INTERACTION AND SPATIALIZATION : THREE RECENT MUSICAL WORKS

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ABSTRACT

This presentation will describe the use of interaction and spatialization in the realization of three recent musical works. In *Echappées*, the computer responds to the live celtic harp by echoes or harmonizations produced with *MaxMSP*. *Resonant Sound Spaces* and *Pentacle* resort to the tape, either alone for the former or in dialogue with the harpsichord played live for the latter. For these two pieces, real-time synthesis and processing have been used to produce sound material for the tape, and a 8-track spatialization has been elaborated, using the *Holophon* software designed by Laurent Pottier at GMEM. The presentation will be illustrated by sound examples.

1. INTRODUCTION

This presentation will describe the use of interaction and spatialization in the realization of three recent musical works by the author.

2. LIVE INTERACTION IN *ECHAPPEES*

Echappées is a work for celtic harp and real-time digital processing. It was dedicated to the late Denise Mégevand, who played a unique role in promoting the celtic harp as a significant instrument for contemporary music : she developped novel performance techniques and she incited composers to write pieces for this instrument. *Echappées* was premiered on february 14, 2004, during the concert-atelier "Celtik" of the Groupe de Musique Expérimentale de Marseille (GMEM) (this was Denise Mégevand's last public appearance).

The celtic harp lends itself very well to a dialogue with an electronic part while maintaining its distinctive identity and its ancient roots. In 1991, the author wrote *Lurai*, a piece where the celtic harp dialogues with a tape comprising both synthetic sounds and harp sounds recorded and processed in real-time with the audio-processor *Syter*.

In *Echappées,* the sound of the live harp is captured by a microphone and sent to a computer using the *MaxMSP* software to process the sound digitally. It is convenient to use a contact microphone attached on the harmony table, to avoid feedback and pick-up of unwanted sounds : however this is not strictly necessary.

The processing consists almost only of adding echoes (delayed copies of the original sound) or harmonization (copies of the original sound both delayed and transposed in pitch). In general four echoes are added. The echoes – transposed or not – are sent into alternate stereo channels, so that they also achieve some kind of spatial widening or ping-pong like bounce. In certain cases, some feedback is introduced : a percentage of the output of the processed sound is sent back to the input of the processing, which enhances or amplifies the processing. If the echoes are not transposed in pitch, feedback causes a longer reverberation. If they are transposed, feedback pursues the transposition upward or downward. Feedback can yield powerful effects, but it should be carefully controlled. The patch is shown on fig. 1.

The delays between the echoes– transposed or not – range from a few milliseconds to more than ten seconds. Untransposed echoes delayed by a few milliseconds produce mostly spectral coloration. Around a few dozen of milliseconds, untransposed echoes cause some kind of broadening of the spatial image; long delays can give the impression of a large space – until they are perceived as aurally distinct echoes. If the soloist plays motives, the echoes respond in canon.

The celtic harp is normally tuned to a E-flat diatonic scale, but each string can be tuned individually. Also each string can independently be raised by one semi-tone using a kind of pin attached at the upper end of the string. The piece *Echappées* uses a scale in which most steps belong to the tempered scale, except for five of them, which depart from the tempered scale by a quarter-tone.

The transposed echoes correspond to one of a few harmonic patterns, selected in relation to the melodic and harmonic motives to be played by the soloist. The transposition intervals range from one semitone or less to two octaves. Certain transposition intervals used in the piece do not correspond to an integer number of semi-tones : then the resulting tones will depart substantially from the tempered scale.

