Harmonic and Formal Processes in Ligeti's Net-Structure Compositions

Miguel A. Roig-Francolí

In the mid-sixties, György Ligeti's compositional focus shifted away from creating the dense micropolyphonic webs characteristic of the earlier works he wrote after fleeing his native Hungary in 1956. In such earlier works as *Apparitions* (1958–59) and *Atmosphères* (1961), the individuality of pitch and rhythm is neutralized by their integration into the overall global function of chromatically-filled complexes. Beginning with *Lux Aeterna* (1966), however, Ligeti started to abandon this "harmonic neutrality" in favor of distinctive harmonic processes based on intervallic units ("intervallic seed crystals") and their constant transformation.[1] "The harmonic crystallization inside the sonorities," Ligeti states, "leads to a type of intervallic harmonic thought which is fundamentally different from traditional harmony (and also from atonal harmony) in that there is no direct succession or progression of harmonies, but rather a *progressive metamorphosis of intervallic constellations*."[2]

Two major compositional techniques embody Ligeti's redefined harmonic syntax in this period. First, in works such as *Lux Aeterna* and *Lontano* (1967) harmony results from linear (canonic or contrapuntal) procedures which, in turn, can only be fully understood as part of a spatially-conceived musical context.[3] These are works in polyphonic style in

An early version of this article was presented at the Annual Meeting of the Society for Music Theory, Montreal, 1993. I am indebted to Jonathan Bernard for his perceptive and helpful comments on an earlier draft.

[1]*György Ligeti in Conversation with Péter Várnai, Josef Häusler, Claude Samuel, and Himself* (London: Eulenburg, 1983), 126. Some other important sources in which Ligeti articulates many of the key concepts, technical principles, and personal processes which inform his musical language in general, and specific works or groups of works in particular, are: "Anlässlich *Lontano*," *Die Begegnung: Sonderheft, Programmheft der Donaueschinger Musiktage für zeitgenössiche Tonkunst* (Donaueschingen, 1967 [program notes for the premiere of *Lontano*, partially translated from the German by Sarah E. Soulsby as "Report on my Own Work," booklet in LP album *Ligeti*, Wergo WER 60095 (1984): 29–30]); "On My Etudes for Piano," *Sonus* 9 (1988): 3–7; "On My Piano Concerto," *Sonus* 9 (1988): 8–13; "La mia posizione di compositore oggi," in *Ligeti*, ed. Enzo Restagno (Turin: EDT, 1985), 3–5; Pierre Michel, *György Ligeti: Compositeur d'aujourd'hui* (Paris: Minerve, 1985).

[2]Ligeti, "Anlässlich *Lontano*." Emphasis added.

[3]The contrapuntal and harmonic techniques developed by Ligeti in these and other microcanonic works of the mid-sixties, as well as the spatial contexts in which they occur, have been studied by Jonathan Bernard, "Inaudible Structures, Audible Music: Ligeti's Problem, and His Solution," *Music Analysis* 6 (1987): 207–36; "Voice Leading as a Spatial Function in the Music of Ligeti," *Music Analysis* 13 (1994): 227–53; and Jane Clendinning, "Contrapuntal Techniques in the Music of György Ligeti" (Ph.D. diss., Yale University, 1989); "Structural Factors in the Microcanonic Compositions of György Ligeti," in *Concert Music, Rock, and Jazz since 1945: Essays and Analytical Studies*, ed. Elizabeth West Marvin and Richard Hermann (Rochester: Rochester University Press, forthcoming). The following are analyses of single compositions dealing mostly with such aspects of Ligeti's "sound

which harmonic "constellations of pitches" emerge, are superimposed on one another, and are constantly and gradually transformed, one note at a time, by means of stepwise voice-leading. As Ligeti has stated about *Lontano*, "polyphony is written, but harmony is heard."[4]

The second technique of harmonic composition is represented by works of this period based on what Ligeti himself has called "net-structures." A net-structure is a continuous web of finely-woven lines or repeated patterns in a constant, interactive process of transformation of one or more parameters, such as pitch, rhythm, texture, dynamics, or timbre. While in canonic or contrapuntal compositions sonorities are transformed by means of linear motion of individual parts, harmonic transformation in net-structures results from systematic processes of chromatic fluctuation or intervallic expansion and contraction. This article examines different types of net-structures in the context of the overall formal design of works such as *Ramifications* for string orchestra (1968–69), the Second String Quartet/V (1968), and the Chamber Concerto/I (1969–70), with a focus on both surface harmonic motion and long-range intervallic frames which underlie the points of formal articulation. Ligeti's concern with balanced musical construction is apparent not only in the meticulously crafted surface textures, but most of all in the variety of symmetrical arrangements present at various compositional levels.[5]

Recent studies by Jane Clendinning and Michael Hicks have focused on the type of net-structure based on the repetition and transformation of patterns.[6] Neither Clendinning

masses" as texture, density, range, timbre, or spatial characteristics (rather than the more elusive issue of pitch organization): Robert Cogan, "György Ligeti: *Lux Aeterna*," in *New Images of Musical Sound* (Cambridge, Mass.: Harvard University Press, 1984), 39–43; Pozzi Escot, " 'Charm'd Magic Casements': György Ligeti's *Harmonies*," in *Contiguous Lines: Issues and Ideas in the Music of the 60's and 70's*, ed. Thomas DeLio (Lanham: University Press of America, 1985), 31–56; Alejandro Pulido, "Differentiation and Integration in Ligeti's *Chamber Concerto*, III," *Sonus* 9 (1988): 17–37; Bruce Reiprich, "Transformation of Coloration and Density in György Ligeti's *Lontano*," *Perspectives of New Music* 16 (1978): 167–80; and Robert L. Rollin, "The Genesis of the Technique of Canonic Sound Mass in Ligeti's *Lontano*," *Indiana Theory Review* 2 (Winter 1979): 23–33. While the complexity and originality of Ligeti's music have encouraged creative analytical methods (such as a variety of graphic analyses), they have also occasioned a number of other studies which have not gone beyond surface description.

[4]*Ligeti in Conversation*, 86.

[5]Other compositions by Ligeti based totally or partially on net-structures are *Continuum* for harpsichord (1968), *Ten Pieces for Wind Quintet*, no. 8 (1968), *Coulée* for organ (1969), and the Double Concerto for flute and oboe/II (1972). Ligeti has also used the terms "net-formations" (*Netzgebilden*) and "net structures" (*Netzstrukturen*) to refer to the compositional techniques of such earlier works as *Apparitions* and *Atmosphères* (Wergo WER 60095, 29–30). However, the net-formations in Ligeti's first West-European period are micropolyphonic webs, with no distinctive harmonic processes, as opposed to the harmonic net-structures of the second period to be studied in this article. The composer's frequent use of web and net images and their musical equivalents is related to his often-cited childhood dream, in which Ligeti could not make his way to his bed because he got entangled in a dense, confused web which filled the room. A variety of insects and objects were also caught in the tangle, and every time one of the insects moved the entire web started shaking. At times these movements caused the web to tear in places, allowing some of the insects to go free momentarily, only to be ensnared again in the tangle of filaments. These recurring events gradually altered the internal structure of the web, which became ever more confused. "These transformations," Ligeti explains, "were irreversible; no earlier state could ever recur. There was something inexpressibly sad about this process: the hopelessness of elapsing time and of the irretrievable past" (György Ligeti, "States, Events, Transformations," trans. Jonathan Bernard, *Perspectives of New Music* 31 (1993), 164–65; also described in *Ligeti in Conversation*, 25).

[6]In "Contrapuntal Techniques" and "The Pattern-Meccanico Compositions of György Ligeti," *Perspectives of New Music* 31 (1993): 192–234, Clendinning provides thorough accounts of surface compositional processes in Ligeti's complex musical webs. Clendinning discusses pattern transformation procedures in works such as *Continuum*, *Coulée*, *Ten Pieces for Wind Quintet*, no. 8, the Second String Quartet/V, and the Chamber Concerto/I, using a variety of graphs to illustrate range, pattern interaction, pattern-change rate, and pattern shift. In "Interval and Form in Ligeti's *Continuum* and *Coulée*," *Perspectives of New Music* 31 (1993): 172–90, Michael Hicks explores the relationship between form and intervallic progression in *Con-*

nor Hicks, however, has chosen to use the term "net-structure," preferring instead the terms "meccanico" and "pattern-meccanico" procedures, which allude to Ligeti's fascination with the ticking of mechanical devices, especially those which do not work properly. Keeping in mind that Ligeti's use of technical terms descriptive of his music is not always consistent, we may note that the composer frequently employs the term "meccanico" (as well as the image of the machine which breaks down) to refer to a type of texture totally different from his harmonic pattern-transformation webs. Ligeti's characteristic "meccanico" passages or movements feature the quick mechanical reiteration of only one pitch per instrument (as opposed to a melodic or harmonic pattern) with *staccatissimo* or *pizzicato* markings.[7] To avoid terminological confusion between the pattern-generated processes which Clendinning and Hicks analyze, and which will be studied in this essay, and the pitch-repetitive, mechanical style, I prefer to use the term "net-structures" to refer to the former, reserving the term "meccanico" for the latter.[8]

tinuum and *Coulée*, two compositions based exclusively on pattern repetition and transformation.

[7]Ligeti's references to the "meccanico" style can be found in *Ligeti in Conversation*, 16–17, 107–8, and 135. The following works feature movements or passages using the "meccanico" technique: Second String Quartet/III (marked *Come un meccanismo di precisione*); Chamber Concerto/III (*Movimento preciso e meccanico*); *Ten Pieces for Wind Quintet*, no. 5; the closing measures of both *Ramifications* and *Continuum*; Cello Concerto/II (1968) (passages marked *mechanisch-präzis*); and a piece which preceded all of the above, the *Poème Symphonique* for 100 metronomes (1962).

[8]"Meccanico" and net-structure passages differ not only in texture and sound, but also in harmonic processes and designs. Analyses of meccanico sections can be found in Bernard, "Voice Leading," 243–48 (Second String Quartet/III), and "Inaudible Structures," 222 (Chamber Concerto/III). Harmonic transformation in these movements, based on techniques similar to those found in *Lux Aeterna* and *Lontano,* results from canonic or contrapuntal processes regulated by spatial principles, and usually based on gradual stepwise voice-leading.

