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INAUDIBLE STRUCTURES, AUDIBLE MUSIC: LIGETI'S PROBLEM, AND HIS SOLUTION

Not long after his emigration to the West in 1956, György Ligeti decided to challenge a well-established compositional trend. Ligeti is known today as one of a relatively small number of composers who in the late 1950s sought viable alternatives to post-Webernian serialism, and it is no exaggeration to say that, nowadays, when aside from a handful of undisputed masterpieces much of what was written during the serialist era seems hopelessly dated, Ligeti's music from about the same time sounds as fresh and original as ever. His career affords the music analyst the opportunity to study one composer's turning away from serialism: the nature of his objections, their implications for the further development of his technique, and the way in which the methods he arrived at achieve a meaningful organization of musical materials. This article discusses these issues and proposes analytic approaches designed to engage Ligeti's solution to problems of musical composition in what turned out to be the post-serialist era.

Ligeti's emigration brought him into contact with a thriving European (especially German) avant garde. Perhaps because he came to it later than others, having lived since the end of the war under conditions of provincial, state-imposed isolation, Ligeti responded to the stimulus of this activity differently from the way many of his contemporaries had done. Although he had arrived with scarcely any knowledge of twelve-note technique, let alone the extension of serial principles to aspects of musical sound other than pitch, not even three years had passed before Ligeti was setting down his criticisms of serial techniques as they had come to be applied to composition during the 1950s.[1] His previously published analysis of Boulez's *Structures* (Part Ia), which reflected an extensive familiarity with serial methods, demonstrated that he spoke from a well-informed position.[2]

Ligeti's difficulties with serialism, as expressed in the early *Die Reihe* article 'Metamorphoses of Musical Form' and in other, subsequent publications, can be succinctly summarized. He found problematic 'the organization of all the musical elements' – that is, pitch, duration, timbre, dynamics, mode of attack – 'within a unified plan' because he 'detected within it a discrepancy:

quantification applied equally within the various areas produced, from the point of view of our perception and understanding of musical processes, radically different results, so that there was no guarantee that a single basic order would produce analogous structures on the various levels of perception and understanding'. Unity, therefore, existed only on the level of verbal description, 'clapped on the musical events from the outside'.[3] Even the generalization of serial procedures to engage more abstract and global characteristics, such as types of motion, form, density and so forth, did not tighten the loose connection that had developed between compositional process and the actual, resultant sound of the music. Pre-planning had become so important that it was the real compositional act.[4]

Even in the treatment of pitch alone, new music had apparently begun to run up against certain limits:

> The individual character of the various serial arrangements fades as a result of the superposition of several horizontal series, in which, wherever possible, common notes occur at the same pitch. Such interweaving obscures the single serial threads (especially when all the parts are played on one instrument), and the resulting intervals have little or nothing to do with the original arrangement. Where such a procedure is coupled with series of durations the composer can hardly even retain an influence over the intervals that are to result, let alone determine them. They follow automatically from the type of procedure. In this way the pitch series loses its last remnant of function, paralysed by the emerging complex.[5]

The relegation of resultant sound almost to the status of by-product had led to 'decreasing sensitivity to intervals' and permeability of structures: 'Structures of different textures can run concurrently, penetrate each other and even merge into one another completely . . . it is a matter of indifference which intervals coincide in the thick of the fray.' Small wonder, then, that composers who had adopted serial methods discovered that it was becoming 'increasingly difficult to achieve contrast' – their music suffering an inevitable flattening-out.[6]

Ligeti did give certain composers, such as Boulez and Stockhausen, credit for having transcended the worst of these difficulties. Yet even they did not escape completely unscathed: 'Although [their] works create the impression of abundant coherence, nonetheless this coherence, arising as it does apart from the relationships established during the compositional process, is not free from a certain quality of "malgré lui".'[7] What Ligeti heard in much of the music being written at that time was a preference for 'homogeneous sequences of intervals, particularly the chromatic scale', with the result that 'the vertical disposition of this material results in a piling up of neighbouring tones. It is no longer primarily the intervals that constitute the structure but relations of density, distribution of registers and various displacements in the building up and breaking down of the vertical complexes.'[8]

These observations seem to have brought Ligeti to a key realisation: if the

qualities he had noted were in fact the true determinants of aural shape in new music, why not engage them directly, instead of through compositional methods that could not control such qualities, except more or less serendipitously? More than a decade after first expressing his reservations, Ligeti summed up his subsequent experience as a composer in a statement which has almost the character of a manifesto: 'In working out a notional compositional structure the decisive factor is the extent to which it can make its effect directly on the sensory level of musical perception.'[9]

This statement, however, is less straightforward than it perhaps appears to be. Certainly it should not be taken to mean that Ligeti felt he had learned nothing from his exposure to serialism except what not to do. He has spoken, for example, of having absorbed and applied to his own work such aspects of serial thinking as 'the principle of selection and systemization of elements and procedures, as well as the principle of consistency: postulates, once decided upon, should be carried through logically'.[10] Further, by making this declaration Ligeti does not categorically reject music that cannot be heard, in all its particulars, according to the way it is composed. One may not actually hear the row at every moment (or even in some cases, as a literal *series*, at all) in the twelve-note compositions of Schoenberg and Webern, but this hardly negates the row's structural importance or mitigates the worth of the music.[11] Clearly there are any number of ways in which a 'notional compositional structure' might *make its effect*, even if restricted to doing so directly. Knowing that this is what Ligeti is after does not make matters any easier for the analyst of his music. For consider the following:

> Technically speaking, I have always approached musical texture through part-writing. Both *Atmosphères* and *Lontano* have a dense canonic structure. But you cannot actually hear the polyphony, the canon. You hear a kind of impenetrable texture, something like a very densely woven cobweb . . . . The polyphonic structure does not come through, you cannot hear it, it remains hidden in a microscopic, underwater world, to us inaudible.[12]

How can we come to terms with this apparent discrepancy between what is written and what is heard? What is the point of composing strict canonic structures that cannot be perceived as such? And if we do not hear this 'micro-polyphony', as Ligeti terms it, then what *do* we hear? Before we can attempt to answer these questions, Ligeti's ideas about his music must be exposed in some detail.

One of the most striking general features of Ligeti's descriptions of his music, both in his articles and in his interviews, is his frequent recourse to visual analogies, especially ones having to do with space. Ligeti is under no illusions about the ultimate significance of these analogies – he calls the space of his pieces 'imaginary' and is careful to distinguish the sense in which his music is spatial from that in which Stockhausen's *Gruppen* is, for instance, or any other work which involves literal dispersal of forces to different points within the

performance space – but still these expressions have an inherent interest. For one thing, Ligeti seems susceptible to visual and tactile parallels to auditory phenomena to a degree that approaches synaesthetic sensitivity: 'The involuntary translation of optical and tactile impressions into acoustic ones occurs to me very often; I almost always associate sounds with colour, form and consistency, and vice versa: form, colour and material quality with every acoustic sensation.'[13] However Ligeti's condition may have originated, it has had an undeniable effect on his compositional development. There is, for example, his famous childhood dream, the memory of which apparently influenced the composition of *Apparitions* (1958-9) and probably some later works as well. In this dream, Ligeti found himself entangled in a gigantic web, along with various insects and inanimate objects, and became a captive audience for the gradual transformation, through the insects' struggles to free themselves, of this web 'universe'.[14] It is tempting to speculate that Ligeti may have been impelled by this intersensory facility to his particular choice of compositional method, in which concentration primarily upon 'conditions of the material' inevitably arouses 'associations with visual and tactile sensations'.[15]

Ligeti's tendency to 'spatialize', if that word can be used, also owes something to the state of new music at the time of his arrival in Western Europe. In 'Metamorposes of Musical Form' he notes 'the seeming conversion of temporal relations into spatial ones', as if a musical composition could in some ways be analogous to a painting. Under these conditions, 'the succession of events is a mere exposition of something that in its nature is simultaneous'.[16] Actually, what seems to happen, in Ligeti's view, is that the time of a composition *evokes* space, and that the spatial analogy thus suggested allows the composer (and, by implication, the analyst) to traverse the structure of the music as if it were present all at once.[17] Furthermore, spatial models of musical structure are of particular interest in the study of form, since the idea of 'form' in music is essentially an abstraction from spatial configurations, from the proportions of objects extended in space. Musical form, then, can be termed the imaginary spatialization of temporal processes.[18]

Not every spatial possibility is equally attractive to Ligeti. His antipathy toward 'moment' form is revealing – for he feels that while mobility may be inherent in musical form, the form *itself* cannot be mobile. Moment form, he says, is based on a false analogy to visual art: for example, Calder's mobiles.[19] 'Musical moments have meaning only in that they point to other moments: not the meanings themselves, but only the shifts and alterations of meaning, are comprehensible.'[20] Instead of writing pieces the order of whose parts was variable, it seemed to Ligeti to be 'much more worthwhile to try and achieve a compositional design of the *process* of change'.[21] For this reason, perhaps, Ligeti has adopted, like Varèse, the analogy to crystallisation in order to describe not only the finished product of his compositional process[22] but also, somewhat inconsistently, the process of eternal 'becoming' exhibited by a piece as it progresses:

> The technical process of composition is like letting a crystal form in a supersaturated solution. The crystal is potentially there in the solution but becomes visible only at the moment of crystallisation. In much the same way you could say that there is [in my music] a state of supersaturated polyphony, with all the 'crystal culture' in it, but you cannot discern it. My aim was to arrest the process, to fix the supersaturated solution just at the moment before crystallisation.[23]

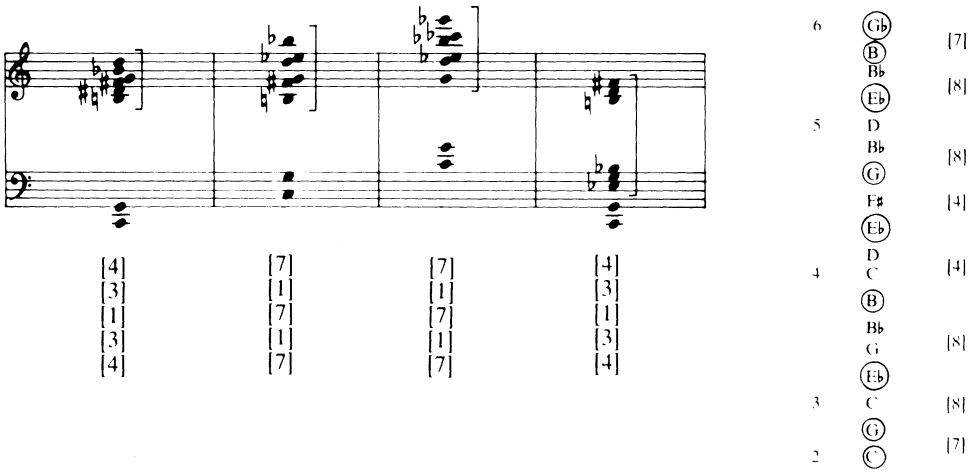
The analogy to crystallisation expresses something else as well: namely, the unidirectional nature of the form-creating process. For instance, Ligeti characterizes his electronic piece *Artikulation* as 'a gradual, irreversible process from the heterogeneous disposition at the beginning to the complete mixture and interpenetration of the contrasted characters at the end'.[24] This is entirely consistent with the atmosphere of his childhood dream, in which the changes in the web 'seemed like an irreversible process, never returning to earlier states again. An indescribable sadness hung over these shifting forms and structure, the hopelessness of passing time and the melancholy of unalterable past events.'[25] The allusions to crystalline structure suggest also the presence of regular, even symmetrical patterns in the music, about which I shall have more to say shortly.

