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Elizabeth West Marvin and Richard Hermann
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Theories of Chordal Shape, Aspects of Linguistics and Their Roles in an Analysis of Pitch Structure in Berio's Sequenza IV for Piano

Richard Hermann

Introduction

Luciano Berio's *Sequenza* series of compositions for solo instrument is an on-going project that had its start near the beginning of his career. *Sequenza IV* for solo piano (1966) has, perhaps, the most complex pitch structure of this influential series of works.[1] Its opening, jagged chordal gestures present an interesting analytical challenge, since set-theoretic equivalence and similarity relations do not always support perceived similarity between chords.[2] The theories developed here attempt to model not only this author's perception of certain chordal shapes as derivations of others, but also to model the physical and registral groupings of

1 This essay is an extensive revision of two of my earlier essays: "Some New Analytical Techniques for the 'Post-Serial' Repertoire, Re: Luciano Berio," delivered at the 1983 meeting of the Society for Music Theory (New Haven, Conn.) and "An Analysis of Berio's *Sequenza IV* for Solo Piano" delivered at the 1989 annual meeting of the Music Theory Society of New York State at Baruch College (New York City).

There is some disagreement as to the year of composition for *Sequenza IV*. Berio's Universal Edition catalog gives the year as 1966, but the corrected edition of 1987 gives 1965 at its end. The facsimile shows no date at all. The pianist of the New York City premiere (Berio was present), David Burge, wrote to me on November 4, 1989: "For the record, . . . the piece was definitely written in 1966."

A recorded performance of *Sequenza IV* by Aki Takahashi can be found on *Piano Space 2* (EMI Angel Japan EAC–60154 Stereo LP, no date). Another by David Burge is on *Avant Garde Piano* (Candide CE 31015 Stereo LP, 197–).

I extend my thanks to Brian Alegant, David Burge, Robert Morris, and Patrice Pastore for reading and making valuable suggestions upon the earlier essays mentioned above.

2 Techniques such as Rahn's ATMEMB and Forte's K/Kh complexes failed to relate strongly many pairs of chords that theories to be developed here do. In fact, these tools in general yielded rather unfocused analytical results for this piece. See John Rahn, "Relating Sets," *Perspectives of New Music* 18 (1979–80): 492–94 for information on the ATMEMB function between two pc-sets. ATMEMB measures and scales abstract subset content held in common between two pc-sets. The function returns a value from 0 to 1. The greater the value, the more closely related the two pc-sets are; the lesser the value, the less closely related. See Allen Forte, *The Structure of Atonal Music* (New Haven: Yale University Press, 1973), pp. 93–100, for detailed information on the Kh relation. Informally, the Kh relation between two set classes (hereafter, scs) holds when the scs can be mapped into each other's sc or each other's complementary sc.

pitches from the perspective of the performer, in light of pianistic technique. Throughout the development of this argument, inspiration is drawn from the field of linguistics, which was an interest of the composer's.[3]

Example 1 reproduces the first page of *Sequenza IV*; the chords displayed there form a rich catalog of 24 different pitch sets belonging to 22 different set-classes. These chords are labeled by italicized capital letters. Those chords labeled *A* through *J* without a superscript "v" are called "referential chords"; those chords with v superscripts are variants of the referential chord bearing the same letter name, for reasons to be developed more fully below.[4] The questions of how many referential chords exist in this piece, how the variant chords are related to the referential chords, why the referential chords are distinct from one another, and so forth are subjects addressed in this essay.

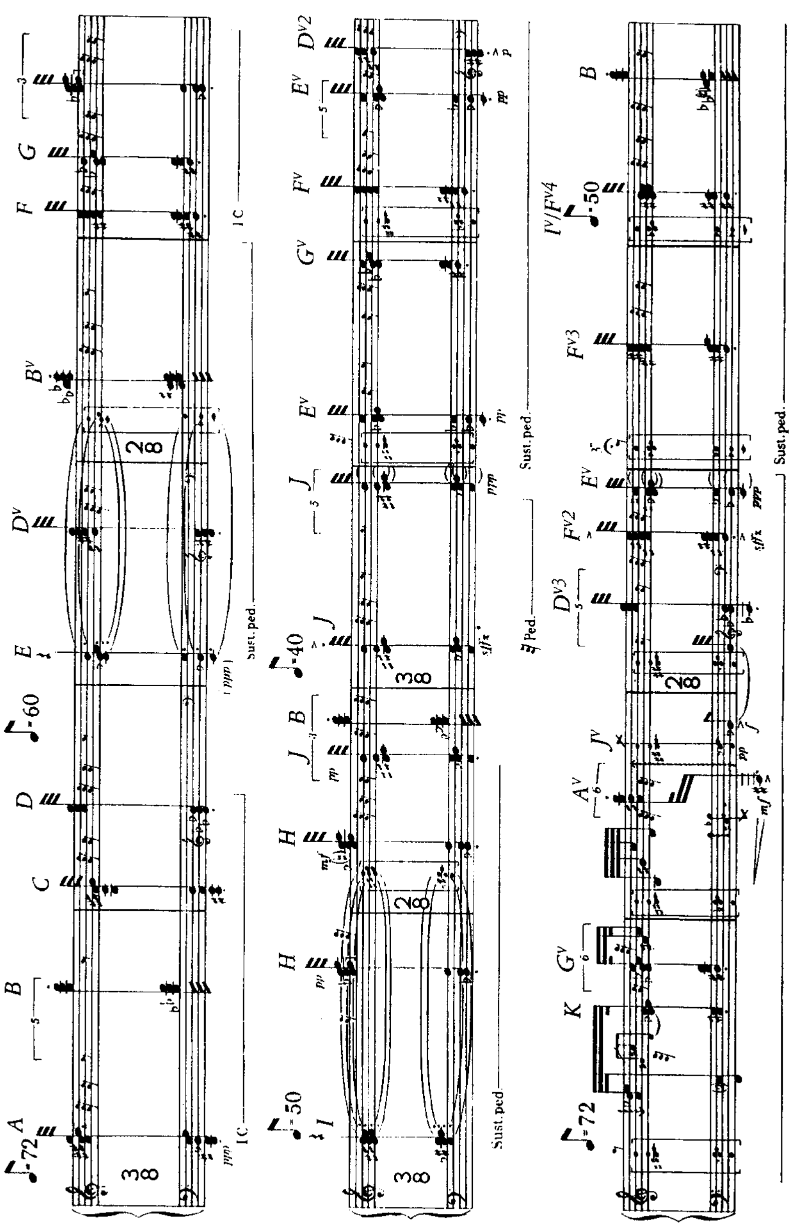
The Editions

Before exploring the relation between pianistic technique and chordal shape in *Sequenza IV*, performers and analysts alike must consider the fact that three editions of the work have appeared to date. These must be investigated in order to establish their relative authority as *Urtexts*.[5] The first two editions of the work were published in 1967. One was a facsimile of the composer's holograph and the other was a traditionally engraved edition. The first mentioned is called the "facsimile," and the second is called "engraved '67." The third edition looks similar to engraved '67, and it has the words "corrected 1987" in the lower right-hand corner of the score's first page. It is called "corrected '87." All are in the oblong format common to Berio's Universal Edition scores.

3 In the following statement, Berio dates his interest in linguistics: "I met [the great novelist, philosopher, and semiotician Umberto] Eco in Milan in the mid-fifties. We soon discovered that we took a similar interest in poetry and within it, onomatopoeia: I introduced him to linguistics and he introduced me to Joyce." See Rossana Dalmonte and Bálint András Varga, *Luciano Berio: Two Interviews*, trans. and ed. David Osmond-Smith (New York: Marion Boyars, 1985) p. 142.

4 The referential chords are labeled alphabetically in their order of appearance. Chords related by pitch-class (hereafter, pc) transposition may be considered distinct from one another for the reasons to be developed later. Chords may also have an Arabic number after the v superscript. These numbers are ordinal labels distinguishing between different variant chords related to the same referential chord.

5 Unfortunately, Universal Edition (London), has given all three the same plate number, 132724 mi. Engraver errors, poor proof reading, and some actual changes by Berio necessitate this brief look at the editions. For instance, the facsimile is 215 bars in length; however, the two engraved editions omit the bar line between measures 96 and 97, thus yielding a total of 214 measures. I have prepared a detailed critical report on the differences between the editions; some of these differences are summarized here as well.



* The attack sffz must always be as loud and as quick as possible. The pedal when used immediately after this type of attack, should collect only random noises and resonances.

Example 1: Luciano Berio: *Sequenza IV* (1965)—First Page of the Corrected 1987 Edition

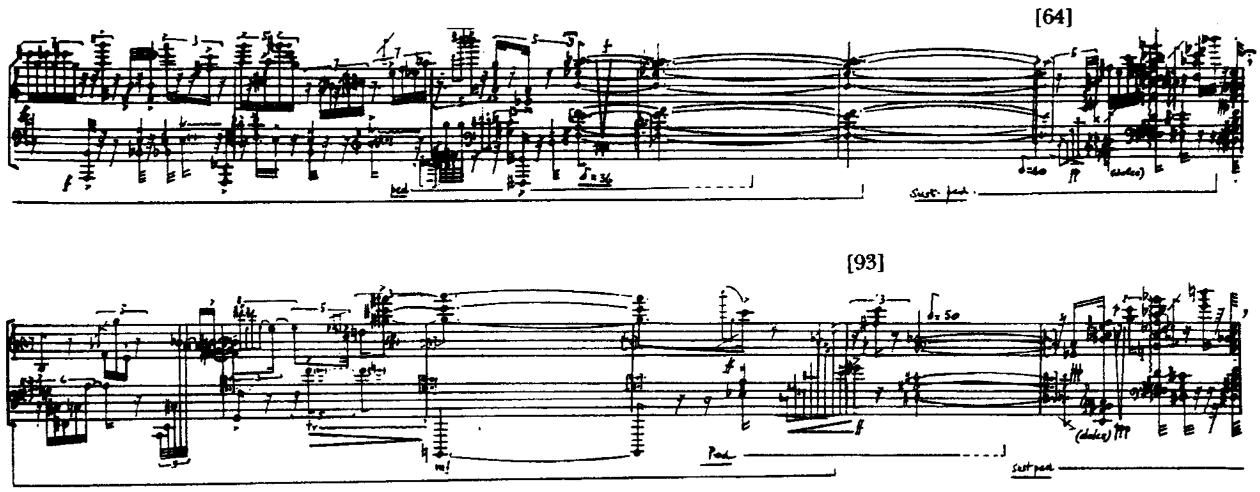
Differences among the three are many, and they range from the engraver's usual insignificant and easily spotted errors to medium and even large-sized errors. There also appear to be several changes by Berio in corrected '87. Unfortunately, the engraver introduced petty errors into engraved '67, which remain uncorrected by Berio. Perhaps the composer consulted his holograph or its facsimile and not engraved '67 when specifying the changes to the editor at Universal Edition. A missing bar line, a few changed pitches, some inaccurate rhythms, omitted accents, and so forth still stand.

Which edition are we to use? The facsimile edition is, for textural reasons, indispensable and the corrected '87 must be consulted for Berio's changes.[6] One should *not* follow engraved '67.

