Composing the remembrance of an inspiration:

an algorithmic approach From the fifth movement of Beethoven's string quartet op.132 to Sinfonia 3 Erinnerung for (double) string quartet, ensemble and live electronics (2008)[1]

Peter Swinnen

This piece, commissioned by the Spectra Ensemble for their participation in the 'Gouden Vleugels Contest 2008' in tandem with the Bl!ndman[strings], is a tribute to Ludwig van Beethoven and Luciano Berio. It takes the fifth movement of Beethoven's string quartet no. 15 op. 132 and treats it as in Luciano Berio's *Sinfonia*. In other words: Beethoven (the past) tries to *break through* Berio (the present). It is as if you *remember* something without knowing precisely what it is: *Erinnerung*. At the same time throughout the piece this idea of the past transforms itself to the point that it can be integrated into the present: *Er-Innerung*. In the same way as the combination of a string quartet and ensemble reminds us of the idea of an eighteenth century *Sinfonia Concertante* (past), the use of electronic transformations recreates it into the present.

1. Introduction

When the members from the Bl!ndman [strings] and the Spectra Ensemble came to me with the proposal for a new project in which each movement of Beethoven's string quartet no. 15 is somehow recomposed by a living composer and successively performed around the original version of the third movement (*Heiliger Dankgesang*), so as to have a big recomposed Beethoven quartet, I was immediately intrigued by the question: what can the past add to the music of the present? However, to be honest, I was not too enthusiastic about merely recycling the thematic material.[2] In the spirit of Beethoven, I preferred to work with the feeling you have when you think you recognise a piece of music, but you just cannot figure out what it is. In other words: remembrance as a struggle with one's own imagination. That is how I came to the algorithmic approach described below.

1 The score can be downloaded from the composer's website at http://home.scarlet.be/~pin01189/_trees/03_repertorium/_compositions/erinnerung.html.
2 See also Swinnen (2003).

2. Analysing Beethoven's string quartet into algorithmic parameters

The piece is conceived as a *Sinfonia Concertante* for string quartet, ensemble[3] and live electronics.[4] At its basis lies the original fifth movement of Beethoven's String Quartet no. 15, running on a pre-recorded CD[5] during the piece, permanently controlling the music through the electronics, but almost never heard unaltered by the audience. This pre-recorded material tries to break through the live music, which apparently does not resemble the original Beethoven music. Yet it is completely derived from it, so as to permit the necessary interaction between them. The material used comes down to three categories: form, harmonic rhythm and melodic shape.

2.1. Form

Traditional form analysis based on thematic correspondences reveals that this movement is a rather unusual rondo form (see figure 1).

Total duration: 390 sec. (6 min. 30 sec.)

Section	A	B	A	C	A'	B	D	A"	E	F	F'	F"
Bar	1	52	90	124	148	161	177	232	247	272	298	321
Time	56"	42"	37"	26"	14"	18"	60"	16"	28"	28"	25"	40"

Figure 1

2.2. Harmonic rhythm

Traditional harmonic analysis describes harmonic rhythm as the rhythm in which chords change. However, to find out when a chord actually changes, it simply neglects all kinds of ornamentations, passing notes, etc. Since I'm more interested in the harmonic value of the sonorous result than in the way the chord was actually constructed, I prefer to define a chord change whenever the combined sounds result in another overtone series.[6] Within the project 'Messiaen reflected, development of a meta-model for musical analysis' (Swinnen and Deneckere 2007: 237-51), we developed an algorithm to do exactly this: chord-partials. This algorithm outputs the root and overtone combination at each point of time. Running the original Beethoven's fifth movement through it delivers a precise harmonic timeline for the whole piece (see figure 2).

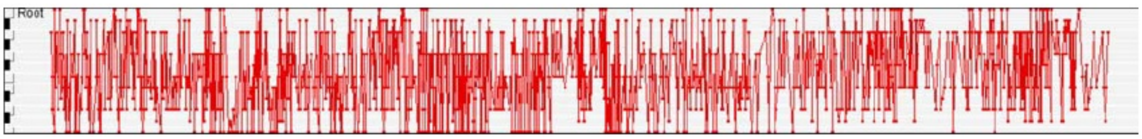

Figure 2

3 Flute (also alto in G), clarinet in Sib (also Bass), viola, violoncello, percussion (marimba, vibraphone, tam tam, triangle, temple block and woodblock) and piano.
4 One person at the mixing desk in the concert hall, triggering the presets and doing the mix. See also chapter 5 'Electronics' of this article.
5 The string quartet should prerecord the fifth movement of Beethoven's string quartet no. 15 op. 132 without *accelerando*. This recording controls the electronic transformations of the live string quartet and ensemble and should be used as a click track by the conductor.
6 See also Hindemith (1937).