Finally, among general aspects of Ligeti's musical outlook his firm grounding in the history of Western compositional practice should not go unremarked upon. This has obvious relevance to the elaborate canonic procedures mentioned earlier; and in fact Ligeti has allowed that he was 'very good at counterpoint' as a student.[26] His educational background placed considerable emphasis upon traditional instruction, and as a pedagogue himself Ligeti remains convinced that even if the old techniques cannot be used directly by contemporary composers, the student can nevertheless learn through them to think logically in the musical sense. Keeping modern composition up to the standards of the past cannot be a matter of indifference to any composer today.[27]

The specific consequences of Ligeti's attitudes and opinions about musical structure are best examined in the context of analytic illustrations. We may turn first to his First String Quartet (1953-4), a work which, like most of what Ligeti wrote before leaving Hungary, bears significant marks of Bartók's influence. Among these is a penchant for symmetrical construction – more precisely, registrally consistent symmetrical construction. Example 1 is a reduction of bs 521-33, from roughly the midpoint of the work. Excluding the open fifths in the cello, the contents of each chord are mirror-symmetrical; the stacks of bracketed numbers below the music show the adjacent intervallic arrangements. Furthermore, the passage as a whole has a symmetrical design, in two senses. First, temporally speaking, the series of four chords begins and ends with the same vertical arrangement (though not the same pitches), and the two chords in the middle share a different vertical arrangement. Second, the verticalized aggregate of all pitches in the passage – including the cello – yields

the arrangement shown to the right of Ex. 1. This is not mirror-symmetrical in all its details, but it does have an overall symmetry embedded in it, as shown. The pitches that serve as the boundaries of intervals in this embedded symmetry are encircled for clarity. They include the lowest fifth of the cello and the lowest pitch of the symmetrical portion of each of the four individual chords.[28]

Ex. 1 First String Quartet, bs 521-33



Apparitions, Ligeti's next major work after the First String Quartet, was also the first work he completed after his emigration, apart from two electronic pieces. Having observed the loss of sensitivity to intervals in serial music, Ligeti decided to see what could be done if this newly evolved condition were taken as a given and, in fact, exaggerated by dispensing altogether with intervals as structural components:

> I composed sound webs of such density that the individual intervals within them lost their identity and functioned simply as collective interval groups . . . this meant that pitch function had also been eliminated . . . . Pitches and intervals now had a purely global function as aspects of compass and note density.[29]

This maximized density took the form of chromatically filled spaces: 'I inserted so many minor seconds that even the minor seconds, the chromaticism, disappeared in the harmonic sense.'[30]

Ligeti's own remarks about *Apparitions* emphasize the idea of *transformation* from one sound group to the next through what he calls 'a continuous reciprocal relationship between states and events'. He continues:

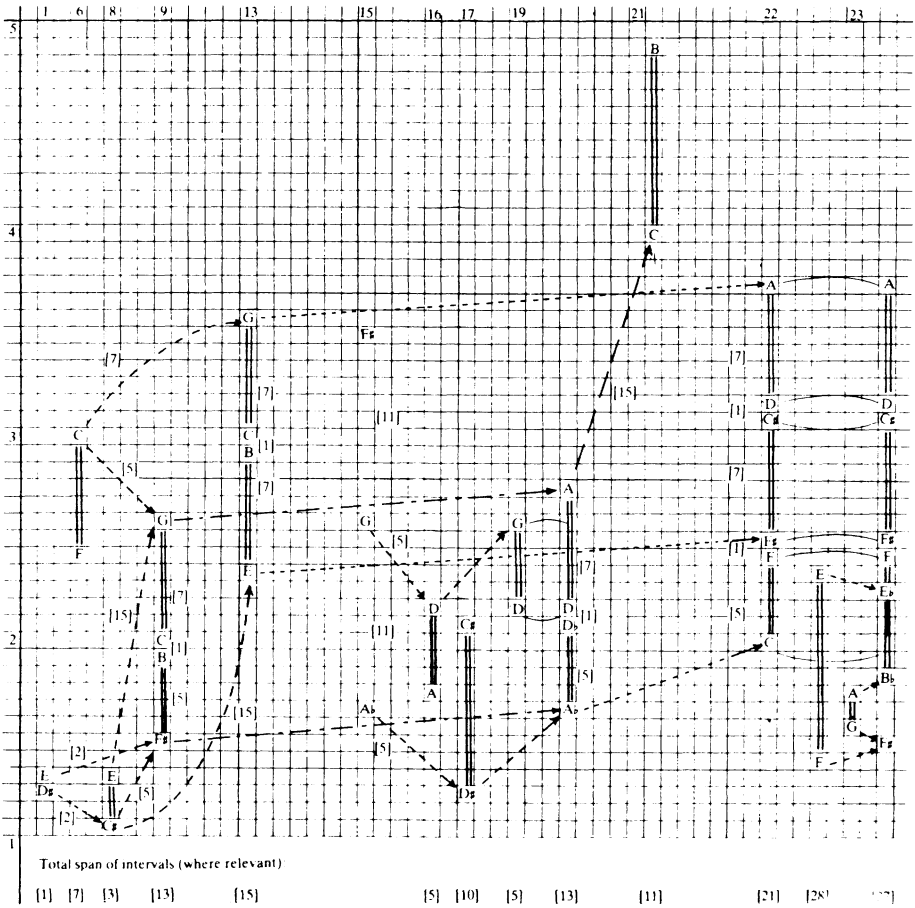
> The states are broken up by suddenly emerging events and are transformed under their influence, and vice versa: the altered states also have a certain effect upon the type of events, for these must be of ever new character, in order to be able further to transform the transformed state. In this way arises an unceasing development: states and events, once they have occurred, reciprocally exclude their repetition, thus are irretrievable.[31]

These formal ideas are evidently combined with fixed repertories within the various domains of musical sound; Ligeti has discussed the repertory of durations in some detail, comparing his employment of it to a typesetter's selection of letters from a type box, and has mentioned others.[32] In no case has he enumerated the contents, but it is possible to speculate analytically about what these are and, more important, about how they are connected – that is, how the transformations take place. The following analysis focuses upon the interrelated domains of pitch, compass (vertical span) and note density to explore the first part of the first movement.[33]

In Ex. 2 the score of bs 1-23 is transcribed into grid notation, which provides a uniform semitonal calibration along the vertical axis. (Numbers in the left margin mark locations of C, with C4 corresponding to middle C. Numbers along the top edge are bar numbers.) The grid may be an especially appropriate analytic tool in Ligeti's case, since it is known that in the initial compositional stages he uses a kind of graphic notation.[34]

The opening bars show a development of pitch/registral space through a strictly controlled group of intervals, several of them determined by the total number of available parts in each of the divisions of string instruments.[35] The initial minor second, (D♯-E)1, is superseded locally by a perfect fifth (span of [7]) [13] above. The next two events incorporate all three of these intervals – [1], [7] and [13] – and bring in new ones as direct resultants of spatial manipulation of the original group. The event (C♯=E)1 (b.8) does not at first appear to be so related, but with the lower boundary of F♯ 1=G2 (bs 9-11) it stands as one arm of a symmetrical expansion from (D♯-E)1.[36] A by-product, as it were, of this expansion is the interval (C♯-F♯)1, or [5], which now appears as a component of F♯ 1=G2, combined with [1] and [7]. Further, the interval [5] describes the distance from upper boundary to upper boundary, C3 to G2. The cluster F♯ 1=G2 is also [13] in *total* vertical extent, which means that the interval of expansion [2] noted earlier is an interval of projection as well: thus F♯ 1=G2 is a projection and filling-in of E1-F2. These two [13]'s taken together yield [15], read either as [13] [2] or [2] [13], which is next immediately stated in two forms: one as the total extent of the cluster in b.13, E2=G3; the other as the interval from previous to new low boundary pitch, C♯ 1-E2. Note that the uppermost [15] is expressed as [7] [1] [7].

Ex. 2 *Apparitions*, I, bs 1-23



Intervals that are present in essentially unrealized potential in this complex are [11]: F♯ 1-F2 and [10]: F♯ 1-E2. The former is brought into play in b.15 (bassoons), in the chord A♭ 1-G2-F♯ 3. Generally speaking, this adjacent doubling of interval size seems to proceed from the idea of doubling previously expressed as [7][7] – F2-(C-G)3, then as [7][1][7] in (E-B)2-(C-G)3 – and [15][15], C♯ 1-E2-G3. It is interesting, though not necessarily significant, that [11] is also the average of [7] and [15]. The occurrence of [5], as a filled-in interval, in b.16 falls within the span of the lower [11] and divides it [5][5][1]; in conjunction with the filled-in [10], D♯ 1=C♯ 2, that follows (in the piano, b.17) it also expresses [11], which can now be regarded as a replica of A♭ 1-G2, transposed down [5] and now completely filled chromatically. The cluster (D=G)2 in b.19 bears a relation to all three previous events, both in that it replicates the [5] A1=D2 and in that, restoring as it does G2, it brings [5] and

[11] into the same spatial relationship that they occupied in the juxtaposition of events in bs 15-16.