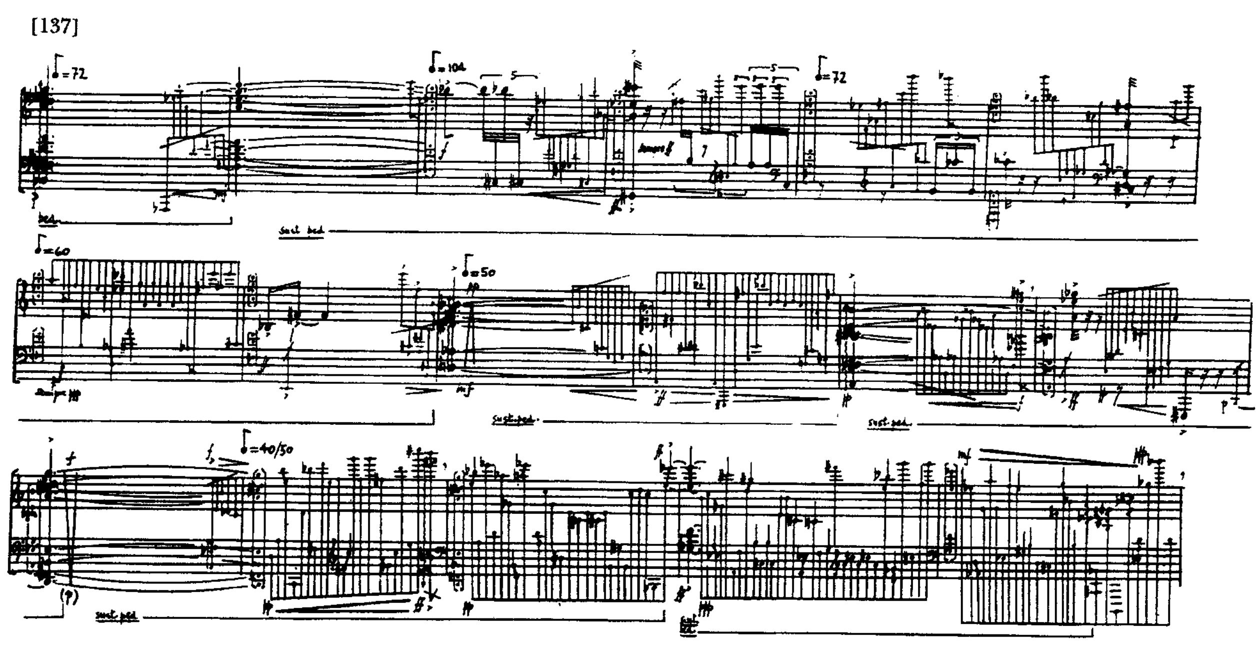
Although the engraved editions are indeed beautifully clear, well spaced and "easy" to read; they are so, however, at the cost of a rough congruence between the proportional spacing on the page and the attack-points of the pitches that is found in the facsimile. The most important benefit of consulting the facsimile is the evidence it contains for a layered method of notation, if not directly for a layered method of composition itself. This should not be surprising, since his *Sinfonia* and *Chemins* series of compositions are explicit in their use of layering.[7] There appear to be at least two stages in the process of notation: the first notated stratum is chordal and the second consists of both chords and lines laid upon the first. Examples of two different kinds of notational adjustments support the thesis of a layered compositional process for this piece. Example 2a shows that on pages 2 and 3 the very last 32nd note of the last measure on each page contains the exact same chord followed by a breath mark that is notated above and to the right of each page's last barline. Further examination of these measures yields other identities and variants. These breath marks and identical chords provide a "frame" for the later embellishing lines that complete the surface of these passages. In Example 2b, the fourth stave of page 5 was carefully extended into the right hand margin, and the first bar of the following stave holds a prominent chord in the piece, indeed a near repetition—only lacking one of the chord's nine pitches—of

6 Sadly, I suspect that copies of the facsimile edition are now rare. Berio's notation of the harmonic intervals of major and minor seconds occasionally deviates from usual practice and has been tacitly "normalized" in the engraved editions. Though altering a highly musically literate composer's notation is a suspect practice, I have yet to discern reasons for his notational "deviations."

7 On his works *Sequenza VI* for solo viola, *Chemins II* (which employs a chamber ensemble aurally surrounding *Sequenza VI* with its own material), and *Chemins III* (which employs an orchestra to further surround *Chemins II*) Berio has said: "The three pieces relate to each other something like the layers of an onion." The quote is found on the record jacket of *Berio Sequenza VI Chemins II Chemins III*, Walter Trampler, viola (RCA LSC-3168, 1970). For recent information on Berio's *Sinfonia* see David Osmond-Smith, *Playing on Words: a Guide to Luciano Berio's Sinfonia* (London: RMA Monographs, 1985).



Example 2a: Luciano Berio: *Sequenza IV* (1965)—The Last Systems of Pages 2 and 3 from the Facsimile Edition



Example 2b: Luciano Berio: *Sequenza IV* (1965)—The Last Three Systems of Page 5 from the Facsimile Edition

the very first chord. As the composer evenly preruled the measures and then added the chords of the first layer, he needed here to extend the measure into the margin in order to hold all of the second embellishing layer's material. That embellishing material could not flow into the next stave because a chord was already placed at the beginning of the stave in the previous layer of composition. Had the composer not preruled the measures ahead of time and flexibly layed out the measures as he went along, the marginal extenstion would not have been needed.

Towards A Theory of Chordal Shape

In order to answer the question of why the referential chords are distinct from one another, we start with some thoughts on a theory of chordal shape. A chord is a set of pitches, and it consists of one or more "shape fields," which have the following properties: 1.) shape fields are chordal subsets of contiguous pitches; 2.) if a chord has more than one shape field, then the shape fields are disjunct and completely partition the chord; 3.) boundary intervals between adjacent shape fields must be equal or greater than some real number variable "x" times any interval found between adjacent pitches within either of the adjacent shape fields. This "x" variable could be set to some value appropriate to the musical dimension under consideration.[8] These definitions of chord and shape field provide reasonable methods for determining whether the pitches of a chord fuse into one perceptual entity or whether the pitches divide into perceptually distinguishable subsets.

Chords may also be partitioned by the performing techniques of the musical medium employed in sounding the chord. These partitions via performance techniques are called "chordal spans" or just "spans" for short. The division of chords between the pianist's two hands is a commonplace example of spans.

The ideas of chords, fields, and spans and their interrelations are roughly analogous to words, morphemes, phonemes, and syllables in linguistics.[9] An

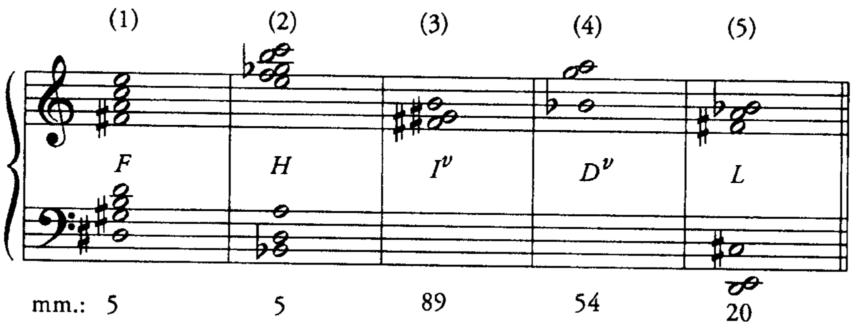
8 I have been influenced by James Tenney and Larry Polansky's "Temporal Gestalt Perception in Music," *Journal of Music Theory* 24 (1980): 205–41 on employing a variable suitable for each musical dimension.

Recent work on contour theory has also been a stimulus to this work. Please see the following: Michael L. Friedmann, "A Methodology for the Discussion of Contour: Its Application to Schoenberg's Music," *Journal of Music Theory* 29 (1985): 223–48; Friedmann, "A Response: My Contour, Their Contour," *Journal of Music Theory* 31 (1987): 268–74; Elizabeth West Marvin and Paul A. Laprade, "Relating Musical Contours: Extensions of a Theory for Contour," *Journal of Music Theory* 31 (1987): 225–67; and Robert D. Morris, *Composition with Pitch-Classes* (New Haven: Yale University Press, 1987), pp. 23–42.

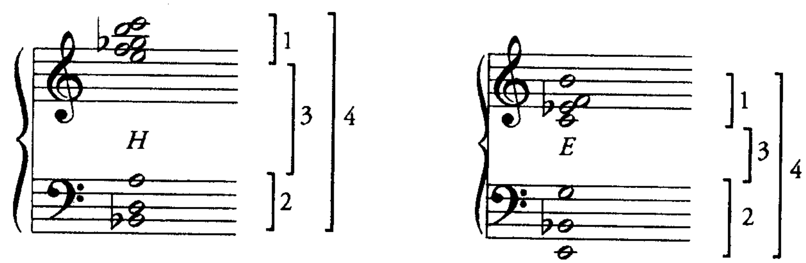
For a differing viewpoint on these issues, see Christopher F. Hasty, "Phrase Formation in Post-Tonal Music," *Journal of Music Theory* 28 (1984): 167–90, and Elizabeth West Marvin's contribution to this volume.

9 Berio's interest in linguistics can be seen in his widely known *Circles* (1960) for mezzo-soprano,

(a) Relations Among Chords, Spans, and Shape-Fields



(b) Parts of Spans or Shape-Fields



(1) Right Hand Span (2) Left Hand Span (3) Intrahand Span
(4) Total Span, Boundary Pitches, Boundary Interval

N.B. Referential Chord *E* is first found in measure 3.

Examples 3a–b: Chords, Spans, and Shape-Fields in Berio *Sequenza IV*

examination of Example 3a, will make the rough analogy clear enough. The word "a" is both a single syllable, and morpheme; furthermore, it is the phoneme [e]. The word "boy" is a single syllable and morpheme but consists of three phonemes: [b] and the two vowel sounds/phonemes [ɔ] and [i] that create the diphthong [ɔi].

harp, and percussion, which employs the international phonetic alphabet in the voice part. Berio's *Sequenza IV* may, thus, be thought of as a transfer of the selected linguistic concepts mentioned above into the musical dimension of pitch-chords.

The word "boys" has a single syllable, two morphemes ("boy" and English's plural morpheme "s"), and phonemes: [b] [ɔi] and [z]. The word "boyish" has two syllables (boy–ish), two morphemes ("boy" and "–ish"), and the phonemes [b] [ɔi] [i] [ʃ]. Thus, words, syllables, phonemes, and morphemes do not simply nest or map onto one another.[10]

Just as a variety of relations exist between the above mentioned linguistic entities, so too, many kinds of relations hold between chords and their shape fields and spans. Example 3a demonstrates this with chords from *Sequenza IV.* If the boundary interval variable mentioned above, "x," is set to 2.0 (in semitones), then chord 1 has one field and two spans, chord 2 has two fields and two spans, chord 3 has one field and one span, chord 4 has two fields and one span and chord 5 has two spans and three fields. Thus, while two or more of the analytical labels of span, field, and chord may be identical in application for some cases, they are not necessarily always identical as the cases from Example 3a explicitly show. Chords with more than one field will hereafter be called "multifielded" (as chords 2, 4 and 5 of the example); chords with two fields are "bifielded" (chords 2 and 4), while chords with a single field are "monofielded" (chords 1 and 3).

