

SEGMENTATIONAL APPROACHES OF ATONAL MUSIC: A STUDY BASED ON A
GENERAL THEORY OF SEGMENTATION FOR MUSIC ANALYSIS

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ABSTRACT

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The complexity of atonal musical structures has led theorists to offer varying analyses of atonal works. This ambiguity stems from the intricacies of human perception: Is it possible to state a definitive analysis when perceptions differ? In order to justify a segmentation, the analyst must provide supporting evidence in the music. Due to the wide range of perception, this evidence yields analyses that are more or less persuasive, but neither correct nor incorrect. David S. Lefkowitz and Kristin Taavola, however, propose a mathematical model that defines a correct segmentation.

This thesis briefly compares Lefkowitz and Taavola's mathematical theory to James Tenney and Larry Polansky's perception-based theory. Tenney and Polansky's theory is rooted in visual Gestalt perception and provides the foundation for Dora A. Hanninen's segmentation theory. I then employ Hanninen's analytical framework to identify segmentational boundaries that support published analyses of two atonal works: the fourth of Anton Webern's *Fünf Sätze*, Op. 5 and an excerpt from Arnold Schoenberg's *Klavierstücke*, Op. 11, No. 1. I apply two of Hanninen's three segmentational criteria: the *sonic*, which refers to acoustical properties, and the *contextual*, which refers to categorizations, such as set-classes.

Lefkowitz and Taavola note that Tenney and Polansky's theory cannot be applied to polyphony. Although Tenney and Polansky concede this point, Hanninen encourages the use of her theory for polyphonic segmentation. She does not, however, provide a method for addressing polyphony. Thus, I combine aspects from Lefkowitz and

Taavola's simultaneous analysis with Hanninen's theory in order to formulate a basic method for segmenting polyphonic music.

I find that sonic and contextual criteria in the music strongly support the analyses by George Perle, Allen Forte, Gary Wittlich, and Charles Burkhart. Due to the emphasis of set-class theory for atonal analysis, there is an inherent reliance on contextual criteria; however, sonic criteria also reinforce their segmentations and sometimes may even support their contextual criteria in places lacking local sonic criteria. Thus, the musical structures strongly support the segmentations, validating the diversity of analyses and suggesting that atonal music can legitimately be heard in different ways.

To my father

It's only when you grow up, and step back from him, or leave him for your own career and your own home—it's only then that you can measure his greatness and fully appreciate it.

-Margaret Truman

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I. INTRODUCTION AND BACKGROUND

Allen Forte, in his preface to *The Structure of Atonal Music*, describes atonal music as “complicated music [that] has not been well understood.”¹ In the forty years since the first publication of Forte’s groundbreaking book, much work has been done in the development of atonal theory; no longer can it be said that atonal music is too complex or completely misunderstood. The theoretical field has developed widely and many offshoots of atonal theory have led to the development of models and methodologies to describe not only how this type of music is written and structured, but also how it is perceived and understood.

Many atonal theories rely on segmentational approaches, a method of breaking musical structures into groups or *segments*, which Dora Hanninen defines as “the basis for subsequent musical organization and interpretation.”² The different theoretical tools that have emerged have led to multiple segmentations, or interpretations, of the same musical work. As Christopher Hasty states in his article “Segmentation and Process in Post-Tonal Music,” “ambiguity...is an extremely important aspect of [modern] music.” Different analyses, then, do not detract from the credibility of the music, but instead add to the profundity and importance of the works.³

This thesis examines different analyses of two atonal works, *Fünf Sätze*, Op. 5, No. 4 by Anton Webern and an excerpt from Arnold Schoenberg’s *Klavierstücke*, Op. 11, No. 1, and defines the most musically apparent boundaries that may have impacted

¹ Allen Forte, *The Structure of Atonal Music* (New Haven, CT: Yale University Press, 1973), ix.

² Dora Hanninen, “Orientations, Criteria, Segments: A General Theory of Segmentation for Music Analysis,” *Journal of Music Theory* 45, no. 2 (Autumn, 2001): 345.

³ Christopher Hasty, “Segmentation and Process in Post-Tonal Music,” *Music Theory Spectrum* 3 (Spring, 1981): 59.

the analysts' segmentations. The multiple segmentations serve to not only authenticate Hasty's ideas about ambiguity, but also lead to a more complete and musically evident interpretation of each musical work.

What Is Segmentation?

Many theories of segmentation have been developed, some involving human perception principles. The main purpose for an interdisciplinary approach (involving perception studies) is to decipher how the brain perceives music, and subsequently, segments the information. Two main theories are discussed here: David S. Lefkowitz and Kristin Taavola's segmentation in music,⁴ which focuses on developing a mathematical model of musical perception, and James Tenney and Larry Polansky's temporal Gestalt perception, which has a basis in visual Gestalt perception and serves as the foundation for Dora Hanninen's theory.⁵ However, a brief overview of the technicalities of segmentation applies before imparting on a discussion of the individual theories.

In their introduction to "Segmentation in Music: Generalizing a Piece-Sensitive Approach," David S. Lefkowitz and Kristin Taavola state that musical analysis relies on segmentation:

Segmentation—the process of parsing a composition into meaningful parts—lies at the heart of many music-theoretic activities. Given the fact that the very word "analysis" means the division of the whole into its constituent parts, segmentation is intrinsic implicitly or explicitly—to many analytic endeavors.⁶

Typing the search string "music segmentation" into any library database brings up hundreds of articles, books, and other resources dwelling on what should appear to be

⁴ David S. Lefkowitz and Kristin Taavola, "Segmentation in Music: Generalizing a Piece-Sensitive Approach," *Journal of Music Theory* 44, no. 1 (Spring, 2000): 171-229.

⁵ Employed for analysis in this thesis and discussed in a later section.

⁶ Lefkowitz, "Segmentation in Music," 171.

the simple concept of dissecting a musical passage. And it might, indeed, be a simple concept were it not for the intricate workings of human perception and its implications on what is heard and, thus, how it leads to segmentation by different individuals.

Since human-brain capacitance is limited, large amounts of information, whether visual, auditory, or other, must be condensed into smaller units. For example, a ten-digit phone number is a string of numbers too long for one to easily parse visually and thus, is usually divided into three separate *groups*, making it easier to discern (Figure 1). This principle of chunking is also true for music, or any type of aural perception.

Figure 1: Visual Example of Chunking
A ten-digit phone number without grouping: 8003932893
A ten-digit phone number grouped into three chunks: 800-393-2893
<i>The latter is not only easier to parse visually, but also easier to remember.</i>

While listening to a musical passage (the musical stream), one subconsciously chunks the stream of sound into separate entities. These entities can either be defined as segments or sub-segments, depending on the level of hierarchy.⁷ According to Dora Hanninen, segments are groupings of musical events that are bounded by musical borders based on changes in musical criteria;⁸ James Tenney and Larry Polansky define these changes as temporal separation and parametric dissimilarity.⁹ Thus, a parameter is established and a method of measurement is used to describe the

⁷ Hanninen's definition depends on whether the group in question involves a phenosegment or not. Others' vary. David S. Lefkowitz and Kristin Taavola say, "There is a roughly ideal number of [three to five] notes that combine to form a segmentational group;" The number is drawn from human perception studies. These ideas vary due to the theorists' respective hierarchical definitions of segments and their sub-components. Lefkowitz, "Segmentation in Music," 181.

⁸ Hanninen, "Orientations, Criteria, Segments," 426.

⁹ James Tenney and Larry Polansky, "Temporal Gestalt Perception in Music," *Journal of Music Theory* 24, no. 2 (Autumn 1980): 208.

differences between musical events that create differences or “disjunctions.” So, for example, if pitch were the parameter, a method of measurement may be the intervallic distance between pitches. Thus, if the musical example consisted of a string of major seconds and then a perfect fourth, the disjunction would occur when that different measurement (the perfect fourth) occurred.

Due to the many similarities between visual and aural phenomena, and the perception of these, some music theorists have drawn parallels between visual Gestalt theory and music perception theory.¹⁰ James Tenney and Larry Polansky, in their article “Temporal Gestalt Perception in Music,” use Gestalt theory principles to develop an algorithm for music segmentation. They define three musical differences that can be perceived between temporal gestalt units:¹¹ state (the mean value of a unit’s measured parameter), shape (the contour of a parameter across time), and structure (the relation of the unit to others across hierarchical levels). At the lowest hierarchical level, or what Tenney and Polansky call the “element-level,” it is hard to discern differences between the temporal gestalt units’ shape and structure (due to the lack of hierarchy and extended time). Thus, they argue that state is the only quality of a unit that pervades through all hierarchical levels, and is the essential difference that drives segmentation.¹²

Tenney and Polansky’s algorithm for segmentation, derived from their theories on disjunctions, is defined as:

¹⁰ For more information on Gestalt Theory, please visit the website for the Society of Gestalt Theory and Its Applications. The International Society for Gestalt Theory and its Applications, *Gestalt Theory and its Applications*, <http://www.gestalttheory.net>.

¹¹ A temporal gestalt-unit is defined as “time-spans” perceived by the listener. These can include anything from a motive to a movement of a piece, depending on hierarchical structures. In either case, these are largely determined by perception and the smallest temporal gestalt-unit can be equated to Lefkowitz’s and Taavola’s event. Tenney, “Gestalt Perception,” 217.

¹² Tenney, “Gestalt Perception,” 214-216.

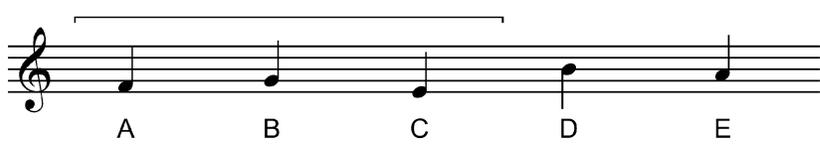
A new [temporal gestalt-unit] at the next higher level will be initiated in perception whenever a [temporal gestalt-unit] occurs whose disjunction (with respect to the previous [temporal gestalt-unit] at the same hierarchical level) is greater than those immediately preceding and following it.¹³

Events in the same hierarchical stream of musical information will only be segmented if the measurement of a musical parameter is greater from the one before and after it.

Dora Hanninen uses their method and further defines it in a footnote:

Starting with the first note, consider each pair of adjacent notes in turn. For the magnitudes of any three adjacent notes, x , y , and z with respect to the sonic dimension in question, determine the (non-directed) intervals $|y - x|$ and $|z - y|$. If $|z - y| < |y - x|$, then place a segment boundary between x and y . Note that the algorithm always considers and compares the size of the *following* interval before placing any boundary...¹⁴

Thus, looking at the melody in figure 2a, a segmentation, according to the pitch parameter, would be appropriate after pitch C.

Figure 2a: Model Using Tenney and Polansky's Theory of Segmentation (Also employed by Dora Hanninen)	
	
Adjacent Differences (based on scalar steps): $ B - A = 1$ $ C - B = 2$ $ D - C = 4$ $ E - D = 1$	Adjacent comparisons: A, B, C: $ C - B > B - A $ B, C, D: $ D - C > C - B $ C, D, E: $ E - D < D - C $ Boundary between C and D.