The cluster in the strings in b.19 is the first event in the piece to enter before the previous event has ended (discounting momentary overlaps, as for example in b.16). Here [13] is expressed as [5][1][7], as in bs 9-11; the overlap of (D=G)2 with the uppermost component, (D=A)2, expresses [7] as [5][2], as occurred in the relationship of the cluster in bs 9-11 to events of earlier bars, but the means in b.19 is different, with the spans of [5] and [7] being given simultaneously. Furthermore, the [5] between successive lower boundaries, (D♯-A♭)1, replicates the [5] (C♯-F♯)1 between successive lower boundaries in bs 8-9, which means that the relationship between the composite spans C♯1-G2 and F♯1-A2 is one of transposed replication, by [2].

The entrance of the celesta in b.21, on (C=B)4, brings in the filled-in interval [11] at a distance of [15] above the immediately previous event. The following chord in the strings (bs 22-3) is the largest simultaneously sounding chromatically-filled span heard so far in the piece, and combines the structures of two previous chords: [5][1][7] and [7][1][7] → [5][1][7][1][7]. Just as [5][1][7] in bs 9-11 was transposed up [2] to its position in b.19, so [7][1][7] in b.13 is now transposed up [2] to its position as a component of the chord in bs 22-3. The total span of [21] duplicates that of the composite of the first two events in the piece: D♯1-C3.

The last events in the graph are not analysed in full, for they seem to belong more to the next part of the piece; but it is possible to find, in their overlap with the preceding [21], the intervals [28] and [27] now emerging as filled-in composite spans after their more oblique statements as A♭1-C4 (bs 19-21) and F♯3-D♯1 (bs 15-17) respectively.

In retrospect, we can identify a series of phases through which all the intervals employed so far pass:

1) indirect or oblique statement;
2) successive lower or upper boundaries of clusters, or space between clusters, or composite space;
3) composite space, filled chromatically;
4) simultaneous statement, filled chromatically;
5) incorporation as segment into larger cluster.

Next, we can detail the actual phases through which each interval participates in this series:

[1]: (4); (5)
[2]: (2); (5)
[5]: (2); (5)
[7]: (4); (5)
[10]: (2); (4)
[11]: (1); (2); (3); (4)
[13]: (2); (4); (5)
[15]: (1); (2); (4); (5)
[21]: (2); (4); (5) (b.26)

It is evident from the above that no two trajectories are identical, and that none of the intervals passes through all five phases. With the exception of the last phase, the series seems to represent a process of gradual emphasis, as the employment of each interval as a space-defining entity is made progressively more explicit. The identification of the fifth phase – incorporation into larger clusters – suggests that the development of spatial relations through various interval sizes in this piece does not proceed simply by means of bringing each interval into prominence and then maintaining it in that status. Once brought to an explicitly space-defining role, an interval can subsequently be employed in any of its various other roles and, as the piece goes on, can be absorbed into the texture to become a component in larger sonorities, perhaps even suffering a temporary or permanent cancellation as an explicit entity.

Conversely, as Ligeti's description of the form suggests, new intervals must also arise. In bs 25-6, for example (not shown in the graph), the interval [8] emerges explicitly from the lower two adjacent intervals in the chord [7][1][7]: F♯ 2=A3. The boundary notes in the cello/viola chord in b.25 are F♯ 2, C♯ 3, D3 and A3; then, in b.26, F♯ 2 and D3 become the boundaries of a separate chord in the winds. A little further on (b.29), [8] becomes a segment of a larger chord, marking the contrabasses' portion, (D♯ =B)1, of D♯ 1=E♭ 3. Phases (2), (4) and (5) are thus represented.

In *Atmosphères* (1961) Ligeti is still working with chromatically filled complexes of sound, but the idea of a *repertory* – of durations or intervals, for instance – has been discarded. 'Rhythm', as Ligeti has said of this work, 'is completely eliminated, [and] the absorption of individual shapes into static planes is accomplished to the greatest possible extent.'[37] *Atmosphères* is widely reputed, not without reason, as Ligeti's *klangfarben* piece, but Ligeti has effectively cautioned the analyst by saying that 'it is a rather superficial view to lay too much emphasis on timbre' in this work or other works of his, and that in *Atmosphères* 'modifications of timbre and dynamics are obviously very significant but the patterns emerging from them are even more important'.[38] It would seem, then, that the 'iridescence', as Ligeti calls it, caused by minute, continual shifts in doubling and in the location of gaps in the chromatic filling, and by dynamic changes, bowing changes and so on serves to characterize and differentiate the various 'static planes' and impels movement from one plane to the next. With this in mind, it is possible to analyse *Atmosphères* through the

same sort of grid notation employed for *Apparitions*. A graph of bs 1-29 appears in Ex. 3.[39]

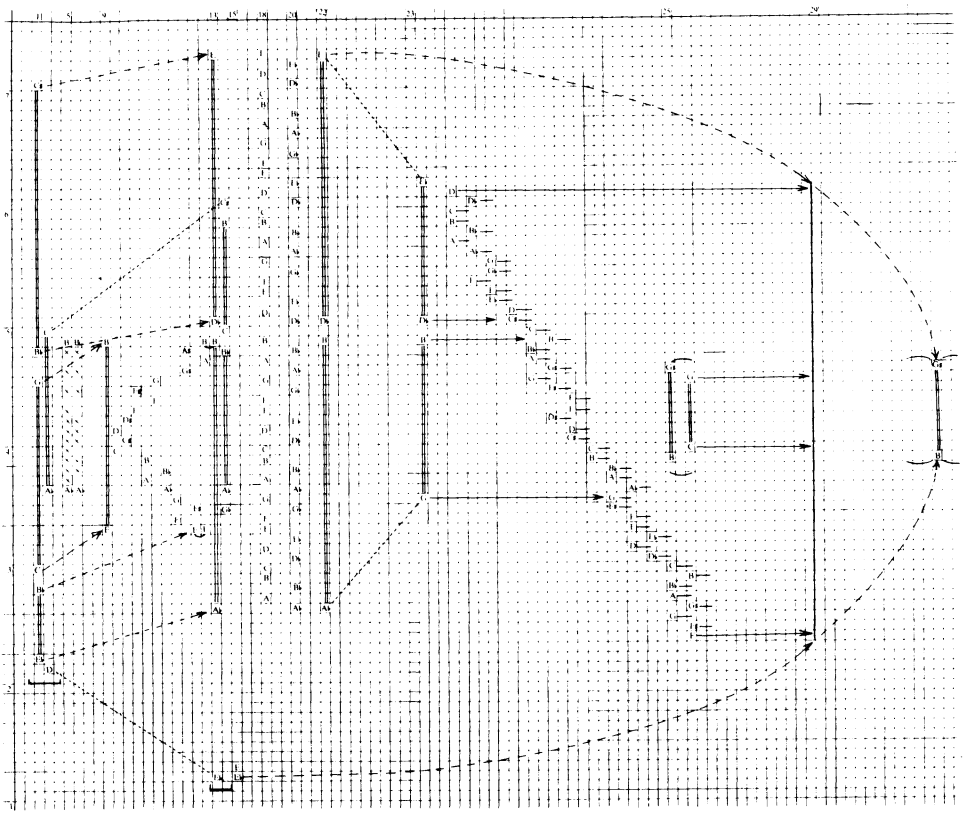
In b.1, the strings enter in three slightly separated groups: contrabasses, (E♭ =B♭)2; cellos/viola, C3=G4; violins, B♭ 4=C♯ 7. Overlapping the gap between violas and violins are the winds: A♭ 3-C5, plus D2 in the contrabassoon. In the course of bs 1-8 the winds' plane undergoes changes, as several pitches drop out; the consecutive stages are displayed in the example. This reduction in density, taking place as it does against a backdrop of chromatically filled space in the strings, causes the winds almost to disappear, as if their plane had merged with that of the strings. In particular, the departure of the flutes after b.4 changes the winds' upper boundary to B4 and prepares for the assumption of this pitch as the cello/viola upper boundary in b.9. At this point, all previous structures are superseded and the cellos and violas sound alone until the rest of the ensemble rejoins them in b.13. In the course of bs 9-13, a ripple of dynamic change passes through the cluster of cellos and violas – or rather two ripples, moving in opposite directions, as pairs of parts *crescendo*, one by one, to *forte* and then drop back to the ensemble *pianississimo*. The succession of dynamic emergences creates the symmetrical design shown in the graph.[40]

The strings reach their new location by transposition of all three groups, although not in parallel: the contrabasses move up [5], the cellos/violas up [4], the violins up [3]. A gap thus remains between the upper two groups, but the lower two have meshed completely, and a new regularity has developed: the segment encompassing low and middle strings, A♭ 2=B4, corresponds precisely to the size of the violins' segment, D♭ 5=E7. During bs 13-22 a new sort of dynamic fluctuation takes place in the strings, dividing the contents of the cluster into two interlaced collections on separate *crescendo-diminuendo* schedules. These momentarily emerging vertical arrangements exhibit the same regularities and mutual complementarity as do the black and white notes on a piano keyboard.

