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Viviana Moscovich

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The composers belonging to what would later be called the 'spectral music movement' started their careers in an unstable political period in France. Between 1962 and 1974, under the presidency of Charles de Gaulle and Georges Pompidou, France (the 5th Republic) was what we can call a 'Gaullist Republic'. But in the middle of the 1960s the economic policy of the government aroused the hostility of the French people. The 'Stabilization Plan' of 1963 induced unemployment for the first time since 1945, and the authoritarian character of a government which, in 1967, legislated in the form of *ordonnances*, turned the people against the presidential policy in every domain.

In May 1968 the crisis became a cultural revolution. The main groups involved were the students and the workers. Immense manifestations were organized following repressions by the police. On 13 May red flags with the insignia 'Ten years is enough!' (*Dix ans ça suffit!*) were raised against the Gaullist government. The objectives of the movement of 1968 (the '*soixante-huitards*') were: 1. the revolt of the people; 2. to free the individual; 3. to reverse the social order; 4. to change the way of life. On 30 May, de Gaulle announced the dissolution of the Assembly, and on 30 June, in the parlimentary elections, the Gaullist party obtained a vast majority.

After this period of crisis, and during the presidency of Georges Pompidou, there emerged – mainly in France – a generation of young composers born in the 1940s. The most important were Johannes Fritsch and Mesias Maiguashca from Germany, Jonathan Harvey from England, Gilles Tremblay and Claude Vivier from Canada, and Gérard Grisey, Tristan Murail, Hugues Dufourt, Horatiu Radulescu from France.

After the events of 1968, recoiling from what seemed a dead-end in the evolution of contemporary music, these young composers gathered together to open a new way in musical composition. They began to create in a period of great instrumental development, or, as Dufourt put it:

> the prominent pheonomena of this decade [the decade of 1967-1977] [are]: the development of instrumental research, the impact of electroacoustics on musical thought, and, above all, the collapse of the social and mental barriers under which the [musical] profession was becoming ossified.[1]

Another reason for this change in aesthetic thought was related to the notion of timbre, for since the beginning of the 20th century, two correlated factors have influenced the aesthetics of the musical world: the emergence of timbre as a fundamental factor in composition, and the development of new materials such as electronics, transmission, recording, computers and data processing. The use of timbre – instead of tones – is a choice based on technological and cultural parameters.

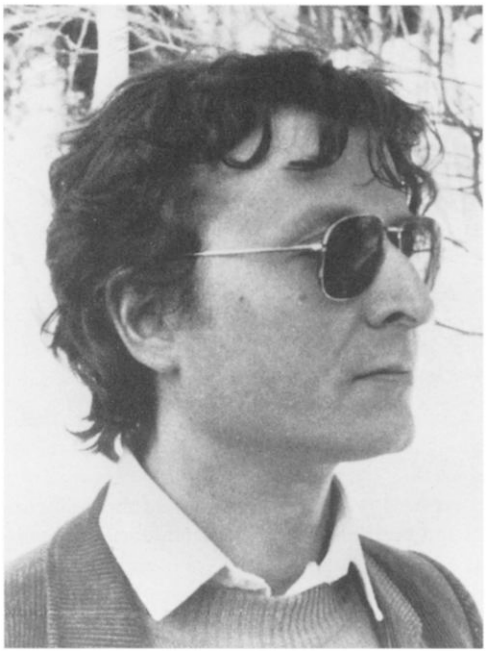
The beginning of this change in musical language and perception began in the 19th century with the appearance of Fourier's sound analysis of any continuous sound signal, giving a physical characterization to each and every signal. Sound is not a nucleus but a whole, composed of different parts. A signal is therefore decomposed in series of harmonics and sound is represented in the form of a mathematical formula. Sound as a whole – and not only as a definite pitch – becomes the composer's raw material, involving also factors such as the acoustic phenomenon of physical sounds, the human perception of these sounds, the psycho-physiological response to sound stimulus, and the choice of sound sources. This kind of compositional work called also for a change in such notions as melody and musical timing.