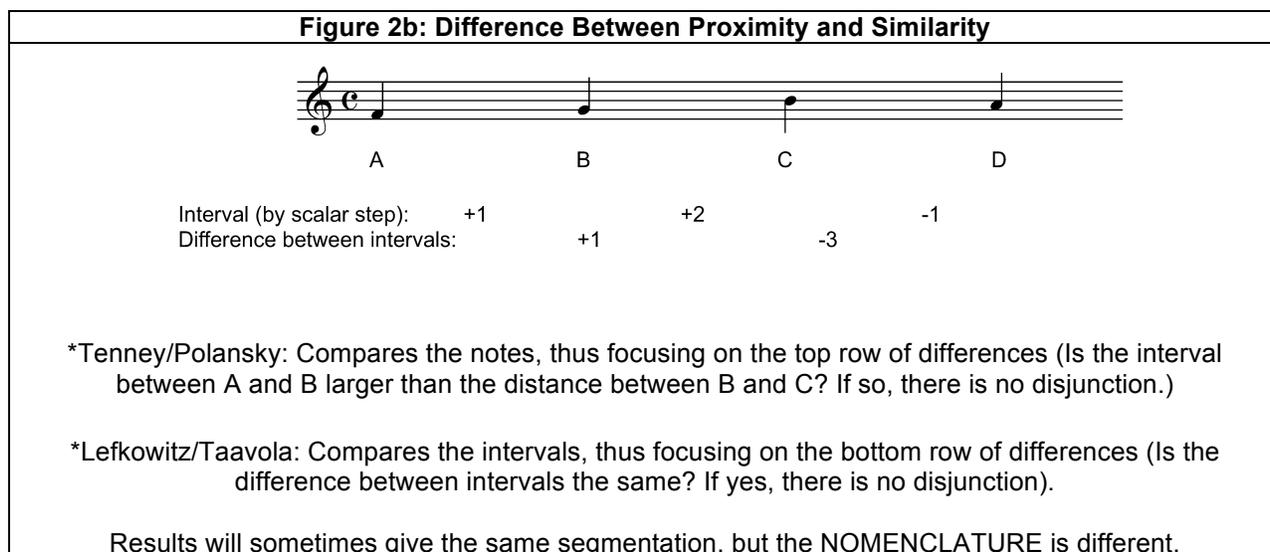
There are drawbacks to Tenney and Polansky's theory.¹⁵ Conflicting segmentations may occur when two separate parameters create boundaries at different points. For example, the pitch parameter, as stated above, could remain the same as in figure 2a, but a rhythm parameter may imply a different segmentation. Also, Tenney and

¹³ Ibid., 217.

¹⁴ Hanninen, "Orientations, Criteria, Segments," 426.

¹⁵ Lefkowitz, "Segmentation in Music," 173.

Polansky's theory is designed for the segmentation of monophonic music, an issue that will be discussed in depth later.



As an alternative to Tenney and Polansky's theory, David S. Lefkowitz and Kristin Taavola define segmentation through an algorithm in which discontinuation is a "change in the rate of change." They argue that this change in definition allows for "preference for similarity...versus proximity." In other words, Tenney and Polansky focus on the similarity of the difference between parameters, in comparison to Lefkowitz and Taavola, who focus on the proximity between parameters. Thus, given a parameter of pitch, Lefkowitz and Taavola's algorithm performs operations on the similarity of the intervals between the pitches, while Tenney and Polansky's method compares the proximity of the pitches (Figure 2b).¹⁶

Essentially, both theories agree that disjunctions, or discontinuations, lead to chunking or segmentation of a musical passage. The definition of these disjunctions, however, is a main topic of discussion: what characteristics lead to the perception of them, how are they measured, how do different musical styles lead to their

¹⁶ Lefkowitz, "Segmentation in Music," 177.

interpretation? All of these and many other questions naturally influence the “method” chosen for segmentation and each method’s inherent problems and implications.

A General Theory of Segmentation

As mentioned before, segmentation theory has been developed for many years and there have been many postulated methods. There is, however, a general lack of codification of segmentation procedures and theories. Two theories have been touched upon thus far, leaving out the fundamental theory employed in this thesis: Dora Hanninen’s theory of segmentation.¹⁷ James Tenney & Larry Polansky’s theory is the foundation of Hanninen’s, the use of which will be justified in this section.

*Overview of the Theory’s Framework*¹⁸

Dora Hanninen’s theory of musical segmentation develops a nomenclature that focuses on the possibilities of not only multiple analyses, but, in contrast to Lefkowitz and Taavola, also emphasizes the importance of the music by stating that segmentations must be audible.¹⁹ The theory focuses on the interaction of three main criteria (sonic, contextual, and structural) and how these affect groupings that enable the emergence of segments based on perceptual and theoretical precepts.²⁰

Musical segments are, in essence, groups of musical material that are isolated from other groups according to boundaries. These groups, according to Hanninen, are

¹⁷ Hanninen, “Orientations, Criteria, Segments,” 345-433.

¹⁸ This section includes a very concise overview of Dora Hanninen’s theory of segmentation, which will be employed for analysis. Please refer to the article for more detail and specific analytical illustrations. Ibid., 345-433.

¹⁹ Hanninen, “Orientations, Criteria, Segments,” 413.

²⁰ There are three criteria involved in Hanninen’s theory, as opposed to the four used by Lefkowitz and Taavola. Hanninen points this out as another flaw in their theory: the four domains do not amply represent the “fourteen dimensions listed.” Ibid., 423.

supported by musical criteria in three ways: instantiation, coincidence, and realization. A single criterion that delineates a musical group (that is, a “one-to-one mapping”) is called instantiation; two or more criteria that identify the same musical group (two-to-one mapping) are called coincidence. In turn, realization is a type of coincidence, in which one criterion is structural and the other contextual.²¹

The sonic criteria are acoustical properties such as pitch, timbre, rhythm, attack, dynamic, and so forth. Each sonic parameter can be considered a characteristic of a note, with magnitude, and exists within one dimension. There are two subtypes of sonic criteria (S_1 and S_2); S_1 defines criteria that are adjacent in sequential time and S_2 defines criteria that may or may not be temporally adjacent.²² Contextual criteria rely on interactions between musical events, and thus are also perceptually grounded. These criteria define musical aspects such as pitch contour, set-classes, interval classes, and other such aspects determined by “basic concepts in music theory...generally understood and used as observation language.”²³ Finally, structural criteria depend on theoretical bases and relate groupings to an established “orienting theory.”²⁴ Thus, a structural criterion would describe aspects such as how a V-I motion may relate to the fundamental structure in Schenkerian analysis, or how a set of pitches is part of a row in Serialism.

²¹ Ibid., 357-358.

²² “Music is represented as a string of temporally adjacent events; the analyst then identifies and compares intervals in pitch, attack-points, dynamics, or some other sonic dimension formed by pairs of temporally adjacent tones...The resulting segmentation is a series of disjunct time-slices. I group all such segmentation criteria based on temporal adjacency under the heading *subtype 1*.”; “Sonic criteria can also be predicated on adjacency in linear dimensions other than time, such as pitch, duration and dynamics. I call these *sonic subtype 2*.” Ibid., 360-361.

²³ Hanninen, “Orientations, Criteria, Segments,” 364.

²⁴ Ibid., 375.

Table 1: Criteria Employed in Analysis (Source: Hanninen, "Orientations, Criteria, Segments," 362, 366-367.)				
S Criterion	Description and Comments	C Criterion	Description and Comments	Example
S _{1-attack}	Simultaneity; share an attack point	C _{cseg}	Pitch Contour	C _{cseg} <0132>
S _{1-pitch}	Proximity in pitch interval between two temporally adjacent notes	C _{ic}	Interval Class	C _{ic} 5
S _{1-duration}	Proximity in beats or seconds of "real time"	C _{sc}	Set-Class	C _{sc} 3-4
S _{1-rest}	Rest marks boundary between two otherwise temporally adjacent events	C _{ip}	Pitch interval; ordering of pitch interval as distances; ordering of directed pitch intervals	C _{ip} 8; C _{ip} <81>; C _{ip} <+8, -1>
S _{2-duration}	Proximity in duration; events may be temporally adjacent or non-adjacent			
S _{1-tone} ²⁵	Measures differences in timbre/articulation.			

A simple labeling system is used to describe each type of criteria by category and descriptor. The letters S, C, and T are used to denote sonic, contextual, and structural criteria respectively. Each label, in turn, also contains a subscript with extra information. In the case of sonic criteria, the subscript contains not only subtype one or two, but also a descriptor such as adjacency, attack, pitch, rest, dynamics, etc. (i.e. S_{1-pitch} or S_{2-dynamics}). Similarly, the contextual criteria will denote a subtype (such as set class) as well as a descriptor of said subtype (i.e. C_{pc R<9A10>} where PC stands for pitch-class set, R for retrograde).²⁶ Structural criteria are comparably shown, however, due to the atonal focus of this thesis, will not be discussed in further detail.²⁷

Dora Hanninen establishes a multitude of sonic and contextual subtypes, a limited number of which will be employed for analysis (Table 1). Following her theory, the criteria will be used to delineate genosegments based on parameter measurements. For example, using the pitch sonic criteria (S_{1-pitch}), a musical line will be analyzed for boundaries based on the size of intervallic distances between the pitches (Figure 3a).

²⁵ Criterion not described by Hanninen.

²⁶ Hanninen, "Orientations, Criteria, Segments," 359-387.

²⁷ Since there is no definitive orienting theory used to describe the musical works analyzed in this thesis (i.e. serialism, reductive analysis, etc.), structural criteria will not be used for analysis.

Using the formula $|z - y| < |y - x|$ (where each set of three notes is labeled respectively; see page 13), a boundary marks a segmentation (denoted by brackets). This fundamental grouping of notes is called a genosegment and is supported by *one* criterion (in this case, $S_{1\text{-pitch}}$). A phenosegment (denoted by a caesura), in turn, arises from the combination of one or more genosegments (Figure 3b).

Figure 3a: An $S_{1\text{-pitch}}$ Genosegment (Musical Example Drawn from Schoenberg Op. 11, No.1)	
	
Figure 3b: A Phenosegment Arising from a Combination of Genosegments	
Phenosegment S_1	
	
<p>*Since there are no common boundaries between the genosegments, except the beginning and end, the phenosegment arising from all three genosegments includes the entire musical example.</p>	

Two Differing Theories

It could be argued that Dora Hanninen's segmentation theory emphasizes the analyst's individuality and perception. Each theorist hears different hierarchies and groupings, suggesting different analyses about a work and, thus, leading to segmentations that may differ from each other. Hanninen's theory is a tool that can lead to a better understanding of how these segmentations have been reached, serving to describe segmentations theoretically, instead of arbitrarily, per se.

It is important to note that the purpose of employing the theory is not to define what segmentations are correct and which are wrong, nor to explicitly define a routine

for musical segmentation.²⁸ If used for analysis after the fact, as in this thesis, Hanninen's theory can aid the understanding of why certain segmentations were chosen since individual perception defines how one chunks musical segments. Thus, the criteria and processes described are only suggestions of how one might go about segmenting a work.

Due to the emphasis on individuality, Hanninen's theory differs substantially from Lefkowitz and Taavola's theory, which weighs the strength of musical segments.²⁹ This huge disconnect between the two theories leads to an interesting quandary: if segmentation depends on individual perception, how is it possible to compare the strengths of said divisions and determine weaker or stronger segmentations?

Hearing is subjective and perception even more so. As stated by Fred Lerdahl and Ray Jackendoff in their influential work *A Generative Theory of Tonal Music*, "Rarely do two people hear a given piece in precisely the same way or with the same degree of richness."³⁰ Thus, an *experienced listener*³¹ is more likely to hear segmentations based on atonal sets than, say, a college music student specializing in 18th-century music. Yet, as musicians, these two very different individuals can agree on certain criteria, such as dynamics or intervallic distances, that help to define

²⁸ "The theory is not a methodology (although it might be used as one), nor is it prescriptive. Rather, it is a flexible, neutral, conceptual framework and language—both terminology and notation—that analysts can use to identify and grasp *sub rosa* aspects of [segmentation.]" Hanninen, "Orientations, Criteria, Segments," 346.

²⁹ "The overall aim of the methodology is a musically-responsive weighting of different parameters' effect on perceptual grouping." This, inherently, leads to the weighting of segments produced by the selection of stronger parameters. Lefkowitz, "Segmentation in Music," 172.

³⁰ Fred Lerdahl and Ray Jackendoff, *A Generative Theory of Tonal Music* (Cambridge, MA: The MIT Press, 1983), 3.

³¹ "The 'experienced listener' is meant as an idealization... Occasionally we will refer to the intuitions of a less sophisticated listener, who uses the same principles as the experienced listener in organizing his hearing of music, but in a more limited way. In dealing with especially complex artistic issues, we will sometimes elevate the experienced listener to the status of the 'perfect' listener—that privileged being whom the great composers and theorists presumably aspire to address." Lerdahl, *Generative Theory*, 3.

segmentations based on theoretically sound boundaries and measurements. Unlike Dora Hanninen's theory, Lefkowitz and Taavola's work ensures optimal chunks for segmentation that are carefully figured through mathematical formulas focusing on a perfect ratio of discontinuities and events within different specified domains or musical parameters.³² This is a methodology that leads to supposedly *ideal* segmentations. However sound, those mathematical models do not guarantee that the human brain will be satisfied with the derived divisions.

