



## Yale University Department of Music

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Proportional Exchange in Stravinsky's Early Serial Music

Author(s): Akane Mori

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# PROPORTIONAL EXCHANGE

## IN STRAVINSKY'S EARLY

### SERIAL MUSIC

Akane Mori

Igor Stravinsky's profound respect for Anton Webern's work manifests itself in his early serial music.<sup>1</sup> The tone row that appears in the "Pas-de-Deux" movement of *Agon* (mm. 452–62 and mm. 495–519), for example, is quite similar to the one in Webern's *Variations for Orchestra* Op. 30 in that their intervallic patterns and symmetrical partitions are almost identical.<sup>2</sup> A twelve-tone technique used in the third movement of *Canticum Sacrum* (mm. 148–53, mm. 169–73, and mm. 178–83) resembles that in Webern's *Quartet*, Op. 22: two different rows are assigned to two contrapuntal melodic lines, and partitions of the rows switch between these two lines.

Despite these similarities, Stravinsky's approach to tone-row organization exhibits several special features during this period. Although composers of the Viennese School tend to use the serial method exclusively throughout a piece—or at least throughout a movement—Stravinsky freely alternates between serial and non-serial methods in the early serial works. Stravinsky also employs rows with lengths other than twelve: a four-note row in *Three Songs from William Shakespeare*; a five-note row in *In Memoriam Dylan Thomas*; and a sixteen-note row in *Septet*. While both Stravinsky and composers of the Viennese School frequently use contrapuntal techniques, especially canon, Stravinsky's use of the row as

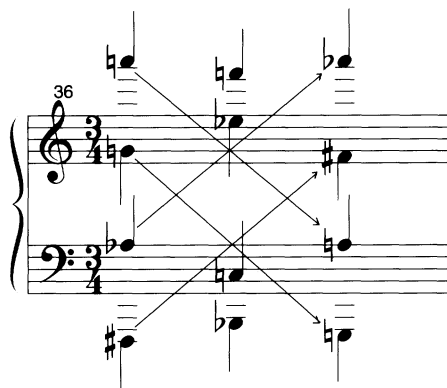
if it were the subject of a fugue or a canon differs from that of the Viennese School.<sup>3</sup>

This essay focuses on a special feature of Stravinsky's early serial works: their proportional formal structure.<sup>4</sup> Because the end of a tone row often coincides with the end of the subject of a fugue or canon, the arrangement of tone rows tends to correspond with the segmentation of sections and the phrase structure. Comparing the durations of the segments created by these tone rows reveals intricate proportional structures. My analysis reveals that proportional structures play a significant role in Stravinsky's musical forms. I first examine *Three Songs from William Shakespeare* and *In Memoriam Dylan Thomas*; I then analyze *Canticum Sacrum* and draw conclusions about how its text and formal design are connected. In the course of my analysis, questions will arise regarding how the concept of exchange contributes to hearable designs in Stravinsky's music: Is it possible to hear intricate or long-range proportional structuring, and if so, how might one develop a sensitivity to it? This investigation of Stravinsky's formal process, viewed in terms of exchange and proportion, gives us new ways of understanding the composer's unique approach to serialism.

To elucidate Stravinsky's conception of form, I introduce the notion of "proportional exchange." Proportional exchange occurs when a proportion manifested between two segments can be found inverted elsewhere. The segments may occur in two different voices, or in two different sections. Because exchange requires two independent elements—such as two segments in two voices—proportional exchange usually occurs in contrapuntal music. Since Stravinsky employs contrapuntal technique frequently during his early serial period; this music is well suited to proportional exchange.

Stravinsky's music is also well suited to proportional exchange because of its pronounced discontinuity. Discrete sections are juxtaposed, with no transition between them. The impression of discontinuity is further heightened by the static character of these individual segments or sections. Repetitive pitch organization in a segment or a section produces harmonic stasis. The music's static character and discontinuities, together, make proportional exchange musically viable, that is, they highlight the boundaries of musical events which, in turn, encourage listeners to identify durational relationships between segments.<sup>5</sup>

Before undertaking specific analyses, it is necessary to consider the general nature of exchange and proportion. Exchange is an action, whereas proportion is a state. The former implies a change; the latter implies a static relationship. Exchange denotes giving and receiving, the replacement of one thing with another. Proportion, in contrast, denotes a comparison of measurable quantities. Thus proportional analysis requires



Example 1. Webern, *Kantata*, Op. 29, I, m. 36

a framework in which form is considered atemporally, as a static, spatial simultaneity.

Example 1 shows instances of voice-exchange from Webern's *Kantata*.<sup>6</sup> The kinetic element of exchange is the process of exchange itself, denoted in Example 1 by the unidirectional arrows. The static element of proportion is the balanced symmetry of the whole, as suggested in the visual notational representation, in which a horizontal and vertical "flip" leaves the pitch-class structure unchanged. Though both symmetry and exchange are manifested in this excerpt, symmetry takes precedence. The static, self-contained character it engenders overwhelms the kinetic quality of exchange. The analyses below further investigate how the concepts of exchange and proportion relate to each other, how one concept may override the other in a given context, and how this affects formal process in Stravinsky's music.

### Proportional Exchange And Formal Design

One of the most straightforward examples of proportional exchange in Stravinsky's music occurs between the two outer "Dirge-Canon" sections of *In Memoriam Dylan Thomas*. These two outer sections frame the central "Song." Figure 1 shows the construction in greater detail. Roman numerals indicate canons and Rs indicate ritornellos. There are two instrumental groups, trombones and strings. In the first "Dirge-Canon," each canon is played by the trombones, and each ritornello is played by the strings. In the second "Dirge-Canon," these assignments are reversed; the trombones play the ritornellos and the strings play the canons. The numbers beneath the Roman numerals and Rs indicate the duration of

	<i>Dirge-Canon</i>					<i>Song</i>	<i>Dirge-Canon</i>				
measure:	1	6	9	14	17	22	77	80	85	87	92
Trombones:	I	II		III			R	R		R	
	27(25)		27(25)		25		16	16(13)		18(13)	
Strings:	R		R				IV		V		
	16		16				27(25)		27(25)		

Figure 1. Form of *In Memoriam Dylan Thomas*

parts in quarter-note units. The numbers in parentheses are the durations up to the attack points of the following parts. For instance, the first ritornello enters two quarter notes before the first canon ends, so the parenthesized number, 25, is the duration of the first canon from its beginning until the entrance of the first ritornello.

A proportional exchange of durations occurs among the canon and ritornello parts of the first and second “Dirge-Canons.” Figure 1 shows a duration of 25 quarter notes (five  $5/4$  measures) for each canon, and a duration of 16 (two  $3/2$  measures and one  $2/2$  measure) for all but the final ritornello with a couple of adjusted values. While the actual canonic duration is 27 in some instances, I choose the parenthesized value 25 as I consider it to be the underlying structural unit. The final ritornello of 18 (rather than 16) reflects an elongation at the music’s close. Thus, every canon has the same length, as does every ritornello. Figure 2a shows the proportions for the total durations of canons and ritornellos in the first and second “Dirge-Canon.” When the number of canons and ritornellos is exchanged—three canons and two ritornellos occur in the first “Dirge-Canon,” and two canons and three ritornellos occur in the second “Dirge-Canon”—the proportion of durations exchange (Figure 2a). Naturally, proportional exchange also occurs between the instrumental groups (Figure 2b). The articulation of these proportional exchanges is supported by three factors: 1) fixed durations in each canon and ritornello; 2) exchange in the number of canons and ritornellos; and 3) correspondence of the number of instrumental groups. Together they make the structure of the two “Dirge-Canon” sections a convincing example of proportional exchange.

