From Fractured to Fractal:

The Improbable Continuum in Twentieth-Century Music

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Introduction

At the foundation of any sound articulation, the continuous/discontinuous dialectic is giving time its dynamics. In Western music, this articulation is supported by inclusive systems: first by means of modality, then more broadly by means of tonality. In fact, between the end of the seventeenth century and the beginning of the twentieth century, tonal functionality determined the movement between tension and resolution in Western music; the fluctuation of harmonic density; the morphology of themes and motifs; and the arrangement of duration (i.e., the combined factors in a modelization of the musical field, supplemented by the diversification of texture, intensity, and timbre). The system as a whole tends towards a form of continuity, at least if we consider it from the point of view of perception and memory. Tonality deals with local discontinuities in an inclusive way, from the smallest elements (the interval, the chord, the melodic-rhythmic cell) to the entire work, by passing through a set of intermediate stages (the cadence, the phrase, etc.). However, it is not a matter of blending the concepts of coherence and continuity. The harmonic functionality is above all a vector of coherence and does not by itself erase discontinuity; it rather circumscribes its action and scope. Thus, in tonal works, even if scattered with various irregularities, continuity appears as a result of the way the listener synthesizes a sound form through tonal acculturation.

In the late nineteenth and early twentieth centuries, the erosion of the tonal language and its related forms leads to a radical mutation in the perception of the relationship between continuity and discontinuity in music. Discontinuity was no longer incorporated into a system confining its manifestations to a local level. The notions of rupture, interruption, contrast, and shock regained an impact and an immediacy that was often lost within older works, but also displayed a potential for

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construction and for generating new forms. This article considers the relationship between continuity and discontinuity in music through the changes in the "regime of historicity"[2] and the mutations of the subjective experience of time at the beginning of the twentieth century. It furthermore discusses some approaches which characteristically illustrate the continuous/discontinuous dialectic, which became one of the driving forces of formal dynamics in atonal music.

Changes in Human Subjective Experience

For a long time, music was subjected to language, before being considered as beyond it, while shaping its forms (the sonata, or the variations, for example) on principles derived from rhetoric. The *absolute music concept*[3] had many ramifications during the nineteenth century, and the form owes its autonomy to this emancipation of music from language; however, the original links between language and music allow for the evolution of music to be taken into account in parallel with the discourse and the mutations in the conception and perception of time at the turn of the twentieth century. In his work on modern-era narrative, Jean-François Hamel postulates that it is "legitimate to index the historicity of narrative practices, that is, their variability in time and space, to the historicity of forms in the experience of time."[4] And with the notion of continuity, we summon as a perceptual correlate the coherence and the rigor of the tonal construction which would globally embrace a time period where a homogeneous conception and apprehension of time would prevail. This is very much the idea of continuity Michel Foucault supports when he points out the specificities of the classical system of thought within which time is "conceived in terms of totalization,"[5] and when he more precisely notes that history, as a discipline, "seems to erase, in favor of structures without lability, the irruption of events."[6]

This way of smoothing time in historical thought can be understood as a correlate of rationality and the commanding functionality of the subject. Indeed, "to make historical analysis the discourse of the continuum and to make human consciousness the starting point of all becomings and all practices, these are two sides of the same system of thought."[7] However, in the nineteenth century, the notion of progress — which partly stemmed from this form of rationality — was itself part of an ongoing corrosion of the consciousness of time inherited from the Christian and ancient regimes of historicity. Time,

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[2] By "regime of historicity," the author refers to a concept introduced by historian François Hartog (*Régimes d'Historicité. Présentisme et Expériences du Temps.* Paris, Seuil, 2003.). This term designates the type of temporal consciousness and the articulation between past, present, and future in connection to a given era and society. Changes in historical regimes occur at the time of significant events that constitute turning points.

[3] Carl Dahlhaus, *Die Idee der Absoluten Musik*, Bärenreiter-Verlag, 1978.

[4] Jean-François Hamel, *Revenances de l'Histoire*, Paris, Minuit, 2006, p. 26–27. All quotations translated by the author.

[5] Michel Foucault, *L'Archéologie du Savoir*, Paris, Gallimard, 1969, p. 23.

[6] Foucault, *L'Archéologie*, p. 13.

[7] Foucault, *L'Archéologie*, p. 23.

therefore, no longer appears only in terms of homogeneity and continuity. A manner of disjunction occurs, a headlong rush: "This is an increasing distance, even reaching a breaking point, which will oppose the fields of experience and the horizons of expectation."[8] We are touching here on the complex zone of intersection between the subject and the world that Walter Benjamin called the *human experience*, and whose mutations he studied through sources as diverse as Baudelaire's work, narration formats, Parisian passages (in *Paris, capitale du XIXᵉ siècle: le livre des passages*) or technical reproducibility. Foucault, for his part, shows that discontinuity is gradually taking "a major place in historical disciplines,"[9] specifying that it is "both an instrument and an object of research."[10]

The scientist and philosopher Gaston Bachelard also placed discontinuity and the *moment* concept at the core of his reflections on time. His thought goes against a fictitious continuity that has for correlation some sort of de-vitalization of the present. The viscosity of duration, which characterizes the Bergsonian vision of time, gives way to a woven temporality the philosopher calls "rhythms" and "systems of instants".

