DYNAMIC MUSICAL THINKING

Some analytical approaches to the use of space in instrumental and electronic music composition

Daniel Zea Gómez – Institute of Sonology – 2006

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Human perception of sound is multidimensional. Psycho-acoustical research in the twentieth century has approached these complex phenomena and has stated some theories, which might explain our internal hearing process. We can distinguish from a single sound event different dimensions: pitch, intensity, duration, localization of the source, timbre (or spectral envelope) among others. Therefore, our brain must have a very refined and high-resolution algorithm for deriving all this information from a one-dimensional wave of air pressure exciting the timpani's membrane.

Experimentation has lead to establish that the symmetry of our aural system, allows us to perceive the localization of a sound source in space mainly by the real-time analysis of inter-aural time-delay, phase, and intensity differences. (Blauert 1974 rev. 1996) Translating these data into physical dimensions brings us into the area of dynamics, where movement is analyzed in terms of time, distance, location and energy involved in the process. All these research has been very influential in various fields and has lead to huge technological developments, specially pulled by the interests of the recording and the film industries, such as the stereo recording and reproduction or surround sound. But somehow, musicians have been aware of the same phenomena in a more empirical and aesthetical way.

We can trace experimentation with music including spatial criteria in its compositional structure, back to renaissance. The earliest published works using space as a compositional element date from the mid-16th century at the Basilica San Marco in Venice, and the influence of the architectural space in music was very determinant, in composers such as Willaert and Gabrielli. But one can be sure that the traditional and popular musical practices had included very interesting spatial procedures since ever, perhaps because the reality of sound demands an awareness of dealing with the sound sources empirically. Nevertheless, this interest for space has re-flourished in the Romanticism with composers like Berlioz, Wagner, among many others and carried out strongly into the twentieth century, in which it became matter of constant experimentation for the sake of new musical expression.

The main purpose of this work is to outline some compositional techniques that have dealt with the dynamic reality of sound in space in various ways. Transcription of processes such as acceleration, Doppler effect, and sound trajectories, and the way of dealing with time and musical sources in space in instrumental music are the body of my first chapter, in which I will refer as well to the tradition of dynamic musical thinking of Xenakis, and the particular approach of Julio Estrada. The second chapter will comment these same concerns from the point of view of electronic music, concentrating on sound routing techniques for multi-track works projected in space. The structures for controlling dynamically routes of sound are the subject of study, from the pre-conceived composed almost architectural organized sound of Varèse's *Poème Electronique* to the French "*Acousmatique*" tradition (which include a live performer controlling this routes) to more recent methods such as spectral panning or more classical ones as the use of correlated and uncorrelated random routed in space.

The third chapter will focus on the use of space as an instrument itself, and as a control interface, and will highlight some interesting use of microphonic techniques mainly in the live electronics context.

Finally I would like to point out, that this paper -far from being a research on spatialisation technologies or a historical treaty on the use of spatialisation, is the collection of the research which has constituted my personal compositional framework during the past years specially the last two I've spent in the Sonology Institute, therefore some of the procedures of my own compositions will be commented.

1. WRITINIG SPATIAL SOUND MOVEMENT IN INSTRUMENTAL AND ELECTRONIC MUSIC

Traditionally movement in music has been related to motion in time. And composers from all times had exploited this basic characteristic of the rhythmic musical phenomenon. Nevertheless there has been a lot of music written (especially in the past two centuries) in which musical movement occurs both in time and space. Spatial placement of sound has had a huge influence on compositional thinking.

One strategy of generating spatial effects in music is separating the musical sources. This discrete and stationary disposition of instruments in space was probably first seen in written music in the Venetian tradition of separated vocal groups in the late renaissance and was influenced by the architectural space itself. This procedure has been adapted to the opera tradition in the romanticism in various ways from Berlioz to Wagner, and in a lot of music of the early twentieth century as well. This way of working is somehow opposite to the idea of the actual sound sources moving present in musical manifestations such as military or other moving bands. This dialectic way of thinking will be highlighted in several moments in my text.

One of the characteristics of this type of music until the mid-twentieth century is that spatial dialog between scattered performers is done in a discrete way, emphasizing more in the spectacular effect of distance and simple canonic effects that imitate echoes and natural reverberation, and these procedures try to highlight somehow the dramatical content of the music.

But a different approach is that one of creating a continuous movement of sound in space, which has been introduced in the second half of last century. This technique involves ensemble dispersion as well, but makes the perceptual interest focus on movement by the dynamic shading and the temporal overlapping of sounds. Stationary instrumental groups are placed around the audience and successively play sounds of similar pitch and timbre with similar dynamic envelopes, making the sound seem to rotate, gradually shifting from one ensemble to the other. This idea of using superimposed layers of dynamic envelopes and temporal shifts to cause continuous changes in the apparent position of instrumental sound, was explored by composers such as Stockhausen, Serocki, and Xenakis, and seems to be more influenced by the use of stereophony in the electronic music studio that by the western musical tradition mentioned above.

Iannis Xenakis inherited somehow the dream of Varèse's of a liberation of sound by creating music in which the movement of sound masses and shifting planes will be clearly perceived. The idea that musical form might not be made of discrete events that build up phrases, but instead will concentrate on the continuous transformation of sound in time, timbre and space, was obsessive in Xenakis musical thinking.

He explored this kind of writing in several pieces such as *Terretektorh* (1965-66) *Nommos Gamma* (1967-68) and *Persephassa* (1969) in which the idea of continuous sound movement is further developed. This piece demands six percussionists encircling the audience. The percussionists are placed at equal distances on the circle so that they outline a hexagon and each one of the percussion set up includes some instruments of similar timbre slightly varying in its relative pitch. One could say that they use cloned installations, using four different timbre families: wood, metal, skin, and stone. Nevertheless there is a very strict way of distributing the instruments among the circle of interpreters so that pitches or relative perception of pitches, accentuate the different layers of timbre that co-exist in the piece.

Spatial movement is usually created by means of overlapping dynamic envelopes; the dynamic peaks mark the shift of sound from one spatial location to another. This procedure is explained by psycho-acoustical research on stereophonic hearing. The stereo field can be divided in zones (that are dependant on distance, time and frequency), in which basically two coherent sound signals coming from different

positions in space are perceived either as one single phantom image, a single source reverberated by its sound reflection, or an echo. The "Precedence effect" (Blauert 1974 rev. 1996) establishes that in the case of two similar sound signals coming from different places into the ears, the sound seems to originate out of the direction from where it first arrived. Tests on how much louder the reflection (the signal arriving later) can be before it is perceived as a separate signal, have proofed that a difference smaller than 11 db does not change this perception of direction given by the first wave.
Localization uncertainty on azimuth, distance and elevation create some other zones of blur in which localization perception is ambiguous.

All these subjects of psycho-acoustic research are as well subjects of compositional research in *Persephassa* in which a more empirical approach allows the composer to create spectacular effects including both brief and extended-continuous moments of rotations, patterns shifting in circles, dynamic shaped tremolos. Perhaps aware of the potential and the nature of this phenomenon, Xenakis created a complex structure of up to 7 layers of superimposed cycles of rotation. He orchestrates the music so that the inner similarity between timbres of the same layer and the timbre differences between layers creates flows of sound that alternate in direction, and differ in their starting point, timbre, and speed, simultaneously.

Speed seems to be one of the most influent parameters in terms of form in *Persephassa* (Harley 1994). A complex structure of sequential accelerations of different layers goes from very low speeds of rotation to extreme fast ones (even to the point in which the rotational phenomenon is perceived come stationary), progressively during the piece. It is noticeable the poly-metric relations between the speeds of the different layers, aspect developed in the music of Nancarrow before, even though Xenakis' approach is more advanced in terms of influence on the formal aspects of the music, and works in a more refined and small time grid that helps the perception of continuity.

The timbral features of the distinct layers are also very important. Layers of almost exact timbre are juxtaposed with others that slightly differ in pitch, and the music flows so that the rotating sound gradually descends in pitch in each trajectory. Each cycle is articulated by a contrasting change in timbre and often in direction as well.

In terms of time it is important to notice that these cycles are circles not spirals. That means that even though the speed increases during the piece, it remains constant in each cycle, there is no inner acceleration inside the trajectories themselves. Xenakis has already worked with this kind of spirals that include both logarithmical and exponential acceleration patterns in *Terretektorh*. This procedure has led my interest to discover *Le Noir de l'étoile* a more recent piece that the French composer Gérard Grisey wrote between 1989 and 1990 for six percussionists, tape, and live diffusion of astronomic signals coming from pulsars (dead stars).

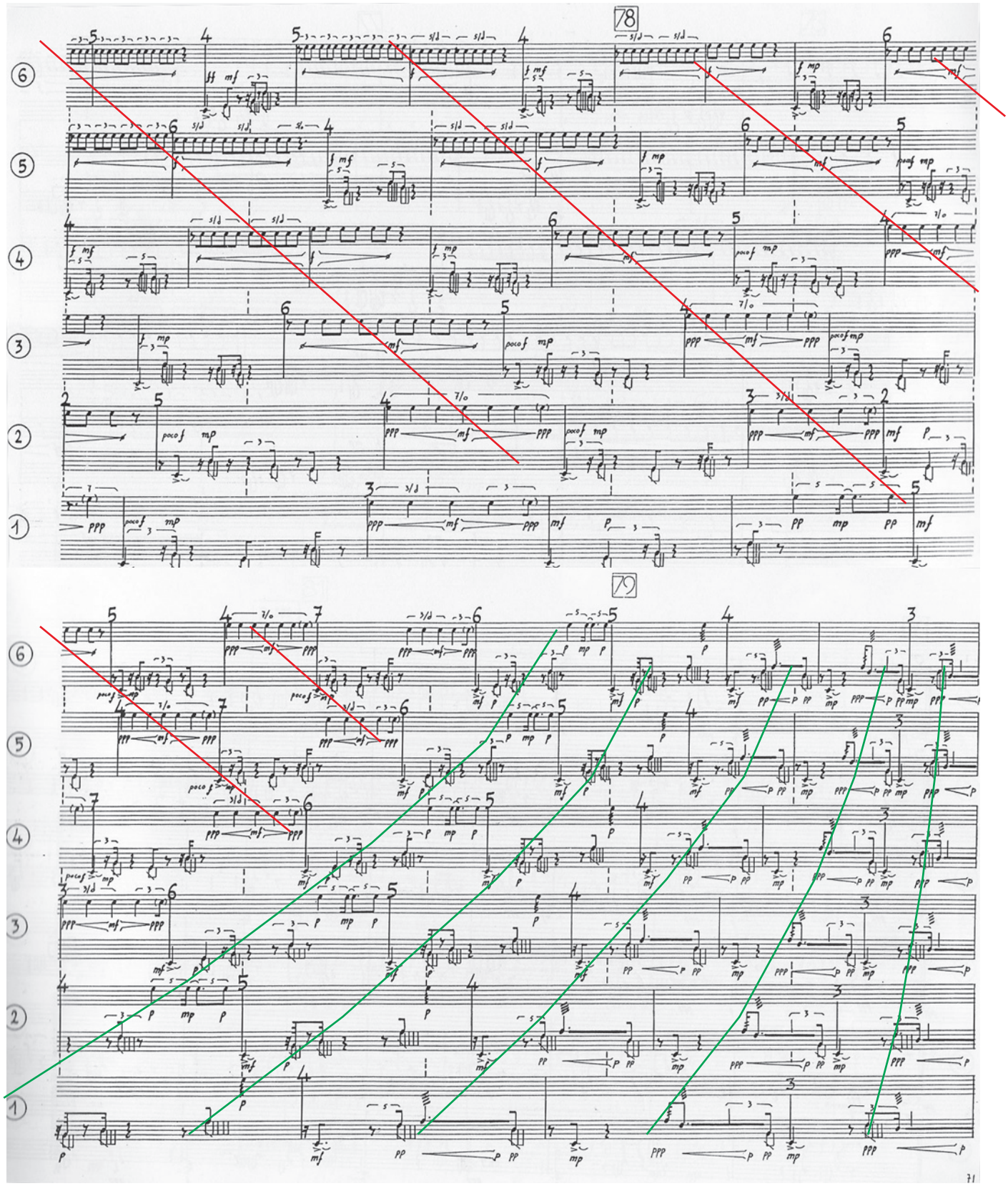
The basic principle of Le Noir de l'Etoile is almost the same of *Persephassa* and the distribution of the percussionists is exactly the same one. Grisey was very impressed when he first met the sound of pulsars in Berkeley in 1985. He decided then to write a piece that integrate this sounds via loudspeaker diffusion allowing them to exist as simple reference points using their frequencies (very low ones) as tempi inside a music that develops the ideas of rotation, periodicity, deceleration and acceleration, and glitches, that the study of Pulsars suggests to astronomers. The choice of percussion was imperative because, like pulsars, it grasps and measures time, in a very basic an implacable way. Instrumentation was reduced to skins and metals excluding all keyboard (pitched) instruments. (Grisey, 1990)

The fact of having as raw material the low frequencies of the pulsars imposed a very complex poly-metrical temporal structure, which governs almost all the piece. This way of notating the music with different tempi for each interpreter requires high

precision, only achievable with the aid of click tracks, and is a remarkable work in terms of compositional handcraft. One could say again that this poly-metrical thinking is also present in music of composers such as Nancarrow, or Carter, but in Grisey's case the challenge is very different: to create inside this multilayered temporal grid, which works like a machine somehow, the movements of periodicity and a-periodicity and the states of transition as moments of deceleration and acceleration orchestrated in space.

Particular interested is given to the phenomenon of Glitches: this term usually used

Figs. 1 2 Fragment from *Le Noir de l'étoile*. (Grisey 1990) The lines show the direction of the trajectories (see Fig.4b)



to describe an unpredicted sudden event in the normally perfect behavior of an electrical appliance, has been used by astronomers to describe the behavior of the dead stars that alter their periodic rhythm suddenly decelerating for a moment until it reaches its new regularity, due to huge energy changes in its internal structure.

I have decided to show pages nos. 70 and 71 **(Fig. 1 and 2)** from the score of *Le noir de l'étoile* that evidence this kind of writing. A sequential acceleration of a decelerating pattern is illustrated. Is noticeable the precision of the score in terms of poly-metric relationships between the voices. An accumulation of layers allows new ones born in the opposite direction towards the end of the section were all different tempi are about to coincide. As in *Persephassa*, the shift of position of the sound is determined by the dynamic peaks of this characteristic envelope dal niente-crescendo-decrescendo-al niente, but an extra feature is added evidencing the decelerating tempo, sometimes very progressively some times abruptly, reinforced by the falling pitch impression, which with skin and wood instruments result in a more refined timbre work more related to the perception of distance and directionality than to the traditional concept of pitch.

The score evidences spiral sound movements. One could even trace curves that follow logarithmical or exponential acceleration patterns. In my personal opinion, there is a geometrical strategy reflected in the score, which might be a very precise transcription of a continuous dynamic structure to a human performers level. The gradient of the curve representing acceleration of the sound trajectory, evident in the analysis of Grisey's score, is a basic strategy already explored by Xenakis in *Terretektorh*. I will discuss this process later in this chapter from other composers' ap-

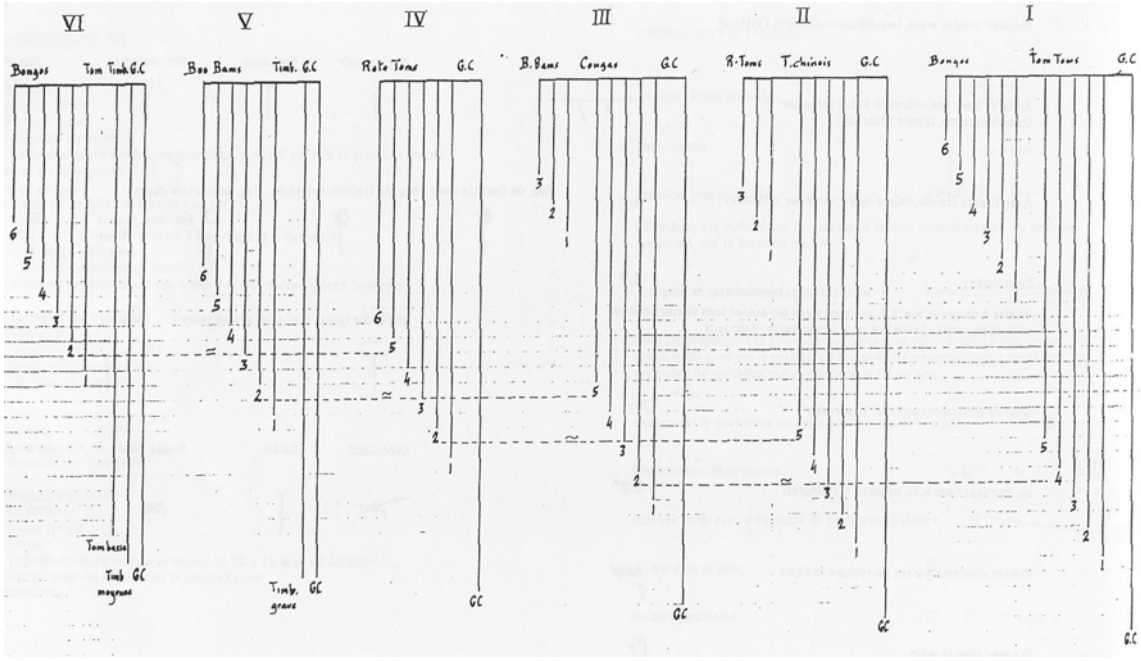


Fig. 3 Tunning chart from *Le Noir de l'étoile*. (Grisey 1990) A strict organisation according to the instrument's apparent pitch is required for all the six installations.

proaches such as Julio Estrada, in which the graphical representation takes a major role.

Back to the piece, one particularity of displaying the performers equidistantly around the audience in terms of physical movement is that distance is a constant, not a variable. Therefore compositional strategies must be developed in order to create the perception of distance in terms of time compression and expansion, dynamic envelopes and timbre transformation. In my personal view, the strict organization for the different timbral families among the six percussion sets **(Fig. 3)** correspond to an intention of adding some Doppler delay effect to the spatial trajectories. The frequency of a sound source seems higher when it gets closer to a stationary listener (which is the case of the audience), and lower, when it is farther away, both in the rhythmic and the pitch domains. A fragment of page 83 from the score **(Fig. 4)** shows this procedure and contrasts the example shown before in terms of tempi.

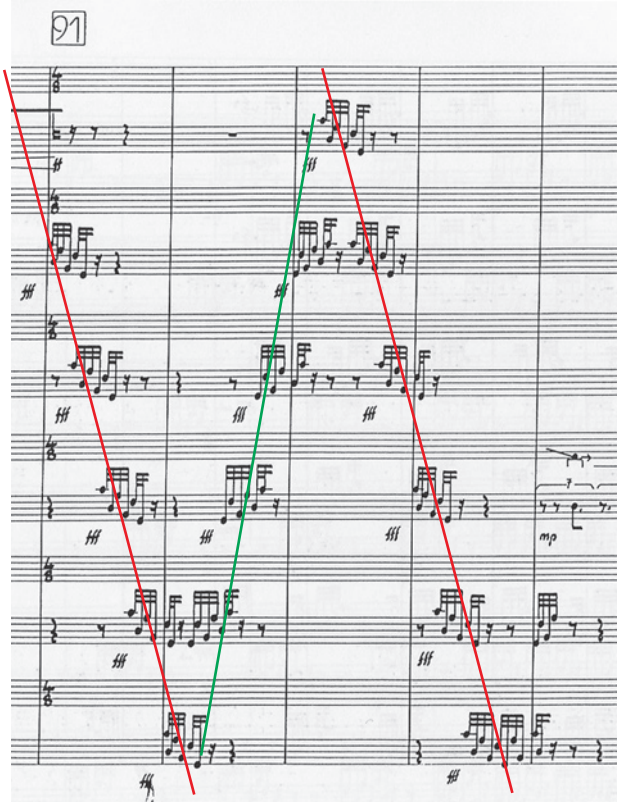
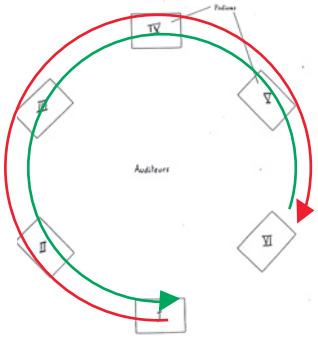


Fig. 4a Fragment from *Le Noir de l'étoile*. (Grisey 1990) The cannon produces circular trajectories that change the sense of direction. The score reflects the clever instrumental organization, that is proposed in Fig. 3

Fig. 4b Diagram showing the movement of sound among the six percussion installations .



Here the procedure is a simple delayed canon over a common pulse and a common rhythmical subdivision. Nevertheless the resultant impression is far from a traditional canon. In this passage the absence of dynamic regulators does not evidence the natural decrescendo, which in space is translated in terms of the sound coming or going far away, this is the product of the clever instrumental disposition.

Another example of a slight variation of this procedure overlaps simultaneous gests in a common tempo but a different rhythmical subdivision. **(Fig. 5)** The difference in lengths of this bursts, in decrescendo create ambiguous moments in which different

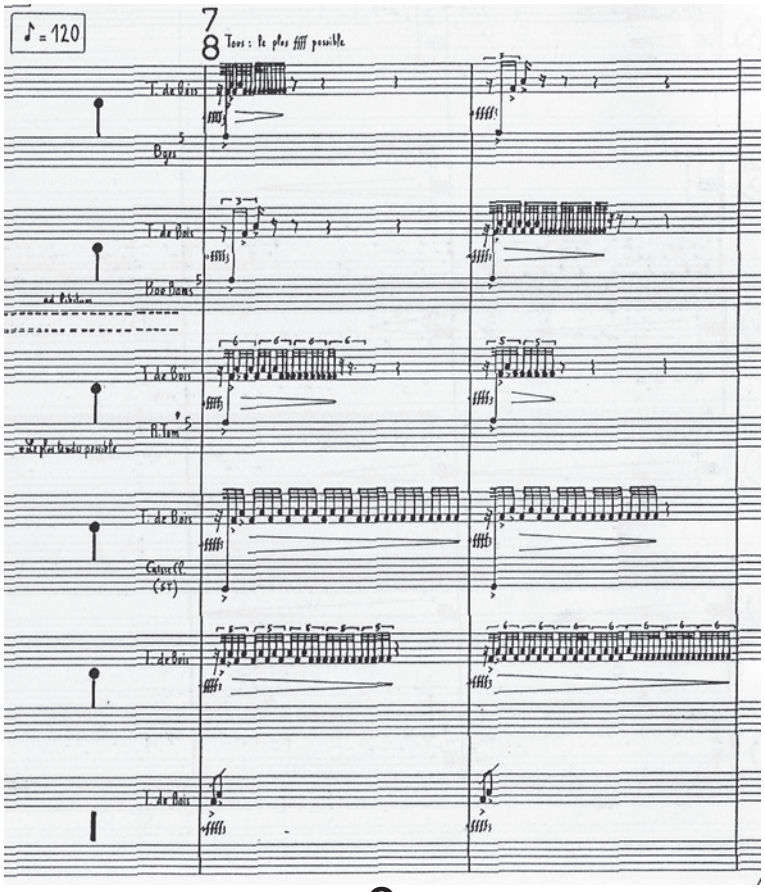


Fig. 5 Fragment from *Le Noir de l'étoile*. (Grisey 1990) The difference in lengths of this bursts, in decrescendo create ambiguous moments in which different trajectories seem to start in different rates and directions, finally dissolving into one single disappearing flow of sound in one specific direction.

trajectories seem to start in different rates and directions, finally dissolving into one single disappearing flow of sound in one specific direction. The tension generated by the initial spatial ambiguity is preceeded by a moment of clear directional perception.

A broader analysis of the score would be interesting specially having as reference the program describing the different movements of this huge oeuvre lasting 60 minutes. Nevertheless this is not the matter of the present study, which pretends to highlight some compositional strategies rather than getting deeper into musicological research.

One final thing to point out about all these procedures used by Grisey is his obsession for zooming into the sound event, and his comprehension of time in different simultaneous scales (he made metaphoric comparisons between the perception of time of whales, of humans, of stars or insects, when speaking about his ideas of dealing with time). Anyway the extended time scale (so necessary in spectral composition) embeds other inner clocks that he had mastered to create not only moving sound in space but real vortexes of expression.

Methods of transcription inside a continuum of rhythm and sound

Various electronic music composers in the 1950's and 60's while working in the studio discovered an actual physical continuum between rhythm and sound. In fact they found that the sound of a sine wave when transposed to very low frequencies is heard not anymore as a pitch but as a rhythmic pulse. Mexican composer Julio Estrada has somehow extended the comprehension of this phenomenon. He proposes that such an observation leads to consider the physical continuum that exist between parameters of pitch, amplitude (intensity) and harmonic content (timbre), and their corresponding rhythmic parameters of duration, amplitude (generally perceived as attack) and the micro-rhythmic structures related to timbre (such as vibrato). In terms of perception, rhythm is related to time and sound is related to the audition of frequency. In terms of physical structure each is a waveform. This physical unity between rhythm and sound as a vibratory phenomenon implies for Estrada, the necessity of extending the concept of acoustics to a global "chrono-acoustical" time-space field, in which the presence of time will help to evidence a different understanding of the perception of this sound-rhythm. (This is somehow close to the idea of the time-line present in musical software, but again, Estrada's approach is by essence, multidimensional).

