

# **VOICE LEADING IN THE MUSIC OF GEORGE PERLE**

by

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Abstract

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by

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Most studies of George Perle's music have an essentially harmonic orientation. They typically involve referring harmonies back to Perle's precompositional arrays. This study seeks to shift the conversation in a new direction by giving priority to voice leading. "Twelve-tone tonality" is construed as a voice-leading system in which two streams of voice-leading flow simultaneously, generating a higher level "counterpoint of counterpoints." Each stream of voice leading consists of trichords or dyads that wedge symmetrically. A novel three-tier analysis is introduced which enables the analyst to peer through the score to the voice leading.

A significant difference is demonstrated between the voice leading among hexachords and tetrachords. The former are shown to represent Perle's voice leading at its clearest, while the latter are shown to be inherently ambiguous.

Motion within and between arrays is considered from a voice-leading perspective. Ample examples of Perle's music are given, included a voice-leading analysis of two full movements. The study ends with a discussion of implications for hearing wedge voice leading.

## ACKNOWLEDGEMENTS

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Evangeline has been *for me* the whole time. "The heart of her husband trusts in her." Both our names should be on the spine.

# CONTENTS

Abstract.....	v
Acknowledgments.....	vi
List Examples.....	ix
Chapter	
1. Twelve Tone Tonality and Wedge Voice Leading.....	1
Introduction	
Wedge Voice Leading $W_n(A^B)$	
Wedge Voice Leading and Twelve-Tone Tonality	
Perle's Voice Leading	
2. Voice Leading of C-Sets.....	37
Trichords and Trichordal Wedge Scales	
Motion within a C-Set	
Voice Leading and Line Leading	
3. Arrays and Modulation of Arrays.....	67
Technique 1—Harmonic Perspective (Modulation through Reinterpretation)	
Voice Leading Perspective: Modulation through “Reorientation”	
Technique 2—Modulation through Substitution (or Oblique Motion)	
4. Counterpoint between C-Sets.....	88
Array Voice Leading: Hexachords	
Array Voice Leading: Tetrachords	

5. Analysis of Two Movements by Perle .....	109
<i>Six Preludes for Piano</i> (1946), IV	
<i>Sonatina</i> (1986), I	
6. Listening for Perle's Voice Leading .....	128
Works Cited .....	135

## LIST OF EXAMPLES

### Chapter One

1.1	Dissonant Figuration .....	5
1.2	Foley's Analysis of Etude No. 1 from <i>Six Etudes</i> .....	8
1.3	Wedge Voice Leading for Dyads .....	12
1.4	All Possible Dyadic Wedge Scales .....	15
1.5	Wedge Voice Leading for Trichords .....	16
1.6	Bach, Fantasia and Fugue in C Minor (BWV 906) M. 33 .....	18
1.7	Berg, "Marie's Lullaby" from <i>Wozzeck</i> .....	18
1.8	Derivation of Perle's Harmonies .....	20
1.9	Axis and Neighbor Notes .....	21
1.10	Properties of Cyclic Sets .....	22
1.11	C-Set Vocabulary .....	26
1.12	Perle, <i>Ballade</i> Mm. 5-6 .....	28
1.13	Partial Trichords .....	32
1.14	<i>Brief Encounters</i> , I "Rondoletto," Mm. 2-3 .....	34

### Chapter Two

2.1	Interval and Index $T_n$ and $W_n$ .....	38
2.2	Odd Interval and Index under $T_n$ and $W_n$ .....	39
2.3	Semi-Transposition .....	41
2.4	Compound Motions .....	42

2.5	Voice Leading Space for Dyads .....	42
2.6	<i>Pars pro Toto</i> .....	44
2.7	Parts of a Trichord .....	44
2.8	Transposition of a C-Set .....	46
2.9	Semi-Transposition of a C-Set .....	46
2.10	Semi-Transposed C-Sets Related by Inversion .....	49
2.11	C-Sets Sharing a C-Set Index .....	50
2.12	Compositional Use of C-Sets Sharing a C-Set Index .....	51
2.13	Cognate C-Sets .....	52
2.14	$T^6$ Equivalent Trichords in a C-Set .....	54
2.15	$W^6$ Progressions .....	54
2.16	Wedging onto Equivalent Chords .....	55
2.17	Wedge Cycles .....	56
2.18	Partial Wedge Cycles between Equivalent Trichords .....	57
2.19	Producing Common Tones .....	59
2.20	Clarity and Obscurity .....	60
2.21	Line Leading Affecting Clarity .....	61
2.22	Parsimonious Line Leading .....	65

### Chapter Three

3.1	Modulation through Reinterpretation .....	71
3.2	<i>Six New Etudes</i> (1984), IV “Romance,” Mm. 1-9 .....	73
3.3	Some Array Interpretations of a Hexachord .....	74

3.4	Modulation through Reorientation .....	77
3.5	Comparison of Reorientation and Reinterpretation .....	78
3.6	<i>Six Etudes for Piano</i> (1973), IV, Mm. 51-53 .....	81
3.7	Modulation through Oblique Motion .....	85
Chapter Four		
4.1	<i>Sonata a Quattro</i> , IV, Mm. 68-69 .....	89
4.2	Syncopated Wedge Progression in <i>Six Etudes for Piano</i> , No. 1 .....	90
4.3	Axis Notes Moving in Unison in <i>Modal Suite</i> , II .....	94
4.4	Axis Notes Moving in Unison in <i>Ballade</i> .....	96
4.5	Axis Notes Moving by Wedge in <i>Ballade</i> .....	98
4.6	Ambiguity in Wedging Axis Notes .....	99
4.7	False Wedges .....	100
4.8	<i>Fantasy Play</i> (1994), Mm. 44-45 .....	101
4.9	Ambiguity of Tetrachords .....	103
4.10	Ambiguity of Dyadic Wedges .....	104
4.11	<i>Brief Encounters</i> , I “Rondolletto,” Mm. 55-56 .....	106
4.12	<i>Brief Encounters</i> , VIII “Strepitoso,” Mm. 36-39 .....	107
Chapter Five		
5.1	<i>Six Preludes for Piano</i> (1946), IV .....	110
5.2	Analysis of Dyads .....	111
5.3	Analysis of Trichords .....	111

5.4	Trichordal Subsets of (0358) .....	114
5.5	Interval “X” .....	115
5.6	(04) Dyad and Axis Note Joined to Form (015) and (014) Trichords .....	117
5.7	<i>Sonatina</i> , I (1986) .....	119
5.8	Progression of Arrays in <i>Sonatina</i> , I .....	124
5.9	Modulation Explained as a Compound Motion .....	126
5.10	$T^9 = T^0$ When the C-Set Interval is 6 .....	127
 Chapter Six		
6.1	Singing Exercises for Teaching Index .....	133

## LIST OF TABLES

Chapter Two		
2.1	All C-Sets of C-set Interval 5 .....	4

## Chapter One

### Twelve-Tone Tonality and Wedge Voice Leading

#### Introduction

This dissertation studies voice leading in the music of George Perle. Perle was a seminal American composer, and there are several studies of his music and theory of “twelve-tone tonality.” There has been ample discussion of the harmonic aspect of his music, but very little about his voice leading and nothing like the approach that will be found here. My intention is to shift the conversation in a significant new direction.

Nearly all of Perle’s music is composed in a pitch language he invented, which he first called the “Twelve-Tone Modal System,” later expanded and renamed “Twelve-Tone Tonality.”<sup>1</sup> Some discussions make much of the different manifestations of Perle’s system. Thomas Patrick Carrabr , for example, divides Perle’s music into three periods: the modal period, the expanded modal period, and the tonal period (i.e., twelve-tone tonality).<sup>2</sup> But since “twelve-tone tonality” does not essentially alter the “twelve-tone modal system” and since nothing is lost in the expansion, I will consider all the manifestations of the system as one and refer to it as “twelve-tone tonality.”

Likewise, I will consider all of Perle’s works that are structured by this system in its earlier or later manifestation as a unified and complete repertoire. I will not adopt the distinction between “modal” works and “tonal” works. Only a few of Perle’s works are

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<sup>1</sup> Perle, *Twelve-Tone Tonality* (Berkeley: University of California Press, 1996). The publication of the first edition of *Twelve-Tone Tonality* in 1977 might serve to mark the formal beginning of Perle’s expanded system, though he traces the expansion back to his collaboration with Paul Lansky between 1969 and 1973.

<sup>2</sup> Thomas Patrick Carrabr , *Twelve-Tone Tonality and the Music of George Perle* (Ph.D. dissertation, City University of New York, 1993).

not structured by twelve-tone tonality.<sup>3</sup> Such works lie outside the purview of this study, which is limited to Perle's main body of music.

Perle traces the origin of his musical language to a misapprehension he had as a young man about Schoenberg's new twelve-tone system. It was the late 1930s and there was still very little published on the subject. Few of Schoenberg's scores were available. Perle understood that the twelve-tone series functioned in the background, like a scale, as a source of pitch relations. He did not understand that unlike tonal scales, the order of the twelve-tone series in Schoenberg's music carried to the musical surface. Each note of a series, he believed, could be associated with the two notes adjacent to it (to the right or to the left) in either the prime or inverted forms of the series at any time. Retrograde was not a distinct form to him.<sup>4</sup> It was Ernst Krenek who corrected Perle's misapprehension about Schoenberg, but encouraged him to pursue his line of thinking by calling his mistake a "discovery."<sup>5</sup>

Perle's "discovery" evolved into the musical language that engaged him as a composer and theorist for the rest of his life. Twelve-tone tonality might be called a harmonic language in that it represents a consistent way of generating discrete harmonies. The harmonies organize into groups analogous to traditional keys. And the keys relate to one another in cogent and musically satisfying ways. Twelve-tone tonality offers composers a chance to treat form in terms of harmonic relatedness—to modulate between close or distant harmonic areas, to create large scale harmonic connections—and it even

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<sup>3</sup> Paul Lansky has identified works that are outside the system in his article on Perle for *The New Grove Dictionary of Music and Musicians*.

<sup>4</sup> *Twelve-Tone Tonality*, xi.

<sup>5</sup> See Perle, "Perle on Perle: The Composer Recalls His Life in Music," interview by Dennis Miller (Englewood, N.J.: Music Associates of America, 1987), 9; quoted in Perle, *The Listening Composer* (Berkeley: University of California Press, 1990), 133; and Perle, "Krenek," in *The Right Notes* (Stuyvesant, N.Y.: Pendragon Press, 1995), 177.

allows for certain kinds of non-harmonic embellishment, all in a fully chromatic pitch space.

We may do even better by calling it a voice-leading language. It is often noted that voice leading and harmony can never be comfortably divorced. One implies the other. But it is possible to focus on either harmony or voice leading, especially in analysis. Set-class theories for example focus on groups of pitches, while transformational theories focus on the ways in which elements of one group map onto elements of another.

Coordination of the vertical and horizontal dimensions—harmony and voice leading—is now as much a part of atonal as tonal theories of pitch. But whereas for tonal music, treatises on counterpoint preceded treatises on harmony, the situation has been reversed for atonal music. An earlier emphasis on simultaneity gave way to efforts at modeling atonal voice leading. Joseph Straus has identified three approaches to voice-leading analysis for atonal music: the prolongational approach, characterized by the application of Schenkerian-style reductive techniques; the associational approach, characterized by the association of pitches *via* register, timbre, dynamics, or other properties; and the transformational approach, characterized by Lewin's theory of transformational voice leading.<sup>6</sup> Today, his categories remain a helpful and valid guide to the mounting literature on atonal voice leading. In practice, however, the categories are not always clear-cut. In particular, there is considerable overlap between associational and transformational approaches. As Straus himself has pointed out, the essential

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<sup>6</sup> Joseph N. Straus, "Uniformity, Balance, and Smoothness in Atonal Voice Leading," *Music Theory Spectrum* 25/2 (2003), 205-52; and Straus, "Voice Leading in Atonal Music," in *Music Theory in Concept and Practice*, ed. by James M. Baker, David W. Beach, and Jonathan W. Bernard (Rochester: University of Rochester Press, 1997), 237-274.

difference is one of emphasis: the associational approach focuses on objects while the transformational approach emphasizes the operations that connect objects.

It is possible to discern Straus's three categories in the literature on Perle's music. The prolongational approach finds the most direct advocacy in the Ph.D. dissertations of Thomas Patrick Carrabr  and Steven Rosenhaus.<sup>7</sup> The stated goal of Carrabr 's work is "an understanding of Perle's compositional method through the definition of a reductive analytical method."<sup>8</sup> His reductive technique is explicitly based on Schenker's. It uses traditional graphic symbols such as stemmed and unstemmed notes, solid and dotted slurs, and beams to "connect the pitches of the structural descent."<sup>9</sup> But just as twelve-tone tonality is only analogously related to diatonic tonality, so the symbols and concepts such as structural descent should be taken only as analogies for their traditional counterparts. Similar techniques are used by Rosenhaus in his analysis of Perle's fourth Wind Quintet. He is particularly interested in the large-scale structure which he considered to be prolongational.

Dave Headlam, on the other hand, stops short of a prolongational approach in his analysis of Perle's first piano concerto.<sup>10</sup> His voice-leading reductions do not illustrate prolongations, and terms such as "background," "consonant," "dissonant," and "resolution" are usually in quotation marks. Yet he maintains: "Perle's references to tonal analogies seem to match at least my own layered perceptions of the music, and his

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<sup>7</sup> Carrabr , *Twelve-Tone Tonality*; and Steven L. Rosenhaus, *Harmonic Motion in George Perle's Wind Quintet No. 4*, (Ph.D. dissertation, New York University, 1995).

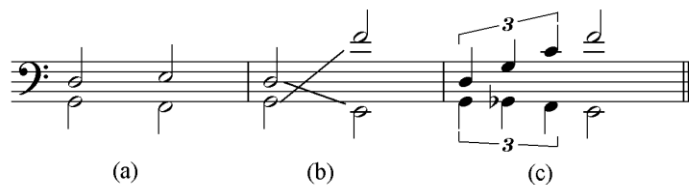
<sup>8</sup> Carrabr , v.

<sup>9</sup> Carrabr , *Twelve-Tone Tonality*, 122.

<sup>10</sup> Dave Headlam, "Tonality and Twelve-Tone Tonality: The Recent Music of George Perle," *International Journal of Musicology* IV (1995), 301-333.

extension of the system to allow for dissonant or cyclic but non-array events is convincing.”<sup>11</sup>

The “extension of the system” to which Headlam refers to is Perle’s inclusion of notes on the music’s surface that are outside the harmonic context. Perle adopted a technique from Berg wherein the space between two notes is filled in with an interval cycle or a segment of an interval cycle. Perle’s term for the technique is “dissonant figuration.”<sup>12</sup> Example 1.1 illustrates. Example 1.1a gives a symmetrical progression—the voices move an equal distance in opposite directions. Example 1.1b creates space by altering the progression using octave displacement and voice exchange. Example 1.1c fills in the space created by the alteration with interval cycles appropriate to each voice.



### Example 1.1, “Dissonant figuration”

The space-filling function of the technique elicits a comparison with traditional passing tones. The basis for the comparison consists in two things. First, both passing tones and Perle’s “dissonant figuration” are extrinsic to a well-defined harmony. Because Perle’s syntax is well-defined, there is a viable distinction between chord tones and non-chord tones. Second, traditional passing tones and “dissonant figuration” fill the space between two chord tones in restricted ways: the passing tone fills the space with scale

<sup>11</sup> Ibid., 331.

<sup>12</sup> Perle, *Twelve-Tone Tonality*, 229-235.

steps; Perle fills the space with interval cycles. The restriction limits potential for ambiguity and disallows arbitrary non-chord tones.

The comparison brings out a difference as well. “Dissonance” may be used in different ways. There is acoustic dissonance—the audible clash of tones in, say, major sevenths. But there is also syntactic dissonance—notes or intervals that are dissonant because of a musical syntax that may or may not be acoustically dissonant in the former sense. For example, in tonal music the perfect fourth is considered dissonant when it involves the bass; otherwise it is consonant. The distinction comes from the syntax of tonality, not from any clash inherent in the perfect fourth. In tonal music non-chord tones are closely related to acoustic dissonance, though consonant non-chord tones and dissonant chord tones are possible. But in Perle’s system, acoustic dissonance has nothing to do with the musical syntax. Rather, intervals are treated contextually; any interval may be “consonant” or “dissonant” depending on whether or not it belongs to the present harmony.

Nevertheless, it is fair enough to consider Perle’s “dissonant figuration” as an analogy for traditional passing tones. In fact, many features of Perle’s system may be considered analogous to features of traditional tonality. But while the analogy may be instructive, it would be a mistake to insist on analytical conclusions based on it without further, more concrete support. In other words, as Headlam puts it, “It may be premature, however, to base any analytical assertions in Perle’s music upon voice-leading procedures analogous to tonality as an explanatory category.”<sup>13</sup>

One of the chief differences between Carrabré’s approach and Headlam’s is that Carrabré presupposes prolongation, but Headlam does not. Neither does Headlam discard

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<sup>13</sup> Headlam, “Tonality and Twelve-Tone Tonality,” 301-333.

prolongational analysis absolutely. Rather he says, “The use of labels such as ‘passing tones’ or ‘arpeggiations’ in their prolongational sense needs to be substantiated.”<sup>14</sup> In my judgment, Headlam’s cautious approach is appropriate. Perle’s music is suggestive enough of traditional categories that the analyst would be unwise to reject prolongational analysis out of hand, but prolongational analysis of atonal music is dubious enough that the analyst would also be unwise to presuppose it as a point of departure.<sup>15</sup>

An associational approach can be found in the third chapter of Gretchen Foley’s Ph.D. dissertation.<sup>16</sup> She looks at two of Perle’s etudes from an explicitly Fortean perspective. “The investigation moves decidedly outside the context of twelve-tone tonality, employing instead labels and tools of pc set theory.”<sup>17</sup> Her major analysis, however, is more closely related to Perle’s own approach. The way she represents her harmonic units follows Perle’s practice. Example 1.2 is part of an analysis of Etude no. 1 from Perle’s *Six Etudes for Piano* taken from Foley’s dissertation. The numbers in bold followed by a colon represent sums. They are used to label Perlean arrays. The numbers in plaintext represent pitch classes, and are organized into segments of the array. Each segment is a distinct harmonic entity and corresponds to the music immediately above it. In effect, they are chord labels, only they include rather specific information.

The kind of representation shown in Example 1.2 is the most common in the literature on Perle, stemming from own Perle’s analysis of his music. Although a voice leading can be teased out of it, making the voice leading explicit is not its purpose. Given Straus’s distinction between associational and transformational approaches, this kind of

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<sup>14</sup> Ibid.

<sup>15</sup> See Straus, “The Problem of Prolongation in Post-Tonal Music.”

<sup>16</sup> Gretchen Foley, *Pitch and Interval Structures in George Perle’s Theory of Twelve-Tone Tonality* (Ph.D. dissertation, University of Western Ontario, 1998).

<sup>17</sup> Ibid., 59.

analysis is more closely related to the former, since it focuses on the harmonic objects rather than the transformations between them.

8,9:	10 10	6 2	4 4	0 8	5,6: 5 0 6	9 8 10	6 11 7
9,6:	11 7	3 3	5 1	9 9	8,5: 2 6 11	11 9 8	3 5 0

**Example 1.2, Foley’s analysis of mm. 25-26 of Etude no.1 from *Six Etudes for Piano* by George Perle.**

The transformational approach to Perle’s music has received the most attention in connection with Klumpenhouwer networks (K-nets). One of the most remarkable features of Perle’s system is the variety of sonorities it produces. Harmonies are not associated on the basis of transposition or inversion alone, but on the interplay between intervals and indices. K-nets are transformational networks designed for transformations that combine transposition with inversion. When David Lewin introduced K-nets to the theoretical community, Perle noticed a connection with the kinds of structures he had been studying all his life; he felt that K-net analysis was redundant in light of his own work.<sup>18</sup> Lewin defended K-net analysis, concluding that although it intersected with Perle’s work, it was nevertheless from a different perspective and could contribute unique insights.<sup>19</sup> Lewin’s

<sup>18</sup> Lewin, “Klumpenhouwer Networks and Some Isographies That Involve Them,” *Music Theory Spectrum*, 12/1 (1990), 83-120; and “A Tutorial on Klumpenhouwer Networks, Using the Chorale in Schoenberg’s Opus 11, No.2,” *Journal of Music Theory* 38/1 (1994), 79-101; Perle, Communication, *Music Theory Spectrum* 15/2 (1993), 300-303.

<sup>19</sup> Lewin, “Thoughts on Klumpenhouwer Networks and Perle-Lansky Cycles,” *Music Theory Spectrum* 24/2 (2002), 196-230.

response was part of an issue of *Music Theory Spectrum* that dealt with the intersection of K-nets and twelve-tone tonality. More recently, Foley has demonstrated ways in which K-nets may be used profitably in analyzing Perle's music.<sup>20</sup> And Michael Callahan has succinctly shown the relationships between K-net transformations and twelve-tone tonality.<sup>21</sup>

I will not have occasion to use K-nets in my analysis for three reasons. The first reason has to do with the visual appearance of K-nets. The networks are designed to show complex and abstract relationships. They are clumsy when it comes to showing the simple flow of voice leading, especially through long passages.<sup>22</sup>

Second, in terms of K-nets the harmonies within any one of Perle's arrays are all strongly isographic with respect to one another—that is, they can all be interpreted with identical networks. Strong isography is something like an identity relationship. K-nets do not distinguish between different progressions if they have the same isography; it only distinguishes between different isographies. But Perle's music contains long passages, sometimes pages, in which the array—and therefore the isography—does not change. K-net analysis will not help us study the voice-leading of such passages. Rather, K-nets are better at illustrating the more abstract relationships between one passage and another, than showing the intricate voice leading that occurs within a single phrase. Not

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<sup>20</sup>Gretchen Foley, "The Efficacy of K-Nets in Perlean Theory," *Music Theory Online* 13/3 (2007); and "Arrays and K-Nets: Transformational Relationships within Perle's Twelve-Tone Tonality," *Indiana Theory Review* 23 (2002), 69-97.

<sup>21</sup>Michael Callahan, "Mapping Sum-and-Difference Space: Parallels Between Perle and Lewin," *Theory and Practice* 33 (2008), 181-217.

<sup>22</sup>For a related discussion of K-nets, see Michael Buchler, "Reconsidering Klumpenhouwer Networks," *Music Theory Online* 13.2 (June 2007), <http://mto.societymusictheory.org/issues/mto.07.13.2/mto.07.13.2.buchler.html>; and Shaugn O'Donnell, "Embracing Relational Abundance," *Music Theory Online* 13.3 (September, 2007), <http://mto.societymusictheory.org/issues/mto.07.13.3/mto.07.13.3.odonnell.html>.

surprisingly K-net analysis of Perle's music has focused on the background, not the foreground. A significant part of my analysis aims at describing foreground patterns.