"The real methodological prudence," cautions Bachelard, "is to postulate a discontinuity as soon as you are sure that a change has occurred. In fact, in this instance, the usual tendency is, on the contrary, to postulate an underlying continuum."[11] On the strength of this inversion of perspective, Bachelard seeks to tighten his apprehension of time on the instant, and pushes this logic of discontinuity to the point of stating that "there is really continuum only in nothingness"[12] and that

> the world is functioning based on a tempo imposed by the beat of the moments. If we could hear all the moments of reality, we would understand that it is not the eighth note that is made with a portion of a half-note, but the half-note that is made of repeats of eighth notes. It is from this repetition that the impression of continuity arises.[13]

At the beginning of the twentieth century, Freud, based on his clinical experience, postulated a disjunction between the subject of reason, whose continuity is the force as well as the cohesive power, and the subject of desire, which reveals the impossibility of harmony between drive and civilization; a disjunction which unfolds and reverberates at various levels, from the dialectic of drive to the most important productions of art and culture. The homogeneous conception of the psyche was shattered, and later Jacques Lacan reclaimed this flaw revealed by Freud with structuralism. The subject is seen as divided, disconnected

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[8] Hamel, *Revenances de l'Histoire*, p. 31.
[9] Foucault, *L'Archéologie*, p. 18.
[10] Foucault, *L'Archéologie*, p. 19.
[11] Gaston Bachelard, *La Dialectique de la Durée*, Paris, PUF, 1993, p. 44.
[12] Gaston Bachelard, *L'Intuition de l'Instant*, Paris, Stock, 1992, p. 38.
[13] Bachelard, *La Dialectique de la Durée*, p. 46.

from itself by language. Discontinuity becomes one of the driving forces of the psychoanalytic clinic itself, through sessions of very variable duration, and the scansion operated by the analyst on the patient's discourse.

Finally, the rapid succession of scientific discoveries at the beginning of the twentieth century is upsetting the positivism dear to the bourgeois class: the theory of relativity, the uncovering of genotype and the atom, the rise of quantum mechanics and physics, are all questioning the certitudes regarding the adequacy between the continuity and the homogeneity of perceptions on the one hand, and reality on the other.

We can see that a range of thoughts, practices, and discoveries, in a world marked by industrial revolutions, urbanization, world wars, and the rise of new technologies, tended to modify the consciousness humans had of their environment, as well as of themselves, in rather significant ways, and to rebalance the notions of continuity and discontinuity, to the benefit of the latter. Exposing the fragmentation and instability of the human experience results in a manner of knowledge disenchantment. Art, of course, is not a simple transposition of reality or the perceptions that one develops from it, but it contributes to both thinking this reality and reflecting on it. It constitutes a modality of knowledge processing. Decoding the processes at work here can teach us about these mutations marking the modern era.

Fragmentation and Montage in the Arts at the Beginning of the Twentieth Century

In the art field, the turn of the twentieth century sees a redefinition in the relationship between continuity and discontinuity. The blurring of the lines and the evolution towards abstraction within pictorial art, the Mahlerian breakthrough, the outbursts of expressionism of the Vienna school, the Baudelairean dream of a prose that could adapt to the ups and downs of consciousness, Stravinsky's contrasts, the progressive or brutal emancipation of noise, are some of the most important and visible aspects the of the discontinuum arising.

These occurrences overlap with modifications of the apprehension of time, the orientation and homogeneity of which are also disrupted by the forms of capture and the manipulations initially allowed by photography, then recording and sound reproduction, cinema, etc. The practice of montage no longer supported unity or a supposedly natural organic form, across a range of disciplines: writers, painters, musicians, plastic artists, make full use of the value of shock between heterogeneous materials; they mix, twist, and overlap, within their works.

From the deconstruction of unity, various meanings, different logics, other tensions emerge. The montage novel genre, for example, is both a testimony to the shocks registered by the subject in the modern world and "a revolt against the dominant discourse that increasingly takes on the aspect, under

cover of popular language, of a false reconciliation."[14] At the same time, cubism presented itself as an upheaval in the relationship between forms and objects. The collage painting in Braque's and Picasso's works used the energy of visual shock, while the Dadaists cultivated absurd provocations and the Surrealists dismembered reality and made desire their own in the heterogeneity of the world. Futurism attempted an aestheticization of machine and speed, and constructivism exacerbated the geometrical-mechanical aspect of representation.

Artists thus received and retranscribed the experience of shock in many ways, from the rawest to the most mediated. In the field of music, productions of Schoenberg and Stravinsky in the 1910s were typical of two complementary ways of dealing with this experience, which explains why Adorno's famous comparison between "progress" and "restoration" in his Philosophy of New Music is not just a clear-cut opposition: both deal with the individual and collective instance of the human subject, and

> in Schoenberg's case, the musical subject becomes a somnambulist inhabited by floating anguish he vigorously transcribes from the depths of his nightmare; on the other hand, on Stravinsky's side, he is like a "severely wounded man" who refuses to admit the accident and re-live the shock, as well as the denial, perhaps hoping that the accident will lose all its seriousness (which eventually happen… This is neo-classicism at its most watered-down moment).[15]

Two forms of fragmentation coexisted therefore, one favoring the organic character of the texture loaded with discontinuities, the other building a sequence of shocks and reconstituting another form of continuity through mechanical repetition. But whatever the texture of either style, taking these shocks into account asks the question of the fragment, of the intensity of a specific part resisting its absorption in the totality, becoming much more incandescent than before. At the same time, the fragmentation reveals the factitious character of the homogeneous work of art, articulated from beginning to end. The art of the twentieth century had to constantly invent new modes of structuring, capable to take into account the weight and irreducible individuality of the fragment.

New Sound Geometries: Stravinsky and Webern

The notions of shock and rupture are more difficult to grasp in the field of music — which is essentially immaterial — than in the field of representation. The concept of montage is de facto much more integrative in music than it is in visual arts. And it is undoubtedly in the art of sound that the greatest inventiveness in composing and recomposing with discontinuum is to be found.

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[14] Jean-Paul Olive, *Musique et Montage. Essai sur le Matériau Musical au Début du XXe Siècle*, Paris, L'Harmattan, 1998, p. 75.
[15] Jean-Paul Olive, *Un son Désenchanté. Musique et Théorie Critique*, Paris, Klincksieck, 2008, p. 29.