The idea of this physical continuity between rhythm and sound is matter of psycho-acoustical research on our brain's ability to discriminate between the two auditory phenomena, getting very close to establish the boundaries. For example we tend to lose our sensation of intervals being discrete when their divisions become too small. Our perception blurs between discontinuum and continuum as we move between very low and very high-resolution scalar values in any given parameter. Gradually changing perceptual boundaries also separate our sensation of discontinuity in duration with continuity in pitch. Experiments to determine the minimum noticeable differences (that our brain can decode from the information perceived by our ears) in terms of level, pitch, direction angles in the horizontal and the vertical plane, etcetera have been realized by several researchers in the twentieth century.

Julio Estrada proposes a compositional method that has for goal a synthesis of rhythm and sound into a continuous macro-timbre. It starts with a broad range of graphical "recording" methods (similar to those proposed by Xenakis to create new instrumental and vocal music, and as well present in his development of the UPIC interface). Comprehension of sound as multidimensional implies the creation of an enlarged field of musical representation in several layers corresponding to parameters sounding simultaneously. These sets of curves reflect either an analysis of real input, or a detailed translation of the composer's imagination described very precisely in time. **(Fig. 6)**

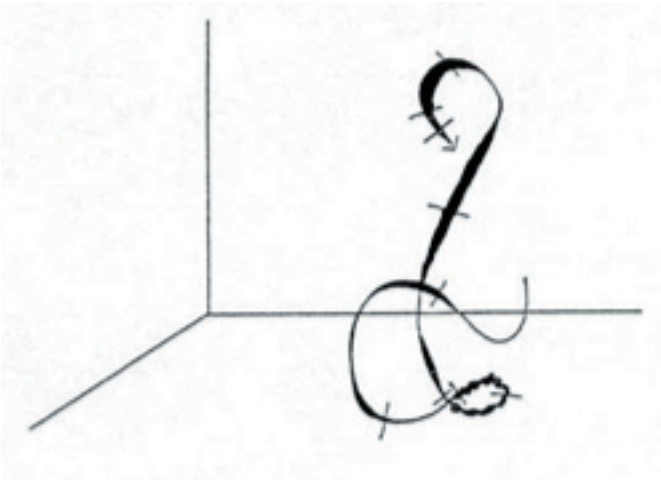


Fig. 6 The figure represents a three-dimensional trajectory. The X axis can be interpreted for frequency, X for amplitude and Z for harmonic content. The speed of change can be derived from the distance between identical time units. Density, can be expressed by the thickness of the line. (Estrada 2002)

In order to consider six or more micro-timbral components is necessary to extend Xenakis methods, which consists basically of individual chrono-graphical recordings (one for each parameter). A common method used in acoustics is to work with three-dimensional trajectories, where each individual dimension can be assigned to an individual parameter, and can be easily repaired simultaneously with the others because of the common time units shared by the graph. Estrada has even developed the Eua'oolin system (meaning in Nauatl language "flying of movements") between 1990 and 1995 in the UNAM. The system uses a cubic space, in which a singe TV camera records three-dimensional movements. A stick delineates these movements with a small white ball at the tip, the main object followed by the camera. TV recordings are converted to a digital flow of 30 images per second, which are then converted to a MIDI-toolkit file consisting of three lists of information corresponding to three previously defined parameters. The main purpose of the system is to produce a computer printed score resulting from the automatic transcription of the three dimensional trajectories. (Estrada 2002)

This procedure of creating the graphical recordings, either from the composer's inner musical dreams and ideas or the actual physical reality, is just the first step, is merely the initial raw material. The most important process comes after this one, and it is basically a process of transcription: converting these chrono-graphical maps into musical notation. Estrada highlights the importance of choosing a small grid of high resolution because it helps the impression of continuity. In terms of time this is more close to the Indian way of conceiving and learning rhythm than our Pythagorean western one.

The transcription method will consist in the precise discretisation of each dimension included on a given trajectory. Both in terms of score notation and musical performance, high resolution in reference scales can also mean the necessity of dealing with a higher amount of information, an aspect in which the pragmatic choice related to the transcription process is very important in compositional terms. The choice of a given resolution will determine the transcription of each parameter through the conversion of this graphical data into the musical score. (Estrada 2002)

This way of working and thinking about music has lead Estrada to write very interesting pieces which profit this initial chrono-graphical recordings by means of other compositional techniques derived from this one, such as the permutation of the behavior of one parameter to another one creating a partial or global variation, or the topological variation, which consists of moving the set of linked parameters by rotating or shifting the whole graphic structure in space and time to obtain variations that might produce new music. In fact these chrono-graphical maps are there, and there is no truth about on how one might transcribe them. Therefore they can be an inextinguishable source for generating new musical compositions, because no version can be judged as wrong or right. It can be judged in terms of aesthetical expression.

Estrada's procedures interested me at first not only because they embed Varèse's or Xenakis' conception of music as a continuous flow of sound in constant evolution, but as well because his methods seem to liberate the pre-compositional and compositional work from any influence or impositions of other preformed musical systems that have a very heavy presence in western conservatories. Moreover, the graphical representation allows a higher consciousness in terms of micro and macro formal levels because of the visualization of the musical project before it is actually written.

Continuum in space

I decided to try out some of the procedures of Estrada, and extend them in different aspects. First of all, I wanted to try out this high-deterministic way of working for writing electronic music, avoiding the concessions one might do when writing instrumental music that will be played by human beings. (Estrada's scores require a lot of time and effort from the interpreters, which sometimes are reticent to invest such a huge amount of time and energy, because of their complexity). The other aspect I wanted to work on is the idea of a continuum that would develop in space, exploring the perceptual borderlines of listening sound trajectories vs. listening to sound textures that create the sensation stationary spaces evolving very slowly. These were the some of the initial motivations for composing *Cambuche* a quadraphonic tape piece completely programmed (written) using ACToolbox, Csound and Max/MSP.

From the aesthetical point of view, I wanted to create a piece that would have somehow the form of an attack, or an aerial fumigation perceived in a "cambuche", a sort of improvised shelter built up with branches, plastic or whatever is available around. An inevitable event experienced in the center of a space in which things are actually dropping dangerously, without any other chance that being part of the texture until it stops. (The oeuvre tries to be a reflection on the influence of the Plan Colombia, program sponsored by the US government "War on Drugs").

For transcribing this sonic idea I made a first graphical sketch representing the whole piece as a continuum. The analysis of this sketch led me to the selection of 5 parameters: density, playback rate (related to pitch and timbre), azimuth, distance and elevation (the latter three referring to spatial position). The first step was to create three sets of samples (I constrained my system to three voices) that increase progressively in density. All these sounds were generated from a single recording of the sound of a maraca lasting 790 milliseconds. This sound was chunked, multiplied, overlapped and mixed according to density curves drawn in AC Toolbox and rendered in Csound. These three sets of 8 samples lasting about 30 seconds each, were very similar in evolution, this was imperative for creating the spatial ambiguity I was looking for. It is important to point out that these samples were merely rough material, as their sound was going to be affected by playback ratio and spatialisation algorithms afterwards, nevertheless their evolution in terms of density was the important thing to establish at first.

As already discussed before when exposing Estrada's ideas, high resolution and a small subdivision are capital for the continuum's architecture. I found a perfect way of translating the graphical scores into control signals, by writing the curves as audio waves. This allowed me to have the smallest unit: the sample, and a 16-bit precision of interpolation resolution. All the evolution of the piece was written then in sequential wave-tables of 512 samples each **(Fig. 7)**. Different algorithms progressively growing in acceleration allowed me to draw the spatial behavior for the

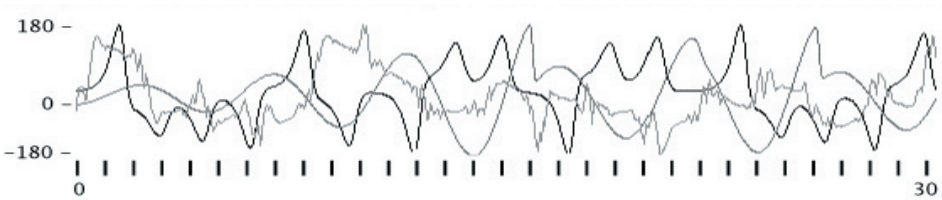


Fig. 7 Parametrical behaviour of azimuth for the three sound sources in *Cambuche* (from min. 1:42 to 2:13.5)

position of my three voices, stored in 9 sets of curves. Other three sets controlling playback ratios were created drawn in the AC Toolbox environment **(Fig. 8)**. With this parameter I explore the different perceptual influences from pitch to timbre. The moment of maximum density in these curves corresponds to a sound gesture that is close to "scratching". Here acceleration (represented in the graphs as the gradient of the curve) is perceived as wild timbral continuous change. Is important to notice that writing acceleration here implied 12 layers extra of collections containing the time-scaling values for each of the wave-tables.

Having all the scores as wave tables, a system was developed in Max/MSP, in which

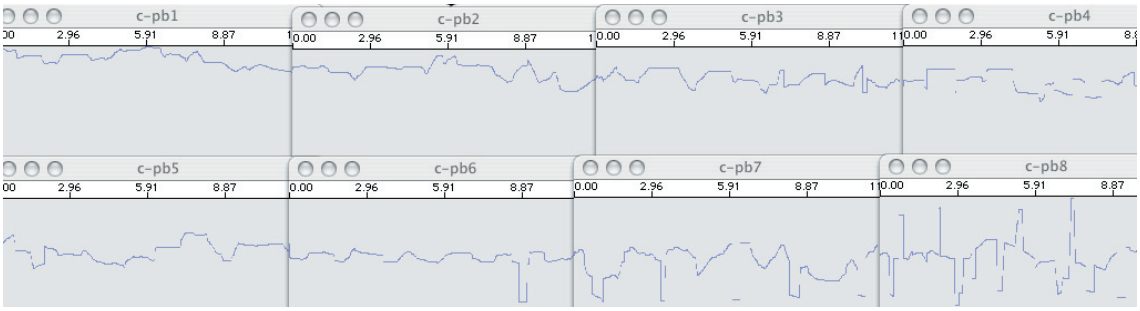


Fig. 8 Playback-ratio control curves stored in audio buffers. The whole parametrical evolution of the piece is written in the same way

three voices were routed in a quadraphonic virtual space using the IRCAM's spatialisation abstraction (Spat), which include modules of Doppler-delay and air absorption simulation. All the continuous control for all the 4 parameters for the three voices was programmed sequentially scheduling the wave-tables (stored in audio buffers and being read in audio rate) into modules of playback that follow a precise plan determined by the time-scale collections. **(Fig. 9)** This facilitated a lot the task of modeling the form of the piece. The final result is a quadraphonic piece entirely written (programmed) in an almost instrumental way, in the sense that every inflexion of the music is precisely determined in the score. One difference with Estrada's approach is that in his case the process of transcription of these chrono-graphical recordings is done in a written score, which is then re-interpreted by the performers. In *Cambuche* the curves are the score itself and the process of transcription is equivalent to the software programming.

This idea of working with quadraphonic surround has the same fragility that Xenakis found on *Persephassa*. (Harley 1994) The efficacy of this writing depends on a lot of factors such as the architectural constraints of the room, the correct disposition

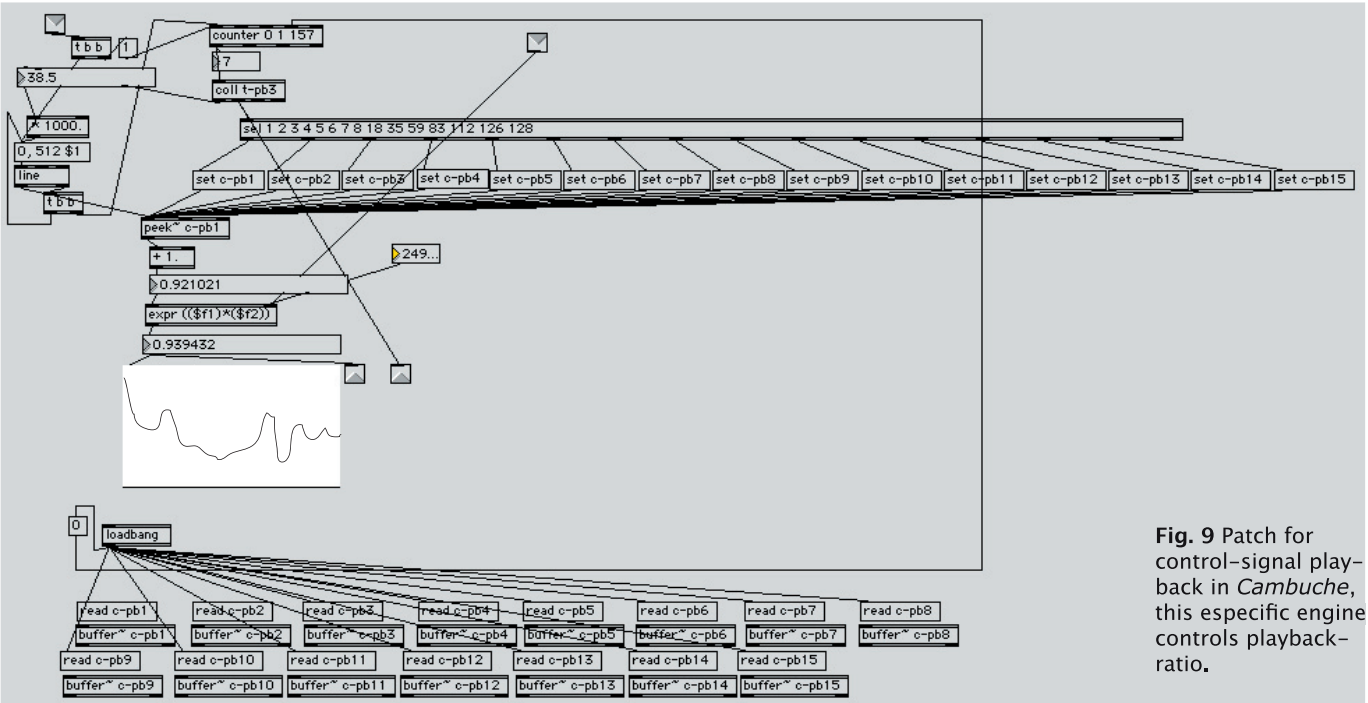


Fig. 9 Patch for control-signal playback in *Cambuche*, this especific engine controls playback-ratio.

of the loudspeakers or the percussion installations, and the result is only fully perceivable in a central spot of the concert hall. Nevertheless, in the case of electronic music, technological developments are being made in various directions for developing more convincing systems of surround diffusion.

This consciousness about the necessity of finding new and more convincing ways of projecting the sound in the hall rooms in a concert situation led me to discover different strategies of sound routing which I will be presenting in the following chapter.

2. SOUND ROUTING AND SOUND PROJECTION IN SPACE

One of the first major experiments in sound routing was the Phillips Pavilion in Brussels World Fair in 1958-59. This project was a creative experiment involving music, architecture, sound-set, visual and lighting design, leaded by Le Corbusier; Xenakis who was in charge of the design of the building and the design of the physical disposition of the arrays of loudspeakers **(Fig. 10)**; Tak and De Bruin, working with Phillips and responsible for studio assistance, the sound routing and the electronic control systems, Varèse; the composer, who could materialize his quest for music projected in space with his *Poème Electronique*.

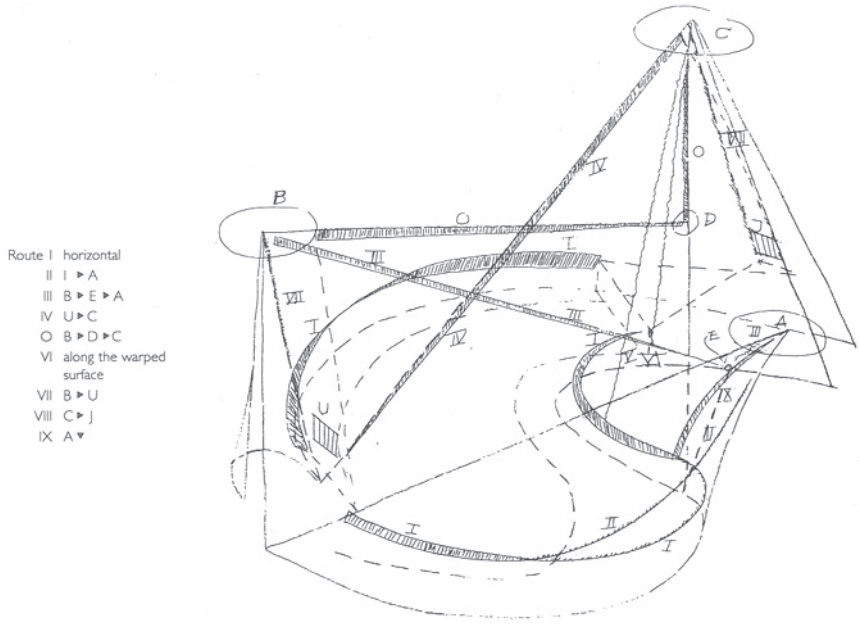


Fig. 10 Sketch of the sound routes in the Phillips Pavillion, designed by Xenakis (Phillips Technical Review)

This project interested me at first not only because its important work on spatialisation but as well, because of Varèse (who was not a very convenient figure to the eyes of the sponsors of the project, who were very skeptical about Le Corbusier's choice (Treib 1996)) who in my opinion, deserved such an interface for developing this new way of viewing music as the evolution of sound masses in time and space, that he began to quest since his first instrumental explorations involving instruments such as sirens or the "Ondes Martenot", or with his new particular way of using percussion instruments. Even though Xenakis never admitted any influence from another composer, his great respect for Varèse could have been inspired in part because of common musical points of view. Nevertheless in my opinion Varèse is one of the strongest initial references of this dynamic musical thinking that I am trying to outline in this article.

Varèse's piece is 480 seconds of organized sound. It is very important to outline that all the sound planes and sound trajectories are composed in terms of the manipulation of musical material in time supported mainly in stereophony. Even though the piece was conceived specially for this very special Pavilion-listening-room it was necessary for the composer that the music had coherence in itself before being projected in space. The final recording was made on a 3-track tape, the first one containing the main body of the piece, and the second and third ones were reserved for reverberation and stereophonic effects. Phillips engineers designed a special playback machine that fed the sound from each one of the three heads into multiple loudspeakers via 20 amplifiers, using a complex automated relay system. For the purpose of stereophony compact groups of loudspeakers were created as well as arrays of individual loudspeakers that were switched on and off successively in such a way that the sound source would describe paths along these routes. **(Fig. 11)** A total of 350 loudspeakers were used, 25 being sub-woofers. (Tak 1958/59)

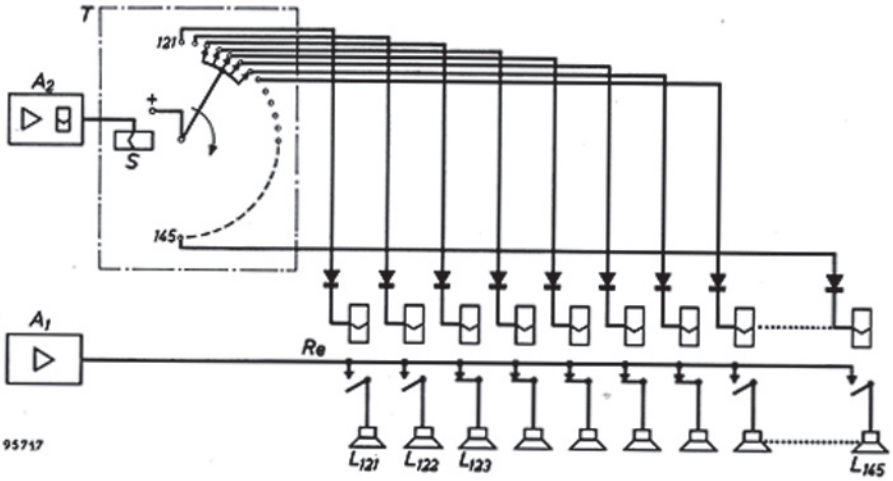


Fig. 11 Diagram of a sound route. Loudspeakers **L** were fed from the amplifiers **A1** via the relay system **Re**. The solenoid **S** of a uniselector **T** was energized by pulses from the control-signal amplifier **A2.** Five speakers were always in operation at one time. At each selector step, one loudspeaker was switched in and another one out. (Phillips Technical Review)

The control score was written on a second 15-channel tape each of the tracks containing 12 superimposed control signals at different fixed frequencies and amplitudes. These allowed a total of 180 simultaneous control channels. These signals coming from each one of the 15 tracks were split then into its components by selective amplifiers. **(Fig. 12)** A system of two-stage amplification with a tuned-circuit of coupling and relay was implemented. **(Fig. 13)** The relay closed only when the input signal in the first stage had the frequency to which the circuit was tuned. Some of the control channels were reserved for the lighting effects. (De Bruin 1958/59)

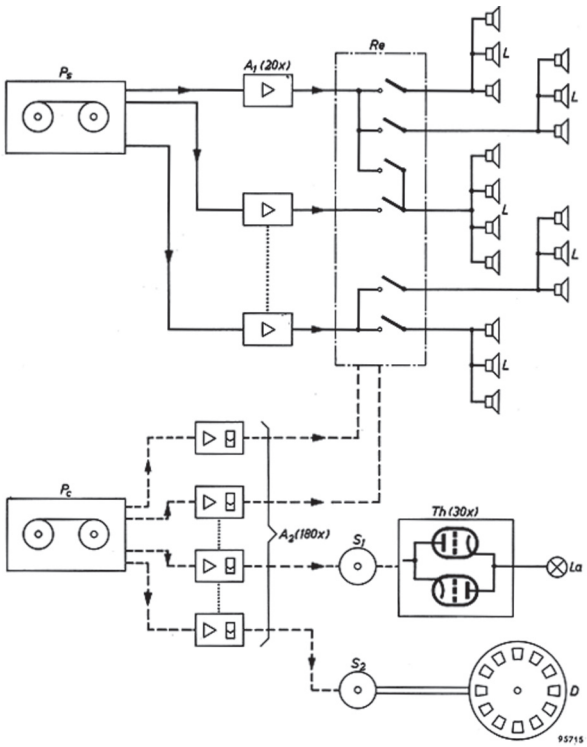


Fig. 12 Simplified diagram of the installation for *Poème Electronique*.
Ps 3 channel playback machine
A1 amplifiers (20 in total)
Re relays
L loudspeakers (350 in all)
Pc 15 channel control playback machine
A2 selective control signal amplifiers (180 in all) controlling the relays and the servo motors **S1**, and **S2** that controlled the lighting effects.
(Phillips Technical Review)

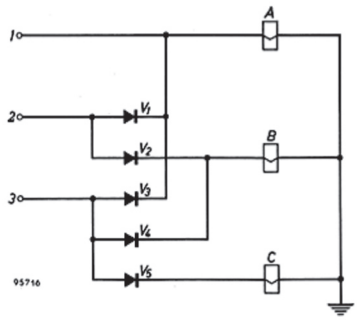


Fig. 13 Circuit with three relays **A**, **B**, and **C**, and rectifiers **V** (1-5). A positive potential applied to points **1**, **2** or **3** energized respectively relay **A**, relays **A** and **B**, or relays **A**, **B** and **C** (Phillips Technical Review)

More important than getting deeper into the technical details of the system (which would be out of the scope of this paper) is understanding the new way of working -perhaps consequence in part of the multidisciplinary and international characteristics of the people and organizations involved in the project, which separates the process of the composition as sound design and the strategy of sound projection. It was remarkable the confidence that Varèse gave to Tak in the task of projecting the piece without blurring the compositional work, and this outlines a new kind of collaboration in which sound projection is a matter of design and composition which can be done a posteriori and by another person other than the composer.

This same aspect is present in the French approach to *Acousmatique* diffusion led by composers such as François Bayle, Pierre Henry, or Christian Clozier, among

many others. (*Acousmatique*, term proposed by Bayle, refers to the tradition of Pythagoras to eliminate all visual repairs between him and his disciples for concentrating all their attention on what they listened to). For these composers diffusion of electro-acoustic music is a process equivalent to interpretation in instrumental music, and there is a need for a pertinent sonic rendering of the timbral, temporal and spatial complexities of polyphony electro-acoustic music, that considers the acoustic reality of the concert room. (Clozier 2000) There is a huge difference in the quality of the sound between an electronic music studio (the composers environment) and a concert room, and it would be naïf to think that the perceptual result would be the same on both places, and therefore it would be unconscious from a composer to ignore this reality. Bayle, who considers that the final product of the studio is just a prototype tested only in that reduced environment, and needs to be tested properly in the concert reality, proposes to substitute the traditional amplification set-up that projects the sound from a frontal point towards the center of the room, for a more refined set-up including a larger number of loudspeakers creating in this way several screens of sound projectors that become a huge instrument to orchestrate the music with. **(Fig. 14)**

"Musique Acousmatique"

This orchestration starts with a pair of wide range loudspeakers that create a referential and reduced stereo image. This "soloists" which number can be extended in the case of multi-track pieces define by their position and their separation this initial reference, which is enriched then by other groups of speakers which have a narrower response in terms of frequency range or are specially filtered and will complement the final timbre of the piece projected in space.

