Photo: Marty Philbey

SOUND FOR THE COMMONWEALTH GAMES OPENING CEREMONY

A flying tram, motocross riders terrorising ballerinas… and a duck – it all might have been mystifying to some. But not as incomprehensible as how a team of crack audio engineers pumped tens of thousands of Watts into an enormous concrete cauldron and made it sound any good.

Text: Andy Stewart

The Melbourne 2006 Commonwealth Games Opening Ceremony was produced by Jack Morton Worldwide, while the Executive Producer was Andrew Walsh.

▸ The difficulties that would be involved in filling the Melbourne Cricket Ground with reinforced sound that's *controlled* and *articulate* were made plainly obvious the moment I walked into the hallowed ground on the first day of rehearsal. Out in the middle of the 'G' in the stark light of an empty sun-drenched arena, a builder was hammering a nail into an innocuous piece of timber. The resulting sonic boom of reverb was quite beyond anything I'd expected; almost as enormous as the sound I once provoked the day I threw a wad of firecrackers into the Grand Canyon. Now *that* was a reverb! But I digress…

The MCG has become one of the most raucous and wildly dynamic spaces in urban Australia; what better place to hold the Opening Ceremony for the Commonwealth Games! Of course, visually, the ground is quite spectacular (although personally I found the new purpose-built stadium development visually disorienting and a tragic loss of iconic Melbourne architecture – but they put you in jail for comments like that in Victoria, so I'd better keep quiet). The 'G' has essentially become a giant concrete echo chamber – although it's more of an 'O' than a 'G' these days – with one of the mightiest, longest and most sensitive reverb tails you'll ever hear from a man-made structure.

It is a truly wild space when empty, and yet somehow this place was going to be transformed over the coming days, from a concrete reverb bunker into a sophisticated sonic soundstage for the entertainment of well in excess of 80,000 dilerious fans, athletes and VIHOs (Very Important Hangers On – royal or otherwise)… and an untold number of television viewers. The monumental scale of this unenviable task can scarcely be overstated. After all, it's one thing to have the best technology, the newest cutting-edge PA components, and a budget large enough to fill the stadium with one-dollar coins, but quite another to make it sound any good. If you think a system like that just puts itself together and sounds fabulous, you'd be dead wrong.

THE SWA-T TEAM

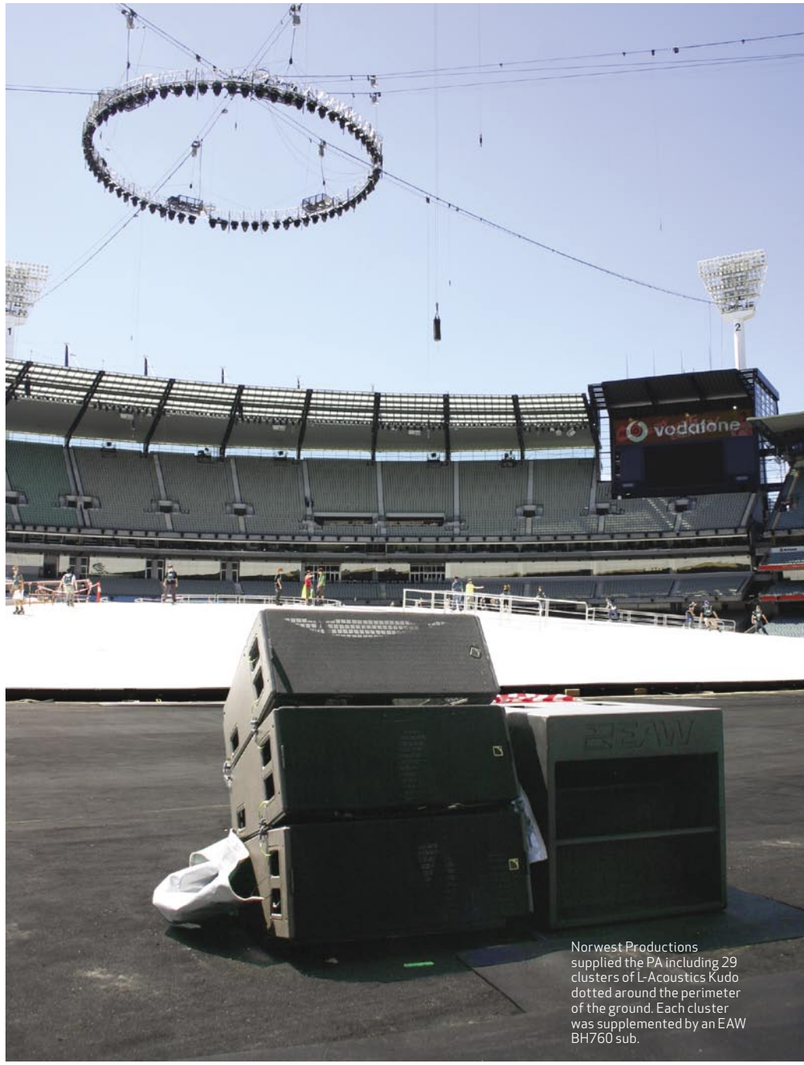
The task of putting this colossal audio show together was the responsibility of a small team comprised of some of the most experienced, knowledgeable and brilliant sound engineers and technicians on the face of the earth. But tell any of them that to their face and they'll scurry off down a rabbit hole faster than you can yell 'wedge-tailed eagle!' The team was virtually the same as the one that produced the sound for the Athens Olympic Games; this show being under the banner of Norwest Productions. It may sound like jingoistic drivel to sing the praises of this team on the basis that they're all locals, but frankly, why not? There's so much propaganda that arrives on our shores with each rising tide that you'd sometimes be forgiven for thinking that overseas is the only source of anything that's done well.

