
ANALYSES

Article received on 22 September 2013

Article accepted on 30 September 2013

UDC: 786.2.087.5.089.6

Man-Ching Yu

The Hong Kong Institute of Education

Cultural and Creative Arts Department

Musical Arts Division

TRANSFORMATIONS OF DIATONIC MATERIALS AND TONAL PROCEDURES IN LIGETI'S *ETUDE NO. 15 "WHITE ON WHITE"*

Abstract: This essay examines interrelationships of various diatonic materials that arise in Ligeti's Etude No. 15 "*White on White*," focusing on transformational properties between different diatonic trichords. Ligeti's distinctive treatments of diatonic materials reflect the utilization of triadic intervallic structures in transformational procedures. In particular, ic5 dominates in abundance, contributing to the consonant tonal property between various pitch-class transformations among trichords, and that some are smoothly interconnected by common tones for preserving diatonic coherent sound. Additionally, some transformations are analogous to tonal procedures – harmonies progress from tonic to dominant or subdominant and vice versa – that manifests Ligeti's pronounced reference to the context of the traditional common practice as three pitch-classes among the same types of trichords map onto each other solely by ic5. Along with the coherent diatonic sound that Ligeti forges, tonal contrasts are achieved through simultaneous tonal occurrences being established by transformed pitch-classes, forming tonal pairings in third relationship with ics 3 and 4 that illuminate the traditionalistic tonic and mediant linkage prevailing in the nineteenth century.

Keywords: Ligeti, transformation, double transformation, common tone, diatonic tri-chord, diatonic collection, micropolyphony, harmonic net-structure, tonal pairing, interval-class.

* Author contact information: manchingyu@msn.com

Ligeti's musical styles underwent various metamorphoses during his compositional career and his compositional styles can be divided into three different periods; each period showed substantial stylistic changes in terms of harmonic structures and languages. The musical style of his earlier period generally reflects the influence of Bartók and Hungarian folklore materials¹. After 1956, his music is characterized by dense micropolyphonic webs² (Roig-Francoli, 1995). Besides micropolyphonic techniques, chromatic intervallic cells are utilized for generating a distinctive harmonic language called "harmonic net-structure."³ In his late period after 1980, Ligeti's musical style drastically shifted as he employed numerous traditional and tonal elements, as he said:

"In the late '50s and early '60s my music moved within harmonic fields filled out with chromaticism, whereas ten years later I composed diatonic music. I felt that chromaticism had been exhausted: the choice was between going "back" to diatonic music and going "forward" outside the sphere of tempered Music. (Varnai, 1983)

Among the works in his late period, his Horn Trio composed in 1982 is the first piece in which Ligeti experimented with his new style.⁴ In this piece Ligeti's use of major and minor harmonies with set-class 3–11 are evident, reflecting the exploration of triadic sonorities without any reference to the syntax of common practice tonality. Along with set-class 3–11 various diatonic set-classes-3–2 [013], 3–6 [024], 3–7 [025], and 3–11 [037] – drawn from the diatonic collection 7–35 [013568A] can be sought in his later period works⁵; Ligeti's particular uses of these generative trichords were regarded as a sort of typical signal⁶ because most of his late works comprise these set-classes serving

¹ Among his works, *Musica ricercata* (1953) and String Quartet No. 1 *Métamorphoses nocturnes* (1953–1954) clearly manifest his earlier styles. (Searby, 2010)

² Micropolyphonic web is the technique adopted by Ligeti where numerous independent chromatic lines are intertwined with each other to create a chromatic-filled complex sound clusters. Those techniques are manifested in his large-scale orchestral works such as *Apparitions* (1958–59) and *Atmospheres* (1961) (Cope, 1997). Ligeti has also mentioned the important innovative concept in *György Ligeti in Conversation with Peter Varnai, Josef Haeusler, Claude Samuel and himself*. (London: Eulenburg, 1983)

³ Harmonic Net-Structure is a continuous web of finely-woven lines in a constant interactive process of transformation of one or more parameters and his *Ramification* (1968–69) and *String Quartet No. 2* (1968) are characterized by such techniques. (Roig-Francoli, 1995)

⁴ Ligeti himself said this Horn Trio was the first piece in his new style, belonging to the last period. (Szigeti 1984, p.210)

⁵ See Cuciurean (2012, pp. 225).

⁶ See Varnai (1983, p.29); the original interview was conducted in 1978. Cuciurean (2012, p.226) also confirms that the generated sonorities built from either conjoined 3–7 or 3–11 trichords will be subsets or supersets of the diatonic collection, 7–35, all of which assume an increasingly prominent role in the music of Ligeti's so-called final period.

as harmonic devices for generating diatonic sound. All these trichords have triadic properties involving triadic intervallic structures—ics⁷ 3, 4 and 5 – and those interval classes are crucial for pitch-class⁸ formation in his late works.⁹

Despite the evident change of his styles, the transformational properties of his earlier micropolyphonic works were frequently investigated. Miguel A. Roig (1995) focuses on the transformational processes¹⁰ of Ligeti's *Ramifications*; Jonathan Bernard (1987) mentions the harmonic processing and spatial contextual issue in Ligeti's *Lontano*, whereas Bruce Reiprich (1978) focuses on the transformation of density in *Lontano*. However, more attention has been paid to investigating Ligeti's late works recently. Clifton Callender (2007) investigates the traditional tertian harmonic materials in Ligeti's *Etude No. VI "Arc-en-ciel"*¹¹; John Cuciurean (2012) gives an insightful inspection into the third movement "Bewegung" from Ligeti's *Three Pieces for Two Pianos* (1976): he generalizes that the piece involves the amalgamation of the past and new stylistic approaches. Diatonic harmonies are marked by several prominent cadential points during the course of the piece, while canonic procedures associated with the unfolding of chromatic dyads are utilized. Thus, an apparent association between his earlier and later musical styles is evident in Ligeti's late works. For gaining a deeper understanding of Ligeti's late work, I investigate one of his piano solo pieces with newly transformed style – the first movement of *Etude No. 15 "White on White."* This piece is rather distinct from his other late work in that it exclusively exhausts all the diatonic subsets drawn from the diatonic scale on C, rather than exhausting all the single pitches or chromatic

