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Aesthetic Appropriation of Electronic Sound Transformations in Ligeti's *Atmosphères*

Sarah Davachi

Introduction: Concerns and Methodology

György Ligeti's 1961 orchestral work, *Atmosphères*, is often viewed as the piece in which his mature style based on the concept of micropolyphony was fully developed. Although the 1960 precursor, *Apparitions*, employs micropolyphony in certain sections of the piece, the technique is maintained and unified throughout the entirety of *Atmosphères*. Micropolyphony is a concept particular to Ligeti's own understanding of the aesthetic of sound-mass composition. Like many other contemporaneous sound-mass compositions, such as those by Penderecki, Kagel, Varèse and, to some extent, Xenakis, micropolyphony is founded upon a disposition toward the emancipation of surface texture, the creation of dense sonorities through chord clusters and the suspension of traditional structures of musical time, form, and pitch relation. However, micropolyphony extends the sound-mass aesthetic further, suggesting the presence of active underlying contrapuntal layers that are revealed over time by way of the comparatively static macro-structure. To this end, the macro-structure is immediately perceptible while the micro-polyphonies take on a more illusory nature; they are not intentionally conceived compositional elements and therefore their perceptibility is contingent upon the aural cognizance of the listener. The way in which musical perception is made functional is a concern that often arises in Ligeti's

concept of micropolyphony and will require continued reference throughout this analysis.

Ligeti spent his early life in communist Hungary. One major development that helped distinguish his early and later styles was his emigration to the West – first to Vienna in December of 1956, then to Cologne in February of 1957 where he began working at the studios of the *Nordwestdeutscher Rundfunk* (NWDR).[1] The technical and aesthetic foundations of Ligeti's concept of micropolyphony can be credited to developments that occurred both prior to his emigration and during his time in Cologne. First among these was his exposure to the early avant-garde environment developing in Western Europe, which he was able to experience while still in Hungary. Albeit indirect and through primarily self-taught methods, Ligeti developed a general understanding of early twelve-tone technique, allowing him to begin experiments in serialist composition. This period was also one of great intellectual and aesthetic growth for Ligeti; via occasional radio broadcasts he was able to hear several of Stockhausen's early works and, through friends and his time at the Franz Liszt Academy in Budapest, he was able to access a limited amount of modernist literature, such as Theodor Adorno's *Philosophie der Neuen Musik* (*Philosophy of New Music*). Following this, Ligeti undertook a significant re-evaluation of his early compositional style; it is in this period that he began to develop the attitude, concepts and terminology that would later inform a fully integrated ap-

[1] It should be noted that both 'NWDR' (*Nordwestdeutscher Rundfunk*) and 'WDR' (*Westdeutscher Rundfunk*) are used interchangeably in the literature to refer to the Cologne studio. 'NWDR' is the abbreviation that will be used throughout the remainder of this analysis.

proach of micropolyphony. In particular, Ligeti explored new ideas of musical space, tone colour, and polyphonic montage; the results of these experiments can be seen in several of the works he composed between 1953 and 1955.[2]

Another development in Ligeti's concept of micropolyphony, and perhaps the one of greatest importance, occurred during his three years of experimentation (1957-1960) with electronic composition at the studios of the NWDR in Cologne. Ligeti worked closely with several composers at the studio, namely Michael Koenig and Karlheinz Stockhausen, and became familiar with their compositional approaches. During this time he produced three electronic compositions (though one remained incomplete) before abandoning the medium altogether in 1960 in favour of a return to instrumental composition.

This analysis will begin by briefly outlining Ligeti's instrumental compositional theory and technique between 1955 and 1957, focusing specifically on the terms and concepts that were later incorporated into his idea of micropolyphony: expansion of tone colour, development of montage and canonical structures to create texture and dimension, the juxtaposition of formal dialectics such as stasis and motion or continual and discrete movement, and the perceptible transformation of sound in musical space. Many of these ideas are theorized in Ligeti's "Wandlungen der musikalischen

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[2] Such as *Musica ricercata* (1953), *Métamorphoses nocturnes* (1953-54) and *Éjszaka, Reggel* (1955). These works are discussed on pages 6-13.

Form".[3] This text will serve as the primary source through which these concepts will be interpreted. As recent research shows, a significant amount of the theoretical concepts Ligeti adheres to in formulating his concept of micropolyphony had already reached a stage of significant development prior to his emigration to the West.[4]

Despite this, however, there are notably distinct characteristics between Ligeti's pre-emigration experiments, in what could be referred to as the "montage" technique, and his fully formed works employing micropolyphony, the latter of which reflect a distinct appropriation of the sounds he heard in electronic music composition and an overt affection for density. The main portion of this analysis therefore examines the space in between - this being his time in Cologne - in order to determine the ways and the extent to which Ligeti's experience with electronic composition further shaped his theories. A comparative analysis of Ligeti's *Pièce Électronique No. 3* with *Atmosphères* emphasizes the particular similarity of technical considerations with respect to the transformation of sound. This comparison illustrates the way in which a deliberate appropriation of technique resulted in a strong aesthetic correlation between the two works. Moreover, Ligeti's reasons for abandoning the electronic medium, which relate to difficulties with perception and transformation, are also of particular inter-

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[3] György Ligeti, "Metamorphoses of Musical Form," trans. Cornelius Cardew, *Die Reihe* 7 (1960).

[4] Primarily: Friedemann A. Sallis, "An Introduction to the Early Works of György Ligeti," (PhD diss., Technische Universität Berlin, 1992); Marina Lobanova, *György Ligeti: Style, Ideas, Poetics* (Berlin: Verlag Ernst Kuhn, 2002).

est. Although Ligeti eventually abandoned the electronic medium, he gained from it a broadened understanding of density and a heightened appreciation for a distinctly electronic methodology of sound transformation; both of which were directly appropriated into his concept of micropolyphony.

Ligeti's Pre-emigration Period (1953-1958): Terms and Concepts

Between 1953 and 1957, Ligeti's early compositional style went through several significant modifications, resulting in the culmination of a renewed overall aesthetic disposition in 1958. It is worth examining a few of the pertinent changes that took place in order to gain an understanding of the creative and intellectual concerns Ligeti brought with him to Cologne. Many of the compositions written prior to 1958 explored the serialist technique, which he had recently learned independently. Moreover, like many composers of the immediate post-war era, Ligeti took initial interest in Webern's pointillist approach to serialism and his extension into an expanded chromatic language. Despite the cultural isolation in Hungary between 1948 and 1956, a limited amount of materials from the West, such as journals and scores, were available to Ligeti through his connection to organizations such as the Franz Liszt Academy and the Association of Hungarian Musicians. In addition to Webern and the composers of the Second Viennese School, Ligeti also took particular interest in Bartók's integration of expanded scales, including chromatic and octatonic sets, as well as his treatment of musical time, including changing meters and asymmetrical rhythms. In *Musica ricercata* (1953), Ligeti explored

a continually expanding chromaticism that increases by one pitch throughout each subsequent movement; the first movement employs a pitch-class set of only 2 pitches while the final movement contains all 12 pitches. The initial stages of Ligeti's compositional style at this time concerned the treatment of pitch-class sets as "units" of sound, the integration of expanded pitch relations, and a loosening of musical time through metric and rhythmic alteration.

Through occasional local broadcasts of West German radio programs, Ligeti was also able to experience a moderate amount of electronic music beginning as early as 1953. In 1956, Ligeti received his first exposure to Stockhausen's *Gesang der Jünglinge* via radio broadcast; this event is often interpreted as a factor contributing to his decision to become involved with the compositional circles of Darmstadt and Cologne. With regard to theoretical and intellectual works, two musical sources seem to have provoked particular interest in Ligeti; namely, Schoenberg's writings on musical thought and his concept of *Klangfarbe*, which theorizes a broadened treatment of pitch as tone colour, and Adorno's writings on a philosophy of modern music, in which he asserts a more pluralistic approach to composition. Notions of plurality and integration are featured quite prominently in Ligeti's aesthetic. Albeit a marginal effect, the totalitarian nature of the Hungarian communist regime during the 1950s also seems to have induced a skeptical reaction toward collective and absolutist approaches. Despite his interest in the activities of the composers at Cologne, it is important to note that Ligeti viewed the confident exhibitions of total serialism with uncertainty and, as a result, internally resolved to explore an alternative route.

