Spatial System Design As A Spatio-Compositional Strategy

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ABSTRACT

Spatio-compositional strategies are employed frequently in the context of electroacoustic music in conjunction with spatial loudspeaker systems when creating new works. There is much literature detailing a range of these strategies describing spatio-compositional approaches composers may use when developing a new piece. This paper addresses a gap in the literature, explaining why spatial system design/construction should also be considered as a spatio-compositional strategy. This research encourages spatial system design to be a key consideration when concerned with the spatial features of a work, while also encouraging a move from regular use of standardized loudspeaker systems.

1. INTRODUCTION

Spatial systems, within electroacoustic music, are considered to be a grouping of (or single) loudspeakers in an array with varying positions and directions. There are many standardized systems, such as quadraphonic, octophonic, stereo and more. There are also less standardized approaches, where the systems may vary, but the technology used for sound creation is consistent, such as Wave Field Synthesis or ambisonics. Beyond these types of systems, there are novel loudspeaker systems. These are systems which have been constructed by a composer, and rarely have applications outside of that composers' creative practice. These systems may rely on specific hardware/software constructions but can also be made with existing materials. Bridget Johnson's *speaker.motion* [1] (a group of rotating and tilting loudspeakers) and Susan Philipsz' *War Damaged Musical Instruments* [2] (a system of megaphone-like speakers that play back numerous recordings of broken wind and brass instruments) are examples of novel spatial systems, where numerous pieces of music have been written specifically for those systems.

When creating music for these systems, spatio-compositional strategies are employed to manipulate the listener's perception of space through the relevant system.

This paper suggests that there is scope to consider the construction of a spatial system as a spatio-compositional strategy and that this is therefore an important consideration when creating a spatial sound work.

Spatial system design refers to the construction of a new loudspeaker configuration. This may range from—but is not limited to—choosing novel positionings and directions for a series of loudspeakers, to constructing custom structures to house or move a collection of loudspeakers.

The following section will review the spatio-compositional strategies that currently exist in the literature and will therefore provide clarity around how spatio-compositional strategies are presently applied. Following that, I will examine works by selected artists that demonstrate how the creation of a novel spatial system functioned as a spatio-compositional strategy within the work. A selection of works by the first author will then be used to exemplify how the creation of a novel spatial system may function as a spatio-compositional strategy. It will conclude with an argument as to why a critical and reflective understanding of novel spatial systems as a spatio-compositional strategy is valuable to the discourse.

2. SPATIO-COMPOSITIONAL STRATEGY REVIEW

In discussing the conceptual gap between spatio-compositional strategies and sound spatialization technologies, Marije Baalman describes spatial composition techniques as strategies that "embody the artistic approach to the use of space, [that] are strongly related to or part of the artistic concept of the work" [3].

In defining spatio-compositional strategies, we are able to complete a review of the existing strategies mentioned in the literature. This section provides a brief summation of existing techniques.

2.1. Spatial Illusion

Spatial illusion is described by Natasha Barrett as where "the perceived space appears real, but we are listening to an illusion in stereo or multi-channel space produced through the phantom images from two or more loudspeakers" [4]. Barrett claims that there are three main considerations when working with a spatial illusion.

"(1) The nature of an enclosure can be indicated through an object sounding within the enclosure.

(2) The size of a space can be indicated through the relation between sounding objects.
(3) The size of a space can be indicated through the motion of sounding objects" [4].

Barrett continues, claiming that the perceived space seems real through the maintaining of real 'spatial laws'. These 'laws' include *the effect of sound transmission, the properties of the reverberant field, object image size and multiple object relationships,* and *Doppler shifts and gestural-spatial definition* [4]. Spatial illusions depend on at least one of these four aspects.

Use of spatial illusory methods allows the composer to create perceptibly immersive sonic environments.

2.2. Spatial Allusion

"When space is implied without a direct illusion, or without a direct connection to the interrelated acoustic laws of objects sounding in spaces, we can begin to discuss the spatial allusion" [4]. These situations require the composer to make assumptions as to the aural interpretation, and listeners have a much more active role in regards to their spatial perception. "Because the spatial allusion is open to interpretation more than the spatial illusion (due to its images being less precise), it is maybe here that the 'music' begins to emerge" [4]. When considering a spatial allusion, we must consider the immediate source-bond and also non real-world sounding implications [4].

Use of spatial allusory methods allows composers to direct listeners into perceiving a particular space, even if the sonic material or spatial system construction does not allow for the creation of a spatial illusion.

