

Transformational Structures in Webern's Opus 5, No. 3

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In a provocative study which intimates much of the analytic approach of his book *Generalized Musical Intervals and Transformations*, David Lewin includes a detailed examination of the first three measures of the second movement of Webern's *Five Pieces for String Quartet, op.5*.¹ He traces the transformations of a "Kopfmotiv" played by the viola at the beginning and then fits these into a transformation network.² Following Lewin's ideas of transformational techniques, I offer here an account of the unfolding of transformations of two pitch-class (pc) sets, 3-3 (014) and 3-4 (015), which are prominent in the third movement of the same Webern

¹Lewin, David, "Transformational Techniques in Atonal and Other Music Theories," *Perspectives of New Music* 21 (1982-83):312-71.

_____. *Generalized Musical Intervals and Transformations* (New Haven: Yale University Press, 1987).

²This article also includes a rhythmic analysis of the first three measures of Webern's op.5, no. 2 based on "time-point sets" derived from attack points. Lewin, "Transformational Techniques in Atonal and Other Music Theories," 348-60.

opus.³ Interactions between the two sets as reflected by the structure will also be examined. Though topics of a different nature will come up occasionally in the course of the presentation, the focus is on the transformation networks derived from the two pc sets and their relationship to one another.

The two pc sets mentioned above are manifested at various levels as melodic motives, as vertical sonorities, and as structural elements governing the larger spans of the composition. The first of the two sets, 3-3, is important as a vertical component in the first half of the piece; in the second half of the piece it is mostly expressed as a linear motive, especially as an ostinato figure played by the cello beginning at m.15. Upon its first appearance in m.1 in the three upper parts, the set consists of the pcs B, D, and E-flat, which I designate as X; thus $X = \{B23\}$. The second set, Y, is first heard as a linear pattern in violin I in m.5, comprising D, E-flat, and G; thus $Y = \{237\}$. Y, in contrast to X, always appears in a linear fashion either as part of a melody or as a motive.

Figure 1. Interval vectors of X and Y

interval vector of X =	101100
interval vector of Y =	100110

The close relationship between X and Y can be seen by comparing their interval class vectors, whose values are identical in four of the six entries. As for the nonidentical entries of interval classes 3 and 5, the values are exchanged (Figure 1). This is what Forte calls the R_1 relationship, which has maximal similarity as well

³Although register does play a role in the structural relation between the two sets, as will be discussed later, we are mainly concerned here with the domain of pitch-class, rather than pitch. Furthermore, the discussion of only two pc sets does not imply the insignificance of other pc sets which may also play a role in the structuring of the piece. These two sets are particularly chosen because of their many appearances on the surface of the music (especially at the beginning) and their close relationship to each other. The reader might want to examine further other pc sets which are prominent in the piece, especially 3-8 and 4-4.

Figure 2. T- and I-matrices of X and Y

T	B	2	3
B	0	3	4
2	9	0	1
3	8	B	0

I	B	2	3
B	A	1	2
2	1	4	5
3	2	5	6

$$\underline{T_1(X)} = \{034\}$$

$$\underline{T_3(X)} = \{256\}$$

$$\underline{T_4(X)} = \{367\}$$

$$\underline{T_8(X)} = \{7AB\}$$

$$\underline{T_9(X)} = \{8B0\}$$

$$\underline{T_B(X)} = \{A12\}$$

$$\underline{T_1 I(X)} = \{AB2\}$$

$$\underline{T_2 I(X)} = \{B03\}$$

$$\underline{T_4 I(X)} = \{125\}$$

$$\underline{T_5 I(X)} = \{236\}$$

$$\underline{T_6 I(X)} = \{347\}$$

$$\underline{T_A I(X)} = \{78B\}$$

Matrices of Y

T	2	3	7
2	0	1	5
3	B	0	4
7	7	8	0

I	2	3	7
2	4	5	9
3	5	6	A
7	9	A	2

$$\underline{T_1(Y)} = \{348\}$$

$$\underline{T_4(Y)} = \{67B\}$$

$$\underline{T_5(Y)} = \{780\}$$

$$\underline{T_7(Y)} = \{9A2\}$$

$$\underline{T_8(Y)} = \{AB3\}$$

$$\underline{T_B(Y)} = \{126\}$$

$$\underline{T_2 I(Y)} = \{7B0\}$$

$$\underline{T_4 I(Y)} = \{912\}$$

$$\underline{T_5 I(Y)} = \{A23\}$$

$$\underline{T_6 I(Y)} = \{B34\}$$

$$\underline{T_9 I(Y)} = \{267\}$$

$$\underline{T_A I(Y)} = \{378\}$$

as exchange of interval class values.⁴ Besides, the closeness

⁴Allen Forte, *The Structure of Atonal Music* (New Haven: Yale University Press, 1973), 48.

Example 1. X forms used in Webern's op.5, no.3. (Note: Dynamics, articulations, etc. have been removed from this and other examples to enhance readability of the segmentations.)

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between the sets is increased by the two invariant pcs 2 and 3

Example 2. Y forms used in Webern's op.5, no.3

mm. 1 2 3 5 6 7

8 10 11 12 13

14 16 17 18

19 20 21 22 23

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shared between them.⁵

⁵This shared invariant subset between X and Y is in fact expressed on the musical surface, as its two pcs (2 and 3) are always presented adjacently or simultaneously. See mm.1-5, 10-12.

The T- and I-matrices of X and Y are shown in Figure 2. According to the figure, each matrix consists of six forms which produce invariant pcs with the prime form. The number of invariant pcs varies from one to two. Most of these operators are employed in the piece: all T forms and three I forms from the X-matrices, and four from each of the Y-matrices. These forms are underlined in the figure. Examples 1 and 2 show the forms of X and Y which are used in the piece.⁶

As mentioned above, X and Y have a close structural relationship. This closeness is reflected in the ways they are connected in the piece. Upon examining the repetition of pcs in different registers spanning the first eleven measures or so, one notices an interesting phenomenon—a pc in a low register (usually at the beginning of a new musical segment, phrase, or idea) is repeated in a higher registral position.⁷ This relationship is shown in Example 3. The first four pcs spanning mm.1-10—D, C-sharp, C, and A—comprise the pc set {9012} which can be partitioned into two X and Y forms, namely $T_A(X)$ and $T_4I(Y)$. However, by grouping the first three pcs (mm.1-8) with the F in mm.10-11, {0125} is formed, which has the same prime form as {9012} and is a transposed inversion of it. More interesting is that, upon partitioning {0125} into forms of X and Y, $T_4I(X)$ and $T_A(Y)$ are formed, which have the same operators as the X and Y subsets of {9012}, except that they are exchanged between X and Y; so, $T_A(X)$ and $T_4I(Y)$ in {9012} vs. $T_4I(X)$ and $T_A(Y)$ in {0125}. This sharing of operators between X and Y will be seen again in the following discussion.

⁶Examples 1 and 2 show the X and Y forms which I have found in the piece. As the discussion continues, I will demonstrate the musical and analytical importance of the X and Y forms shown in these examples.

