Contemporary Music Review
Vol. 24, No. 2/3, April/June 2005, pp. 121 – 135

The Revolution of Complex Sounds

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The most sudden and important revolution to affect the musical world during the recent past was based not on some type of reflection upon musical grammar (serial or other), but rather—more deeply—upon the world of sounds themselves: in other words, in the sonic universe that summons the composer. For any composer reflecting upon his place in music's evolution, this unprecedented opening of the world of sounds that we now recognize cannot fail to make itself felt in the compositional technique itself. More precisely: any attempt to integrate these new sounds that are above all, as we shall see, sounds of a 'complex' character, necessitates a profound revision of traditional compositional techniques (by 'traditional' I include serialism, aleatoric composition, stochastic composition, etc.: techniques that continue to use antiquated grids of parameters) and of our very conception of the compositional act.

A New World of Sounds

We have witnessed, in fact, a double evolution in the world of sounds. On the one hand, our tools for analysing sound have advanced considerably (spectrograms, sonograms, digital recording, etc.), as have theoretical reflections based in observation. On the other, the material of sound itself is constantly being enriched, a process whose culmination has not yet even entered our field of vision.

The enrichment of musical material is not, in fact, new. It occurred slowly over the entire course of the 20th century, first with the development of percussion instruments, then with the appearance of electronic instruments (of which the first essays take us back to the beginning of the century, with Thaddeus Cahill's 'Telharmonium', an instrument several tons in weight that required a telephone for operation; but by 1928 we already had a more practical instrument, the ondes Martenot, which is for that matter still used today). But it is after World War II, of course, that the domain of electronic music begins developing rapidly, starting with work on analogue tape in the classical studios and ending with the computer, passing along the way through synthesizers, and miniaturized studios that allow the creation of live electronics.

ISSN 0749-4467 (print)/ISSN 1477-2256 (online) © 2005 Taylor & Francis
DOI: 10.1080/07494460500154780

Along with the birth of new instruments, instrumental technique also renewed itself, giving the composer an entire category of sounds with previously unimagined characteristics—sounds that fall between two categories, paradoxical sounds, unstable sounds, complex sonorities that defy the traditional classification of harmony and timbre completely, inhabiting the unclaimed territory between them.

The new analytic tools I mentioned above allow us, at the same time, to bring a different perspective to sounds, to journey to the interior of sounds, to observe their internal structures. In this way, we immediately discover that a sound is not a stable and self-identical entity, as traditional notation might have us believe.[1] Our entire musical tradition assumes a direct correspondence between the symbol and the thing. But sound is essentially variable—in the sense, of course, that a sound can never be repeated exactly, but variable also within its own unique lifespan. Rather than describe a sound by describing its 'parameters' (timbre, register, volume, duration), it is more realistic, more in keeping with physical reality and perception, to consider a sound as a field of forces, each force pursuing its own particular evolution. Such an approach empowers us to work more precisely upon sounds, to perfect instrumental techniques in the context of an understanding of sonic phenomena. It allows us also to develop a compositional technique based on the analysis of sounds, and to make of their internal forces a starting point for the composer's task.

But the revolution of the world of sounds also took place within us. In effect, we are participating in a large-scale reappraisal of traditional listening. I perceive a double influence of electroacoustic music and non-western musics, which have enabled us to discover a different sense of time; they have led us to alternative methods of orienting ourselves to duration; through them, we are now attentive to phenomena previously considered secondary: microfluctuations of many kinds, sound colours, the production of sound, etc.

Fans of rock music provide a good example of this 'other listening'. For us ('serious' musicians), all rock is terribly alike and monotonous (4/4 time, electric guitars, pentatonic melodies, E minor—because it is easier for the guitarists—etc.). For rock listeners, however, there is no doubt about identity of the band or the song, after hearing only a few seconds. What they are hearing is not what we hear: they listen to the sound before anything else; they see the differences and subtleties that will go unnoticed by the musically educated—and thus compartmentalized and conditioned—ear.

