



Let's begin with a leading question: why bother? Line array and point source configurations at the end of a stereo master output from the console have served us perfectly well for decades, and the quality of sound reinforcement systems has increased beyond argument almost year-on-year. Well, the truth is many professionals are now suggesting that despite these advances audio is falling behind video, lighting and special effects as productions achieve greater sophistication. And, with greater clarity in the mix, windows open on new vistas of sound suggested by that very improvement.

"Productions are getting larger, immersive experiences are crossing over from video and lighting and now is the time for surround - which we've had for quite some time, in fact - to live up to its potential," comments Andrew J Horsburgh, a professional sound engineer, audio system consultant and lecturer at Solent University, who completed his PhD focussing on perceptual measurements of soundfield techniques with a special interest in Ambisonics. "We're able to give companies new graduates who understand how the technology works so, when the industry makes the leap of faith that it should, we'll be ready."

Horsburgh correctly points out the live industry is now well and truly engaged in 'reinforcement' rather than mere amplification, and concert hall designers are more than ever mindful of the multi-purpose and multimedia requirements of their clients. "New buildings are dry, acoustically, and surround systems are often a form of reverberation - so we are going to find more interest in how we can use more speakers in a venue over the next five to 10 years," he says.

#### ECHOES

Leading manufacturers are responding with a variety of solutions. Meyer Sound's CueStation software interface for the D-Mitri networked digital engine already features a panning matrix called Space Map: this offers over 80,000 cross points across 288 channels. Sennheiser's AMBEO '3D' audio format has won plaudits in playback-themed attractions and other applications - the most notable recent example being the exhibition *Pink Floyd - Their Mortal Remains* at the Victoria & Albert Museum in London (see LSi July 2017). This has a concluding display of 360° video with AMBEO mixes of four well-known Floyd songs: an installation of 18 Neumann KH 420 midfield monitors and seven Neumann KH 870 subs delivers the 18.3 mix made at Abbey Road studios for the purpose.

It's a typical example of the emerging technique of object-based audio, in which spot sources are used in place of separate channels. In playback, this process reveals a believable music and effect soundscape in three dimensions, and if more loudspeakers are required in the budget to make that happen, well . . . hopefully promoters and specifiers will take note and seize the opportunity to change the paradigm.



The TiMax SoundHub was used to spatialise the audio at The Young Vic's production of Life of Galileo, complete with planetarium dome and staging in-the-round

St Margarethen Quarry is Europe's largest natural stage: 65m wide and 25m deep, it is set in 7,000sq.m, with an audience capacity of 4,700. With the added complexity of loudspeakers embedded into non-static elements of the set, TiMax is essential for accurate localisation

Photo: Leon Puplett Projection:

Two more European examples illustrate the versatility of the applications. Aachen-based Klang:technologies exploits widespread headphone and ear-bud use for its 3D in-ear monitoring, having created a musician-friendly 'acoustic virtual reality' for onstage use, with interesting potential beyond. In Holland, Astro Spatial Audio has DSP named SARA II that it refers to as a 'rendering engine', a means of applying a proprietary algorithm called Spatial Sound Wave (SSW) to both 3D sound and room acoustics. This is precisely for immersive, loudspeaker-based sound reinforcement systems, and up to 64 MADI channels or 128 Dante network streams are supported, with up to 32 inputs. Up to 10 interface devices can use the intuitive GUI simultaneously, and until FOH console use begins to adapt to 3D workflow - typically, DiGiCo is first out of the blocks on this score - this will be the control model for the first wave of 360 systems - at least for installation.

"Ambisonics is particularly well suited to recording and playback," points out Horsburgh, "being unobtrusive and offering a very high sense of immersion, and in reproduction you're not limited channel-wise and you can expand upwards into all manner of irregular configurations. Live sound is something else, however . . ."

Indeed. Scott Willsallen is an Emmy Award-winning expert in sound design for major international events, with design credits including multiple Olympic and Commonwealth Games ceremonies since 2003. It's partly his work in 360° sound you can currently hear at the V&A, and he's a director of Australian consultancy Auditoria and of UK-founded Remarkable Projects, instigated with like-minded business partner and fellow sound designer Bobby Aitken (see *Dinosaurs in the Wild*, LSi September 2017).

"Playback has no sound sources other than the ones recorded," Willsallen points out. "In a live environment there are acoustic and backline sources on stage not controlled by the fader on the console, so there is less scope creatively to exploit 360. Here, what 360 does is more corrective - but no less exciting for that."

## POST LINE ARRAY

In the cases so far stated, the exact model of loudspeaker is an open choice, although some kind of networkability is a bonus -Astro Spatial Audio has been demonstrated with Alcons Audio's Dante-ready pro ribbon loudspeakers, for example. However, two brands in particular - taking full advantage of their position at the very leading edge of sound reinforcement - have revealed plans that will carry their rarefied product lines into this arena. Indeed, their very involvement underscores the seriousness with which the industry is approaching this challenge, and others are bound to follow this lead as global audiences are exposed to 360° audio at the highest level of production.