Example 3b displays other descriptive terminology demonstrated on referential chords *H* and *E*. Relevant dyadic pitch segments in these chords are labeled with numbered brackets denoting various parts of the chord's right- and left-hand spans. These dyadic segments may be used to define a measurement of a given chord's "sparseness" or "denseness." The *d*egree *o*f *c*ompactness, DOC, of a span, shape field, or chord is the ratio of its *b*oundary *i*nterval (bi) divided by (n-1), where n equals the cardinality of the pitches. Hence, where X is a span, shape field, or chord, DOC(X) = bi/(n-1). If the DOC function returns values that are equal for two different spans, shape fields, or chords, they are members of the same equivalence-class. This measurement gives an average distance between pitches; higher DOC values model relatively "sparse" chords, while lower values model "dense" chords. For this piece, it seems reasonable to call a span, shape field, or chord "sparse" when its DOC value is equal to or greater that 3.0, and it also seems reasonable to call them "dense" when that ratio is less than 3.0. Figure 1 gives the DOC values for the referential chords and their shape fields and spans.

Example 4 lists the referential chords. Questions remain: Why 14 referential chords and not more or less, and how are the variants related to the proper referential chord? Some reasons for assigning a generator-like status to these 14 come from empirical observations: they are the chords that appear most frequently among apparently closely related chords, and, more importantly, they frequently assume boundary positions in the gestural form of the piece. The referential chords

10 See Mario Pei and Frank Gaynor, *Dictionary of Linguistics* (New York: Philosophical Library, 1954), pp. 140, 167, 209, and 233 for concise definitions of morpheme, phoneme, syllable, and word; see Bertil Malmberg, *Phonetics: Physiological Phonetics, Experimental Phonetics, Evolutionary Phonetics, and Phonemics* (New York: Dover, 1963) for information on the international phonetic alphabet and on phonemes; and see Oswald Ducrot and Tzvetan Todorov, *Encyclopedic Dictionary of the Sciences of Language*, trans. Catherine Porter (Baltimore, Maryland: John Hopkins University Press, 1979), pp. 173–6, 199–203 for information on the relations among the concepts of morpheme, phoneme, syllable, and word.

RIGHT HAND SPANS OR SHAPE-FIELDS

bi/n-1	DOC	from Ref. Chord
3/2	1.500	*K*
7/4	1.750	*I*
7/4	1.750	*M*
4/2	2.000	*L*
8/4	2.000	*H*
9/3	3.000	*G*
10/3	3.333	*A*
10/3	3.333	*F*
7/2	3.500	*B*
7/2	3.500	*D*
11/3	3.667	*E*
11/3	3.667	*J*
11/3	3.667	*N*
13/3	4.333	*C*

LEFT HAND SPANS OR SHAPE-FIELDS

bi/n-1	DOC	from Ref. Chord
2/1	1.000	*L**
3/2	1.500	*M*
7/3	2.000	*I*
4/1	2.500	*K*
10/3	3.333	*J*
7/2	3.500	*B*
7/2	3.500	*D*
11/3	3.667	*F*
15/4	3.750	*A*
8/2	4.000	*G*
13/3	4.333	*C*
11/2	5.500	*H*
11/2	5.500	*N*
15/2	7.500	*E*

* Referential Chord *L* has two shape-fields played by the left hand, <D2,E2> and <C♯3>. As the second shape-field has only one element, bi/n-1 = 1/0 whose value is undefined. Because DOC gives an average of intervals between elements, a one element shape-field creates no intervals within itself and, thus, can generate no measurement. This is much like a single point in geometry. It has no magnitude; it merely has location.

MONOFIELDED REFERENTIAL CHORDS

bi/n-1	DOC	Ref. Chord
16/8	2.000	*I*
19/6	3.167	*G*
16/5	3.200	*D*
25/7	3.571	*F*
26/7	3.714	*J*
31/7	4.429	*C*
29/6	4.833	*N*
31/6	5.167	*E*

MULTIFIELDED REFERENTIAL CHORDS

bi/n-1	DOC	Ref. Chord
13/4	3.250	*K*
23/7	3.286	*M*
28/5	3.571	*B*
41/8	5.125	*A*
38/7	5.429	*H*
32/5	6.400	*L*

Figure 1: DOC Values for Referential Chords and Their Spans and Shape-Fields

were statistically tested to see whether they would collapse into fewer referential chord categories, and the results indicate that these 14 are reasonably distinct from one another.[11]

* = Multifielded Referential Chord

Example 4: A Catalog of Referential Chords for Berio's *Sequenza IV for Piano*

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11 The statistical testing was was done by finding out the probability of each pair of chords having the number of pitch (not pc invariants) common tones that they actually do have. Those pairs of referential chords having improbably high numbers of common tones were considered possible candidates for merger into a single referential chord category. These pairs were also examined with the theory of chordal shape outlined above. They were considered sonically independent if they had significant differences in two or more of the following categories: total boundary interval, number of shape fields, degree of compactness, or set-class membership.
In my 1983 essay, referential chords were there called "archetypal chords," and they were 15 in number. Recent rethinking of what was, in my first essay, a more implicit theory of chordal shape and the statistical testing allowed me to eliminate one of those referential chords.

Some Interactions Between Performing Technique on the Piano and the Theory of Chordal Shape

Each referential chord as labelled in Example 4 has its own sonic signature created by differences of hand-position, registral location and pitch, pitch-class, intervallic and set-class design. Significant matching within these sonic realms can assure resemblance between a referential chord and a variant of it. Thus, the manner of playing chords is naturally tied to a theory of chordal shape that, in turn, contributes to the concepts of chordal shape identity and resemblance.

In considering how differences in chordal shape come about, some clues can be gleaned from the fact that Berio, a pianist himself, coordinates the pitch structure of his pieces to rethinkings of the medium's capabilities and the processes of performing in that medium.[12] Thus, I infer the piece to be an exposition of chordal playing and the list of referential chords detailed above (see Example 4) to be a catalog of the kinds of ways in which the pianist can deploy the hands in playing chords.

Four oppositions provide the means for understanding each chord's uniqueness: 1.) is the chord monofielded or multifielded? 2.) is it dense or sparse? 3.) does it have a high or low tessitura, and 4.) is it like or unlike other chords in pitch, pc, intervallic and sc design? The first of these oppositions describes the pianist's hand positions; informally, are they close together or far apart? Chord *E* (monofielded) is an example of the hands being close together, and the multifielded chord *H* is an example of hands spread further apart. The second opposition describes the positions of the fingers; informally, is the hand called upon to play many or few pitches, and does the chord force the fingers to stretch apart or contract toward one another? For instance, the right-hand of referential chord *H* is an example of a dense deployment: DOC(*H*'s top field) = 8/(5-1) = 2.0. The left-hand span of referential chord *E* is an example of a sparse deployment: DOC(*E*'s left-hand span) = 15/(3-1) = 7.5. The third opposition describes the rough location of the hands upon the piano: chord *M* is high in tessitura, and chord *C* is low in tessitura.[13] The fourth opposition is the subject of traditional atonal theory and some of the theory unveiled here.

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12 Berio has commented (Dalmonte and Varga, p. 99): "Control of the development of harmony and melodic density is a feature common to all the *Sequenzas*, though it takes different forms because, in each case, certain aspects of the instrument's technique are examined critically."

13 *Pitch* transformations of transposition, inversion, and their combinations on chords naturally preserve chordal shape as a by product of preserving intervals. However, if both chords are not literal pitch-transpositions or pitch-inversions of one another, and if they inhabit different areas of the pitch spectrum, they can certainly still be related to one another through chordal shape-transformations. These transformations can only be suggested here. A transposition-like transformation called SHIFT, an inversion-like transformation called FLIP, and their combinations can create equivalence-classes that preserve chordal shape, boundary-interval spans, DOC

Another way to understand the differences between two chords through the third opposition, pitch-space location or register, is through the real value returned by a function called the "*d*egree of *s*patial *o*verlap," abbreviated DSO. The DSO function returns a number between 0 and 1; the closer the value is to 1 the closer the two chords are in pitch space, and the closer the value is to 0, the further apart they are. The DSO function consists of a relationship between two other functions: the "*e*lement *s*pan," abbreviated ES, and the "overlap span," abbreviated OS. The ES function applied to a chord returns the integer value of the interval (in semitones) formed between the lowest and highest pitches plus 1. Thus, the ES function counts all of the elements that could occupy the space described by that interval. The OS function applied to the two chords under consideration measures their overlap by taking the integer value of the interval formed between the higher value of the two chords's lowest elements and the lower value of the two chords's highest elements and adds 1. The DSO of chords X and Y equals OS(X,Y) divided by either ES(X) and ES(Y), whichever is lower. The range of the DSO function is between 0.0 for two chords that do not spatially overlap and 1.0 for two chords that overlap entirely. An example in pitch space follows. Returning to Example 1, consider the referential chords *C* from measure 2 and *H* from measure 5; recall from Figure 1 that they share the same sc membership, 8-16 [0,1,2,3,5,7,8,9]. The function ES(*C*) = 33 (the distance in semitones between C♯2 and G♯4 is 32) and the function ES(*H*) = 39 (the distance between B♭2 and C6 is 38 semitones). The OS(*C*, *H*) = 23 (since the interval between B♭2, the higher of the two chords's lowest pitches, and G♯4, the lower of the two chords's highest pitches, is 22). Thus, the DSO(*C*, *H*) = OS(*C*, *H*)/ES(C) = 23/33 = 0.697. Thus, *C* and *H* are not closely related through the opposition of pitch-space location, despite the fact that they belong to the same set-class.[14]

values, and relative relations of the chord's shape-fields or spans with one another. Certainly, similarity functions can be easily designed for the DOC function. Order transformations such as rotation could also be useful in describing relations between multifielded chords.

14 Because *C* is monofielded and *H* is bifielded, their chordal shapes are different and not chordal shape equivalent under operations suggested in footnote 13. Further, their degree of spatial overlap is not great (0.697). Even though the referential chords *C* and *H* share the same sc, these two referential chords are distinct from one another according to the oppositions as demonstrated above.

The operation of set intersection of pitches between chords can be thought of as describing their "literal overlap" in pitch space; the DSO function between two chords can be thought of as describing their "abstract overlap" in pitch space.

Towards a Theory of Chordal Shape Functions

Chordal shape functions give the specifics of how variant chords may be related to or generated from referential chords. Of the nine functions introduced here, seven involve literal pitch-subset and -superset relations. Example 5a presents referential chords *A*, *B*, *E*, and *K* which will be transformed into variant chords or other, non-variant-chords by chordal shape functions in Examples 5b, c and d. Extending the linguistic comparision, the chordal shape functions can be thought—at this level—as analogous to the linguistic transformations upon the morphemic, phonological and syllabic structure of words. Some of these linguistic transformations are declension, conjugation and adding prefixes, infixes or suffixes.

