THE *DECCA TREE* — IT'S NOT JUST FOR STEREO ANY MORE

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INTRODUCTION

Ever since the early experiments on both sides of the Atlantic Ocean in the 1930s, two basic but radically different approaches to stereophonic recording have coexisted. Each has its own "camp" of followers that espouses its own attributes and often denigrates those of the other.

One of these techniques employs coincident microphones to create a stereophonic pickup based entirely on the *intensity* differences generated between the two microphones as the soundwave passes by. Its claim to excellence relies on the strong stability and clear articulation of the stereophonic image. It's primary drawback, however, is its somewhat constricted width and a tendency to sound "dry" or "sterile."

The other camp utilizes two (or sometimes three) spaced microphones to capture and reproduce both the intensity and time-of-arrival cues of a soundwave as it passes by the microphone array. Because of the spacing between the microphones, a greater sense of "spaciousness" is created than is possible with solely intensity-derived techniques. Hence, these techniques are deemed to offer a more pleasing and sensuous sound than their coincident counterparts. The drawback of this technique, however, is a lack of articulation across the stereophonic image and some ambiguity in the center imaging.

Hence a dichotomy has prevailed for the seven decades since stereophonic recording techniques were first developed: coincident microphones *vs.* spaced microphones: articulation *vs.* spaciousness. What is gained by the one is compromised by the other.

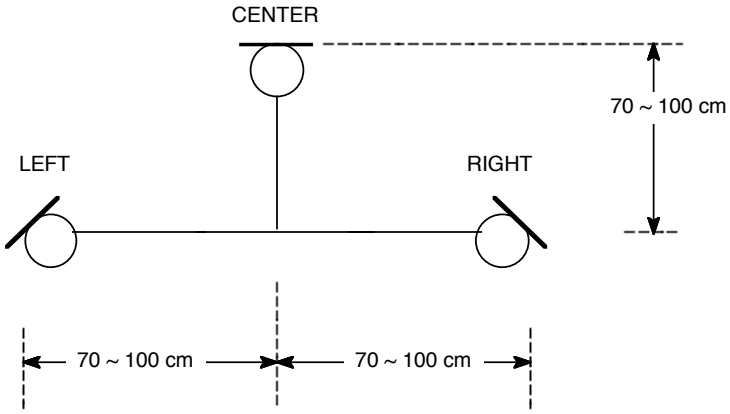
Now that the recording industry is well into the realm of multi-channel, surround-sound production — frequently combined with or accompanying a visual image — there is a strong demand from listeners (and viewers) for both of these attributes: image articulation and envelopment by the sound track. The logical solution, therefore, is to utilize and combine the best of both the coincident and spaced microphone techniques.

HISTORICAL PERSPECTIVE

In March of 1954, engineers Roy Wallace and Arthur Haddy at the Decca Studios in London were preparing for a recording session with the Mantovani Orchestra. Always experimenting in the then-new medium of stereo, Wallace assembled a T-shaped array constructed of Dexion steel and attached a Neumann M49 microphone to each of the three ends. He then suspended the entire array from a large studio boom. Wallace recalls: "It was a crude attempt to recreate the artificial head that

I spent about a year making." When Haddy first saw the array, he remarked: "It looks like a bloody Christmas Tree!" The name stuck.

In later revisions, Wallace and Haddy utilized Neumann KM56 microphones, sometimes also experimenting with a "Blumlein shuffler" for the center channel. Further refinements by Decca engineers Ken Wilkinson and Stan Goodall evolved the "Decca Tree" as we have come to know it today: three Neumann M50 omnidirectional microphones arrayed as shown in Figure-1.



THE "DECCA TREE"