Already well-documented in these pages, L-Acoustics' L-ISA project has generated a system called L-ISA Live, while d&b audiotechnik is about to launch its Soundscape hardware and









From top: At this year's Urban Voices the audience experience was further enhanced with the use of L-Acoustics' L-ISA Live system

Scott Willsallen of Auditoria and Remarkable Projects

Guillaume Le Nost, head of R&D at L-Acoustics

Out Board's Dave Haydon

software solution. Guillaume Le Nost works directly with L-Acoustics founder Christian Heil at his North London HQ as head of R&D in the development of L-ISA, the radical immersive sound format that will target not only live sound but also studio recording, re-mixing and remastering. His L-Acoustics roots include a spell as senior acoustics engineer, and he's also gained valuable experience in audio for video games and post-production, an area already well ahead in immersive audio landscapes.

Le Nost is quick to differentiate between the two main goals of 360° audio - what L-Acoustics calls 'Immersive Hyperrealism'. "The first is localisation," he explains, "meaning how to place sound objects, like instruments, in space. The other is immersion: being immersed in the sound and the action. You can be immersed with four speakers - front left, front right; back left, back right - but you don't get good localisation. It's still the 5.1 effect. To address localisation, you need much finer steps between speakers at the front, so we design the frontal system first and then the immersion aspects of the system."

L-ISA Live requires a minimum of five arrays across what it identifies as the Performance Zone - this is the horizontal frontal system - but this can be appended by more arrays into the Extension Zone to enhance the localisation experience. The more you add, the better the localisation - and the greater the 'hyperrealism'. In some installations we have 24 arrays, all around the audience," confirms Le Nost.

The system takes the output from the console before its busses begin the job of squeezing the quarts of audio into the pint pots of panning, and the L-ISA processor turns the channels into objects and generates the speaker feeds. At the console, the level of granularity is entirely up to the engineer.

## RALF AND FLORIAN

If this sounds radical, it should. The organisation of the console may not appear to change that much, but what you're listening to sure does. "It's time to change

the game," announces Ralf Zuleeg, head of sales services and application engineering at d&b audiotechnik, based in Germany. Since joining d&b in 1995, Zuleeg has worked on several milestone events, including tours with Coldplay, Muse and The Who, Kraftwerk's 3D concerts and pioneering 360° sound system designs at the Matsumoto Concert Hall and the Hyogo Centre for Performing Arts in Japan; Germany's Staatstheater Mainz, Staatstheater Darmstadt and Residenztheater München; and most recently Sydney Opera House. "We are about to establish a different idea of sound reinforcement," he continues, "and before we start competing we should set some standards. There are many possibilities . . ."

Exactly. The impact of systems like the d&b Soundscape on PA deployment can be measured using the same criteria that are applied to the proverbial piece of string. "It all depends what you want to do," says Zuleeg. "If you just want most people turning their heads towards specific positions on stage, and getting a better perspective of all the sources generally, you might settle for left and right - providing the distance between the arrays is not too big. However, if you want exact localisation, even tracking, you need more loudspeakers."

Zuleeg agrees that depth is much more difficult to achieve than breadth and height. "Even our brains are not very good at determining a source in the vertical plane," he says. "Most of it is experience of associating known sounds with where you expect them to be - like birds in the air. For me, it's a success to conquer the horizontal plane. The effort of placing speakers in the ceiling and so on, in ratio to the effect, is scarcely worth it yet."

Soundscape's hardware engine, the 3U rackmount DS100, is capable of 64 x 64 Dante streams with an overall latency for positioning of sources of 1.3 ms, reckoned to be the minimum possible. "I've used systems with latencies between 15 and 35 ms," says Zuleeg, "which might be acceptable in a huge stadium, but in most theatres or clubs it's like having the signal attached to the fader with an elastic band! It's really tiring, especially as you try to match it with a visual image."

According to Zuleeg, Soundscape will typically require around a 30% increase in actual loudspeaker enclosures, in at least a LCR cluster or line array configuration. Five arrays would be Zuleeg's ideal minimum, none of which should exceed the 5m rule of separation. But there is a trade-off . . .

"You don't need those long line arrays any more," he insists, "at 3m long deployed left and right, ruining sightlines. You can use five or six smaller arrays - using smaller elements, too - hung across the proscenium arch or truss. I proposed this at one recent project, and they were delighted that they could still see their iconic organ at the back. There should usually be more opportunities to hide the system."