2.3. Melodic reservoir

A well-known way to create new melodic material from an existing one is to calculate the number of times a transition between each note of the original material occurs and to use this as a probability table from which to generate new material.[7] This new material then shares some important characteristics with the original one: it is based on the same melodic cells but became a complete new melody. For each section as described in chapter 2.1, all pitches are sorted, counted and stored in such probability tables, to be used to generate melodic material for the ensemble (see chapter 3.3.2).

2.4. Melodic shape

Another interesting source of material is the musical gesture as reflected by the different Beethovenian melo-rhythmic motives. In order to capture these, I reused the bitmap-synthesizer I developed for earlier pieces.[8] Its function can briefly be described as follows: each pixel row in the image addresses a single pitch, each pixel column a moment in time; by scanning the pixels ('black' means 'on', 'white' means 'off', 'grey values' give volume information) the image gets *translated* into a usable polyphonic musical texture.

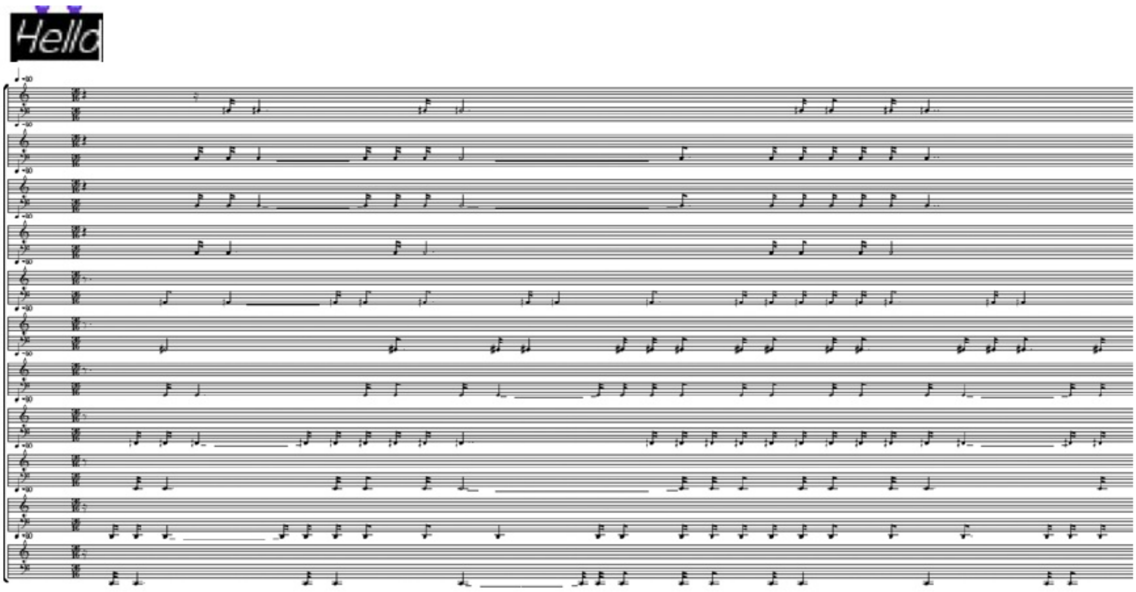

Figure 3: the music visually reflects the original text ("Hello").

3. Designing the piece

3.1. Form

Since the original duration of 6 min. 30 sec. turned out to be a little short to justify such a demanding performance set-up, I decided to double each section, playing it sometimes forwards, backwards or even back and forth. Hence the total duration becomes ca. 13 min., ensuring it can be played as an independent

7 Also known as a Markov chain.

8 e.g. *Nevrištec, per quartetto d'Archi* (2006): 15 and *Hodechtri*, for flute, clarinet, violin, cello, piano, percussion and electronics (2006): 30.

piece. The tempo retains the original 3/4 *Allegro Appassionato* (*164=crotchet*), resulting in the table in chapter 6 'Overall Structure'.