⁷This pc repetition in another register is interesting in its own right. A detailed investigation of this phenomenon using Robert Morris' concept of p-space mentioned in his book *Composition with Pitch-Classes* (New Haven: Yale University Press, 1987) might be fruitful.

Example 3. Registral doubling of pcs, mm.1-11

$\{0125\} = T_4I(X) \cup T_A(Y)$

$\{9012\} = T_A(X) \cup T_4I(Y)$

mm. 1 4 7 8 10 11

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Various forms of X are presented as vertical sonorities by the three upper parts in mm.1-6. See Example 4. They all have the same spacing ($8 + 3$), with the exception of $T_B I(X)$ which has the spacing of $(4 + 9)$.⁸ Most of the adjacent forms share a common pitch. By grouping the common pitches of the first three pairs of X forms (not counting the repetitions of $T_0(X)$ and $T_8(X)$), $T_2 I(Y)$ is formed (Figure 3). Similarly, by grouping the common pitches of the first two pairs and the $T_1(X) - T_4(X)$ pair of m.6, $T_2 I(X)$ is formed. ($T_4(X)$ and $T_5(X)$ in m.6 do not share any common pitch nor pc.) Here again, an X form and a Y form share an operator, which is $T_2 I$ in this case.

Another connection between X and Y is seen in the restatements of some of their forms. Some X and Y forms stated at the beginning of the piece (mm.1-5), $T_4(X)$, $T_8(X)$, $T_B(X)$, $T_1(Y)$, $T_7(Y)$, $T_2 I(Y)$, $T_5 I(Y)$, and $T_6 I(Y)$, are restated (recapitulated?) at or near the end, beginning at m.19 (Examples 1, 2). These analogous placements of X and Y forms at the same locations, in addition to the R_1 relationship and the sharing of operators mentioned

⁸ $T_B I(X)$ is unique in its spacing because it is the only inverted form of X among the others ($T_0(X)$, $T_8(X)$, $T_1(X)$, $T_4(X)$, and $T_5(X)$).

Figure 3. Sharing of operator between an X form and a Y form

$$\left. \begin{array}{l} T_0(X) \cap T_8(X) = \{B\} \\ T_B I(X) \cap T_1(X) = \{0\} \\ T_5(X) \cap T_4(X) = \{7\} \end{array} \right\} T_2 I(Y) = \{B07\}$$

$$\left. \begin{array}{l} T_0(X) \cap T_8(X) = \{B\} \\ T_B I(X) \cap T_1(X) = \{0\} \\ T_1(X) \cap T_4(X) = \{3\} \end{array} \right\} T_2 I(X) = \{B03\}$$

later discussion.

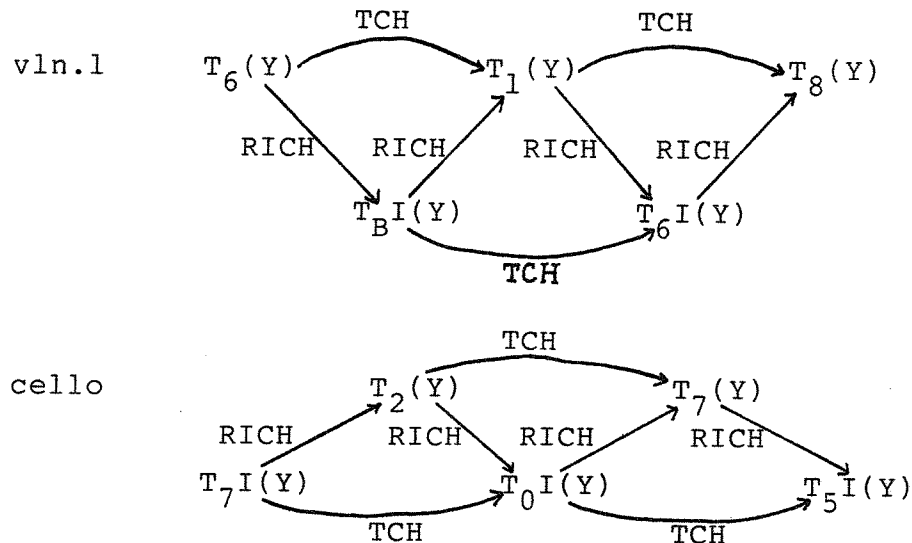
Example 5. Webern's op.5, no.3, m.7

The image shows a musical score for Webern's op.5, no.3, m.7, with transformational operators labeled above and below the notes. The score consists of four staves: Violin I (top), Violin II, Viola, and Cello/Double Bass (bottom). The notes are annotated with operators: $T_6(Y)$, $T_B I(Y)$, $T_6 I(Y)$, $T_8(Y)$, $T_1(Y)$, $T_7 I(Y)$, $T_2(Y)$, $T_0 I(Y)$, $T_7(Y)$, and $T_5 I(Y)$. The operators are arranged in a way that shows their relationships and how they transform the notes in the music.

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Two places in the music generate all the transformational operators of X and Y. They contain a saturation of X or Y forms. Interlocking forms of Y dominate the whole of m.7. In addition, the imitative passages between violin I and cello are inversionally related

Figure 4. RICH structure of Y



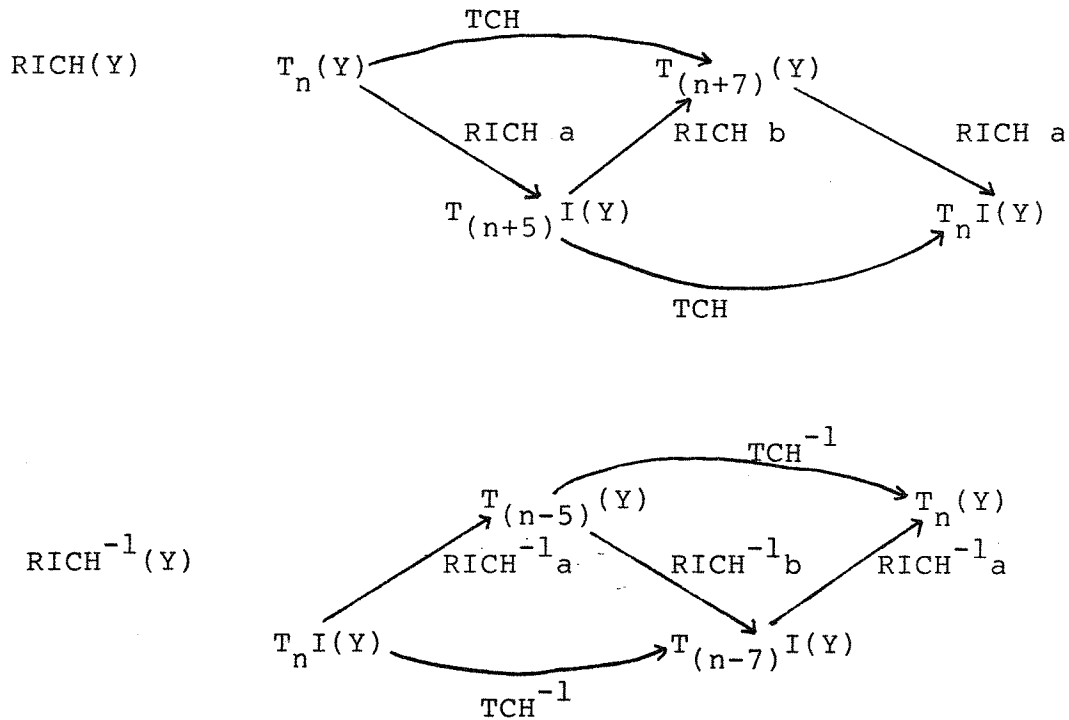
(Example 5). The structure in each of the two parts can be described in terms of Lewin's RI-chain (RICH), in which the last two elements of an ordered pc set are taken as the first two elements of a transposed retrograde inversion.¹⁰ Figure 4 reflects the RICH structure of the two parts.