HARMONIC PROCESSES IN LIGETI'S NET-STRUCTURES

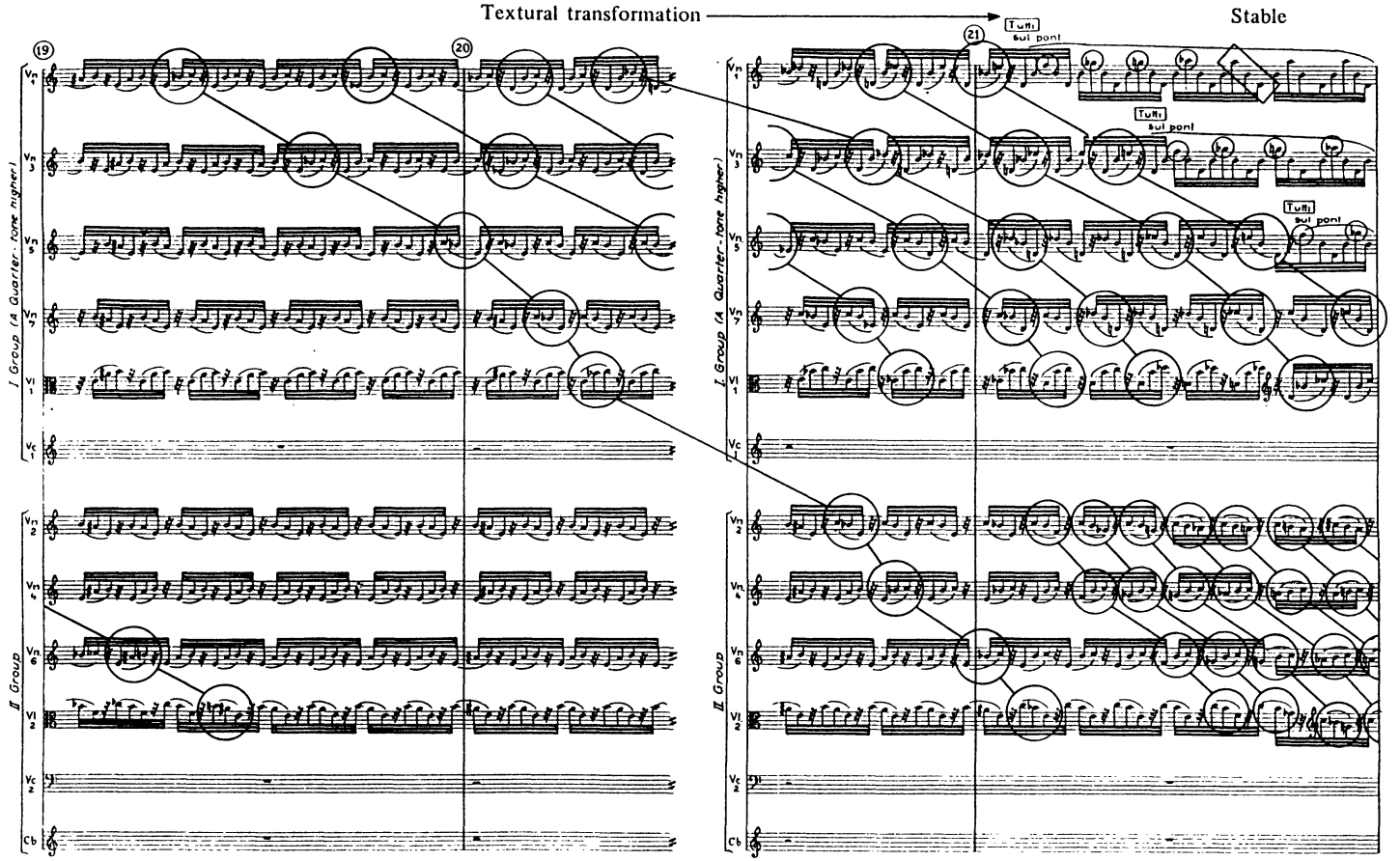
Ramifications is a work largely constructed through the technique of net-structures, and scored for two groups of strings tuned a quarter-tone apart. Ligeti's intention was not to produce microtonal music, but rather, as he declared, "mistuned music."[9] The composer has noted that in actual performance the two groups naturally tend to get nearer one another in pitch, and the tuning difference between them is thus in constant fluctuation, contributing to the effect of mistiness and blurred contours achieved by the interlocking patterns of net-structures, as well as to the overall performance difficulties presented by the piece. Since the mistuning is thus an ornamental surface event which has no significance at the level of structural pitch organization, I will disregard it for analytical purposes, and I will rather use the pitches of both groups as notated.[10]

At the immediate surface level, which determines the texture of a net-structure, the unfolding of the same harmonic processes by all instruments is not simultaneous. Intervallic transformations are displaced temporally, in more or less strict canonic form, and are often presented in layers of diverse rhythmic groups moving at different speeds. Example 1 illustrates a case of intervallic transformation unfolded "diagonally" by the different instruments (the metronome

[9]*Ligeti in Conversation*, 54.

[10]A perceptual—and also analytical—casualty of such pitch blurring, however, is the concept of pitch class. As discussed below, octave and inversional equivalences (and hence pitch-class sets) lose their theoretical effectiveness in a musical context in which, as in the case of Ligeti's music, spatial and registral principles are essential to structure. Pitch blurring, moreover, destroys the sense of fixed, qualitatively different identities of the twelve pitch classes, while preserving the perceptibility of pitch distance. The analytical methodology used in this study is based on measurements of interval space by means of pitch distance, and hence it is not affected in any substantive way by the deliberate mistuning of the instrumental groups in *Ramifications*.

Example 1. Ligeti, *Ramifications*, mm. 19–21, annotated score. © B. Schott's Soehne, Mainz, 1970. All rights reserved. Used by permission of European American Music Distributors Corporation, sole U.S. and Canadian agent for B. Schott's Soehne, Mainz.



marking for this and all other passages of *Ramifications* reproduced in this article is ♩ = 60). The first violin, for instance, progressively expands the linear intervals of a harmonic cell. In each of the circled trichords, one of the outer boundaries of the previous trichord has been expanded by a semitone or a tone, the upper voice following an ascending motion and the lower voice a descending motion. The same process occurs in the remaining instruments, except that each instrument is temporally delayed with respect to the instrument immediately above it in the score. This twining of the harmonic strands, together with the constant metric overlap of the harmonic cells, creates both the effect of interweaving so characteristic of net-structures, and the flowing, nonmetrical textures so familiar in the music of Ligeti.

Pitch reductions of the melodic-harmonic processes common to all instruments reveal the middleground organization of net-structures.[11] At this level, the pitch content defines four distinct types of net-structures. In the first type, the harmonic process is produced by chromatic fluctuation of melodic microstructures, short melodic patterns moving within a range no larger than [6] and in which adjacent intervals are usually not larger than [4].[12] The second type results from chromatic transformation of harmonic cells by means of intervallic expansion or contraction, while the third type is generated by chromatic transformation of triadic units. The fourth type of net-structure is based on pitch-static textures which undergo processes of progressive change in such other parameters as dynamics, timbre, or rhythm. It will be noticed that an element common to the first three types is the process of constant chromatic transformation, a procedure which Ligeti has used widely both in micropolyphonic and harmonic textures, and which is achieved by half-step alterations of pitches one at a time, a voice at a time. The examples that follow illustrate such chromatic transformation of both melodic and harmonic cells.

A pitch reduction of the opening section of *Ramifications* (mm. 1–10) appears in Example 2a. (A portion of the score appears in Example 4.) This is an instance of a net-structure of the first type mentioned above, demonstrating the process of chromatic fluctuation of melodic microstructures. The outer boundaries of the melodic cells expand from interval [2] to interval [4], while inner chromatic fluctuation within the cells covers all of the possible subdivisions for each outer interval. The interval [4], for instance, is broken up into the following microstructures: 121, 112, 211, 1111, 31, 13, 22, and 4.[13] A complex set of symmetrical relationships governs the passage: group cardinality (that is, the number of pitches in a group) is symmetrical, creating the pattern 2–3–4–5–4–3–2; the arrangement of microstructures is symmetrical around interval [4] = 1111, the only group with a cardinality of 5; the equal divisions of [2], [3], and [4] (11, 111, 1111, and 22, respectively) are arranged symmetrically (Example 2b); and finally, the structural cluster of the passage displays a symmetrical configuration: the piece begins with the pitches A4–G4, connected at m. 2 by the passing A♭4, and expanded a half-step above and below to the outer boundaries of the passage, B♭4 and F♯4 (Example 2c). The whole section is

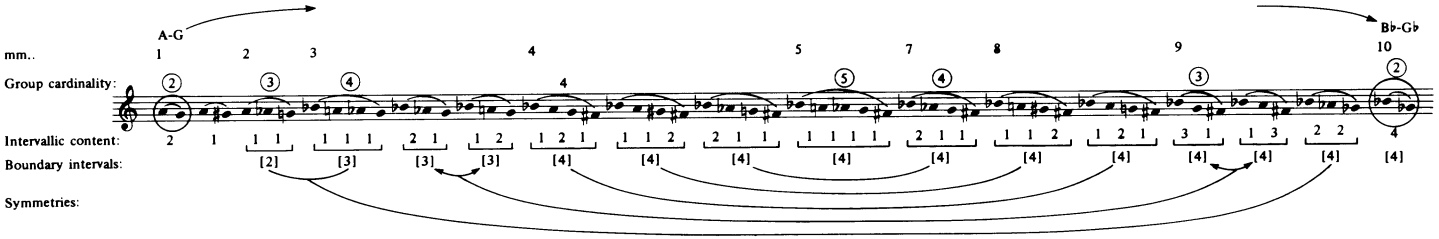
[11]The term *middleground* is used in this article in a way totally unrelated to Schenkerian principles. While trying to identify any kind of universal background design in Ligeti's music would obviously be a foolish endeavor, non-Schenkerian reductive techniques can be useful in demonstrating long-range, contextual middleground coherence as well as the relationship between surface events and their underlying structure. See pp. 253–55, below, for a fuller discussion of this issue.

[12]Numbers in brackets denote the size of intervals in semitones. Pitch designation throughout this article follows the system of the Acoustic Society of America, whereby middle C is C4, the C an octave above is C5, an octave below is C3, and so forth.

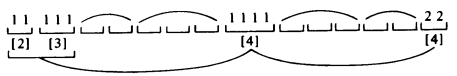
[13]To avoid unnecessary clutter, brackets are omitted here and elsewhere when notating melodic microstructures by means of strings of intervallic subdivisions.

Example 2. Ligeti, *Ramifications*, mm. 1–10

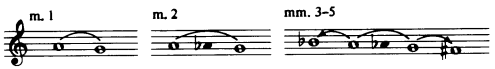
a) Pitch reduction



b) Equal divisions of [2], [3], and [4]



c) Structural cluster



supported by a triple pedal on the pitches A4–A♭4–G4, the inner cell of the structural cluster.[14]

The second type of net-structure is illustrated by mm. 10–24 of *Ramifications*. The score for a fragment of this section appears in Example 1. Example 3a displays the middleground structure of the complete passage: harmonic transformation results from constant intervallic expansion or contraction of trichordal cells, or, in Ligeti's own language, by "progressive metamorphosis of intervallic constellations."[15] Contraction and expansion are here again effected chromatically, following the model of chromatic transformation discussed above: harmonic cells change by half-step motion, one pitch and one voice at a time.[16] The pitch space of an interval pair (that is, a trichord) is represented by two superposed numbers—one for each interval—in brackets. The spatial position of the intervals within the pair is preserved in this notation: $\left[\begin{smallmatrix}2\\3\end{smallmatrix}\right]$ is thus a spatial inversion of $\left[\begin{smallmatrix}3\\2\end{smallmatrix}\right]$.