3.2. Harmonies

All harmonies are built from a continuous and gradual spectral morphing between three sounds ('plate' over 'cello' to 'pipa'). This corresponds to a harmonic colour that gradually opens up and then enriches itself into the higher harmonics. In order to create waves of harmonic tension and relaxation, spectral compression[9] is used on the resulting morphed spectra. For an overview of the parameters used, see the table in chapter 6 'Overall structure'.

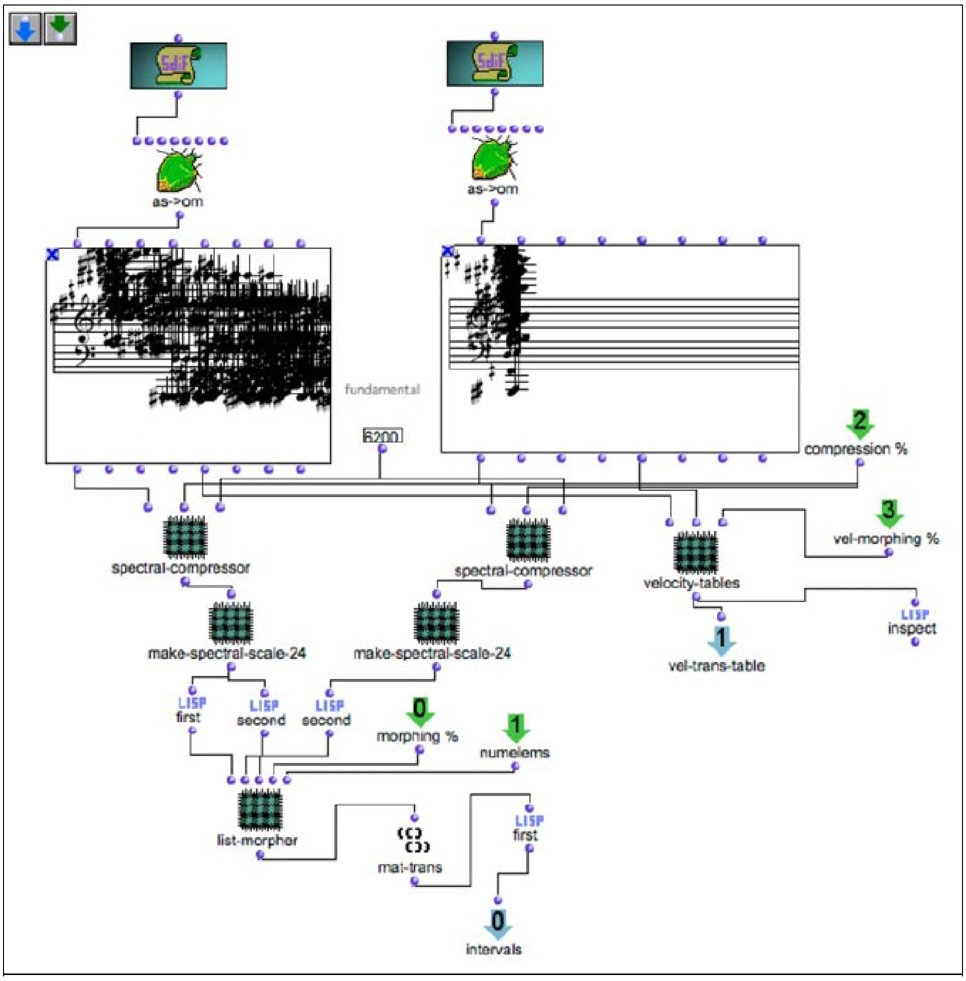

Figure 4: spectral morphing and compression.

The actual spectral calculations are done in the computer programme[10] in figure 4. For each moment in time the computer programme receives at its inputs two 'base spectra' and the current 'morph%' in-

9 This technique, as explained by the outstanding British composer Jonathan Harvey, builds on the fact that if you add to all notes of an overtone series the base frequency, you come back into the same overtone series, but one overtone higher; if you add a fraction of the base frequency, all overtones come closer to each other, creating a whole new spectrum; hence the term compression.

