Stria by John Chowning: Last Improvements

Olivier Baudouin, MINT-OMF, Paris IV Sorbonne

olivierbaudouin@gmail.com

Since my first paper about *Stria* (*Computer Music Journal*, 31:3, 2007), a lot of adjustements have been made in the reconstruction of the piece. I started this project in 2006, which was just achieved for the re-premiered in Paris, at the concert "Musique et Complexité" held by Nicolas Darbon and Jean-Claude Risset, at the CDMC-Cité de la Musique, the 11th December, 2008. *Stria* (1977) – as most of electroacoustic music produced in the beginning of digital synthesis techniques – was fixed on a mass storage disk with a strong background noise caused by the use of low sample rates (12.8 and 25.6 kHz).

In 1988, John Chowning published a commercial CD containing *Phoné*, *Turenas*, *Stria* and *Sabelithe*. Unfortunately, the remixing and resampling of *Stria* not only did not lend to a great progress in the sound, but also caused damage: the loss of original form. This unsuccessfull attempt can be explained. First, resampling is efficient on condition that music comes from strict analogic records, and a synthesis sound – stored on digital tapes, fixed on a mass storage disk or converted in an analogic signal – is sampled upstream inherently. Secondly, several versions of the piece coexist, as showed by Laura Zattra in her paper about *Stria* in the same issue of the *Computer Music Journal*: Johannes Goebel, the CD's master builder, pasted and mixed sections according to the composer's memories, and Chowning was very busy at this time. At last but not least, this version does not solve the problem of background noise (and clicks), for which sound cleaning would be very destructive.

Despite these arguments for a full reconstruction, I came to *Stria* with analytical reasons, not as a rescuer! My purpose was to describe the piece as best as possible and, one thing led to another, I first got in touch with John Chowning to have the original sources in Music 10, SAIL (a kind of ALGOL), and the best version of the audio files, namely the 1977 CCRMA version. Finally, still for analytical goals, I transcribed these obsolete codes into Csound and Python. This paper describes improvements added in the months following my first paper, as well as the benefits and difficulties involved by this experiment.

Elimination of clicks

For the frequency modulation device, Chowning gave me a set of six curves, among which an alternate curve for carrier amplitude characterized by a very sharp and percussive attack. This part of the curve was vertical, with an inclinaison close to zero degrees. Because of a quick rise of energy, audible clicks appeared in the spectrum, and this problem could not remain unresolved. A handcrafted solution would be to correct the waveform in an audio editor, but this operation would have had to be repeated for each new version. Finally, I chose the compromise between neatness, ease and respect for the composer's idea. I applied an elusive inclinaison to the sharpened part of the curve until the clicks disappeared, at least for the listener.

Reconstitution of the ending section

One of the benefits given by art researches is to gather and classify all records, documents, sketches, etc. on a piece in order to command a maximum of data. It also reveals gaps in the composer's records: Chowning realized that parameters of the ending section had to be computed with an early – and missing – version of his program. Then, I carried out a set of numerous tests and comparisons between changes in the program and their results watched through sonograms (*). The solution was not sophisticated: a retrogradation of the second prime "serie" – a 9 pseudo-tones scale based on the Golden Ratio – and a mild change in the temporal weight of the elements of this section.

Transfer of amplitude

Stria's generation program produces four sound tracks with a very low amplitude, and consequently little intensity. In fact, the composer changed the loudness by hand, after the sound synthesis. Modify amplitudes in parameters before computation would not be a right answer, because of the type of elements generation. Indeed, all elements of the piece are overlayed as tiles, which would not allow to obtain a steady-stream amplitude. So, amplitude had to be transfered from the composer's version (manually mixed) to the reconstruction version, by means of a trick. I tried to use the Csound opcode "balance", which adjusts one audio signal according to the values of another, but its performance on *Stria* turned out disasterous. So, I wrote then a slicker instrument (see below) to compare the two signals (CCRMA / reconstruction), to reduce, by down-sampling, the amount of variations of the amplitude curve, and to eliminate, by a conditionnal value, any possibility of click.