[14]Aspects of pitch symmetry in Ligeti's music have been explored by Bernard in "Inaudible Structures." Escot, on the other hand, has studied formal, registral, and spatial symmetries in *Continuum* and *Harmonies* ("Charm'd Magic Casements").

[15]Besides using the term "intervallic constellation" in the context cited in note 2, Ligeti also speaks of "constellations of pitches" to describe the processes of harmonic transformation in *Lontano*: harmonic units, or "chords," can be clearly heard until clouded over by "parasitic" notes which turn the previously clear harmonic structure into an "opaque plane." "In the middle of this opaque or neutral plane we then get signs of a new constellation of pitches which by degrees becomes more and more dominant. At first, the new constellation is barely audible. Gradually, however, the different parts gather together into the individual intervals which are later revealed in a bright light" (*Ligeti in Conversation*, 97).

[16]Twice in this passage voices move by whole-step instead of half-step (Example 3a, m. 20, group 1, top voice, D♭5–E♭5; and m. 23, group 2, bottom voice, F4–E♭4). The function of the whole steps in both cases is apparently to avoid octaves between the outer voices of the respective trichords.

The graph in Example 3a reveals that the interval [4], reached at m. 10, is subjected to two parallel transformations by the two instrumental groups (an example of the type of "ramification" to which the title of the piece refers).[17] In group 1, [4] first expands to [5], and at m. 15 becomes the trichord $[^{1}_{5}]$. A process of constant chromatic expansion of this interval pair leads to m. 26, where the expanding harmonic cell reaches its widest span in the form $[^{8}_{11}]$. During the process, a section of textural transformation (mm. 20–21) is delimited by $[^{2}_{8}]$ and $[^{6}_{8}]$, while in mm. 21–26 a passage of relative harmonic stability is based first on $[^{10}_{8}]$ and then on $[^{9}_{10}]$.[18] Group 2, meanwhile, presents an extension of the harmonic material by means of a series of expansions and contractions. An initial expansion leads from [4] to $[^{2}_{6}]$ at m. 20, followed by a contraction to $[^{2}_{1}]$ (m. 21), a symmetrical and spatially inverted expansion from $[^{1}_{2}]$ to $[^{6}_{2}]$ (m. 22), and a series of fluctuations, also symmetrical, around boundary interval [8] (mm. 22–23). Finally, at mm. 23–24, $[^{6}_{2}]$ expands to $[^{6}_{8}]$, the same pitch configuration which was reached at m. 21 by group 1.

A deeper level of middleground reduction appears in Example 3b. Jonathan Bernard's spatial trichordal configurations, which he applied originally to the music of Varèse, are suitable to demonstrate connections among interval pairs at this deeper level.[19] The intervallic configurations at the main points of structural articulation in group 1 are [2][8] and [6][8] (the trichords which begin and end the passage of textural transformation), [8][10] and [9][10] (the two relatively stable sonorities), and [8][11] (the trichord which closes the process of expansion). On the other hand, structural points in the harmonic fabric of group 2 (determined, in this case, by processes of chromatic expansion or contraction and by intervallic and spatial symmetrical designs) feature the same division of interval [8], that is [2][6]. Figure 1 illustrates the

Figure 1.

Basic Forms:	[2][6]	[8][10]
Derivatives:	[2][8]	[2][8]
	[6][8]	

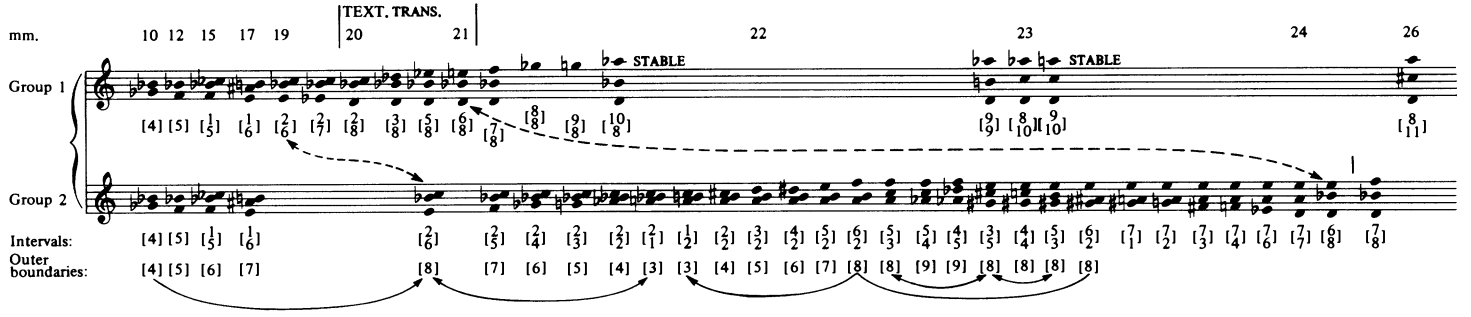
[17]"The title [*Ramifications*] refers to the polyphonic technique of the part-writing; in one skein, individual parts that are twisted together move in divergent directions so that the strands of the voices gradually become disentangled. The total form is made up of the alternation of ramification and unification of the parts and of the rents or bunching together of the net-formation that ensues from this" (from Ligeti's notes on *Ramifications*, Wergo WER 60095 booklet, 20).

[18]The term *textural transformation* (abbreviated "text. trans." in Example 3a) refers to progressive changes of patterns or figuration in all instruments. In this case, for instance, there is a progressive transformation of figuration beginning with the first violin in mm. 20–21: from the three-note cells separated by thirty-second note rests (m. 19) to the continuous arpeggiation of trichords in open position at m. 21 (shown in Example 1).

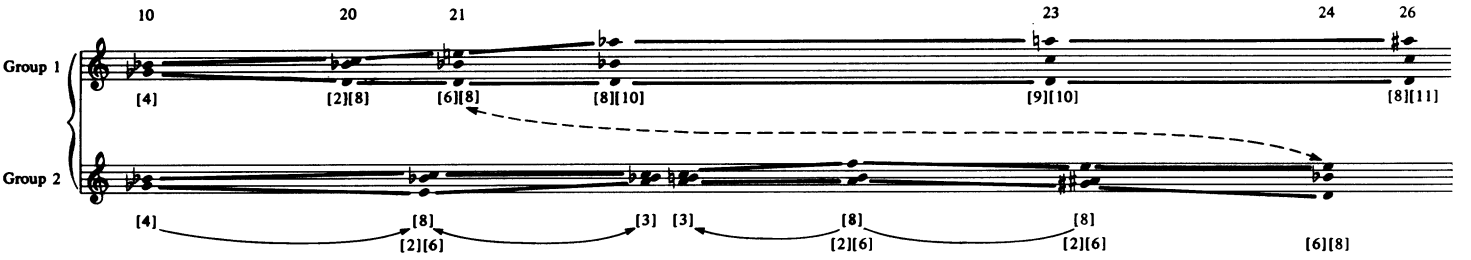
[19]Bernard refers to a pair of adjacent intervals by a series of bracketed numbers, the smaller interval preceding the larger. Thus, both $[^{6}_{2}]$ and $[^{2}_{6}]$ are equivalent, and represented by the configuration [2][6]. Any trichordal configuration has three related forms, called first-order derivatives. Bernard summarizes the operations that generate these related forms as follows: "For any trichord, or stack of two adjacent (unequal) intervals, there are two possible *unfoldings* and one *infolding*. The first term refers to the spatial operation in which one of the two intervals is taken outside the larger interval that encompasses both the adjacent intervals and attached there as a new adjacency; the second term denotes the placing of the smaller of the two intervals within the larger such that the two intervals continue to share one pitch" ("Voice Leading," note 12; see also *The Music of Edgard Varèse* [New Haven: Yale University Press, 1987], 74–75). Thus, [2][6] can be unfolded either to [2][8] or to [6][8], and infolded to [2][4]. An original configuration (*basic form*) together with its three derivatives constitutes what Bernard calls a *constellation*. Finally, two or more constellations are said to constitute a *family* when their basic forms hold a first-order derivative in common (*The Music of Edgard Varèse*, 97).

Example 3. Ligeti, *Ramifications*, mm. 10–24

a) Pitch reduction



b) Deeper middleground reduction



relationship among the configurations discussed above: [2][6] is the basic form of a constellation that includes [2][8] and [6][8] (both by unfolding), two prominent structural configurations in group 1. Yet the basic forms [2][6] and [8][10] intersect in [2][8], a first-order derivative common to both; [2][6] and [8][10] thus form a family of constellations linked by the common [2][8]. Finally, both [9][10] and [8][11] can be seen as closely-related chromatic alterations of [8][10].[20]

[20]Ligeti has often referred to his use of certain intervallic configurations (normally dyads or trichords) at points of structural and formal articulation in his music. Characteristic intervals contained in these configurations are, Ligeti says, octaves, tritones, or major seconds. Ligeti stresses in particular

Ligeti's description of harmonic transparencies in *Lontano* relates to the type of process just discussed and illustrated by Example 3a:

> The harmonic crystallizations contain several strata: inside the harmonies we find other subharmonies, which in turn contain new subharmonies, and so on. There is not a single process of harmonic transformation, but rather several simultaneous processes moving at different speeds. These layered processes are translucent, and by means of varied refractions and reflections they create an imaginary perspective.[21]

In our example, the two translucent processes moving at different speeds are defined by the two instrumental groups. The more complex process of group 2 expands the harmonies of group 1, and covers the same ground as the latter in a more elaborate way. Translucence is achieved by keeping one group static while the other moves at a faster harmonic rhythm: the [2][6] reached at m. 19 by group 1 is delayed for a full measure in group 2, and the [6][8] which closes the harmonic phrase in group 1 at m. 21 is not reached by group 2 until m. 24, after the fast chromatic development which we hear through the transparency of more stable harmonies in group 1.

Along with harmonic motion, Ligeti uses rhythm as one of the determining factors in the shaping of a net-structure's surface. Interweaving patterns in net-structures result, on the one hand, from the twining of melodic or harmonic strands as discussed above: various instruments present identical processes of chromatic transformation with a temporal displacement with respect to each other. On the other hand, strands are further interlaced, and the resulting designs constantly transformed, by means of layers of contrasting beat subdivisions and by processes of rhythmic transformation which parallel the harmonic processes. The opening measures of *Ramifications* feature four active rhythmic layers and a fifth layer of sustained tones, as shown in Example 4. The layers are made up of triplets, sixteenth notes, quintuplets, and sextuplets, respectively. All possible expectations of rhythmic regularity are broken by the irregular grouping of the pitches that constitute the fluctuating chromatic microstructures. Rests of different values are irregularly placed within the melodic cells, further differentiating the layers already moving at different speeds. In mm. 6–17, the layers undergo a process of written-in acceleration, first by the occasional introduction of smaller beat subdivisions (septuplets and thirty-seconds within the layer of sextuplets, for instance), and, after m. 12, by a systematic motion through successions of progressively smaller subdivisions. The transformation leads to m. 17, where all the voices join in a rhythmic continuum in thirty-seconds which is sustained, with minimal disturbances, until m. 32.

