“IN THE REAR”: ARTISTIC CONCEPT AND DIFFERENT SPATIALISATION METHODS

Lidia Zielinska & Rafal Zapala

The inside of the piano gets resized to the volume of a concert hall, with acoustic properties of the piano’s interior being preserved and intensified. The composition deals with sounds generated inside the instrument, sounds of the instrument’s mechanics, inaudible outside. In order to carry out the concept of sound space in full, a system of virtual devices had to be created. Their functions combine a number of spatialisation methods.

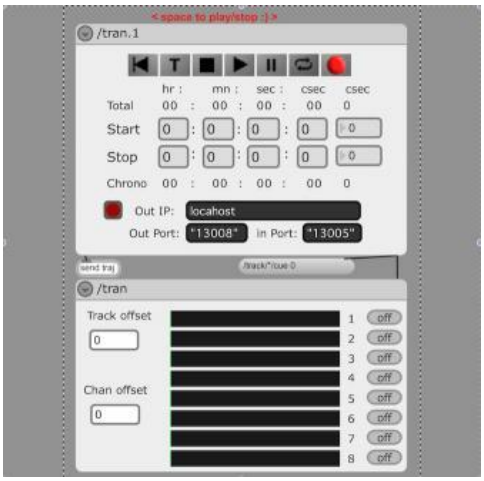

Figure 1. Patch 1_bp_holoinput.

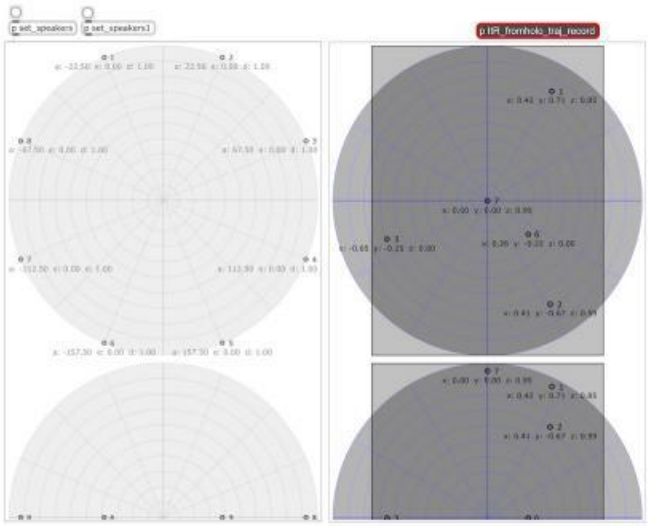

Figure 2. Patch 2_bp_ambisonics.

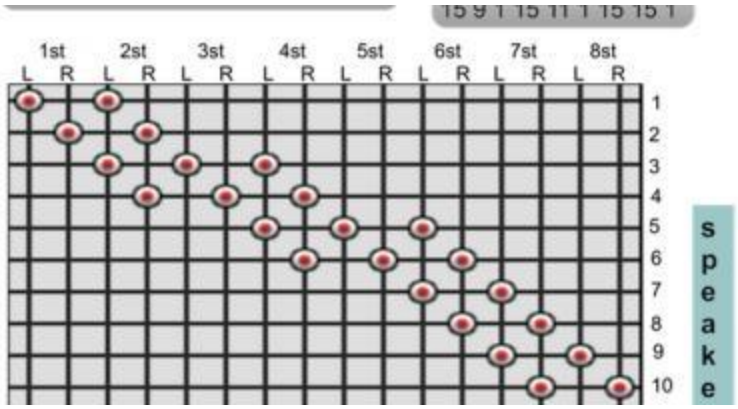

Figure 3. Patch 3_bp_player

1. INTRODUCTION

Composed simultaneously in ambisonic (live) and multichannel (fixed) versions, Lidia Zielińska's composition "In the Rear" (2010) is an acousmatic piece. The integrated system of different spatialisation methods was made by Rafal Zapała.

2. THE IDEOLOGY

In "In the Rear", piano keyboard becomes the interface between the inside of the instrument and accumulated experience of the listener's life. The acoustic world inside the piano looks different to what we experience at a concert: it resembles the experience of a child sitting under the piano. The acoustic world outside the instrument is not only its real sound at concert, i.e. in specific acoustic spaces of different reverberation, but also – or perhaps, above all – its sound in our long-term memory, in the tradition of piano literature, in various cultural codes and emotional reactions remembered.

