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Spectralism. Spectral composition techniques

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Abstract: *Spectral music stands out as a touchstone in the music soundscape of the first half of the 20th century. Alongside other movements such as graphism, minimalism, aleatoric and archetypal music, pointillism, spectral music was born as a reaction to the excessive calculation and rigour that the structuralists of the50s promoted in their compositions.*
The movement is subscribed to post modernism since it seeks to recuperate traditions and origins by returning to the practice of natural resonance and re-establishing a gravitational centre for the musical discourse. The following text aims at outlining the previous cultural parameters that rendered such a change necessary, the sub-directions circumscribed to spectral aesthetics and also it seeks to point out to aspects of composition techniques in order to create an image, as accurate as possible, of this musical movement.

Keywords: *natural resonance, sound spectrum, additive synthesis, instrumental synthesis*

1. Spectralism – a reaction to the structuralist music of the 50s

The roots planted by Edgar Varese (1883-1965), Giacinto Scelsi (1905-1988) and Gyorgy Ligeti (1923-2006) in the ground of prospecting the anatomy of a sound generated in time profound ideational connections. While Scelsi potentiates the inner reality of a sound, the projection of its interior dynamics "into an acoustic time and space" (Cornicello 2000, 30), spectral music does so to the idea of gradual, progressive transformation of a sonority. The ideational connections mentioned, would be defined and successfully implemented in the work of the composers known as *the Spectralists* of the 70s. Composer Marc-Andre Dalbavie (b 1961) pointed to the *Prelude* in *Das Rheingold* by Richard Wagner (1813-1883), as an early example of timbre evolution. Isolated within the composer's work, this moment seems to induce the germs of spectral thinking. The motifs that form its sonic configuration are generated by the gradual unfolding of the harmonic series starting from the sound E flat. The harmonic series unfolds by means of a 135 bars pedal woven through a dynamic arpeggio ascension (starting with bar 17). This culminates at bar 67, on the same tonal level. The manner of the melody stands out –

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at times in discord with the chromatic element – sometimes inflationist (perceived as a separate item).

Another example is detectible in *Symphony No 1* by Johannes Brahms (1833 – 1897) which starts with an 8 bars pedal over which the violins build an expansive melodic discourse. The tone of the pedal Brahms uses differs from Wagner's by the latter's introduction of tone sonority and an additional accent on the dominant function.

On taking one step further, roots of spectral thinking are to be found even in the *Harmony Treaty* by Arnold Schoenberg (1876-1951), where he discusses the concept of *Klangfarbengmelodie*. A musical sound (*Klang*) – as it is known – has three acknowledged characteristics: pitch, tone colour (timbre) and dynamics. In the previous musicians' experience with sound, this was assessed mostly by its pitch, while the other aspects remained insufficiently explored. Schoenberg has the merit of approaching the tone colour parameter (*Klangfarben*) by stating that the musical sound (*Klang*) is perceptible through its tone colour – while the pitch is nothing but the tone colour measured in a certain direction.

In *Farben* – a canon unfolding over the course of 44 bars – the third part of his work *Five Pieces for Orchestra* op.16 (1909) – one can detect a specific sonic aspect of the kind called *Klangfarbenmelodie*, even if Schoenberg himself does not admit to applying this concept there.

The term *Klangfarbenmelodie* was also associated with the composing projects of Anton Webern (1883-1945) whose music is constructed on the timbre variations that maintain the form continuity. No composer made use of *Klangfarbenmelodie* until Scelsi started producing works based on sound constellations featuring one note or one chord (see *Quatro Pezzi per Orchestra (Ciasunosuuna nota),* 1959).

As mentioned in the beginning, Varese and Ligeti also used tone colour elements in their works, as instrumental, orchestral effects. From his static areas Varèse releases a certain chord – sustained for a significant period of time – and thus creates an unequivocal spectral reference. Thus in his work *Integrales* (1923), on the course of 29 bars, the first chord and the clarinet motif (with its variations) is repeated several times suggesting the presence of a harmonic and partials spectrum. (Figure 1)