As the Technical Director, Nick Eltis nonchalantly remarked over a relaxed cup of tea on the first day of rehearsal: "You can't afford to have lots of layers of staff in a situation like this, so I always employ people I know are very, *very* good at their job. That way I can feel happy divesting myself of the endless tasks and responsibilities. It's hard enough letting go of knowing what every cable does out there… so I'd rather employ half a dozen seriously switched-on people I don't have to think about, than 30 average people who need babysitting."

What Nick was essentially revealing was an Australian character trait that I imagined had been virtually extinguished from the social landscape. It's virtually a 'digger' mentality: trust your mates implicitly, get the job done well with a minimum of fuss, work hard, don't take yourself too seriously, and whatever you do, don't let anyone know that you think you're good at your job! This 'crack team' of individuals, whether they realised it or not, neatly personified several classic ingredients of the Australian ethos: humility, competence in adversity, and confidence in knowing that a small team of (bashful) experts gets the job done far better than a large group of noisy wannabe's.

Joining this team for a beer during one of their informal get togethers after the first dress rehearsal revealed a group of people wholly obsessed and into their work. No-one better exemplified this keenness and exuberance than Peter Wood who talked at length about 'comms', 'in-ears' and 'FM transmitters', in a language that was only safe to use in the confines of this small and elite group of audio 'super-dweebs'. If he'd stepped outside the room people would have assumed he was from Mars (or perhaps one of those obscure nations competing in the Games.)

The night, regardless of your taste, political persuasion, or level of interest in the event was an unequivocal success from a technical audio standpoint. I spoke to several of the key human components about their roles, expectations and impressions of how the setup was progressing right up until the curtain went up and the tram came down…



Norwest Productions supplied the PA including 29 clusters of L-Acoustics Kudo dotted around the perimeter of the ground. Each cluster was supplemented by an EAW BH760 sub.

SWA-HILI

From an audio perspective, if one person could be singled out as the 'brains' behind this gig it would have to be Scott Willsallen, or Swa, as he's known to his mates. Swa is one switched on cat when it comes to sound reinforcement. Along with Nick Eltis, it was he who bore the greatest burden of responsibility for the success of the show. Yet despite this level of responsibility (which would be enough to shake most engineers to pieces by exposing shortcomings in their level of technical expertise), Swa was so relaxed and confident in his role that he had time to walk half way round the MCG on two separate occasions during the lead up to the Opening Ceremony to make sure I got into the ground okay. I started the formal part of our conversation by asking Swa what he'll be doing on the big night.

