STRUCTURE IN CHARLES WUORINEN'S STRING TRIO

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Submitted in Partial Fulfillment

of the

Requirements for the Degree

Doctor of Philosophy

Supervised by Robert D. Morris

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Rochester, New York

1984

ACKNOWLEDGEMENTS

I wish to express my sincere appreciation to Dr. Robert Morris for his valuable guidance in the analysis of Charles Wuorinen's String Trio and in the writing of Tachyons, the composition for divided string orchestra, which accompanies this essay. I would also like to thank Dr. Samuel Adler, Chairman of the Composition Department, for his generous support and encouragement, and for his permission to use the Eastman facility in the preparation of the essay and composition.

There have also been others without whom the work would not have been possible. Special thanks go to Jan Grimes for her patience in typing and editing this paper, Hali Fieldman for her help in copying Tachyons, and Craig Harris for his expertise and the use of his equipment in the preparation of graphs and charts.

Final thanks are extended to my husband, Timothy Morin, for his help in preparation of musical examples, and for his constant encouragement and understanding.

ABSTRACT

Charles Wuorinen is one of the foremost American serial composers in the second half of the twentieth century. The purpose of this analysis of his String Trio (1967-8) is, in specific, to outline aspects of Wuorinen's own musical language and, in general, to illustrate basic procedures and applications of serial composition in recent twentieth-century music.

The analysis is based on a set-theoretic approach, incorporating pitch-class structure with rhythm and texture in a three-dimensional overview. The use of different pitch, rhythmic and textural contours makes it possible to divide the work into twelve sections. Although boundaries defining sections in pitch, rhythm and texture sometimes do not intersect at the same time point, it is possible to relate sections of the composition by retrograde, transposition, inversion operations, as well as manipulation of rhythmic and textural material.

The analysis uncovers an abundance of intricate cross-relations which provide the piece with a high degree of musical unity. At the most global level, the Trio is a type of rondo. However, degrees of correspondence between sections are not of the same weight and when material returns, it is often highly varied.

Structure in Charles Wuorinen's String Trio

Introduction

Charles Wuorinen (b. 1938) is undoubtedly one of the most important American composers of our time. He is also well known as a pianist, conductor and pedagog. His composition and electronic music teachers were Otto Leuning, Jack Beeson and Vladamir Ussachevsky. Mainly New York based, Wuorinen presently teaches at the Manhattan School of Music and has held posts as a visiting lecturer at Princeton and the New England Conservatory. Among his many prizes and honors, Wuorinen received the Pulitzer Prize in music for Time's Encomium (Nonesuch H-71225), an electronic piece realized at Columbia-Princeton Electronic Music Center on the Mark-II Synthesizer. Wuorinen's main compositional influences are diverse: Stephen Wolpe (articulation and pitch structure); the late works of Stravinsky (rhythm and orchestration); the music of Arnold Schoenberg (classical twelve-tone technique); and the music and writings of Milton Babbitt. It was Babbitt who especially influenced Wuorinen in the realm of temporal and rhythmic serialization (i.e., the time-point system). In addition to his many compositions and recordings, Wuorinen has also written Simple Composition, a manual of twelve-tone composition which contains many of his working methods, almost all of which are found in the String Trio.

Charles Wuorinen's String Trio¹ was written in 1967-68 for the

¹Charles Wuorinen, Trio (New York: C. F. Peters Corp., 1971).

Potomac String Trio. According to the composer's liner notes,² the work is based on the hexachord (G C A^b B^b B A), which, for the purpose of analysis, I shall call X. This ordered hexachord "unfolds slowly, or rather is assembled at the opening of the work as an improvisatory outgrowth of the initial drone 'G.'" After the hexachord is stated, the remaining pitch classes are introduced and the work proper begins.

The composition is in one movement, divided into sections whose pitch-class material³ is derived from X.⁴ This material is based on members of set-class 6-1 (the unordered content of X), its "M" related set-class (6-32) and the rotations⁵ of members of the segment-classes of X and MX. At times this material is used to delineate sections which coincide with rhythmic and textural dimensions of the piece; at other times, the material overlaps the other dimensions.

Overview

The composition employs a wide range of textures, rhythms and dynamics. Various textures--drones over melodic lines, intricate contrapuntal passages, homophony, melody vs. sparse accompaniment--help to determine the types of rhythmic flow found in the piece.

²Charles Wuorinen, String Trio (New York: Nonesuch Records, 1975).

³For the definition of terms and other technical matters refer to the Glossary, Appendix IV.

⁴See Appendix III for the tables of the segment-classes based on X and MX.

⁵See the rotational arrays in Appendix III, (examples c and d).

Sections which are homophonic usually have much simpler rhythms than contrapuntal sections. Many passages utilize intricate rhythmic motives which have a variety of different note values and often span several measures. Those passages which contain slow, unfolding melodies over drones tend to sound senza misura in contrast to the contrapuntal and homophonic passages. There is also an abundance of different dynamic markings and articulations which contour the surface of the composition. At times, almost every note has its own dynamic marking. Although atonal, the trio's musical surface contains many octaves, linear and harmonic.⁶

The use of different textures, pitch material and rhythm makes it possible to divide the composition into sections according to these three musical dimensions. Divisions derived from one dimension may not necessarily coincide with those derived from another. For instance, pitch and rhythmic material may not parse the musical flow at the same time point. At points of coincidence, it is clear that the composition has come to the end of a section; but when the divisions do not coincide, one dimension may take precedence in determining the extent of the section, or it may be simply ambiguous where one section ends and one begins. Since there is some degree of correspondence among these three dimensions' division of the piece into parts, I have been able to divide the whole work into 12 sections labeled with Roman numerals. This is shown in Appendix I where the textural, rhythmic and pitch

⁶This undoubtedly reflects the direct influence of Stephen Wolpe.

material continuities contributing to each section will be labeled A_n , B_n , C_n , respectively, where n equals the section number.

Appendix I is also designed to show the cross relations among sections related by retrograde, transposition, inversion operations, as well as manipulation of the rhythmic and textural material. Therefore, the sections of the composition are not diagrammed in chronological order but rather horizontally aligned to show corresponding relationships. Each section will be diagrammed by the three-level " A_n , B_n , C_n " labeling. In general, sections which are related by retrogression are placed directly one over the other. Other sections related by transposition, inversion, and/or rhythmic alteration, together with their corresponding retrogrades, are placed directly beneath the section/retrograde section pairs with which they correspond.⁷

Example 1 extracts the three-level structural analysis of section XI from Appendix I.

Example 1

A_{11}	$\boxed{255 \quad - \quad 282}$	$A = \text{texture}$
B_{11}	$\boxed{255 \quad - \quad 282}$	$B = \text{rhythm}$
C_{11}	$\boxed{240 \quad - \quad 262 \mid 262 \quad 273 \mid 274 \quad 282}$	$C = \text{pitch}$
$C_{11.1}$	$C_{11.2}$	$C_{11.3}$

Three-level structural analysis of Section XI extracted from Appendix I.

⁷A detailed pitch structure analysis corresponding to Appendix I is contained in Appendix II.

This section begins with a thirty-second note rhythm in a heterophonic texture, and in general, these two aspects of structure delineate this section. The pitch material in these measures, however, can be grouped in three different subsections which match the retrograde of the pitch material in sections II, III, and part of IV up to measure 81. In fact, if the pitch material of XI is traced back to measure 240, the complete retrograde of section IV is displayed. This kind of cross-relation is typical of most of the work.

