Tech Summary

Fredrik Gunnarsson

- *I have been introduced to a bunch of different new technologies over the years but I never been hooked the way I am on EmbracingSound™.*

Per Hallberg

Academy Awarded Supervising Sound Designer Hollywood. Black Hawk Down, Gladiator, Braveheart.

- *EmbracingSound™ gives me the freedom to work anywhere. All I do is take along my computer and the system and I can even sit in my summerhouse and finish mixing.*

Tore Johansson

Producer of The Cardigans, Sophie Ellis Bextor, A-ha, Tom Jones…

- *EmbracingSound™ is the only way to monitor a 96k recording knowing that it will work all the way.*

Michael Beinhorn

Producer of Marilyn Manson, Korn, Soundgarden, Fuel…

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Preface

The EmbracingSound® technology is a groundbreaking new approach to the way we experience reproduced audio. Using a single speaker unit, all formats, whether they are Mono, Stereo, Binaural or Down Mixes from any surround sound format can be referenced accurately, while eliminating many of the problems (phase and cross talk) associated with conventional multi speaker systems.

Experience a sharper, clearer, high definition sound image while, at the same time, eliminating the fatigue from processing redundant L/R signal information. With the EmbracingSound® technology you will begin to *see* and *feel* the sound image right before your very eyes.

The Traditional Way with Left and Right Speakers

The traditional way with Left and Right speakers includes two mono loudspeakers and a listener positioned in an equilateral triangle where the sides are approximately three meters. Time and/or Level Difference are reproduced between these two points with the aim of creating a sound stage between the speakers in front of the listener and in best cases extend this outside the base of the triangle.

Difference in amplitude alone can never result in anything else than localization of the actual loudspeakers and an imIf difference in amplitude is presented between two points in space, localizable to the left and right of the listener, an imaginary sound source can be moved back and forth like a horizontal pulley system (i.e. a washing line) between the two points.

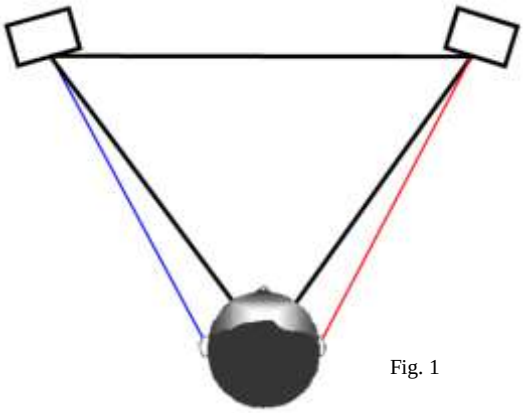


Fig. 1

This technology was further developed in the 1930s by Mr. Alan D. Blumlein, the inventor of 2-channel stereophonic disc cutting. The system suggested by Blumlein was formed with the background of Lord Rayleigh's duplex theorem presented in 1877. The theorem suggests difference in phase to the listener ears for localization below 700Hz and difference in level above 1800Hz with an overlap of the two localization functions between approximately 700-1800 Hz.

Blumleins main interest was to create an audible stage to compliment a "binaural" sound movie, something that his patent ably shows. The resulting system formed up to the late 1950s and is what we have been living with ever since.

The traditional Left and Right speakers require an absurd degree of high quality in the separate loudspeakers and components and. Such quality is not found in most places other than in esoteric HiFi systems and a few professional studio monitors. The discrete localization of the two loudspeakers is an obstruction to the experience of a well resolved sound image in between the two speakers as well as positions that extends outside the distance of the two loudspeakers if any phase or level differences are introduced by either errorus placement or electric/mechanical differences between the separate speakers.

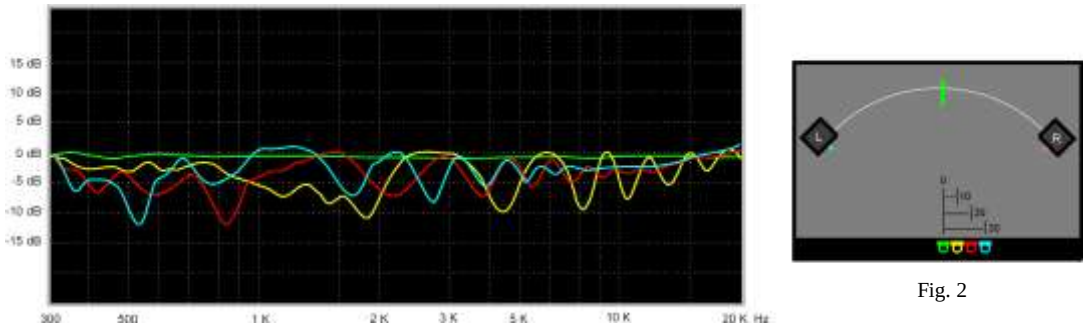


Fig. 2

The right part of figure 2 shows the positions of the loudspeakers and the measuring points that the graph to the left is showing. The green microphone position is in the apex of the equilateral triangle and is taken as a reference for the measurements. The next measurement points are 10cm offsett in relation to the apex (yellow), (approximate ear distance) 20cm (red) and 30cm (blue).

