Luis Zanforlin
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Berklee College of Music

Historical & Artistic Uses of Spatialization in Music

This paper discusses local-spatialization as a property of sound and music. Sound spatialization is the act of changing the perceived location of the sound's relative position between the source and the listener (imaging) as well as the interaction between the sound source, its environment, and listener (reverberation). This paper will focus on historical and cultural manipulation of imaging (relative position between sound source and listener) as a property of sound spatialization.

History

Music has arguably been spatialized since its invention, taking the stance that music requires a player (emitter) and a listener (receiver) their different positions provoke music spatialization. It is also possible to imagine that players probably moved to specific locations in order to "optimize" the listening experience therefore consciously spatializing music. According to an article by the Acoustical Society of America, it is hypothesized "causal connection between the "points of resonance" in three French caves and the position of Paleolithic cave paintings" (Acoustical Society of America 2017) suggesting sound spatialization has been used as a musical device for millennia. However, it is easier to imagine the placement of musicians relative to listeners has mostly been done in favor of the listener's ability to see the musical performance rather than to affect the listening experience through sound imaging manipulation.

In orchestral music, seating placement dictates sound imaging and for most classical compositions it is up to the conductor's best judgment to decide where each player is supposed to seat. One notable conductor famous for experimenting with non-conventional seating was

Leopold Stokowski. Through photographic reviews, it is possible to track Stokowski's seating experiments from the early 1920s to late 1950s. In one historical performance, maestro Stokowski decided to place the woodwind instruments in front of the strings a choice that reportedly annoyed many listeners who mailed complaints to the orchestra. In an interview with Klaus George Roy Stokowski hypothesizes the public's annoyance with his seating experiments were due to the fact string players move their bodies more actively then woodwind and brass players there for placing strings at the front of the stage renders a more visually pleasing experience (Ro: 1971).

Four years after the invention of the wax cylinder recording device (1887) the Paris Opera presents the first demonstration of stereophonic sound reproduction using two telephones as reproduction devices which listeners could connect two and hear the music with dichotic reproduction. An 1881 Scientific American article detailing the inner-workings of the stereo reproduction method entails the listeners' reactions as being able to "follow the singer's movements and relative positions"(Scientific America 1881: 422) with a sense of "auditive perspective" (Scientific America 1881: 423).

With a positively received example of stereophonic reproduction, it was just a matter of time until stereo sound would enter the world of music recording. In 1931 Bell Laboratories collaborated with nonother then Leopold Stokowski in order to create the multi-channel recording system and later further releasing Disney's Fantasia (once more conducted by Leopold Stokowski) which was the first film to use stereo sound (Théberge 2015: 4). Though stereophonic sound wouldn't become commercially available until the 60s and 70s, the language surrounding stereo sound as a high fidelity reproduction technique was already used

as in this account by French inventor Clément Ader: “stereo audio would also become conflated with discourses appending to a kind of audio realism” (Théberge 2015: 7). Since the invention of stereo technology, other configurations of multi-channel audio reproduction became popular, specifically by the movie industry which standardized formats such as 5.1 and 7.1 surround sound.

Another imaging method developed by the National Research Development Corporation in 1975 was called ambisonic spatialization. Ambisonic technology involves generating audio recordings representing the spherical sound field from the perspective of the listener which can later be decoded into corresponding speakers positioned in a room (Gerzon 1975: 2). A different way to make sense of ambisonics is to characterize stereo and surround sound as generating and placing sounds where their sources would be relative to the listener, ambisonics consists of generating sounds that the listener should hear and extrapolating (decoding) their position by measuring the differences between each field (Left, Right, Up, Down) in order to generate the sounds that need to come out of positioned speakers.

The advantage of ambisonics is that it is possible to reproduce the project in any speaker configuration with the same four or eight (depending on the ambisonic order) audio tracks, taking full advantage of their spatial position. The disadvantage of ambisonic technology compared to stereo is the need for intensive real-time processing units that were not available until the early 90s resulting in the disappearance of ambisonics as a spatialization method until its recent resurgence in 2000s