Stravinsky's 1914 Three Pieces for String Quartet[16] are an interesting example, on a miniature scale, of research geared towards integrating discontinuity itself into a more global process. These pieces can be considered as a necessary step in focusing, using a concentrated and refined material and form, some specific processes resulting from the Rite of Spring which reveal while transforming the innovative time conception later exposed, seen, and developed in the Symphonies of Wind Instruments.

The contrasting succession of repetitive music with a popular and mechanical character (piece #1), eccentric music inspired by famous English music-hall artist and dancer Little Tich (piece #2), and a very calm and distant spiritual music (piece #3) covers the fundamental categories of Stravinsky's aesthetics, within which a singular relationship to time is at play. What unfolds in these miniatures, in a different way each time, is first repetition, which Stravinsky explores in various facets, seemingly gaging and testing the potential in the context of a recomposition of the relationship between continuum and discontinuum.

The second piece is characterized by its constant ruptures, exacerbated by elements with strong and distinctive morphologies. The abrupt changes in tempo, register, nuance, and density create a juxtaposition of more or less short sections, the scheme being built through the alternation of four specific materials: an aggregate consisting of two superimposed fifths deforming and repeating itself by sliding down from its three upper layers (material #1), a sort of very brief "signal" on the repeated E and A sounds which seem to mimic a cadence in an ironic way (material #2), the non-harmonized succession of a few notes (material #3), and a series of brief, desynchronized impulses enriched with appoggiatura (material #4). The alternation of these constitutes an ever-changing kaleidoscope of kind, each of them reappearing in a way that is both recognizable and slightly modified. It is as if four distinct formal paths are interwoven with each other (Example 1). This brief description is not enough to account for the extremely fine relationships that are established between the intertwined types of writing, all the more so as the tempo itself becomes a structuring material, with two reference values (76 and 112-116 on the quarter note) in a 1-3/2 ratio to each other.

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[16] Igor Stravinsky, *3 pieces for String Quartet*, Hawkes Pocket score HPS 634.
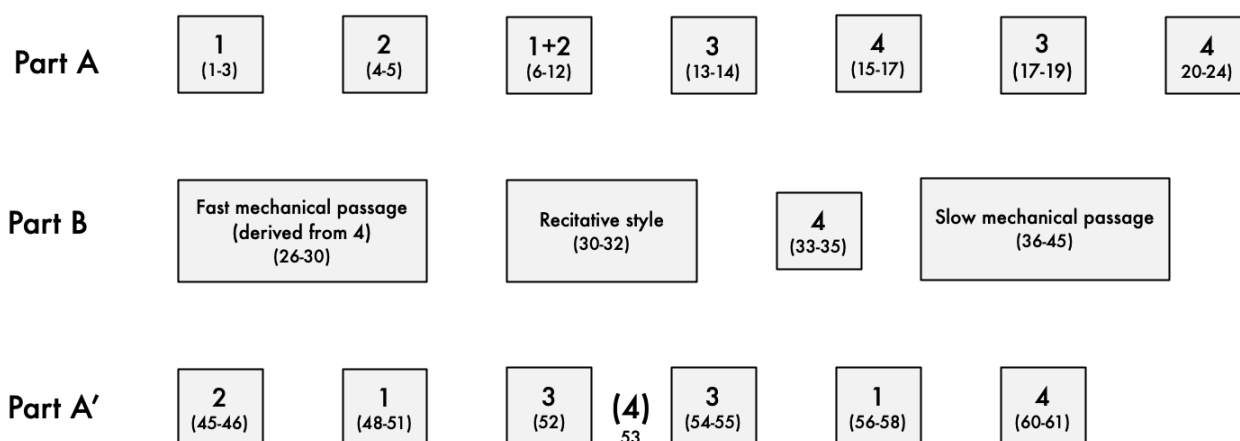
EXAMPLE 1: Overall form of Stravinsky's Second piece for string quartet

Webern's works explore a fragmented space-time (the *Six Bagatelles for String Quartet*[17] from 1911-1913 is one of the most striking examples), which tends towards greater discontinuity both in musical writing and at hearing when the structure becomes twelve-tone.

The difference between organicity and continuity is possibly illustrated in *Symphony Op. 21*[18] (1928) where Webern develops a structure steadily recombining its own microscopic internal soundscape (the sequences of specific intervals), a pattern in which homogeneity and symmetry are the product of a self-replicated interval-matrix (Example 2). The notion of continuity aside, this constitutes the organic dimension of this piece, Webern's ideal, and beyond, ensuring an underlying global coherence. The texture layout gives priority to intelligibility. To do this, it relies on the tight articulation between a certain discontinuity on the surface, which allows the macroscopic soundscape to unfold by stretching itself in an almost geometric way, and elements of continuity marking out this complex fabric, creating scriptural as well as perceptual anchoring points. This stretching and spatialization, combined with literally vaporized timbres all over, as well as the emergence of an underlying continuity at the heart of the texture, modify the usual perception we have of the musical elements.

The score of the Symphony Op. 21 first displays an atomized space-time, a distribution of mostly isolated sounds, particles entrusted to solo instruments, in a texture dotted with many silences. On hearing this piece, the music is essentially perceived as a non-oriented sound texture. However, we know this distribution is the result of a whole organization of pitches, the consequence of a meticulous symmetrical conception, manifesting itself as a complex canon. The whole work of Symphony Op. 21 is conceived around an interval of a tritone: the series, and by extension, the soundscape, are wrapped

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[17] Anton Webern, *6 Bagatellen*, Op. 9, Universal Edition, UE7576.
[18] Anton Webern, *Symphony*, Op. 21, Universal Edition, PH368.