Chunking provides some justification for Lefkowitz and Taavola's mathematical models: "Based upon...research into studies of psychological perception, we have determined that [the] ideal number [of events within a chunked entity] is between three to five."³³ The mathematical model takes into account this formula and derives the strongest possible boundaries within each domain (or a combination of domains), thus creating the aforementioned segmentations. These may be technically correct, according to statistical testing and mathematical formulas, but serve only as that, a model for the perfect segmentation of the musical passage. They cannot accurately portray how one (or many) would hear these musical ideas.

Dora Hanninen's theory corroborates Lerdahl and Jackendoff's argument that a musical theory should describe multiple ways of organization to appease the possibility of different hearings.³⁴ Taavola and Lefkowitz, in turn, while proposing that different

³² The domains defined are pitch, articulation, timbre, and rhythm. Lefkowitz, "Segmentation in Music," 175-182. Hanninen has issues with these as they are limiting "fourteen dimensions" into four domains. Hanninen, "Orientations, Criteria, Segments," 423.

³³ Lefkowitz, "Segmentation in Music," 181.

³⁴ "A theory of a musical idiom should be concerned above all with those musical judgments for which there is substantial interpersonal agreement. But it also should characterize situations in which there are alternative interpretations, and it should have the scope to permit discussion of the relative merits of variant readings." Lerdahl, *Generative Theory*, 3.

methods of segmentation are viable, contradict the idea through the use of an exact mathematical approach to describe an outcome of subjective perception. They state:

In sum, this is a theory of segmentational processing, not a theory of music. The results of the segmentational system are not, therefore, “answers” in and of themselves to traditional questions about the structure and content of a piece of music—that is, they do not necessarily reveal the underlying unities or hierarchies.³⁵

Thus, one could employ this theory when attempting to *understand* segmentational processes but not necessarily to concretely *segment* a piece of music. The theory certainly should not be used to comprehend the meaning of said segments within a musical structure.

Aside from the philosophical and perceptual issues with Lefkowitz and Taavola’s methods, there is an inherent flaw in their basic definition of disjunctions. This fundamental issue leads to contradictions within the algorithm, which may or may not be augmented in computational practice.³⁶ Either way, the theory defines a discontinuity at the point where the rate of change changes. Lefkowitz and Taavola employ multiple examples, including one that focuses on rhythm (Figure 4a):

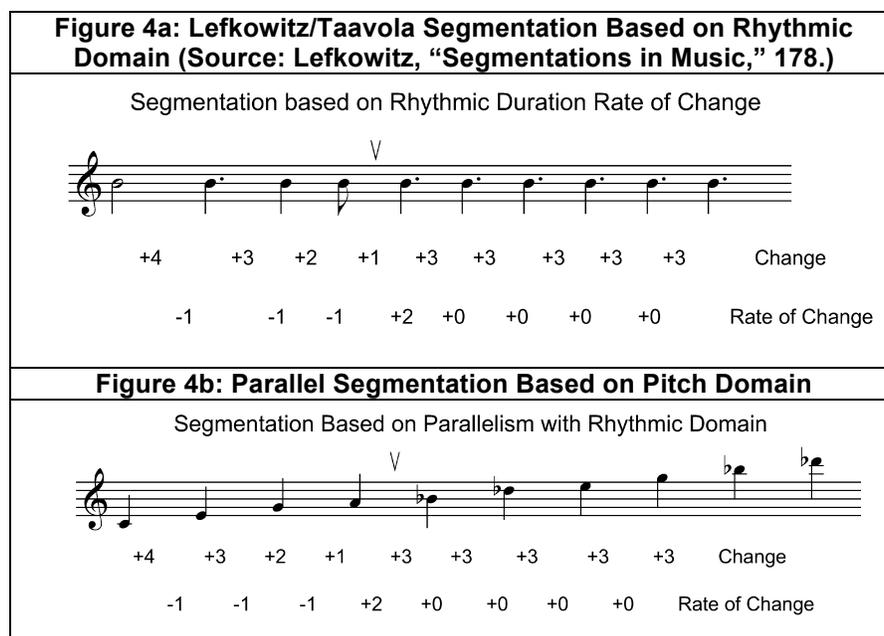
Thus, the change-in-rate-of-change approach enables one to segment the passage in [Figure 4a] as shown. For the first four notes in [Figure 4a], the rate of change within the Rhythm Domain is minus-one-eighth, while for the next six notes the rate of change is zero.

Taking into account that the distance between each subsequent note is shorter by one eighth-note each time (thus having the same rate-of-change), a discontinuity occurs after the fourth note, at which point the rate of change becomes three eighths. Now, consider a similar scenario employing the pitch domain: figure 4b features the exact

³⁵ Lefkowitz, “Segmentation in Music,” 220.

³⁶ The depth and strength of the flaw has not been examined within the algorithm or mathematical computations, only within the definition of the discontinuities.

same rate-of-change as figure 4a, yet the parameter is pitch. Following the similar schematic for segmentation, a segment would arise after the fourth note (between the A and B-flat). However, looking at the melodic line, it seems logical that there should be *no* segmentation between the B-flat and A due to their intervallic proximity, especially considering the surrounding intervals.



The complex issues described above limit the use of Lefkowitz and Taavola's theory. Yet polyphonic music still poses a problem for the use of Dora Hanninen's theory. Unlike Lefkowitz and Taavola's method, Tenney and Polansky admit that their theory should only be used on monophonic music.³⁷ Hanninen, however, implies that the method *can* be used for other textures; she mentions drawbacks to theories limited to homophonic music³⁸ and labels criteria that allow simultaneities.³⁹ Still, there is no analysis of polyphonic music in Hanninen's article and no mention of the flaw with

³⁷ Tenney, "Gestalt Perception," 212.

³⁸ Hanninen, "Orientations, Criteria, Segments," 352.

³⁹ See the definition of S_{1-attack}. Ibid., 362.

Tenney and Polansky's method, which is the fundamental algorithm used for Hanninen's theory.

A wise word of advice from Lefkowitz and Taavola now applies: "It is important to understand that we need not be slaves to any theory or system."⁴⁰ Their theory provides a method for dealing with polyphonic music, which can be employed using Hanninen's criteria. A work can be heard as a single line or multiple lines at once (and everything in between). It is important to consider an analysis of multiple ways of hearing, thus isolating different domains/criteria into single lines (what Lefkowitz calls the SINGLE-line listening) and a composite whole (the SIMUL).⁴¹ Therefore, a combination of both theories can be employed to describe a very limited polyphonic texture of music, a process that will be described in the following sections.

Polyphonic Analysis

It is impossible to predict the multiple ways in which one may hear polyphony. However, it is possible to gain an understanding of how multiple parts interact by performing a polyphonic analysis, like that of Lefkowitz and Taavola's theory, using sonic and contextual criteria.⁴² They perform a simultaneous analysis, which they call a SIMUL analysis, by isolating a specific parameter (for example, timbre) and analyzing the interaction of the multiple lines as a whole.⁴³ This concept can be used in combination with Hanninen's theory. Since a genosegment is defined as the grouping based on one

⁴⁰ Lefkowitz, "Segmentation in Music," 219.

⁴¹ *Ibid.*, 208.

⁴² It must be clear that this is only a slight approximation. The multitudes of ways in which musical lines can interact to form a polyphonic texture are innumerable and cannot be fully understood with this method.

⁴³ Lefkowitz, "Segmentation in Music," 208.

specific criterion, it could be stipulated that the grouping of multiple genosegments for individual lines can be combined to create a single genosegment for a multiple-voice example (the individual-voice genosegments will be called SINGLE genosegments; Figure 5a). In turn, these SIMUL genosegments can be combined across multiple criteria in order to create phenosegments for multiple voices (Figure 5b).

Figure 5a: SINGLE $S_{1-pitch}$ Genosegments Forming a SIMUL Genosegment	
SIMUL Genosegment $S_{1-pitch}$	
Figure 5b: SIMUL Genosegments Forming a SIMUL Phenosegment	
SIMUL Phenosegment	
*SIMUL S_{1-rest} derivation not shown	

The combination of these two theories could be considered controversial. However, it is imperative that some sense of polyphonic analysis be used. Most music is polyphonic, and thus a monophonic analysis is extremely limited in order to define the perception of segmentation. The methods employed here for polyphonic study are very limited; this is only a demonstration of the potential arising from the fusion of two diverse methods for analysis.

The following section describes analyses for sections of two works. The analyses contain similar segmentations, but sometimes deviate in detail or underlying structures.

A survey of main sonic criteria precedes the discussions of three analyses, which, in turn, highlight some of the contextual criteria emergent in the passage.

II. ANALYSIS OF *KLAVIERSTÜCKE*, OP. 11, NO. 1

Overview

As Allen Forte states in his article “The Magical Kaleidoscope: Schoenberg’s First Atonal Masterwork, Opus 11, Number 1,” the piece has been analyzed from multiple perspectives and has given theorists many hardships, contradicting Schoenberg’s belief that the piece was one that was easily understood.⁴⁴ Various approaches have led to a multitude of different analyses, relying on tonality and atonality alike.⁴⁵ However, the focus will be on atonality in this thesis. Some of the theorists who have endeavored to analyze the work include Allen Forte, George Perle, and Gary Wittlich, three analyses that will be discussed by focusing on coincident excerpts.

Opus 11, No. 1 begins with a passage that introduces the fundamental material of the piece. Perle describes the first three measures by placing emphasis on the trichords,⁴⁶ while Forte focuses on hexachordal divisions.⁴⁷ Wittlich brings both ideas into play and describes the trichords as the building materials of the hexachords.⁴⁸

⁴⁴ Allen Forte, “The Magical Kaleidoscope: Schoenberg’s First Atonal Masterwork, Opus 11, Number 1,” *Journal of the Arnold Schoenberg Institute* 5, no. 2 (November 1981): 127-129.

⁴⁵ “There is a long history of published analyses of this work, beginning soon after the score was published, in October, 1910...Many of them attempt to place the music in some kind of tonal framework.” *Ibid.*, 129.

⁴⁶ George Perle, *Serial Composition* (Berkeley, CA: University of California Press, 1991): 10-15.

⁴⁷ And as such, this thesis will focus on segmentations of hexachordal divisions, and will only touch on divisions of dyads, trichords, tetrachords, and pentachords as mentioned in Forte’s article. Forte, “Magical Kaleidoscope,” 127-129.

⁴⁸ Gary Wittlich, “Interval Set Structure in Schoenberg’s Op. 11 No. 1,” *Perspectives of New Music* 13, no. 1 (Autumn-Winter, 1974): 42.

Measures 1 – 3

A rest on the downbeat of the fourth measure sectionalizes the beginning of the piece. This sudden repose brings attention to the importance of the opening statement in the first three measures. This opening material is clearly divided into two main parts: a melodic segment in the right-hand and a harmonic segment comprised of two chords on the second beats of mm. 2-3. Gary Wittlich describes each of the two parts as autonomous hexachords, each playing a fundamental part in the fabric of the work.⁴⁹ Similarly, Forte also describes these two hexachords, along with a multitude of others, which are supported by both contextual and sonic criteria.

Focusing on a monophonic (or SINGLE) analysis of the sonic criteria for mm. 1-3, it is easy to differentiate between four voices, following a standard S-A-T-B voice-leading structure in which the soprano is an accompanied melody. The main sonic genosegments appearing in this passage are $S_{1\text{-pitch}}$, $S_{1\text{-duration}}$, and $S_{1\text{-rest}}$ (Figure 6). Dynamics do not exert segmenting power, and due to the short length of the passage, S_2 criteria do not seem to play a large part either ($S_{2\text{-duration}}$ criteria will be discussed in a polyphonic analysis).

The soprano line is fairly conjunct and thus can be described by the connection of mainly two $S_{1\text{-pitch}}$ genosegments.⁵⁰ The only segmentation apparent occurs at measure two, after which the segment continues far beyond the reach of measure three (due to the sameness of the intervals between measures 4-8). The $S_{1\text{-duration}}$ and $S_{1\text{-rest}}$ criteria, however, end at the rest (m. 4) due to their emphasis on musical time. A strong

⁴⁹ Wittlich, "Set Structure," 42.