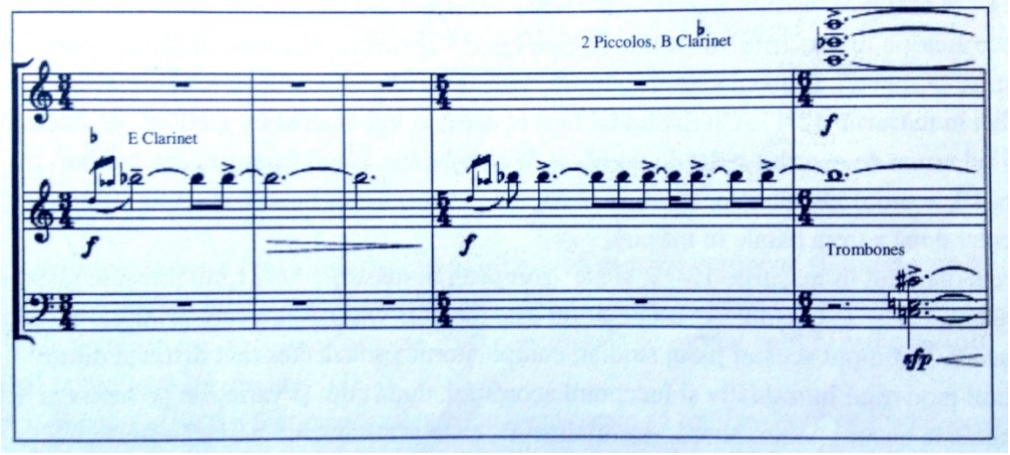

Fig. 1. Edgar Varèse, „*Intégrales*", measures 1-5

By means of repetition the aggregates in *Integrales* not only create a referential chord but also a referential sonority (timbrality grows here by variation of duration and intensity). In *Integrales* a change in harmony is associated with a transformation of the timbre; it can thus be said that Varese considers harmony and timbre as a whole (one referential sonority).

The composition *Lontano* (1967) by Ligeti is generated by the polyphonic and timbre development and the expansions of pitches in the smooth undetectable incoming of sounds. This is known as the *ligetian micro-polyphony* which creates the image of a continuum, stimulated by sounds sustained through constant movement. One or several sounds are rearticulated and each is generally sustained along several bars – which also suggests the expansion of a spectrum of partials – it being the mark of this kind of micro-polyphony.

Further on we will list the aesthetic trends that generated the controversy field of what will be designated as the *spectral movement.* Their roots are to be found early within the area of dissonance emancipation, of atonality and the familiar dodecaphonic technique (see Schoenberg, Webern, Berg). There followed the generation of composers that dared even further in the same direction. Olivier Messiaen (1908-1992) composed, in Darmstadt in 1949, a series of pieces for piano *Quatre etudes derythme,* of which the second one, *Mode de valeurs etd'intensites* played a proeminent role in what would later be called *Structuralism* in music. The work includes 36 pitches, 24 beats and 7 dynamics elements that are treated in a modal manner and it is considered the first work to explore all musical parameters (pitch, duration, attack modalities) it would further influence the orthodox structuralists (Pierre Boulez (b 1925), Karl Heinz Stockhausen (1908-2007), Luigi Nono (1924-1990) – by becoming a model for the composers interested in the serial

approach. The works *Kreuzspiel* (1951) by Karlheinz Stockhausen, *Structures I* (1952) for piano by Pierre Boulez are representative of the respective aesthetic orientation. On the Avant-garde scene of the 50s (Boulez, Stockhausen, Nono) – as a constructive essence of structuralism – one can distinguish the common ground of the composition prospects for all those who set into parameters (and calculated to the maximum) the manner of the dodecaphonic structures. It is the technique that caused vehement reactions from the spectralist composers, of the spectral movement referred to here.

2. The Spectral Aesthetics. Sub directions

Seeking to organize the thinking that defined the domain of spectralism especially with regard to France and Romania one can imagine a classification (Nemescu 2015, 12) generated by the specific differences within the respective aesthetics. **The first spectral sub direction** (1965-1975**)** advances into the history of contemporary music with six Romanian composers. These simply created music on the harmonics, a fundamentalist type. At the time when fundamentalism emerged as an aggressive religious movement, especially in the Islamic regions (1979), this type of music, on the harmonics, was stimulated analogously.

The very promoter that legitimized this first sub direction Corneliu Cezar (1937-1997) questions, in the year 1965, the rigidity imposed by those mathematical calculations underlying the construction of serial works. Furthermore, he opposed the state of desperation and nervousness (which generated a genuine expressionist ethos via Schoenberg); that is to say, music called inexpressive and violent, which is at best anguishing… This was due to its excessively using dissonances since consonance was banned.