In addition to his practical experiments in serialism, Ligeti also theorized a good deal of his compositional sentiments in written works, again composed both before and after his emigration to the West. Among these are two critiques on the serialist works of Pierre Boulez, which were published by Herbert Eimert, the co-director of the Cologne studio and founder of its periodical on avant-garde and electronic music, *Die Reihe*.[5] Although Ligeti was still employing the twelve-tone technique both before and after he emigrated, his writing expresses a strong opposition to what he recognizes as a stasis of form embedded in the theory. He cites a lack of timbral and gestural control that results despite the apparent stability of the procedure. In addition to his writings on serialism, Ligeti also expresses a similar dissatisfaction with the tenants of aleatory. Unlike his critique of serialism however, Ligeti's primary concern with aleatoric procedures was unrelated to a lack of compositional control. Rather, Ligeti notes difficulty with the perception of the aleatoric process; that is, the chance-controlled nature of an aleatoric composition is not typically perceptible to the listener.[6] Such views reflect a preoccupation with musical perception and the notion that perception of musical space, form and shape must occur with a sense of immediacy and not "after-the-fact".

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[5] "Pierre Boulez" and "Some Remarks on Boulez's 3rd Piano Sonata".

[6] Unless, perhaps, the listener were to experience two performances of the same work or receive information regarding the composer's intentions, as would be documented in a score.

Ligeti's personal expression of a new musical style culminated most prominently in "Wandlungen der musikalischen Form", which was begun in 1956 and later published in 1958. In this essay, Ligeti outlines a large portion of his terminology and formats several overarching concepts inherent in his concept of micropolyphony: the emergence of new conceptions of musical form, transformation of sound over time, contrast of dialectic and textural characteristics, juxtaposition of continual and discrete structures, stasis and motion, use of canon to create multi-dimensional sound, integration in musical space, and neutralization of rhythm are described. He begins by suggesting that a coherent understanding of form is not achieved by quantifying parameters such as pitch, rhythm and duration into pre-determined serialist arrangements. Instead, he suggests that the approach to musical form should be expanded to emphasize more global concerns related to surface structure, movement of sound, and distribution of density across register. The latter notion represents a shift from the horizontal layering of sound, as is practiced in serialism, to a vertical organization of texture.[7] In reference to layering, Ligeti describes a methodology based on permeability; he suggests, "[permeability] means that structures of different textures can run concurrently, penetrate each other and even merge into one another completely, whereby the horizontal and vertical density-relationships are altered."[8] In this, Ligeti is alluding to a superimposition of texture and tone colour, as well as a fluid transfor-

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[7] Ligeti, "Metamorphoses of Musical Form," 5-6.

[8] Ibid., 8.

mation between textures. Two concepts, namely 'stasis' and 'synthesis' can be used to describe this fluid movement of transformation. 'Stasis' refers to a musical object existing, changing and moving in space.[9] 'Synthesis' may be considered analogous to 'homogeneity' and suggests that individual lines lose their identity when placed within the context of the larger, complex musical structure.[10] Ligeti further defines his notion of transformation in relation to the material characteristics of sounds (for instance, grainy, fibrous, sticky and compact) and suggests that the transition from heterogeneity to complete integration is achieved through contrast and juxtaposition of these textures.[11] From this, Ligeti begins to outline his notion of musical space in relation to time; in particular, he suggests that transformation of sound is perceived as the simultaneous expansion of a series of sound events presented successively in time. This perception of simultaneity occurs when one is able to apprehend transformations of sound in the surface texture of a piece. Recognition of this process as the unification of aural space and duration can also be understood as spatialization of sound.[12] Ligeti effectively relates this sensation of surface material to the distinction between tactile creation of a painting and the beholder's visual experience; although the

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[9] It should be noted that Ligeti also referred to 'stasis' in contrast to dynamic movement of surface texture.

[10] Lobanova, *György Ligeti: Style, Ideas, Poetics*, 32.

[11] Ligeti, "Metamorphoses of Musical Form," 15.

[12] 'Spatialization' in this sense is not to be confused with the terms more common reference to the multi-channel diffusion of sound within a particular space.

transformation of texture and colour is created over time, it is presented at-once to the viewer. This is possible given that representation of two-dimensional space is not restricted to occur over time. Ligeti suggests that simultaneity is similarly attainable in time-based forms such as music, citing the deconstruction of temporal-flow in literary works such as James Joyce's 'Ulysses'. He suggests that in this text, the manipulation and interweaving of unrelated thoughts and events creates an effect of suspended time.[13]

The beginnings of these views can be traced back to several of Ligeti's pre-emigration experiments with "montage", a process in which canonical techniques are employed to create multi-dimensional sound-space. In particular, several theorists have selected both *Métamorphoses nocturnes* (1953-54) and *Éjszaka, Reggel* (1955) as works that exemplify the use of canon for creating clusters of sound and the juxtaposition of contrasting ideas.[14] In figures 1 and 2, one notes that the canonical technique has been employed in *Métamorphoses nocturnes* in order to create an overall texture that is dense and filled with sound at every point. In figure 2, the canon-

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[13] Ibid., 15-17.

[14] Several other composers, such as Varèse and Cowell, had experimented with the use of tone clusters in the 1940s, which enforces the view that the sound-mass did not rise out of, but was rather supported by, the advent of electronic technology. Stockhausen's experiments with texture and dense sonorities, beginning with instrumental works such as *Punkte* (1952), *Kontra-Punkte* (1952-53) and *Gruppen* (1955-57), and his progression toward larger transformations of sound in *Carré* (1960) and *Momente* (1963) illustrate this point.

ical movement transforms into a homophonic structure, thus producing a new texture.

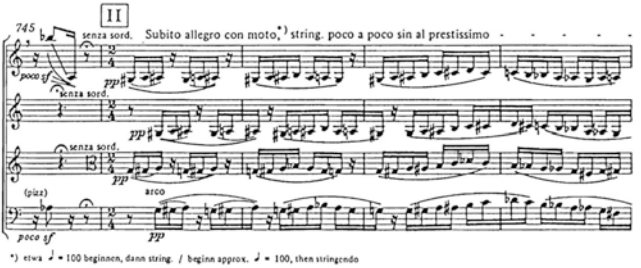

Figure 1. Measures 745-74 of *Métamorphoses nocturnes.*[15]

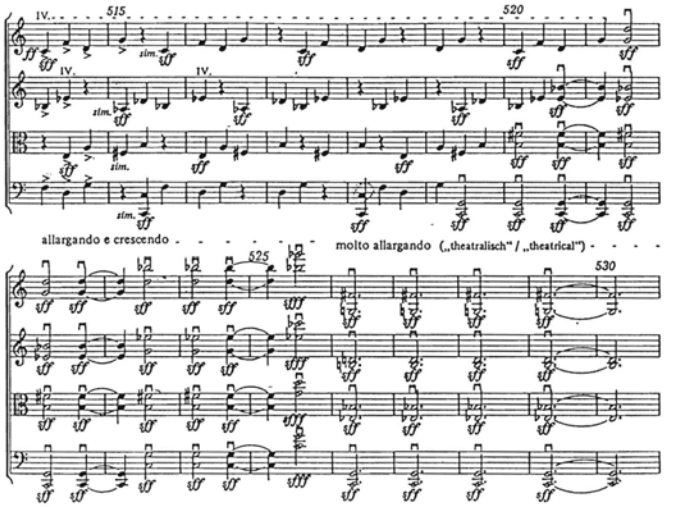

Figure 2. Measures 514-530 of *Métamorphoses nocturnes.*

[15] Figures 1 and 2, *Streichquartett Nr. 1* (*Métamorphoses nocturnes*) © 1972 by Schott Music GmbH & Co. KG. All rights reserved. Used by permission of European American Music Distributors, sole U.S. and Canadian agent for Schott Music GmbH & Co. KG.

Moreover, figure 3, a passage from the *Éjszaka* portion of *Éjszaka, Reggel*, shows how slight rhythmic alterations have been made to produce another type of density; particularly in measures 24-27, one sees suspended tones in at least one of the four voices across beats two and three.

