

Bilateral Keyboard Symmetry in the Music of Einojuhani Rautavaara

Brandon Paul
School of Music

20th-century Finnish composer Einojuhani Rautavaara's fascination with symmetry played an integral role in his compositional evolution. Inherent in 12-to-the-octave composition, pitch symmetry has been exploited by many twentieth-century composers. One type of visual symmetry—*bilateral keyboard symmetry*—influences Rautavaara's compositions in both piano and non-piano settings. Bilateral keyboard symmetry organizes the piano keys into a symmetrical plane creating axes at pitch classes {2} and {8}. Every note consequently has a complement in mirrored respect to the axes (i.e., {7} complements {9} and {1} complements {3}) which can then be used to generate harmonies and melodies. These harmonies and melodies coincide with tonal and aesthetic choices in the music of Rautavaara yielding triadic relationships such as D-major complementing G-minor. This non-transposing type of symmetry is not based upon auditory organization of pitches, but of visual organization of piano keys and is used with mirrored physiological motions of the hands at the piano. This system can also be found in many non-piano pieces such as *Ballad for Harp and Strings* and *Sonata for Solo Cello no. 1*, which feature sections resembling bilateral keyboard symmetry. Using a novel system of analytic notation, bilateral keyboard symmetry can be examined on local and global levels.

Introduction

This research focuses on a method of composition that is based upon the physical construct of the piano and organizing the piano keys into symmetrical groups. Many composers, including Persichetti and Chopin, have understood the symmetrical relationships of keys on the piano. However, Einojuhani Rautavaara has taken this compositional system a step further to create new musical forms. Through studying the majority of Rautavaara's scores, I have come up with a system to analyze Rautavaara's music and determine that the symmetry of the piano keys has influenced Rautavaara's compositions for all types and groups of instruments. I clearly define the technical aspects of my analysis in the paper; only a few musically technical terms need to be defined. Pitch classes, abbreviated pcs, refer to numbers that represent traditional note names: (0=C, 1=C#/Db, 2=D, 3=D#/Eb, 4=E, 5=F, 6=F#/Gb, 7=G, 8=G#/Ab, 9=A, 10=A#/Bb, and 11=B). Pitch classes are placed in brackets, such as {2}. Interval classes refer to the number of semitones that separate one pitch class from the next. Dominant and tonic relationships, discussed in the *Tonality* section, deal with a relationship between two chords where the dominant chord is built on pitch class {7} from the tonic chord built on pitch class {0} and is a common chord movement in tonal music. Advanced theory knowledge is not necessary to understand the relationships I discuss; my argument comes from a primarily visual and spatial paradigm.

About the Author

Brandon Paul is currently researching the social functions of listening to nostalgia-inducing autobiographical songs. He is interested in emotions that are perceived and experienced by listeners. He intends to graduate in Spring 2010 with a degree in Musical Theory, and then to go on to earn a PhD in Psychology, examining emotions and other effects arising from listening to auditory stimuli such as music and speech. His undergraduate advisors have been David Huron and Gregory Proctor.

Background

Einojuhani Rautavaara, prominent 20th-century Finnish composer, incorporates a vast amount of symmetry into his compositional products. Beginning with the 1950 solo piano piece *Three Symmetrical Preludes*, various uses of symmetry have evolved up into his most recent works, including the symmetrically driven solo piano piece *Narcissus*. Formal symmetrical structures are found in every stage of his evolution as a composer, evidenced in the serial *Symphony no. 4 "Arabescata"* as well as in the orchestral work *Prevariata* (Sivuoja-Gunaratnam 77). Pitch symmetry was the primary source of generation for material through his first serial period of composition. Extramusical symmetry also influences his composition, including the inherent symmetry in the word *Arabescata* as well as the celebration of the palindromic year 2002 (Sivuoja-Gunaratnam 206; Rautavaara).

One unique type of symmetry is prominent throughout Rautavaara's oeuvre; the symmetry of physical space by visual organization at the piano and the relationship of white and black keys has become a generative system of composition. The arrangement of piano keys allows certain axes of reflective symmetry. Examining the symmetrical groups around axes of pitch-classes {2} and {8}, each remaining pitch class has a reflective complement: {0} complements {4}, {1} complements {3}, {5} complements {11}, {6} complements {10}, and {7} complements {9}. This system is referred to as *bilateral keyboard symmetry*.

The reflectivity of bilateral keyboard symmetry is based upon the visual organization of keys in physical space on a piano plane. The result is a non-transposing system of pitch symmetry, which is unlike a transposable symmetrical pitch system, as one would find in the music of Webern or Bartók. This allows for residual applications in both tonal and atonal senses.