The forerunners of this composition technique in music are, in chronological order: Debussy, Varèse, Scelsi and Messiaen.

Debussy revolutionized the musical world by introducing two major changes in the linear organization of melody:

1. By thinking of sound as a perceived object, and using it to evoke an image, a colour or a feeling by choosing to mix the sounds into sound-fields of different lengths.

[1] H. Dufourt, *Auto Portrait*, extract from the file on spectral music (Centre de Documentation de la Musique Contemporaine), (Paris, La Villette: 1977), p.3: *Orientations*.



Tristan Murail (photo: United Music Publishers)

2. In his use of time, focussing on the notation of the instant and on its acoustic qualities.

In Edgard Varèse's works we find the next stage in the evolution towards spectral music. For Varèse, sound is an essential structural element in music. Varèse wanted to liberate sound from its scholastic rules. He invented the 'ionisation': a technique in which different elements of sound are projected into a dynamic acoustic space. For him, tomorrow's music should be 'spatial', thus involving the movement of areas and resounding masses varying in intensity and density.[2]

Giacinto Scelsi considered sound as an entity we have to explore and compose with, to feel its pulse at every instant of the piece. He spoke of density, dynamics, spatial position, smooth or rough particles, spectral composition before the appearance of the computer generation.

Oliver Messiaen, named professor of composition in the Conservatoire de Paris in 1942, had as his students composers such as Pierre Boulez, Karlheinz Stockhausen, and in the 1960s: Tristan Murail, Gérard Grisey and Michaël Lévinas. In his work he used the parameter of Acoustics, specially in what he called: 'the resonance chord', as for example in his transcriptions of birds' songs – each with its exact timbre. In these transcriptions we find one of the first examples of a fusion between harmony and timbre.

This new approach to sound was also made possible thanks to the evolution of technology, and, especially, of computerized sound analysis which enabled composers not only to modify already existing sounds but to create new and unknown ones as well.

J.C. Risset – who, in 1969, published a 'catalogue of synthesized sounds through computer' – described this interaction between composer and computer in an article of 1977, saying that

> thanks to the control of timbre by analysis and synthesis, composers can not just compose with timbres but also create the timbres. . . in this way the control of timbre can bring about the creation of new musical architectures [. . .] This will require from the musician a subtle hearing, but also a background in psychoacoustics and a good interactive environment.[3]

In spectral music, the spectrum – or group of spectra – replace harmony, melody, rhythm, orchestration and form. The spectrum is always in motion, and the composition is based on spectra developing through time and exerting an influence on rhythm and formal processes.

As to spectral music composition techniques, two main streams may be perceived: that of Dufourt and Grisey, and that of Murail and Risset.

Tristan Murail has given a picturesque description of his work as a composer:

> I imagine myself as a sculptor in front of a stone block which conceals a hidden form; a spectrum will thus be able to conceal forms of different dimensions which we can reveal according to certain criteria – and with the help of certain instruments: active filtering, selection of tempered pitches, spectral areas, spectral exploration. . . this composition technique, from the whole to the unit, is opposed to the classical cellular construction technique.[4]

According to Murail, if a composer wants to belong to the spectral universe, he has to accept five essential precepts:

1. to think of the continuum before thinking of the discrete.
2. to have a global approach and not a cellular or a sequential one.
3. to use logarithmic/expositional methods of organization instead of linear ones.
4. to build in a functional way.
5. to be concerned with the relation between conception and perception.

[2] After A. Castanet and Odile Vivier in A. Castanet, 'Musiques Spectrales: nature organique et matériaux sonores au 20e siècle', in *Dissonanz (Dissonance)* no.20, p.5.

[3] J.C. Risset, 'Exploration du timbre par analyse et synthèse', in *Le timbre, métaphore pour la composition*, eg. J.H. Barrière (Bourgois/Ircam, 1991), pp.125-126.