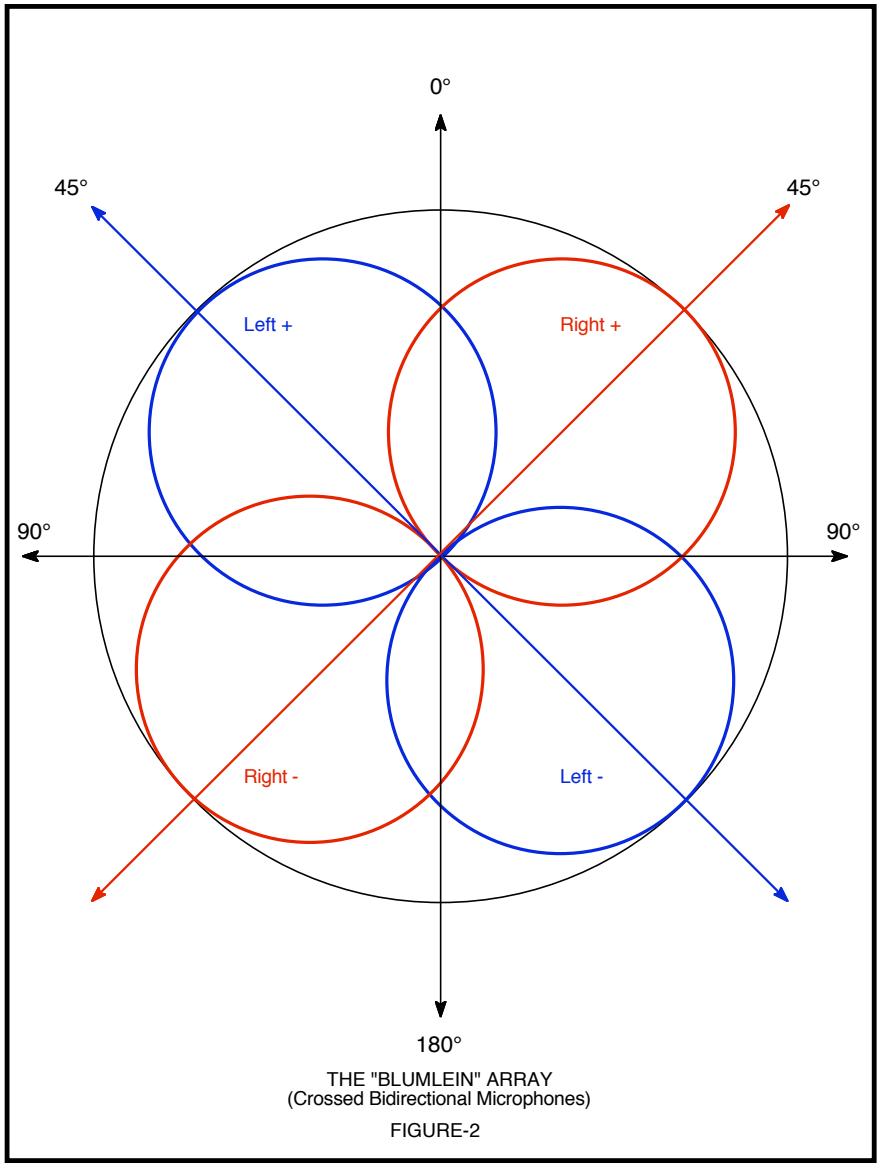
(Originally configured with Three Neumann M-50 Omnidirectional Microphones)

FIGURE-1

Because the sound arrives at the center microphone slightly before the left/right pair, the *Law of the First Wavefront* guaranteed that this central image would be strongly focused and clear. This resulted in a significant improvement over earlier spaced microphone configurations which often exhibited poor or diffused central imaging. [Reference 1]

Since its inception, the "Decca Tree" has been widely used for large-scale recordings and is a favorite among film scoring mixers because of its ability to maintain excellent imaging and separation even through the various matrix systems employed in the distribution of film soundtracks.

In the early 1930s, at the same time that early experiments in spaced-microphone left-center-right stereo were being conducted in the United States by the engineers at Bell Laboratories, British scientist Alan Blumlein, on the other side of the Atlantic, was developing the concepts of coincident microphone techniques. His pioneering work was codified in his landmark patent of 1933 (British Patent Specification No. 394,325) [Reference 1] in which he defined and described a technique to create a stable and articulate stereophonic image by using just two crossed-bidirectional microphones — a configuration which has come to bear his name: the *Blumlein* technique.

