A "Simple Composition" of Charles Wuorinen: Isomorphism, Self-Similarity, and Nesting in *Cello Variations*

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Perhaps the most significant advance in Charles Wuorinen's *Simple Composition* (1979) is its introduction of the "time-point nesting method," a technique that transfers the implications of an ordered series to the background structure of a piece. Unlike the other twelve-tone techniques he discusses—most of them inheritances from Schoenberg, Stravinsky, and Babbitt—Wuorinen's own "nesting method" has been difficult for theorists to document in real pieces of music. This study aims to show that Wuorinen's *Cello Variations*, written almost a decade before *Simple Composition*, offers a clear instance of the nesting method and thus an important window into Wuorinen's workshop. I shall show that a parallel consideration of *Simple Composition* and *Cello Variations*—kindred works of theory and practice, respectively—offers us a deeper understanding of Wuorinen's art and a clearer image of his contributions to twelve-tone music in the last part of the twentieth century.

Thirty-two years after the publication of *Simple Composition*, Charles Wuorinen's didactic treatise is still an object of misunderstanding. During a 2007 interview with *NewMusicBox*, composer and journalist Frank J. Oteri pointed out to Wuorinen, "It's interesting—your book about composition is called *Simple Composition*. It's ironic, in a way, considering its assumed difficulty"—to which Wuorinen replied, "Or accurate! I didn't intend it ironically; it's accurate" (Oteri 2007, 3). Oteri's comment illustrates that book and composer alike still stand to be better understood. For Wuorinen's intention has never been to impose "difficult" music on his readers and listeners.[1] Rather, it is to promote music that is, in his mind, composed in a "systematic" and "orderly" fashion (3). This study aspires to clarify Wuorinen's idea of "systematic" composition—and, in so doing, dispel any number of misguided assumptions about Wuorinen's aesthetics and craft—by exploring one of his works in light of his pedagogical writings.

Wuorinen stresses that although *Simple Composition* "is often general and abstract, it is nevertheless a practical manual. In particular, it is not analytic—that sphere we leave to our scholarly colleagues" (1979, vii). Joseph N. Straus, Louis Karchin, Jeffrey Kresky, and James Romig have uncovered critical details of Wuorinen's methods in their analyses

Many thanks to Professor James Romig, Professor Louis Karchin, and the editorial board of *Theory and Practice* for their review and invaluable assistance during the preparation of this article.

[1] The term "difficult" has persisted in recent years in descriptions of Wuorinen's music, most notably in music criticism. Other examples of authors who have used this term are *New York Times* critics Johanna Keller (2005) and Vivien Schweitzer (2007).

of his works.[2] This article aims to do the same with Wuorinen's *Cello Variations* (1970),[3] but in a manner that more explicitly links analytical findings to practices described in *Simple Composition* while also revealing Wuorinen's method to include significant expansions of established twelve-tone practices. In pursuit of this goal, my discussion will provide several additional perspectives on *Cello Variations*. First, I will show that the work provides a window into Wuorinen's workshop, including a relatively straightforward example of the time-point nesting method outlined in *Simple Composition*. Thus, in a broader sense, we shall come to see *Cello Variations* as both a vehicle for understanding *Simple Composition* and a crucial step in Wuorinen's formulation of the ideas it espouses. Along the way, I shall also argue that *Cello Variations* manifests the "general and abstract" musical relationships espoused by *Simple Composition* in clear, aurally perceptible ways. Through this coordinated discussion, the article thus aspires to show how *Simple Composition* might serve as a foundation for future analytical work on Wuorinen's music.

Viewed broadly, my analysis of *Cello Variations* is meant to mirror the structure of *Simple Composition* itself, in that it is structured around four central topics, in Wuorinen's original order of presentation: "fundamental operations," "further operations" (multiplicative transformation and rotation), the "time-point system," and the "time-point nesting method." With the first three of these topics, Wuorinen develops concepts first advanced by Arnold Schoenberg, Igor Stravinsky, and Milton Babbitt. These then provide the foundation for his time-point nesting method, a technique that transfers the intervallic design of an ordered series to multiple structural levels of a piece.

Fundamental Operations in *Cello Variations*

Cello Variations is built from a six- rather than twelve-tone series.[4] The opening measures, shown in Example 1, clearly project the original (prime) form of the work's source hexachord <F, D, E, F♯, B, G> with the ordered pitch-class (pc)-interval sequence

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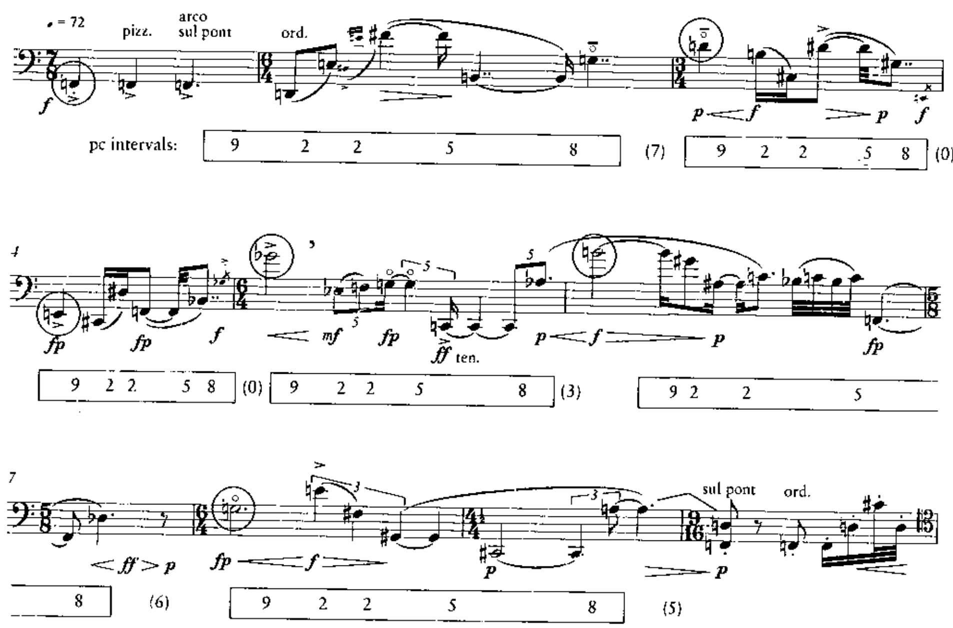
[2] For representative scholarship and analyses of Wuorinen's compositional procedures see Straus 2009, Karchin 1989–90, Kresky 1987, and Romig 2000.