[4] T. Murail, 'Questions de cible', in *Entretemps 8*, p.154.

George Benjamin has written about Murail's work:

Murail's music is based on the physical, acoustic properties of sound itself, rather than on any artificial abstract theory. The most immediately noticeable features of his music are its unbroken continuity. . . it is above all music for the ear, inviting the listener on a journey to new, undiscovered worlds of sound and the imagination.

Murail dreamed of composing with the computer (in French, CAO) and worked side by side with the programmers of the IRCAM to develop the Patchwork programme. With this programme composers can finally create their own tools which are immediately perceived either graphically or as sounds. According to Murail, these changes had an enormous influence on the compositions of the whole spectral movement, for in the early 1980s the evolution from one harmonic spectrum to another was slow, and the music was static. In the 1990s, one can instantaneously hear complex transformations. This has affected the form of the pieces, which became more whole and contrasting, instead of linear and progressive.[5]

In *Entretemps 8*, Marc-André Dalvabie analyses at length the beginning of Murail's *Gondwana* (1980). Some of the main points of his analysis will serve to illustrate Murail's compositional process in this work:

The whole harmonic generating principle in *Gondwana* is based on a technique of sound synthesis started by John Chowning. This technique is based on an algorithm that generates the partials as well as the amplitudes, which constitute the basic structure of the timbre. The frequencies result from an algebraic operation:

HARMONICS = CARRIER (porteuse) ± [MODULANT x INDEX]

The index of the modulation represents the harmonical density.

In the beginning of the score, (for example) if we have as carrier sol(G)3 i.e. 392 Hz, as modulant sol(G)#2: 207,6 Hz and as index of modulation 9, according to the algorithm exposed before we obtain the following harmonics:

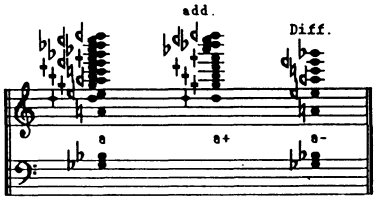
Hi = P + (Mx1)
H1=392 + (207,65x1)=599,65
H2=392 + (207,65x2)=807,30
etc
Hi=P - (Mx1)
H-1=392 - (207,65x1)=184,35
H-2=392 - (207,65x2)= 23,30
etc.

[5] After Marc Texier, 'L'univers de Tristan Murail', in *Résonance No.1*, IRCAM, Mars 1992.

Afterwards, the frequencies obtained are approximated to a quarter of a tone so they can be played by musical instruments, which results in:*

Additionals	*Differentials*
H1=599,65 : D +4	H-1=184,35 : F# 2
H2=807,30 : G +4	H-2=23,30 : F# -1
H3=1014,95 : B +4	H-3=230,95 : A# 2
H4=1222,60 : D +5	H-4=438,60 : A 3
H5=1430,25 : F +5	H-5=646,25 : D# +4
H6=1637,90 : G# 5	H-6=853,90 : G# +4
H7=1845,55 : A# 5	H-7=1061,55 : C 5
H8=2053,20 : B +5	H-8=1269,20 : D# +5
H9=2260,85 : C# +6	H-9=1476,85 : F# 5

This chord constitutes the harmonic structure of the first chord of *Gondwana* (3rd bar):



This chord's sound makes us instantaneously think of a bell. It has an amplitudes envelope whose model is the percussion/resonance. In the orchestration, we see that the medium and low sounds are played by the brass, that the modulant is played by the tuba, which has the largest mass, and that the high frequences are played by the woodwind instruments with a certain imbalance: the first clarinet is placed above the first two oboes in a very resonant register (A♭ 5), while the oboes are in their weak register (F+5 and E♭ 5).

Next, the composer starts a process of interpolation which consists in a continuous evolution from an object A to an object B. The above-mentioned chord will be repeated 12 times. The first, second, fourth, fifth and eighth chords are frequence modulations whose pitch relations become more and more harmonic. The last chord is a superposition of two harmonic spectra: G# 1 and F# 2.