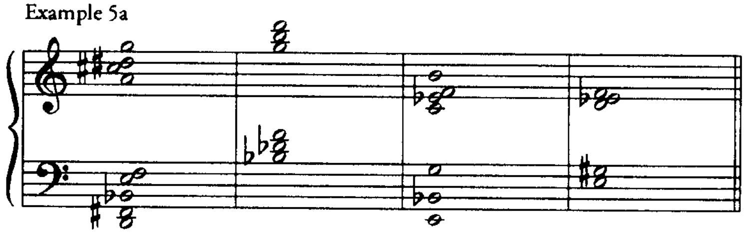
Example 5b shows the results of the chordal shape functions AddPitch, AddSpan, AddField, and AddChords as applied to the referential chord *K*. These chordal shape functions are abbreviated as AP, AS, AF, and ACS respectively. AP takes as its arguments a chord and the pitch set to be added to it. AS and AF also take a chord as its first argument and the span or shape field to be added to it as the second argument. The span or shape field to be added can be specified as a pitch set or by a number subscripted to a named chord, which represents a span or shape field from that chord. As a convention, spans or shape fields from chords of n spans or shape fields are numbered from lowest to highest, with the lowest called 0 and the highest n-1. For instance, the second chord of Example 5b could also be labelled AF(K, B_0). ACS takes as its arguments all of the chords to be added. The chordal shape functions DeletePitch, DeleteSpan, and DeleteField take the same arguments as their add counterparts and give the expected results. These are illustrated in Example 5c and abbreviated as DP, DS, and DF respectively.[15]

The chordal shape function SubstitutePitch, abbreviated SP, takes three arguments: the first is a chord, the second is the ordered set of pitches to be replaced, and the third argument is the ordered set of pitches of the same cardinality to be substituted in their "places." The pitch substitutions are done by

15 All the contour-functions mentioned so far are mathematically classed as either "into" or "onto" functions. Under pitch transposition of 0 semitones, the mapping of referential chord *A* of measure 1—see Example 1 or 4—to measure 29's variant chord of *A*, A^v which consists of only the pitches A4, E♭5 and G5, is "onto" because each element or pitch of A^v has at least one element from *A* mapped onto it. Reversing the order of the mapping, A^v to *A* creates an "into" mapping because each element of A^v is mapped to at least one element of *A*. As this mapping pairs only one element of A^v with only one element of *A*, this mapping is a special case of an "into" function called a one-to-one function, abbreviated, 1–1. See David Lewin, *Generalized Musical Intervals and Transformations* (New Haven: Yale University Press, 1987), pp. 123–34 for his theoretical and analytical use of 1–1 functions as his "injection function."

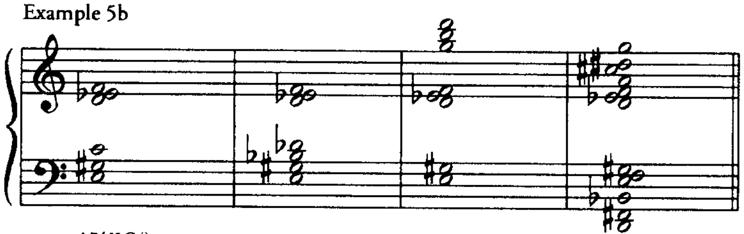
Thus, all the contour-functions with "Delete" in their names are "onto" functions and all with "Add" in their names are 1–1 functions. For more on functions see Seymour Lipschutz, *Theory and Problems of Discrete Mathematics* (New York: McGraw-Hill, 1976), pp. 43–46.

Example 5a



A *B* *E* *K*

Example 5b



AP(*K*,C4) AS(*K*,<Bb3,Db4,F4>) AF(*K*,<G5,B5,D6>) ACS(*A*,*K*)

Example 5c

DP(*K*,Eb4) DS(*E*,<C4,Eb4,F4,B4>) DF(*K*,<E3,G#3>)

Example 5d

SP(*K*,G#3,G3) CFOS(A_1,B_0,E_0)

Examples 5a–d: Results of Contour-Functions upon some Referential Chords

swapping pitches of the same ordinal numbers in arguments two and three.[16] The last chordal shape function to be introduced here is ConcatFieldsOrSpans, abbreviated CFOS. This function takes as arguments any number of shape fields or spans desired and concatenates them. The arguments can either be given in the form of pitch sets or in the form specified by the convention given above. See Example 5d for instances of their use.

These chordal shape functions can have interesting effects. For instance, ACS, AF, AS, and CFOS create chords with resemblances to more than one referential chord. Chords that refer to more than one referential chord are called "multi-variant chords." Further, the use of chordal shape functions in combinations can result in new chords with resemblances to multiple referential chords or to none at all.[17] When composite chordal shape functions change chordal shape and possibly sc membership and pc-sets as well, they are called metamorphic transformations.[18]

Some of the chordal shape functions can also be thought of in terms of the pianist's performing techniques in playing chords. Recall the oppositions of the pianist's relative individual hand-positions and the general registral placement of the hands mentioned above. The chordal shape functions of AP, and AS or AF can be thought of as addition-functions for the techniques of playing at the levels of finger- and hand-deployment respectively. Naturally, the chordal shape functions DP and DS or DF operate as subtraction-functions at the levels of finger- and hand-deployment. The function CFOS can be thought of as a technique of swapping the shape of hand-spans between parts of two different chords.

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16 The chordal shape function of SubstitutePitch, SP, swaps one or more pitches of a chord for spatially adjacent pitches, no more than two semitones away. This function is a first cousin to Lewin's SLIDE operation which preserves the third of a tonal triad while changing its mode by altering (or substituting for) the chord's root and fifth. For instance, an F as the chordal third of a D minor triad after SLIDE-ing becomes the same chordal member of a D♭ major triad. See Lewin, *Generalized Musical Intervals and Transformations*, p. 178.

17 In answer to an interviewer's question on his compositional processes, Berio said the following (Dalmonte and Varga, p. 102): "It's not really a matter of manipulatory capacities (I find that a somewhat degrading expression), but of the ability to transform. We're always dealing with models, even those that we make for ourselves, and our work consists in widening the field of transformational paths until we manage to transform one thing into another, as in a fairy tale."

18 These chordal shape functions are closely related to analog electronic studio techniques of the time such as tape-splicing, band-reject-filtering, band-pass-filtering, amplitude-modulation, frequency-shifting and so forth. Needless to say, Berio was an early practitioner and master of them all. See David Osmond-Smith, *Berio* (New York: Oxford University Press, 1991), pp. 11–15, for a description of Berio's early interests in analog electronic compositional techniques. See Thomas Wells and Eric S. Vogel, *The Technique of Electronic Music* (Austin, Texas: Sterling Swift, 1974) for a contemporaneous view and definition of the electronic music terms used here.

Large-Scale Form Part 1: Referential Chord-Layers.

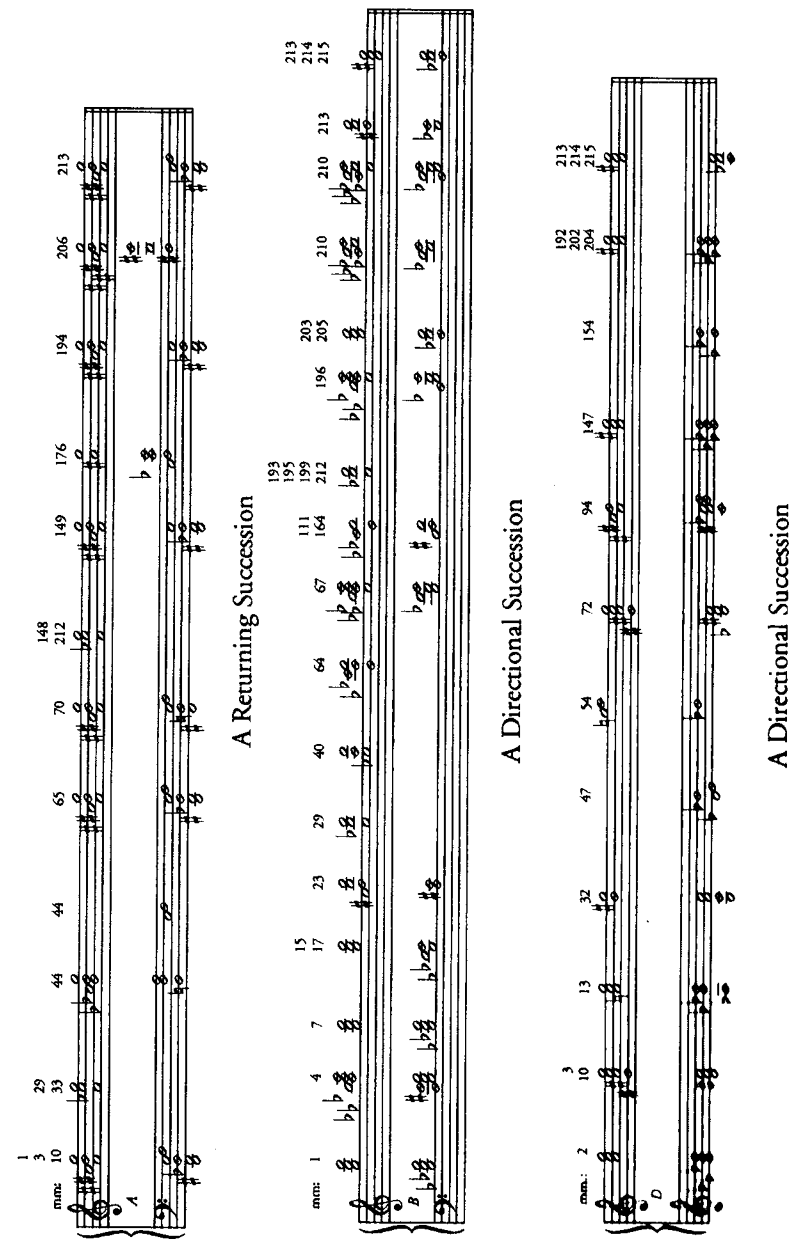
Figure 2 outlines the work's gestural form.[19] With a little practice, one way of hearing this work can be of considerable interest: that of following the succession of variant and multivariant chords, as they refer to specific referential chords, throughout the piece.[20]

Section Numbers	Subsection Numbers	Measure Numbers	Description
I			
	.1	mm. 1–17	Opening chordal section presents Referential Chords
	.2	mm. 18–49	Chords and Arpeggios
	.3	mm. 50–61	Cluster Chords and Arpeggios
	.4	mm. 62–70	Chords
II			
	.1	mm. 71–80	Chords with Repeated Notes and Arpeggios
	.2	mm. 81–82	Chords (flashback to the beginning?)
	.3	mm. 82–90	Chords with Repeated Notes and Arpeggios
	.4	mm. 91–94	Chords
	.5	mm. 94–102	Cluster Chords with Repeated Notes and Arpeggios
III			
	.1	mm. 103–166	All previous textures rapidly changing over sustained chordal "backdrops." Frequent and rapid tempo changes.
	.2	mm. 167–187	A gradual return of a chordal texture, "Retransitional"
IV			
	.1	mm. 188–215	A Varied "Reprise" of the Opening Chordal Material

Figure 2: A Gestural Description of Surface Formal Design in Berio's *Sequenza IV for Piano*

19 For alternate analytical viewpoints on this piece, see John MacKay, "Aspects of Post-Serial Structuralism in Berio's *Sequenza IV* and *VI*," *Interface* 17 (1988): 223–39 and Gale Schaub's unpublished essay "Transformational Process in Luciano Berio's *Sequenza IV*," 32 pp. presented at at the 1989 annual meeting of the Music Theory Society of New York State at Baruch College. Other interesting information about this piece and other pieces for piano by Berio can be found in David Burge's *Twentieth-Century Piano Music* (New York: Schirmer Books, 1990), pp. 161–65.

