



## ***Optimising audio imaging and surround sound for auditoriums, events and themed environments.***

*(INTRO) Source Oriented Reinforcement (SOR) techniques for amplifying sound can help provide accurate panoramic imaging and virtual surround sound in auditoriums, events and themed attractions that will improve the listening experience for all audience members.*

Source Oriented Reinforcement (SOR) is the technique of amplifying sound while localising it back to its source. In a theatre context this means localising sound back to the mouth of an actor on the stage or to a musical instrument or to the point on stage from which a sound effect should emanate.

The advantages of SOR are discussed here with reference to some of the facets of human auditory perception and psychoacoustic phenomena as are relevant to amplification of sound in auditoriums, such as:

- n Perception of direction and distance
- n Echo perception and suppression
- n The Cocktail-Party Effect (see below)

A well-implemented SOR system will achieve an even distribution of sound level over a large listening area while maintaining directional information about multiple sound sources, thus reducing listener stress and ensuring that the suspension of disbelief willingly entered into by a theatre audience is not undermined. Indeed, significant improvements in the perception of the quality of amplified sound in a large listening area are possible using SOR techniques. SOR typically widens the 'sweet spot' (the area in which panoramic or spatial information in the sound mix is perceptible) from 10 per cent to 90 per cent of the audience's listening positions.

SOR techniques have been used for top international productions of musicals, plays, arena operas, concerts and special effects soundscapes.

### ***Disadvantages of using a large stereo loudspeaker system***

Delivering sound to an auditorium from a large stereo loudspeaker system prevents the audience in most listening positions (i.e. off-centre) from hearing any panoramic information in the sound mix. This is because the sound from the closer loudspeaker will arrive at a listener's ear before the sound from the more

distant loudspeaker. The psychoacoustic law of Precedence, sometimes known as “Haas-effect” after its originator, dictates that even if the level of sound from the more distant (e.g. right) loudspeaker is significantly higher than that of the closer (e.g. left) loudspeaker, a listener will perceive the more distant sound as coming from the closer loudspeaker.

Thus an audience member’s perception of stereo imaging in a stereo sound mix will only be as good as their proximity to the centre line of the auditorium dictates. Sound engineers therefore often compromise and deliver a mainly mono mix to avoid the majority of audience members missing out on certain sounds panned anything more than slightly to the left or right.

If all of the sound that listeners hear from an amplification system comes from one direction they cannot use their auditory cognition to the full.

This results in:

- n Reduced intelligibility
- n Loss of the ability to differentiate between different actors/presenters dialogue.
- n Increased listener stress due to loss of correlation between visual and auditory perspective
- n An undermining of the audience’s suspension of disbelief

### ***The advantages of SOR***

Well-implemented SOR sound designs result in most of the audience hearing correct localisation of sound, so that, for example, an actor’s, musical instrument’s or special effect’s “audio position” authentically matches the actual, “visual position”.

SOR is achieved by exploiting the psychoacoustic principle of Precedence which causes the sound from a loudspeaker nearby to localise towards a distant sound source providing the nearby loudspeaker’s sound is suitably delayed and levelled with respect to the sound arriving from the distant sound source (either a natural acoustic source or another loudspeaker).

A SOR system utilises a special type of multichannel audio matrix which gives every audio source it’s own unique level and delay setting with respect to every loudspeaker, which allows every sound source to be independantly and identically localised for every audience member.

Another advantage of a SOR system is its exploitation of natural ways of hearing. The human hearing system is binaural. This gives people the ability to hear multiple sounds from two separate points and thus draw clearer conclusions about the positions of the sources of the sound. Differences in sound levels and soundwave arrival times at the ears provide the main clues to localisation of sound. The characteristics of the external parts of the ears, the head and the torso further colour the sound, depending on the sound’s direction. Listeners make deductions about the

distance of the sound source from, among other things, the sound's level, frequency content and the balance of its direct and reverberant energy. Listeners also make judgements about their acoustic environment that are based on their perception of echoes and reverberation and the frequency-dependent absorption characteristics of reflective surfaces within the environment. These differences also allow people to “focus” their hearing on what is of interest to them and to filter out what is not (this has been aptly named the Cocktail-Party Effect).