Third, in basic transformational analysis, arrows often map one instance of a voice onto another instance of the same voice (however "voice" may be defined). For example, an arrow with a  $T_n$  label probably suggests that the arrow connects two notes from the same voice, and that the first note "travels" at  $T_n$  to get to the second note. Although K-nets are transformational networks, and the nodes of a network may be interpreted as voices, the arrows are pointed inward, describing transformations between voices rather than between instances of the same voice. The labels that do connect one harmony to another, such as  $\langle T \rangle$  (read "hyper T") do not directly show the voice leading between the harmonies, but rather show the relationship between the networks that interpret the harmonies. Shaun O'Donnell makes this point in discussing the difference between his dual transformations and K-nets. He writes:

Dual transposition (like traditional transposition) transforms pitch classes through a specified external or horizontal motion... K-nets' internal transpositions and inversions transform pitch classes by a vertical distance, or through a vertical axis. This process makes the set dynamic, yet renders the transformation static; the horizontal voice leading results from equivalent locations in the internal or vertical structure rather than from any particular linear transformation.<sup>23</sup>

Of Straus's three approaches discussed, mine relates most closely to the transformational approach. I am not as interested in the harmonies themselves as I am in the movement of voices between harmonies. Further, as is typical of the transformational

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<sup>23</sup> Shaun O'Donnell, "Klumpenhower Networks, Isography, and the Molecular Metaphor," *Intégral* 12 (1998), 70.

approach, I distinguish between voice and line. A line connects pitches on the basis of some common element, usually register or timbre. A voice, on the other hand, connects pitches on the basis of an underlying voice-leading syntax. Voices and lines may coincide—that is, a voice may also be a line. But in transformational analyses of post-tonal music, they usually do not coincide. The coincidence of voice and line might be viewed on a continuum. On one side of the continuum there is a perfect coincidence: lines are voices and *vice versa*. In that case, one might say with respect to the musical surface that the voice leading is perfectly *clear*. On the other side of the continuum there is no correspondence whatsoever between voice and line. In that case one might say that the voice leading is *obscure*. This distinction will be helpful in describing the relationship of Perle’s voice leading to the musical surface. For the most part, however, my analysis focuses on the voice leading alone.

Straus observes that “transformational analyses in general do not purport to describe voice leading of entire passages, much less in entire pieces.” He goes on to say, “I don’t think that the post-tonal repertoire lends itself to single, all-encompassing readings of that kind.”<sup>24</sup> If Straus is right about the repertoire in general, Perle’s music represents a significant exception. In Perle’s music such an all-encompassing reading for every note (top to bottom, beginning to end) is possible because Perle’s voice-leading syntax is well-defined and consistent. And because my analytical model captures that syntax, I can indeed attempt to describe the voice leading of entire passages and even entire pieces. As Shaugn O’Donnell observes, “It is absolutely essential that a successful voice-leading model be capable of describing complete passages, because there must be

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<sup>24</sup> Straus, “Voice Leading in Atonal Music,” 259.

some aural continuity in these musical gestures or we would not reify them with the term ‘passages.’<sup>25</sup>

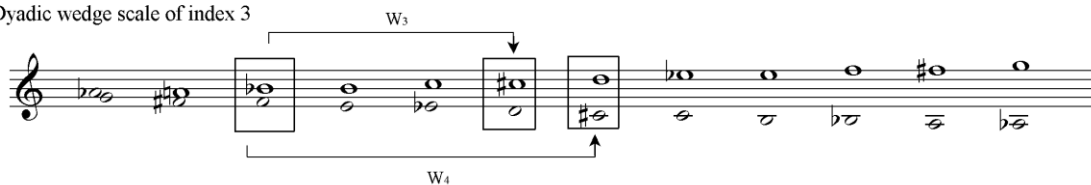
### Wedge Voice Leading, $W_n(A^B)$

Example 1.3 introduces the fundamental type of voice-leading motion in Perle’s musical language. In Example 1.3a, one dyad expands symmetrically or “wedges” onto another dyad. It is important to note that the first dyad neither transposes nor inverts onto the second dyad, yet the voice leading seems as intuitive as either transposition or inversion. In order to describe the motion in terms of traditional T or I labels, we can invoke O’Donnell’s dual transposition, in which a harmony is divided into two subsets that transpose differently, resulting in a composite transposition.<sup>26</sup> In the case of Example 1.3a, one note transposes at  $T_3$  while the other transposes at  $T_9$ . Another interpretation of the same progression is that one note transposes at  $T_4$  while the other transposes at  $T_8$ . Either way, the motion is symmetrical: the two voices move an equal distance in opposite directions.

(a) Voice leading between two dyads



(b) Dyadic wedge scale of index 3



### Example 1.3, Wedge voice leading for dyads

<sup>25</sup> Shaugn O’Donnell, *Transformational Voice Leading in Atonal Music* (Ph.D. Dissertation, City University of New York, 1997), p. 17

<sup>26</sup> O’Donnell, “Klumpenhouwer Networks,” p. 62 ff.

The principle of symmetrical motion lies at the heart of Perle’s music. Newton’s third law—for every action there is an equal and opposite reaction—aptly summarizes Perle’s pitch language. Put simply, in Perle’s music every time a voice moves, another voice moves the same distance in the opposite direction. I am using the phrase “opposite direction” loosely. Although Perle’s voice leading is sometimes expressed in pitch space, it more often lies in pitch-class space. To be more specific I should say that every time a voice moves at  $T_n$ , another voice moves at  $T_{12-n}$ .

$T_n/T_{12-n}$  is but one instance of O’Donnell’s dual transposition. Yet since it forms the core of Perle’s voice leading, since it is constantly and consistently applied throughout his music, and since no reference will be made in this paper to any other kind of dual transposition,  $T_n/T_{12-n}$  will have its own name, “Wedge,” and its own symbol, “ $W_n$ .” Wedge, then, may be defined as a specific kind of dual transposition in which the two subsets of a harmony transpose by complementary T numbers. Specifically, for subsets (A) and (B) of some collection  $\{AB\}$ ,  $W_n(A^{\wedge}B) = \{T_n(A), T_{12-n}(B)\}$ . Three things should be noted. First, a caret (  $\wedge$  ) is used in the expression to separate the intended subsets. Second, the notated order of the subsets in the expression is important. The subset on the left side of caret is transposed at  $T_n$ , while the subset on the right side of the caret is transposed at  $T_{12-n}$ . Third, the subsets themselves may be of any cardinality greater than zero, though twelve-tone tonality uses only a few of the possibilities.

In letter (a) of the example, the voice leading can be expressed as  $W_3(B^{\flat}^{\wedge}F) = (C^{\sharp}^{\wedge}D)$  or  $W_4(B^{\flat}^{\wedge}F) = (D^{\wedge}C^{\sharp})$ . We can say that the first dyad “wedges” onto the second at  $W_3$  or  $W_4$ , depending on our interpretation. The subscripts might also have been 9 and 8 instead of 3 and 4. The choice is not significant at this point, but it is important to be

consistent in order to avoid confusion. As a convention, whenever a wedge progression is shown in pitch notation, the element that transposes at  $T_n$  will be in the “upper voice.” Thus it is motion of the “upper voice” in example 1.3b that provides the  $W$  subscript. A helpful way to remember it is to think of wedge as an expansion primarily. For example, a dyad that wedges at  $W_1$  will appear to expand by one semitone in the voice-leading analysis, whereas a dyad that wedges at  $W_{11}$  will appear to contract by one semitone. Of course, such an expansion or contraction may not be what is expressed on the surface of the music.

O’Donnell also uses the symbol “ $W_n$ ,” but my usage is slightly different from his. In his usage the  $W$ -number represents the vertical index of the wedging dyads, whereas in mine it represents the number of semitones traversed in pitch-class space by each voice. While an index number is of value in naming a group of symmetrically related dyads, it tells you very little about the voice leading involved because it does not tell you how many semitones a voice travels. Suppose the dyad (CD) wedges at  $W_2$ , there would be no telling whether it should map onto (BD#), (BbE), (AF) or any particular dyad with an index number of two. A more specific use of Wedge is implicit in O’Donnell’s language however, as when he speaks of “two pitches” that “wedge further apart by a whole tone each.”<sup>27</sup> To say that they wedge apart by a whole tone is to describe a voice leading motion in clear and specific terms, which is what I have attempted to capture in my revised use of  $W_n$ .

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<sup>27</sup> O’Donnell, *Transformational Voice Leading*, p.91.

Example 1.3b shows a complete dyadic wedge scale. All dyads of index 3 are arranged by semitone. Since all of the dyads in a wedge scale share the same index number, it is convenient to use that number as a label for the scale.

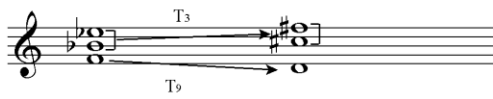
Note: Accidentals affect only the notes to which they are attached.

### Example 1.4 All possible dyadic wedge scales

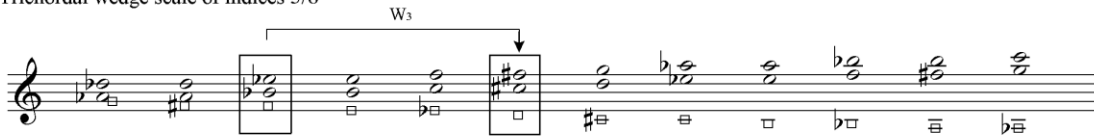
Example 1.4 shows all possible dyadic wedge scales. Every dyad belongs to one and only one of these scales. Except unisons, every dyad has exactly two locations on its one scale. For instance, the dyad (CE<sup>b</sup>) is located in two places on the index 3 scale and nowhere else. One could conceive of these scales as small voice-leading spaces for dyads in which motion along the scale is governed by wedge voice leading. There are twelve scales that divide into two kinds, even and odd. The even scales are shown in the left column and the odd scales are shown in the right column. Since an even index number

entails an even interval number, the even scales contain only even intervals and the odd scales contain only odd intervals. All the even scales are T-related, as are all the odd scales. There are only six distinct transpositions of each type of scale because transposition by T6 results in an identical scale. Therefore  $T_0=T_6$ ,  $T_1=T_7$ ,  $T_2=T_8$ ,  $T_3=T_9$ ,  $T_4=T_{10}$ , and  $T_5=T_{11}$ .

(a) Voice leading between two trichords



(b) Trichordal wedge scale of indices 3/8



### Example 1.5, Wedge voice leading for trichords

While dyadic wedging is important in Perle's music, it is trichordal wedging that lies at the very center of his musical language. Example 1.5 illustrates a trichordal wedge. Example 1.5a shows two trichords. As in Example 1.3a they are related neither by transposition nor inversion, but we can invoke dual transposition to describe the voice leading between them. And as before, the operation is symmetrical:  $T_n/T_{12-n}$ . That being the case, we can describe the voice leading as a wedge. Specifically, we can say that the first trichord wedges onto the second at  $W_3$ , since  $W_3(E^bB^b^A F) = (F^{\#}C^{\#}D)$ . It might be noticed that there is an inherent asymmetry in such a trichordal wedge in that a dyad is

pitted against a singleton. It is the dual motion that is symmetrical, not the structure of the trichord. The trichord itself may or may not be symmetrical.<sup>28</sup>

Example 1.5b gives the complete wedge scale containing the foregoing trichords. Since there are now two notes moving symmetrically against one, there are now also two indices shared by all the trichords of the scale: index 3 between the singleton and the lower note of the upper dyad, and index 8 between the singleton and the dyad's upper note. As in the previous example, I will use the indices to identify trichordal wedge scales. Accordingly, the wedge scale in Example 1.5b is identified with the label "3/8." As a convention, the singletons will be shown in a lower register than the dyads. The W subscript, then, will always be taken from the motion of the upper dyads. The voice leading for Example 1.5a is therefore expressed as  $W_3$  rather than  $W_9$  because the upper dyad transposes at  $T_3$ .

The wedge is an essential tool for analyzing Perle's voice leading. But it is also valuable for analyzing other music. The symmetrical expansion and contraction of voices is a device composers have used at least since the invention of equal tempered tuning. Bach's chromatic wedge shown in Example 1.6 is best understood in terms of its diatonic context. Nevertheless it is a striking example of Bach's tendency to fill in chromatic space on the keyboard, in this case through a symmetrical wedge.

The most likely use for Wedge as an analytical tool is in music where symmetry plays a consistent role. Works by Bartók and Berg come naturally to mind, and it is no surprise that a large portion of Perle's analytical effort was spent on these two composers.

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<sup>28</sup> The relationship between symmetrical construction and symmetrical motion is important in Perle's analysis of Bartók's Fourth String Quartet. See George Perle, "Berg's Master Array of the Interval Cycles," in *The Right Notes: Twenty-Three Selected Essays by George Perle on Twentieth-Century Music* (Stuyvesant, NY: Pendragon Press, 1995), 207-236; see also *Twelve-Tone Tonality*, 12-17.

The famous lullaby from *Wozzeck* shown in Example 1.7 illustrates the kind of situation where a  $W_n$  label would be handy.



**Example 1.6, Bach, *Fantasia and Fugue in C Minor*, BWV 906, m. 33**



**Example 1.7, Berg, "Marie's Lullaby" from *Wozzeck*, mm. 1-2.**

Without a doubt, however, no composer has exploited the potential of wedge voice leading as George Perle has. It served as the core of his pitch language for most of his long life. In nearly all his scores, virtually every pitch is referable to wedge scales like those just illustrated.

### **Wedge Voice Leading and Twelve-Tone Tonality**

In order to show the relationship between my analytical apparatus and Perle's I will give a summary explanation of some basic concepts of twelve-tone tonality. My intention is not to repeat the excellent work done by Foley and others at clarifying Perle's

treatise. Indeed, if that were my purpose my explanation would be quite incomplete, leaving out many of the more interesting and important concepts found in Perle's system. Rather my intention is to show some of the ways in which my analysis, although rooted in Perle's own explanations of his language, is rather different in perspective. Further, since my terminology sometimes differs from Perle's, this will be an opportunity to clarify the difference. In order to understand this dissertation it is not necessary to be fluent in the terminology of twelve-tone tonality.

The most widely discussed feature of twelve-tone tonality, the derivation of Perle's harmonies, is easily summarized. Perle weaves together an interval cycle and its inversion to create a unique ordered set called a "cyclic set" (Example 1.8a). Then he creates harmonies by combining two- or three-note segments from two different cyclic sets (Example 1.8b). The association of two cyclic sets in this way is called an "array."

It should not be inferred from the brevity of my account that Perlean arrays are not complex. Much could be said about them, of which a perusal of the relevant literature is proof enough. Suffice it to say that their unique properties provide a consistent basis for small- and large-scale harmonic relationships. Harmonies drawn from the same array are analogous to tonal harmonies drawn from the same key in that they form a definable group.<sup>29</sup> A passage of music may move within a single array, or it may modulate from one array to another.

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<sup>29</sup> In twelve-tone tonality, "key" and "mode" are technical terms that describe sum and difference relationships within the array.

(a) A cyclic set

○ = Interval 1 Cycle  
● = Interval 11 Cycle

The image shows a single staff of music with a treble clef. It contains a sequence of notes: C4, D4, E4, F4, G4, A4, B4, C5, B4, A4, G4, F4, E4, D4, C4. The notes are marked with circles. The first circle is open (Interval 1 Cycle) and the rest are filled (Interval 11 Cycle). A legend below the staff defines these symbols.

(b) Segments from two cyclic sets combined

The image shows two staves of music. The top staff is the same cyclic set as in (a). The bottom staff is a second cyclic set, shifted to the right. Two rectangular boxes are drawn around segments in both staves. Arrows point from these boxes to a chord diagram below. The chord diagram shows a treble clef with a sharp sign (F#) and a bass clef with a flat sign (Bb). The notes are: treble clef (F#, C5), bass clef (Bb, F4).

### Example 1.8, Derivation of Perle's harmonies

The forgoing description of how Perle generates his harmonies departs slightly from the usual understanding. Normally the cyclic sets from Example 1.8b would have been arranged so that the boxed segments were in alignment. If the chord had been composed of other segments, those segments would have been in alignment. Thus, the array is usually pictured as two cyclic sets that slide back and forth into different alignments from which harmonies may be extracted. The subject of alignment, especially the pattern of vertical sums and differences that are the result of alignment, is an important topic in Perle's treatise, but inasmuch as it is not directly relevant to voice leading, I will not address it further. Perle's harmonies may be conceived simply as a segment from one cyclic set combined with a segment from another—regardless of alignment.





labeling system.<sup>30</sup> He designates each sum with a “p” or “i” using a rule that is not easy to deduce.<sup>31</sup> One of Perle’s labels, such as “p<sub>0</sub>p<sub>7</sub>,” consists of two tonic sums with their p/i designations. But it is not the index that is considered prime or inverted. The labels are designed rather to show whether the set itself is in a prime or inverted form. But what is gained in precision by the labels does not equal what is lost in accessibility, and some of the literature on Perle has abandoned them in favor of a simpler system in which sets are named simply by their two unique index numbers, without p/i designations, a convention I will follow. For example, “p<sub>0</sub>p<sub>7</sub>” will be labeled “0/7”.

Perle calls the interval created by the neighbor-note dyad the “cyclic interval.” It is the interval that generates the interval cycle that builds the set. It is an interval and not interval class because Perle distinguishes between which cycle is to be considered prime, and which inverted. He even seems to go to pains to avoid invoking the concept of interval class. Observe the advice he gives for deducing the cyclic interval from a set’s label: “The cyclic interval of a set may be deduced by subtracting an even p or odd i sum from the alternate sum, or by subtracting the alternate sum from an odd p or even i sum.”<sup>32</sup> He could have said that the cyclic interval *class* is found as the difference between the set’s index numbers. Thus, for the set 7/0 the cyclic interval-class is 5,

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<sup>30</sup> To the frustration of readers of *Twelve-Tone Tonality*, the labeling system is not explained well. It is first introduced on p. 23 only with the statement that “Lower-case letters will be used for the names of cyclic sets.” The labels p<sub>0</sub>p<sub>7</sub> and i<sub>5</sub>i<sub>0</sub> are given as examples. But the reader is not told just how the p and i labels are to be applied, nor in what sense a sum may be considered as prime or inverted. The only other help comes more than fifty pages later in a passing comment about the label p<sub>6</sub>i<sub>8</sub>: “Both sums being even, each takes its aspect name from the cycle that contributes the left element of each adjacency.” (p. 77)

<sup>31</sup> Though it is never stated outright, the rule can be deduced and stated this way: Tonic sums are ordered dyads containing “right and left” notes. 1) If the index number of a tonic sum is *even*, attend to the left note: if it comes from the prime interval cycle then the sum is given a “p” designation, but if it comes from the inverted cycle then the dyad is given an “i” designation. 2) If the index number of a tonic sum is *odd*, attend to the right note: again, if it comes from the prime interval cycle then the sum is given a “p” designation, but if it comes from the inverted interval cycle then the dyad is given an “i” designation. One must decide in advance which cycle is to be considered prime and which inverted—it is a matter of perspective.

<sup>32</sup> *Twelve-Tone Tonality*, 23.

because  $0 - 7 = 5$ . In the end, however, it is a matter of interpretation whether, say, an interval 5 is considered an actual interval 5 or an inverted interval 7.

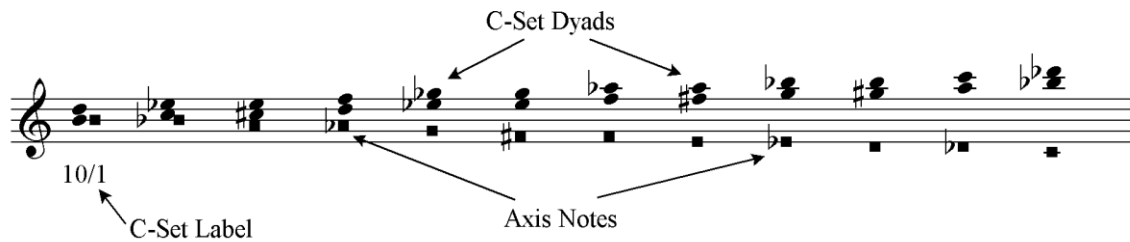
When three-note segments are construed as trichords, they manifest both properties (Example 1.10c). Property 1 is manifest as an ever-present dyad (shown in open noteheads); property 2 is manifest as the symmetrical balance between the neighbor note dyad and the axis note (shown in filled-in noteheads).

The reader will have noticed that when the three-note segments of a set are construed as trichords, as they are in the Example 1.10c, the result is a trichordal wedge scale of the kind described earlier (c.f. Example 1.5b). A trichordal wedge scale may be viewed as a manifestation of one of Perle's cyclic sets. Alternatively, a cyclic set may be viewed as a serial arrangement of a trichordal wedge scale. Either way, each three-note segment of the set corresponds to a trichord of the scale and *vice versa*. Perle's "axis notes" correspond to the singletons of the scale, and Perle's "neighbor-note dyads" correspond to the upper dyads of the scale. Further, the interval of each dyad corresponds to the set's cyclic interval (the interval that generates the cycle that builds the set).

In the past, analysis of Perle's music has involved referring harmonies back to the ordered array. Such analysis follows Perle's own example and has been a window into Perle's compositional practice. It also expresses the assumption that Perle's voice leading is the product of his harmonic concept. I wish to look at Perle's music from the opposite viewpoint—to give priority to voice leading. I wish to view wedge scales as self-sufficient entities that do not require reference to an ordered cyclic set. The chapters that follow will show that Perle's voice leading can be described and discussed without reference to the ordered array.

For this reason the term “C-set” will not be used in reference to Perle’s ordered cyclic set; rather it will refer to the collection of “strongly isographic” trichords expressed by a trichordal wedge scale. Further, the term “array” will not be used primarily in reference to the alignment of two ordered cyclic sets; rather, it will refer simply to the association of two C-sets.

I will use the term “axis note” in my analysis to refer to the singleton of a wedging trichord. I will refrain, however, from using Perle’s terms “neighbor note” and “neighbor note dyad.” Usually when Perle borrows a term from tonal analysis he intends an analogy. His use of “key” and “mode,” for example, are analogous to the use of the same terms in tonal analysis in that transposing a cyclic set produces a change of key, and internally restructuring a cyclic set produces a change of mode. His use of “neighbor note,” however, might be misleading because it does not have to do with “neighbor notes” as they are normally understood. Presumably the term was chosen because of the notes’ location on either side of the axis note in an ordered cyclic set. In order to reserve the term “neighbor note” for neighbor notes proper, I will refer to the dyads in question as C-set dyads. Example 1.11 illustrates the C-set vocabulary. Additionally, I will refer to the interval of the C-set dyad as the C-set interval, and the indices between the axis note and each member of the C-set dyad as the C-set indices. The C-set indices give the C-set its label.



**Example 1.11 C-Set vocabulary**

**Perle’s Voice Leading**

There are two main varieties of voice leading in Perle’s music: voice leading between hexachords and voice leading between tetrachords. It will be easiest to take them one at a time. Since tetrachords will be viewed as incomplete hexachords, I will begin with voice leading involving the latter.