20 Only a few chords receive metamorphic transformations, and these chords are difficult to assign as a variant to one or more than one referential chords. If the context does not assist, the analyst may assign it to one by applying the law of parsimony, the simplest of available



Example 6: Referential Chord Succession or "Sequences"

Here, one aspect of the work's form can be heard as an interlacing of multiple referential chord-layers. Example 6 gives these piece-wide layers for referential chords *A*, *B*, and *D*, their variants, and those multivariant chords that refer to them. Eight of the fourteen referential chord-layers begin and end on the same chord from the catalog of referential chords with at most, in several cases, a single pitch deleted. They are the referential chords *A*, *C*, *E*, *H*, *I*, *J*, *L* and *N*. The others, *B*, *D*, *F*, *G*, *K* and *M*, become changed by the chordal shape functions and end without returning to their original generator chords from the catalog of referential chords. Note that the *B* and *D* layers shown in Example 6 are both directional in that they do not return "home," and are transformed to the same ending point; they are the only pair to do so. Also, as mentioned before, they share membership in the same set class: 6-Z49 [0,1,3,4,7,9]. They share four of five adjacent intervals, too, and they are the only pair to share n-1 adjacent intervals.[21] These properties shared by referential chords *B* and *D* and their merging as a frequently repeated hybrid chord (a multivariant chord) in the last measures of the piece make for a striking and fitting "ending" signal.

The relation of *B* and *D* to *C* is also of interest. The first page of the score, previously given as Example 1, shows that *B* and *D* are constantly repeated and reordered and, further, it shows *C* as presented just once in the opening after which it is temporarily abandoned. While referential chords *B* and *D* and their variants occur throughout the piece, *C* and its variants resurface only twice at measures 50 and 66 to "round off" the first section. (Recall Figure 2.) They reappear much later in the piece from measures 132 on, where, in conjunction with *B* and *D*, they appear to act as a kind of catalyst for closure. Referential chord *A*, on the other hand, seems to function as a "start" signal for many of the sections and subsections of the piece.

Contiguous or Surface Pitch Relations

Example 7 contains four quite brief passages from *Sequenza IV* that form the subject matter for a more detailed analysis of contiguous pitch structure. In the analysis, the results of composite chordal shape functions are presented one function at a time, and those intermediate results will be labelled by the referential chord's letter and a suitable numerical superscript. As a chord is returned from a chordal shape function and as it becomes the input for the next chordal shape

explanations, or may embrace the ambiguity as intentional and integral to the piece. (At a later date I will offer some statistical and other theoretical tools to assist with employing the first option.) In this context, recall Berio's comment cited in footnote 17 above.

21 However, *B* is bifielded and *D* is monofielded, and DOC(*B*) = 26/5 = 5.2 and DOC(*D*) = 17/5 = 3.4, DSO(*B*, *D*) = 18/26 = 0.692; they have only 1 of 6 possible pitches in common, G5, for 0.167%. By the measures introduced in this essay, these chords are dissimilar.

function, its superscript is incremented. The final result is given the v superscript and an appropriate ordinal number, if needed.

Example 7a contains measure 136 and the beginning of the next measure. The first chord, specified by the temporary variable X, resembles or perhaps evokes referential chords *A* and *K*. Referential chord *A*'s relation to X is described by applying the following chordal shape functions: $\mathrm{DP}(A, \{\mathrm{D2}, \mathrm{F}\sharp 2, \mathrm{F3}, \mathrm{A4}\}) = A^1$, $\mathrm{SP}(\mathrm{A1}, \{\mathrm{F3}\}, \mathrm{F}\sharp 3) = \mathrm{A}^2$, and $\mathrm{AP}(A^2, \{\mathrm{C5}\}) = A^v$. Referential *K*'s relation to X is described by the following chordal shape function: $\mathrm{DP}(K, \{\mathrm{E}\flat 4\}) = K^v$. Finally, we have $\mathrm{X} = \mathrm{ACS}(A^v, K^v)$. In this instance, listing X's multiple references as a set of chords well reflects the fact that A^v spatially envelops K^v, $\mathrm{DSO}(A^v, K^v) = 1.0$, hence $\{A^v, K^v\}$ is an appropriate label for this chord, a multivariant chord. The second chord is an arpeggiated variant of *N*: $\mathrm{AP}(N, \{\mathrm{D4}\}) = N^v$.

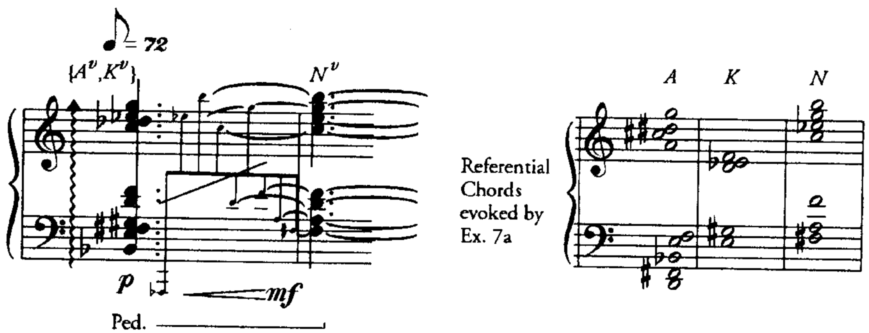
Measure 117 is presented by Example 7b. This chord also has multiple references; they are to referential chords *H* and *L*. This chord is the result of the concatenation of *H*'s lower field, H_0, and *L*'s highest field, L_2. However H_0 has been subjected to a *pitch* transposition that lowers the field two semitones. This chord is described as follows: $\mathrm{CFOS}(\mathrm{T}_{-2}(H_0), L_2)$. As neither field spatially subsumes the other, the chord's label is given as an ordered set starting with the lowest sounding field and proceeding in order towards the highest sounding field. In this case the chord is labelled $< \mathrm{T}_{-2}(H_0), L_2 >$.

Example 7c displays a slightly more complex passage found in measure 64 and the beginning of measure 65. Here six chords are numerically labelled with the last being a literal appearance of referential chord *A*. The others are variant or multivariant chords. The first chord, X1, is multivariant, here referring to *H* and *L*. The chordal shape functions upon *L* are as follows: $\mathrm{AP}(L_2, \{\mathrm{G}\sharp 4\}) = L_2{}^1$; $\mathrm{SP}(L_2{}^1, \{\mathrm{F}\sharp 4\}, \{\mathrm{F4}\}) = L_2{}^v$. The chordal shape function upon *H* is as follows: $\mathrm{DP}(H_1, \{\mathrm{B5}, \mathrm{F5}\}) = H_1{}^v$. Finally, $\mathrm{X1} = \mathrm{CFOS}(L_2{}^v, H_1{}^v)$; its label follows the convention set above for Example 7b: $\mathrm{X1} = < L_2{}^v, H_1{}^v >$. The second chord, X2, has resemblances to *N* and *K*. Two chordal shape functions upon *N* contribute: $\mathrm{AP}(N_1, \{\mathrm{E}\flat 6, \mathrm{A5}, \mathrm{F}\sharp 5\}) = N_1{}^1$; $\mathrm{SP}(N_1{}^1, < \mathrm{B5}, \mathrm{E}\flat 5 >, < \mathrm{B}\flat 5, \mathrm{D}\flat 5 >) = N_1{}^v$. Likewise, two chordal shape functions upon *K* contribute: $\mathrm{AP}(K, \{\mathrm{F}\sharp 3\}) = K^1$; $\mathrm{DP}(K^1, \{\mathrm{E}\flat 4\}) = K^v$. Thus, $\mathrm{X2} = \mathrm{CFOS}(K^v, N_1{}^v)$, and its label also follows the convention set above for Example 6b: $\mathrm{X2} = < K^v, N_1{}^v >$.[22] The third chord, X3, is generated as follows: $\mathrm{SP}(F_1, < \mathrm{E5}, \mathrm{C5}, \mathrm{A4}, \mathrm{F}\sharp 4 >, < \mathrm{E}\flat 5, \mathrm{C}\flat 5, \mathrm{B}\flat 4, \mathrm{F4} >) = F_1{}^v$; $\mathrm{SP}(N_0, < \mathrm{F4} >, < \mathrm{E4} >) = N_0{}^1$; $\mathrm{AP}(N_0{}^1, \{\mathrm{C}\sharp 4\}) = N_0{}^v$; $\mathrm{X3} = \mathrm{CFOS}(F_1{}^v, N_0{}^v) = < N_0{}^v, F_1{}^v >$. Chord four is generated as follows: $\mathrm{SP}(\mathrm{M}_1, < \mathrm{F}\flat 6, \mathrm{E}\flat 6, \mathrm{A5} >, < \mathrm{G}\flat 6, \mathrm{D}\flat 6, \mathrm{A}\flat 5 >) = M_1{}^1$; $\mathrm{AP}(M_1{}^1, \{\mathrm{D5}\}) = M_1{}^2$; $\mathrm{X4} = \mathrm{DP}(M_1{}^2, \{\mathrm{B5}\}) = M^v$. Chord five is as follows: $\mathrm{AP}(F, \{\mathrm{B}\flat 4\}) = F^1$; $\mathrm{X5} = \mathrm{SP}(F^1, < \mathrm{F}\sharp 4 >, < \mathrm{F4} >) = F^v$.