According to Lewin, the (RICH)(RICH)- or TCH-interval of a RICH structure can be calculated by the formula $i = \text{int}(s_1, s_N) + \text{int}(s_2, s_{N-1})$ where i is the TCH-interval and s_1, s_2, s_N , and s_{N-1} are the pcs of the ordered set $s = s_1, s_2, \dots, s_n$.¹¹ By taking the first ordered set $T_6(Y) = \langle 198 \rangle$ of violin I in m.7, the TCH-interval is calculated as $\text{int}(1,8) + \text{int}(9,9) = 7$. By the same token, the TCH-interval of the cello part is calculated to be 5, or the mod12 complement of 7. This is so because, as already mentioned, the cello part is an inversion of the violin I part. Thus the two RICHs can be generalized and related one to the other, as shown in Figure 5. As seen from the figure, the RICH- and TCH- intervals of the RICH structure of the cello part are inversions of the values of the RICH structure of violin I. Thus the entire former structure is a transposed inversion of the entire latter structure. I call the former

¹⁰David Lewin, *Generalized Musical Intervals and Transformations*, 180-88.

¹¹Lewin, *Generalized Musical Intervals and Transformations*, 181.

Figure 5. RICH(Y) and RICH⁻¹(Y)



RICH⁻¹(Y), and the latter RICH(Y).

Figure 6. RICH and TCH operations derived from RICH(Y) and RICH⁻¹(Y).

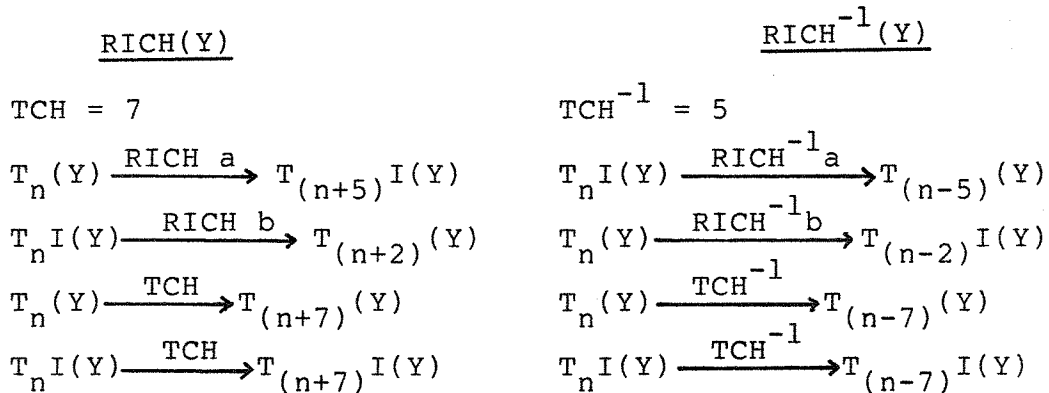


Figure 6 shows all the RICH and TCH operations within RICH(Y) and RICH⁻¹(Y) which transform forms of Y. Based on these operations, a network of transformational relations can be drawn between the various Y forms presented in the piece, as shown

Figure 7. Transformational structure derived from Y

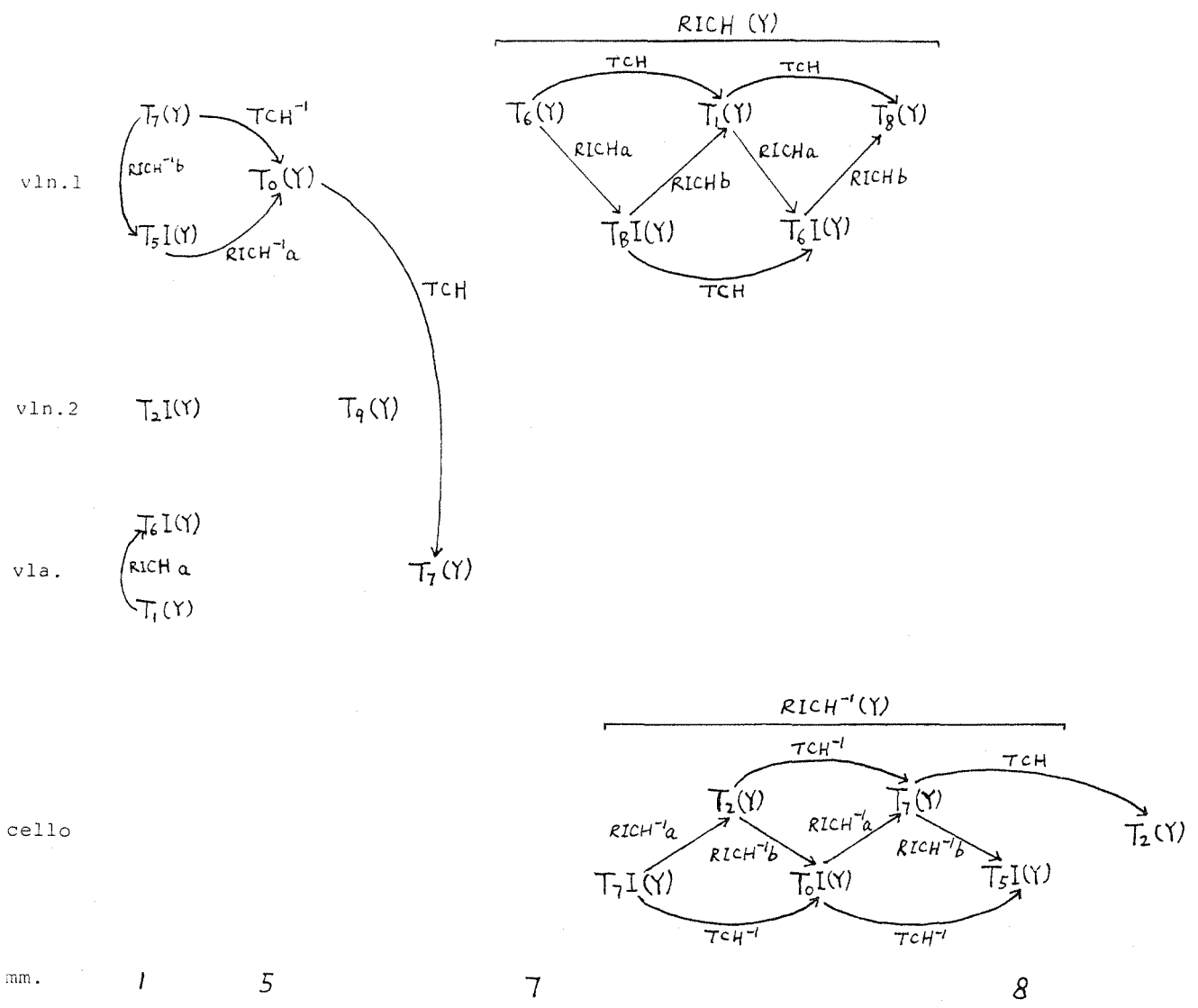


Figure 7 (cont.)