On the other hand, the rhythmic, textural and pitch material of Section I (labeled A_1 , B_1 , and C_1) all coincide. The texture in section I consists of a violin melody over a drone in the viola and cello. Appendix I shows that section XII is the pitch class retrograde of section I. The boundaries of XII (mm. 315-284) are also delineated by rhythm, pitch and texture. However, section XII is homophonic, moving by steady quarter notes; the drones of I become repeated notes.

Texture, Rhythm and Pitch-Structure Interrelations

In this section of the paper, I continue to discuss the remaining nine sections given in Appendix I. Section II has different divisions for rhythmic (B_2) and textural/pitch (A_2/C_2) material. The rhythmic structure in this section consists of twelve measures in 15/8, extending from mm. 32 to 43. The pitch material consists of transpositions and inversions of hexachord X over a

drone up to m. 46, where the pitch material is then used differently, thus beginning a third section. Even though section II's texture is almost identical to section I's, texture alone is not strong enough to compel one to hear section II as a mere continuation of I. The change of pitch material, and the use of a specific sonority (see below) articulates the division between the sections.

Section III begins in measure 43 articulated by a single 15/16 measure, and texturally, in measure 46, with chords. The section "cadences" in measure 69 because pitch material, rhythm and texture are all coterminous. In III the violin plays a melody overlapping harmonic sonorities in the viola and cello. Here again the pitch material consists of members of the segment-class of X, now used linearly and vertically, followed by members of the segment-class of MX near the end of the section. Metrically, the section begins in 6/4; it ends in 6/8.

As mentioned above, section XI (mm. 282-255) contains retrograde pitch material from II, III, and part of IV, and corresponds as the retrograde of mm. 31-81. Rhythm and texture are the determining features of this section.

Section IV, beginning in 3/8 meter, extends from measure 70 to 108; A₄, B₄, C₄ all coincide. This section corresponds to mm. 6-31 of section I. The viola and cello play the material of section I over which new material, consisting of ordered transpositions and inversions of segment-class of MX, is taken up by the violin. The texture (A₄) in the viola and cello is the same as

in A₁ (melody over a drone), but, with the addition of the new violin material consisting of an ornamented complex rhythmic line, texture in this section is different.

The corresponding retrograde pitch material in section XI (C_{11.3}) extends from mm. 262 to 240, and overlaps part of textural sections A₁₁ (255-282) and A₁₀ (218-254). Rhythmically, section XI contains two parts B_{11.1} and B_{11.2}.⁸ The rhythm in B_{11.2} is almost an exact diminution in retrograde of mm. 81-108 in section IV.

The viola and cello in section V (109-128) are related in pitch-class content and order (C₅) by tritone transposition to the violin in II and III up to m. 51; the rhythm in the viola and cello (B₅) is exactly preserved. The violin in section V is a tritone transposition and retrograde of the violin in section IV and part of section III (from mm. 108-51). The violin rhythm (B₅), however, is a retrograde diminution of the violin part in B₄. The pitch material that was presented in two different textural sections, A₂ and A₃, is articulated by the texture (A₅) in section V. The viola texture in V is the same as the violin in A₂ and A₃ up to m. 51. Of course, the violin part in V obscures the direct relationship.

⁸B_{11.1} which overlaps into section IV was described previously.

Example 2 a and b

a) 32

* $\frac{15}{8}$ here = $\frac{6}{8}$, and is so divided.

b) 109

* $\frac{15}{8}$ here = $\frac{5}{8}$, and is so divided

Comparison of the first measure of Section II (ex.2a) with the first measure of Section V (ex.2b).

Section X corresponds to retrograde of V. This is most strongly apparent in the comparison of rhythms (B₁₀ vs. B₅), but only vaguely noticeable in pitch content. The rhythm of X divides into two parts. B_{10.2} (m. 237-226) contains a strict rhythmic retrograde of B_{5.1} (mm. 109-120) and B_{10.1} contains an augmented retrograde of B_{5.2} (mm. 121-128). A similar type of texture extends from mm. 218-254 and actually overlaps three rhythmic subsections of the composition, B_{10.1} (218-225), B_{10.2} (226-239) and B_{11.2} (mm. 240-

254). The uniting factor in these three subsections is the long drone in the cello part over which the violin and viola become increasingly active producing an accellerative effect.

Section VI (mm. 129-132) contains a "ritornello" consisting of the first four measures of the piece. VI is not long enough to be a section in the same sense as the others, but, since it aurally punctuates the entire composition, it is labeled with its own section label, Rit. VI. Its corresponding retrograde measures (mm. 214-217) are not articulated as a distinct group, but, rather, occur as part of section IX.

Section VIII extends from m. 133 to the grand pause at m. 178. The viola is related to the violin in V (C_5) (through m. 117) by tritone transposition; hence it is also related to the (C_2) viola (mm. 32-46) in II. This occurs at the same pitch level since C_5 is related to C_2 by tritone transposition.

A broader view of the entire Trio's structure reveals that mm. 315-217 are a retrograde of the first one hundred and twenty-nine measures of the piece. Section VII (mm. 133-117) corresponds to section V up to measure 117. This leaves only sections VIII and IX unaccounted for. Perhaps other analysts will be able to show that VIII and IX is a retrograde of VII, making the piece one huge retrograde whose mid-point is the grand pause at mm. 178 and 179.

Basic Properties of Pitch Material

Special properties of hexachord 6-1 and its M-related

counterpart, 6-32, are used as the basis for pitch structure in the Trio. Members of set-class 6-1 map into their complements under T_6 and, for some n , under T_nI ; they are invariant under T_mI for some m . The M-related set-class, 6-32, has isomorphic properties to 6-1; its members also map into their complements under T_6 and T_nI and are invariant under T_mI . The possibilities of complementation for each set-class allows the formation of twelve-tone combinatorial relationships and linear aggregates. Example 3 shows the normal form of each set-class 6-1 and 6-32.

Example 3

6-1 $\{0,1,2,3,4,5\}$

6-32 $\{0,2,4,5,7,9\}$

Normal form of hexachord 6-1
and hexachord 6-32.

Hexachord X is an ordered member of set-class 6-1. As an ordered member it becomes one of a group of ordered segments which are related by transposition and/or inversion which is the definition of a segment-class.⁹

The pitch-class interval 5 is the first interval in X. 5, often realized as a perfect 4th, and its intervalic generalization as a member of ic5 are of great harmonic and motivic importance in the work. Ic5 is unique in set-class 6-1; the perfect 4th, the

⁹See Appendix III for the tables of the segment-classes based on X and MX. Also, see Glossary.

largest interval in the most compressed articulation of a member of 6-1, defines the outside boundaries of such a presentation.

Example 4

$$6-1 \quad \{0, \overset{\curvearrowright}{1, 2, 3, 4}, 5\}$$

Normal form of 6-1 illustrating
ic5 defining its outside
boundaries.

Ic5 initiates the beginning of the piece and is the first linear interval of X which is a member of 6-1. This in turn readies our ear for the abundance of perfect fourths which will occur when set-class 6-32 (related by M to 6-1) is used later in the piece.

As I mentioned above, members of set-class 6-1 and their M-relations in 6-32 are both invariant under $T_m I$ for some m. This invariance allows for melodic repetition and "simultaneous and successive pitch relations which can be made to harmonize in their unfolding: lines which are independent can be combined so that tones simultaneously sounding support those successively sounding."¹⁰

Multiplicative mapping of a hexachord offers interesting and well-understood intervallic relationships.¹¹ In general, multiplicative transformation alters certain interval classes--all ic1s are changed to ic5s and vice versa. The following example contains the interval vectors¹² associated with 6-1 and 6-32.