Having these duo of loudspeakers as spinal chord, five extra layers of loudspeakers groups that cover all the registers being placed with enough space between them and the soloists are added: First, one ensemble of low-tone speakers or sub-woofers are in charge of the region between 20 and 400 Hz. The disposition of these speakers is the less relevant due to their very weak directional characteristics. A symmetrical placement, close to the walls of the room is nevertheless recommended. Second, in the other extreme of the register, a chain of high-response loudspeakers (tweeters) is in charge of frequencies between 4000 and 16000 Hz. The disposition of these chains must be regular and spaced among the room and they might be even placed between the public. Symmetry or asymmetry would be a matter of aesthetical choice of either the composer or the interpreter of the music.

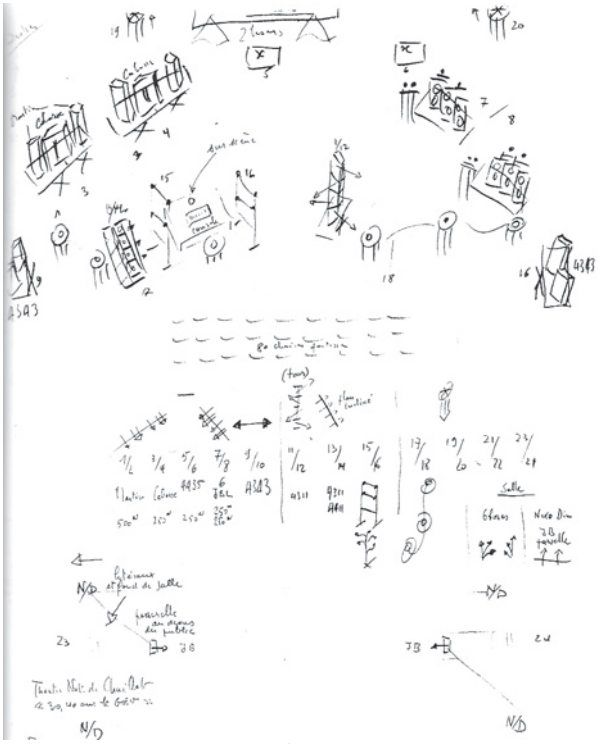


Fig. 14 Sketch of François Bayle's Acousmonium. This set-up enhances the depth of the traditional frontal stereo image. (Bayle 1992)

The rest of the register is divided in three medium range groups. These loudspeakers are in independent as well and their disposition must be adaptable in width and depth, according to two main strategies: first a symmetric disposition by pairs that keeps and enhances the stereophonic effects; second, an asymmetric disposition of the stereo pairs inside the reference image given by the soloists' couple. With the first method, the objective is to outline the different sound-planes that could be created in space (diagonal disposition is often used) by the lines described by each stereo-pair. With the second one, a more intimate reduced image is achieved that allows spatial antiphonies with the rest of the set up, or could be used to orchestrate dramatical or expressive musical moments. (Bayle 1975 rev.1992)

Other groups of special loudspeakers can be added to create a contrast with the main compact group. It is recommended to have as well some loudspeakers that create the farthest possible image; sometimes placing the loudspeakers facing towards the reflecting surfaces of the walls of the concert halls can be useful for creating this impression. (Simonot 2006) It is also recommended the set-up of lateral speakers that help to enclose the frontal image.

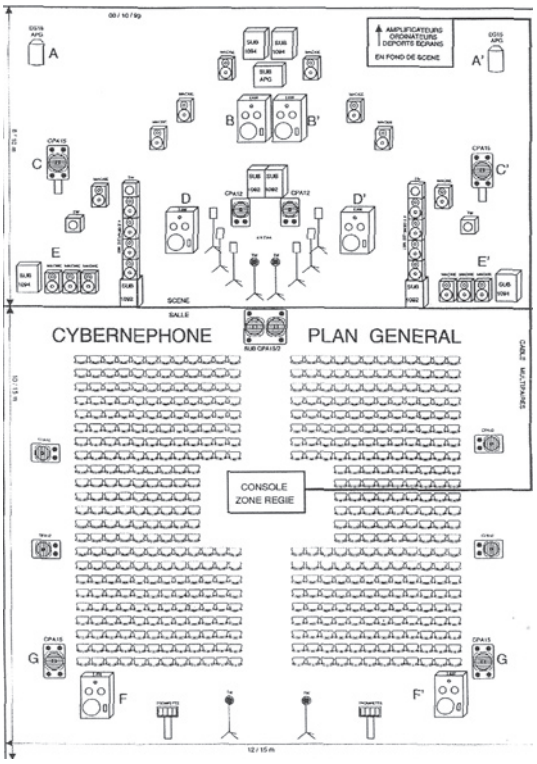
All these groups of loudspeakers must be controllable independently. A mixing desk or several ones used in cascade can provide such an interface. The rest of the system involves an interpreter and a preparation of the piece. There are two different approaches in what a diffusion score (which is indispensable) should look like. The first one, which I would call the composer's score, that sometimes reflects very well the form of the piece, but it is often the case that it contains too much information for being read in real time while performing. These scores are often reduced to the second category, that I would call the diffusion score. This score is more austere in terms of indications and is basically a chronological collection of the most important time markers that have been defined during the preparation of the piece. The fact that the interfaces are always changing because of the differences in the equipment used in different concerts, makes very complex the development of virtuosic dexterities from the performers. The real virtuosic aspect is developed in terms of an attentive listening, a mature comprehension of the piece that would help the proper music projection in space.

In the case of *Poème Electronique*, a very refined control structure was written as a fix score on a magnetic tape. This process was done in non-real time and was specific for the sound-system designed previously. In the "*Acousmatique*" approach the design of the diffusion system is the first compositional-diffusion-task, which defines the aesthetical direction and determines somehow the way of approaching the preparation of the piece and writing the personal performance score. The final result of all the performances of *Poème Electronique* is almost identical, due to the automation; in contrast, the concept of interpretation plays a major role here; each performance of a piece is influenced by the person performing and the specific sound-set, and this aspect of having a different version of a piece each time, in my opinion, is a fact that brings electronic music close to the human level of instrumental music. These French composers (Clozier, Bayle, Henry) they all refer to their sound-sets "instruments for interpreting electronic music", loudspeakers orchestras.

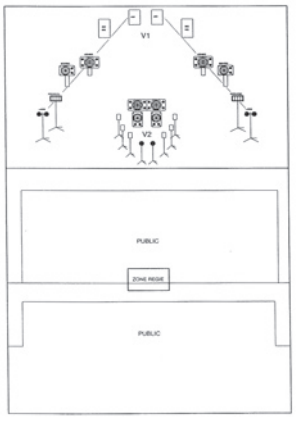
In Bourges, France, there has been a conscious and consistent program that involves the development of a system for interpretation-diffusion of electronic music that is tested each summer since 1973 in the Festival International de Bourges organized by the International Institute of Electronic Music of Bourges IMEB. They called this system the Gmebaphone and they re-baptized it the Cybernéphone, when it incorporated digital technologies (since the year 1999-2000). **(Fig. 15)** Developed by Christian Clozier, François Giraudon and Jean-Claude Le Duc this system proposes six networks of loudspeakers of two different types: The "Vs" and the references.

The Vs are groups of 12 loudspeakers, 6 for each side of a stereo field. **(Fig. 16-17)** For each group an analysis and a selection of timbres is made to divide the register

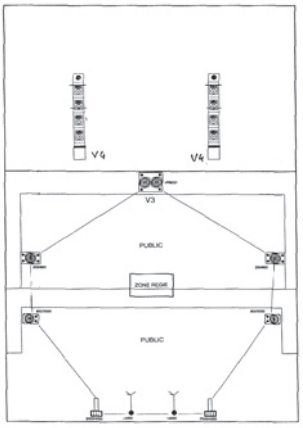
of the sound in 6: 2 basses, 2 mediums and 2 for the high frequencies, routing the sound to specialized speakers using cross-over techniques. Strategically disposition of these groups allows the multiplication of the stereo phantom images, and creates depth effects by the "dégradé" of timbre. (Clozier 1999) There are a total of four Vs in the system. V1 is described as the main one. Its concave disposition provides the natural main space of the room in all its volume. V2 has a convex disposition and provides a compact space embedded in the music itself that is used either to reinforce "tutti" textures or create antiphonal dialogs with V1 or the other networks.



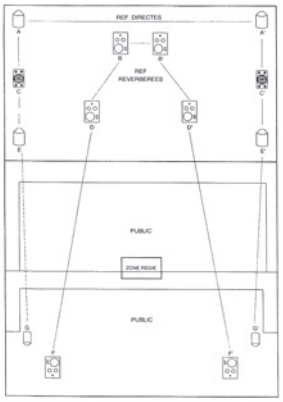
Figs. 15 16 17 18
Loudspeaker layout of the Cybernéphone. The whole set-up is showed above, and the figures below explain the system's sub-divisions (networks). (Clozier 2000)



Plan de V1 et V2



Plan de V3 et V 4



Plan des Réfrences

It allows as well the possibility of spatial "zooms" as expressive diffusion tools. V3 expands the planes to the sides of the room. This lateral disposition creates a very direct and close influence on perception: the stereo image is no longer perceived in space but synthesized in the head of the listener. Finally V4 spreads vertically creating the sensation of proximity, of a screen, of a surface. Clozier claims that in this network, due to the vertical disposition, the influence on sound is not so important in timbre but in outlining time structures: "Timbres that give position to time".

The other groups of loudspeakers are the references. **(Fig. 18)** There is a different approach here. Bayle proposed only one pair of loudspeakers as a reduced stereo reference image. The Cybernéphone instead proposes two groups of references.

The first one, formed by 4 pairs of wide-band speakers (called direct references) are in charge of outlining the dimensions of the room creating the sensation of far, close and back. They permit effects of depth, diagonals and planes. The second group, or "reverberated references" are as well three pairs of wide-range speakers creating the planes far, façade and back. They do not change the perception of the room dimensions; instead, they create simulated acoustics inside the room. (Clozier 1999)

The system proposes in total 12 stereo plans, 124 diagonals and 4 surround networks. It offers a very interesting and particular control interface. The first task of this interface is to provide the control of the sound-levels for each network or each individual speaker. 16 touch-faders allow this control live during performance, or prerecorded during rehearsals. This pre-automated memory permits the creation of global set-ups as presets to be recalled "on the fly" and the registration of continuous or fixed gestures. The control surface offers as well icons for each channel that show the specific filtering curve for each speaker and allows real-time manipulation. Other icons offering the possibility of solo, mute and groupings (close to traditional mixing desks) are present. Finally, pop-up menus are available for controlling additional real-time digital signal processing such as delay, reverb or phase manipulations. There are in total 46 channels in the mixing console controlling 62 loudspeakers.

Such a complicated system requires from the interpreter a lot of time of preparation for getting acquainted with the interface, which is not always the case. It is frequent the lack of time for rehearsals and sound checking in Festivals and concerts; the installation of such a system implies a lot of time and people working. This obligates the performer to have a previous and conscious contact with the oeuvre so that he can profit the little amount of time that he will have in front of the real device. Nevertheless the memory of the system can be a huge help, and the fact that both the manual and the automated control can co-exist ensemble makes the instrument very versatile and expressive. On the other side, using the system without the proper preparation could harm really the music. Both Bayle and Clozier claim for interpretation as the final step of composition of tape music. I would extend the limits to music including live electronics or simply amplification.

During the last year I have participated in the creation, design and installation of two special set-ups for concerts of the ensemble Vortex, dedicated to the performance of new instrumental mixed and electro-acoustic music, in Geneva (Switzerland) the second one "Salon d'écoute" referenced here was developed by Thierry Simonot (from Switzerland, specialist in electro-acoustic music and sound projection) and Dimitri Coppe (electronic music composer from Belgium).

(Fig. 19) Shows a chart that explains the sound routing for a stereo source. This table contains a description of the patch used in concert (march 30th 2006) in the Pitoeff Theater in Geneva for the diffusion of stereophonic tape pieces. Each one of the 32 console channels used is referenced. The first column (01V AD in) in the left describes the inputs of the system in this case 1 stereo pair of channels 15-16. The second column (localization) describes the actual placement of the loudspeaker; P refers to the loudspeakers in the plateau and B to the ones in the balcony **(Fig. 20)** The third column (P IN) shows the source used for each loudspeaker. Although they seem here to keep the left-right order, sometimes if wished by the performers, the order might be mirrored (by inverse panning) for some pairs of loudspeakers to create special surrounding effects. This technique is often used. Fourth and fifth columns (CHAN, HP) show each loudspeaker used by its nickname with its respective channel number. Here there is a huge difference with the systems of Bayle and Clozier. Their systems use mainly high quality studio monitors as speakers, only reinforced by some PA amplification ones. In the Phillips pavilion there were 325 identical ones (somehow as a show room for Phillips products) plus 25 "subs". In this installation (Salon d'écoute) the heterogeneity of loudspeakers types is intended for the aim of timbral richness. Studio monitors, PA outdoor system loudspeakers,

Figs. 19
Salon d'écoute, routing patch of the mixing table, for stereo tape pieces. (Simonot 2006)

Festival Archipel 2006 patch "salon d'ecoute"

01V AD in	localisation	P IN	CHAN	HP	P OUT	01V OUT	remote	MULTI	Y (ligne)	AMPLIS localisation =		Y hp	HP	CABLE HP	220 V
	P	15	1	4425 L	DIR1	DA24A 1 int	1			RANE 5	P J		4425 L	2.5 CARRE 20m	
	P	16	2	4425 R	DIR2	DA24A 2	2			RANE 6	P J		4425 R	2.5 CARRE 20m	
	P	15	3	TRPT L	DIR3	DA24A 3	hui 6		AMP LINK	R150 1/3/5/	P J		TRPT L	220V	
	P	16	4	TRPT R	DIR4	DA24A 4	hui 6		AMP LINK	R150 2/4/6/	P J		TRPT R	220V	
	P	15	5	802 L plateau	BUS5	DA24A 5	3			BST+process+sub	P J		802 L plateau	2.5 CARRE 10m	
	P	16	6	802 R plateau	BUS6	DA24A 6	4			BST+process+sub	P J		802 R plateau	2.5 CARRE 15m	
	P	15	7	CTRL 10 L	DIR7	DA24A 7	5		Y	RANE 1/3	P J		CTRL 10 L	2.5 CARRE 5mx2	
	P	16	8	CTRL 10 R	DIR8	DA24A 8	6		Y	RANE 2/4	P J		CTRL 10 R	2.5 CARRE 10mx2	
	P	15	9	SRX L	BUS7	OMNI OUT 1	7	j/xlr+20M 1		QSC TOP (filtre 50Hz)	P J		SRX L	SPEAKON	
	P	16	10	SRX R	BUS8	OMNI OUT 2	8	j/xlr+20M 2		QSC TOP (filtre 50Hz)	P J		SRX R	SPEAKON	
	P	15	11	SUB L	ST	LEFT	ST	20M 5		QSC SUB +process	P J		SUB L	SPEAKON	
	P	16	12	SUB R	ST	RIGHT	ST	20M 6		QSC SUB +process	P J		SUB R	SPEAKON	
	P	15	13	tweet perche	DIR13	OMNI OUT 3	hui 8	j/xlr+ 20M 3		R150 7	P J		tweet perche	220V 20m	
	B	16	14	tweet balcon	DIR14	DA24C 8	hui 8			dB 4	B J		tweet balcon	220V 10m	
AD 15 CD	P	15	15	PHONIC L	DIR15	2TD DAbehr	9	20M 7	Y x 3	AA			PHONIC L		
AD 16 CD	P	16	16	PHONIC R	DIR16	2TD DAbehr	10	20M 8	Y x 3	AA			PHONIC R		
	P(DAbalc)	15	17	802 L arriere	DIR17	DA24B 1 sl1	11			QSCcoco+process	B J		802 L arriere	2.5 CARRE 10m	barrettes
	P(DAbalc)	16	18	802 R arriere	DIR18	DA24B 2	12			QSCcoco+process	B J		802 R arriere	2.5 CARRE 20m	barrettes
	B	15	19	ACR diag L	DIR19	DA24B 3	13			yam petit	B J		ACR diag L	2.5 CARRE 25m	
	B	16	20	ACR diag R	DIR20	DA24B 4	14	8m		yam petit	B C		ACR diag R	2.5 CARRE 5m	
	B	15	21	800 diag L	DIR21	DA24B 5	15			hh	B C		800 diag L	2.5 CARRE 10m	
	B	16	22	800 diag R	DIR22	DA24B 6	16			hh	B C		800 diag R	2.5 CARRE 20m	
	B	15	23	BEHR cat L	DIR23	DA24B 7	hui 1		LINK xlr/J	AA			BEHR cat L		barrettes
	B	16	24	BEHR cat R	DIR24	DA24B 8	hui 2	8m	LINK xlr/J	AA			BEHR cat R		barrettes
	B	15	25	dB L	DIR25	DA24C 1 sl2	hui 3		LINK xlr	AA			dB L		barrettes
	B	16	26	dB R	DIR26	DA24C 2	hui 4	8m	LINK xlr	AA			dB R		barrettes
	B	15	27	ACR balcon L	DIR27	DA24C 3	hui 5			yam gros	B J	Y	ACR balcon L	2.5 CARRE 10m	
	B	16	28	ACR balcon R	DIR28	DA24C 4	hui 5	8m		yam gros	B C	Y	ACR balcon R	2.5 CARRE 10m	
	B	15	29	PIEZZO L	DIR29	DA24C 5	hui 7			dB 1	B J		PIEZZO L	0.5 CARRE	
	B	16	30	PIEZZO R	DIR30	DA24C 6	hui 7			dB 2	B J		PIEZZO R	0.5 CARRE	
	B	15	31	acr mon2	DIR31	DA24C 7		xlr bal->Pla		qsc coco	p				
	B	16	32	acr mon2	DIR32	omni out4		20M 4		qsc coco	p				

spare:
rme adat AD x8
dbx spdif mic preamp x2

spare:
ST1/2/3

31/32 master: Unity !!!!

spare:
bus1à4
aux2à8

spare:

multi:
8+4 > Moss P
12+4 > Vortex P
8x20m > LE B

spare:
hh 1 canal (mobile)
R150 1 canal (P)
dB 1 canal (B)
acr1300 vdg (mobile)

test link sur behr ?

tweeters, were mixed together; even speakers which sound quality might be considered deficient, could be very efficient when using their sound reflected directly with the speaker facing towards the wall. Trumpets as those used in stadiums or in school campuses were as well included for their natural reverberated timbre. (These trumpets are very efficient in creating the sensation of far). Another aspect that differences this installation from the Acousmonium or the Cybernéphone, is that the "back" (no public but loudspeakers only were present in the balcony) and the lateral sides of the room were treated with almost the same care as the "front" aiming for a more surrounding result. Garlands of tweeters (16 by line, one each 60 cm) were even suspended above the audience about 2 meters from the listener's head. The presence of speakers in the lighting racks and the balcony permitted a lot vertical possibilities to explore.

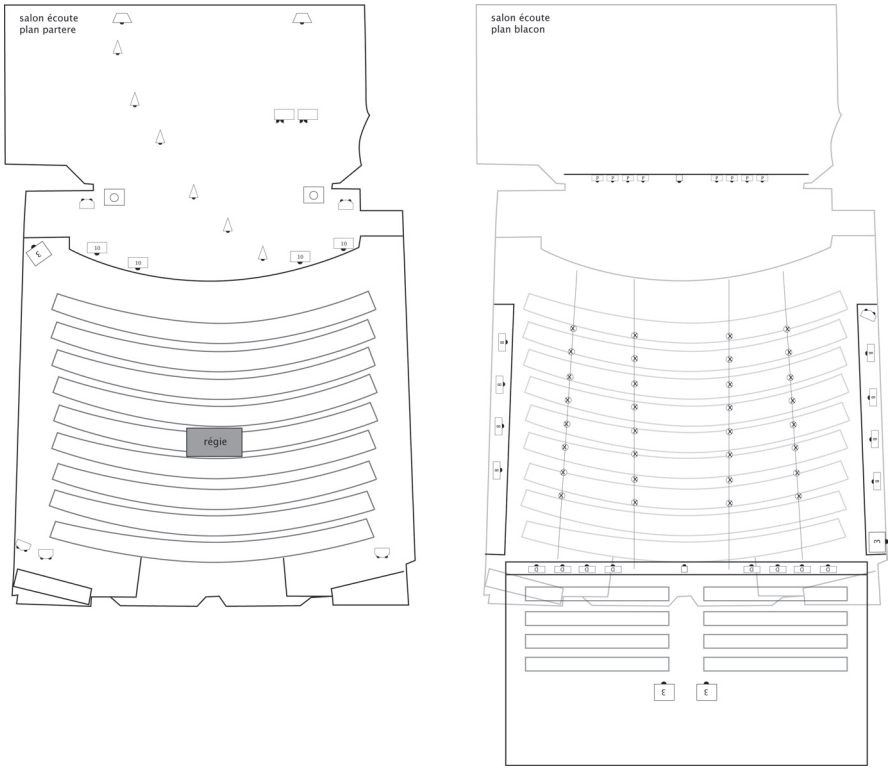


Fig. 20
Loudspeaker layout of the Salon d'écoute. At the left, the first level of loudspeakers in the scene and in the room. At the right, the "second floor" of the set-up, that included the balcony, the lighting racks, and other separated suspended loudspeakers. (Simonot 2006)

The sixth column (**Fig.19**, P OUT) refer to the bus used to route the sound out of the desk in 32 different channels and the seventh one (01V OUT) describes the actual digital to analog converter used for each track. Three 8-track external DA converters were used (DA24A, DA24B, DA24C) plus the eight ones included in the mixing desk. (YAMAHA 01V.2) The eighth column (remote) refers to the fader assigned for the level control of each individual speaker. 1 to 16 and ST refer to faders on the mixing desk. (hui #) refers to an external set of 8 faders linked to the main table via MIDI. The control surface offered in total 25 faders. The rest of the columns are the inventory of cables, (for sound and electricity) and amplifiers (AA means active speakers) involved.

Other interesting feature of this "Salon d'écoute" is that it was adapted for tape pieces, instrumental amplified works, with tape and live electronics for the same concert. The presence live performers using microphones implied a specific input-output routing patch in the mixer for each piece that profited the system differently according to the needs of the oeuvre, taking in consideration all feedback complications. This versatility is an advantage in comparison with the systems discussed previously that responds to the esthetical needs of the ensemble. Another important aspect to mention is that all the components of the system were either borrowed (by the special support of Association de Musique, Electronique de Genève, AMEG), or rented by the festival. This special set-up uses available commercial devices, and this allows a new design for each new concert, with its own particularities, without implying huge economical investment. The proof is that a newly founded ensemble without budget implemented the example described here. Projects such as *Poème Electronique* can only be realized with the financial backup of institutions as Phillips. The Cybernéphone is sponsored by the French ministry of culture, and by the city of Bourges. Even though there has been a lot of interest from private corporations and from the cultural departments of some countries in Europe in this type of projects during the last years, our example adapts to a modest scale without been less effective in the task of projecting electronic music properly in a concert room.

Cross-fading vs. spectral-panning

In all the examples of sound routing described above, there is a multiplication of the sound source that is being sent to multiple points of an installation that follows a geometrical plan adapted to space of the room. Some times only part of the frequency band is sent to specific loudspeakers. This filtering intends the creation of different "orchestral" colors, but it is mainly the same sound divided smoothly in its whole register.
Cort Lippe proposes one different paradigm of sound routing in space. It consists of the spatial distribution of spectral material in real time using spectral processing.

Real-time spectral processing is now a popular procedure in commercial and open-source musical and sound production software, and a lot of facilities provided by these programs are the result of algorithms employing FFT analysis-re-synthesis techniques. These techniques are as well the starting point of the methods of spatial distribution of spectral material proposed by Lippe. The basic principles of the system are illustrated in a simple model of a user-controlled interface for distributing spectral material in a stereo field. (Lippe, Torchia 2003)

This interface consists of a two dimensional table. One of the axes represents each one of the spectral bins and the other one describes its position in the stereo field. The output of this table (implemented as a multiSlider in the Max/MSP environment) is converted into amplitude coefficients for each individual bin for both the left and right stereo channels. The algorithms used for panning may vary. These amplitude coefficients are stored in wave tables (audio buffers) the indexing corresponding to the respective FFT bin number.

A "patcher", analyzing spectral information from a monophonic input signal, creates the two stereo channels by multiplying separately the spectral information with each

spatial location signal stored previously in the buffers, before re-synthesizing. This procedure is easily extendable to multi-channel surround panning systems, and this demands the consequent design of a graphical interface for multi-dimensional representation.

The idea of dissecting and scattering the spectrum in space proposes a new paradigm of sound routing. This same idea has been concern of instrumental composers such as Grisey, in which spectral material is orchestrated, scattering the timbre of sound among the ensemble, which becomes a macro-instrument that zooms into the structure of sound to create musical form. Nevertheless there is a huge difference in the way of dealing with this information in real time.

Lippe proposes other control systems for the spatial distribution other that the graphical-user-interface, (which in my personal opinion is very limited for developing the macro-formal aspects of a piece, but very useful for studio work and compositional sketching). Very interesting ways of controlling the distribution of spectrum in space are presented, which include signal-analysis-control.