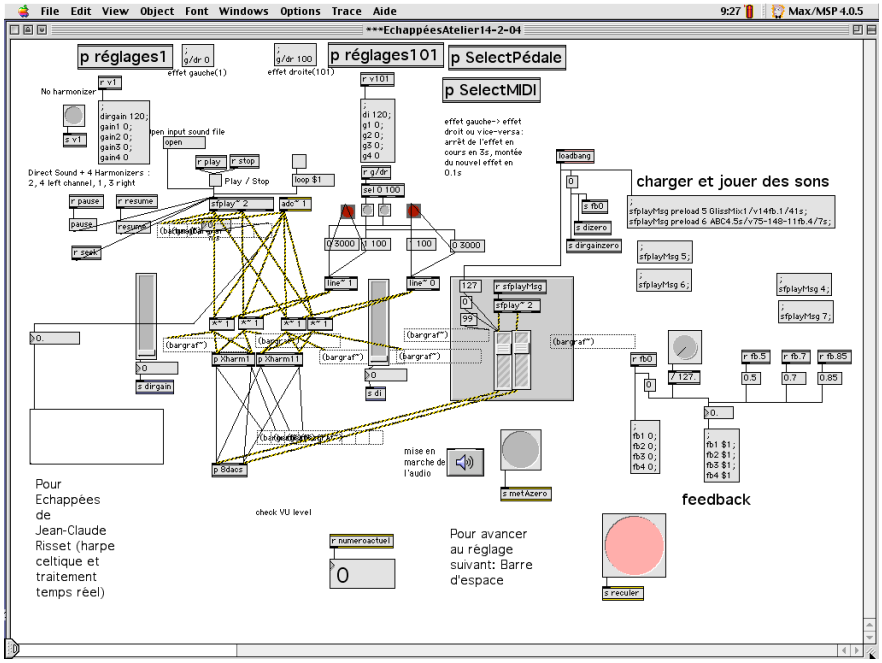

Figure 1 : MaxMSP patch realizing echo, harmonizing and feedback (cf. also fig. 2 & 3)

If feedback is used, special attention must be given to the tone quality attained after a number of cascaded echoes : the strong spectral coloration linked to comb-filtering-like effects can be quite objectionable in the high range. Thus feedback has been used mostly with descending transposition patterns.

The different settings for the possible values of delays and trasposition intervals are specified in different boxes shown synoptically in a *MaxMSP* patch : a given box can be activated manually by clicking on it (fig. 2). This