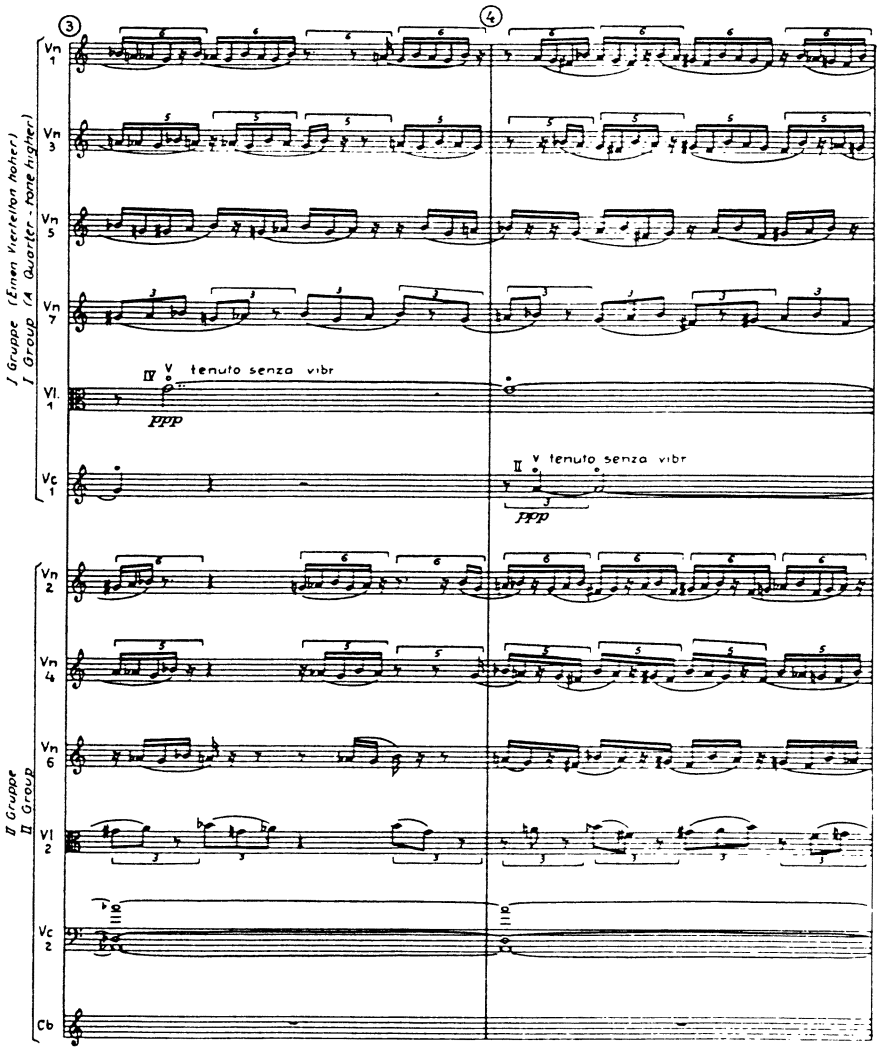
The irregular melodic cells which begin the piece turn into regular groups of two notes at m. 10, underlying the change of harmonic process, and by m. 17 the two-note groups have progressively become cells of three pitches. This texture made up of three-note cells in a continuum of thirty-seconds is illustrated by Example 1. Rhythmic processes in these

---

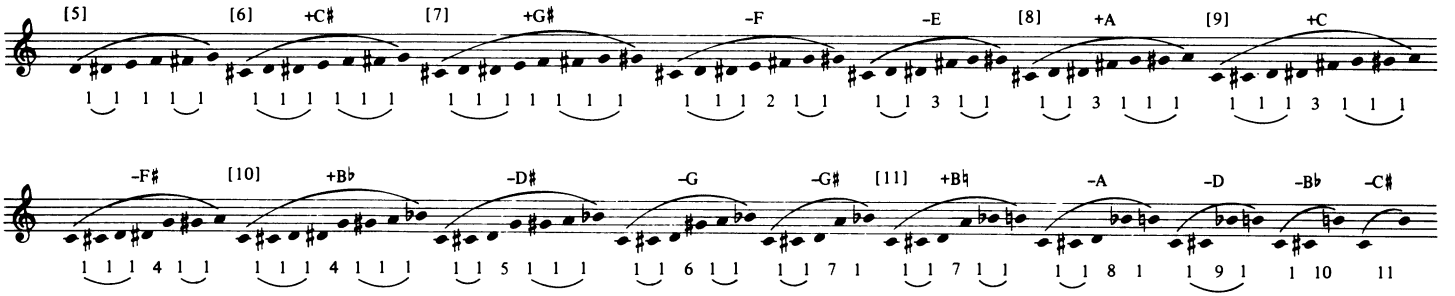
what he calls "another typical Ligeti signal": "a fourth made up of a minor third and a major second or the other way round" (*Ligeti in Conversation*, 29). In their commentaries on Ligeti's harmonic language, both Clendinning ("The Pattern-Meccanico Compositions") and Hicks ("Interval and Form") attach great structural significance to the "typical Ligeti signals" as a general principle. As the composer himself notes, the configuration [2][3] does indeed play a structural role in such pieces as *Lux Aeterna* and *Lontano* (see Bernard, "Inaudible Structures," 227, and Clendinning, "Contrapuntal Techniques," 140–48). In the compositions which I have analyzed, however, I have not detected any significant structural presence of any of the "typical Ligeti signals," which leads me to conclude that their role should not be overestimated or overstated. Clendinning's affirmation that cluster-like, chromatically-filled intervals can be thought of as being built from overlapping [2][3] trichords seems to be an example of the latter ("Contrapuntal Techniques," 147 and 235–36; "The Pattern-Meccanico Compositions," 201).

[21]Ligeti, "Anlässlich *Lontano*," n.p.

Example 4. Ligeti, *Ramifications,* mm. 3–4, score. © B. Schott's Soehne, Mainz, 1970. All rights reserved. Used by permission of European American Music Distributors Corporation, sole U.S. and Canadian agent for B. Schott's Soehne, Mainz.



Example 5. Ligeti, Chamber Concerto/I, mm. 56–62, pitch reduction



opening passages, in a way similar to the harmonic processes, are thus based on fluctuation and transformation. To paraphrase Ligeti, and transferring his harmonic concept to the rhythmic realm, one could speak of "progressive metamorphosis of rhythmic constellations."

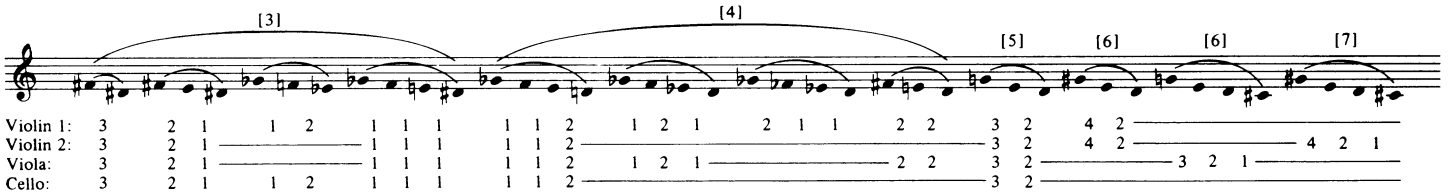
Examples from the Chamber Concerto and the Second String Quartet illustrate Ligeti's use, in other compositions of the same period, of the two types of net-structures just discussed. A net-structure, complex in both texture and surface pitch content, closes the first movement of the Chamber Concerto (mm. 56–62). A reduction of the passage reveals the series of pitch collections used by all instruments, as well as the process of constant harmonic transformation undergone by the collections and effected by means of subtraction and addition of single pitches. The expanding pitch structures that result from the process present the alternation of symmetrical and asymmetrical states illustrated by Example 5. A chromatically filled-in [5] expands to a [7] by addition of C♯ and G♯. The deletion of F at m. 57 creates a momentarily asymmetrical [7], immediately balanced by the deletion of E, which results in the symmetrical configuration [1][1][3][1][1]. The addition of A, which produces an unstable [8], is balanced by the addition of C and the consequent symmetrical configuration of [9]. A similar process of alternation of asymmetrical and symmetrical configurations by addition and subtraction of pitches produces the expansion both of the outer boundaries of the collections and of the inner gap between the clusters of semitones, which become progressively compressed towards the edges of the configuration. By m. 60, a balanced [1][9][1] becomes [1][10] by deletion of B♭, and finally turns into the open [11] on which the movement closes.

Movement V of the Second String Quartet opens with a net-structure in which chromatic fluctuation of microstructures is combined with intervallic expansion.[22] The opening [3], D♯4–F♯4, expands to [7] by m. 13, where a major and sudden registral expansion occurs. Example 6a contains a middleground pitch reduction of the passage, mm. 1–13, showing the intervallic expansion from [3] to [7], and the chromatic fluctuation within both [3] and [4]. (Only the first-violin part contains each of the microstructures which result from chromatic fluctuation within [3] and [4], while

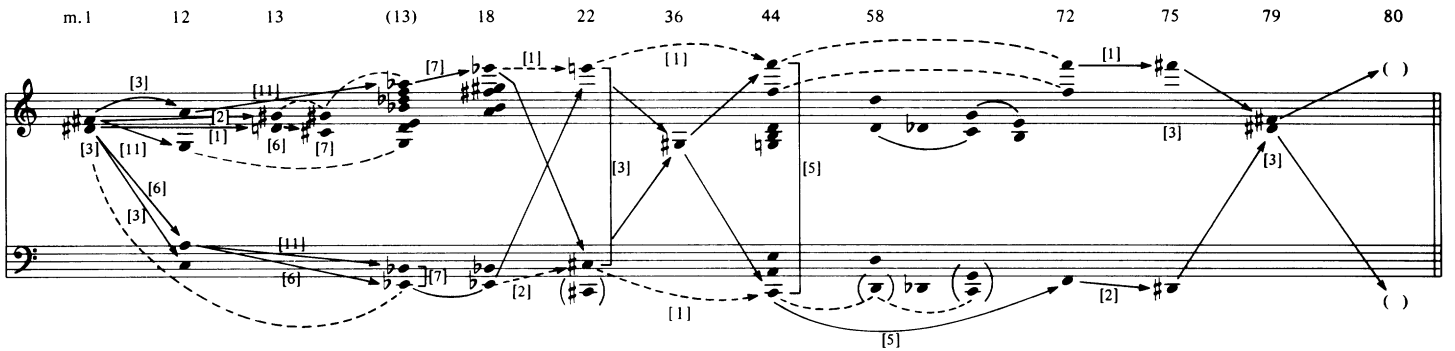
[22]A detailed analysis of this movement appears in Clendinning, "Contrapuntal Techniques," 221–29.