Bilateral keyboard symmetry has two main operations: immediate realization and deferred realization. Immediate realization occurs when a pitch class or collection of pitch classes are played simultaneously with their complements. For example, an A-major triad played in the left hand and a C-minor triad played with the right hand contains select pitches and their complements. Deferred realization occurs when complements of one or more pitch classes are played after an initial statement or simply not in simultaneity. Immediate and deferred realization can be used in conjunction to create complex symmetrical relationships.

Rautavaara incorporates bilateral keyboard symmetry with relatively, clearly defined tonal and aesthetic choices. Often permeating through the symmetric texture are characteristic melodies and harmonies. Natural exploitations of

tonal conventions are usually a central facet in Rautavaara's music. The symmetrical relationship of D major complementing G minor is particularly favored due to its dominant-and-tonic or tonic-and-subdominant relationships with D acting as a symmetrical axis. The same may be said about the relationship between C major and A minor as well as A-flat major and D-flat minor. The juxtaposition of bilateral keyboard symmetry with tonal or neo-tonal ideas is vital in much of Rautavaara's music.

Exploiting bilateral keyboard symmetry as a method of composition, Rautavaara has used this piano-related system as a means to generate non-piano music as well. Evidence can be found in several works such as *Nirvana Dharma, Symphony no. 8 "The Journey"* and the *Cello Sonata no. 1*, a piece for solo cello. The *Ballad for Harp and Strings* is almost completely based around a pitch collection that portrays bilateral keyboard symmetry. The influence of this compositional technique stretches over a span of 50 years.

The musical works that will be referenced most frequently are *Piano Concerto no. 1*, *Piano Sonata no. 1 "Christus und die Fischer"*, *Piano Sonata no. 2 "The Fire Sermon"* and the *Three Symmetrical Preludes*. Many other works feature the principles of bilateral keyboard symmetry, yet these pieces exemplify all qualities found within the system and lie at the core of the most active period during which these techniques were employed.

Graphic Notation

A unique system of graphic notation will be used to show local and global relationships of bilateral keyboard symmetry. Figure 1 shows a sample of this graphic notation. Resembling the layout of a keyboard, this system displays the pitches to show immediate and deferred realization and subsequent operations. Collections emphasized by red structures represent the left hand and blue structures, the right hand. Pitches played by both right and left hands in an aggregate collection are colored purple. Graphics in the confines of braces represent aggregate structures of a section or aggregate part of a section. Brackets indicate a local (typically one or two measures) component of a section. The notation displays the relative register of a symmetrical formation proportionately to the pitch layout of a

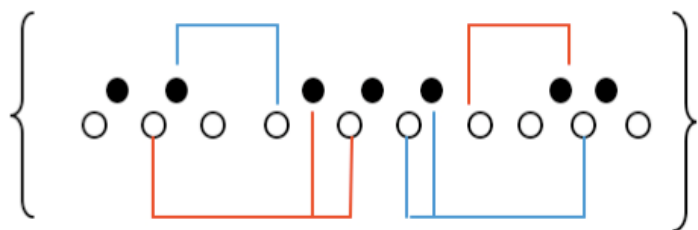


Figure 1. Sample Graphic Notation.

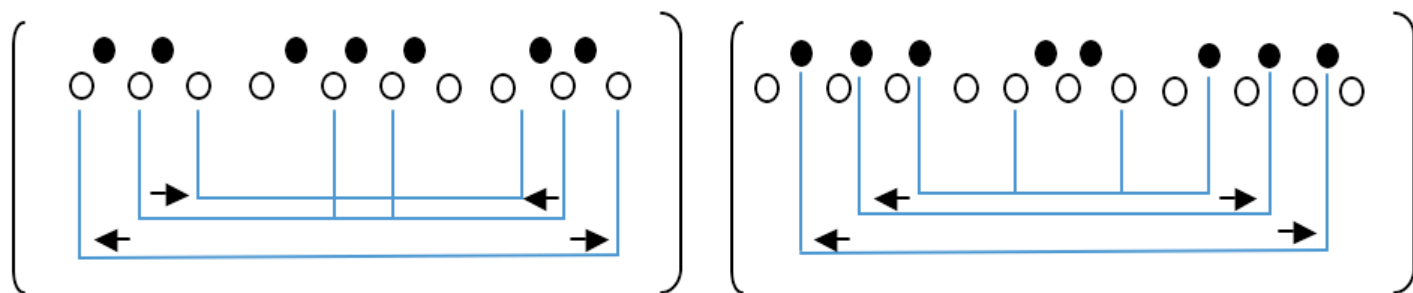


Figure 2. Rautavaara, *Piano Sonata no. 2* “The Fire Sermon,” I, mm. 95–96. Graphic Analysis of Right Hand Material.

piano. In other words, any repeating octave to the right of a given octave will be the next adjacent octave or higher. Structures will be discussed in terms of pitch classes (pc[s]) and referenced by tonal pitch names when appropriate. *Symmetry* discussed henceforth will refer to *bilateral keyboard symmetry* and not to any formal or pitch-space symmetry, unless explicitly stated.