The intermediate chords (third, sixth, seventh, ninth, tenth, eleventh) are each one made of the resulting interpolation of the two surrounding chords. The third chord, for example, is the result of the interpolation between the second and fourth chords. ... This progression process has as its model the trombone sound in the eleventh chord. ... It is interesting to notice the strong relation existing between perception and writing procedures ... This kind of sound control could not have been achieved without the timbre torsion procedures available in electroacoustic music and those of the orchestra, which induce the division of parameters. [...] Transposing studio techniques to the orchestra corresponds to a synthesis. Spectral music is but the continuation of this synthesis. ... Tristan Murail perceived this need, and *Gondwana* corresponds to a

* Note that in this table the plus sign represents a quarter-sharp.

kind of ultimate point of what can be realized with a symphonic orchestra in the utilization of a highly permeating timbre model.[6]

J.C. Risset represents the most scientific point of departure within the spectral movement. His basic interest is in the discovery and the creation of new sounds, distorting sound, and obtaining unknown sound illusions with the help of computerized sound analysis. In *Musique, calcul secret*, he explains that:

Mathematics seems proper to throw the light on many musical phenomenae. [...] It give us generating or explanatory musical models – but it does not seem to give us *the* key, *the* model. ... The long distance modes of arrangements, of musical equilibrium, remain mysterious, the sense of the 'big form' seems to escape any explanation based on models. The validity, the musical sense of a formalism, of a syntax depends on the context and even more on the compositional purpose – and as to the creative process: does it not consist in creating and elaborating new rules rather than in exploiting existing ones?

[...] The computer seems to ascribe to the role of a notes' mill, a musical rilling mill to the Km, better than the synthesizers and their sequencers... There is nothing fatal in that the computer will be used in a normative, oppressive sense, to codify, to homogenize. ... The computer is not there to make music profit from the prestige of science... it is not unimportant to show that the computer can be turned into a tool to the service of the musician – a multiple tool in favour of individuality, of the difference, helping each musician to make his own musical instrument, to evoke and transform sounds to his will. ... It is essential to make it [the computer] work in synergy with man – the human intervention has to inflect or direct the implemented processes. ... At each stage, at each level, the musician will be able to keep control (or not).

[...] The computer's synthesized sound material presents a malleability without precedent, it lends itself to new modes of arrangement, to new architectures. But we have to 'clarify this material' in the light of perception.[7]

Hugues Dufourt has written that:

From the work of Jean-Claude Risset we conclude to the certitude that the fundamental concepts of the new musical acoustics have an intercategorical status, that they proceed by differentation and integration of the various information categories. Psycho-acoustics will have the task of identifying the constraints of coherence and assembling them into an ensemble of conditions.[8]

About his own work, Dufourt has written that there are six basic precepts in spectral music:[9]

1. The piece is conceived as a synthetic whole;
2. There is a basic congruence between the whole and its inner division;
3. The manner in which the piece is organized coincides with the manner in which it evolves through time;
4. Spectral music is founded on a theory of functional fields and on an aesthetics of unstable forms;
5. This music marks a progress towards immanence and transparence;
6. The renewal of the traditional instrumental practice, that of string and wind instruments.

In his *Auto portrait* from 1977, in his own analysis of his work *Erewhon* (Symphony for percussion, written between 1972-1976) he explains the following:[10]

What counts in the percussion is not the impact, it is the resonance's dynamic spectrum. According to the nature of the sticks and to the playing quality, we obtain from the same instrument – gong, cymbal, tam-tam – a multitude of unstable and very varied resonances: quick or slow developments, oscillations ... Percussion modifies profoundly the relations between production and sound perception.

[...] Percussion changes are perception of duration ... by carrying us to extremes, it intensifies the contradictions – it is the conflict of these dynamic systems that decides of the temporal form. A flow (flux) for example, is but a way of oscillating, without deciding, between two antagonizing Tempi. All my writing principles rely on opposing and complementary determination systems.