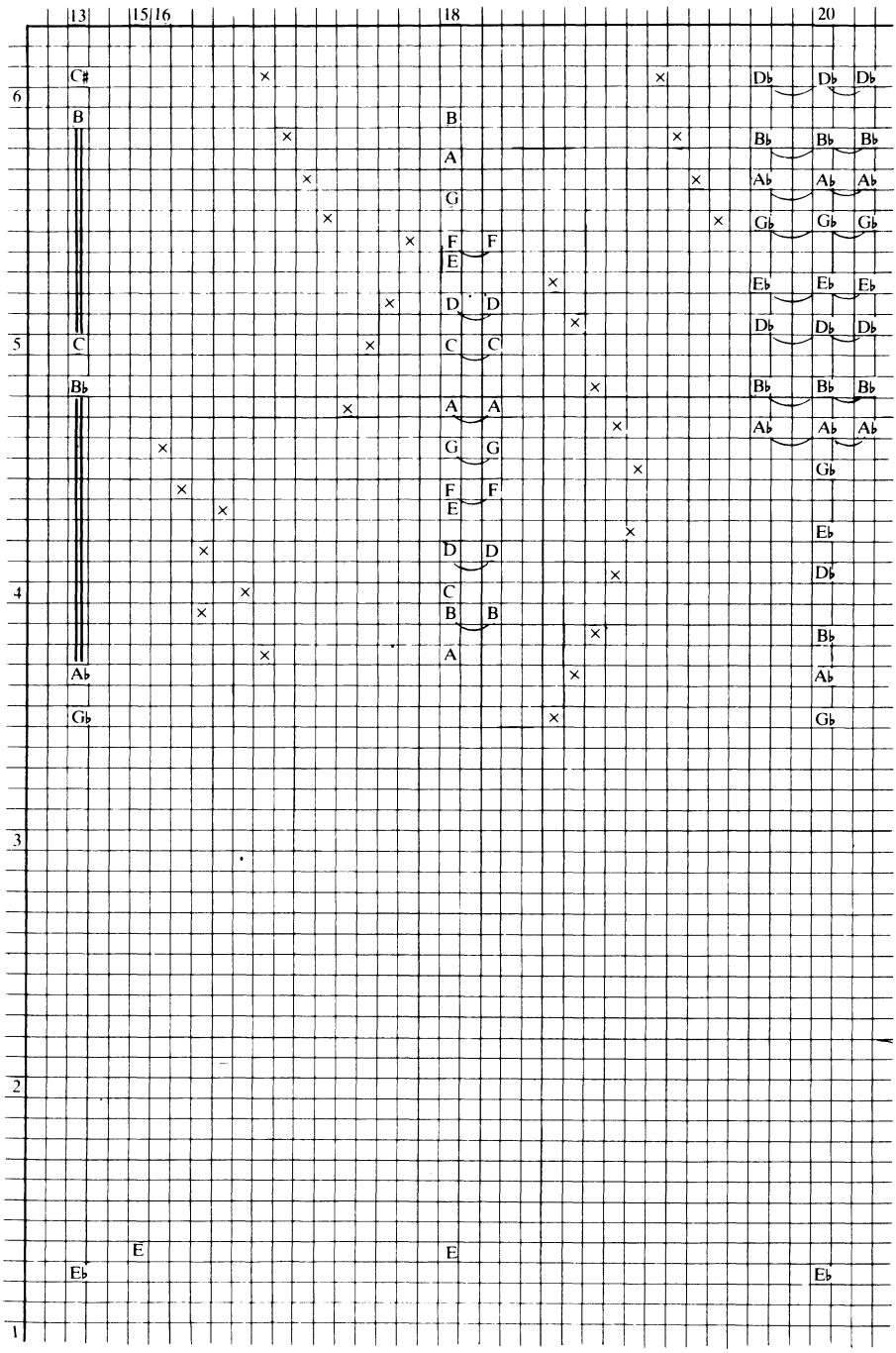
Meanwhile, something else has happened to the winds, which now occupy a space (not completely chromatically filled) bounded by G♭ 3 and C♯ 6, plus E♭ 1 in the tuba, joined at b.15 by E1 in the contrabassoon. From their original location at D2-C5, they have undergone an expansion that adds two octaves to their compass. This will be called an '[11]-[13] expansion', after the two intervals that define the intervals of change at lower and upper boundaries respectively. The winds' fluctuations at this point are more complex than those of the strings and for the sake of legibility are shown in a separate example (see Ex. 4). As in the strings, *crescendi* successively emphasize white-note and black-note collections, but unlike the strings the winds project staggered dynamic patterns; and besides dynamic change another form of 'disturbance' is introduced into the texture: rearticulation of individual notes, shown by the placement of crosses. As in bs 1-8, the winds in bs 18-22 die away by stages and sound as though they have been absorbed into the strings.

From b.22 to b.23 the strings contract a total of two octaves in range, from A♭ 2-E7 to G3-E♭ 6. This can be called an '[11]-[13] contraction', complementing

Ex. 3 *Atmosphères*, bs 1-29



Ex. 4 *Atmosphères*, bs 13-20, winds



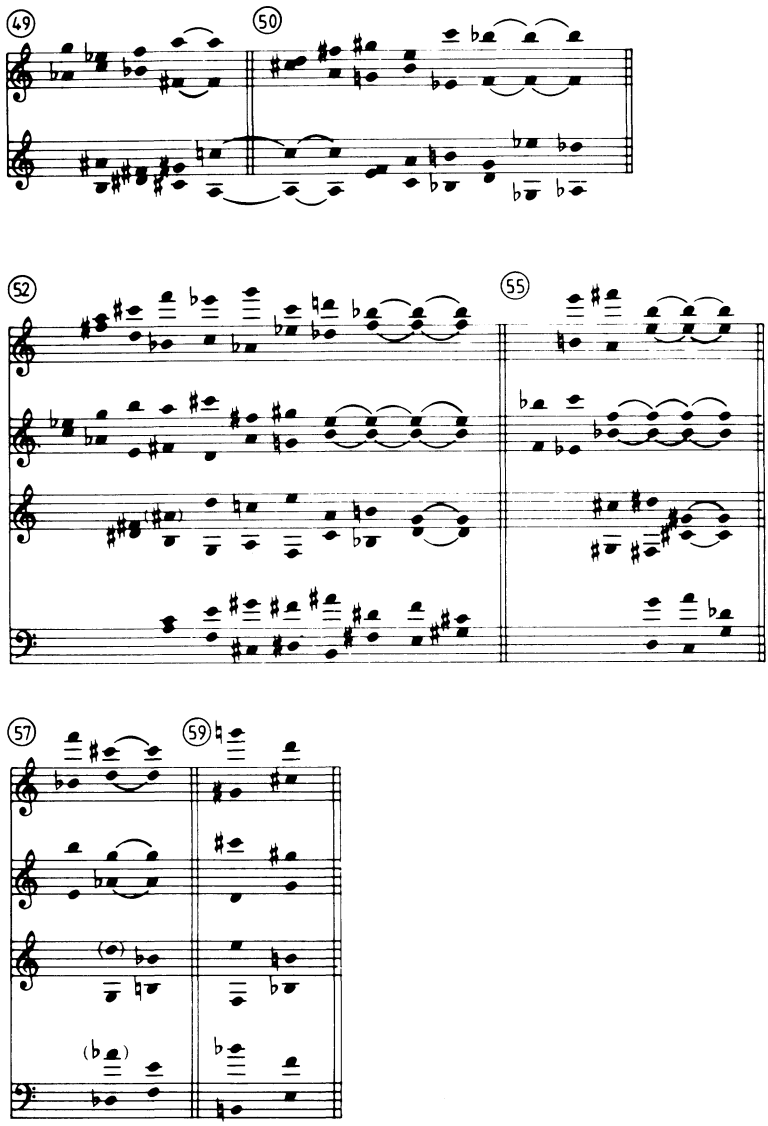
the previous expansion in the winds. The new span now serves as the point of departure for a great downward sweep, from D6, the upper boundary of this plane from b.24 on, to F2. The textural change as this happens is quite dramatic: *sul ponticello*, *molto vibrato* playing in ever faster figuration alternating in each part between two pitches takes over from *sul tasto* sustaining of single pitches as the downward sweep progresses.[41] Just before the bottom is reached, two more planes appear (b.25), flutes and clarinets nestled symmetrically within the compass of the contrabasses plus three cellos. This smaller string group is left sounding alone in b.29 after all other instruments suddenly exit.

The graph displays the striking symmetries outlined by the succession of planar states from b.13, where the composite winds'/strings' range is E♭ 1-E7, to the sweep of bs 23-9, which represents a symmetric contraction from the outer boundaries of that range, to the further symmetric contraction to the small string group left sounding in b.29.

The organization of volumes of sound of varying density according to schemes based upon vertical span and symmetrical considerations has remained a prominent feature of Ligeti's work since *Atmosphères*. Beginning with the second movement of *Apparitions* and continuing, with increasing explicitness, in subsequent works, Ligeti integrated this basic 'spatial consciousness' with other compositional preoccupations, notably the high regard for the rigorous contrapuntal procedures of older music that he had acquired as a student.[42] Two relatively brief examples from works of the 1970s will serve to illustrate types of techniques inspired by (if rather remotely related to) these procedures. In 'Bewegung', the third of the Three Pieces for Two Pianos (1976), the closing section is based on a rigorous pitch symmetry, canonically unfolded (see Ex. 5a). Each strand of the canon considered separately is a pair of voices moving note-against-note strictly in mirror fashion, so that the intervals formed vertically expand and contract symmetrically.[43] In bs 49-52 two such pairs constitute the entire texture, apart from rapid figuration (not shown in the example) overlapping from the previous section and slowly fading away here, producing a double canon with the *comes* entering [9] below the *dux*. (This can, of course, just as accurately be described as a double canon in inversion.) In bs 52-8 the double canon is itself doubled to become a quadruple canon, with the overall axis of symmetry, A4, preserved from the preceding bars. Here the original pair of pairs becomes the centre of the entire structure as two new pairs are added, [6] above and [6] below respectively. In bs 57-8 the canon begins to dissolve, as the two upper pairs enter together, followed one chord later by the lower two pairs. During the final two chords of the piece (bs 59-63) the symmetrical layout is expressed entirely in simultaneities.