¹⁰Charles Wuorinen, Simple Composition (New York and London, Longman, 1979), p. 55.

¹¹Hubert S. Howe, "Some Properties of Pitch Structures," Perspectives of New Music 4/1:45-61, (1965). Charles Wuorinen, Simple Composition (New York and London, Longman, 1979), pp. 98-101.

¹²The interval vector is an ordered array of numerals which represent the interval content of a given set. The first numeral gives the number of ic1s, ic2s, and so on.

Example 5

$$\begin{array}{rcl} 6-1 & [5 & 4 \ 3 \ 2 \ 1 \ 0] \\ 6-32 & [1 & 4 \ 3 \ 2 \ 5 \ 0] \end{array}$$

Interval vectors
associated with
6-1 and 6-32

The interval vectors in the above example show that the two sets share the same number of ic2s, ic3s, ic4s, and ic6s. The number of ic1s and ic5s interchange.

Thus, according to Forte,¹³ the sets share maximum similarity with respect to interval content. If the comparison of the two vectors is based on the total number of ics that are different, however, their differences become more apparent.¹⁴ By subtracting the number of ic1s, ic2s and so forth, from the two interval vectors, the total number of ics that are different may be found. This number is called the similarity index.¹⁵ The similarity index between hexachord 6-1 and 6-32 is 8 because the two sets have 8 ics that are different.

Thus, the similarity index shows a considerable difference between the two set-classes. In resolving the discrepancy between "maximal similarity" and the similarity index, we can simply say that, depending on what intervals are stressed (i.e., ic1 and ic5 vs. the others), the two set-classes can be made to sound alike or

¹³Allen Forte, *Structure of Atonal Music*, (New Haven and London, Yale University Press), p. 48.

¹⁴Robert Morris, "A Similarity Index for Pitch Class Sets," *Perspectives of New Music* 18/2:445-60, (1980).

¹⁵*Ibid.*

different. In any case, it is worth pointing out that the 6-1/6-32 distinction is crucial with respect to tonal vs. atonal sonorities.

A tetrachordal set-class which is very important to the structure of this composition is not abstractly¹⁶ included as a member of either set-class 6-1 or 6-32. This tetrachord (named 4-9) whose normal form is (0 1 6 7), occurs as a result of the combination of two complementary X or MX hexachords.

Example 6

Members of set-class 4-9 are derived from partitioning two complementary 6-1 or 6-32 hexachords.

The 4-9 tetrachord contains both tritones and the perfect 4th thus merging two intervals which are of great importance in this piece. As we shall see, the overall pitch structure of the composition relies heavily on the tritone relation. Nearer to the compositional surface, T_6 (and T_{6I} or T_{7I}) relationships are used to produce combinatoriality and linear aggregates.

In addition, the (C, C#, F#, G) member of the 4-9 tetrachord is used as an articulator of the beginnings and endings of certain sections in the composition. 4-9 punctuates the beginning of the ritornello in m. 129 and the end of section IX. These places, shown in example 7 a and b, are where the composition obviously retrogrades itself.

¹⁶Robert Morris, Class Notes (1982) Section 104, p. 1 and 2, Theory 405, Theory and Analysis of Contemporary Music I, Eastman School of Music.

Example 7 a and b

a)

129 130

4-9

pizz. *sfff* *ppp* *n.v.* *arco pont.* *vib.* *ord.* *sf* *mf* *<f* *mp* *<ff*

b)

215 216 217

4-9

p *fp* *PP* *ord.* *p* *fp* *[sul A]* *[sul D]*

The (C, C#, F#, G) member of the 4-9 tetrachord used as an articulator at the beginning of Section VI (ex.7a) and at the end of Section X (ex.7b).

Example 8 illustrates other important locations where the 4-9 is present.

(see next page for Example 8 a, b, c, and d)

Example 8 a and b

a)

4-9

3 *fp* [gliss.] *f*

8 *sfpp* [*p* sempre]

b)

29 *al* ... *ord.* 30 31

15 8

4

pp *n.v.* *pp* *tenuto*

32 [*♩ = ♩*]

15 * *ff* *pp* *fp*

8

Example 8 c and d

c) Handwritten musical score for piano (c). It features three staves. The top staff has a treble clef and a key signature of one flat. It contains measures 107 and 108. Measure 107 has a half note G4 with an accent (^) and a dynamic of *5ff*. Measure 108 has a half note A4. The middle staff has a bass clef and contains measures 2 and 3. Measure 2 has a half note G3 with a dynamic of *[pp]*. Measure 3 has a half note A3. The bottom staff has a bass clef and contains measures 4 and 8. Measure 4 has a half note G3 with a dynamic of *[pp]*. Measure 8 has a half note A3 with a dynamic of *[n.v.]*. There are some additional markings like '2' and '4' in the left margin.

Important locations in the Trio where the 4-9 tetrachord is found.

Example 8a marks the first time in the composition that the complement of X is used. The D^b and G^b of the complement combines with G and C of the hexachord X. Example 8b shows the end of section I and the beginning of section II. The entire complement (T₆X), (C#, F#, D, E, F, E^b), of hexachord X embedded in the first section (m. 31) begins the second section (m. 32) revealing the tritone relation and creating a linear 4-9 tetrachord in the violin. The union of drone tones in sections I and II constitute a 4-9 tetrachord. Example 8c shows the end of section IV. Here only two notes (F# and G) are sustained, but these are two notes of the same tetrachord (C, C#, F#, G) that has been found at the beginning and end of sections.¹⁷ Example 8d also shows the end of a section but with a different member of the 4-9 set-class, (E^b, E, A, B^b).

Sectional Analysis

The following analysis continues the comparison of section/retrograde sections, pairs and other corresponding areas, incorporating a detailed examination of pitch, rhythm and texture.

The first section of the composition (mm. 1-31) utilizes only one specific member of set-class 6-1. This is the X hexachord, (G, C, A^b, B^b, B, A) and its invariant RI form, (B^b, A^b, A, B, G, C).¹⁸ (Example 9 displays the first three measures of the Trio.)

¹⁷These two notes are actually sustained from the (C, C#, F#, G) 4-9 member which occurs 3 measures earlier.

¹⁸ See Appendix III.

Example 9

The first three measures of the Trio, illustrating hexachord X.

These six pitch classes make up the underlying material for the first thirty-one measures of the composition. The note "G", out of which the composition unfolds, is used as a drone throughout this section. The other notes of the hexachord are used freely over the drone after they are first stated in order--not only in blocks of six different pitch classes, but so that after a pitch-class has been introduced, it can be repeated (among other notes already introduced) before the rest of the hexachord has been stated. The interval of the perfect fourth is aurally established at the onset within the pitch material of set-class 6-1.

The remaining six pitch classes are introduced according to the T_6X order, embedded in the structure as grace notes.

Example 10

7

16

17

↓ = T₆X

Measures in Section I which contain T₆X embedded in grace notes.

The remaining six pitch classes are a tritone transposition of X: X = (G C A^b B^b B A); T₆X = (C# F# D E F E^b).

The section ends with an ordered retrograde of hexachord X (mm. 26-30).

Section XII consists of an augmented re-articulation in retrograde of I. As I have noted, texturally the sections are rather different.