The first song of *Three Songs from William Shakespeare*, “Musick to heare,” is in five sections: an introduction in which only instruments play, and four vocal sections which correspond to the stanzas of the sonnet.<sup>7</sup> Four-note rows, <11 7 9 10>, are applied throughout this movement, and in the introduction (mm. 1–8) and the last section (mm. 44–50) the ordered diatonic pentachord <C D E F G> and its retrograde appear along

with the tone rows. Figure 3a shows the construction of this movement according to the numbers of sections, measure numbers, durations in eighth notes, metric structure, and tone-row structure.<sup>8</sup> The first and the fifth sections are closely related: they are the only two sections featuring the diatonic pentachords and, except for the additional tone-rows,  $R_3$  and  $I_2$  in the fifth section, their tone-row structures are identical. The second and fourth sections are also related, not only in terms of row structure (which is similar), but also in terms of metrical structure: in both sections  $3/8$  and  $4/8$  meters alternate regularly. Thus the first and the last sections correspond, as do the second and the fourth sections.

Comparing the duration of the sections in this movement, based on the similarities between the sections, reveals a proportional design. Sections 1 and 5 are in the proportion  $32 : 26$ , that is,  $16 : 13$ ; sections 2 and 4 are in the proportion  $46 : 32$ , that is,  $23 : 16$ ; sections 1 and 2 are in the proportion  $32 : 46$ , that is  $16 : 23$ .  $16 : 23$  is the inversion of the  $23 : 16$  proportion occurring between sections 2 and 4. Section 5, (which corresponds to section 1), and section 4, (which corresponds to section 2), is in the proportion  $26 : 32$ , that is  $13 : 16$ —again, the inversion of the  $16 : 13$  proportion which appeared between sections 1 and 5. Figure 3b (p. 233) summarizes these relationships. There are two sets of proportional exchange: sections 1 and 5 exchanging with sections 5 and 4, and sections 2 and 4 exchanging with sections 1 and 2.

The proportions in the first exchange pair are established by comparing symmetrically opposed sections, i.e. the corresponding sections (sections 1 and 5, and sections 2 and 4). The proportions in the second pair are established by the two pairs of adjacent sections. Two elements are

	<i>First</i>		<i>Second</i>			
Canon	75	:	50	=	3	: 2
Ritornello	32	:	48	=	2	: 3

Figure 2a. The proportions of the canons and ritornellos between the first and second “Dirge-Canons” in *In Memoriam Dylan Thomas*

	<i>First</i>		<i>Second</i>			
Trombones	75	:	48	=	25	: 16
Strings	32	:	48	=	16	: 25

Figure 2b. The proportions in the instrumental groups between the first and second “Dirge-Canons” in *In Memoriam Dylan Thomas*

section	measures	duration	metric structure	tone-row structure*
1	1-8 (8)	32	eight 4/8 measures	Fl. P <sub>11</sub> , I <sub>8</sub> , P <sub>11</sub> , I <sub>11</sub> , P <sub>2</sub> , I <sub>11</sub> Cl. diatonic pentachord Va. diatonic pentachord
2	9-21 (13)	46	4/8 and 3/8 appear alternately  seven 4/8 measures six 3/8 measures	Vo. P <sub>11</sub> , I <sub>8</sub> , P <sub>11</sub> , I <sub>11</sub> , P <sub>2</sub> , I <sub>11</sub> Fl. P <sub>3</sub> , P <sub>3</sub> , I <sub>5</sub> , P <sub>8</sub> Cl. P <sub>5</sub> Va. I <sub>0</sub> , I <sub>2</sub>
3	22-34 (13)	45	two 4/8 measures and two 3/8 measures appear alternately  six 4/8 measures seven 3/8 measures	Vo. P <sub>11</sub> , I <sub>8</sub> , P <sub>11</sub> , R <sub>11</sub> , P <sub>1</sub> , P <sub>0</sub> , P <sub>11</sub> , I <sub>8</sub> Fl. P <sub>7</sub> , P <sub>7</sub> Cl. I <sub>6</sub> , P <sub>7</sub> Va. R <sub>13</sub> , I <sub>4</sub> , I <sub>6</sub>
4	35-43 (9)	32	4/8 and 3/8 appear alternately  five 4/8 measures four 3/8 measures	Vo. P <sub>11</sub> , I <sub>8</sub> , P <sub>11</sub> , I <sub>10</sub> , I <sub>1</sub> Fl. I <sub>6</sub> Cl. P <sub>8</sub> , I <sub>6</sub> , P <sub>8</sub> Va. I <sub>5</sub> , P <sub>9</sub>
5	44-50 (7)	26	no pattern  five 4/8 measures two 3/8 measures	Vo. P <sub>11</sub> , I <sub>8</sub> , P <sub>11</sub> , I <sub>11</sub> , P <sub>2</sub> , R <sub>3</sub> , I <sub>11</sub> Fl. I <sub>2</sub> Cl. diatonic pentachord Va. diatonic pentachord

\*The alignment of row names reflects their relative position. For example, at the close of section 4, P<sub>8</sub> occurs slightly after I<sub>1</sub>.

Figure 3a. The sections in "Musick to heare" from  
*Three Songs from William Shakespeare*

necessary for the proportional exchanges appearing in these pairs to be realized: the same duration in sections 1 and 4—that is, 32 eighth notes—and the similarity in the character of the first and last sections, and the second and fourth sections (as mentioned above).

The Dirge-Canon and Shakespeare song examples represent instances of proportional exchange which appear between the outer sections of a movement. These examples foster large-scale formal balance. Moreover, in both examples, as in the voice-exchange example of Webern, the static aspect of proportion predominates over its kinetic aspect.

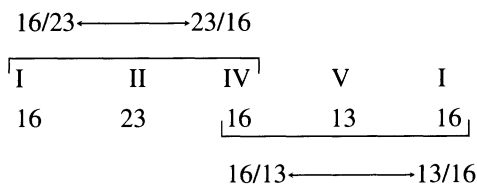


Figure 3b. Proportional structure in “Musick to heare” from *Three Songs from William Shakespeare*

### Proportional Exchange Between Voices And Compositional Procedure

The fourth movement of *Canticum Sacrum* consists of three sections, each of which features proportional exchange. The manner of their appearance and their ratios are different in each section. The second section is a canon while the first and the third sections consist of a baritone solo and two other layers. The tone row employed through this movement is the same as the one in the third movement,  $\langle 9\ 8\ 10\ 0\ 1\ 11\ 4\ 3\ 6\ 2\ 5\ 7 \rangle$ . In each section the assigned text can be divided into two large parts, and the tone rows support these divisions. These features set up the proportional exchange that occurs.

Example 2 shows section 1, which consists of three layers: baritone solo, chorus, and instrumental long notes. This section divides into two parts according to the text division. Both parts begin with an instrumental prelude (mm. 250–54, and mm. 262–65). The prelude to part 2 begins at the exact center of the section. Thus, both the first and second parts have the same duration: 60 eighth notes. Although the meter changes, the tempo is stable, so the clock-time durations are also equivalent.

In section 1, the baritone solo is echoed by the chorus. As shown in Example 2,  $P_9$  is used for the baritone solo and its echo in part 1. In part 2,  $R_9$  is used for the baritone solo and its echo. Part of the pitch organization of parts 1 and 2 is thus palindromic. The first segment in part 1 (mm. 254–57), sung by the solo baritone, is named X1 on Example 2 and the echo of this segment, sung by the chorus from mm. 257 to 258, is named X1'; subsequent baritone statements are labeled Y1, Y2, and X2, with corresponding echoes Y1', Y2', and X2'. Y2 and Y2' are so named because they include retrograde statements of the last four pitch classes in Y1 and Y1'. Another layer, Z, consists of instances of a single pitch class played by the trumpet or trombone. The attack-points of these pitch classes coincide with the last note of each baritone solo segment. For example, at Z1 (m. 256) the trumpet joins the last note in the baritone solo,  $D\flat_4$ , and remains on that note through half of m. 259. The second segment in this layer (shown as Z2) consists of the trombone G3 from m.



# Part 1

250

Baritone solo

Chorus

Bass I/Trumpet I

Bass II/Trumpet II

Viola

Cel./Trb.

254

Bar. solo

Chorus

Bass I/Trumpet I

Bass II/Trumpet II

Vla.

Cel./Trb.

258

Bar. solo

Chorus

Bass I/Trumpet I

Bass II/Trumpet II

Vla.

Cel./Trb.

