content to the two main displays, two more displays wrap around the stadium at ground level and L1. The ground-level ribbon measures slightly over 1m high x 345m long with 10mm line spacing, whereas the L1 0.75m x 380m ribbon comes with a 15HD pixel layout. In addition to the IPTV network and LED screens, a large inventory of Blackmagic Design Smartview Duo dual vision monitors serve as additional video outputs.

Daktronics Show Control software unites all the data, video, graphics and animations created in the production suite. Ross Video's XPression Tessera real-time workflow tools connect and synchronise multiple XPression graphics suite engines that create the scenes across the LED screen network. The minimum signal format on all cabling systems is standardised as 1080p/60 3G SDI (SMPTE 424M) with 4K formats supported by OS1 fibre extension and quad link SDI over four HD-SDI channels. Keeping in parallel with the current Australian broadcasting standards, the house-wide video standard adopted was a 1080i/50 format.

As the broadcast industry's only open-hardware platform, a Ross Video openGear 3.0 server lies at the heart of the production suite operations. Each of the four OG3-FR frames

The OB trucks can patch into the extensive fibre system for point-to-point broadcasting
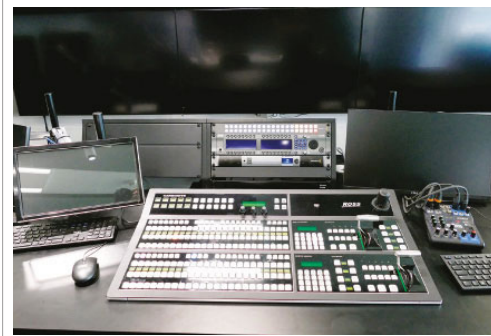
A Ross Carbonite Video Switcher serves as the control interface for routing video signals throughout the stadium

are inserted with up to 20 openGear cards connecting Mac, PC and server inputs over BNC, twisted-pair audio and fibre for output to the LED screens. Basic configuration and monitoring of the openGear cards is conducted over the Ethernet using the Dashboard control system. Advanced features including DataSafe and an SNMP (Simple Network Management Protocol) interface for system-wide monitoring provide


Project manager Elijah Steele at the helm of the Yamaha CL5 console in the broadcast production suite

An EV RE-20 microphone is used for commentary and announcements

enhanced functionality. A Switchcraft patchbay provides control room patching throughout the network.

A Dante-networked audio interface integrates the in-house mixing and production systems. Located in the production suite, the same Yamaha CL5 digital mixing console receives inputs including an EV RE-20 announcer's mic, a TASCAM CD-500B CD player and Denon DN-3001 radio tuner for broadcasting to the Bowl PA. A further two channels of Sennheiser 5000 series microphones are available for on-field announcers. Audio distribution to the back of house zones is relayed via a Q-LAN I/O equipped with 32 AES3 inputs and outputs to and from the production patch panel. XLR connections can also be patched through the main Neutrik Bantam patchbay accepting AES3 inputs and outputs.

A multicore fibre and baseband copper cabling network connects the local patches in the primary and secondary
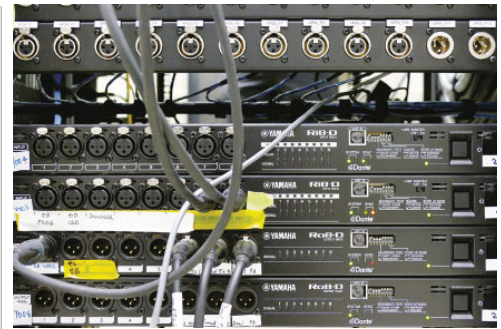
A mobile production rack in the OB compound is outfitted with Yamaha Dante RI8 and RO8-D frames and routed to the CL5 console

studios in addition to the press conference room. Analogue and AES3-rated tie lines connect the main OB compound patch panel to and from the primary and secondary studio patch panels in addition to the press conference room. Here, a mobile production rack incorporates a Yamaha Dante Rio1608-D I/O frame providing 16 XLR inputs and 8 XLR outputs to the CL5 console.

Cat-6a analogue and digital partyline communication systems were preferred in the players' areas, with the home and away team benches utilising 18 Clear-Com PS-704 Encores in IP65-rated EB-704 enclosures. Operating over the OS1 fibre network via a Cisco IE5000 switch, the in-house broadcasting operations staff communicate via an RTS Omneo platform. An RTS XCP-ADAM-MC breakout panel has been added, providing ample outputs for future requirements. A Studio Technologies 216 announcer's console receives two Cat-6a inputs from the Q-LAN network, the RTS Adam-M intercom matrix frame and an Omneo 4-channel router for outputting to the OB patch panel and 15 key panel stations fitted with headsets.