The composition deals with sounds generated inside the instrument, at the back of the keyboard, so to speak: with sounds of the instrument's mechanics which are inaudible outside, as well as with specific reverberation inside the sound box. Symbolically, it also refers to what the instrument has experienced under numerous pianists' fingers. The inside of the piano gets resized to the volume of a large concert hall, with all acoustic properties of the piano's interior being maintained and intensified. Listeners experience resized timbres, as if they found themselves inside the instrument. Due to the scale shift, the aesthetic experience is accompanied by a more distinct physiological sensation (increased changes of acoustic pressure). One also hears idioms of great historical piano literature reverberate; this, in turn, is the support structure on which musical memory of each individual listener rests.

Motifs of 19th-century piano literature appear throughout the piece. The keys of these fragments have been adjusted; they employ a similar piano idiom. They have been edited as one sequence which preserves the musical logic and character of the erstwhile idiom even in the monophonic version. However, the motifs, which come flying to their meeting place from three spatial zones, establish a thoroughly different musical quality.

I also took the liberty of carrying out an experiment concerning our mental base. The piece originated in 2010, i.e. in F. Chopin's Year, and had its ambisonic première performance at the "Warsaw Autumn" International Festival of Contemporary Music. Listeners expected references to Chopin, and – even though there were none at the time – heard citations from Chopin's works, instead of Brahms', Rachmaninoff's and Gershwin's musical gestures quoted.

These were practical, both composing and performance/concert-related considerations that prompted simultaneous writing of two (multichannel and ambisonic) versions of "In the Rear".

In a home studio, one could control the results of a preliminary composition of the sound material solely in stereophonic and binaural way. It was only a trial at the 8-channel SMEAMuz studio that made it possible to compare the results with the imaginary spatial vision. A few days before the opening performance, a provisional system of 12 loudspeakers was assembled, which let us initially verify the ambisonic effectiveness of movement trajectories originally charted for sound objects in imagination.

From the technical point of view, performance of the multichannel (i.e. fixed) version, is relatively simple, and its acoustic adaptation is carried out by the composer or sound diffusion director as it develops. The ambisonic version, however, is performed by at least two persons: the sound director and the composer, or another competent person who computer-activates subsequent modules of the system and oversees their reliable operation. Furthermore, the ambisonic version requires an extra rehearsal to adapt the virtual system to the existing acoustic and technical conditions.

Unlike the ambisonic system, multichannel projection makes sounds move only along the circumference of the auditorium, and excludes their sufficiently precise travel along diagonals of the room. As it takes the dramatic edge off certain phases of the piece, duration of these fragments should be shortened. Thus, in terms of composition, it constitutes a different version of the piece with slightly modified contents and objectives.

At the composition stage, simultaneous development of both versions made one realise the consequences of particular solutions faster than usual. It also required permanent and full control over the whole of the sound material, as well as over its spatial distribution potential. It also led to quicker conclusions concerning perception of musical time in the all-important relation to the type of spatial distribution of the sound material. These experiences would be an ample source of material for a separate study; above all, however, they have already contributed to one's composing skills.

As far as the choice of technology is concerned, the most important assumption of the composition are three sonic layers related to their spatial disposition: a group of static stereophonic timbres, a group of monophonic sound objects dynamically exploring space, and a group of reverberation timbres.

The static group mixes different acoustic orders taken from the real world. A conventional multichannel system and 8 speakers would be sufficient for its projection.

The dynamic group – motifs "floating" in the space of the concert hall – required creating a special tool to precisely design movement trajectory, and to play it in the ambisonic system. The greater the number of speakers, the greater the precision of movement trajectories. With an arrangement of 48 speakers, the listener feels as if he or she were directly touched by sound objects floating in space.

The reverberation group required highest sampling frequency and employment of the ambisonic system to create an illusion of a concrete concert space significantly increased in size.

Each sonic group is the foundation for one phase of the composition. Thus, a need arose for each of them to build appropriate tools for concert projection.

For a composer witnessing a performance of her composition, these were observations of how different kinds of spatialisation affect the perception of time, the piece's dramatic quality, and listeners' comfort that were of great significance. Particularly important is the middle episode of the piece, in which spatial dimension and increased distance play a key role. Drastic reduction of the episode to a stereophonic version would require significantly shorter time proportions than the original ambisonic version. Similarly, an insufficient number of speakers would require recomposing the piece's time proportions. A small venue, causes considerable discomfort to listeners due to high acoustic pressure felt simultaneously from several different directions.