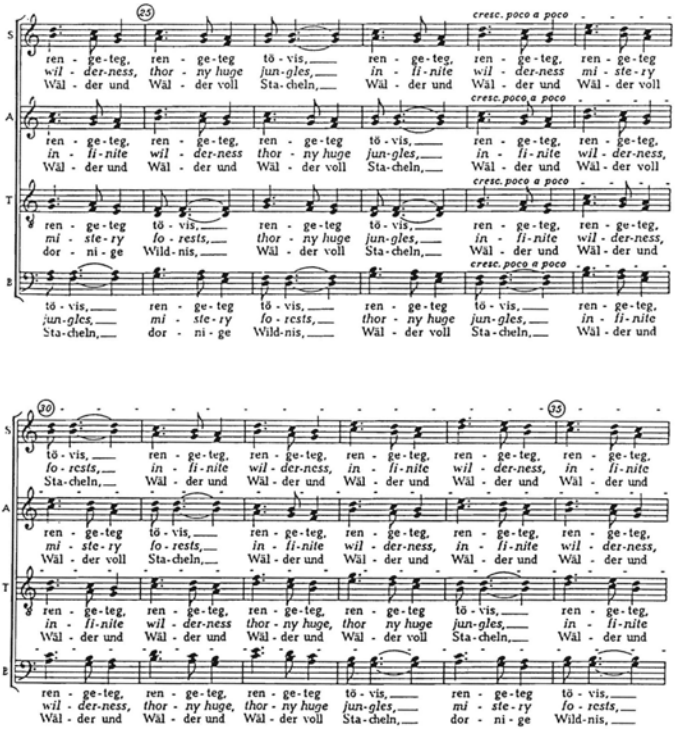

Figure 3. Measures 24-35 of *Éjszaka.*[16]

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[16] Figure 3, *Nacht - Morgen (Éjszaka, Reggel)* © 1973 by Schott Music GmbH & Co. KG. All rights reserved. Used by permission of European American Music Distributors, sole U.S. and Canadian agent for Schott Music GmbH & Co. KG.

Analysis of Ligeti's Electronic Music (1957-1958) and Nature of Appropriation in Micropolyphony (1960-1961)

Despite Ligeti's geographic isolation in the East, early exposure to the electronic music of composers such as Stockhausen instilled in him an acute understanding of the electronic music studio as a place in which any compositional idea could be realized. In particular, layering processes such as those employed in multi-track recording provided another method for implementing montage in the overall formal structure. Moreover, the ability to synthesize and actively manipulate individual sounds over time suggested a tangible way of representing analogous larger-scale transformations in structure and surface texture. In "Wandlungen", Ligeti briefly discusses electronic composition and the ease of interpenetration that occurs when individual structures are created and then superimposed, asserting that this produces layers of forms, each of a different quality.[17] As such, Ligeti's early compositional attraction to electronics is often viewed as a motivating factor in his relocation to Cologne in 1957.

The post-war avant-garde aesthetic present at Darmstadt and Cologne in the 1950s, particularly in response to the advent of electronic music, was one based largely on the acceptance of non-traditional sounds and expanded control of sound parameters such as dynamics, tone colour and envelope, in addition to pitch and rhythm. New approaches to composition made possi-

[17] Ibid., 9.

ble by electronic media existed in two prominent forms; namely, magnetic tape and its associated recording devices, as well as primitive synthesis equipment such as sine tone generators, filters, reverberators, noise generators, ring modulators and envelope generators. The former lent itself to experimentation with techniques of pastiche, montage and collage while the latter supported a Futurist expansion of acceptable and possible sounds. Both technologies offered composers direct access to a variety of sound parameters and, thus, a more kinetic form of control. The *elektronische Musik* aesthetic at the Cologne studios meant that the preferred sources of sound material were those that had been generated electronically.[18] During Ligeti's period of residence at the NWDR, the available equipment consisted of a sine tone generator that produced exact whole number frequencies between 30 and 11 000 Hz, a selective dial generator for producing glissandi between tones, low frequency and beat-frequency oscillators used for amplitude modulation, a variety of filters including high-pass, low-pass, band-pass and band-stop, impulse and noise generators, a variable speed recorder as well as units for ring modulation and reverberation.[19]

With respect to theoretical concerns and methodology, Cologne was also associated with the development of

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[18] One notable exception is Stockhausen's *Gesang der Jünglinge* (1955-56), which employs manipulated vocal recordings.

[19] Benjamin R. Levy, "The Electronic Works of György Ligeti and Their Influence on His Later Style" (PhD diss., University of Maryland, 2006), 35-36.; Elliot Schwartz and Daniel Godfrey, *Music Since 1945: Issues, Materials and Literature* (New York: Schirmer Books, 1993), 113.

total serialism in the European avant-garde; that is, the expansion of serialist control away from exclusive focus on pitch to include elements of rhythm, duration, timbre, dynamics and register. Interestingly, however, theories of music controlled by aleatory and chance-operations were also circulating at Cologne in the latter half of the 1950s, primarily through lectures given by John Cage at the Darmstadt summer school in 1958. As a result, several Cologne composers also experimented with aspects of aleatory and improvisatory technique, such as Boulez with his later work *Pli selon pli* (1957-62). Although traces of serialism could still be found in Ligeti's pre- and post-emigration works, his aesthetic rejection of both serialism and aleatory suggests that his interest in turning towards electronic music composition was based upon finding an appropriate medium in which to further develop his ideas.

While at Cologne, Ligeti gained a greater technical understanding of electronic music composition by assisting Koenig in the studios and by observing Stockhausen while he worked on his own electronic compositions. It was during this period of experimentation that Ligeti began to expand his notions of density and texture with the theorization of illusory polyphony; that is, polyphony that is hidden within a complex monophonic sound mass and emerges through continual transformation of form, structure and surface material. Both Stockhausen in his 1955 article "Structure and Experiential Time" and Koenig in his *Essay* of 1957 indirectly expressed this idea; they describe a phenomenon in which sine tones, when slowed down, reveal hidden interior rhythms as well as extended harmonic and sub-harmonic spectra. Koenig took this idea further in his explication of the neutralization of rhythm

that occurs in electronic music. He suggests that sequences of notes or rhythms can be sped up such that they are no longer audible as discrete movements, but are rather perceived as a singular static object.[20] These descriptions are particularly significant for Ligeti's concept of micropolyphony; by superimposing individual contexts of manipulated sine tones, a sort of micro or sub-surface polyphony is revealed as a concrete shape. Moreover, the treatment of a single sine tone as a musical structure transformed over time fosters the notion of a continual sound-space to unify the piece. Many of Ligeti's experimentations with electronics focused on the implementation of additive synthesis and multitrack recording to produce complex layers of sound that could be regulated between the foreground and background through subsequent filtering. The band-pass filter in particular became an important tool for working with layers of sound; the filter could be used to emphasize different bands of either definite-pitched tones or noise while attenuating the extraneous frequencies. These isolated bands could then be recorded as individual lines and superimposed through additional recording. Furthermore, real-time control of the filter could be used to sculpt the structural shape of the piece as it unfolded. In this way, it is apparent that acquiring a technical knowledge of electronic music composition was pivotal in Ligeti's development of a functioning notion of micropolyphony.

Throughout 1957 and 1958, Ligeti produced three electronic works at the NWDR. *Glissandi* (1957) is often viewed as a study in studio technique and, as the name

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[20] Lobanova, *György Ligeti: Style, Ideas, Poetics*, 39.

suggests, it explores the interpenetration of different instances of glissando in order to produce both continual and discrete transformations of sound. Although this piece does not focus on the development of microstructure and illusory polyphony, it is an interesting illustration of the elongation of timbral transformation and juxtaposition. Ligeti's second electronic work, *Pièce Électronique No. 3*, was initially begun in 1957 as a notated work. Although the score was eventually abandoned, this piece exemplifies many of Ligeti's pre-emigration concerns with transformation and motion of sound and, in particular, the perceptibility of these transformations. The piece employs processes of additive synthesis, superimposition and filtering of different harmonic and sub-harmonic sound spectra, including pure sine tones and white noise. The individual spectra and differential tones are varied such that they move between foreground and background; individual tones become clearly perceptible as they transition into the foreground and, as they are gradually overpowered by new sounds, they become muddied within the fully integrated background texture. In this piece, Ligeti intentionally kept the sound materials in constant states of motion and transformation in order to avoid musical stasis, a phenomenon he believed would result in a flattening-out of sound. These experiments with sound spectra and transformation were further explored in *Artikulation* (1958), Ligeti's final electronic music composition. Not unlike Stockhausen's *Gesang der Jünglinge* and Luciano Berio's *Thema: Omaggio a Joyce*, *Artikulation* explores the possibilities of language and processed speech-sounds. Although *Artikulation* in itself is considered a viable work of electronic music, the extent to which the uniquely electronic method of sound transformation informed Ligeti's concept of micropolypony,

and the way in which he appropriated these techniques into his later instrumental works, is best illustrated by *Pièce Électronique No. 3*.