⁷ Ic, an abbreviation of interval-class, is the shortest distance between two notes in pitch-class space; pitch-class space is an associational circular space containing all the notes within a musical octave, and in this space, there is no differentiation between notes that are distinct by different octaves. For instance, although C4, C5, and C6 situate in different octaves position, they belong to the same point in pitch class space. (Straus 2005)

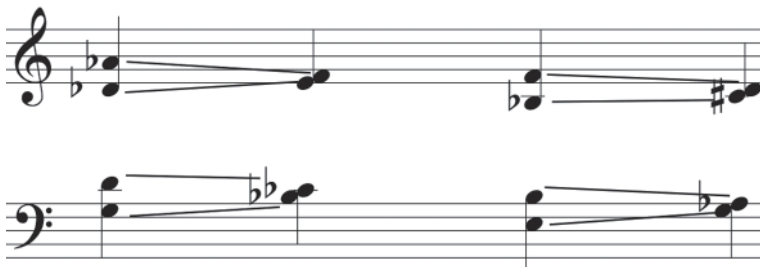
⁸ Pitch-class, being abbreviated as pc, is a set of pitches translated by integer notation into whole numbers regardless of their octaves position; e.g. C=0, C#=1, and D=2. (Straus 2005)

⁹ In Ligeti's later period works, set-class 3–11 surfaces as a new Ligeti signal that begins to assume a more prominent role from the mid-1980s onwards. (Cuciurean 2012, p.225–226)

¹⁰ In the Roig-Francoli (1995) article, transformational properties have been addressed in Ligeti's works written in the middle period. In his *Ramifications*, harmonic transformation is generated by constant intervallic expansion or contraction of trichordal cells. Chromatic fluctuation associated with intervallic expansion also occurs in his Second String Quartet; in his Chamber Concerto harmonic transformation is undergone by means of subtraction and addition of single pitches, effecting the symmetry of groups of pitches.

¹¹ Callender (2007) uses neo-Riemannian theory to delineate the harmonic progressions in the piece and he also figures out that jazz harmonies partly influence the harmonic materials of the piece.

dyads within the chromatic scale benchmarked in his earlier works. I also pay specific attention to the transformational properties of pitch-classes at various levels and in different dimensions of the piece. Moreover, I further contend that Ligeti contrasts drastically with his earlier micropolyphonic techniques, which are prominently featured by saturating, unfolding, and transforming chromatic cells and dyads, by maximally employing consonant interval¹² ic5 and preserving tonalities and traditional approaches for governing harmonic relationships. As a matter of fact, the significance of ic5 has been highlighted in Ligeti's Sketch Page I for *Bewegung*¹³. As illustrated in example 1, Ligeti writes four perfect fifths and the particular intervals serve as central arrival points from where various chromatic dyads unfold. The contrasting consonant quality of ic5 serves as a basis for displaying transformational process and tonal procedures throughout the first movement of "*White on White*."



Example 1: Sketch Page I for *Bewegung* emphasizes perfect fifths

In *Etude No. 15 "White on White,"* diatonicism in association with consonant¹⁴ tonal sound based on all pitches of the white keys¹⁵ is so central that the sound reflects Ligeti's application of transformational techniques. In the piece, all diatonic set-classes in various transpositional levels are exploited and they are more often displayed in a condensational form of trichordal configuration. These diatonic set-classes dominate the whole movement at various levels from vertical to horizontal dimensions, manifesting Ligeti's use of economical post-

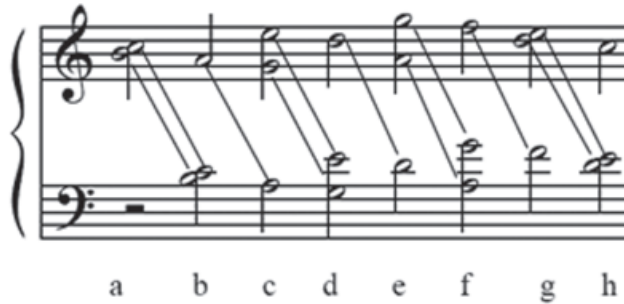
¹² Here I contend that ics 1 and 5 are in stark contrasts in terms of the nature of dissonance and consonance.

¹³ See Cuciurean's (2012, p. 223) essay.

¹⁴ Various theorists have delineated explicitly the level of consonances and dissonances. According to Howard Hanson (1960), Vincent Persichetti (1961), and Paul Hindemith (1941), perfect intervals include perfect 4th and perfect 5th having the most consonant sound.

¹⁵ I refer to the white keys of the piano keyboard, reflecting the title "*White on White*."

tonal materials¹⁶ for generating coherent sound. Additionally, a strict canonic relationship dominates between the upper and bottom layers of the piece and subsequently common tones extensively exist between adjacent trichords for displaying a smooth transformational process. The horizontal counterpoint-oriented canonic process combines with the vertical harmonic-oriented features of various trichordal materials, creating a substantive diatonic variety. Moreover, tonal procedures¹⁷ are manifested as a result of the transformations between trichords, and these particular triadic interval classes are employed predominantly for transformations between trichords during the course of the piece. Nevertheless, the tonal procedures manifest Ligeti's drawing on the past techniques and illuminate Ligeti's special manipulation of diatonic materials in his late work.