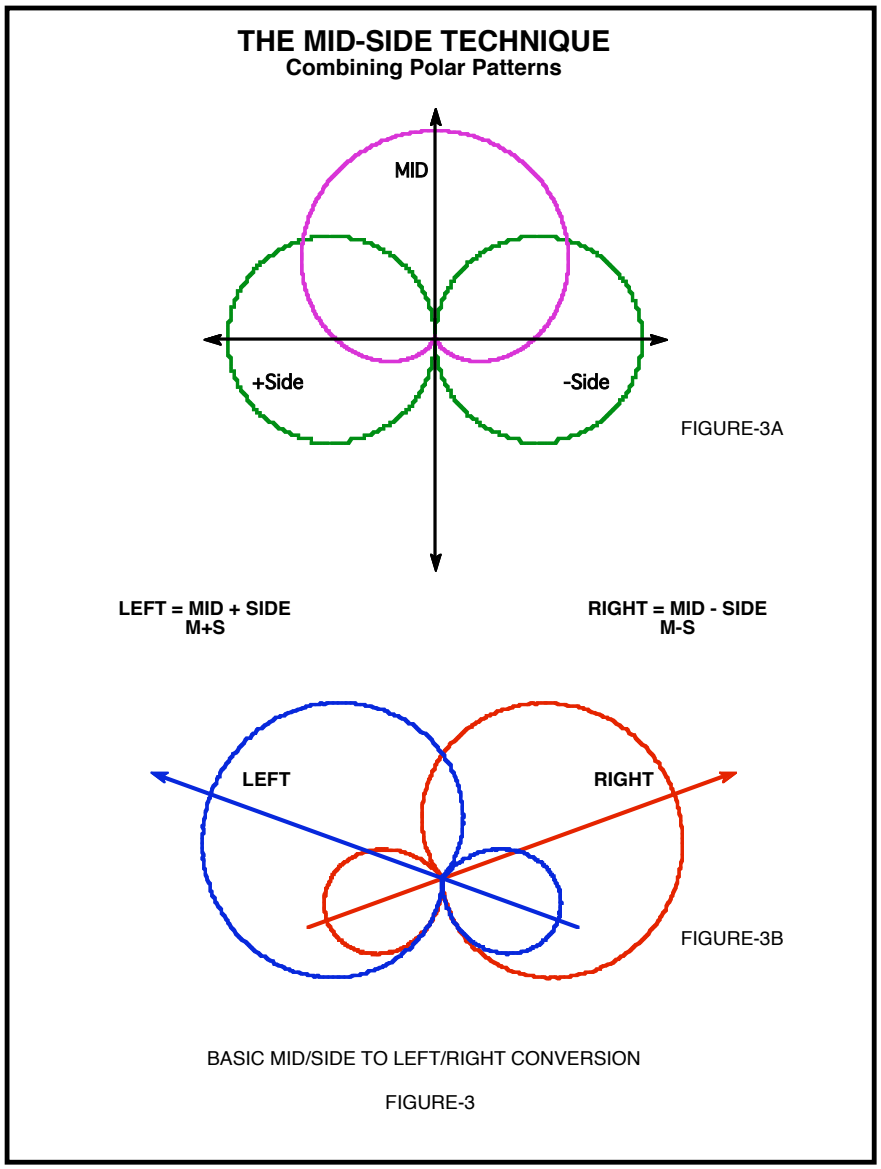


THE "BLUMLEIN" ARRAY
(Crossed Bidirectional Microphones)

FIGURE-2

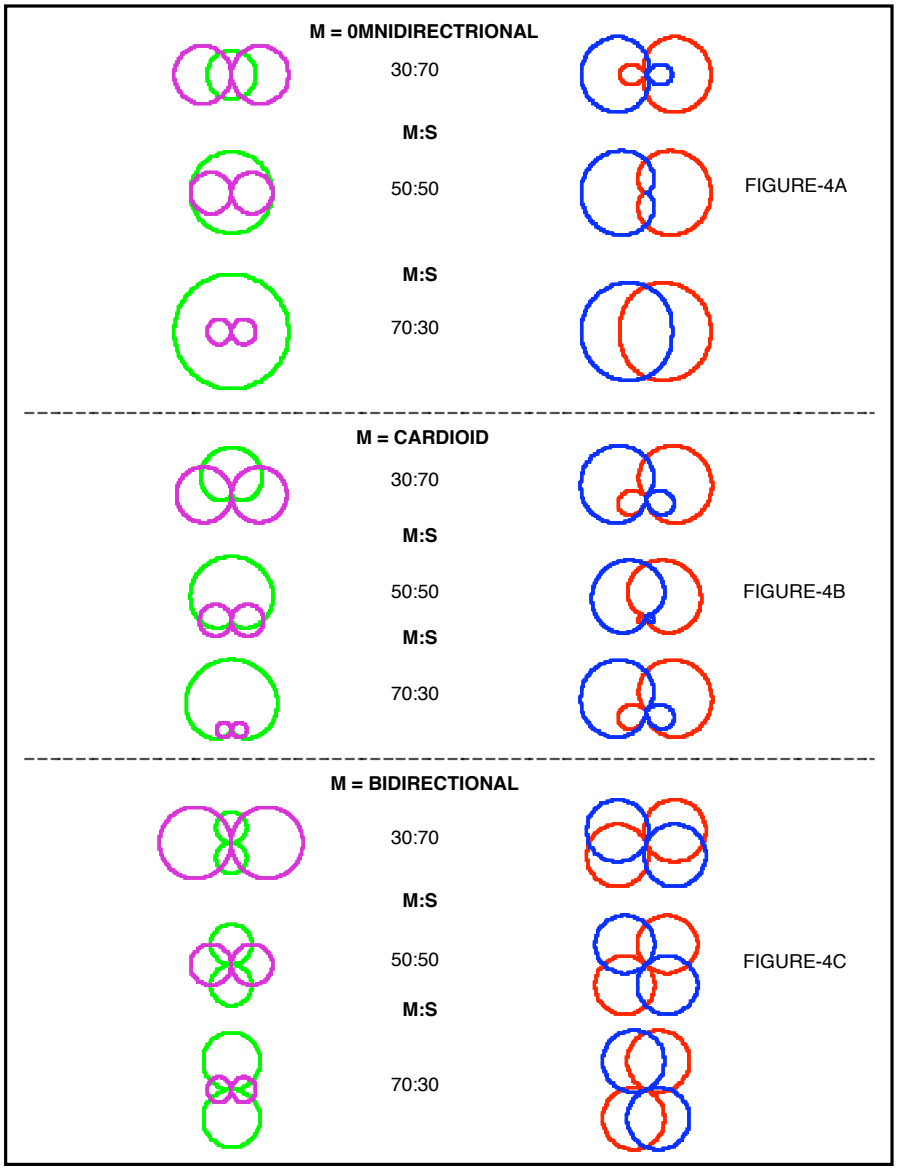
Blumlein realized that by utilizing the unique cosine pattern of the bidirectional microphone the principal pickup axis of one could be precisely co-aligned with the axis of minimal pickup (the null-axis) of another, resulting in a very stable, extremely accurate and well articulated stereophonic image — one that relies entirely on the differences in the intensity cues as the sound reaches each of the two microphones.