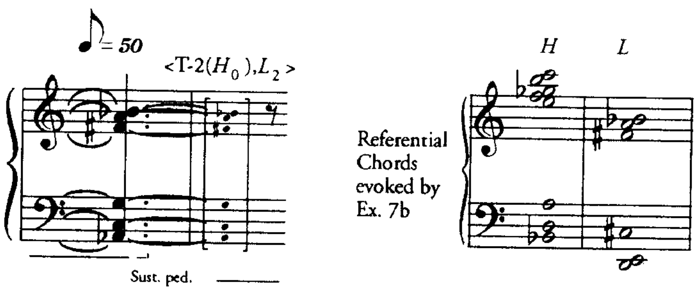
Measures 70–72, given at the top of Example 7d, show other aspects of

22 The second chord of the facsimile has a different pitch content than in corrected 1987. The facsimile lacks the pitch G5 and has F5 and G4 for F♯5 and F4 respectively

(a) Measures 136–37

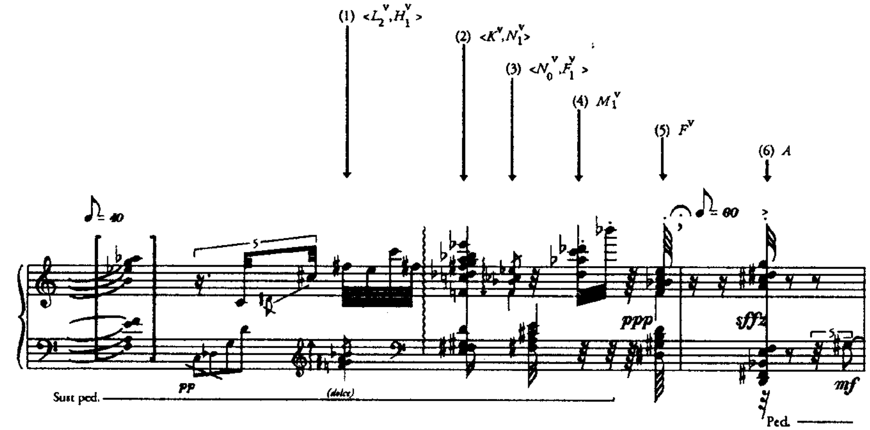


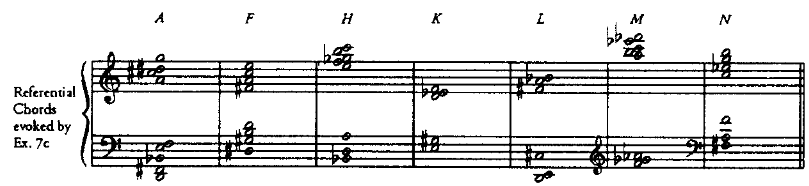
(b) Measure 117



Examples 7a–d: Analysis of Surface Pitch-Structure in Brief Passages from Berio's *Sequenza IV*

(c) Measures 64–65





Examples 7a–d (cont.): Analysis of Surface Pitch-Structure in Brief Passages from Berio's *Sequenza IV*

(d) Measures 70–72

Examples 7a–d (cont.): Analysis of Surface Pitch-Structure in Brief Passages from Berio's *Sequenza IV*

analytical technique using chordal shape functions. The excerpt consists of three chords with a *fioritura*-like passage of pitches played by the right hand between the last two chords.[23] The bottom system gives the referential chords evoked by this passage. As before, the three chords may be generated as follows: SP(F, $< D\sharp 3, D4 >$, $< D3, D\sharp 4 >$) = F^1, X1 = DP(F^1, {G♯3, B3, C5}) = F^v; SP(A, $< B\flat 2 >$, $< B2 >$) = A^1, X2 = DP(A^1, {D2}) = A^v; SP(A_1, $< A4, D\sharp 5 >$, $< G\sharp 4, E5 >$) = $A_1{}^v$, SP(B_0, $< D\flat 4, F4 >$, $<D4, F\sharp 4>$) = $B_0{}^v$, X3 = CFOS($B_0{}^v$,$A_1{}^v$) = $<B_0{}^v, A_1{}^v>$.

The middle two systems show how the *fioritura* may be generated as arpeggiations of chords 2 and 3 along with the use of the SubstitutePitch, SP, chordal shape function. Half-notes indicate chordal pitches and the quarter-notes indicate substituted pitches; the arrows make the connections between substitute pitches and chordal pitches clear. The second chord's arpeggio occurs after that chord is struck—a "post-chord" arpeggio—and the third chord's arpeggio occurs before the chord is struck—a "pre-chord" arpeggio, perhaps here retrospectively understood. This later case is a slightly more complicated situation but similar to that of the second chord, N^v, from the previously discussed Example 7a.[24]

The vertical dotted lines point out the same pitches between the two middle systems; these show the area of connection between the two arpeggiations. Note how the crescendo to *ff* and the appearance of rests in the left hand point out the only two pitches in common between the chords, G5 and C♯5. Further, the diminuendo starts upon the arrival of a chordal pitch, A♭4, from chord 3.[25] The first and fourth pitches connected by the vertical dotted lines also serve a transitional purpose between the chords. The first note is in anticipation of a pitch from the next chord to come, and the fourth note has its function reinterpretated; it starts as a chordal pitch, and then it becomes a substitute pitch for A♭4, the one just mentioned above.

When referential chords can clearly be established within a piece, theories of chordal shape and chordal shape functions can give some account not only for polyphony but even for some rudimentary "voice-leading" techniques as the preceding discussion demonstrates.[26] The theories of chordal shape and chordal

23 I wonder whether Berio had passages like this in mind when he said to David Burge after hearing him play this work before its New York City premiere: "Just play it like Chopin." The quote is from David Burge's letter of November 4, 1989 to this author.

24 As these chords and the contour-functions upon them are manipulations of pitch-space and not pc-space, there is no question of quasi-Schenkerian "unfoldings." Unfoldings may rely upon pc- and name-class equivalence in reaching a *Stufe's* chordal member not previously present as a pitch in the initial appearance of the *Stufe*. See Joseph N. Straus, "The Problem of Prolongation in Post-Tonal Music," *Journal of Music Theory* 31 (1987): 1–20 for more detailed discussion of these issues.

25 Corrected '87 has the diminuendo starting on the preceding F4; however, the facsimile has it starting on A♭4 as notated in my Example 7d.

26 For an alternate view on "atonal voice-leading," see Fred Lerdahl, "Atonal Prolongational Structure," in *Music and the Cognitive Sciences* 4, ed. Stephen McAdams and Irène Deliège (Paris: Centre National d'Art et de Culture 'Georges Pompidou,' 1989): 65–88.

Example 8: Chaconne-Like Model Sequences of Sostenuto Pedal Emphasized Chords in Berio's *Sequenza IV for Piano*

shape function may also be of particular importance when traditional atonal theoretical tools and the newer contour theory tools seem to provide unfocused results. They, of course, also provide alternate theoretical and analytical instruments for theorists and analysts and may be suggestive for composers.

Large-Scale Form Part 2: Two Chaconne-Like Sequences

Taking up hints gathered from the study of the facsimile and Berio's comments favoring a layered method of composition, a deeper layer of structure, created by the use of the sostenuto pedal, is shown in Example 8. Here, two chaconne-like, model-successions of referential chords are displayed. They are labeled with Roman numerals I and II. Unlike a conventional chaconne, the harmonic succession is not always present in the piece nor, when one of the chaconnes occurs, are all the chords of the harmonic succession necessarily present or present as a pure referential chord. A variant chord or multivariant chord may take its referent's

place in the sequence, and a "DeleteChord" function, DC, may omit one or more of the chordal locations from that sequence. Further, the chords in these harmonic designs are only ordered with regard to their place within the sequence, there is no durational patterning or meter implied.[27]

Chaconne I, occurs six times in the piece, while Chaconne II, appears only twice. The frequency that each referential chord, its variant, or multivariant appears in one of the chaconnes's successions is shown by the numbers given below each of the two chaconne models of Example 8. Note that the first element of Chaconne I and the last element of Chaconne II are the same referential chord or are variants of it. This ability to overlap the two is exploited in both of the second chaconne's appearances. The importance of the sostenuto pedal in creating a subsurface layer — featuring the chaconnes—upon which other material is projected is paramount. The greater use, durationally, of the sostenuto pedal over the other pedals underlines its importance.[28]

Figure 3a provides a chordal shape function analysis of all chords found in each appearance of Chaconne I, and Figure 3b does the same for Chaconne II. In those figures, the top rows are labeled I.0 and II.0, and they represent the two chaconne models. The chaconnes, however, never appear in their model forms. The referential chords of each model form the top elements of the columns under which each of the model-variant's chords are aligned, and their chordal shape functional derivation from their respective referential chords are shown. Each chord in the succession of a model variant is separated by a semicolon. When several chordal shape functions are employed, commas separate each chordal shape function statement from the next. Frequently space does not permit all members of the row to appear on the same line, and statements are aligned under each other in their respective columns. Note that in the last entry for Chaconne I.3, the dashes between pitches mean that all pitches between those pitches are also included. In *Sequenza IV*, the same chordal shape functions that generate the work's detail from the referential chord catalog are also employed in generating the deeper-layer, sostenuto-pedaled chaconne sequences from the chaconne models.[29]

27 The use of a transformed chaconne-like structure should come as no surprise in Berio's work. He has said the following on the uses of the past (Dalmonte and Varga, p. 66): "No, there can be no *tabula rasa*, especially in music. But this tendency to work with history, drawing out and consciously transforming historical 'minerals', and absorbing them into musical materials and processes that don't bear the mark of history, reflects a need—that has been with me for a long time—to organically continue a variety of musical experiences, and thus to incorporate within the musical development different degrees of familiarity, and to expand its expressive design and the levels on which it can be perceived."

28 The use of the other pedals is the pianistic equivalent of panning between speakers in an analog electronic-music studio. This, together with the over-dubbing effect of the layered surface of the piece, radical changes of dynamics, chord density and location, seems to generate an effect of shifting distances and depths of sound.

29 Berio has said the following (Dalmonte and Varga, p. 103): "But if the deeper structure is to

(a) Chaconne I

I.0 $< N, \quad F, \quad J, \quad A, \quad B >$
(Chaconne I model)

I.1 $DC(N)$; $DC(F)$; J; $DC(A)$; $SP(B,\{F4\},\{E4\}) = B^{v}$.

I.2 N; $DC(F)$; $DP(J,\{A2,F3,C\sharp4,E4\}) = J^{1}$,
$SP(, <E\flat3,G3>,<E3,G\sharp3>) = J^{v}$;
$DP(J,\{A2,B\sharp3,B4\}) = J^{v2}$;
$DC(A)$; $SP(B_0,<B\flat3,D\flat4,F4>,<B3,C4,F\sharp4>) = B_0^{v2,}$ $SP(N_1, <B5,G5,E\flat5>, <B\flat5,A\flat5,D5>) = N_1^{1}$, $DP(N_1^{1},\{C5\}) = N_1^{v}$, $CFOS(B_0^{v},N_1^{1}) = < B_0^{v2,}N_1^{1} >$.

I.3 $AP(N,\{D4\}) = N^{v}$;
$SP(F, <D\sharp3,D4>, <D3,D\sharp4>) = F_0^{1}$,
$DP(F_0^{1},\{B3\}) = F_0^{v}$;
J; $DP(A,\{F3\}) = A^{v}$;
$AP(B,\{G\flat3-A3,B3,C4,D4-E4,E5-F\sharp5, A\flat5-B\flat5,C6,C\sharp6,E\flat6\}) = B^{v3}$;

I.4 N; $DC(F)$; $DP(J,\{B\sharp3,B4\}) = J^{v}$;
$DC(A)$; See entry at I.2.

I.5 See I.3; See I.3; J; See I.3; $SP(B_0,<B\flat3,D\flat4>,<B3,D4>) = B_0^{1}$,
$AP(B_0^{1},\{A4\}) = B_0^{v4}$,

I.6 $DC(N)$; $DC(F)$; J; $DC(A)$; $SP(B,\{B\flat3\},\{A3\}) = B^{v5}$.

Figures 3a–b: A Contour-Function Analysis of All Chaconne Appearances

The layout of all chords that employ the sostenuto pedal, including the chaconnes, is given in Example 9. In order to save space in that example, chords are simply labelled by the referential chords to which they refer. The instances of each chaconne sequence are indicated by brackets underneath the staves. The members derived from Chaconne I are given in solid brackets and those derived from Chaconne II are shown in broken-lined brackets. The Roman numerals identify which of the two chaconne models is present, and the arabic numeral gives

influence what we hear *structurally*, then there must be many links, a hierarchy of many different signals that can at least potentially be deciphered and recognized—even though sometimes these signals are destined to disappear, to be swept away and absorbed by the events that they have themselves initiated . . . ."