In the reduction of Ex. 5a, double barlines mark the points at which the one or more *comes* 'catch up' with the *dux*. This happens once during the double canon (b.50), once just before the quadruple canon begins (b.52) and again at bs 55, 57 and 58. At these five points all voices resolve, as it were, into a mirror-symmetrical chord, to which the last two chords, also mirror-symmetrical, serve as a kind of culmination. The catch-up chords can be heard as points of phrase

Ex. 5a 'Bewegung' (3 Pieces for 2 Pianos, III), bs 49-63



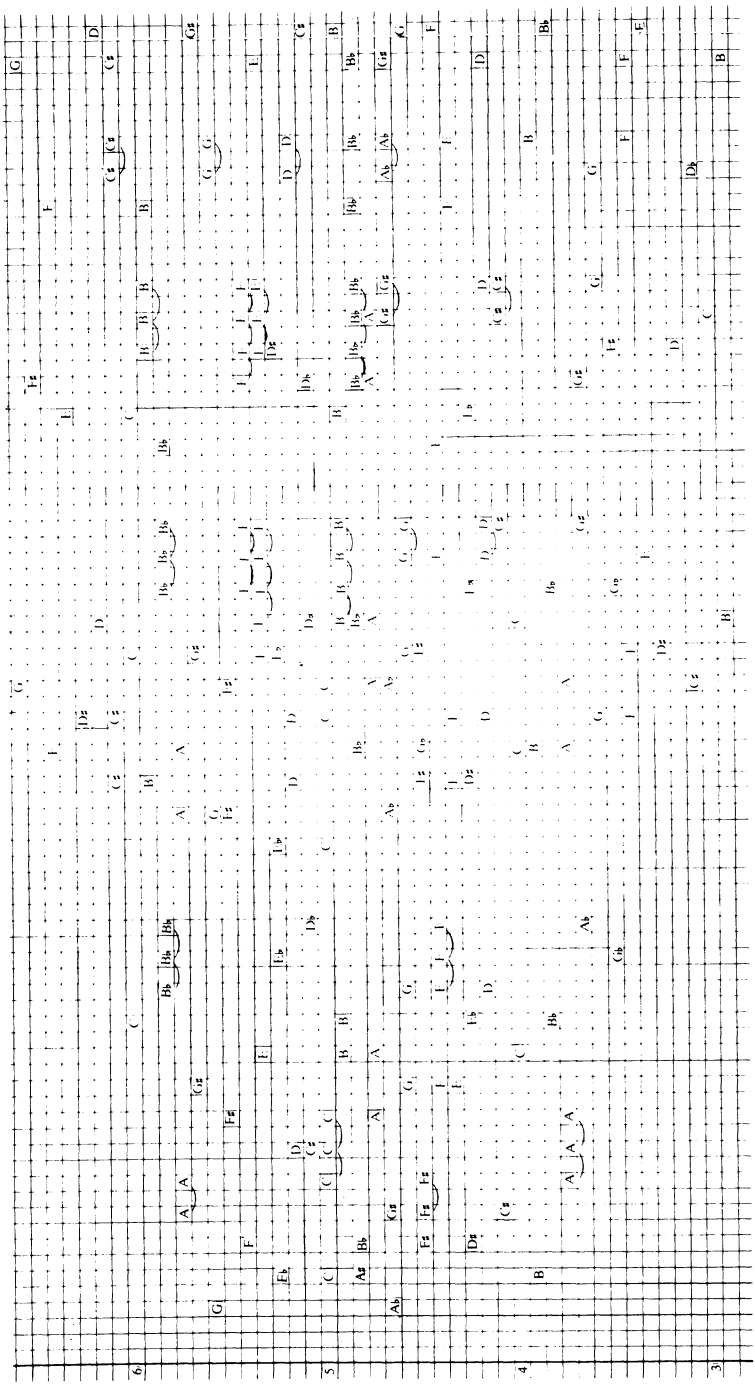
articulation, with the shift to the thicker texture of the quadruple canon and the final abandonment of canonic projection (b.58) the principal points among the five. In between it may well be impossible to hear the canonic design, since the ensemble of two pianos is exploited, here as in much of the rest of the work, to produce a unified (as opposed to stratified) texture. (What is not apparent from

Ex. 5a is that none of the four canonic pairs is confined to a single line in the score; the two piano parts continually exchange pitches at irregular temporal intervals.) It should be possible, however, to hear something else: see Ex. 5b. Here the contents of Ex. 5a have been transcribed into grid notation. This notation provides a more accurate idea of the spatial quality of the music, enabling the listener/analyst to see it whole – as if, as Ligeti put it, the whole passage were present all at once. From this graph it is evident that, despite the time lag between entrances of parts enforced by the canonic plan, one can really perceive the general outline that emerges as a *resultant* of the canon, and that, despite the fact that the internal details are slightly askew, the external dimensions stand out clearly.[44]

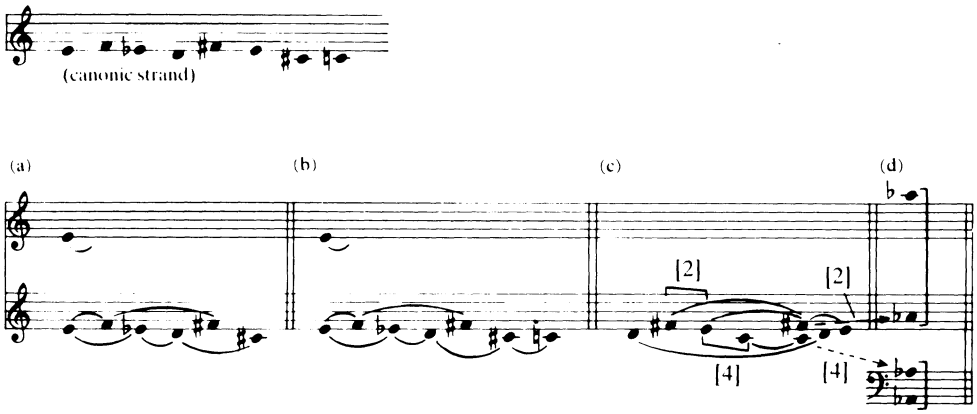
In the third movement of the *Kammerkonzert* (1969-70), we encounter another application of canonic procedure, in a setting radically different from that of the previous example. Bars 1-12 present one of Ligeti's *meccanico* textures, a device which is one of his principal agents for 'get[ting] rid of rhythm as a concept altogether'.[45] In this passage, an initial pitch is joined, successively, by others in close spatial proximity, forming a slowly, steadily expanding web of sound. The resultant of the canon can be interpreted in terms of gradually shifting symmetrical relationships. Example 6 displays the overlapping stages of development. The first stage, at (a), surrounds initial pitch E4 symmetrically, then by adding C♯4 leaves E4 no longer quite at the centre. In (b), at b.5 a new group of instruments begins the canon over again; this time the eighth note in the canonic series, C4, makes its appearance, pulling the centre even further downward. With the entrance of the first sustained pitch, in b.7, the third stage begins: see (c). This eventually takes the form of a 'whole-tone' division of the space opened up by the canon, as C♯4, E♭4 and F4 are completely suppressed. With respect to the original axis and initial pitch E4, space has been expanded by [2] above and [4] below, a condition which is neatly summed up by the last three sustained pitches to enter – F♯4, E4, and C4 respectively – and which effectively 'predicts' what happens next, shown in (d): a new *meccanico* section begins at b.12 in octave A♭s. The two central A♭s, in octaves 3 and 4, are reached by motion [4] below C4 and [2] above F♯4 respectively; the outer A♭2 and A♭5 simply expand occupied space outward from this central arrangement.

Two works of the 1960s, *Lux aeterna* (1966) for sixteen-part *a cappella* choir and *Lontano* (1967) for orchestra without percussion, are especially rewarding subjects for study of Ligeti's canonic technique, principally because they represent a deliberate attempt on the composer's part to exert more control than previously over the spectrum of relative clarity (transparency) to relative opacity of texture. Ligeti regards *Lux aeterna*, in retrospect, as a turning point for him of comparable importance to *Apparitions*.[46] In a brief essay entitled 'Auf dem Weg zu *Lux aeterna*' he notes that the work, which he composed directly after finishing the *Requiem* but which was conceived as a separate work even though its text is taken from the traditional Requiem mass, was deliberately designed to have more limited possibilities for opacity; its ensemble has only sixteen choral parts to the *Requiem*'s twenty and omits orchestral forces. Ligeti identifies

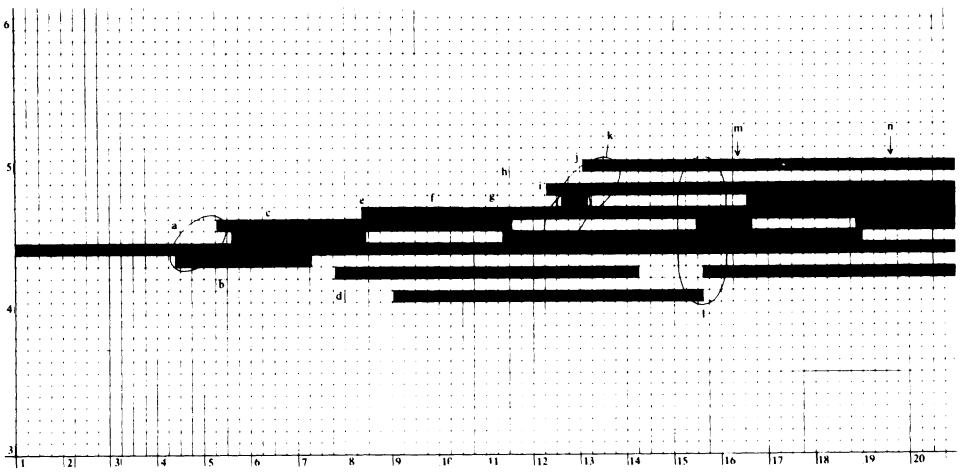
Ex. 5b 'Bewegung', bs 49-63



Ex. 6 *Kammerkonzert*, III, bs 1-12



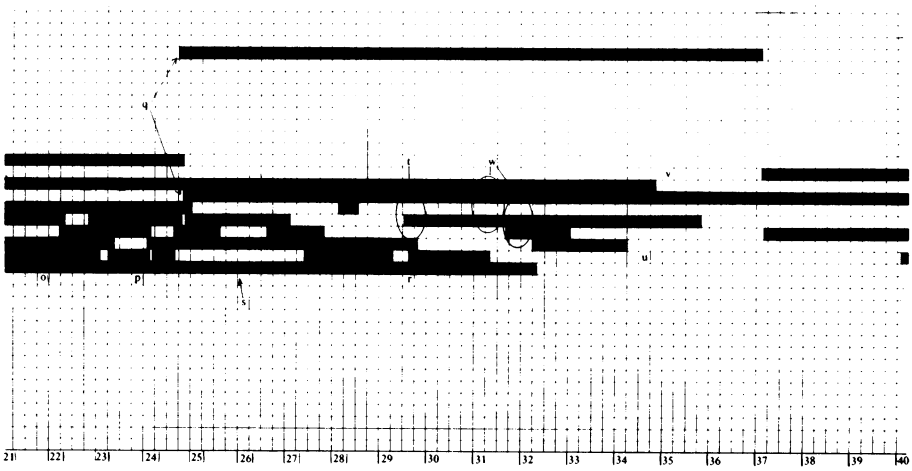
Ex. 7 *Lux aeterna*, bs 1-37



gradual transformation as a principle of harmonic construction and states that the counterpoint has the function of destroying old structures and building new ones.[47] To track and interpret this process, graphic notation of a slightly different variety from that of previous examples will be useful. In Ex. 7 the duration scale (horizontal axis) is consistent: one square equals one beat in common time, at a tempo of approximately crotchet = 56. Pitch names have been dispensed with; instead, the shaded areas correspond to durations of individual pitches, projected and prolonged by overlapped entries in multiple parts. In this, as in many subsequent works, Ligeti has explicitly directed the performers to make their entrances as gently, even imperceptibly, as possible during sustained passages. The listener is evidently not intended to focus upon attack points; thus the graph simply shows where each pitch is present in at least one part.