around this gravity center (Example 2). The second part of the series is in fact the recurrence of the first, transposed from a tritone.
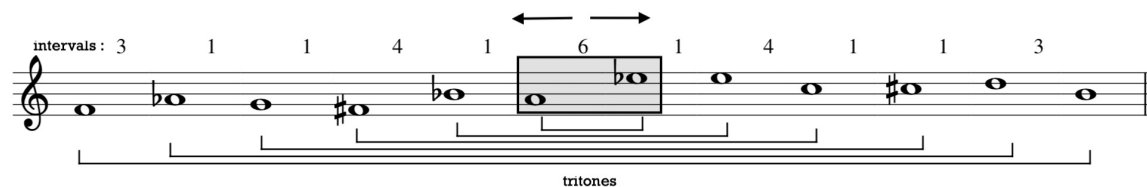
EXAMPLE 2: Original form of the twelve-tone series in Webern's Symphony op. 21

The voices work in a "monodic" way except in four instances, where two simultaneous sounds are played, always the same A/E flat tritone, and always entrusted to plucked strings. The A is fixed, the E flat is either above or below. Around this pivoting tritone, the notes are "frozen" in their register. A short score of the first bars (Example 3) makes visible this distant connection between each replay of the notes as well as the two first occurrences of the tritone in which an E flat is placed beyond and then bellow the fixed note.

EXAMPLE 3: Reduction of the beginning of Webern's Symphony op. 21

The canon, too, matches a same sonority in different places and times, creating resonance effects both establishing and abolishing the work's place in time, this moment of inner consciousness, folding it back on itself as if nothing but an enlarged present existed.[19]

The polyphonic structure, therefore, does not allow the listener to synthesize melodic-rhythmic forms other than intervals, most of which are disjointed. But the underlying structure as a whole creates a sound geometry that offers different reference points for listening.

Beyond what separates them and above what our nowadays perception allows, says André Boucourechliev, "Stravinsky and Webern, unaware of each other in this extraordinary period, appear to have been the only ones to have reached, though through very short pieces, for the very heart of time."[20]

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[19] Philippe Albèra, "Webern, après-coup," in *Anton Webern : Le Chemin vers la Nouvelle Musique, et Autres Écrits*, Genève, Contrechamps, 2008, p. 166.
[20] André Boucourechliev, *Igor Stravinsky*, Paris, Fayard, 1982, p. 134.

The composers of the 1950s and 1960s were confronted with the tendency to generalize serial logics, with all implications in terms of discontinuity in the sound texture; and on the other side, the need to design new structuring modes re-establishing some forms of continuity.

Faced with this complex equation, and once the avant-garde radicality of the immediate post-war period ended, creators were hard at work inventing, initiating new relationships between continuity and discontinuity, from a structural, formal and perceptual standpoint. I would like now to use as examples, among many possible, some approaches I consider both representative and remarkable.

Musical Gesture and Form: Berio and Dusapin

For some fifteen years after the end of the Second World War, the serial and electroacoustic avant-gardes focused on thinking about musical composition avoiding any reference to tradition and pushing to the extreme the demands of combinatorics and coherence. The importance of structure in these works brings to the forefront a process of rationalization which has become more pronounced over the centuries, accompanying the division between the scholarly and popular repertoires, and strictly framing the musical gesture in its various meanings. Avant-garde music appears to be undifferentiated in terms of sound, often erasing notions of continuity and discontinuity in favour of a fairly neutral texture.

However, during the 1960s, and once the stranglehold of serial practices was loosened, there was a return of the musical gesture; gesture reappeared in its most concrete dimension with the development of musical theatre by authors such as Kagel, Schnebel, and Aperghis. The notion of gesture takes on multiple meanings in a composer like Berio, in the articulation of notions of continuity and discontinuity, and the spirit of musical theatre penetrates into instrumental music. It is in this context that from 1958 to 2003, Berio developed a group of solo pieces: the 14 *Sequenze* form a homogeneous corpus, ruled by a common set of aesthetic and compositional principles. The virtuosity unfolding here is not a superficial posture but crosses into all the layers of memory and creation. Berio aims to achieve a virtuosity that is part of a historical perspective, encompassing the instrumental technique and the movements associated with it. By combining and exaggerating some of them, the composer serves the theatrical character of these works. Cheerful testimony to this are provided in *Sequenza III*[21] (1966), for female voice, and *Sequenza V*[22] (1965), for trombone, which happened to be the most successful: They engage in an uneven musical discourse, alternating very dense passages—almost saturated—and more relaxed moments where the performer works more precisely the way he connects the sounds. Discontinuity dominates, but it is a scenic rather than a purely musical discontinuity. The writing, for its part, is based on ideas and general principles which are developed in each of the pieces, often in a braided or simultaneous way (as in

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[21] Luciano Berio, *Sequenza III*, for female voice, Universal Edition, UE13723.
[22] Luciano Berio, *Sequenza V*, for trombone, Universal Edition, UE13725.

Sequenza I, where two parameters among the list of possible ones—pitch, rhythm, density, etc.—are used as a basis and are always maintained at a maximum degree of tension, within a globally discontinuous flow cultivating illusive polyphony). *Sequenza III* is part of the constellation of vocal works in which Cathy Berberian performs the fragmentation of a minimalist English text. This linguistic deconstruction constantly interferes with vocal gestures and expression, which are the other two factors at work in this piece. Unity is achieved, particularly through elements coming back to their original position, the four parts making various use of a limited number of materials.

The *Sequenza V*, for its part, acts on two levels: playing the trombone and vocalizing, as well as three sound layers: the natural sound of the trombone, the trombone with a mute, and the voice. Berio plays with reversing: vocalizing the instrument and instrumentalizing the voice; a simple word ("Why") offers the link between the sound production modes and serves as a 'stem cell' for the work.

In *Sequenza VII*[23], for oboe, the most continuous note that can be heard, a note (B) held (electronically) throughout the piece, coexists with the discontinuous texture of variable density entrusted to the performer: he only produces a few isolated sounds, and the reservoir of available notes is gradually enriched in a predetermined order of appearance by a symmetrical arrangement around a center of gravity (D flat). The succession of notes is essentially disjointed, according to a progressively contracting timing logic, making the production of the sounds more and more frenetic, then relaxing again with each change of system.