River View Rooms

Located on the western façade of L3, the three River View Function Rooms operate independently, as doubles or as one large combined room. Capable of accommodating 1,500 patrons, the fully glazed exterior provides a bright vista across the Swan River to the CBD of Perth.
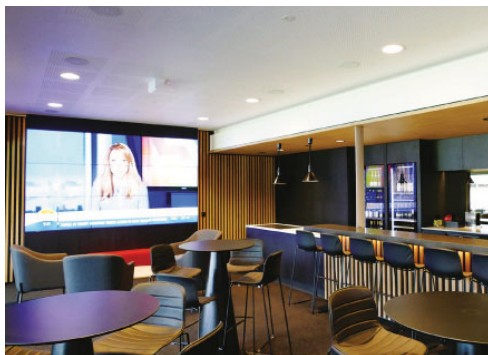
An impressive number of private suites can be hired during match days and beyond

Crestron control is enabled by integrated iPad touchscreens in many of the private suites

During match days, these rooms operate as a premium location for functions, while on other days they are in high demand for conferencing and private events. Event connections are reinforced through A/V displays, for which Rutledge AV has created a flexible design with multiple configurations for individual or combined room use.

The Crestron CP3 control platform is interfaced via four wireless tablet devices allowing the configuration of the audio, projector displays and IPTV media players in each room. This also integrates with Optus Stadium's building management system to provide localised control of lighting and local monitoring of air conditioning systems. The integration is made possible by the converged ICT network, which allows authorised technicians to remotely monitor and control A/V systems in the function rooms.

While the number of permanently installed displays has been minimised, the highly flexible design draws on a large

Room-combining functionality in the Western function rooms is entrusted to a Q-Sys Core 110f processor

number of video inputs. A Crestron digital matrix switcher lies at the heart of operations, routing computer, HDMI and camera input sources to the projection and flat panel display outputs. Additional HDMI inputs have been added at control points at the rear and side of the room, allowing hirers with more complex requirements to connect video source equipment to the integrated A/V switching and display rack.

Each function space comprises two 200-inch diagonal motorised projection screens – located on the western and eastern edges of each room – and 1080p DLP projectors discreetly housed in retractable projection lifts. An additional 10 flat panel displays can be temporarily installed in each function space by patching them into points distributed through the room. The Crestron digital matrix switcher also links up to five Cisco IPTV digital media players to display content distributed over the StadiumVision IPTV system including TV, event broadcasts and team branding channels. Located at the rear of each function space, a high-definition camera patch point provides connection into the Crestron system to project a presenter onto the installed screens in the room.

For speeches and presentations, two channels of wireless Sennheiser Speechline handheld or lapel microphones are available in each room. Vocal reinforcement and BGM is routed to a Q-Sys Core 110f processor, and two I/O frames provide DSP settings for room combining in addition to connecting these rooms to the stadium-wide audio system via the network. For more complex events, room flexibility and expansion has been provided in the form of additional audio inputs and cabling provisions. From the Core 110f processor, the audio signal is fed to the QSC CXD4.5Q amplifiers and Tannoy ceiling speaker system. A Univox SLS-3 Super Loop System provides assistive listening capabilities.

Five in-house radio commentary feeds from the stadium-wide audio system are supplied via a rack-mounted Linear Broadcast FMT25 transmitter. XLR and Cat-6 tie lines between the presentation points on the western edge of the function spaces and the control point locations provide additional audio inputs and outputs to support other media such as video extension. When required, these can be easily added without having to run extra cabling across the floor. XLR inputs have been installed at the control locations for hirers to add a mixing desk when needed.

To support event lighting, DMX tie lines have been added between the presentation points and control points, and control points and the A/V rack. Also connected to the A/V
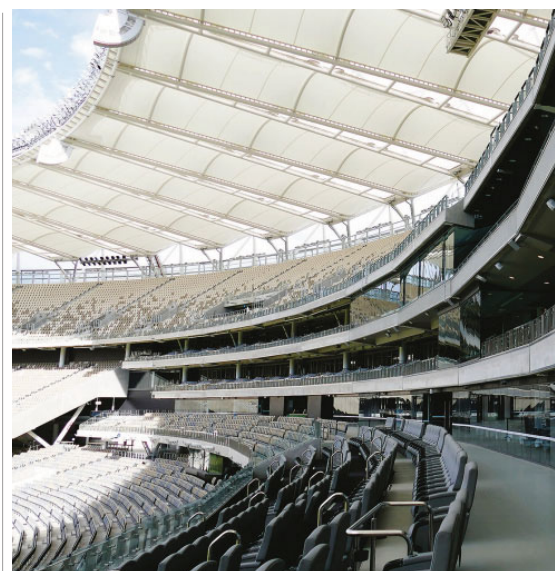
Optus Stadium boasts multiple traditional and social suites for a
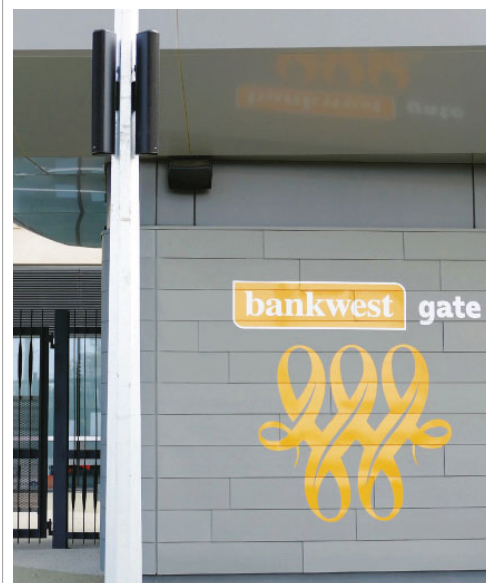
The outside ticket points, bus stops and rail station are furnished with various Tannoy models including the Di8 and VL15