Perle’s voice leading always involves a nested counterpoint—that is, a counterpoint of counterpoints. Voice leading between trichords has already been described. A trichord is divided into a dyad and a singleton which move equally in opposite directions. As long as the dyad’s interval doesn’t change, and motion between the dyad and the singleton is balanced, the resulting trichords will always be part of the same C-set. (Modulation from one C-set to another is discussed in the following chapter.) But Perle always uses two C-sets working in tandem. Moreover, except in some of his earliest music, the two C-sets take distinct voice-leading paths. In other words, there are two streams of wedge voice-leading running through the music at all times. Taken together, the two streams form a counterpoint of their own—thus, a counterpoint of counterpoints.

At times the voice leading is very *clear*, which is to say that it coincides or nearly coincides with musical lines. The voice leading is on the surface. But most of the time the voice leading is more or less *obscure*. Voices do not coincide with musical lines, so the voice leading is hidden beneath the surface. In such passages it would be valuable to have a lens, as it were, to enable us to peer through the musical surface and see the voice leading at work. Throughout this paper I will use a technique of voice-leading extraction designed to provide just such a lens. Example 1.12 illustrates using a passage from Perle's *Ballade* for piano. It contains three tiers of analysis. The first tier shows the voice leading in pitch-class space. The two streams of voice leading are distinguished by their noteheads. Filled-in noteheads represent one stream, and open noteheads represent another stream. Between the first and second tiers there is a key to show what C-sets the streams belong to. In this example the voice leading stream shown with filled-in noteheads belongs to C-set 10/1, and the stream shown with open noteheads belongs to C-set 7/11. (Recall that the labels represent the two constant indices of the C-set).

Additionally the two parts of a wedging trichord—the axis note and the C-set dyad—are distinguished by the shape of their noteheads. For either stream the axis notes have square noteheads and the C-set dyads have round noteheads. On the first tier the axis notes from both streams are placed in the bass clef, and the C-set dyads from both streams are placed in the treble clef. Where practicable, the streams are also distinguished spatially: one takes an outer registration (i.e., highest and lowest position), and the other takes an inner registration (i.e., a middle position).

*poco rit.* ----- ♩ = 96

Tier III:  
The score

Tier II:  
Voice leading  
in pitch space

●■ = 10/1  
○□ = 7/11

Tier I:  
Voice leading  
in pc space

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### Example 1.12, Voice-leading analysis for George Perle, *Ballade* mm. 5-6

The second tier shows the voice leading in pitch space. It duplicates the registral and rhythmic position of pitches in the actual score, but it also duplicates the noteheads in the first tier. Boxes isolate harmonies. The two voice-leading streams remain distinct; the axis notes and C-set dyads remain distinct; but voices now have a place in the musical texture. The third tier is the score itself.

A three-tier representation may seem bulky, but each tier contributes something important that the other tiers do not. The first tier shows the voice leading in its simplicity. It enables us to take in each stream of voice leading separately or together with relative ease in order to see the flow more clearly. Further, we can more easily see the counterpoint between the streams by focusing on the axis notes alone. Since the motion between the axis notes and C-set dyads is always symmetrical, the path of the axis note

implies the path of the C-set dyad. For that reason the singleton may be taken to represent the trichord as a whole. The bass clef of tier one, then, which contains the axis notes of both C-sets, represents the voice-leading path of both streams together. It can be used to analyze the interaction of the two sets, something that has never been done before. We might notice, for instance, by looking at the bass clef of tier one in this example, that from the second chord to the third, and from the third to the fourth, the two streams wedge against each other at  $W_1$ . Such an observation may or may not be relevant to an overall analysis, but the possibility of saying such a thing is enticing.

The simple flow of voices is not as easy to see in the second tier. But it contributes something to the analysis that the first tier cannot. It is designed to be compared to either tier one or tier three—the abstract voice leading, or the surface of the music. It serves, in a manner of speaking, as a translator between the two. Further, it enables us to trace the actual path that a voice or stream takes on the surface. It enables us to compare voices with lines, and to see what role registral and temporal placement of voices plays in the music. The third tier, the actual score, is important not only for the purpose of verification, but also so that the details—dynamics, articulation, tempo, pedal markings, and so forth—might be allowed to contribute to the analysis.

Passages like the one quoted, in which the two streams of voice leading consist in wedging trichords, contain the least ambiguous voice leading. Yet there is still some ambiguity that has to be recognized. For example, the first tier analysis of the passage indicates that in the last chord there are three instances of the note ‘F.’ Multiple instances of a pitch class are not to be thought of as redundancies. Voices remain distinct even when they share the same pitch class. In such cases it is usually Perle’s practice to

instantiate each voice separately in the music, although sometimes a single note represents more than one voice.

On the other hand, a single note of a voice is sometimes represented multiple times at the musical surface because of repetition or octave doubling. In the beginning of the passage above, for example, the dyad (C#F) occurs twice on the surface, though it occurs only once in the voice leading. In the second tier analysis, multiple occurrences of the same voice will be either left out or connected with a dotted slur as they are here. The use of the dotted slur is meant only to show repetition; it is not meant to suggest the prolongation of that voice.

Returning to the last chord, the multiple instances of F in the voice leading are represented by multiple instances of F in the music. But it is not clear which instance of F in the music represents which voice. In order to preserve continuity in the second tier analysis, the analyst has to decide which voice moves where. In making the decision, contextual factors such as agreement with the interpretation of the passage as a whole will interact with *a priori* voice-leading principles. There are two *a priori* principles in particular that will inform my own judgment in these cases. The first is the traditional law of parsimonious voice leading. Put simply, I will prefer to move voices as short a distance as possible. The justification for this principle comes from its widespread use in voice-leading analysis of many different kinds of music. Moreover some of Perle's writings suggest that he was concerned with this principle.<sup>33</sup> Second is the principle of clarity. My preference will be for voices to coincide with lines where possible. The

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<sup>33</sup> For example, in the chapter titled "Composing with Twelve-Tone Modes," he says: "A second step toward a compositional interpretation... would be the imposition of a voice-leading design by applying the traditional 'rule' of elementary tonal harmony respecting the treatment of common tones." *Twelve-Tone Tonality*, 42.

justification for this principle is only my intuitive impulse as an analyst and listener. Contextual factors might trump these principles, and one or more of these principles might trump contextual factors. There will also be situations in which different interpretations have equal merit.

So far I have been describing the voice leading of hexachords. The voice leading of tetrachords presents a rather different and more complex picture. But it is based, as all Perle's voice leading is based, on the voice leading that has already been described. As mentioned earlier, tetrachords are considered incomplete hexachords. More specifically, a tetrachord is divided into two dyads, and each dyad is an incomplete trichord. Voice leading in the foregoing situation consisted in two streams of wedging trichords. The difference in the following situation is that each of the trichords will be missing one of its elements. Thus, dyads will not be considered as dyads *per se*, but as partial trichords.

Example 1.13a shows a simple wedge progression between two trichords. It might occur as part of one stream of voice leading. Because a wedging trichord has two components—the axis note and the C-set dyad—we can whittle it down in two basic ways: by removing the axis note or by removing one of the elements of the C-set dyad. Example 1.13b shows three possibilities. In the first instance both chords lose the singleton. The result is no longer a wedge but a simple transposition. Since there is no possibility of wedge voice leading, this kind of progression does not typically occur in Perle's music. As a rule the axis note is always present, though there may be exceptions.



The remaining possibilities are more typical. In the second and third instances each chord loses one note from its C-set dyad. The result is still a wedge. But since it is only a dyadic wedge, it introduces some ambiguity. Without prior knowledge it is impossible to say which note is the axis note. And if it is not clear which note is the axis note, then it will not be clear what path each voice actually takes since there are always two ways to interpret wedging dyads, as Example 1.13c illustrates. The ambiguity would clear up if we always knew what the complete trichord was, but without knowing the axis note we can never be sure what the missing element is. Example 1.13d shows a pair of notes and a trichordal wedge scale. Assuming we know that the notes comes from C-set 0/5, there are still two possible interpretations, shown in boxes in the example.

Example 1.13e shows two more ways to whittle down Example 1.13a. This time the two chords do not shed the same voice. Although the result is not a direct wedge, indirect wedge voice leading is still possible, in fact unavoidable when more chords are added. Examples 1.13f-h illustrate the point. Example 1.13f extends the progression by a few chords. Example 1.13g whittles down each chord as before, removing one or the other element from the C-set dyad. Example 1.13h brings out the wedge voice leading using beams and stems. Since the progression comes from C-set 0/5, the wedges exhibit the indices 0 and 5. Dyads with downward stems share the index number 0, and dyads with upward stems share the index number 5.

The previous example deals with only one set and so only one stream of voice leading. But in Perle's music there are always two streams flowing at once. Example 1.14 is an excerpt from the first movement of *Brief Encounters*, Perle's last string quartet. The passage uses only tetrachords. Beneath the score there is a voice leading analysis showing

two streams. The streams come from the two C-sets of the array, 1/5 and 7/8.<sup>34</sup> The parentheses in the penultimate chord of the excerpt are mine, and the (x) that marks each note of that chord is mine as well. The chord is not part of the array. It is an instance of Perle’s “dissonant figuration” discussed at the beginning of this chapter. In each line, the note marked with an (x) fills in the space between the note before and after it with part of an interval cycle.

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**Example 1.14, George Perle, *Brief Encounters, I* “Rondoletto,” mm. 2-3**

<sup>34</sup> Readers unfamiliar with twelve-tone tonality may be curious how I arrived at the array. There are a number of strategies an analyst may take in order to “crack the code,” but it is beyond the scope of this essay to illustrate them. For a discussion of some strategies, see David Schober, *George Perle’s Six New Etudes: Symmetry, Audibility, and the Rhetoric of Reconciliation* ( Ph.D. dissertation, University of Michigan—Ann Arbor, 2004).

Patterns of voice leading begin to emerge when the two streams of voice leading are separated as they are here. The upper stream, for instance, forms a palindrome. The downbeat of the second measure is the center. In contrast, the other stream is asymmetrical. Symmetry versus asymmetry is a recurring theme in Perle's music, of which this short excerpt is a good example. Compare the asymmetrical rhythm and dynamics of the two measures with the symmetrical contour of the phrase.

While the voice leading analysis in Example 1.14 does enable us to peer through the surface of the music at the wedge voice leading beneath, it contains a great deal of ambiguity. Despite the clarity of the wedges, it is still unclear what specific path each voice takes because it is impossible to tell which notes the axis notes are. But the ambiguity is inherent in Perle's use of tetrachords to represent what can only be fully represented by hexachords. In the chapter on "sum tetrachords" in *Twelve-Tone Tonality* Perle writes:

The degree to which any given moment in a composition *must* be representative of the key and the mode of the work is no more predetermined for twelve-tone tonality than it is for diatonic tonality. But wherever it *is* fully representative an axis-dyad chord [a hexachord] will be uninterruptedly present in some sort of distribution among the simultaneities and melodic details of which that moment consists.<sup>35</sup>

In other words, the relationships of twelve-tone tonality are clearest in progressions involving hexachords, but the ambiguity inherent in the use of tetrachords is just as much a part of his musical language.

Finally, the topic of voice leading among tetrachords ought not to pass by without a word about chapter 32 of *Twelve-Tone Tonality*, "Voice-Leading Implications of Sum

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<sup>35</sup> *Twelve-Tone Tonality*, 55; emphasis original.

Tetrachords.” With such a title the chapter would seem directly relevant to the discussion at hand. While it is full of penetrating insight, it does not bear directly on the present discussion of voice leading. In the context of current analysis of atonal voice leading Perle’s chapter is more properly about registral lines than voices. Its main topic is the relationship between the collective sum of a tetrachord (the sum of all pitch-class numbers of the tetrachord) and the total number of semitones that must be displaced in the various registral lines in order to progress to a tetrachord of a different collective sum. The study is highly instructive, but is not immediately relevant to our study of wedge voice leading.

## Chapter Two

### Voice Leading of C-Sets

The previous chapter explained how Perle's music contains two streams of voice leading working together. Each individual stream moves within a C-set, and the two streams together move within an array. It is both logical and useful first to study one voice leading stream in isolation, then to study two streams together. This chapter is concerned with the former. Although the patterns and techniques discussed here are based on Perle's practice, few examples are taken from his music since he never uses C-sets in isolation. Chapter 3, which deals with complete arrays, will be more directly relevant to Perle's scores.

We will begin with some observations about dyads, and then take up trichords and C-sets. Perle sometimes uses the terms "dyad" and "interval" interchangeably. In this paper "dyad" will refer to two-note collections. "Interval" will be used as an attribute of dyads. "Index" is another attribute. (The radical difference between index and interval, and the implications it has on how to listen to Perle's music, are discussed in Chapter 6.) Since the effect of transposition and wedge on the interval and index of dyads restricts the content of Perle's harmonies, it is useful to understand what happens to the interval and index of a dyad when it transposes, and what happens when it wedges.

First, the interval of a dyad does not change under transposition, but the index increases by twice the transposition number. Since an index number is taken from the sum of two pc numbers, when both numbers gain 1 there is a net increase of 2. Example

2.1a shows a dyad transposing at  $T_3$ . There is no change in the interval of course, but the index number increases by six because six is twice the transposition number.

The reverse is true under wedge. The index of a dyad does not change, but the interval increases by twice the wedge number. Since an interval is taken from the difference between two pc numbers, when one number gains 1 and the other loses 1, the difference between them either grows or shrinks by 2, depending on whether the dyad is expanding or contracting. Example 2.1b shows a dyad wedging at  $W_3$ . The interval increases by six because six is twice the wedge number. The index is not affected.

(a)		(b)	
Interval: 4	4	Interval: 4	10
Index: 2	8	Index: 2	2

### Example 2.1, Interval and index under $T_n$ and $W_n$

To summarize, transposition at  $T_n$  preserves the interval of a dyad but revises the index by the addition of  $2n$ ; wedge at  $W_n$  preserves the index of a dyad but revises the interval by the addition of  $2n$ .<sup>36</sup> Because the revision is always by a multiple of 2, it is always by an even number, thereby limiting the dyads that can be connected by wedge or transposition. A dyad with an even index cannot transpose onto a dyad with an odd index

<sup>36</sup> Inversion as an operation does not play a significant role in my methodology, but its effects on the interval and index of dyads can be described as well. Under inversion the interval of a dyad is, of course, inverted (about 0). The effect of inversion on the index is less obvious. The index number of an inverted dyad will be twice the inversion number minus the index number of the original dyad.

or *vice versa*. Neither can a dyad with an even interval wedge onto a dyad with an odd interval or *vice versa*. Example 2.2a illustrates the former case. Every possible transposition of an interval-5 dyad is shown. The index number of the dyad is always odd. Example 2.2b illustrates the latter case. No matter how the dyad is wedged, the interval number is always odd.

(a) Transposition

Interval:	5	5	5	5	5	5	5	5	5	5	5	
Index:	1	3	5	7	9	11	1	3	5	7	9	11

(b) Wedge

Interval:	1	3	5	7	9	11	1	3	5	7	9	11
Index:	9	9	9	9	9	9	9	9	9	9	9	9

### Example 2.2, Odd Interval and Index under $T_n$ and $W_n$

What makes a dyad's interval even or odd is also what makes its index even or odd. When a dyad's pcs are both even or both odd, it will have an even interval and index. When one pc is even and the other odd it will have an odd interval and index.<sup>37</sup> A dyad with an even interval, therefore, has necessarily also an even index and *vice versa*. Likewise a dyad with an odd interval has necessarily also an odd index and *vice versa*. I

<sup>37</sup> The reason is basic arithmetic: the difference between like integers is always even, while the difference between unlike integers is always odd; and adding like integers always has an even result, while adding unlike integers always has an odd result.

will sometimes refer to dyads themselves as even or odd without specifying interval or index.

With respect to transposition and wedge voice leading, then, even and odd dyads form mutually exclusive groups. Even dyads cannot wedge or transpose onto odd dyads, and neither can odd dyads wedge or transpose onto even dyads. The distinction is not merely arithmetical. Even dyads, in my judgment, have a palpably distinct sound that contrasts with odd dyads, owing perhaps to the fact that only they belong to the whole-tone scale. But regardless of any qualitative difference between the two groups, more pertinent is the lack of a voice-leading connection between them that preserves either index or interval. A dyad from one group can only move to a dyad from the other group by an unequal transposition or an asymmetrical wedge.

Unequal transposition and asymmetrical wedging are two ways of describing the same thing. Perle uses the term “semi-transposition” for the unequal transposition of the two cycles that generate a cyclic set. For this paper the term will be expanded to include the unequal transposition of two subsets of any chord. Semi-transposition is one of a number of similar tools designed recently by theorists for jury-rigging strict operations to allow for a broader range of connections among pc sets. Straus’s “near transposition,” for example, is designed to compare groups that are almost, but not quite T-related.<sup>38</sup>

The purpose of semi-transposition is to allow a voice-leading connection between even and odd dyads. In Example 2.3a and 2.3b even dyads semi-transpose onto odd dyads. In Example 2.3a one voice moves one semitone up while the other stays put. We will refer to this and similar situations as semi-T<sub>1</sub>. In Example 2.3b one voice moves

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<sup>38</sup> See, for example, Straus, “Voice Leading in Atonal Music,” in *Music Theory in Concept and Practice*, ed. by James Baker, David Beach and Jonathan Bernard (Rochester: University of Rochester Press, 1997), 237-274.

down while the other stays put. We will refer to this and similar situations as semi- $T_{11}$ . There are, of course, many other ways to produce unequal transpositions or asymmetrical wedges, but semi- $T_1$  and semi- $T_{11}$  are all that we require. The choice of calling this semi-transposition instead of semi-wedge is arbitrary, but it follows Perle more closely.

(a)

Interval: 4      5  
Index: 0      1

(b)

Interval: 4      3  
Index: 0      11

### Example 2.3 Semi-Transposition

In the previous chapter, wedge was described as a special case of O'Donnell's dual transposition. Semi-T can also be described as a special case of dual transposition—specifically, semi- $T_1$  is equivalent to the dual transposition  $T_0/T_1$ , and semi- $T_{11}$  is equivalent to the dual transposition  $T_0/T_{11}$ .

With the introduction of semi-transposition, all three prototypical voice-leading motions are available: parallel motion, which is transposition; contrary motion, which is wedge; and oblique motion, which is semi-transposition. Any voice-leading motion that is not one of these three can be viewed as a compound motion, combining two or all of them. For instance, the two dyads in Example 2.4a are connected by a compound motion combining semi-transposition and transposition. In Example 2.4b the two dyads are connected by a compound motion combining wedge and transposition. The compound motion in Example 2.4c combines semi-transposition and wedge. And finally, Example

2.4d shows all three motions combined. In any of these compound motions, the order of operations does not matter.

(a)  $\text{semi-T}_1 + \text{T}_9$  =

(b)  $\text{W}_1 + \text{T}_3$  =

(c)  $\text{semi-T}_1 + \text{W}_2$  =

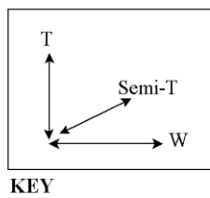
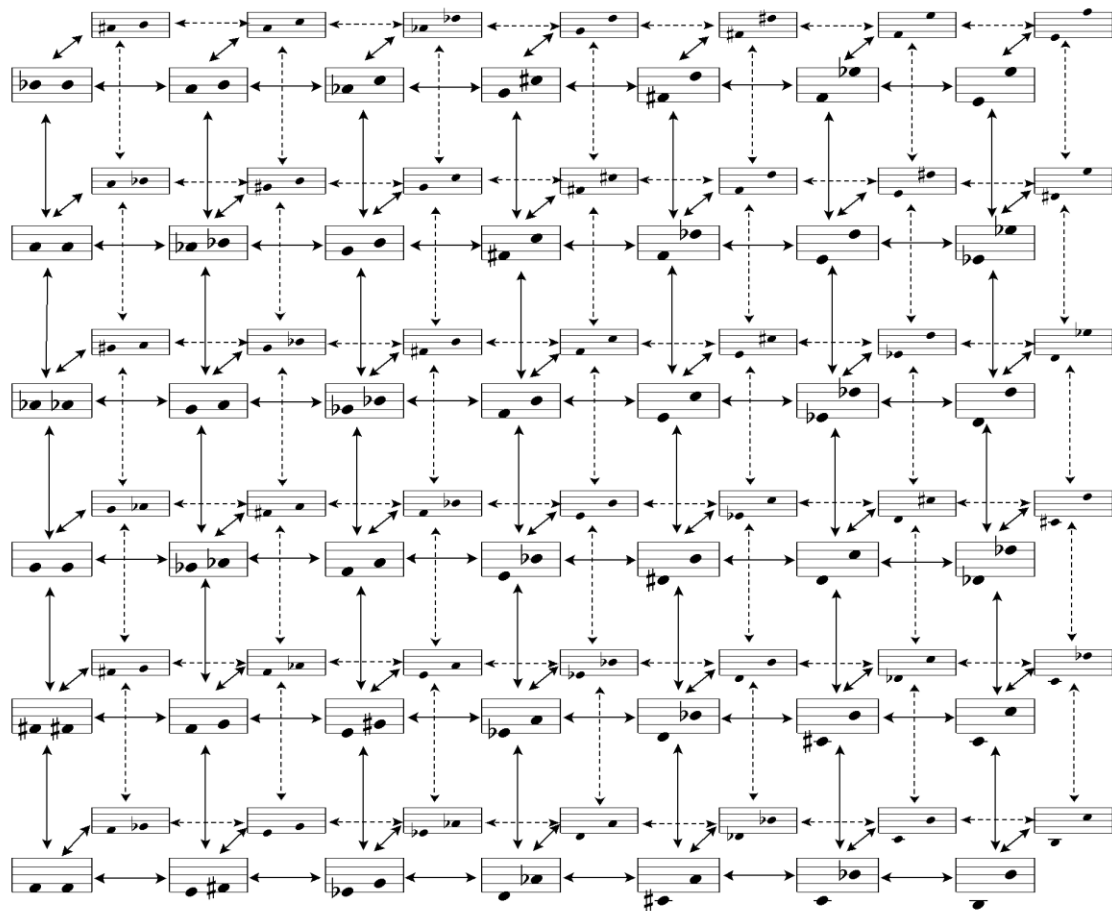
(d)  $\text{Semi-T}_1 + \text{W}_{10} + \text{T}_3$  =


### Example 2.4 Compound Motions

O'Donnell's dual transposition would describe all the progressions in Example 2.4 more efficiently, but there is an advantage to thinking of them, in this essay at least, as compound motions. First, it restricts the possible voice-leading motions to those that are central to Perle's language: wedge, transposition and semi-transposition. Second, it enables us to compare short compound motions, like those in Example 2.4, with longer progressions. Conversely, it will enable us to summarize longer progressions as short compound progressions.

Third, it enables us to construct a simple voice-leading space for dyads based on the three motions described. Example 2.5 shows what it might look like. Transposition

defines the vertical axis and wedge defines the horizontal axis, creating a plane. One plane contains either all the even or all the odd dyads. Semi-transposition defines a third axis connecting the even dyads with the odd dyads. Only two planes are necessary for all possible dyads to be represented. The space is self-contained since each axis, if continued, would repeat itself.