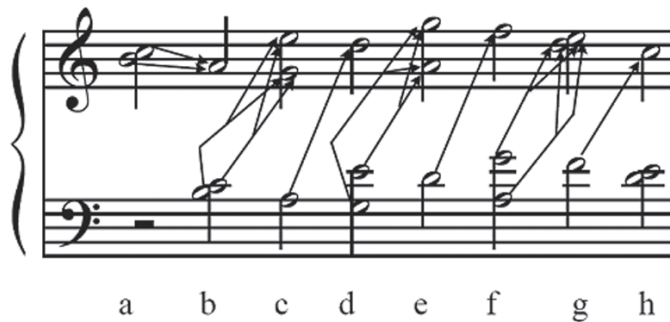
Example 2: Chain of common tones between each adjacent trichords from 'b' to 'h' in m. 1

Example 2 illustrates each trichordal configuration displayed in vertical dimension, and in m. 1 there are seven different trichordal configurations with different pitch classes in the upper and lower layers. Common tones are preserved between each pair of neighboring trichords, resulting from the strict canonic relationship between the upper and bottom layers from 'b' to 'h.' For instance, one common tone pc 9 exists between chord 'b' and chord 'c'; two common tones pc 4 and 7 exist between chord 'c' and chord 'd,' and so forth. The constant preservation of common tones strongly conserves the affinity relationship and the similar diatonic sound between each pair of trichords, as well

¹⁶ Herein I use "post-tonal materials" to describe various diatonic set-classes in different transpositional relationships.

¹⁷ I use the term "tonal procedures" for referring to all the traditional common practices related to harmonic progressions and forming tonalities.

as smoothing the transformational process between each chord; however, the common tones between each pair are in an octave relationship. As shown in example 2, pc 9 in chord 'c' is an octave lower than that in chord 'b.' Despite the "octave transfer",¹⁸ the sense of sameness between the common tones is not destroyed, as they belong to the same pitch-classes, and it also offers an interesting way to echo the same pitch-classes in an octave equivalent relationship between each trichordal pairs. Ligeti draws on the characteristic of the harmonic progression of the traditional harmonic practice by preserving common tones between triadic materials, however, the common tones in this piece are in an octave registral relationship which is quite an interesting treatment.



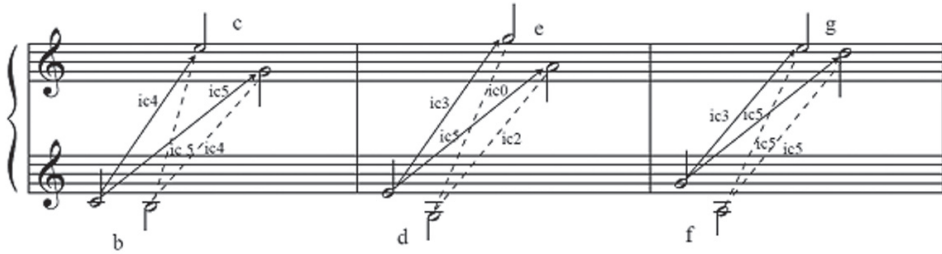
Example 3: Transformation of different pcs between neighboring trichords from 'b' to 'h'

Because of the vast amounts of common tones, transformations among non-common tones emerge between trichords. Example 3 reveals that extensive transformations occur between different pitch-classes. In trichord 'b,' pc 0 and pc 11 split into a dyad, by transforming into pcs 4 and 7; pc 9 in trichord 'c' transforms into pc 2 in trichord 'd,' similarly, pc 4 and pc 7 split into a dyad with pcs 7 and 9, and so forth. The interval classes of all the transformations between pitch-classes are overwhelmingly dominated by ics5 and 3, which are the paramount intervallic structure of a triad. The transformations are all governed by the consonant triadic intervals for generating tonal sound and those massive chains of consonant skips¹⁹ of ics3 and 5 strongly stabilize the consonant and

¹⁸ The "octave transfer" that I address here is the spatial transposition of the common tones belonging to the same pitch-classes.

¹⁹ Here the consonant skip that I mention is an associational model, which is different from that of the concept used in the traditional Schenkerian Analysis. This consonant skip emphasizes the triadic consonant intervallic classes, ic3, 4, and 5 operating on transformations between trichords.

tonal quality of the passage. It should be noteworthy that ic5, which is considered as the most consonant interval in a triad, exhibits its maximum occurrence. This interval plays a significant role in forging consonant and tonal sound in the piece, as well as reflecting the purity of diatonic sound.



Example 4: Double transformations between trichords ‘b’ and ‘c’, ‘d’ and ‘e’, and ‘f’ and ‘g’

Some interesting tonal phenomenon arises as a result of the transformations, leading to the formation of tonal pairing²⁰ at the preliminary section of the piece. The formation later forecasts the emergences of other tonal pairings during the course of the first two measures and it will be addressed in the ensuing discussion.

As in example 2, trichords ‘b,’ ‘d,’ and ‘f’ at the bottom layer are characterized by two voices and each transforms into two different pitches, and thus four transformations occur. Example 4 illustrates double transformations display between trichords ‘b’ and ‘c’, ‘d’ and ‘e’, and ‘e’ and ‘f’. The result reveals that ic5 emerges in six transformational processes, ics3 and 4 appear twice, and ics0 and 2 show their minimum occurrences. Thus, it is evident that triadic intervallic class 5 dominates the double transformational processes. In addition, the implication of the unions of two different triads, C major and E minor, is imaginarily generated by simultaneous consonant motions. The combination of the transformational processes of both triads results in tonal pairing, creating a double-tonic complex²¹ that comprises the pitches C-E-G-B. Apparently, a C tonality is potentially implicated in the complex and its significance gradually emerges

²⁰ Tonal Pairing has been first addressed by Robert Bailey (1985) in his work on Wagner. It is generally defined as a situation where two tonics simultaneously occupy the same position within a tonal hierarchy.