The idea is to select spectral characteristics (such as the amount of energy or phase position per bin) of a sound to create a spectral spatialisation pattern. (Lippe,Torchia 2003) The sound used to determine this spatialisation pattern could be the same signal actually being spatialized (a kind of self-spatialisation) or a complete different signal.

A method was designed for mapping the energy dispersion pattern of a stereo signal (which the authors call modulator) and applying then that pattern to an incoming monophonic signal (as the carrier). **(Fig. 21)** Two channels are brought into frequency domain, and for each FFT bin the amount of energy in each channel is compared and weighted on a scale between 0 and 1 for both left and right. These values are used then as amplitude coefficients for a monophonic signal, as well in

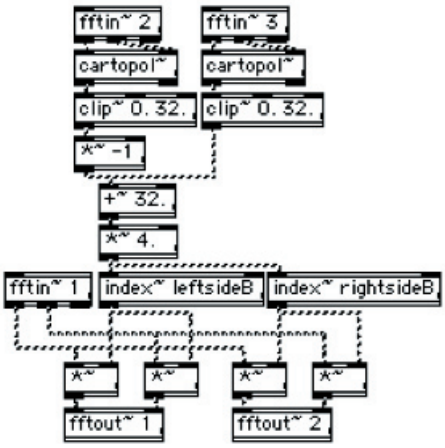


Fig. 21
The pfft~ subpatch used to multiply the spatial pattern of a stereo signal on to a monophic signal. (Lippe,Torchia 2003)

the frequency domain, that is then re-synthesized into a stereo signal. This technique is very similar to cross-synthesis, but the difference is that all the frequencies present in the monophonic original input will still be present at the output regardless of whatever is found in the analyzed stereo signal (modulator). Since this signal is only analyzed for spatial energy distribution the presence of silence still gives an equally balanced signal as well and results in the monophonic signal remaining monophonic. (Lippe,Torchia 2003)

These methods proposed here, can be extended to multiple strategies of multichannel composition, reason that first woke up my interest in spectral panning. Nevertheless, the idea of signal-based control is even more related to the spirit of this paper and my own compositional curiosity. In *Cambuche* I proposed a continu-

ous structure of control written in the audio domain for the sake of having the finest possible resolution that could allow gestures that can exist in the micro, mezzo and macro time levels exploring our perceptual borderlines of discontinuity and continuity (see chapter 1). The extension of this procedure in the frequency domain opens a wide number of possibilities by deriving multiple control signals from a single one, expecting as result complex-continuous control structures that keep certain internal coherence (That is what Estrada would call topological description).

It is important to point out that the idea of signal-based control is not new in electronic music. One can trace back the use of continuous control-voltage signals to the early electronic music of Koenig. In the series of pieces Funktionen (Grün, Gelb, Orange, Rot) he explores diverse strategies of using curves to generate sound and control structures using the analog electronic music studio. The recording of control signals in tape was a recurrent strategy. (Koenig 1971) Multi-channel distribution of sound responds sometimes to serial procedures, but the use of aleatoric control signals and the generation of material by parallel aleatoric procedures that have similar tendencies in multi-channel is as well proposed as a way of incorporating the sound routing in the compositional procedure from the very essence.
The perceptual result plays in the borderline between coherent and non-coherent signals in space that create ambiguous spatial sensations. This result is very close to the one given by spectral panning (sometime the coherence of the sound as a single source is lost because of the extreme scattering of timbre); even though the criteria for sound routing in both paradigms follows different compositional strategies; in Lippe's spectral panning the criteria of sound routing is based on the spectrum of sound and the compositional strategies are applied in the design of interesting (but always arbitrary) possible mappings of this information extracted from the very core of the sound's internal structure into space. In Koenig the "space" is a by-product of the interactions of the sound and control structures that are precisely determined by the compositional process (even if it contains random procedures). These approaches differ from the *Acousmatique*, in which sound routing strategies respond to the composers work on the idea of interpretation, of performance over a recorded work. Although there have been a lot of critical positions against this practice, considering it superficial and full of banal effects, for more than thirty years the French electro-acoustic community has witnessed the interest of composers in this area.

3. SPACE AS AN INSTRUMENT, SOUND AS AN INTERFACE

I have reviewed in previous chapters some examples of diverse musical strategies for creating dynamic control structures associated to the projection, routing or distribution of sound in space. Somehow there is a similarity in all of them in terms of conceiving space as a volume, as a passive agent. This fact motivated me to explore some other approaches in which the interaction with physical space is determinant.

The *Audible Eco-system interface*

Italian composer Agostino Di Scipio proposes a very interesting approach to the use of space. The system can be explained quite straightforwardly **(Fig. 22)**:

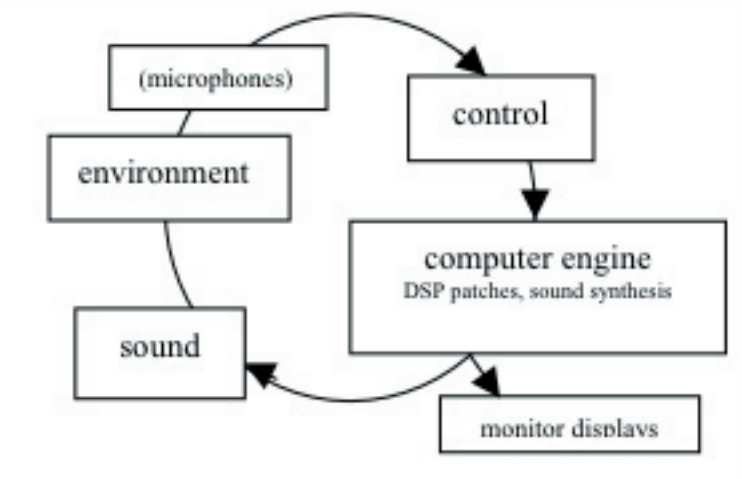


Fig. 22
The overall conceptual design in the *Audible Eco-system Interface* project. (Di Scipio 2003)

Sound is emitted into the room. This can be done by the computer via the speakers or by a performer. The sound is fed back to the computer by microphones strategically placed among the room. Placing them close to the speakers allow the creation of audible feedback by means of Larsen effect, placing them far from them allow the machine to "listen" and analyze the effect of the room specific resonances and reflections in the resulting sound. The data extracted from this analysis is used to generate control signals that drive the audio signal process' parameters applied to the sound fed back. The differences between the signal emitted and the signal received are weighted as well with the aim of creating a "difference" signal that adapts progressively a number of DSP parameters to the room's response. This circular recursive circuit is continuously adapting it self according to the room via a series of dynamic networks created by the composer. Di Scipio defines his point of view as composing interactions that leave audible traces rather that creating wanted sounds via interactive means.

These series of dynamic networks establish several interdependencies among the system components. The main aspects tracked by the computer out of the audio signal are amplitude, density of events (as a rate of onset transients, a sort of attack statistical following), brilliance or other specific spectral properties, and very important, the transient delay between room microphones, to detect different 'early reflections' in different places of the room, and tracking other spatial cues, such as the occurrence of the "precedence" effect in the room. (Di Scipio 2003) Differing from Lippe's spectral panning approach, frequency-related data is often ignored, perhaps because the nature of the system and the aesthetical choice of the composer. Nevertheless, in both cases, there is the intention of the creation several simultaneous control signals out of a single extraction process.

These interdependencies between the system's elements are described as "functions" (they are implemented in fact applying transfer functions to the control data, to create this self automated control). The relationships created between elements follow different criteria.

Compensation is the first of these strategies. An example quoted by Di Scipio is the link between the decrease amplitude of input material when sonic density in the ambience increases. This is so to say, a self-regulating mechanism. Another example consists of shortening the grain durations (in granular synthesis), as the impulse signal gets louder. Shorter grains will less overlap among them, resulting in the decrease of the total amplitude.

Following is another important strategy. The use of delay lines and other various types of "control-signal-processing" allow to "run after, and finally match the value of a given variable (as set by other process) with some delay". Di Scipio claims that this like the hysteresis processes found in biological and mechanical systems.

Redundancy, is kind the opposite of *compensation*, because it supports a predominant sound feature. For example automatically increase the density of generated grains, as the external amplitude gets louder. This will increase the perceived intensity without necessarily increasing the actual signal level.

Concurrency, on the contrary, supports a contrasting sonic feature that could even "compete" with the predominant sound. For example, augmenting comparatively high frequencies when low ones predominate in the room.

All these "functions" described above create a network of constraints between the systems' variables depending in both the external (room resonances) and internal conditions (described as Di Scipio as the diverse features of the computer generated sound itself before the output). This constant exchange in this "eco-systemic" relationship, between the machine and the ambience (and performers whenever involved) enhances two types of relationships or contrasting states, which defined by the author as "omeostasis" and "omeoresis" refer to a stationary or recurrent vs. a more dynamical-non-linear behavior of the system. In fact for Di Scipio a rich and variable behavior, making for a desirable performance is the resultant of the competitions of these two states.

The concept of musical form in this approach is very different of the tradition. Composer limits himself to create a series of dynamic sound interactions strategies on a recursive audio generating cycle. Form is the byproduct of the behavior of the system in time and in the room. This attitude assumes all the risks and undesired byproducts of such interactions trying to incorporate them in the system itself.

Di Scipio has used his "Audible Eco-systemic Interface" in the following works:
- *Audible ecosystems: no. 1 impulse response study*
- *Audible ecosystems: no. 2a feedback study*
- *Audible ecosystems: no. 2b feedback study, with vocal resonances*
- *Audible ecosystems: no. 3a background noise study*
- *Audible ecosystems: no. 3b background noise study, with mouth performer*

I find Di Scipio's music very interesting, nevertheless I have some personal remarks to his approach. As the title of the system and of the pieces produced with, the result is quite homogeneous among all the works. I perceive this music in the macro-formal aspect as evolving sound-escapes, which might be the composer's intention, but I think that in terms of different formal development the system gets limited and should be adapted, (which he actually did for other of his works, where he explored the concept of adaptive DSP).

Another aspect that would be questionable is the following: is the system adapting to the space, or to the miking structure installed in the room? This question arises because, as sound is the interface, all processes and equipment involved including microphones and loudspeakers become active agents of sound generation and their influence on the result must be taken in account. Therefore in my personal opinion, the influence of this microphonic space is as important as the real acoustic response

of the room in the whole structure of the system.

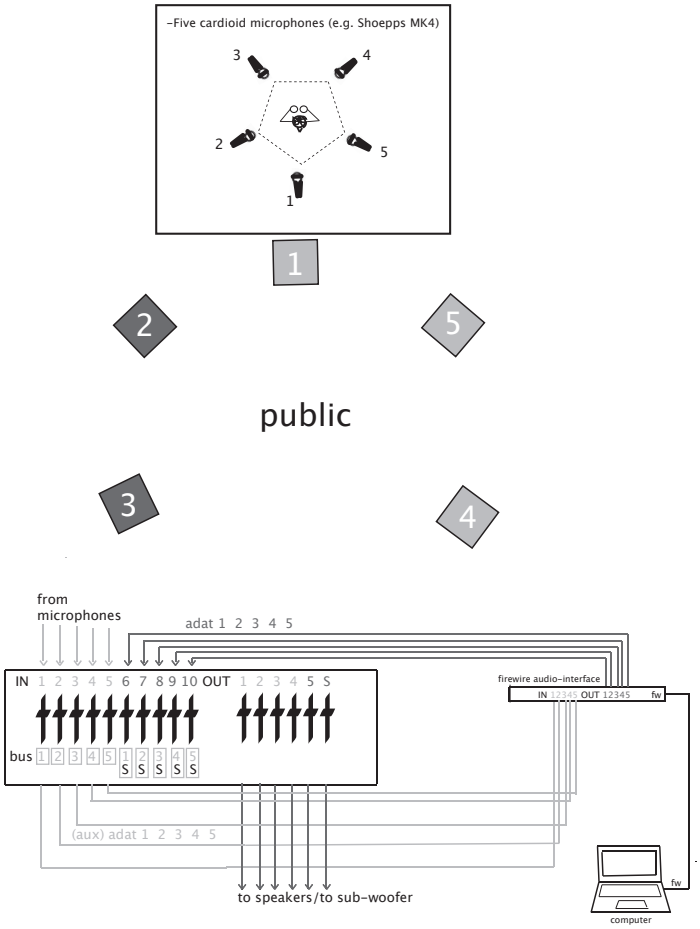
This consciousness about the importance of the use of microphones, as strategically placed “ears” of a live electronic music circuit, made me interested in developing miking structures that would respond both to spatial and control necessities, in a very different way.

Microphonic space as an interface

There has been a lot of research in microphone design, specially oriented to the recording and film industries. Diverse stereo recording techniques have been developed, such as the ORTF (the classical stereo pair of cardioids that imitate the ears disposition, named after the French radio), the MMS (that enhances the central image, of common use by professional film sound engineers), the Jeckilng disk, (that proposes a physical barrier between the two microphones), among many others. There has been as well a lot of research in surround recording that include various types of clever combinations of the stereophonic configurations.

All this research, which responds mainly to the interest of commercial applications that aim for fidelity in sound reproduction, can be profited for creative composi-tional work. I am at the moment developing a live electronic multi-channel piece for maracas, in which a microphonic space is proposed for creating a surround amplifi-cation ring, and is at the same time a control interface for sound spatialisation and digital signal processing, and a chorographical space for musical performance.

The disposition of the microphones creates a pentagon, which is replicated by the loudspeakers around the audience. In the center of each of these pentagons we find the interpreter and the audience respectively. Each microphone is assigned only to its corresponding speaker in the space. The whole ring of amplification recreates in the room the spatial sound movement produced inside the microphonic-space by the percussionist. **(Fig. 23)**



Set-up for signal flow, miking and speakers' distribution in “Te masca” for maracas and live electronics

Fig. 23
The diagram shows the basic set-up for micro-phones and loudspeak-ers in TE MASCA for ma-racas and live electronics (work in progress)

This very straightforward way of spatial micro phoning is not new. Stockhausen in his early studio experiments designed such a structure, with a rotating loudspeaker in the middle. The microphones captured the sound trajectories into multi-phonic channel recordings. This technique has been used a lot, even after the appearance of amplitude panning techniques, and is present in the music of composers such as Rainer Boesch, and a lot of composers from the concrete music tradition. (Boesch 1997)

For the conception of this final set, I tested diverse quadraphonic configurations in a square, an octo-phonic one distributed as 4 stereo pairs in a square, the pentagon using an MMS couple in the center, and some other set-ups. The final set-up (five cardioids pentagon) was chosen for its good directionality and its homogeneous coverage of all the performance area. Another important criteria was to have the smallest number of microphones; as all the incoming audio signals are analyzed in real-time, reducing the number of voices (without scarifying spatial covertures) will result in economy of computer processing power. It is important to notice that before using microphones for deriving control signals, I tried the use of accelerometers to retrieve control information from the X and Y position of the performers hand. The idea was soon discarded because there are a lot of movements in the maracas performance which are not directly related to the sound production. Therefore the use of position sensors was not pertinent, because of the excess of non relevant continuous data, that bring undesired, chaotic, or redundant data into the system. **(fig 24)**.

The idea of economy of materials is an aesthetical constraint of the work. This austerity is reflected in the instrumentation (only a pair of maracas, simple pitch-

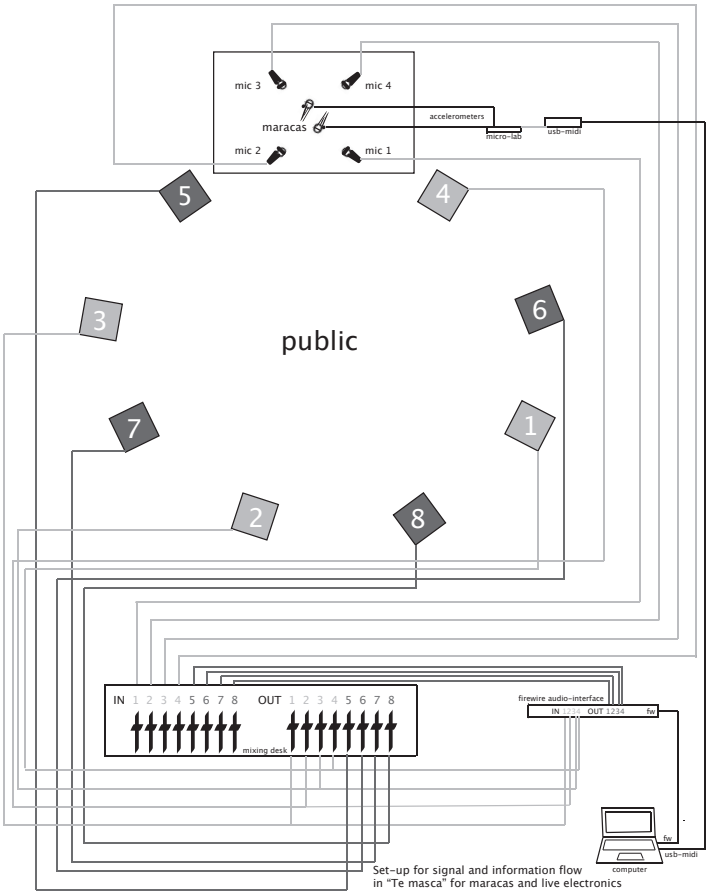


Fig. 24
The first experiments for creating the control structure in TE MASCA for maracas and live electronics (work in progress). The use of accelerometers was discarded because of the huge amount of data derived from non-musical gestures, during the performance.

less percussive instruments), and one of the technical challenges is to drive all the system with a laptop, no additional DSP modules, or controllers. This idea of "Austere Music" has been defended in various ways by a number of recent Latin-American composers such as Jacqueline Nova, Cergio Prudencio, Graciela Parasquevaidiz,

Eduardo Bértola, Coriún Aharonián, among many others.

Such a microphonic set-up implies a chorographic space by essence. The spectacular effect of the over-amplification has a very evident visual repair on the performer's action. Xenakis, who explored with performers in movement in pieces such as *Eonta*, paradoxically considered problematic this theatrical aspect of performance. (Harley 1994) Nevertheless the nature of the maracas playing embeds a lot of movement, and I decided notate it on the score. The exact location of both hands inside the pentagon is given and the progressive translations from one point to another are précised among all the piece. **(Fig. 25)** This is like composing a music, which is at the same time dance, hyper-deterministic chorographical movement that becomes spatial sound gesture. The performer must anchor his feet facing the audience and all the points in the performance area must be reachable by both hands. This implies movements such as the arms crossing or the torso spinning around its vertical axis, which can articulate a very interesting visual and musical discourse. Apart from the direct spatialisation, and the chorographical aspects, the most important function of this microphonic space is to provide the whole control structure for the live-electronics circuit. As in spectral panning or in Di Scipios Eco-system,

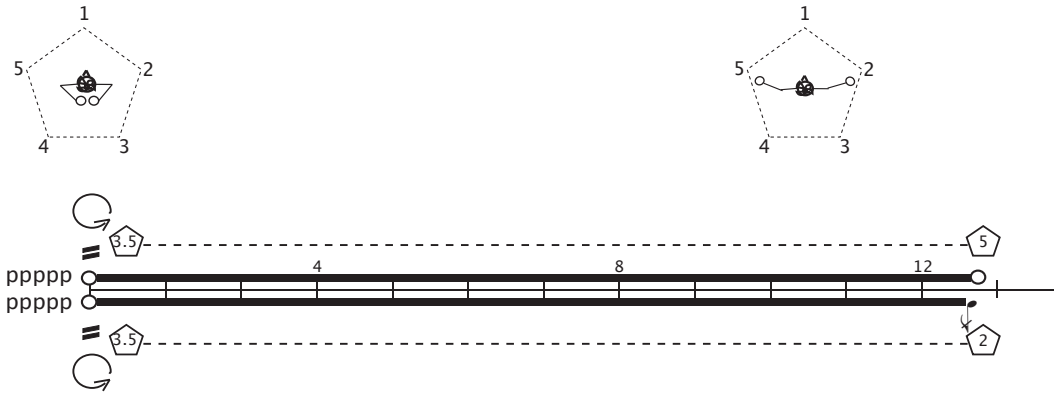


Fig. 25
Extract of the score of TE MASCA for maracas and live electronics (work in progress). Apart from its musical function, it has chorographical and spatialisation implications

I am trying to derive several control signals out of a single extraction. The basic strategy is to follow the amplitude envelope for each microphone separately. Figure 26 shows a simplification of the Max patch that makes the simultaneous envelope following of all the microphones. Each curve is sent separately to the DSP engines, which include mainly granular synthesis modules and some others of minor spectral manipulation. All the engines are 5 channels as well and the control derived from the audio-signals is assigned and mapped in different ways.

As in the *Audible Eco-system*, there are several relationships that can be exploited

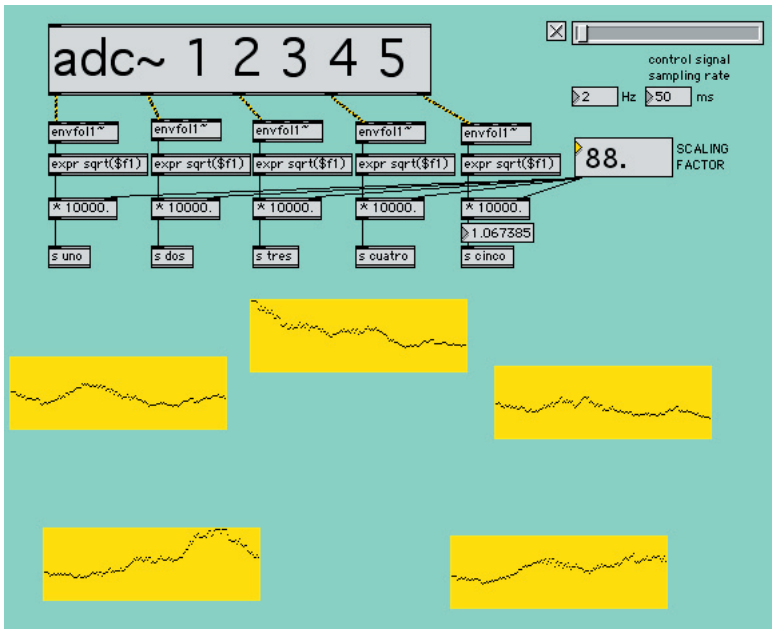


Fig. 26
Simplification of the envelope-following patch in TE MASCA for maracas and live electronics (work in progress). The amplitude envelope of each microphone is converted into a control-signal.

between the sound reality and its effect on the live electronic system. The most straightforward relationship proposed is the amplitude of each microphone, controlling the amplitude level of the corresponding channel of the granulator. This would be a kind of regulating mechanism, which responds to the performer. In this case, for example, silence from the interpreter can only generate silence from the machine. This regulating mechanism is not an algorithm derived from the room's response but from the performers action, which is precisely determined in the score. Anyway in my opinion is similar to the *redundancy* explained in Di Scipio's approach.

Just in terms of mapping amplitude to amplitude there is a lot of interesting spatial relationships to explore. Mapping with the same correspondences that the ones used in the microphonic amplification **(Fig. 23)** would result in the impression of the electronics and the instrumental sound as a whole single voice. Changing this mapping for example for a crossed counter-clockwise correspondence would create a spatial counterpoint between the amplified instrumental sound and the sound from the computer. **(Fig. 27)** The several mappings possible allow multiple relationships such as those of *following*, *competition*, or *redundancy* proposed by Di Scipio that can be applied both in the spatialisation criteria and in the control of the granulator's timbre. Mapping amplitude, directly, inversely, or via transfer functions into several parameters of the granular synthesis engine (I use the application proposed by Johan Van Kreij in his Sonology MSP courses with some minor adaptations to my control structure) permits the timbre of the maraca (that has a natural granular sound) to enlarge its sound in time and space.

All these interactions are tied up by the musical score (that I'm actually writing), which fixes the topography of all the control signals determining the system behavior (inversely from Di Scipios approach in which the system's behavior determines the musical form). The programming of the control processing is parallel to the writing of the score. One can imagine that this system could be used in an

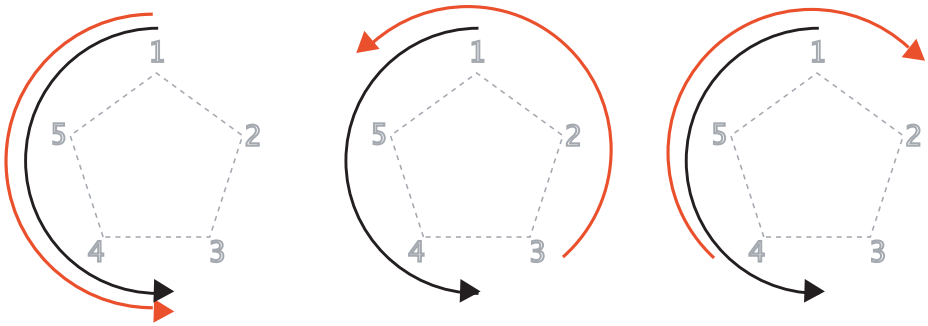


Fig. 27 TE MASCA for maracas and live electronics (work in progress). The figure shows the some of the possible spatial relationships between the amplified sound (in black) and the sound of the computer (in red).

improvisation context, but in my opinion this could only be done after having a composition as a starting point, to explore the initial potentialities and settle up the basic interactions between the musician, the DSP circuit, and the location of sound in the room.