3. THE TECHNOLOGY

The multichannel version of "In the Rear" was intended for performance using the traditional multichannel system. Each audio track of DAW program has a fixed place in the surrounding space; it has a dedicated speaker. In order to satisfactorily present the complex spatial structure of the piece, 16 or more speakers (12 on the auditorium level, and 4 above) should be available.

It is the ambisonic technology that optimises execution of the composer's assumptions and visions related to spatial phenomena in the composition. In particular, this concerns organisation of object movement in space.

Ambisonics is a technology of work with the surrounding sound whose origins go back to the 1970s and the pioneering work of Michael Gerzon at the Mathematical Institute of Oxford University. It is particularly useful for a composer who finds the limitations of commercially available systems (5.1–10.2) unacceptable. These were the characteristic features of the ambisonic system that prompted the decision to use it in "In the Rear".

For the composer, the key requirement was full periphony, i.e. ability to freely compose in three dimensions. It concerns horizontal space, in which natural and flexible design of movement around the audience, as well as along diagonal axes of the system is possible. It also concerns unrestrained upward and downward movement of sound objects along the vertical axis. It was the efficiency of ambisonic technology that made fuller and more subtle design of one of the layers of the composition possible.

Ambisonics does not treat speakers as separate sources of sound. They are not borderlines between which the composer is forced to stretch his or her soundscape. Here, the idea is an opportunity to independently create a three-dimensional sound space developed virtually in the studio, or captured by means of relevant techniques of recording the surrounding sound. Such composition exists almost independently of the number and arrangement of speakers, as each time it can be adjusted to the size and type of the space, in which the piece is presented. It can be one of both regular, and unusual, experimental configurations. As I have already said, in Lidia Zielińska's composition the optimum arrangement is an axially symmetrical set of 16 speakers on two horizontal planes (12+4).

An additional advantage of the system which prompted the choice of this technology, is equivalent treatment of sounds coming from all directions – equivalent treatment of speakers, which only constitute a medium intended to carry a B-Format-coded composition in a manner closest to the natural. In traditional systems, particular speakers play highly specialised roles, which limits their functionality.

In line with the composer's assumptions, and – as a result – with the multi-layered structure of the piece, "In the Rear" combines different approaches to work with spatial sound.

The full spatial structure of the composition consists in the following layers:

- dynamic layer – monophonic objects moving in periphonic space,
- static layer – stereophonic sounds of defined location in the surrounding space,
- reverberation sound layer.

3.1. THE DYNAMIC LAYER

The dynamic layer is a set of monophonic sounds of precisely designed movement in space. Adequate precision and comfort of designing the trajectory was achieved with Holo-Edit software module, part of Holophon project systematically developed at GMEM Institute in Marseilles. [1]

Holo-Edit is a graphic editor of sound trajectory, which makes simultaneous animation of as many as eight tracks in three-dimensional space possible. It was selected for its high precision and method of operation known from DAW programs. The program automatically converts spatial trajectories drawn by the user into tonal changes of the moving sound, such as stratification of the spectrum, the Doppler effect, structure of reflection and reverberation, air absorption, etc.

It has to be noted that despite a similar working method, the program is not an audio sequencer. It is a tool intended only and exclusively for drawing and recreating trajectories. We do not process or edit sound; we only organize its movement in three-dimensional space. The program has no audio output to make hearing sound possible. There is no B-Format coding, either. To make it possible, data from Holo-Edit had to be sent to relevant tools created in Max/MSP.

3.1.1. Patch 1_bp_holoinput

Constructed for "In the Rear", the first patch (see Figure 1.) acquires data from the Holo-Edit program. Its main elements are two modules from Jamoma, an extensive set of tools created for the Max/MSP environment.[2] Open Sound Control data transmission technology is used at the crucial moment of communication between programs (Holo-Edit and Max).[3]

The first module of the patch is responsible for the so-called "transport" functions, i.e. transmission of data concerning time synchronisation, as well as for receiving key data about sound trajectory. The other module receives sounds, monophonic audio signals from the Holo-Edit. The dynamic layer of "In the Rear" consists in seven tracks.

3.1.2. Patch 2_bp_ambisonics

The task of the second patch (see Figure 2.) is ambisonic operation proper: coding to B-Format and decoding to multichannel form, which makes feeding sound to speakers possible. These functions are performed by a set of objects (ambiencode~, ambidecode~) written for the Max/MSP environment at the Institute for Computer Music and Sound Technology in Zurich.[4]

By coding a moving sound object to B-Format, we place it in a virtual, three-dimensional space. Two GUI type objects (ambimonitor) enable the user to monitor this space: control the objects' movement, and define location of speakers by means of which the piece shall be presented.