²¹ Double-tonic complex has also been introduced by Robert Bailey (1985) and it is formed by the unions of two different triads in third relationship, as in this case, the combination of C major and E minor triads to form C-E-G-B.

during the course of the piece. For instance, its first arrival in trichord 'h' at the end of m.1 marks the first cadential point (see example 2). On the other hand, an A minor tonality gradually conforms for establishing tonal focus alongside the C tonal centre. Throughout the whole piece the simultaneous emergences of A minor and C major tonal centers play prominent roles in synthesizing the tonalities of the piece.

The music is initiated with an important dyad with pcs0 and 11 at the first beat in m.1 and it transforms into pc9 in trichord 'b,' (see example 3); the transformation serves as a resolution resembling the traditional common practice by implicating an A minorish tonality. By interacting the A minorish trichord 'b' with pcs 4 and 7 in trichord 'c,' a generalized tertian 9th chord is superimposed as shown in example 5. This tertian chord reveals the composer's harmonic signature set-class 5–27, emerging in his later style.²² Moreover, the intervallic structure of the chord reflects an interval cycle dominating the single pitch-classes as shown in example 6. The ascending arpeggiation of pcs 2, 5, 9, and 0, with the exception of pc4, outline an interval cycle filled with ics 3 and 4. In other words, the intervallic pattern, ic3–ic4–ic3–ic4, is condensed within the A minorish tertian 9th chord in example 5. As we can see, consonant intervals ic3, ic4, and ic5 play constructive roles in synthesizing pitch materials in various dimensions at the musical surface even though the whole piece is chiefly dominated by post-tonal set-classes with dissonances minor 2nd and 7th and major 2nd and 7th. (Example 2)

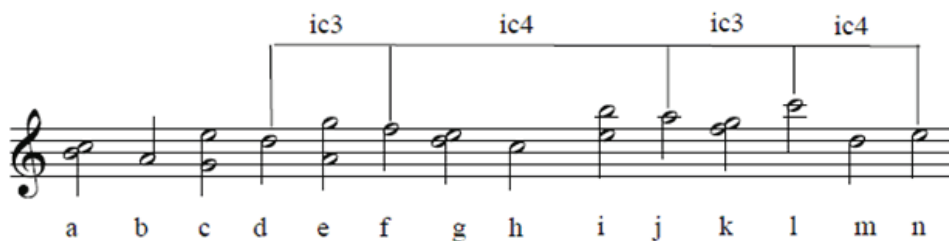
Interestingly, another occasion of tonal pairings can also be sought (Example 7), however, these tonal pairings between D- and F⁺²³ comprise pitches projected at a larger surface level and they are in third-related tonal relationships. As shown in example 7, non-dotted arrows indicate that transformations take place between different single pitch-classes, whereas dotted arrows represent common pitch-classes between the upper and lower layers. As mentioned previously in example 3, by holding common tones between adjacent trichords, transformations of different pitch-classes take place between the lower and upper layers. In example 6, pc 9 in trichord 'c' transforms into pc 2 in trichord 'd,' and thus due to the same pcs 9 possessed by trichords 'b' and 'c,' transformation also takes place in the upper layer between pc 9 in trichord 'b' and pc 2 in trichord 'd,' and so forth. Subsequently, the chain of transformations takes place

²² Ligeti employs his typical trichordal signals as a family of subsets which appear as embedded structures within more complex surface harmonies that arise through transpositional combination of set-classes 3–2 (013), 3–6 (024), 3–7 (025), 3–10 (036), and 3–11 (037) (Cuciurean 2012, p. 225).

²³ Here I use the signs + and – to denote major and minor respectively. (Straus 158)



Example 5: Tertian 9th chord with root A is formed as a result of the superimposition of three triads, A-, C+, and E in m. 1



Example 6: Interval cycle filled with ics3 and 4 formed by single pitch-classes

extensively between different single pitch-classes in the upper layer as shown in example 7. The interval cycle that dominates the arpeggiated pitch-classes in example 7 is the same as the interval classes that dominate the transformations between different pitch-classes in the upper and lower layers in example 3. In other words, transformations govern the triadic arpeggiation of the pitch-classes in the upper layer in example 7.

Furthermore, the importance of the single outlined pitch-classes in the upper layer in example 7 can also be manifested by the motional tendency of each pitch-class's previous dyad. This is analogous to the resolution manner of the traditional common practice period, i.e. particular pitch in one chord resolves to the neighboring pitch by means of stepwise motion. In this case, the unstable dyad on the down beat, pcs 0 and 11, in chord 'a', tends to gravitate toward the rather stable single pc 9 in chord 'b' on the upbeat and so as the rest of the trichords from 'c' to 'j,' however, the dyad with pcs 5 and 7 in chord 'k'

Example 7: Resolved pitches outline tonal pairings

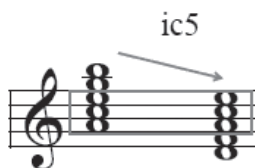
resolves to pc 4 in chord ‘n’ and this resolution is delayed by pcs 0 and 2 in between. By combining the outlined resolved pitches in trichords ‘b,’ ‘d,’ ‘f,’ ‘h,’ and ‘j,’ three different triads can be formed, D-, F+, and A- triads as illustrated in example 7. Tonal pairings between D- and F+ as well as F+ and A- generate two pairs of third-related tonal centers. These pronounced tonal relationships hark back to the 19th century where third-related tonal centers are a commonplace²⁴. In addition, by combining all three triads together, an implicative tertian 9th chord can be formed as shown in example 8. The chord is made up of the superimposition of three different triads and the “upper structure²⁵” of the chord is made up of an A- triad. Due to the uppermost pitches’ sounding of the “upper

Example 8: Another tertian 9th chord is formed as a result of the superimposition of the three triads, D-, F+, and A-

²⁴ Tonal pairings in third-relationship are also manifested in other twentieth-century works; Brown (2009) noted the prevalence of third-related tonal pairing in Shostakovich’s works.