Scott Willsallen: On the night of the Opening Ceremony I'll be all around the place. I'm not interested in engineering anything, I'm more interested in talking to Shappy (Ian Shapcott, at FOH); you know; 'a little more of this, a little less of that…' He's stuck in that one position and is utterly reliant on the fact that the system is sounding the same everywhere – it's not like the entertainment centre where you're in front of the whole PA, he's only in front of one small part of it. This 'second opinion' is very worthwhile, for no other reason perhaps than the fact that I'm in a different location. We're usually talking 1dB here and there, it's not big stuff, it's really subtle, but in a system like this it's amazing the difference 1dB makes.

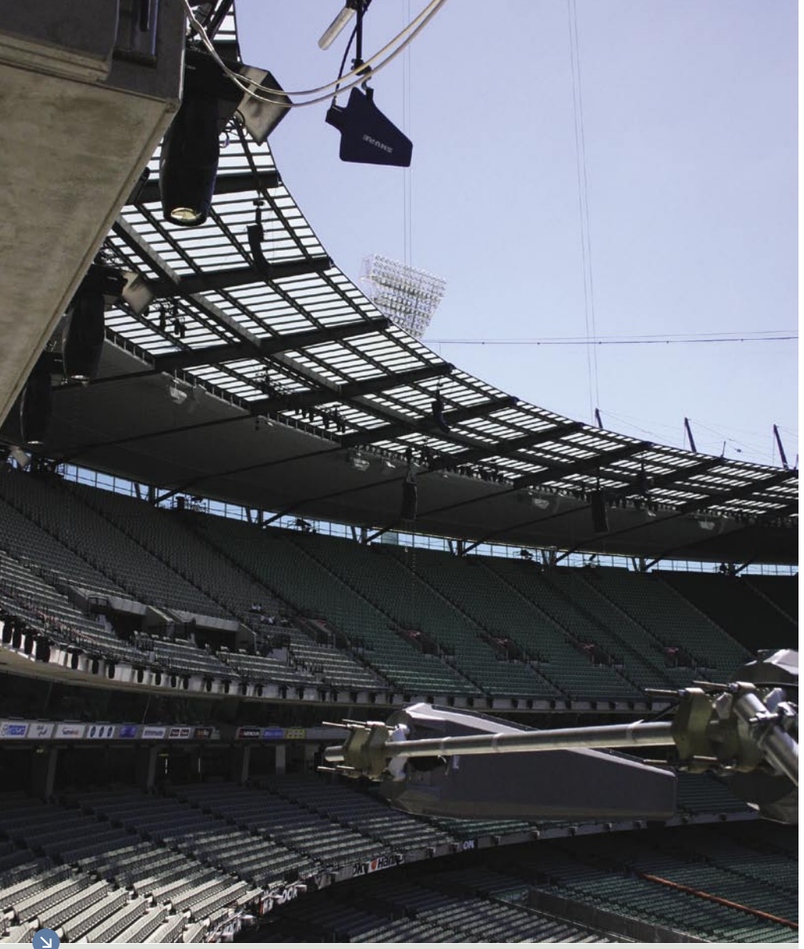
THE PA

SWA: The PA consists of 29 identical clusters spaced about 15 to 20 metres apart. Each array consists of three Kudo elements, which vary in angle depending on where the array is. There's also an EAW BH760 sub with each Kudo array. Field-of-play also has 30 RCF ART300s scattered around the circle of lights, pointing in at the stage and acting as stage monitoring.

In the new 'Northern' stand there are eight arrays of six EAW KF730s, with an SB730 on top. Of the MCG's JBL house system, we're using the rear firing boxes as a delay and the forward firing boxes as an effects system for things like crowd noise, thunder, and any of the other sound effects in the show. In the Southern Stand, which has a considerably smaller upper bowl, we've got a bunch of Nexo PS15s out on the end of each roof truss, and again, using the house rear-firing element as a delay.

AS: How far do the Kudo reach?

SWA: The on-field Kudo is the point of focus ▸▸



for the whole system, and the top element on the field-of-play is covering the upper bowl, but it's a long way away, hence the delay stacks. But the timing between the Kudo and the EAWs is such that the point of focus remains the field-of-play. The idea is to pull the focus down onto the ground, rather than have it all up in the air where it doesn't mean anything.