The order of entrances of the first four notes, (F-E-G-F♯)4, can be described as two interlocking three-note groups with vertical intervallic arrangements [1][2] and [2][1] (*a* and *b*); the symmetrical arrangement here ensures that the

Ex. 7 cont.



available semitonal space is completely filled. As in the previous example, from the *Kammerkonzert*, the semitonal web spreading out from an initial pitch has grown slightly asymmetrically with respect to that pitch. By and large this is typical of Ligeti's practice: here, as the dimensions of occupied space continue to spread outward, the general idea of a symmetrical centre is effectively conveyed, but the actual, specific location of that centre is constantly in flux.

Pitch E4 drops out in b.7, leaving the cluster (F = G)4, [2] in extent (*c*). As if in response to this, E♭4 enters (b.7), then D♭4 (b.9), marking off striations of the semitonally calibrated space [2] apart (*d*). (Henceforth, in this analysis and the one of the opening of *Lontano* that follows, such formations will be referred to as '[2]-striations'.) Meanwhile, in b.8, A♭4 enters (*e*), at first seeming to function as an extension of the semitonal cluster (F =G)4. However, this effect is only momentary, for F♯4 soon exits, leaving (F-G-A♭)4, or [2][1], as the top portion of the structure (*f*). Pitch F♯4 reenters in b.11, again seeming to reassert chromatically filled space (*g*); but almost immediately G4 drops out, leaving [1][2]: (F-F♯-A♭)4 at the top of occupied space (*h*). The effect is of F♯4 replacing G4, with a bit of overlap; the resultant is a duplication of the [1][2]/[2][1] relationship that opened the piece, one semitone higher and with greater temporal separation between the components.

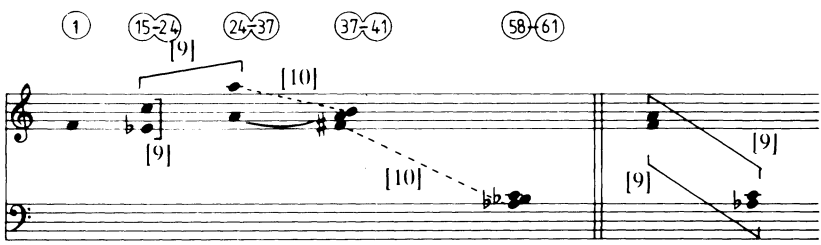
The entrance of B♭4 in b.12 (*i*) comes in apparent reflection of the [2]-striations below. In fact, this impression is strengthened by the subsequent C5 in b.13 (*j*); in between, however, the appearance of A4 (bs 12-13) briefly reasserts chromatically filled space as well as forming [2][1]: (F♯-A♭-A)4 and [1][2]: (A-B♭)4-C5 (shown interlocked at *k*). With the entrance of C5 and the nearly simultaneous exit of A4, [2]-striations flank a [1][2] centre, (F-F♯-A♭)4. Further developments emphasize symmetry, but through a constantly changing web structure. First, just as D♭4 disappears, a thickening develops at what would be the centre if D♭4 were still present (*l*). The formation is, literally speaking, asymmetrical (*m*). The 'lump' is gradually dissipated with the exit of G4 (b.16) and of F♯4 (b.18); while this is happening, A4 reenters (b.16), then G4, just as F♯4 disappears in b.18, yielding another lump in reflective symmetry to the first one (*n*).

As A4 exits in b.20, the pace of events accelerates somewhat. The graph shows clearly how a 'ripple' of semitonal filling (*o*) moves up through the space in use from the bottom, starting with E4 above the already present E♭4. For a split second, in b.22, the interval (E♭-A♭)4 is completely filled. Behind this ripple comes another, less well defined (*p*). The graph shows momentary gaps in the continuity of individual pitches, as well as the fact that the entire space traversed is only (E♭-G)4 this time and is never filled all at the same instant. The ripple analogy is particularly apposite, since the change in the texture at this moment sounds as though a disturbance of some sort has been introduced – or perhaps the ripple is simply a premonition of some larger effect about to break out upon the surface of the music. In any case, just as the second ripple is making its way up the semitonal spectrum, A5 enters dramatically, along with its octave A4, which functions as a continuation of the first ripple's ascent (*q*).

The pitch A5 is quite a bit higher than any other yet heard in the piece. The location of this seemingly deliberate discontinuity is, however, actually determined by the dimensions of the space previously occupied, or, more precisely, what these dimensions have come to be. The graph shows that after the exit of D♭ 4 in b.15, the upper and lower boundaries remain fixed at C5 and E♭ 4 respectively, until the entrance of A5. This space, [9] in extent, is doubled by the entrance of A5, for A5 is [9] above C5. At that moment, in b.24, we have two spatial regions: one rather densely packed, the other completely empty. Immediately thereafter the lower, dense region begins to thin out: first, C5 exits; then a kind of descending ripple occurs across bs 26-31, leaving larger intervallic interstices in its wake (*r*). The effect here brings to mind Ligeti's description of a process that takes place in *San Francisco Polyphony*, in which the texture 'gets less dense, as if someone went through it with a comb, thinning it out'.[48] Already in bs 25-6 the [2]-striations have reappeared: (E♭ -F-G-A)4 (*s*). These are momentarily obscured by the descending ripple, emerge again partially in b.29 (*t*) as (F-G-A)4, then finally are presented in unmistakable fashion by the successive exits that attenuate occupied space from below: E♭ 4 (b.32), F4 (b.34) and G4 (b.35), leaving A4 (*u*). Meanwhile, from above, the successive exits of C5 in b.24 and B♭ 4 in b.34, together with the remaining A4, present the by now familiar [1][2] pattern (*v*). Other [1][2] and [2][1] configurations are also present as the process of attenuation continues (*w*).

At b.35 the only pitches left sounding comprise the empty octave, A4-A5. This event marks a return to the maximal clarity of the single-pitch opening but cannot be considered exactly equivalent to it, since the octave interval does define a region of space, however equivocally. Octave-bounded spaces play a considerable role later in *Lux aeterna*; here, the octave, besides serving as a point of arrival and as an obvious sectional division, has other, long-range functions. The chord that enters in b.37 (basses falsetto, F♯ -A-B) incorporates A4. This intervallic structure, [3][2], is identified by Ligeti as the principal stable harmony of the piece.[49] Here it serves as a spatial pivot (see Ex. 8): the vertical distance [10] from A5 down to B4 (successive upper boundaries) is duplicated in the distance from lower boundary F♯ 4 (b.37) down to A♭ 3, the lower boundary of the next stable configuration in the piece, first entering in b.51.

Ex. 8

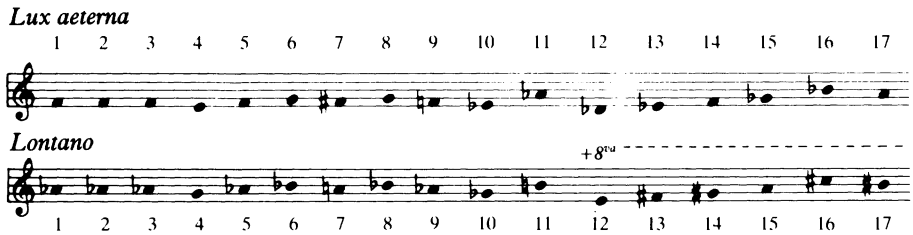


As for A4's role, it is of even longer-range import: in one sense a component of the falsetto chord at b.37, but in another, in the bars immediately preceding the entrance of that chord, the true 'replacement' of the initial F4 of the piece. In other words, A4-A5 can be heard as intervallic space, but it can also be heard as a single pitch with a prominently audible overtone. The interval defined by F4 and A4 is duplicated, [9] lower, in the boundaries of the stable harmony heard in isolation in bs 58-61, A♭ 3-C4. The interval [9] is thus connected to both A4 and A5: the latter on the local level, the former over a longer span of time.[50]

Ligeti calls *Lontano* a 'sister work'[51] to *Lux aeterna*, and indeed a close relationship between the two pieces is evident from the outset – not simply in the general similarity produced by the use of canonic procedures in both, but more specifically in that the pitch series which, used in canon, 'generates' the first section of *Lontano* (bs 1-41) is nearly identical to that of the first section of *Lux aeterna* (bs 1-37), [3] higher.[52] Example 9 presents a comparison. Apart from the obvious difference of chosen medium, however, the treatment of the canonic strand in *Lontano* produces considerable textural differences from its predecessor. For one thing, the strand in *Lontano* becomes doubled at the octave above beginning in b.14, with the twelfth note of the series; for another, non-canonic pedal pitches extend certain canonic pitches beyond the duration that they would have if they were projected solely by the canon; for a third, in *Lontano* continual shifts occur in the orchestration of the canon, allowing one choir of instruments to begin a segment of the canonic line as another choir is finishing and producing thereby a greater degree of overlap than is possible in the first section of *Lux aeterna*, with its consistent setting of four soprano and four alto parts.[53]

The opening ten bars (see Ex. 10) have the same basic shape as do the first six of *Lux aeterna* (*a*), and after that the [2]-striations open up below in similar fashion: F♯4 in b.11, E4 in b.13 (*b*). Already, however, the course of development has begun to diverge from that of the earlier work. Note that the pitch A4, once introduced in b.9 (*c*), continues to sound until towards the end of the section, whereas F♯4, its counterpart in *Lux aeterna*, exits from the texture for several bars as the [2]-striations are formed. In *Lux*, F♯4's absence has the

Ex. 9



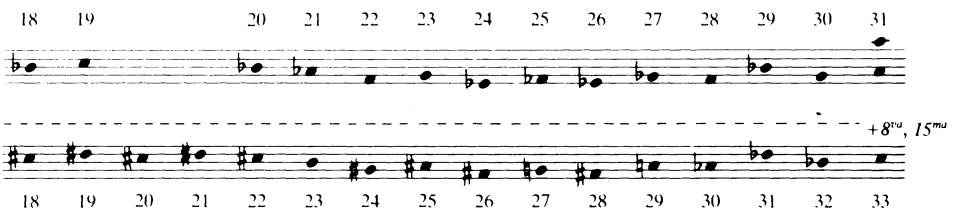
effect of extending the striation through much of the rest of the texture at that point; in *Lontano* the retention of A4 contributes to a greater opacity overall, by comparison with the other work.