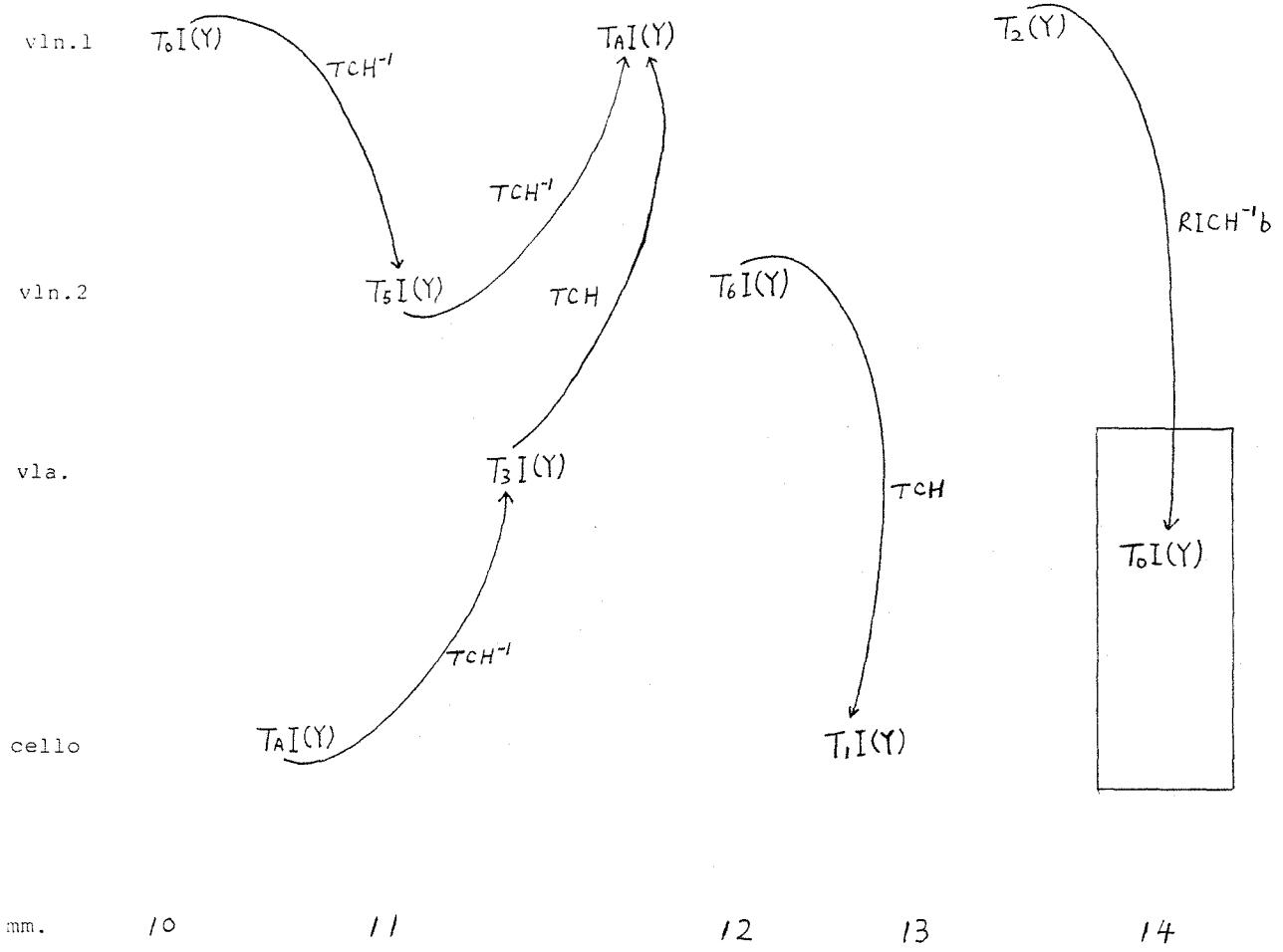
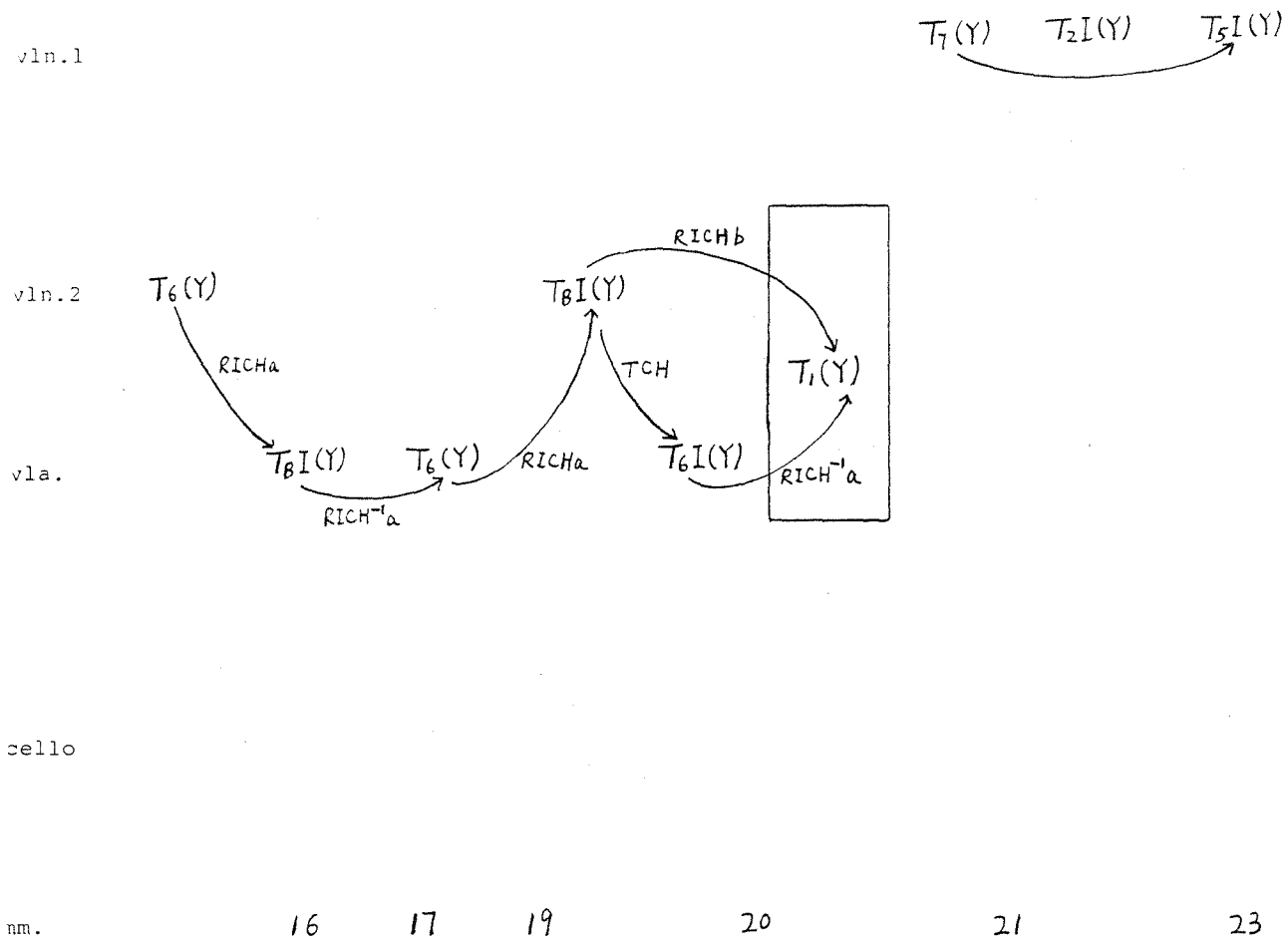