AS: What does the Kudo sound like; how is it performing?

SWA: It sounds superb. We've got the new Version 2 settings on pre-release, and it's sounding significantly better. The crossover point has moved from 300 to 200Hz, which has made a huge difference to the sound. Getting the new settings on pre-release from L-Acoustics has been great for us because otherwise it would be a lot harder to keep the bass under control with this system.

CONTROLLING THE 'G' VERB

SWA: We've created a circular array of loudspeakers simply because the stage is circular and the building is circular. We're then shooting that system at a giant circular reflector – the windows on the corporate boxes, the concrete balcony fronts etc. The sound then bounces straight back – suffice it to say there are considerable issues in this space with reflections, to put it mildly!

But the crowd will obviously absorb a lot of the stuff that's bouncing around, and the noise floor will go up considerably, which effectively shortens the experience of the reverb time. It's doesn't *actually* shorten the reverb time, it only masks it.

One way to deal with it, of course, would have been to put drapes everywhere, but that's very expensive and in the end it's very hard to justify *before* the system's in place. But if there was a lot of money left in the budget now we'd be able to justify it, I'm sure! For the recent Military Tattoo at Aussie Stadium in Sydney we put drapes between the concourse and the back row of the audience, which made the whole space feel more like a theatre, with less of a footy ground feel. All the background noise of people shouting and ordering chips and pies in the concourse, was really well blocked by the woollen barrier.

The absence of the drapes here simply means that the sound system – and the venue – is far more sensitive, and we have to be more careful about where our faders are. The range of volume difference between 'loud enough' and 'too loud' is only about two or three decibels. It's a very small window. When it gets too loud the build up is huge and you lose every word.

OTHER NEW AUDIO GEAR

AS: Are you using anything particularly new other than the Kudo?

SWA: We've implemented almost the same system we did for Athens, which again is nothing new. If someone says to me: 'I've got this new box I'd like you to use', I'll tell them; 'Come back when someone else has had it fail on them on another event,' because I don't want to be the person to use something first… ever. ▶▶

IT'S BETTER TO SEND & RECEIVE

Steve Caldwell was the man in charge of setting up the transmitters and receivers that managed to keep four and a half thousand cast members 'in the picture' during the ceremony – no easy feat. This is what the system comprised of… in his own words.

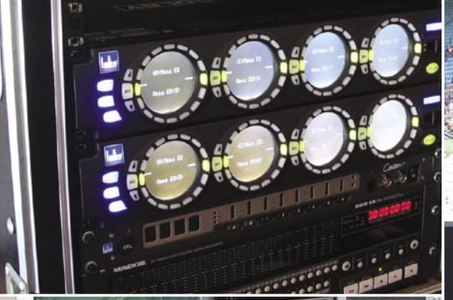
SC: In simple terms, the Shure PSM transmitters are mixed into an eight-into-one combiner, sent through two coax cables down into two RF amplifiers – both broadband, extremely linear Class-A amplifiers. They'll take anything from 470 up to 1GHz in and give us 30W output, or 2W per frequency. That's actually a lot of wattage considering the average PSM outputs about 100mW. (We have a special licensing dispensation from the relevant authority that will allow up to 2W per channel.) The third amplifier in the system broadcasts a holding tone of all our frequencies. We use a computer that continually cycles through all the frequencies that we intend to use during the show so that anyone scanning for unused frequencies will see that these frequencies are being utilised.

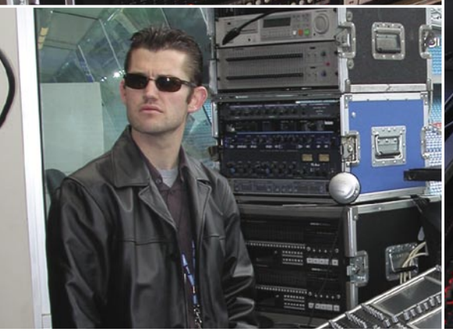
In terms of power, this extra wattage provides extra strength to the signal – highly desirable, especially given the size of the venue. It allows us to retain a good transmission signal with everyone, not just those ideally placed to receive it. The extra power also helps us to get over any of the reflections that are coming off the stadium structure. Each RF amplifier is running flat out the entire time, so that's why we use Class A amps, to get that high linearity. What happens with lesser quality amps is that when you combine two frequencies together they produce a third harmonic and intermodulation between those two frequencies, like a normal audio amplifier. With RF these side effects are particularly bad because this harmonic may wind up right on top of someone else's frequency. So we have to build better amps to keep the harmonic distortion extremely low, and the intermodulations to a minimum.