Principles of Motion

Inherent in bilateral keyboard symmetry is the lateral motion across the plane of piano keys. The first basic motion involves the expansion and contraction of intervals in either one hand or in both hands. In one-handed interval expansion and contraction, an initial interval that is not static increases or decreases its interval by inward or outward motion to successive complements by semitone or more. As one pitch changes, the second pitch will reach the appropriate complement depending on deferred or immediate symmetry. As the interval expands and contracts in one hand the pitch-classes will eventually invert. The limit of interval-class 17 is generally the extent to which one-handed expansion reaches.

An example of one-handed interval expansion and contraction may be found in the *Piano Sonata no. 2* “The Fire Sermon”. The right-handed material in mm. 95–96 involves an initial symmetrical structure built on pcs surrounding axis {2} ({7 9}) and {2} an octave higher. Pcs {7} and {9} in m. 95 remain static as the outer interval expands from {2} and {2} to {0} and {4}. In m. 96 a new symmetrical structure is stated involving pcs {10 0 4 6}. {0} and {4} remain static as the interval expands from {10} and {6} to {8} and {8}, then to {6} and {10}. The pitches are, at this point inverted, and they have reached the general interval-class outer limit. This motion is demonstrated in Figure 2.

Two handed interval expansion and contraction involves the intervals between the lowest and highest pitch class of a formation. In Rautavaara’s music, this motion is almost always concurrent with immediately-realized symmetry but may combine with deferred symmetry. Much like one-handed expansion and contraction, as one pitch moves, its complement will move accordingly. In *Piano Sonata no. 1* “Christus und die Fischer”, mm. 61–68 feature two-handed interval expansion and contraction. The initial symmetrical structure of pcs {7 10 0 4 6 9} expand to larger symmetrical structures as m. 68 approaches. The graphic

