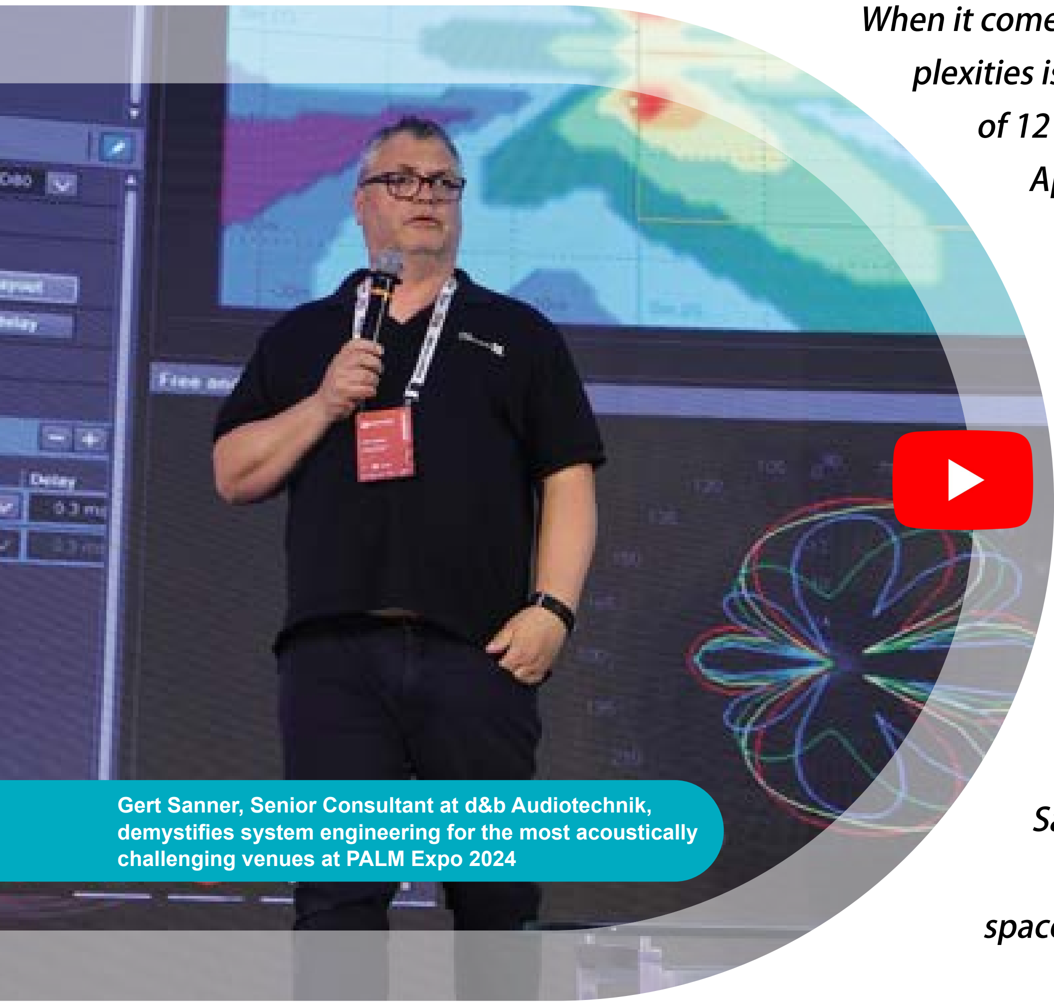
TAMING THE ECHO: Gert Sanner on System Engineering for Stadiums



Gert Sanner, Senior Consultant at d&b Audiotechnik, demystifies system engineering for the most acoustically challenging venues at PALM Expo 2024

When it comes to stadium sound, understanding the complexities is vital to creating a good show. With a tenure of 12 years as Senior Consultant for Education and Application Support at d&b audiotechnik, Gert Sanner has spent nearly 30 years learning to master the art and science of live sound, whether for corporate events, Broadway productions, stadium tours, or major UK festivals. Last May, at the PALM Expo 2024, he delivered an electrifying session on the challenges of stadium acoustics, offering insights into the system design, subwoofer placement, delay towers, and more. With his signature blend of deep technical expertise and real-world examples, Sanner revealed what it takes to turn the most acoustically demanding venues into concert spaces. Read on to explore the cutting-edge techniques shaping the future of stadium sound.