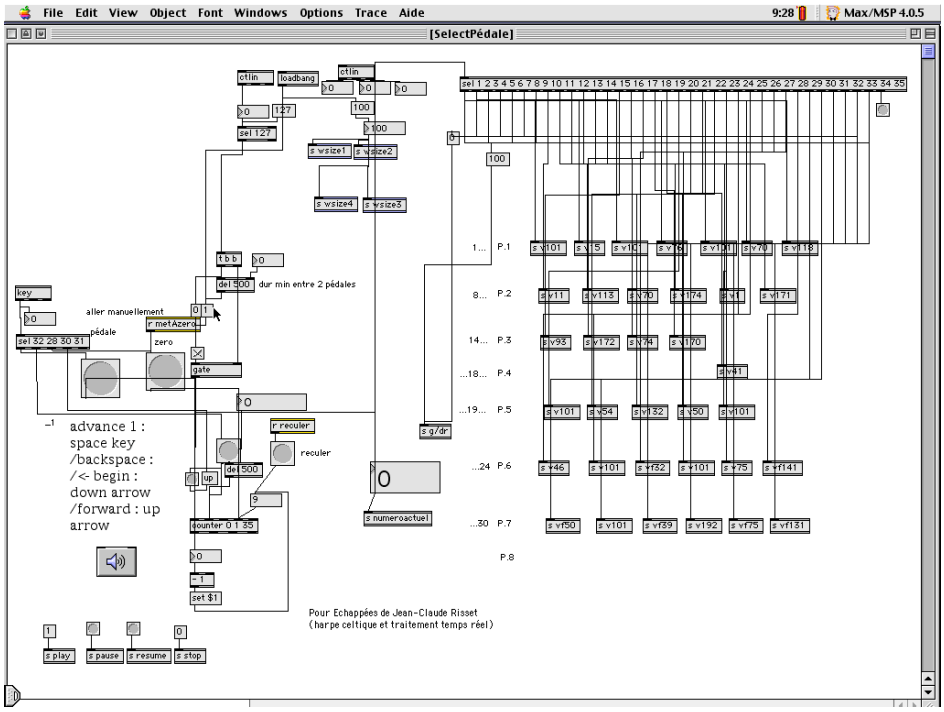

Figure 2 : Patch with different possible settings for the echo and harmonizing

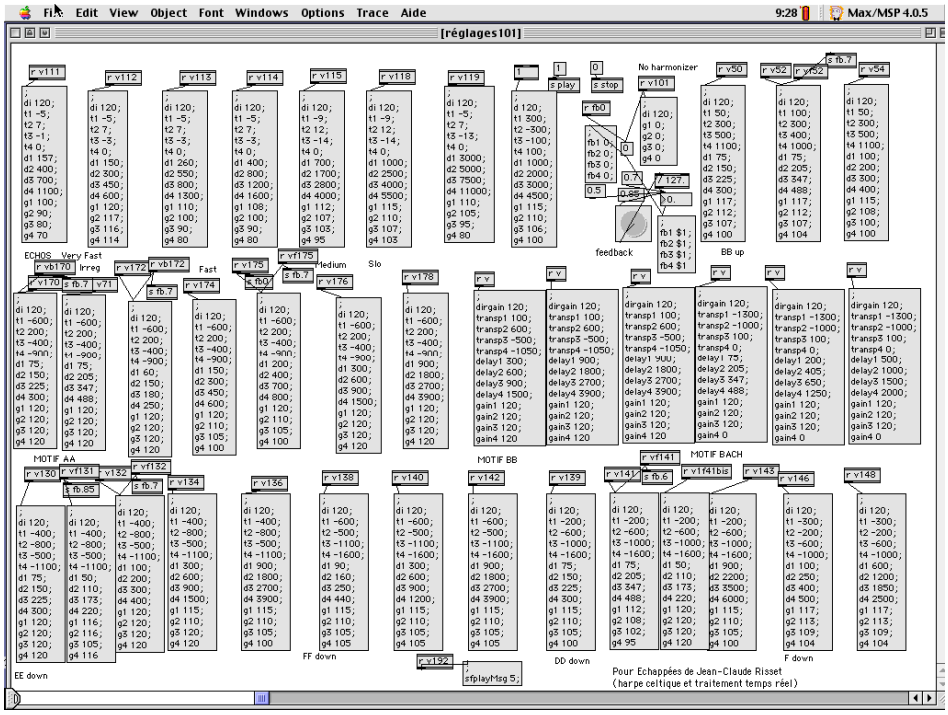

Figure 3 : Patch for performance, triggering the succesive settings

facilitates the experimentation in the course of the composition. Once the successive settings have been chosen, a patch for performance triggers them in succession. Calling for the next patch can be controlled by the performer through pushing a MIDI pedal connected to the computer ; it can also be done by someone at the computer keyboard through hitting the space bar. (Cf. fig. 3).

The title *Echappées* alludes to both space and pitch : the digital sounds which respond to the harp are replicas of harp tones, but they can be spatialized to escape beyond the stage; they also occasionnally escape the tempered scale

3. REAL-TIME SYNTHESIS IN *RESONANT SOUND SPACES* AND IN *PENTACLE*

Both *Resonant Sound Spaces* and *Pentacle* resort to a tape elaborated in non-real-time : however the tape includes a substantial amount of sound material obtained through real-time synthesis or processing.

Antonio de Sousa Dias has adapted to the *MaxMSP* software certain processes I had implemented on *MusicV*, such as *harmonic cascading* (also called *phasing)*– adding together a sound and copies of that sound with a slight frequency difference, which makes the harmonic components wax and wane at rates proportional to their rank,– or *endless glissando* – a gliding sound made up of octave components controlled in amplitude so that the pitch seems to go up or go down indefinitely.

I also synthesized bell-like tones, composed like chords, that can be turned into fluid textures while keeping the same harmonic composition – I used these in my *pieces Little Boy* (1968), *Mutations* (1969) and *Inharmonique* (1977). Thanks to Charles Dodge and Denis Lorrain who documented these recipes for inharmonic tones, Antonio de Sousa Dias who performed a conversion to *MaxMSP*, and Daniel Arfib, who developed that conversion, such inharmonic tones can be performed in real-time or generated – also in real-time – according to a predetermined score. A single click can instantly change the component envelope for one pre-determined shape to another one, thus turning for instance a bell-like tone into fluid or rebouncing textures (in the latter case, the envelopes scanned at different rate have their peaks at different times, yielding scintillating spectra). I took advantage of these possibilities in the last movement of *Resonant Sound Spaces*, using quasi-improvisional procedures but also pre-determined scores to obtain effects of desynchronization with rendez-vous and effects similar to change ringing.

As explained in the next paragraph, the sounds of the first movement of *Pentacle* have been synthesized by a DX7-II Yamaha digital synthesizer.