W1

X1

X1'

Z1

Y1

Y1'

Z2

p

f

mf

p9

pizz

f

poco

sus

au - tem a ri il li:

au - tem a ri il li:

Example 2. *Canticum Sacrum* IV, section 1, mm. 250–73

260 to the first eighth note of m. 262; Z3 and Z4 follow as shown. The instrumental prelude and interlude are named W1 and W2 respectively.

Example 3 is a proportional graph of section 1.<sup>9</sup> The numbers in parentheses give the lengths from the initial attack point to the terminal release point of each segment in eighth-note units. The number shown above or below a brace indicates the length between the attack point of a segment and the attack point of another segment in a different layer. For

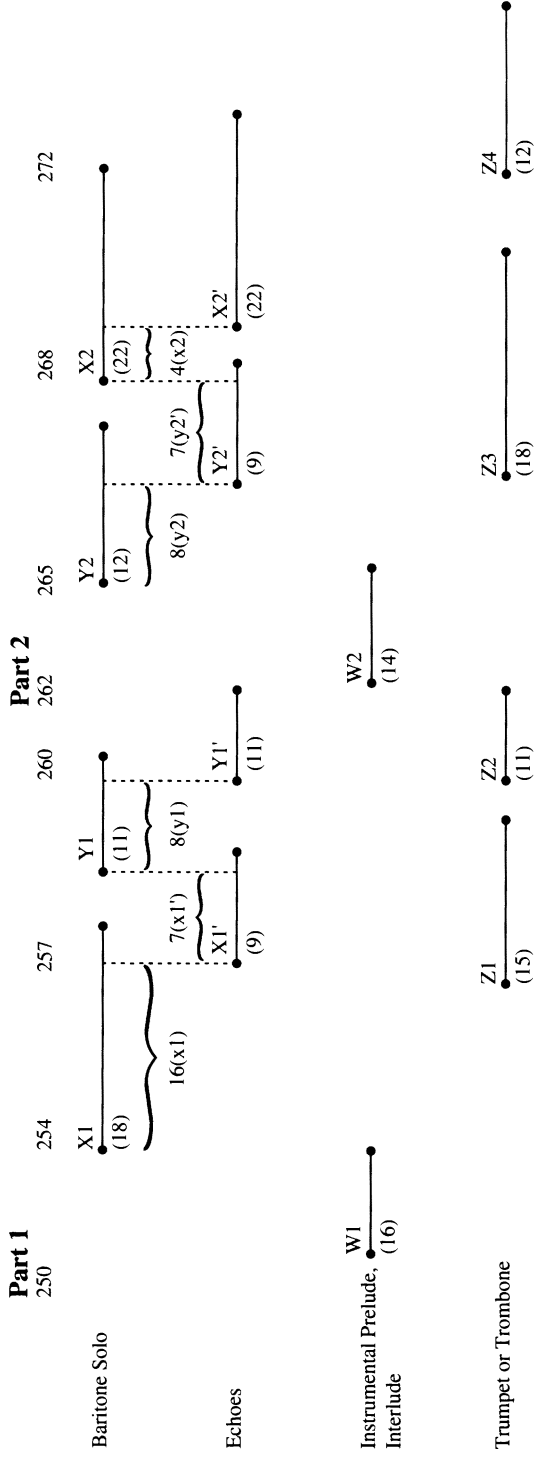
**Part 2**

The musical score for Part 2 consists of three systems of staves. The first system (measures 262-265) shows the Baritone solo and Chorus parts. The Chorus part has lyrics: "Si po - tes". The second system (measures 266-269) continues the vocal parts with lyrics: "cre - de - re, om - ni - a pos - si -". The third system (measures 270-274) shows the vocal parts with lyrics: "bi - li - a sunt cre - den - ti. pos - si bi - li - a sunt cre - den - ti." The score includes various musical markings such as "I5", "W2", "Y2", "R9", "X2", "Z3", and "Z4".

Example 2 (continued)

instance, before segment X1 ends, its echo, segment X1', begins; thus X1 has a duration of 16 eighth notes from the initial attack point of X1 to the entrance of X1'. Attack points that overlap with other segments are shown by vertical dotted lines.

Figure 4a (p. 238) summarizes these significant proportional relationships between parts 1 and 2. The proportion of Z1 to Z2 in part 1 is close to the proportion of Z3 to Z4 in part 2. The second segment and its echo



in part 1, Y1 and Y1', have the same length, duration 11, as do the second segment and its echo in part 2, X2 and X2', namely, 22.<sup>10</sup> In Example 3, numbers presented under the braces reveal another significant similarity between parts 1 and 2. The duration from the attack point of X1 to the attack point of X1' is 16 (labeled x1), and the duration from the attack point of Y1 to the attack point Y1' is 8 (labeled y1). The proportion of x1 to y1 is 2 : 1. The duration between the attack points Y2 and Y2' (labeled y2) is 8, and between the attack points X2 and X2' (labeled x2) is 4; thus the proportion of y2 to x2 is also 2 : 1. Therefore, in both parts 1 and 2, the proportion of the baritone solo segments, until the attack points of their echoes, is 2 : 1. Further, the first echo segments of parts 1 and 2 indicate parallel construction: both x1' and y2' comprise durations of 7 eighth notes. So two segments with identical durations, x1' and y2', are placed between the two segments, x1 and y1, and y2 and x2, whose proportions are 2 : 1.

Comparison of corresponding segments reveals another significant structural relationship between parts 1 and 2. The proportion of the first baritone solo sections, x1 to y2, is 2 : 1. The same proportion can be found between y1 and x2, the second baritone solo sections. The duration of y1 is 8 and the duration of x2 is 4, so the proportion of y1 to x2 is also 2 : 1. On the other hand, the proportion of Y1 (in part 1) to X2 (in part 2) is 11 : 22, that is, 1 : 2. Since Y1 and Y1' both have duration 11, and since X2 and X2' both have duration 22, the proportion of Y1' to X2' is also 1 : 2. Figure 4b summarizes the proportions of the corresponding segments in parts 1 and 2.

Independent of the correspondences between parts 1 and 2 shown in Figure 4a, proportional exchange occurs between segments within these parts, as Figure 4b shows, that is, the first and second segments of the baritone solo until the attack points of their echoes in part 1 are twice as long as the corresponding segments in part 2, while the second segment and its echo in part 1 are half the length of the corresponding segments in part 2. Interestingly, the proportional exchange does not appear between the segments which are related palindromically. Rather, the proportional exchange occurs between the segments which are formally parallel. Several elements are essential for the intricate proportional structure in the durations of segments in this section: the construction with the baritone solo followed by its echo by the chorus, the length of each segment, and the points where each segment in a voice begins. These elements set up the proportional relationships shown in Figure 4a which in turn set up the proportional exchange.

Section 3 (mm. 281–306) presents a slightly different manifestation of proportional exchange, though the segmental construction is very similar. As in section 1, there are three layers in section 3: X, Y, and Z. Example 4 (p. 240) labels the layers and the rows. Layer X is the baritone solo

part 1	part 2
$Z1 : Z2 = 15 : 11 \approx 3 : 2$	$Z3 : Z4 = 18 : 12 = 3 : 2$
$Y1 : Y1' = 11 : 11 = 1 : 1$	$X2 : X2' = 22 : 22 = 1 : 1$
$(X1 : X1' = 18 : 9 = 2 : 1)$	$(Y2 : Y2' = 12 : 9 = 4 : 3)$
$x1 : y1 = 16 : 8 = 2 : 1$	$y2 : x2 = 8 : 4 = 2 : 1$
$x1' = 7$	$y2' = 7$

Figure 4a. Proportions of part 1 and part 2 in section 1 in the fourth movement of *Canticum Sacrum*

Part 1		Part 2		
x1 (16)	:	y2 (8)	=	2 : 1
y1 (8)	:	x2 (4)	=	2 : 1
Y1 (11)	:	X2 (22)	=	1 : 2
Y1'(11)	:	X2'(22)	=	1 : 2

Figure 4b. Proportions of corresponding segments in part 1 and part 2 in section 1 of the fourth movement of *Canticum Sacrum*

part and can be divided into three segments—X1, X2, and X3—because of the rests. Similarly, layer Y, in which the trombones play, consists of three segments, Y1, Y2 and Y3. Layer Z, in which only D3 is played by the viola and contrabass, has two segments, Z1 and Z2. This section is divided into two parts at the double bar between m. 294 and 295. This division matches the division of the text between “credo, Domine” and “adjuva, incredulitatem meam.” The metric organizations between parts 1 and 2 are similar: four 3/4 measures, one 2/4 measure, and one 5/8 measure, appearing in that order, followed by 3/4 measures (seven for part 1 and six for part 2). Unlike section 1, this section is unevenly divided; the first part lasts for a duration of 101 eighth notes, the second for 69 eighth notes. Although the durations in eighths is unequal, the duration in seconds is nearly equal. At the double bar the tempo changes from quarter note equals M.M. 88 to quarter note equals M.M. 60; both parts are about 34 seconds long. Because of the tempo change at the double bar, the proportional exchange based on duration in eighth-notes is not valid for duration in seconds. The following analysis, however, reveals that the proportional exchange based on notated rhythmic values nonetheless provides significant insights.