Example 11 a and b

a)

b)

Comparison of mm. 2 and 3 Section I (ex.11a) with their corresponding retrograde, mm. 313 and 314 Section XII. (ex11b).

Example 11 compares the first few measures of section I (mm. 2 and 3) with the corresponding section XII (313 and 314). With the

exception of the chordal interruption in measure 314 within the second beat, the successive pitch classes are in retrograde. The drones in measures 2 and 3 become repeated notes in 313 and 314.

The beginning of the retrograde from measures 303-315 follows the pitch material of the first 13 measures (C_1 , Section I) almost exactly. The remaining measures do not follow as strictly and some pitches are replaced by others. Measures 286-302 seem to use the inversion of X in free ordering. This corresponds in part to the use of the content invariant RI form of X, in section I, but at a different pitch level. Here G, and only G, the axis of symmetry, intersects X and its inversion.¹⁹

Example 12

X	(G C A ^b B ^b A)
	↕
T ₂ I of X	(G D F [#] E ^b F)

The inversion of X with
the axis of symmetry
around G.

There are four chordal interruptions to this section some of which employ the use of rotational arrays.²⁰ A contrasting dynamic level and articulation isolate these vertical sonorities.

¹⁹Since 0 is "C" the inversion of X is around 7, thus the name of its inversional pair is T₂IX rather than IX.

²⁰John Rogers, "Toward a System of Rotational Arrays," Proceedings of the American Society of University Composers 2 (1967): 61-84.

Example 13

The image displays three systems of musical notation, likely for piano, with various annotations and dynamic markings. The first system (top left) is marked with a measure number '298' and a bracketed section '5-32'. It includes dynamic markings 'nat.', 'f', and 'pp'. The second system (top right) is marked with a measure number '309' and a bracketed section '4-20'. It includes dynamic markings 'fpp', 'pp', and 'pp'. The third system (bottom) is marked with a measure number '312' and a bracketed section '21' over '4'. It includes dynamic markings 'pp', 'sf', and 'sf'. The notation includes treble and bass staves with various notes, rests, and articulation marks.

Chordal interruptions in Section XIII which employ the use of rotational arrays.

An exact but retrograde statement of the rotational array of X is given in example 14a. The presentation occurs in the measure preceeding section XII, measure 283 (see example 14b). The unison "G" in measure 284 is the "unison" column of the rotational array. Three of the vertical hexachords of the rotational array are embedded within the last section of the composition, as I mentioned above.

Example 14 a and b

a)

9	B	A	8	0	
2	4	6	5	3	7
B	6	8	A	9	
5	9	4	6	8	7
6	4	8	3	5	
9	8	6	A	5	7

$\uparrow$ $\uparrow$ $\uparrow$ $\uparrow$ $\uparrow$ $\leftarrow$
 5-32 5-23 4-21 4-20 5-32 $\leftarrow$
 $\downarrow$ $\downarrow$ $\downarrow$ $\downarrow$ $\downarrow$

b)

283

pont. *fp* *fp* *fp* *fp* *p* *ff* *pont. al...*

12 16

pont. *fp* *fp* *fp* *fp* *p* *ff* *pont. al...*

16 4

pont. *fp* *fp* *fp* *fp* *p* *ff* *pont. al...*

284

Marcato c
sff *ord.*
pizz.

16 *ord.*
pizz.
4 *sff*
pizz. sff L.V.
ord.

Rotational array of transforms of X in retrograde (ex.14a), placed over the measure in the score with which they correspond (ex.14b).

The second section (15/8) of the composition begins with a statement of T_6X which was introduced in section I embedded as grace notes.

Example 15

32

15 *

8

** $\frac{15}{8}$ here = $\frac{6}{8}$, and is so divided.*

33

First two measures of Section II, illustrating T_6X .

Throughout this section transpositions and inversions of X are used linearly in the violin,²¹ while the cello and viola alternate in playing a drone. The "G" drone in the cello extends to measure 37. The viola plays a $C\sharp$ drone beginning in measure 40 to the end of section II articulating the tritone relation. In the violin part (mm. 40-46) linear aggregates are formed by using successive members of segment-class of X that map into their complements under T_6 or T_{nI} . This corresponds to the subsection supported by the ($C\sharp$) drone.

²¹Appendix II contains a detailed analysis of the sequence of transforms of X and MX throughout the piece.

Example 16

40

RT4 X

fp *n.v.* *mfp* *f* *L.V.* *sf* *pont.*

p[p]

41

RTA X

[pont.] *sf* *L.V.* *p* *L.V.* *mf* *[tenuto]*

(p[p])

42

p *[sub.]* *mfp*

Section II mm. 40 through 42, linear aggregate.

Section III begins in measure 43 articulated by a single 15/16 measure, and texturally in 46 with chords. The violin plays a line which overlaps vertical sonorities in the viola and cello. Pitch material consists of members of segment-class of X stated linearly in the violin and vertically, shared between the cello and violin line up to measure 62. Throughout this section Wuorinen employs a hexachord that was previously stated as a melodic line now as the next vertical sonority over new melodic material. (See ex. 17 a and b).

into dyads and tetrachords so that certain set classes are extracted. Example 17 reveals three- and four-note sets that feature ic5s. Of special importance are set-classes 3-7 and 3-9. While these measures (46-62) combine members of segment-class X for their basic pitch material, the resulting combinations yield set-classes found linearly in the segment-class that is the M of X's segment-class, i.e., orderings of 6-32.

Measures 54-62 still contain members of set-class 6-1, but unlike measures 47-53 which utilized hexachordal combinatoriality, measures 54-62 use harmonic 6-1 hexachords in the viola and cello which have tones in common with the melodic hexachords in the violin part. Harmonic octaves and unisons have been characteristically generated from the drones as well as direct and indirect repetitions of ordered hexachords in the beginning sections. Now these "doublings" are the result of combinations of material. Wuorinen calls this process verticalization.²² This process is taken one step further with the use of rotational arrays where the octave becomes part of the structure and is accepted as an actual interval instead of just a doubling. Notes which are stated melodically are simultaneously sounding vertically and support those tones sounding successively.

²²Charles Wuorinen, Simple Composition (New York and London, Longman, 1979), pp. 55-57.

Example 18

60 Doubling 61 [ord.] 62 63 64 65

verticalization

verticalization

Illustration of verticalization -- harmonic octaves between the cello and violin (mm. 60-61) and violin and viola (m. 63); collections of pitch-classes vertically supporting those that are successively sounding (mm. 60 and 63).

The vertical sonorities in mm. 54-62 are either stated as hexachords or hexachords partitioned into three dyads. The latter produce some trichords when combined with the violin, that can only exist between two 6-1 hexachords (Refer to examples 18 and 19).

Example 19

The musical score for Example 19 consists of three staves. The top staff is in treble clef and contains several measures of music with dynamic markings such as *fp*, *f*, and *pp*. Above the first measure, there is a boxed annotation $RT_1 \bar{I} X$. Above the second measure, there is a boxed annotation $3-5$. Above the third measure, there is a boxed annotation $3-2$. Above the fourth measure, there is a boxed annotation $3-9$. Above the fifth measure, there is a boxed annotation $(T_3 I X)$. The middle staff is in treble clef and contains several measures of music with dynamic markings such as *pp*, *f*, and *pp*. Above the first measure, there is a boxed annotation $3-5$. Above the second measure, there is a boxed annotation $3-2$. Above the third measure, there is a boxed annotation $3-9$. Above the fourth measure, there is a boxed annotation $(T_3 I X)$. The bottom staff is in bass clef and contains several measures of music with dynamic markings such as *pp*, *f*, and *pp*. Above the first measure, there is a boxed annotation $3-5$. Above the second measure, there is a boxed annotation $3-2$. Above the third measure, there is a boxed annotation $3-9$. Above the fourth measure, there is a boxed annotation $(T_3 I X)$. Below the staves, there is a large annotation $TAI X$.