More recently, the testimony of a composer such as Pascal Dusapin is striking with regard to a problematic structural relationship between continuity and discontinuity used as a creative means. In his case, writing acts as a brake, as a scansion, paring down, and a tool for cutting into the flow of sound that is constantly imposing itself on his mind. His studies for piano, a collection of seven pieces composed between 1998 and 2002, are based on discontinuity, meaning elements sometimes agglomerate into portions of continuity, but remain gestures, fragments slowed down, stopped by the writing, then relaunched, projected into a myriad of combinations where flow and scansion intertwine.

> There was nothing because for a long time I didn't write for the piano. No doubt I was a bit fed up with this piano, which had driven me away from itself, sending back so many doubts and failures. And then it came back. Through the body. Inside the body. But in order to consider this question, it was necessary first to reconquer something of this body absent from the piano. That's why these studies were first built on micro-movements, jolts, long hesitant sounds, postures and a pianist's pantomimes.[24]

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[23] Luciano Berio, *Sequenza VII*, for oboe, Universal edition, UE31263.
[24] Pascal Dusapin, *Une Musique en Train de se Faire*, Paris, Seuil, 2009, p. 59.

The very layout of the compendium reflects a form of discontinuity through successive additions, a design revealing afterward some sort of organic dimension. It is not uncommon, in fact, for the fragments of one piece to be taken off and inserted into another, where it then 'irrigated' a third, returning to the first, etc. "In my studies, there is no theme but a context of transformation which the multilayered folds can be reconnected from one piece to another by many different vectors."[25] The psychoanalyst François Ansermet sees it as a relationship with time 'soaking' in discontinuity: more generally, he asserts that music is

> time establishing itself from something that has no duration, creating a gap, an interval. Music is a game with time, between time and the instant. Time makes us always dangling, at every moment, from the possible synchronic emergence of the new, the different, the discontinuous [...] Everything passes. There is only discontinuity, retraction, going back, break, we recompose in this shadow of composition that is listening, reconstituting a continuity from discontinuity, a continuous flow from discontinuity, to go towards a retroactively produced continuity.[26]

In Berio's case, as in Dusapin's, discontinuity is somehow gesture supported. A musical gesture-based way of thinking composition favors the configuration of dynamic sound forms. Strongly characterized and contrasted, their virtuoso physical translation by the musician can go as far as requiring some form of theatricality (Berio). The very idea of cutting into the sound continuum in order to extract the elements which the discontinuous assembly will then make the work stand (Dusapin), also contrasts with the classical conception of composition supporting first and foremost the combination of figures intended to fit harmoniously into a pre-existing sound space.

Cybernetics, Computer Science, and Musical Composition

As I have described it at the beginning of this paper, the 19th century saw a movement pushing progressively a whole era mainly characterized by the primacy of totality and its correlated aspects, coherence, and continuity, into experimenting fragmentation and discontinuity at the turn of the new century. Then, a set of philosophical and poetic schools of thought along with a series of major scientific discoveries have contributed to a shift in human experience which artistic expression has been shaped by the aesthetic translations of these breakthroughs.

The emergence of new forms of "globality" to response to a very powerful world globalization, is the trademark of the second part of the century. As a consequence, innovative approaches have followed the rise of new theories in the information, network, and communication fields. In music, the

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[25] Dusapin, *Une Musique en Train de se Faire*, p. 77.
[26] François Ansermet, "Capter la Voix," in Pascal Dusapin, *Flux, Trace, Temps, Inconscient*, Paris, Defaut, p. 151–152.

relationship between continuity and discontinuity will develop under an unprecedented reconciliation between modern technology and music. As an example, cybernetics, the science of giving shape and describing information, created by Norbert Wiener in the middle of the century, enhanced by a closely related science, Claude Shannon's "information theory," will be taught by Werner Meyer-Eppler to the young Karlheinz Stockhausen. He will strongly be influenced by it while writing his static sound clusters in the 1955-1956 *Gesang der Jünglinge,* for voices and electronic sounds.[27] Gradually, music digests the operational constraints of the technology. In the field of timbre, it triggers a thorough exploration of the hybrid zones and fringe areas of the sound. While residual in classical music, it becomes here a major element. Computer models are gradually replacing those induced by mechanical action which dominated early in the century and

> the digital synthesis of complex acoustic spectra through frequency modulation, as revealed by John Chowning, single-handedly undermines the classical conceptions of timbre. The subtle phase shifts that Giuseppe Di Giugno and Jean Kott make with their "4X system" show that a tiny alteration in the field of physics can have considerable consequences when it comes to the hearing domain. This way, we can indeed generate through a physical process in which unity is irreducible, discontinuous perceptive effects, qualitatively distinct, and perceived them as a journey through thresholds.[28]

These combined factors will greatly influence composers like Gerard Grisey and György Ligeti, just to name two of the most interesting from an artistic standpoint. Grisey will elaborate a thought thinking around the notion of continuity, but which includes a zoom-in dilatation of time concept. Therefore, even when a texture is characterized by a strong discontinuity, this will only be, in fact, the result of some sort of magnification as well as the focused detailed presentation of a precise object, otherwise part of a whole continuum. Ligeti, after having experimented with the limits of the discontinuous-continuous perception, has developed a fascination for the theory of chaos, and will strive to musically transpose the principle of the "butterfly effect". Moreover, computer science profoundly influenced his way of thinking: "It is not the computer itself as a device that has such an influence on my musical conceptions, but rather the thought around the computer: a thought in signals, super-signals, and super-super-signals that computer science and artificial intelligence delivers to us."[29]

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[27] Marc Battier, "Science et technologie comme sources d'inspiration", in *Musiques. Une encyclopédie pour le XXIᵉ siècle*, Vol. I, Jean-Jacques Nattiez (Dir.), Arles, Actes Sud, 2003, p. 521.

