Correction of Spatialization Issues in Acousmatic Music: Remedying Incompatibility Between SpatGRIS and Logic Pro X

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Abstract

In this project, a technical solution for incompatibility among software programs involved in the spatialization of sound in multichannel speaker arrays was designed and implemented. Acousmatic music is a genre of electronic music intended for playback by a group of loudspeakers with the central concept being calculated ideation by the composer on how sound moves in space. Dr. Robert Normandeau, a pioneer in both acousmatic composition and sound spatialization research, describes the genre as "Cinema for the Ear." Through his efforts with Groupe de Recherche en Immersion Spatiale (GRIS), Dr. Normandeau created a software plugin, SpatGRIS, which allows composers to send sounds around the space to come seemingly from anywhere in relation to the listener. This allows acousmatic composers to send sounds around, over, or through the audience for a completely immersive experience. Through use of SpatGRIS in conjunction with Logic Pro X, one of the most globally popular Digital Audio Workstations, the plugin has proven useful to create complex sonic movements in acousmatic compositions produced throughout the completion of this research. However, when trying to export these projects in their entirety for playback and sharing, both programs labeled and exported channels differently in octophonic (eight channel) compositions. This difference resulted in sounds from the composition being spatialized incorrectly. Therefore, a method using a free third-party software, which can easily remedy this error and correct the final recordings to their originally intended state, was created to serve as solution.

Keywords: Acousmatic Music, Logic Pro X, SpatGRIS

1. Introduction

1.1 Acousmatic Music

Acousmatic music draws its name from the tutoring practices of Pythagoras, whose most elementary class of students was known as the "*akousmatikoi*" (Figure 1). These pupils were made to listen to Pythagoras teach from behind a curtain, so as to focus on listening to the words he spoke without the distraction of seeing him visually.[1]
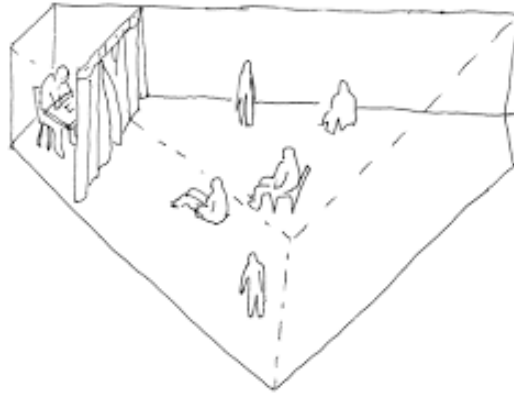
Figure 1. Pythagorus lecturing the *akousmatikoi* from behind a curtain[2]

In 1955, Jérôme Peignot first used the word "acousmatic" to describe musique concrète[3], a style of experimental composition which focused on obscuring from the audience the source from which a sound came. Pierre Schaeffer later defined "acousmatic" as "referring to a sound that one hears without seeing the causes behind it*",* in his 1966 publication*, Traité des Objets Musicaux*.[1] Thus, acousmatic music is a style of electroacoustic musical composition which is presented in a concert setting, but without visible performers of traditional instruments. Instead, the sounds are projected from an array of loudspeakers positioned throughout a space. The loudspeaker effectively veils the original source of the sound from the listener, much like the curtain from behind which Pythagoras tutored. In these compositions, spatialization is a carefully considered and intentionally used component. The space from which a sound comes is composed into the work and is integral to experiencing the piece properly; the space is not merely an effect or afterthought.[4]

1.2 Multichannel Speaker Arrays

Many acousmatic works are arranged in stereo (2 speakers), but others are arranged for multichannel audio. These compositions can range from Quad (4 speakers) to 7.1 (7 Speakers and 1 subwoofer) to an endless number of speakers limited only by cost. Arrays have previously been composed of up to 350 speakers, such as the one created by Xanakis at the 1958 Brussels International Exhibition.[4] These speakers can be placed in any form or arrangement the composer desires, but often they are positioned symmetrically around the audience. In many multichannel works, the speakers are arranged in a ring around the audience, but with more speakers comes the possibility of also placing speakers above the audience and creating a dome of speakers that the listener experiences the composition from within.[4] The speaker array examined in this project is the octophonic ring (Figure 2), which consists of 8 discrete channels and no subwoofer, placed symmetrically around the listener.
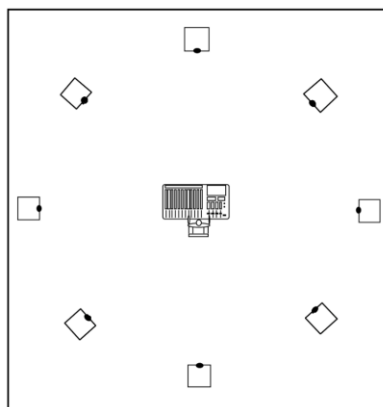