Interestingly, *Pièce Électronique No. 3* began with the title *Atmosphères*, however this title was abandoned along with the partially notated score for the work. Although Ligeti does not acknowledge any significance to the borrowed title, an aesthetic and technical correlation between the two works cannot be denied. Both share a similar sound quality, characterized by slow-moving progressions of sound as well as contrasting fluctuations of density and diffusion or sparseness. In particular, the two works share similar formal gestures and movements. Figure 4, a descriptive score corresponding to the cited recording of *Pièce Électronique No. 3*, was the main point of reference used for this analysis in the absence of an actual notated or aural score. The first ten seconds of the piece open with a dense, noise-like tone, from which a number of frequencies are then filtered out at seven seconds. The second time this tone sounds and is filtered, one can detect subtle melodic structures emerging from the background. This tone then undergoes a sort of glissandi transposition at 0:21, at which point density is increased with the gradual addition of individual tones and melodic lines. The next section, from 0:37 until 1:05, employs overlapping glissandi in order to again build up a dense texture that continues on as the background material for the subsequent section. At 1:06, various other textures (such as glissandi, filtered shapes and brief impulse tones) are sounded and merge to create a new background texture. The final section, from 1:40 until the end of the piece, explores another method of textural build through glissandi. Short "units" of glissandi are inter-

jected with brief moments of silence; with each subsequent unit, the texture becomes denser until the final unit reaches a largely homogeneous texture. The Webernian pointillist technique can be seen to have influenced this section.

0:00 - 0:10	cluster, starting to filter at 0:07
0:11 - 0:20	second cluster, filtering and short lines emerging
0:21	cluster begins to transpose upwards
0:26 - 0:33	more tones added, greater density
0:33	initial tone continues as subsidiary lines begin to sound
0:37 - 0:49	glissandi effect, overlapping
0:50 - 1:05	build-up of cluster
1:06 - 1:29	superimposition of different textures (initial tone, glissando at 1:15, filtering, impulse at 1:18, melodic lines at 1:21)
1:30 - 1:39	background texture (static tone) and glissandi
1:40 - 1:42	glissando
- silence -	
1:47 - 1:56	more complex glissando, gradually moving from independent units to a homogeneous unit/sound
- breath -	
1:58 - 2:00	compact glissando "unit"
- breath -	
2:00 - 2:05	glissandi moving to another static texture (homogeneous)

Figure 4. Descriptive analysis of *Pièce Électronique No. 3*.

Many of the processes described above, as well as several general concepts related to the electronic process of transformation and superimposition, are further explored in *Atmosphères*. The cluster chord that opens the piece - 55 pitches spread over almost 4 octaves - is in close likeness to dense structure that opens *Pièce Électronique No. 3*. Moreover, figure 5 shows how the electronic filtering technique, similar to that which follows the presentation of the initial tone in *Pièce Électronique No. 3*, has been appropriated in instrumental notation; the opening cluster chord in *Atmosphères* is slowly filtered to reveal only the sounds of the viola and cello at section A. This sort of timbral filtering (isolation of certain instruments) also transforms tone colour throughout the piece. Another homophonic cluster chord similar to that used in the opening is found further in the piece at measures 66 – 74 (Figure 6). Appropriation of another type of band-pass filtering or additive process can be seen in figure 7; transition from a singular tone to another dense texture is created through the gradual addition of closely positioned pitches. By also incrementally decreasing note value throughout the build-up of this texture, even greater density is achieved. Yet another form of filtering is shown in figure 8; in the closing measures of the piece, a transformation from dense to sparse texture is done by intermittently removing certain instruments while spacing out others in order to keep the sound continuous.

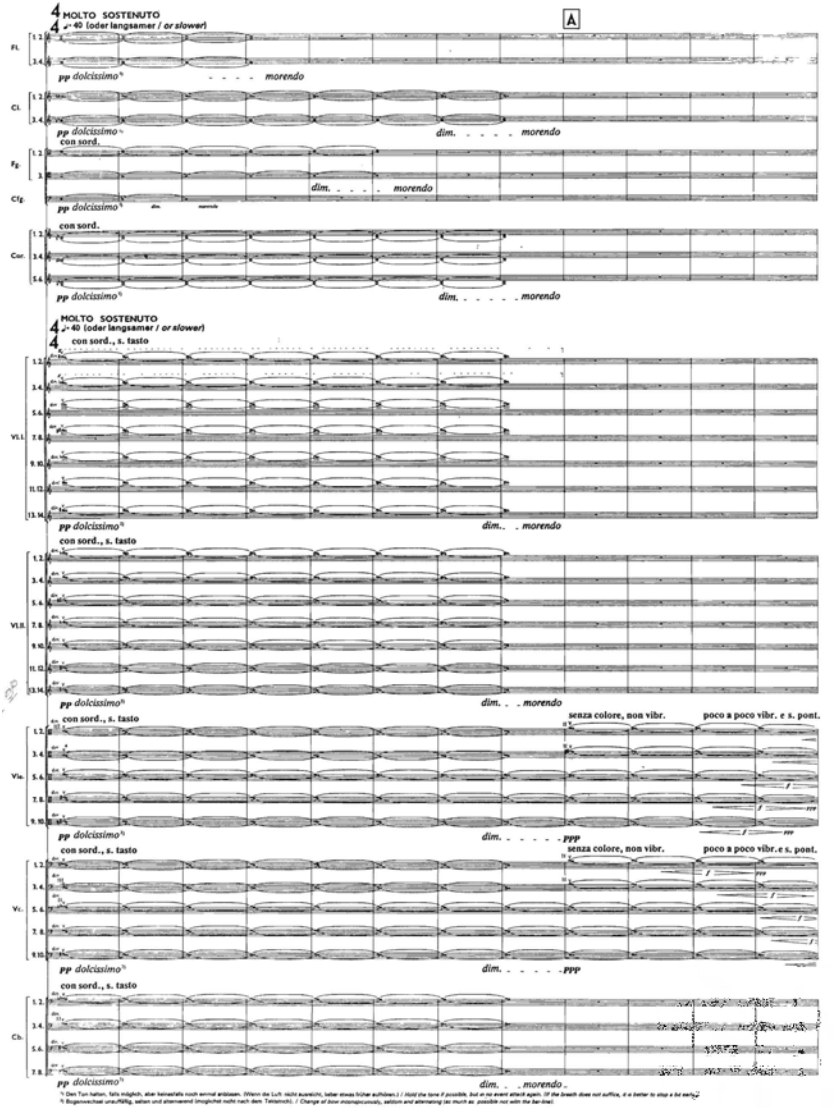

Figure 5. Measures 1-12 of *Atmosphères*.[21]

