E&E Revisits Singapore's National Stadium

EAW speakers provide coverage, intelligibility and OOMPH

How often does it happen that the company responsible for the integration of the sound system in the previous venue once again gets involved with the new venue, 41 years on! That's exactly what has happened.
The original National Stadium was opened in 1973, was torn down and rebuilt as part of the new Sports Hub and now stands proudly as an outstanding icon in Singapore. It just goes to show E&E's perseverance, reliability and credibility to once again play a key role.

Located on a 35-hectare site in Kallang, near central Singapore, The Sports Hub consists of the new National Stadium which is the jewel in its crown as well as an Olympic-sized aquatic centre, a multi -purpose arena and a water sports centre. Catering to social needs it also includes a Retail Mall, restaurants, skate park, a Sports library and the Singapore Sports Museum, in an environment that just makes you want to hang out there or start getting fit for sports.

The New National Stadium

The giant dome with the retractable roof will capture your attention immediately as you step into the Stadium. The retractable roof covers 95% of the 55,000 seats and takes about 20 minutes to open or close. The roof is made of cutting edge weather-resistant material that blocks out the sun's heat as well as the rain. Thus easily ensuring that an event carries on even in wet weather conditions.

Considering that Singapore is located along the Equator, it would get easily hot and bothersome in a closed environment. Anticipating that, the designers have created an innovative bowl cooling system, where cool air of 23 degrees is pumped from underneath all seats, using less than 15% of the energy required for similar conventional air-conditioned stadiums. Brilliant!

The Stadium was also designed to host a multitude of events such as rugby, cricket, football, athletics, concerts, family entertainment shows, national and community events. The lowest tier of seats can be mechanically and automatically retracted thus enabling the stadium to be configured to accommodate the different types of events – ingenious! Thus the seating capacity changes according to the event. As an example an Athletic event will accommodate 50,000, a Cricket event 52,000 and a Football/Rugby event the full 55,000 capacity.

It has also been reported that with a dome of 312 metres in diameter, the National Stadium currently holds the record of the largest dome structure in the world.

Enough said. The new National Stadium will indeed hold pride for many Singaporeans. Adding to that is a carefully thought out and designed sound system that can easily be considered as one of the best sound system in the world for a Stadium.

The Sound System Configuration

There are two sound systems in place. The Event Sound System which consists of all EAW speakers. The entire speaker system is suspended from trusses way above the seats and the Voice Evacuation system which consists of Community speakers also hung from the trusses.

The Event Sound System consists of 35 units of EAW QX 2,000 watt 3-Way Full range speakers installed across the dome roof. There is a mix of QX speakers offering different distribution angles for optimum coverage. In addition to the QX speakers, 6 units of EAW MQX 4,000 watt dual driver/ horn speakers were installed serving the lowest section of the grand stand and VIP area. Generally unusual in a stadium installation but 48 units of EAW SB528ZPWP-W 2,000 watt Dual 18" Subwoofers were also installed below the dome roof. The Subwoofers were configured into 12 clusters of 4 speakers each, 2 units stack 600mm above another 2 units all facing down for a cardioid distribution pattern; that is with all the sub bass energy aiming downwards towards the seating galleries and not upwards and avoiding the roof. The 12 units of cardioid subwoofer clusters are evenly spaced over the seating galleries. All the EAW speakers are weather proofed models painted over with fiberglass resins and painted in light grey to blend in with the roof trusses.

The high power speakers are driven by 70 units of Powersoft K10 2×6,000 power amplifiers and 26 units of Powersoft K2 2×4,000 watt s power amplifiers. Processing is handled by 40 units of Symetrix Symnet Edge DSPs featuring Dante Network cards that are linked to 40 units of NETGEAR 1000 base network switch. The signals are transmitted via fibre optic cables to the control room in a loop configurati on for maximum redundancy.

The power amplifiers, DSPs and NETGEAR switches are all mounted in 16 units of specially constructed sealed air conditioned equipment racks that are installed up in the Cat-walk that runs across the roof. The speakers are then connected directly to the power amplifiers in the nearest rack location. Gary Goh, Deputy MD of E&E highlights "Having the amplifiers in the cat-walks allows us to minimize the cable lengths between the amplifiers and speakers thus maximizing the efficiency of the system." Gary adds, "The air-conditionned racks serve two purposes – To cool the power amplifiers when they are in operation and to act as a de-humidifier when they are not in use. This will keep the delicate electronic equipment dry and in optimum condition.