Corneliu Cezar therefore envisaged abandoning clusters – the main generators of dissonances – and the return to the fundamentals and the proximal harmonics. He thus suggested the re-discovery of consonance and the creation of music with a permanent fundamental. Cezar's first proposition to justify his thesis is the electronic work *Aum* (1965). Other composers followed suit, who used the proximal harmonics and the permanent fundamental: Ovidiu Nemescu in his orchestral piece *Iluminations,* Lucian Metianu in *Pitagoreis,* Costin Cazaban in *Naturalia.* Others to be mentioned in this context are Aurel Stroe with his opera *Orestia II* – with a prelude regarded as isonic; later on Stefan Niculescu, with his works *Ison I* and *Ison II* . Thus was this trend officialised in Bucharest, Romania.

The **second sub direction** is also known as spectralism around a chord (the harmonics of a fundamental have a static hypostasis as well as the generating sound); see *Colinde* (1968) by Mihai Mitrea Celarianu.

The third subdirection (1970-1980) is represented by Horatiu Radulescu and Iancu Dumitrescu. The former employs another spectral modality which O. Nemescu called improvisational and monochord. Radulescu invites the performer to make use of instrumental effects which may unleash harmonic but also partial sounds (that is to say the emission of sound close to the bridge, then activating a free string to result into a harmonics spectrum; also the multi-phonics produced by woodwind instruments; thus was the timbrality of the instrument transformed).

One could label these composers as inductive spectralists as they imagine an asymptotic tone colour i.e. whatever they wish to obtain with the sound (when playing for example *sulponticello* they could not accurately calculate the resulting harmonics) (Anghel 1997, 57).

The fourth sub direction was born in France, in Paris after 1975 – so 10 years later than the first, Romanian, sub direction and lasted until the 90s. It was represented by Gerard Grisey, Tristan Murail, Hugues Dufurt, Michelle Levinas, Roger Tessier, and Jean Claude Risey. The French are the ones to coin the term *spectral music*; considering that the Romanian composers used to call it music in the harmonics or in the natural resonance. The French however resorted to harmonics that were more and more distant from the fundamental (from the 16^{th} harmonic to the 64^{th} one, from the 80^{th} to the 640^{th} etc.). Using computer programs, and devices that produced the spectral analysis of instruments, they intended to uncover the harmonics spectrum of various instruments and use it with the orchestra; this resulted into the production of sounds that were quite dissimilar from the timbre specific for the instruments considered as prototypes in the analysis. Furthermore, in notation harmonics used to be indicated by double or triple alliterations. There were other European composers who adhered to this type of calculated spectralism, structuralist and speculative: the Finn Katja Sariaho, the Italian Salvatore Scciarino, the English Jonathan Harvey, etc.

By extrapolating, one could term these composers as the deductive spectralists or spectral structuralists due to the fact that they used to calculate with affectation the sonic elements (harmonics, partials, noises, the nature of bangs, etc).

The fifth sub direction (subsequent to the year 1980) realizes a synthesis of the previous directions. The composers circumscribed here are again Romanians: Calin Ioachimescu and Fred Popovici. In is worth noticing that Romanian composers are part of the first, the second and the fourth sub direction while the French are only part of the third.

3. Spectral composition techniques

The spectral composition techniques are a special array of techniques tackled by the composers interested in employing the sound spectrum as their creative material. We would like to begin characterizing them by referring to the acoustics, since research into modern acoustics has created room for maneuver and set things into motion. Any vibrating body generates pressure waves that propagate in the air. These pressure waves are the actual physical reality of the sound. Depending on the properties of the generated sound, these waves can be represented in various ways. The structure of the sound differs from one instrumental rendering to another. For example it can be captured by means of a recording device that will convert the pressure variations into a mechanism which can be visualized. The device for such a recording is called *spectrograph* and the optical resultant is a *spectrogram.*

The following example presents in a diagram the optic representation (in a spectrogram) – a two dimensional one (amplitude and frequency) - of a sound. The diagram highlights that which constitutes the sonic field of spectrality - namely the *frequency harmony*. (Figures 2 and 3).