Partitioning of two members of set-class 6- yielding trichordal members of 3-5 and 3-9.

Trichords 3-5 and 3-9 are important harmonic sonorities. 3-5 is the unique trichordal (abstract) subset of 4-9 and 3-9 is a typical member of 6-32. In partitioning the hexachordal sonorities as dyads, Wuorinen makes sure that the trichordal sonorities have a prominent perfect fourth. Of special importance here in mm. 54-55 is the 3-9 trichord since the M-related 6-32 hexachord is the primary pitch material used for the rest of this section (mm. 63-69). Compare example 20 below, which contains sets made up of partitioned 6-32 hexachords, with the previous examples from this particular section which contain sets made up of partitioned 6-1 hexachords (examples 17, 18, and 19). Notice the use of the same partitioned sets with both the 6-1 and 6-32 hexachords. In measure 69, the final 6-32 hexachord of section III is partitioned into two 3-9 trichords.

Example 20

The same partitioned trichords (3-5 and 3-9) occur with combinations of hexachord 6-32 as they did with combinations of 6-1.

The corresponding retrograde measures to sections II and III encompass (mm. 259-282) and are included in section XI. This almost completely covers one rhythmic and textural section (B_{11.1} and A₁₁), which extends from mm. 255 to 282.²³ With the exception of a few chords that interrupt the structure, the retrograde measures use

²³Refer to Appendices I and II.

the notes of sections II and III (mm. 32-69) in exact retrograde but with completely different rhythmic values and in a different texture.

In section XI, the retrograde of II, III, and part of IV (mm. 255-282), the material is introduced by thirty-second notes in a heterophonic texture. This is in contrast to section II which contains a melodic line over drones and section III which contains a slowly unfolding melodic line over interspersed chordal accompaniment (see examples 15 and 19). The same exact pitch material is used in XI but within a completely different musical context. Example 21a and b compares the beginning of the second section (m. 32 and 33) with the retrograde section at measure 282. Example 21c and d compares the beginning of section III (m. 47) with the continuation of the retrograde procedure which coincides with measure 273.

(See next page for Example 21 a and b)

Example 21 a and b

a)

32

15*

8

ff *pp* *fp*

$T_1 X$

* $\frac{15}{8}$ here = $\frac{6}{8}$, and is so divided.

33

mf *sf* *mp* *fp*

$T_2 X \rightarrow$

b)

$RT_1 X$

p

Comparison of the beginning of Section II (ex.21a) with its corresponding retrograde, the end of Section XI (ex.21b).

Example 21 c and d

c)

d)

Comparison of the beginning of Section III (ex. 21c) with its corresponding retrograde, the middle of Section XI (ex. 21d).

Section IV uses the musical fabric of mm. 6-32 (section I) with a few exceptions and minor reordering. This material occurs in the viola and cello over which a new line is added in the violin part. Example 22 is a comparison of the first few measures of each section.

Example 22

a) *arco*
[G]

Meno, accel. al più *Meno, accel. al più*

12
8 (p) $f > p$

7
3 *fp* [o] *f* *f* *p* [sub.]
8 *sfp* *[p sempre]* *pont.* *sf* *p*
sfppp

b) 70 *arco*
3 *sf* *f* *f* *f* 71 72

arco *marcato* *mp* *fp*
8 *mp* *mp* *fp*
arco *p* *sf* *fp*

73 74 75 0
73 74 75 0
fp *f* *sfpp* *f* *sfpp* *sfpp* *sfpp* *f* *sfpp* [sul G]

Comparison of corresponding measures in Section I (ex.22a) with Section IV (ex.22b).

Some registral differences occur because of the change of instrumentation and there is the rare addition of one or two new notes in the viola and cello.

Example 23

a) b)

The image shows two musical staves, labeled a) and b). Staff a) is for violin and staff b) is for cello. Both staves show a musical motif with a dynamic marking of *f* (forte). The notation includes various musical symbols such as notes, rests, and dynamic markings. The cello part (b) includes additional markings like *p* (piano), *f* (forte), and *vib.* (vibrato).

Comparison of the same motive used in Sections I and IV with different instrumentation. Ex.23a Section I - violin vs. Ex.23b Section IV - cello.

The violin part in IV contains new material. It consists of ordered transpositions and inversions of hexachord 6-32. Thus section IV is the first section of the piece which combines members of 6-1 with members of 6-32.

Linear aggregates occur in the violin part from mm. 72-82 as a result of successive 6-32 hexachords, transforms of MX, which map into their complements under T_6 or T_{nI} .

Example 24

The musical score for violin melody (mm. 72-82) is presented in four systems. The notation includes various transformations of MX aggregates, indicated by brackets and labels above the notes. The first system (mm. 73-75) shows transformations $RTA MX$ and $T_5 I MX$. The second system (mm. 76-78) shows $TAMX$ (marked *marcato*) and $RT_5 I MX$. The third system (mm. 79-81) shows $RTBI MX$ and $RT_5 T_0 MX$. The fourth system (m. 82) shows a final transformation T_0 . The score includes dynamic markings *fp* and *f*, and a *marcato* marking. The key signature has one flat (B-flat), and the time signature is 3/4.

Linear aggregates as a result of successive transforms of MX which map into their complements under T_6 or TnI , violin melody (mm. 72-82) Section IV.

Other sections of the violin melody in section IV utilize successive intersecting hexachords. These common pitches occur in different orders and rhythms, yet the preservation of pitch classes helps preserve melodic continuity.

(See Example 25 on next page.)

Example 25

95 96

T₁ MX
(1,0) *f* *f* *mp*

ff *sff* *pont., n.v.* *ppp*

ff *ppp* *pont.*

97 98 99

f *RT₇ MX* *p* *ord.* *vib.* *p*

f *ord.* *pont.* *ord.* *[sul D]* *p*

f *ff* *sf* *ppp* *[ppp]*

100 *RT_I* 101 102

f *sf* *sf* *ten.* *ff* *p* *(7 8)*

f *ten.* *ff* *ff* *ff*

f *[sub.]* *ff* *ff* *ff*

Preservation of melodic continuity in the violin
by use of linear hexachords with common pitch classes.

The same techniques apply to the harmonic aspect of section IV. The violin has no notes in common with the viola and cellos either to create pitch-class sets of secondary importance such as 3-5, 3-9, 4-20 between the two parts (example 26), or the violin doubles tones at the octave or unison to specifically reinforce notes in the viola or cello (example 27).

Example 26

Handwritten musical score for Example 26. The score is written for three staves (violin, viola, and cello). The violin part is marked with a tempo of 90 and includes the notation (RTLMX) and (B94). The viola and cello parts are marked with a tempo of 91 and include the notation (TBLMX) and (6831). The score shows various pitch-class sets: 3-5, 3-9, and 4-20. The violin part is marked with a forte (f) dynamic, while the viola and cello parts are marked with a fortissimo (sf) dynamic. The score also includes a bracketed section labeled 6-1.

Pitch-class sets 3-5, 3-9, and 4-20 resulting from a combination of a member of set-class 6-32 (partially revealed in this example in the violin) with a member of set-class 6-1 in the viola and cello.