Figure 2. An example of an octophonic ring, with the listener seated in the center of the array[5]

1.3 SpatGRIS

Designed by Dr. Robert Normandeau and his team at Groupe de Recherche en Immersion Spatiale, SpatGRIS (Figure 3) is a software plugin that allows acousmatic composers and sound designers to spatialize audio in the two-dimensional plane.[6] The plugin is embedded within a Digital Audio Workstation (DAW), and uses a graphical interface to allow any number of virtual speakers to be placed in any configuration to represent how their physical counterparts are arranged in a space. It is able to write automation data to control a variety of variables involved in the playback of audio, namely volume, Y axis panning, and X axis panning. The altering of these three parameters allows the program to use pan law to assign audio playback to multiple speakers at different gain (volume) levels. This allows the listener's brain to localize the position of the sound source[4] and allows the sound to be placed in a specific location in the physical environment. This allows greater immersion and is an integral part of acousmatic music.
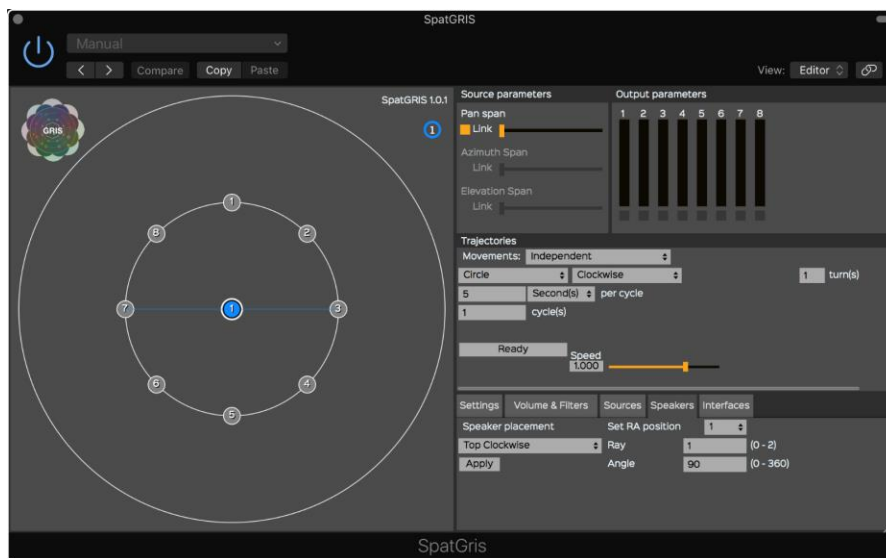

Figure 3. A screenshot of the SpatGRIS interface, set up for use with octophonic ring

2. Incompatibility Issues

When using SpatGRIS in combination with Logic Pro X (a globally popular DAW) to compose acousmatic music for octophonic ring, an incompatibility exists, and the spatialization displayed in the plugin differs from the final spatialization heard upon playback. Not only is this difference heard during the composition process, but it changes yet again after exporting the final project as an interleaved (.wav) file. Sounds are not only heard in the wrong place in the physical space, but some sounds are also occasionally omitted entirely.

3. Methodology

In order to remedy the spatialization issues, a pattern of incorrect spatialization had to be established. Each channel of the interleaved file was examined individually, as well as compared to the other seven. A test file was created that had very simple sounds, which only played through one channel at a time and progressed from channel 1 to channel 8 in numerical order. Waveform analysis was performed inside of Adobe Audition (Figures 4, 5, 6), to determine in which channel (and therefore which speaker) a particular sound was appearing at a given time. This was compared to the channel it was expected to appear in, based on the spatialization added to the test file in SpatGRIS. After repeating this process and analyzing each channel, a pattern was observed. Channels 1, 2, 5, and 6 appeared in the proper place,