²⁵ In jazz music, the term upper structure or upper structure triad refers to a voicing approach developed by jazz pianists and arrangers, defined by the sounding of a major or minor triad in the uppermost pitches of a more complex harmony. (Ellenberger, 2005)

structure,” an A minorish tonality is again emphasized, and the implication of A minor tonality becomes pronounced near the end of m.2. In examples 5 and 8, the tertian 9th chords manifest several tonalities emerging at the same time for creating an interesting tonal phenomenon. Tonal pairings in third are reflected at different levels during the preliminary portion of the piece, and the triadic intervallic structure- ic3 and ic4– at the larger surface level in example 7 are also manifested in the transformational processes at the microscopic level between the trichords in examples 3 and 4.



Example 9: Two tonal complexes are in an ic5 relationship.

Another interesting phenomenon is that the two tertian tall chords are in an ic 5 transpositional relationship as shown in example 9. This ic 5 consonant interval interconnects the two multiple tonal complexes which resembles the tonal procedure: the cycle of 5ths in the traditional harmonic progressive context and the tonic-subdominant relationship. Additionally, common tones made up of an A minor triad are generated upon undergoing ic5 transposition. The presence of the common tones reaffirms the prominence of the A minorish tonality despite the presence of tonal pairings.

The confirmation of A minorish tonality can also be sought in m. 3 as shown in example 10, since another tonal pairing emerges between trichords ‘c1’ and ‘d1’.²⁶ In example 10, pcs 4 and 5 of trichord ‘c1’ undergo transformation by splitting into pcs 9 and 0 of trichord ‘d1’ respectively.

Again, ic5 dominates the transformations and reflects the consonant motions between the pcs. Upon the transformational process, two different triads in third relationship are generated, A– and F+. Tonal center is swung between triads F+ and A–, however, A minor tonality is emphasized in trichord ‘e1’ by ic5 transforming the pc 11 in trichord ‘d1’ into the pc4 in trichord ‘e1,’ which is a complete A minor triad. It should be noteworthy that the A minor triad is the only triad emerging as a trichord in the whole piece, in this case, the trichord

²⁶ For the sake of convenience, I label the trichords in m.3 with a1–h1 due to the fact that the contours of the soprano notes (the upper layer) in m.3 are the same as that of the soprano notes in m.1. Obviously, there is a close relationship of the soprano notes between m.1 and m.3.

Example 10: Transformations between trichords ‘c1’ and ‘d1,’ and trichord ‘e1’ as an A minor triad

‘e1,’ and the crucial importance of this tonality is reinforced. In addition, one more interesting spot is that the tonality of A minor is made even more apparent by means of its tonic-dominant relationship with a E minor triad, which is formed by the arpeggiated transformation of the single pcs 7, 11, and 4 as illustrated in example 11.

Thus, from mm.1–3 (example 3), an A minorish tonality makes its first appearance in trichords ‘b’ and ‘c,’ and during the course of the trichordal transformations from trichords ‘d’ to ‘n,’ A minorish tonality competes with C tonality in trichords ‘c’ and ‘h’ as well as other tonalities formed by tonal pairings from mm.1–2, and lastly it confirms in trichord ‘e1’ in m.3. In example 9, the A minorish tonality is restated at the second cadential point²⁷ in trichord ‘h1.’ Although ‘h1’ is not an A minor triad, its tonality is subtly implied by experiencing a “dissonant counterpoint,²⁸” where the pc 0 in trichord ‘g1’ resolves to pcs 9 and 11 in ‘h1.’

A minorish tonality gradually shifts to C majorish tonality from mm.4–5. Example 12 reveals the fact that the transformational single pitch-classes in the upper and lower layers, pcs 5 in trichords ‘q’ and ‘r,’ pcs 2 in trichords ‘s’ and ‘t,’ pcs 11 in trichords ‘u’ and ‘v,’ and pcs 7 in trichords ‘w’ and ‘x,’ outline a dominant 7th triad of C+. The tonal polarity of music tends to gravitate to C by

²⁷ Here I refer the cadential point to the apparent moment in which the music arrives at a rather stable tonality, ie. A– or C+. As a matter of fact, Ligeti favored employing particular harmonies for signifying important cadential arrival points in his micropolyphonic pieces (Cuciurean 226), and thus it is not surprising that he retained the similar technique and concept in the diatonic work.

²⁸ Dissonance counterpoint differs from traditional counterpoint in that all the procedures of resolutions in the traditional counterpoint are reversed. It was first established by Charles Seeger in 1930.

Example 11: Single pcs form E minor triad

Example 12: Single pcs form dominant 7th of C major in m.4
and the resolution of C in m.5

means of the strong resolvent tendency of the tritone, pcs 5 and 11 in m.4. Moreover, in m.5 the third cadential point takes place in the upper layer as pcs 2 and 4 in trichord 'g2' transforms into pc 0 in trichord 'h2.' In this passage from mm.4–5, the tonal procedure resembles traditional common practice by preparing the dominant 7th chord to tonic, however, in this case, the dominant 7th chord is formed by the transformational single pitch-classes in a transverse and diagonal manner, and that the pitch-classes are projected over a farther distance from the tonic pitch. Thus, from a large-scale tonal perspective, tonal pairing between A- and C+ takes place from mm.1–5, and the polarity shifts from A- to C+ during the course of the first five measures. Even more, the third relationship between A and C equate with the major and relative minor key relationships prevailing in the traditional common practice period.