⁵⁰ Due to the focus on atonality, interval size is evaluated by interval-class 1 increments. The first pitch is technically its own genosegment due to the size of the following interval, thus creating three total genosegments. However, the majority of the melody is included in the two genosegments and very limited in segmentation.

phenosegment appears from the melodic line due to the interaction between all three of the aforementioned criteria subtypes and their coincidental segmenting points at measures 1 and 4.

In a similar fashion to the melodic line in the excerpt, the subservient harmony lines feature genosegments described by the subtypes for rest, duration, and pitch. Taken individually, each harmony voice (alto/tenor/bass) contains an apparent phenosegment supported by $S_{1\text{-rest}}$ and $S_{1\text{-duration}}$. However, due to the simultaneity of the harmony (chordal texture) and the repetition of said harmony (mm. 2 and 3), there is also a subcriterion of $S_{2\text{-duration}}$ that also supports the aforementioned phenosegment (Figure 6).

Figure 6: SINGLE Genosegment/Phenosegment Analysis, mm. 1-3

Soprano

Phenosegment: $S_{1\text{-pitch/duration/rest}}$

$S_{1\text{-rest}}$ _____

$S_{1\text{-duration}}$ _____

$S_{1\text{-pitch}}$ _____



Alto

Phenosegment: $S_{1\text{-rest/duration} \& 2\text{-duration}}$

$S_{1\text{-rest}}$ _____

$S_{2\text{-duration}}$ _____

$S_{1\text{-duration}}$ _____

$S_{1\text{-pitch}}$ _____

Tenor & Bass

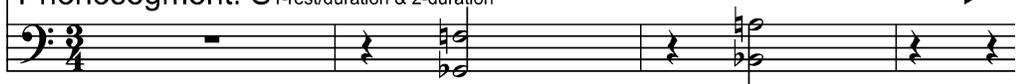
$S_{1\text{-pitch}}$ _____

$S_{1\text{-rest}}$ _____

$S_{1\text{-duration}}$ _____

$S_{2\text{-duration}}$ _____

Phenosegment: $S_{1\text{-rest/duration} \& 2\text{-duration}}$



Taking a SIMUL segmentation approach, it is necessary to differentiate between each criteria subtype while combining the individual voice parts. As a whole, it is apparent that a phenosegment is mainly supported by the harmonic voices (alto-tenor-bass; Figure 7). This is in part due to the strong attack of the left-hand chords and the prevalence of the $S_{2\text{-duration}}$ criteria, which emphasizes a symmetrical structure. Unfortunately, however, the SIMUL segmentation does not support the right-hand melody and thus detracts from that segmentation.

Figure 7: SIMUL Analysis, mm. 1-3

Phenosegment: $S_{1\text{-pitch/attack/rest \& } 2\text{-duration}}$ (A/T/B) ≡ ≡

$S_{1\text{-attack}}$ (A/T/B) _____

$S_{1\text{-duration}}$ (A/T/B) _____

$S_{2\text{-duration}}$ (A/T/B) _____

$S_{1\text{-rest}}$ (A/T/B) _____

$S_{1\text{-pitch}}$ (A/T/B) _____

*Genosegments denote supporting voices in parentheses (A = Alto, T = Tenor, B = Bass)

Figure 8: Perle's Segmentation, mm. 1-3
(Source: Perle, *Serial Composition*, 11.)

Figure 10a: Forte's Hexachord Segmentation, mm. 1-3
(Source: Forte, "Magical Kaleidoscope," 139.)

Figure 10b: Support for C_{SC 6-Z44}, mm. 1-3

In contrast to Perle, Allen Forte segments the first three measures into four separate hexachords: $C_{SC\ 6-Z10}$, $C_{SC\ 6-Z44}$, $C_{SC\ 6-21}$, and $C_{SC\ 6-16}$ (Figure 10a).⁵⁴ Sonically, the most readily apparent hexachords are $C_{SC\ 6-16}$ and $C_{SC\ 6-Z10}$ due to the strong stratification of the left and right hands into melody and accompaniment chords. He describes these two hexachords as the thematic components of the work. The two segmentations are supported by the SINGLE-line analyses of sonic criteria (Figure 6), while $C_{SC\ 6-16}$ emerges through the phenosegment established by the SIMUL sonic criteria $S_{1-pitch}$ and $S_{2-duration}$ (Figure 7). Two contextual criteria help to establish the $C_{SC\ 6-Z44}$ hexachord: motion by $C_{ip\ <+4>}$ in the bass staff and $C_{cseg\ <210>}$ in the melody (Figure 10b). The chordal nature of the alto, tenor, and bass lines discourage any attempt to divide the three into separate groups, yet the similar movement that exists only between the tenor and bass voices supports a decision to segment the voices

⁵⁴ Forte, "Magical Kaleidoscope," 139.

separately. The phenosegment that would justify the segmentation with $C_{SC\ 6-21}$ is only supported by the $S_{1-pitch}$ criteria. $C_{SC\ 6-21}$ contains the strong melodic line of the right hand and the alto and tenor voices, an odd segmentation on the basis of sonic criteria. Thus, the SINGLE criteria of S_{1-rest} and $S_{1-duration}$ for the bottom voices lead to a phenosegment, but exclude the bass voice; the strong correlations between the three harmony voices could challenge this segmentation.

Figure 11a: Wittlich's Trichord Segmentation, mm. 1-3
(Source: Wittlich, "Set Structure," 42.)

*Unless otherwise noted, segmentations are $C_{SC\ 3-3}$.

Figure 11b: Wittlich's Tetrachord Segmentation, mm. 1-3
(Source: Wittlich, "Set Structure," 42.)

Anachronistically speaking, one could say that Gary Wittlich's analysis in "Interval Set Structure in Schoenberg's Op. 11, No. 1" builds on the analyses by Allen Forte and George Perle. Wittlich discusses the prominent segmentations from both theorists' analyses, including the importance of trichords and two main hexachordal figures in

mm. 1-3. Wittlich's segmentations into trichords are the same as Perle's except for an extra segmentation of a $C_{SC\ 3-5}$, which creates a second trichord segmentation of the right-hand melody (Figure 11a); this segmentation is also supported by the aforementioned $C_{cseg<210>}$ criterion that supports the first trichord division of the line stipulated by Perle.

Wittlich also discusses fundamental tetrachord segmentations that are supported by trichord subsets and, in turn, support hexachord segments. These tetrachords emerge from criteria $C_{SC\ 4-2}$, $C_{SC\ 4-5}$, and $C_{SC\ 4-19}$ (Figure 11b). The melodic $S_{1-pitch}$ criteria supports one of the melodic line tetrachords ($C_{SC\ 4-2}$) while no apparent sonic criteria supports the similar overlapping mate. Two tetrachords form symmetrical segmentations in measure 2 and measure 3; these include the chord structures and the downbeat pitch of the melody (apparent from $C_{SC\ 4-5}$ and $C_{SC\ 4-19}$). Because of the attack offset between melody and harmony, a SIMUL phenosegment does not emerge from $S_{1-attack}$. However, due to the simultaneity, harmony is a strong parameter for the contextual parameters. This quality, on the other hand, hurts the emergence of Wittlich's last tetrachord segment (m. 3) since the bass voice is omitted from the segment, despite the support from the SINGLE $S_{1-pitch}$ criteria. Either way, Wittlich argues for the importance of these tetrachords and trichords due to their relation to his hexachordal segments,⁵⁵ narrowing the "supersets of practically all the smaller sets of the piece" into two of Forte's same hexachordal segmentations (delineated by $C_{SC\ 6-Z10}$ and $C_{SC\ 6-16}$). As previously mentioned, these two hexachords are the most apparent due to strong

⁵⁵ See Table 2. *Inclusion of the Primary Tetrachords and Hexachords* in Wittlich, "Set Structure," 44.

sonic support from criteria and the inherent homophonic texture, as well as the strong contextual support emerging from Wittlich's inclusions.

Measures 4 – 8

After a short three-measure introduction, the texture of the movement becomes more contrapuntal, weaving an intricate web of segment juxtapositions. There is still a distinct four-part texture as in the prior three measures. As before, the four distinct parts (S-A-T-B) can be analyzed for individual segments, and combined for a SIMUL approach.

The structure shows that measures four and five are reiterated in measures five and six yet the attacks of each voice are offset by an eighth-rest. Despite this change, the segmentations apparent in the first appearance of the musical passage still hold for the repetition, the only difference being a change in genosegment support. Each individual line is a repeats its own respective motive. The soprano line is a repetition of the E and G, which leads to a $S_{1-pitch}$ genosegment that pervades throughout most of the four measures, except for a disjunction in measure seven due to the following material (in measure 9). Thus, the more influential genosegments of the soprano line (that is, those which combine to create a phenosegment) are the S_{1-rest} and $S_{1-duration}$ that break the line into three separate segments (Figure 12a). The alto line, which begins with an attack concurrent with the soprano line, is a string of seconds that essentially embellishes the top line.⁵⁶ Except for an eighth-note neighbor, the alto line would be equal in rhythm to the soprano. The neighbor resolution (Bb to B) is highlighted in the disjunction apparent from the S_{1-dur} and $S_{1-pitch}$ criteria that brings forth a genosegment

⁵⁶ However, the alto line will diverge from the soprano by an eighth rest, as previously mentioned.

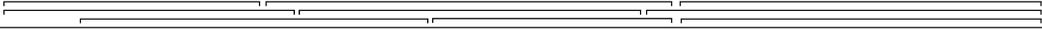
beginning in the second note of the motive. Thus, the phenosegment that appears is supported by these two criteria, diverging from the $S_{1\text{-rest}}$ genosegment.

Figure 12a: SINGLE Analysis of Top Lines, mm. 4-8	
Phenosegment: $S_{1\text{-rest/duration}}$	
$S_{1\text{-rest}}$	
$S_{1\text{-duration}}$	
$S_{1\text{-pitch}}$	
Phenosegment: $S_{1\text{-pitch/duration}}$	
$S_{1\text{-duration}}$	
$S_{1\text{-rest}}$	
$S_{1\text{-pitch}}$	
Figure 12b: SINGLE Analysis of Bottom Lines, mm. 4-8	
$S_{1\text{-duration}}$	
$S_{1\text{-rest}}$	
$S_{1\text{-pitch}}$	
Phenosegment: $S_{1\text{-rest/duration/pitch}}$	
$S_{1\text{-rest}}$	
$S_{1\text{-duration}}$	
$S_{1\text{-pitch}}$	
*Due to the pitch proximity of the pitches in m. 7, these are considered part of the tenor line despite stem directions.	

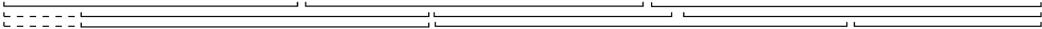
Like the soprano/alto pairing, the tenor and bass voices in these measures also appear coupled. The tenor line could be described as an embellished arpeggiation of a D Major chord in which the fifth is further elaborated through a string of minor seconds in order to resolve to a B (a case which can be made due to the alto sonority held during the cadence). The bass merely serves as a pedal tone to the figure. The SINGLE analysis of the tenor is very straight forward in that a phenosegment arises from $S_{1\text{-pitch}}$, $S_{1\text{-duration}}$, and $S_{1\text{-rest}}$; there is a strong appearance of a disjunction between iterations of the tenor motive. This is further amplified by an $S_{1\text{-rest}}$ genosegment in the bass (Figure 12b). Since the bass line is only one pitch with the same rhythmic duration, no segments are supported by $S_{1\text{-duration}}$ or $S_{1\text{-pitch}}$. A slight departure from the motivic line occurs in measure seven, two pitches which can be considered neighboring

embellishments to the tenor line, an explanation supported by the S_1 criteria. This is perhaps due to a lack of rhythmic importance in support; the rhythmic simultaneity dissolves so that by measure 7, the top voice and bottom voice motives are no longer juxtaposed, allowing for the addition of the embellishment to the bottom voice.