Despite this outpouring of new methods, of new concepts—or perhaps because of them—we are currently witnessing many composers performing a kind of turning backwards, a reversion to a maternal embrace, to a collective refusal of instrumental innovations, a refusal even of serialism or postserialism; a return, finally, to techniques dating to the period between the wars. Fear of the unknown, lack of imagination, or balking in front of the immensity of the task? This path is often disguised as a virtue, under noble pretexts: the return to 'expression', to 'simplicity', to 'harmonic' (*sic*) music. Like all forms of neoclassicism, like all examples of 'retro' styles, it is fundamentally sterile. The unlimited promise of electroacoustic music was doubtlessly deceptive: but this is not a reason to spurn its gifts, no more than an eschewal of Asian music is justified simply because its message is disfigured by 'oriental' muzak in a supermarket. In truth, what have been missing are concepts permitting us to organize the new reality that, whether we like it or not, faces us. If we do not find them, others will; they are not waiting around for their turn. The spectacular development of synthesizers, of electronic sound, owes considerably more to Pink Floyd than to Stockhausen.

The Broader Influence of Electroacoustic Music

It was inevitable that the development of electroacoustic techniques, and of our understanding of acoustics, would affect traditional compositional techniques. Indeed, electronic music produced a more or less deliberate proliferation of instrumental and orchestral music, which as a result proposed new schemes, new forms, new ideas as far as the use and combination of instruments, etc. It is obvious that we would not have Ligeti's *Atmosphères* without the development of tape music. In effect, electricity provided for the first time sounds of infinite duration, stable masses of sound, continuums.[2]

Composers naturally sought to create these electronic continuums within the orchestra. It was in this way that they began to think in terms of masses, rather than lines, points and counterpoint. The true musical revolution of the 20th century lies here, in the fluctuation between abstract concept and aural perception that permits access into the depth of sounds, that allows us truly to sculpt sonic material, rather than piling up bricks or layers. One might speak of an opposition between the traditional compositional practice of amassing and compounding elements advocated by harmony and composition textbooks, and another method I designate as synthetic: the sculpting of music, as a sculptor moulds marble, gradually revealing manifold details from a global approach.

I will mention just one more of many other fundamental contributions of electroacoustic music: the very essential idea that the musical 'atom' is not the notehead written on staff paper. The musical atom is the perceptual atom, tantamount, perhaps, to Pierre Schaeffer's 'sonic object'. It is possible as well that there is no perceptual atom, that music is indivisible, that we perceive only flux (to borrow an image from theories interpreting light in terms of waves, rather than particles).

An orchestral piece I wrote in 1974, *Sables*, could serve as an illustration of this idea. The music of *Sables* is a music made from masses of sound, where individual notes are nothing more than grains of sand, bereft of significance, but whose accumulation furnishes the music with both its form and its content, just as grains of sand supply a dune both shape and substance.

Properties of the New Materials

The new materials that offer themselves to the composer have some common properties, whether they originate in instrumental or electronic music. These are often complex sounds, intermediate sounds, hybrids, sounds that possess new dimensions (transitions, development over time), sounds that are neither harmonic complexes nor timbres but something between the two. Conjointly, there is a general abolition of limits: acoustic analysis and even simple observation show us that there is no precise line between pitch and noise, rhythm and frequency; harmony and sound colour are continuous phenomena. Are we to refuse these new categories, as do certain current tendencies? Too often where integration is required there is merely collage, in which complex sounds merely serve—at best—to create 'special effects' within a traditional musical discourse made up of conventional sonorities.

Musical structures of the past (tonal, serial, etc.) fail to account for intermediate categories because they force acoustical reality through inexorable sieves. We must, in fact, work with precisely those areas that have been neglected, and use their specific qualities, exploiting the imbalances of their internal energies and flowing dynamism, even drawing from them new structures of order that might apply to both the micro and the macro level of the score.

We need, in fact, new organizing principles that do not exclude one or more categories *a priori*, but integrate the totality of sonic phenomena. There is no such thing, in itself, as a beautiful or an ugly sound: sounds are beautiful or ugly as determined by their contexts. In general, their qualities are perceived as a function of the energy directing the musical work in which they figure. We cannot, then, exclude or isolate: we need a method of synthetic composition.