All staves 

**Example 2.5 Voice-Leading Space for Dyads**

## Trichords and Trichordal Wedge Scales

It is sometimes cumbersome to display entire C-sets or arrays. Fortunately, a single chord can be used *pars pro toto*. A trichord whose axis note is identified can serve as a synecdoche for its C-set. In Example 2.6 the trichord on the left stands for the entire C-set on the right. As long as the axis note is identified, as it is here using a square notehead, it is not difficult to visualize the wedge scale. I will sometimes use individual trichords to stand for entire C-sets.

The image shows a musical notation example. On the left, a treble clef staff contains a trichord consisting of three notes: a square notehead on the second line (F#), a square notehead on the second space (G#), and a square notehead on the third line (A). To the right of this staff is the text "STANDS FOR". To the right of this text is a larger musical staff enclosed in large square brackets. This staff contains a sequence of chords. The top staff of this sequence is in treble clef and contains eight chords, each with three notes. The bottom staff of this sequence is in bass clef and contains eight square noteheads, each corresponding to the axis note of the chord above it. The axis notes are: F# (square), G# (square), A (square), B (square), C# (square), D# (square), E (square), and F (square).

### Example 2.6 *Pars pro toto*

The image shows a musical notation example. It features a treble clef staff with three notes: a square notehead on the second line (F#), a square notehead on the second space (G#), and a square notehead on the third line (A). An arrow points down from the text "C-Set Dyad" to the G# note. Another arrow points up from the text "Axis Note" to the F# note.

### Example 2.7 Parts of a Trichord

In the language of twelve-tone tonality there are two main components to a trichord: the axis note and what Perle calls the “neighbor-note dyad,” which I refer to as the “C-set dyad” (Ex. 2.7). I will refer to the interval of the C-set dyad as the “C-set interval.” Both members of the C-set dyad join with the axis note to form two indices which I will refer to as “C-set indices.”<sup>39</sup> Looking at it another way, the C-set interval is only the result of the two C-set indices: since two voices are equally balanced against an “axis voice,” they must have a fixed distance from one another. Consequently, the C-set indices imply the C-set interval; if we know the one we can infer the other. The C-set interval can always be found as the difference between the two C-set indices. In Example 2.6 above for instance, the two C-set indices are 10 and 3. The difference between them is  $10-3=7$  or  $3-10=5 \pmod{12}$ . Therefore the C-set interval is 5, or its inversion 7. It does not particularly matter whether 5 or 7 is chosen since they are of the same interval-class. (In the course of analysis, however, it may be more helpful to choose one or the other for the sake of a particular interpretation.)

To wedge a trichord always produces a new trichords, but as long as the C-set dyad wedges against the axis note, the new trichords will always belong to the same C-set. Every set is characterized by its C-set interval and two C-set indices. The C-set shown in Example 2.6 is characterized by C-set interval 5 and the C-set indices 10 and 3. Any interval may serve as a C-set interval, and any pair of indices may serve as C-set indices.

In Perle’s music, C-sets are often related on the basis of a shared interval or index. If two sets share a C-set interval then they are related either by transposition or semi-

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<sup>39</sup> Perle calls them “tonic sums.”

transposition.<sup>40</sup> Example 2.8 shows C-set 8/1 and its  $T_1$  transposition, 10/3. Every trichord of the first C-set is transposed up a semitone in the second set. Since the numbers that name C-sets represent indices, they will increase by twice the transposition number, as discussed above. Thus C-set 8/1 becomes 10/3 under  $T_1$ . To arrive at C-set 9/2 from 8/3 requires a semi-transposition. The semi-transposition of a C-set requires holding its axis notes while the C-set dyads transpose up or down a semitone. Example 2.9 shows the semi-transposition of 8/1 onto 9/2 in *précis*. C-set 8/1 has one even and one odd C-set index. Under semi-transposition an even index number becomes odd (in this case 8 becomes 9) and an odd index number becomes even (in this case 1 becomes 2).

**Example 2.8 Transposition of a C-set**

**Example 2.9 Semi-transposition of a C-set**

<sup>40</sup> In Philip Lambert's K-net terminology, they belong to the same K-family. See Philip Lambert, "Isographies and Some Klumpenhouwer Networks They Involve," *Music Theory Spectrum* 24:2 (Autumn, 2002), 165-193.

Within a C-set there are at most six trichord-classes because every chord is duplicated at the tritone.<sup>41</sup> In Example 2.8 for instance, the first chord is the  $T_6$  transposition of the seventh chord, the second chord the  $T_6$  transposition of the eighth, the third of the ninth, and so on. Transposing a C-set by  $T_6$  therefore would only map each chord onto another from the same C-set. Transposition at the tritone is thus an identity operation, equivalent to  $T_0$ . For that reason there are only six levels of transposition for any C-set, not twelve. There are also six levels of semi-transposition. Table 2.1 lists all the C-sets that have C-set interval 5. C-sets in the same column are related by transposition; C-sets across the two columns are related by semi-transposition. As the table shows, there are exactly twelve C-sets whose C-set interval is 5 (or 7). There are in fact exactly twelve C-sets of any C-set interval, and they all likewise fall into two groups of six.<sup>42</sup> C-sets within a group are always related by transposition, and C-sets from one group to the other are always related by semi-transposition.

<b>0/5</b>	<b>1/6</b>
<b>2/7</b>	<b>3/8</b>
<b>4/9</b>	<b>5/10</b>
<b>6/11</b>	<b>7/0</b>
<b>8/1</b>	<b>9/2</b>
<b>10/3</b>	<b>11/4</b>

**Table 2.1 All C-Sets of C-Set Interval 5**

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<sup>41</sup> Lambert (“Isographies,” 169–171) makes similar and other helpful observations in relation to “K-classes.”

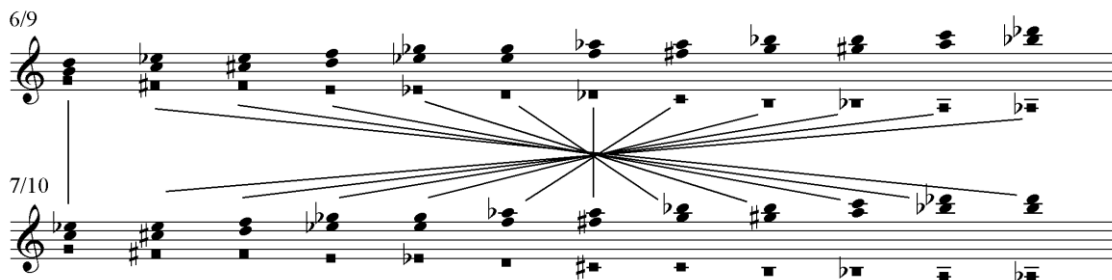
<sup>42</sup> The twelve T- and Semi-T-related C-sets correspond to one of Lambert’s K-families. He likewise divides them into two groups of six K-classes. See Lambert, “Isographies,” 170.

Since transposition perfectly preserves the harmonic content of a C-set, it constitutes one of the most basic relationships in Perle's music. Through transposition it is possible to present the same music at different pitch levels or to provide harmonic continuity by presenting different musical ideas using T-related C-sets.

Semi-transposed C-sets also form a valuable relationship, but unlike strict transposition, semi-transposition revises the harmonic content of a C-set. The precise effect of semi-transposition depends on whether the C-set interval is even or odd. If it is even, then the intervallic content of each chord changes significantly under semi-transposition. To be specific, two of the three intervals in each trichord will change. Only the C-set interval does not change. The reason is that the C-set indices of C-sets with an even C-set interval will both be even or both odd. That entails that the intervals of the dyads that form the C-set indices will likewise both be even or both odd. Since semi-transposition converts even to odd and *vice versa*, the dyads that form the C-set indices will change their even/odd aspect together. Thus two of the three dyads in a trichord change when a C-set is semi-transposed. Further, if a palpable, audible polarity between the even and odd dyads is granted, then the difference between C-sets related by semi-transposition will also be palpable, since one will have a preponderance of even intervals, and the other will have a preponderance of odd intervals.

C-sets with an odd C-set interval, on the other hand, have one odd C-set index and one even. When the indices change their aspect under semi-transposition, the result makes no difference: there will remain one even and one odd index. As a result, the harmonic content of C-sets related by semi-transposition whose C-set interval is odd is not significantly different. In fact, the two C-sets will be inversions of one other—every

chord from one C-set will be the inversion of a chord from the other. Example 2.10 illustrates with C-sets 6/9 and 7/10. Their C-set interval is 3 and they are related by semi-transposition. Trichords are connected to their inversions with a line. In terms of order, the C-sets are retrograde inversions of one another, though order does not play a significant role in Perle's music.



**Example 2.10 Semi-Transposed C-sets related by inversion**

Semi-transposed C-sets with odd C-set intervals, then, constitute a valuable harmonic relationship since they will be related by inversion, which means they will have the same interval content. What is more, inversion sometimes plays a role in Perle's motivic and thematic design. An easy way to ensure the possibility of motivic inversion is to use C-sets that are related by inversion. This is not to say that semi-transposed C-sets whose C-set interval is even do not make for a useful musical relationship. Rather, they form a different kind of relationship. Two such C-sets will be unified by virtue of their common C-set interval, but they will afford a contrast in that one will have more odd intervals and the other will have more even intervals. Such a balance of unity and contrast might be the kind of nuanced relationship a passage requires.

The relationships discussed so far are based on a shared C-set interval. C-sets can also be related on the basis of a shared C-set index. For example, C-sets 3/8 and 1/3 have different C-set intervals (5 and 2 respectively) but they share 3 as a C-set index. As a result, they share a dyadic wedge scale, shown in Example 2.11. The shared dyadic wedge scale is seen in slightly larger noteheads, and it is shown separately in the third system. It is worth noticing that corresponding chords between the two C-sets have two notes out of three in common, but only one interval out of three in common. Compare, for example, the first chord shown in both C-sets. They share the notes C and E $\flat$  and the interval between C and E $\flat$ , but differ in all other ways. This kind of relationship, like semi-transposition of sets with an even C-set interval, offers unity and contrast.

Example 2.12 shows, in a simple way, some potential uses of C-sets related through a shared C-set index. Example 2.12a takes a short progression from the first C-set of Example 2.11 and gives it a melodic interpretation. Then the melody is restated, but this time the progression is taken from the second C-set of Example 2.11, taking care to use the corresponding chords. The resulting melody is clearly based on the first, but different in obvious ways.

The image displays three systems of musical notation on a single staff, all in a key signature of two flats (B-flat and E-flat). The first system is labeled '(3/8)' and shows a sequence of chords: C4-E4, C4-E4-G4, C4-E4-G4-A4, C4-E4-G4-A4-B4, C4-E4-G4-A4-B4-C5, C4-E4-G4-A4-B4-C5, C4-E4-G4-A4-B4-C5, C4-E4-G4-A4-B4-C5, C4-E4-G4-A4-B4-C5, C4-E4-G4-A4-B4-C5. The second system is labeled '(1/3)' and shows a sequence of chords: C4-E4, C4-E4-G4, C4-E4-G4-A4, C4-E4-G4-A4-B4, C4-E4-G4-A4-B4-C5, C4-E4-G4-A4-B4-C5, C4-E4-G4-A4-B4-C5, C4-E4-G4-A4-B4-C5, C4-E4-G4-A4-B4-C5, C4-E4-G4-A4-B4-C5. The third system is labeled '(3) Shared dyadic wedge' and shows a sequence of notes: C4, E4, G4, A4, B4, C5, C4, E4, G4, A4, B4, C5, C4, E4, G4, A4, B4, C5. The notes C4, E4, G4, A4, and B4 are marked with larger noteheads, indicating they are part of the shared dyadic wedge scale.

**Example 2.11 C-sets sharing a C-set index**

**Example 2.12 Compositional use of C-sets sharing a C-set index**

Example 2.12b shows the same progression treated in a two-part contrapuntal texture. In the restatement of the phrase next to it, the left hand is no different, but the right hand is transposed up at  $T_5$ . This device takes advantage of the fact that when two C-sets are related in the way that these are, and when a progression from one corresponds to a progression from the other (i.e., when their trichords correspond), they will have two voices in common between them, and a third that differs by some fixed interval. In Example 2.12b, the left hand uses the two common voices while the right hand uses the other.

We have discussed C-sets that share a C-set interval and those that share a C-set index. C-sets may also be related on the basis of both a shared C-set interval and a shared

C-set index. Perle's term for C-sets so related is "cognate sets."<sup>43</sup> To be consistent I will refer to them as "cognate C-sets." For instance, 1/2 and 2/3 are "cognate C-sets" since they share their C-set interval (1 or 11) and one of their C-set indices (2). Obviously, if they shared both C-set indices they would be one and the same C-set. Cognate C-sets are related by transposition when the C-set interval is even; when it is odd, they are related by semi-transposition. Thus, for example, 1/3 and 3/5 are related by transposition but 1/2 and 2/3 are related by semi-transposition. Cognate C-sets are particularly close because corresponding chords will share two out of three pitches (the two pitches that form the shared C-set index) and two out of three intervals (the C-set interval and the interval of the dyad that forms the shared C-set index). Example 2.13 gives two pairs of cognate C-sets, one with an odd C-set interval and one with an even C-set interval. The trichords may be taken as representative. The first pair shares the pitches G and D $\flat$  and the intervals 6 and 5. The second pair shares the pitches F and D $\sharp$  (=E $\flat$ ) and the intervals 10 and 4. The cognate relationship ensures that the sets will be as similar as possible.

(a) With an odd C-set interval



(b) With an even C-set interval



### Example 2.13 Cognate C-Sets

<sup>43</sup> Actually, Perle's two definitions of "cognate sets" found in *Twelve-Tone Tonality* differ slightly in scope. He first defines them on p. 22 as "Inversionally related set forms that share a single series of dyads," which would restrict the term to sets with an odd C-set interval since only they have inversionally related set forms. On p. 77, however, he defines cognate sets more broadly as "cyclic sets of the same interval system that share a tonic sum." The latter definition would include sets with both even and odd C-set intervals. Presumably the second definition was written at a later time, after he had begun to include cyclic sets made from even interval-cycles. It is the second, broader definition that I have adopted.

## Motion within a C-Set

Notwithstanding Perle's reputation as a twelve-tone composer, the only serial ordering present in his system occurs in the way he derives cyclic sets. The order of hexachords as they appear in a Perlean array is no clue to the succession of hexachords in the music. It is an extremely rare passage indeed in which hexachords appear in their array order. That is not to suggest that the structure of an array has no bearing on harmonic progression. The contrary is true. It is the purpose of the following paragraphs to explore how the structure of C-sets produces patterns that might be useful to a composer. But unlike most twelve-tone music, the structure of the (C-)set does not depend on the order of its elements.<sup>44</sup>

Transposition at  $T^6$ , it was pointed out, is an identity operation. Every set is its own tritone transposition. Every chord within a set has a  $T^6$  equivalent elsewhere in the set. There are, then, at least two of every trichord class, and at most six different trichord classes, since there are exactly twelve trichords in every C-set. Example 2.14 shows all the trichords of C-set 3/8. There are six different kinds of trichord, each represented twice in the set at a tritone apart. In terms of voice leading, we can say that wedge voice leading at  $W^6$  always produces an equivalent chord a tritone away; or, more concisely, that  $W^6=T^6$ .

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<sup>44</sup> It was implied in Chapter 1 that Perle's serial derivation of cyclic sets is not an essential part of the system. Using Ockham's razor it would be possible to eliminate reference to serial ordering altogether. But why? Perle's serial derivation of sets is consistent with his attempts to reconcile the disparate strands of twentieth-century atonal composition.

C-Set 3/8

047 057 055 035 015 016 047 057 055 035 015 016

T<sup>6</sup>

Detailed description: The image shows a musical staff in treble clef with a key signature of one sharp (F#). It contains 12 trichords (three-note chords) arranged in a sequence. Below the staff, the same 12 trichords are labeled with numbers: 047, 057, 055, 035, 015, 016, 047, 057, 055, 035, 015, 016. Arrows connect the first six trichords to the last six, illustrating a T<sup>6</sup> transposition. For example, an arrow points from the first 047 to the seventh 047, and from the second 057 to the eighth 057, and so on.

N.B. Transpositional equivalence is assumed, but *not* inversional equivalence. Thus, 047 is distinguished from 037. Additionally, redundancies are shown, e.g. 055.

### Example 2.14, T<sup>6</sup> equivalent trichords in a C-set

W<sup>6</sup> is equivalent to T<sup>6</sup> for the simple reason that the tritone is its own inversion. Since wedge is a specific dual transposition where one subset transposes at T<sup>n</sup> while the other transposes at T<sup>12-n</sup>, if n=6 then the subsets transpose identically by six semitones: T<sup>6</sup> and T<sup>12-6=6</sup>. The equivalency of W<sup>6</sup> and T<sup>6</sup> means on the one hand that it is always possible for a chord to wedge onto its own transposition, and on the other hand that it is always possible to transpose a chord (or a passage) without leaving the C-set. Example 2.15 shows the six possible progressions of this kind within C-set 2/4.

Set 2/4

Detailed description: The image shows a musical staff in treble clef with a key signature of one sharp (F#) and a time signature of 2/4. It contains six measures, each showing a different progression of chords. The chords are connected by lines, illustrating the six possible progressions of W<sup>6</sup> transpositions within the C-set.

### Example 2.15, W<sup>6</sup> progressions

(a)  $T_6$   
 056 045  
 $W_1$   $W_7$

(b)  $T_6$   
 056 025  
 $W_2$   $W_8$

(c)  $T_6$   
 056 005  
 $W_3$   $W_9$

(d)  $T_6$   
 056 037  
 $W_{11}$   $W_5$

(e)  $T_6$   
 056 027  
 $W_{10}$   $W_4$

### Example 2.16, Wedging onto equivalent chords

In Example 2.16 wedge progressions are arranged into pairs in which the results of each pair are related by  $T^6$ . Example 2.16a, for instance, pairs  $W^1$  with  $W^7$ . The result is two 027 trichords a tritone apart. Example 2.16b pairs  $W^2$  with  $W^8$ . Once again the result is two trichords, this time 025, a tritone apart. Notice that the paired W-numbers always show a difference of 6, e.g.  $7-1=6$ ,  $8-2=6$ , etc. Only five pairings of this kind are shown:  $W^1/W^7$ ,  $W^2/W^8$ ,  $W^3/W^9$ ,  $W^4/W^{10}$ , and  $W^5/W^{11}$ . The sixth pairing that could be included is the trivial  $W^0/W^6$ , which has already been discussed as a single progression (see Ex. 2.15).

Besides voice-leading progressions that arise from set characteristics, like the equivalence of  $T^6$  and  $W^6$ , progressions can also be based on *a priori* patterns. For example, interval cycles or segments of interval cycles can serve as voice-leading paths

for wedge progressions. I will refer to such progressions as “wedge cycles.” A few of these are shown in Example 2.17. In Perle’s music, complete wedge cycles are rare. Partial wedge cycles are more common. Since a wedge cycle repeats a voice-leading motion, it provides continuity of motion while constantly refreshing the harmony. The longer cycles, 1 and 5, are particularly useful in that regard.

W<sub>3</sub> Cycle

W<sub>6</sub> Cycle

W<sub>1</sub> Cycle

### Example 2.17 Wedge Cycles

A partial wedge cycle can also fill in the space between  $T^6$  equivalent chords. I wish to add a hint of caution to my use of the phrase “fill in the space.” Perle’s system does have a place for the functional distinction between structural notes and non-structural “space-fillers”—what Perle calls “dissonant figuration”—but that is not what is meant here. I do not wish to suggest that the following represents necessarily an embellishing progression. Rather, I am connecting two ideas: the equivalence of two chords at  $W^6$ , and the use of wedge cycles. The equivalent chords form a logical *inclusio*

and the wedge cycles a logical link. Whether the cycle can fairly be said to embellish the  $W^6$  progression should not be determined without a context.

Any of the cycles can link two chords except  $W^4$  and its inversion  $W^8$ . In order to serve as a link, the W-number of the wedge cycle must be a multiple of 6 (mod 12). 1, 2, and 3 are multiples of 6, and 5 is a mod 12 multiple of 6 since  $5 \times 6 = 30 = 6 \pmod{12}$ . All the inversions of 1, 2, 3, and 5 are likewise mod 12 multiples of 6. Only 4 and 8 are not multiples of 6. Example 2.18 shows a number of such progressions using chords from C-set 0/5.

**Example 2.18 Partial wedge cycles between equivalent trichords**

Harmonic connection need not be determined by abstract patterns, such as interval cycles, or aspects of C-set structure, such as  $W^6/T^6$  equivalence. Motivic concerns might be determining factors: interval requirements, contour requirements, register

requirements. Aesthetic concerns, such as consonance/dissonance requirements, might be determining factors. Chords might be connected solely on the basis of how they sound.

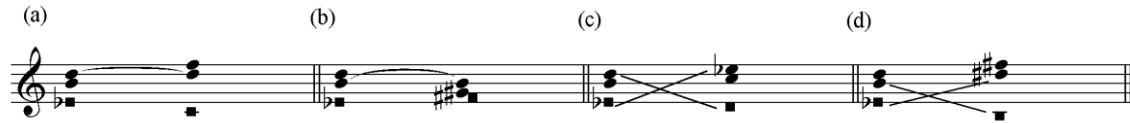
Chords might also be connected because they share common tones, or expressly because they do not. The possibility of common tones bears elaborating. Two different trichords from the same C-set will have two, one, or no tones in common. But one need not run through a list of chords in order to find one with a common tone. There are two voice-leading maneuvers that guarantee them.

The first maneuver guarantees one common tone. It involves wedging by the C-set interval or its inversion. Example 2.19a illustrates. Here the C-set interval is 3. Wedging at  $W^3$  means that the C-set dyad transposes up three semitones. Because the upper member of the dyad is three semitones above the lower, the lower member transposes onto it, ensuring a common tone between the two chords. Wedging by the inversion,  $W^9$  shown in Example 2.19b, has the same result; only, this time the upper member transposes onto the lower.

The second maneuver guarantees two common tones. It involves an exchange between one member of the C-set dyad and the axis note. The trichord wedges in such a way that one member of the C-set dyad trades pitches with the axis note. The result is a new trichord with two common tones. Examples 2.19c-d show the two possibilities.<sup>45</sup>

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<sup>45</sup> It would be tempting to refer to this maneuver as a voice exchange, borrowing a term from tonal voice-leading analysis. But that would confuse the issue. A voice exchange has more to do with the intersection of line and voice. It typically occurs in the context of a single harmony. But here there is a change of harmony. If anything, this maneuver has more in common with the 5-6 technique, a voice leading maneuver that produces a new harmony with two common tones.



### Example 2.19 Producing common tones

### Voice Leading and Line Leading

Although the distinction between voice and line has become explicit in voice-leading theories relatively recently, it has been an implicit part of musical understanding for centuries. Bach’s solo partitas, for example, are impressive demonstrations of the potential of this distinction. Both tonal and atonal theories of voice leading rely on it. When beginning theory students are taught about voice exchange, or transferring the 7<sup>th</sup> of a Dominant 7<sup>th</sup> chord, they are implicitly being taught the distinction between voice and line. Voices are formed on the basis of an *a priori* voice-leading syntax. Musical lines on the other hand are formed on the basis of some associational parameter. The most common parameters are timbre and register, though there are many others.