In the same patent of 1933, Blumlein also described a mathematical transformation of these crossed bidirectionals, which he termed the Mid/Side technique. Also employing the bidirectional microphone as the essential contributor to the stereophonic imaging, this "Side" microphone was oriented laterally, with the null-axis aimed directly at the sound source. The "Mid" microphone had its principal pickup axis aimed directly at the sound source, hence again co-aligned with the null axis of the bidirectional microphone.



Although not yet a stereophonic pickup, when the signals of these two microphones are combined via a sum-and-difference matrix system, conventional Left and Right stereophonic signals result.

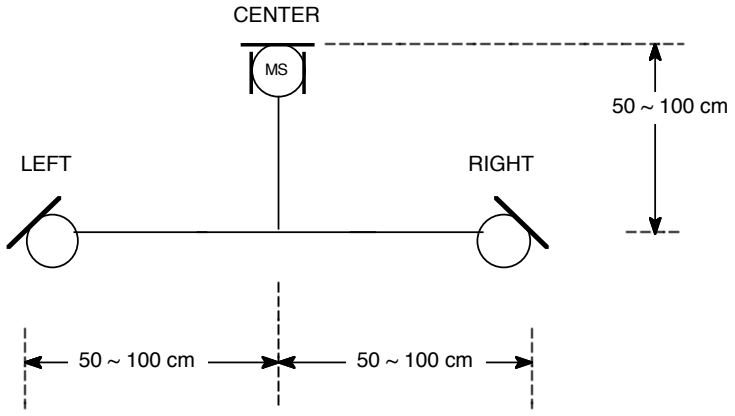
It is important to understand that although convention depicts a cardioid as the Mid microphone, in fact this may be *any* polar pattern, from omnidirectional to bidirectional. At the same time, the ratio of Mid-to-Side signals introduced into the matrix can be varied. By virtue of these two variables (Mid pattern and Mid-to-Side ratio) an infinite variety of "virtual stereo pairs" can be created using this technique. [Reference 2]



THE BEST OF BOTH WORLDS

One frequent criticism of the Blumlein and Mid/Side techniques is that their stereo imaging is too constricted or "sterile" and lacks the spaciousness provided by spaced microphones. Conversely, spaced microphone techniques are criticized for not providing the same clear, articulate image — particularly in the center of the stereophonic panorama that results from coincident configurations. An easy solution to this controversy is to combine the desirable elements of both techniques.

Long an advocate of Mid/Side recording, the author began experimenting in the late 1980s with a variation of the Decca Tree that employed a M/S microphone, rather than a single omni, for the front-center pickup. The purpose was to maintain the articulation derived from the M/S pickup but "broaden" it slightly and provide the spaciousness which could be derived only from the flanking microphones. To preserve the sonic integrity of the entire array, all microphone capsules initially were similar: the center stereo microphone was an AKG C426 and the flanks were AKG C414s — all large-diaphragm condensers using the same capsule design. Various spacings were tried, both front-to-back and side-to-side; all were based on the size of the performing ensemble. These ranged from the "mini tree" which was one-meter wide and a half-meter deep, to the "full size" tree with the standard spacing of two-meters by one-meter.