10 Implemented by the composer within Ircam's Open Music environment, a standard platform for algorithmic composition, available at http://forumnet.ircam.fr/.

between them, plus a 'compression%'. For each note of this resulting spectrum the programme outputs its pitch and volume. Based on this information, I transpose all pitches within one octave and, starting on the corresponding roots from the Beethoven analysis, create scales with the *n* loudest notes, omitting doubles. These scales are used as modal pitch reservoirs wherein all note combinations are allowed, fully retaining the colour of its originating spectrum.

3.3. Melo-rhythmical material

3.3.1. Live string quartet

The melo-rhythmic material for the live string quartet is generated from the original Beethoven score, scanned through the bitmap-synthesizer. But, whereas Beethoven uses the same motives throughout all sections of his rondo, I change the text font (see figure 5) over the different sections, changing gradually from mere text characters to genuine musical symbols (see figure 6). This ensures the resulting musical gestures are indeed coming closer and closer to the original printout of Beethoven's string quartet, hence it reinforces the suggestion of finally *remembering* the lost music.

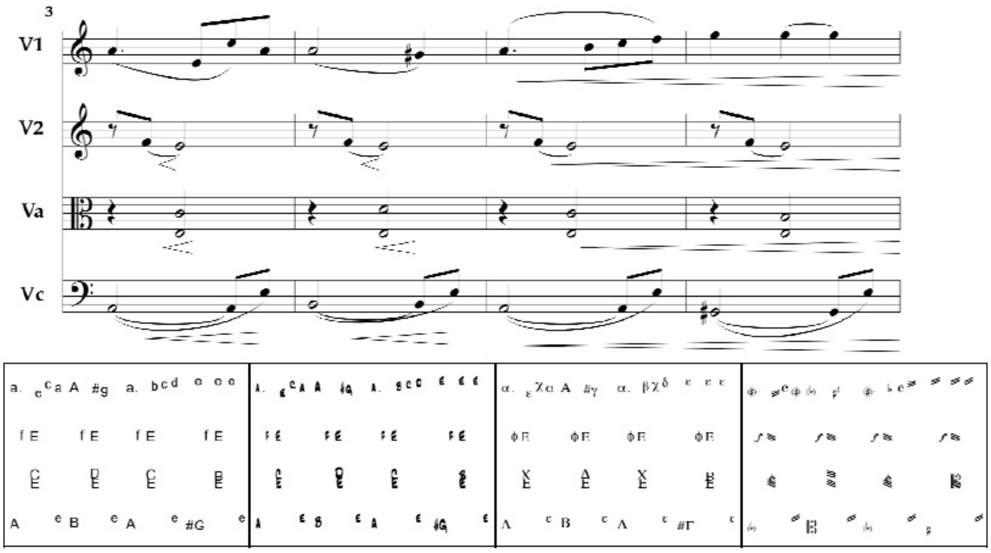

Figure 5: all texts are the same, but in a different font.

Section	Font	Sampler	Stems	Ties	Smart Shapes	Note shapes
a	Arial	text	0	0	0	X
b	Arial italic	*text*	0	0	0	X
c	Arial	text	0	X	0	X
d	Apple Chancery	text	0	X	0	X
e	Arial bold	**text**	X	X	0	X
f	Arial italic	*text*	X	X	0	X
g	Bodoni Ornaments	[illegible]	X	X	0	X
h	Arial	text	X	X	X	X
i	Wingdings 2	♦♏⌧♦	X	X	X	X
j	Maestro	[illegible]	X	X	X	X
k	Maestro	[illegible]	X	X	X	H
l	Maestro	[illegible]	X	X	X	0

Figure 6

The musical textures coming out of the bitmap-synthesizer are always mapped into the proper scales as calculated in chapter 3.2, to ensure that they fit into the proper harmonic context at each moment in the piece.

3.3.2. Ensemble

The melo-rhythmic material for the ensemble is based upon a continuous and gradual metric morphing from a standard 5/8, over a 4/8+3/8+3/8 (bar 408) towards the original metrics 3/4 at the end. Each resulting metric gives a probability table for each possible rhythmic position. For an overview of the parameters used, see the table in chapter 6 'Overall structure'.