The voice-leading patterns described throughout this paper may be manifest in musical lines in almost limitless ways. The voice leading need not be literally expressed in the musical lines, but it can be. I will refer to the way musical lines move and interact as “line leading.” The interplay between line leading and voice leading is a rewarding and instructive study. Earlier I suggested a continuum to express the way voices and lines interact. The two extremes of the continuum are clarity and obscurity: when the voices and lines are identical, the voice leading is said to be clear; when there is no correspondence between voices and lines the voice leading is said to be obscure.

Example 2.20 shows a voice-leading progression from set 3/9 in three different contexts. In the first (Ex. 2.20a) the voice leading is rather clear. It coincides exactly with the line leading. In the second (Ex. 2.20b) the voice leading is a little more obscure, but still relatively clear. The voice leading and line leading do not precisely coincide, but the differences are not so great as to utterly mask the voice leading. In the third (Ex. 2.20c) the voice leading is obscure. There is little correspondence between voice and line.

(a)

(b)

(c)

Each example consists of three staves. The top staff is a treble clef with a key signature of one flat (B-flat) and a 3/4 time signature. The middle staff is a bass clef with the same key signature and time signature. The bottom staff is a treble clef with the same key signature and time signature, labeled 'Voice Leading'. In (a), the voice leading is a sequence of chords: G4-B4, F4-A4, E4-G4, D4-F4. In (b), the voice leading is a sequence of chords: G4-B4, F4-A4, E4-G4, D4-F4. In (c), the voice leading is a sequence of chords: G4-B4, F4-A4, E4-G4, D4-F4.

**Example 2.20 Clarity and obscurity**

(a) (b) (c) (d) (e)

(f) (g) (h) (i)

(j) (k) (l)

(m)

Example 2.21 Line Leading Affecting Clarity

The remainder of this chapter is concerned with the interplay of voice leading and line leading. I will first discuss elements of line leading that affect the clarity and obscurity of voice leading. Then I will discuss some line-leading patterns.

In Example 2.21 some clear voice-leading progressions are instantiated as lines in various ways. The line-leading choices progressively add obscurity to the voice leading. Each example is given in multiple tiers, as described in Chapter 1. The topmost tier instantiates the voice leading beneath it. Example 2.21a shows a simple two-voice wedge. The only difference between the voice leading and the instantiation above it is in the direction of the top line. Technically, the voice leading is in pitch-class space, so that it is not affected by register or contour. But line-leading is in pitch-space. Contour and octave displacement are pertinent to line leading whenever lines are connected on the basis of register and proximity of pitches. Wedge voice-leading is most clearly perceived as equal contrary motion, just as transposition is most clearly perceived as equal parallel motion. Example 2.21a demonstrates the simplest and most basic element of obscurity that can be introduced: octave displacement.

Example 2.21b shows a three-part voice-leading progression in its clearest form. The instantiation is in fact identical to the voice leading, and there is no octave displacement. The lines all move by semitone, the axis-note line distinct and moving in contrary motion to the others. In Example 2.21c, however, an element of obscurity is added to the same progression. In general terms we could say that the second dyad in the right hand is inverted. But notice the effect on the actually lines. Instead of each line moving by semitone with the C-set dyad lines moving contrary to the axis-note line, all the lines move in similar motion, each by a different interval. Nevertheless, the axis note

is still kept separate from the other voices. The simple maneuver adds great variety to the line leading at a small cost of clarity.

The same progression is expressed in Example 2.21d. This time the axis note trades positions with another voice. There is a  $W^9$  wedge in the line-leading between the top and bottom lines, but it is not the wedge that defines the voice leading. The middle voice discloses the true voice-leading interval of a semitone.

In Examples 2.21a-d at least one line is always identical to a voice. In Example 2.21e, on the other hand, none of the lines is an actual voice. There is total variety of intervals in the lines, but the voice-leading interval is not there. There is also no wedging between lines. This example hides the voice leading more than any of the previous ones.

So far there have been as many lines as voices, even though they did not always coincide. The next few examples look at clarity and obscurity in the context of compound melody, in which more than one voice is instantiated in a single line. Example 2.21f uses the same progression as before. The voice leading is relatively clear. Corresponding elements of the two trichords appear in the same register and in the same order: first the axis note, then each member of the C-set dyad. It is not very difficult to extract the axis note from the C-set dyad, even though the axis note occurs in the middle position. In Example 2.21g the registers are the same, but the order changes, adding an element of obscurity. It is not quite as easy to follow the wedging trichords.

Example 2.21h shows what happens when neither the respective registers nor the order of voices is consistent in the line. The voice leading is relatively obscure. Still, at least the metrical grouping of notes helps to keep the trichords distinct. In Example 2.21i even that is removed. The beaming and accents work deliberately against the voice

leading, giving the impression that there is a compound two-voice texture moving in parallel thirds, rather than a three-voice texture. (In the same way, Perle's line leading often gives the impression of a *faux* voice leading.)

Examples 2.21j-l give instances of two part contrapuntal texture. They may be examined in a similar way without much comment. It is notable how many possibilities of line leading there are for a simple progression of two trichords. Each has its own place along the clarity/obscurity continuum, for each reveals or disguises the voice leading in its own way. The possibilities increase exponentially the more chords are added and the more notes in each chord. Example 2.21m gives a lengthier progression. The constant change of texture removes the lines even further from the voice leading. In Perle's music there are always two streams of three-part voice leading. With six voices to work with, the voice leading is capable of being expressed in countless ways, through abundant textures, revealing or disguising itself in the lines with limitless variety.

Naturally, line leading is subject to more considerations than the clarity and obscurity of voice leading. Line-leading patterns can take shape according to their own purposes. In *Twelve-Tone Tonality*, Perle describes some hypothetical steps that bring an abstract series of chords toward a compositional realization. One such step would be, he suggests, "the imposition of a voice-leading design [I would call it a line-leading design] by applying the traditional 'rule' of elementary tonal harmony respecting the treatment of common tones."<sup>46</sup> He goes on to give a series of hypothetical "keyboard harmony exercises" in which lines are formed not only by holding common tones, but by observing the traditional rule of parsimony.

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<sup>46</sup> *Twelve-Tone Tonality*, p.42.

Example 2.22 illustrates what parsimonious line leading would look like in three voices. In Example 2.22a trichords from set 4/7 wedge by the set interval (3), ensuring a common tone between each pair of chords as explained above. The wedge voice leading is shown first, then a line leading interpretation in which common tones are held in whatever line they appear. Example 2.22b gives a similar case, this time with set interval 5. The voice leading in Example 2.22c seems parsimonious enough, but the lines could move even less, as shown. The line leading would have to be considered relatively obscure. One would have to listen quite carefully in order to hear the underlying voice leading.

(a)

(b)

(c)

The image contains three musical examples, (a), (b), and (c), each on a single staff in treble clef. Example (a) shows two measures of music. The first measure contains three trichords: a G4-A4-B4 triad, a G4-B4-C5 triad, and a G4-A4-B4 triad. The second measure shows voice leading with common tones held across the measures. Example (b) shows two measures of music with trichords and voice leading. Example (c) shows two measures of music with trichords and voice leading.

### Example 2.22 Parsimonious line leading

Finally, simple melodic or motivic concerns might be the engine behind line leading. Thematic play is a large part of Perle's musical rhetoric. Themes are transposed, inverted, reversed, rearranged; motives pop in and out of the texture; imitative counterpoint abounds in some works; and melodic details seem always to repay close

attention. All of that relies on the line leading as much as the voice leading. And as I mentioned above, the line leading seems sometimes to play against the voice leading, hinting often at other arrays.

Chapter 32 of *Twelve-Tone Tonality* bears the title “Voice-Leading Implications of Sum Tetrachords.”<sup>47</sup> Perle does not distinguish between voice and line. Nevertheless, portions of the chapter explore with great insight the way lines interact with voice leading, in our sense of the phrase. It is an example of how to solve line-leading problems, such as how to create a situation in which a three-note chord is sustained while a fourth “voice” (line) ascends by a certain interval: “Analogous progressions—a three-note chord sustained while a fourth voice ascends by interval 5—may be derived from any array whose tetrachordal sums show the same differences as the tetrachordal sums of the preceding array [7,0/4,9].”<sup>48</sup> My point is not to repeat the conclusions of Perle’s chapter, but to demonstrate that interplay between voice leading and line leading was a significant part of Perle’s theoretical and compositional thinking, even if his terminology differs.

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<sup>47</sup> A “sum tetrachord” is an incomplete hexachord. It consists of the two axis notes (the “axis dyad”) and one note from both set dyads. In other words, it consists of two “tonic sums.”

<sup>48</sup> *Twelve-Tone Tonality*, 178.

## Chapter Three

### Arrays and Array Modulation

In previous chapters I discussed the voice leading of individual C-sets. This chapter deals with arrays—two C-sets working together—and with connections among different arrays. Specifically I discuss two procedures that Perle consistently uses to “modulate” from array to array. Perle has described these techniques under the names “modulation through reinterpretation” and “modulation through substitution.” I propose to shift the perspective on these techniques by understanding them in terms of their voice leading.

Arrays define harmonic territory in Perle’s music. “Territory” is one of many spatial metaphors that are traditionally used in discussions of harmony. “Region” and “area” are others. In tonal music the keys of C minor and B major are said to be “distant,” while G major and D major are “close.” The essential point of comparison is that “territories” or “regions” have boundaries on the one hand, but are inter-connected on the other. The metaphor applies just as well to Perle’s arrays as they do to tonal keys. Arrays have harmonic boundaries. Each array has only so many possible harmonies and no two arrays are harmonically identical. Yet they also relate and overlap to various degrees. Some arrays share harmonies; others share none. Some have a similar construction; others are quite dissimilar. But no array is utterly isolated. They are all interconnected.

Not unlike “key” in tonal music, the notion of the array as a harmonic territory has far reaching implications for form.<sup>49</sup> It enables contrast of sections, which in turn

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<sup>49</sup> This is not a reference to Perle’s use of the term “key.”

enables breadth and length of design. The possibility of exploring harmonic territories opens the door to extended works. It enables large-scale harmonic relationships that serve structural ends. Departing from an array and returning to it, the most basic formal plan, unifies a movement even when there is no explicit thematic recapitulation because the same harmonies will define the beginning and the end. Furthermore, because the relationship between arrays is nuanced—many shades of similarity, different kinds of relatedness—the large-scale relationships can be nuanced. The “nearness” and “farness” of different arrays opens the door to traditional formal procedures, but also allows for imaginative designs. Among the pitch systems invented in the twentieth-century, twelve-tone tonality is impressive for the degree to which the make-up of the language suggests its own formal drama. In my opinion it is this aspect of the language, much more than real or implied symmetrical pitch centers, that merits the name twelve-tone *tonality*.

Almost all of Perle’s works include changes of array. Sometimes a short passage moves rapidly through many different arrays; other times an array can last for many measures. In Perle’s earliest works, an entire movement may be composed in a single array. Such movements are naturally quite brief. More typically, Perle’s works change arrays many times in the course of a movement, whether it be long or short. Short works outnumber long works. Though he has several extended movements (the *Ballade* for example is unusual for its length, ca. nine minutes), brevity is Perle’s *modus operandi*. Even in longer works, his phrases and gestures usually unfold in short breaths. Twenty measures should be considered quite a long time to go without a modulation; and arrays will often be found to last for only a few measures, or even a few beats.

I will use the term “modulation” to denote motion from one array to another. The word “modulation” has connotations of process, in contrast to abrupt change. It is of course possible simply to end one section in one array and begin a new section in another, but Perle’s modulations usually occur in the course of a phrase, and he typically makes the connection smooth.

There are two main ways in which Perle modulates from one array to another. They are described in *Twelve-Tone Tonality* under the headings “Modulation through Reinterpretation” and “Modulation through Substitution.”<sup>50</sup> The first technique is analogous to the standard “pivot chord” modulation. It takes advantage of the fact that a chord may be interpreted as a member of more than one array. At the point of modulation a chord from the old array is reinterpreted to be a member the new array, hence the name “Modulation through Reinterpretation.” In the second technique, a chord from the old array is rebuilt by replacing one or two notes with new ones. The substitution forces the chord into a new array, hence the name “Modulation through Substitution.”

The explanations of these modulation techniques found in *Twelve-Tone Tonality* are suitable for their purpose, but the perspective is different from mine in two important ways. First, Perle’s explanations suggest a vertical/harmonic conception of modulation. Modulation occurs either by restructuring or reordering a single chord. This is more plausible in the case of modulation through reinterpretation, where a single chord is in fact the locus. But modulation through substitution, as we will see presently, always occurs as a progression of two chords. Yet in an analysis of one such modulation, Perle

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<sup>50</sup> See *Twelve-Tone Tonality*, chapters 25, 35 and 36.

overlaps the two chords as though they occurred simultaneously, emphasizing the harmonic rebuilding of one chord, rather than the linear connection between two.<sup>51</sup>

Second, Perle treats modulation as something *done to* the music rather than as something the music does. The harmony is frozen in time while reinterpretation or substitution takes place. It implies an interruption in the real-time flow of the music. The distinction may seem over subtle, but it can make a significant difference in how we conceive the music, and therefore ultimately a difference in how we perceive it.<sup>52</sup> A voice-leading perspective sheds new light on these techniques by focusing on the active role of voices in a modulation. In the discussion below, I will explain the techniques from both vantage points: vertical/harmonic, *à la* Perle, and horizontal/voice-leading. The different perspectives make for different ways of understanding of how these modulations take place. In the one, the array changes because a chord has been reinterpreted or rebuilt; in the other the array changes because the voices move in a certain way. Because of the change, Perle's own names for these techniques will not make sense in the voice leading model. I will give appropriate new names to these techniques. One will be called "modulation through reorientation," and the other "modulation through oblique motion."

### **Technique 1—Harmonic Perspective (Modulation through Reinterpretation)**

It will be easiest to examine these techniques using the trichords of C-sets first before seeing them at work in arrays. Example 3.1a gives three instances of the trichord [F, G, A]. Each instance interprets the trichord to be a member of a C-set by selecting one

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<sup>51</sup> *Twelve-Tone Tonality*, 125-127: compare Perle's Example 60 with his analysis on 127.

<sup>52</sup> The discussion of the relationship between *conceiving* and *perceiving* music appears in chapter six.

note to be the axis note. When the axis note is selected (shown with a square notehead), the remaining dyad is the C-set dyad. Any trichord that has three distinct members (i.e. there is no pc duplication) is susceptible to exactly three C-set interpretations because there are only three possible axis notes. Where there is pitch class duplication in the trichord the possible interpretations are fewer. The trichord [F, G, A] is common to the three C-sets 0/4, 2/4, and 0/2 as shown. Therefore it could serve as a pivot chord between them in a “modulation through reinterpretation.”

(a) Three interpretation of a trichord

C-set: 0/4      2/4      0/2

(b) Modulation through reinterpretation

reinterpretation

0/4      2/4

(c) Modulation through reinterpretation

reinterpretation

7/11      7/10

**Example 3.1 Modulation through reinterpretation**

Modulation through reinterpretation is much like traditional common chord modulation. A chord that is common to two arrays serves as a pivot between them. The common chord functions in one way with respect to what precedes it, and another way with respect to what follows it. To put it in active terms, Perle modulates by reinterpreting a chord from the old array so that it functions as part of a new array. Example 3.1b gives a progression that modulates from C-set 0/4 to 2/4 using the common chord from Example 3.1a. The reinterpretation that produces the modulation is shown in brackets. It is not a separate chord in the progression but rather a restructuring of the same chord. Therefore there are not five chords but four in this progression. Example 3.1c provides a second illustration. This time the trichord [A, B $\flat$ , C $\sharp$ ] serves as a pivot chord to connect C-sets 7/11 and 7/10. At the point of modulation the notes A and B $\flat$  (=A $\sharp$ ) swap functions.

Example 3.2, the beginning of the fourth of Perle's *Six New Etudes*, contains three modulations.<sup>53</sup> Combining the progressions from Example 3.1b and c above produces the array modulation shown in measure six. The passage begins in array 7/11, 0/4, but the third chord of measure six is reinterpreted to belong to a new array, 7/10, 2/4. The "reinterpretation," shown in brackets, consists in swapping the functions of A and B $\flat$  as well as those of A and G. At the end of the following measure there is another modulation through reinterpretation back to array 7/11, 0/4. The reinterpretation swaps the functions of E $\flat$  and E as well as C $\sharp$  and E $\flat$ . Example 3.2 ends with a third modulation

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<sup>53</sup> I have leaned on David Schober's array analysis of this movement in *Goerge Perle's Six New Etudes: Symmetry, Audibility, and the Rhetoric of Reconciliation* (Ph.D. diss., University of Michigan—Ann Arbor, 2004).

to array  $8/0, 1/5$ . It is a modulation through substitution and will be discussed in a subsequent section of this chapter.

Tempo I  $\text{♩} = 66$  accel. Tempo II  $\text{♩} = 78$  ( $\text{♩} = 104$ )

*p* *poco a poco cresc.* *f* *poco dim.* *rit.*

Legend:  
 ● = 7/11  
 ○ = 0/4

Legend:  
 ● = 7/10  
 ○ = 2/4

**Example 3.2, Two examples of modulation through reinterpretation in *Six New Etudes* (1984), IV Romance, mm. 1-9. Reinterpretation shown in brackets.**

The musical score consists of three systems. The first system is a piano and bass staff with a tempo of  $\text{♩} = 52$ . It features a piano (*pp*) dynamic and includes markings for *Tempo I* and *rit.* (ritardando). The second system shows chord diagrams for the piano and bass parts. The third system shows chord diagrams for the piano and bass parts. A legend below the staves defines note types: a solid black square represents  $7/11$ , an open square represents  $0/4$ , a solid black circle represents  $8/0$ , and an open circle represents  $1/5$ .

(Example 3.2 continued)

Hexachords have much greater potential as pivot chords in arrays than trichords have in C-sets. Any trichord belongs to three C-sets at the most. Therefore a trichord from one C-set can serve as a pivot chord to only two others. (The C-set itself has more possibilities because it has other trichords). But a hexachord belongs to a host of arrays, which means there are many more possibilities for common chord modulation. Any two notes of a hexachord can serve as axis notes. Fifteen combinations are possible. Additionally, for each combination the remaining notes of the hexachord can pair off into C-set dyads in three different ways. By this calculation a hexachord can belong to as many as forty-five arrays. Example 3.3 shows only eight of the many possible ways to

interpret the same hexachord. In each instance the function of the notes changes, not the notes themselves.

$\bullet\blacksquare = 5/11$     $\bullet\blacksquare = 4/8$     $\bullet\blacksquare = 5/8$     $\bullet\blacksquare = 3/9$     $\bullet\blacksquare = 2/8$     $\bullet\blacksquare = 5/8$     $\bullet\blacksquare = 5/7$     $\bullet\blacksquare = 2/7$   
 $\circ\square = 1/5$     $\circ\square = 2/8$     $\circ\square = 5/11$     $\circ\square = 1/4$     $\circ\square = 2/8$     $\circ\square = 5/8$     $\circ\square = 9/2$     $\circ\square = 5/9$

### Example 3.3, Some Array Interpretations of a Hexachord

In theory, it is possible to modulate by common chord from one array to forty-four different arrays. But all common chord modulations are not equal inasmuch as all arrays are not equally related. It is possible to modulate to close or distant arrays. Of the arrays shown in Example 3.3, some are quite similar; others are not. The first array (5/11, 1/5) and third array (5/8, 5/11), for instance, are quite similar. They share one C-set, 5/11; and from their other C-set they share one index, 5. All together, three out of four indices are the same, and one out of two C-set intervals is the same. The two arrays will have much in common harmonically. On the other hand, the fourth array (3/9, 1/4) and the seventh (5/7, 9/2) are not similar at all. They share neither any indices nor any C-set intervals.

### Voice-Leading Perspective: Modulation through “Reorientation”

The word “reinterpretation” implies an action done *upon* the chord *by* someone, in this case the analyst or composer. It is not an action within the music, in real-time—hence the need for a bracketed chord. It is possible to give an account of the same modulation technique in a way that preserves the flow of the music, minimizing the

interruption that the previous explanation implies. The perspective shifts from that of the composer or analyst who reinterprets a harmony from the outside, to that of the voices themselves moving on the inside. Personified voices are the implicit conceit of much music analysis. It is a valuable rhetorical device that enables musicians to enter more fully into the musical drama by supporting the illusion that voices move, act, interact and even have needs and desires.

In shifting the focus onto the voices, modulation becomes the result of their movements. With respect to the technique discussed above, modulation is the result of one voice reorienting its movements with respect to the other voices. Specifically, one voice from the C-set dyad reorients its movement with respect to the axis voice. Where it was formerly moving contrary to the axis voice, it now moves parallel to it. From this perspective it does not make sense to call it a reinterpretation, since no reinterpretation takes place. For that reason I will refer to it as a modulation through “reorientation.”

To illustrate, Example 3.4 restates the two C-set modulations from Example 3.1 above from this new perspective. Solid lines trace the two voices moving in parallel motion (the C-set dyad voices); and a dotted line traces the voice that moves in contrary motion to the others (the axis voice). The same voice leading pattern is found in both Example 3.4a and 3.4b. The two bottom voices move in contrary motion to each other throughout the progression. Their orientation doesn’t change. But the top voice reorients itself on the third chord, marked with an asterisk. It stops moving contrary to the bottom voice, which is the axis voice, and starts moving parallel to it. That entails a reorientation with respect to the middle voice as well. It stops moving parallel with it, and starts moving contrary to it.

By coupling with the bottom voice, the top voice forms a new C-set dyad with it. Therefore, as a consequence of the reorientation of the top voice, the bottom voice changes function from an axis note to a member of the C-set dyad. The middle voice changes function, too. It becomes the new axis voice. Ironically the top voice, which caused the modulation, is the only one whose function does not change.

(a)

reorientation

$\square \circ = 0/4$        $\square \circ = 2/4$

(b)

reorientation

$\blacksquare \bullet = 7/11$        $\blacksquare \bullet = 7/10$

### Example 3.4, Modulation through reorientation

The progressions of Example 3.4 are combined in Example 3.5, system (b), to form an array progression. Example 3.5 reproduces the modulation from measure six of the etude shown earlier (Example 3.2). System (a) shows the registral and rhythmic placement of the voice-leading analysis as usual. System (c) gives the previous “pivot chord” analysis for comparison.

rit.

(a)

(b) (reorientation)

■ = 7/11      ■ = 7/10  
 □ = 0/4      ○ = 2/4

(c)

■ = 7/11      ■ = 7/10  
 □ = 0/4      ○ = 2/4

Not the same voice!