3.1.3. Patch 4_bp_output

Upon decoding, the signal is sent to 4_bp_output patch, which is responsible for audio interface outputs. This patch closes the audio network on the computer. Made up of typical elements of Max/MSP environment, as well as of objects which constitute the SPAT set developed at IRCAM in Paris, it enables the composer to add the final reverberation to correspond with the acoustics of the performance venue. [5]

3.2. THE STATIC LAYER

Stereo audio tracks transmitted in the periphonic space in a distinct way constitute the second layer of "In the Rear". Together with the designed movement inside its stereophonic space, each timbre has been assigned to a pair of speakers around the audience, and duplicated with speakers over the listeners' heads. This has created a static (though "live") space based on eight independent stereophonic systems expanded with sound coming from above.

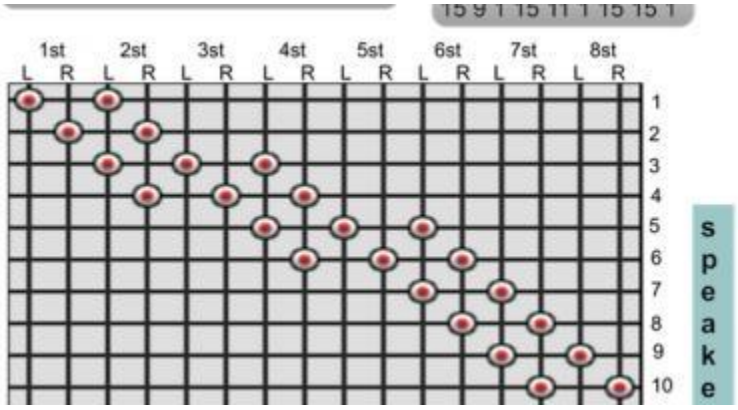

Fig. 3. Patch 3_bp_player

Patch 3_bp_player is responsible for playing these tracks. This patch works as a multichannel player of tracks created by the composer during her work at SMEAMuz studio in Poznan. Consisting in a set of multichannel players of stereo sounds, it is synchronised in time with Holo-Edit program and other elements of the system. To perform live in different spaces, the composer had to be able to freely assign particular tracks to specific pairs of speakers. This function has been incorporated into the patch in the form of matrix (see Figure 3.)

3.3. THE REVERBERATION LAYER

The material used to produce this layer mainly originated in a recording of real timbres inside the piano. It was also here that ambisonic technology was used, although it was employed in a different way.

Using the tools built to meet the requirements of the composition's dynamic layer, the composer was able to create virtual space in the studio, practically speaking, from scratch. The goal of the reverberation layer, in turn, was to render the acoustic reality of the inside of the piano, and to expand it to the size of the concert hall. Thus, a technology of recording the material directly in the 4-channel structure of the B-Format was employed. SoundField ST350 microphone was used. An extensive collection of piano timbres was built: whole phrases, individual timbres, sounds of the instrument's mechanics, as well as specific reverberations inside the body. The character of the recorded timbres is both static and dynamic: they move in space. In her work, the composer used Lexicon 960LD to select and transform the material, as well as to elaborate its reverberation.

Sounds of this group are played by the other multichannel player in patch 3_bp_player. Similarly to static sounds, it boasts the ability to configure speakers through the matrix.

Sounds from all sources, effects of all spatialisation methods, "meet" in the previously discussed patch 4_bp_output. Objects employed on it enable its quick adaptation to specific performance conditions: the number of sound card outputs (which is related to the number of speakers used), and acoustics of the hall (through the ability to finally correct the reverberation of the entire piece).

References and Notes:

1. *Holophon Project Web Site, http://www.gmem.org/index.php?option=com_content&view=article&id=346&Itemid=232 (accessed November 1, 2010).*
2. *Jamoma Platform Official Web Site, http://jamoma.org (accessed November 1, 2010).*
3. *Open Sound Control Protocol Home Page, http://archive.cnmat.berkeley.edu/OpenSoundControl (accessed November 1, 2010).*
4. *Institute for Computer Music and Sound Technology Web Site, http://www.icst.net/research/projects/ambisonics-tools (accessed November 1, 2010).*
5. *IRCAM Spatialisatour Web Site, http://forumnet.ircam.fr/692.html?L=1 (accessed November 1, 2010).*