[21] Figures 5-13, *Atmosphères* © 1963 by Universal Edition A.G.,

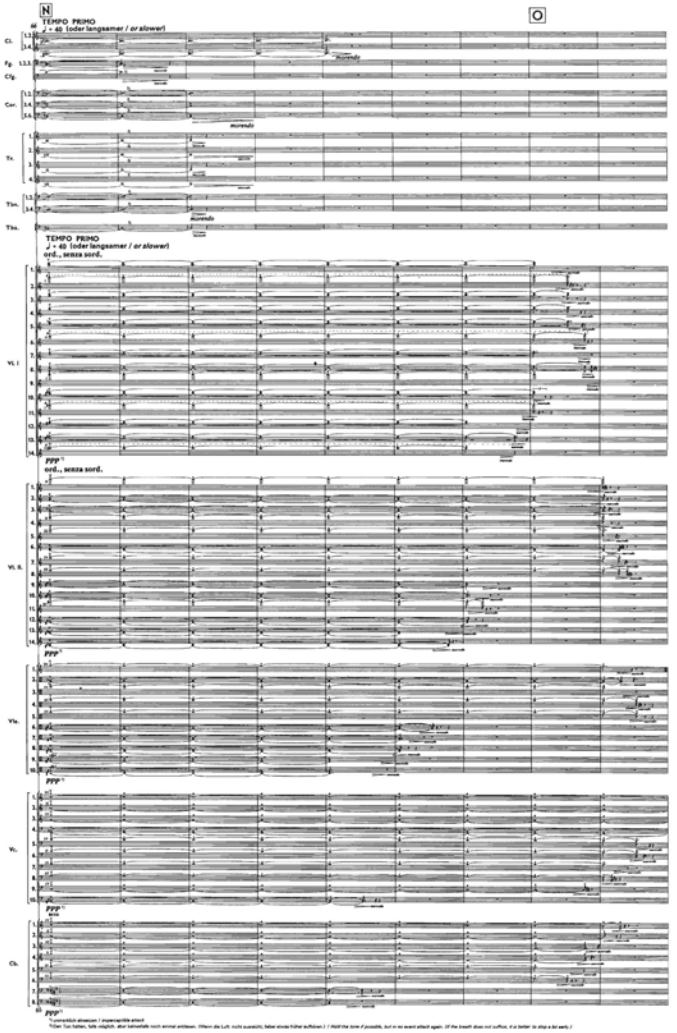

Figure 6. Measures 66-74 of *Atmosphères.*

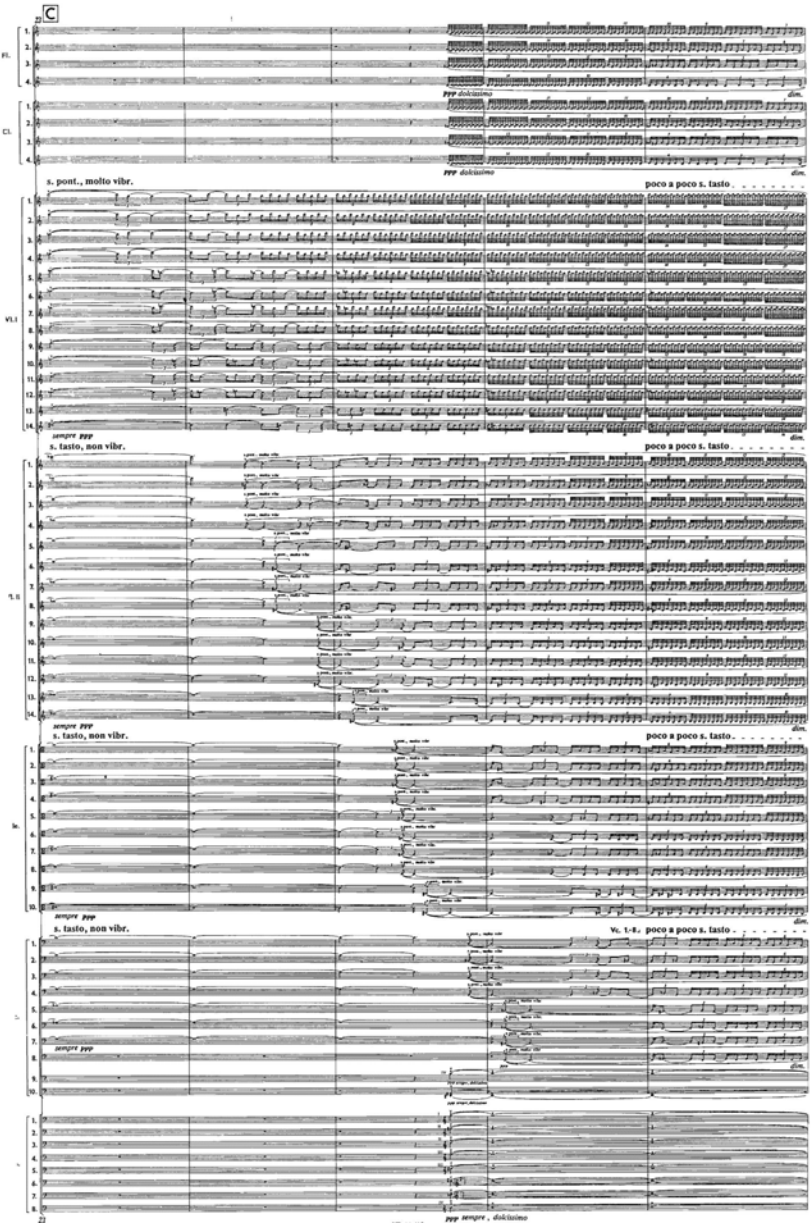

Figure 7. Measures 23-27 of *Atmosphères.*

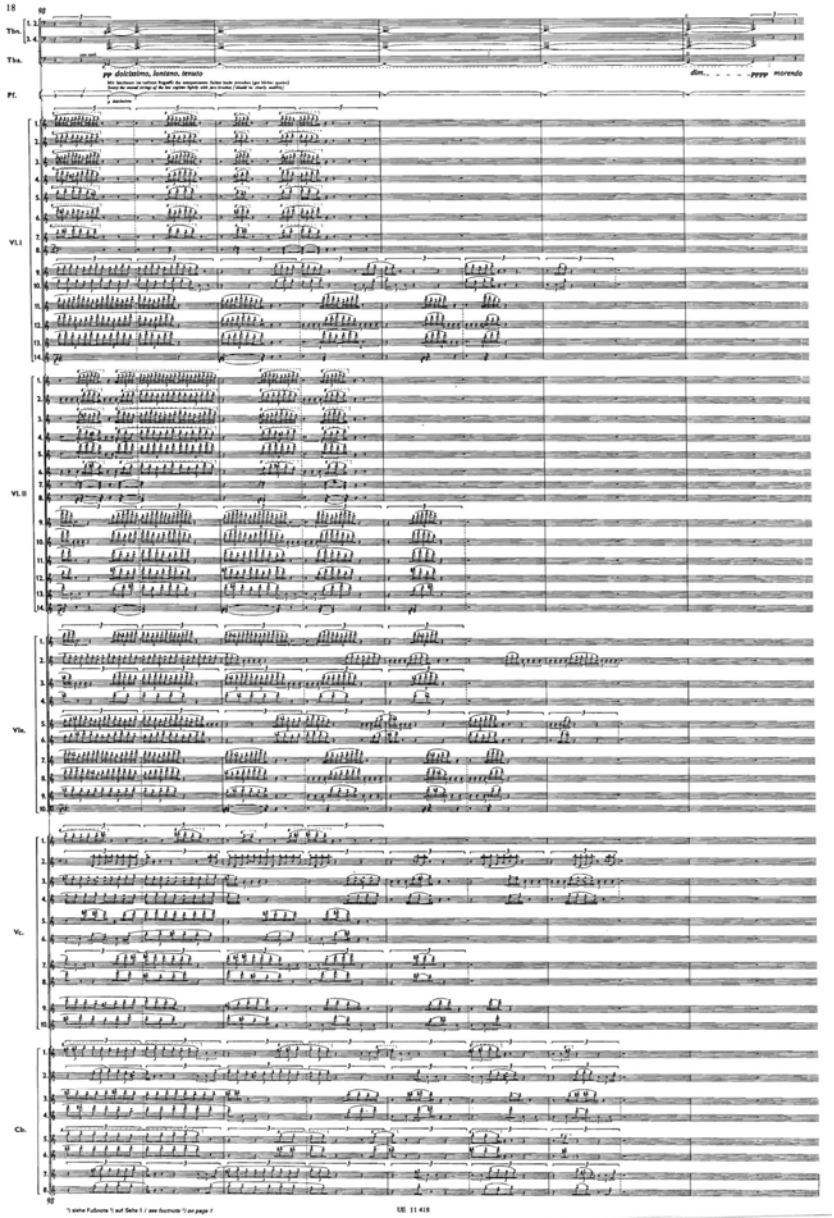

Figure 8. Measures 98-102 of *Atmosphères.*

Figure 9 represents a particularly interesting point in the piece as it illustrates instantiations of several different electronic processes. A transition-filtering effect can be seen between the two violins in which a glissando into the next higher register is also created. Moreover, neutralization of rhythm and texture occur in this section as a result of the overlapping and juxtaposition of different rhythms. This technique can be found throughout much of the piece, as in figures 10 – 12. Figure 12 also shows appropriation of the electronic "impulse" tone; in electronic music composition, impulse generators are used to produce discrete, finite tones whereas oscillators (or sine tone generators in the case of *Pièce Électronique No. 3*) and noise generators are more easily applicable for creating continuous and droning tones. While Ligeti's static clusters can be seen to resemble fixed, continuous tones, the brief "units" of sound in this section can be interpreted as impulses. These units are then layered, juxtaposed and overlapped in order to produce a dense texture, within which unique rhythmic or melodic lines may surface. Finally, figure 13 illustrates another method of fluid transition between dense and sparse texture based on the principle of overlapping and suspension of tones.[22]