**Example 3.5, Comparison of “Reorientation” and “Reinterpretation”**

Comparing the two analyses reveals their respective strengths and weaknesses. The “pivot chord” version has the advantage of clearly demarcating the axis notes and C-set dyads by reshuffling the voices at the point of modulation so that axis notes always

appear in the lower staff. Yet it could be visually misleading because it gives a false appearance of connection between voices before and after the modulation: the axis note G before the modulation, for instance, is a different voice from the axis note F<sup>#</sup> after the modulation, despite the appearance of continuity. The reason is that the bracketed chord reshuffles the voices so that the axis notes appear in the lower staff. In order to follow a voice, you have to follow it through the reshuffling.

On the other hand, in the “reorientation” version (system (b)) the voices maintain their registral positions through the modulation. Since there is no reshuffling of voices, the continuity is real. The obvious advantage is that it represents the individual voice-leading paths more faithfully. Comparing systems (a) and (b) it is particularly remarkable that during the modulation the registral lines faithfully trace the voices: the “line leading” coincides with the voice leading making the latter clear. The arrows in system (a) point out the path of the voices through the modulation. The voices are instantiated as registral lines on the surface. One disadvantage to the reorientation model is that although the paths of individual voices are clearly represented, the overall symmetrical interaction of voices is harder to follow through the modulation, even more so when the modulations are more complicated.

Modulation through “reinterpretation” and modulation through “reorientation” are complementary viewpoints, each with something to offer that the other has not. In system (c) the *function* of the voices within the chord comes to the fore; but in system (b) the *path* of each voice is the focus. Both perspectives are valuable in analysis and I do not want to discard the one by introducing the other. On the contrary, I will use the “pivot chord” model when it is necessary to keep the axis voices demarcated, but then it should

be kept in mind that in order to trace the actual path that a voice takes through a modulation of this kind, one has to follow where that voice is sent when the voices are shuffled in the bracketed pivot chord.

Array modulations have a possibility that C-set modulations do not have. In a C-set modulation, one voice reorients itself with respect to the other voices of the C-set, as shown above. It stops moving contrary to its axis note and starts moving parallel to it. In an array, however, there are two C-sets. It is possible for a voice from one C-set to reorient itself so that it begins to move in relation to voices from the other C-set. As a result, the two C-sets intermingle and the voice-leading becomes more complex than what we have seen so far. An instance is given Example 3.6, an excerpt from the fourth movement of Perle's first set of etudes.<sup>54</sup> System (a) shows the voice leading analysis from the standpoint of "reorientation." The voices, which maintain their registral positions throughout the example, are numbered one through six, top to bottom for reference. The new array appears after the third chord. Before the modulation the C-sets are located on different staves and the voice-leading is straightforward. But after the modulation the C-sets appear intermingled and the symmetry is difficult to follow visually.

In order to take in the voice leading, it is helpful to consider voices a few at a time. System (b) highlights voices two, three, four and six. In the top staff, voices two and three are in constant symmetry, as are voices three and six in the bottom staff. These are not the culprits of the modulation: they do not reorient themselves. Their functions do

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<sup>54</sup> I am relying on Gretchen Foleys array analysis of this movement in *Pitch and Interval Structures in George Perle's Theory of Twelve-Tone Tonality* (Ph.D. diss., The University of Western Ontario, 1999), appendix four.

(a) *mf* *dim.* *p* *pp*

(b)

(c) reorientation

(d) reorientation

Legend:  
 ■ = 10/2      ● = 5/10  
 □ = 3/5      ○ = 5/11

Example 3.6, *Six Etudes for Piano* (1973), No. 4, mm. 51-53

change where the modulation occurs, but that is a consequence of the reorientation of other voices.

System (c) traces voice one in relation to others with which it has to do. At first it moves in parallel motion with voice two, contrary to voice three as member of C-set 10/2. But after arriving on the third chord, it begins to move in relation to members of the other C-set. Specifically, it begins to move parallel to voice six and contrary to voice four. This reorientation of the movements of voice one causes voices four and six to change their functions. It forces voice six to become a C-set dyad member by moving parallel to it, and it forces voice four to become an axis voice by moving contrary to it.

System (d) tells a similar tale. It traces voice five in relation to other pertinent voices. At first voice five is a member of C-set 3/5. It moves parallel to voice four and contrary to voice six. After chord three, however, it begins to move in relation to voices from the opposite C-set: parallel to voice three and contrary to voice one.

Taken voice by voice the counterpoint is manageable. But the excerpt requires a feat of mental coordination to comprehend the voice-leading as a whole. The voice-leading in Example 3.5 seems simple in comparison. Furthermore, the voice-leading is quite obscure on the surface. The lines in the score bear no resemblance to the voice leading. One has to hunt for notes in order to follow a voice on the surface. The difference between Examples 3.4 and 3.5 deserves comment. The voice-leading is straightforward and the instantiation is clear, but in the latter the voice leading is complicated and the instantiation obscure. Such different ways of treating texture as it relates to voice leading is not incidental. "For the essence of a modulation," as Arnold

Schoenberg says, “is not the goal but the way.”<sup>55</sup> Such details in Perle’s music are worth attending to. To miss them is to miss something important about his style.

### **Technique 2: Modulation through Substitution (or Oblique Motion)**

As one of the two principal ways that Perle connects arrays, modulation through reinterpretation/reorientation appears very frequently in his music. Perle’s second modulation technique is also very common. As before, there is a vertical/harmonic perspective and a horizontal/voice-leading perspective. The hexachord is viewed either as a chord with interchangeable parts or a confluence of voices. Modulation is once again seen either as something done to the music from the outside or the result of movements of the voices.

“Modulation through substitution” occurs when elements from a hexachord are replaced by new elements that change the structure of the chord, forcing it into a new array. The chord gets a new pair of axis notes, for example, or perhaps keeps its axis notes but trades out one or both C-set dyads. Perle limits the use of this technique in his treatise in ways that ensure certain outcomes, but in principle there are more possibilities for modulation through substitution than are described in *Twelve-Tone Tonality*.

Example 3.2 above contains a modulation through substitution in the last two chords of the excerpt. The axis notes of the first chord (B $\flat$  and C $\sharp$ ) are replaced by new ones a semitone higher in the second chord (B and D). The substitution changes the array from 7/11, 0/4 to 8/0, 1/5.

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<sup>55</sup> *Theory of Harmony*, trans. by Roy E. Carter (Berkeley: University of California Press, 1978), 165.

From the standpoint of the aligned and ordered arrays in Perle's treatise, it makes sense for him to refer to modulation as a substitution. His perspective seems to be mainly precompositional. His discussion of modulation gives one the feeling of being in a musical laboratory—what happens to the array when you do this, or this?—in which the system is the subject, not the music. The central purpose of *Twelve-Tone Tonality* is to explicate the system, not analyze his scores. But from the perspective of voice leading analysis—what are the voices doing now?—the modulation appears straightforward: some voice holds while others move a semitone. It takes the action out of the precompositional laboratory and places it back in the music. As with the previous technique, thinking of this modulation not as something done to the music, but as something the notes themselves do helps preserve the illusion of movement and connection.

Example 3.7 breaks down some of the possibilities of this technique using a series of C-set progressions. Each progression begins with C-set 5/9 wedging outward, then modulates to a new C-set. In every case the modulation is caused by oblique motion in the voices—at least one voice stays put while the others move. The first four instances are the most common in Perle's music. In Example 3.7a the C-set dyad holds while the axis note moves. The result is a semi-transposition of the set (discussed in Chapter Two). The modulation in the last bar of Example 3.2 discussed above follows the pattern of Example 3.7a. The C-set dyads hold while the axis notes transpose by semitone. The result is a semi-transposition of both C-sets.

In order to achieve a full transposition of the C-set, the axis note needs to move by two semitones, as shown in Example 3.7b. The C-set dyad holds while the axis note

moves down two semitones. As a result the C-set is transposed down one semitone to C-set 3/7 (recall that the C-set labels represent index numbers, and the index number of a dyad increases/decreases by two for every semitone the dyad transposes).

(a) 5/9 4/8

(b) 5/9 3/7

(c) 5/9 6/10

(d) 5/9 7/11

(e) 5/9 5/10

(f) 5/9 6/9

(g) 5/9 4/10

(h) 5/9 6/8

### Example 3.7, Modulation through Oblique Motion

Examples 3.7c and d are similar, but this time the axis note holds while the C-set dyad moves. The result is likewise a semi-transposition when the motion is by semitone, and a full transposition when the motion is by two semitones. In fact, in modulations of the kind shown in Examples 3.7a-d, semi-transposition is the result when the motion is by any odd interval, and transposition is the result when the motion is by any even interval. For example, to modulation to a  $T^3$  transposition of a C-set, the axis note could be held

while the C-set dyad moves up six semitones (twice the desired T-number for the C-set), or the C-set dyad could be held while the axis note moves up six semitones.

In Examples 3.7e and f only one member of the C-set dyad moves while the other member holds with the axis note. As a result, the interval of the C-set dyad changes, which dramatically alters the character of the C-set. It is not completely unrelated however, because one of the indices will be the same.

Examples 3.7g and h are hypothetical. I have not encountered them in Perle's music. I include them here as the next logical step in this type of modulation. The axis note holds while the C-set dyad *wedges* rather than transposes. The result is a completely unrelated array, which may be the reason Perle excludes the maneuver.

As Example 3.7 shows, there are many possibilities for modulating using oblique motion—and there are more than are shown in the example. In an array setting, one or both of the C-sets might modulate. If they both modulate, they might modulate in the same way or in different ways. The following lists the possibilities for modulation through oblique motion that are most likely to be found in Perle's scores:

1. C-set dyads transpose by the same interval while the axis notes hold
2. C-set dyads transpose by complementary intervals while the axis notes hold
3. Axis notes transpose by the same interval while the C-set dyads hold
4. Axis notes transpose by complementary intervals while the C-set dyads hold
5. One member from each C-set dyad transposes while the remaining notes hold
6. One C-set Dyad transposes while its axis note holds (the remaining C-set either holds or wedges)

7. One axis note transposes while its C-set dyad holds (the remaining C-set either holds or wedges)
8. One member from one C-set dyad transposes while the other member and the axis note holds (the remaining C-set either holds or wedges)

The discussion of modulation given in this chapter is by no means exhaustive. Its purpose is rather to give a sense of the principal modulation techniques found in Perle's music, and to recast them in terms of voice leading. In summary, both techniques can be profitably explained in terms of voice leading. In the first technique, modulation is the result of a voice reorienting itself with respect to the motion of the other voices. In the second technique, the modulation is caused by oblique motion, which momentarily breaks the symmetry that preserves the C-sets of an array. In both cases it is instructive to think of modulation as an effect of the movement of voices.

## Chapter Four

### Counterpoint Between C-Sets

I defined “array” in Chapter One as the association of two C-sets. The purpose of this chapter is to examine how the two C-sets of an array work together. I will divide the discussion into two parts. First, I will examine hexachordal progressions, which are normative for Perle’s system, and in which the voice-leading is clearest. Then I will discuss tetrachordal progressions. Though not normative (even Perle describes tetrachords as incomplete hexachords), they appear very frequently in his music.<sup>56</sup> Others have discussed Perle’s hexachord and tetrachord progressions, but not from a voice leading perspective, and not with an eye on the counterpoint *between* the two C-sets.

#### **Array Voice Leading: Hexachords**

Since the basic harmonic unit of a C-set is the trichord with its axis note and C-set dyad, the basic harmonic unit of an array is the hexachord with two axis notes and two C-set dyads.<sup>57</sup> Each C-set has its own voice leading, but the movement of one C-set compared to the other creates a new, larger voice-leading pattern—a counterpoint of counterpoints. Happily, observing the larger voice-leading pattern is not as complex a job as it might seem to be. The overall motion of a C-set is faithfully represented by its axis

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<sup>56</sup> In *Twelve Tone Tonality*, pg. 53, Perle describes two kinds of “tetrachordal collection,” both in terms of hexachords that omit two notes: first, “We have formed tetrachordal collections by aligning three-note segments of two set forms and *omitting the middle column...*” (emphasis mine) and second, “We have taken the same alignment...and combined what we have been calling an ‘axis dyad’ with *only one pair of its neighbor notes...*,” (emphasis mine). The first kind, dubbed “cyclic chord,” does not typically appear as separate entities in his music; the second kind, dubbed “sum tetrachord,” is the subject of the second part of my chapter.

<sup>57</sup> Perle calls the pair of C-set dyads a “cyclic chord” and the complete hexachord an “axis-dyad chord” (see *Twelve-Tone Tonality*, 28-29).

voice alone, since the other voices are bound to it by the obligation of symmetry. Therefore, to follow the “counterpoint of counterpoints,” the voice-leading between C-sets, one simply follows the counterpoint between the axis voices. It remains only to describe the patterns that emerge, and their effect.

The image shows a musical score for Example 4.1, an excerpt from the fourth movement of *Sonata a Quattro*. The score is written for four instruments: Flute (Fl), Clarinet (Cl), Violin (Vn), and Cello (Ce). The music is in 3/4 time and consists of two measures. The first measure is in 3/4 time, and the second measure is in 5/4 time. The score includes dynamics markings such as *f* (forte) and *p* (piano). Below the main score, there is a legend indicating that a solid circle represents a 0/1 note and an open circle represents a 5/11 note. The score also includes a diagram showing the progression of C-sets (represented by circles) and their corresponding harmonies (represented by squares) across the two measures.

Perle SONATA A QUATRO  
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**Example 4.1, George Perle, *Sonata a Quattro*, IV, mm. 68-69**

Because wedge voice leading generates harmonies, it generates a harmonic rhythm. When two C-sets are in play at the same time, each with its own wedge voice leading, there are in theory two distinct harmonic rhythms. In practice, however, it is rare to find the C-sets’ harmonies progressing at different rates of change. As a rule in Perle’s music, the two C-sets move together in simultaneous wedge progressions. But it is not an absolute rule. Example 4.1, an excerpt from the fourth movement of *Sonata a Quattro*,

shows an exception. In the first measure, the two C-sets have the same harmonic rhythm: their wedge progressions occur simultaneously at a rate of one chord per quarter note. But beginning with the second measure, second beat, C-set 5/11 moves independently of C-set 0/1. At that point the cello, which takes the axis note of C-set 0/1, holds in the manner of a pedal point while the flute, clarinet and violin wedge outward by semitone. The wedge voice leading is clear in the upper parts—the clarinet descends by semitones while the flute and violin ascend symmetrically.

(a)

sempre stacc. cresc.  $ff$  dim.  $ppp$

Legend:  
 ■ = 5/8      ■ = 2/5      ■ = 0/3  
 □ = 5/6      □ = 2/3      □ = 2/3

(b)

**Example 4.2, Syncopated wedge progression in *Six Etudes for Piano* (1973-76), No. 1 mm. 27-33**

Example 4.2a, an excerpt from the first movement of *Six Etudes for Piano*, is another intriguing example in which the C-set's harmonic rhythms differ.<sup>58</sup> The passage is a modulating sequence. The third and fifth measures both show a modulation through oblique motion. In the first modulation, the axis notes move while the C-set dyads hold. Since the axis notes transpose by an odd interval, the result is a semi-transposition of the array. In the second modulation, only one of the C-sets modulates. Its axis note holds while its C-set dyad transposes by  $T^{10}$ . Since the T-number is even, the result is a full transposition of the C-set.

Apart from the points of modulation, the C-sets move consistently at  $W^{10}$ . However, the harmonic rhythm of the C-sets is syncopated: one C-set moves, then holds while the other moves, and so on, as highlighted in Example 4.2b. The effect is something like the fourth species of counterpoint in its rhythm, but the syncopations do not create "suspensions" inasmuch as there is no dissonant chord that begs resolution.

Perle emphasizes the syncopation on the surface of the music by keeping the axis notes separate from the C-set dyads. The left hand takes the axis notes; the right hand takes the others. By keeping the voice leading relatively clear, the sequential pattern can propel the passage toward the climactic *fortissimo*. The anticlimactic "trailing off" at the very end of the phrase is a frequent gesture in Perle's music, one of a number of traits that give the music a prose-like, conversational manner.

The foregoing examples represent the exception rather than the rule. The C-sets of an array usually progress simultaneously. Perle does not seem to have explored the possibility of freeing them rhythmically from one another, even though he treats them

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<sup>58</sup> I refer the reader again to Gretchen Foley's excellent study of this piece from which I gratefully glean the array analysis of this example: Foley, "Pitch and Interval Structures," Appendix Three.

independently in other respects. Perhaps, since the voice leading is so often obscure with respect to register and instrumentation, too much rhythmic independence would obscure the voice leading beyond all comprehension. The success of Examples 4.1 and 4.2 depends in part upon the relative clarity of their voice-leading. In Example 4.1 the wedge is unmistakable in the upper parts; and in Example 4.2 the segregation of the axis notes lets the ear track the sequence.

Although C-sets are usually coordinated with respect to rhythm, they can be quite independent with respect to their voice-leading paths. This is an aspect of Perle's music that has received virtually no attention, though the paths that the C-sets take and the relationship between those paths surely constitute essential features of his style. Whereas in tonal composition predetermined harmonic/intervallic preferences (i.e. the priority of consonant intervals and triads) limit the voice-leading possibilities, in Perle's composition it is the other way around. The predetermined voice-leading preferences (i.e. the priority of symmetrical progression) limit the harmonic/intervallic possibilities. In that light, it would seem fundamental to examine the relationship between the voice-leading paths of the two C-sets of an array. An exhaustive account would prove an enormous undertaking. It is my intention here only to suggest a direction.

In broadest terms, the two C-set paths are either coordinated or independent. Coordinated paths interact in a consistent way, moving in parallel motion, contrary motion, or a combination of the two. Independent paths, on the other hand, seem to go their own way. They do not coordinate in any obvious way, each path possessing its own logic. In order to distinguish between the counterpoint *within* a C-set and the counterpoint

*between* two C-sets, I will refer to the latter as the “axis note counterpoint” since the axis notes represent the whole.

Coordinated paths move either in parallel or contrary motion, or a combination of both. That means that the axis note counterpoint can be described in terms of transposition and wedge. A single progression between two chords could hardly be described as a coordinated path, but a series of several such progressions in a row is more suggestive. Yet given the short-breathed character of Perle’s rhetoric, we should not generally expect to find extended examples of any one type of axis note counterpoint. A few chords are generally enough to suggest a pattern.

In the most extreme kind of coordination, found most often in Perle’s earlier music, the axis note counterpoint moves strictly by parallel motion, often in unison, for an extended progression or even an entire movement. This paper has stressed the individuality of C-sets, but in some early works the C-sets work so closely together that they are hardly divisible.

Example 4.3a shows an excerpt from the second movement of Perle’s first published composition in twelve-tone tonality, *Modal Suite* (1941), the work whose first movement often serves as an introduction to his system. The axis counterpoint is no counterpoint at all, for the axis voices move strictly in unison throughout the example.

The undifferentiated axis voices make for a slight difficulty of interpretation. The difficulty is not in describing the voice leading *per se*, but in naming the C-sets and therefore in naming the array. Given this excerpt alone, it is not possible to ascertain what the C-sets are, no matter how unambiguous the symmetrical voice leading. Example 4.3a interprets the passage using C-sets 0/5 and 3/8. But example 4.3b gives an alternative

(a)

Musical score for Example 4.3(a) in 2/4 time. The score consists of four staves. The top staff is a grand staff with treble and bass clefs, containing melodic lines with dynamics *p*, *mf*, *p*, *mf*, and *p*. The second staff is a grand staff with treble and bass clefs, containing chordal accompaniment with some notes boxed. The third staff is a grand staff with treble and bass clefs, containing chordal accompaniment. The fourth staff is a grand staff with treble and bass clefs, containing chordal accompaniment. A legend below the score indicates:  $\bullet \blacksquare = 0/5$  and  $\circ \square = 3/8$ .

(b)

Musical score for Example 4.3(b) in 2/4 time. The score consists of two staves. The top staff is a grand staff with treble clef, containing chordal accompaniment. The bottom staff is a grand staff with bass clef, containing chordal accompaniment. A legend below the score indicates:  $\bullet \blacksquare = 5/8$  and  $\circ \square = 0/3$ .

(c)

Musical score for Example 4.3(c) in 2/4 time. The score consists of two staves. The top staff is a grand staff with treble clef, containing chordal accompaniment. The bottom staff is a grand staff with bass clef, containing chordal accompaniment. A legend below the score indicates:  $\bullet \blacksquare = 3/5$  and  $\circ \square = 8/0$ .

(d)

Musical score for Example 4.3(d) in 2/4 time. The score consists of two staves. The top staff is a grand staff with treble clef, containing chordal accompaniment. The bottom staff is a grand staff with bass clef, containing chordal accompaniment. A legend below the score indicates:  $\bullet \blacksquare = 3/5/8/0$ .

Modal Suite © by Galaxy Music Corporation, a division of ECS Publishing, Boston, MA. Reprinted by permission.

**Example 4.3 Axis notes moving in unison in *Modal Suite, II*, mm. 1-5**

interpretation, equally correct, using C-sets 5/8 and 0/3. The axis notes are the same; the voice leading paths are the same—the difference is in choosing which pair of notes forms a C-set dyad. In other words, it is clear which notes are axis notes and which are not, but it isn't clear how the latter pair up into C-set dyads. Taken together they form [0358] tetrachords that could be divided up in several ways. The first interpretation divides them into two i.c. 4 dyads. The second interpretation divides them into two i.c. 3 dyads. Example 4.3c divides them into i.c. 2 and i.c. 4 dyads, making the array 5/3, 8/0.

There is nothing in the music that forces one interpretation over the other. All three are technically correct.<sup>59</sup> Unless context gives it away, the same difficulty in naming the array will occur whenever the axis counterpoint moves in parallel motion, whether at the unison or any other interval. Fortunately for the analyst, unrelieved parallel motion in the axis counterpoint is not the norm. Context almost always gives clues to the array. But as long as the parallel motion persists, there will be an element of ambiguity—an ambiguity that can be turned to useful ends. For example, an extended progression that can be interpreted by two different arrays can also form a smooth link between them.

Even though the passage in Example 4.3 can be interpreted by three different arrays, the aggregate voice leading is the same for all three: they all show the same axis notes wedging against the same tetrachords. The wedge voice leading is certain, even though the array is not. The unison axis notes may be reduced to one pitch class, and the voice leading seen not as two wedging trichords, but as a wedging pentachord split one

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<sup>59</sup> All three are correct as far as internal evidence is concerned. The first interpretation is the better, however, if external evidence is given weight. Perle did not begin to build cyclic sets from interval cycles other than 5 and 1 until later in his career, so in composing this work he would not have been considering 3/5, 8/0, 0/3 or 5/8 as possibilities.

note against four. Example 4.3d shows how that would appear. The label 0/3/5/8 merely indicates all the indices.

Although more typical of Perle’s earliest music, persistent parallel motion in the axis counterpoint is sometimes found in later works. If the syncopated C-set progressions shown in Example 4.2 above were “normalized” so that the trichords moved at the same time, the axis voices would also move in parallel motion. Example 4.4 gives an instance from Perle’s *Ballade*. The extent of the progression is not what it first appears to be. Each measure repeats and elaborates the preceding one, as though several attempts were necessary in order to accomplish the final progression. Except for a slight modification on the penultimate chord, the axis counterpoint moves in parallel unison throughout.

