A PARADIGM FOR SCORING SPATIALIZATION NOTATION

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ABSTRACT

The present paper is a shortened version of the one presented at the ICMC/SMC2014 [1] where it was demonstrated that SSMN (Spatialization Symbolic Music Notation) research seeks to establish a paradigm wherein OSC (Open Sound Control) [2] and a Rendering Engine allow a musical score to be heard in divers Surround formats.

The research team consists of composers, spatialization experts, IT specialists and a graphic designer. After having established a taxonomy identifying and classifying spatiality of sound with associated parameters, open source software is being developed and tested by practitioners in the field. Composers, utilizing dedicated graphic symbols integrated into a score editor, have full control over spatialization characteristics. They can audition the results and communicate their intentions to performers (i.e. conductors, musicians, dancers, actors) as well as to all participants in the chain from rehearsal to performance.

SSMN capitalizes on time-based phenomena: choreographers can combine and synchronize sound and body movement; installation artists can program interactively visuals with audio manipulation; film and video can be enhanced with 3D sound effects and spatialized scores. SSMN focuses not only on musical composition, other performing and media arts or even game interaction design, but is useful in academic contexts such as professional training in conservatories and in musicological research addressing the perennity of spatialization in early electroacoustic music.

1. INTRODUCTION

Research on spatialization in music dates from practices in early civilizations through today's contemporary output. SSMN investigations concentrate on composers' means of expressing placement and/or motion in space (e.g. Stockhausen, Boulez, Brant), and of more recent methods of graphic representation proposed in various research centers (i.e. Ircam's OpenMusic [3] & Antescofo [4], MIM's UST [5], Grame's 'inScore' [6]). During the past decade certain composers using WFS [7] and Ambisonics [8] pointed to the need of musical notation wherein graphic symbols and CWMN (Common Western Music Notation) could coexist on a time line along with audio rendering.

2. DEFINING A SPATIAL TAXONOMY

The SSMN Spatial Taxonomy is an open-ended systematic representation of all musical relevant features of sound spatiality. It is organized as follows: basic units of the SSMN Spatial Taxonomy are called descriptors, i.e. room descriptors and descriptors of sound sources. Descriptors can be simple or compound and are assumed to be perceptually relevant. Simple descriptors denote all single primary features relevant to sound spatiality and can be represented as symbols. Compound descriptors are arrays of simple descriptors used to represent more complex spatial configurations and processes. Structural operations and behavioral interactions can be used to transform elements previously defined using descriptors or to generate new elements. Descriptors are progressively being implemented in the project when proven to be of general user interest. Although the taxonomy is classifying and describing sound in a three-dimensional space, some objects and symbols are, for practical reasons represented in two dimensions. As this taxonomy contains a very systematic vocabulary it proves to be useful for other research projects related to 3D Audio currently under development at the ICST. To assure the validity of concepts within this taxonomy, the SSMN team has undertaken the task of testing perception of sound spatiality elements both in 2D and 3D mode, with key questions being what can be perceived or not, and under which conditions.

3. CREATING GRAPHIC SYMBOLS

In accordance with the SSMN Spatial Taxonomy requirements, a basic set of symbols was researched and designed with the primary criteria requiring clarity, legibility and rapid recognition. Equally, the choice between symbolic or descriptive designs becomes particularly relevant. Thus, the SSMN Symbol Set synthesizes both approaches. Depending on the requirements of a musical composition, spatialization information can be very complex; configurations consisting of simultaneous trajectories with varied types and durations require transmitting elaborate I/O data that must be readily understood and communicated to all in the chain from creator to performer to sound engineer. Communication between the target users is simplified with SSMN: the symbols could be common to various types of outputs (score, cue sheet, sound design, video editors) and the associated rendering parameters can be freely edited in available and future tools. They can also be used in remastering situations, preparation of audio tracks for video games, 3D cinema, surround radio broadcasting, theater productions, choreography and installations.