The Enrichment of Compositional Technique by Its Materials

At this point, I would like to give some simple examples of the interaction of the new materials and compositional technique, of the enrichment of compositional technique by its materials. This is a vast subject, and I will limit the discussion to a few precise examples: the influence of certain electroacoustic techniques on creating hybrid 'intermediate' states, the transposition of techniques from one domain to the other, and the integration of noise and complex instrumental sounds.

Echoes, Loops, Reverberation

Systems of echoes or re-injection loops provide a good illustration of instrumental composition's adaptation of studio techniques. The re-injection loop, the classic procedure of setting music to tape live, is a familiar idea. The set-up involves two recorders separated by a precisely calibrated distance; the tape runs from one to the other. The first recorder tapes the signals it receives (often an instrument recorded through a microphone); the second reads the tape after a lag, the length of which is determined by the distance between the recorders. As the second recorder reads the tape, it sends the signal back to the first, where it blends with the new signals that are simultaneously arriving. This creates an accretion of sounds that is theoretically infinite. The process is not a classical canon, even if today's machines are without imperfections. The interest in the process is that the sound, recopied and, above all, continually remixed with the new signals, is progressively worn down, degraded, transformed, destroyed. The sound merges with white noise, and the process ends with the emergence of new frequencies, of self-generated rhythms, of interferences.

I used the principle of the re-injection loop in a purely instrumental piece, *Mémoire/Erosion*, written for horn and nine instruments (four winds, five strings). The horn produces sounds that will be recorded by an entirely imaginary set-up. As in a re-injection loop, the listener will hear each phrase played by the horn repeated after a certain interval of time; it is, of course, the other instruments that produce the re-emission. But the initial phrase (or sound) will never be exactly repeated. With each repetition, a process of erosion will be played out that, while destroying the original musical structures played by the horn, will gradually reconstitute new structures that, in turn, will be put to the same process of erosion; and in this way the piece develops. Several types of erosion are at the heart of *Mémoire/Erosion*: erosion through timbre, by the wearing out or smoothing of contours, by proliferation, by interference.

This brings us to the closely related concept of entropy, which I have found highly fruitful—above all when composing with processes. Positive entropy is defined as the progressive passage from order to disorder. The entire universe is subject to its law: natural erosion, one of its manifestations, destroys geological structures to create disorder, the final stage of which is indifferentiation. Life, considered as negative entropy, constructs an ephemeral order.

This idea also suggests an obvious technique to integrate noise naturally. The slow process of desegregation and restructuring described above permits the imperceptible passing from 'pure' sounds to noisy ones, via manifold forms of complex sonorities.

To return for a moment to the parallel between studio techniques and compositional method, the studio has limitations that composition does not. For example, if one uses re-injection loops in a studio, the length of the tape must be preserved over the course of the work, unless complicated set-ups are used that only function with enormous difficulties. On the other hand, on paper the only problem is calculating the durations. In *Mémoire/Erosion*, the length of the fictional re-injection loop varies between and one and three seconds. The changes in duration are sometimes sudden, at other times gradual (which necessitate more complex calculations). One can imagine many other manipulations through composition, for example to suddenly stop the re-injection process for some of the instruments and throw them in another loop that feeds upon itself (producing a rapid degradation), etc.

One can subject other electronic effects to this type of treatment. Take the phenomenon of echo: if a normal echo repeats identically and regularly—which is hardly interesting—one could very well imagine an echo that, for example, slows over its successive repetitions, all the while modifying the repeated object along certain rules. Figure 1 shows a sound (the note C) put to this type of imaginary echo. Here, the harmonics of the C appear progressively and descend an octave at each repetition, producing increasingly complex chord-timbres (the opposite of a natural echo, which

Figure 1 A sound (the note C) put in an imaginary echo.

tends to filter in the opposite direction). I have explored this effect fairly thoroughly in the piano solo *Territoires de l'oubli.*

Clearly, many other types of transpositions (and many other stratagems inspired by them) are imaginable. I will limit myself to just a few examples: the use of sequencing similar to that of a synthesizer; working on intensities like faders on a mixing board (sudden movements would translate as an immediate drop in volume; 'zooms' in intensity would highlight a particular texture, or certain elements of a texture, like a microphone approaching an instrument), the establishment of relations between parameters, like those aided by voltage controls (e.g. a relation between interval and duration or between duration and frequency off-sets, as occurs when we speed up a tape recorder, etc.), the exploitation of electrical mishaps (saturation, bleed-through), etc.