•■ = 1/4  
 ○□ = 7/11

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**Example 4.4, Axis notes moving in unison in *Ballade* (1981), mm. 42-46**

The context (not shown) clarifies what the array is, as does the deviation on the penultimate chord. Without those hints as to the array, the C-set dyads could be plausibly interpreted by a different array.

Another kind of coordination occurs when the axis note counterpoint moves symmetrically by wedge. The excerpt in Example 4.5a is divided in the middle by a modulation in one of the C-sets. The axis note counterpoint on either side of the divide is coordinated by a semitone wedge.

The modulation is by oblique motion however, it appears differently here than in previous examples. To see how this modulation relates to others of the same kind, it is helpful to imagine it as a compression of two motions. Example 4.5b illustrates. Two motions—a modulation by oblique motion like the ones previously seen, and a standard wedge progression—are compressed to one asymmetrical motion by omitting the middle chord. The result is still a modulation through oblique motion (in its more precise meaning, “oblique” encompasses similar, though not parallel lines), but none of the voices are stationary. They all move, but asymmetrically. The imaginary second chord in the uncompressed version shows the axis note transposing by  $T^3$  while the C-set dyad holds. The odd T-number reflects the semi-transposition of the C-set from  $1/4$  to  $4/7$ .

To discover the array in Example 4.5a, I relied on context not shown here. As with persistent parallel motion in the axis note counterpoint, persistent wedge motion creates an uncertainty about the array unless there are further clues. Example 4.6 illustrates the difficulty. Example 4.6a restates the latter half of Example 4.5a with a more general voice leading analysis. Instead of identifying the axis notes and C-set dyads, it shows a three-against-three wedge progression:

1.  $W^1(t02^479) = (9e1^58t)$
2.  $W^1(9e1^58t) = (8t0^69e)$

All three notes on the top staff of the analysis wedge symmetrically against all three notes of the bottom staff. But which are the axis notes and which are the C-set dyads? Without further evidence it is impossible to determine. Example 4.6b shows nine possible array interpretations. Any one of those interpretation could faithfully represent the voice leading.

(a)

The musical score for Example 4.5(a) consists of three systems. The first system shows a piano score with a treble and bass staff. The treble staff contains a sequence of chords, and the bass staff contains a sequence of notes. The tempo is marked *poco cresc.* and the dynamics are *pp*. The second system shows a simplified piano score with treble and bass staves, where notes are enclosed in boxes. The third system shows an analysis staff with treble and bass staves, where notes are represented by squares. A note in the bass staff is labeled "Causes modulation!". Below the analysis staff is a legend: a solid square represents 1/4, an open square represents 7/11, a solid square with a dot represents 4/7, and an open square with a dot represents 7/11.

(b) Modulation by oblique motion: compressing three moves into two

The diagram illustrates modulation by oblique motion. It shows a sequence of three chords in a treble staff, with time signatures 1/4 and 4/7. The text "compresses to" is placed between the two staves. The second staff shows the same sequence of chords compressed into two measures, with time signatures 1/4 and 4/7.

Example 4.5, Axis notes moving by wedge in *Ballade* (1981), mm. 59-60

The difficulty with the axis note counterpoint moving by wedge is that there is *too much* wedging. It creates a tangle of symmetry that Perle sometimes exploits—a labyrinth full of mirrors and misleading pathways. Example 4.7 shows many false wedges in the short progression at hand. The  $W^1$  progressions in Example 4.7a would seem to be good candidates for the underlying voice leading, but none of them is a wedge that defines the actual C-sets. The wedge progressions in Example 4.7b are also suggestive, but they derive from an internal symmetry within the chords, rather than voice leading between them. Example 4.7c reveals another symmetry that is ultimately disqualified. With such a preponderance of symmetry, the real voice leading is difficult to find.

(a)

Example 4.7a shows a piano score in 9/16 time with a piano (*pp*) dynamic. The top part shows a piano score with a treble and bass clef. The bottom part shows two staves with chords and arrows indicating voice leading between them.

(b)

Example 4.7b shows a piano score with chords and arrows indicating voice leading. The bottom part shows a series of chord diagrams with numerical ratios:

●■ = 4/7	●■ = 2/5	●■ = 6/9	●■ = 7/9	●■ = 5/7	●■ = 9/11	●■ = 9/4	●■ = 7/2	●■ = 11/6
○□ = 7/11	○□ = 9/11	○□ = 9/7	○□ = 2/6	○□ = 4/6	○□ = 4/2	○□ = 5/9	○□ = 7/9	○□ = 7/5

**Example 4.6, Ambiguity in wedging axis notes**

(a)

(b)

(c)

### Example 4.7, False wedges

The ambiguity caused by persistent symmetrical or parallel motion between sets is related to longstanding principles of counterpoint. After all, the more two things are alike, the less they are distinguishable. On the other hand, differences help to define things. By way of preface to his discussion of the three motions, Fux says: “Pleasure is awakened by variety of sounds. This variety is a result of progression from one interval to another, and progression, finally, is achieved by motion.”<sup>60</sup> It is an old principle of counterpoint that a good mixture of parallel, contrary and oblique motions produces independent lines. C-sets only assert themselves when their voice-leading paths diverge. Perhaps it is for that reason that Perle most commonly uses a mixture of motions, as in Example 4.8.

<sup>60</sup> Fux, Johann Joseph, *The Study of Counterpoint*, revised edition, trans. and ed. by Alfred Mann (New York: Norton, 1971), 21.

Tempo III, ♩ = 66

*mp* *cresc.* *f* *poco dim.* *poco riten.*

■ = 4/8  
 □ = 3/7

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### Example 4.8, *Phantasyplay* (1994), mm. 44-45

#### Array Voice Leading: Tetrachords

I have been focusing on hexachords because they are the representative harmonic unit in Perle's system. As I pointed out in chapter one, the voice leading is clearest in hexachord progressions, and that tetrachord progressions introduce significant challenges to voice leading analysis. Nevertheless, tetrachord progressions or mixed hexachord and tetrachord progression constitute a significant portion of Perle's music. The following section recapitulates the difficulty in analyzing tetrachord progressions, and then offers a way to address it.

In chapter one I defined tetrachords as incomplete hexachords. To be specific, since the array exists as a double stream of C-sets, and each C-set exists as a stream of wedging trichords, array hexachords exist as the coincidence of two trichords. Array

tetrachords are the result of omitting one note from each trichord. They exist as the coincidence of two dyads—two incomplete trichords. Defining tetrachords negatively, in terms of what they lack, is consistent with Perle. He discusses two types of tetrachords in *Twelve-Tone Tonality*, both of which are defined in terms of what they lack: Perle’s “cyclic chords” are missing the axis notes from both trichords; and his “sum tetrachords” are missing one note from each C-set dyad. Example 4.9 shows a hexachord progression and several tetrachord progressions derived from it. Example 4.9b shows what a progression of Perle’s “cyclic chords” would be. Since the axis notes are missing, there is nothing against which the C-set dyads wedge. The complete lack of symmetrical voice leading renders this type of progression fairly useless in Perle’s system. It almost never occurs. Example 4.9c-d show Perle’s “sum tetrachords.” They are more promising due to the presence of wedge voice leading. However, the C-set dyad is not given. Thus both “cyclic chords” and “sum tetrachords” are incomplete versions of an implied hexachord. Perle describes the two kinds this way:

In itself, a cyclic chord [Example 4.9b] is equally representative of *any* pair of set forms of the given interval system [i.e. the pair of C-set dyad intervals]. A sum chord [Example 4.9c], on the other hand, while it partially identifies the specific set forms, does not identify the interval system of which they are members, since it omits the cyclic intervals [i.e. the C-set dyad intervals].<sup>61</sup>

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<sup>61</sup> *Twelve-Tone Tonality*, 55.

Diagram illustrating five examples (a) through (e) of tetrachords, showing the relationship between the upper and lower tetrachords and their associated indices:

- (a) Upper tetrachord: 4/9; Lower tetrachord: 10/1
- (b) Upper tetrachord: ??; Lower tetrachord: ??
- (c) Upper tetrachord: 9/?; Lower tetrachord: 1/?
- (d) Upper tetrachord: 4/?; Lower tetrachord: 10/?
- (e) Upper tetrachord: 4/.....9; Lower tetrachord: 10/.....1

### Example 4.9, Ambiguity of tetrachords

The main issue Perle was describing is one of array identification. A tetrachord alone is not enough to identify the array. A series of tetrachords, however, is capable of conveying all the information necessary. Example 4.9c shows one pair of indices; Example 4.9d shows another. Example 4.9e shows all four indices by alternating which note of the C-set dyad is missing. Yet the presence of all four indices is still not enough to identify the array because the indices still have to be associated into the two pairs that define the C-sets. In other words, even if the four indices 4, 10, 9 and 1 are present, it still remains to be seen whether the array is 4/10, 9/1 or 4/9, 10/1 or 4/1, 9/10. However, the fact that each tetrachord contains an index from both C-sets is a clue to how they pair up: given two indices from a tetrachord, you know that one belongs to one C-set and the other belongs to the other C-set. In short, Perle's solution to the array identification problem is to take care to include all four indices in their various combinations.<sup>62</sup>

<sup>62</sup> The example is simplified somewhat. For a more thorough discussion of how tetrachords define arrays, see Schober, "George Perle's *Six New Etudes*."

(a)

(b)

(c)

### Example 4.10, Ambiguity of Dyadic Wedges

However, even after the array is identified, the voice leading remains ambiguous. I have shown passages in which the voice leading is straightforward but in which the array cannot be ascertained. The reverse is true with tetrachord progressions: the array may be certain but the voice leading never is. The difficulty comes from the fact that a wedging dyad is always susceptible to two interpretations. For instance, there are two possible voice-leading paths for the dyadic wedge in Example 4.10a. What is more, as Examples 4.10b and c demonstrate, the longer the succession of dyads, the more possible paths there are. For any progression of dyads, the number of possible voice leading paths will be  $2^{n-1}$  (2 to the power of n-1) where n is the number of dyads in the progressions. In a progression of only eight dyads, there would be already one hundred twenty-eight ways to interpret the voice leading.

In Example 4.11 the array is certain, and the wedging dyads are clear. As in Example 1.14, C-sets are divided between staves, and beams connect dyads of the same

index number. For instance, the first dyad in the upper staff, G#B, wedges onto the fourth dyad, AB $\flat$ . However, the specific path that a voice takes is up for interpretation. Does G# of the first dyad map onto A or B $\flat$ ? Yet despite the inherent ambiguity of tetrachord progressions—an ambiguity Perle admits (see p. 36 above)—interpretations of the voice leading are still possible and indeed valuable, as long as the difference between the hypothetical paths of wedging dyads, and the conclusive paths (given my analytical framework) of wedging trichords is kept in mind.

Moreover, the problem of array identification and, to a certain extent, voice leading ambiguity, disappears in progressions that mix hexachords with tetrachords. As for array identification, the issues that arise from omitting notes are moot when full hexachords enter the picture. As for ambiguous voice leading, the presence of unambiguous trichordal wedges often ameliorates the difficulty in interpreting dyadic wedges by suggesting the trajectory for a voice. When the line-leading supports such a trajectory by tracing it in pitch-space, we can be more confident about a voice's path, but never as confident, it must be admitted, as when a progression involves hexachords alone.

Example 4.12, a passage from the strident eighth movement of *Brief Encounters*, is a progression involving both tetrachords and hexachords. Despite the presence of tetrachords, and therefore ambiguous dyadic wedges, I have constructed complete voice leading paths for all the voices. When a hexachord progresses to a tetrachord, one of the C-set dyad voices disappears; and when a tetrachord moves to a hexachord, a C-set dyad voice suddenly appears. I use a solid line in such cases to clarify which voice goes where. The paths involving tetrachords may be considered hypothetical, though the given interpretation is not unsupported.

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**Example 4.11, *Brief Encounters, I* “Rondolletto,” 55-56**

The chords have been labeled 1-11 for convenience. Chords 1 and 2, and 6 and 7 are tetrachords, the rest are hexachords. (Although there are three different tetrachords in the first measure, only two of them are “harmonic.” The second tetrachord, labeled “p” in the second tier, is an instance of Perle’s “dissonant figuration” discussed in chapter one (see Example 1.1)). The path through chords 6 and 7 is a very likely interpretation. First, the cello line suggests a trajectory for the axis voice of C-set 1/4. From chords 5 through 10 the cello appears to trace the axis voice, as shown in the second tier. It makes good sense, for the sake of continuity, to assign the same voice to the cello on chords 6 and 10. Moreover the same voice is instantiated in a consistent registral line from the second chord to the end of the example, though it passes once from the second violin to the cello,

and again at the end from the cello to the viola. If the cello line on chords 6 and 7 may be taken as the axis voice, then we can infer the other voice of C-set 1/4, since knowing one voice of a wedging dyad gives away the other. In the same way, the first violin suggests a trajectory for the axis voice of C-set 5/9. In chords 5 through 10, the axis notes are consistently emphasized with down-bow strokes.

Legend:  
 ■ = 1/4  
 □ = 5/9

Measures: 1 2 3 4 5 6 7 8 9 10 11

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**Example 4.12, Brief Encounters, VIII “Strepitoso,” 36-39**

Line-leading also informs the interpretation of chord two. The connection of A# to A in the cello part suggests that they be treated as the same voice, which makes the

former an axis note. The second violin likewise connects D $\flat$  and D, which leads to the interpretation of the former as an axis voice. The interpretation of the first chord is a little more arbitrary. The second violin's staying on C $\sharp$ /D $\flat$  is the only clue to go by.

In summary, some of Perle's music, whether passages or whole movements, uses only tetrachord progressions; some uses only hexachord progressions; and some uses a mixture of both. When only hexachords are used, the voice leading paths are conclusive. When only tetrachords are used, the wedging is clear, but the specific paths of voices are uncertain. When both tetrachords and hexachords are used, the paths are still subject to interpretation, but the interpretations may be more or less plausible depending on how many tetrachords there are in succession, the extent to which the voice leading of the hexachords suggests a trajectory for that of the tetrachords, and whether the line-leading offers any clues to the voice-leading.

## Chapter Five

### Analysis of Two Movements by Perle

Examples of Perle's music in previous chapters consisted only of excerpts, usually out of context. This chapter places what has been discussed about voice leading in the context of two complete movements composed roughly forty years apart. Although the heart of this chapter is the notated three-tier voice-leading analysis of the two movements, I will discuss various other aspects of the music as well.

#### *Six Preludes for Piano (1946), IV*

We will begin with an analysis of one of Perle's early works, the fourth of his *Six Preludes for Piano* (1946) (Example 5.1). It does not contain some of the complexities of his later music. There is no modulation—only one array. The C-sets, inasmuch as the piece can be said even to have C-sets, do not move independently. The harmonic vocabulary is quite small in comparison with later works. Nevertheless the prelude already shows Perle taking features of the system and turning them into compositional opportunities. Perle's exploiting simultaneously the vertical and horizontal dimensions—the chord structure and the wedge scale—constitutes a basic structural feature of this movement. Further, some of the techniques exhibited in it become staples of Perle's composition for his entire career.

A B

$\text{♩} = 240$

$\frac{3}{4}$  *ff*

♩ = 6/9/1/4

C D

*sempre ff*

$\frac{4}{4}$   $\frac{3}{4}$   $\frac{3}{4}$

Perle SIX PRELUDES  
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**Example 5.1, *Six Preludes for Piano* (1946), IV**



The six preludes are not stand-alone works. They are intended to be performed as a set. Only twelve measures long at a tempo of two hundred forty quarter-notes to the minute, the fourth prelude lasts only about ten seconds. It charges along without pause, *sempre fortissimo*, with an unwavering texture: dyads pitted against trichords from beginning to end. Yet it is possible to discern four separate sections which I have labeled A, B, C and D. The distinguishing features are rhythm, articulation, and dyadic and trichordal content.

The texture is consistent throughout: one hand plays trichords while the other plays dyads. The dyads and trichords have separate stories to tell. Example 5.2 separates the dyads from the trichords. The dyads begin in section A as (01) in quarter notes. Each instance of (01) is longer than the previous one by a quarter note, generating the pattern 12, 123, 1234, 12345. In section B (01) expands to (02) but continues in quarter notes. Section B ends notably with series of (02) dyads ascending by step, [FG]→[GA]→[AB]→[B♭C]. The (02) dyads continue in section C, but in half-note values. In section D, (02) briefly expands to (03). If the movement had been longer, perhaps the dyads could have continued to expand by semitone through (04), (05) and so on. But as if sensing that the end was coming, the dyads rapidly expand to an octave in the final measure.

The trichords also have a story. In section A they all belong to set class (025). We find them in both prime and inverted forms. The six trichords group into pairs of  $T_1$ -related instances. The second trichord transposes the first by semitone; the fourth transposes the third by semitone; and the sixth transposes the fifth by semitone. In section B (025) becomes (015) and then (014). Once again both the prime and inverted forms appear. The close intervallic relationship between the (025) trichords of section A and the

(015) and (014) trichords that follow is faintly veiled by the different spacing they are given on the surface—close spacing in section A contrasted with open spacing in sections B and C. Section C continues to use (014) and (015) trichords, but gives them a new rhythm. As the analysis indicates, all the trichords of sections B and C are wedge-related. There is a solitary (014) in section D, but the conspicuous newcomer is set class (037), the common triad. And it appears, not surprisingly, in both prime and inverted forms.

Returning to the full score in Example 5.1, the voice leading analysis does not show two streams of trichordal wedge voice leading as usual. This prelude is an example in which the voice leading paths of the two C-sets are identical from beginning to end. Consequently, from the perspective of the listener/analyst, distinguishing between the two C-sets would be arbitrary. We could assume that the array is 1/6, 4/9, since in Perle's early career he evidently only used interval classes 1 and 5 as C-set intervals, but there is nothing intrinsic to the music to make us favor that interpretation. If anything, the trichordal wedge in sections C and D (Example 5.3) would suggest 9/1 as one of the C-sets, making the array 9/1, 4/6, but that would be anachronistic as far as the development of Perle's theory is concerned. As an alternative to the standard array, I have shown tetrachords wedging against a singleton. The name of the "array" is therefore not given as two pairs of index numbers, but as one set of four index numbers: 6/9/1/4 (the order is unimportant). This approach departs from Perle's theory, but it does some justice to the music which, after all, appears as a series of pentachords, not hexachords.

I will refer to the singletons as "axis notes," and to the tetrachords that wedge against them as the "C-set tetrachords." The C-set tetrachord is (0358), or the "minor-minor seventh chord." Every harmony in the prelude, therefore, could be described as a

minor-minor seventh chord plus one note. The variety of content in the four sections of the prelude—the different dyads and trichords—is the result of exploiting the structure of the C-set tetrachord and features of the wedge voice-leading.

Section A, as we have noticed, uses (01) dyads and (025) trichords in separate hands. The trichords all are taken from the C-set tetrachord, since (025) is a subset of (0358). Because (0358) is symmetrical—it is its own inversion—each of its subsets is the inversion of another of its subsets. There are exactly four trichordal subsets: a prime and inverted form of (025) and a prime and inverted form of (037) (Example 5.4). Getting the right trichord is a matter of leaving the right note out of the C-set tetrachord. Taking the chord [CE $\flat$ FA $\flat$ ] and removing [C] leaves the prime form of (025). Removing [A $\flat$ ] leaves the inverted form. In this way Perle is able to easily generate the trichords of section A. He could have also generated the (037) trichords of section D in the same way, but he used other means to the same end.

The image shows a musical staff with five chords. The first chord is a C-set tetrachord, labeled (0358). The second and third chords are (025) trichords, and the fourth and fifth chords are (037) trichords. The chords are arranged in pairs, with the first pair being (0358) and (025), and the second pair being (025) and (037).

#### Example 5.4, Trichordal Subsets of (0358)

The notes that are left out of the C-set tetrachords join with the axis notes to form the (01) dyads. We have already noticed that the harmonies in section A are grouped in pairs. Each pair follows the same pattern on the surface: the dyad stays put while the trichord transposes a semitone. The reason for this grouping has to do with one of Perle's staple voice-leading techniques. To help illustrate it, Example 5.5 gives a typical

trichordal wedge progression. The key measurements in discussing such a progression are the interval of the C-set dyad and the index between the axis note and each of the members of the C-set dyad. One of the measurements so far not discussed is the *interval* between the axis note and either member of the C-set dyad. That interval is variable because the interval of a wedging dyad changes as it wedges. I will refer to the interval of a wedging dyad as interval “X.”

Interval "X"

$W_5(F^{\wedge}CE\flat) = (C^{\wedge}FA\flat)$

### Example 5.5, Interval “X”

The technique on display in Section A of the prelude uses interval X as a way to ensure common tones. The technique is to wedge by the complement of interval X so that the dyad’s two notes swap places. For example, if interval X is 3, then wedge at  $W_9$ . If interval X is 5, then wedge at  $W_7$ . In Example 5.5, interval X is 7. Wedging by 5, the complement of 7, exchanges the two notes of interval X, ensuring two common tones. Holding the two common tones on the surface of the music disguises the fact that the voices are in fact trading places. In section A, the semitones that apparently do not move while the trichord transposes are the result of just such a maneuver.

To sum up the discussion so far, section A exhibits a two-chord progression in which a prime or inverted form of (025) transposes by semitone against a stationary (01) dyad. The pattern occurs three times. Beneath the surface, the progression is the result

mainly of three compositional choices: first, to create (025) trichords out of the C-set tetrachord by omitting the appropriate note; second, to create (01) dyads out of the omitted note and the axis note by selecting the point along the wedge scale where they meet; and third, to wedge at  $W_{11}$  or  $W_1$ , depending on the specific situation, ensuring that the (01) dyad can hold while the (025) trichord moves a semitone.

Sections B and C are alike in their harmonies and techniques, so we will consider them together. As we observed earlier, (02) dyads and (015) and (014) trichords replace the (01) dyads and (025) trichords from section A, and the trichords appear again in prime and inverted forms. Beneath the surface, the dyads are now discovered to be drawn from the C-set tetrachord, and the trichords are formed in conjunction with the axis note. There is only one (02) subset of the C-set tetrachord (0358), and it serves as the dyad in section B and C. What remains of (0358) when (02) is pulled out is a (04) dyad. That (04) dyad combines with the axis note to form the (015) and (014) trichords. To ensure the correct trichord it is only necessary to select the position along the wedge scale where the axis note borders the (04) subset of the C-set tetrachord by a semitone: a semitone on the outside of (04) for (015) and a semitone on the inside for (014).

To illustrate, Example 5.6 gives the tetrachordal wedge scale on which the prelude is based. Each position along the scale is numbered 1-12. The (04) subset of the C-set tetrachord is found as its two middle notes (shown in slightly larger noteheads), which will be combined with the axis note to form (015) and (014) trichords. The position along the scale where the axis note borders the (04) dyad by a semitone on the *outside* will generate (015) trichords. If the axis note lies a semitone below the (04) subset, it will form a (015) trichord in prime form; if it lies a semitone above the (04)

subset it will form a (015) trichord in inverted form. The former is found at positions six and twelve, the latter at positions three and nine. Likewise, (014) in prime and inversion may be found where the axis note borders the (04) dyad by semitone on the *inside*. Positions five and eleven show (014) in prime form, and positions four and ten show it in inverted form.