but sounds intended to occur in channels 3 and 4 were actually observed in channels 7 and 8 respectively. The expected sounds for channels 7 and 8 were similarly observed in channels 3 and 4.
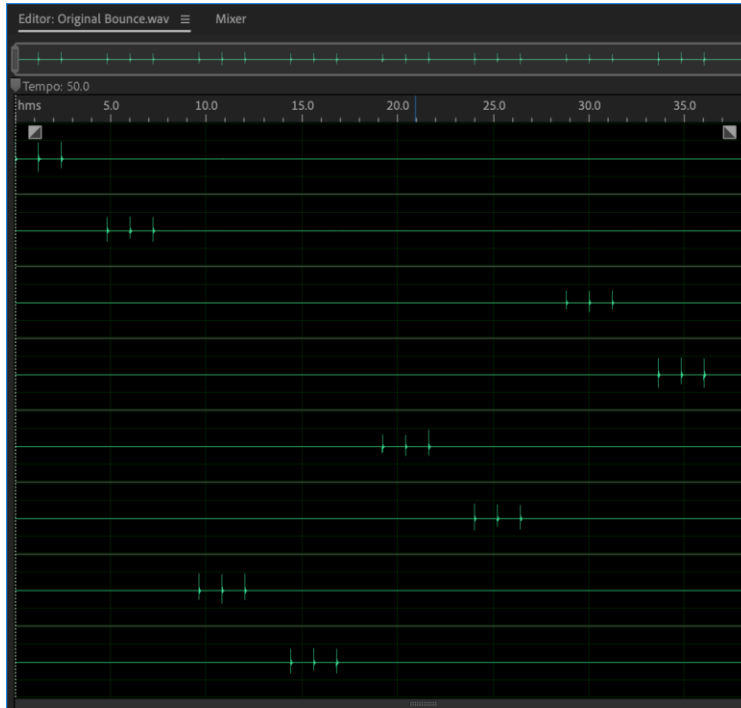

Figure 4. Waveform analysis of the test file

Channels within this file were then reordered to reflect the intended appearance of sounds in the appropriate channels at the expected times. However, this was ultimately unsuccessful, and a system of trial and error was used to find the proper reordering of channels to achieve correct spatialization upon playback, despite this order contradicting the waveform analysis.
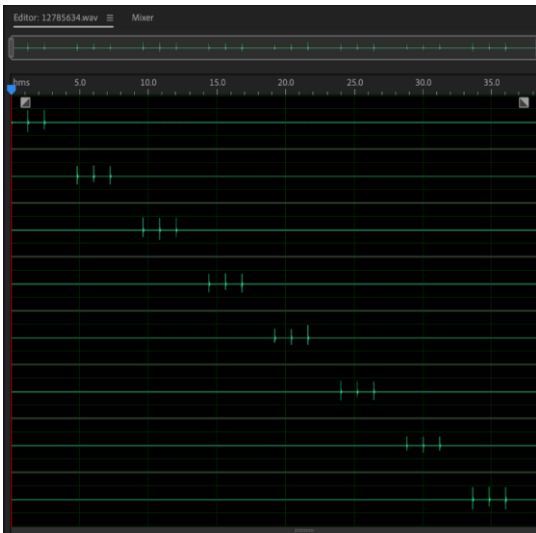

Figure 5. Waveform analysis of a file corrected to match the expected results after analysis; This reordering was unsuccessful upon playback.
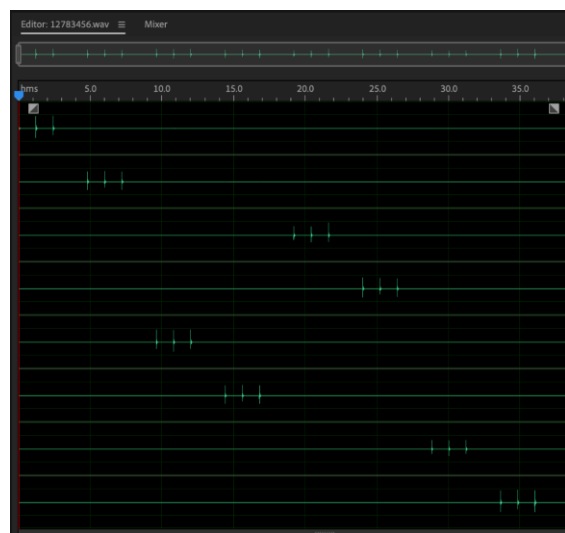

Figure 6. Waveform analysis of the reordered file that proved successful at remedying spatialization upon playback, despite showing as incorrect during analysis

4. Solution

In order to correct the incompatibility issues, preferences must be adjusted in Logic Pro X, and a free-third party software must be utilized. Multiple steps are necessary to ensure that spatialization is correct both during the composition process and upon playback during performance of the work.