One of the advantages of using sound as an interface is that, in the context of instrumental music, all the control gestures are musical gestures generating very organic results when proper mapping and scaling is applied. Another feature is the continuous character of the control signals result of the interpolation and the sampling rate of the analysis module. A lot of interesting control processing can be made by manipulating the resolution of the analysis in real time, before it is actually bounded to any parameter. This possibility of shaping the control curves can facilitate the mapping response to proper parametrical resolution. Although the use of delay and feed back lines in the control domain seems to me a very interesting idea, I have not dealt with these processes until the moment, perhaps in part to avoid any inertia (so present in the Audible Ecosystem) of the electro-acoustic implementation. Nevertheless this can be a way of further developing the system perhaps with other configurations that respond to different compositional ideas.

This continuity, and the possibility of controlling the resolution of the system in real time, and somehow in real space, imply a dynamic approach in musical thinking. Julio Estrada with his Eua'oolin system uses a camera to follow three-dimensional movement in order to produce a control map, an automated transcription consisting of a set of curves (derived from a same single gesture), which will define parametrical behavior in instrumental music transcription. This is a non real time strategy. In fact there are various levels of transcription, and even the final score, then needs to be interpreted by a human performer. In contrast, the system I propose here creates a listening three-dimensional space (that would be the equivalent of Estrada's camera) that is defining all the parametrical behavior of the resulting sound, in real-time, by the sound itself. This implies the careful programming of all the interactions of the system, (that would be somehow a parallel score). All these processes can only be tested in real time, and these needs a lot of time of studio work, ideally in company of the instrument's player.

FINAL REMARKS

I have tried to outline some compositional strategies dealing with space. This paper is far from being an extensive historical study, and it reflects the theoretical framework of my compositional work during the past three or four years. The main conceptual link between all the different approaches presented here is what I call Dynamic Musical Thinking. From Varèse to Di Scipio, there is a common conception in all the examples reviewed of music as continuous transformation of sound in time and space.

In the first chapter with the works of Xenakis and Grisey, I tried to outline some strategies for writing continuous sound trajectories in space, emphasizing in the implications on notation for human performance. Making a parallel between instrumental and electronic music procedures that aim the same perceptual results seems to me a very pertinent thing from a compositional point of view. This might be as well of interest of musicologists, but this is not the target of the present article. For the sake of showing this parallel I include some references to the concept of continuum of macro-timbre as proposed by Julio Estrada (and developed by him mainly in the composition of instrumental music) and the way I applied it both in timbre and space in the electronic music field with *Cambuche*, a quadraphonic tape piece that works with a similar paradigm of the one explored in pieces such as *Le Noir de l'étoile* or *Persephassa*.

There is a common graphical reasoning underlying all examples of my first chapter. The chrono-graphical recordings in Estrada, the control curves that I stored as audio waves, and the circular and spiral trajectories in Xenakis' or Grisey's scores they all respond to a geometrical conception of space, and time, and they reveal a continuous musical discourse, in which sound is shaped in time and space.

The third chapter of this paper develops these same concerns, from the point of view of the live electronic music. I've dealt with some examples of creating compositional control structures that are derived from the sound itself. The use of sound as an interface of control of live electronic music circuits allows several possible continuous interactions derived from the nature of sound. The role of microphones and sound analysis algorithms such as the amplitude or spectral following is shaped responding to compositional strategies, that aim different ways of involving the physical space in which the music is produced into the musical discourse.

Another important concern of my work has been dedicated to the study of different approaches for routing sound in space, that are discussed in the second chapter of this article. Sound projection in space is presented as a matter of compositional design, responding to various criteria. While composers from the tradition of "Musique *Acousmatique*" claim sound diffusion as the final step of all electronic music composition, other approaches involve different ways of routing sound material in space "non-a-posteriori" (included in the initial compositional process) such as spectral panning or the use aleatory control signals in multi-channel.

All the positions expressed in this paper reflect somehow my own compositional points of view in one way or another. Therefore I would like to insist in the subjective character of this work, which pretends just to be an analytical portrait of my compositional curiosities on the use of space in electronic and instrumental music. I include as an appendix to this paper some of the compositional projects that I developed during the past two years in the Institute of Sonology that might illustrate in scores and recordings some of the ideas presented here.

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APPENDIX – Some projects developed during my stay in the Institute of Sonology

LATEX (2006)
for amplified ensemble
(oboe, violin, double bass, guitar and percussion)

LATEX (2006)

for amplified ensemble
(oboe, violin, double bass, guitar and percussion)

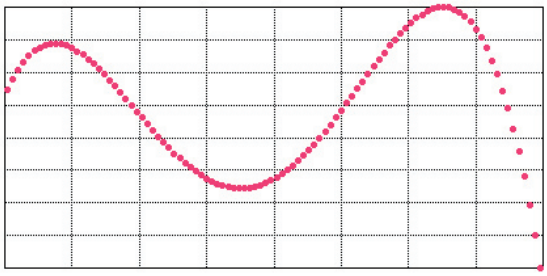
This piece uses the ensemble as a single macro instrument. The first half of the piece (until bar 72) is structured around a continuous process of ring modulation algorithmically programmed in AC Toolbox (and then retranscribed into musical notation).

The basic motif of the piece is a curve (borrowed from Clarence Barlow's Music-quantics book) which describes a combination of a logarithmical and exponential motion (a sort of "s").

I programmed the formula in LISP and I adapted it to change the gradient of the curve linearly in time, and I compiled it to be used as a tool in the AC Toolbox.

Fig. 28 29 LISP code and graphical representation of the basic motif in LATEX

```
(defun dynamic-logexpo-motion (n min-gradient max-gradient)
  "does an s motion from 0 to 1 with a constant ascending or descending gradient.
  Arguments are n number of steps (resolution) min-gradient and max-gradient
  syntax-> (dynamic-logexpo-motion (n min-gradient max-gradient))"
  (loop
    for x in  (create 'list n (line-segment n 0 1))
    and gradient in (create 'list n (line-segment n min-gradient max-gradient))
    collect (+
            (* gradient x)
            (+
             (* (* 3 (- 1 gradient))
                (* x x))
             (* (* 2 (- gradient 1))
                (* (* x x) x))))))
```



All the form of the piece in this first part is an evolution of this basic curve which is being ring-modulated, first by a constant frequency, then by a continuous ascending glissando, then by an inverted version of the motif and so on. All this evolution is developed around the idea of the elasticity of the materials both in time and frequency, therefore there is a constant process of shrinking and extending of the musical material.

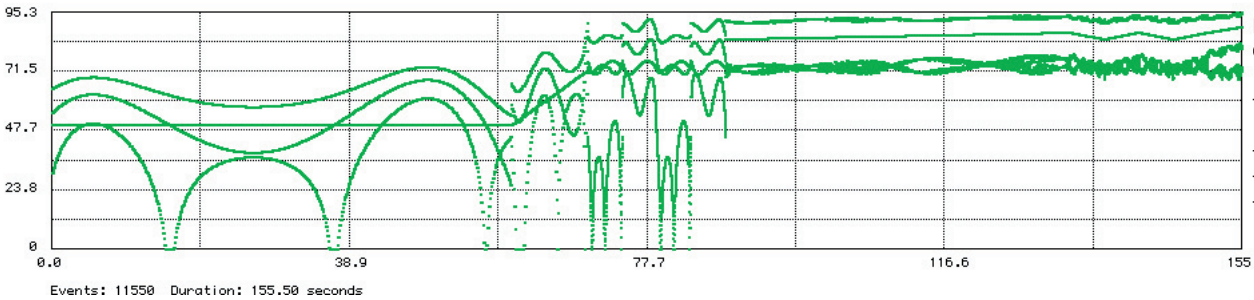
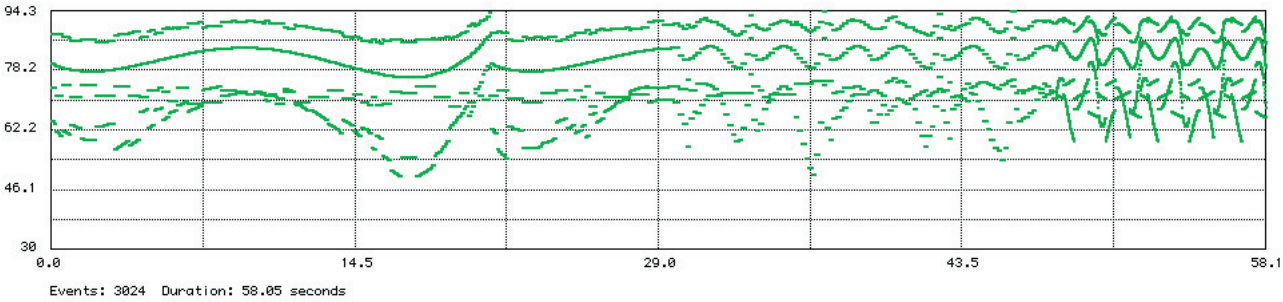


Fig. 30 31 Graphical representation of the ring modulation process that governs the harmony in LATEX



The ring modulation algorythm produces then a total of four curves which are associated among them by a continuous transformation of timbre. This is as important for creating the idea of a single macro-instrument, as it is the use of rythmic homophony, and the use of amplification.

This map, produced the basic material to be transcribed. The particularities of the instrumentarium implied a lot of strategies for reconstructing the process with the register limitations of the ensemble. The transcription demands a very detailed and rigurous compositional work. The facilities of printing text scores in the AC Toolbox helped a lot in this process. Nevertheless it is always an arbitrary procedure and that is the charm perhaps of this way of working.

The rest of the piece from bar 72 until the end is based on the harmony of oboe multiphonics, as a way of creating a contrast with the machine-like timbre of the first part. The idea of a single instrument is almost broken by a sort of hoquetus antiphony, which blurs soon into homophony. Polyphony does no exist in the piece as voice counterpoint, but sometimes a sort of polyphony can be perceived as internal changes inside an evolving timbre.

This piece was commisioned by Vortex Ensemble with the sponsorship of Fondation Nicati and Fondation Nestlé pour l'art and was premiered the 30/03/06 in Festival Archipel in Geneva Switzerland, using the set-up discussed in chapter 2 (Salon d'écoute).

L A T E X

para ensamble amplificado

Daniel Zea Gómez (2006)

oboe

violín

contrabajo

guitarra

percusión

SEXY Y ESTRIDENTE
♩= 52 - 60

mf

sfz

l.v

sfz mp sfz

sfz mp sfz

p

crótalo sobre
el timbal

platillo

mute!

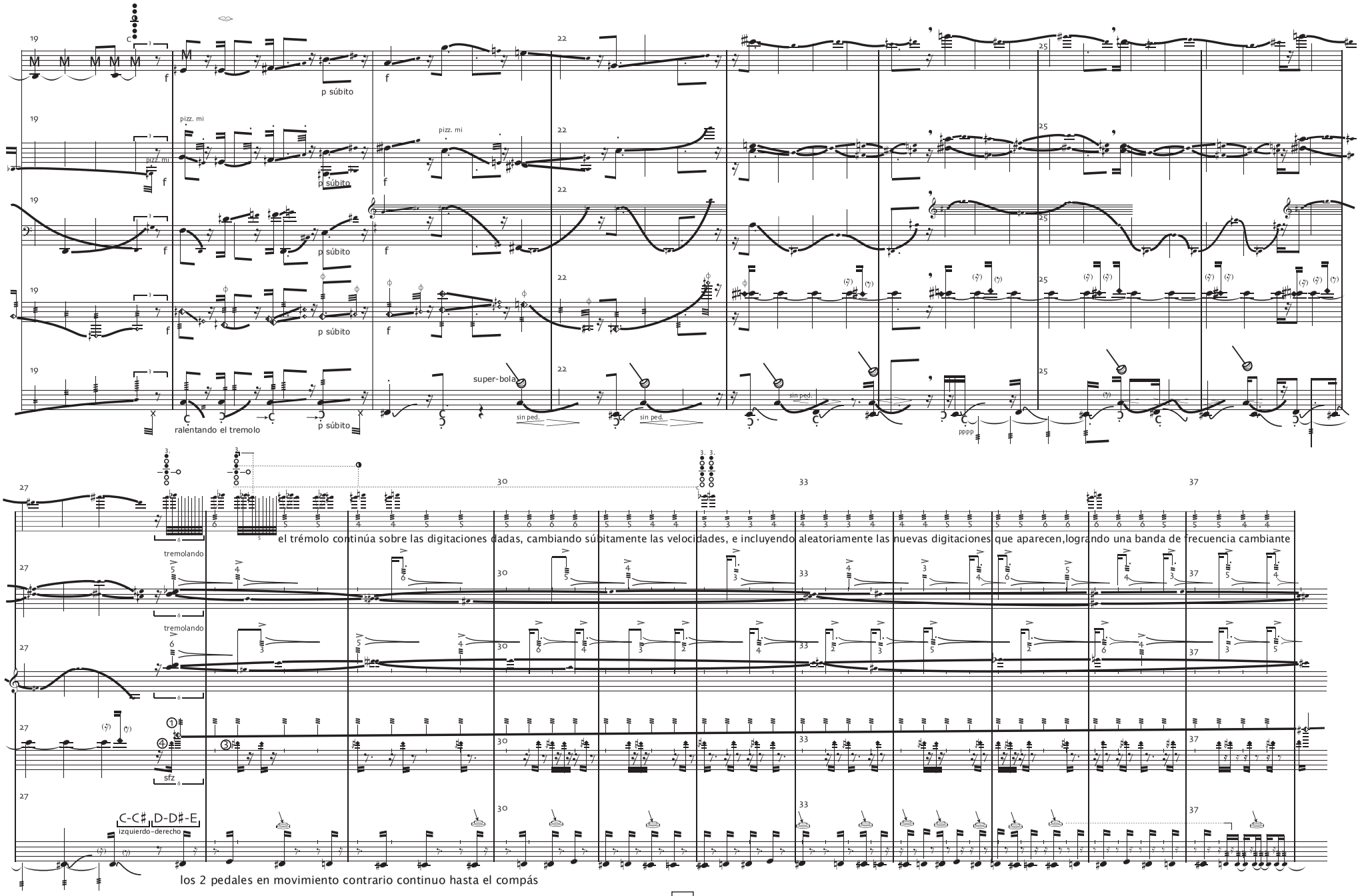
timbal-tremolo sobre la sordina
ralentando-acelerando radicalmente la densidad

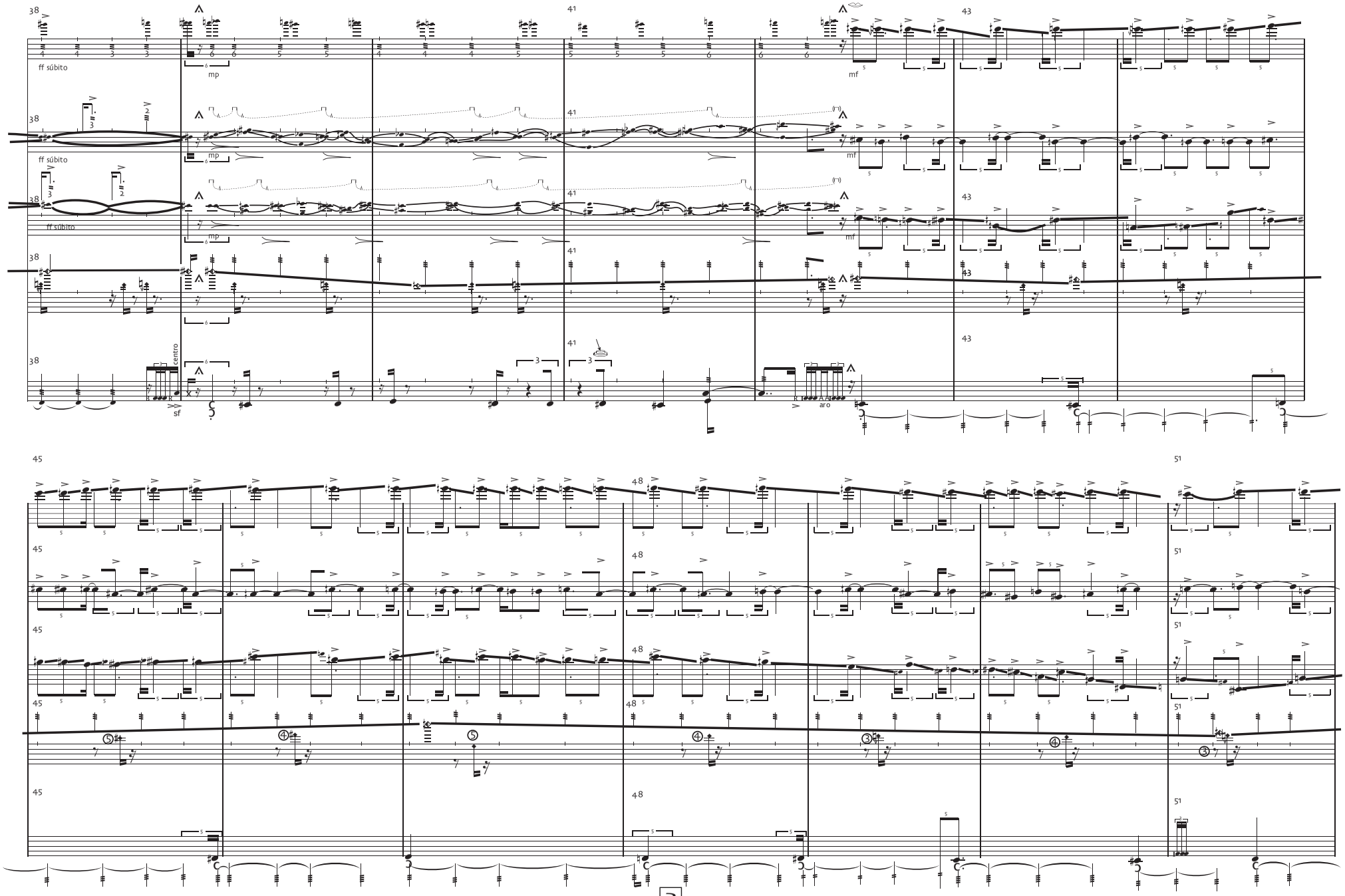
8va

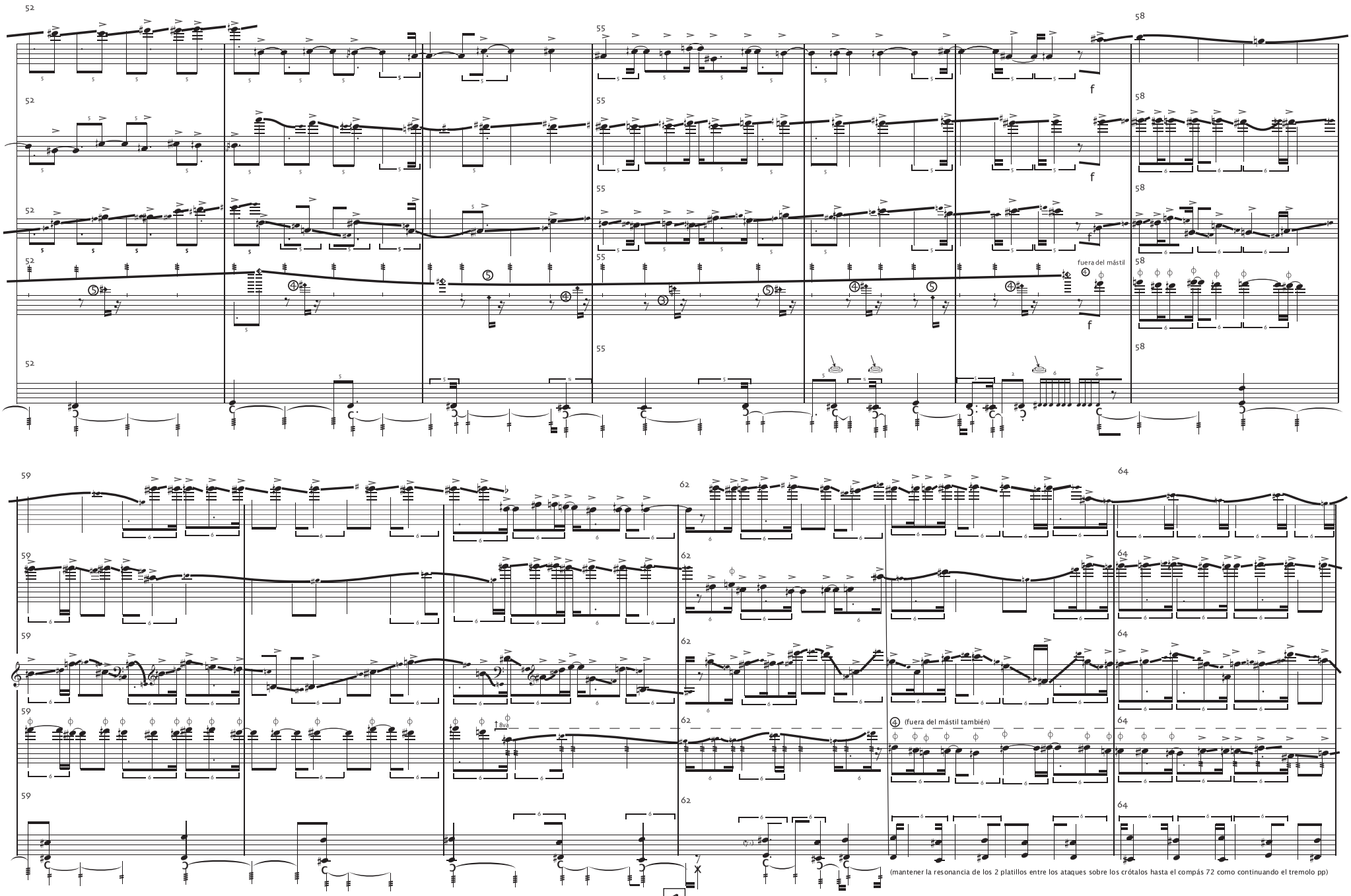
pizz (m.i)

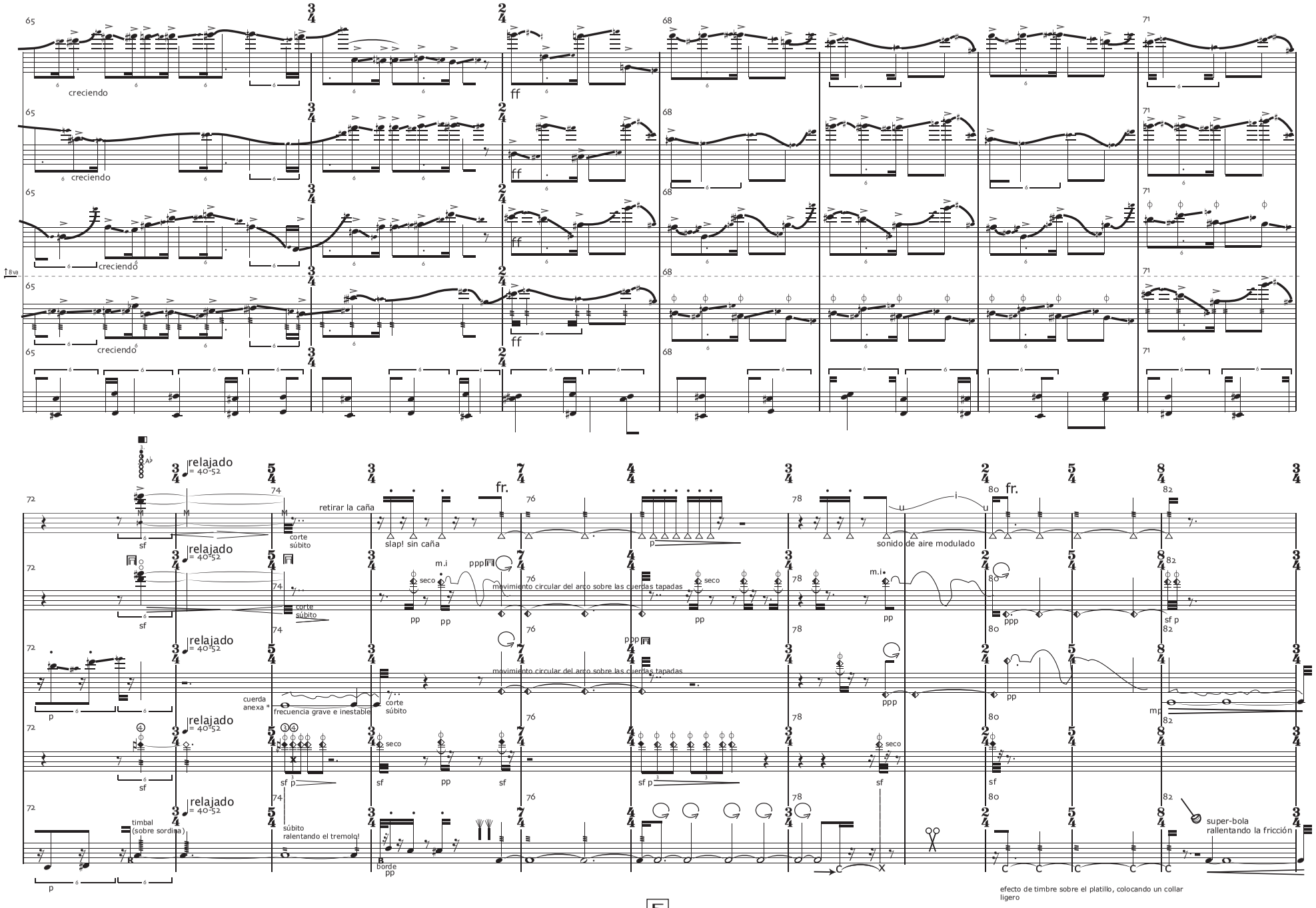
(continuo)