■• = 6/9/1/4

1	2	3	4	5	6	7	8	9	10	11	12
		(015) Inverted	(014) Inverted	(014) Prime	(015) Prime			(015) Inverted	(014) Inverted	(014) Prime	(015) Prime

### Example 5.6, (04) Dyad and Axis Note Joined to Form (015) and (014) Trichords

In measure seven the (02) dyads that rise by step, [FG]→[GA]→[AB]→[B<sup>b</sup>C], are produced through a sleight of hand. The dyad (GA) is not a subset of the C-set tetrachord like all the others. As the second tier of the analysis shows, [G] is the axis note.

In section D the trichord (037) is used for the first time. It appears in inverted form (the major triad) in measure eleven, and in prime form (the minor triad) in measure twelve. As I pointed out earlier, Perle could have exploited the structure of the C-set tetrachord again, since the prime and inverted forms of (037) are both subsets of (0358); but he uses other means. He generates the (037) trichord in four different ways. Each time he combines the axis note with a subset of the tetrachord, but always in a different way. For the sake of description let us refer to the members of the trichord as the “root, third, and fifth.” In measure eleven the axis note takes the place of the “root.” In the next

instance it is in the place of the “third;” then the “fifth,” and lastly the root again, but this time it doubles one of the notes of the C-set tetrachord. The octave dyad in the right hand is a feint. There is only one C# in the voice leading.

### **Sonatina, First Movement**

Perle’s Sonatina (Example 5.7) participates in the classical Sonatina tradition, at least superficially, in a number of ways. It is a moderately small work (approximately five minutes) with three complementary movements in a fast-slow-fast arrangement: *Allegretto*, *Molto Adagio*, and *Allegro*. The texture is generally delicate and understates its underlying complexity with a simple, elegant surface.

The motivic structure of the first movement echoes the classical sonata plan. The first group of motives in measures 1-27, the “A-group” for the sake of argument, contrasts with a second group, the “B-group” in measures 28-42. A brief, loosely constructed section follows where a development section would go (measures 43-48). It contains the only 9/16 and 6/16 time signatures in the piece. It is the motivic and harmonic “point of furthest remove” to use Leonard Ratner’s phrase, and precedes a clear recapitulation.<sup>63</sup> Measure 50 onward sees the recapitulation of both A-group and B-group material, though the A-group predominates.

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<sup>63</sup> Leonard Ratner, *Classic Music: Expression, Form and Style* (New York: Schirmer, 1980), 225-227.

Allegretto (♩=ca. 48, ♩=144)

*delicatamente* 2 3 4 *poco riten.* (♩=36, ♩=108) 5 6 7 8 9 10 *a tempo* 11 12 13

*pp* *misterioso [sic]* *p* *pp* *mf* *p* *dim.* *pp* *con ped.*

14 15 16 17 18 19 20 21 22 23 24 25 26 27

*mp* *poco dim.* *p* *mp* *poco dim.* *p* *mp* *p* *mf*

■ = 9/3  
 □ = 1/6

■ = 0/6  
 □ = 4/9

Example 5.7, Sonatina, First Movement

28 *f* 29 30 *pp* 31 *cresc.* *(mf)* 32 33 *f* 34 35 *mp* 36 37 *p* 38 *pp* 39

rit.----- a tempo

$\square \cdot$  = 8/2  
 $\square /$  = 6/11

40 *p* 41 *pp poco cresc.* 42 *mf* 43 *p sub.* 44 45 *mp* 46 *pp* 47 *p* *mf* *dim.*

$\square \cdot$  = 11/1  
 $\square /$  = 9/10

Example 5.7 (Continued)

48 *pp* 49 50 *mp* 51 *pp* 52 *mp* 53 *poco dim.* 54 55 *p* 56 *mf*

57 *f* 58 *dim.* 59 60 61 62 *p cresc.* 63 *mf* 64 *f dim.* 65

$\square \bullet = 1/7$   
 $\square \circ = 9/2$

$\square \circ = 9/3$   
 $\square \circ = 1/6$

$\square \circ \bullet = 3/9$   
 $\square \circ = 1/6$

Example 5.7 (Continued)

66 *mp* 67 *p* 68 *dim.* 69 *pp* 70 *a tempo* 71 72 *poco riten.* 73 74 75 76 77 78 79

□ = 9/3  
 □/ = 7/0

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### Example 5.7 (Continued)

On the other hand, the harmonic structure, described by the progression of arrays, follows a ternary plan. The first three arrays use the same C-set intervals (6 and 5).<sup>64</sup> The fourth and fifth arrays use a different pair of C-set intervals (2 and 1). The remaining four arrays return to the original pair (6 and 5). Because of their constant presence, the C-set intervals are crucial elements of the overall sound of an array. For example, one of the salient features of this movement is its “diminished” or “octatonic” sound. Sonorities such as (036), (016), (0369), and (0147)—those often associated with “octatonic” music—are ubiquitous. The main reason for their presence is that for the majority of the piece one of the C-set intervals is 6. The sound of the tritone thus stamps itself on the music by its constant presence as a C-set interval. The middle section, where 6 is no longer one of the C-set intervals, therefore affords a real contrast with the outer sections.

The harmonic structure and the motivic structure do not precisely coincide. The motivic B-group begins in measure 28, whereas harmonically the middle section does not begin until ten measures later. The resulting overlap makes for a smooth transition from the beginning of the movement to the middle, blurring the line between the sections. Moreover, the opening motive of the B-group (mm. 28-29) resembles one of the motives from the A-group (m. 10), which blurs the line between the two sections even more.

Not so with the recapitulation. There is no overlap, no smooth transition. The beginning of the A section occurs both harmonically and motivically at measure 50, and an empty measure precedes it, setting it off dramatically. Formally, it makes good sense for the first section to transition smoothly into the second in order to keep momentum going, but for the recapitulation to be clearly marked, signaling a return and the approaching end.

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<sup>64</sup> Perle calls any given pair of C-set intervals the “interval system.”

Example 5.8 shows a bird's-eye view of the array progressions for the entire movement. Only the first and last chords of each array are given. Measure numbers are indicated above the staff. Where notes are tied, it means there is a modulation through oblique motion (Perle's "modulation through substitution"). Where there are brackets, it means that there is a modulation through reorientation (Perle's "modulation through reinterpretation").

1 19 32 38 42 48 52 56 63 66 78

$\blacksquare$  = 9/3     $\blacksquare$  = 0/6     $\blacksquare$  = 2/8     $\blacksquare$  = 0/10     $\blacksquare$  = 1/11     $\blacksquare$  = 1/7     $\blacksquare$  = 9/3     $\blacksquare$  = 6/0     $\blacksquare$  = 3/9     $\blacksquare$  = 9/3  
 $\square$  = 1/6     $\square$  = 4/9     $\square$  = 6/11     $\square$  = 8/9     $\square$  = 9/10     $\square$  = 9/2     $\square$  = 1/6     $\square$  = 10/3     $\square$  = 1/6     $\square$  = 7/0

**Example 5.8, Progression of arrays in *Sonatina*, mvt. I**

As Example 5.8 shows, there are a number of different kinds of modulation in this movement. The first several modulations are straightforward, seen from a voice-leading perspective. At measure 19 the C-set dyads hold while the axis notes move. Because they both move by the same interval and because that interval is odd, the result is a semi-transposition of the array. In the next three modulations the axis notes hold while the C-set dyads move. At measure 32 they move by the same interval which, being an even interval, produces a transposition of the array. At measure 38 we have the arrival of the harmonic middle section, where the C-set intervals change. The axis notes hold while each C-set dyad wedges, one inward and one outward. At measure 42 the dyads transpose again, but this time by different intervals, which produces neither a transposition nor a

semi-transposition of the array. Nevertheless, the basic character of the new array will be the same since the C-set *intervals* are the same.

The next two modulations are modulations through reorientation (or “reinterpretation”). The chord in measure 48 is a pivot chord that prepares the recapitulation in measure 50. Like similar examples in chapter four, this modulation occurs because one voice from each C-set reorients itself with regard to the other voices. Specifically, the E $\flat$  stops wedging against the black axis voice and starts wedging against the white axis voice. At the same time, the B stops wedging against the white axis voice and starts wedging against the black axis voice. The reorientation revises the C-set dyads, restoring the original C-set intervals 5 and 6 for the recapitulation. For the sake of visual clarity, I show the “revised” chord in brackets, but it should be kept in mind that the voices do not in fact move into the bracketed chord. The note B, for instance, appears in measure 48 both as a white note in the unbracketed chord and as a black note in the bracketed chord, but it is to be considered the same voice in both cases.

The modulation in measure 52, another modulation through reorientation, restores the array with which the movement began: 3/9, 1/6. It is the reorientation of the axis voices that causes this modulation. Each axis voice stops wedging against its own C-set dyad, and starts wedging against the other C-set dyad.

The following two modulations are once again modulations by oblique motion. At measure 56 the C-set dyads hold while the axis notes move. Since they move by the same interval, and since that interval is odd, the result is a semi-transposition of the array. At measure 63 the result is also a semi-transposition of the array. In fact it semi-transposes right back to where it came from: 3/9, 1/6. But it is not obvious how it is accomplished,

since the C-sets seem to be moving quite differently from one another. It is easiest to examine this modulation one C-set at a time.

First take the C-set 10/3 modulating to 1/6, shown with white notes. In the immediately previous modulation (at measure 56) the C-set dyad held while the axis note moved down three semitones. To cancel that modulation we would expect the axis note to hold while the C-set dyad moves *up* three semitones, giving it a chance to catch up, as it were. That is, in a way, what happens in the modulation at measure 63. The axis note moves down six semitones, but the C-set dyad moves up by nine. The motion may be thought of as a combination of two moves, as illustrated in Example 5.9: first a modulation in which the axis note holds while the C-set dyad transposes at  $T^3$ , then a simple wedge at  $W^6$ .

The image shows a musical staff with two systems. The first system shows a treble clef with a C-set dyad (two notes) and a bass clef with an axis note. The second system shows the same C-set dyad transposed up three semitones, labeled (T3), and the axis note moved down six semitones, labeled (W6). An equals sign (=) is placed between the two systems, indicating that the compound motion of (T3) and (W6) is equivalent to the overall modulation shown in the first system.

### Example 5.9, Modulation explained as a compound motion

The process is different for the other C-set (shown in black noteheads in Example 5.8, 6/0 modulating to 3/9). Instead of reversing the motion that caused the previous modulation, it actually adds to it. Previously (measure 56) the C-set dyad held while the axis note moved down three semitones. Now at measure 63, the C-set dyad holds again while the axis note moves down an additional three semitones. Yet the motion still manages to restore the previous array because of a unique property that only pertains to

C-sets whose C-set interval is 6.<sup>65</sup> We have seen how a C-set transposes onto itself at T6 so that T6=T0. But in addition, if the C-set interval is 6, then the C-set will also transpose onto itself at T3 or T9, as Example 5.10 shows. The two modulations at mm.56 and 53 combine to make a T9 transposition which, since the C-set interval is 6, generates the same C-set.

The image shows two staves of music. The top staff is labeled (T9) and the bottom staff is labeled (T0). Arrows point from notes in the top staff to notes in the bottom staff, illustrating a transposition. A legend at the bottom left indicates that a pair of notes represents 3/9 and a pair of notes with a bar over them represents 9/3.

**Example 5.10, T9=T0 when the C-set Interval is 6**

At measure 66 there is a modulation through reorientation. Like that of measure 52, the axis voices swap their C-set dyads. Thus each axis note is reunited with its original C-set dyad just before the end.<sup>66</sup> In the final modulation at measure 66, only one of the C-sets modulates: 1/6 to 7/0. The C-set dyad holds while the axis note transposes at T6.

<sup>65</sup> The two C-sets labeled 9/3 and 3/9 are *virtually* identical in that they have identical content. In fact there is a slight difference: their C-set dyad has been inverted. In other words, the difference lies in the disposition of the two voices that make the C-set dyad—which one is on top, so to speak.

<sup>66</sup> The motion is restorative in another, subtle way. C-set 3/9 becomes 9/3 again, restoring the original disposition of the two voices of the C-set dyad (see previous footnote).

## Chapter Six

### Listening for Perle's Voice Leading

The purpose of this dissertation has been to introduce a new way of hearing Perle's music. The focus has been primarily on the wedge voice leading that lies behind it, and on the projection of that voice leading to the surface. To that end, I have introduced a way of showing voice-leading analysis using a three-tiered analytical score that illuminates the background wedge progressions as well as their registral and temporal instantiation. In conclusion I will offer a reason *why* one might want to listen for the wedge voice leading in this repertoire.

Why listen for wedge voice leading? The answer intersects with what I will call Perle's "difference/sum paradigm." In his words, "We start with the assumption that intervals [i.e. dyads] can be identical in two different ways," namely, their sum and their difference, or index and interval.<sup>67</sup> Again, at the end of *Twelve-Tone Tonality* he says: "so everything in twelve-tone tonality derives from two types of identity relations inherent in a new kind of scale: intervals (=differences) and PI dyads (=sums)."<sup>68</sup> In the difference/sum paradigm, index and interval are the twin aspects of any dyad—two sides of the same coin—sum and difference—addition and subtraction. It might fairly be said that the sum/difference paradigm is the keystone of his system.

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<sup>67</sup> George Perle, "Symmetry, the Twelve-Tone Scale, and Tonality," in *The Right Notes: Twenty-Three Selected Essays by George Perle on Twentieth-Century Music* (Stuyvesant, NY: Pendragon Press, 1995), 237. Perle sometimes uses the terms "interval" and "dyad" interchangeably, referring to two-note collections, which explains the apparent tautology that two "intervals" may be identical with respect to their "interval."

<sup>68</sup> *Twelve-Tone Tonality*, 249.

Unfortunately, Perle leaves unsaid something very important regarding the sum/difference paradigm. He never discusses how radically different the interval and index of a dyad are, or the implications of that difference on musical hearing. I suggest that the *difference* between hearing intervals and hearing indices leads us to a good reason to listen for wedge voice leading in Perle's music.

I will illustrate the difference with an imaginary scenario and then try to pin it down more precisely. Imagine, for the sake of illustration, an ear-training course in which index and interval are supposed to be taught. The instructor plays two notes and asks the students to identify the interval by ear. They identify it correctly as, say, a major third, or as interval 4. So far so good. The students have demonstrated that they can *hear* the interval of that dyad in some important sense. Now the instructor plays the dyad again and asks the students to identify the index. What kind of training could the students be given that would enable them to give a correct answer? Is it possible for them to "hear" the index of the dyad in the sense that they "heard" the interval? If they have perfect pitch they will know the pitch-class numbers and can do the calculation, but that would obviously not be "hearing" it in the same sense.

No curriculum in the world could train students to identify index in the same way they identify interval (and to my knowledge none that attempts it), not because of any limitations on hearing, but because the different natures of interval and index require different kinds of test.<sup>69</sup> After unpacking the different natures of index and interval a little

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<sup>69</sup> I am keeping in mind Babbitt's sensible words he gave in response to a critique by Perle: "I cannot assume responsibility for what is 'heard,' but only for what can be learned to be 'heard.'" Milton Babbitt, "Reply to George Perle," in *The Collected Essays of Milton Babbitt*, ed. Stephen Peles, Stephen Dembski, Andrew Mead and Joseph Straus (Princeton: Princeton University Press, 2003), 142.

more, I will return to the ear training scenario and suggest ways in which students can be taught to hear index *indirectly*, through wedge voice leading.

The sum/difference paradigm might subtly suggest that what “difference” is to “sum,” “interval” is to “index.” But that is not the case. Subtracting one pc number from another, finding the difference, is directly related to the concept of interval itself, which is a measurement in semitones of the difference between two notes. But adding one pc number to another is not as immediately referable to the concept of symmetrical balance that index is meant to convey. Furthermore, unlike an interval number, an index number is dependent on the value assigned to the pitch classes. If something other than C were assigned pc number 0, then the index numbers for all the dyads would change, even though nothing about what those numbers are meant to convey changes. In other words, the interval number conveys something immediate and essential about a dyad, but the index number does not.

Index conveys the idea of symmetrical balance. As with a seesaw, balance means that the two extremes are equidistant from some axis of symmetry. This is why measuring the index of a dyad must involve comparison with something outside of the dyad itself. In theory, the axis of symmetry is a single point. But in practice, in terms of pitch classes, the axis of symmetry can only be represented by a second dyad. The dyad chosen to represent the axis of symmetry may be the smallest one available—a unison dyad when the index is even, a semitone when the index is odd—but the actual choice is arbitrary. The only requirement is that its own components be equidistant from the components of the original dyad. For example, the dyad (BC) could serve as an axis of symmetry around which the dyad (AD) may be symmetrically balanced because the

distance from A to B equals that from D to C (or, if you prefer, the distance from A to C equals that from D to B). Similarly the unison dyad (DD) could serve as an axis of symmetry for (CE).<sup>70</sup>

That, or something like it, seems to be what the concept of index is meant to convey: balance around some axis of symmetry. What does “sum” or index number have to do with balance? Mainly, it is a convenient way to group and label dyads that are balanced around the same axis of symmetry. It works well because the sum of two numbers remains the same as long as what is added to one number is taken away from the other. Or, to return to the seesaw metaphor, as long as the two sides of the seesaw are lengthened or shortened by the same length in opposite directions, the fulcrum does not need to be moved—the axis of symmetry remains the same.

The point here is only to illustrate the significant differences between interval and index. Returning to our imaginary ear-training scenario, the reason that it was fair to ask the students to name the interval of a dyad, but unfair to ask them to name the index is that it does not take into account the difference between the two things. To “hear” the interval, whatever else it means, surely means to recognize it—to identify it. But hearing an index cannot be judged in the same way. What could be meant by “hearing” an index except hearing the symmetrical balance that the index represents? But as it has been pointed out, the index number is only a convenient way to group dyads that are balanced symmetrically with one another; it does not measure that balance the way interval measures a dyad.

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<sup>70</sup> The seemingly redundant unison dyad is necessary in order to have the correct index number: in this case 4, not 2.

However, students can learn to hear the index relationship indirectly, through wedge voice leading. First, the students would sing wedge scales. Singing is usually the first step in any kind of ear training. It prepares the students to audiate (hear internally) so that they can have a way of measuring what they hear externally. The singing exercises might take a variety of forms. Example 6.1 shows a number of possibilities. In (a) and (b) the students sing a simple chromatic wedge scale. Dyads are delineated with bar lines and could also be emphasized using rhythm or articulation. Two students could sing the dyads as a duet as in (c). In (d) and (e) the students “skip” dyads along the wedge scale. In effect, they are wedging by  $W$ -numbers other than 1. In (f) they change the order of notes in the dyad, which begins to free their hearing considerably. And finally, in (g) the students improvise based on the wedge scale, wedging by different distances, changing the register and order of pitches of each dyad. Still they are singing dyads that all share the same index number.

Having laid the foundation through singing, the next step would be for the students to learn to recognize a wedge progression when they hear it, and to identify the  $W$ -number. Since Wedge is a dual transposition, its measurement is intervallic. Thus students can learn to identify the  $W$ -number just as they can learn to identify intervals. A simple first exercise would be for the instructor to play a pair of dyads, and for the students to identify whether they are wedge-related (i.e. whether they share an index) or not. The pairs of dyads may be graduated, beginning with obvious examples, moving toward more obscure examples (made obscure through registral displacements). The instructor may also focus on particular wedge progressions, such as  $W1$  and  $W11$  only.

(a) Sing the wedge scale (odd)



(b) Sing the wedge scale (even)



(c) Duet. Sing these wedging dyads.



(d) Sing the wedge scale as in (a) but use whole tones instead of semitones.

Example



(e) Sing the wedge scale as in (a) but use interval 3.

Example



(f) Sing the wedge scale as in (a) but change the order of notes within the measure.

Example



(g) Improvise using the wedging dyads of (a). Change the order of the dyads, order of notes within the dyad, and the registral placement of notes.

Example



## Example 6.1 Singing exercises for teaching index

Then the students would learn to hear the difference between different wedge progressions. The instructor might play a pair of dyads and ask, “Is this a W1 or a W2 progression?” Once again the instructor could move from clear examples to obscure examples. In time, the students would be able to name any wedge progression by its W-number, though they would not be able to identify the index number. Nevertheless, they would be demonstrating that they hear what index is meant to convey: symmetrical balance—when one side of the see-saw moves, the other side has to balance it out—wedge voice leading.

Finally, the student would be asked to identify the succession of W-numbers for a longer progression of dyads, all of which are wedge-related, beginning once again with clearer examples and moving toward more obscure examples.

Index, as I pointed out, cannot be heard in a dyad in isolation, because it is a comparison of one dyad with another. But it can be heard indirectly in the wedge voice leading between two dyads. Herein is the argument for listening for wedge voice leading in Perle’s music. Symmetrical balance is not heard in a lone dyad but in the progression of dyads that share an axis of symmetry. Such a progression of symmetrically related dyads is precisely what is meant by a wedge progression. Since index—symmetrical balance—is so fundamental to Perle’s system, then to hear the wedge voice leading is to hear the basic grammar of his music. All musicians will not agree on the merits of listening for the grammar of a piece; but to the extent that we wish to include that grammar as part of our listening experience, we need to listen for Perle’s wedge voice leading.

However, hearing wedge-related dyads is one thing; hearing the highly intricate and often obscure six-part voice leading in a work by George Perle is another. In his music there are two different streams of wedge voice leading working simultaneously. There are frequent modulations. All manner of textural devices obscure the voice leading. How is it to be followed by ear?

Several things ought to be taken into account when considering these things. First, the degree of difficulty in hearing the wedge voice leading varies with the clarity or obscurity of the passage. At any given moment in Perle's music the voice leading ranges from very clear to very obscure. There are places where it is instantiated in the registral lines so exactly that one can hardly fail to hear the wedge progression. Most of the time, however, there is some difference between the surface lines and the voice leading underneath it, whether the difference is significant or slight.

Second, to hear the voice leading does not mean that one has to hear it prior to analysis. On the contrary, one of the chief purposes of the kind of analyses introduced in this dissertation is to enable the listener to hear the voice leading. Hearing it "raw," before there has been a careful analysis of the score does not somehow make the hearing more authentic. Conversely, analyzing a score closely and then listening for what has been found does not invalidate the hearing.

Nor does hearing the voice leading mean that one has necessarily to hear it in real-time. It is useful and instructive to play through the background voice leading at a keyboard instrument, slowly, one stream at a time, then to compare it with the surface instantiation. The listener can gain many valuable insights into the music that way.

Lastly, although emphasis has been placed on listening to Perle's voice leading, it should not be concluded that the usefulness of the kind of analysis introduced in this dissertation depends on the ability to hear it. The intricate weave of voices discussed throughout the previous chapters is the fiber of Perle's music. It is deeply connected to all the different elements and that make up one of his works. The usefulness of wedge voice-leading analysis will be found in the way it enables us to describe, discuss and handle that fiber, both in its own right, and in relation to other elements of the music.

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