In terms of system engineering for live concerts, stadiums pose unique challenges. As **Gert Sanner** succinctly puts it, "You have to remember before you even start working, that a stadium is not made for concerts. Stadiums are made for sports." The acoustic design of a stadium is built to enhance the crowd's response during sporting events, where reverberation and echo amplify audience engagement. However, these same characteristics complicate live sound reinforcement for concerts.

A critical factor in stadium acoustics is the RT60 time, the time in seconds it takes for sound levels to decay by 60 dB. Sanner stresses that the key challenge for audio engineers is not to work against stadium acoustics but to work with them.

Managing Reverberation: Why Volume Isn't the Answer

A common misconception is that increasing the PA system's volume can overcome stadium reverberation. Sanner refutes this approach: "Trust me, that does not work." Instead of overpowering reverb, the focus must be on optimising the system to reduce reflections and increase the critical distance, the point at which direct sound and reverberant sound are equal in level.

A stadium's large scale means that a single speaker system cannot cover all seats effectively. The primary goal is to ensure even sound distribution while minimising unwanted reflections. High directivity loudspeakers, precisely focused arrays, and careful speaker placement are essential in mitigating excessive reverb.

Low Frequency Management: Subwoofer Placement

Subwoofer placement is another crucial consideration in stadium sound design. Many engineers' default to placing all subwoofers in a left and right configuration at the front of the stage, which can lead to uneven bass distribution. Sanner cautions against this: "If you have to shoot 140 metres and you've got 60,000 people, just putting all the subwoofers in one big pile in front of the stage is going to be maybe okay in the last row, but in the first row, it's very unpleasant."

Instead, engineers should design directional subwoofer arrays to ensure a more balanced low-frequency experience across the entire venue. The goal is to prevent excessive bass energy from bouncing off stadium walls and causing further acoustic issues.

Overcoming Physical Constraints

Rigging in a stadium can be challenging due to structural limitations. As Sanner recalls, Trim height, which is the height at which the PA system is flown, is another critical factor. Sanner has observed systems flown excessively high, which can lead to suboptimal coverage. The placement of main arrays, outfill systems, and delay towers must be calculated to ensure even sound dispersion.

The Science Behind Reflection and Speech Intelligibility

Reverberation stems from sound reflections bouncing off various surfaces. "Depending on the room volume and the surface of the room, this can get quite tricky," Sanner explains. In large stadiums, secondary and tertiary reflections compound the problem, creating a muddled and unintelligible mix. Speech intelligibility relies on a strong direct sound component, which competes with reverberant sound. The critical distance marks the point where direct sound and diffuse sound are equal in level. Beyond approximately 3.14 times the critical distance, sound quality deteriorates significantly. "If somebody says 'Turn it up! We need to get over the reverb,' they are misunderstanding the problem. If you turn the system up, both the direct sound and the reverb increase at equal levels. In other words, you have the same problem, just louder."

Designing an Effective Stadium Sound System

To achieve the best possible audio quality in a stadium setting, engineers must focus on minimising sound reflections and extending the critical distance. Several key approaches help accomplish this goal:

One of the most crucial elements is high directivity speaker systems. As Sanner states, "Directivity is everything." Speakers with narrower dispersion patterns help ensure that sound is projected precisely where it is needed, reducing unwanted reflections from surrounding surfaces.

In addition to speaker design, accurate placement and angling play an essential role. Engineers must strategically position loudspeakers so they direct sound towards the audience.

Advanced signal processing technologies, such as d&b audiotechnik' s Array Processing, provide another layer of control in managing stadium acoustics. These solutions allow engineers to fine-tune coverage patterns, dynamically adjusting levels and time alignment to counteract acoustic challenges within the venue. By leveraging such technologies, sound reinforcement can be tailored more precisely to the stadium's unique shape and structure.

Lastly, directional subwoofer arrays are essential in controlling low-frequency dispersion. Unlike traditional subwoofer setups, where low frequencies radiate in all directions, a directional array ensures that bass energy is focused and does not unnecessarily excite reflective surfaces. This design prevents excessive low-frequency buildup in specific areas, maintaining a balanced sound field across the venue.

To illustrate these principles, Sanner presents a conceptual stadium sound system design. The setup consists of multiple key components, each serving a specific role in ensuring even and intelligible sound distribution.

The main PA system is the backbone of the setup, providing coverage for the majority of the audience. Its design ensures that sound energy is directed efficiently without excessive projection towards distant sections, which can lead to unnecessary reflections and loss of clarity.