4.1 During Composition

During the composition process, it is important that the composer be able to accurately hear where sounds are placed around them in the space, and it is paramount that these locations match those intended by the composer and displayed on the SpatGRIS interface. In order to achieve these results, the user must alter the output settings (Figure 7) of Logic Pro X from the standard multichannel settings. The composer must choose the 7.1 (3/4.1) surround format from the audio preferences menu, and set the I/O (input and output) assignments as follows:
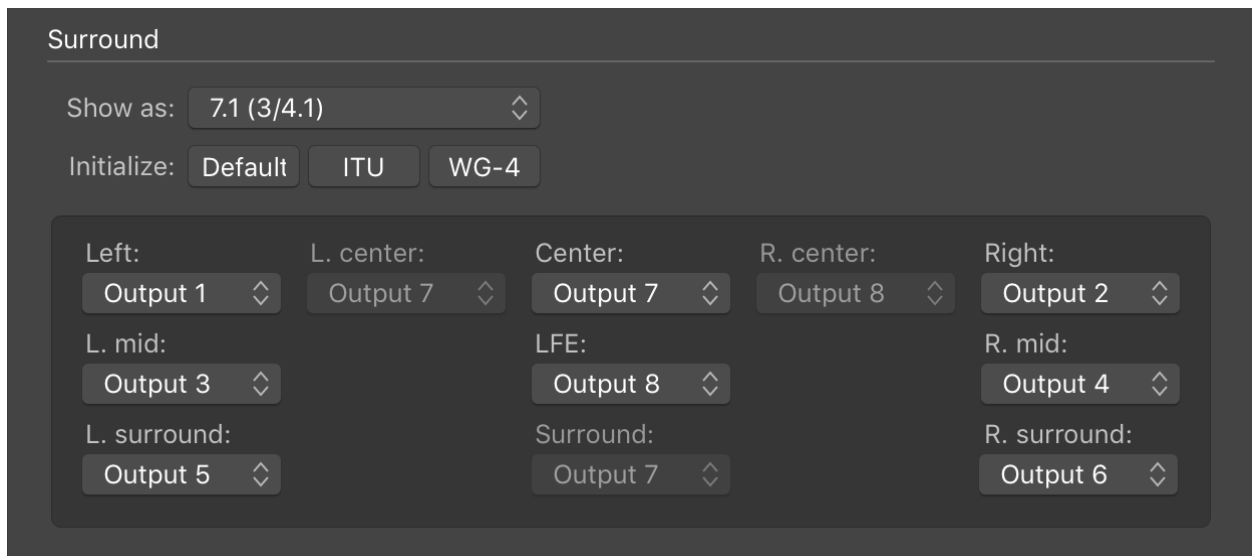

Figure 7. I/O settings in the Logic Pro X audio preferences menu necessary for correct spatialization of sounds during the composition process

It is important to note that the project settings must also be changed to reflect the 7.1 (3/4.1) surround format. These can be found under the File menu in the top left hand corner of the screen.

Assuming that the physical speakers are connected to the interface properly, and the SpatGRIS speaker location settings match these speakers, this change to the Logic Pro X surround output settings will allow the plugin to work effectively. The composer will then have the ability to hear correct spatialization of sounds during the composition process.

4.2 Exporting the File

Although the previous step corrected spatialization during the composition process, it does not remedy the file once exported. When the composition is converted into an interleaved file for playback, the spatialization is saved as if the audio preferences had remained in their default settings. The changes to the settings only apply when working in the DAW, not after it is exported. The I/O Assignments only change which output on the interface sound is sent from, which aids in proper spatialization within the DAW. They do not, however, affect the way files are bounced. The reason for this is that in an interleaved file, each audio channel is exported separately and then recombined and compressed into one final file. Logic Pro X has a preset format for this recombination, which cannot be altered by the user. In order to remedy this problem, the composer must use a third-party software to rearrange the order in which each channel's monophonic file is combined into the interleaved polyphonic file.