Proportional exchange occurs in the main part of this section between mm. 282 and 303, after X1 and before Y3. The text for the X1 segment,

the first segment of the baritone solo, is the same as that for the second half of the previous section. The text repetition provides a transition from the previous section and sets off X1 as an introduction to section 3, rather than as the beginning of its main part. In Y3, the oboe, bassoons, and organ play, whereas in the other Y segments only the trombones play. This is the first time that the organ appears in this movement; its appearance anticipates the next movement. Thus Y3, like X1, is set off from the main part of section 3. The setting off of X1 and Y3 is supported by the pitch construction. A different tone row is assigned to each segment except for Z1 and Z2, which are ostinato segments.  $R_{11}$  is assigned to X1,  $P_7$  to X2, and  $I_7$  and its retrograde to X3.  $P_7$  has three invariant subsets with  $I_7$ , but not with  $R_{11}$ .<sup>11</sup> Hence X1, which uses  $R_{11}$ , is set apart from X2 and X3. In layer Y,  $R_2$  is assigned to Y1,  $RI_2$  to Y2, and  $P_7$  to Y3. As with the segments in layer X,  $R_2$  has three invariant subsets in common with  $RI_2$ , but none with  $P_7$ .<sup>12</sup> So Y3, like X1, is set apart from the other segments in its layer.

Example 5a (p. 242) is a proportional graph for section 3.<sup>13</sup> Proportional exchange appears between X and Y layers. The durational proportion of Y1 : Y2 is 5 : 3 (45 : 27). The proportion of X2 until the attack point of Y2 (labeled x2) and X3 until the attack point of Y3 (labeled x3) is about 3 : 5 (32 : 53). Hence the proportion 3 : 5 occurs in layer X, while its inverse proportion, 5 : 3, occurs in layer Y in the main part of section 3.<sup>14</sup> The following considers the formal significance of this proportional exchange.

Although the organization of voices resembles that of section 1, some adjustments to entrances of the segments in layer Y take place in section 3. As in section 1, where layer Z always picks up the last note of each segment in layer X, in section 3, layer Y picks up the last note of layer X, the baritone solo, as shown in Example 4. The attack point of the first segment in layer Y, Y1 in tenor trombone I, picks up the last note, B3, of X1 in m. 281. However, the same pitch as the last note (F3) of the second baritone solo segment (on the last beat of m. 290) does not occur until m. 292, played by the bass trombone, 8 eighth notes later than the initial attack point of the last note in X2. In fact, Y2 starts from m. 290 with three other notes, E3 and A3 played by the contrabass trombone and F#3 played by the bass trombone, before the bass trombone picks up the pitch F3 from X2 at measure 292.

Furthermore, considering that the pulse is a quarter note, Y2 enters one eighth note earlier than expected. This relates to the retardation at the end of X2 and the beginning of Y2 (mm. 289–91). There are three groups formed with three notes that have longer note values in each successive group. The first group consists of the quarter-note triplet at m. 289 to which the text “credo” is assigned. The second group consists of the quarter notes from the last beat of m. 289 to the second beat of m. 290, to

[illegible]

Example 4. *Canticum Sacrum* IV, section 3, mm. 281–306

which the first two syllables of the text “Domine” are assigned. Before the word “Domine” ends, the trombones begin to play another three-note group. This three-note group consists of dotted quarter notes. The adjustment for the entrance of Y2, namely that segment Y2 enters an eighth note earlier than expected, is necessary for the retardation at the end of part 1.

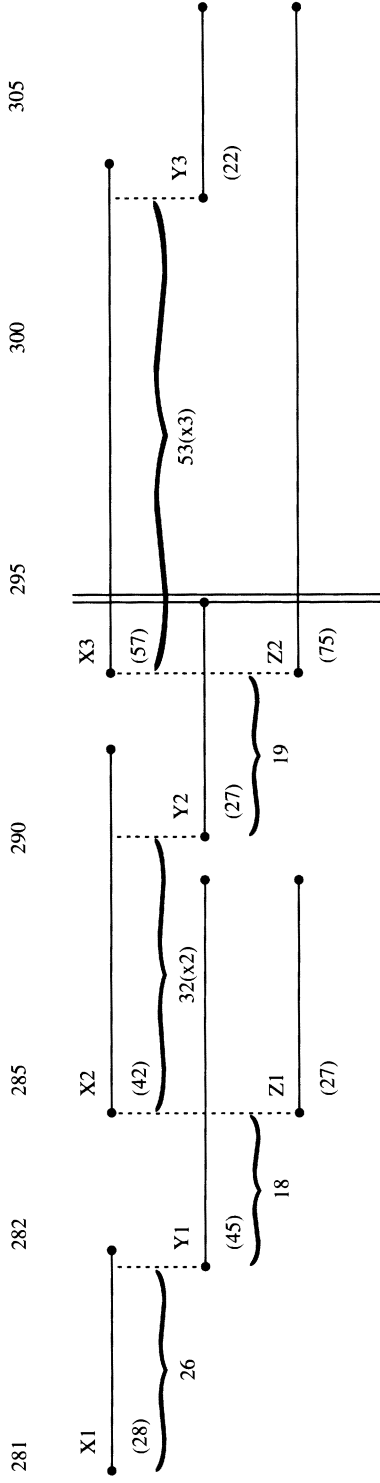
A similar situation occurs with the entrance of the third segment in layer Y. Y3 picks up the last note of X3, G3 in the organ, at m. 303. However, the oboe has already begun Y3 two eighth notes before the organ enters.<sup>15</sup> Because X3 is the longest among the X segments (57 eighth notes), two tone rows, I<sub>7</sub> and RI<sub>7</sub>, are assigned to it. The last three notes of RI<sub>7</sub> (G<sup>b</sup>, A<sup>b</sup>, G) are also the first three notes of P<sub>7</sub> in Y3. The entrance of Y3 two eighth notes early thus underscores the overlap between the end of RI<sub>7</sub> and P<sub>7</sub>. To summarize, for both entrances of the segments in layer Y, Y2 and Y3, some adjustments occur: Y2 enters an eighth note early and Y3 enters two eighth notes early.

Example 5b is a hypothetical proportional graph omitting the adjustments of the attack points of segments in layer X. As shown by asterisks in Example 5b, the assumed duration of x2 becomes 33, and that of x3 becomes 55. Compare these values with the notated durations shown in Example 5a of 32 and 53 for x2 and x3 respectively. The assumed numbers show an exact ratio, 33 : 55, or 3 : 5. Since the discrepancy between the assumed proportion of 3 : 5 and the notated proportion of 32 : 53 is small, I regard the proportional exchange as not affected by the adjustments. For this reason I present the assumed proportional graph (Example 5b) to support my contention that proportional exchange is an essential element of the formal construction in this section.