Figure 7 (cont.)



in Figure 7. Most of the forms are presented in a linear fashion, with the exception of $T_1(Y)$ (m.20), of which two pitches (E and D-sharp) are presented simultaneously by violin II and viola. This set, though it may not be recognized aurally as easily as the others, is considered important because of its location—right after the change of ostinato patterns in violin II and viola at the same measure—and because it is played by the same instruments as $T_6I(Y)$ and $T_BI(Y)$ (Example 6).

Example 6. Webern's op.5, no.3, mm.19-20, violin II and viola

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The notes of most Y forms are played by the same instrument except $T_0I(Y)$ at m.14 and $T_1(Y)$ at m.20. These two forms are shown inside a box in Figure 7. A few general comments precede specific observations:

1. All the RICH and TCH (including $RICH^{-1}$ and TCH^{-1}) operations are employed.
2. TCH operations dominate the middle of the piece (mm.10-11), whereas RICH operations are prominent in the rest of the music.
3. Most of the forms in the graph are connected by one or more arrows, with the exception of $T_2I(Y)$ and $T_9(Y)$ (mm.1, 5, and 21). These two forms are related to the large-scale transformations as will be discussed later.
4. $T_6(Y)$ and $T_BI(Y)$ dominate mm.14-19.

5. The five forms which appear in mm.1-3 are restated at the end (mm.19-23).

Example 7. Webern's op.5, no.3, mm.1-3

The image shows a musical score for Webern's op.5, no.3, mm.1-3. It consists of four staves: two treble clefs (Violin I and Violin II) and two bass clefs (Viola and Cello/Double Bass). The music is in 3/4 time. Several musical phrases are boxed and labeled with transformations: $T_7(Y)$ (top staff), $T_5I(Y)$ (second staff), $T_6I(Y)$ (third staff), and $T_1(Y)$ (bottom staff). A fifth $T_5I(Y)$ label is at the far right. Below the staves, there are four groups of notes, each with a sharp sign, representing the transformations of the notes.

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Figure 8. RICH_a and RICH⁻¹_b transformations, mm.1-3

$$\begin{aligned}
 T_7(Y) &= \{9 \begin{array}{|c|} \hline A \\ \hline 2 \\ \hline \end{array}\} \\
 T_5I(Y) &= \{ \begin{array}{|c|} \hline A \\ \hline 2 \\ \hline 3 \\ \hline \end{array} \} \xrightarrow{\text{RICH}^{-1}_b}
 \end{aligned}$$

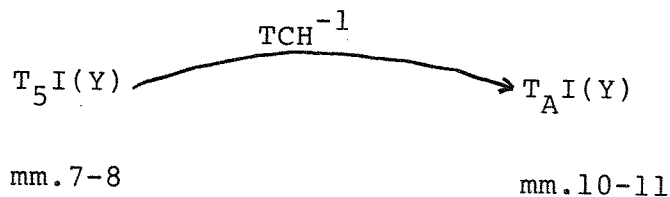
$$\begin{aligned}
 T_1(Y) &= \{ \begin{array}{|c|} \hline 3 \\ \hline 4 \\ \hline 8 \\ \hline \end{array} \} \\
 T_6I(Y) &= \{ \begin{array}{|c|} \hline B \\ \hline 3 \\ \hline 4 \\ \hline \end{array} \} \xrightarrow{\text{RICH}_a}
 \end{aligned}$$

Now here are the details. Before Y is clearly stated in m.5, it is implied by its various forms which are embedded within the vertical X forms (Examples 4, 7, mm.1-3). Four of these five forms appear later as part of the RICH(Y) and RICH⁻¹(Y) structures at m.7. Two of these four forms are related by RICH_a, whereas the other two are related by RICH⁻¹_b (Figure 8). A comparison of these two pairs with the analogous ones in m.7 shows that their transformations are identical. Thus RICH(Y) and RICH⁻¹(Y) are

anticipated at the beginning of the piece before their full presentations. This structural relationship between the two pair forms is also reflected in mm.19-23, although the transformation from $T_1(Y)$ to $T_6I(Y)$ is reversed (Figure 7).¹²

Another pair of Y forms from RICH(Y) which dominates a major portion of the composition is $T_6(Y)$ and $T_BI(Y)$. These two forms are linked by RICHa and $RICH^{-1}a$ (mm.14-19). (This alternation between RICHa and $RICH^{-1}a$ may also be related to the stasis created by the ostinato figure in this passage.) It is interesting to note that these two forms, which are used at the beginning of the RICH structure at m.7, are also employed here at the beginning of the last section of the piece, at m.14 (violin II, $T_6(Y)$) and m.16 (viola, $T_BI(Y)$). By the same token, the pair $T_7(Y)$ and $T_5I(Y)$ mentioned above as the last two forms of the RICH structure, are presented at the end of this section (or the whole composition) at mm.20-21, 23. By extending the idea of RICHa/ $RICH^{-1}a$ pairing between $T_6(Y)$ and $T_BI(Y)$ to TCH and TCH^{-1} operations, the relationship occurs at other locations as well (mm.1-6, 10-12).

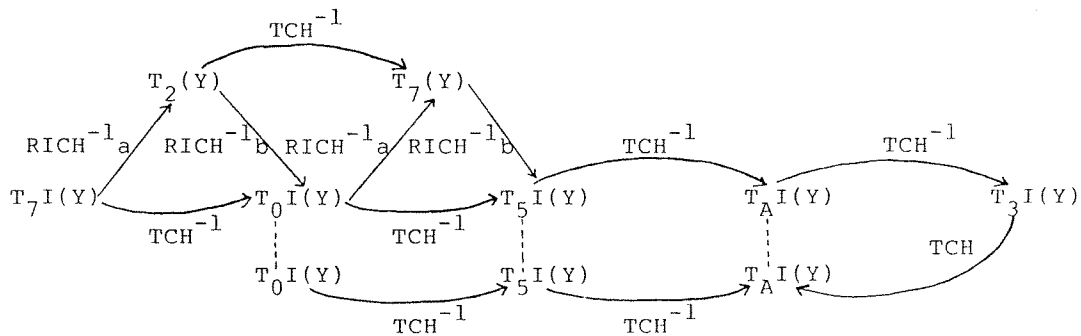
Figure 9. TCH^{-1} as a link between $RICH^{-1}(Y)$ and TCH transformations.