The imitation of [2]-striation in the subsequent entries of higher pitches in *Lux* also occurs in *Lontano*, but by different means: the introduction of octave doubling, as E, F♯ and G♯ 5 enter in bs 14-15 (*d*). The explicit octave relation to the already present E, F♯ and G♯ 4 begins to establish a two-tiered structure, with events in two separate registers moving in parallel. At this point, though, separate entrances in the two registers serve to suggest that this parallelism is not yet quite established: A5 enters in b.15, to complement the already present A4 (*e*); C♯ 5 and B♯ 4, also in b.15, are followed closely by C♯ 6 and B♯ 5 (bs 15-16, *f* and *g*); then the apex of the canonic strand, D♯ 5, preceding D♯ 6 (bs 15-16, *h* and *i*).

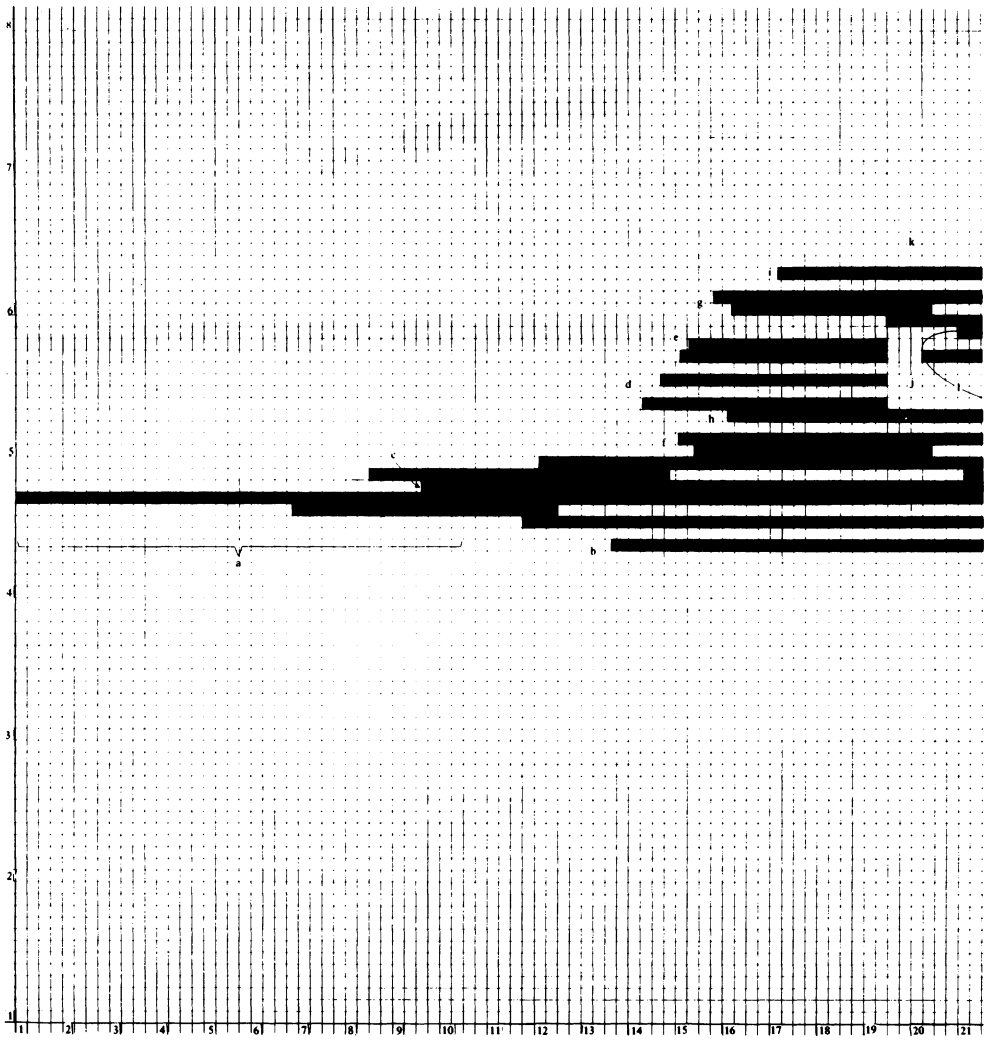
The sudden ceasing of (E-F♯ -G♯ -A)5 in b.19 leaves a hole in the texture (*j*). The break is short-lived, but the momentary separation actually serves to emphasize a parallel development in the descent of the canonic strand from D♯, through C♯ to B (*k* and *l*). The [2]-striation now becomes a feature of the upper region of the texture in the two registers, as it did in the one register of *Lux aeterna*'s opening passage. Already in b.20 we hear G♯ 5 reentering, followed by A♯ 5 and F♯ 5 in bs 21 and 22 respectively (*m*). The hole is thus filled again, but not completely, and not quite in the same way. In fact, these three pitches – G♯, A♯ and F♯ – are the next segment of the canonic strand, after D♯, C♯ and B, and they project another [2]-striation.

The graph shows, from about b.22 onwards, a distinctly more pronounced spatial separation of the two registers, as they continue to move ever more closely in parallel. In fact, all pitches in one octave now have octave-correspondents in the other, except for E4, the lowest of all. The graph suggests one possible reason for the omission of E5: precisely to provide some measure of separation between the two registers. The [2]-striation D♯ -C♯ -B is maintained on both tiers, but otherwise, and especially from b.24, the texture enters its most opaque phase, with the space F♯ -B in both registers completely filled chromatically (*n*). The orchestration here, except for one sustained clarinet part, is all strings, thus

Ex. 9 cont.



Ex. 10 *Lontano*, bs 1-41



Ex. 10 cont.

emphasizing homogeneity of texture by comparison with what has gone before. This passage has the effect of cancelling most previously established relationships and paving the way for the shape of the section's conclusion. As for the [2]-striation preserved above, it is not disrupted, appropriately enough, until the entrance of the pitch C (b.31), which in several octaves serves the same function here as do the octave As in *Lux*.

After the entrance of C(5, 6, 7), the texture begins to thin noticeably. Pitch D♯ drops out in b.32, then E4 and B (4,5) in b.33. The graph (at *o* and *p*) reveals that the thinning process systematically exposes [2]-striation in both registers, and that the pitches forming these striations then proceed to drop out, beginning with the lowest and ending with the highest, thus attenuating the texture until only C is left. Combined with this reemergence of the [2]-striation is the persistence of C♯ (5, 6) until b.38. As in *Lux*, the descent of the upper boundary (*q* and *r*) produces the intervallic arrangement [1][2]; also as in the earlier piece, the sounding of the last three notes of the canonic strand alone (D♭ -B♭ -C) from b.37 on constitute a form of [2][1].

Looking back, we find that the fluctuations in the density of the texture, as revealed by the graph, are to a certain extent reflected in the series of pitches in the canonic strand. Already noted are the [2]-striations at the outer edges of the range of the strand: E-F♯ -G♯ and D♯ -C♯ -B, which occur as distinct segments of the canonic series (twelfth to fourteenth and nineteenth to twenty-third pitches respectively). Also worth mentioning are, for one, the very opening, which as in *Lux* produces a narrow, compact band of pitches from two symmetrically arranged forms of [1][2], and from numerous repetitions of A♭ among the first nine pitches in the series; and for another, the segment extending from the twenty-fourth pitch (G♯) to the thirtieth (A♭), in which the constricted range and constant changes in direction produce the climax of opacity noted earlier in bs 25-32.

These canonic 'resultants' are also noticeable as features of the *Lux* graph. At this point, a side-by-side comparison of Exs 7 and 10 is instructive. The similarities between the two pieces show up more in general shape and contour than in specific details. Internal relationships, in particular, are quite different. It is well to remember that owing to the octave doubling in *Lontano* the visual comparison with *Lux* is more accurately made (especially from about b.21 in *Lontano*) between *Lux* and half the texture of *Lontano*. Even so, however, the realisation of notes 22-8 of the canon in *Lux* (*o* and *p*, Ex. 7) differs considerably from that of notes 24-30 in *Lontano* (*n*, Ex. 10) because of the larger number of parts in the latter. Furthermore, the motion toward the bare octaves at the ends of the sections under analysis is managed, in *Lux*, partly through an internal 'emptying' of occupied space which does not take place in *Lontano*. (See the fissure that appears in the wake of the descending ripple *r* in Ex. 7.) This, as noted in the analysis above, comes about in apparent response to the region of empty space, equal in size to the space already densely filled below, opened up by A5. But in *Lontano* the entrance of C7 is a less dramatic event than that of A5 in *Lux* simply because octave doubling is already a fact of the texture in the

orchestral piece. The progress from this point to the concluding octave spacings in *Lontano* sounds less like an *emptying* of space than a *focusing* upon octaves that are already present.