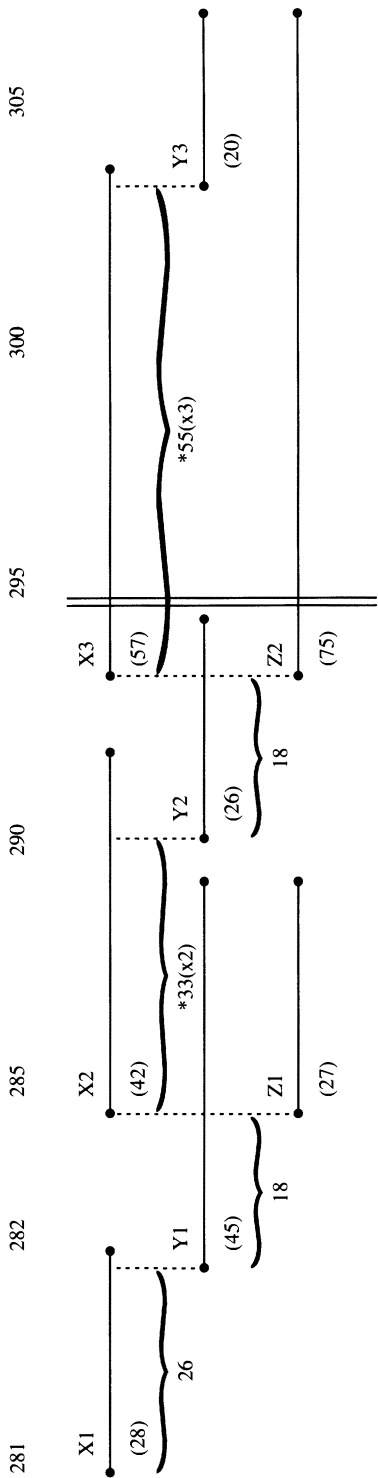
Example 6 (p. 244), the second section of the fourth movement of *Canticum Sacrum*, shows another example of proportional exchange in a four-voice choral canon (mm. 274–80). Like the other sections of this movement, the text can be divided into two parts: “Et continuo exclamans pater pueri,” and “cum lacrimis aiebat.” Example 7a (p. 246) is a proportional graph showing the major attack points of segments: “et,” “cum,” “pater,” “lacrimus,” and “aiebat.” These words or parts of words are also shown on the graph. The vertical lines are the notated bar lines. The numbers above the words indicate the duration (in eighth notes) from the attack points of these words to the following words. Since a syncopated rhythm is a basic feature of this passage, in the graph the attack point of “cum” in the tenor at m. 276 is indicated on the initial downbeat of the measure instead of on the second beat, considering that the quarter rest is a part of the syncopated rhythmic unit but augmented. Similarly, the attack point of “pater” in the alto at m. 278 also appears on the initial downbeat in the graph.

The proportional graph shows that during the first three measures of this section (mm. 274–76) the attack points match metrically strong





Example 5a. *Canicum Sacrum* IV, section 3, proportional graph



Example 5b. *Canticum Sacrum* IV, section 3, an alternative proportional graph

274 Più agitato,  $\text{♩} = 96$

Discanti

Alti

Tenori

Bassi

*più tosto f e risoluto*

**R17** Et con - ti - nu - o ex - cla - mans pa - ter pu - e - ri,

**R2** Et con - ti -

**14** Et con - ti -

276 *più tosto f e risoluto*

D.

A.

T.

B.

**P2** Et con - ti - nu - o ex -

nu - o ex - cla - mans pa - ter, pa - ter pu - e - ri,

cum la - cri - mis, cum **17**

nu - o ex - cla - mans pa - ter pu - e - ri, cum

278 Doppia mente lento,  $\text{♩} = 96$

D.

A.

T.

B.

cla mans pa - ter pu - e - ri, cum la - cri - mis ai - e - bat: *poco*

pa - ter pu - e - ri, cum la - cri - mis ai - e - bat: *poco*

la - cri - mis, la - cri - mis ai - e - bat: *poco*

la - cri - mis ai - e - bat: *poco*

**P7**

Example 6. *Canticum Sacrum* IV, section 2, mm. 274–80

beats. Thus the 4/4 metric structure is regular in these three measures. Metric irregularities begin to occur from m. 277 onward, because the entrance of the discanto part is one quarter note later than the listener's expectation. As shown in Example 6, the tenor part supports the discanto by employing the same syncopated rhythm at m. 277. The second and the third syllables of the word "lacrimis" ("crimis") and "cum" are assigned to this rhythm. This delayed discanto entrance affects the attack points of

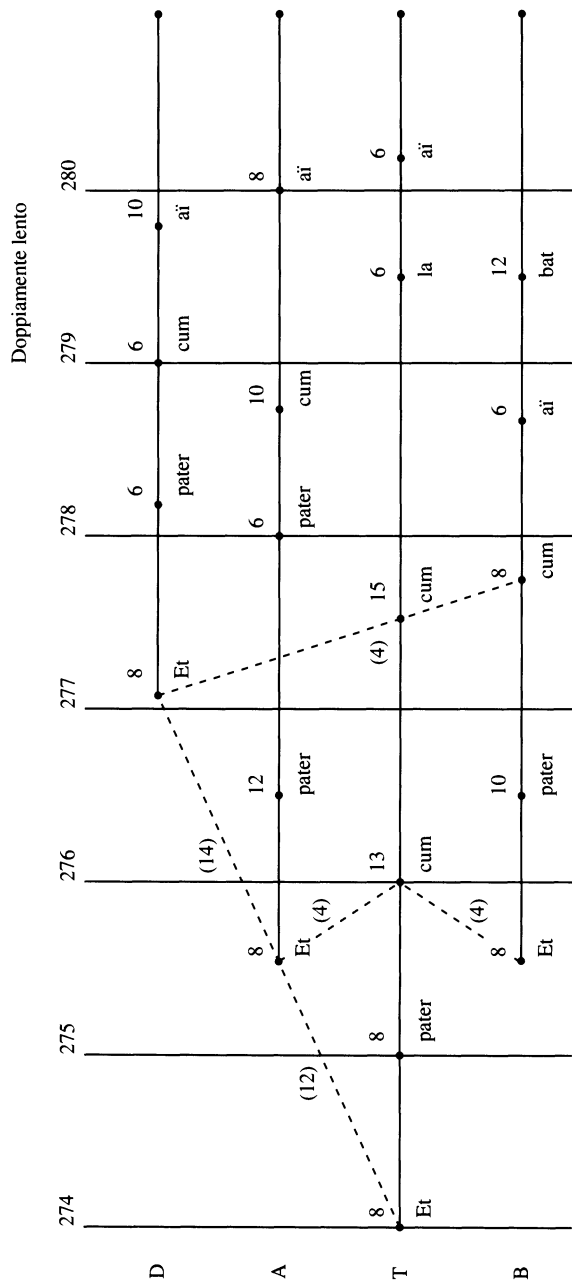
the word “pater” in the same voice at m. 278 and “cum” in the bass at m. 277; that is, the duration between the attack points “et” and “pater” in the same voice is always 8. Thus, the attack point of “pater” in the discanto comes on the second beat of m. 278, instead of on the initial down-beat of the measure. Also, as the duration between “et” in the alto and bass in m. 275 and “cum” in the tenor at m. 276 is 4, the duration between “et” in the discanto and “cum” in the bass is also 4. The attack point of “cum” in the bass, therefore, comes on the fourth beat in m. 277. Accordingly, unlike the first three measures of this section, the attack points of these segments, such as “et” and “pater” in the discanto and “cum” in the bass, fall on metrically weak beats.

Example 7b is a proportional graph that indicates the attack points of the first and second parts. A proportional exchange occurs between the alto and the bass; the proportion 18 : 26 in the alto exchanges with the proportion 26 : 18 in the bass. There is another proportional exchange between the discanto and tenor. The discanto values are 14 and 16, as compared with tenor values of 16 and 13. A metric adjustment affects the tenor’s durations. The “cum” in the tenor at m. 277 appears an eighth note earlier than “cum” in the bass, because the syncopated rhythm in the tenor reinforces the delayed entrance of the discanto as mentioned earlier. Because of this adjustment, the proportional exchange between discanto and tenor is not numerically exact (14 : 16 exchanges with 16 : 13). As in section 3 (Examples 4 and 5), the proportional exchanges occurring in section 2 are based on durations in notated rhythmic values, and not on duration in seconds because the tempo changes in the last two measures (mm. 279–80).