Figure 13a: SIMUL Analysis of Four Parts, mm. 4-8

S1-duration 

S1-pitch 

S1-rest 

This figure shows the genosegments for the four individual lines (top=soprano, bottom=bass). Notice the lack of bracket-endpoint overlap, which prevents the emergence of four-part genosegments.

Figure 13b: S_{1-rest} Phenosegments from SIMUL Analysis of Left Hand, mm. 4-8



S1-rest
Phenosegment: S1-rest 

Figure 13c: $S_{1-attack}$ Genosegments from SIMUL Analysis, mm. 4-8

(ALL) 

(S/A) 

(S/T) 



(T/B) 

*Text in parentheses denotes which voices support the genosegment (S = Soprano, A = Alto, T = Tenor, B = Bass).

A SIMUL analysis of each individual subcriterion for all four parts does not lead to prominent genosegments (Figure 13a). This is probably due to the strong pairing of the

right and left hand voices and variation of attacks in the reiterations. Thus, the analysis must also support the structure of the musical passage, leading to a SIMUL analysis of the two top voices and the two bottom voices individually along with a combination of the four voices. This analysis shows support for an $S_{1\text{-rest}}$ phenosegment in the tenor and bass voice (Figure 13b). Also, due to the consequent attack points, the $S_{1\text{-attack}}$ criterion contributes to the emergence of a phenosegment supporting segmentations arising from pairing of voices (Figure 13c). Despite the lack of $S_{1\text{-attack}}$ between left and right hands, though, there could be a case made for an $S_{1\text{-rest}}$ phenosegment arising for all four voices because of the rests in the lower voices and the ambiguity for the beginning of the $S_{1\text{-rest}}$ criterion (see dotted phenosegment lines in Figure 13a). This phenosegment, however, would encompass all four measures.

Allen Forte describes this passage in two sections, measures 4 to 6 (containing a repetition of the material) and measures 7 to 8. There is a division between the top voices, which contains an iteration of the criterion $C_{SC\ 5\text{-Z38}}$, and the lower parts, which introduce the hexachord $C_{SC\ 6\text{-Z39}}$ (Figure 14). This division into top and bottom voices is not only supported by the aforementioned sonic criteria, but also by further contextual criteria as explained by Forte.⁵⁷ The rhythmic offset in the repetitions does not alter the support for the individual contextual criteria, mainly due to the support from other contextual criteria. For example, the prominence of $C_{SC\ 5\text{-Z38}}$ is not only supported by the same hexachord heard as the attack on the third beat of measure 4 (and thus $S_{1\text{-attack}}$), but also by the relationship to another structural hexachord, $C_{SC\ 6\text{-Z42}}$, which is introduced in measure 7. Also, Forte describes the bottom voices and their contextual criteria as inclusive: a pentachord appearing in the tenor voice ($C_{SC\ 5\text{-Z37}}$), which is

⁵⁷ Forte, "Magical Kaleidoscope," 140-141.

included in a hexachord with the bass pitch ($C_{SC\ 6-Z39}$).⁵⁸ These contextual criteria are supported by the tenor $S_{1-pitch}/S_{1-rest}/S_{1-duration}$ genosegments and the bass/tenor S_{1-rest} phenosegment, respectively.

Figure 14: Forte's Segmentation, mm. 4-8
(Source: Forte, "Magical Kaleidoscope," 139.)

George Perle's analysis describes the importance of the new passage for the introduction of a second theme. The tenor voice's prominent line returns throughout the work and is derived from Perle's basic cell $C_{SC\ 3-3}$ and $C_{SC\ 3-12}$. He states that these ideas return throughout in the development and even later in the introduction as permutations.⁵⁹ The aforementioned hypothetical phenosegment between all four voices (arising from the ambiguity of S_{1-rest}) could show enough support for the importance of the tenor line as a melody with cadential-harmony accompaniment.

Figure 15: Cadential Contextual Criteria, mm. 4-8

Perle further describes that the predominant factors of the musical structure (of said second theme) are the contextual criteria $C_{ic\ 3}$ and $C_{ic\ 4}$ (Figure 15). These interval

⁵⁸ Forte, "Magical Kaleidoscope," 140-141.

⁵⁹ Perle, *Serial Composition*, 14.

classes, which occur as cadential harmonies, are derived from the relations of the pitches in the basic cell $C_{SC\ 3-3}$.⁶⁰ Likewise, Allen Forte also emphasizes the importance of the $C_{SC\ 3-3}$ as a cadential component of measure 5.⁶¹ These contextual correlations are visually obvious, especially when naming the trichord as a component of $C_{SC\ 5-Z38}$. Sonically, the harmonic implications are supported at measure 4 and 6 through $S_{1-attack}$ in the right hand. The rhythmic disparity, however, later causes an interaction between the sonic criterion and the contextual; the criterion $S_{1-attack}$ supports $C_{SC\ 3-3}$ at measure 4 and 6, a criterion that later heralds the sustained $C_{SC\ 3-3}$ at measure 8 without the need of a sonic criterion. This strong correlation leads to a prominent segmentation (as proposed by Forte and, indirectly, by Perle).

Figure 16: Wittlich's Segmentations, mm. 4-5
(Source: Wittlich, "Set Structure," 45.)

Gary Wittlich compares two methods of analysis for the four-measure excerpt. He recognizes the basic cell emphasis as described by Perle and gives his own interpretations, which give prominence to the criteria $C_{SC\ 3-3}$, $C_{SC\ 3-1}$, and $C_{SC\ 3-8}$. Wittlich describes a trichord segmentation that is reminiscent of Perle's in that it contains the $C_{SC\ 3-3}$ segmentation on the third beat of measure four, but also emphasizes a $C_{SC\ 3-3}$ prior to that (Figure 16). To support said segmentations, Wittlich argues that $C_p [78E]$ is

⁶⁰ Perle, *Serial Composition*, 13.

⁶¹ Forte, "Magical Kaleidoscope," 141.

emphasized due to the prominence at the onset of the piece, a similar argument to Perle's.

Wittlich's segmentations focus on sets of trichords, which lead to tetrachordal and hexachordal inclusions not mentioned in the text of his article, are themselves contextual criteria that support the segmentations.⁶² The sets are derived from similar trichords employed by Perle, as mentioned before, and are also subsets to Forte's hexachords. Therefore, some of the similar sonic criteria support Wittlich's analysis. The division of top and lower voice aid in the division of segments by trichords that include only soprano/alto or tenor/bass voices. The $S_{1\text{-rest}}$ for the soprano and alto helps to differentiate the trichord on the second beat of measure 4 from the trichord including the bass and tenor of the bottom voice. $S_{1\text{-rest}}$ for the alto is also support for the trichord emphasizing the lone alto line. Due to the hierarchical nature of the phenosegments, it was possible to state that $S_{1\text{-pitch}}$ supported a segmentation of the tenor line as a whole melodic swoop, but the actual genosegments of said criterion provide support for the analysis given by Wittlich. This same tenor line is described to be part of the hexachord $C_{SC\ 6\text{-Z}39}$, which is related to both $C_{SC\ 6\text{-16}}$ and $C_{SC\ 6\text{-Z}10}$.⁶³ The segmentation of the line into two hexachords is the same as Forte's analysis and thus similarly supported.

⁶² Wittlich, "Set Structure," 44-45.

⁶³ Ibid.

III. ANALYSIS OF *FÜNF SÄTZE*, OP. 5, NO. 4

Overview

A relatively short piece, characteristic of Anton Webern's compositional output, the fourth movement of Op. 5 has been a favorite for analysis.⁶⁴ Analyses by three theorists are discussed in depth here: George Perle, Charles Burkhart, and Joseph Straus. All analyses agree that the piece consists of a three-part form. However, there is a bit of contention as to where the exact boundaries lie. Burkhart believes that the sections are demarcated by a seven-note motive (at mm. 6, 10, 13).⁶⁵ Perle, however, states that the second section occurs at measures seven through nine.⁶⁶ Straus is a bit more ambiguous, claiming that measures seven through nine are clearly a contrasting section, yet later stating that the seven-note figure at measure ten ends the second section.⁶⁷ Taking into account the expression markings of the piece and the seemingly punctual purpose of the seven-note motive, three sections emerge: section A (mm. 1-6), section B (mm. 7-10) and section C (mm. 11-13). The following discussion will focus on each of these parts as individual excerpts to facilitate examination, with a separate section focusing on the segmentation of seven-note motive.

The orchestration of the movement allows for a clearer SINGLE analysis. Yet, there are some areas that feature double stops and other such non-monophonic playing

⁶⁴ Charles Burkhart, "The Symmetrical Source of Webern's Opus 5, No. 4," *The Music Forum* 5 (1980): 317.

⁶⁵ "To me this little piece has long been a tantalizing puzzle, particularly so the three transposition of what I call the '7-note figure'—that is, the rising unaccompanied figure...that demarcates the end of each of the piece's three sections." Charles Burkhart, "Symmetrical Source," 318-319.

⁶⁶ Perle, *Serial Composition*, 16.

⁶⁷ Joseph N. Straus, *Introduction to Post-Tonal Theory* (Upper Saddle River, NJ: Prentice Hall, 2005), 119.

abilities. Such figures will be analyzed to portray the aural qualities of the piece, more than the pitches or similar attributes which appear on the written paper.

The abilities of the instruments also allow for a variety of timbral interchanges. Dora Hanninen does not define a quality for timbre or articulation due to their multidimensionality.⁶⁸ However, an extra subcriterion will be employed, the $S_{1\text{-tone}}$, which will be, for the purposes of this thesis, a one-dimensional approach to timbre. As suggested by Hanninen, only change will be evaluated.⁶⁹ Thus, whenever a change of bowing or sonority occurs (i.e. harmonics/*arco/sul ponticello/pizzicato/tremolo*), a genosegment will arise in the $S_{1\text{-tone}}$ criterion.

Section A, Measures 1 – 6

The first two measures of the piece serve as an introduction to the movement, in which the violins introduce the fundamental pitch-sets of the musical material employed throughout.⁷⁰ The rest of the section is categorized by contrapuntal interplay featuring overlapping of the established sets.⁷¹ A slight pairing of voices begins the piece, in which the violin one and two enter with tremolos and the viola and cello play an accompanying role. This is quickly dissolved at measure three, during which the voices contrapuntally share motives. The change of texture supports the division of a two-measure quasi-introduction.

⁶⁸ Hanninen, "Orientations, Criteria, Segments," 362.

⁶⁹ "One interim solution is to treat timbre and articulation as nominal spaces. Musicians have long done this in practice, registering simply the presence or absence of change: change indicates disjunction and marks a segment boundary, whether in $S_{1\text{-timbre}}$, $S_{2\text{-timbre}}$, $S_{1\text{-articulation}}$,

$S_{2\text{-articulation}}$." Ibid, 363.

⁷⁰ Burkhart, "Symmetrical Source," 319; Straus, *Post-Tonal Theory*, 120.

⁷¹ Perle, *Serial Composition*, 16.

Following a SINGLE $S_{1\text{-pitch}}$ analysis, it is difficult to categorize the opening tremolos of the violins. The analyses put forth by Perle, Straus, and Burkhart pay close attention to the pitch material of the figures. However, it is difficult to aurally discern the exact pitch material of these ornamentations, and thus, it is a prerogative to label these as non-pitched figures. The pizzicato in the first violin also poses an issue as to what combination of pitch material is heard, and thus is left out of the $S_{1\text{-pitch}}$ analysis (as will the last pizzicato figure of the viola part).

Figure 17: SINGLE Analysis of Violin I, mm. 1-6

The figure displays a musical score for Violin I, measures 1-6, in 3/4 time. The score includes markings for 'am Steg' (above measures 1, 3, and 5), 'pizz.' (above measure 2), and 'arco' (above measure 3). Below the staff, a SINGLE analysis is shown with four horizontal lines representing different parameters: $S_{1\text{-pitch}}$, $S_{1\text{-duration}}$, $S_{1\text{-rest}}$, and $S_{1\text{-tone}}$. Brackets indicate the application of these parameters to specific measures: $S_{1\text{-pitch}}$ and $S_{1\text{-rest}}$ are applied to measures 1-2 and 3-4; $S_{1\text{-duration}}$ is applied to measures 1-2, 3-4, and 5-6; and $S_{1\text{-tone}}$ is applied to measure 1.