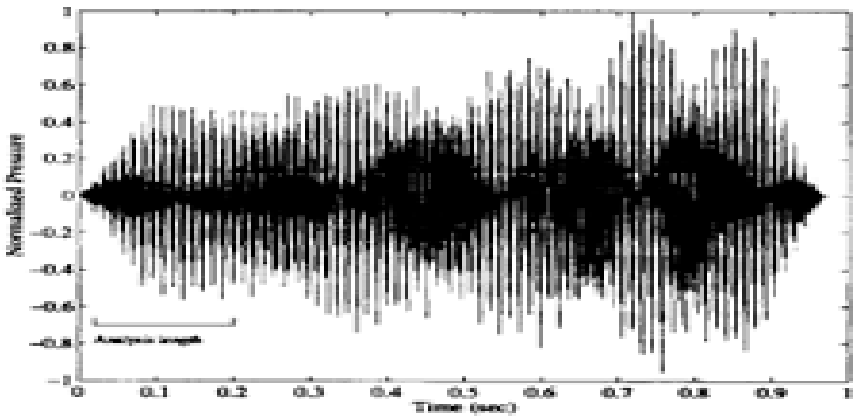

Fig. 2. *Spectrogram analysis of sound*

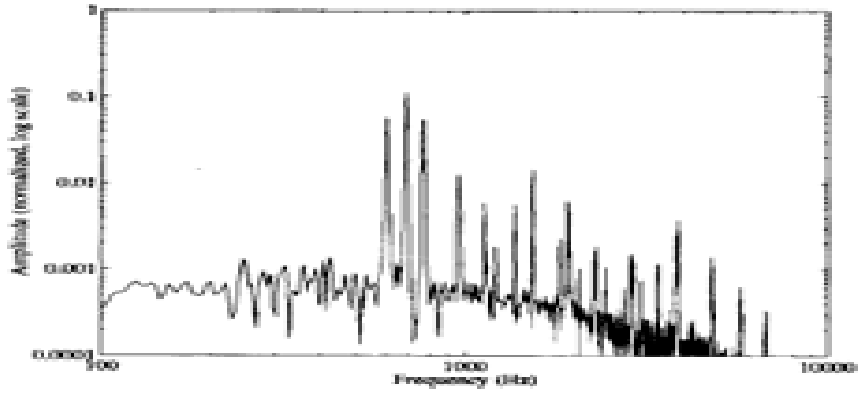

Fig. 3. *The Fourier transform (the frequency spectrum)*

This representation of the pressure wave reflects the entire temporal evolution of refined granulation (within the resolution limits of the strictly visual representation). Thus the sound is adapted to manipulations such as cutting and decomposing, inversion or repetition of its phase variations. To be noted that the mathematic model of formalising the acoustic status is all present within the design of the technique under consideration.

Fourier (1768-1830) defines the life conditions of a sonic continuum (the Fourier Integral) deducted from the discreet elements of the spectrum (the Fourier Series). The theory is used as application in the spectral analysis of sonic events. For example, Joseph Fourier's theory (1768-1830) demonstrates that any complex signal can be decomposed into a sum of sinusoidal waves within a determined time interval, by exactly specifying their amplitude and relative phases. It so becomes possible to decompose a complex sound into a sum of parts (partials, harmonics, inharmonics, noises) which are globally called harmonics of the sound, the set of which form by their integration, the sound spectrum. Fig.2.2.). The spectral shape of the vibrations of a sonic corpus consists of the configuration that these take in the process of being produced (a phenomenon which results into the harmonics of a sound). The mix of the fundamental sound (in varying proportions) with its harmonics as well as their intensity or quality resulting from the way they are produced, determines the sonic timbre.

Therefore all of these ingredients of the anatomy of a sound generate a special technologic mechanism. Composers resort to it by various means: *paradigmatic procedures* (*delay, reverb, echo, pan, the Doppler effect*) and *syntagmatic procedures* (*filters, the real time sound synthesis, modulations).* A generous

repertoire of effects that modify the intimate constitution of the sound includes *the zoom*, *the Doppler effect*, and *the filters* – with an entire range of fluctuation forms; there is actually a classification that helps to understand the filter procedure.