Example 6. Ligeti, Second String Quartet/V

a) Mm. 1–13, pitch reduction



b) Long-range pitch reduction



the remaining three instruments sustain some of the microstructures—as indicated by horizontal lines on the graph—and omit others.) The long-range pitch coherence of the complete movement is illustrated by Example 6b, which displays the voice-leading connections between major points of formal articulation. Before examining this example, however, some methodological questions concerning the implications of such a reductive graph need to be addressed. Do such concepts as prolongation, directed motion, and pitch centricity apply in any way to the music of Ligeti which we are analyzing? Or, to begin with a more general question, is this music linear (that is, driven by the type of progression in which events are somehow generated by earlier events) or nonlinear (that is, governed by principles which inform the entire piece or section, but which do not create a cause-effect relationship between successive events)?[23]

[23]Jonathan Kramer thoroughly discusses linearity and nonlinearity in music in *The Time of Music* (New York: Schirmer Books, 1988), 20–65.

Ligeti has referred to his interest in musical forms which are "object-like," rather than "process-like," as well as to the non-teleological nature of his musical time. Concerning *Lontano*, for instance, Ligeti declares: "It is music that gives the impression that it could stream on continuously, as if it had no beginning and no end; what we hear is actually a section of something that has eternally begun and that will continue to sound forever."[24] The type of harmonic processes discussed in this essay, however, do not result in anything like the static, non-linear music with "no beginning and no end" which Ligeti describes. Extended harmonic processes, moreover, produce by definition musical forms which are "process-like" rather than "object-like," and which feature linear motion, no matter how slow it may be. Examples 3 and 7 illustrate passages that could hardly be considered static, on account of the distinctive stepwise linear motion which defines their harmonic contents. Moreover, linear pitch transformation is supported by such contextual factors as textural and timbral transformations. Linear motion, however, does not necessarily imply directionality towards predictable goals. Unequivocal goals cannot be defined in Ligeti's music any more than in most post-tonal music. The [2][6] configuration has structural significance in the passage reduced in Example 3, but in no way does it function as a goal, nor can any of the configurations in the example be considered structurally stable.

Thus, while stepwise voice leading is one of the elements which Ligeti uses to achieve foreground—and even, in some cases, middleground—pitch coherence, the absence both of unequivocal goals and of any kind of background stability precludes the idea of goal-directed linearity at the structural level. Jonathan Kramer refers to the time sense exhibited by such type of music as "nondirected linearity": goals in this music are unpredictably defined as they happen, rather than having been explicitly established by either such contextual means as previous reiteration or emphasis, or by a priori references to "neotonal" procedures.[25]

What is, then, the role of prolongation in music which is linear but nondirected? In the absence of a universal, unified structural system underlying post-tonal music (a system in some way analogous to functional tonality), the definition of generalized criteria to substantiate a theory of prolongation in the post-tonal repertoire has not been possible.[26] Paul Wilson has noted that even in a body of music with such strong underlying tonal references as Béla Bartók's, while one can find surface prolongational gestures "derived from contexts," "on the larger scale the prolongational hierarchy is much weaker."[27] Even if we could define that which will be prolonged (such as an interval or a pitch-class set), the *means* of prolongation cannot be easily established. Joseph Straus has suggested four conditions for the possible application of a prolongational model to post-tonal music.[28] Ligeti's music does not meet any of the four conditions; neither does it meet Wilson's requirements for the establishment of musical

[24]*Ligeti in Conversation*, 84. See also Ligeti, "On My *Piano Concerto*," 13.

[25]Kramer, *The Time of Music*, 32–40.

[26]James Baker reviews the most significant prolongational studies of post-tonal music in "Schenkerian Analysis and Post-Tonal Music," in *Aspects of Schenkerian Theory*, ed. David Beach (New Haven: Yale University Press, 1983), 153–86.

[27]Paul Wilson, "Concepts of Prolongation in Bartók's Opus 20," *Music Theory Spectrum* 6 (1984), 89.

[28]Joseph Straus, "The Problem of Prolongation in Post-Tonal Music," *Journal of Music Theory* 31 (1987): 1–21. Straus's four conditions (pp. 2–5) are, in summary: 1) the consonance-dissonance condition (there must be a way based on pitch to distinguish between structural and non-structural tones); 2) the scale-degree condition (there must be a harmonic hierarchy of consonant harmonies); 3) the embellishment condition (there must be a consistent set of relationships between tones of lesser and greater structural weight); and 4) the harmony/voice-leading condition (there must be a clear distinction between the vertical and horizontal dimensions).

hierarchies.[29] As Straus points out, however, we should not throw out the baby of large-scale organization along with the prolongational bath water. Straus proposes an "associational model" as an alternative to prolongation: given three successive musical events, X, Y, and Z, we may establish contextual connections between X and Z without commenting one way or another about Y.[30] Middleground linear designs may be determined in this way without having to justify them by prolongational means.

In his study of middleground step connections in Ligeti's *Ten Pieces for Wind Quintet*, Charles Morrison finds contextual voice-leading relationships which are convincing in the way they link points of structural articulation.[31] Morrison, however, does not explain his use of the terms "prolongation," "directed motion," or "pitch centricity" in reference to the pieces he analyzes. For instance, he finds a linear connection between "high pitches" (that is, using the contextual criterion of register) in the tenth piece, but he does not substantiate his claim of prolongation by taking into account the intervening pitches.[32] And, as already noted, the concept of directed motion ruled by pre-established harmonic functions or hierarchical structures is foreign to Ligeti's music. We can determine the initiating and goal events of sections a posteriori, and then, using what Morrison calls "contextual anticipation," we can anticipate the primary points of articulation. However, a music which does not have a consistent set of hierarchical functions does not become goal-directed simply because, as Morrison writes, "once the piece is familiar" we are aware of a "contextually directed stepwise continuity" (which, however, we cannot hear as leading to a goal).[33]

As for pitch centricity, it must be established by such means as repetition, symmetry, prolongation, or by a hierarchical design of some kind. Again, none of these are present in Ligeti's music, at least beyond short foreground spans. Even when Ligeti uses extended pedals in some passages, we cannot determine any kind of systematic hierarchical organization of other pitches around this potential center. Ligeti himself has disavowed the idea of tonal centers in his music, while indicating the real determinants of underlying structures in his compositions:

> The musical language of this work [the Chamber Concerto], as is the case in all my compositions since the middle sixties, is neither tonal nor atonal. There are no tonal centres, nor are there any harmonic combinations or progressions which can be functionally analyzed; on the other hand the twelve notes of the chromatic scale are not treated as notes of equal importance, as in atonal and serial music. There are specific predominant arrangements of intervals which determine the course of the music and the development of the form.[34]

The graph in Example 6b, a long-range reduction of the Second String Quartet/V, does not imply any prolongation or directed motion. Rather, it illustrates how middleground coherence in this movement is provided by voice-leading designs and by intervallic relationships which connect the vertical and horizontal dimensions. Specific middleground pitches, while influenced by such contextual considerations as register, duration, and textural changes, are mostly determined

[29]Paul Wilson, *The Music of Béla Bartók* (New Haven: Yale University Press, 1992), 42. His three conditions are: 1) the music must display, and a theory of it must recognize, a differentiation in the structural weight of events within a given musical context; 2) we must be able to discern within such a context some consistent organization of such differentiations, and that organization must involve more than one span of time; and 3) we must be able to specify the musical conditions that give rise both to those differentiations of structural weight and to the organization that encompasses them.

[30]Straus, "The Problem of Prolongation," 13.

[31]Charles Morrison, "Stepwise Continuity as a Structural Determinant in György Ligeti's *Ten Pieces for Wind Quintet*," *Perspectives of New Music* 24 (1985): 158–82.

[32]Ibid., 168–69.

[33]Ibid., 159.

[34]György Ligeti, liner notes on LP DECCA-headline 12 (1976).

here by their role in establishing and signaling points of formal or sectional articulation.

Before explaining the graph, however, one more methodological matter needs to be addressed. Jonathan Bernard has appropriately pointed out that such concepts as inversional and octave equivalence, fundamental to pitch-class set theory, must be ruled out in studies which take into account pitch structure in its spatial context.[35] Bernard's commitment to criteria of absolute intervallic size and distance is essential to his analyses of pitch space in the music of both Varèse and Ligeti. The central focus of the present study, however, is on the intervallic relationships within harmonic and structural processes in Ligeti's net-structures—while certainly recognizing the spatial nature of such processes. Absolute intervallic size presents obvious problems in comparative discussions of intervallic relationships; it may not be immediately apparent that interval [27] is [3] enlarged by two octaves (i.e., a compound [3]). For purposes of clarity in the comparison of intervallic structures, I use octave equivalence (although not inversional equivalence) in the following commentary to Example 6b. That is, numbers in brackets do not necessarily denote absolute size, but rather may refer to compound intervals reduced to their simple octave equivalents, without implying in any way pitch position in a spatial context. The graph itself, however, preserves the registral and spatial properties of pitches. This allows the reader to verify visually whether a particular interval actually appears in the music in simple or compound form.[36]

[35]*Varèse*, 43–44 and 102. See also "Voice Leading."

[36]Bernard recognizes that octave equivalence may indeed be used under certain circumstances even in discussions of pitch in a spatial context. Thus, after unequivocally dismissing inversional equivalence, he writes: "Octave equivalence, however, is different *if* it is consistently employed with reference only to interval sizes and not to the positions of individual pitches. That is, octave equivalence does not mean that a pitch in one octave means the same thing as it would in any other octave, but that an interval enlarged or shrunk by an octave (or compound octave) has, *for some purposes only*, a meaning equivalent to its unaltered form" (*Varèse*, 102).

The fifth movement of the Second String Quartet begins (mm. 1–13) with the net-structure discussed above, which is based harmonically on the transformation of the opening [3] into the microstructures [6]=42 and [7]=421 at m. 13. [3], [6], and [7], together with [11], are, indeed, the principal middleground voice-leading intervals in this opening section. An abrupt registral expansion at m. 13 projects the G♯4 of the net-structure an octave above, to A♭5, while a double pedal [7], E♭2–B♭2, is established by the cello. A sustained open-string chord, which beginning at m. 12 accompanies the continuing net-structure patterns, constitutes an intervallic and registral link between the opening [3] and the expanded texture at m. 13. The initial D♯4 is projected two octaves lower, to E♭2 in the cello, by means of the cello's open A3 at m. 12 (hence, by means of two successive [6] motions, the second of which is a compound [6]). The initial F♯4 and D♯4 are respectively related by [3] to the highest and lowest pitches in the open-string chord, the first violin's A4 and the viola's C3. The second violin's open G3, at a distance of [11] from the initial F♯4, is an anticipation of the G3 at m. 13, the lowest pitch in the texture other than the cello's double pedal. Finally, there is a symmetrical registral expansion of the two As in the open-string chord: A4 in the first violin is transferred up an [11] to A♭5, the highest pitch in the expanded texture at m. 13, while A3 in the cello undergoes a double projection to become this instrument's double pedal, and thus moves down an [11] to B♭2, as well as a compound [6] to E♭2, as already mentioned.