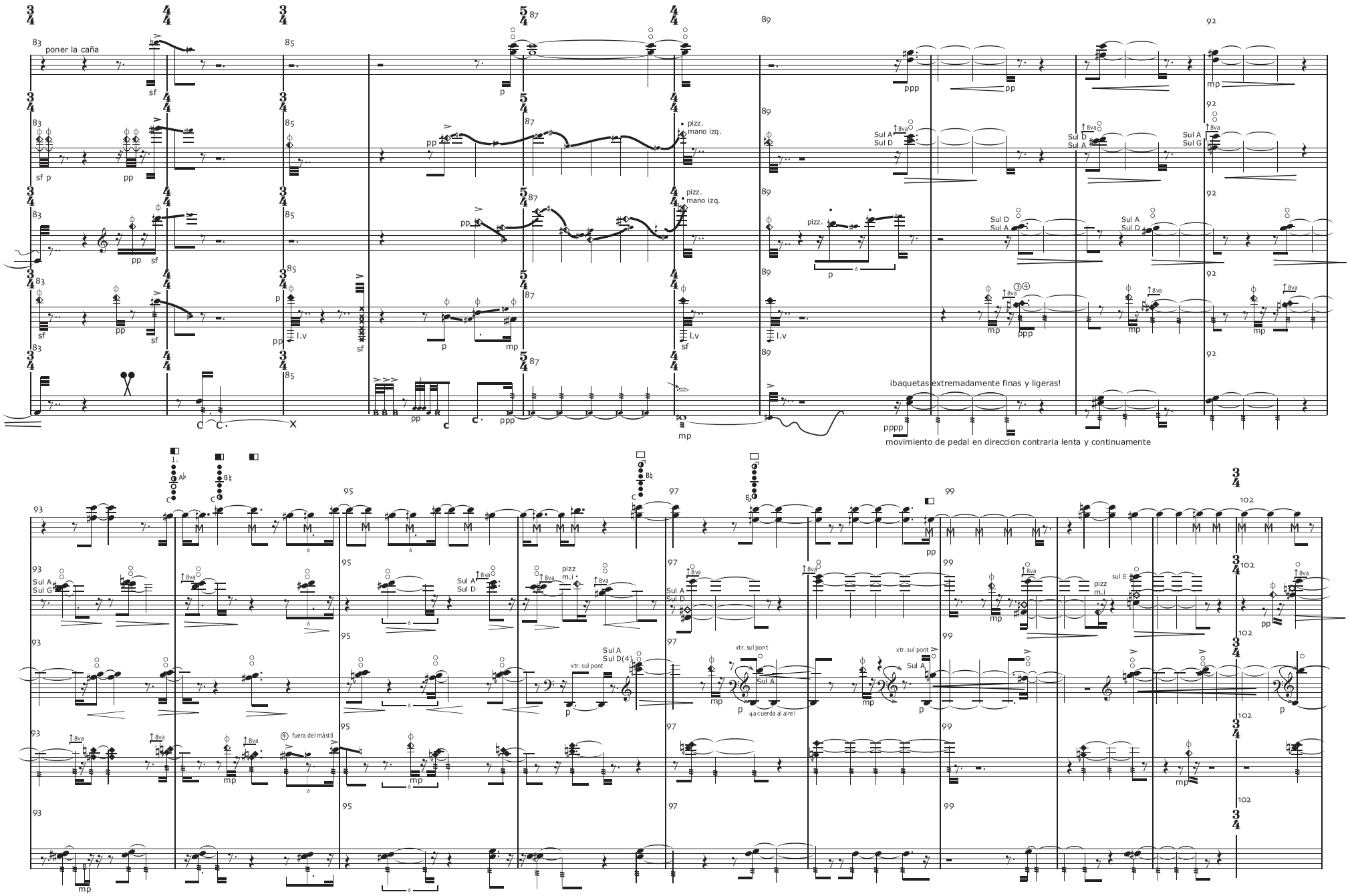
platillos-tremolo y ataque los 2 pedales de los timbales se mueven paralelamente


p súbito
pizz. mi
super-bola
sin ped.
ralentando el tremolo
pppp
el trémolo continúa sobre las digitaciones dadas, cambiando súbitamente las velocidades, e incluyendo aleatoriamente las nuevas digitaciones que aparecen,logrando una banda de frecuencia cambiante
tremolando
sfz
C-C♯-D-D♯-E
izquierdo-derecho
los 2 pedales en movimiento contrario continuo hasta el compás


38
41
43
45
48
51
ff súbito
mp
mf
sf
centro
aro


52
55
58
59
62
64
f
fuera del mástil
8va
(fuera del mástil también)
(mantener la resonancia de los 2 platillos entre los ataques sobre los crótalos hasta el compás 72 como continuando el tremolo pp)


creciendo
ff
8va
relajado
= 40-52
retirar la caña
corte súbito
slap! sin caña
fr.
sonido de aire modulado
seco
m.i
movimiento circular del arco sobre las cuerdas tapadas
cuerda anexa *
frecuencia grave e inestable
timbal (sobre sordina)
súbito ralentando el tremolo!
borde
super-bola rallentando la fricción
efecto de timbre sobre el platillo, colocando un collar ligero


poner la caña
pizz.
mano izq.
Sul A
Sul D
Sul G
ibaquetas extremadamente finas y ligeras!
movimiento de pedal en direccion contraria lenta y continuamente
pizz
m.i
sul E
Sul D(4)
xtr. sul pont
4a cuerda al aire!
fuera del mástil

¡sin multifónicos!

pppp sonido de aire modulado con la caña puesta

rallentando, rebotando el arco sobre las cuerdas tapadas

Sul A

Desafinando la cuarta con la clavija sobre los ataques, hasta lograr un ruido de motor

③ fuera del mástil

Recorriendo toda la extensión de la ⑥ cuerda, rascando lentamente con la uña

pppp frotando las cuerdas con la palma, de irregular a regularmente

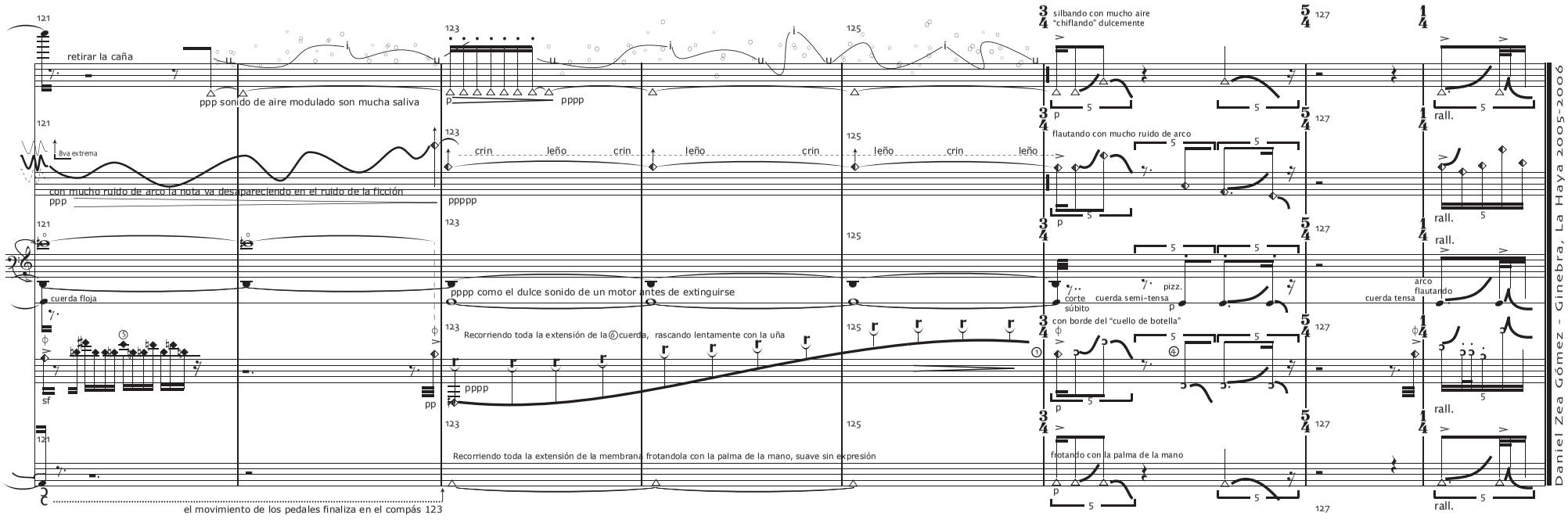
pedales en movimiento contrario muy lento y continuo hasta el compás 123

4ta cuerda floja que suena como un motor + cuerda annexa, coro de sub-graves

golpe del choque de la uña contra el puente al finalizar el largo total de la cuerda recorrida rascando.

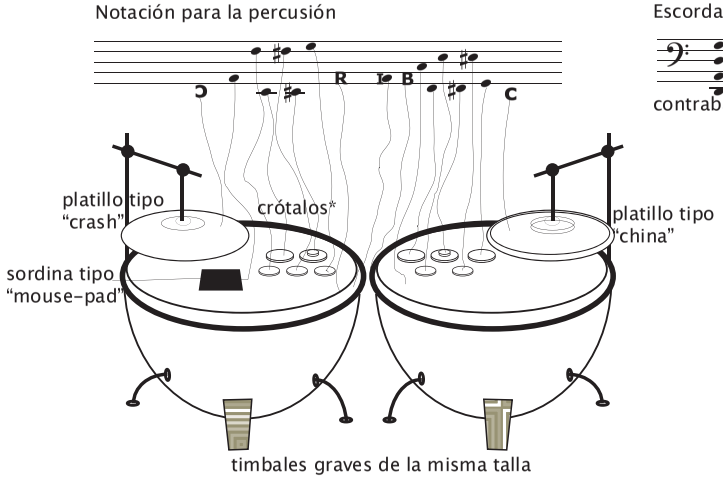
pp tranquilo y sin sobresaltos!

mp sobresaltos



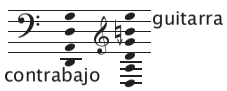
I N D I C A C I O N E S

Notación para la percusión



* el C y D sostenidos graves se ubican acostados sobre su cara mas grande de manera tal que su sonido se ensordina un poco. El resto reposa sobre su cara angosta transmitiendo su reonancia a la membrana del timbal.

Escordatura



tres cuartos de tono arriba

un cuarto de tono arriba

un cuarto de tono abajo

sonido armónico

media presión

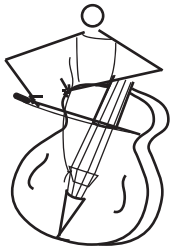
sonido aéreo o de fricción, como un dulce ruido blanco

cambiando la presión de los labios para obtener los glisandos (oboe)

sonido multifónico (oboe) solo debe aparecer sobre las notas cuyas plicas lleven la M apesar de que estén ligadas.

las cabezas de nota pequeñas indican el punto de llegada de los glisandos y nunca deben ser re-atacadas

* Una cuerda gruesa de guitarra, de arpa o de bajo eléctrico debe amarrarse a la 4a cuerda del bajo detrás del puente, y debe tensionarse con la mano izquierda con el fin de producir una frecuencia muy grave de estabilidad o inestabilidad modulable. Esta notada como un sistema adicional de una sola línea añadido a la parte del bajo, aparece a partir del compás 74.



MICROFONIA

oboe: mic. cardioide tipo shoepps con base
violín: un mic. de contacto tipo AKG C410
contrabajo: un mic. de contacto tipo AKG C410
guitarra: un mic. de contacto tipo AKG C410
percusión: 2 mic. cardioides tipo overheads con base

AMPLIFICACION
Una consola de audio debe estar disponible para controlar la mezcla de los diferentes micrófonos durante la pieza por parte de un asistente. La mezcla debe difundirse en sala a traves de por lo menos un sistema de dos parlantes, aunque un dispositivo mas grande es aconsejable.

MURO (2005)
Video and sound installation in collaboration with Alexandra MAURER

MURO (2005)
Video and sound installation in collaboration with Alexandra MAURER

This sound installation is a collaboration with the swiss artist Alexandra Maurer, who works with animated paintings. The animation loops are randomly generated each time there is an attack percieved by the computer comming from the audio loops. Attack detection also controls hard panning changes over a quadraphonic speaker set-up, with the aim of generating this "wall-reflecting-spatial" sensation.

Fig. 32 33 Sceen-shots of MURO, sound and video installation.

All the sounds used in the piece were extracted from the original films that the artist used as raw material for her paintings. The whole system works as a stand-alone application designed in Max/MSP. A first application was designed using Jitter, but the result in terms of resolution was deceiving. The final application was implemented using the GEM objects (initially developed for the Pure Data environment) which control the video card of the computer, without using the internal processor.

This installation has been presented in different art festivals and expositions in Zurich, Basel, Mulhouse, Belgrade, Geneva, Fribourg, St. Gallen and Paris.

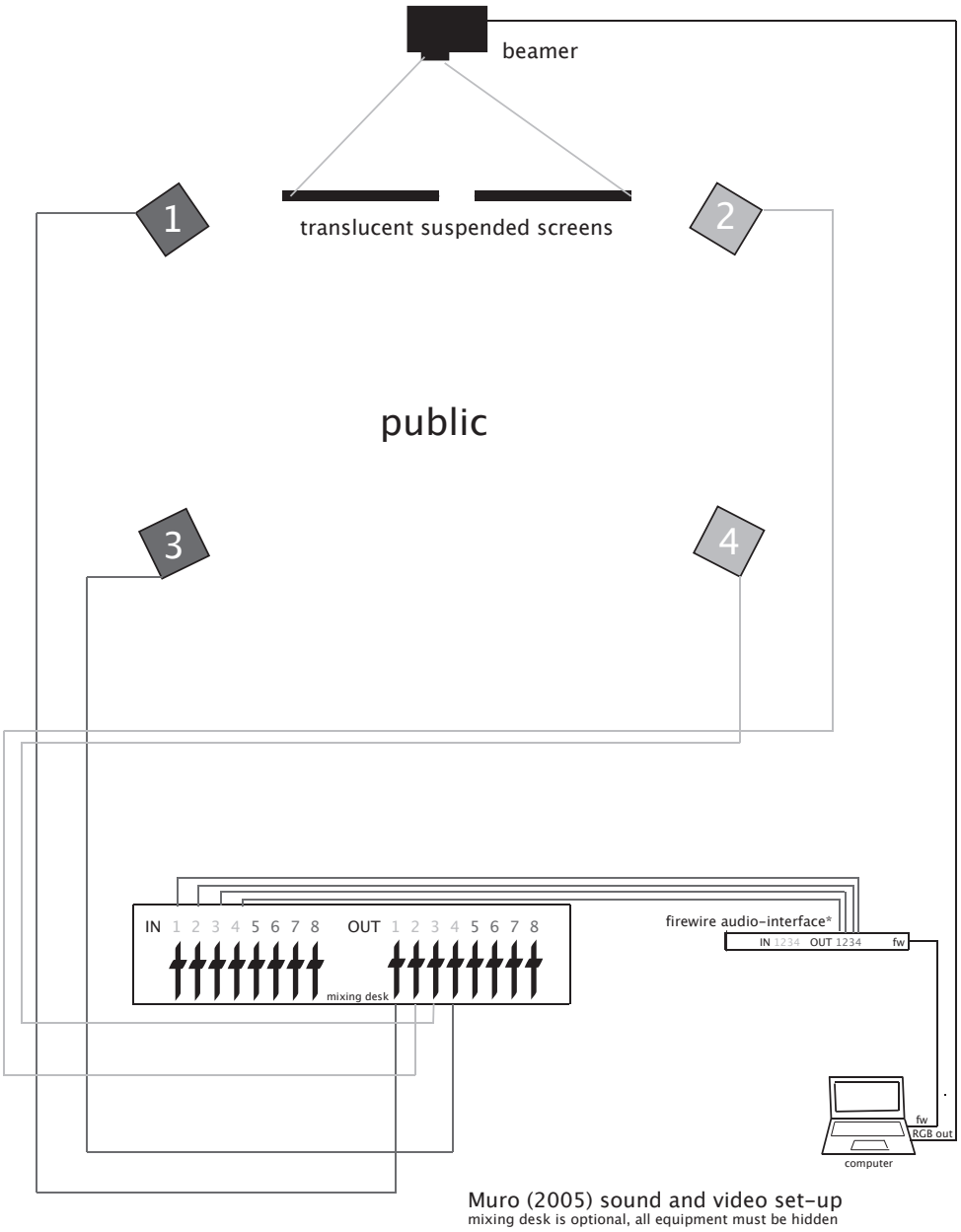


Fig. 34
Technical installation for MURO

SAN PEDRO (2005)
For the two organs in Pieter's Kerk in Leiden

San Pedro

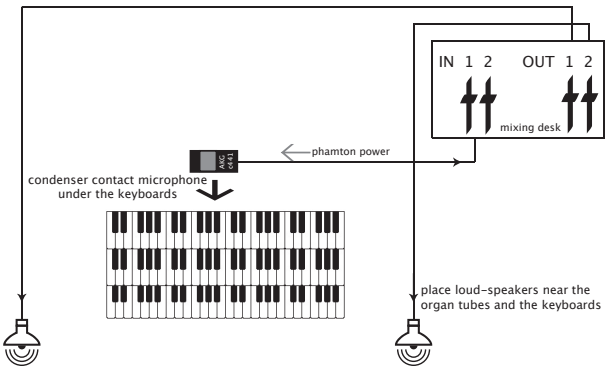
for the 2 organs in Pieterskerk, Leiden – Daniel Zea Gómez (2005)

This piece was specially written for the Van Hagerbeer organ (tunned in mean tone temperament A=419Hz) and the Thomas Hill organ (tunned in equal tone temperament A=440Hz)

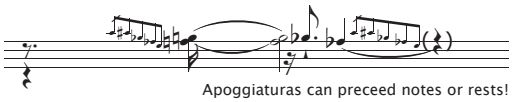
The registration of the piece is specified in the score, nevertheless the organists might change it at their will but always respecting the size of tube written. Only 16', 2', 1+1/2', and 1'foot pipes are used.

For the sake of synchronization a monitoring system of audio and video between the organists must be set up. A special feature of this piece is the amplification of the keyboards' noises creating another sound layer added to the music.

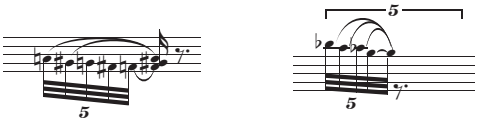
Amplification system for keyboard noise (must be set for both organs)



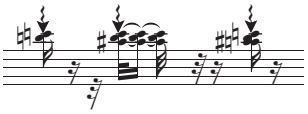
Indications on the notation:



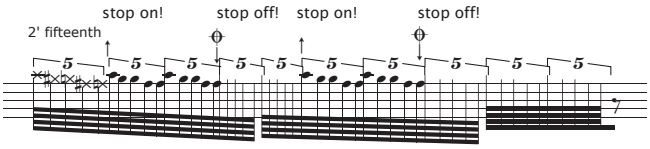
Apoggiaturas can preceed notes or rests!



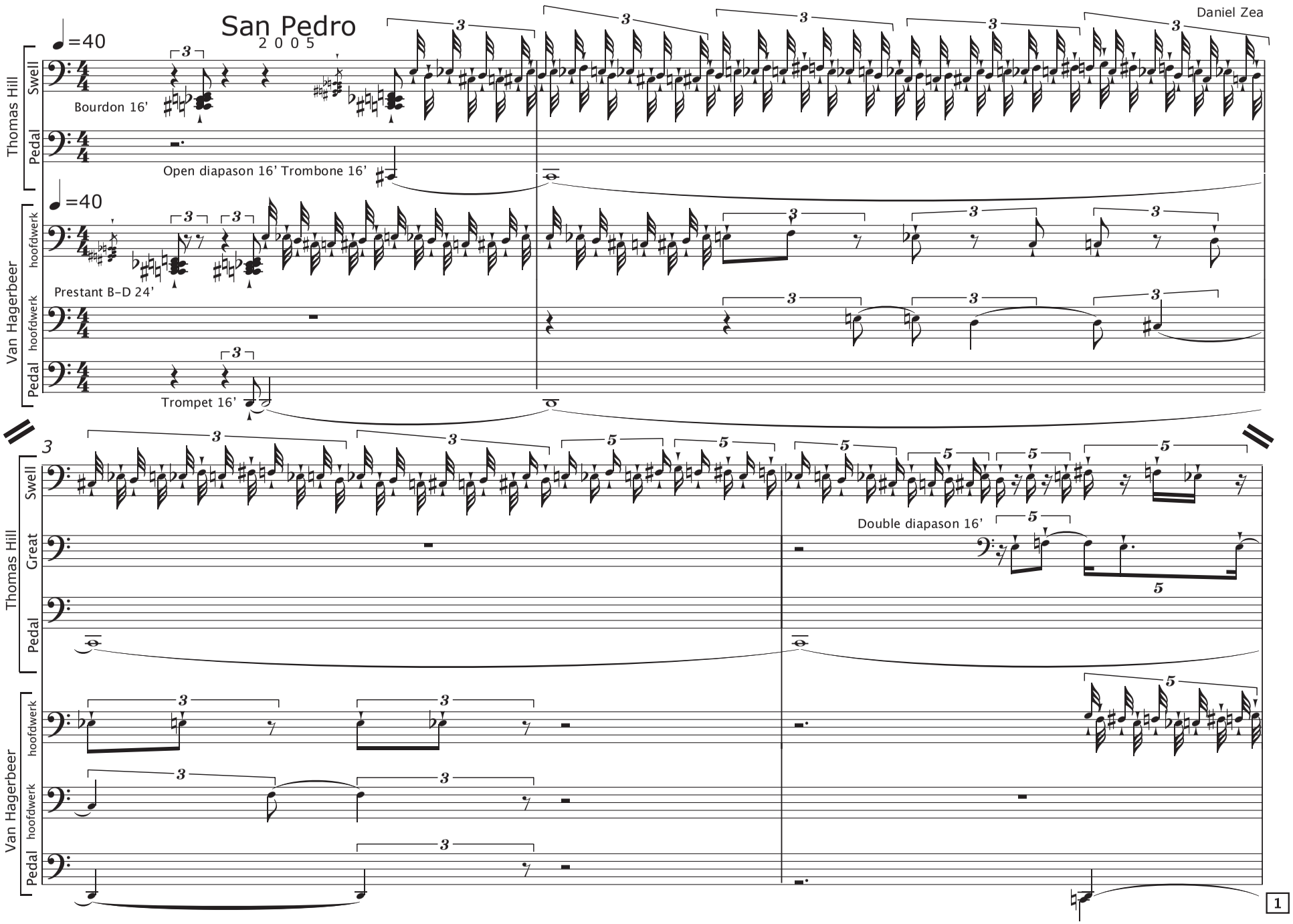
Tied notes extend their duration until the end of tie even if it is not over an adjacent note!