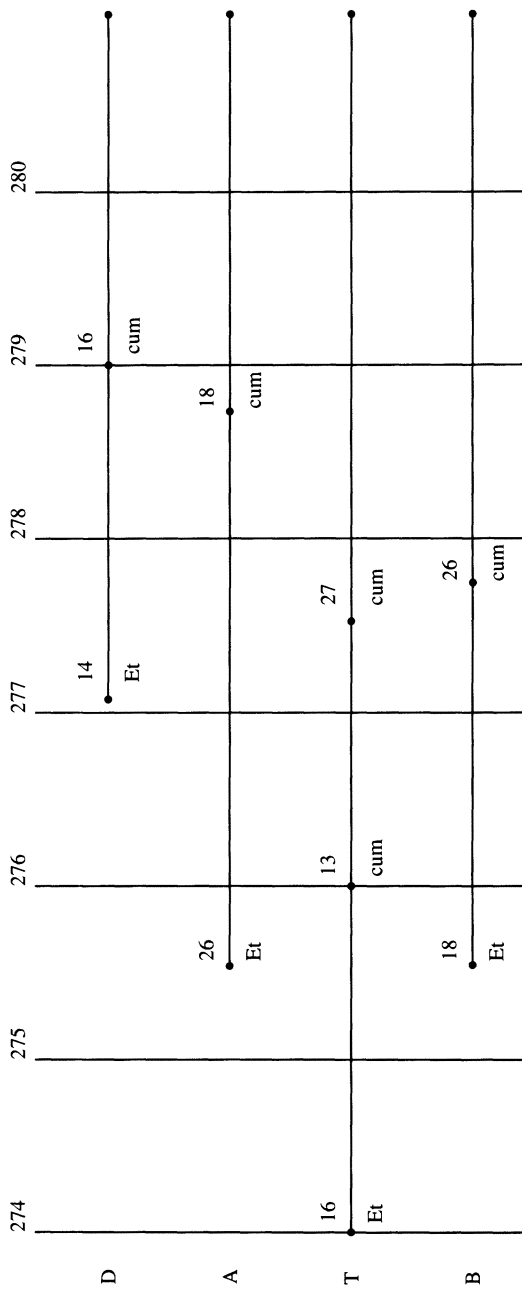
In section 2, both of the proportional exchanges involve not only an exchange between the proportion of segments in a pair of voices, but also an exchange of the durations themselves. Since the durations exchanged are in a 1 : 1 relation, this example of proportional exchange is similar to the earlier example of voice-exchange in Webern (Example 1). Therefore, the proportional exchanges in this section suggest an element of symmetry more strongly than the aforementioned examples (*Canticum Sacrum* IV, section 1: Example 3 and section 3: Example 5).

### Proportional Exchange And Text-Setting

The following discussion of the *caritas* section of the third movement of *Canticum Sacrum* considers in detail how text and proportional structure can be related. This movement consists of three sections: *caritas*, *spes*, and *fides*. The *caritas* and *fides* sections are similar; both of their second parts employ canon. The proportional exchanges that are strongly affected by the text setting occur in the canon part of the *caritas* section (mm. 116–29). Example 8 (pp. 248–49) shows the canon and the row structure. This section is repeated with different text (mm. 116bis–29bis).



Example 7a. *Canticum Sacrum IV*, section 2, proportional graph



Example 7b. *Canticum Sacrum* IV, section 2, proportional graph showing the attack points of “et” and “cum”

Example 8. *Canticum Sacrum* III, the *caritas* section, mm. 116–29 and mm. 116bis–29bis

The musical score is presented in three systems. The first system (mm. 116–119) features Tenors (TENORI), Alto (ALTI), and Basses (BASSI). The lyrics are: "Di - li - ges Do - mi - num De - um". The second system (mm. 120–124) continues the text: "Di - li - ges Do - mi - num De - um tu - um ex to - mi - num De - um tu - um ex to - ta a - ni - ma tu - tu - um ex to - to cor - de tu - o. Di - li - ges". The third system (mm. 125–129) concludes with: "ta for - ti - tu - di - ne tu - a. a. Di - li - ges Do - mi - num De - um tu - um. Do - mi - num De - um tu - um." The score includes various musical markings such as *f*, *canti - num*, *R4*, *RI 11*, *RI 10*, *DISC. 120*, *I 10*, *P4*, and *I 11*.

Example 8. *Canticum Sacrum* III, the *caritas* section, mm. 116–29 and mm. 116bis–29bis

Though the difference between the first canon and its repetition may at first appear to be limited to the text, it actually involves the formal design.

Figure 5a shows the text assigned to the first canon (mm. 116–29) and the distribution of the text among the three canonic voices. The first part of the text, “Diliges Dominum Deum tuum,” is assigned to the beginning of each voice; at the end of the tenor and the alto parts this part of the text is repeated. The second part of each voice starts with “ex” (omitting “et”

The musical score is divided into three systems, each with three staves (A, T, D) and lyrics below.

**System 1:**

- Staff A:** Melody starting at 116bis, 117bis, 118bis, 119bis. Includes a circled  $R_4$  and a circled  $(b)$ . Lyrics: "...qui - a cha - ri - tas ex".
- Staff T:** Tenor part. Lyrics: "Di - li - ga - mas nos in - vi - - cem, qui - a cha - ri - tas ex".
- Staff D:** Discanto part. Includes row labels  $RI_{11}$  and  $RI_{10}$ .

**System 2:**

- Staff A:** Melody starting at 120bis, 121bis, 122bis, 123bis, 124bis. Includes a circled  $R_4$  and a circled  $(b)$ . Lyrics: "...et om - nis..... qui di - - li - git, ex De - o na - - - tus".
- Staff T:** Tenor part. Lyrics: "ri - tas ex..... De - o est; et om - nis qui di - - li - git ex...".
- Staff D:** Discanto part. Includes row labels  $RI_1$  and  $I_{10}$ .

**System 3:**

- Staff A:** Melody starting at 125bis, 126bis, 127bis, 128bis, 129bis. Includes a circled  $P_4$  and a circled  $(b)$ . Lyrics: "est, et..... cog - nos - cit De - - - - um.....".
- Staff T:** Tenor part. Lyrics: "De - o..... na - tus est, et cog - nos - cit De - - - - um,.".
- Staff D:** Discanto part. Lyrics: "est, et cog - nos - cit De - - - - um.....".

Example 8. (continued)

in the original text). “Ex toto corde tuo,” “ex tota anima tua,” and “ex tota fortitudina tua” are assigned to the tenor, alto, and discanto respectively. Thus, with respect to the text, the tenor and the alto can be divided into three parts, and the discanto into two parts. The row structure in this canon closely corresponds to the division of the text. In both tenor and alto, up to the points where the repetition of “Diliges” begins, the same rows appear twice:  $RI_{11}$  for the tenor, and  $R_4$  for the alto. At the point where the



Diliges Dominum Deum tuum ex toto corde tuo, et ex tota anima tua, et ex tota fortitudine tua. (*Vulgata, Deuter., VI:5*)

Tenor: Diliges Dominum Deum tuum ex toto corde tuo,  
Diliges Dominum Deum tuum.

Alto: Diliges Dominum Deum tuum ex tota anima tua,  
Diliges Dominum Deum tuum.

Discanto: Diliges Dominum Deum tuum ex tota fortitudine tua.

Figure 5a: The text in the *caritas* section of *Canticum Sacrum III*  
(mm. 116–29)

Diligamus nos invicem, quia charitas ex Deo est; et omnis qui diligit ex Deo natus est, et cognoscit Deum. (*Vulgata, Prima Epistola Beati Joannis Apostoli, IV: 7*)

Tenor: Diligamus nos invicem, quia charitas ex Deo est;  
et omnis qui diligit ex Deo natus est, et cognoscit Deum.