Example 27

Handwritten musical score for Example 27. The score is written for three staves (violin, viola, and cello). The violin part is marked with a tempo of 73 and includes the notation (h). The viola and cello parts are marked with a tempo of 74. The score shows various pitch-class sets: 3-5, 3-9, and 4-20. The violin part is marked with a forte (f) dynamic, while the viola and cello parts are marked with a fortissimo (sf) dynamic. The score also includes a bracketed section labeled 6-1.

The violin reinforces notes in the viola and cello by octave doubling.

Measures 240-262, part of XI, (C_{11.3}) contain a pitch class retrograde of section IV. Here the pitch structure does not correspond to the textural and rhythmic divisions of the composition.²⁴ Temporally, there are two successive parts: one extends from mm. 240-255 (B_{11.2}); the other extends from mm. 255-284 (B_{11.1}). The corresponding retrograde of the pitch material in section IV occurs in part of one rhythmic subdivision of section XI and overlaps the next. The pitch material of the retrograde measures (240-262) is exactly the same as the original measures (70-108) again with a few exceptions. The rhythmic and textural setting of the pitch material is highly diverse in these two retrograde portions of the piece.

²⁴Refer to Appendix I.

Measures 240-251 form a rough to nearly exact rhythmic diminution of measures 84-108. Each string part has its own independent rhythmic retrograde and diminution. Compare such parts in example 29.

Example 29 a and b

a)

248 249 250

3 8

sf p sf sf p f

[f] [pont. frog] [pont.]

sf ff mp ff sf

sfp pont.

b)

87 88 89 90

7sf 4 p fp fp p 3 fp 3 f

16 8 16 8

sf fp p mp sf ff

pont. ord. f

Comparison of the retrograde rhythmic diminution of Section IV (ex.29b) found in Section XI and part of Section X (ex.29a).

Section V corresponds to II and part of III (to m. 51) in the viola and cello parts, and to a retrograde of section IV into part of III (to m. 51) in the violin part. In spite of its derivation, V sounds as one single section. Rhythmically, it is partitioned into two groups to coincide with the division between sections II and III. Section V is related by tritone transposition to section II and part of section III (mm. 32-51) in the viola and cello parts. The violin part (mm. 109-128) contains a retrograde of the violin part in mm. 51-108 transposed by a tritone.

Example 30

SectionII	SectionIII	SectionIV
32 - 46	46-(51)-69	70 - 108
vln, vla, vc		

109 - 128	128 - 109
SectionV	SectionV
vla/vc	vln

Comparison of pitch structure in
Section V with II, III, and IV

Example 31 illustrates the rhythmic subdivisions of this section.

Example 31

SectionII B2	SectionIII B3
32 - 43	44 - (51) - 69
vln, vla, vc	vln, vla,
15/8 (12mm)	vc

109 - 120	121 - 128
15/8 (12mm)	vla, vc
vla, vc	
Section V	

Comparison of the rhythmic subdivision of
V with B2 and B3, Sections II and III.

Examples 32 a and b compare the first two measures of section II (mm. 32-42) with their corresponding measures (mm. 109-111), which constitute the beginning of each.

Example 32 a and b

a) 32 [♩ = ♩]

b) 109

110 [P] sempre n.v.

Comparison of the violin at the beginning of Section II (ex.32a) with the viola at the beginning of Section V (ex.32b).

With the exception of the C# in the viola in measure 109 and the F# in the cello, all of the notes that occur in the viola and the cello (mm. 109-111) match those in mm. 32-34 transposed by T_6 . This holds true for comparing the complete section from mm. 109-128 (viola and cello) with section II and part of section III (mm. 32-51).

Another interesting feature which occurs between the corresponding parts (from mm. 114-122 and mm. 38-45) is registral "inversion" of intervals (M3--m6 and so on). Examples 33 a and b compare the violin part of measure 45 with the viola part in measure 122 to display this complementation within the octave (or over two octaves).

Example 33 a and b

Example 33a (top) shows measure 45 of Section II. The violin staff (top) has a 6/8 time signature and a key signature of one flat. It contains a melodic line with dynamics *f* and *p*, and markings *pont.* and *al. ord.*. The viola staff (bottom) has a 4/4 time signature and a key signature of one flat. It contains a melodic line with dynamics *f* and *p*, and markings *[p]* and *niente!!*.

Example 33b (bottom) shows measure 122 of Section V. The violin staff (top) has a 12/8 time signature and a key signature of one flat. It contains a melodic line with dynamics *[f]*, *p*, *ff*, and *ff*, and markings *pizz.*, *arco*, and *L.V.*. The cello staff (bottom) has an 8/8 time signature and a key signature of one flat. It contains a melodic line with dynamics *f*, *p*, and *p*, and markings *pont.*, *al. ord.*, and *[p]*.

Comparison of measure 45, Section II (ex.33a) with the viola and cello, Section V (ex.33b) displays complementation within the octave a tritone apart.

The rhythm in B₂ is exactly preserved in B_{5.2} (see example 18). The material which was previously in the violin part (mm. 32-46) as described above contains transpositions and inversions of X; it now occurs in the viola (mm. 109-122) over a drone transposed by T₆ in the cello.

Example 34 a and b

a) 34

b) III

p sempre [n.v.]

The rhythm in Section II, B₂ (ex.34a), is exactly preserved in the cello and viola, Section V, B_{5.2} (ex.34b). Pitch material of II is transposed a tritone in V.

The measures of section III that correspond with the viola and cello in the rest of this section V (mm. 123-128) share a melody/chordal accompaniment texture.

Example 35 a and b

a)

b)

Section III (mm.49&50) and their corresponding measures in Section V (mm.126-128). The violin melody and viola/cello accompaniment are now present in the viola and cello in Section V (mm.126-128), transposed a tritone with one hexachordal addition-- the sextuplet in m.126.

As mentioned previously, the violin part in measures 109-128 is an exact T_6 retrograde of the violin part, mm. 51-108. At times, other members of segment-class X are interpolated in the violin line. Example 36 illustrates the beginning of the violin line in measure 109 with its retrograde at T_6 . The rhythm of the violin melody (mm. 109-128) is an exact diminution of the rhythm of the violin melody from measures 108-51.

Example 36 a and b

a)

b)

The violin part in section IV (ex36a) is retrograde a tritone apart from the violin in Section V (ex36b). The rhythm of the violin in Section V is a rough to nearly exact diminution of the retrograde of the violin rhythm (mm.51-108).

Continuing beyond the passage shown in example 36, measures 110-113 and their corresponding retrograde measures 103-185 make use of the segment-class of MX (orderings of 6-32). The successive hexachords in these measures have pitch class sets in common. Measures 113-116 and its corresponding retrograde, mm. 71-84, contain linear aggregates as a result of successive complementary hexachords (under T_6 or T_{nI}). Measures 51-70 and 116-129 contain 6-32 (MX) hexachords and 62-51 and 120-128 use X.

The corresponding retrograde section to measures 109-128 extends from measures 218 to 237. Just as measures 109-128 were divided in order to fit with sections II and III, so are the corresponding retrogrades divided.

Example 37

Section V			
B5.1	B5.2		
109	120	121	128
237	226	225	218
corresponding retrograde			
B10.2	B10.1		

Rhythmic subdivisions of
Section V and its correspond-
ing retrograde (mm. 213-237).