Two loudspeakers placed several meters apart, results in a filter due to their discrete placement and the fact that we have two ears on the sides of our head. The result is then a rhomb and not an equilateral triangle. (red and blue line Fig.1). The typical resultant frequency response of the filter introduced by the two speakers is shown in Fig. 2.

The theory behind the rhomb is that it is needed to create level difference to our ears, a level difference that varies from different conventional loudspeaker setups depending of the separating distance and the separation achieved by the listeners head.

It is common practice to increase the Difference information if the distance between the two loudspeakers is much less than the norm of three meters, as in a TV-set or a portable HiFi system. The result is a questionable solution when two separated loudspeakers are unable to reproduce Difference (L-R) without differences in amplitude between left and right ear of the listener.

Headphones utilize the difference of time of arrival from 0.00 ms to 0.6 ms to localize sound in combination with level difference. This is to be compared with the time difference of 2ms that result in localisation of a speaker, 30º to the left or right in a conventional loudspeaker system. The Difference in amplitude results in an imaginary source that moves inside the head of the listener.

The Next Step in the Evolution

The aforementioned filtering action can be totally avoided by placing the two loudspeaker drivers as closely together as possible. This is the only configuration where the relationship between the listener and the loudspeakers is truly triangular (Fig.3). The purpose is to form one sending surface with the capability of reproducing the electrical signal without adding any angular difference, separating the two vectors, Sum and Difference.

A system like this works like an M/S microphone but is reproducing the sound instead of picking it up. The time and/or level differences present in the recording are accurately reproduced making the audible information identical to the image seen on an audio vector scope. The result is a system less dependent of the quality of the separate drivers for reproduction of the sound image because the drivers unique localization are not needed for the system to work.

Fig. 3

The most remarkable properties of such system are that phase differences can be reproduced and that time differences reproduced thru the system is true to the human resolution of localization.

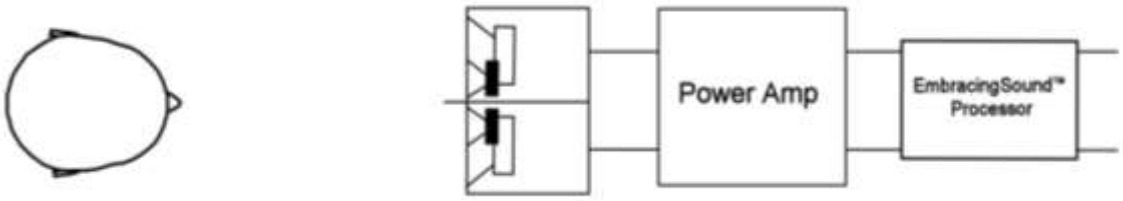
The purpose of EmbracingSound™ is to enable the listener to experience all the information originally in the recording making the Sum and Difference information to be reproduced, rather than the vectors Left and Right. This viewpoint is invaluable even in an electric compatibility aspect, as we all know that not all listeners have Surround Sound equipment or even Stereo.

In a mix, the engineers' aim is to blend sounds together or differentiate them in a creative way to form a sound image. This sound image is what is intended to be transmitted to the listener, not the difference between two mono loudspeakers in a room.

The EmbracingSound™ Technology

The EmbracingSound™ technology includes three main parts:

- The speaker configuration
- The signal treatment
- The plate element that protrudes centrally between the speaker pairs on the baffle of the speaker system.



The speaker configuration consists, in it simplest form, of two loudspeaker drivers in a single unit. The two drivers are side-by-side, as close as possible, in flush with each other facing forward towards the listener.

The principle behind EmbracingSound**™** makes use of the *Sum (L+R)* and *Difference (L-R)* between the audio channels. The *Difference* is reproduced with opposite polarities to the listener ears. In simple terms this means a simultaneous high pressure to one ear and an equally low pressure to the opposite ear for all wavelengths. This is a signal that the brain cannot localize and makes us feel embraced by the sound.

The *Difference* is describing the horizontal (azimuth) dimension of the sound image. Together with the *Sum* that creates equal pressure to the ears and describes the depth, the sound image is perceived in $\pi/2$ in front of a central positioned listener. The resultant frequency response at 1 m is shown in Fig.4.