The entire audio system distribution is run on Symetrix and Dante and Dante itself has primary and secondary redundant network. “We also catered for redundancy into the amps – so AES as primary inputs and analog as back up. There is also redundant processing built into the design and all these measures result in a very robust system,” adds Gary.

The control room located at Level 5 of the National Stadium features an Allen & Heath iLive 64 channel Digital Mixer, Tascam CD player and recorder. There is also a Control PC installed in the control room for the Dante soft ware control and patching to the room.

The sound installation is complemented by a range of Shure microphone systems, including the UHF-R Wireless System with UR4D+ receivers, UR handheld transmitters with Beta58 mic heads, UR1 bodypack transmitters with MX150 lavaliers, as well as UA845SWB antenna distributors. Several VP89 shotgun condenser microphones encased in Rycote windshields have also been installed across the stadium for broadcasting and media applications. The control rooms are equipped with Shure Microflex MX405 gooseneck microphones mounted onto MX400DP desktop pre-amps, as well as SRH940 headphones for monitoring.

Ronald Goh on the EAW system

Ronald Goh, Managing Director of Electronics & Engineering Pte Ltd who was 27 years old when he was involved in the original National Stadium comments about the sound system at the new National Stadium, “After watching the World Rugby 10s that was held from 21-22 June at the new stadium and seeing how the sound system was used, I realised that this is the new age sound system. 40 years ago the sound system at the National Stadium was a Voice or Public Address system. Now it is a Disco quality sound system with sub frequencies going down to 25 Hz and literally hits you on the chest. Whenever, a goal is scored from either side, the soundman or DJ in this case, cranked up the sound level to enhance the cheering and built up the mood. In fact, at one point the DJ played the familiar disco song “YMCA” and got the whole crowd in the stadium standing up, swaying to the beat and acted on the Y M C A as it is being played over the main event sound system just like in a disco except that this is in a 55,000 seat stadium. The subwoofers did provide all the “oomphs” to get the crowd excited. What a far cry from the old stadium sound system and technology of 40 years ago. He adds, “At the end of the day we have provided a good world class sound system and it is up to the person using the sound system to make full use of the high power sound system to create the ambience to excite the crowd.”

Ronald is indeed very pleased with the EAW speakers. “In our business it is always location, location, location and then the choice of speakers. The EAW QX speaker systems are outstanding speakers that enabled us to meet the criteria set by the owners and consultants and I honestly doubt any other speakers would have met all of the criteria, especially on the speaker power output, clarity and its size.”

“There was already an operational criteria provided by the Sports Council on what their new sound system in the main stadium should be like. We are to meet their criteria and to provide a turnkey solution. They were obviously looking at cost as a key factor. They wanted to see if we can meet the criteria – price, weight, SPL. As the speakers would be installed under the roof, weight was a critical factor. We came up with the design to meet all their requirements.”

Ronald continues, “It is made possible because EAW has the right speaker. The EAW QX series speaker fits the bill perfectly. It has a 600mm square horn fitted with a high power mid and high coaxial driver/horn surrounded by 4 units of 12” bass speakers in a super compact enclosure. The winning factor was its clarity and the throw of the horn. But there were certain areas where we needed a double QX which is essentially a MQX model which has the same two co-axial drivers and two horns and aiming at a distribution angle served by a QX horn. They narrowed the horn so the sound can penetrate better. So for the lowest seating galleries which has the longest throw from the roof trusses, we used 3 MQX for each side of the grandstand to meet the Sound Pressure Level criteria at that distance of throw. MQX is a custom-made product that was designed specifically for stadiums and they had it which helped to meet the distribution power and at that height.”

Ronald provides a deeper insight as to the workings of the EAW QX system. “30 years ago a constant directivity horn will give you a frequency range of between 800 to 8,000Hz. Anything below that is omnidirectional. Whereas the EAW QX speaker is able to achieve good coherence and pattern control well into the low frequency range from 55Hz to 20,000Hz. This is made possible by having four Phase Aligned 12” low frequency transducers arranged as vertical and horizontal pairs that leverage beneficial interaction based on their spacing within the cabinet with minimal phase distortion throughout the whole frequency spectrum.”