Yet another retrograde occurs between measures 237-226 and 109-120. Both sections structurally fill twelve measures in 15/8, but only vaguely resemble each other with regard to pitch material. The rhythms in the violin, viola and cello (mm. 226-237) are a strict retrograde of the rhythms in the violin, viola and cello (mm. 109-

120). Example 38 compares the beginning of the retrograde measure 237 with measure 109.

Example 38 a and b

a) 109

[p] *sempre n.v.*
 * 15 here = 5, and is so divided

b) 237

pp sempre

Comparison of the beginning of Section V (ex.38a) with its corresponding retrograde (ex.38b).

The above example shows that in the retrograde of the violin part, measure 237 is a major 3rd higher measure 109 and the cello in measure 237 is a major 3rd lower than in measure 109. Such clear-cut relationships do not continue for long though. The rhythms are preserved in this example as they are throughout the "15/8" section (with the exception of the four repeated thirty-second notes in measure 237). The "15/8" section and its corresponding retrograde, end in measures 120 and 226 respectively.

At this point the violin part in the retrograde measure (226) is transposed a minor 3rd lower than the violin line in measure 120.

Example 39 a and b

a)

120

b)

226

Comparison of the last measure of B5.1 (ex39a) with the first measure of B10.2, its correspond-retrograde (ex39b). The violin melody in ex39b is a minor third lower than ex39a.

This retrograde m3 relationship can be traced back to measure 118 and its corresponding measure 228.

Example 40

mm.	119		120	vs.	mm.	226		227
	RT7	RT1	T6I			RT3I	TA	T4
	MX	MX	X			X	MX	MX

Diagram of the minor third relationship between
mm.119-120 and 226-227.

Section VII extends from measure 133 to the grand pause at measure 178. The viola in section VII is related to the violin in section V (C₅) (through m. 117) by tritone transposition; hence it is related to the viola in II (C₂) (mm. 32-46) at the same pitch level since V was a tritone transposition of II.²⁵

²⁵Notice that the C# in measure 109 could have been a C $\flat$. Wuorinen also uses a "G" instead of "F#" in measure 133. As a result, what would have been a member of 6-1 is obliged to be (C#, G, D, E, F, E $\flat$), a member of set-class 6-2. The same hexachord appears in measure 56.

Example 41 a, b and c

a) 32

* $\frac{15}{8}$ here = $\frac{6}{8}$, and is so divided.

b) 109

[p] sempre n.v.

* $\frac{15}{8}$ here = $\frac{5}{8}$, and is so divided

c) 133

ord. $\frac{15}{8}$ here = $\frac{5}{8}$, and is so divided

The violin in Section VII (ex.41c) is related to the viola in V (ex.41b) by tritone transposition and hence, related to the violin in Section II (ex.41a) by the same pitch-classes.

The viola part in VII (mm. 133-178) is the inversion ("around" E) of the violin part in V (mm. 109-117). The rhythms in both the violin and viola (mm. 133-178) are exactly the same as the rhythms of the same instruments in measures 109-117.

Conclusion

The foregoing analysis has uncovered a multitude of interrelations among sections of the composition. If the chart in Appendix I is put in chronological order--the actual order in which one hears the piece--certain aspects of the form are apparent.

Example 42

a	b	c	a	a	a	a	d	e	a	acb	a
I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
A		B		C	A	C	D	E	C	B	A

Chronological Ordering of Appendix I

Example 42 shows, in essence, a type of rondo form. However, degrees of correspondence between different sections are not of the same weight. The A sections all generally contain the same pitch material, but the final section is in retrograde and the rhythms in XII are not the same as in I and VI. B sections contain the same basic material but with completely different textures and often varied rhythms. The first B section is a sequence of three sections differentiated by distinctions in rhythm, pitch and texture. The final B section (XI) collects the retrograde of the three-part B

section into a unit delineated by the same texture and rhythm. The three C sections (V, VII, and X) are also made up of material from II, III and IV, thus, sections B and C have a modest degree of relation. Section VII is a tritone transposition of V while the final C section, X, is a rhythmic retrograde of V but only vaguely related in the pitch dimension. Section VIII, the sole D, has a few of the characteristics of the section before it. It is in 3/8 and employs a thick texture which at times contains five- and six-note verticalities. E, section IX, is unique in texture. It consists primarily of a cello solo, utilizing double, triple and quadruple stops, with intermittent chordal punctuations played by all the instruments. This section may have something to do with rotational arrays, but after much analysis, I have been unable to make such an association.

From these considerations, Wuorinen's Trio is a hybrid form which incorporates rondo and variation techniques -- a form, albeit simple -- which one finds in earlier twentieth century music. For instance, the five movements of Bartok's fourth and fifth String Quartets form the following pattern:

A B C D E

The arrows show that the last movement (E) is a variation of the first movement (A) and D is a variation of B. The fifth movement of the quartets is also in sonata - rondo form in which each return to the primary material is also varied. Another possible precursor of the Wuorinen String Trio is Schoenberg's String Trio -- one of his last works. This work had a profound influence on American serial

composers, most notably Milton Babbitt, in his formulation of hexachordal combinatoriality with trichordal generators. Yet, for Wuorinen, this work is transitional leading to his more-clearly articulated time-point pieces of the 1970's. But in the largest sense, all pieces are transitional and I have chosen Wuorinen's Trio to exemplify aspects of his mature compositional style.

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Appendix I
Structural Diagram.

Section I A1	Section II A2	Section III A3	Section IV A4
1- (4) (6) - 31	32 - 46	46 - (51)	69 70 - 108
B1	B2	B3	B4
1- (4) (6) - 31	32 - 43 44	(51)	69 70 - 108
C1	C2	C3	C4
1- (4) (6) - 31	32 - 46	46	69 70 (81) 108
315 - 284	282	(214) (213)	(262) (262)
C12 PR	C11.1 PR	C11.2 PR	C11.3 PR
315 - 284	282		255 254 240
B12	B11.1		B11.2
315 - 284			255
A12	A11		
Section XII (R of Sect. I)	Section XI (R of II, III, part of IV)		

rR = rhythmic
retrograde

arR = augmented
rhythmic
retrograde

drR = diminished
rhythmic
retrograde

T6 = tritone
transposition

RT6 = retrograde
tritone
transposition

RI = retrograde
inversion

pP = pitch preserve

rP = rhythm preserved

FR = pitch retrograde

() | () = measures
which mark
subdivisions
of a section

() = measures which
|| mark the begin-
ning and/or end
of a correspond-
ing section

||

||

||

||

Section V
A5 (vln, vla,)

109	-	128
B5.1 (vla, vc)	B5.2	B5.2 (vln) B5.1
109 120 121	128	128 121 120 109
rP of (B2 and B3 vln) to m. 51		drR of (B4 and B3 vln) to m. 51
C5 (vla, vc)		(vln) C5
109 (117)	128	128 (117) 109
T6 of (C2 and C3 vln) to m. 51		RT6 of (C4 and C3 vln) to m. 51
237	218 218	237
	C10 C10	
	(vla, vc) (vln)	
237 226 225	218 218 225 226	237
rR of (B5.1)	arR of B5.2	arR of B5.2 rR of B5.1
	B10.2 B10.1 B10.1 B10.2	
	(vla, vc) (vln)	
237		218
A10 (vln, vla, vc)		
Section X (R of V)		

Rit. 6
A6

129-132

B6
129-132

C7
129-132

217-214
C9.1

Section VII
A7

133 177 | (*****)