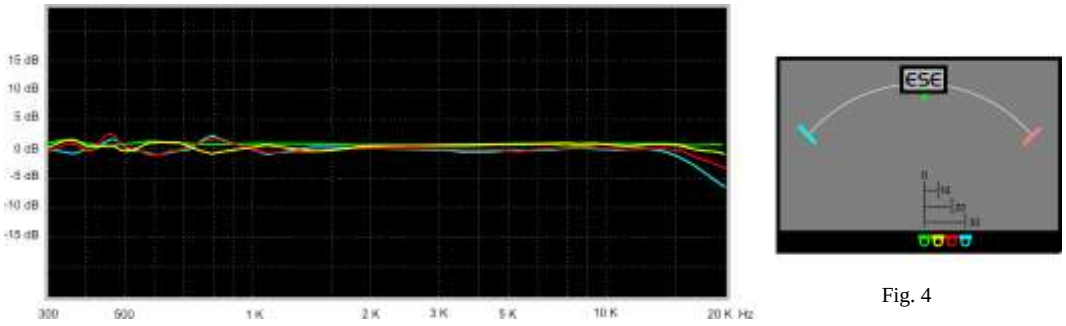


Fig. 4

Similar to figure 2, the right part of figure 4 shows the positions of the loudspeakers and the measuring points that the graph to the left is showing. The green microphone position is on axis of the EmbracingSound™ system and is taken as a reference for the measurements. The next measurement points are 10cm offset in relation to on axis (yellow), (approximate ear distance) 20cm (red) and 30cm (blue).

The signal treatment adopts the relation in level between Sum and Difference to be reproduced through the speaker configuration. The *Sum* reproduced from the speaker configuration uses the surface of the two drivers together (Fig.5), unlike the *Difference* that uses only half of the surface (Fig.6) to generate each lobe of the dipole.

This differing surface is taken care of by level adjustment that gives the *Difference* information the power needed to restore the relation between the *Sum* and the *Difference*. The processor furthermore translates all wavelengths to be correctly localized by the listener.

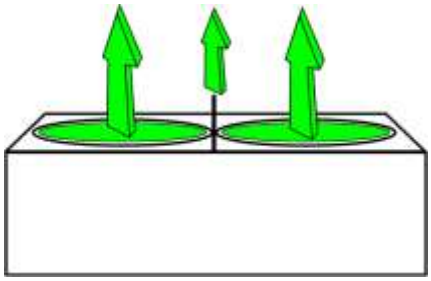


Fig. 5

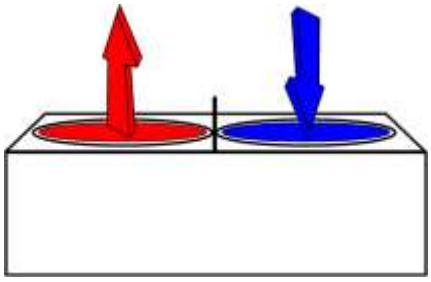


Fig. 6

The plate element is used to stabilise the reproduction of the monopole. The plate separates the drivers and splits the baffle in two equally large parts. The result is a secondary transducer, by diffraction, of the sound waves travelling on the baffle. The plate must be short in relation to the wavelength reproduced by the drivers and in relation to the driver size to avoid unwanted reflections.

Acoustics

The EmbracingSound™ technology works as a +- 30° reference setup regardless of the distance. This means that the perceived width of the stereo image is increasing proportionally to the listening distance. This is true given that the acoustic environment is meeting certain criteria and that the loudspeaker drivers used are of sufficient size.

Generally the rule applies that as long as the distance to the room boundaries at the side of the listener are at least two times the listeners distance to the EmbracingSound™ speaker configuration it is possible to use the system as a +- 30° reference setup (Fig. 7).

In this environment it is possible to use EmbracingSound™ as a perfectly calibrated Left, Centre, and Right speaker in a 5.1 setup by using a Downmix Controller to get the LCR signals properly reproduced.

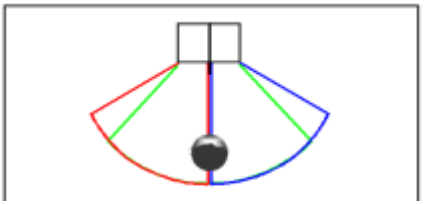


Fig. 7

If the EmbracingSound™ technology is used in an environment where the distance to the room boundaries are shorter than the distance to the speaker configuration, the experience is spiced up by the room reflexions as shown in Fig. 8.