Outfill arrays, which are sometimes mistaken for traditional side-fill speakers, extend the system's coverage to areas not reached by the main PA. These arrays help create a uniform listening experience for attendees seated at the sides of the stadium.

A 270-degree system is often implemented in cases where artists have a strong fanbase willing to purchase tickets behind the stage. This system ensures that even those seated in non-traditional areas receive high-quality sound reinforcement.

Delay towers play a vital role in large stadiums, allowing for consistent sound coverage over long distances. These towers help extend the reach of the system without requiring excessive levels from the main PA, preventing distortion and unwanted reflections in the farthest sections of the venue.

Lastly, a subwoofer array with directional control is employed to ensure that low frequencies are distributed evenly while avoiding excessive spill into areas where deep bass is not needed.

Striking the Right Balance

Sanner underscores the importance of thoughtful planning, by focusing on accurate speaker aiming, minimising reflections, and leveraging technology, engineers can transform an acoustically challenging stadium into a venue capable of delivering an exceptional concert experience. One of the key discussions during the conference was the necessity of designing outfill systems that account for stadium architecture and acoustic reflections. Sanner explained, "If this is an open stadium, I can happily overshoot, only by a half a degree or so, because if there is a reflection—a glass wall in the back—the reflection would go up at the same angle as the impact, and it would go up and above the stadium, out of the way." This principle ensures that unwanted reflections do not interfere with the listening experience while maintaining consistent sound coverage.

Managing Delay Systems and Speaker Placement

Sanner introduced the concept of delay systems, which are critical for achieving even sound distribution in large venues. One particularly innovative approach discussed was the use of rotatable ring delay speakers in stadium installations. In many cases, stadiums have pre-installed speakers that could be rotated to align with different stage configurations, allowing them to be used as delay systems. However, as Sanner pointed out, "The caveat is that the profile will change. You need some form of steering possibility without changing the mechanical setting of the array. In our world, that's array processing."

Speech Intelligibility and the Role of STI

A significant concern in stadium audio engineering is ensuring speech intelligibility, particularly for public address announcements and emergency communications. Sanner introduced the concept of the Speech Transmission Index (STI), explaining, "STI is a measure of quality for speech, how well can I understand a spoken word? It's not a quality measure for audio. A good STI doesn't have to sound nice, like those evac systems. They don't sound nice, but you can understand them."

One of the key factors affecting STI is comb filtering, which occurs when multiple audio sources overlap, causing destructive interference. Sanner emphasized that reducing overlap is crucial in order to minimize this effect.

Subwoofer Strategies: Cardioids Are Your Friends

A major highlight of the session was Sanner's detailed discussion on subwoofer configurations for stadiums. He strongly advocated for cardioid subwoofer arrays, stating, "Cardioid is your friend." Cardioid subwoofers direct bass energy toward the audience while minimising rearward sound propagation, preventing unwanted low-frequency build-up in certain areas.

He also explained why a single row of subwoofers at the front of the stage is preferable to left-right sub stacks. "When you stack them all up left and right, you get a massive power alley. A subarray can be manipulated like a like a line array laying on its side

Beyond technical principles, Sanner highlighted the practical challenges faced when deploying large-scale sound systems. In some stadiums, accessing rigging points for speakers is impractical. He stressed the importance of collaborating with set designers to find optimal subwoofer and speaker placements. "If the stage has a thruster in the middle and you can't put subwoofers there, well, that's unfortunate. You have to find a way to put them there. Usually, that means speaking to the set designer and seeing if you can put them under it. If it's open, if it's just cloth, then it's not a problem, you can put them there."

The Science Behind the Art

Sanner's session at the PALM Expo 2024 underscored the intricate balance between physics and artistry in stadium sound engineering. His final thoughts revolved around the importance of understanding and applying these principles rather than treating audio design as a mystical process. "Most people think it's some sort of magic, but it's actually not," he said.

With a combination of technology, physics, and practical know-how, Sanner provided an invaluable masterclass on the realities of engineering sound for large-scale stadium events. His insights serve as a blueprint for professionals aiming to create unparalleled auditory experiences in some of the most challenging acoustic environments.

To view the full conference session, visit the link -
https://www.youtube.com/watch?v=s0HuDgKS5sQ
*Head to the **PALM Expo Official YouTube channel** for more confer-ence videos on industry pathbreakers!*