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[22] It should also be noted that there are certain instances in both *Pièce Électronique No. 3* and *Atmosphères* in which the two simply *sound* similar. For instance, there is a glissando that occurs between 3:20 and 3:43 in *Atmosphères* which very closely resembles a glissando that occurs between 0:20 and 0:37 in *Pièce Électronique No. 3*. Similarly, a similar melodic line emerges between 7:17 and 8:00 in *Atmosphères* and 0:33 and 0:37 in *Pièce Électronique No. 3*.

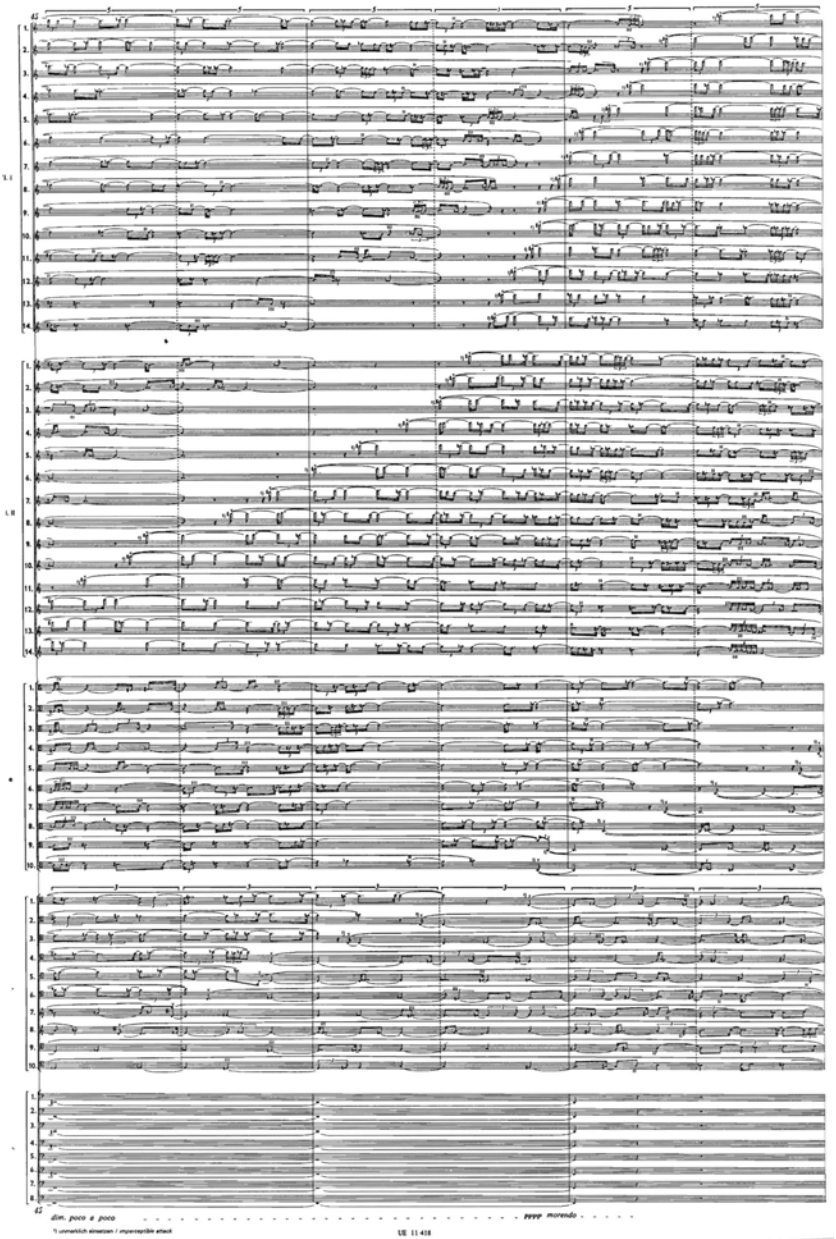

Figure 9. Measures 45-50 of *Atmosphères*.