In his preface to *L'orage – d'après Giorgione* of 1976-1977, Dufourt explains:

the bass register of wind instruments – flute, double bass, clarinet, cor anglais (tenor oboe) and trombone – unfold in a very slow time, of heaviness and sluggishness.

The emission is ample and enables the mutual recovery of the masses, the somewhat atmospheric treatment of timbre. This treatment is emphasized by the utilization of electronic instruments that set up, in the background, a field of tensional values.

The sonority of the vibraphone, of the guitar or of the electric organ is not diffused in the space, it would rather tend to be contracted. From here we come to the somewhat paradoxical interest that could represent the confrontation between all these instruments.[11]

[6] Marc-André Dalbavie, 'Notes sur *Gondwana*', in *Entretemps No.8*, Paris, Sept. 1989.

[7] Jean-Claude Risset, 'Musique, Calcul secret?', in *Critique No.359*, 1977.

[8] H. Dufourt, 'La dialectique du son usiné', in *Conséquences No.7*, automne 85-printemps 86, p.199.

[9] H. Dufourt, 'Musique spectrale', in *Conséquences No.7*, 1985-1986, pp.114-115.

[10] H. Dufourt, *Auto Portrait*, extract from the file on Spectral Music, CDMC Library, La Villette, Paris, 1977.

[11] H. Dufourt, Preface to the score of this work.

Dufourt's composition technique is thus based on sound fields manipulated by the composer. For Dufourt, variation and movement are the elements upon which the structure of the piece is based. There is no preconceived general structure. The movement of the different sound masses (resounding instruments) and the piece's structure form one interactive entity (as in *Erewhon* or in his work *L'Orage*).

Gerard Grisey has largely exposed · his aesthetical points of view – as well as his compositional techniques – in his article: '*La musique: le devenir des sons*' (*Music: the becoming of sounds*). For him, the piece's form is determined by the evolution of the sounds. The music *is* the sounds, their changes, their differentiations, their history, or as Grisey puts it in the title: *le devenir* (*the becoming*) of the sounds. The questions asked by the listener are: where does this sound come from? Where does it go to? What is its way between the manifold? What sense does it have in this place, and in that one? The apprehension and the assessment of the difference between the different sounds at every given moment become the real material of musical composition.

Sound parameters determine the fluctuating and ambiguous character of the fields, as in the case of the work on the contrast 'luminosity/ shade' of each sound or group of sounds. It is the distribution of the harmonics, the relative intensity of the partials, the combination sounds, and the different fluctuations, that give to each sound or group of sounds a specific aura, and

> by selecting one of the potential components and bringing it out, it will then become a new radiant object. Out of this sound we can again choose and update this or that component, and so forth.[12]

In this composition process – which Grisey calls '*le principe de la génération instantanée*' (the principle of the instantaneous generation) – each gesture determines the next one as in a chain-reaction and the composer has to control its power and effects. Furthermore, sound has a birth, a life and a death, and the time in which it evolves is both its atmosphere and its territory. Musical form becomes the projection of a natural microphonic space onto an artificial screen which serves to deform, to focalize, to multiply, to select, and so on.

As an example of Grisey's composition process, we could consider his work *Modulations*, analysed at length by M. de la Cruz Padron Lopez Le Dilly in her DEA paper. She writes:[13]

Gerard Grisey (photo: Guy Vivien, courtesy of Ricordi & Co. (London) Ltd.)

Modulations: composed as a piece that can be played alone (see recording by Erato). It is part of the cycle *Espaces Acoustiques*, designed as a crescendo of timbre and density that progresses from the solo piece to the large orchestra.

Prologue	for viola solo (1976)
Périodes	for 7 musicians (1974)
Partiels	for 16 or 18 musicians (1975)
Modulations	for 33 musicians (1976-77)
Transitoires	for orchestra (1980-81)
Epilogue	for orchestra (1985)

We remark that the chronology of the pieces' creation does not correspond to the cycle's order...