For each of the four homophonic instruments (flute, clarinet, viola and violoncello) a rhythmic line is generated using the probability table from the resulting morphed metric above. The pitch for each note is generated from an index-based pitch probability table as described in chapter 2.2 and mapped to the corresponding note from the current scale as calculated in chapter 3.2. For each of the two polyphonic instruments, three voices are generated as above, but only the chromatic notes are kept and merged into one polyphonic part.

The volumes are calculated whether following the natural decay of the current spectrum, whether following the reversed decay, whether on a fixed value. In order to be able to reflect these subtle fluctuations without overloading the musician’s reading, the final score uses the size of the note heads, instead of traditional dynamic markings (see figure 7).

Figure 7

4. Instrumentation

As stated before, the piece was conceived as a *Sinfonia Concertante* for string quartet, ensemble and live electronics. The string quartet acts like a polyphonic soloist, *looking for the lost Beethoven's op. 132*, which resonates in their memory. Along the road, as if they want to *reconstruct history*, they form all kinds of standard chamber music combinations with individual members of the ensemble: string quintet (bar 239), string sextet (bar 260), piano quintet (bar 423) and clarinet quintet (bar 464).

After an opening burst of the ensemble, the string quartet is presented in a kind of cadenza (bar 54). They try to *start looking*, but get interrupted by a second burst of the ensemble (bar 179). After a second cadenza (bar 214), the string quartet finally succeeds in *getting on their way* and the piece starts transforming the material until it arrives suddenly in a kind of slow movement (bar 388). Here, for the first time, fragments of the original Beethoven succeed in breaking through. A dispersed dialog between the string quartet, the ensemble and the pre-recorded material then tries to recombine the musical ideas into a new form until it turns into a kind of obsessive dance (bar 498) where all performers participate and through which Beethoven finally gets his recognition.

5. Electronics

The electronics are implemented as a custom made 'Mac OSX' application,[11] consisting of two audio inputs (one for a sub mix of the live string quartet, one for a sub mix of the ensemble) and two audio outputs to be directly connected to front left and front right speakers, plus an additional output for the conductor's click track. The presets have to be triggered by a musician nearby the mixing console in the concert hall. The idea is to try to create the illusion of the electronics overwhelming the musicians in the beginning, then sounding more like a *distant remembrance* in the middle part, and blending as much as possible with the acoustical instruments by the end.

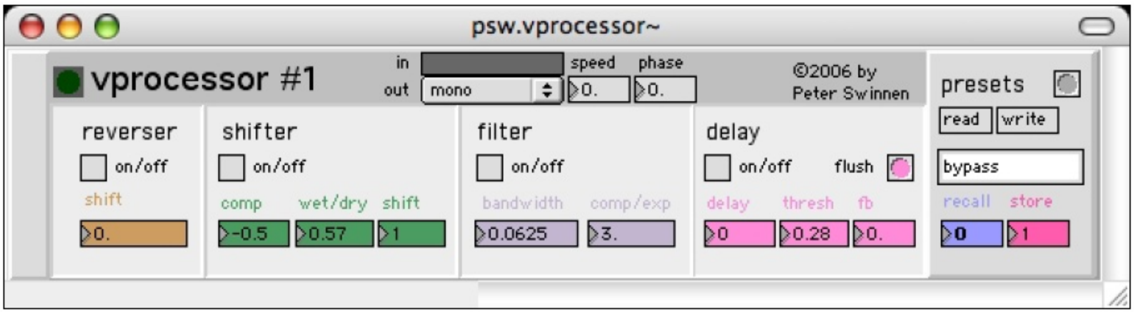

Figure 8

The core of this real-time sound processing application is a custom developed engine (see figure 8): the vprocessor, a real-time FFT[12]-based cross-processor for sounds, running in 'MaxMSP'.[13] It takes two sounds and analyses their spectral contents through standard FFT techniques. Several statistics ('max', 'min',

11 This programme, a patch for use with 'Cycling '74s MaxMSP' can be downloaded from the composers website at http://home.scarlet.be/~pin01189/_trees/03_repertorium/_compositions/erinnerung.html.
12 'Fast Fourier Transform', a standard technique for frequency analysis of digital sound.
13 'MaxMSP' by 'Cycling '74' (http://www.cycling74.com) is a standard environment for programming real-time audio and video applications, and is especially suitable for implementing live electronics.