RON STREICHER's Variation
on the Conventional Decca Tree

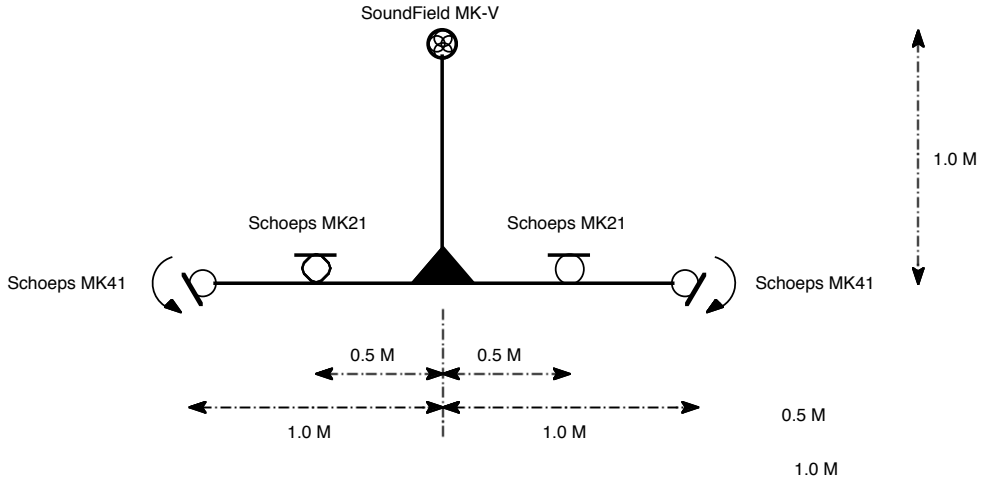
Originally configured with an AKG C426 as the Mid/Side Center Microphone
and two AKG C414 cardioids as the Left and Right Flank Microphones

The spacings were dependent on the size of the performing ensemble.

FIGURE-5

THE EVOLUTION OF THE “SURROUND-SOUND” DECCA TREE

Building on the author’s variations on the “Decca Tree” an expanded surround-sound configuration has been realized. This employs a SoundField MK-V microphone (or a Mid/Side mic) as the front/center pickup and two pairs of flanking microphones on the rear bar. One of these pairs is aimed forward, toward the sound source, and serves to “flank” the center stereo pickup in the front Left and Right channels. The second pair is aimed rearward and provides the essential signals for the surround channels.

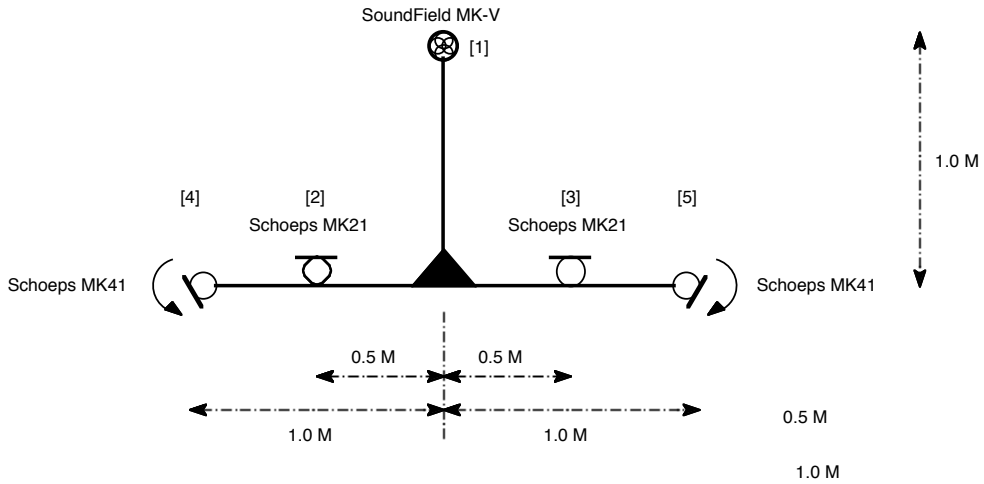


RON STREICHER's SURROUND-SOUND DECCA TREE

FIGURE-6

A major advantage of this microphone configuration lies in its ability to combine several discrete stereophonic pairs into a complex and widely variable array of front and surround pickups.

The SoundField (or Mid/Side) pickup, (marked as [1] in Figure-7) can be combined with the two front flanking mics [2&3] to provide both the articulation and variable imaging inherent from the coincident pickup with the spaciousness derived from the closely-spaced pair. If the [2&3] pair are cardioid or subcardioid microphones, for example, their focus will be strongly forward, leaving the more widely spaced pair [4&5] to generate a separate, full stereophonic pickup for the surround channels.



STEREO CONFIGURATIONS DERIVED FROM
SURROUND-SOUND DECCA TREE

1: SoundField MK-V Microphone (various XY options)
2: Near-coincident frontal stereo pair: Mics 2&3
3: Near-coincident surround stereo pair: Mics 4&5
4: Traditional Decca Tree: Mics 1,2,&3
5: "Ambient" Decca Tree: Mics 1,4,&5

FIGURE-7

An important feature of this array is that all of the microphones are relatively closely spaced so that minimal phasing anomalies or cancellations will be introduced if/when these signals are reduced to "smaller" formats, such as conventional stereo or even mono. Phase cancellations are unavoidable with *all* separated microphone techniques, and some comb-filtering inevitably will result. However, due to the relatively close spacing among all of the microphones, these anomalies will be less objectionable than with more widely spaced arrays. Therefore, for a conventional stereophonic (two-channel) recording, the surround microphones [4&5] can be mixed with the signals of the other mics to provide a precisely controlled amount of ambience and/or natural reverberation that will be reasonably phase coherent with and well within the "fusion zone" of the primary stereo signals. An ideal initial choice for these surround microphones is a good pair of hypercardioids. (The "purist" might prefer cardioid patterns, because the rear lobes of hypercardioids tend to "cross" the channels of the front stereophonic image. The author, however, finds this effect increases the sense of envelopment in a total surround perspective.)