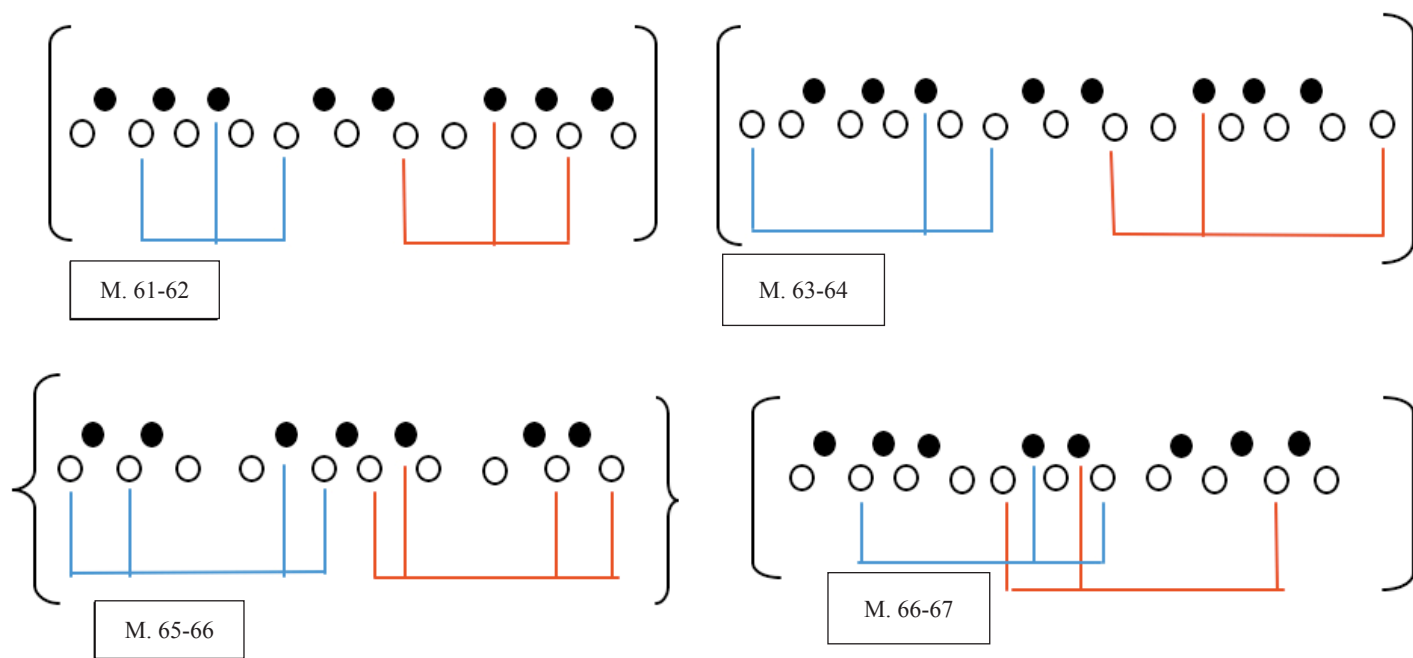


Figure 3. Rautavaara, *Piano Sonata no. 1* “Christus und die Fischer,” I, mm. 61–66. Graphic analysis.

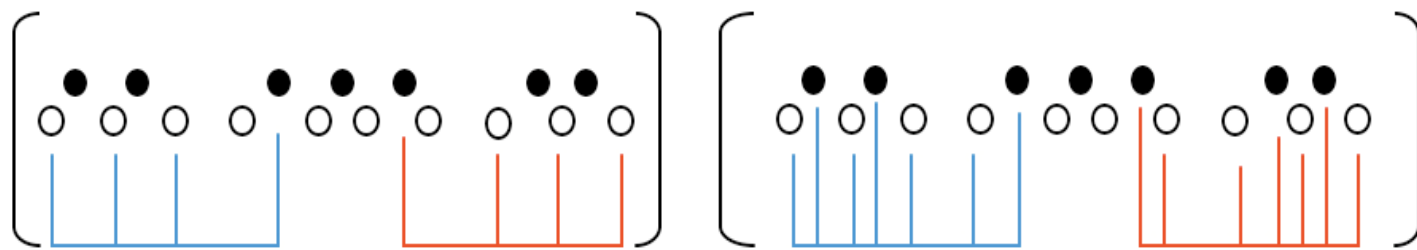


Figure 4. Rautavaara, *Narcissus*, mm. 1–4. Graphic Notation.

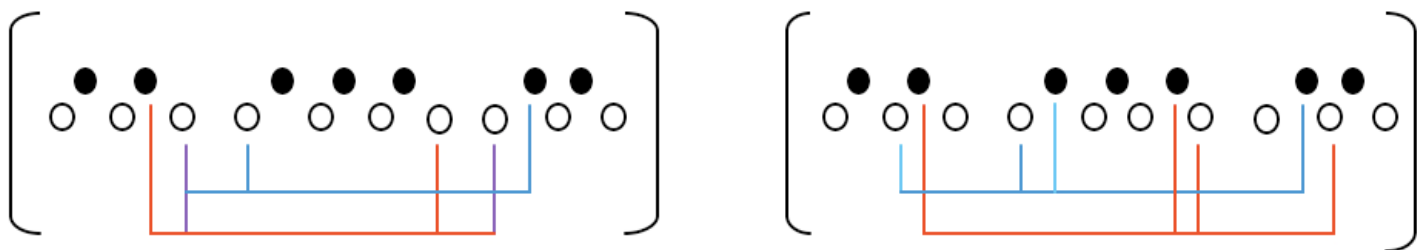


Figure 5. Rautavaara, *Narcissus*, mm. 100–103. Graphic Notation.

notation in Figure 3 presents the initial structure's transformation to m. 68. Note the melody coinciding with the system.

Interval expansion can also occur at the structural level of a work. *Narcissus*, a solo piano piece written in 2002, features opening material based on a symmetrical formation built on pcs {0 2 4 6 8 10}. The material is seen graphically in Figure 4. During the recapitulation starting in m. 100, the intervals have expanded and have also added symmetrical pcs complements of {7} and {9} (Figure 5).

The motion of two-handed bilateral keyboard symmetry is not always by expansion and contraction of intervals. In many works, the general intervals may not change, but the pitch-classes and octave placement may. Reflective motion of the hands is inherent when complements expand or contract. The distance between the hands therefore changes and, as such, exists as a feature in bilateral keyboard symmetry. An example of reflective motion may be found in the *Piano Concerto no. 1*, Op. 45. Mm. 83–103 contain a string of two-handed reflective and concurrent motion. The symmetric structure does not change through intervals (as seen in Figure 6), yet the structure moves through the 12-pitch collection in different octaves while still maintaining bilateral keyboard symmetry.