The log periodic Kathrein antennas that we're using allow us to focus the beam of the RF quite successfully. They have a reasonably wide horizontal coverage of about 50° and a vertical coverage of about 28° or so – almost like the component of a line array or a cardioid pattern mic that's been squashed horizontally. The ones you see here [see Image] cover the whole MCG. Unlike a speaker system, where all the components work together, RF antennas don't like working in combination. There are another two Kathreins covering the Yarra river aspect of the ceremony: one pointing up river, the other pointing down.

The RF amps run 24/7 so anyone can use the system day or night during preparations. Right now they're controlling the communications between the choreographers and the airborne ballerinas [as we spoke there were 10 or so of them floating about above the arena]. The ballerinas are wearing Shure UR1 transmitters with lapels as well as receivers, so they can send and receive information, for safety reasons primarily. The transmitters are received back next to FOH on the circular antennas. These new antennas have a very narrow beam width, and we're currently experimenting between the two forms you can see up there.

Most antennas are polarised horizontally or vertically so if the artist tips the antenna they're wearing you lose 20dB with cross polarisation. These new antennas solve that problem by being circularly polarised. What happens is that from zero through to 360° through the waveform the polarisation rotates through 360° also, which means, no matter which way an artist holds their mic, the reception is the same.





Feeling Game: (Main shot) FOH Engineer, Ian Shapcott at the controls of the Yamaha PM1D main board – it was a game of 1dB here, 1dB there. (Left) Audio Director, Scott Willsallen, remained cooler than a cucumber throughout. (Top left) The Dolby Processor took care of in-ears, while Contours were in charge of system control.

AS: I see though that you're using the new Dolby Lake Processors, surely they're not in the 'tried and tested' category quite yet?

SWA: True, but I've got 20 Lake [Dolby] Contours and Mesas sitting in the system already and I have an enormous amount of faith in what the Lake guys can do, and the role the Lake Processors are performing here isn't critical; we're easing them in if you like… they're controlling the in-ears. But already the Processor's proving to be a quantum leap up from the previous model, which was already – and is still – a remarkable product… And we've got a way around them in the system. If something goes wrong, we can push one button and they're not in-line anymore. I want to use them because I'm very passionate about the product.

AS: You mentioned the JBL-based MCG house system earlier. Can you give an example of how it's used?

SWA: We use the house system as an effects channel. For example, during one part of the show there's interaction between the stadium and the Yarra River. We're feeding crowd noise from mics down on the river into this system via Opticore – which will get to us in about 2.2 milliseconds.

We're also feeding incidental stuff – effects, crowd noise – into the 'rears'. If you want the crowd to swell, you put crowd noise through the rears and the crowd responds. We did that at the Rugby World Cup [opening ceremony] and it worked a treat. We effectively cue the audience to react.

AS: No subliminal advertising as well I hope?

SWA: No, none… *buy Coke!*

TECHNICAL DIRECTOR – NICK ELTIS

At the centre of all this technology for the Commonwealth Games was Nick Eltis. I spoke to Nick about his role and how things were progressing. He seemed pretty relaxed…

AS: What is the scope of your responsibilities here Nick?

NE: As technical director I'm responsible for the delivery of all technology. So anything that plugs in is my problem: sound, lights, communications, power, surveillance systems, video screen and all the rigging for technology…

AS: You seem incredibly relaxed about it all. Given how much you have on your plate it's a wonder you're not feeling ill with anxiety right about now. Has the experience of managing the Athens Olympics given you this unswerving confidence?