'mean', 'standard deviation', 'skew' and 'kurtosis') of the spectral contents of the engines second input are then used as parameters to transform the spectrum of the engines first input. In other words, the timbre of sound two is used to transform the timbre of sound one in real time (see figure 9). Main transformations are: reverse the spectrum top/down, timbre dependent frequency shift, timbre dependent filtering, timbre dependent delay and timbre dependent spatialization. All these transformations are implemented as custom made 'C externals'[14] for 'MaxMSP' (see figure 10).

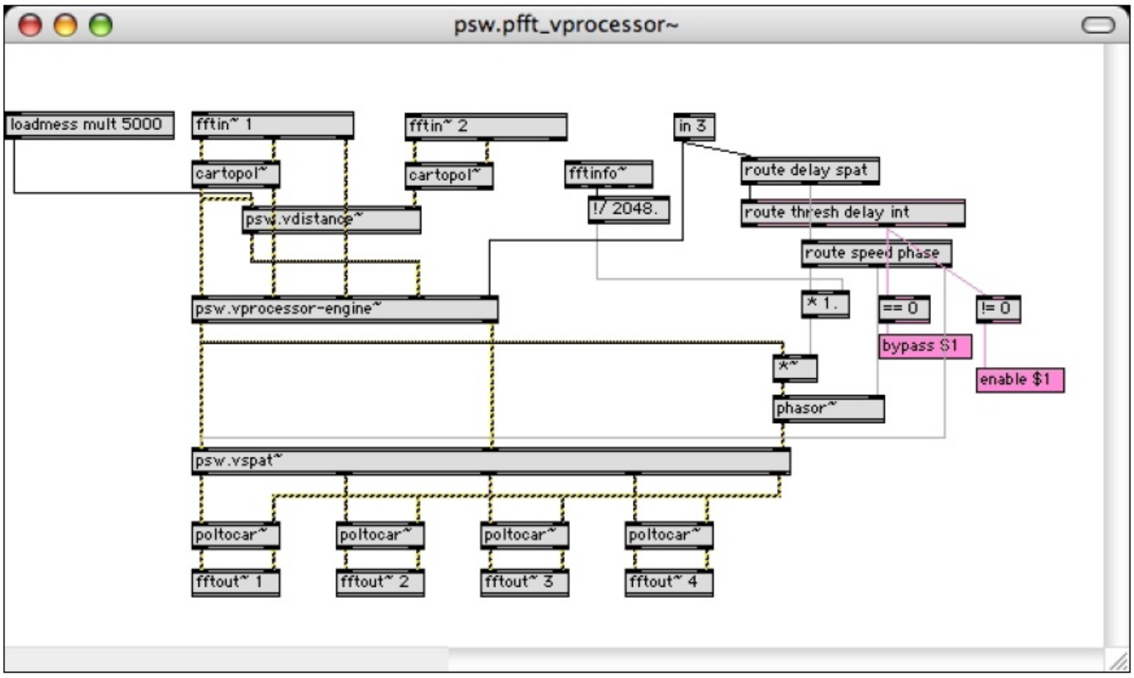

Figure 9

In order to achieve the various desired timbre-interactions throughout the piece, the vprocessor is fed with changing proportions of the pre-recorded Beethoven string quartet, the live string quartet and the ensemble. The presets evolve as indicated in chapter 6 'Overall structure'. Since all sources are continuously harmonically connected (see chapter 3.2), the spectral interference remains stable throughout the section, allowing the musicians full control by their timbre. The electronics are indeed extremely sensitive to even small changes in timbre of the instruments, which gives the instrumentalists a lot of extended expressive means. As a general rule the instrumentalists should always strive to play in such a way that the acoustical blend amongst them is as smooth as possible, and then deviate from that to create special effects through the electronics. In this way, the electronics behave like a genuine timbral extension of the performers’ instruments, or, putting it differently, provide the performers with what could be called 'extended instruments'.

14 You can download them from the composer’s website at http://home.scarlet.be/~pin01189/_trees/05_software/_download/max-externals/PSW%20Tools%203.0ub.dmg.