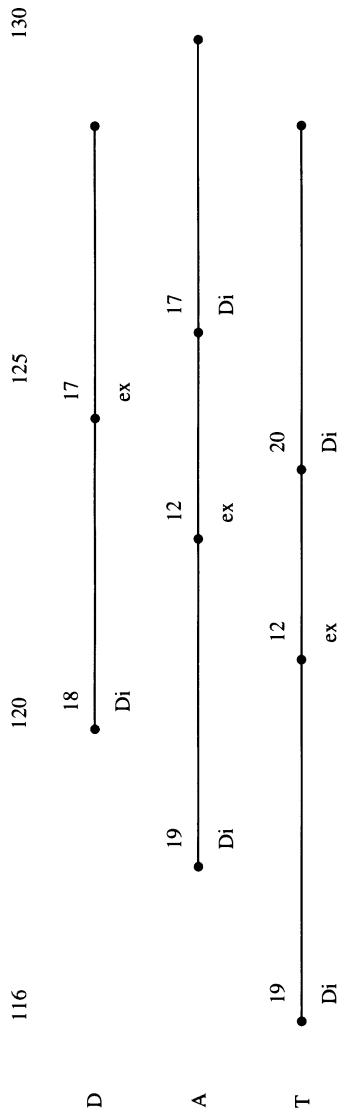
Alto: quia charitas ex Deo est;  
et omnis qui diligit ex Deo natus est, et cognoscit Deum.

Discanto: et omnis qui diligit ex Deo natus est, et cognoscit Deum.

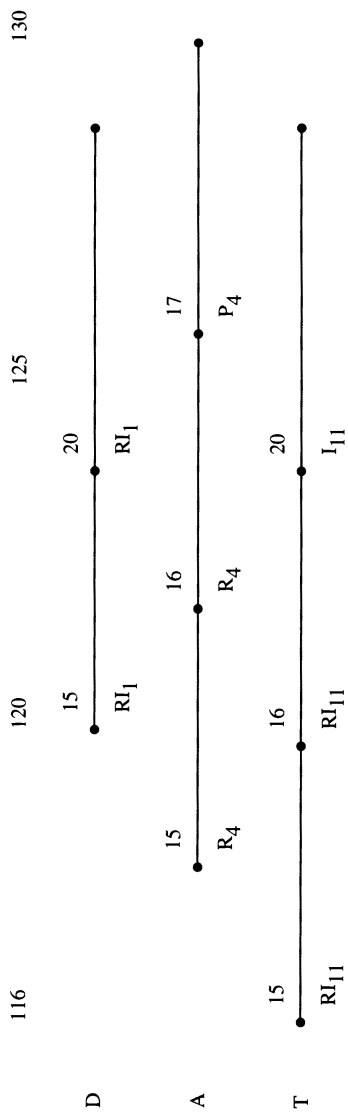
Figure 5b: The text in the *caritas* section of *Canticum Sacrum III*  
(mm. 116bis–29bis)

repetition for “Diliges” starts, their non-retrograde forms appear:  $I_{11}$  for the tenor and  $P_4$  for the alto. In the discanto  $RI_1$  appears twice.

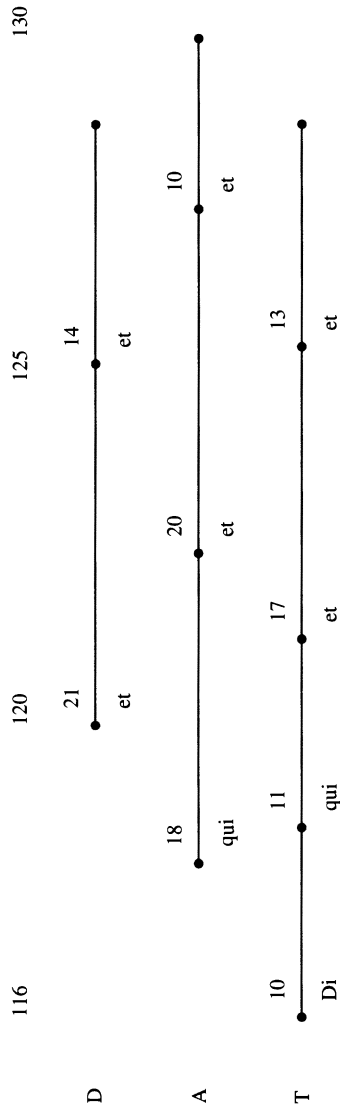
The proportional relationships between the text and rows is quite clear. Example 9a shows that the tenor and the alto last a duration of 19 quarter notes until the phrase with “ex” starts, and then last 12 quarter notes until the repetition of “Diliges.” Thus, the tenor is divided into  $19 + 12 + 20$ , the alto into  $19 + 12 + 17$ . The discanto lasts 18 quarter notes until the text with “ex” starts; it is divided into  $18 + 17$ . Example 9b shows another proportional graph according to the row structure. In both tenor and alto, the segments with the retrograde forms ( $RI_{11}$  for the tenor and  $R_4$  for the alto) last a duration of 31 quarter notes, whereas the non-retrograde forms last a duration of 20 for the tenor ( $I_{11}$ ) and 17 for the alto ( $P_4$ ). Comparing Examples 9a and 9b reveals that the points where the retrograde forms turn to non-retrograde forms coincide with the points where the text repeats (starting with “Diliges”). In the tenor, the text before the repetition lasts 31 quarter notes, as does the  $RI_{11}$  row form. The text repetition



Example 9a. *Canticum Sacrum* III, the *caritas* section, mm. 116–129, proportional graph according to the text division



Example 9b. *Canticum Sacrum* III, the *carias* section, mm. 116–129, proportional graph according to the tone-row structure



Example 9c. *Canicum Sacrum* III, the *caritas* section, mm. 116–129 bis, proportional graph according to the text division

occupies 20 quarter notes, as does the  $I_{11}$  row form. Similarly, the text before the repetition lasts 31 quarter notes as does the  $R_4$  row form; the rest of the text and the  $P_4$  segment last 17 quarter notes alike. Only in the discanto is the proportion of text and row divisions dissimilar: the former is 18 : 17 and the latter is 15 : 20. Thus, in the first canon of *caritas*, the proportion between the two segments according to text division corresponds to that of the tone-row division in the tenor and alto parts.

In the second canon (mm. 116bis–29bis), the text and row proportions differ. Figure 5b (p. 250) shows the text assigned to the second canon and the distribution of the text to its three voices. Unlike the first canon, in the second the entire sentence is assigned to the tenor, the sentence from the second phrase to the end is assigned to the alto, and the sentence from the third phrase to the end is assigned to the discanto. There is no text repetition in any of the voices. The text assigned to the second canon can be divided into two large segments at the semicolon: “Diligamus . . .” and the second phrase starting with “et omnis. . .” Example 9c shows a proportional graph indicating the attack points of the beginning of text phrases. According to these divisions, the tenor durations are 21 and 30 quarter notes; the alto durations are 18 and 30.

Because only the text differs in the second canon, its proportional graph according to row structure is the same as that of the first canon (Example 9b). However, comparison of Examples 9b and 9c discloses proportional exchanges in the second canon not found in the first. In the tenor, while the proportion between the first and second text segments (Example 9c) is 21 : 30, the row proportion is 31 : 20 (Example 9b). In the alto, the text proportion is 18 : 30 while the row proportion is 31 : 17. In the discanto, a text proportion of 21 : 14 exchanges with the row proportion of 15 : 20. In every voice of this canon, therefore, the proportion between the two large segments according to text divisions exchanges with that between the segments according to the row divisions.<sup>16</sup>

The two different realizations of proportional structure in the two *caritas* canons give to text setting a pronounced formal role. In the first canon, the proportion based on the text division and that based on the tone-row division are parallel, while in the second canon the proportion based on the text division exchanges with that based on the tone-row division. The realization of proportional exchange in the second canon is unlike our earlier examples, because it depends on the superimposition of two proportional structures. This allows for the voice in the second canon to be divided in two different ways.

The audible difference between the two canons does not rely only on their dissimilar proportions. The syllabic organization audibly differs. The text assigned to both first and second canons has 37 syllables. About the same number of syllables is assigned to each alto and discanto: 28 syllables for the alto in both canons, and 20 syllables for the discanto in the

first canon and 19 for the discanto in the second canon. By contrast, 27 syllables are assigned to the tenors in the first canon and 37 syllables are assigned in the second canon. So the audible difference between these two canons might more depend on these surface, textual differences than on the occurrence of the proportional exchange. Indeed, the proportional differences between the canons is not readily heard. Nevertheless, as a constructive feature with connections to other parts of the works, proportional exchange as an outgrowth of the text setting is, I would argue, significant in the *caritas* canons.