In addition to the fact that ic5 transformations dominate different adjacent trichords (example 3), they also emerge exclusively between trichords with set-class [013] at a middleground level. Example 13 reveals the extensive transformations between each type of sc [013].²⁹ Most of the scs [013] exhibit single path transformations, i.e. one pitch maps onto another pitch between two scs. For example, in m.1, pcs0, 11, and 9 in trichord 'b' map onto pcs5, 4, and 2 in trichord 'g' by means of ic5 respectively. Moreover, most of the transformations occur between the first type of sc [013] in the shortest path. For instance, ic5 transformation connects between trichords 'b' and 'g' in m.1, between trichords 'g' and 'd1,' and so forth. Furthermore, some transformations diverge into the two different trichords with sc [013]; trichord 'g' in m.1 transforms into two trichords 'd1' and 'h1' in m.3. In the second type of sc [013], some transformations are exhibited over a longer distance span; trichord 'o' in m.2 transforms into trichord 'i' in m. 7. It is of interest to notice that trichord 'i' is transformed by trichords 'o,' 'r,' and 'c' at the same time because of their same pcs' possession even though their pitch-class spaces are presented in different orders. In example 13, the extensive ic5 transformations between the two types of sc [013] are similar to the tonic-dominant relationship in the traditional common practice. Ligeti applies this tonal procedure to sc [013] and exhausts all these diatonic scs [013] throughout the movement, and they are presented in all transpositional and inversional formats. The first type of sc [013] involves pitch-class sets (9,B,0) and (2,4,5) whereas the second type of sc [013] comprises pitch-class sets (4,5,7) and (B,0,2). All the pitch-classes regardless of any pitch-class spaces in sc [013] are derived from the diatonic collection with pitch-class set (B,0,2,4,5,7,9)

As shown in example 14, maximally smooth³⁰ transformations also occur between different types of sc [013] and are achieved by holding one or two common tones (indicated with lines). The transformational pcs are governed by ic5 for consonant motion (indicated with arrows), and thus the prominence of this interval not only reflects on governing between the same type of sc [013]

²⁹ In example 13, I classify two types of sc [013]. The first type indicated with square is in an inversional transpositional relationship with the second type indicated with circle. Each type generates its own transformational paths.

³⁰ Maximally smooth transformation is originated by Richard Cohn (1996) and it refers to the transformational process by holding the maximum number of common tones between two triads; only a single pitch within a defined set changes by semitone per unit move. Here I articulate the same concept on sc [013], however, ic5 rather than semi-tone or whole-tone is emphasized between the transformations. Furthermore, the transformations in example 14 rely on common tones rather than voice-leading procedure that induces mapping in a transpositional inversional relationship. (Straus 2005)

The image shows a piano score with five systems of staves, labeled m. 1, m. 3, m. 5, m. 7, and m. 9. Each system contains two staves (treble and bass clef). The score illustrates transformations between sets of three notes (trichords) labeled as sc [013].

- m. 1:** Treble clef has a trichord [013] with notes b and g. Bass clef has a trichord [013] with note o.
- m. 3:** Treble clef has a trichord [013] with notes d1 and h1. Bass clef has a trichord [013] with note r.
- m. 5:** Treble clef has a trichord [013] with notes g2, a', and c'. Bass clef has a trichord [013] with notes d', e1', f1', g1', and h1'.
- m. 7:** Treble clef has a trichord [013] with note i'. Bass clef has a trichord [013] with notes e1', f1', g1', and h1'.
- m. 9:** Treble clef has a trichord [013] with notes r', a2', and c2'. Bass clef has a trichord [013] with note c2'.

Arrows indicate transformations between trichords across measures. Ovals group trichords that are related to each other. A dashed vertical line is present between measures 2 and 3.

Example 13: Transformations between each type of sc [013] from mm.1–10.

(Example 13), but they also serve as a smoothing agent for transformation between the two different types of sc [013].

Besides sc [013], transformations between scs [024] and those between [025] are also governed by ic 5 as shown in example 15. By treating C major as the central tonality in the passage from trichords 'f' to 'k', trichord 'h,' which is the first cadential point, serves as a central point for transformation. For sc

The image shows a piano score for measures 1 through 9. The score is written in two staves (treble and bass clef) for the piano. A vertical dashed line is placed between measures 3 and 4. The notes and their pitch classes are as follows:

- Measure 1:** Treble clef has a whole note chord with notes g and o . Bass clef has a whole note chord with notes g and o .
- Measure 3:** Treble clef has a whole note chord with notes r and r . Bass clef has a whole note chord with notes r and r .
- Measure 5:** Treble clef has a whole note chord with notes g^2 and d' . Bass clef has a whole note chord with notes g^2 and d' .
- Measure 7:** Treble clef has a whole note chord with notes i' and $[013]$. Bass clef has a whole note chord with notes i' and $[013]$. To the right of measure 7, there are two more chords: $e'l'$ and fl' in the treble, and gl' and hl' in the bass.
- Measure 9:** Treble clef has a whole note chord with notes $a2'$ and $c2'$. Bass clef has a whole note chord with notes $a2'$ and $c2'$.

Arrows indicate transformations between notes across measures, showing how the same pitch class or intervallic structure is maintained or transformed.