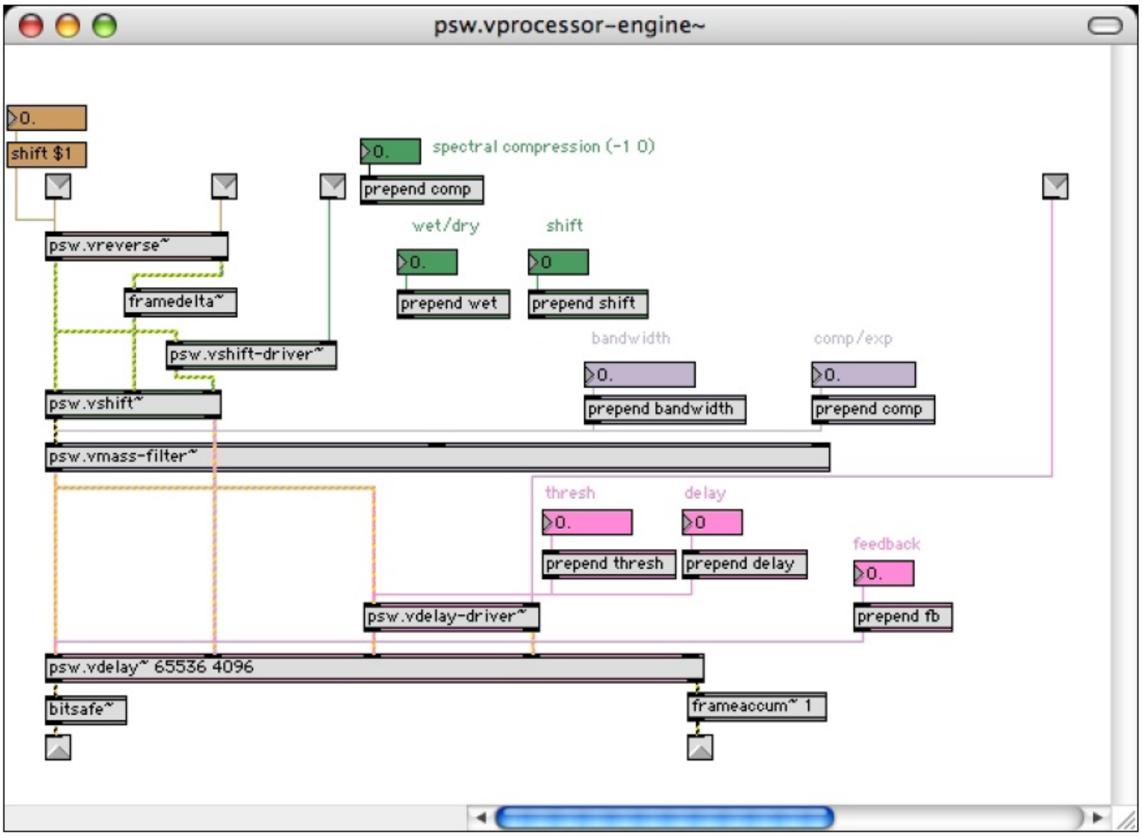

Figure 10

Of course, in order for this illusion to work, the different acoustic and electronic sound components should blend perfectly together. However, the classic solution to add some reverberation to the electronic sounds, turns out to be unusable in this case, since it drastically increases the risk for feedback loops, which completely messes up the harmonic interconnectivity as described in chapter 3.2. That is why, before reaching the speakers, the output of the vprocessor passes through an additional granular synthesizer,[15] adding some *mist to* the electronic generated sound, which also helps for a better blend with the acoustic instruments, but with reduced risk of feedback, especially in acoustically more difficult concert halls.

15 See http://en.wikipedia.org/wiki/Granular_synthesis; the implementation used here is Nathan Wolek's Granular Toolkit, downloadable from http://www.nathanwolek.com.