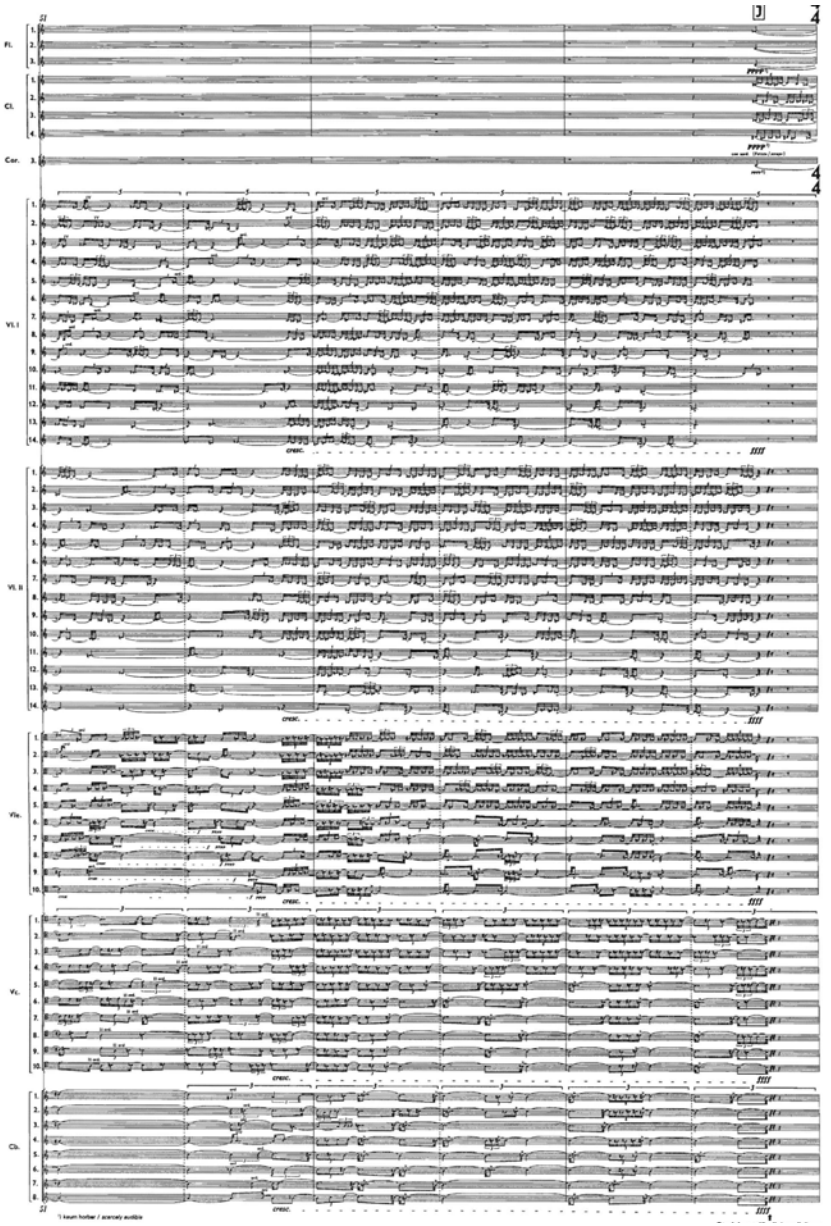

Figure 10. Measures 51-53 of *Atmosphères.*

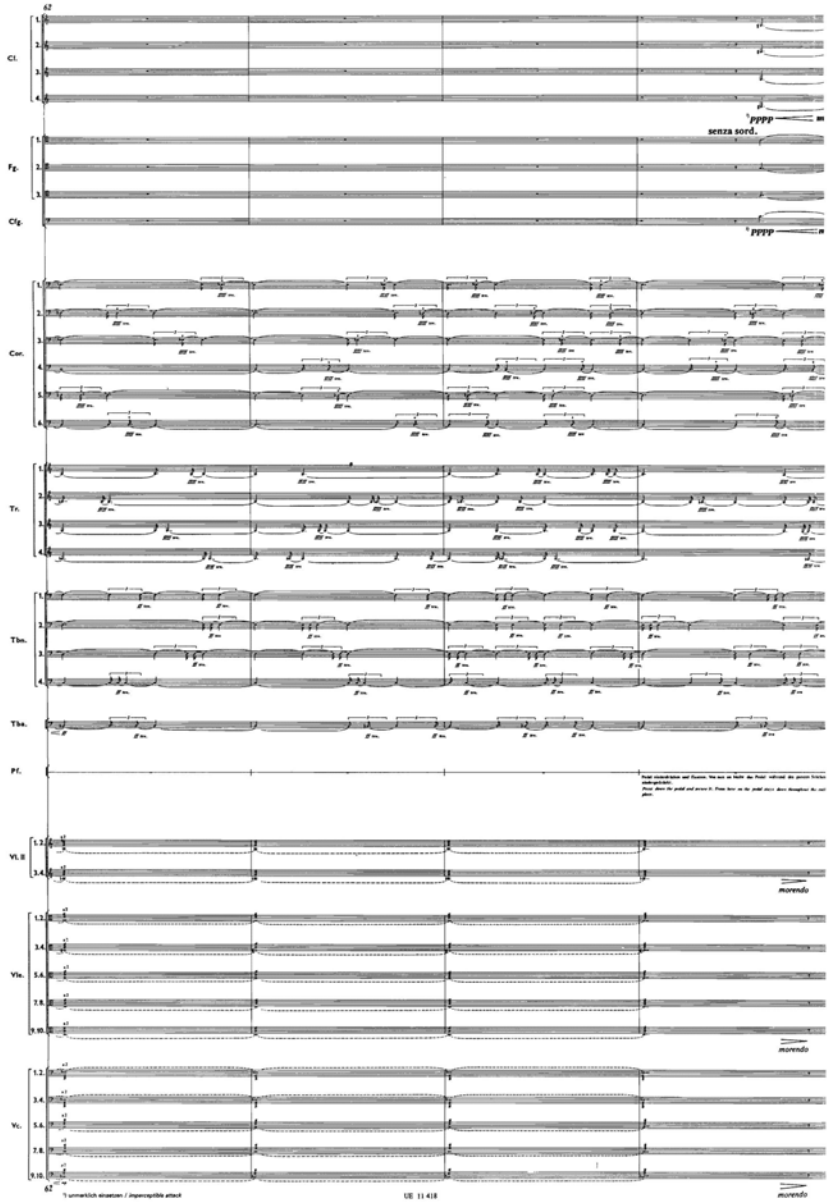

Figure 11. Measures 62-65 of *Atmosphères.*

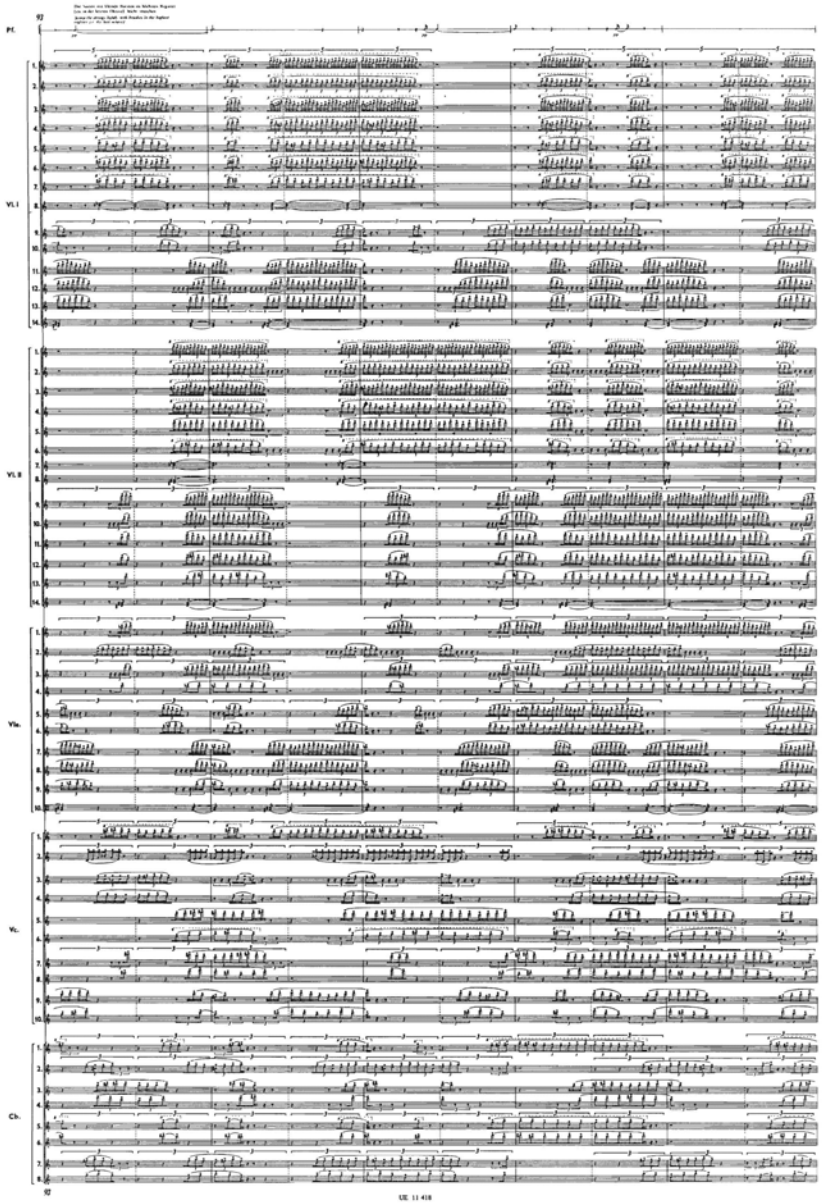

Figure 12. Measures 93-97 of *Atmosphères.*

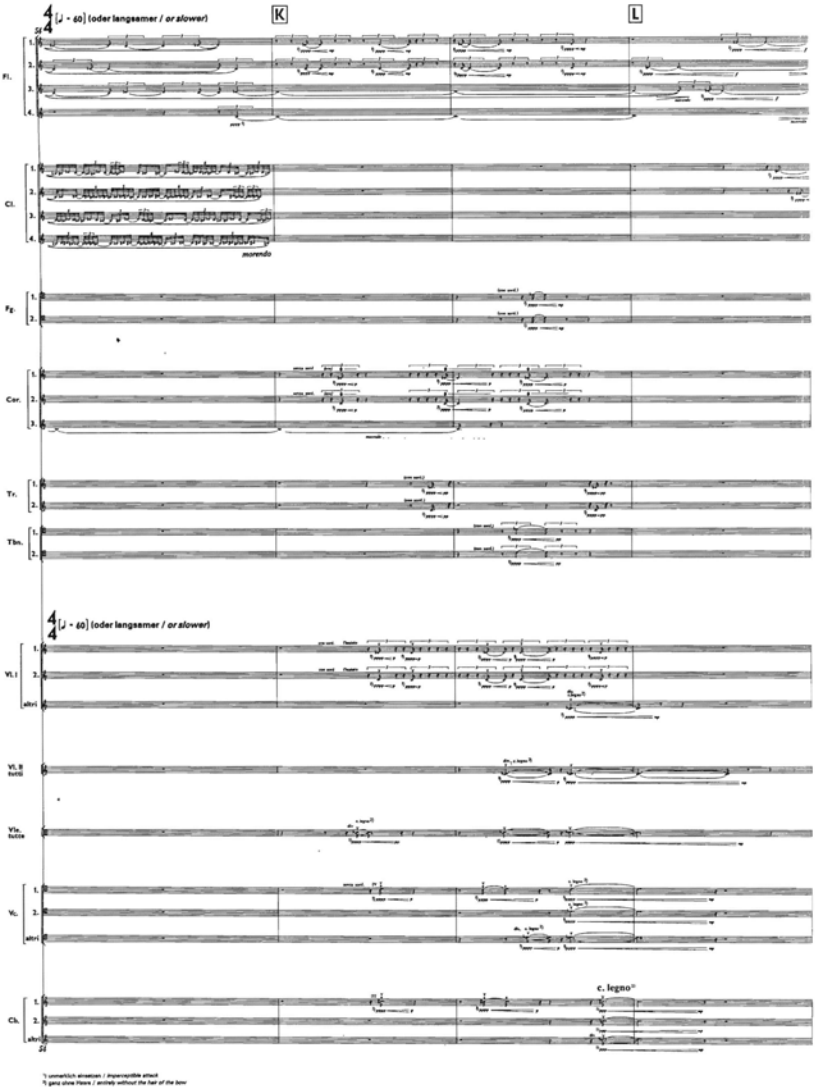

Figure 13. Measures 54-57 of *Atmosphères*.

As this analysis shows, many of the ideas Ligeti had outlined in "Wandlungen" were still predominant components of his concept of micropolyphony. *Atmosphères* may be viewed as an extension of *Pièce Électronique No. 3* in that it continues to deal with the juxtaposition and continual fluctuation of sounds, as well as the degree to which individual sounds are either made perceptible or are interpenetrated among the sound-mass. However, there are notable differences between *Atmosphères* and works such as *Métamorphoses nocturnes* and *Éjszaka, Reggel*, many of which are evident simply by comparing the notated material; *Atmosphères* exhibits a vastly more dense texture and a particular attention to register. The montage and canonical technique of the pre-emigration works has been replaced by the use of expansive cluster-chords and a more integrated method of overlapping and superimposition. Moreover, given that the primary focus of *Atmosphères* is based on gradual transition and transformation of a unified sound-mass over time, the work takes on largely minimalistic and monolithic character. As a result of his experimentation with electronic music composition, Ligeti acquired and incorporated into his concept of micropolyphony newly expanded notions of density and transformation. The treatment of sound in electronic music as an individual entity that, when manipulated, reveals hidden forms and structures seems to have supported an organic notion of unification and cohesion. To this end, the sound material of *Atmosphères* is treated as a single, homogeneous unit of sound that is molded and shaped over time. Micro-structure is another important feature of Ligeti's concept of micropolyphony, and it can be seen that the theorization of illusory rhythm in electronic music composition has been directly translated into illusory polyphony in instrumental music; when the

musical structure is manipulated, lines and shapes that were once hidden in the background texture become perceptible in the surface material. In relation to this process, the technique of actively filtering complex frequency-collections (such as white noise) to attenuate particular bands of sound is apparent in the gradual shaping of dense formations in *Atmosphères*; clusters of sound are transformed by gradually decreasing and increasing the number of notes used to make up the chord. *Atmosphères* employs the full orchestra and by subtly varying the instruments and timbres used to produce the cluster at any given time, the tone colour of the macro-structure is also manipulated. Furthermore, these techniques of electronic transformation all seem to have informed a new understanding of density and cluster; instead of expansion through chromaticism, density is established in *Atmosphères* through the statement of a single massive complex texture (the cluster chord of the opening bars) that is continually deconstructed and reconstructed throughout the remainder of the work. This correlates directly to electronic processes of filtering, in which particular frequency bands of complex or dense tones (such as white noise) are emphasized while others are removed, as well as electronic processes of additive synthesis, in which the complexity of simple sine tones is gradually increased through the addition of various harmonic spectra. Infinite sustenance of these sound transformations is made theoretically possible by the mechanistic nature of electronic equipment; indeed, the monolithic character of *Atmosphères* evokes the almost tangible image of an ever-changing object suspended in time.

Conclusions Regarding the Limitations of Transformation and Perception in Electronic Music Composition