The symbol set

The SSMN Symbol set and subsets are organized so as to be easily inserted in a GUI (Figure 1). In order to facilitate the use of the SSMN symbols and their introduction into the musical score five categories of symbols related to the following aspects are defined:

- Physical performance space characteristics (geometrical form, size, reverberance, inside/outside)
- Initial physical placements of performers, microphones, loud speakers and objects
- Localization and quality of sound sources (acoustic and projected audio[1])
- Trajectories and/or displacement of sound sources, microphones, loud speakers, and objects whether individually, in groups or more complex configurations (sound clouds, planes, surfaces)
- Inter-application communication possibilities and protocols (OSC, MIDI) as well as integration with external programming environments.

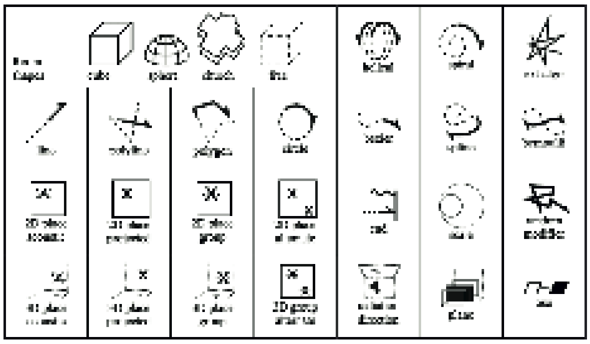

Figure 1. Extract of SSMN symbols set.

4. IMPLEMENTATION OF MUSESCORE_SSMN

The notation editor MuseScore was chosen due to its Open Source characteristics and its OSC communication possibilities, i.e. on/off/play/pause/next/. The SSMN implementation now allows all parameters and values of the symbols to be transmitted to target software within the tool set and equally receive data for control. Symbols are organized into palettes and menus according to SSMN categories, classes and functions. Once placed in the score, an Inspector window displays user-defined rendering parameters and flags specific to each type of symbol. A 2D/3D radar view displays the activity of the spatial movements from a selected note to another, or over a section of the score. Clicking on a symbol in the score allows seeing the entire trajectory in the radar. Several templates have been designed to facilitate formatting various score-types. The user commonly places SSMN symbols on any instrumental staff; nonetheless, a dedicated *SSMN Staff* can be utilized to transmit spatialization data as well as OSC messages, independently of notation, to any software with OSC functionality (Figure 2).

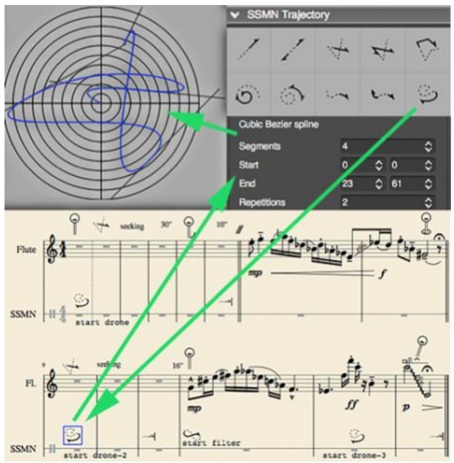

Figure 2. MuseScoreSSMN example:
symbol → score → parameters → radar

[1] Acoustic audio refers to the natural sound of instruments whereas projected audio refers to sounds coming from loudspeakers.

5. INTER-APPLICATION COMMUNICATION

The use of OSC (Open Sound Control) possibilities allows messages to be directed to various target software modules. Typically, spatialization data from MuseScoreSSMN flows to an audio renderer-engine capable of spatializing in various output formats, e.g. Ambisonic B-Format, WFS, multi-channel encoded audio files. OSC messages and RAW data are also routed to DAW (Digital WorkStation) or to programming environments (e.g. SuperCollider, C-Sound, MaxMSP.) At this time exporting possibilities include MusicXML and SVG.