B7
133 177

C7
133 177
vln T6 of (C5 vla)
to m. 117
hence pP of (C2 vln)
to m. 41

A7

177 133

B7
177 133
vla rP of (B5 vln) to
C7 m. 117

177 133
vla RI of (C5 vln) to
m. 117

Section VIII Section IX

178 - 202 | 203 - 218

AppendixII

AppendixII

SectionI	SectionII	SectionIII	SectionIV
mm 1-(4) (6)-31 T7 hex 6-1 retro	32 vln: T1 T2 RT9I RT7 T4I RT4 RTA T9I TA RT9I RT3I vla/vc G-----C#-----G----- TA T9I	46 (51) start hex 6-32 T7 (6-1) RT0I start 6-32 T7 T1 T6 RT5I RT7	69 70 T4I RT4 RTA T5I TA RT5I RTBI RT5I TA TAI RT1 TBI T1I RT7 RT8I T7 hex 6-1
mm 315 - 284	282 vln RT1 RT2 T9I T7 RT4I T4 TA RT9I RTA T9I T3I vla/vc G-----C#-----G----- RTA RT9I	(274) start hex 6-32 RT7 (6-1) T0I start 6-32 RT7 RT1 RT6 T5I T7	(262) RT4I T4 TA RT5I RTA T5I TBI T5I RTA RTAI T1 RTB RT1I T7 T8I RT7 hex 6-1
SectionXII	SectionXI		255 254 (238)

SectionV

109 via T7 T8 RT3I RT1 TAI RTA RT4 T3I T4 RT3I RT9I RT3I vc C#-----G-----C#--(T0""RT4I)""(RT4)""	(120) (121) 226 225 218	128 RT4 RT4I T7 RT9I RT1I T1 T6I start 6-32 RT1 RT7 RT0 TBI T1 RTAI TA T4 RTBI RT4 TBI T5I TBI RT4 RT4I T7 RT5I RT7I T1 T2I RT1	(117) 109
237 vl/vc---strict rhythmic retro-----augmented retro----- of_vla/va_(mm.109-120) of_vla/vc_(121-128)		218 ---vln augmented retro of vln (109-128)	237 strict rhythmic retro of vln (mm109-128)
SectionX			

Rit.VI

Section VII

129-132	133 vln T1 T2 RT9I RT7 T4I RT4	177
217-214		
retro		

Section VII

VIII IX

177	133 177-202 203-218
-----	---------------------

6-32 T6I RTA TAI T4I RT4I T9 T3I T9 RT6I T2 T1I RT3 RT1 T6 RT7I
vla inversion around "e"
strict rhythm in viola of violin (mm.109-117)

APPENDIX III

The tables for the segment class of X and MX are read in the following manner: left to right = transposition; right to left = retrograde; high to low = inversion; low to high = retrograde inversion.

Hexachord 6-1

Hexachordal Segment Class of X

I	T →	0 5 1 3 4 2	← R
↓		7 0 8 A B 9	
		B 4 0 2 3 1	
		9 2 A 0 1 B	
		8 1 9 B 0 A	↑
		A 3 B 1 2 0	RI

I	T →	6 B 7 9 A 8	← R
↓		1 6 2 4 5 3	
		5 A 6 8 9 7	
		3 8 4 6 7 5	
		2 7 3 5 6 4	↑
		4 9 5 7 8 6	RI

Hexachord 6-32

Hexachordal Segment Class of MX

I	T →	0 1 5 3 8 A	← R
↓		B 0 4 2 7 9	
		7 8 0 A 3 5	
		9 A 2 0 5 7	
		4 5 9 7 0 2	↑
		2 3 7 5 A 0	RI

I	T →	6 7 B 9 2 4	← R
↓		5 6 A 8 1 3	
		1 2 6 4 9 B	
		3 4 8 6 B 1	
		A B 3 1 6 8	↑
		8 9 1 B 4 6	RI

Hexachord 6-1

Rotational Array

7 0 8 A B 9
 7 3 5 6 4 2
 7 9 A 8 6 B
 7 8 6 4 9 5
 7 5 3 8 4 6
 7 5 A 6 8 9

1 6 2 4 5 3
 1 9 B 0 A 8
 1 3 4 2 0 5
 1 2 0 A 3 B
 1 B 9 2 A 0
 1 B 4 0 2 3

Hexachord 6-32

Rotational Array

7 8 0 A 3 5
 7 B 9 2 4 6
 7 5 A 0 2 3
 7 0 2 4 5 9
 7 9 B 0 4 2
 7 9 A 2 0 5

1 2 6 4 9 B
 1 5 3 8 A 0
 1 B 4 6 8 9
 1 6 8 A B 3
 1 3 5 6 A 8
 1 3 4 8 5 0

APPENDIX IV

GLOSSARY*

Abstract Inclusion - a set class is said to be abstractly included in another if there is at least one member of that set class literally included in a member of the other. (M)

Complement - if K is a pitch-class set containing n elements, then the complement of K, written K^c , is the set of $12-n$ elements (pitch-class integers) not contained in K. (M)

Invariant Set - a set which under transformation (i.e., transposition or inversion) preserves all its elements.

Interval Class (ic) - one of seven interval classes each of which collect all intervals that are equivalent under complementation and octave expansion. (M)

Interval Vector - an ordered array of numerals enclosed in square brackets that represents the interval -class content of a pitch-class set. (F)

Inversion - refers to the process by which each element e of a pitch-class set is replaced by $12-e$. Ia is the inversion of the pitch-class a (Mod-12). (F)

Normal Form - a particular circular permutation of a pitch-class set, K, in ascending order used to stand for all the pitch-class sets in the set-class that contains K. (F)

Ordered Set - a pitch-class set in which the order of the elements is regarded as significant. (F)

Multiplicative Transformation - an operation by multiplication on a pitch-class succession which transforms the interval content of a set. Ma is the equivalent to the pitch-class a multiplied by 5 (Mod-12). M is also notated as M_5 . (W)

* Definitions are taken from Allen Forte's Structure of Atonal Music, Robert Morris' Theory 406 Notes and "A Similarity Index for Pitch-Class Sets," Perspectives of New Music; and Charles Wuorinen's Simple Composition. Terms will be coded with F, M or W respectively.

Pitch-class (pc) - a pitch-class is the collection of all pitches that are enharmonically equivalent and/or octave (or multiple octave) transpositions of one another. Pitches that differ by multiples of 12 are all members of the same pitch-class. (M)

Pitch-class Set - a set unordered of distinct integers representing pitch classes. (F)

Rotation - order transposition; change of position in a cyclicly ordered succession of pitch classes. (W)

Rotational Array - the set of six transpositions of X, an ordered set beginning with the pitch-class n, so that each transposition contains n in a different order position, aligned in a matrix via rotation, so all the pitch-class n's fall in the matrix's first column. (M)

Segment - an ordered set of pitch-classes with or without replication. The contents of a segment are listed between commas within round brackets. (M)

Segment Class - a collection of segments related by T_n , T_{nI} , and/or R.

Set Class - a collection of sets related by T_n and/or T_{nI} .

Set Inclusion - a set is said to be (literally) included in another set if all of its elements are also elements in the latter. (M)

Transposition - transposition of a pitch-class set S consists of addition (mod-12) of some integer t to each element of set S. T_5a is the pitch-class a transposed by 5; $a + 5 \text{ (Mod-12)}$. (F)

Verticalization - successive pitch classes can be made to harmonize in their unfolding: lines which are independent can be combined so that tones simultaneously sounding support those successively sounding. (W)