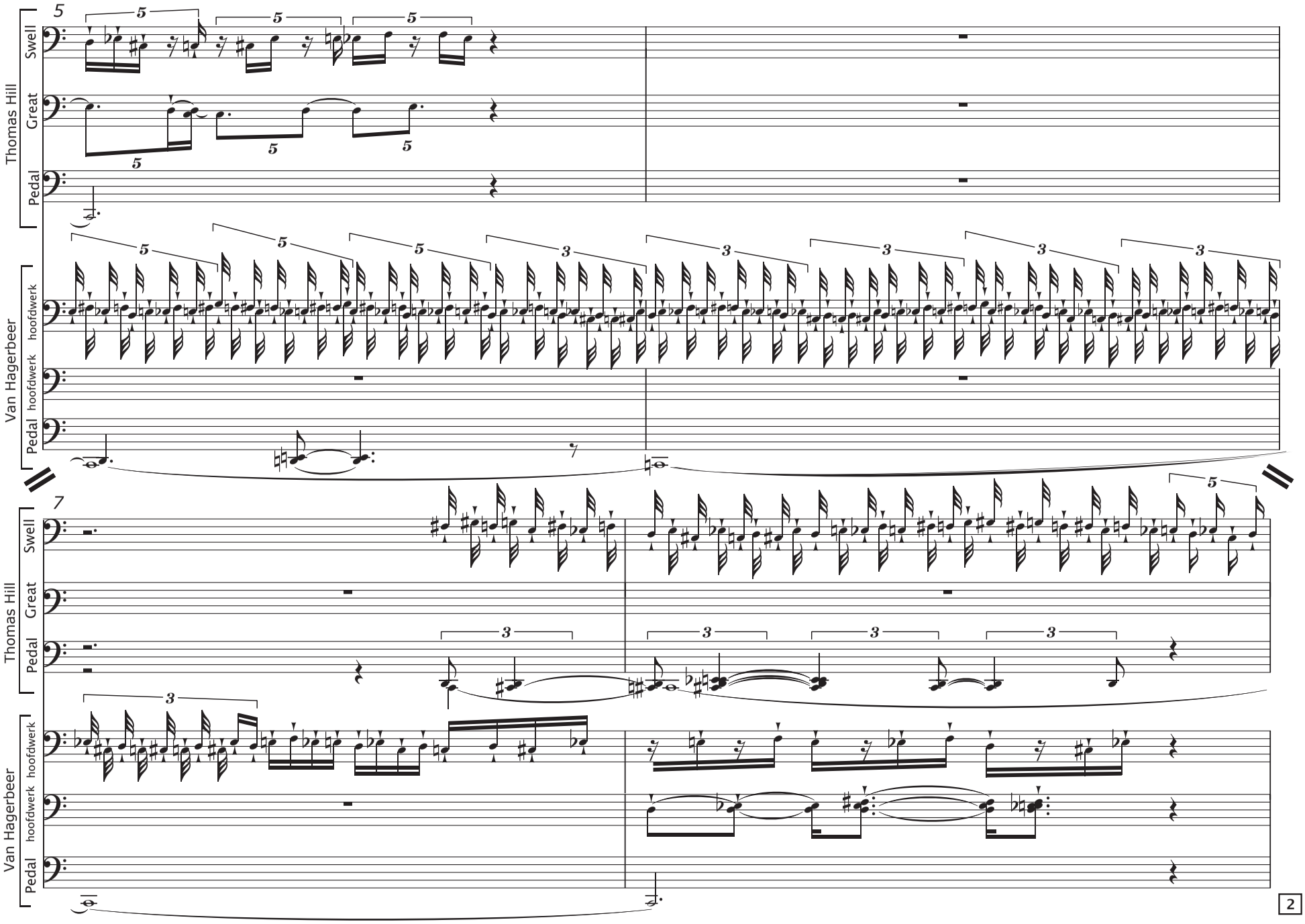


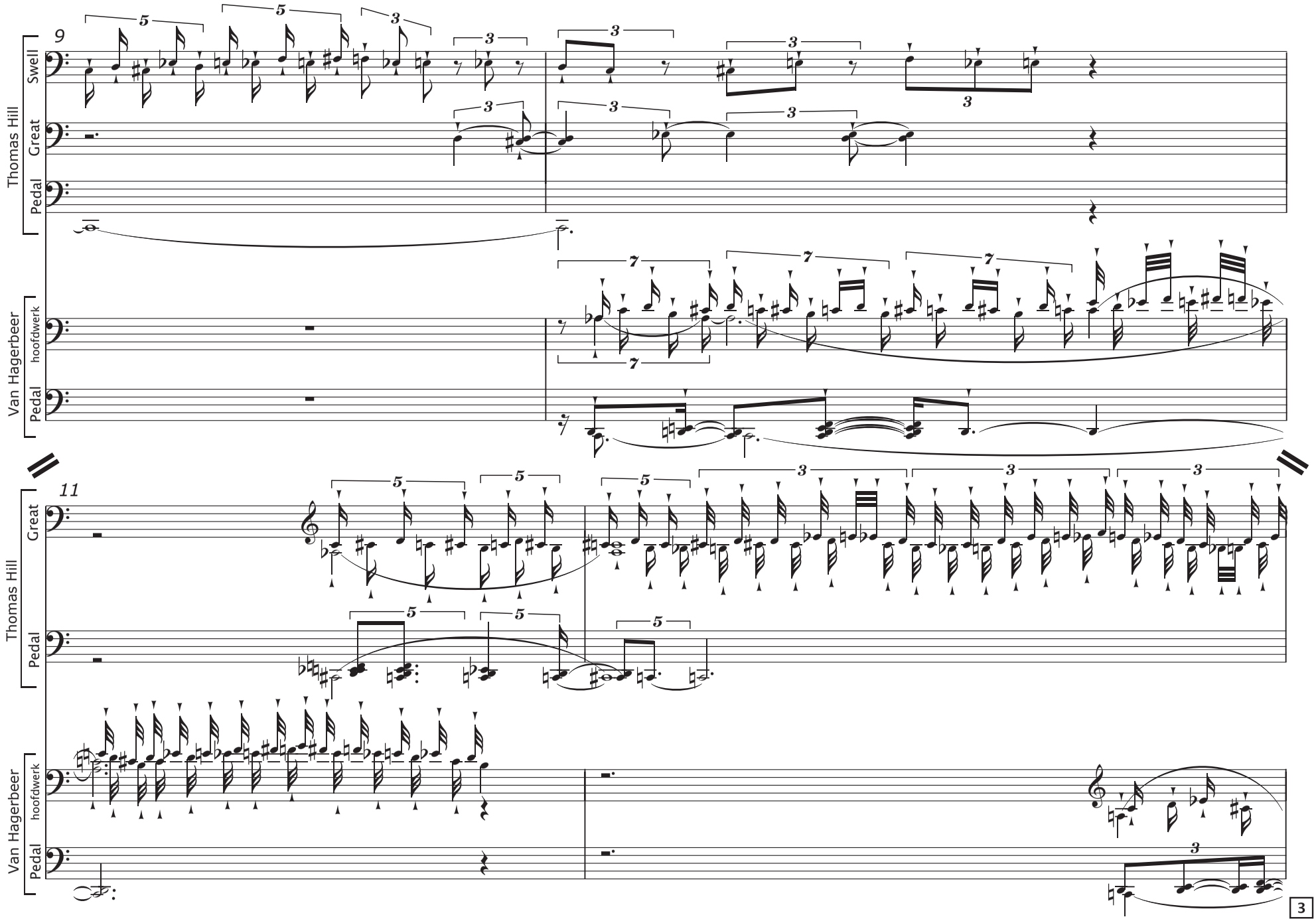
Arpeggiated chord (downwards)

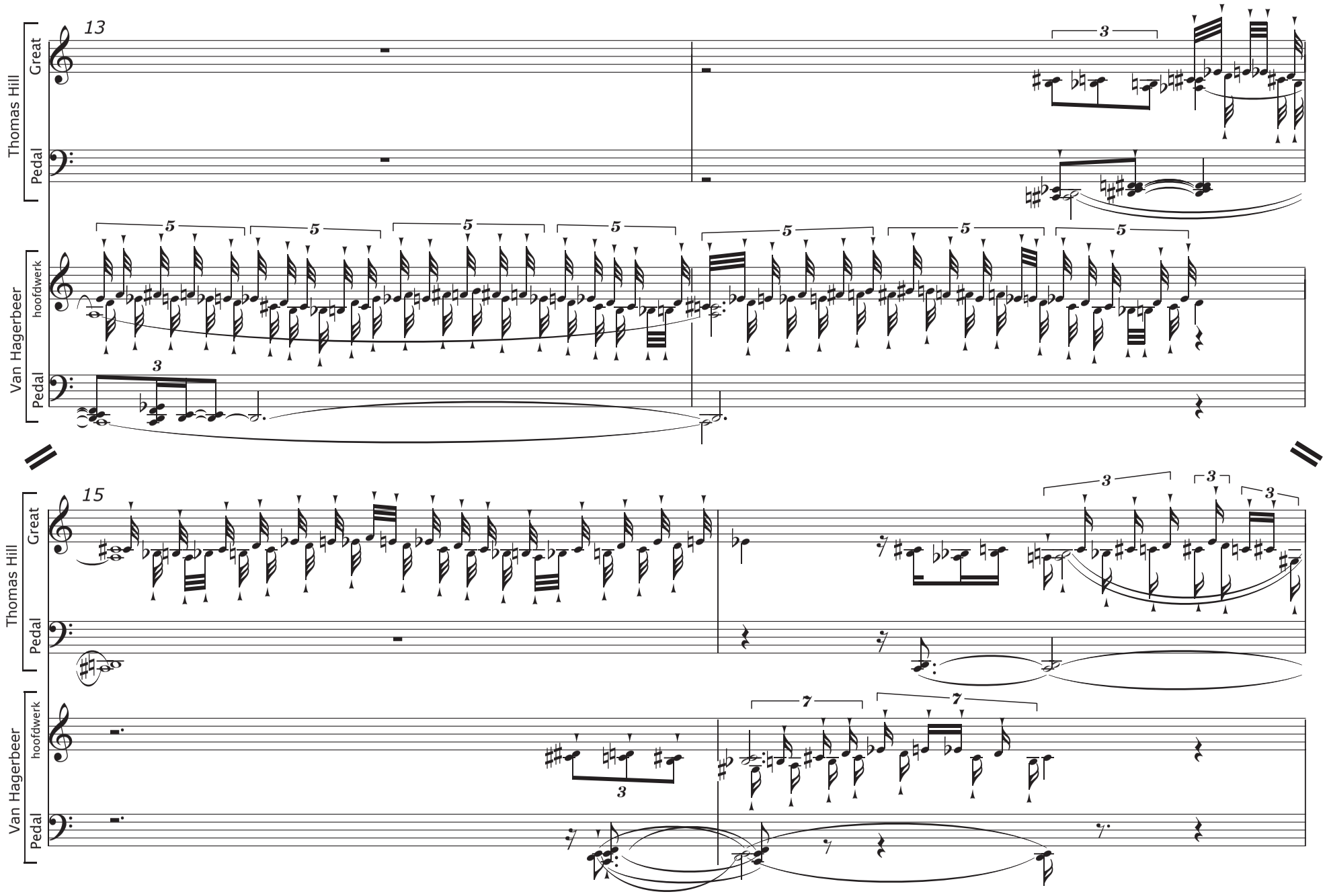


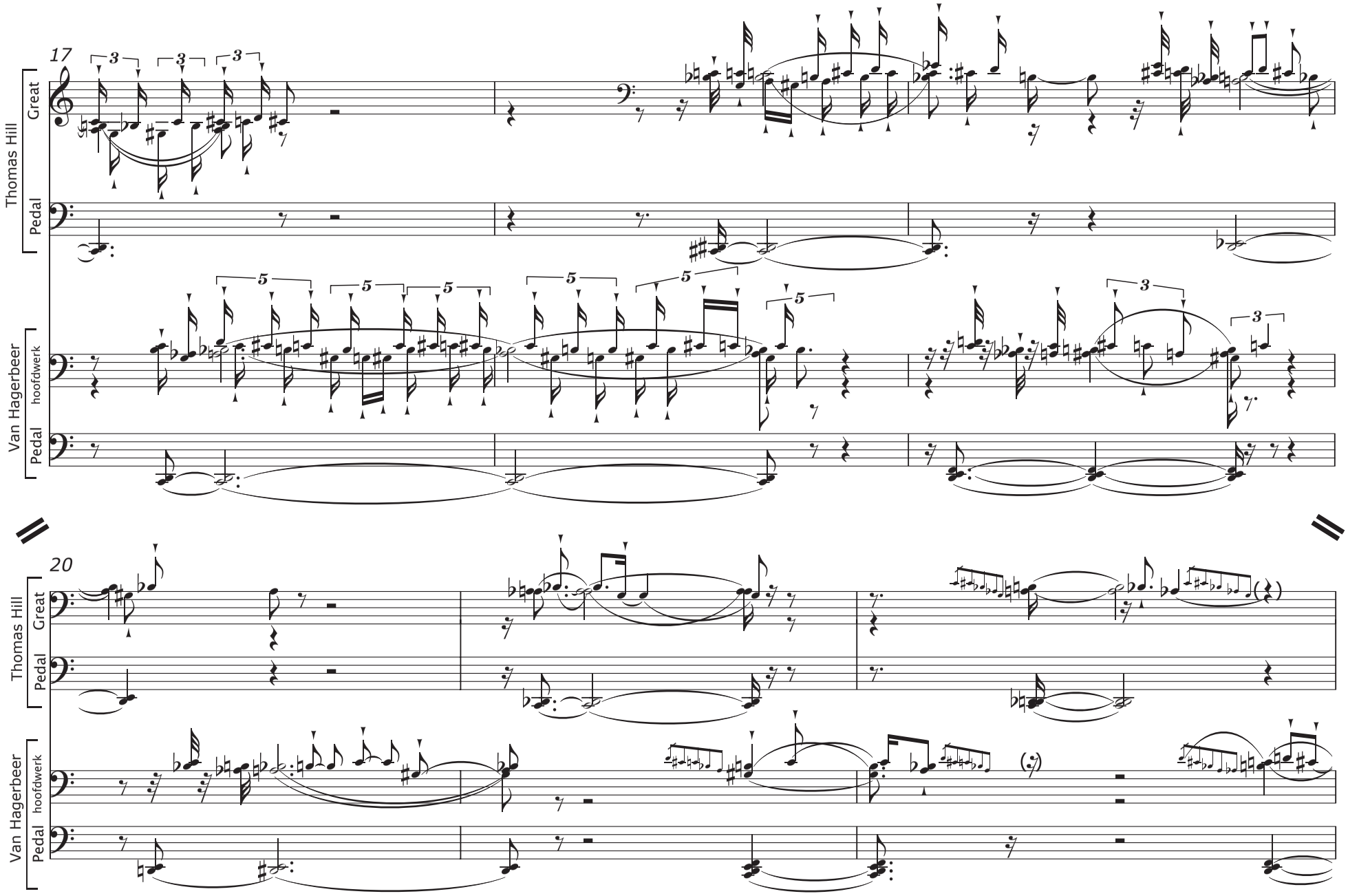
Accidentals are only written in the beginning of the repeated groups, notes with a cross as notehead or without noteheads at all are played without any stop on, therefore only the percussive noises of the attakcs are heard.

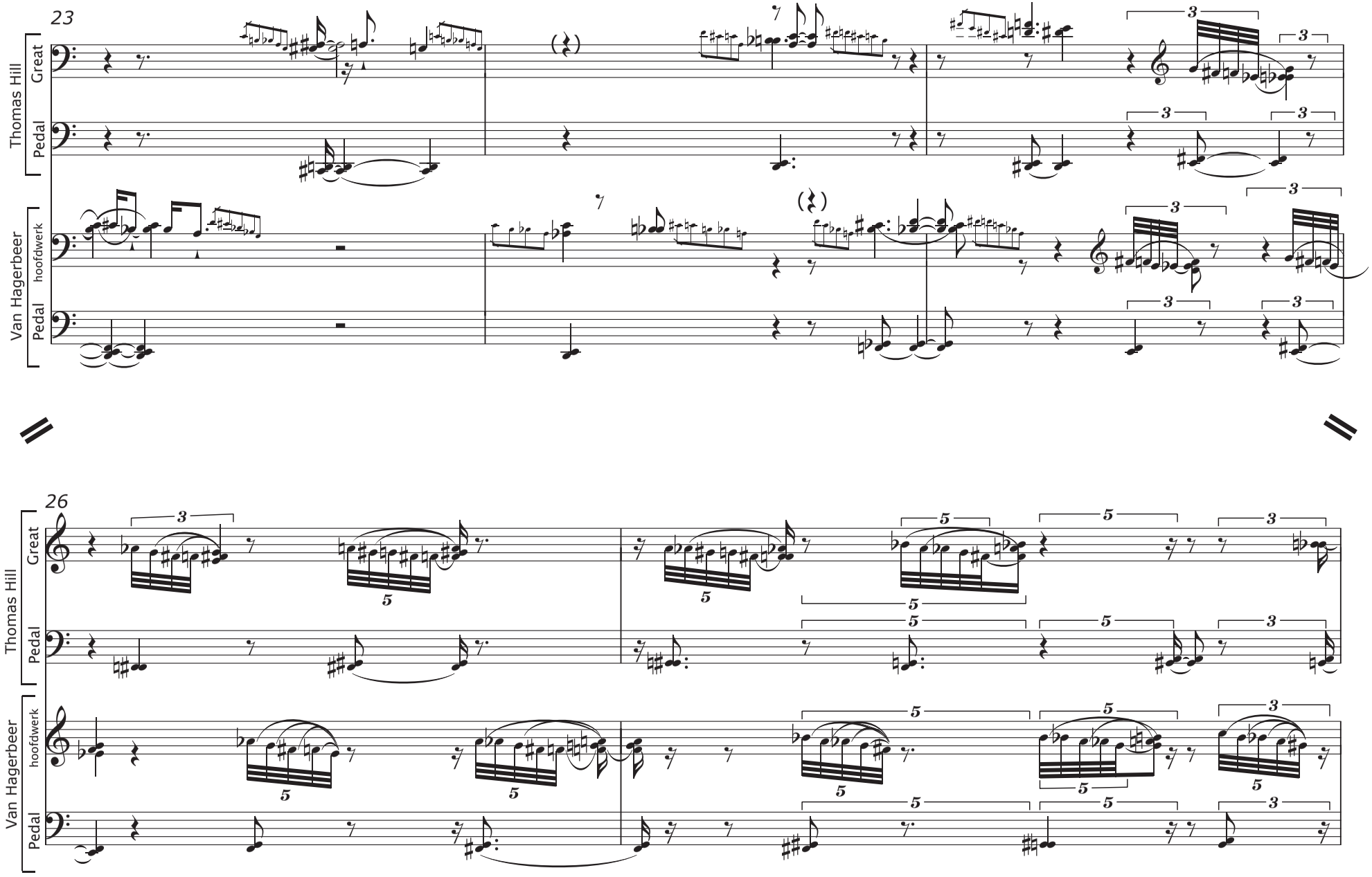

San Pedro
2005
Daniel Zea
♩=40
Thomas Hill
Swell
Pedal
Bourdon 16'
Open diapason 16' Trombone 16'
Van Hagerbeer
hoofdwerk
Prestant B-D 24'
Trompet 16'
Great
Double diapason 16'
1

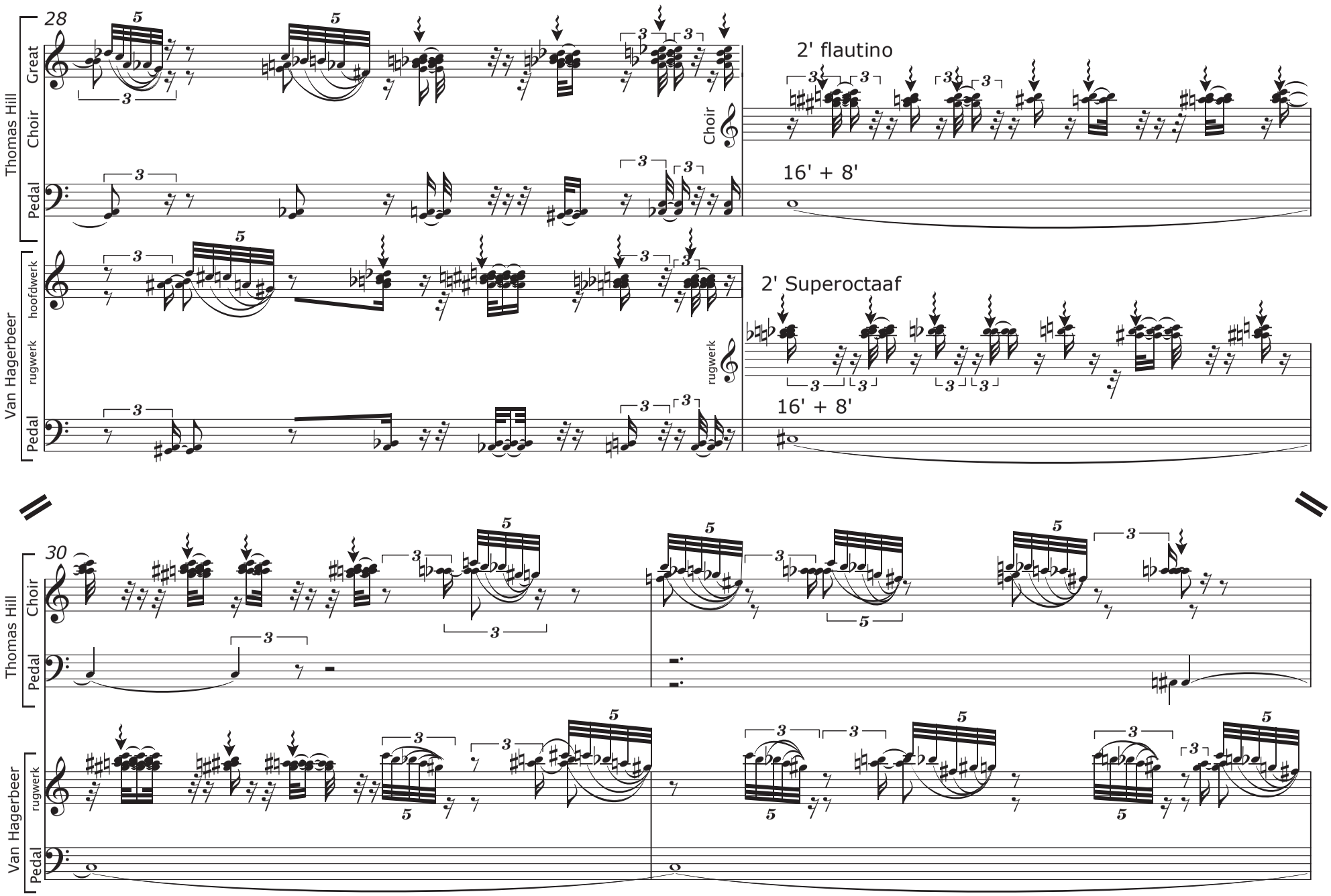

5
Thomas Hill
Swell
Great
Pedal
Van Hagerbeer
hoofdwerk
hoofdwerk
Pedal
7
Thomas Hill
Swell
Great
Pedal
Van Hagerbeer
hoofdwerk
hoofdwerk
Pedal