NE: It has in many way, because Athens was obviously a big step up for most of us, we all learnt more in that 10 months than the several years preceding it. And that experience definitely supports the decision-making here. We learnt what worked, what didn't work, what we could have done better, what we forgot, what we missed, what we didn't budget properly for. That's obviously a huge part of what I do, making sure we can afford what we're trying to do. I'm given 'X' amount of money and I've got to make it all work out of that.

There's money set aside for unexpected occurrences and changes of heart from the 'creatives', but the trick is deciding early which elements you think are critical and making them the priority, while trying to say 'yes' to as many requests for extra funds as possible. For example, this morning we discovered that there are 56 seats that you can't see a loudspeaker from. It was something that Swa hadn't allowed for because the stage didn't exist when he did the initial design. So we've had to find money to cater for that problem. As for the stress of it all… I just chew gum.

ONE HAPPY SHAPPY

Nick Eltis seemed relaxed despite his responsibilities looming as large as the new Northern Stand. Swa seemed even more so, almost to the point where I thought maybe he'd forgotten what date it was. Did he remember that the final dress rehearsal was due to start in 40 minutes? In fact, he was so laid-back during the lead up to the final dress rehearsal he used my spare 'General Admission' ticket to get back into the ground, rather than flash his special pass!

And the rest of the team were all smiles as well. Nary a cross word between them. But the king of laid back was surely Ian Shapcott (aka Shappy). Feet up on the console, enjoying a quiet moment in the Autumn breeze…

AS: What are you focussed on right now Shappy?

Shappy: Well, not much really, as you can see we're running a bit late and nothing's happening! Hard work this job!

AS: What about when there's actually work to do?

Shappy: The job really consists right now of listening to the dynamics of the audio pieces that are playing off the Pyramix playback system; listening to their tone; how boomy or bright they are and comparing sounds – hearing what sort of response we're getting in different parts of the venue and then comparing that to how it sounds at the mix position. I'm just doing a lot of listening… getting to know the stems [strings, brass, percussion, etc], knowing exactly what each one does so that by the time the show starts I'll know them backwards. But right now that guy down there with the hammer is sounding pretty ▶▶

good. Have a listen to that reverb!

AS: Are you actually getting a proper multitrack version of these songs files, almost as if they were live inputs?

Shappy: Some songs are broken down into stems, some of them are effectively only half stems… The Cat Empire file is kick, snare, stereo toms, stereo cymbals, bass guitar, three stereo tracks of keys and backing vocals. Quite a big stem, 28 channels I think. *Under the Milky Way*, by The Church, is broken down into kick, snare, stereo drums, bass, acoustic, electric and vocals, with an orchestra mix left and right.

AS: Does a gig like this feel radically different to other big concerts you've mixed, being largely pre-recorded and so rehearsed?

Shappy: Yeah, it does. The environment's very different; the PA rig is set up very differently to most other concert PAs; and the levels of redundancy and the amount of rehearsal is unheard of – except maybe at the Olympics! By the time the show comes along you know each piece intimately, which is a great thing [laughs]. You feel a lot more comfortable and confident not having to cope with the freakiness of not knowing what's going to happen next. It makes you much cooler during the event. But if something goes wrong on the night you just call on your live experiences and say to yourself, 'alright, I've got to make it happen right now, what do I do, what do I adjust?'.

AS: Will you be doing much wandering about during the Opening Ceremony, or is Swa your ears out on the ground?

Shappy: I'll be able to go about 10 metres to the right of here, and that's about as far as I'll be prepared to venture from the console.

Once the show starts I'll most likely be stuck to the console changing balances – the venue will change so much when the 80,000 punters arrive. If I have to, I'll change the tone without hesitation. The top end will definitely change because at the moment there are 100,000 plastic seat configured in a giant circle, whereas later it'll be full of people. The background noise alone will go up at least another 10dB, so listening to stuff here and now in the empty stadium is quite different.

APPLYING FOR REDUNDANCY

While Shappy and I chatted about the setup, waiting for rehearsal to start (which was running about two hours behind schedule, according to the call sheet), directly behind us in one of the corporate boxes, where the patching, comms and playback were setup, 'the lads' were starting to get restless and were trying to put Shappy off this interview by wiggling the master fader of the console remotely from behind the glass.