Modulations merges the traditional sense of modulation and the acoustic ones that serve as a beacon for the composer: amplitude modulation and frequence modulation. Even if these are not equivalent, at the moment of putting the parameters into music the composer uses only the part of the mathematical formula that gives the additional and differential sounds. The composer can also interpret the resulting sounds as generating sounds, and so exploit the sonorous extension.

In this work I consider the harmonic level in a traditional sense. ... There is, in the part I shall call A – from the beginning to rehearsal number 22 – a series of pertinent polarizations: E, B, and F which correspond to the Tonic note, the Dominant and the second, as in classical harmony. These harmonies are frequently present. If we try to approximate the

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[12] G. Grisey, 'La musique: le devenir des sons', in *Conséquences No.7/8*, p.128.

[13] Maria de la Cruz Padron Lopes Le-Dilly, 'Aspects de la "musique spectrale": *Modulations* de Gérard Grisey', Mémoire de DEA de l'Ecole des Hautes Etudes en Sciences Sociales, 1993, pp.93-109.

micro-intervals to their nearest tempered sounds, we shall see that their utilization serves to muddle the traditional sense of the modulation.

On the other hand, it is important to remark the crossings of different nature that are an integral part of this work.

I found in *Modulations* a form divided into various sections. ... These sections shall be assembled into a global tripartite form: A (from the beginning up to the number 22); (transition: number 22 – last bar before 23); B up to the fourth bar before 43); A′ (to the end) ... A′ is a kind of mirror of the first part. The composer uses as the bass for this piece a spectrum on an E 41,2 Hertz, but he uses approximations and not the precise correspondences that could be given by the computer. To show this point, I join a spectrum in quarters and eighths of tones of an E 41,2 H obtained with the Patchwork programme. In the analysis which appeared in the review *Mélos*, Péter Niklas Wilson gives us the spectrum used by Grisey; this spectrum does not correspond to the one we have just examined:

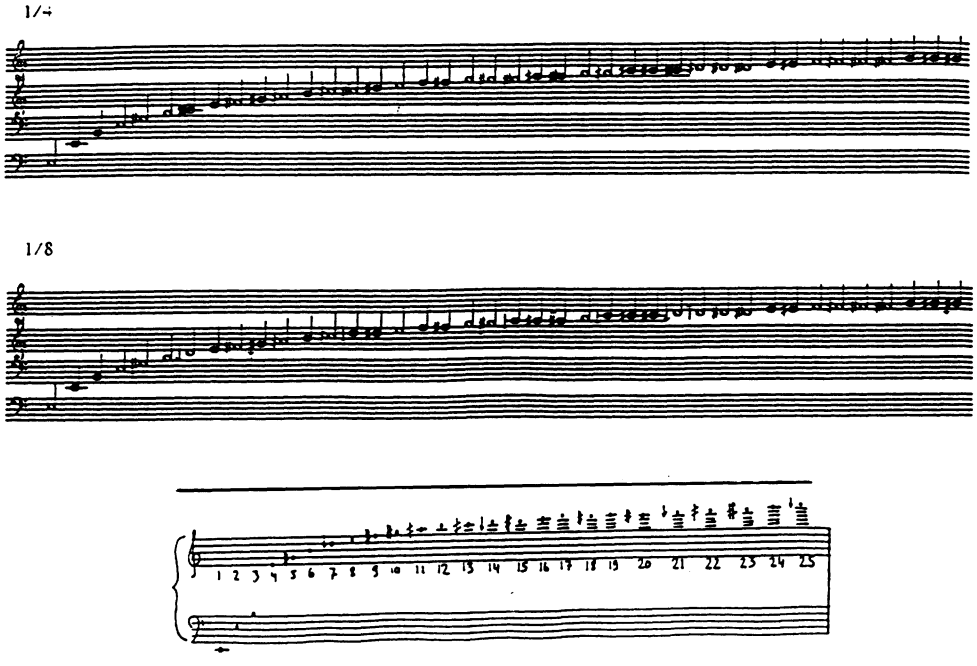
- vertical crossing-over
- cellular crossing-over

Duration: A=424 seconds, B=397 sec, A′=224 sec
This shows a progressive diminution in the total durations' trajectory.