2.3. Spatial Movement

Sound and sound objects may be moved around (a) space. This movement may cause spatial allusion to occur and will cause spatial illusion to occur, as for a sound to perceptibly move from one point to another, the listener will perceive an imagined size of the space. This is through phantom imaging which makes use of complex panning algorithms. Where spatial movement goes beyond methods of spatial allusion and illusion is through methods of diffusion and localization serialization (where sounds are moved discretely from loudspeaker to loudspeaker in a serialized motion).

Diffusion systems, such as BEAST [5], Gmebaphone [6], and the Sonic Laboratory [7] allow composers to position sound around a space. Methods of spatialization for diffusion systems can vary from creating an immersive sonic space, where sound surrounds you, to focussing sound to very specific singular points, or even just one speaker. While there may be moments that exhibit spatial illusion and allusion, there is much that happens spatially outside of that, where listeners may not perceive to be within a particular space, or they may perceive that a particular sound is emanating from outside of that space and the illusion/allusion is broken. Movement can also occur spatially without constructing a spatial allusion/illusion through methods of location

serialization [3]. Used by Stockhausen, Baalman suggests of how location as a serial parameter will "introduce a choreography of sounds" [3]. The serialization of a sound's temporality and location will remove any existing spatial illusion.

The ability to move sound around a space allows the composer to manipulate the perceived size of the space as well as the level of spatial activity within that space.

2.4. Timbre Spatialization

Robert Normandeau's idea of timbre spatialization is a spatialization method exclusive to the acousmatic medium. In describing the performance of instrumental works, Normandeau says that "the sound and the projection source are linked together", but with the acousmatic medium and its virtuality "the sound and the projection source are not linked" [8]. With the ability of loudspeakers to play any type of timbre, one can fragment sound spectra amongst a group of loudspeakers. When an acoustic instrument is played, "the entire spectrum of the instrument sounds, whereas with multichannel electroacoustic music, timbre can be redistributed over all virtual points available in the defined space" [8].

These methods allow composers to spatialize a single source, by breaking it into frequency bins, allowing for alternative spatial perceptions of sound objects.

2.5. Temporal Nature of Space

Barrett points to how our memory plays a key role in our understanding of space within a work and our treatment of it. A "listener's spatial perceptions can be linked to an experience of the world outside the context of the music" [4]. A listener's experience of space within a work may also exist upon a spatial memory that is formed within the context of the piece. "The spatial information presented over time can be unique to the context of that particular work, and therefore requires listeners to train their memory through the act of listening" [4]. Wishart also illustrates how various spatial gestures can be combined to create a spatial form across a work [9].

Variations in sound spatialization throughout a work allows the composer to create an effective spatial form.

2.6. Localization Characteristics of Varying Types of Sonic Material

Due to listener's perception of different sounds, varying amplitude envelopes, onsets, timbres, and/or frequency may be used to either reinforce, confirm, confuse, or make ambiguous the listener's perception of their space.

"Rakerd and Hartmann note that "impulsive tones were localized quite accurately… while the slow-onset tones were localized poorly as to reach the upper limit of our ability to measure the localization error" [10]. They claim that "a steady-state sound field of a sine tone does not provide useful localization in a room… [unless] it has an onset transient" [10]. This extends some of Hartmann's previous research where, through testing, concluded that "it is impossible to localize a steady low

frequency sine tone in a room… [and] the localization of steady noise can be significantly degraded by increasing reverberation" [11]. [12]"

Barrett also says, backed up by Blauert [13], that as "our aural perception can locate higher frequencies and texturally varying material more easily than lower frequencies and static material, the intrinsic nature of sound will play an important part in the composer's choice of material" [4].

The manipulation of these types of material and their relationship with one another throughout a work allow the composer to further manipulate the listener's perception of space.

This collection of strategies allows composers ways of embodying an artistic approach to the use of space, similar to the way composers have done so with spatial system design.

3. EXAMPLES OF ARTISTS' WORK

The following examples are of works for which a spatial system was devised in tandem with composed sound. The audio was not created for an existing system, rather, the system and the composition were created together in a reciprocal relationship within a discursive compositional and design process.

3.1. Bridget Johnson – *spatial.reflections*

Johnson's *spatial.reflections* (2018) [14] comprises parametric loudspeakers that project sound towards rotating panes of glass. When the glass rotates, the spatial understanding of the audio changes depending on the listeners' location. This work was installed as a part of the Aotearoa Audio Arts festival in 2018, and has not been installed since, with the audio and the system is strictly interdependent. Consequently, the artist, as of yet, has chosen to not create more material for the spatial system designed.