Wave Agent is a free third-party software that provides the ability to separate the channels of the multichannel file into multiple monophonic files and then recombine them in a different order.[7] First, the user must split the polyphonic file into 8 monophonic files (Figure 8), with the first channel (referred to as a "track" by Wave Agent) becoming the first file, the second channel becoming the second file, etc., as follows:
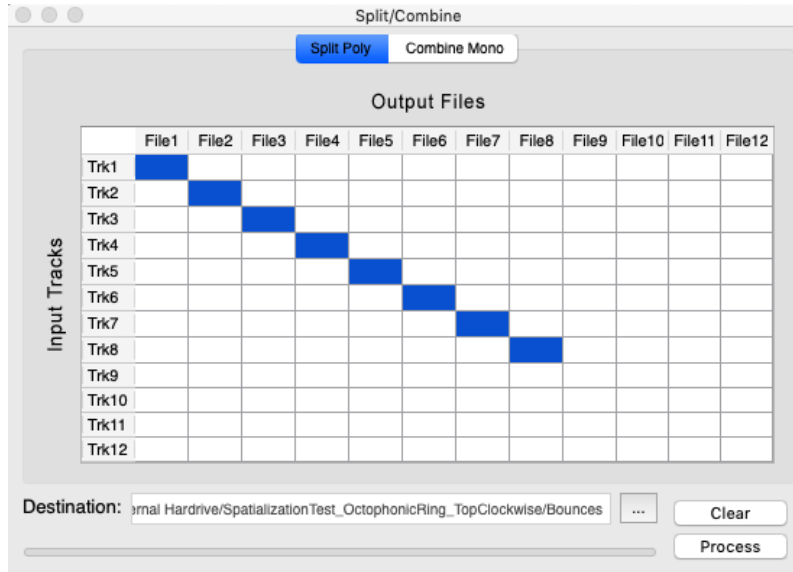
Figure 8. Splitting the polyphonic interleaved file into 8 separate monophonic files using Wave Agent

Secondly, the user should combine the monophonic files into a new polyphonic file with a different ordering (Figure 9). It is important that the user use Wave Agent's Batch mode, as opposed to its Manual mode. The files should be reordered as follows:
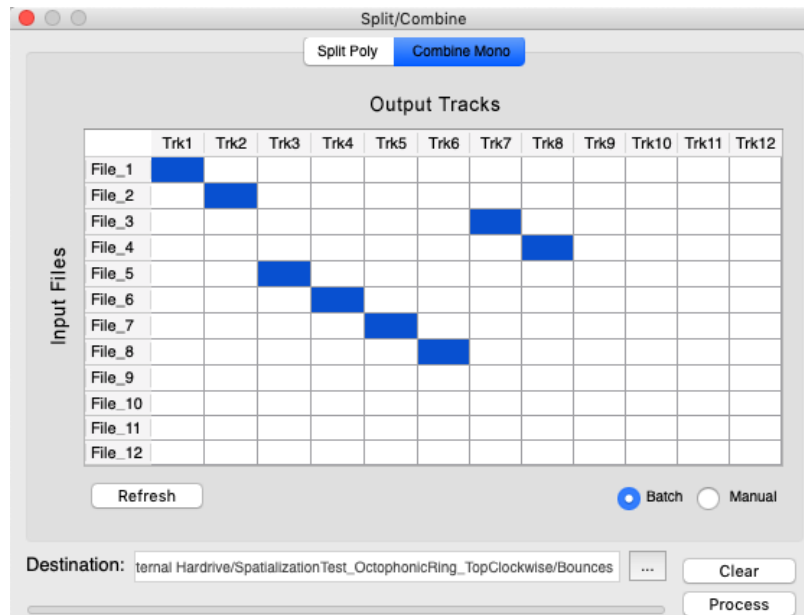
Figure 9. Combining the monophonic files into one interleaved file, using a different ordering of channels

In this new ordering of channels, channels 1 and 2 remain as they were, but the other six channels are reordered. The old channels 3 and 4 become the new channels 7 and 8 respectively. The old channels 5-8 also shift to the new

channels 3-6 in a similar way. Once this new multichannel interleaved file is processed, it is ready for playback on an octophonic speaker array.