Grisey himself wrote about *Modulations*:[14]

In *Modulations*, the material does not exist anymore, it is sublimated in a pure, never-ending mutating sonorous evolution (becoming) imperceptible in the instant; everything is movement. The only beacons in this simultaneously slow and dynamic drift: a harmonic spectrum on E (41′2 Hertz) and periodical durations.

The form of this piece is the history of the sounds that compose it. The sound parameters are oriented and directed to create many processes of modulation, processes that largely require the discoveries of acoustics: harmonic spectrae, partials spectrae, transitories, formants, additional sounds, differential sounds, white noise, filterings, etc ... On the other hand, the analysis of the brass instruments' sona-



At the beginning, we can note that the wood and brass instruments use tempered sounds, and the the non-tempered sounds are reached by the strings. These sounds, mostly in harmonics, will slowly give place to harmonic sounds throughout the piece.

[...] a process of continuity directs the major part of *Modulations*.

The idea of crossing-over is represented in many different ways of writing:

- formal crossing-over,
- block crossing-over
- instrumental crossing-over
- linear crossing-over

grammes and of their mutes enabled me to rebuild their timbre synthetically or, on the contrary, to distort them.

By the attention brought, constantly, no longer on the material itself, but on emptiness, on the distance which separates one perceived instant from the next one (degree of change or evolution), I think I have come a little closer to the fundamental time, no longer chronometrical time but the psychological one and its relative value. Despite the continuity in evolution, we

[14] After M. de la Cruz Padron Lopez Le-Dilly, *idem.*, pp.75, et 79-81.

can distinguish and summarize *five processes and one breaking-up of the discourse, whose durations are proportional to the odd harmonics' spectrum intervals.*

Maria Padron Lopez Le Dilly summarizes Grisey's cycle *Espaces Acoustiques* saying that:

> In the whole cycle there is a growth in sonorous density. There is an omnipresent use of micro-intervals, noise, beats, harmonic and inharmonic spectrae, differential and additional sounds. There is a process of continuity, and two common landmarks: the spectrum and the periodicity. The idea of human breathing is one of the key parameters for the composer.[15]

Thus, in conclusion, we can see that there is a subdivision of the French spectral school into two aesthetic groups:

1. The group of Grisey and Dufourt, who believe that the musical piece is built from within, by sound-entities that are formed, transformed and transmuted. These sound-entities thus become the nucleus from which the piece develops over time.

2. The group of Murail and Risset, who represent a compositional tendency in which science and psychoacoustics are essential to the composition process. The quest for new formulas, and the use of the computer as an essential tool in the composition process, are also specific features of this group. The piece is considered to be a whole, in which different events come one after the other but preserve its global structure.

Spectral music seeks to exteriorize the inner reality of sound, to project its inner dynamics into an acoustic space and time, and to transmit to the public the reality of sound in all its complexity. Another feature is the use of acoustic suggestion and perception, as we have seen in Grisey's description of spectral music; in Murail's precept that the composer has to be concerned by the relation conception/perception of a piece; and in Risset, who wrote that the composer of spectral music should have some knowledge of Psycho-acoustics.

To conclude: Spectral music, with its ideal of a spatial sound – achieved by the decomposition of sound – that shows its components on a large scale, found its aesthetic sources in the music of Debussy, Varèse, Scelsi and Messiaen, for whom sound was no longer a specific musical note, neither was musical composition expected to show the contradictions between different pitch areas. Sound, considered as a whole integral entity, is decomposed into its different components to show – by achieving a hearing synthesis – the real essence of each and every sound complex.

(I would like to thank my family and Nefer, without whose assistance I would not have arrived this far.)

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[15] Ibid., page 83.