3.2. Janet Cardiff - Forty Part Motet

Janet Cardiff's *Forty Part Motet* (2001) [15] is a reworking of Thomas Tallis' *Spem in Alium* (1573) for forty separately recorded voices. These voices are then played back through a forty-speaker array placed strategically around a space. The speaker configuration is unique to this particular work and Cardiff, like Johnson, has neglected to create further works for the system, nor invited others to create works. It has however, been installed in multiple locations, sometimes, with the positioning of the loudspeakers in relation to one another sometimes varying between installations.

3.3. *The Clearing*

The Clearing (2019) is a dance work by Footnote New Zealand Dance, choreographed by Ross McCormack with sound design by Jason Wright. Wright and McCormack construct a physical space within the work in which dancers interact with four loudspeakers. The speakers are rotated, placed facing the ground, and moved by the dancers during the performance. One of the loudspeakers is a part of a helmet worn by a dancer. This spatial system allows the speakers to be moved in a way that creates novel spatial results integral to the narrative of the dance work. Cable length limitations present a physical limitation to the boundaries in which it operates. As with Johnson and Cardiff's work, the system is inseparable from the musical material created for it. This interdependence is further enhanced by the inclusion of dance within this dynamic.

These three works provide examples whereby bespoke systems have been designed to achieve an intentional and artistically-driven spatial result. Much like the spatio-compositional strategies described in the second section, specific decisions were made as to the construction of these systems to achieve specific spatial aesthetics.

4. EXAMPLES OF FIRST AUTHORS' WORKS

The following works are spatial systems created by the first author in order to execute particular spatial ideas. In regards to these works, their construction is considered a spatio-compositional method for the first (and sometimes only) work composed for the system. Successive works were created *for* the systems (rather than alongside), no longer treating those systems, or the construction of those systems, as a spatio-compositional strategy.

4.1. *5 Moving Speakers*

5 Moving Speakers (2018) [16] is a work with five speakers that travel parallel with one another, perpendicular to the listener. The speakers move at different rates, transitioning from being in and out of phase. In creating the system, the first author intended to use the system as a way to explore causality within mechanical moving speaker arrays, using the motor sound as a sound source that also emanates from the speakers. Since being devised, no further works have been created with/for the system.

4.2. *beyond nearishgtedness* for The Extended Stereo Speaker Configuration

The Extended Stereo Speaker Configuration [12] was devised in conjunction with the work *beyond nearsightedness* (2018) [17] to explore the perceptual relationship between proximate and distal sound sources through the use of a hybrid spatial system using a pair of headphones and a pair of loudspeakers set at 180 degrees either side of the listener. The process of simultaneously creating the system for the work, and the work for the system, was integral in executing the compositional motive which explored proximate and distal space. Further pieces were created for the configuration that explored the same idea, however those pieces are considered to have explored the idea through the system,

rather than having constructed a system to explore an idea.

4.3. *Square Waves* for 8x5 Speaker Array

The 8x5 Speaker Array [18] was built to realise the piece *Square Waves* (2017). The piece takes eight short square wave samples and move them slowly out of sync temporally with one another, not unlike Steve Reich's *Clapping Music* (1972), while the loudspeakers have limited physical spatial seperation. In order to have the sounds placed close enough, an 8 channel array was built to realise the work. Subsequent pieces were written for this array, however those pieces are considered to have explored the spatial features of the array, rather than constructing an array to explore an idea

5. SPATIAL SYSTEM DESIGN AS A SPATIO-COMPOSITIONAL STRATEGY

The six cases above provide examples whereby a novel spatial system has been devised to fully realise a work. These examples "embody the artistic approach to the use of space, and they are strongly related to or part of the artistic concept of the work" [3] in the same way all of the spatio-compositional strategies reviewed above also do. It is clear how the construction of these systems adheres to Baalman's definition of a spatio-compositional strategy. In the context of novel systems, the system must be constructed as a part of the piece. If the system already exists, then the system itself cannot be seen as a spatio-compositional strategy, as the composer is writing for a system, rather than making a system for a work. What this does suggest, however, is that in addition to system design being considered a spatio-compositional strategy, we may also consider system selection as a spatio-compositional strategy.

Considering spatial system design as a spatio-compositional strategy encourages composers to more specifically consider the configurations they work with and write for. A greater critical understanding of spatio-compositional strategies has the potential to inform broader creative outcomes by encouraging artists to expand beyond standardized systems of spatialization.

6. CONCLUSION

This paper has encouraged consideration of spatial system construction and the selection of a spatial system as spatio-compositional strategies. Through a review of existing spatial strategies and analysis of relevant spatial systems, one can observe a discursive compositional and design process and this interdependence is currently poorly theorized in the literature.

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