6. DEVELOPING THE RENDERING ENGINE

Compatible with the Open Source Initiative for standardized Max/MSP Module, the SSMN Rendering Engine has been engineered to allow real-time spatialized audio rendering and visual feedback for all SSMN activity. Functionalities include OSC routing over UDP ports, and user control of encoding and decoding in various formats; the user determines speaker configuration, designs the distance characteristics and is able to select effects such as reverb, air absorption, and Doppler. All audio activity can be saved and reopened in common audio file formats. Real time visual feedback allows the user to monitor single or multiple trajectories and sound placements in 2D/3D. An AUAmbi plug-in allows communication with audio software that have AU implementation. In order to facilitate overall OSC control, a set of descriptions were created that would allow multiple cross-application communication, also adaptable to other protocol context such as SpatDIF and MusicXMuse-SoreML (Figure 3).

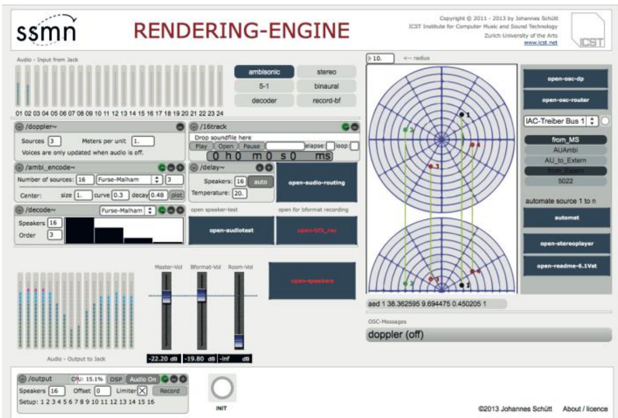

Figure 3. SSMN Rendering Engine main screen.

7. TWO CASE STUDIES

Urwerk by Vincent Gillioz

A first SSMN case study consisted of a film score, which revealed the combining of instrumental notation with 3D spatialization effects to be integrated into 3D cinema. Here a score for 9 instruments and electronics was originally notated in a popular score editor. Initially the composer created his personal symbols and spatialization annotations, but was limited to hearing the results in a stereo version. He now exported his score in MusicXML format (notation only), and imported it into MuseScoreSSMN utilizing the SSMN spatialization symbols. Then, the composition with accompanying audio files was rendered in B-Format onto an Ambisonic speaker system. Having been able to audition the impact of the sound motion, he could consequently edit and modify various parameters of SSMN symbols to his taste and allow for more coherent musical effects. Interestingly, Gillioz had little experience in spatialization at first and began by creating erratic sound movements – skips and wide jumps at 8thnote-120BPM rate. His esthetics obliged him to modify the displacement rate (speed and distance). Having mastered the process, he modified the score as necessary and gave us precious feedback.[2]

CHoreo by Melissa Ellberger, choreographer

CH*oreo* was a simple case study demonstrating advantages in using SSMN within a rehearsal context. A choreographer trained performers wearing portable loudspeakers to move along trajectories in a hall. Sound files projected from the portable loudspeakers accompanied the body movements. In play mode, MuseScoreSSMN triggered sound files transmitted to the SSMN Rendering Engine, all the while sending streams of OSC data controlling the 3D spatialization process. The performers could execute their roles by following the printed MuseScoreSSMN; the learning process prior to an actual public presentation was greatly facilitated (Figure 4).