4.3 Playback

To confirm that this process has been done correctly, the composer should listen to the file and confirm that the spatialization is as originally intended. To easily do this, the file should be imported back into Logic Pro X; the audio preferences at this point however, will be different than during composition (Figure 10). The surround format used should be the 8-channel Sony Dynamic Digital Sound format, or 7.1 (SDDS). The default I/0 assignments for this format should be used.
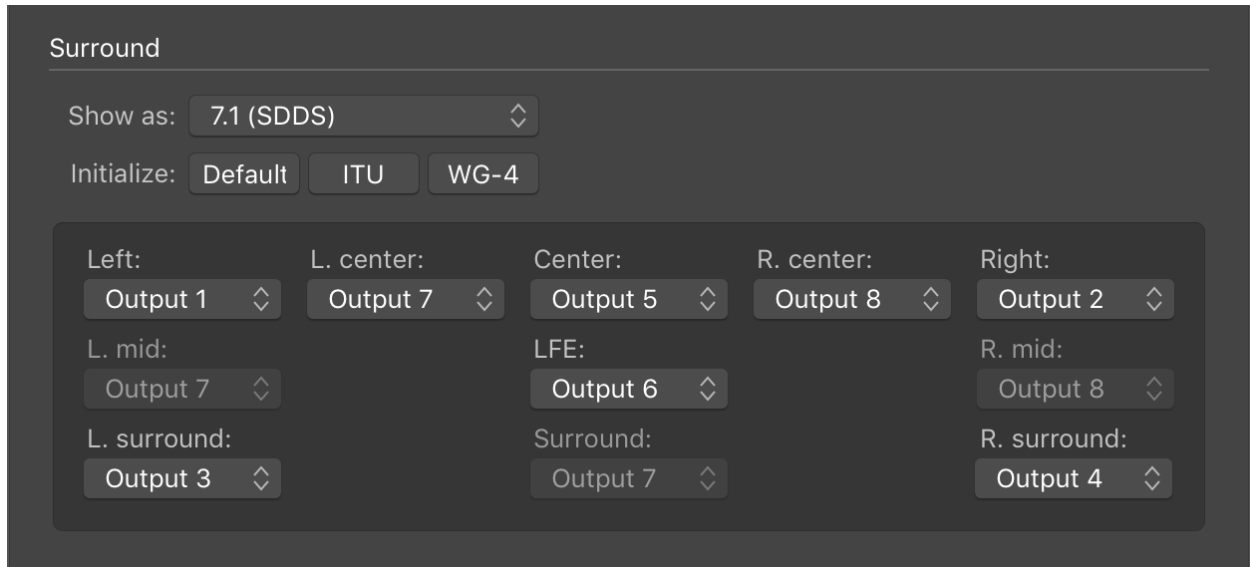

Figure 10. I/O settings in the Logic Pro X audio preferences menu necessary for correct spatialization of sounds upon playback

Presuming correct setup of the octophonic ring, consistent with the setup used during composition, the piece will be played back as originally intended by the composer. Because Logic Pro X is an industry standard DAW for electronic music composition, it is widely available at most institutions which might sponsor the premiere of acousmatic pieces. Therefore, this method of playback will easily allow widespread dissemination of the composition in a variety of venues.

5. Conclusion

Acousmatic music has been described as "Cinema for the Ear" by Dr. Robert Normandeau[8], for compositions in the style aim to paint a picture or scene in the head of the listener using only sound. To do this, the music must be totally immersive, and the human brain's capacity for localization of sound allows this to be done through the calculated spatialization of audio. Because spatialization is such a central focus for acousmatic composers, it is of utmost importance that there is a way to accurately place sounds in a space during composition and playback. Although Logic Pro X and SpatGRIS both have the ability to produce spatialized multichannel audio, composers seeking to use both during production of their works for playback on octophonic ring will find incompatibility issues that compromise the accuracy of the intended spatialization in their works. Through use of a free third-party software, Wave Agent, composers can easily remedy these issues and properly share their music with a global audience.

6. Future Work

Research should be conducted to investigate if similar incompatibilities exist when working with other multichannel speaker arrays and surround output formats. Additionally, will the same solution apply to fixing those incompatibilities, should they be found to exist? Further, no easy way exists to convert a piece from diffusion for one speaker array to another, while maintaining the same spatialization, exclusively using the SpatGRIS tool.[9] For example, a piece intended for playback on octophonic ring could not be played using a 5.1 speaker array without completely recreating the project. A method should be developed using SpatGRIS, which allows acousmatic works to be scaled up or down to be diffused over differently sized and shaped speaker arrays. This would ultimately allow for acousmatic compositions to be performed in a wider variety of venues. Finally, what is the reason for the anomaly observed during waveform analysis? Why does the file which shows correct ordering of channels during the analysis, not play back correctly in Logic Pro X? These methods and files have not been tested on other DAWs. Further testing may reveal the reason for this phenomenon.

7. Acknowledgements

8. References

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