Harmonic and Inharmonic Spectra

If harmonic spectra have often been invoked to justify this or that theory of music, a systematic study and conscious use of their characteristics is a recent development. The harmonic spectrum's composition is well known (Figure 2).

Nature, traditional instruments and synthesizers all offer examples of defective spectra: spectra composed of odd-numbered partials (roughly corresponding to the clarinet's spectrum—or a pure square wave, to be precise); harmonic series missing one out of every three partials; etc. (Figure 3).

From this starting point, a variety of treatments can, of course, be invented with a little ingenuity: 'filters' that latch onto the harmonic series in various ways, by selecting only certain components, to produce aggregates of frequencies with interesting properties; a 'band-pass' filter, for example, which masks all but a portion of the spectrum. In Figure 4, a portion of a spectrum of odd-numbered partials is filtered.

It is also easy to imagine a type of 'comb filter' in which every third harmonic starting at the third partial are selected, or every fifth starting from the fifth, or an irregular selection, etc. (Figure 5).

It would be equally possible to create filters inspired by 'phasing' that would produce a kind of filtering in motion. Transposed to instrumental writing, this

Figure 2 The harmonic spectrum (built here on a C).

Figure 3 Defective spectra.

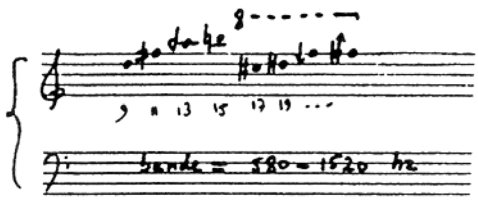

Figure 4 A 'filtered' square wave.

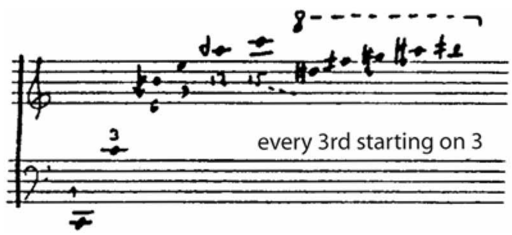

Figure 5 A 'comb filtered' harmonic spectrum.

process would generate internal movements within harmonic aggregates, a sweeping through all frequencies; I used this especially in *Ethers* (see Figure 6).

Properties of spectra, then, support harmonic ideas, and allow the fabrication of agglomerations that are neither harmonies nor timbres, but rather progressions within the domain of timbre-harmony—for example, progressive decompositions from timbre to harmony. A first and very simple example is the excerpt from *Territoires de l'oubli* shown in Figure 7.

Figure 6 Internal movements within a harmonic aggregate from *Ethers*.

Figure 7 Progressive decomposition from timbre to harmony from *Territoires de l'oubli*.

The piano repeats formula *a* several times. After a while—the pedal remaining depressed—a G emerges, since it is present in spectra of three of formula *a*'s frequencies. The pitch G is then actually played, and the first formula is replaced by formula *b*.

This type of procedure can be generalized; an entire passage, even a whole score, could be organized by a system of pitch generation. Formulated in this way, the rules of harmonic chains would easily extend to the categories of complex, intermediate or instable sounds and the like, and would even determine their usages. The entire basic structure of *13 couleurs du soleil couchant*, as well as certain passages in Gérard Grisey's *Partiels*, are based on such schemes (e.g. see Figure 8).

The sound generator a creates its own harmonics (via an intermediate stage a in which the timbre is decomposed); harmonic 1 creates its own harmonic c. Sounds c and d react against each other as in ring modulation and we hear the differential tone δ and the additive tone σ. δ then becomes the next sound generator, and the process continues.