Ligeti's problem could be summarized in the following question: How does one arrive at a compositional practice that satisfies the intellect as well as the ear? The worst excesses of the serialist era indulged the former at the expense of the latter, but particularly for those who shunned the serialist path, after learning what it led to, the experience of serialism made it effectively impossible to devise alternatives in which conscious method did not play a prominent role. Ligeti has said that when he composes he always begins by imagining the way he wants a piece to sound, in great detail, from beginning to end; then he figures out how to produce that sound. This might seem to be excess at the opposite extreme, were it not that the act of writing the piece, for Ligeti, invariably changes the original, imagined plan.[54] This must mean that the imagined sound can only become audible if it is based on consistent principles. The inaudible structure does not *justify* the audible music, but without a structure it will not be possible to know precisely what the music *should* sound like. Here is where the purpose of contrapuntal structure in Ligeti's music becomes evident: it is a rule, hidden though not secret, that can be applied flexibly and with great control over temporal and spatial dimensions. Because it is noticeably not a mechanical procedure, it does not automatically dictate in all respects the sound of the emergent music, but neither is it simply a convenient excuse on which the composer may hang his preconceived notions. There can be little doubt that Ligeti derives a deep satisfaction, both aesthetic and technical, from employing canonic procedures as behind-the-scenes devices that enter into an intricate reciprocal relationship with the sounding surface, shaping the final result even as they are shaped to meet the exigencies of the work. It is a satisfaction that is readily communicable to the listener and analyst.

NOTES

1. György Ligeti, 'Metamorphoses of Musical Form' (1958), in *Die Reihe*, Vol. 7 (*Form – Space*), English edn (Bryn Mawr: Presser, 1965), pp.5-19.
2. Ligeti, 'Decision and Automatism in Structure Ia' (probably 1957), in *Die Reihe*, Vol. 4 (*Young Composers*), English edn (Bryn Mawr: Presser, 1960), pp.36-62.
3. Ligeti, 'Fragen und Antworten mit mir selbst' (1971), trans. Geoffrey Skelton, in *Ligeti in Conversation* (London: Eulenberg, 1983), pp.124-37.
4. Ligeti, 'Über Form in der neuen Musik,' *Darmstädter Beiträge zur neuen Musik*, Vol. 10 (1966), pp.23-35.
5. 'Metamorphoses,' pp.5-6.
6. *Ibid.*, pp.8, 10.
7. 'Über Form', p.31: my translation.
8. 'Metamorphoses', p.6. Specifically, in *Structures* Ia he noted that 'When we hear this composition a complex network unfolds – of coarser or finer weave . . .

consisting of a significantly ordered flock of sounding "points": these are organised to form threads of varied thickness, which now stand out plastically, now become less distinct. The threads, for their part, are woven together with greater or lesser density' ('Decision and Automatism', p.61).

9. 'Fragen und Antworten', p.131.
10. 'Fragen und Antworten', p.131.
11. Ligeti, 'On Music and Politics', trans. Wes Bloomster, *Perspectives of New Music*, Vol. 16, No. 2 (1978), pp.19-24.
12. Péter Várnai, 'Beszélgetések Ligeti Györggyel' (1978), trans. Gabor J. Schabert, in *Ligeti in Conversation*, pp.13-82.
13. Ligeti, 'Zustände, Ereignisse, Wandlungen', *Melos*, Vol. 34 (5 May 1967), pp.165-9: my translation.
14. *Ibid.* An English translation of Ligeti's account of this dream appears in *Ligeti in Conversation*, p.25n.
15. 'Metamorphoses', p.15.
16. *Ibid.* The latter phrase is Ligeti's own quotation from Adorno. See Theodor W. Adorno, *Philosophy of Modern Music*, trans. Anne G. Mitchell and Wesley V. Bloomster (New York: Seabury, 1980), p.188.
17. 'Über Form', p.24.
18. *Ibid.*, pp.23-4, 34.
19. *Ibid.*, p.34.
20. *Ibid.*, p.26: my translation.
21. 'Metamorphoses', p.19; emphasis in original.
22. 'Fragen und Antworten', p.125.
23. Várnai, p.15.
24. 'Metamorphoses', p.15.
25. Várnai, p.25n.
26. Paul Griffiths, *György Ligeti* (London: Robson, 1983), p.20.
27. Ligeti, 'Über neue Wege im Kompositionsunterricht: Ein Bericht', in *Three Aspects of New Music* (Stockholm: Nordiska, 1968), pp.9-44.
28. It is surely significant, in this connection, that in his own analytic writing Ligeti has noted instances of pitch symmetry in Bartók; see 'Über die Harmonik in Weberns erster Kantate', *Darmstädter Beiträge zur neuen Musik*, Vol. 3 (1960), pp.49-64. Registrally based symmetry, in particular, plays more of a role in Bartók's work than has generally been recognised; see my article 'Space and Symmetry in Bartók', *Journal of Music Theory*, Vol. 30 (1986), pp.185-201.
29. 'Fragen und Antworten', p.128.
30. Josef Häusler, 'Zwei Interviews mit György Ligeti' (1968, 1969), trans. Sarah E. Soulsby, in *Ligeti in Conversation*, pp.83-110. It should be noted that, even though in the resultant texture of clusters the traces of Bartókian style have all but vanished, still the original idea of clusters predates Ligeti's emigration from Hungary and is attributed by him to his familiarity with Bartók's music (Griffiths, p.26). See, for instance, the third movement of *Music for Strings, Percussion and Celesta*, bs 20ff. The first version of the first movement of *Apparitions* was a work entitled *Víziók*, completed in Budapest in 1956.

31. 'Zustände, Ereignisse, Wandlungen', p.169: my translation.
32. 'Metamorphoses', p.14; 'Fragen und Antworten', pp.131-3.
33. This plan of attack leaves other aspects of Ligeti's sound structure unengaged. The reader should bear in mind, however, that these other aspects, mostly of secondary importance according to the composer, are organised along independent schemes (again according to Ligeti) and thus are presumably separable for the purposes of analysis.
34. Ursula Stürzbecher, 'György Ligeti' [interview, c.1970], in *Werkstattgespräche mit Komponisten* (Cologne: Gerig, 1971), pp.32-45. Obviously, however, I make no claim to having recapitulated, in any substantive sense, Ligeti's compositional process. As he himself said of his analysis of Webern's Op.29, 'Analysis can do no more than merely conjure up the shadow of the actual creative process' ('Über die Harmonik in Weberns erster Kantate,' p.53n: my translation).
35. Throughout this article the word 'interval' is used exclusively to mean *vertical* distance, whether chromatically filled or not. Thus 'interval' really means 'vertical compass' in Ligeti's terminology. Despite the potential confusion, I have decided to use 'interval' in a sense not meant by Ligeti's use of the word, since 'vertical compass' or even 'compass' is syntactically awkward.

    The double vertical bars in the graph indicate clusters: complete chromatic filling. The fact that highest and lowest points, and boundaries of instrumental groups within clusters, are marked with pitch names is not meant to suggest that these boundaries are more 'pitch-like' than the notes within the boundaries; they are shown in this fashion only to make it easier for the reader to grasp visually the info mation concerning interval sizes contained in the graph.
36. The short dash or hyphen is used here and subsequently to separate single pitches or to refer only to the boundaries of filled spaces; the long double dash (=) refers to the contents of clusters: chromatically filled spaces bounded by the pitches named.
37. Stürzbecher, p.39: my translation.
38. Várnai, p.39.
39. The horizontal bracket in bs 1, 13 and 25 signifies that the verticals encompassed are attacked simultaneously.
40. The pitch names in the graph, here and in bs 18-20 (and also in Ex. 4), mark the individual points of maximum loudness.
41. Pitch names in bs 23-5 show each separate set of entries verticalized.
42. The quasi-canonic passage of the second movement of *Apparitions* (bs 25-37), in which 46 string parts (24 + 8 + 8 + 6) playing four different lines begin together but then immediately get out of phase, seems to be the first example of this integration. For extensive critical commentary of widely varying usefulness on Ligeti's work up to 1965, see Erkki Salmenhaara, *Das musikalische Material und seine Behandlung in den Werken 'Apparitions,' 'Atmosphères,' 'Aventures,' und 'Requiem' von György Ligeti*, trans. from the Finnish by Helke Sander, *Forschungsbeiträge zur Musikwissenschaft*, Vol. 19 (Regensburg: Bosse, 1969); Ove Nordwall, *György Ligeti: Eine Monographie*, trans. from the Swedish by Hans Eppstein (Mainz: Schott, 1971), pp.9-77.
43. The canonic structure of this passage is also discussed, incompletely, by Reinhard

Febel in 'György Ligeti: *Monument – Selbstportrait – Bewegung* (3 Stücke für 2 Klaviere)', *Zeitschrift für Musiktheorie*, Vol. 9, No. 1 (1978), pp.35-51; Vol. 9, No. 2 (1978), pp.4-13.

44. For another analysis that explores large-scale symmetry in Ligeti's music, see 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), pp.31-56.
45. Häusler, p.108.
46. Stürzbecher, p.44.
47. Ligeti, 'Auf dem Weg zu *Lux aeterna*', *Österreichische Musikzeitschrift*, Vol. 24 (1969), pp.80-8.
48. Várnai, p.44.
49. *Ibid.*, p.29. Ligeti calls this harmony a 'typical Ligeti signal' and describes it as 'a fourth made up of a minor third and a major second or the other way around' – that is, [3][2] or [2][3], which formulation seems to confirm that the idea of inversional equivalence is valid in general for analysis of his music.
50. The reader's attention is directed to two other analyses of *Lux aeterna*: Clytus Gottwald, '*Lux aeterna*: Zur Kompositionstechnik György Ligetis', *Musica*, Vol. 25 (1971), pp.12-17; Robert Cogan, *New Images of Musical Sound* (Cambridge, Mass.: Harvard, 1984), pp.39-43. Cogan's spectrum photos seem to some extent to coincide with my graph, although detail in the photos is difficult to make out at certain points.
51. 'Auf dem Weg zu *Lux aeterna*', p.86.
52. There are close relationships between the canonic strands of other sections as well, although they vary as to order within the pieces and as to level of transposition, and some strands and/or parts of strands in each are unique.
53. Bruce Reiprich, in 'Transformation of Coloration and Density in György Ligeti's *Lontano*', *Perspectives of New Music*, Vol. 16, No. 2 (1978), pp.167-80, has discussed this orchestrational segmentation. However, Reiprich complicates matters unnecessarily by referring to each of the segments – eight in all – as a separate canon.
54. 'Ligeti Talks to Adrian Jack', *Music and Musicians*, Vol. 22, No. 11 (1974), pp.24-30.