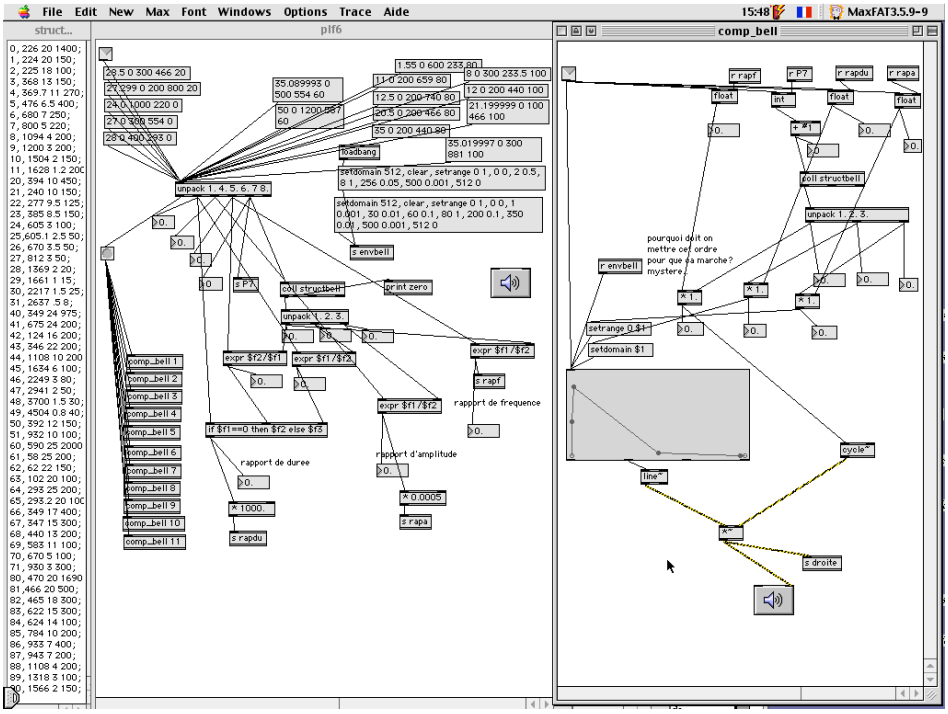

Figure 4 : MaxMSP patches used to produce variants of inharmonic structures in real-time.

4. REAL-TIME PROCESSING IN *RESONANT SOUND SPACES* AND IN *PENTACLE*

The second movement of *Resonant Sound Spaces* resort to digital filtering of flute, clarinet and saxophone sounds through resonant filters with frequencies chosen so as to suggest some virtual harmony. These filters are implemented in real-time through *MaxMSP* patches. The third movement resorts to a Disklavier Yamaha piano – an acoustic piano that can be controlled like a player piano by a MIDI sequence: selected keys are held down by a *MAX* patch; the corresponding strings are plucked or hit, and they resonate freely. The fourth movement turns resonant filtering into reverberation.

Pentacle (2006), a work for harpsichord and computer-generated " tape " commissioned by the GMEA – Groupe de Musique Expérimentale d'Albi – is dedicated to Elizabeth Chojnacka, an outstanding performer who has inspired a number of significant contemporary compositions for her instrument, including Ligeti's *Hungarian Rock* and Xenakis' *Naama* and *Khoaï*. Many of the sounds of the tape for *Pentacle* come from the real-time digital processing of musical motives – scales, melodies, chords or complex rhythmic passages – specified in advance and performed by Elizabeth Chojnacka on her beautiful modern harpsichord built by Anthony Sidey. I have used mostly *MaxMSP* to realize echoes and harmonization with or without feedback, similarly to the real-time processing mentioned above in the description of *Echappées* : however the processing performed for *Pentacle* has served to generate sounds from which a stereo tape has been elaborated in non-real-time, using the *Pro Tools* mixing program. Some processing was also performed using the *Peak* software. The processing is heavier than in *Echappées*, so that the " tape " can be very dense. This " tape " has subsequently been spatialized as described below.

In *Pentacle*, I have also used in the first movement processes of compositional development similar to those I implemented in my *Duet for one pianist* (Risset & Van Duyne, 1996). These processes are implemented through *MAX* patches, which process MIDI information without any signal processing : they are applied to MIDI sequences played on a DX7-II Yamaha digital synthesizer, using synthetic harpsichord-like tones. A sequence of notes is played on the keyboard of the DX7 and augmented by *MAX* patches. The process used is mostly the generation of arpeggioes piling notes above or under the played note with intervals such as a fourth, an augmented fourth, a sixth or a seventh – the speed of the arpeggio depends upon the loudness of the played note (the louder the faster in certain cases, the contrary in other cases). This augmentation creates sort of sonic pilars or columns – the first movement is akin to a propyleus.

5. SPATIALIZATION SCHEMES FOR *RESONANT SOUND SPACES* AND IN *PENTACLE*

Resonant Sound Spaces (Espaces résonants) is a spatialized version of *Resonant Soundscapes (Paysages résonants)*, a work commissioned in 2001 by the city of Basel and dedicated to Gerald Bennett. The 8-track

spatialization has been realized in 2002 at Groupe de Musique Expérimentale de Marseille (GMEM) thanks to the spatialization software *Holophon* by Laurent Pottier. This software implements the proper modification of the sound in the different channels to give the illusion of the specified localizations and motions as desired : but it also offers powerful tools to define localizations, trajectories and timing of motions, leading to precise specifications – a spatial score akin to the usual musical score.