The *additive synthesis* (the synthesis by addition/subtraction of inharmonics). The sonic spectra fall into two categories: *harmonic spectra* (with an exclusive content of harmonics) and *inharmonic spectra* (which contain both harmonics and inharmonics) also known as partials spectra. John Chowing (b. 1934) advanced a formula for calculating the inharmonic components of a sound: $fn=fo+/-n$ x *fm*where*fm* is the modulating frequency, *fo* the modulated frequency, the number *n*=positive unit and *fn*=the resultant of applying (by addition or subtraction) n times of *fm* over *fo*. Granular synthesis is potentiated as a technique in the work of Yannis Xenakis (1922-2001) – the first to create dense sonic structures formed by infinitesimal particles (with durations varying between 1ms and 50ms). This method presents some similarities with the *sampling* method (*samplers*), and is based on cutting up extremely small (and extremely mobile) fragments of the sonic parameters. *Ring – modulation* refers to the production of reciprocal effects between two sonic signals so that the sum and difference between their frequency values should create inharmonic layers.

On discussing spectral composition techniques one considers a repertoire of syntheses. One of these, which highlight the way spectra and their components work together, is the instrumental synthesis. Used by Grisey in his work *Partiels* (1975), it proposes the use of spectres as metaphors (Rose 1996, 11). That is to say the sound analysis by means of a spectrograph (in the way rendered above) will subsequently enable the composer to get the optical resultant rendered by the spectrogram in order to further grasp the important elements in the *life* of a spectrum. He thus orchestrates the respective spectrum, administering its harmonics by attributing them to each instrument in the orchestra depending on the intensity they emerge with (see the optical co-ordination in the spectrogram). For example, the *metaphorical* representation in the score (by means of the familiar semiography) of a spectrum (Figure 4) is suggestively rendered in the work *Streamlines* (1995) by Joshua Fineberg (b.1969) (Pressnitzer 1999, 4). It is well-known that these semiographic representations are used in various composing strategies, yet they rather constitute instructions for the performers; they are a mere description of the sound actually produced.

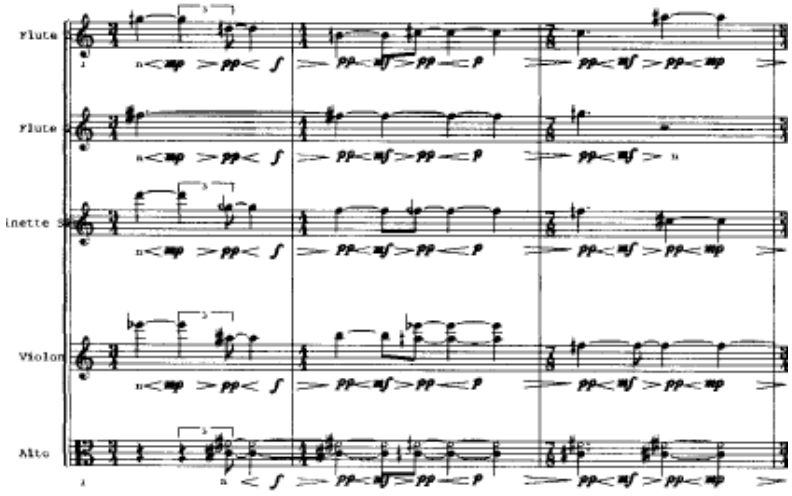

Fig. 4. *Joshua Fineberg*, „*Streamlines*"

The global sonic product is evident in the example above, which resulted from texturing a spectrum. *The instrumental synthesis* is – as it has been shown – the optimum formula to simulate the spectrum of a complex sound, with its fundamental and harmonics; the distribution of the partial components of this complex sound to each instrument in the orchestra, is relevant. In my opinion, Fineberg's work includes a proto-spectral aspect since the sonorous resultant is a quasi -atonal *micro-poliphony*, or perhaps a neo-atonal one, with Ligetian accents. I believe it is difficult to commensurate here the perception of a spectrum.

4. Conclusion

These techniques with all their ramifications, will ensure a complex development of the electro-acoustic music and also of computer music, both of which impact on the music that works with the material of a single sound. This is because they are used not only to produce the electronic component in an electro-acoustic work but also to create the harmonic units, the sound object now becomes the polarizing centre of the composition, generating harmony, melody, rhythm, form and orchestration,

Exploring the natural resonance of the sound had and still has the attention of the Romanian contemporary music, the names of the mentioned composers bear witness to that. These names also foreground the powerful presence of the Romanian music school in the respective domain.

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