6. Overall structure

Section	A		B		A		C		A'		B		D	
Score		A	B	C	D	E	F	G	H	I	J	K	L	M
Bar	1	53	104	141	179	213	246	265	289	302	317	334	352	388
Harmony:														
Scale: spectral morphing from the beginning ("PLAT 2") over D, H and N ("CE D4 S") to W ("FRT-Pipa D4 mp|")														
Morph%	0	0	0	0	33	33	33	33	66	66	66	66	66	66
Notes/oct	15	15	15	15	13	13	13	13	11	11	11	11	11	11
Compr.	50	0	33	66	50	0	33	66	2	10	18	26	34	42
Roots														
CD	a-1	0	0	0	c-1	0	0	0	E	e-1	F	f-1	g-1	g-1
Ens.	a-1	0	0	b-1	c-1	0	0	d-1	E	e	f-1	F	g	g-1
Quartet	0	a	B	b-1	0	c	d	d-1	e*2	->	f*2	->	1/2g*2	0
Melody														
Quartet: bitmap-synthesizer														
Image	0	a	B	->	0	c	d	->	E	->	F	->	g	0
Rest%	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ensemble: metric interpolation 5/8 (no subdivision) - 10/8 (4 + 3 + 3) at N - 3/4 in I2														
Interpol%	0	0	0	0	33	33	33	33	66	66	77	77	88	88
Vel-rev.	0	0	0	1	0	0	0	1	40	45	55	70	90	0
Rest%	5	0	0	15	5	0	0	15	35	45	55	65	75	85
Electronics														
Preset	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Effect	Granrev			Rev	granrev			rev	grandel		grandelshift		+ wet	
Vproc	50	0	0	51	50	0	0	51	52	53	54	55	56	57

Section	A"		E		F		F'		F"	
Score	N	O	P	Q	R	S	T	U	V	W
Bar	408	423	438	464	488	512	538	564	590	625
Harmony:										
Scale										
Morph%	100	100	100	100	83	66	49	33	16	0
Notes/oct	9	9	10	10	11	11	12	12	13	13
Compr.	50	40	45	35	25	30	15	20	10	0
Roots										
CD	h	h	0	0	0	j	k-1	k	l	L
Ens.	0	0	i-1	0	j	j-1	k	k-1	l	L
Quartet	h-1	h	0	2/2i*2	j*2	->	k-1*2	->	l*2	->
Melody										
Quartet										
Image	h	->	0	i	j	->	k	->	l	->
Rest%	85	80	0	82	79	74	66	32	53	0
Ensemble										
Interpol%	100	100	100	100	83	66	49	33	16	0
Vel-rev.	0	0	0	0	-100	-90	-80	-70	-60	-50
Rest%	0	0	85	0	83	66	33	49	16	0
Electronics										
Preset	15	16	17	18	19	20	21	22	23	24
Effect	Granchordel		Chordel		chordelshift		chorshift		Chor	
Vproc	58	59	60	61	62	63	64	65	66	66

Figure 11: parametric overview of the piece.

7. Conclusion

The use of these algorithmic techniques turned out to be a very valuable means to achieve the desired effect. By carefully playing with the different parameters throughout the piece, it allowed me to meticulously dose the amount of alienation against the original Beethoven's music. Reinforced by the electronics, this created the necessary musical textures, which are at the same time sufficiently linked to, yet sufficiently different from the original, so as to get rid of the mere *referential* in favour of a truly composed remembrance, honouring the original inspiration that gave birth to Beethoven's masterpiece.

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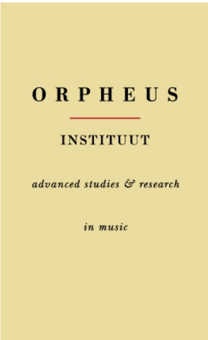
Wikipedia, http://en.wikipedia.org/wiki/Granular_synthesis (accessed 1 July 2009).

After completing his studies at the Royal Conservatory of Brussels (1983-1992), **Peter Swinnen** *obtained a masters degree for composition under André Laporte from the Queen Elisabeth College of Music in Waterloo (1989-1992). Since 1992 he teaches Analysis, and later Music Technology (2002) and Composition (2004) at the Royal Music Conservatory of Brussels. Peter Swinnen is also founding member and president of the International Society for Contemporary Music Flanders (2005). In 1997 his piece Quar´l was awarded the "Prix de Musique Contemporaine de Québec" and Canzone won the "National Composition Contest" of the Queen Elisabeth International Music Competition of Belgium, an honor repeated in 2001 with Ciaccona. In 2005 he was named "Laureaat van de Koninklijke Vlaamse Academie van België voor Wetenschappen en Kunsten" (Laureate of the Royal Flemish Academy of Belgium for Arts and Sciences).*



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