A SINGLE analysis of the violin one part supports a division of the section into three phenosegments (Figure 17). Two are strongly supported by $S_{1\text{-pitch}}$, $S_{1\text{-duration}}$, and $S_{1\text{-rest}}$ (in mm. 3 and 4), while $S_{1\text{-tone}}$ also supports the first (mm. 3). A third phenosegment arises at the end of measure four, but continues through to the next section of the piece. However, the material after the section break does not contain anything aside from rests, so it could be said that the phenosegment indeed ends at the end of the section. Thus, the phenosegment contributes to the delineation of formal structure. The violin two parts also supports this delineation, mainly due to the seven-note motive.

Figure 18: SINGLE Analysis of Violin II, mm. 1-6

The figure shows a musical score for Violin II in 3/4 time, measures 1-6. The score includes annotations: "am Steg" with a dashed line above measures 1-2, "pizz." above measure 3, and "arco" above measure 4. A double bar line is placed between measures 3 and 4. Below the staff are four horizontal lines representing S1-pitch, S1-duration, S1-rest, and S1-tone. Brackets indicate the spans of these criteria: S1-pitch spans measures 1-2 and 4-6; S1-duration spans measures 1-2 and 4-6; S1-rest spans measures 1-2 and 4-6; S1-tone spans measures 1-2 and 4-6.

A phenosegment boundary arises in the violin two part at measure three, supported by $S_{1\text{-pitch}}$, $S_{1\text{-duration}}$, $S_{1\text{-rest}}$, and $S_{1\text{-tone}}$. This new phenosegment, however, ends immediately before the seven-note figure in measure five as supported by $S_{1\text{-pitch}}$, $S_{1\text{-duration}}$, and $S_{1\text{-rest}}$. The figure could be called its own phenosegment, as a boundary arises immediately before the beginning of violin-two material in section B. However, this boundary before section B is only supported by $S_{1\text{-rest}}$ and $S_{1\text{-tone}}$ (Figure 18).

Figure 19: SINGLE Analysis of Viola, mm. 1-6

The figure shows a musical score for Viola in 3/4 time, measures 1-6. The score includes annotations: "Phenosegment S_1 " above measure 1, and "am Steg" with a dashed line above measures 1-2. A double bar line is placed between measures 3 and 4, and another between measures 5 and 6. Below the staff are four horizontal lines representing S1-pitch, S1-duration, S1-rest, and S1-tone. Brackets indicate the spans of these criteria: S1-pitch spans measures 1-2 and 4-6; S1-duration spans measures 1-2 and 4-6; S1-rest spans measures 1-2 and 4-6; S1-tone spans measures 1-2 and 4-6.

The viola part contains two very strong phenosegments, supported by all evaluated criteria (Figure 19). Once again, the second phenosegment lingers into section B, but only containing rest material before the onset of viola ostinato in measure 7. The musical material of the viola is not as varied as that of the violins, as the

instrument only plays for pitches in the span of six measures. Thus, the main breaking segmentation points are characterized by its steep change in register and its change to *am Steg* (in measure 4).

Figure 20a: SINGLE Analysis of Cello, mm. 1-6

Figure 20b: S_{1-pitch} Analysis of Cello, mm. 3-4

The two bottom staves show the division of the cello part into two separate lines. Thus, a nesting of S_{1-pitch} occurs in the original line (top).

The cello part contains perhaps the most ambiguous material of the section. The strongest phnosegments would only arise from support by three criteria at any one time (Figure 20a). The double stop at measure four adds to this ambiguity: the addition of the extra note juxtaposes boundary notes, in essence abolishing said disjunction. Thus, if the G were placed linearly next to the C-sharp, a genosegment boundary would

occur. However, this slight temporal modification liquefies the segmentation, creating a type of $S_{1\text{-pitch}}$ elision (Figure 20b).

Despite a general agreement between genosegments for the individual parts, a SIMUL analysis of the four instrumental parts does not show a large amount of consensus. Generally, the $S_{1\text{-tone}}$ criterion is highly inconsequential in the scope of the SIMUL analysis. A phenosegment does seem to have a bit of support at the end of measure four, where the violin one and viola parts interact to form a disjunction in the $S_{1\text{-pitch}}$, $S_{1\text{-duration}}$, and $S_{1\text{-rest}}$ criteria at measure four, along with some participation from the cello in the $S_{1\text{-pitch}}$ criteria (Figure 21).

Figure 21: SIMUL Phenosegment from Selected Genosegments, mm. 1-6

Phenosegment: $S_{1\text{-pitch/duration/rest}}$ (V1/Va) & $S_{1\text{-pitch}}$ (C) \neq

am Steg ----- am Steg -----

pizz. arco

am Steg ----- pizz. arco

am Steg ----- am Steg -----

am Steg -----

$S_{1\text{-pitch}}$ (V1/Va/C) _____

$S_{1\text{-duration}}$ (V1/Va) _____

$S_{1\text{-rest}}$ (V1/Va) _____

George Perle's analysis of the movement reveals a strong influence of the tremolo pitch material. His ideas stem from the transposition of an intervallic cell. The fundamental material is a semitone dyad transposed by a tritone, thus creating criteria $C_{SC\ 4-8}$ and $C_{SC\ 4-9}$. Perle pays close attention to the iterations of these sets as they appear at measure three (Figure 22a)— $C_{CS\ 4-8[E045]}$ and $C_{CS\ 4-9[E056]}$. These sets contain

three common tones, excluding pitch classes E and F-sharp, a dyad that appears as the highest pitches of the opening tremolos.⁷² This segmentation is not supported by the aforementioned analysis due to the aural qualities of the tremolo. However, a later melodic iteration of the dyad in the viola (measures two and three) is highly supported by genosegments arising from the SINGLE $S_{1\text{-pitch/rest/duration}}$ criteria (Figure 22b). The dyad also appears at the end of the section (mm. 5-6) in the violin one and cello parts, two iterations that are minimally supported by the respective $S_{1\text{-pitch}}$ criterion.

Perle alludes to segmentations of $C_{SC\ 4-8}$ and $C_{SC\ 4-9}$ throughout measures three to six, yet only clearly describes five iterations (Figure 22a).⁷³ The SINGLE analysis supports iterations occurring in violin one (Violin one $S_{1\text{-pitch/duration/rest}}$, m. 3) and violin two (Violin two $S_{1\text{-pitch/duration/rest}}$, m. 4). The cello figure (mm. 4-5) is not strongly supported, however, as the phenosegment arising from any SINGLE criteria extends to measure six. The $C_{SC\ 4-8}$ occurring in measure three is also not supported by any SINGLE criteria, but the $S_{1\text{-attack}}$ criterion supports the inclusion of the viola pitch on the upbeat of beat two. The more interesting support, however, occurs at the downbeat of measure four where the all of the parts sound simultaneously. The SINGLE criteria for the second violin, which are not included in the segmentation, are actually the support as the melodic line genosegments detract from the inclusion. Once again, like in the cello part in measure two, a quasi-elision has occurred and thus, aids the support for the harmonic segmentation.

⁷² Perle, *Serial Composition*, 16.

⁷³ Ibid.

**Figure 22a: Perle's Segmentation, mm. 3-5 and Support
(Segmentation Source: Perle, *Serial Composition*, 16.)**

Violin I Phnosegment: $S_{1\text{-pitch/duration/rest}}$

Violin II Phnosegment: $S_{1\text{-pitch/duration/rest}}$

Genosegments: $S_{1\text{-attack}}$

*Violin 1 = V1, Violin 2 = V2, Viola = Va, Cello = C

Figure 22b: Phnosegment Support for E/F-sharp Dyad in the Viola, mm. 1-4

Phnosegment: $S_{1\text{-rest/duration/pitch}}$

E-F# Dyads

$S_{1\text{-duration}}$

$S_{1\text{-rest}}$

$S_{1\text{-pitch}}$

Charles Burkhart's analysis has many similarities to Perle's. He establishes the importance of the $C_{SC\ 4-9}$ and $C_{SC\ 4-8}$ criteria, but also connects them to larger overarching concepts, including a $C_{SC\ 8-9}$ criterion and the multiple ways in which the eight-note set is realized in order to create symmetry. Burkhart describes the opening tremolo measures as segments including a $C_{SC\ 4-9}$, $C_{SC\ 4-8}$ and $C_{SC\ 4-16}$ (Figure 23a).⁷⁴ The genosegments created by $S_{1\text{-attack}}$, $S_{1\text{-tone}}$, $S_{1\text{-duration}}$, and $S_{1\text{-rest}}$ show great support for the

⁷⁴ Burkhart, "Symmetrical Source," 319-324.

harmonic iterations of $C_{SC\ 4-9}$ and $C_{SC\ 4-8}$ in the violins. The $C_{SC\ 4-16}$, occurring in the violin one part, is well supported by the same melodic criterion.

Figure 23a: Burkhart's Segmentation, mm. 1-3 and Supporting Criteria
(Segmentation Source: Burkhart, "Symmetrical Source," 319-321.)

Phenosegment: $S_{1-attack/duration/rest}$ \neq \neq

Phenosegment: S_{1-tone} $C_{SC\ 4-16}$ \neq

The score for Figure 23a consists of four staves: Violin I, Violin II, Cello, and Bass. The music is in 3/4 time. The Violin I and II parts feature melodic lines with 'am Steg' markings and a 'pizz.' (pizzicato) section. The Cello and Bass parts provide harmonic support. Segmentation boxes are drawn around specific melodic phrases in the violin parts, labeled with $C_{SC\ 4-16}$, $C_{SC\ 4-8}$, and $C_{SC\ 4-9}$. Below the score, a legend defines the supporting criteria: $S_{1-attack}$ (a short horizontal line), $S_{1-duration}$ (a longer horizontal line), S_{1-tone} (a horizontal line with a vertical tick), and S_{1-rest} (a horizontal line with a vertical tick). These criteria are applied to the musical notation to identify the segments.

$S_{1-attack}$ $S_{1-duration}$ S_{1-tone} S_{1-rest}

Figure 23b: Burkhart's Segmentation, mm. 3-6
(Source: Burkhart, "Symmetrical Source," 321.)

The score for Figure 23b consists of four staves: Violin I, Violin II, Cello, and Bass. The music is in 3/4 time. The Violin I part starts with a triplet of notes marked 'am Steg'. The Violin II part has an 'arco' marking. The Cello and Bass parts continue the harmonic support. Segmentation boxes are drawn around various melodic phrases across all parts, labeled with $C_{SC\ 4-9}$ and $C_{SC\ 4-8}$. The boxes are more complex, overlapping across different staves and time points, indicating the relationship between the segments in different parts of the ensemble.

Just like Perle, Burkhart describes the importance of the dyad occurring in the top register of violin one, as well the polyphonic interplay of $C_{SC\ 4-9}$ and $C_{SC\ 4-8}$ in measures three through six. Burkhart, however, delineates the tetrachords, seven in total, four of which are identical to Perle's segmentations (Figure 23b).⁷⁵ The remaining segmentations are a little difficult to show support for using sonic criteria. Some of the segmentation can be supported in individual parts but not through the four parts. For example, the violin and cello parts in the $C_{SC\ 4-9}$ segment of measure 5 are supported by $S_{1-pitch}$, yet the viola part has no support for said segmentation. In this context, it is easier to explain the support through the inherent contextual criteria of the segmentation.

It is logical that Joseph Straus's analysis would build on previous analyses. While the overarching theories digress (Perle's basic cell versus Burkhart's symmetry), the three segmentations studied increasingly build on each other and share many ideas. Straus's analysis is a bit more pedagogical (due to its inclusion in an atonal theory textbook) yet it contains a very intricate and well-defined web of segmentations.

Straus, like the other analysts, emphasizes the sets that underlie the first measures of the movement. However, he also makes mention of a $C_{SC\ 5-19}$ appearing in measure two, a figure which includes the cello's E-flat pedal (Figure 24a). Straus defines this set due to its complementary nature against $C_{SC\ 7-19}$, the fundamental set of the seven-note motive.⁷⁶ The $S_{1-duration}$ for the cello voice is the only sonic supporter of said segmentation, but the relationship between the aforementioned contextual criteria is strong.