The double pedal E♭2–B♭2, a vertical [7], is sustained until m. 18, while the highest voice of the texture moves (by steps of [1] or [2]) from A♭5 to E♭6, a horizontal [7]. A sustained chord at mm. 18–20 signals a change of section and texture. Cadenza-like runs in the second violin/viola and in

the cello effect a voice- and register-exchange, whereby E♭6 is taken down to C♯3, and E♭2 is projected up to E6. The resulting sonority, C♯–E, reached at m. 22 and sustained until m. 30, is a transposed and registrally-expanded version of the opening [3]. The ensuing section of cadenzas in all instruments is closed at mm. 36–37 with a unison on G♯3. A series of abrupt registral expansions (mm. 40–43) leads to the sonority at m. 44, which marks the beginning of a new texture and section and which is contained within the outer boundaries C2–F5/F6, a compound [5]. A closing net-structure is woven by the two violins (mm. 58–72) over an extended series of pedals in the cello and viola which provide a long-range "melodic flourish" of C2 from m. 44 (C–D–D♭–C, mm. 58–69). The F5–F6 high octave from m. 44 is re-established at m. 72, while the vertical [5] from m. 44 finds its horizontal projection in the long-range C2–F2 in the cello (mm. 44–72). The movement closes, in a gesture of tonal and formal balance, with a return to the original D♯–F♯ [3] in all instruments (as an open, sustained D♯2–F♯6 in cello and viola, and a closed D♯4–F♯4 tremolo in the two violins), followed by a final cadential figure in which, as Ligeti instructs on the score, "all four instruments disappear suddenly, as though into nothingness."[37] In summary, this movement illustrates Ligeti's use of long-range stepwise voice-leading and of unity of intervallic content in the vertical and horizontal dimensions as means to connect points of formal articulation, and hence to provide pitch coherence to a non-tonal middle-ground structure.

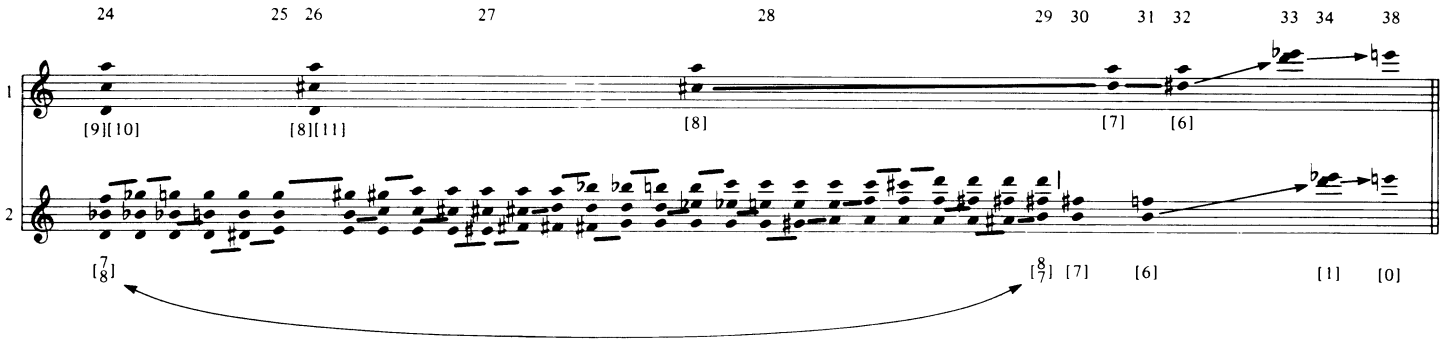
The two types of net-structures studied so far, based respectively on chromatic fluctuation of microstructures and on expansion and contraction of intervallic constellations, illustrate how these highly-chromatic webs in constant transformation, so intricately crafted at the surface level, are supported at the formal level by long-range intervallic configurations and by different layers of formal symmetries. Two more types of net-structures based on less complex pitch processes can be found in *Ramifications*. One is generated by constant chromatic transformation of triadic units. The $[^{6}_{8}]$ which at m. 24 closes the section discussed above, immediately turns into a $[^{7}_{8}]$ (a triad in open position) by half-step ascending motion in the top voice. The same process of chromatic transformation by half-steps one voice at a time continues through m. 29, as shown in Example 7. The last triadic unit, the $[^{8}_{7}]$ at m. 29, is a spatial inversion of the initial $[^{7}_{8}]$ configuration. The triadic cell in both orchestral groups then becomes a single interval which undergoes a process of contractions and expansions leading from interval [8] to interval [0], a unison on E6 in all instruments at m. 38.

The fourth type of net-structure, even simpler in pitch content, features textures, totally static in pitch, built on complex overlapping rhythmic relationships, as illustrated by mm. 61–71 of *Ramifications*. Rhythm, timbre, and dynamics are the elements in transformation in this passage (a fragment of which appears in Example 8). Otherwise, all voices share the same melodic microstructure, a [4] on A♯3 filled in by half-steps (A♯–B–C–C♯–D, a spatial inversion of the [4] G♭–B♭, which constitutes the outer boundaries of the opening net-structure in mm. 1–10). The initial measures of the passage feature simultaneous layers of seven different beat subdivisions. Progressive written-in acceleration within each of the layers eventually leads to rhythmic uniformity—all voices in thirty-seconds—reached at m. 66.

The filled-in A♯–D melodic microstructure begins in each voice on a different thirty-second, with the result that in each thirty-second the complete microstructure is heard harmonically, producing a total spatial unity of vertical and horizontal

[37]One should not be tempted, however, to make too much of this "tonal" return to the opening [3], which in itself is no proof of pitch centricity or prolongation of any kind. As Straus correctly points out, "mere departure and return do not constitute prolongation" (Straus, "The Problem of Prolongation," 6).

Example 7. Ligeti, *Ramifications,* mm. 24–38, pitch reduction

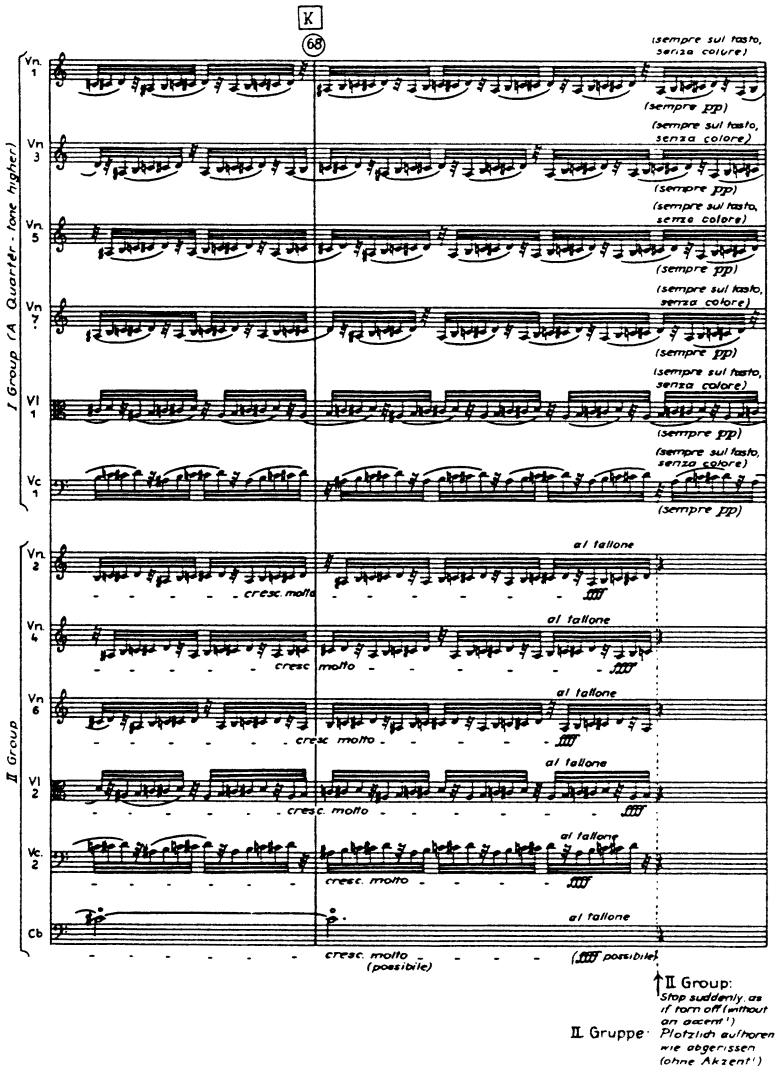


pitch content. The following words, written by Ligeti on the occasion of the performance of his Piano Concerto, are applicable to this texture: "I favor . . . music as a structure that, despite its unfolding in the flux of time, is still synchronically conceivable, simultaneously present in all its moments. To hold on to time, to suspend its disappearance, to confine it in the present moment, this is my primary goal in composition."[38] Once the *perpetuum mobile* in thirty-seconds is reached at m. 66, stasis in pitch and rhythm do indeed result in a momentary suspension of temporal linearity, disturbed only by a process of timbral and dynamic transformation. After slowly changing from *pp sul tasto senza colore* to *ffff al tallone*, group 2 suddenly stops "as if torn off" at m. 68, leaving group 1 sounding in the *pp sul tasto senza colore* which it had never abandoned.

In contrast to the stasis of the previous section, a transitional passage of scales treated canonically (mm. 71–73) leads to the most complex net-structure in the entire piece, mm. 73–81. The passage begins with fast lines in half-step tremolos, followed by a highly chromatic and accelerating antiphonal dialogue between the two orchestral groups. The blocks of sound alternating between the two groups become progressively shorter in length while the intervallic content of the tremolos becomes progressively wider. The pitch content of each of the simultaneous instrumental tremolos which constitute the antiphonal blocks is different, and so are the exact processes of intervallic expansion in each instrument. The general harmonic process, however, is of expansion from the initial [1] (C6–D♭6, m. 73) to the intervals that make up triads in open position: [7], [8], and [9] (perfect fifth and major and minor sixths). Indeed, this section is immediately followed by a triadic net-structure totally based on these three intervals. Two characteristics of net-structures present in this passage (mm. 73–81) are the rhythmic interweaving of the overlapping antiphonal figures and the progressive expansion of intervallic patterns. On the other hand, the tonal complexity of the fragment and its fast chromatic and intervallic transformation contrast with the harmonic processes in other types of net-structure. From both a formal and a tonal point of view, this section represents the counterpart to the unison passage on E6 at mm. 38–46.

[38]Ligeti, "On my *Piano Concerto*," 3.

Example 8. Ligeti, *Ramifications,* mm. 67–68, score. © B. Schott's Soehne, Mainz, 1970. All rights reserved. Used by permission of European American Music Distributors Corporation, sole U.S. and Canadian agent for B. Schott's Soehne, Mainz.