Ligeti abandoned the electronic medium after *Artikulation* in order to fully realize his concept of micropolyphony through instrumental means, which he felt was the only appropriate way of expressing this idea. As such, it is worth considering which characteristics of electronic music composition Ligeti cites as inhibiting for sufficiently implementing the tenets of micropolyphony into a musical work. Ligeti does not describe any particular issues with the electronic sound in itself; that is, he does not suggest that the timbral quality of electronically generated tones is in any way inferior to that of acoustic instruments. It seems instead that Ligeti's difficulties with the electronic medium are based on an inability to perceive the actual process of sound transformation. As discussed, Ligeti's concept of perception in relation to transformation of sound is directly related to his notion of simultaneity. Although Ligeti was initially attracted to electronics as a way of implementing his earlier concepts, he was unable to overcome problems associated with creating a unit of sound that remains continuous over time, throughout alterations, transformations and manipulations.

Ligeti does not explicitly document his reasons for rejecting electronic music composition in any prominent writings from the 1960s, however several conclusions could be drawn based on the comparison of the previous section. It could be argued that the difficulty of perception is related to the fact that, in electronic mu-

sic, illusory and micropolyphony is created with intention in the compositional process and not in the sounding process; the composer intentionally isolates certain structures for the listener to perceive. As a result, the "revealed" quality of micropolyphony is lost in that one does not actually perceive or experience the transformation of sound over time; rather, they only hear it after-the-fact. In this way, the structures that emerge in these processes of transformation become static artifacts instead of dynamic, transitioning events. This becomes problematic with respect to Ligeti's view that although contrapuntal lines do occasionally sound individually within a sound mass, they are still meant to be indistinguishable from the larger texture. As such, a lack of simultaneity occurs when the work is not perceived as a singular, homogeneous unit that moves and changes over time. A more succinct description of Ligeti's difficulties with perception of transformation in electronic music can be considered in reference to the notion of integration.[23] As mentioned, both Koenig and Stockhausen describe the electronic music compositional process as one in which individual lines or structures are first created and then subsequently superimposed amongst one another. Although this technique at one time appeared to Ligeti as a viable solution for the creation of density and texture, the disconnected nature of this process seems precisely the reason he felt unable to integrate sounds such that their transformations would be perceived as homogeneous. In the instrumental realm, transformations occur concurrently; it is the *immediacy* of the listening experience that allows

[23] Ibid., 45.

the listener to perceive the work as a unified sound-mass that simply transforms itself over time.

Despite rejecting electronic media as the tools for realizing micropolyphony, Ligeti did still maintain adherence to several aesthetic sensibilities and methodologies specific to electronic music-making practices; namely, transformational processes that affected the treatment of sound and the manipulation of density. These qualities were appropriated quite predominantly into his concept of instrumental micropolyphony and, without some incorporation of the electronic aesthetic, it may be argued that the concept as such could not have fully developed.

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Abstract
The technical and aesthetic foundations of György Ligeti's concept of micropolyphony, which he employed most prominently in his 1961 orchestral work, *Atmosphères*, can be credited, in part, to his post-emigration experiments with electronic composition at the studios of the NWDR in Cologne in the late 1950s. Although Ligeti had already theorized general concepts of musical texture and space prior to his emigration to the West in 1956, the nature of the micropolyphony he employs in his later work is characteristically distinct, exhibiting a greater sensitivity to density and timbre in addition to processes of aural integration and interaction. To this end, this analysis examines the way, and more importantly the extent to which, Ligeti's often overlooked work in electronic music directly influenced his approach to the implementation of sound-mass in his later methodology. This is done through a comparison of *Pièce Électronique No. 3*, an electronic work begun in 1957, and *Atmosphères*. This comparison lends support to the contention that, despite his rejection of the electronic medium as a tool for practical implementation, Ligeti maintained several aesthetic sensibilities specific to electronic music-making practices; namely, the treatment of texture and the transformation of sound.