Example 14: Transformations between different types of sc [013]

[024], all three pcs between trichords 'f,' 'h,' and 'k' experience functional progressions in the context of traditional common practice. Pcs '5,' '7,' and '9' in trichord 'f' transform into pcs '0,' '2,' and '4' in trichord 'h' as a subdominant to tonic relationship and vice versa from trichords 'h' to 'k.' Interestingly, trichord 'k' splits into two [02] dyads 'm' and 'n.' Pcs '5' and '7' in trichord 'k' transform into pc '0' in trichord 'm' and pc '2' in trichord 'n' respectively, whereas pc '9' in trichord 'k' transforms into two pcs, pc '2' in trichord 'm' and pc '4' in trichord 'n.' Another instance of ic5 transformation occurs between trichords

The musical score for piano consists of five measures, grouped into three systems. The first system (m. 1) shows two staves with notes c, d, f, h, k, m, n. Trichords 'c' and 'd' are marked with [025], while 'f', 'h', 'k', 'm', and 'n' are marked with [024]. The second system (m. 3) shows notes fl, s, w, with trichords 'fl', 's', and 'w' marked with [025]. The third system (m. 5) shows notes a2, e2, h2, b', with trichords 'a2' and 'e2' marked with [025], and 'h2' and 'b'' marked with [024]. Lines connect notes between measures to illustrate transformations governed by ic5.

Example 15: Scs [025] and [024] governed by ic5

‘h2’ and ‘b’ in mm.5–6 where each pc in trichord ‘h2’ descends a perfect 4th interval becoming a new pc in trichord ‘b.’ This transformation correlates to the functional harmonic progression from tonic to dominant in the traditional context. For sc [025], similar events happen, however, the transformations are displayed over a larger distance between set-classes. Moreover, maximally smooth transformation exists between trichords ‘c’ and ‘d’ as well as trichords ‘s’ and ‘w’ due to the occurrence of two common tones in each trichordal pair. In each of these pairs, one pc transforms to another one by ic5; pc ‘9’ in trichord ‘c’ transforms to pc ‘2’ in trichords ‘d’ and ‘fl,’ and its reverse is applied between trichords ‘s’ and ‘w’. In m.5, all three pcs in trichord ‘a2’ transformed by ic5 generate three new pcs in trichord ‘e2.’ While serving trichord ‘h2’ as a C major tonic center, one can generalize that the progression from trichords ‘e2’ to ‘h2’ is from dominant to tonic, conveying a sense of perfect cadential closure.

Examples 16 to 18 demonstrate an interesting phenomenon; numerous different combinations of trichords with sc [027] transform into trichord ‘g1’ in m.3, and each transformation is achieved by a pair of [027] trichords and is operated by ic5. Most importantly, the prominence of trichord ‘g1’ is reflected

m. 1

Piano

[027] [027]

e l

m. 3

[027] [027] [027] [027]

gl t v x

Example 16: Trichords ‘e’ and ‘l’ with sc [027] transform into trichord ‘gl’ with sc [027]

m. 1

Piano

[027] [0247]

e l

m. 3

[027] [027] [027] [027]

gl t v x

Example 17: Trichords ‘l’ and ‘p’ with sc [027] transform into trichord ‘gl’ with sc [027]

on its transformation from the abundant pairs of trichords---‘e’ and ‘l’ (Example 16), ‘l’ and ‘p’ (Example 17), ‘p’ and ‘al’ (Example 18). Trichord ‘gl’ comprises pcs 0, 2, and 7; considering its prime form-pc 0, C-is the first pc in the set.³¹ Thus, the vast convergent transformations to pitch-class set (027) in ‘gl’

³¹ Here I regard pc 0 as the first pc in the (027), which is equivalent to the root of C major triad. Most importantly, pc 0 in (027) plays a central role in transformations as if the root of C major triad governs harmonic progressions.

The image shows a musical score for piano with two systems of staves. The first system is labeled 'm. 7' and the second 'm. 3'. Both systems are for the piano and consist of two staves. In measure 7, the upper staff has a trichord labeled '[027]' with notes F4, A4, and C5. The lower staff has a trichord labeled 'e' with notes G3, B2, and D3. In measure 3, the upper staff has a trichord labeled '[027]' with notes G4, B4, and D5. The lower staff has four trichords labeled '[027]' with notes G3, B2, D3; A3, C4, E4; F3, A3, C4; and G3, B2, D3. Lines connect notes between the two measures: a line from F4 in m. 7 to G4 in m. 3, a line from A4 in m. 7 to B4 in m. 3, and a line from C5 in m. 7 to D5 in m. 3. A vertical dashed line is present in both systems, separating the first two notes from the last note of each trichord.

Example 18: Trichords ‘p’ and ‘a1’ with sc [027] transform into trichord ‘g1’ with sc [027]

emphasize the centric role of pc 0 and implicate the central C tonality dominating the rest of the piece. Example 19 reiterates the significance of pc (027) in m. 4; trichords ‘l’ and ‘p’ in m.2 transform into trichord ‘t’ in m. 4. Additionally, examples 20 and 21 show that both trichords ‘x’ and ‘f2’ in mm. 4 and 5 are ic5 transformed by trichords ‘g1’ in m. 3 and ‘t’ in m. 4, and the secondary important role of trichords ‘x’ and ‘f2’ with pc (570) is made apparent by their ic5 relationships with trichords ‘g1’ and ‘t.’ In trichords ‘x’ and ‘f2’ pc 5 is the first pc in the set and correlated to pc (027) in a sense of a tonic to subdominant relationship in the functional context. In example 22, trichord ‘j’ [027] in m. 7 is ic5 transformed by trichords ‘v’ in m.4 and ‘e’ in m.6. This transformation takes place over a larger distance span that largely minimizes the important role of trichord ‘j.’ Moreover, ‘j’ is made up of pc (249) with pc 2 serving as a supertonic role to trichords ‘g1’ and ‘t.’ Generalizing the degree of prominence of different sc [027] members, member pc (027) plays its predominant role in determining the tonality of the piece; pc (570) has its secondary importance in connecting with pc (027) in a subdominant sense, whereas pc (249) has the least significant role in contributing to the overall transformation in the piece. Nevertheless, examples 16 to 22 generally manifest that ic5 transformations operate in trichords with sc [027], and that some are transformed by numerous pairs of [027] trichords at the same time within shorter distance spans, while one is transformed by just one pair of [027] trichords over a larger distance span, vanishing its effect on establishing the tonality of the piece.

