Spatial Orchestration

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Abstract — **The emergence of multiple sites for the performance of multi-channel spatial music motivates a consideration of strategies for creating spatial music, and for making necessary adjustments to existing spatial works for performances in spaces with significantly different acoustic properties and speaker placement. Spatial orchestration is proposed as a conceptual framework for addressing these issues.**

I. INTRODUCTION

Projection of electronic sound over multiple speakers has been an aspect of both live and fixed media electroacoustic music since the emergence of these artistic practices. The Telharmonium, perhaps the earliest electronic performance instrument, first publicly presented in 1906, produced its sound through acoustic horns distributed throughout the performance space [1]. The premieres of early electroacoustic masterpieces such as Karlheinz Stockhausen's *Gesang der Jünglinge* in 1956 [2] and Edgard Varese's *Poème Électronique* in 1958 [3] both surrounded the audience with speakers. Spatial projection is the central feature in performances at Audium, which have been ongoing since 1960 [4]. In the case of both *Poème Électronique* and Audium, the performances were site specific, so that the problem of transferring the piece to different spaces did not yet arise.

II. MAPPING STRATEGIES

Mapping of channels has been treated flexibly in both directions. For distribution purposes, both the five-channel tape of *Gesang der Jünglinge* and the four-channel tape of *Poème Électronique* were mixed down to stereo for commercial distribution on vinyl recordings. The four channels of *Poème Électronique* were performed into a 400 speaker space, the Philips Pavilion. The source tape for the 136 speaker space of Audium is also a four-channel recording. While mapping from multi-channel down to stereo is inevitably seen as a compromise, mapping from fewer to more speakers is an opportunity. We first consider existing mapping strategies before moving on to spatial orchestration schemes.

III. DIFFUSION

Diffusion is a key performance strategy in which relatively few channels of audio are mapped to a potentially large number of speakers in a given space. This has the advantage of separating the structure of the original audio from that of the performance space. Diffusion, properly done, can add a sense of liveliness to the composition. Irrespective of locative aspects of spatialization, a good diffusion performance can create the impression that the musical source is comprised of many more tracks than the stereo pair that often forms the basis for diffusion. This is often enhanced by interactions between the recorded audio materials and frequency-specific radiation properties of the performance space.

IV. AMBISONICS

Ambisonics encoding attempts to provide compositional access to spatial imaging throughout a given performance space [5]. Perception of localized images should be irrespective of listener position. However, as part of the ambisonics process, input sounds are filtered, which may go against the composer's intentions. Speakers must be placed fairly precisely in the space in order to preserve the ambisonics effect.

V. POINT SOURCE

Point source composition requires advance knowledge of the locations of speakers in the space. The spatial location of each sound is then calculated as part of the composition process. This is a highly effective method for realizing trajectory patterns. Point source is essentially a panning scheme, without the psychoacoustic filtering in ambisonics.

VI. CURRENT STANDARDS

It is customary at electroacoustic music festivals to have access to at least an eight-channel (octophonic) playback system of good quality. However there are two common octophonic configurations, box and diamond, and neither configuration appears to be winning out over the other. One could compose with either point source or ambisonics for up to eight speakers, and expect a reasonable performance, though the ambisonics encoding would still be subject to vagaries of speaker placement to a greater degree than point source. Diffusion can be done to any number of speakers. However the more speakers available, the more difficult to control the performance with live diffusion, though this problem can be addressed with multiple performers, if a software system is prepared for merging control streams to the computer controlling outputs. But in general diffusion will still be limited to spatial movements that can be performed in realtime. Spatial aspects involving fragmentation of the sound, for

example spectral diffusion could not be performed with precision, without custom software.

VII. SPATIAL ORCHESTRATION

We do not have a good model for composing for performance of music with greater than eight channels into a space other than that for which the piece was composed. Spatial orchestration is proposed as a set of strategies to meet the challenge of composing for larger numbers of speakers. It is not a magic bullet that automates a mapping process. Instead it suggests that composers re-orchestrate spatial attributes of their piece for each new space in which performances will take place. Rather than compose relatively few tracks to be expanded for each multi-channel space by means of live performance, the composition should make full use of the spatial properties of the hall for which it is composed, most likely creating separate tracks for each available speaker.

VIII. BASIC MAPPING

The Sonic Lab at the Sonic Arts Research Centre can project sound from at least three elevation levels: below the audience, at audience level and above the audience. Works composed to be performed in the Sonic Lab can take advantage of these properties and design pan patterns that move above and below the audience, as well as around them. However, most other multi-channel spaces do not have the capability to project sound from below the audience. Thus a work composed for the Sonic Lab would need to have its spatial properties adjusted when performed into another space. The elevation panning might be preserved, but it might start at ground level and then pan above the audience. Similarly, if a work composed at Sonic Lab is projected into a space with two layers of elevation, the three layers of Sonic Lab elevation could be recompiled with a virtual layer halfway between the upper and lower elevation level.

IX. OTHER ASPECTS TO REORCHESTRATE

While all the speakers in the Sonic Lab are placed around the audience, in BEAST performances and MANTIS performances, speakers are placed throughout the space. In this case, surround trajectories may be reconceived to move throughout the space. Or existing virtual motion through the space could be re-orchestrated into actual point source motion through speakers distributed throughout the audience. Another important aspect of the space will be its reverberant properties. In case of moving a composition from a fairly wet space to a drier one, convolution with impulse responses from the original space might preserve the intended spatial environment. Alternatively, the actual timing of events might be changed as appropriate for the new performance space.

X. PRACTICAL ASPECTS OF SPATIAL ORCHESTRATION

Since the strategies of spatial orchestration require a degree of experimentation in each target hall, it is proposed that a group of multi-channel works be composed at a consortium of institutions with multi-channel performance spaces. Each work should be performed in each space, with a suitable amount of time given to prepare the piece for the space. This would require not just sufficient rehearsal time, but a sharing of essential aspects of the hall in advance of the performance, possibly by a preliminary composer residency, so that the work can be properly prepared for each performance.

XI. COMPOSITIONAL STRATEGIES

Compositional strategies are highly conditioned by the outlook of the individual composer, as well as the aesthetic goals of specific compositions. The constraints of the compositional environment further condition these strategies. Composing multichannel works with precise intended spatial attributes imposes serious constraints, often in the form of stringent requirements for the performance situation, especially when ambisonics encoding is involved. Composing multichannel works that are intended for multiple performances imposes the potential constraint that the piece will be restricted exclusively to the compositional possibilities that are most likely to robustly survive significantly different spatial performance environments. Spatial orchestration eases this last constraint, with the understanding that the composition may be reconfigured for each individual performance. This will require at times that the composer conceive of spatial attributes in a more abstract fashion, that is then instantiated in potentially different ways into different performance environments. The key practical measure will be to maintain the composition in highly multichannel fashion, such that the individual elements can be remixed, or reconstituted for each performance as necessary.

XII. FUTURE WORK

The work presented here is ongoing, as it is in the early stage of conception and experimentation. At present all experimentation has taken place at the Sonic Arts Research Centre. The next step will be to compose a complete multi-channel work, intended for performance in multiple venues. Several collaborating institutions have been identified, and it is anticipated that this work will commence in 2009.

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