Figure 9 shows another example of organizing pitches (and timbre) by successive generators, this one from the beginning of *Mémoire/Erosion*.

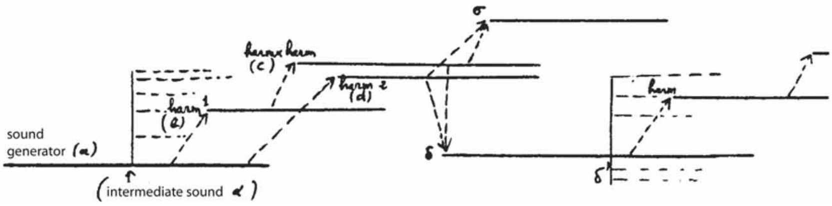

Figure 8 System of pitch generation from a passage in Gérard Grisey's *Partiels*.

Figure 9 Organizing pitches by successive generators, from the beginning of *Mémoire/ Erosion*.

The whole harmonic structure is drawn from the first C of the horn. The strings, having taken over the C, gradually move their bows towards the bridge, projecting harmonics taken up elsewhere in the ensemble, while the C drifts slightly flat, as if it were slowed down on a turntable (b). These effects of drift and germination are intensified (d—e – f). The C, weakening as its harmonics strengthen, finally disappears, while its spectrum is increasingly distorted, along with its timbre—rubbings and distortions of the strings (g—h – i). The B-flat is reinforced at the heart of this composite spectrum—a familiar phenomenon of re-injection loops (j)—and finally sustained, accompanied by high frequencies that sound like its partials. Please note that this brief analysis is necessarily incomplete, limited to the work's harmony, ignoring the intimate interdependence of harmony, rhythm and timbre.

This last example, where harmonic relationships are quickly distorted, might provide an entry into the domain of inharmonic spectra. Many instruments have inharmonic spectra, including the piano and the tubular bells. Inharmonic spectra themselves give rise to particularly rich and interesting spectra and can be classified under this new category of complex sounds, since they resist analysis as either harmonies or timbres. One can try to synthesize them within a composition and handle them artificially, through 'instrumental synthesis'. Gérard Grisey did this very often, especially with processes of passing from a harmonic spectrum to an inharmonic one. The entire structure of *Sortie vers la lumière du jour* is based on this idea: in the middle of the score, we hear the harmonic spectrum of a low C. All harmonies before and after this point are based upon a progressive deviation from this spectrum; at the same time, a filtering effect reduces what we hear of these spectra to increasingly constricted frequency bands.

In *Modulations*, Grisey makes simultaneous use of four defective harmonic spectra, three of which correspond to actual spectra of muted horns (the fourth is imaginary but completes the others). The four spectra evolve progressively to inharmonicity by divergent shifts in frequency; the maximum point of inharmonicity is reached with A'', B'', C'', D'' (Figure 10).

Frequency modulation provides a process rich in spectral synthesis. This technique has been highly developed in computer-driven synthesis: it can also serve to calculate frequency aggregates for 'instrumental synthesis'. Here is a brief résumé of results obtained through this process: we start with two frequencies, the carrier tone c and the modulator m. The modulator is added to and subtracted from the carrier i number of times. If $i = 1$, the resultant frequencies are: c, $c + m$, $c - m$. If $i = 4$, the resultant frequencies are: c, $c + m$, $c - m$, $c + 2m$, $c - 2m$, $c + 3m$, $c - 3m$, $c + 4m$, $c - 4m$, etc. In reality, things are a little more complicated, since the intensity of each component must be accounted for—a situation that depends upon a precise mathematical law (Bessel functions).

If c and m are related by a factor of a whole number, the ensemble of components forms a harmonic spectrum; if they are not, the resultant spectrum is inharmonic.

Substracting m from c brings us into the domain of negative frequencies; in other words, when $c - im < 0$, an interesting phenomenon of 'foldover' occurs. Since from the sonic perspective a negative frequency is identical to its absolute value,

Figure 10 Four spectra and their evolutions from Grisey's *Modulations*.