For creation of a full 5.1 surround-sound pickup, the W-component of the SoundField microphone (or the Mid signal from the M/S pickup) can be utilized as the

Center channel. Because the W-component is a pressure-response signal, it also can be low-pass filtered to provide a signal for the LFE channel if desired.

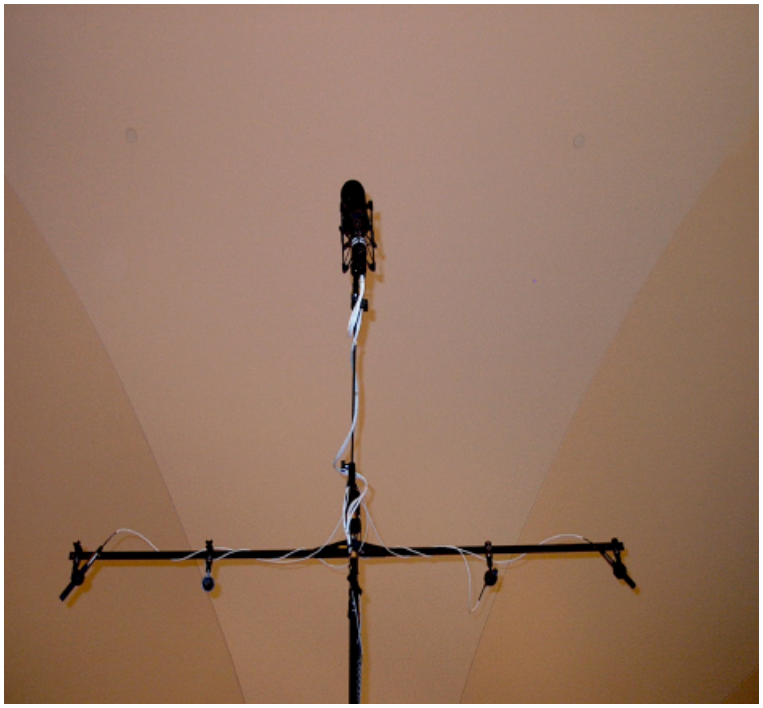
When a SoundField MK-V microphone system is employed as the front/center pickup, additional options for surround sound recording become available because this unique microphone is inherently a surround-sound pickup in its own right. When processed through the SoundField SP451 Surround Sound Processor, the system provides a full 5.1 surround array with complete variability of the balance and sonic character. Now, by combining these coherent surround signals with the [2&3] and [4&5] microphone pairs, it becomes possible to create an even broader spectrum of stereophonic and/or surround-sound images and at the same time satisfy the desire for both articulation and accuracy of the sonic image as well as breadth and spacious envelopment of the listener. This is, indeed, the best of both worlds.

CREATING THE SURROUND TREE ARRAY

It is possible, of course, to configure this Surround Sound Decca Tree array by placing (or suspending) separate microphones in the appropriate relationships to one another. This can, however, be cumbersome and time-consuming at the least. The most convenient method, therefore, is to mount all of the microphones onto a common fixture and then support the array from above or below as appropriate.

SURROUND-SOUND DECCA TREE

FIGURE-8



SURROUND-SOUND DECCA TREE
(Utilizing the Decca Tree fixture from
Audio Engineering Associates, Pasadena, CA)