## Conclusions

This essay suggests that proportional exchange is a primary formal feature of Stravinsky's canonic compositions. It is, however, not readily audible, due to its intricate realization. The function of proportional relationships is analogous to the superstructural ironwork of a building. Though once a building is completed the superstructure becomes invisible, it nonetheless provides an essential structural frame. Analogously, proportional exchange relates to organization on a compositional level, but perhaps not on a perceptual level.

Proportional exchange allows a section to be well-balanced, hence confers a formal stability. As a result, sections that are organized through proportional exchange are well-articulated and set off in the formal design. The underlying idea of "exchange" is processual, and suggests change and motion. Stravinsky, however, reinterprets the role of exchange, and uses it to evoke qualities such as symmetry, balance, and stability. So the essence of Stravinskian proportional exchange lies in a transfer of the kinetic to the static.

However, a question remains: Do proportional exchange and symmetry always perform a similar function? In terms of formal design, for example, does the symmetrical structure of *Symphony in C* perform the same function as the proportional exchange structure of *Canticum Sacrum*? Although the proportional exchanges in the analyses show simple symmetrical structures (for example, 2 : 1 exchanging with 1 : 2), the actual durational values involved with the exchange are related in quite abstract ways.

To clarify the complex nature of proportional exchange, I refer again to Figure 4b, in which proportional exchange occurs between the proportions 2 : 1 (the actual durations are 16 : 8 and 8 : 4) and 1 : 2 (11 : 22). The durations of the first part of the former ratio, 2 : 1 (numeral "2"), are 16 and 8, and those of the second part of the latter ratio, 1 : 2 (again, numeral "2"), are 22; the durations of the second part of the former ratio (numeral "1") are 8 and 4, and those of the first part of the latter ratio are 11. Comparison of these durations (16 and 8 to 22, and 8 and 4 to 11)

does not disclose obvious structural significance or balance. Proportional exchange, therefore, manifests itself through highly elaborate durations. Though a ratio which is an outcome of proportional exchange might present a simple symmetrical balance, the structures of proportional exchange actually differ from symmetry because of their intricacy of musical realization.

The quality of balance in Stravinsky's use of proportional exchange can be appreciated by considering the music spatially, atemporally.<sup>17</sup> In this regard, it is interesting to note how Stravinsky described Webern's music:

[E]ach opus offers itself only as a whole, a unity to be contemplated. It is essentially static, therefore, and thus the cost in subjectivity is high. But if one feels constricted listening to a succession of Webern's very short pieces, and attributes the feeling to 'lack of scope', let me say that the attempt to follow a chain of unities is a quantitative misunderstanding in the first place.<sup>18</sup>

As indicated in the analyses in this article, Stravinsky's early serial music stresses kinds of formal balance, apart from temporal process. It is not the intent of this article to deny the presence of the linearity in Stravinsky's music, but rather, to emphasize aspects of the musical structure detached from temporality.

When we look at a painting, we are able to experience the work's many elements as we choose, without a rigid, fixed order. Similarly, analyzing proportional exchange highlights significant atemporal and noncontiguous relationships between segments. The idea of proportional exchange, therefore, suggests that we consider atemporal structures within music, as we do for pictorial art. The analysis of proportional exchange in Stravinsky's music reveals not only an aspect of his innovative approach to formal design, but also the spatial aspect of his aesthetics.

## NOTES

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1. By early, I mean works before *Threni*, which do not consistently use twelve-tone rows as do the later works.
2. Henri Pousseur (1972) shows the similarities between Stravinsky's pitch organization and Webern's.
3. Stravinsky had employed contrapuntal techniques since the beginning of his career, but the number of contrapuntal compositions increased once he became involved with serial technique. Glenn Watkins (1986) includes a list of canonic works found in Stravinsky's music. From this list, it is apparent that canonic work was concentrated in the composer's early serial music.
4. Proportional structure is also found in Bartók's and Debussy's music. See Ernő Lendvai (1966), and Roy Howat (1983).
5. Several important investigations of Stravinsky's music have been carried out invoking proportional structure. Edward Cone (1962) proposes a proportionally symmetrical structure for the first movement of *Symphony in C*. B. M. Williams (1973) extends Cone's analytical principles into the second and third movements and presents a proportional structure symmetrically established over the entire piece. Jonathan Kramer (1986) applies proportional structure as a principle of formal coherence in *Symphonies of Wind Instruments* and *Agon*. Kramer suggests that in *Agon* the proportional ratio, 1 : 1.19, is found extensively among segments, sections, or movements. Marianne Kielian-Gilbert's (1987) analyses of *Three Pieces for String Quartet* and *L'Histoire du soldat* attempt to elucidate the composer's design by considering foreground pitch and rhythm, and formal organization as a rhythmic unit.
6. The term "voice exchange" in post-tonal music as used in this discussion does not imply a transfer of all the connotations associated with the terms used in tonal analysis, such as in Schenkerian analysis.
7. Milton Babbitt (1964) briefly mentions the construction of the row applied in this movement. He points out the Webernian character of the row structure.
8. I label the rows taking  $P_0$  as beginning on C. So  $P_{11}$  in Figure 3a is <B G A B>.
9. The graphing in this essay follows Allen Forte's (1980) method of graphing durations.
10. Strictly speaking,  $Y1'$  starts with one rest which has the value of a quarter-note triplet (duration  $1 + 1/3$ ). However, the attack point of the Z2 segment on the downbeat reinforces the attack point of the  $Y1'$  segment on the upbeat. Hence, in the proportional graph of this section (Example 3), the attack point of the  $Y1'$  segment occurs on the initial downbeat of m. 260, where the Z2 segment also starts.
11. The three invariant subsets between  $P_7$  and  $I_7$  are as follows:  

$P_7$	7 6 8 10 11 9 2 1 4 0 3 5
$I_7$	7 8 6 4 3 5 0 1 10 2 11 9
12. The three invariant subsets between  $R_2$  and  $RI_2$  are as follows:



$$R_2 \quad \underline{0\ 10\ 7\ 11} \quad \underline{8\ 9\ 4} \quad \underline{6\ 5} \quad \underline{3\ 1\ 2}$$

$$R1_2 \quad \underline{4\ 6\ 9} \quad \underline{5\ 8} \quad \underline{7\ 0\ 10\ 11} \quad \underline{1\ 3\ 2}$$

13. As in Example 3, the proportional graph for section 1, the numbers in parentheses represent the total length of each segment (in eighth notes). The numbers indicated under the braces are the lengths of segments up to the entrances of segments in other layers. The attack points affecting the other segments are shown by vertical dotted lines.
14. The proportion 3 : 5 or 5 : 3 is prevalent in this section.  $Y1 : Z1 = 45 : 27 = 5 : 3$ ;  $Y1 : Z2 = 45 : 75 = 3 : 5$ ;  $X1 : Y1 = 28 : 45 \approx 3 : 5$ ;  $x1 : Y1 = 26 : 45 \approx 3 : 5$ . These proportions, however, do not appear among corresponding segments and do not produce proportional exchange.
15. As the attack point of the segment Y1' in Example 3 occurs on the initial downbeat, the attack point of Y3 in Example 4 also comes on the downbeat of m. 303 (considering that a rest, one third of a quarter-note triplet, is a part of the beginning of Y3).
16. The durations involved with the exchanges systematically diverge one unit from producing their simple ratios; for example, 21 : 30 exchanges with 31 : 20. (Similarly, 31 : 17 exchanges with 18 : 30, as does 15 : 20 with 21 : 14). Because the percentage of the deviation is small and, moreover, the proportional structure brings about a significant difference between the first and second canon, the proportional exchanges cited here, I consider, are valuable for my discussion.
17. Robert Morgan (1980) points out that a "musical grammar" of tonality is independent of time. He mentions the concept of background in Schenkerian analysis as an example.
18. Igor Stravinsky 1966.

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