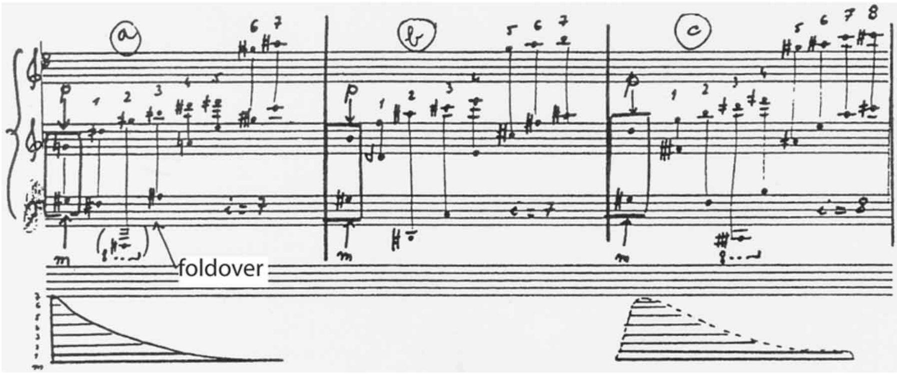

Figure 11 Frequency modulation aggregates from the beginning of *Gondwana*.

subtraction results in ascending frequencies that will eventually mesh with the original additive components, which will reinforce certain regions of the spectrum.

Figure 11 illustrates three examples of aggregates obtained by frequency modulation. They are drawn from the beginning of *Gondwana* for orchestra (almost the entire work is based on this type of aggregate).

The role of these aggregates—played by wind instruments—is to synthesize large bell sonorities (whose attacks progressively soften to resemble, at the end, horn attacks in *c*). The intensities of each component lessen as they ascend in pitch, while their durations are based on each component's numerical position in the order. This is symbolized by the small 'sonograms' represented under aggregates *a* and *c*.

It is essential to remember that these aggregates are not simple chords in the classical sense of the term. They resound as complex units that are frequently difficult to analyse by ear. The relations between the components transform them into indissoluble blocks (similar, in this sense, to sounds produced by ring modulation in electronic music). This brings us to the idea of 'harmony-timbre'. Each component of a 'harmony-timbre' possesses a frequency, an intensity, and a numerical position in the order (that indicates its beginning and ending points).

Integration of Complex Sounds and Noise

The classical orchestra had long possessed a method for integrating white noise. Cymbals, timbales and the bass drum were used to add components of white noise to orchestral tones, in order to render more complex an orchestral spectrum that was otherwise simple by the very definition of tonality. Since the music was so often (and in the case of a final chord always) limited to the three pitches of the triad, adding percussion was the only method of adding complexity and lustre. Later, when the percussion arsenal was expanded and given some independence, it was highlighted instead of integrated. It must be said that in many cases, an elementary and arbitrary juxtaposition was employed, without any aesthetic rationale other than the wish to appear modern.

We are currently witnessing a subtler, more intelligible use of percussion. It has largely resumed its original role as the supplier of white noise that either combines with the purer frequencies of the orchestra or creates independent structures.

A perfect example of this new method of integration is found in Hugues Dufourt's *Saturne*, where the six percussionists blend with 12 winds and four live electronic instruments, giving the composer a large palette capable of producing a wide arsenal of sounds from the purest to the most complex, and every nuance between.

Michaël Lévinas has developed a singular method of integrating white noise: snare drums are placed in front of wind instruments to resonate sympathetically. The complex sounds that result are formed from the sounds of the instruments and the vibrations of the snare heads. A particularly good example of this method is his work *Appels*, for amplified instrumental ensemble.

It must be noted that the use of percussion described above is frustrated by the current lack of precision in describing the instruments' characteristics. What, exactly, is the effect of a 'high' cymbal or a 'low' tam-tam? Different orchestras and different instruments attach different meanings to the same appellation. Why can't the frequency bands of percussion instruments be as exactly defined as those of other instruments? Without some type of standardization, it will be impossible to continue much further in the direction of a sophisticated and intelligent use of the instruments.