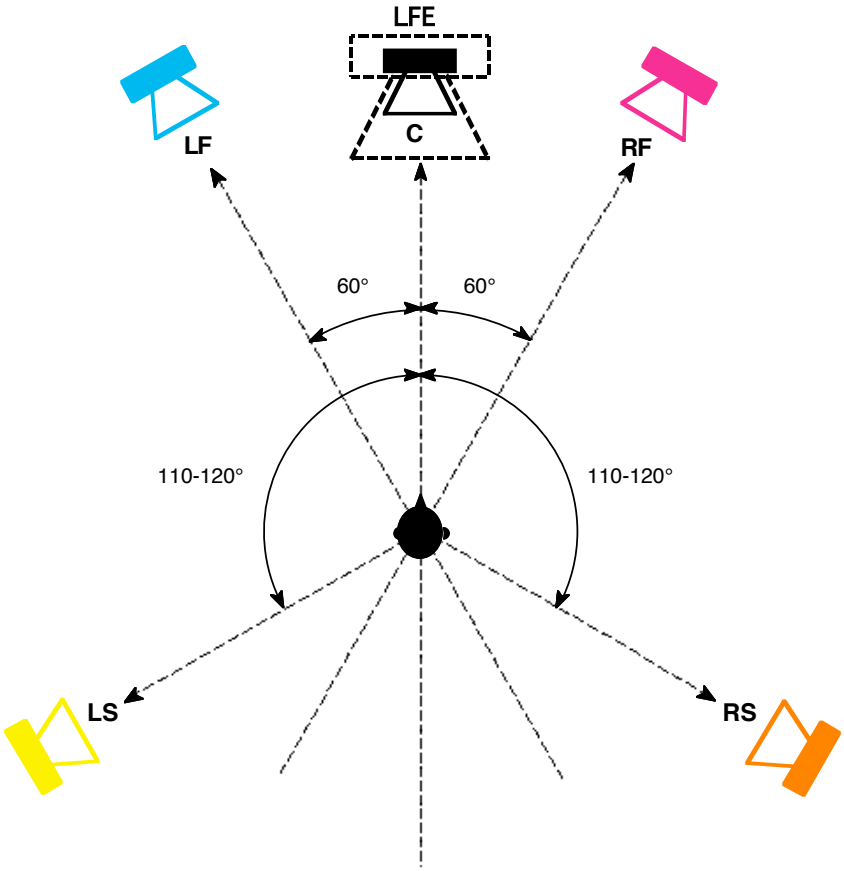
FIGURE-9

In this configuration, a SoundField MK-V serves as the front/center microphone pickup; two Schoeps MK-21 subcardioid microphones are the [2&3] pair; and a pair of Schoeps MK-41 hypercardioid microphones are the [4&5]. Of course, any microphones can be used as desired. After all, creativity is the essence of the recording experience.

5.1 and BEYOND

The basic loudspeaker arrangement for 5.1 surround systems has been defined as a front pair (**L**eft **F**ront and **R**ight **F**ront), a **C**enter, and a surround pair (**L**eft **S**urround and **R**ight **S**urround); the "point-one" speaker is a subwoofer, referred to as

the "**L**ow **F**requency **E**xtension (or effects) channel. The general placement and orientation of these six loudspeakers is shown in Figure 10.