⁷⁵ Burkhart, "Symmetrical Source," 319-324.

⁷⁶ Later discussed in detail. Straus, *Post-Tonal Theory*, 122.

Figure 24a: Straus's Segmentation, mm. 1-2
(Source: Straus, *Post-Tonal Theory*, 120-122.)

Figure 24b: Straus's Segmentation, mm. 4-5
(Source: Straus, *Post-Tonal Theory*, 124.)

All arrows depict $C_{SC\ 3-5}$ harmonies unless otherwise stated

Straus also makes mention of trichord segmentations, which have generally been ignored by Perle and Burkhart. $C_{SC\ 3-4}$ and $C_{SC\ 3-5}$ are both subsets of $C_{SC\ 4-8}$ and $C_{SC\ 4-9}$ and play an important role in contrapuntal interplay of measures four and five, or the canon section, as Straus nicknames it (Figure 24b).⁷⁷ Melodically, Straus identifies $C_{SC\ 3-4}$ in the violin one part, which is strongly supported by $S_{1-pitch}$, and the cello part, which contains limited support by the same. Harmonically, the segmentations are also

⁷⁷ Straus, *Post-Tonal Theory*, 124-125.

apparent on every beat of measure five, interchanging between $C_{SC\ 3-4}$ and $C_{SC\ 3-5}$.⁷⁸

However, only two of these harmonic segmentations are truly supported by any of the sonic criteria analyzed: the pickup to measure five, the upbeat of the first beat, and the second beat (all supported by $S_{1-attack}$).

Section B, Measures 7 – 11

The texture of the piece once again changes in measure seven as the three lower parts take subservient roles and the first violin takes on the melody. The section ends with a seven-note punctuation in measure ten, which also heralds a tempo change on the downbeat of measure eleven (the beginning of the next section).

Figure 25: S_{1-rest} Genosegments, mm. 7-9

S_{1-rest}

*The genosegments are arranged by part (Violin I = top; Cello = bottom). Notice how the section is marked by rests on both sides, thus creating a segment despite how the genosegments line up.

Due to the shorter length of this section, it is not necessary to divide it into parts like the first section, and no strong phenosegments appear that would indicate otherwise. However, it is imperative to point out that a strong S_{1-rest} offsets section B

⁷⁸ Straus, *Post-Tonal Theory*, 124.

from the rest of the movement (Figure 25). The viola sets up an ostinato that is strongly supported by the SINGLE analysis criteria $S_{1\text{-rest}}$, $S_{1\text{-tone}}$, and $S_{1\text{-duration}}$. To create harmonic interest, the cello and second violin add pedals, individual lines which are supported by the cello's $S_{1\text{-rest/pitch/tone}}$ and the violin's $S_{1\text{-rest}}$. No strong SIMUL phenosegments exist, however, most likely due to the offsetting of the parts' attacks. The violin one contains the melodic interest, and contains a highly sectionalized line according to $S_{1\text{-pitch/rest/duration}}$.

Figure 26: Perle's Segmentation, mm. 7-9
(Source: Perle, *Serial Composition*, 16-18.)

George Perle focuses on the ostinato and the relationships between the voices. He denotes a segmentation that emphasizes the criterion $C_{SC\ 4-16}$ emerging from the combination of the pitches for the three accompaniment voices (Figure 26).⁷⁹ It could be said that the delay of the first violin causes the accompaniment to be more audible and therefore a segmentation would be supported. In this case, the most prominent sonic criteria would be the $S_{1\text{-rest}}$, despite no support for a true phenosegment. Perle also points out a prominent dyad (E/F-sharp), which appears in the cello and viola (as a G-

⁷⁹ Perle, *Serial Composition*, 18.

flat).⁸⁰ Due to the high harmonic range of the cello, these two pitches sound next to each other in range. A segmentation is supported by the $S_{1\text{-attack}}$ criterion due to the simultaneity of the cello's attack and the first G-flat of the ostinato. As the viola ostinato dies out (in m. 9), the violins and cello come to rest on $C_{SC\ 3-4}$, establishing the foundation for a $C_{SC\ 4-8}$ that arises with the last pitch played by the viola.⁸¹ There are no strong sonic criteria to support this segment, and thus the support must rely on the contextual criteria and the simultaneity.

**Figure 27: Straus's Segmentation of the Viola Ostinato, mm. 7-9 and Support
(Segmentation Source: Straus, *Post-Tonal Theory*, 121.)**

Burkhart's analysis of these measures is highly focused on proving his theory behind symmetrical analysis. Thus, his segmentations are limited to the $C_{SC\ 4-16}$ as proposed by Perle and a discussion of their relation to the original $C_{SC\ 4-16}$ appearing in the first violin in measures one and two.⁸² Similarly, Straus focuses on the accompaniment's emergent $C_{SC\ 4-16}$ set.⁸³ However, he also mentions the subset produced by the viola line alone, a $C_{SC\ 3-12}$. This new, completely distinct subset is used for contrast.⁸⁴ The viola's $S_{1\text{-pitch}}$ criterion shows many divisions during this ostinato, each of which supports the subset as it matches the three-note division pattern established by the viola (Figure 27).

⁸⁰ Perle, *Serial Composition*, 16.

⁸¹ *Ibid.*, 18.

⁸² Burkhart, "Symmetrical Source," 325-327.

⁸³ Straus, *Post-Tonal Theory*, 121.

⁸⁴ *Ibid.*, 119.

Section A', Measures 11 – 13

The third section of this movement does not contain material that is musically similar to that of the first section. As Straus mentions, though, the final section still sounds very similar to the beginning.⁸⁵ This is due to, as Straus states, a similar pizzicato figure to that of measure two and the stark contrast of sets employed in section B. Thus, a return to the initial sets creates a sense of closure.

Figure 28: Phenosegments and Genosegments, mm. 11-13

Phenosegment: $S_{1\text{-pitch}}$ (V2/Va), $S_{1\text{-rest}}$ (V2/Va/C) & $S_{1\text{-tone}}$ (V2/Va/C)

*Violin I = V1, Violin II = V2, Viola = Va, Cello = C

The last three measures of the movement contain genosegments that support a stark segmentation into two phenosegments, a disjunction that occurs before the pizzicato at measure twelve (Figure 28). The first violin line does not contain the pizzicato or any material after the second beat of measure twelve, and thus is not included in the segmentation. The SINGLE analysis shows a strong support for the

⁸⁵ Straus, *Post-Tonal Theory*, 122.

phenosegment in the other lines. The viola and cello lines contain no material after the pizzicato, yet they both show $S_{1\text{-tone/rest}}$ support for a phenosegment break before it (the viola also includes a $S_{1\text{-pitch}}$ criterion). The only voice that contains music afterward, the violin two splits the pizzicato into a phenosegment that is supported through $S_{1\text{-pitch/tone/rest}}$. Due to the strong, and similar, phenosegments arising from the SINGLE analysis, the SIMUL analysis shows the same support stemming from $S_{1\text{-rest/tone/pitch}}$.

Figure 29: Comparison of Burkhart and Straus Segmentations, m. 12
(Sources: Burkhart, "Symmetry Sources," 329; Straus, *Post-Tonal Theory*, 122.)

Pitches included in Burkhart's Segmentation $C_{SC\ 4-9}$ Straus's Segmentation

George Perle does discuss the final section in depth. He mainly focuses on the seven-note motive and its relation to the material in section A.⁸⁶ Burkhart, on the other hand, brings the piece full-circle by discussing the return of $C_{SC\ 4-9}$ and the transposition of this set that contributes to his symmetrical theory.⁸⁷ As he states, the pizzicato chord nearing the end (at measure twelve) is one of the most structurally important moments of the movement, a statement that mirrors Straus' comments about its formal

⁸⁶ Perle, *Serial Composition*, 17-18.

⁸⁷ Burkhart, "Symmetrical Source," 327-330.

implications. As Straus segments the chord, it harmonically forms a $C_{SC\ 4-9}$ criterion.⁸⁸ Burkhart segments this harmonic criterion, but also combines it with other pitch classes from the sonorities that appear earlier in the measure (Figure 29).⁸⁹ By itself, the pizzicato chord is most strongly supported through $S_{1-attack}$. However, the segmentation including the other pitches is a bit more ambiguous and the only strong support appears to be the contextual criterion. Burkhart also mentions a $C_{SC\ 4-28}$ set that is more relevant to the discussion of the seven-note motive.⁹⁰

The Seven-Note Motive

The main emphasis on the fourth movement of Webern's Op. 5 is placed on a seven-note motive that appears three times during the work (Figure 30). The analysis of the motive has led to the discussion of its influence on the form of the movement and the sets employed.

The figure itself is comprised of $C_{SC\ 7-19}$ and it is generally permuted through transposition and rhythmic change. A SINGLE analysis supports a phenosegment of the motive during all three appearances. The first, in measure six, is supported in the second violin by $S_{1-pitch/duration/rest}$ and the second appearance, in measure ten, is supported by $S_{1-duration/rest/tone}$. The last iteration, however, is the only one that is fully supported by all four analyzed SINGLE sonic criteria ($S_{1-pitch/tone/rest/duration}$).

⁸⁸ Straus, *Post-Tonal Theory*, 122.

⁸⁹ Burkhart, "Symmetrical Source," 329.

⁹⁰ *Ibid.*, 330.

Figure 30: Appearances of the Seven-Note Motive, mm. 6, 10, 12-13.

Phenosegment: S₁-pitch/duration/rest

S₁-pitch _____
S₁-duration _____
S₁-rest _____

Phenosegment: S₁-duration/rest/tone/pitch

S₁-duration _____
S₁-rest _____
S₁-tone _____
S₁-pitch _____

Phenosegment: S₁-pitch/rest/duration/tone

S₁-pitch _____
S₁-rest _____
S₁-duration _____
S₁-tone _____

George Perle's discussion of the seven-note motive focuses on the inherent relationship stemming from the basic cell described above. Thus the first iteration of the motive includes the exact initial four-note C_{SC 4-16} in the first violin part.⁹¹ Not only that, but the two notes of semitone dyad (E/F-sharp) are also adjacent (Figure 31a). No

⁹¹ Perle, *Serial Composition*, 16.

sonic criterion supports this segmentation of the motive into a tetrachord and a trichord, yet the dyad segmentation is supported by $S_{1\text{-pitch}}$. The contextual relations also serve as support for both the segmentation of the motive *and* the segmentation occurring in measure one. The second iteration of the motive contains the $C_{SC\ 4-16}$ set in the middle (the third through sixth notes; Figure 31b).⁹² Again, there is no strong support for a segmentation that would divide the motive into a dyad, a tetrachord, and a dyad. Yet, once again the appearance of the dyad is supported by a genosegment in the $S_{1\text{-pitch}}$ criterion of the viola. No direct $C_{SC\ 4-16}$ from the beginning of the movement appears in the last appearance of the motive and thus a segmentation is mostly dependent on the phenosegment that groups the septachord together (violin two, $S_{1\text{-pitch/duration/rest/tone}}$).

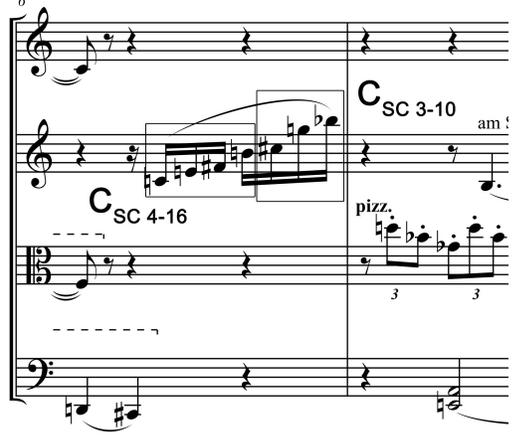
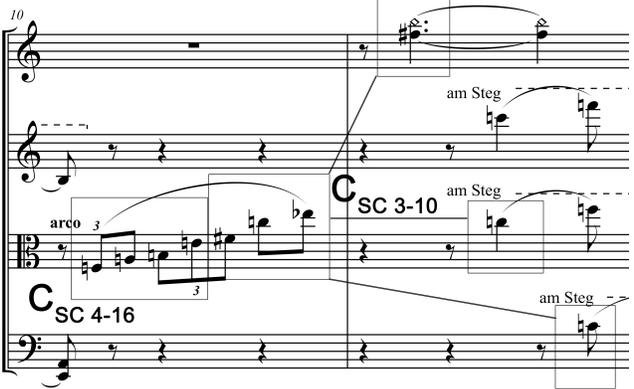
Figure 31a: Perle's Segmentation of the First Seven-Note Motive, m. 6 (Source: Perle, <i>Serial Composition</i> , 16.)	Figure 31b: Perle's Segmentation of the Second Seven-Note Motive, m. 10 (Source: Perle, <i>Serial Composition</i> , 18).