Uses of Complex Instrumental Sounds

As mentioned above, composers have often thrown themselves into the world of extended instrumental techniques with much abandon but little discernment. Rather than creating a coherent system for the integration of new instrumental sounds, extended techniques have been used as simple 'sound effects', as exotic stunts, often inappropriate or casually tossed off.

But if these sounds—their inner structures and the way they are produced—are studied with some scrutiny, more rational methods could be discovered that could well give rise to a new musical logic. This could lead to an ideal compositional method in which structures of sounds would correspond to musical forms. Both would adhere to the same criteria and follow the same principles of organization; there would be perfect reciprocity between the score's microcosm and macrocosm; the form – content distinction would be blurred and finally rendered meaningless, as one half of the opposition would be understood as a direct result of, and even identical to, the other. We have seen some examples of this kind of organization in the use of harmonic and inharmonic spectra. Here are some simple examples of integrating complex instrumental sounds, and of 'feedback' between compositional technique and the material it can elicit.

Multiphonics

Figure 12, drawn once again from *Mémoire/Erosion*, displays the transformation of a simple chord (*a*) to a complex sound (*d*) through wind multiphonics and *ponticello* string sounds.

Chord *a* is played with internal movements by all instruments. The frequencies drift slightly to produce *b*. The strings, playing on the bridge, add new frequencies (harmonics), while multiphonics drawn from the first chord appear one by one, each adding distortion. The process ends in the highly complex final aggregate that is more a timbre—a global sound—than a chord; the noteheads in the score are only components and their pitches are not really audible. Curiously, the resulting sonority has a somewhat electronic quality. The process is also one of movement from the fragment of a harmonic spectrum (*a*) to a totally inharmonic one (*d*).

Figure 13 presents three of the aggregates that end *13 couleurs du soleil couchant*. Here we have 'bell-like' sonorities. Sound *a* is formed of fragments of two harmonic spectra based on D-sharp and F-sharp (these share components that link their fundamentals, in the way that inharmonic partials of a bell give the impression of fusion). In *b* and *c*, the introduction of multiphonics and *ponticello* (harmonics of harmonics) render the sound more complex; the fundamentals' primacy cedes to

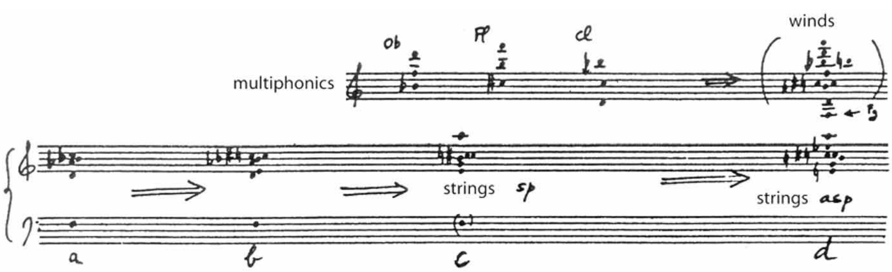

Figure 12 Transformation from simple sound to complex chord from *Mémoire/Erosion*.

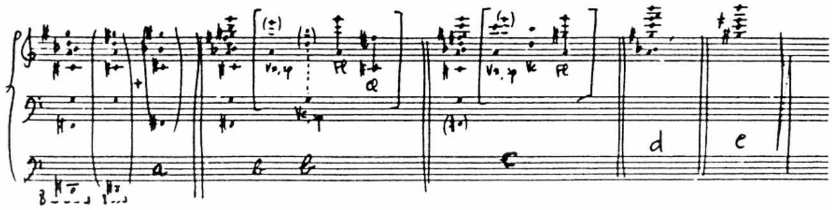

Figure 13 Aggregates from the conclusion of *13 couleurs du soleil couchant*.

harmonic and inharmonic partials towards the high register. By the end (*d* and *e*), only a few high partials remain.

'Crushed' String Sounds

The increased pressure of the bow on the string produces more than a 'scrape' effect; it also produces frequencies lower than the fingered pitch, a type of inferior harmonic. Theoretically, we should hear a pitch an octave below the notated one (this is how Crumb notates the effect in *Black Angels* for amplified string quartet). But, in practice, the pressure distends and raises the string, so we hear a pitch close to a major seventh below. The process is at the heart of the example shown in Figure 14, from *Ethers* for six instruments.