[28] Hugues Dufourt, "La dialectique du son usiné" (1982), in *Musique, pouvoir, écriture*, Paris, Delatour, 2014, p. 343-344.

[29] Gyorgy Ligeti, « Ma position comme compositeur d'aujourd'hui », in *L'atelier du compositeur. Écrits autobiographiques. Commentaires sur ses œuvres*, , Genève, Contrechamps, 2013, p. 124.

The Improbable Continuum: Grisey and Murail

From the mid-1970s, the French spectral music movement developed an intense reflection regarding to the relationship between musical material and musical form. Initially, the lengthy time ranges neutralized any musical asperity: continuity is absolute in some works of Gérard Grisey's *Espaces Acoustiques*, for example. In other pieces, such as Murail's *Territoires de l'Oubli*, for piano, the significant variability of texture, including discontinuities, is absorbed by the resonance triggered through a damper pedal being constantly activated. Piece after piece, Grisey refines his conception of the process, which can take many different forms, like a discontinuous evolution of successive phases, or the symmetrical transformation of two different objects. The first movement of *Vortex Temporum*[30] (1996), for piano and five instruments, initiates three successive processes, each progressively transforming the main material (a quotation from Ravel's *Daphnis et Chloé*). These processes obey the same logic, which consists first in making tiny, almost imperceptible modifications, then making them more and more frequent, brutal, unpredictable. Thus, homogeneity is achieved by the very principle of transformation of a single object, initially implemented in a continuous manner, and progressively, in a more and more discontinuous way. Moreover, while the first movement invests the volume of an "ordinary" space-time, according to the composer, the second, on the other hand, unfolds within an extremely stretched temporality. The gesture of the first's basic formula, an arpeggio, becomes the second's macro-form as if we were totally immersed in the material, which has now morphed into a gigantic arch. The third movement, on its side, combines in a manner of braided form, the three types of temporality, normal, stretched, and contracted, giving place to the coexistence of the continuous and the discontinuous as wholly integrated into the general process, which consists in embodying a journey of an ordinary temporality into a stretched one.

Simulating the electroacoustic feedback loop process with acoustic instruments, Murail's *Mémoire /Érosion*[31] (1976) proceeds in the opposite direction by slowly erasing dry and discontinuous material. This type of work—focusing on the coexistence of two elements, one modern, one ancient, mutually corroding each other—is setting the use of repetition as a way to put objects into a loop where round after round they are transformed, mixing themselves with other sounds, generating a feeling of accumulation as well as progressive exhaustion. This is an aesthetic use of what initially resulted from the imperfection of machines. Such an approach is nothing new, and is even common in various musical fields. However, through his composition, Murail captured the sound degradation process, a degradation which simultaneously generated additional phenomena, and therefore also proved itself to be an enrichment of sort. It is as if the composer was trying to capture and preserve, in a circular motion, all

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[30] Gérard Grisey, *Vortex Temporum*, Ricordi, NR13944400.
[31] Tristan Murail, *Mémoire / Érosion*, for 9 instruments, Henry Lemoins, TR1419

that is orbiting the sound, this evanescent halo surrounding all sound reality and which constitutes its envelope.

Murail's most recent works are constructed based on few elements, and subject to constant transmutations which sometimes radically alter their morphology and impact. A balance seems to have been achieved between the importance of the flow and the categories it had initially occulted, such as contrast, fragmentation. His music gains in diversity and depth, without denying any of the 1970s achievements. Connection with Nature is omnipresent and appears first and foremost through the titles, the materials template design, and the composer's comments.

The idea of an impalpable object that takes shape under different lights, under different angles, then asserts itself head-on, and then fades into sophisticated distortions, is at the center of a 1988 work by Murail, *Vues Aériennes[32]*, for horn, violin, cello and piano. Murail refers to some of Monet's works, the thirty paintings named *Cathédrales de Rouen* and the twenty-five paintings in the series entitled *Les Meules*. "The object of departure is in fact at the heart of the third part of the piece: it is revealed upfront, under crude light. It is the only moment when the horn can be heard in all its fullness. Before and after, one will perceive the distortions of this object."[33] This idea of a central material permeating the whole form anticipates the composer's recent works. The main object is characterized by a long phrase played by the horn (consisting of multiple appoggiaturas followed by held notes), at the heart of the third moment of the work, consisting of four parts. Each of these moments is structured as a succession of a waiting phase, a central object, and a release of unequal length, evoking the lifespan of a musical sound (attack, maintenance, extinction). The following section is a generalized, descending, repetitive process, dizzying at first, then gradually slowing down and withering away toward stagnation.

From Fractured to Fractal: Ligeti and Guerrero

Chaos theory founds its origins in the observation of natural phenomena. Research in the field of weather forecasting, among others, has made a number of processes at work within dynamic systems possible to understand. In the 1970s, these discoveries and the progress made in computer science are closely connected. Composer György Ligeti, who always has been attracted to science, experimented with the emergence of unpredictable patterns from uniformed sound structures in his compositions (*Poème Symphonique* for 100 metronomes in 1962, *Continuum* for harpsichord in 1968). He thus joined, although unaware of its content at the time, Steve Reich's work based on the concept of phase-shifting (*Piano phase* and *Violin phase* in 1967, *Phase patterns* in 1970). His music has in common with the American repetitive

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[32] Tristan Murail, *Vues aériennes*, for horn, violin, cello and piano, Henry lemoine, 28241.

[33] Tristan Murail, "Au Fil des Œuvres," in *Tristan* Murail, textes réunis par Peter Szendy, Paris, L'Harmattan, 2002, p. 111.

aesthetic, a way of making rhythmic patterns emerge by overlapping two similar structures evolving at different speeds.