The spatialization turning *soundscapes* into *sound spaces* has been effected from the eight tracks of the *Pro Tools* sessions, that is, starting from multiple sound sources before their mixing down to a stereo sound file. The spatial dissemination of sounds enhances depth is the literal sense, but also in the figured sense : it helps hearing to sort out the multiplicity of sound sources, thus facilitating for the listener a personal exploration of the proposed sonic territory. But it also proposes specific spatial figures, which differ for the different movements. The titles proposed for each of the five sections - five different *soundscapes* - refer to the material or the process used. However these may be illusory or "virtual" - for instance, all the "bells" of the second part of section V (except one) have been synthesized: no metal, no percussion. The sections are entitled as follows :

1. *Bell, brass, metal.* This section mostly resorts to recorded sounds processed in simple ways : time reversal, frequency changes with or without change of duration. At the beginning, one can hear three synthetic variants of the bell tone opening Varèse's *Poème électronique*, from an analysis realized by Vincent Verfaille. Spatialization locates various sounds in various places - only exceptionally does it suggest circular motions of sound sources around the audience.

2. *Filters*. After calls and responses from brass tones, a filtered echo introduces tiled clarinet arpeggios ascending toward a A, a B or a F, heard through a set of resonant filters tuned to certain specific " chords ". The feeling of giration is reinforced by illusory spatial rotations (inverse clockwisefor the A motive, clockwise for the others). Toward the end, two fixed percussions introduce a rapid and swiftly moving flute motive, and a bird circling around further and further.

3. *Plectra*. Thanks to the computer control of the motions of hammers and dampers, the *Yamaha Disklavier* mechanized piano at the Laboratoire de Mécanique et d'Acoustique of CNRS in Marseilles makes it possible to produce sounds through direct actions upon the strings, like using plectra, thus turning the piano into a variant of the harp. Putting fingers at specific positions along the strings inhibits certains partials and reinforces other ones. The spatialization attempts to suggest resonances expanding along huge harmony boards.

4. *Reverberated.* This gloomy section was realized in the aftermath of september 11, 2001. Crowds, screans and laughs, rumors, cymbals, choruses, voice, organ, through an ample and slowly moving reverberation. The section is concluded by distant explosions from an obscure disaster.

5. *Bell, horns*. Scanned by ship horn calls, the fifth section alludes to the book *Les cloches de Bâle* : recordings and reconstitutions of material bells are answered by a virtual chime of synthetic tones. The spatialization fills the space by demultiplying the sources and dematerializing them through illusory motions. It also attempts to suggest a motion for the listener : initially the sea sounds are in front of the audience, while the bells come from the back – from the city center. Then the listener is amidst the many bells, and the foghorns are heard from the back. Finally the sea is in front again, and the return of the Varèse bells comes from behind.

The tape for *Pentacle* (2006) has also undergone a 8-track spatialization with *Holophon*, following specifications that differ for the five successive movements. In the first movement, presenting arpeggiated chords and likened to a propyleus, the tape response comes from the stage, on both sides of the harpsichord. In the second movement, chords get more and more dense : successive chords appear to originate from different points of the room, but left-right symmetry is preserved. In the third movement, melodic motives rotate around polar centers. The sounds come from the stage at the beginning, but at some point the tones from the tape proliferate in non-tempered tuning : these tones are scattered all around the room. In the fourth section – the longest – the sounds gets airy ; the harpsichord responds in filigree from various points in the room to soft resonances and stealthy rubbings or scrappings from the stage. The last movement is a implacable downward perpetuum mobile that gets lost amidst the gloom : it soon starts rotating around the room, first as a beam, then as a global twirling, and it becomes randomly distributed as the sound is *en route to chaos*.

6. CONCLUSION

Real-time can be a strength but also a limitation. It can allow to introduce performance nuance and to improvise while composing sound as well as while composing with sounds. However a careful elaboration of certain aspects is often invaluable, thus it can help to be freed of the constraint of real-time. This seems to be the case for spatialization : its specification deserves thought and precision. The software *Holophon*, with its input editor *Holo-Edit,* offers powerful tools in this respect : it appears to the author as a milestone toward composing space – " vers l'écriture de l'espace ".

7. ACNOWLEDGMENTS

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