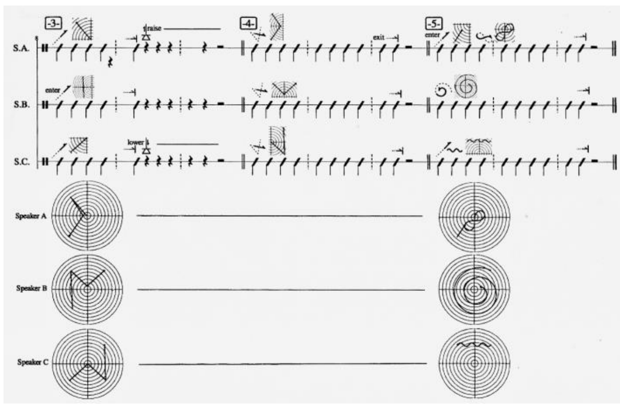

Figure 4. *CHoreo* trajectory score**.**

[2] *Urwerk* score/renderer/qtmovie (binaural version) can be accessed at http://blog.zhdk.ch/ssmn/movies/

8. CONCLUSION

At this stage of the “work-in-progress” of SSMN, its basic workflow is optimized for the user case in which notation for instrumental music (often incorporating live electronics) is introduced into a music editor and spatialized audio rendering is a requirement. Other user cases include the additional use of audio files managed within DAW software. SSMN equally targets state of the art venues, namely 3D cinema (with a great need for encapsulating height information into surround systems), 5.1 radio and web-based broadcasting (video, music and radio theater productions), choreography notation, artistic multi-media and interactive installations, surround CD, DVD and Blu-Ray market, as well as game design.

An SSMN user group provides inestimable feedback. Questions that are continuously taken into account concern the type of strategies adopted, their usefulness, the choice of symbols, the clarity and speed of recognition, the flexibility offered by the tool set and overall user friendliness. Performers and audio engineers note that they find useful features that allow them to consult both a printed version of the score containing the SSMN symbols as well as its electronic version allowing rendering the symbols in an active timeline.

The potential of the prototype was also tested with several choreographers and their composers at Tanzhaus Zurich. Results of the SSMN project have been incorporated into the composition curriculum at the Zurich University of the Arts and have been presented at the Haute École de Musique of Geneva. The actual experience with the composers, interpreters and composition students has shown that they have experienced increased awareness of spatialization possibilities within their own creation process and developed an augmented spatial listening acuity. A future SSMN goal addresses developing awareness of spatialization through pedagogical interactive software for all school ages as well as for pre-professional music education. There also appears to be a need within musicological research for archiving and assuring the perennity of electroacoustic music, transcribed with symbols for study purposes. It is also expected that the SSMN project will contribute to generating a sustainable impact on creative processes involving three-dimensional spatialization.

Further aspects are also being investigated such as the integration within the MusicXML protocol and SpatDIF compatibility (Peters, Lossius and Schacher 2013). The SSMN tools set and documentation are available to the scientific and artistic communities via a website that has been setup to document project results, distribute the software, and receive user input.[3] The SSMN workflow is shown below (Figure 5).

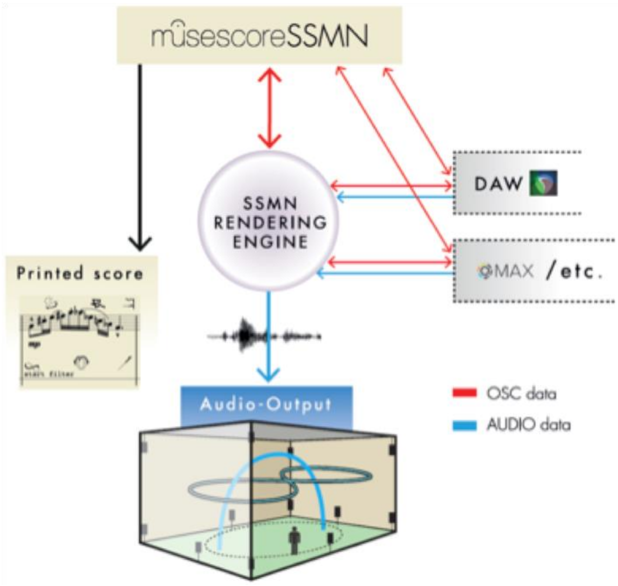

Figure 5. Basic MuseScoreSSMN I/O workflow.

Acknowledgements

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