Shappy: Right now Coops (patch systems engineer, Ian Cooper) is wiggling the master fader… playing silly buggers… unfortunately Coops has control of my desk as well! They're all finding it very hilarious, trying to put me off… they're obviously very bored in there, to be finding something this stupid so bloody hilarious. Coops can control things from up there if needs be, even if this board's switched off and I'm out to lunch! The computer, the brain and all the patching is in the control room behind me. Coops is looking at this console via the studio manager software, and he can use that to manipulate all the audio, as this wiggling master fader proves! [Up behind the glass Coops and co. are still moving the master fader up and down, and rolling about in fits of laughter…]

AS: I assume there's another form of redundancy here, other than Coops' software control?

Shappy: There's a second identical board that chases front of house with a Midi link. There's a redundancy for everything basically. The difference is that the backup [Yamaha] PM1D receives analogue in, whereas the front of house board gets digital-in at line level. It follows everything I'm doing: as I recall scenes at FOH, it's following along recalling its scenes as well. But when we do line checks I have to do both boards. Because the second console is analogue, there's no mirroring of the mic preamp gains, That's something I have to adjust separately.

AS: Will you be doing a test mix from the redundancy board?

Shappy: Yep, we'll do an analogue test sometime soon, without warning. When that happens I'll immediately go to the backup console and we'll see how I go!

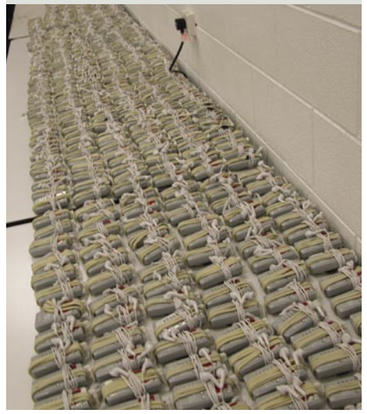
A-LIVE AT THE 'G'

AS: What's it like trying to mix in the new MCG; are tone and definition a problem?

Shappy: The 'G' mainly takes definition out of the top end because it's so reverberant, and the resonant frequencies can be pretty awful. ▶▶

IN-EAR MONITORING

Pick an ear, any ear!: Ami McDonald has tidied up the in-ears for the photo. There are about 4750 in-ear monitor receivers – one for each and every cast member, 4,500 of which are FM receivers, 150 are Shure PSM 200, 400, 600 or 700. The FM receivers were supplied by The PA People, which took care of Comms for the event. There were three FM transmit channels being used for mass cast instruction, monitoring and a safety channel which communicated with anyone hoisted up in the air on the flying system… and more Duracell AAA batteries than we'd ever seen before!



FROM ATHENS TO MELBOURNE

AS: What's different here to the Athens setup Swa?

SWA: In Athens we were limited by budget and we couldn't have as many Lake [Dolby] devices as I would have liked. There are two ways to do it. One way is to process the signal at FOH and deliver that to the transport system as processed audio, which is what I did in Athens. Here, the audio goes on unprocessed, comes out of the digital transmission system into the processor at the amplifier. In Athens the main and primary switch was done at FOH with the rack of Lake processors taking a digital-in from the main board and an analogue from the backup board. Here the digital network exists as far as the inputs of the processors, as does the analogue, so all of the switching occurs post the 'transport'. The benefit of that being that when things go bad, limiters post the transport can save your bacon (when things go bad on a digital network it's really easy to break stuff). It also gives you far more control over the system because you've got more processors. For this field of play system we've got four Lake Contours, for Athens we had two. So the difference here is there's a lot more control of the system.

The beauty of it is that we can, for example, have a mic down on the field, a 10-metre mic cable, plug it into a converter that delivers the signal to Opticore, which in turn delivers it to the Yamaha PM1D, processes it digitally, delivers it back onto Opticore, back down to the output node and into the Lake Contour. In this system we haven't left the digital domain since the end of the 10-metre mic cable. It's a beautiful system: the latency's low, there aren't multiple conversions along the way… it's quite elegant. It also has the added advantage of being easier to fault-find, and if there's a fault, a far smaller area is affected.