There were other issues that E&E had to come to grips with and convince the project team to see it from their view and thankfully it all worked out well. EASE soft ware was used to decide on the location of the speakers which was all well. However Ronald points out, “The speakers were too high. I mean on paper it is okay but in reality it is different. It was 60m up. That means sound takes more than 200 millisecond to reach your ears when it is produced from the speaker. We needed to reduce that as much as possible and to keep the direct sound within the “criti cal distance” that is the direct sound from the speaker and the reflected sound from the ceiling and walls as far apart as possible. We managed to lower the speakers to a height of 45 meters so as not to interfere with the lights and other services. Lowering the speakers helps to bring a higher level of direct sound to the ears to improve on the overall clarity in a reverberant environment.”

Another aspect that mattered was regarding sound absorption or the reverberation coefficient in the stadium. “Sound travels and it gets reflected in all directions unless it is being absorbed by acoustic material in the space

or its decay to 60dB and below. I always talk about the “car” and the “road”. We can design the best and fastest car, but we must have the road to complement the performance of the car. Likewise, the stadium interior and environment must complement the sound system for its best clarity. It was fortunate that the dome ceiling panels were absortive as they were perforated with the 50mm thick rock wool behind them, to isolate the interior from the roof panels.

Ronald adds on, “I was initially also concerned about the sound travelling from one side of the gallery to the other side. The stadium has four sides to it – East, West, South and North. My concern was if the reflected sound from speakers serving the North grandstand travels to the South grandstand, how much interference it will have on the intelligibility on the other side. It worked out quite well because of the seating incline and the absorptive ceiling, whatever remains of the sound travelling to the other side will be masked or drowned by the direct sound on the same side without affecting too much of the intelligibility of speech.”

The Sweet Spot on the West Side

Ronald lets us in on where in the Stadium you can appreciate the EAW speakers perform at their best. “We have installed two speakers facing the open air space on the West Side. Initially the project team wanted the speakers to be installed on either side of the side roof trusses. I told them it was not a good idea as the side facing speakers would have the sound travelling in opposite directions and it will lose its directional realism. That is, sound does not travel from the centre of the field like the other speakers anymore but from the side galleries. It is best to mount them within the triangle of the truss as it is small enough and face the west seating gallery accordingly to maintain directional realism for the west gallery. The two speakers were therefore suspended within the truss in the air providing sound coverage to the open side on the West.”

Ronald insists that you need to stand there to appreciate why he keeps raving about the EAW QX system. “To appreciate such a high power mid/high co-axial driver/horn speaker with phased aligned bass speakers with minimal or no phase distortion, that would be the spot. Those two speakers are installed at a height of 50 meters, which would be the highest placed speakers in the stadium but it sounded so clean and clear because it is from a one point source with no surfaces or reflecti on close to it and the presence of sound sounded like it is so much closer to you than it is 50 meters away and with no colouration at all. Humans can tolerate total harmonic distortion – we can handle 5% but when it comes to phase distortion – even at 1% you can hear the difference. Here there was no colouration, no near reflections – you will need to listen to it to appreciate the quality of the speaker. I never knew a speaker could sound so sweet, so clear and so loud too and at that height. It is the clarity of sound that strikes you – it is so clear,” said an enamoured Ronald.

Ronald concludes, “At the end of the day throughout the whole stadium the sound is good because we have chosen the right speaker and it sounded right because we have installed them in the right locations.”

Visual Treat

The main displays at each end of the stadium feature Daktronics 20HD pixel layouts and each measures 16.46 meters wide by 9.51 meters height. They are each able to provide live video and instant replays but are also capable of being programmed into multiple sections to provide additional up-to-the-minute statistics, graphics, animations, advertising messages and other information.

Two ribbon displays of 73 cm height and stretching 149.96 meters wide along both the stadium's seating fascia, provide additional advertising opportunities and game relevant information. Each ribbon display features 20 mm line spacing.

The displays incorporate excellent image clarity and contrast with wide angle visibility to provide an improved view and experience for all those in attendance.

The LED displays were installed by Electronics and Engineering Pte Ltd.|