(b) Chaconne II

II.0 $< L, \quad K, \quad A, \quad N >$
(Chaconne II model)

II.1 $CFOS(T_{-2}(H_0),L_2) = <T_{-2}(H_0),L_2>$;
$AP(K,\{B\flat4\}) = K^{v}$; $DP(A,\{D2,F\sharp2,B\flat2,A4,D\sharp5\}) = A^{1}$,
$AP(A^{1},\{E\flat4\}) = A^{v}$;
$AP(N,\{D4\}) = N^{v}$.
(Same as I.3)

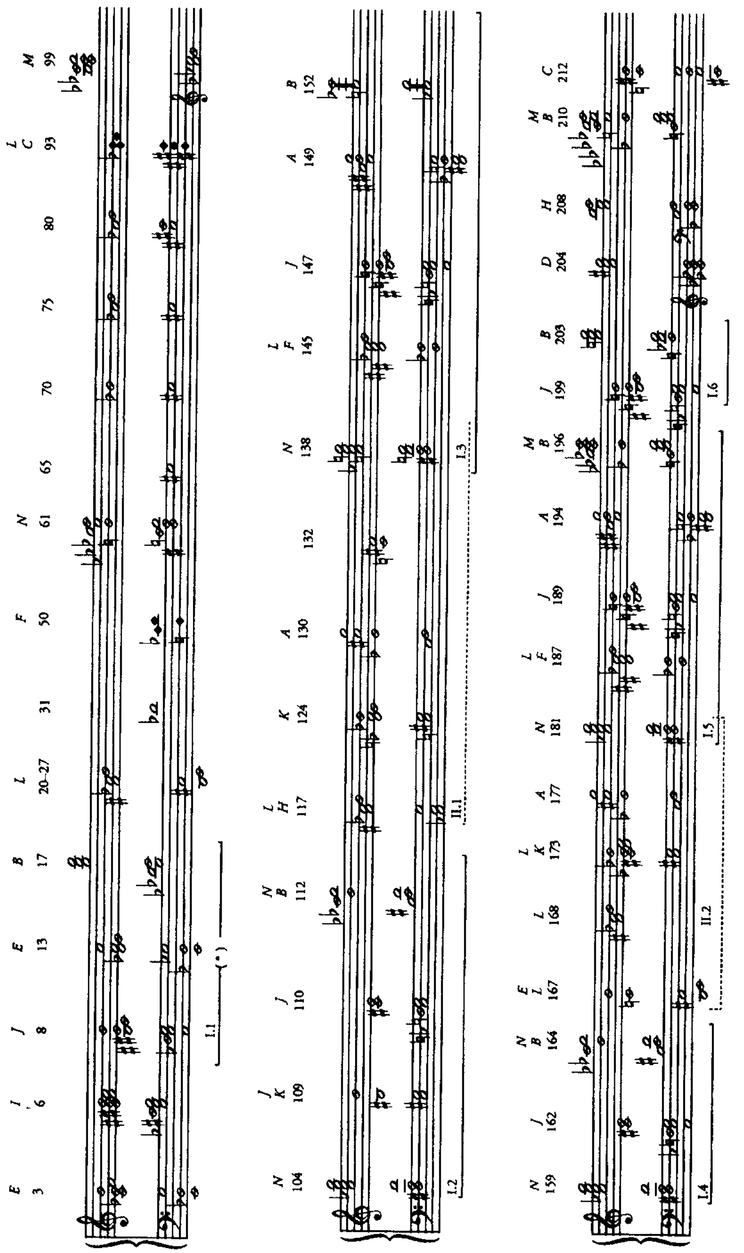
II.2 $DP(J_1,\{C\sharp4,E4\}) = J_1^{v}$, $CFOS(L_0, L_1, J_1^{v}) = <L_0, L_1, J_1^{v}>$;
L_2;
$AP(K,\{C\sharp4,B\flat4\}) = K^{v}$;
$DP(A,\{D2,F\sharp2,B\flat2,A4,D\sharp5\}) = A^{1}$,
$AP(A^{1},\{E\flat4\}) = A^{v}$;
$AP(N,\{D4\}) = N^{v}$.
(Same as I.3 & II.1)

Figures 3a-b (cont.): A Contour-Function Analysis of All Chaconne Appearances

the respective ordinal number of its appearance. Those chords indicated with black diamond-shaped note-heads are chords "played" by silently depressing those keys.

The bottom two systems show a similar pattern of chaconne-successions with an overlap. These describe a pitch-structural design of A B B'. In this example, then, each system represents one of those pitch-structural design sections. Note that the first occurrence of a succession generated from the first chaconne model has an interpolated *E* variant indicated by an asterisk in Example 9. Of interest is the first appearance of the referential chords *M* at the end of the "A" section, and *N* which forms the start of the "B" section. These two referential chords were missing from the original presentation of the other twelve referential chords at the opening of the piece. Their first appearances seem reserved especially as signals for these locations of structural articulation.

Two other ways of organizing the chaconnes within the sostenuto-pedaled layer are shown in Figure 4. The top row recalls previous comments made about Example 9. The middle row has an upper and lower arrow tipped brackets which point out Chaconne I pairs that greatly resemble one another. Four of their five entries in their harmonic sequences are identical, and the remaining sole entries resemble one another closely. This can be confirmed by consulting either Example 9 or Figure 3a. The pair I.1 and I.6 provide a frame for the whole; continuing the



Example 9: Structural Layer Created by the Sostenuto Pedal

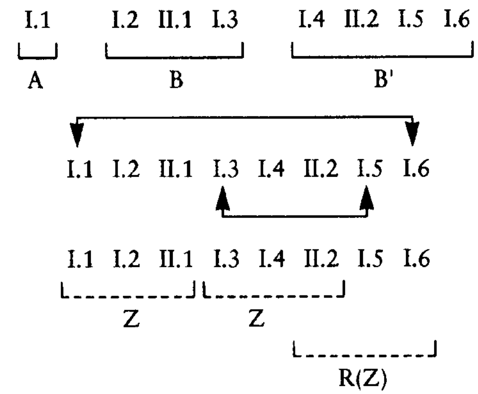


Figure 4: Three Structural Designs for the Chaconnes from the Layer of the Sostenuto Pedal

metaphor, the other pair, I.3 and I.5, provide weight bearing walls for the interior. The bottom row displays another design that emerges from the previous observations. The "Z module" is here a succession of two successive and different iterations derived from the Chaconne I model followed by an appearance of an iteration derived from Chaconne II. A retrograde equivalent pair of Z modules, using the "frame" pair of Chaconne I appearances, begins and ends the work. Another Z module is also shown in the figure, and all three appearances account for all instances of the chaconnes.

Comparing the pattern of deeper layer sostenuto-pedaled chords as given in the top row design of Figure 4 with the surface articulations of form given previously in Figure 2, we find some striking correspondences and differences. The Chaconne I's first appearance marks the end of the opening gestural form's first subsection—the presentation of the referential chords. The start of the sostenuto-pedaled B section nearly coincides with the gestural division at measure 104. The "retransitional" section of the gestural form, starting at measure 167, is also marked by the last appearances of a Chaconne II derived iteration. Important differences include the lack of gestural marking of the sostenuto pedal's B' section and the lack of confirmation with the sostenuto-pedaled layer for the gestural "reprise" at measure 188. These correspondences and differences make for some large-scale formal design and pitch-structural "cross rhythms" that contribute to the interest of the piece. Note that C appears only once in the sostenuto-pedaled layer of structure at the very end. Again, it takes on the function of an ending signal as mentioned in the preceding discussion of referential chord successions.

Linguistic Analogies/Reprise

Earlier discussions mentioned some analogies with linguistics, one of Berio's long standing preoccupations, and we now can fruitfully expand the analogies. The piano's total pitch-space may be thought of as the alphabet, the catalog of referential chords as a lexicon, the chordal shape functions as means of producing new lexical units from the lexicon, and the theory of chordal shape as a means of determining what are distinct lexical elements and what are the principles of combining the elements to form "words."[30]

At the next levels of syntactical structure, the analogies become less precise but they are still of some interest and use. How are words combined into phrases, clauses, and sentences? Here in *Sequenza IV*, the chaconne sequences from the sostenuto-pedaled layer seem likely candidates for sentences. The two chaconne models may be thought of as the kernel sentences or deep structures of these actual sentences. The chordal shape function DeleteChord may be thought of as a transformational rule which changes the deep structure of a chaconne model into a surface structural chaconne sequence, much like the imperative-mode transformation that changes the deep structural sentence of "You will open the window." into the surface sentence of "Open the window."[31] As noted before, the other chordal shape functions are used to explain surface details of the chords

30 A lexicon differs from a dictionary or a word list in that all semantic elements such as word "roots" and other non-word morphemes are also included as independent items in a lexicon. See Adrian Akmajian, Richard A. Demers and Robert M. Harnish, *Linguistics: An Introduction to Language and Communication*, 2nd ed. (Cambridge, Mass.: MIT Press, 1984), pp. 260–65.

31 Many readers will note technical terms from Noam Chomsky's transformational grammar are employed throughout this paragraph. For a good and gentle tutorial on transformational grammar that includes discussion of some of the main differences between Chomsky's first two books, see John Lyons, *Noam Chomsky*, revised ed. (New York: Penguin Books, 1977).

On another and related note, Chomsky's first book, *Syntactic Structures* (The Hague: Mouton & Co., 1957), introduced his initial version of transformational grammar, and it made him a figure of international prominence in linguistics. From 1955 on, he has resided in Cambridge, Massachusetts and taught at the Massachusetts Institute of Technology. His next book, *Aspects of the Theory of Syntax* (Cambridge, Mass.: MIT Press, 1965) introduced a completely reworked transformational grammar—now called the "standard theory." In his own words from page vii of the preface of the second book dated and placed at Cambridge, Massachusetts, October 1964, "The writing of this book was completed while I was at Harvard University, Center for Cognitive Studies . . ." The corrected edition of 1987 for *Sequenza IV* gives the date of 1965 and the location of Arlington, Massachusetts (a suburb of Boston across the Charles river from Cambridge) at the end of the score. Further, David Osmond-Smith writes: "In the autumn of 1964, Oyama [Susan, soon to be Berio's second wife] began her doctoral research at Harvard University, where Berio also took on a semester's teaching." See Osmond-Smith, *Berio*, pp. 28–29. It is difficult not to draw conclusions about possible influences of Chomsky upon Berio's compositional thought—for at least this work—given the coincidences of interest, time, and location between these two men.

projected upon the sostenuto-pedaled layer and also to describe the derivation of the chaconne sequences of the sostenuto layer from the chaconne models. While other transformational rules for generating the surface chaconne sequences from the chaconne models could be devised, the analogical point has been made.