The resulting psychoacoustic motifs, which do not exist on the score, constitute the elements of discontinuity within a sound continuum produced by an almost stroboscopic repetition of basic elements. In the following decades, Ligeti continued to branch out into processes challenging the traditional balance between continuity and discontinuity, and with the *Etudes pour Piano*, he achieved true artistic mastery of chaos emergence within iterative structures. The sound illusions are no longer conceived as end products but as actual writing material. In the first study for piano, the butterfly effect is indeed quite easily audible as a perfectly synchronous structure at the beginning of the piece, undergoes the effects of a tiny modification of duration within one of the two superimposed layers. Combining with the principle of transposition the amplification of the effect, the composer finally reaches a defining breaking point, creating a scansion within the piece. This way of proceeding, however, is helping us understand in what the Ligétian approach can differ from other musical aesthetics:

> Still, it is possible to connect Ligeti's ideas, for instance in *Désordre*, to the discovery of determinist chaos. Their common base lies in the deterministic character of chaos, as opposed to chaos in the sense used by Xenakis, whose compositions owe more the traditional concept of chance and stochastic phenomena.[34]

The fourth movement of Ligeti's *Piano Concerto*[35] (1985) is also showing an innovative approach using transposition patterns applied to music from the fractal's domain. A fractal is a

> neologism created by the mathematician Benoît Mandelbrot in 1975 from the Latin *fractus*, which itself derives from the word *frangere*: to break, to tear to pieces, to crumble into irregular fragments. Fractal, means fragmented, sectioned, interrupted. Generally speaking, the fractal theory is a theory of the broken, the fractured, the scattered, or even the grained, the porous, the tangled, etc. The forms it deals with are characterized by an intrinsic complexity, is visible at all scales.[36]

Thus, fractals combine discontinuity and continuity: discontinuity on surface, through shapes, outlines, irregularity, and fragmentation; and continuity in-depth, through the exact replication of these shapes at all scales.

Ligeti's inspiration for this movement was specifically "29 Arms at Seahorse Valley," a detail of the Mandelbrot Set.[37] On the first page of the score, the initial attack, very harsh, violent, *forte*, combines

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[34] Heinz-Otto Peitgen, "A Fractal Friendship", in *György Ligeti. On foreign lands and stange sounds*, edited by Louise Duchesneau and Wolfgang Marx, Woodbridge, The Boydell Press, p. 95.

[35] György Ligeti, *Konzert für klavier und orchester*, Schott, LS2769-01.

[36] Alain Boutot, *L'Invention des Formes*, Paris, Odile Jacob, 1993, p. 31.

[37] For more information see: http://www.alunw.freeuk.com/seahorsevalley.html

the *pizzicati* of the bass strings, with an impulsion from the *tamburo piccolo*, the woodwinds and the horn clearly accentuated; This attack is literally projecting the basic cell into sound space. After a silence, the violins (using harmonics) suggest it through a toned-down echoing. Then, a punctuation made of two aggregates ends the sequence (Example 4). This movement's genetics is in some way all contained in this small discontinuous set. There are parallel consonant intervals (exact fifths) and marked contrasts (ff/pp, ascending/descending movements, a succession of timbres families—wind/strings/piano), the whole thing contributing to cut up the sound space with sharp figures and providing with an impression of highlights and depth.

EXAMPLE 4: Reduction of the beginning of the fourth movement in Ligeti's Piano Concerto

From bars 8/9 we can hear an amplification of measures 2/3 with modifications in timbre, mode of playing, direction, and reference interval for parallelism. This amplification is overlapping a tightened and thickened replica of the piano aggregates.

Then we see the cells proliferating rapidly and simultaneously (bars 10 to 13), some extending, others retracting, all in very different registers, always to the benefit of parallel movements, reinforcing the impression of sharpness in lines and directions. This form of densification is irregular, with some later sound ranges proving less saturated than others heard earlier, yet, an overall process is at work, and from letter L in the score, tremolos make the texture iridescent. The last part of the movement is very busy and thus becomes a sort of general polymetric mechanism.

Ligeti's attraction for science might have predisposed him to work on a transposition of fractals into and through music writing, using precise numerical formulas for example. However, as he always did and like many of his colleagues, he opted for a poetic and intuitive approach regarding this source of inspiration, which, nevertheless, remains *the* model for composition. He elaborates "fractals of time," i.e. a material used at different scales where morphological principles are constant. The coexistence of rhythmic ups and downs, the progressive evolution towards an increasingly dense texture, the work of

timbre as a differentiating element, certainly give this whole work richness and complexity. The contour given to the material, the attacks, the contrasts of dynamics, register, and directionality determine a sharp sound geometry and shape the dimension of depth in time itself. In this movement, discontinuity primacy and anteriority are taking over continuity, the end of the piece no longer having, strictly speaking, the jagged character of the beginning, since the progressive enrichment leads to a form of uninterrupted chaos which Ligeti is fond of.

> As the texture builds up, we come to realize that initially we had been at the periphery of what the composer calls a "maelstrom"—a dense kaleidoscope of interlocking segments which hectic motion is apparent from a "medium" perspective, but which, once one is at its centre, again become "static", albeit in a much more convulsive, overwhelming way.[38]

Rather than progressive, the overall shape then looks like a spiral, somehow as if we would reach the eye of a hurricane.