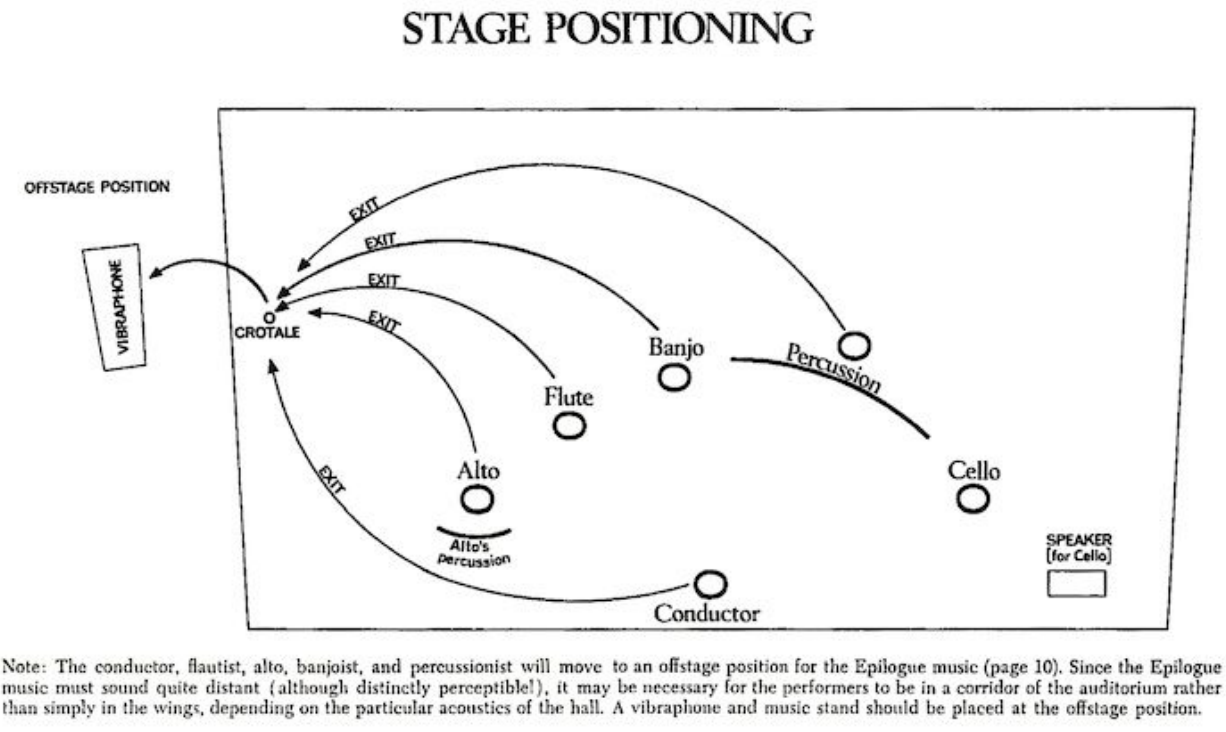
With the commercial success of the stereophonic tape in the 70s together with the decrease in cost of multichannel recording devices artists started to artistically explore sound imaging in order to create effects that better express their artistic intents. In the late 60s, American classical composer George Crumb experimented with sound imaging by having performers walk around the stage according to drawings printed in the score. Another notable example is Bill Evans' record "Conversations With Myself." On this record Bill Evans play a piano performance solely on the left speaker while improvising with himself playing a different performance on the right speaker. The use of stereo as a compositional device has since become a more prominent element in recorded music though often less obvious compared to both previous examples. According to a study by the University of York, 21% of modern record producers alleged to use spatialization in a "functional or dramatic role" in their music this number has decreased compared to an earlier study (with the same methodology ran by the same university) that showed in 1997 24% of musicians used spatialization in that capacity (Otondo 2006: 78). One possible explanation for the decrease in dramatic uses of imaging is the novelty effect of using new technology, with time it becomes less interesting and producers take for granted the ability to spatialize sounds.

Spatial Music Notation

In notated music (music performed in accordance with a written set of instructions) spatialization has often been left to the conductor or sound engineer's discretion, however, some composers wished to indicate their sound imaging intentions leading to multiple forms of spatial notation. Some of the earliest kinds of spatial notation from the 16th century came in the form of instructions such as in pieces by Giovanni Pierluigi da Palestrina, Thomas Tallis and

Alessandro Striggio who often included comments such as *“in mezzo del mezzo-circolo”* (in the middle of a semi-circle) written in the middle or the beginning of the score in order to dictate the spatial orientation of singers and instrumentalists (Striggio IMSLP 1537).

In the 19th century, as the size of orchestras grew, the conductor emerged as a crucial figure in determining the modern orchestra seating giving birth to a new spatialization method, the orchestra seating chart. The seating chart is a visual diagram that represents a top-down (bird’s eye view) of the stage indicating the location of each instrumentalist. As composers such as George Crumb and Charles Ives became more concerned with spatialization in the early 20th century they included their personal seating chart at the beginning of the score, these often indicated movements to be performed by instrumentalists at specific measures.



Note: The conductor, flautist, alto, banjoist, and percussionist will move to an offstage position for the Epilogue music (page 10). Since the Epilogue music must sound quite distant (although distinctly perceptible!), it may be necessary for the performers to be in a corridor of the auditorium rather than simply in the wings, depending on the particular acoustics of the hall. A vibraphone and music stand should be placed at the offstage position.

With the introduction of stereo recording technologies music spatialization has been more commonly dictated by producers and music engineer rather than composers, diminishing its use in notated music though there are examples of post-spectral music notation that indicate imaging through azimuth and elevation coordinates drawn with lines under an instrument's staff (Zanforlin 2018: 2).

Present and Future of Sound Spatialization

Today the majority of distributed music is mixed in the stereophonic format with a balanced stereo image that aims to maintain a constant similar loudness level in each side of the stereo field. Thanks to the prevalence of stereo in the music industry a majority of modern synthesizers and effects processing units deliver stereo audio output further reinforcing the stereo dominance. In popular electronic music, effects such as ping-pong delays (an effect that repeats a signal in the left and right channels consecutively) stereo reverb deliver a satisfyingly wide stereo image tailored to stereo-sterile headphone and earbud environments.

With the increasing accessibility of virtual environments technology, spatial audio has become a crucial feature in 360 videos, virtual reality experiences, and video games. This technology allows composers to precisely locate each of the composition's sound sources. Digitally placing sound sources using ambisonics enables composers to move sounds in ways that are impossible to achieve in acoustic settings. For example, it is difficult to physically move heavy instruments around a microphone at great speeds. Yet with ambisonic technology, it is easy to manipulate where instruments are located and how they move in virtual space. The new ability to widely distribute music with precise spatial imaging allows contemporary composers and producers to create music using realistic spatialization as a compositional device.

Conclusion

Stereo imaging has always been an intrinsic property of music. Before humans were able to record audio, experimentations in instrument placement were already a common practice in music-making. The historical use of spatial music notation showcases composers' conscious and intentional use of space as a compositional device and as an important property of music. With the advent of recording technology, multichannel recording enabled sound imaging experimentations unimaginable in the acoustic world and furthered the language of space in music. As new technologies for music reproduction such as ambisonics are introduced to the consumer world new imaging, experimentations are bound to change the world of music and make available a new language f spatial music expression.

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