rack, ceiling-mounted DMX patch points located in close proximity to rigging points have also been provided for event lighting.

Function spaces and stadium-wide PA

A number of 'traditional' and 'social' suites can be found throughout the stadium, designed to offer an atmosphere of exclusivity and intimacy while providing high-quality food and beverages. A/V functionality in each room is via a Crestron DM wireless control tablet together with a Crestron input panel for the connection of local devices.

Located within a 50m arc on both north and south sides, the traditional suites attract more formal business gatherings for up to 24 guests in front of the glass line in tiered rows. Larger in capacity, the social suites are designed to be more informal than the traditional suites. Both types of suite share many of the same A/V design elements including a mobile audio device input, two HDMI inputs and two IPTV media players feeding the two 55-inch LCD screens. Rather than being networked, video content and control is localised to individual sources. For all the suites, audio source switching and volume/mute control from the Lab.gruppen Lucia amplifier is made possible via the local Crestron controller. Tannoy ceiling speakers specifically tuned to local event replays provide local audio reinforcement.

more exclusive and intimate experience

The L1 and L3 function rooms lead onto an extensive back of house area equipped with Tannoy speakers including OCV8 coaxial pendant models. The Tannoy speaker system is extended both within the stadium and out onto the concourse, covering the ticket outlets and bus zones. Over 1,000 speakers, including CMS, AMS 6 and AMS 8 cabinets together with VLS15 and VLS30 column speakers, are daisy-chained and zoned throughout the expansive area.

Finale

'Optus Stadium took us to a new level,' concludes Mr Steele, having relived the events of the past two years. 'The line array structure alone was a massive undertaking, but then you have to add the cabling infrastructure, back of house premium venues and the broadcasting facilities to that. There were many challenges along the way but, ultimately, we pulled it off. From day one, the team we assembled was extremely committed and professional. The result is a multifunctional venue that can offer a high degree of flexibility depending on the scale of the event.

'Future-proofing played an important part in shaping the final schematics of the stadium, with some criteria demanding a

Both the premium A/V spaces and extensive back of house corridors incorporating toilets, F&B outlets and other facilities are connected via the Q-LAN network, which operates over the existing IT infrastructure. While also interfacing with the evacuation system, the standalone 110f processors operating within the Q-LAN Layer 3 network provide both local and stadium-wide specific audio fulfilments. Preset QSC audio parameters are accessed via the Crestron control touchscreens, while DSP functionality including acoustic echo cancellation, gain sharing and gating automixers can be monitored and configured centrally.

One of many premium suites

design life to extend to 20 years. We had to really research what was out there on the market to ensure the technology was not in need of replacement several years from now. That's why the fibre backbone is so important. In addition, aspects such as the Ross Video Open Gear server will provide so many new inputs to be added over time. Most hardware these days, such as the CL5 console and the Q-Sys Core processors, can be updated via their software and firmware, extending their use for many more years.'

Rutledge AV not only conducted thorough, professional works, it listened intently to ensure all parties were served faithfully. 'Like most multipurpose venues, multiple users place different requests and demands, all of which need to be considered and implemented,' he continues. 'Having input from the various broadcasters, sporting teams and other users, it became apparent that the camera points, for example, varied dramatically according to the type of broadcast and the sport being played. They all had to be factored in and, as such, the design became ever more complex.'

Reliability, ROI, ease of use and versatility are more than buzzwords for today's venue design. Rutledge AV has ensured that the audio and visual components that have been combined to bring Optus Stadium to life will endure well past tomorrow. In the interim, it will welcome operators back time and time again to marvel at both the ease of set up and the high degree of venue flexibility provided. In short, revenues will be maximised. So sit back in your comfortable seats, sports fans, enjoy the Wi-Fi, order food and drink, listen to the announcer purr over the deluxe PA and marvel at the HD LEDs.

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