A link between $RICH^{-1}(Y)$ and the TCH transformations at mm.10-11 is shown in Figure 9. This link is formed by $T_5I(Y)$ of $RICH^{-1}(Y)$ with $T_A I(Y)$ of the cello part in mm.10-11 and is crucial

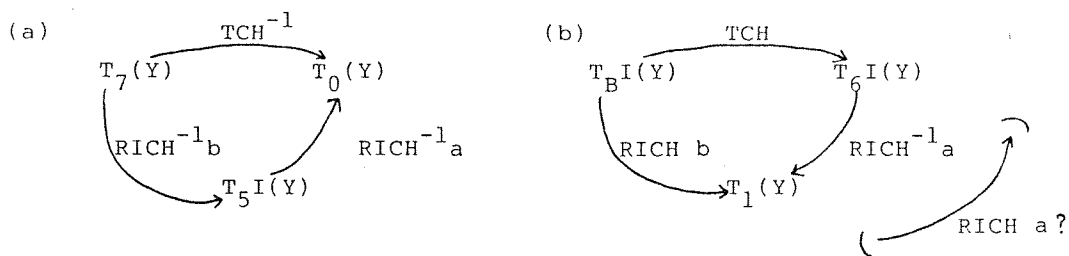
¹²There is a process going on in the presentations of these two pair forms. At mm.1-3, they are "hidden" within the vertical X forms, whereas at m.7 they are heard as part of the RICH structure, although each form is still interlocked with its partner within the RI-chain. The forms, upon their last presentation at mm.19-23, are separated from one another, with $T(Y)$ (mm.20-21) and $T_5I(Y)$ (m.23) heard most clearly in the high register played by violin I. Thus there is a gradual aural realization of these two pair forms in the course of the composition.

Figure 10. Transformation network formed by $RICH^{-1}(Y)$ and TCH transformations.



because it extends from the end of $RICH^{-1}(Y)$ to include a TCH transformation network in mm.10-12. Further examination of this TCH network with $RICH^{-1}(Y)$ reveals other relationships—the Y forms of the TCH network "reverse" their directions back to $RICH^{-1}(Y)$ (Figure 10) with T_3^I as the pivot, and three pairs of Y forms are identical in the whole network. This structure is related to the musical surface as the middle of m.12 signifies the entry of a new musical idea, and the measure before it has imitative figures which "recur" one after the other.

Figure 11. Transformation networks of Y; 18a) mm.1-5, violin I; 18b) mm.19-20, violin II and viola.



Violin I in mm.1-5 reflects a transformation network as shown in Figure 11a. A similar network occurs at mm.19-20 between violin II and viola (Figure 11b). If the $RICH^{-1}a$ arrow is reversed in Figure 11b to give $RICH\ a$, an inversive structure of Figure 11a would result. The arrow cannot be reversed for the only purpose of obtaining a close relationship between Figure 11a and Figure 11b,

as the meaning of Figure 11b would be totally different.¹³ This ambiguity between RICHa and RICH^{-1}a seems to imply a structural phenomenon which is reflected elsewhere in this piece, for example, the continuous transformations of $\text{T}_6(\text{Y})$ and $\text{T}_B\text{I}(\text{Y})$ via RICHa and RICH^{-1}a in mm.14-19.

Figure 12. Transformation network formed by $\text{T}_2\text{I}(\text{Y})$, $\text{T}_9(\text{Y})$, and $\text{T}_7\text{I}(\text{Y})$, mm.1-6.

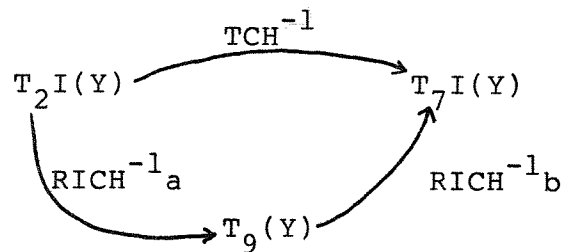
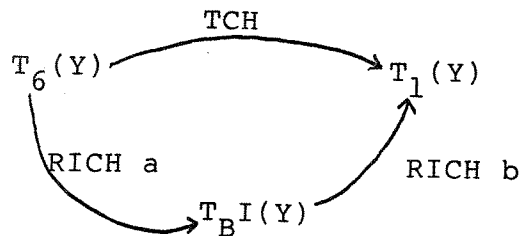


Figure 13. Transformation network of Y, mm.14-20, violin II



$\text{T}_2\text{I}(\text{Y})$ and $\text{T}_9(\text{Y})$ at mm.1-6, which are not connected with any other Y forms via RICH or TCH in Figure 7, can be linked with $\text{T}_7\text{I}(\text{Y})$ of $\text{RICH}^{-1}(\text{Y})$ to form a transformation network which is very similar to Figure 11a (Figure 12). A comparison of Figure 12 with Figure 11a shows that the two networks are basically the same, excepting the reversal of order of the intermediate transformations (RICH^{-1}a and RICH^{-1}b). In contrast to Figure 11a, which does not have its own inverse structure, the inverse structure of Figure 12 is presented in the music. Figure 13 shows the transformation network formed by the Y forms in violin II of mm.14-20. The operators in

¹³ $\text{T}_6\text{I}(\text{Y})$ generating $\text{T}_7(\text{Y})$ via RICH^{-1}a is totally different from $\text{T}_7(\text{Y})$ generating $\text{T}_6\text{I}(\text{Y})$ via RICHa .

this network are exactly the inverse of the ones in Figure 12, and the order of the respective transformations is the same. More precisely, the network of Figure 12 is the inverse of the one in Figure 13. This relationship could in fact be treated as an extension of the RICH structure.¹⁴

Figure 14. "X-Matrix"

	$T_1(X)$	$T_4(X)$	$T_5(X)$
$T_4(X)$	3	6	7
$T_1(X)$	0	3	4
$T_5(X)$	4	7	8
	$T_6I(X)$		

Having exhausted the investigation of Y and its transformations, it is time to examine X and its transformations. As with Y, there is a location in the music at which a saturation of X forms occurs, namely m.6. The three upper parts from the second to the fourth beat comprise three forms of X: $T_1(X)$, $T_4(X)$, and $T_5(X)$. These three forms are presented vertically as well as linearly (Example 4). A matrix is formed as shown in Figure 14 by taking these nine pitches and labelling them with pc numbers. One more form of X, $T_6I(Y)$, is projected by the numbers forming the diagonal from the lower left corner to the upper right corner.¹⁵ Further investigation of this "X-Matrix" reveals another interesting aspect: the operands of the three T forms (1, 4, and 5) comprise a form of set X ($T_2(X)$). Because of its structural significance, this matrix is assumed to be a kind of generator of all the X forms in the piece.