To make the comparison with picture, the quality of the sound image is more like an impressionistic painting as opposed to a sharp photograph. As a fact, many Pro's are using this versatility of the system to get other perspectives to ensure that their mix will sound better when played back by the consumer.

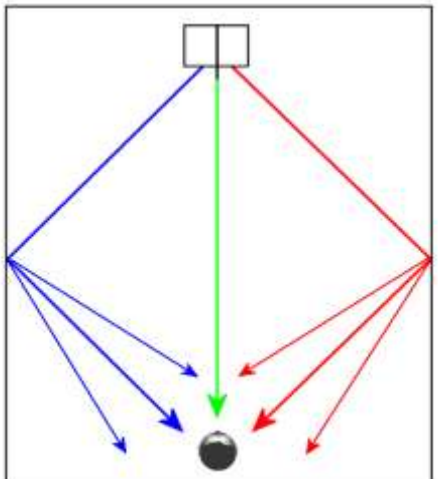


Fig. 8

When comparing a traditional pair of Left and Right speakers in an ordinary room and the EmbracingSound™ speaker configuration it is common to see that a single mono speaker placed to the side is reaching for example 78dB at the listening point at 2W input, the Left and the Right speaker together sum up to approximately 83dB.

Due to the commonly centred position in the room by the EmbracingSound™ speaker configuration just one single side of the configuration will reach approximately 81dB with the same input just by changing the position. Two sides of the EmbracingSound™ speaker configuration results in approximately 86dB. The explanation to this effect is that the EmbracingSound™ configuration is homogenously exiting the room modes. The most apperant benefit of this is that the EmbracingSound™ technology provides typically 5-6 dB more headroom to the sound system than traditional speakers.

Conclusion

The advantages with the EmbracingSound™ technology compared to the traditional Left and Right speakers is that the quality of the system components is not as critical. Both systems are using differences in amplitude and time to reproduce a sound image. The distinction is that the EmbracingSound™ is only reproducing the recording as it is, without any added differences between speakers, as opposed to the traditional way. This also helps to increase the headroom as more energy reaches the listeners ears with the EmbracingSound™ technology. This is why the audible result directly corresponds to the professional's visualization tool of the stereo signal, the audio vector scope.

The EmbracingSound™ technology is the standard reference stereo speaker technology of the future. It allows listeners to experience the exact same sound image that the producers and engineers intended. We all know that the typical consumer rarely ever places their Left and Right speakers correctly and this problem is only compounded by six speaker setups. The EmbracingSound™ technology eliminates these variables and has created the first standard reference system that can be relied upon without the chance of incorrect placement. It is only the sound quality or tonality that may differ or vary due to the quality of the speaker's components.

Glossary

Amplitude	The power of a sound wave expressed by the height of the sound wave in a given instance.
Audio vectorscope	Also known as goniometer. The device is used for viewing the interaction between the vectors Mid/Side and Left/Right.
Baffle	Front panel of a speaker enclosure on which the drivers are placed. The main purpose is to increasing the path length from front to back of the driver. But may also be the front of an enclosure making the baffle infinite.
Binaural	Sound reproduction using two microphones at ear distance with some kind of non-reflective barrier in between, usually mounted in a "dummy head" (to emulate the shape and the response of the human hearing system) feeding a pair of headphones, so that the listener hears the sound he or she would have heard if present at the recording location.
Crosstalk	Any leakage of signals between two channels; i.e. two channels of a multipair cable, two channels of a mixer, etc. Usually not desirable.
Diffraction	A change in the direction of a wave that is caused by the wave moving past or hitting an obstacle such as a speaker cabinet edge, grille cover, screw heads etc.
Difference	Right contains the positive polarity of the Difference, Left contains the negative polarity of the Difference. Difference is the same as Side, the dipolar side microphone in an M/S microphone configuration. See M/S.
Dipole	A sound source emanating sound in two directions with opposite polarity i.e. a plate vibrating in the air without any resonance box. The dipole source is known for very little acoustic output since the both directions never are in phase at the same time given that the dipole is not inserted in a baffle.
Dipolar Speaker	Speaker featuring speaker drivers on two opposite sides of a speaker enclosure and wired to operate out of phase (as one driver moves in the other moves out) creating a null to the sides of the speaker (very little sound emanating to the sides) and a broad, spread-out sound in general.
Frequency	The number of repeating occurrences of a particular distinct and complete element (the positive and negative crest and trough of a single sound wave in audio) in a given time (one second).
Hz (Hertz)	A unit of measurement denoting frequency, originally measured as **C**ycles **P**er **S**econd, (CPS): 20 Hz = 20 CPS. Kilohertz (kHz) are hertz measured in multiples of 1,000.
Imaging	Listening term. A good stereo system can provide a stereo image that has width, depth and height. The best imaging systems will define a nearly holographic re-creation of the original sound.

