



THE NATURE OF SOUND SOURCES

Over the years we have come to accept that there are two different types of sound sources – live and reproduced. We continue to be dissatisfied with this state of affairs. We want the reproduced sound to match the live performance. The capture, storage, transmission and reproduction of musical sounds have been the subject of extensive and ongoing investigation.

We now identify a key restriction on the realistic reproduction of live sound sources.

THE SWEET SPOT

A key recurring issue in modern sound reproduction is that of the sweet spot. Modern formats have evolved to concentrate on presenting a quality result “as the director intended” at one location and so are largely based on preserving the *direction* of sound sources. The loudspeakers are placed in a circle targeting in the centre – the so-called “sweet spot”. Move away from this location and there are no guarantees of reproduction fidelity. Any attempt to increase the effective size of this sweet spot will adversely affect the accuracy of the reproduction. Toole [1] summarises the dilemma of the present state of the art surround systems in this regard:

“by simplifying the process (of reproduction), corrupting it some would say, it is possible to create systems that generate a gratifying sense of envelopment and space, but that cannot deliver the perceptions of images precisely located where they should be”.

“As the sweet spot is enlarged, the localizations become less well defined but a pleasant spaciousness can be preserved”.

So the choice is between:

1. Being forced to sit rigidly in one location in order to be surrounded by precise sound objects.
2. Adding artificial envelopment effects that broaden the sweet spot so that you can move, but reduce the clarity of the images in the process.

No other practical alternative is available with the present surround formats. A number of tools have been developed that assist in adjusting and optimising this compromise because most listeners just do not respect the sweet spot in their listening habits.

Live sound sources do not behave like this. Each sound source is placed in space and remains so, even when the listener moves and turns. A listener can move amongst the complex acoustic field of a number of sources and can approach and even circumnavigate any source with expected, consistent and repeatable results. Any number of listeners can simultaneously experience their own perspective of the sound field in this way.

Sweet spot based sound reproduction cannot achieve this. What can be done?

Towards live sound

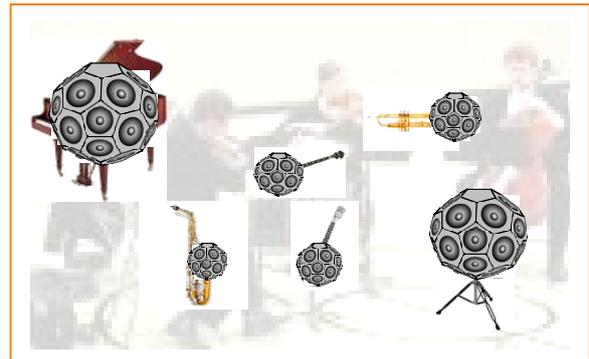
For live sound, each live sound source originates at a defined point or region in space. The perceived location remains (or should remain) independent of any listener location or movement.

It therefore follows that if each sound source could be recreated at a particular location in space, then the perceived sources would behave correctly for any listening location and orientation. The listener could move and turn freely and could even walk completely around the sound sources, and experience the correct behaviour of a live sound field with multiple sources.



The key part missing from today's sound reproduction formats is *the reproduction of each source at its correct location in space*. Correct location of all reproduced sound sources in space would enable the accurate and consistent reproduction of sound with free listener movement and no sweet spot restrictions.

A simplistic approach to reproduction could provide a separate loudspeaker at each desired source location. These loudspeakers would need to be fed separate signals captured individually from each sound source. A further refinement of this approach would be to mimic the directivity of each source in the polar response of the loudspeakers used.



This would be a hopelessly impractical approach, particularly when, for example, the reproduction of a complex source such as a symphony orchestra was required, but it serves to clarify three aspects of accurate reproduction:

1. It is possible to eliminate the sweet spot restriction. Greatly expanded sweet spots would be possible if sound sources could be created as required at points in space. The listening experience would then be correct throughout the reproduction room. Off sweet spot image-smearing effects such as immersive treatments would not be necessary. The sweet spot could be effectively eliminated.
2. The sound objects created this way would all behave correctly with listener head turning and movement - a significant improvement over present approaches in fidelity of reproduction.
3. Shared listening experiences would be possible. Behaviours such as shadowing would also be reproduced as per the "normal" reality we are all used to. ("sit down in front, please").

Next we discuss techniques that can place reproduced sound sources in space without needing a separate and special loudspeaker for every source and location.



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1 An expos é on the state of the art and its limitations has been presented by Floyd Toole, Vice President Engineering Harman International Industries Inc. "Direction and Space – the final frontiers" October 2004. (Harman website).