The visual and spatial aspect of Rautavaara's compositional style is further exemplified through the use of organization of the piano keys themselves. Physical qualities of the piano and the awareness of its space contribute to the basic principles of bilateral keyboard symmetry. White keys and black keys are yet another feature of the piano, especially the relative elevation of black keys in comparison to the white keys. Rautavaara utilizes these features in many piano works. Clusters of white and black keys are often explicitly demanded in several works, such as in the *Piano Sonata no. 2* "The Fire Sermon". In other works,

clusters of white and black keys are written explicitly, such as in *Piano Sonata no. 1* "Christus und die Fischer" and *Piano Concerto no. 1*.

Physical motion without the requirement of bilateral keyboard symmetry is also a prominent feature in Rautavaara's music. Reflective motion as expansion and contraction of physical space between the hands controls the movement between musical structures. Examples may be found in *Icons*, Op. 6; *Piano Concerto no. 1*, Op. 45; *The Fiddlers*, Op. 1; and *Etudes*, Op. 42. An example of reflective motion coinciding with white and black note clusters also exists in the *Piano Sonata No. 2* "The Fire Sermon". The hand and arm clusters move reflectively around a thick inner layer of arpeggiation.

Formal Construction

Rautavaara's 1949 piano piece *Three Symmetrical Preludes* is the first instance of bilateral keyboard symmetry in his oeuvre. Within this piece, the establishment and breaking of immediately-realized symmetry creates distinct A and B sections for each movement. For each of the three preludes, an A section featuring immediate symmetry is followed by a B section that breaks the immediate symmetry. While the B sections in the preludes do not feature deferred symmetry, later B sections contrast immediate symmetry

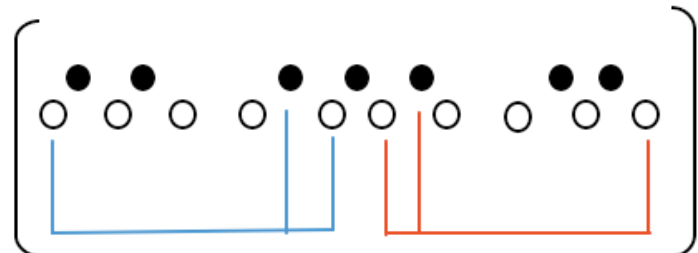


Figure 6. Rautavaara, *Piano Concerto no. 1*, I, m. 83. Graphic Notation of original symmetric structure.

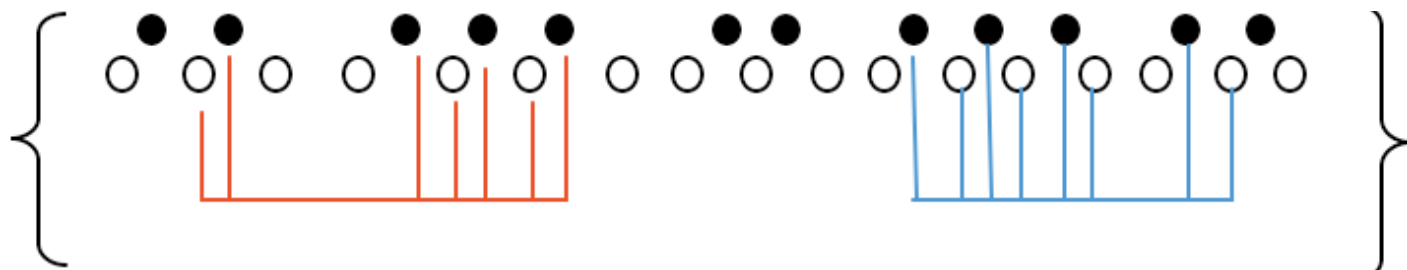


Figure 7. Rautavaara, *Three Symmetrical Preludes*, I, mm. 1–2.

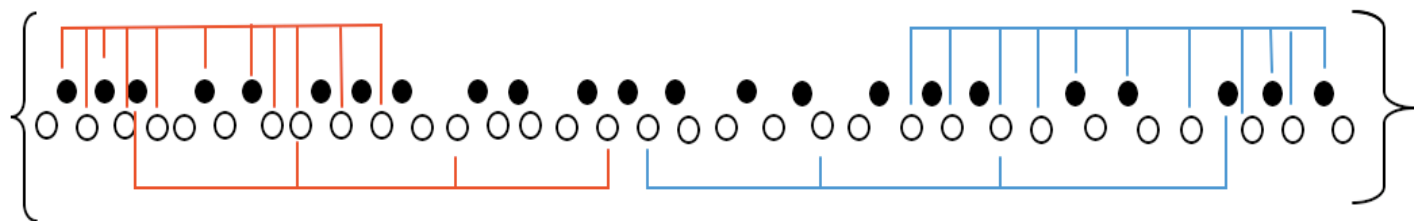


Figure 8. Rautavaara, *Piano Sonata no. 1* “Christus und die Fischer,” I, aggregate mm. 1–5, 15–16 and 27–31.

with deferred symmetry as in *Piano Sonata no. 1* “Christus und die Fischer”.