Charles Burkhart's analysis of the seven-note motive is similar to Perle's but is also dependent on the appearance of incomplete $C_{SC\ 4-28}$ criteria that relates to an inventory of pitch classes for the movement. Thus, he argues that the seven-note motives are really based on eight-note groups, an explanation he uses to prove his points about symmetry.⁹³ The contextual criteria, $C_{SC\ 4-28}$, however, is not present in the

⁹² Perle, *Serial Composition*, 16.

⁹³ Burkhart, "Symmetrical Source," 322.

iteration of the motives as Burkhart segments them, so it does not work to support said segmentation (Figure 32a). On the other hand, a $C_{SC\ 3-10}$ is apparent, and thus can be supported by the contextual criteria.

<p>Figure 32a: Burkhart's Segmentation of the Seven-Note Motive, m. 6 (Source: Burkhart, "Symmetrical Sources," 322.)</p>	<p>Figure 32b: Burkhart's Segmentation of the Second Seven-Note Motive, mm. 10-11 (Source: Burkhart, "Symmetrical Sources," 325-327.)</p>
 <p>Notice that the last segment is a trichord, which Burkhart labels as an incomplete $C_{SC\ 4-28}$. Here, it is labeled as the appropriate trichord set.</p>	

Like Perle's analysis, Burkhart's segmentation of the first iteration of the seven-note motive focuses on a tetrachord ($C_{SC\ 4-16}$) followed by a trichord ($C_{SC\ 4-28}$). The groupings of the last two appearances of the motive, however, vary from Perle's: Burkhart follows the pattern of tetrachord and trichord to segment the motives into a $C_{SC\ 4-16}$ and $C_{SC\ 4-28}$ once again (or $C_{SC\ 3-10}$ for the purposes of this analysis).⁹⁴ The sonic criteria still, however, do not support these segmentations. There is a stronger case made for the contextual criteria and its repetitive nature in the three motives, however, along with the aforementioned segmentation that lingers into measure eleven (Figure 32b). The beginning of each part (except the second violin) re-states pitch-classes from

⁹⁴ Burkhart, "Symmetrical Source," 326.

the end of the seven-note motive. Despite no sonic-criteria support, the contextual criterion does uphold the segmentation.

Straus follows Perle's segmentations of the seven-note motives.⁹⁵ However, he also makes two very important observations, which may add answers to the questions raised by the movement's musical structure. As mentioned before, measure two contains a segmentation of a $C_{CS\ 5-19}$, which is the complement to the seven-note motive's $C_{CS\ 7-19}$.⁹⁶ The segmentation is mainly supported by S_{1-rest} criteria. There is also a complementary set to $C_{SC\ 4-9}$ in the last two measures of the movement ($C_{SC\ 8-9}$; Figure 33).⁹⁷ This segmentation contains the pizzicato chord and the seven-note motive, so as mentioned before, the sonic criteria support is very strong (Figure 28).

Figure 33: $C_{SC\ 8-09}$ Segmentation, mm. 12-13
(Source: Straus, *Post-Tonal Theory*, 122.)

The figure displays a musical score for measures 12 and 13. It consists of four staves: two treble clefs (top two) and two bass clefs (bottom two). The key signature has one flat (B-flat). Measure 12 begins with a treble clef staff containing a half note chord (F4, A4, C5) and a quarter note (G4). The second treble staff has a half note chord (B3, D4, F4) and a quarter note (E4), with 'pizz.' written above. The first bass staff has a half note chord (B2, D3, F3) and a quarter note (E3), with 'pizz.' written above. The second bass staff has a half note chord (B2, D3, F3) and a quarter note (E3), with 'pizz.' written above. Measure 13 starts with a treble clef staff containing a half note chord (F4, A4, C5) and a quarter note (G4). The second treble staff has a half note chord (B3, D4, F4) and a quarter note (E4), with 'arco' written above. The first bass staff has a half note chord (B2, D3, F3) and a quarter note (E3), with 'pizz.' written above. The second bass staff has a half note chord (B2, D3, F3) and a quarter note (E3), with 'pizz.' written above. A large box labeled $C_{SC\ 8-09}$ encompasses the second treble staff and the first bass staff of measure 13. A box labeled '5' is under the fifth note of the second treble staff in measure 13. The number '12' is written above the first treble staff of measure 12.

⁹⁵ Straus, *Post-tonal Theory*, 119-124.

⁹⁶ *Ibid.*, 122-123.

⁹⁷ *Ibid.*

IV. CONCLUSION

Discussion

This study served two main purposes: to describe the contextual and sonic criteria apparent in the musical examples, and to describe how the criteria may have supported the segmentations by several theorists. The analyses were, indeed, limited and sampled a very small part of the large body of work that has been implemented on segmentation analysis. No single thesis would be able to discern all of the intricate inner workings of each excerpt. However, it is interesting to note that, however cursory and contextually based the analyses were, each theorist's analysis was supported by a significant amount of both contextual *and* sonic criteria.

Some of the analyses included individual segmentations that were wholly dependent on contextual criteria, for example, Burkhart's and Straus's analyses of the canonic section in measures four through six of Webern's Op. 5, No. 4. It is possible that the highly trained theorist did indeed hear these segmentations. Other explanations are also probable: these types of segmentations rely on the existence of a similar contextual criterion for support. In that case, prior contextual criteria were introduced in the first measures of the piece and were supported by sonic criteria. Thus, in essence, the aural cues that influenced the initial segment may indirectly influence the perception of the latter contextual criteria; the contextual criteria that seem to have no sonic support are subconsciously recalled in the mind through recurring aural cues.

Dora Hanninen believes that there should be a minimum of sonic support for segmentations since “we must be able to hear them as musical units.”⁹⁸ It is arguable that the amount of sonic support needed to justify an analysis depends on the purpose of said analysis. However, whether the theorist decides to employ an aural perspective or not, music is an auditory experience. Despite the amount of emphasis placed on contextual criteria in order to define groups of musical material, this thesis shows that sonic criteria serve as the majority of support for the segmentations. Also, the contextual criteria employed could also be aural cues for certain trained listeners as corroborated by Hanninen.⁹⁹ Whichever criteria serves as aural support, it is apparent that the theorists are, in fact, processing their segmentations musically, however subconscious their musical judgment and whatever their analytical aims may be.

Sonic and contextual criteria form an intricate web of possible segmentations as expounded by Hanninen,¹⁰⁰ and supported by the analyses of the two pieces in this thesis. In more than one instance, sonic criteria alone did not describe the support for the contextual criteria. For example, in the analysis for measures four through six of Schoenberg’s Op. 11, No. 1, the segmentation C_{SC 3-3} was originally supported by sonic criteria. However, as the motives were rhythmically rearranged, the sonic criteria failed to support later segmentations of said contextual criterion. The earlier sonic support, however, solidified that segment in the mind, and thus when it reappeared in a different manner, the contextual criterion was the one that supported the segmentation.

⁹⁸ Hanninen, “Orientations, Criteria, Segments,” 413.

⁹⁹ “Sonic and contextual criteria identify features of a sound-surface (sonic disjunctions and contextual associations) that may be grasped by basic perceptual and cognitive faculties.” Ibid., 357.

¹⁰⁰ Ibid., 413.

It is, of course, possible to segment depending solely on either contextual or sonic criteria. Theories such as Allen Forte's *Structure of Atonal Music* rely on contextual criteria; thus, an exclusive sonic-criteria-based analysis would only hinder the contributions made by such theories. Going further, Hanninen describes contextual criteria as sometimes bolstering or even displacing sonic criteria.¹⁰¹ However, an only contextual-criteria based analysis would detract from the musical context. Sure, an *experienced listener* may be able to hear sets and retrogrades of those sets, yet the average listener may not. Just like when analyzing tonal or any other type of music, it is important to employ both sonic and contextual criteria, as indirectly done by Straus, Wittlich, Forte, Perle, and Burkhart, in order to better understand the depth of the musical structure.

Despite their subconscious musical thinking, the aforementioned theorists lacked a precise and *common* language to communicate their musical findings. All of them were able to relay their findings, yet some of the writing described the segmentations as if they were self-evident; take, for example, a passage from Perle's discussion of Webern's Op. 5, No. 4: "At the same time the figure as a whole is a linearization of elements comprised within the initial transpositions of x and y, from the conclusion of bar 3 through the beginning of bar 4."¹⁰² Of course, Perle wrote his analyses before the development of a common segmentation language,¹⁰³ yet, despite the theorists' ability to discuss their contextual criteria findings, it seemed difficult to communicate the ways in which the music portrayed their analyses.

¹⁰¹ Hanninen, "Orientations, Criteria, Segments," 413.

¹⁰² Perle, *Serial Composition*, 16.

¹⁰³ For example, Allen Forte's *The Structure of Atonal Music*.

Further Research

It is without question that much work still remains to be done in segmentation theory. This thesis works to describe the criteria that may have influenced segmentations of Schoenberg's Op. 11, No. 1 and Webern's Op. 5, No. 4. Although only hinted, this study proposes the development of a polyphonic method that would work with Dora Hanninen's theory. However, this method is still far from perfect and much still needs to be done in order to make it adaptable for more complex polyphonic textures.

As discussed in the introduction, there are many doubts about how humans perceive polyphony. It is difficult even for a computer program to describe the exact segmentations and combinations of sounds that are extracted from a musical stream.¹⁰⁴ Even so, who is to say that the rules of perception for monophonic music are fully understood? This thesis has combined two theories in order to arrive at some understanding of polyphonic ideas: Hanninen's methods for criteria analysis and Lefkowitz and Taavola's imperfect SINGLE versus SIMUL methodologies. The result is not precise, but it is an important step in a very intricate and winding path toward the understanding of a widely used musical cognitive function.

Dora Hanninen defines subcriteria that give insights to the potential for analysis of polyphonic music. As employed in this thesis, $S_{1\text{-attack}}$ is a fundamental sonic criterion that defines simultaneity of attacks. The development of subcriteria to define other polyphonic attributes is required for further work. For example, throughout the analysis, there was a need for describing simultaneity of notes, despite a lack of concurrent

¹⁰⁴ Lefkowitz and Taavola attempt to do this with a SIMUL analysis, yet the matching of voices and mathematical operations to decipher differences in pitch height and other such criteria do not break the code of human polyphonic perception.

attacks (for example, to define harmonies). This lack of subcriteria is, thus, detrimental to a full polyphonic analysis.

Closing Thoughts

Segmentation is an inherent practice needed for musical perception. The process of analytical segmentation is an attempt to understand the cognitive workings of the musical human mind. Thus, the methods of analysis should include cognitive roots in order to truly grasp the musical understanding. As Dora Hanninen states in her writing, it is imperative for theorists to be aware of the underpinnings that may influence their analyses in order to achieve a more fruitful musical experience as it extends not only to listening, but also performance, music instruction, and other musical endeavors.¹⁰⁵

¹⁰⁵ Hanninen, "Orientations, Criteria, Segments," 347.

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APPENDIX A: SCORES

SCHOENBERG: *DREI KLAVIERSTÜCKE*, Op. 11, No. 1
 Excerpt, mm. 1-12

Mäßige ♩

p

6 *rit.* *langsamer*

p

10

Source: Arnold Schoenberg, *Drei Klavierstücke* (Vienna: Universal Edition, 1924).

NOTE: Only measures 1-8 are studied in this thesis. Measures 9-12 are given for contextual reference.