FORMAL PROCESSES

Ligeti thinks of form as a process of temporal transformation, while shunning developmental, hierarchical formal models. The composer recognizes that his idea of form was most directly influenced by Webern and Debussy, and also by Varèse and Messiaen.[39] The main types of form which he identifies among his compositions are the "balanced, or static forms" (as in *Atmosphères* and *Lontano*); the "dynamic, restless, fragmented forms" (which he also calls "interlocked" or "split"), as in *Aventures*; the forms "like a precision mechanism," discussed above (as in *Continuum*, Second String Quartet/III, and Chamber Concerto/III); and the "kaleidoscopic" type, made up of "separate and contrasted musical shapes" (as in *Ten Pieces for Wind Quintet*).[40] In the compositions based on net-structures, which fall into the category of "balanced, static forms," the harmonic, intervallic, and rhythmic metamorphoses become the main structural functions of the form-generating textures. We do not perceive thematic developments, but rather textural processes in constant states of transformation. Such forms may be considered "balanced or static" because they do not feature long-range directional tensions, because they do not break up into hierarchical or mutually-dependent components, and hence because each moment within the process has the same formal significance as any other moment.

In the absence of conventional formal markers (such as phrases, themes, thematic relationships, cadences, or directed harmonic motion), sectional determination is not always immediately clear in net-structure compositions. Knowledge of the inner harmonic processes, however, provides identifying criteria from a formal point of view. My decisions on form and sectional divisions have been based on the following factors: a) harmonic, intervallic, and spatial processes, insofar as their beginning and end can be established, b) rhythmic processes, which are often parallel to the harmonic processes, c) textural changes, which usually also accompany changes in harmonic process, d) clearly emphasized means of formal articulation (such as a sustained rest or a sustained chord between texturally contrasting sections), and e) auxiliary factors of sectional definition such as instrumentation and dynamics.[41]

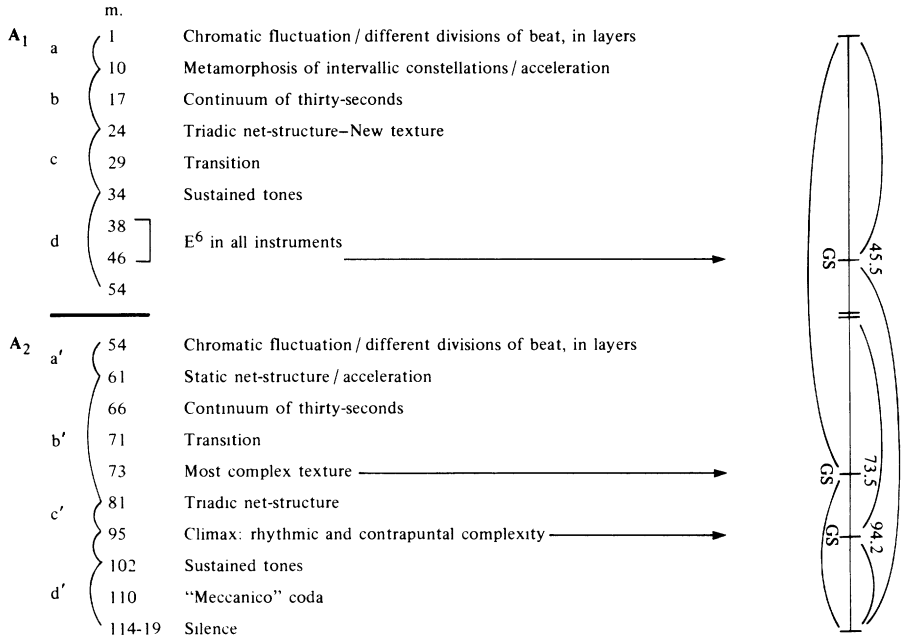
Ramifications provides a good example of form generated by harmonic, rhythmic, and textural transformation. The composition can be divided into two major parts (A_1, mm. 1–54, and A_2, mm. 54–119), each of which in turn contains four large sections, as illustrated by the formal outline reproduced in Figure 2. The main formal division at m. 54 is marked by the conclusion of a static twenty-measure section of sustained tones and the beginning of a new net-structure similar, in its harmonic and rhythmic characteristics, to the initial net-structure. The opening section (*a*), mm. 1–10, features chromatic fluctuation of microstructures within the boundaries F♯4–B♭4, which, as discussed in connection with Examples 2 and 4, is presented in rhythmic layers with different divisions of the beat. While no visible section change occurs at m. 10, a new formal/harmonic unit (*b*) starts at this

[39]"I learned from Webern that form is not a development (there are certainly temporal transformations, but there are not developments as in a sonata, where a theme is developed) and that all moments of a piece have the same importance. This already exists, for that matter, in *Jeux* and in Debussy's *Études*, which are also crucial works from this point of view." Michel, *György Ligeti*, 140–41; all translations from Michel's book are by the present author.

[40]*Ligeti in Conversation*, 134–35.

[41]In her study of "pattern-meccanico" compositions, Jane Clendinning relies on range or pitch-space as "the primary agent in creating both sectional coherence and division between sections." She also uses two additional criteria: "harmonic practice," equivalent to my "harmonic processes," and "perceived variation in the pacing," a combination of my "rhythmic processes" and "textural changes." See Clendinning, "The Pattern-Meccanico Compositions," 205–6.

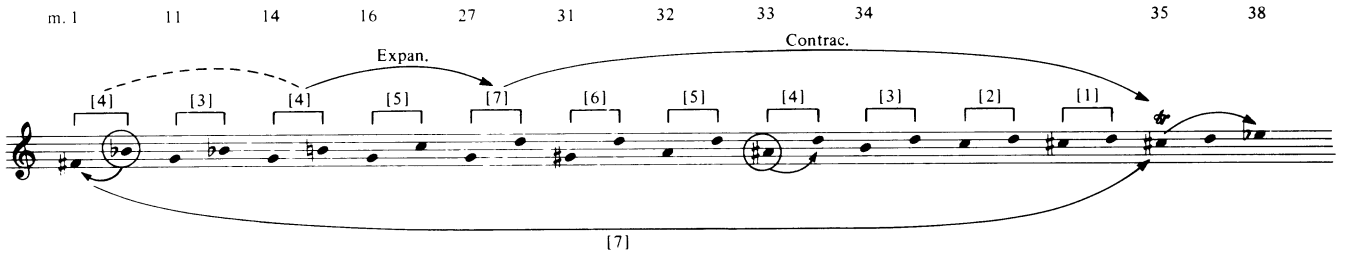
Figure 2. Ligeti, *Ramifications,* formal outline (GS = golden section)



point. The outer pitches of the previous melodic microstructure (G♭–B♭) become a trichordal configuration which is then constantly transformed through m. 24 by means of a chromatic process of intervallic and spatial expansion and contraction ("metamorphosis of intervallic constellations," see Example 3). The process of rhythmic acceleration which begins at m. 12 leads, by m. 17, to the continuum of thirty-seconds which remains through m. 33. The prevailing texture in the *b* section, made up of overlapping three-note cells in thirty-seconds, separated by a thirty-second rest (Example 1), turns, by m. 24, into a net-structure of triadic cells in uninterrupted thirty-seconds (section *c*, see Example 7). A transitional passage leads to the closing section of A_1, *d* (mm. 34–54), featuring sustained tones in all instruments, and including the passage on the unison E6 (38–46).

A_2 (mm. 54–119), which can be seen as a macrovariation of A_1 because of the formal parallelisms between the two sections, opens with a net-structure based on chromatic fluctuation of microstructures, also presented in rhythmic layers with different divisions of the beat (*a'*, mm. 54–61). A static

Example 9. Ligeti, Chamber Concerto/I, mm. 1–38, transformation of outer boundaries



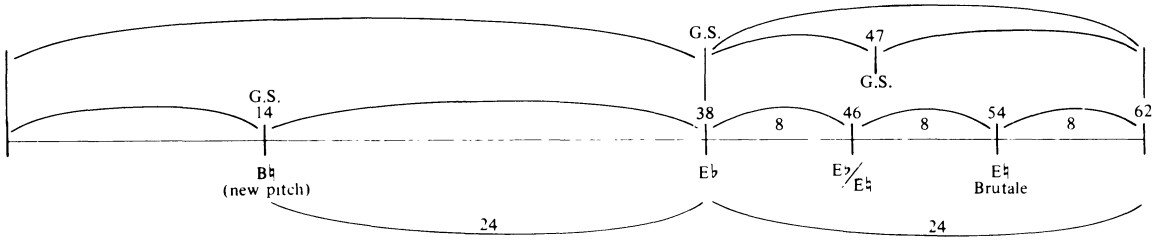
net-structure on the filled-in [4] A♯–D, (*b′*), features an acceleration to a continuum of thirty-seconds (Example 8), followed by the most complex net-structure in the composition, the antiphonal passage at mm. 73–81. Section *c′* parallels section *c* by starting with a triadic net-structure and leading, at m. 102 (after a six-measure forceful, climactic contrapuntal passage), into a section based on sustained tones (*d′*, mm. 102–10) which functions, as did section *d* before it, as a relief to the rhythmic and harmonic activity that preceded it. The piece closes with a coda in "meccanico" style and five measures of silence.

Especially noteworthy in *Ramifications* is the placement of textures that break the perpetual flow of net-structures. A_1 closes with the static section of sustained notes with very soft dynamic markings (*p* to *ppppp*), in which, as already discussed, all instruments converge on a high E in harmonics extending from m. 38 to m. 44, and *morendo al niente* by m. 46. The golden section from the end of the piece, which has a total of 119 measures, occurs at m. 45. Conversely (and symmetrically), the most complex passage in the whole composition both texturally and tonally (the antiphonal net-structure) starts at m. 73, the golden section from the beginning. Finally, the dynamic climax of the piece, the section of furiously accented counterpoint (*fff possibile*), begins at m. 95, the golden section of A_2.

Similar formal relationships can be found in the first movement of the Chamber Concerto. The opening net-structure, which results from the canonic treatment of melodies with a limited pitch-content, is based on chromatic fluctuation within the space of [4] F♯4–B♭4 (mm. 1–13, see Example 9 and Figure 3).[42] In mm. 14–35 the outer boundaries of the texture first expand from [4] to [7], and then contract by half-steps, converging on a C♯5–D5 trill (m. 34). It will be noticed that the total range of the complete section, [8] F♯4–D5, is symmetrical around B♭4, the upper boundary for the opening [4]. Thus, mm. 14–33 provide a spatial and registral balance to mm. 1–13, with B♭4 as a pivotal axis for the [4] below and above it. The C♯–D trill leads, by half-step mo-

[42]This is, incidentally, the same boundary interval which, in the opening section of *Ramifications*, is subjected to a similar process of inner chromatic fluctuation. An analysis of the melodic and canonic structure of this movement can be found in Clendinning, "Contrapuntal Techniques," 252–72. See also Michel, *György Ligeti*, 208–20.

Figure 3. Ligeti, Chamber Concerto/I, formal proportions (GS = golden section)



tion, to the major point of formal articulation, a sustained E♭ in six octaves beginning at m. 38, the golden section from the end of the movement.[43] The E♭ unison is equidistant by 24 measures from both the final measure (62) and m. 14, where the French horn prominently comes in with a sustained B, the first new pitch over the opening net-structure on the F♯–B♭ static chromatic space. It will be noted that m. 14 is itself the golden section for the first part of the movement (from the beginning to the E♭ unison, mm. 1–38); and that, conversely, the golden section for the second part (mm. 38–62) is marked by the only measure in the whole movement which contains the total chromatic collection of 12 pitches (m. 47). Underlying pitch events determine a further division of the second part of the movement into three eight-measure sections. The E♭ pedal which is established at m. 38 becomes a double pedal, E♭/E, at m. 46. And at m. 54 an E pedal is established by a prominent entry of the clarinet, trombone, and double bass, marked *sub. fff brutale*, thus creating an extended E♭–E♭/E–E pedal design which spans the whole second part.