The initial material of *Three Symmetrical Preludes* focuses on a collection surrounding the pc {2} axis operating under immediately-realized symmetry graphically seen in Figure 7. The B section breaks the immediate symmetry in order to contrast the initial statement. Rautavaara utilizes the inherent symmetry of 12-to-the-octave composition in order to articulate the left-hand accompaniment to the melody. The termination of this section on pcs {1 2 3} further emphasizes the {2} axis and its proximal complements, much like the goal of the A section.

Piano Sonata no. 1 “Christus und die Fischer” features contrasting sections defined by immediate and deferred symmetry. Moreover, quintal harmonies are combined with deferred symmetry and tertian harmonies are joined with immediate symmetry to define each section further. At the beginning of the sonata, a descending melody underneath a quintal collection built on pc {10} at first displays no noticeable bilateral keyboard symmetry. The following interlude section in measures 6–8 is built on tertian harmonies that are immediately realized. A C-minor triad in the left hand and an A-major triad in the right move by expansion into the same complements, but reversed. The pattern continues until the restatement of the A section with the right handed material starting an octave higher. Using a combination of immediately-realized and deferred symmetry, this B section features a repeating pc {1} in the right hand, which is important for later realization.

A monophonic melody leads into the realization of the deferred A section of *Piano Sonata no. 1* “Christus und die Fischer”. Completely flipped over the axis, a combination of mm. 1–4 and mm. 15–16 of the first A sections create the A’ section—starting in m. 27. Graphic notation (Figure 8) showing the aggregate outer voices of mm. 1–5 and mm.

27–31 confirms the symmetry. The material in the B section is also flipped over the axis in mm. 32–41. This demonstrates an immediately-realized and deferred symmetry section that has been immediately realized on a structural level later in the work. This is similar to the result of *Piano Sonata no. 1* “Christus und die Fischer”, I, mm. 27–31: a section flipped over the axis to create structure. These multiple layers of symmetry can also be found in the 2002 piano piece *Narcissus*.

Bilateral Keyboard Symmetry and Tonality

The juxtaposition of bilateral keyboard symmetry with tonal or neo-tonal ideas is central to the compositional method of Rautavaara. Triadic relationships; tonic, dominant and predominant functions; modality; and polytonality are just a few areas of exploitation derived from the cooperative use of both ideas. Throughout Rautavaara’s works, the coincidence occurs most frequently from 1969 to 1973 when bilateral keyboard symmetry is most active. Harmonic and melodic ideas alike can be transformed and developed through this system.

One of the most obvious features of triadic harmonies operating in bilateral keyboard symmetry is the relationship between triads built upon G and D. The D-major triad is complemented by a G-minor triad; D-minor and G-major as well, only vice-versa. One of the most prominent examples occurs in the *Piano Concerto no. 1*, Op. 45. The first movement opens with an arpeggiation of a D-major/minor triad in the left hand. Acting under the domain of deferred symmetry, a G-major/minor triad enters in m. 7. Figure 9 shows this relationship. By using major/minor triads in the *Piano Concerto no. 1*, Op. 45, the qualities of sonorities are preserved. If D-major was the first chord, G-minor must have been the second, thus changing the quality of the so-

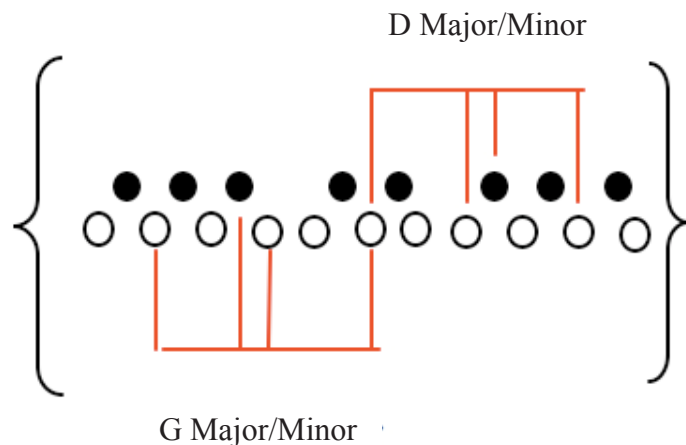


Figure 9. Rautavaara, *Piano Concerto no. 1*, I. D and G relationship.

nority. The relationships between D and G are further exploited in the application of bilateral keyboard symmetry in non-piano music such as in *Symphony no. 7* “Angel of Light”, *Symphony no. 8* “The Journey” and the vocal work *Nirvana Dharma*.