¹⁴This inversive relationship, of course, is different from the one mentioned in Lewin's article, which deals with inversion about an axis of symmetry. See Lewin, "Transformational Techniques in Atonal and Other Music Theories."

¹⁵Each of the members of $T_6I(X)$, 3, 4, and 7, is presented twice in the matrix. The remaining pcs belong to set 3-8 which, as mentioned before, may be another important set in this piece.

Figure 15. Operations derived from the X-Matrix

$$\begin{array}{ccccc}
 T_1(X) & \xrightarrow{T_3} & T_4(X) & \xrightarrow{T_{-3}} & T_1(X) \\
 T_4(X) & \xrightarrow{T_1} & T_5(X) & \xrightarrow{T_{-1}} & T_4(X) \\
 T_1(X) & \xrightarrow{T_4} & T_5(X) & \xrightarrow{T_{-4}} & T_1(X) \\
 T_1(X) & \xrightarrow{T_7^I} & T_6^I(X) & \xrightarrow{T_7^I} & T_1(X) \\
 T_4(X) & \xrightarrow{T_A^I} & T_6^I(X) & \xrightarrow{T_A^I} & T_4(X) \\
 T_5(X) & \xrightarrow{T_B^I} & T_6^I(X) & \xrightarrow{T_B^I} & T_5(X)
 \end{array}$$

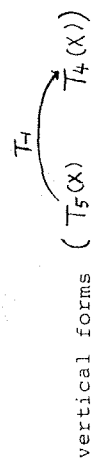
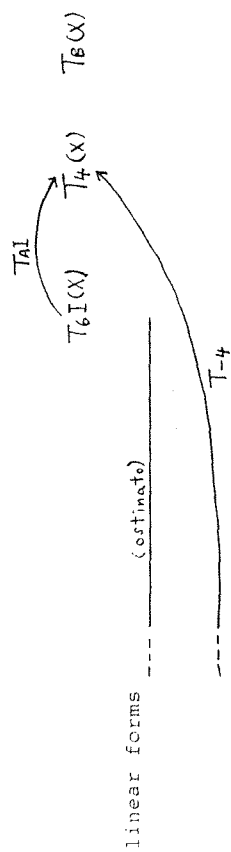
A series of operators which connect the four forms of X with one another is derived from the matrix and shown in Figure 15. This figure shows that the operators transforming $T_m(X)$ to $T_6^I(X)$ and vice versa (where $m = 1, 4, \text{ or } 5$) are identical, since they are all T_n^I operators (T_7^I , T_A^I , and T_B^I), and they are involutions.¹⁶ By connecting all the X forms in the piece with these operators, another transformational structure is formed (Figure 16). The graph groups the presentations of X forms into two categories, linear and vertical. Although the X forms in parentheses are not as easily audible as the others, they are not unimportant. According to the graph, X is always presented as a vertical component in the first half of the piece, whereas in the second half it is always linearly presented. $T_B(X)$, though not connected with other X forms in two of its three presentations, plays a significant role in the "framing" of the piece, as it is presented at the beginning, the end, as well as at the statement of the melodic idea in m.9.¹⁷

At first glance, m.4 seems to be an interruption of the vertical presentations of X, due to the imitative figures played by the violin and viola (Example 4). Closer study reveals that this measure

¹⁶Morris, 127.

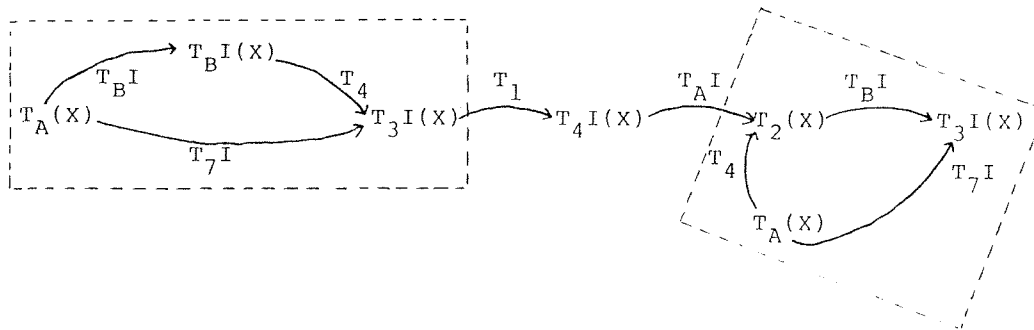
¹⁷ $T_6^I(X)$ at m.13, which is also not connected with other X forms, has a minor role to play, since one of its pitches (E-flat) only spans a duration of a sixteenth-note. This sonority is thus hard to be perceived in the context, especially with $\downarrow = 84$.

Figure 16 (cont.)



mm. 18 22 23

Figure 17. Transformation network of X, mm.3-4



actually consists of four overlapping forms of X (Example 1, Figure 16). Furthermore, in addition to $T_B I(X)$ and $T_1(X)$ in the three upper parts of m.3, two other forms of X are formed by the pedal C-sharp in the cello part together with two of the pitches above. These two forms, $T_A(X)$ and $T_3 I(X)$, also appear in m.4. The transformation from $T_A(X)$ to $T_3 I(X)$ by $T_7 I$ is present in both measures, and these transformations are linked by $T_4 I(X)$ (Figure 17). Of greater interest is the other path which directs $T_A(X)$ to $T_3 I(X)$. In Figure 17, the two transformations from $T_A(X)$ to $T_3 I(X)$ are also done by $T_B I$ and T_4 . The only difference between the two transformations is that the order of $T_B I$ and T_4 is reversed. The reader should recall the same phenomenon discussed earlier in the Y transformations (Figures 11a, 12). I am obliged to call this type of relationship "semi-isographic", in relation to what Lewin calls isographic.¹⁸

The semi-isographic structures of Figures 11a, 12, and 17 are generalized in Figure 18. x , y , and z represent the different operators through which the transformation from a to b is accomplished. By substituting the corresponding operators mentioned in the previous examples for x , y , and z , the two transformation networks of Figure 19 result.

¹⁸See Lewin, *Generalized Musical Intervals and Transformations*, 198-200. As this article was being prepared for publication, another article by Lewin appeared in which the discussions could very well be linked with my semi-isographism and other ideas presented in this paper. See David Lewin, "Klumpenhouwer Networks and Some Isographies That Involve Them," *Music Theory Spectrum* 12/1(1990):83-120.