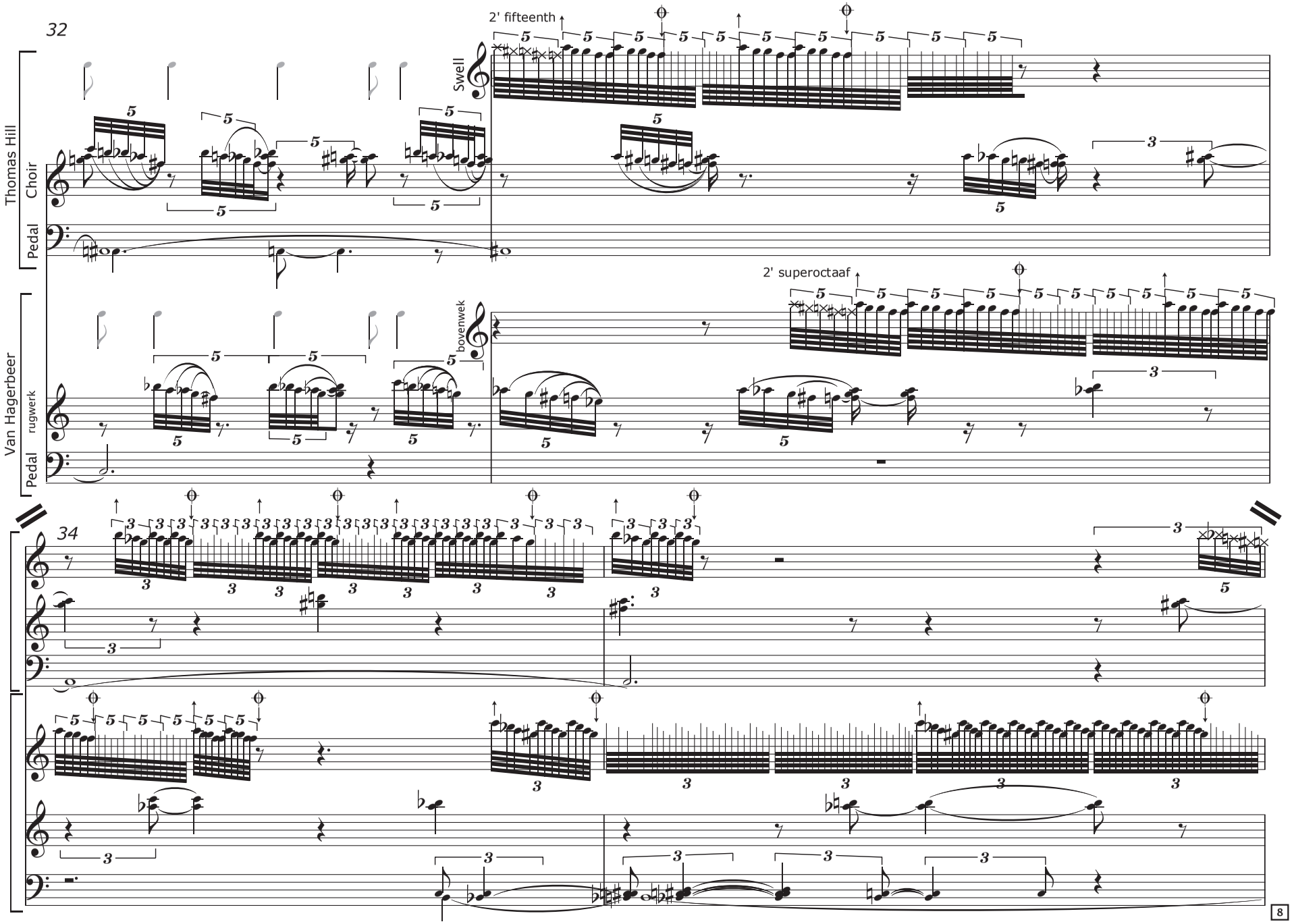

9
Thomas Hill
Swell
Great
Pedal
Van Hagerbeer
hoofdwerk
Pedal
11
Thomas Hill
Great
Pedal
Van Hagerbeer
hoofdwerk
Pedal

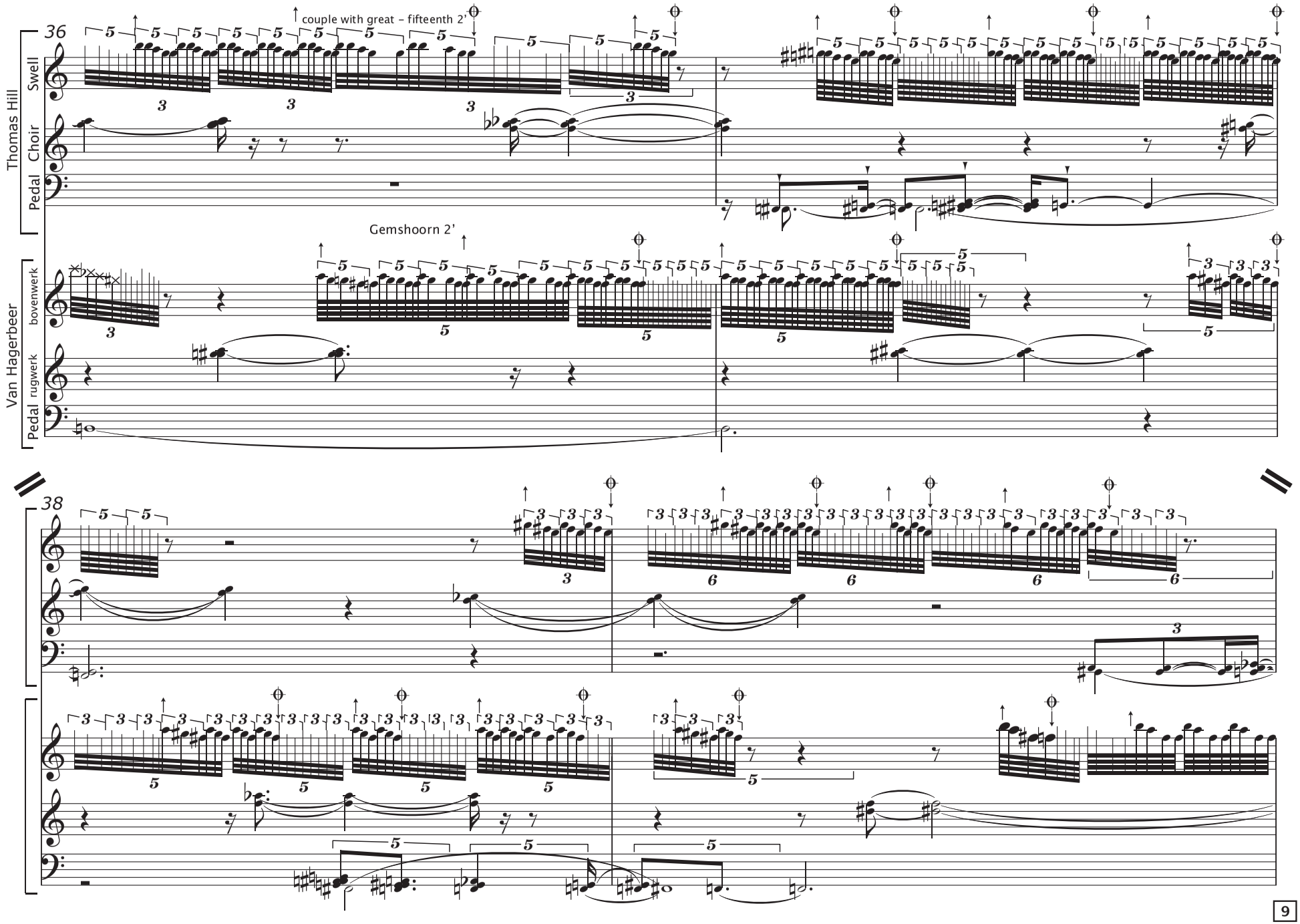

13
Thomas Hill
Great
Pedal
Van Hagerbeer
hoofdwerk
Pedal
15
Thomas Hill
Great
Pedal
Van Hagerbeer
hoofdwerk
Pedal

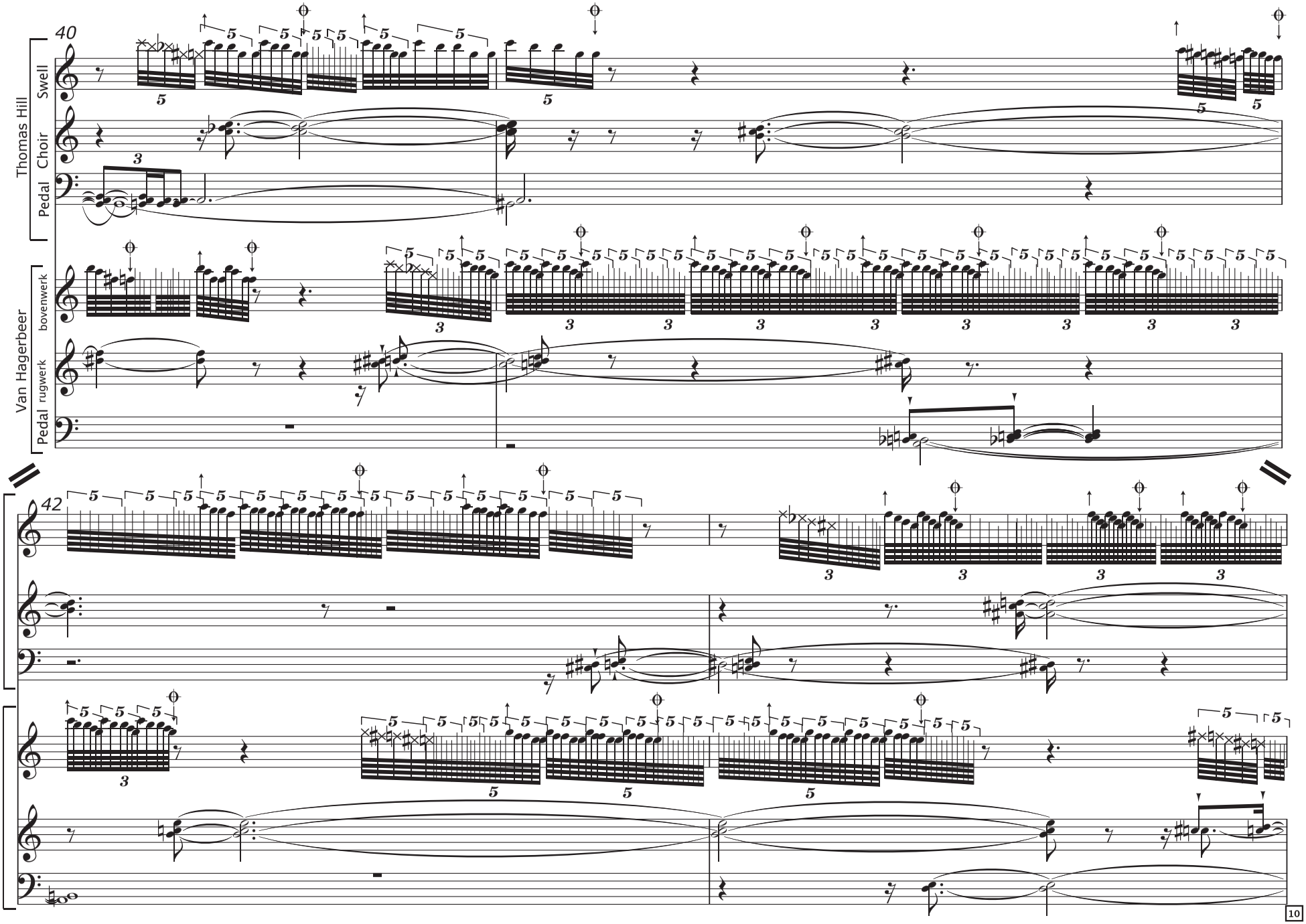

17
Thomas Hill
Great
Pedal
Van Hagerbeer
hoofdwerk
Pedal
20
Thomas Hill
Great
Pedal
Van Hagerbeer
hoofdwerk
Pedal

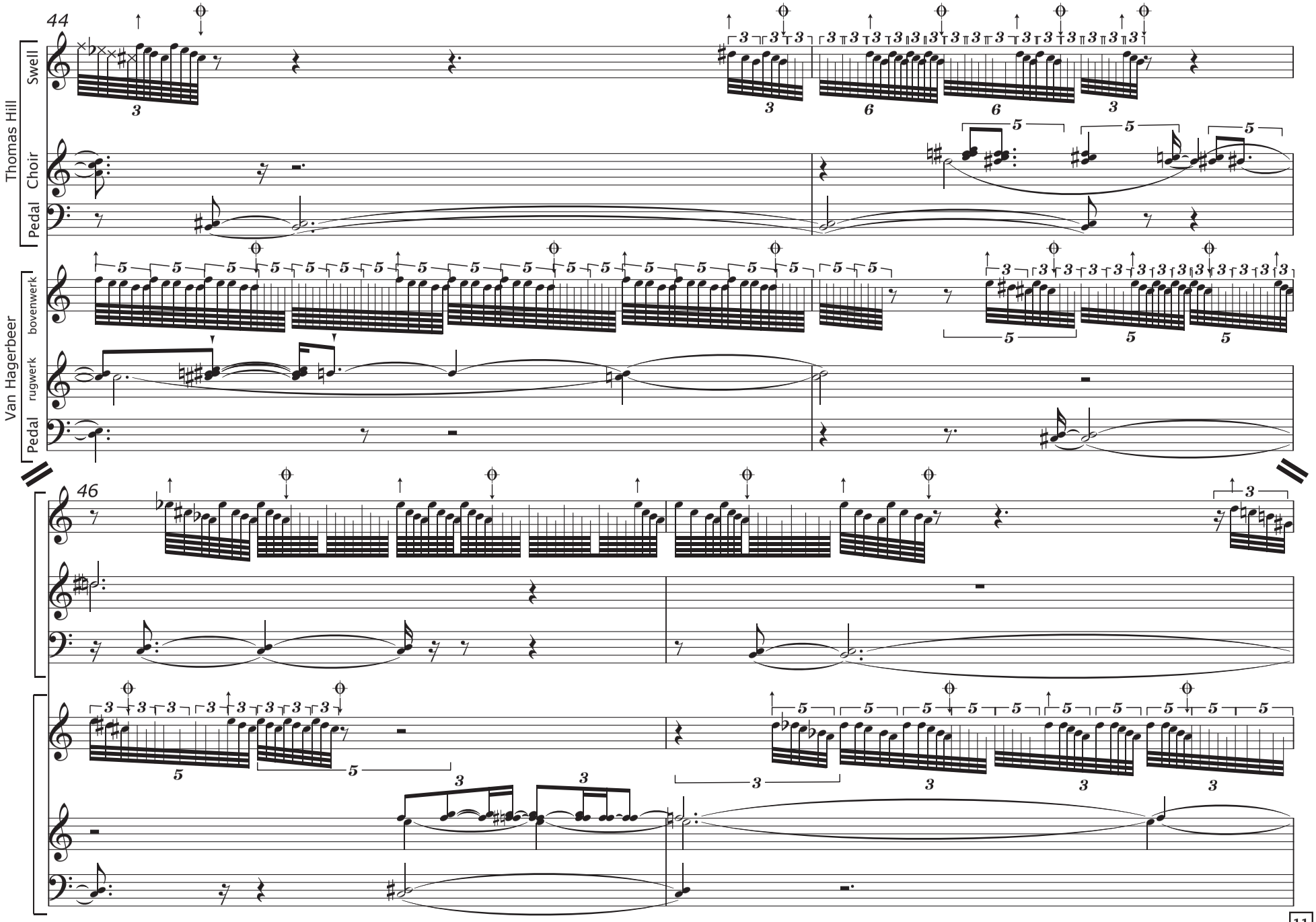

23
Thomas Hill
Great
Pedal
Van Hagerbeer
hoofdwerk
Pedal
26
Thomas Hill
Great
Pedal
Van Hagerbeer
hoofdwerk
Pedal

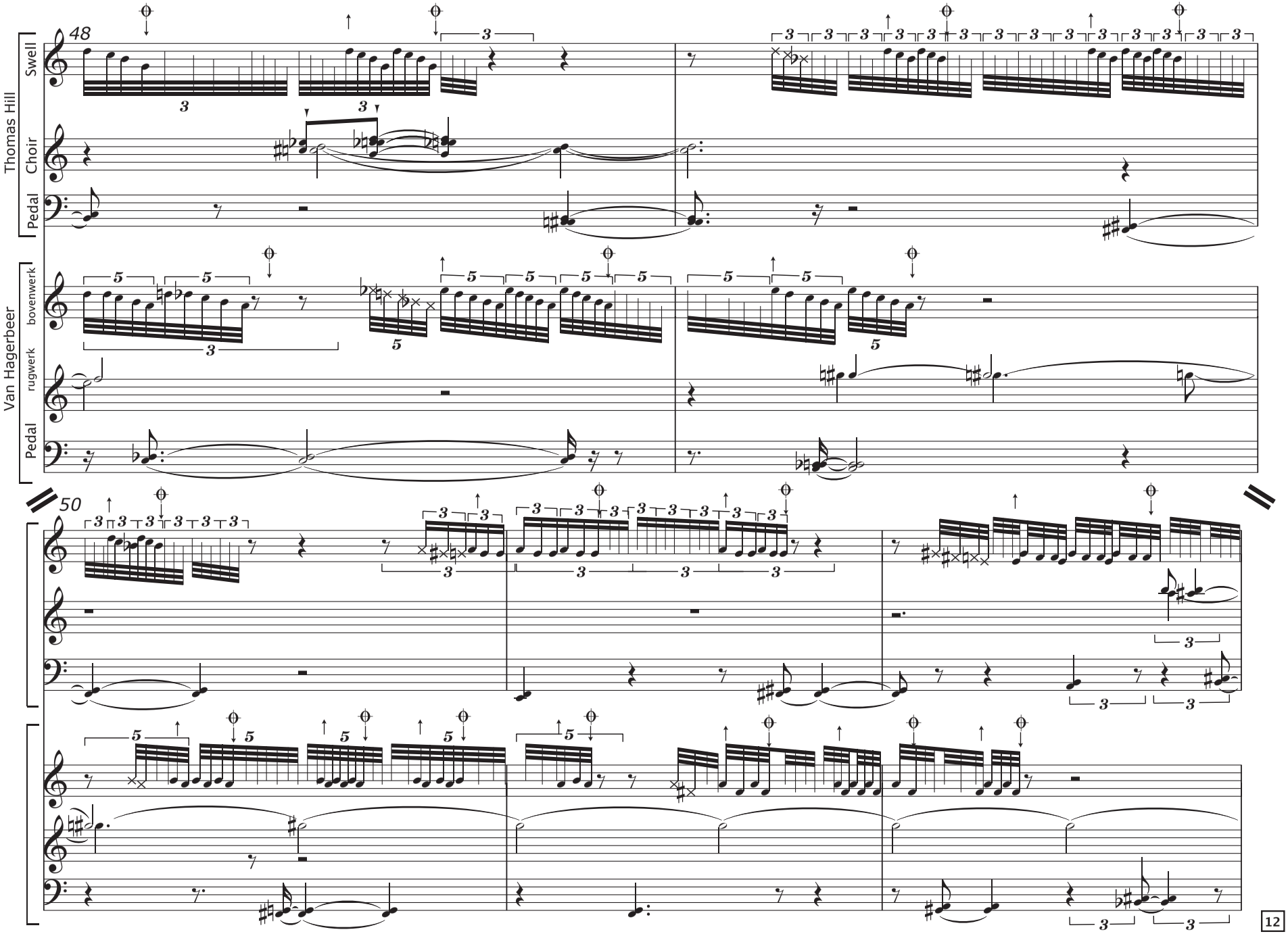

28
Thomas Hill
Great
Choir
Pedal
Van Hagerbeer
hoofdwerk
rugwerk
Pedal
2' flautino
Choir
16' + 8'
2' Superoctaaf
rugwerk
16' + 8'
30
Thomas Hill
Choir
Pedal
Van Hagerbeer
rugwerk
Pedal

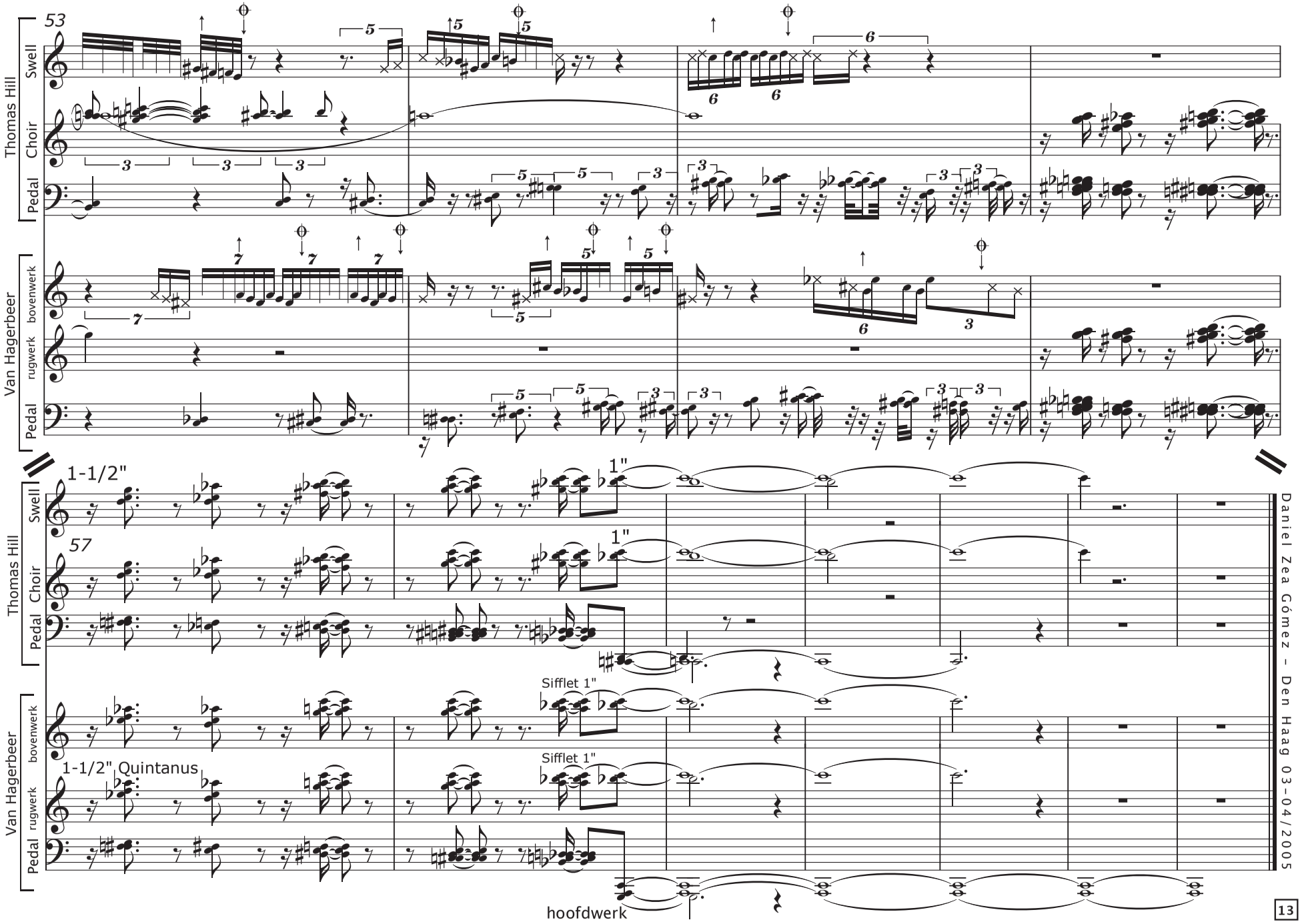

32
Thomas Hill
Choir
Pedal
Swell
2' fifteenth
Van Hagerbeer
rugwerk
Pedal
bovenwek
2' superoctaaf
34


36
couple with great – fifteenth 2'
Thomas Hill
Swell
Choir
Pedal
Gemshoorn 2'
Van Hagerbeer
bovenwerk
rugwerk
Pedal
38


40
Thomas Hill
Swell
Choir
Pedal
Van Hagerbeer
bovenwerk
rugwerk
Pedal
42


44
Thomas Hill
Swell
Choir
Pedal
Van Hagerbeer
bovenwerk
rugwerk
Pedal
46


48
Thomas Hill
Swell
Choir
Pedal
Van Hagerbeer
bovenwerk
rugwerk
Pedal
50



Daniel Zea Gómez - Den Haag 03-04/2005

CAMBUCHE (2005)
Quadraphonic tape

CAMBUCHE (2005)
Quadraphonic tape

Cambuche is a slang word used in Colombia to describe an improvised shelter (usually a kind of tent made with plastic and branches) to protect from rain, the "plan Colombia's" air-craft assisted fumigations, bullets, branches or animals falling from trees or bushes, or sleep over night in the country-side.

Some of the compositional procedures used in this piece are presented in the first chapter of this document. The final version was recorded on January 18 2005 in the Institute for Sonology. An early stereo version was recorded for the CD "Hommage à Eric Gaudibert" (published in 2005 by Conservatoire de Musique de Genève) one month before.

Cambuche has been performed in The Hague, Geneva, Karlzruhe, Bogotá, Cali, Barranquilla, Mexico, and has been submited to the 34e Concours International de Musique et d'Art Sonore Electroacoustique de Bourges, this summer.

Cambuche (2005) - for quadraphonic tape

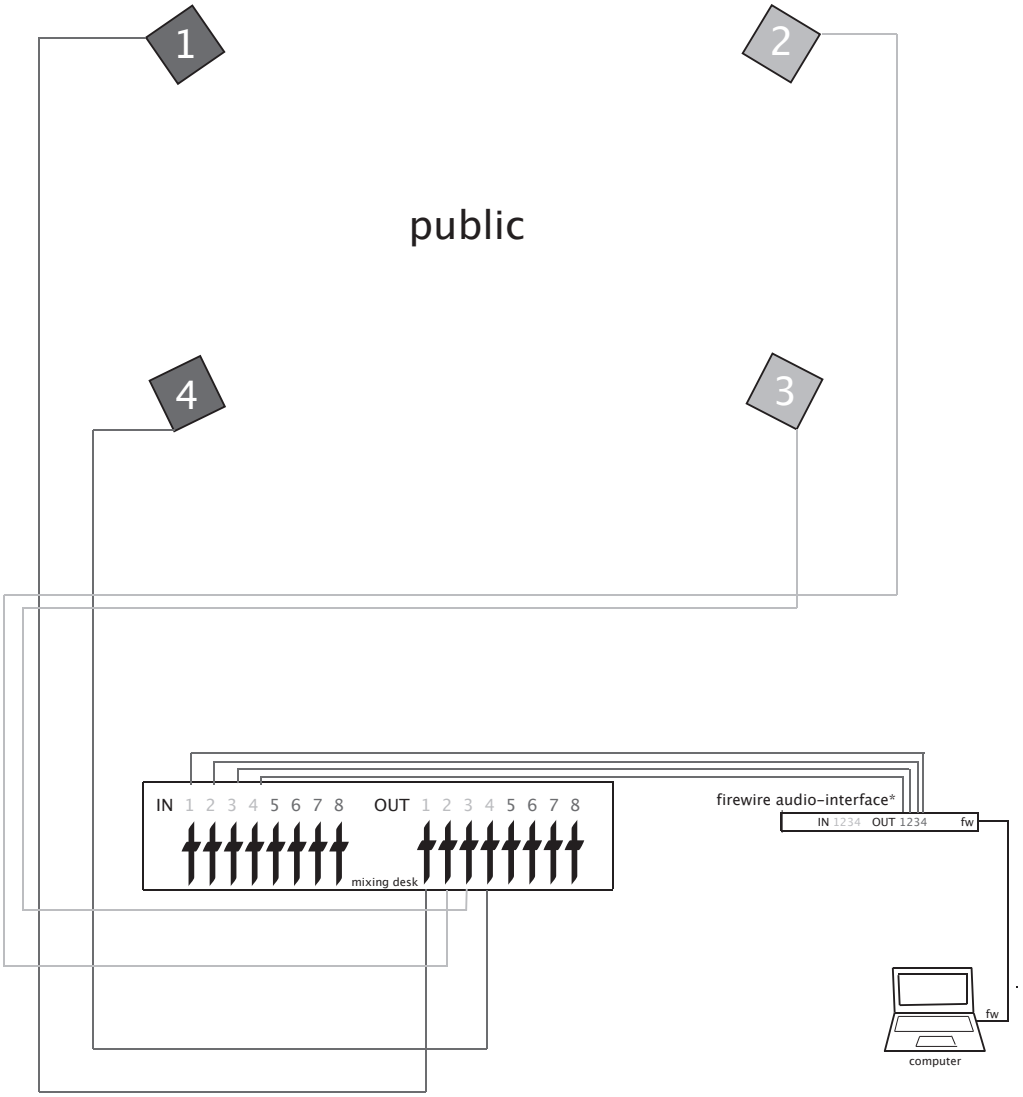


Fig. 35
Set up for CAMBUCHE

Cambuche - loudspeaker distribution
* computer and firewire interface can both be replaced by an ADAT player