Another tonic-dominant relationship is implied in the third prelude from *Three Symmetrical Preludes*. Mm. 3 and 4 contain the notes C and E. A dominant relationship occurs on beat two of the measures, with the notes G, B, F and A suggesting a dominant-9th chord. The 9th chord then resolves back to the C-major dyad. This is repeated in m. 20 of the prelude. See Figure 10 for graphic notation.

Building triads and deferring them to their complements is another technique apparent in many works. In the *Piano Sonata No. 2* “The Fire Sermon” II, a string of triads and their complements occur in succession in mm. 1–5. In the left hand, an arpeggiated F-major triad is succeeded by an E-minor triad, E-flat followed by F-sharp, A-flat by D-flat, and so on. The right hand features a single-line melody that always is followed by its collection of complements. This deferred symmetry allows for a creative use of triadic harmonies that Rautavaara incorporates into his collection of sonorities.

Applications in Non-Piano Music

An interesting implication of Rautavaara’s use of bilateral keyboard symmetry lies in the translation into non-piano music. Most material is not generated by these methods, yet the material often is transformable through the symmetrical plane of the piano. The vocal piece *Nirvana Dharma*, for example, contains a melodic passage for soprano voice. In the music that follows the soprano solo, pcs {7 0 10 9} are realized after 15 measures with complements {9 4 6 7}.

One of the strongest examples of bilateral keyboard symmetry in non-piano music is the *Cello Sonata no. 1*.

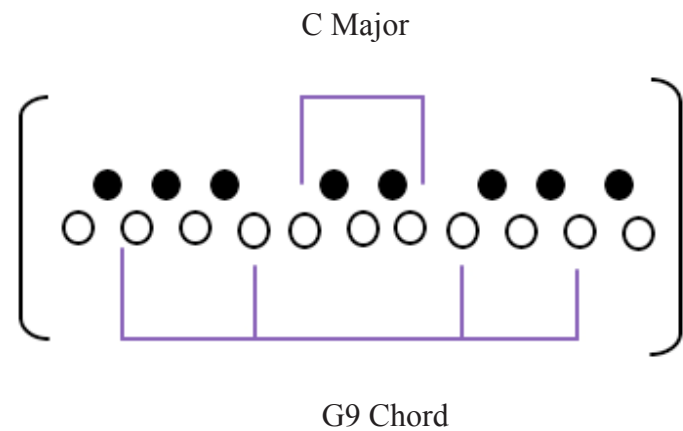


Figure 10. Rautavaara, *Three Symmetrical Preludes*, no. 3, mm. 3–4. Graphic Notation.

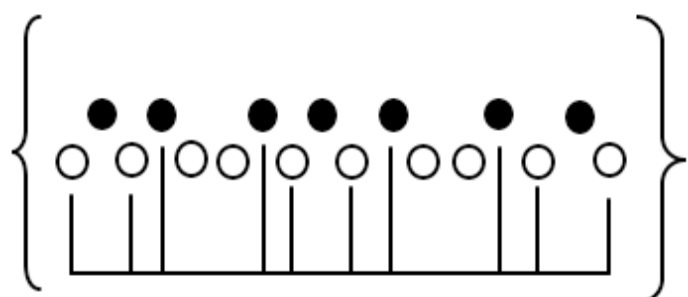


Figure 11. Rautavaara, *Cello Sonata no. 1*, I, mm. 1–5. Aggregate Graphic Notation.

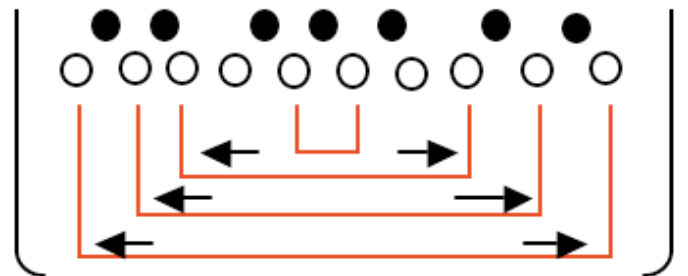


Figure 12. Rautavaara, *Ballad for Harp and Strings*, mm. 34–35. Graphic Analysis.