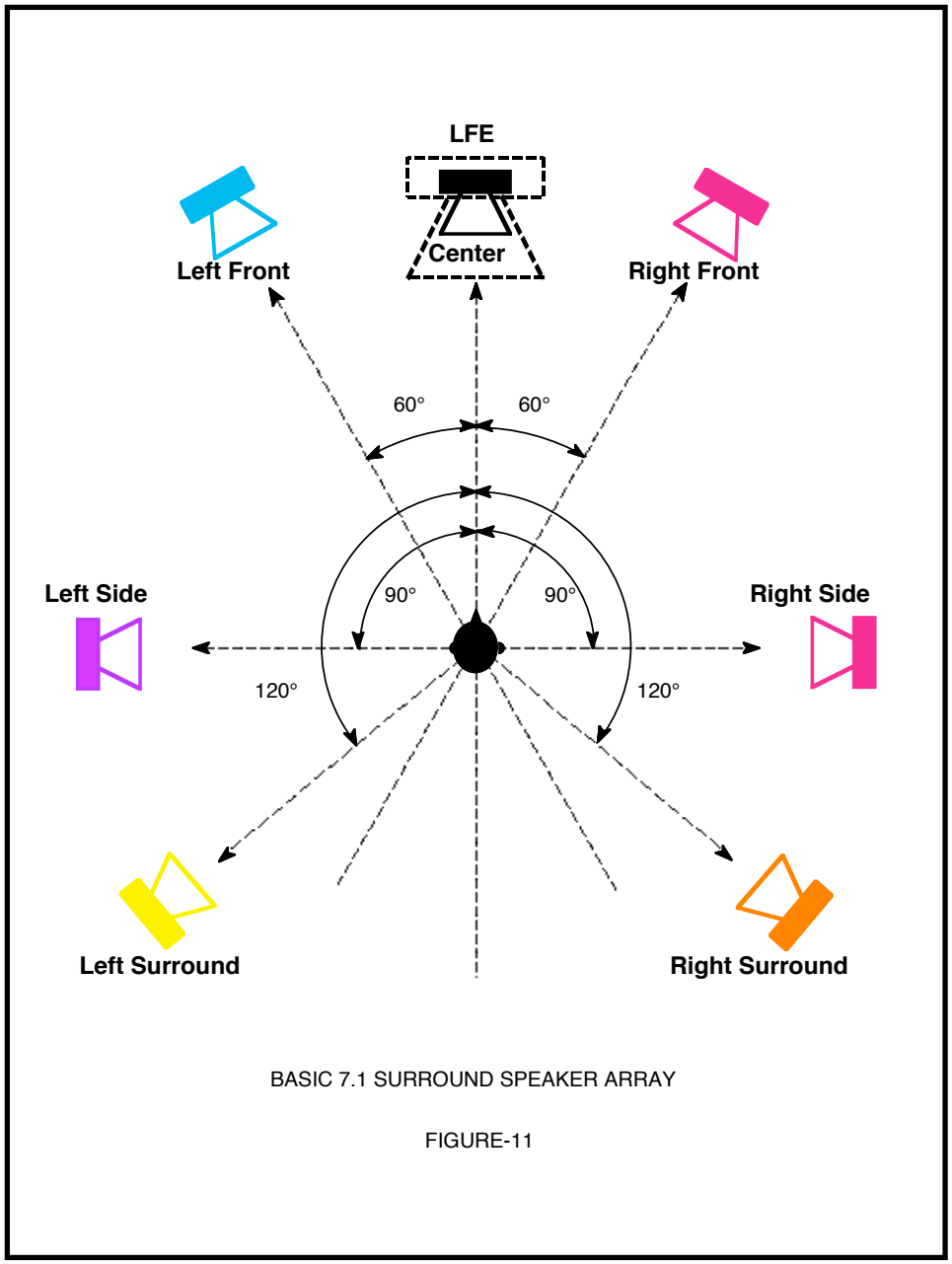


BASIC 5.1 SURROUND LOUDSPEAKER ARRAY

FIGURE-10

Many advocates of surround sound systems urge even more channels and loudspeakers. In fact, Tomlinson Holman (the TH of THX, and one of the most innovative practitioners of surround sound recording and reproduction) has written extensively on the need for a 10.2 (or greater) system in order to present the all of the spatial information necessary for the listener to feel fully enveloped. [Reference 4]

When the Surround Sound Decca Tree employs the SoundField microphone as its front/center pickup, the array can provide sufficient discrete directional information to generate a 7.1 surround system, because either the SoundField or the rear-facing [4&5] microphones may be utilized to derive the Side or Surround signals, or *vice versa.*



BASIC 7.1 SURROUND SPEAKER ARRAY

FIGURE-11

If the Surround Sound Decca Tree is combined with a second pair of ambience (or additional surround) mics, the surround depth and/or the number of channels can be expanded geometrically. Technology, like creativity, knows no bounds.

SUFFIX: A FEW PRAGMATIC ISSUES

The support fixture shown in the photographs (Figures 8 , 9, 12, 13, and 14) is the conventional "Decca Tree Bracket" from Audio Engineering Associates in Pasadena, CA, fitted with two extra "sliders" to hold the additional microphones for the [4&5] pair. [Reference 5]

DECCA TREE BRACKET ASSEMBLY
Audio Engineering Associates, Pasadena, CA

FIGURE-12

It is important to notice that all of the microphones shown in Figures 8, 9, and 14 are mounted in individual shockmounts and that the entire array is further shock-isolated from the microphone stand. This is essential to minimize the significant mechanical noise that otherwise would be picked-up by this large and heavy array.

The shockmount that is supporting the entire array is the “Floater” from Ambient Systems in Munich, Germany. It is available in three degrees of “strength,” this one being the “heavy duty” version.) [Reference 6]

DECCA TREE BRACKET ASSEMBLY
Showing "FLOATER" Shockmount
Ambient Systems, Munich, Germany
(Available from Audio Engineering Associates, Pasadena, CA)

FIGURE-13

Also shown in Figure-14 is a custom microphone “snake” made from a nine-channel Mogami cable: five of the channels are used for the SoundField microphone and one channel for each of the other individual mics. In this way, only a single cable is required to carry the signals from the Surround Sound Decca Tree back to the recording system. This not only makes cabling the system easier and neater, it saves time during setup and strike. This snake also can be used to suspend the entire array from above if necessary.

RON STREICHER's
SURROUND-SOUND DECCA TREE

FIGURE-14

CONCLUSION

Combining the various elements of the Surround Sound Decca Tree is, as with all recording situations, a matter of personal and/or professional taste. If a more articulated image is desired, the coherent or coincident components should dominate the mix. To achieve a more "spacious" sound, the L/R2 and L/R3 pairs may be increased. Additional microphones also may be added into the mix to highlight individual sections or soloists, and/or to augment the surround experience. Technology, like creativity, knows no bounds.

REFERENCES:

1. The New Stereo Soundbook Second Edition by Ron Streicher and F. Alton Everest, published by Audio Engineering Associates, Pasadena CA 1998
   - Blumlein Stereo Technique, pp. 7.2—7.8
   - British Patent Specification No. 394,325 by Alan D. Blumlein, 1933; a complete copy of this landmark patent in reproduced in the Appendix
   - The Decca Tree and "Mini Decca Tree," pp. 9.12—9.13
   - The SoundField Microphone, pp. 13.11—13.17

2. "M-S Stereo: A Powerful Technique for Working in Stereo" published in the *Journal* of the Audio Engineering Society, Vol. 30, No. 10, pp. 707—718, 1982 October

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5. Audio Engineering Associates, Pasadena, CA; website address: http://www.wesdooley.com

6. Ambient Systems, Munich, Germany: website address: http://www.ambient.de

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