Mask or Masking	Psychology of Hearing. The human hearing phenomenon where the response to one stimulus is reduced in the presence of another, i.e., two sounds arrive but only one sound is heard. Particularly evident when one sound is louder than another, with the result being that we hear the louder sound, even if arriving at a slightly different time. Frequency plays a part: a louder sound heard at one frequency prevents softer sounds near that frequency from being heard. However, not all frequencies mask the same. Mid-band frequencies mask far better than low frequencies, for example.
Mirage	A listening term, refers to the enveloping experience of a sound system without focus to any loudspeakers in the listening room. A sound image in 360º A suitable sound system can be reproduced by an infinite number of loudspeakers
Modulation	Modulation is a method of placing one signal on top of another by altering the base or carrier signal in a particular way that can be decoded to extract the additional, modulated signal.
Mono	Consisting of only one channel. Mono or monaural simply means one. A movie with a mono soundtrack has only one channel of information. A mono amplifier has only one channel of output. Think of a car with four tires - the car is four-tired or four-channeled in audio terms (like a four-channel amplifier). If the car had only one tire it would be mono (like a single channel amplifier).
Monopole	A sound source that is emanating sound energy in essentially all directions if present in free space. If a loudspeaker driver, that is a dipole of nature, is inserted in an enclosure, the minus lobe is not coupled to the air mass and a monopole is obtained emanating into half space.
M/S	(Mid-Side or Sum/Difference) originally known since 1931 from the patents of Alan Dover Blumlein. One of the two incarnations of a stereo signal i.e. Left/Right and Mid/Side (Sum/Difference). Left/Right and Sum/Difference is liner transformable with each other. *L+R = Sum* *L-R = Difference* *Sum + Difference = L* *Sum – Difference = R* The microphone technique was expound and made practical in the mid '50s by the Danish radio engineer Holger Lauridsen based on the Blumlein patents. The method means for capturing stereophonic sound using two microphones. One microphone with a cardioid response (although any polar pattern will work) is aimed straight ahead toward the sound source (this is the mid or mono M part), and a second microphone with a figure-8 (or dipolar) response is placed so that the two lobes are directed toward the sides (this is the side or stereo S part). The two signals are then combined using an M-S matrix circuit that yields two signals: M+S and M-S that is equal to Left and Right.

Phantom Image	A created illusion of sound sources that seems to be located in between the two stereo loudspeakers.
Phase	Refers to the timing relationship of two or more signals or sound waves. Specific point in a cycle, namely a sound wave in audio, measured from a zero point and given as an angle.
Phase Coherence	The relationship and delicate timing of sounds that come from different drivers (subs, mids, tweets) mounted in different locations.
Phase Distortion	A type of audible distortion caused by time delay between various parts of the signal; can be caused by equalizers.
Polarity	The orientation of magnetic or electric fields. The polarity of the incoming audio signal determines the direction of movement of the speaker cone. Must be observed when wiring speakers, so that they are "in phase".
Polarity reversal	Also known as “out of phase”. When your speakers are mounted in reverse polarity, i.e., one speaker is wired +/+ and -/- from the amp and the other is wired +/- and -/+. Bass response will be very thin due to cancellation.
Rhomb	Diamond shaped triangle
Sound Stage	A listening term, refers to the placement of discrete sound sources in the stereo panorama in a fashion that replicates the original performance.
Stereo	From the Greek meaning solid. The purpose of stereo is *not to* give you separate right and left channels, but to provide the illusion of a three-dimensional, holographic image. The term applies to any system of recording (or transmission) using multiple microphones for capturing and multiple loudspeakers for reproduction the sound. Stereo as the term has become popularly used restricts the number of playback loudspeakers to two, but strictly speaking the term can apply to any number of loudspeakers. Although stereo was first demonstrated at the Paris Opera in 1881 (really) using carbon microphones and earphones, it would not become widespread until the work of Blumlein in the 1930s.
Sum	Sum is carried in equal parts in Left and Right. Sum is another name for Mono or Mid, the Mid microphone facing forward towards the desired sound sources in an M/S microphone configuration. See M/S.
Sweet Spot	Prime listening position for an audio system; the "best seat in the house."
Transducer	A device that converts one form of energy to another. Playback transducers are the phono cartridge, which changes mechanical vibrations into electrical energy, and l loudspeakers, which change it back, from electrical energy coming from the amp mechanical movement of the diaphragm, causing audible pressure changes in the ai