Amplified sound, delivered in a way that utilises the auditory system's natural ability to determine direction and discriminate between sounds with different localisations (i.e. SOR) is less tiring and less stressful than conventional mono or stereo, or even un-amplified sound, and does not need to be so loud to be heard.

SOR designs are more sympathetic to the environment in which the sound system is to operate than non-SOR designs. Reflections of sound off architectural features and effects of reverberation in large spaces will result in spectral changes to the sound, while an acoustically over-damped environment will yield a very dead or lifeless sound. Both these conditions result in loss of intelligibility. However, in almost all applications, using a distributed sound system, such as in SOR, will yield improvements over large single (mono) or dual (stereo) speaker systems. Loudspeakers can be placed and targeted so as to largely avoid reflective surfaces and reverberant voids, and to ensure that more of the audience can be in direct-field coverage, and the effect of unavoidable echoes can be minimised.

Stereo music reproduction from a distributed loudspeaker system can be achieved using SOR by incorporating a delay matrix that feeds several loudspeakers with both channels of the stereo signal delayed and summed so as to maintain the left and right perspective of the two signals for all listening positions. The same idea can be used to reproduce pre-recorded film surround-sound material; each of the five signals intended for the left, centre, right, left-surround and right-surround loudspeakers can be fed into a delay matrix and the signals can then be post-processed in such a way as to enable a distributed system of smaller speakers to give a better delivery of spatial information for all audience members by creating a “Virtual” surround environment rather than relying on a conventional “discrete” surround configuration.

In most cases, use of SOR techniques in the pursuit of amplification of acoustic instruments such as those used in orchestral or operatic productions, and for enhanced reinforcement of instruments for rock or contemporary music shows, will result in breaking up the one-dimensional wall of sound that is driven from a conventional stereo loudspeaker system. Instead, SOR will replace this with a wide, spatial panoramic soundfield driven from a

distributed sound system, which will ensure an even spread of sound pressure and definition over the entire listening area and thus benefit more of the audience.

### ***Summary of advantages of SOR***

SOR has the following advantages:

- n It reduces listener stress levels significantly as it provides better spatial separation of sounds due to improved intelligibility and correlation between visual and auditory action
- n By using a distributed loudspeaker system, SOR can realise 100dBa SPL at 30 metres from the stage while not requiring 130dBa in the front row of seating. This enables better conformance to health and safety criteria
- n This also ensures fewer problems with echoes from the walls and other architectural features of the auditorium. Loudspeakers that are placed closer to the audience do not excite the space to the same extent as a large and distant single or dual loudspeaker system.
- n Low-powered loudspeakers and amplifiers are smaller and easier to mount and conceal. They also may be cheaper than high-powered units of equivalent quality

QUOTE) *Many have commented that SOR has enabled them to hear detail in the orchestration of music or definition and intelligibility of spoken and sung word . . . that had redefined what they had thought possible*

### ***The TiMax delay matrix – a practical SOR system processor***

In the course of my work implementing the TiMax delay matrix on SOR applications on West End and Broadway shows, industrial and corporate events, arena opera and orchestral productions, as well as rock music productions and many other events, I have had the privilege to work with a number of world-famous and highly respected sound engineers who have greatly assisted in the development of the knowledge and understanding of SOR. Many have commented that the SOR system has enabled them to hear detail in the orchestration of music or definition and intelligibility of spoken and sung word, as well as accuracy and realism of sound effects and soundscaping, that had redefined what they had thought possible. n

Robin Whittaker, BSc Hons, is the founder and the managing director of OutBoard Electronics Limited who for the last ten years has designed and manufactured specialist automated sound control equipment for theatre. The company's flagship product, TiMax, is one of the first (digital signal processor) DSP-based delay matrix systems specified for live performance applications to be commercially available.