The compositional process underlying this work could be viewed as ways of generating surface and subsurface layers of structure through the use of a few well chosen procedures (chordal shape functions) upon a few distinct and well chosen referential chords (theory of chordal shape). These are clearly related to the technique of playing chords upon the piano as demonstrated above. The work's economy of means and materials place quite manageable demands upon the auditor's memory and associative capacities; these are the keys that permit auditors to follow the various aspects of the work's pitch structure. This economy allows for enormous variety of new "words" and "sentences," perhaps seemingly infinite, and it enables the auditor from being completely overwhelmed by the various layers of sound. Should attentive and reasonably experienced listeners, competent listeners, become temporarily lost, they can always find a way back "into" the piece because of these economies. Further, these economies enables auditors to "bootstrap" themselves into hearing as much of the work's pitch structure as they may wish through repeated hearings. This economical and "bootstrapable" approach seems to separate Berio's work from that of his Darmstadt colleagues of Boulez and Stockhausen at various points in time in their careers. Oddly enough in that regard, it also connects him with some American composers of a formalist bent who also concern themselves with creating hearable—that is, for competent listeners—musical structures in their works. Berio, however, disagrees with many American compositional and theoretical preoccupations because of their reputed lack of historical connection and their deemphasis of process.[32]

Returning to linguistics, the seemingly infinite generative capacity and yet manageable demands upon memory and associative capacities described by this analysis of, and speculative comments upon, Berio's compositional process for *Sequenza IV* mirrors some of transformational grammarians' analyses of natural languages.[33]

32 Berio's criticism of formalist composers and theoretical thought has been plentiful and long standing. See George W. Flynn, "Listening to Berio's Music," *Musical Quarterly* 61 (1975): 393–94 for a concise summary of Berio's criticisms.

33 Ray Jackendoff in his *Semantics and Cognition* (Cambridge, Mass.: MIT Press, 1983) pp. 5–6 and 7 says the following on these economies in natural languages: "Linguistics is the study of grammatical structure—what Chomsky (1965) calls *linguistic competence*. Psycholinguistics is the study of the strategies employed in processing grammatical structure in real time—*linguistic performance*. Obviously these two inquiries have a natural influence. On the one hand, a theory of language processing presupposes a theory of linguistic structure; on the other hand, one crucial test of a theory of linguistic structure is whether it can be integrated into a theory of processing. Moreover, many phenomena are amenable to either structural or processing

While other analogies with natural languages could be made, a brief look at a few of the important ways in which the analogies break down is worth pursuing. Before we begin, we should remember that other fields of endeavour, such as linguistics, need only to serve as stimuli for a composer's compositional process. There is no need—nor should there be an expectation—for any given composer to "translate" one field, lingusitics in this case, into another. Influences from past musical work and from other fields also are likely to contribute significantly to the poietics of musical composition.

On the syntactical level, an important difference is in the simultaneous layers of pitch structure, such as the chaconnes and referential chord sequences. The main model for such simultaneity found in natural language use is from the theatre: there multiple characters can concurrently speak or sing. No individual character's line of discourse directly or indirectly conveys the entire situation to the audience. It is the clatter of the competing lines that represents the emotional states of characters who find themselves in some particular situation together. The collective emotional relationships are, perhaps, what is most importantly portrayed by this device, not the sum of the possible meanings of each character's individual lines. To my knowledge, linguistics has not attempted analyses of these kinds of language uses.

Of course, this theatrical meaning leads us to another main branch of linguistics, semantics. Meanings set forth here are naturally my own, though my arguments receive some support from Berio's thought.[34] These meanings fall under the headings of the extra-musical and the purely musical; however, meanings assigned to one of the categories are not always completely limited to that one category.

Berio's colleague, Umberto Eco, has made the case that coherent writing in natural languages contains very significant correlations of meanings between individual readers.[35] However, extra-musical meanings for *Sequenza IV* do not appear to be easily expressed by natural language. Associations made within this

description, and it is often an interesting question how to divide up the power of the theory between the two elements.

"In particular, one must always remember that a theory of mental information structure must eventually be instantiated in a brain. This imposes two important boundary conditions on the theory: (1) the resources for storing information are finite; (2) the information must somehow get into the mind, whether through perception, learning, or genetic structure."

For those familiar with Chomsky's work, the use of functions to describe natural language-like phenomena in music should come as little surprise. John Lyons has said of Chomsky: "The revolutionary step that Chomsky has taken, as far as linguistics is concerned, has been to draw upon this branch of mathematics (finite automata theory and recursive function theory) and to apply it to natural languages, like English . . ." (Lyons, *Noam Chomsky*, p. 59).

34 Please recall notes 3, 7, 12, 17, 27, and 29 for Berio's thoughts on these matters cited in this essay.

35 See the witty introduction to Umberto Eco, *The Limits of Interpretation* (Bloomington: Indiana University Press, 1990), pp. 1–7.

realm are most likely to be quite idiosyncratic and with little correlation between individual listeners. Certainly, the linguistic analogies and mathematical modelling are extra-musical meanings too; however, if these structures are hearable, then they also have a purely musical meaning. The modelings and analogies are then merely tools used to help the inexperienced listener focus upon some aspects of the purely musical meanings (musico-structural and self-referential meanings) present in a sensitive and intelligent performance of the score.

More purely musical meanings also fall into two categories whose various constituent meanings, again, are not necessarily mutually exclusively assigned to one or the other category. They are on one hand the "diachronic" meanings or more historically based relations between the work and preexisting works and techniques and, on the other hand, the "synchronic" meanings or self-referential relationships found within the work itself.[36]

Among the diachronic relationships in *Sequenza IV* are the following: the reexamination of the technique of chordal playing on the piano, the reinterpretation of the chaconne technique for generating large scale pitch-structural units, the multiple references of the multivariant chords which recall the *Mehrdeutbarkeit* of traditional tonality's fully diminished seventh chords, the rethinking of variation technique as described by the chordal shape functions, and the simultaneous layers of pitch structure recalling—among other works—moments from Ives's *Fourth Symphony*.

The synchronic relationships found within *Sequenza IV* and touched upon in this essay are the following: its gestural form with the special formal functions for referential chords *A*, *B*, *C*, *D*, *M* and *N*; the narrative created by following chordal shape functional variation upon the referential chords; the means—displayed in Figure 4—of organizing the derived chaconne sequences into larger pitch-structural units; the rhythmic interactions of gestural form with larger pitch-structural units as they go in and out of phase with one another; the transition-like spaces inhabited by multivariant or metamorphic chords between the "nodes" of the network that contains the referential chords; and the dramatic narrative of shifting the listeners attention between the various simultaneous layers of pitch structure through the imaginative use of the piano's pedals, and dynamic, durational and articulative contrasts. My favorite metaphors for this piece are that of multiple partially overheard and followed conversations at a dinner party or that of the mind's self-reflection upon its own "stream of consciousness."

Although I've made fairly extensive analogies between linguistics and Berio's *Sequenza IV*, it should be clear that this work can not be "reduced" to those analogies. They merely point to a "way in" for the inexperienced listener. Even the combination of the linguistic analogies with mathematical modelling techniques are

36 See Ducrot and Todorov, *Encyclopedic Dictionary of the Sciences of Language*, pp. 137–44 for discussion of the linguistic concepts of diachrony and synchrony.

not sufficient for a critical assessment of Berio's *Sequenza IV*. That combination omits the work's diachronic and narrative references and its transformations of them.

This essay might, therefore, give pause to those in the fields of philosophy, linguistics and artificial intelligence who solely equate mind with thought, thought with natural language, and the anatomical structures of the brain that instantiate natural language with potentially adequate working models of the mind.[37] In a letter to Marc-André Souchay of October 15, 1842, Mendelssohn wrote "People often complain that music is ambiguous, that their ideas on the subject always seem so vague, whereas everyone understands words. With me it is exactly the reverse—not merely with regard to entire sentences, but also as to individual words. These, too, seem to me so ambiguous, so vague, so unintelligible when compared with genuine music, which fills the soul with a thousand things better than words."[38] That thought might also apply to the hope of finding fully adequate interpretations of any sort for sophisticated music; nonetheless, the continuing process of interpreting sharpens our perception and understanding.

37 See Pamela McCorduck, *Aaron's Code: Meta-Art, Artificial Intelligence, and the Work of Harold Cohen* (New York: Freeman, 1991) for a flawed but interesting account of these same issues—among others—with regard to visual art. In *The Open Work*, trans. Anna Cancogni, intro. David Robey (Cambridge, Mass.: Harvard University Press, 1989), first published in Italy as *Opera Aperta: Forma e indeterminazione nelle poetiche contemporanee* (Milan: Bompiani, 1962), Umberto Eco realizes that critical theory and aesthetics must engage non-linguistically based art works too. In fact he starts out that work with discussion of contemporary musical compositions including Berio's *Sequenza per flauto solo* of 1958. A rewritten version of that opening appears later in his *The Role of the Reader: Explorations in the Semiotics of Texts* (Bloomington: Indiana University Press, 1979).

38 See *Letters of Felix Mendelssohn Bartholdy from 1833 to 1847*, trans. Lady Wallace, 1864 cited in Ruth Halle Rowen, *Music Through Source & Documents*, (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1979), p. 261.

Stylistic Competencies, Musical Humor, and "This is Spinal Tap"

John Covach

I

As its title suggests, this study focuses upon matters of humor and musical style, specifically the ways in which musical numbers in the 1984 Rob Reiner film *This is Spinal Tap* elicit an amused response.[1] On first pass, one might wonder how such seemingly diverse concerns as nineteenth-century German philosophy, recent theories of musical style, and late 1960's rock and roll could possibly intersect: one could hardly imagine a more incongruous trio of figures than Arthur Schopenhauer, Leonard Meyer, and the fictional Nigel Tufnel, lead guitarist of the equally fictitious rock group "Spinal Tap." I hope to demonstrate not only that there are music-analytical concerns that make for these rather strange bedfellows, but also that the notion of incongruity itself plays a pivotal role in this eclectic combination.

The present study will explore the various ways in which three Spinal Tap numbers elicit an amused response from listeners. I am primarily concerned with the ways in which humor is created through specifically musical means. In the context of the film, there are many factors at work in the Spinal Tap songs that contribute to their humorous impact; each song, for instance, is accompanied by visual images (shots of the performers, audience, off-stage shots, etc.). Each song is also situated in the context of the unfolding of the story itself, and can elicit an amused response according to these relationships. In addition, each song has lyrics that elicit an amused response. There are, for example, a number of factors creating humor in the Spinal Tap song "Big Bottom," and perhaps the most obvious of

1 "This is Spinal Tap," Rob Reiner, dir., written by Christopher Guest, Michael McKean, Harry Shearer and Rob Reiner, Embassy Pictures, 1983, video cassette 1987 (ISBN 1-55847-103-0). All musical examples are drawn form the original soundtrack album, *Spinal Tap* (Polygram Records, 817-846-1-Y1, 1984).

For those unfamiliar with the film, Spinal Tap is a fictitious British heavy-metal rock band. The film poses as a documentary ("rock-umentary") of what appears to be Spinal Tap's last American tour. The tour falls apart as the group makes its way from the East Coast to the West Coast; by the time they reach Los Angeles the band has almost broken up completely. The film features concert footage, glimpses backstage, interviews, and flashbacks.