The venue resonates for such a long time that it impacts quite heavily on the high/mid clarity. But obviously once you get tens of thousands of people in here, cheering and clapping, everything changes – it doesn't have to sound good when the venue's empty, after all. I have to make the mixes a little barky and bright right now – the hardest bit remains anticipating what's going to happen in the venue when the punters descend on the place while mixing the rehearsals to an audience of five seagulls...

PANNING

AS: Can you tell us about panning and stereo in an environment like this? How is stereo replayed and how does that influence your mix?

Shappy: It's a difficult question to answer actually. Up here in the monitoring position, listening on the Tannoys, the stereo image sounds fantastic but out in the stands most of that definition is lost. It's much harder to perceive stereo placement in this massive environment than it is on a single set of speakers. In a sense, there's only 'middle' and 'not-middle', rather than true left and right.

AS: Do the vagaries of the stadium mean that very few things are hard panned?

Shappy: Most of the stems I get from the Pyramix are already stereo, but nothing's panned too hard left and right on the board. It's a traditional orchestra mix: violins on your left and your bass strings on the right etc… but because the field-of-play speakers are fairly close together you really only get good stereo imaging in the lower bowl. The further back you go, the less stereo effect you get. But there's nowhere where a 'right' speaker stack is hard up against the next 'left' speaker stack. It just goes around the stadium left, right, left, right… So for some people the image might be backwards, but it's stereo nonetheless.

The wind's going to be the biggest factor on the night… and completely beyond our control [Shappy shoots me a pensive look]. Once it picks up it takes all the top end away and there's nothing you can do about it. And there have been some seriously windy days here – I'm praying that on the night it's nice and still. The other day I was sitting in the stand and there were Coke cans flying by in a howling gale, and I was thinking, 'My God, if we have this wind during the Opening Ceremony we'll be in big trouble!'

FETED & FATED

As it was, the Commonwealth Games Opening Ceremony went off without a hitch, thanks in no small part to the Swa, Nick, Shappy and the experienced Norwest team. It was no accident of course, the meticulous planning and execution was a credit to everyone involved. The relief that Melbourne's changeable weather chose to be merciful was palpable, choosing as it did to bucket down several hours *after* the event. For this there was no real contingency… no 'redundancy' as they'd say. Every time I asked anyone about what would happen if the wind blew hard and the rain came down I got the same response…. 'Dunno really, I s'pose we'd just all go home and admit defeat!' ■

TAKE A BOW – THE CREW

Nick Eltis – **Technical Director**, Scott Willsallen – **Audio Designer**, Ian Baldwin – **Production Manager**, Chris Kennedy – **Norwest Productions CEO**, Adrian Riddell – **Audio Project Manager**, Nick Hutchinson – **River Site Project Manager**, Ian Shapcott – **FOH Mix Engineer**, Ewan MacDonald – **Monitor Mix Engineer**, Steve Law – **River Site FOH Mix Engineer**, Trevor Beck – **Replay Systems Engineer**, Ben Whincop – **Assistant Replay Engineer**, Matt Debien – **Senior Systems Engineer**, Ian Cooper – **Patch Systems Engineer**, Peter Wood (Doc) – **Wireless Systems Manager**, Peter Twartz – **RF Spectrum Manager**, Steve Caldwell – **Senior Technician**, Amy MacDonald – **IEM Manager**, Anthony Calvi – **FOP Systems Engineer**, Chris Martin – **Upper Bowl Systems Engineer**, Adam Williams – **Control Room Systems Engineer**, Curtis Tennant – **Rehearsal Venue Systems Engineer**, Martin Tyrell – **FM IEM Manager**, David Robertson – **FM IEM Manager**, Chris Twartz – **River Site Wireless Systems Manager**, Ryan Twitty – **Audio Technician**, Matt Whitehead – **Audio Technician**, Nathan Anic – **IEM Assistant**, Liam White – **IEM Assistant**, Simon MacNamara – **IEM Assistant**, Brendan Petty – **IEM Assistant**, Edwin Tedjokusumo – **IEM Assistant**, Danial Straka – **IEM Assistant**, Chris Hampton – **FOP Audio Assistant**, David Pyke – **FOP Audio Assistant**.