Ligeti himself designed the musical categories which, considered in an abstract way, seem to carry the notions of continuity and discontinuity in his music: "clocks" and "clouds," the title of one of his works, composed in 1972–73 (*Clocks and Clouds*, for orchestra and female voices). These terms, based on an essay by philosopher Karl Popper[39], resonate with a mechanical/discontinuous type of music on the one hand, and a static/continuous one on the other, these two being the composer's most significant forms of writing. However, these are by no means categories with hard limits. The transition, the transformation, from one to the other, can take all the shapes and shades from the most abrupt juxtaposition to the smoothest mutation. Moreover, continuity and discontinuity exist within each of those "areas"; we can mention the process characterizing the famous *Continuum* for harpsichord of 1968, where discontinuity, on the microscopic scale of systematic repetitive scanning generates global continuity on a larger one. Here, tempo and speed make the connection between discontinuity and continuity. In the fourth movement of the *Piano Concerto*, the final texture leans toward continuity in contrast to an absolutely discontinuous opening; yet, in opening another piece with this very same texture, it might lean more toward discontinuity, eventually turning into a section made entirely of held notes.

The writing of the composer Francisco Guerrero Marin was also directly, and even more systematically, inspired by the world of fractals. Deeply involved in the field of electroacoustics, Francisco Guerrero founded the Electronic Music Laboratory in Granada, and later the Department of Electronic

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[38] Richard Toop, *György Ligeti*, Londres, Phaidon Press, 1999, p. 198.
[39] Karl Raimund Popper, *Of Clouds and Clocks. An approach to the problem of Rationality and the Freedom of Man*, St Louis: Washington University, 1966.

Music at the Polytechnic University of Las Palmas. From the 1990s onwards, he consistently mined fractal theory for composition. In a work such as *Sahara*[40] (1991), for orchestra, the use of the fractal model does not, as in Ligeti's work, result in the exposure of small sound objects with sharp contours, which are then engaged in transformations through time-scales to the point of constituting an organized chaos. On the contrary, the texture of *Sahara* is very continuous from the beginning, and is based on more or less developed processes rather than on melodic-rhythmic cells. Strings dominate most of this long movement, and modes of playing such as trill, tremolo, and screeching bow heel attacks create microscopic stir and "grain" effects animating a piece devoid of rhythmic figures and featuring, at least at the beginning, a very limited number of pitches (the initial unison is evidence of this). The processes in this work consist of gradually and more rapidly moving through the ambitus, starting from the low, medium or high register, and moving into a higher-pitched one. As in a piece such as Ligeti's *Atmosphères* (1961), there are sometimes abrupt contrasts in register and density breaking up and reviving a process. The direction is invariably oriented upward, swinging from low to high, and gradually tiling up as the contrasts become faster and faster. Different speeds then coexist, giving a different interpretation to the idea of time fractals found in Ligeti's work. An impression of movement overwhelms the listener as the waves follow one another. The culmination of the first major part, along with the absolute domination of the strings is achieved when, sounding like electronics, the highest-pitched point is finally reached. The second part sounds richer and more diversified. Much more static at the beginning, it later moves again toward making high-pitched inroads.

Thus, unlike the previous example, the fractal design does not result here in a cut-out sound geometry, but rather generates a mostly continuous ground. Where Ligeti injects fractal thinking into the sound form, Guerrero uses it at a structural, less audible level.

Conclusion

The goal of this article is certainly not to naively marvel at the existence of continuous processes within discontinuous textures; this, as we have said, has existed since music was. Rather, it is to show in what ways the continuous and the discontinuous genres thrived in the post-tonality era, which for more than two hundred years have been ruling over all manners of soundscapes.

Indeed, the dissolution of tonal functionality had many consequences for early twentieth-century music. Among these, Adorno notes (for composers as different as Debussy and Stravinsky) a retreat from a time-related dimension approach in favor of spatial conceptions of music: "It requires our ear to be reeducated in order to properly listen to Debussy's music, not as the processing of tensions and

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[40] Francisco Guerrero Marín, *Sahara*, for orchestra, Edizioni Suvini Zerboni.

resolutions, but as the juxtaposition of colors and surfaces like in a painting."[41] Similarly, in Stravinsky's case, "composition is not achieved through a developing process but thanks to the 'fissures' crisscrossing it. They perform the function that expression once had."[42] These "juxtapositions" and "fissures" are the marks of discontinuity, which works its way into the art of time at various levels and results in a pseudomorphosis from music to the arts of space. The development of montage practices we saw in music, making some specific expressions, followed this general trend for a moment.

But through the century, other solutions had to gradually be found in order to reinject some continuity into music, with the idea of innervating it again with a temporality of its ownor risking to see it being reified. In the few cited examples, we see continuity and discontinuity no longer being in a relationship of opposition, nor willing to integrate the latter within the former. The second half of the twentieth century saw the emergence of aesthetics in which continuity occurs through the elaboration of discontinuity, no longer denied or absorbed, but used to generate processes. These can be inspired by extra-musical models such as fractals (in Ligeti or Guerrero's music) which diversity of graphic expression, transposed into the musical field, generates multiple types of paths where the equivalence of the micro and macro dimensions ensures homogeneity. The Ligetian spiral form and the waveform in Guerrero's works are just two particular examples of a wealth of possibilities. Perhaps the greatest degree of refinement in the mediation between a specific sound object and globality is to be found in spectral music, which manages, especially in Gérard Grisey's work, to achieve the fusion between discontinuity and continuity, through the total blending of process and form. Finally, the development of multiple forms of musical theatricality restores the status of physical movement previously lost in academic music. The related musical styles of writing provide significant room for the inherent irregularity in musical postures expressed both through sound and body, and the composition takes into account the scenic dimension of this type of work. In this sense, the accumulation of gestures produces a notion of discontinuity, in Berio's solo pieces for instance, but also in a variety of works which, because of this, regain in their expression a way of immediacy and effectiveness.

Thus, the musical form experiments anew with coherence that again fully integrates the expression of physical movement, through the scenic dimension, part of the writing and the instrumental expression itself. This also reminds us that music is inextricably linked to a body expression set in motion by the vibrations of desire, through dance and trance.

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[41] Theodor W. Adorno, *Philosophie de la Nouvelle Musique* (1958), Paris, Gallimard, 1962, p. 193.
[42] Adorno, *Philosophie de la Nouvelle Musique*, p. 192.