The entire first and second movements demonstrate typical symmetrical operations. Examining the opening five measures, the material distinctly resembles deferred symmetry. Graphic notation displays the aggregate collection in Figure 11. One handed interval expansion and contraction also occurs in this sonata. Measure 41 involves symmetric complements of pcs {1} and {3} expanding to {0} and {4} and continuing outward. The same process occurs starting on pcs {7} and {9} moving out to {6} and {10}.

Another example for discussion is the *Ballad for Harp and Strings*. Bound in a symmetrical form of ABA, The B material, especially for the harp, resembles a collection of bilateral keyboard symmetry. The first appearance of symmetry occurs in m. 15 where a collection of complementary pcs {6 7 9 10} are presented through an expansion operation to include pcs {5} and {11}. The trend continues to

include pcs {1} and {3}. The main collection that demonstrates symmetry in the final expansion includes pcs {1 3 5 6 7 9 10 11}. As in the *Cello Sonata no. 1*, the appearance of one-handed expansion and contraction is found in mm. 34–35 using the pitch classes from the main collection. Figure 12 shows the expansion and contraction.

These examples reveal that bilateral keyboard symmetry is not just a means for composing piano music, but for orchestrations of all types. The sonorous possibilities of a visual system can suggest everything from a two-note melody to a global symmetrical structure. Physical motion across the lateral piano plane is a direct result of the spatial and symmetrical organization of the keys and its performance can be just as rewarding as the experience of listening to the interaction of sound and vision. Moreover, it is essential to keep in mind that bilateral keyboard symmetry is inherently a deaf system. That is to say, aural pitch organization is not responsible for the generation of these structures. The guidance of tonal, aesthetic and conventional

choices allows a deaf system to be musical

Conclusion

Thorough analysis of Rautavaara's music has definitively shown the relationship of a symmetrical style of composition applied to his music. Whereas Rautavaara's symmetry is explicit, a system of analysis from visually-oriented perspective can lead to future analysis for all composers who use a piano as a tool for composition. The layout and construction of the piano or keyboard, as well as placing our hands to the instrument, has some form of influence in composition. Future research can determine the amount of relationship from the piano into compositions. If theorists think outside of the mathematical, abstract, and relational aspects of traditional theory, then a paradigm of the human body's physical relationship with instruments can shed light on describing music and its evolution.

References

- [1] Rautavaara, Einojuhani. *Omakuva*. Juva: W. Söderström, 1989. (2002). Accessed 16 November 2008. Magdeburg: Otto-von-Guerike-Universität (1999).
- [2] ---. "Some Reflections on a Symmetrical Year," *Highlights*. http://www.fennicagehrman.fi/highlights/hl12_rautavaara.pdf
- [3] Sivuolja-Gunaratnam, Anne. "Narcissus Musicus' or an Intertextual Perspective on the Oeuvre of Einojuhani Rautavaara," *Topics, Texts, Tensions: Essays in Music Theory*.
- [4] ---. *Narrating with Twelve Tones. Einojuhani Rautavaara's First Serial Period*. Finland: Suomalainen Tiedeakatemia, 1997.

Referenced Scores

- [1] Rautavaara, Einojuhani. *Three Symmetrical Preludes*. Edited by Fazer, Warner/Chappell Music. Espoo, Finland, 1950.
- [2] ---. *The Fiddlers, Op. 1*. Edited by Fazer, Warner/Chappell Music. Finland, 1952.
- [3] ---. *Icons, Op. 6*. Edited by Fazer, Warner/Chappell Music. Espoo, Finland, 1955.
- [4] ---. *Etudes, Op. 42*. Edited by Fazer, Warner/Chappell Music. Espoo, Finland, 1969.
- [5] ---. *Piano Concerto no. 1, Op. 45*. Edited by Breitkopf & Hartel, Leipzig, Germany, 1969.
- [6] ---. *Cello Sonata no. 1, Op. 46*. Edited by Fazer, Warner/Chappell Music. Espoo, Finland, 1969.
- [7] ---. *Piano Sonata no. 1 "Christus und die Fischer"*. Edited by Fazer, Warner/Chappell Music. Espoo, Finland, 1969.
- [8] ---. *Piano Sonata no. 2 "The Fire Sermon"*. Edited by Fazer, Warner/Chappell Music. Espoo, Finland, 1970.
- [9] ---. *Ballad for Harp and Strings*. Edited by Fazer, Warner/Chappell Music. Espoo, Finland, 1973.
- [10] ---. *Nirvana Dharma*. Edited by Fazer Musik. Helsinki, Finland, 1979.
- [11] ---. *Narcissus*. Edited by Fennica Gehrman. Helsinki, Finland, 2002.