Spectrum and sampling rate

Stria was sampled at 12.8 and 25.6 kHz. Increasing the rate from these values to 44.1 kHz revealed details hitherto

omitted by the sampling process, especially in the reverberation instrument, initially at 12.8 kHz. To avoid an impeding proliferation of high partials, I used a low-pass Butterworth filter ruled with a cutoff frequency at 12.5 kHz.

```
---------------------------------------------------
ain1b init 0
ain1c init 0
fin "reconstruction.wav", 0, 1 , ain1b
fin "ccrma.wav", 0, 1 , ain1c

aenv2 follow ain1c, 0.25
aenv1 follow ain1b, 0.25
kenv2 downsamp aenv2
kenv1 downsamp aenv1

if (kenv1 != 0) kgoto label0
                kenv2 = 0
                kenv1 = 1
label0:
kmul = kenv2/kenv1

if (kmul < 20) kgoto label1
                kmul = 1
label1:
kmul2 portk kmul, 1, 0

asig = ain1b*kmul2
out asig
---------------------------------------------------
Instrument for the transfer of amplitude.
---------------------------------------------------
```

Inaccurate transcription in the reverberation instrument

A serie of all-pass and comb filters (REV2 and REV1) are called by the Music 10 program. In my early transcriptions to Csound, I merely used their homonyms “alpass” and “comb”, in spite of inconsistencies in parameters. Indeed, REV2 and REV1 require a gain factor and a delay, whereas “allpass” and “comb” compute the gain factor from a logarithmic formula involving delay and loop-time. So, I compared the Music 10 and Csound source codes to understand their mechanisms and to build a non-litteral but correct reverberation instrument:

```
---------------------------------------------------
iosr = 1/25600 ; original sample rate.
arev4 init 0
(...)

arev3 nestedap arev2, 1, 1, 67*iosr, 0.7 ; instead of alpass opcode.
                ; single all-pass filter at mode 1, to simulate Music 10 REV2 all-pass filter.
                ; see M. Battier, Le langage de synthèse Music 10, p. 4-16 and Csound 5.08 source code (biquad.c file).

arev4a init 0
arev4 = arev3 + arev4a*.802  ; instead of comb opcode.
arev4a delay arev4, 3201*iosr, imaxdel
                ; to simulate Music 10 REV1 comb filter with a feedback factor.
                ; see M. Battier, op. cit., p. 4-15.
                ; cf. Csound 5.08 source code (ugens6.c file).
(...)
---------------------------------------------------
Reverberation instrument (excerpt).
---------------------------------------------------
```

Pure sound vs. old sound

When I compared the reconstruction version to the historical version, I missed its near-analogic sound, only for a while. Indeed, with all these improvements, *Stria* sounded “pure”, very clear, and when you are used to listening to the antique version, it is surprising! So, I suggested to John Chowning a new version including a subtle background noise, to “bind” the spectrum and to make the sound milder. Fortunately, John detered me from following this archeological phantasm, and my ear gradually grew accustomed to the beautiful crystalline, zen sound of *Stria*.

Conclusion

This type of overall reconstruction presents three aspects, whose significance varies according to if you are composer, musicologist, student or listener. First, the piece can be heard in its full quality of sound, complied with requirements of the actual studio. Second, the new code can be easily read and used for didactic and analytic purposes, and, to that end, tested by means of a graphical interface (primarely designed to make the first reconstruction attempts smoother). Thus, such a work could be associated with other educational projects such as the “Jonathan Harvey's *Mortuos Plango, Vivos*

Voco" by Michael Clarke. Finally, the aspect of heritage conservation has to be highlighted. Here, reconstruction goes hand in hand with rebirth. It is the golden opportunity – if I may say so – for renewal studies and knowledge about one of the most prominent *chef-d'œuvres* of electroacoustic music.

http://ccrma.stanford.edu/pieces/chowning/stria/

References

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(*) Contrary to what I notified in my first paper, I finally could not benefit from any efficient data for the ending section.