### THE KICK INSIDE

The use of smaller, less powerful individual models of loudspeaker is a spin-off benefit of 360°-audio that, according to Scott Willsallen, could have far-reaching consequences for the industry. "One of the main areas where I expect this to make a huge difference is rock and roll," he states. "Currently





- Top: The chamber in Backnang, Germany where d&b's Soundscape platform was developed
- Above: Ralf Zuleeg

you only hear one array if you're as little as 10m off centre; 360 can dramatically enrich this experience, and you're not losing any impact. You're protecting it, in fact, since the time arrival of the two wavefronts from the kick drum remains coherent. The new systems 'point-source' all that LF energy, so everyone receives the same amount of level from any given array. In fact, once mix engineers get used to it, it could attenuate overall levels without appearing to! We ought to develop new



# The New Normal

Boheme, Showboat, Disney Aladdin New York London Hamburg Tokyo, King & I Shuffle Along Fiddler On The Roof Hello Dolly Fun Home - Broadway, Milan Expo & Kew Gardens Hive, National Gallery Soundscapes, Atlantis Shuttle Experience NASA KSC, Fremont Street Experience Las Vegas, Fukui & Yokkaichi Planetariums, HMS Britannia, NCL Getaway, New National Theatre Tokyo, Turku Theatre, Stockholm Royal Dramatic Theatre, Oscars Theatre Stockholm, Gothenburg Folksteater, Gothenberg City Theatre, Helsinki City Theatre, Finnish National Opera, Deutsches National Theatre Weimar, Ronacher & Raimund Theatre Wien, Stanislavsky Theatre Moscow, Tangshan Grand Theatre PRC, Thunersee, Dance of The Vampires Austria Germany France Russia, Rocky Horror Show, Phantom of The Opera, Les Miserables, Jesus Christ Superstar, Titanic, Neumann&Muller, Feedback, Autograph, Orbital, Sound Associates, Masque Sound, PRG, Creative Technology, Edinburgh Military Tattoo, Basel Tattoo, Zurich

Max spatial audio

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techniques of localisation and take our feet off the accelerator . . ."

Willsallen continues: "There's a stereo paradigm for rock and roll, and maybe an LCR paradigm for theatre, but the first step in understanding what 360 could bring is to grasp how it can fix the errors inherent in those configurations.

The dispersion intended by them exists only for a narrow section of seats, and if you're lucky enough to be sat there, you'll scarcely notice any difference with L-ISA Live, for example. But actually, with 360, anyone on axis with all five, seven or nine arrays will be in a zone where localisation is perfect - you're not relying on an equal level between two arrays. Rather than 5% of the audience hearing a spatialised mix, like stereo, 70% to 80% are hearing it, depending on the geometry of the venue. That's an amazing achievement."

In this light, UK-based signal processing expert Out Board emerges as a true pioneer as 360° audio grows. It's now 15 years since TiMax first appeared, at the time heralded as 'Source Oriented Reinforcement' and for many years the only surround engineering option. Dave Haydon and Robin Whittaker founded Out Board, and today's products centre on the TiMax2 SoundHub delay-matrix, audio show control and spatial audio processor and playback server, as well as the TiMax Tracker performer tracking and vocal localisation system.

"The biggest challenges to localisation are budget and logistical freedom, as audio is always last in line," warns Haydon. "That's why TiMax gives you an advantage - you can squeeze it in where you can. It's true, the brain does not localise well vertically, so it's usually a horizontal, radial speaker solution with clever EQ and filtering. We use matrix delays and Haas Precedence Effect for localisation, and that physics works the same in both vertical and horizontal domains."

SoundHub's delay matrix imaging objects remain the most malleable in detail, acknowledged by sound designers who

- L-Acoustics collaborated with Meta, Invisible Light Network and Dirt Empire to create The Dome, a 360° virtual reality theatre for the inaugural Panorama Festival in New York City
- The largest L-ISA system yet immerses spectators in natural sound for Verdi's Requiem

understand the importance of the "last millisecond or dB of tweak," as Haydon puts it. It's also a visible calculation system rather than a hermetic algorithm, and operators are used to bolting it on to sound reinforcement layouts that otherwise look like they always have.

The adoptability of the new systems will depend on the familiarity factor, as they always do in live sound. Why bother? Because no matter how good it sounds, it can always sound better...

"The point about L-ISA Live and Soundscape is that you're not mixing with a mouse, like a DAW; you're mixing with faders and a console," says Willsallen. "That's more reassuring to a lot of operators. The sooner these systems are integrated into consoles there's already an L-ISA plug-in for the DiGiCo SD Series - the quicker 360 will be picked up by the live sound industry."

"The key word is 'experience'," reflects Andrew Horsburgh. "An Ambisonic microphone, such as the Sennheiser AMBEO mic, records a sound in a specific three-dimensional position, and so you can reproduce the experience of listening to it in reality - or very closely, anyway. It's very exciting to see the number of productions now showing an interest in 360° techniques, and we're in a strange position in which very few people know how to do this in live sound. But we've had some very good experiences already, and we will develop some really solid best practice - which has been missing for a long time. Mixing has been like trying to fit a beautiful, huge canvas through a letterbox. 360° audio will allow us to keep more of the painting." 😣