m. 1

Piano

[027]

e

[027]

[0247]

l

p

m. 3

[027]

[027]

[027]

[027]

g1

t

v

x

Example 19: Trichords 'l' and 'p' with sc [027] transform into trichord 't' with sc [027]

m. 3

[027]

[027]

[027]

g1

t

x

Example 20: Trichords 'g1' and 't' with sc [027] transform into trichord 'x' with sc [027]

m. 3

[027]

[027]

[027]

[027]

g1

t

v

x

m. 5

[027]

f2

Example 21: Trichords 'g1' and 't' with sc [027] transform into trichord 'f2' with sc [027]

The image shows a musical score for three measures (m. 3, m. 5, m. 7) illustrating transformations of trichords. Each measure is represented by two staves (treble and bass clef). A vertical dashed line is placed between m. 3 and m. 5. The trichords are labeled as follows:

- m. 3:** Treble clef contains four chords, each labeled [027]. The bass clef contains four notes labeled g1, t, v, and x.
- m. 5:** Treble clef contains two chords, each labeled [027]. The bass clef contains two notes labeled f2 and e'.
- m. 7:** Treble clef contains one chord labeled [0257]. The bass clef contains one note labeled j'.

Lines connect the notes of the trichords across measures, showing voice-leading transformations. For example, the 'v' note in m. 3 moves to the 'e'' note in m. 5, and the 't' note in m. 3 moves to the 'j'' note in m. 7.

Example 22: Trichords ‘v’ and ‘e’ with sc [027] transform into trichord ‘j’ with sc [0257]

In “White on White” Ligeti’s distinctive treatments of diatonic materials reflect tonal procedures governed by ic 5, resembling tonic-dominant and tonic-subdominant relationships in the traditional context as it dominates numerous pitch-classes’ transformations between set-classes [013], [024], [025], and [027] and the transformations are more often smoothly interconnected by means of common tones. Alongside with common tones, voice-leading transformations inducing equivalent mapping between set-classes also emerge and ic5 is the prominent operator between the transformations. Additionally, different tonalities are established by emphasizing transformational resolved pitch-classes, generating tonal ambiguity by tonal pairings during the course of the piece. All tonal pairings are in third relationship with ics 3 and 4 that illuminates the traditionalistic tonic and mediant linkage back in the 19th century. It is evident that triadic intervals- ics 3, 4, and 5– are profusely formed and used consistently; they are also central for transformations between each pair of adjacent trichords throughout the whole piece subject to the strict canonic procedures between the two layers. Similar to the transformation, unfolding, and saturation of chromatic cell, ic1, in his earlier micropolyphonic and “harmonic net-structure” compositions, the exclusive dominance of ic5 in this piece

resulting from transformational processes benchmarks his favorite utilization of a particular interval for forging and refining the transformational processes in his later diatonic works.

References

- Bailey, R. (1969). *The Genesis of Tristan und Isolde and a Study of Wagner's Sketches and Drafts for the First Act*. Ph.D. diss., Princeton University.
- Bernard, J. (1987). "Inaudible structures, audible music: Ligeti's problem and his solution." *Music Analysis*, 13, 207–236.
- Brown, S. (2009). "Axis Tonality and Submediant in the Music of Shostakovich." *Music Theory Online*, 15, 2.
- Callender, C. (2007). "Interaction of the lamento motif and jazz harmonies in György Ligeti's Arc-en-ciel." *Intégral* 21.
- Cope, D. (1997). *Techniques of the Contemporary Composer*. New York, New York: Schirmer Books.
- Cuciurean, J. (2012). "Aspects of Harmonic Structure, Voice Leading, and Aesthetic Function in György Ligeti's in Zart Fließender Bewegung." *Contemporary Music Review*, 31, 221–238
- Cohn, R. (1996). "Maximally Smooth Cycles, Hexatonic Systems, and the Analysis of Late-Romantic Triadic Progressions." *Music Analysis*, 15, 9–40.
- Ellenberger, K. (2005). *Materials and Concepts in Jazz Improvisation*, 20.
- Hanson, H. (1960). *Harmonic Materials of Modern Music*. New York: Appleton-Century-Crofts.
- Hindemith, P. (1941 and 1942). *The Craft of Musical Composition*. New York: Eur-Am Music.
- Persichetti, V. (1961) *Twentieth Century Harmony*. New York: Norton.
- Reiprich, B. (1978). "Transformation of Coloration and Density in György Ligeti's Lontano." *Perspectives of New Music*, 16, 167–80.
- Roig-Francoli, M. (1995). "Harmonic and formal processes in Ligeti's net-structure compositions." *Music Theory spectrum*, 17, 242–267.
- Straus, J. (2005). *Introduction to Post-tonal Theory*. Upper Saddle River, NJ: Prentice Hall.
- Szigeti, I. (1984). "A Budapest interview with György Ligeti." *The New Hungarian Quarterly*, 25, 205–210.
- Várnai, P. (1983). *György Ligeti talking to Peter Várnai. In Ligeti in conversation*. (G. J. Schabert, Trans.) (pp/13–82). London: Eulenburg Books.