Figure 18. Semi-isographism

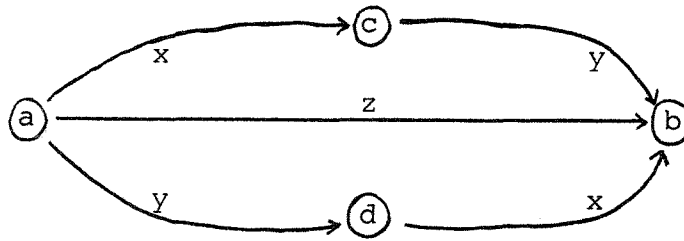
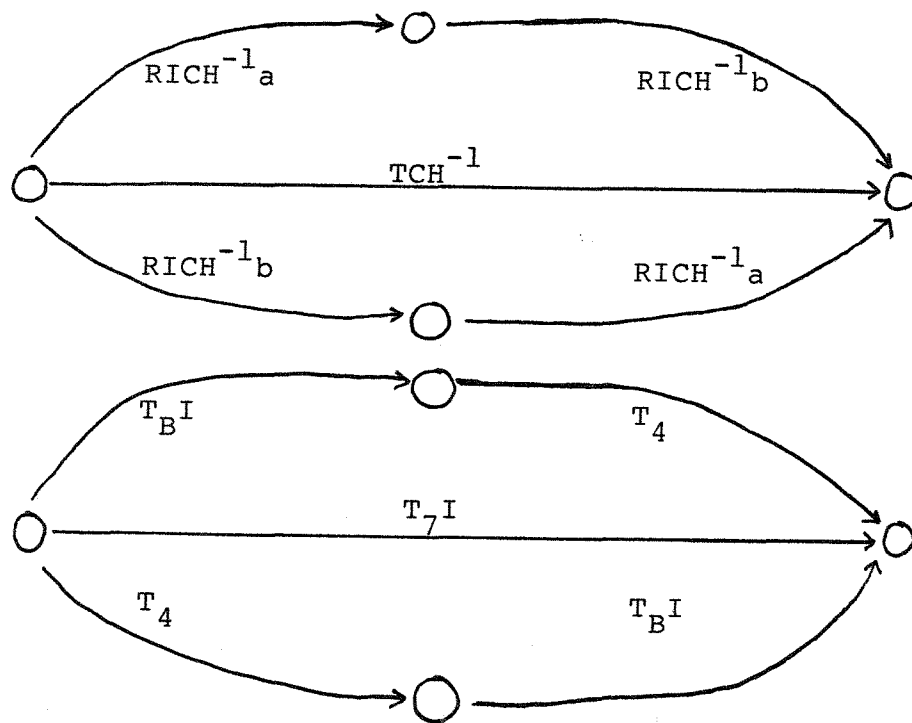


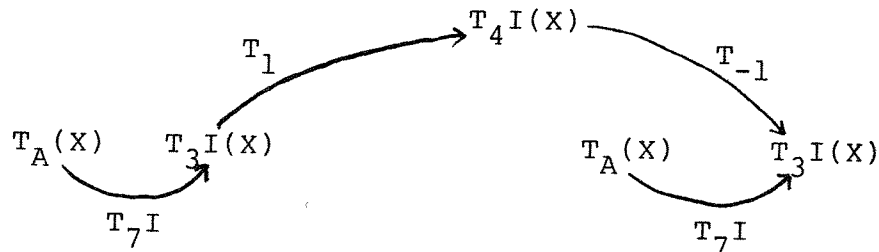
Figure 19. Semi-isographic structures in Webern's op.5, no.3



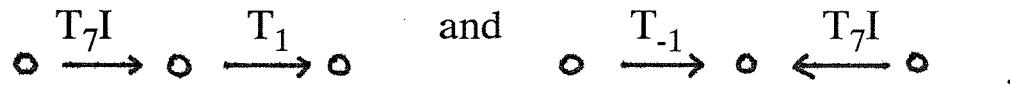
Another interesting transformational structure is revealed by examining the network in Figure 17 from a different angle. As mentioned before, $T_4I(X)$ connects the two networks of $T_A(X) \rightarrow T_3I(X)$. The transformation from $T_3I(X)$ of the first network to $T_4I(X)$ is accomplished by the operator T_1 , whereas the transformation from $T_4I(X)$ to $T_3I(X)$ of the second network is done by T_{-1} , the inverse of T_1 (Figure 20).¹⁹ This somewhat symmetrical structure is

¹⁹This T_1/T_{-1} relation is manifested on a more "audible" level between $T_4(X)$ and $T_5(X)$. See mm.5-6, Example 4 and Figure 16.

Figure 20. $T_4I(X)$ as link between transformations of $T_A(X)$ $T_3I(X)$.



further condensed in mm.8-9, in the transformation from $T_A(X)$ to $T_2I(X)$ via $T_9(X)$ (Figure 21a). The operators used in this transformation are T_{-1} and T_7I . If the directions of both arrows of Figure 21a are reversed, the left network of Figure 20 results (Figure 21b). If only the direction of the T_7I arrow of Figure 21a is reversed, the right network of Figure 20 results (Figure 21c). Thus the network formed by the X sonorities at mm.8-9 represents a hybrid structure of



although it is unique in its own right. The operators T_7I and T_{-1} are also used in the transformations of X elsewhere in the piece, but they are not connected by the same form of X (Figure 16).

In m.4 of Figure 16, $T_2(X)$ and $T_A(X)$ are connected by two arrows, T_4 and T_{-4} . The cyclic quality of this transformation results from the simultaneous realizations of $T_2(X)$ and $T_A(X)$ —both forms are completely realized at the same time at the second half of beat two. It is also reflected in mm.1-3 in the repetition of T_0 T_8 . Here the same operators T_4 and T_{-4} are used. The same structure is also manifested on a higher level, in mm.3-6, between $T_1(X)$ and $T_5(X)$ (Figure 16).²⁰

²⁰Like $RICHa/RICH^{-1}a$ and TCH/TCH^{-1} , this T_4/T_{-4} relation, together with the previously mentioned T_1/T_{-1} relation, can be traced back to the inversion within the RICH structure. Besides, they are analogous to the FIRST 4 THEN 8 transformation network mentioned in Lewin, "Transformational Techniques in Atonal and Other Music Theories," 326-29.

Another related transformation network is perceived at a higher level in mm.9-15 (Figure 16, shown in dotted lines). This transformation network, in fact, does not fit into the above networks due to the overall transformation which is $T_1 = T_{-3} + T_4$ instead of T_4 or T_{-4} in mm.1-2 and mm.5-6. It can thus be treated as an anomalous case.

Though the foregoing analysis has not exhausted all the analytical possibilities, it does serve to reveal structural connections through transformations which are essential to the piece as a whole. The close intervallic relationship between sets X and Y already provides a structural link between the two, but this relationship is further expanded in the piece by pc set intersections as well as identical operators governing the forms of the two sets. $RICH(Y)$, $RICH^{-1}(Y)$, and the X-Matrix serve as basic structures which govern and monitor the interrelated transformation networks permeating the piece. Inversional relation and semi-isographism act as major components framing the transformations of X or Y. In addition, there are structures extending out from the basic structures, as was shown in Figures 10, 12, and 22. Indeed, Lewin's statement that transformation graphs and networks may be understood "not as ubiquitous features of atonal music, but rather as paradigms that are only sometimes completely fulfilled in any given piece"²¹ suits well this discussion of Webern's op.5, no.3.

²¹Lewin, "Transformational Techniques in Atonal and Other Music Theories," 335.