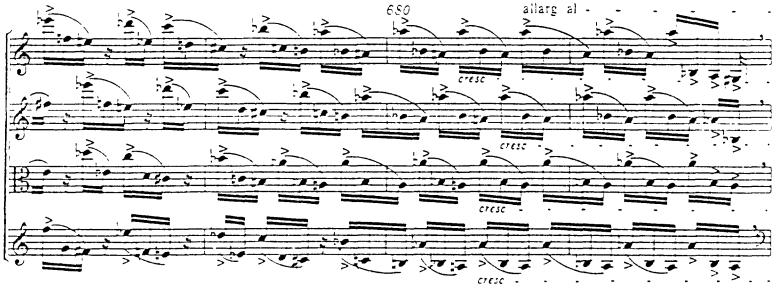
Ligeti's net-structures are thus supported by carefully balanced harmonic processes which display both symmetrical arrangements and long-range intervallic structural relationships. These sonorous gestalts, which integrate the constant transformation of such elements as harmony, rhythm, texture, timbre, register, and dynamics, generate large formal designs governed by the golden mean and other proportional relationships.

Jonathan Bernard has noted that Ligeti's penchant for symmetrical constructions is one of the marks of Bartók's influence on the younger Hungarian composer.[44] The same can be said of Ligeti's fondness of formal proportional relationships, and specifically of his use of the golden section at the formal level. Asked whether *Víziók* (1956), a work of

[43]The movement has a total of 62 measures. It may be objected that using these "measures" to locate golden sections is implausible, since these measures are of widely varied length and *tempi*, and some of them simply denote long passages of "unmeasured" cadenza-like lines, marked *senza tempo*. This objection is well founded, and it invalidates any temporal or durational golden-section proportions. However, Ligeti's "measure" numbers are still a fact, and they provide a tangible, legitimate way of establishing abstract formal relationships based on the golden section, such as the ones discussed here.

[44]Bernard, "Inaudible Structures," 211. One may add that it is also a mark of Webern's influence on Ligeti, who declares: "There is always in Webern a concern for symmetrical units with respect to both rhythm and pitch. I was very fascinated by this when I analyzed his works" (Michel, *György Ligeti*, 140).

Example 10a. Ligeti, First String Quartet, mm. 678–81. © B. Schott's Soehne, Mainz, 1972. All rights reserved. Used by permission of European American Music Distributors Corporation, sole U.S. and Canadian agent for B. Schott's Soehne, Mainz.



the Hungarian period which would become *Apparitions* two years later, was written in the language of Bartók, Ligeti answered:

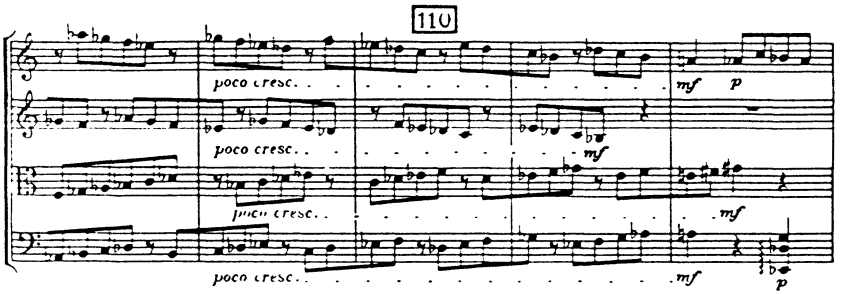
> No! These were already static conglomerates, without melody or rhythm, which were even constructed following geometrical proportions. Certainly, I used the golden section, a direct influence from Bartók. You undoubtedly know about Lendvai and his theory on the golden section in Bartók . . . I was very close to Lendvai and appreciated him very much. His reflection on the golden section led me to musical forms without melody, harmony, or rhythm, with sound masses, chromatic sound complexes organized according to the golden section; at the time I thought in a very geometrical way.[45]

Bartók's influence on the technique of net-structures should also be remarked. The principle of metric displacement of a melodic cell and of displacement of the different voices bearing the cell among themselves, one of the defining characteristics of net-structures, is present in many of Bartók's works, notably in some of the string quartets, which had such an early impact on Ligeti. The latter's own First String Quartet (1953–54), one of the major works of his Hungarian period, was influenced, as the composer acknowledges, by both Bartók and Alban Berg's *Lyric Suite*.[46] Some passages in the quartet not only show Bartók's effect on Ligeti's ex-

[45]Michel, *György Ligeti*, 131. See also *Ligeti in Conversation*, 43. Ligeti's use of the golden section has not gone unnoticed by analysts. Thus, Michael Hicks has remarked on the formal role of the golden section in *Continuum* ("Interval and Form," 177), and Charles Morrison has uncovered golden section relationships in both the first and third pieces of *Ten Pieces for Wind Quintet* ("Stepwise Continuity," n. 12).

[46]*Ligeti in Conversation*, 88. The *Lyric Suite*'s third movement, *Allegro misterioso*, contains some of the textural, rhythmic, and metric characteristics discussed above in connection with Ligeti's net-structures.

Example 10b. Bartók, Fourth String Quartet/IV, mm. 108–12. © Copyright 1937 by Universal Edition; Copyright Renewed. Copyright and Renewal assigned to Boosey & Hawkes, Inc. Reprinted by permission.



perimentation with metric displacement, but also prefigure his later technique of net-structures. Example 10 compares mm. 678–81 from Ligeti's quartet (10a), along with mm. 108–12 from Bartók's Fourth String Quartet/IV (10b), and mm. 100–110 from *Music for Strings, Percussion, and Celesta*/II (10c). All three passages may in turn be compared with the fragment of *Ramifications* in Ex. 1 above.[47]

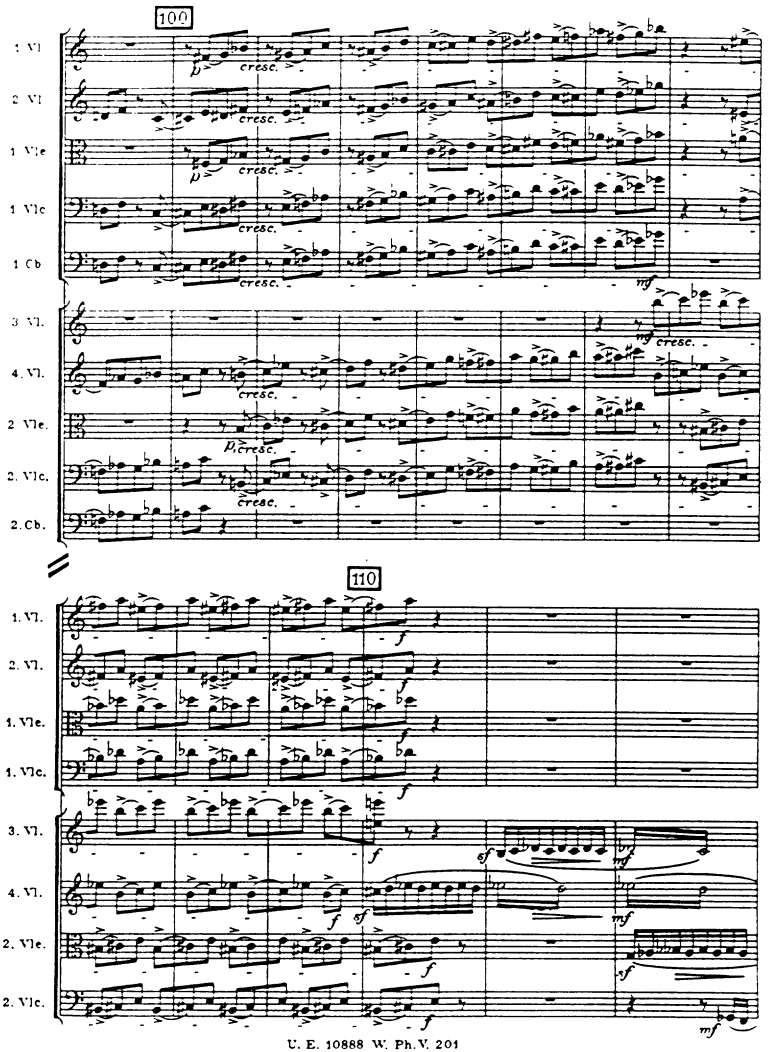
"In my music," Ligeti has written, "one finds neither that which one might call the 'scientific' nor the 'mathematical'; but rather a unification of construction with poetic, emotional imagination."[48] Indeed, Ligeti's structures are seldom "mathematically perfect." The inexorability of his carefully planned processes is often broken by such purposeful elements of imperfection and subjective freedom as slightly unbalanced symmetries or golden sections displaced by one measure or so. Ligeti has explained that he composes with his inner ear first, and then he looks for a system, a certain "construction" which, while important and necessary to him, is only second to the music itself: "I detest both absolute geometrical precision and total openness. I want a certain order, but an order slightly disorganized . . . I love irregularities. My artistic credo is, truly: I want to be free, individualistic, do as I please, and I refuse to subject myself to a certain rule. But I cannot compose without a set of rules adequate to the idea. Music comes first: *prima la musica, dopo la regola.*"[49] And yet, his painstaking constructivist approach to musical structure is present at every level of his compositions, always in combination with a thoroughly original and personal musical expressivity.

[47]See also Ligeti, First String Quartet, mm. 746–80, and Bartók, Fourth String Quartet/V, mm. 300–308 and Fifth String Quartet/III, mm. 58–65.

[48]Ligeti, "On my *Etudes* for Piano," 4.

[49]Michel, *György Ligeti*, 180. See also *Trackings: Composers Speak with Richard Dufallo* (New York and Oxford: Oxford University Press, 1989), 330 and 334.

Example 10c. Bartók *Music for Strings, Percussion, and Celestra*/II, mm. 100–110. © Copyright 1929 by Universal Edition; Copyright Renewed. Copyright and Renewal assigned to Boosey & Hawkes, Inc. Reprinted by permission.



ABSTRACT

This article examines the compositional techniques used by Ligeti in the building of net-structures, webs of finely-woven interacting lines or repeated patterns in constant process of transformation. Pitch reductions are used to analyze net-structures based on chromatic fluctuation of melodic microstructures and those that result from constant transformation of harmonic cells by means of intervallic expansion or contraction in works such as *Ramifications*, the Second String Quartet/V, and the Chamber Concerto/I. Ligeti's net-structures are supported by carefully balanced harmonic processes which display both symmetrical arrangements and long-range intervallic structural relationships. Harmonic and textural transformation in net-structure compositions are the main generating elements of large formal designs governed by the golden mean and other proportional relationships.