The violin's double stop replicates the flute's multiphonic, then 'crushes' the bow, producing something close to aggregate *a*. The viola takes this 'crushed' sound and 'crushes' it again (*b*), and the cello does the same. With the final sound (*d*), the process ends, and the music rises by playing with harmonics from the viola's *ponticello* sounds. The violin's final double stop creates a new multiphonic dyad for the flute, and the process is renewed (the piece continues in this way under a large acceleration where each process is compressed by degrees, until the short duration of a 32*nd* note brings it to an end).

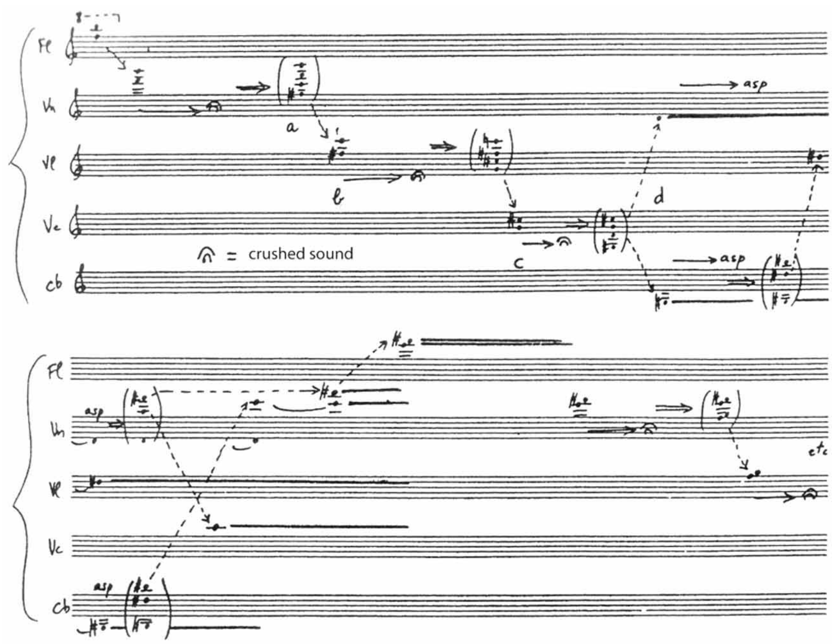

Figure 14 Process of sound generation from *Ethers*.

It seems to me that the entire range of complex sounds can be integrated functionally within a musical logic, rather than used as a startling daub of colour, or only for expressive ends, for their anomalous or paroxysmal qualities. But on a more fundamental level they have an irreplaceable role in all processes of harmony and timbre. With their help, timbres are split into harmonies, harmonies fuse as timbres; without them, certain types of evolution that by definition require intermediate stages would prove impossible. They also demand that we open our musical horizons, and burst the traditional grids with which we have tried to imprison music (ring or frequency modulation in electronic music, like complex instrumental sounds, require us to abandon the tempered scale, and will not permit us to replace it with another filigree just as arbitrary, like an octave divided into 24 or 36 microtones). From this new reality of sounds should grow new methods of organization capable of embracing all categories of sound, past and future.

It will be an organization of energies, or paths—the path from pitch to noise, from smooth frequencies to rough ones, from periodic to random rhythms, etc. Musical form will no longer consist of frozen structures but of forces, and dynamisms. The old oppositions of container and content, of form and material will lose all meaning, since compositional process will have become an art of synthesis, born of a continuous movement from differentiation to integration.

Notes

[1] Our hearing has also been highly conditioned to perceive categorical entities where they do not exist—particularly through contextual effects. This has been the subject of numerous psycho-acoustic experiments studying why, for example, do we often hear as in tune a violin that is, in fact, playing out of tune.

[2] The organ already possessed this ability. However, it was not until Messiaen, with his radically slow tempos, that any composer took advantage of this capacity. Moreover, the organ is too stable: it is nearly impossible to create progressions of intensity, successive cross-fades, etc; whereas, the electroacoustic studio makes almost anything possible, in this domain.