[3] *Cello Variations* was composed for his friend and collaborator, Fred Sherry, and is published by C.F. Peters Corporation, New York, NY. Sherry performed the work on a recording available from Albany Records (*Fast Fantasy*, TROY658).

[4] Wuorinen's use of a six-tone series in *Cello Variations* is consistent with what he later expresses in *Simple Composition*, namely, that "A set may contain any number of elements" (1979, 27). Wuorinen even uses a six-tone series in the book to illustrate certain concepts, such as rotation (in his Example 72, p. 106) and the time-point system (Example 100–a, p. 137).



EXAMPLE 1
Transpositions according to ordered pc-interval sequence 9,2,2,5,8,(*n*)
in Wuorinen, *Cello Variations*, mm. 1–9
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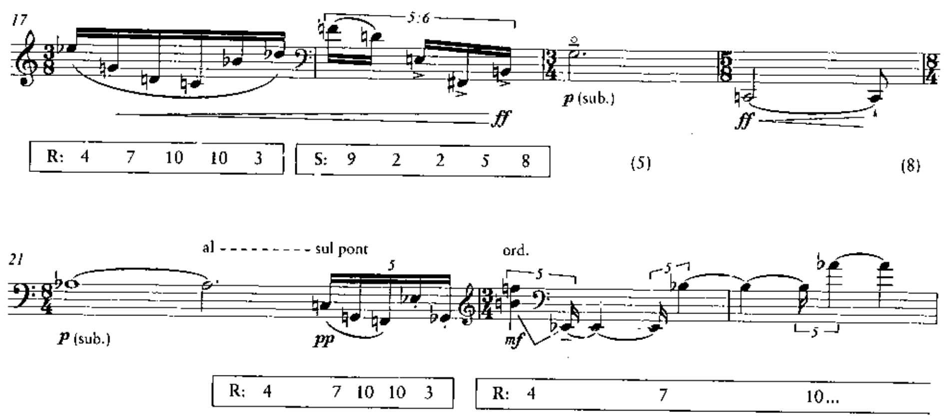
i<5, 2, 4, 6, 11, 7> = 9, 2, 2, 5, 8, *n*.[5] (The "*n*" in the sequence emphasizes that the final interval is variable, since Wuorinen may or may not return to a given hexachord's starting pc.[6]) From there, Wuorinen builds the first nine measures by employing the most basic of his "fundamental operations"—that is, *transposition*.[7] As the boxed annotations

[5] This article identifies all pitch, local temporal, and global temporal intervals in ascending, ordered interval sequences. Like *Simple Composition*, this article retains the interval as a centerpiece for analysis. For more discussion of ordered pc intervals see Morris (1987, 62 and 107) or Rahn (1980, 25). This article uses Morris's and Rahn's interval formula (i<a, b>=b-a mod 12) when calculating intervallic annotations for analytical examples, yet here the argument for the interval formula is expanded out to a set, e.g., i<a, b, c, d, e, f> = b-a, c-b, d-c, e-d, f-e, a-f mod 12. The interval sequence here could also be defined using Morris's (1987, 107) function CINT1<5, 2, 4, 6, B, 7> = <9 2 2 5 8 10>.

[6] As a closed hexachordal entity, the source interval sequence would be 9, 2, 2, 5, 8, 10, which brings the final pitch back around to the initial pitch. In most local pitch transformations, however, Wuorinen does not wish to return to the initial pitch.

[7] The other "fundamental operations" are inversion, retrograde, and retrograde-inversion.



EXAMPLE 2
S and R operations in *Cello Variations*, mm. 17–23
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show, this pc-interval sequence recurs five times, at five different transpositional levels. What is more, the starting pitches of the six hexachords—the F, D, E, F♯, B, and G circled in Example 1 and given distinct metric, timbral, agogic, and dynamic accents—represent the six "pitch centers" that will carry considerable weight throughout the work.[8] Finally, note that these six (circled) starting tones are themselves a large-scale projection of the opening hexachord. Thus the same pc-interval series that generated the six-note set also governs its transpositions; or, viewed the other way, the opening bars contain a "nested" version of the intervallic sequence that determines the overall transpositional pattern. Such nesting techniques will become increasingly important as *Cello Variations* unfolds.

Elsewhere in the work, Wuorinen will use the other "fundamental operations" on the source hexachord. Example 2 shows an intermingling of R and S forms (mm. 17–23), while Example 3 shows the alternation of I and RI forms (mm. 44–46).[9] Note that each

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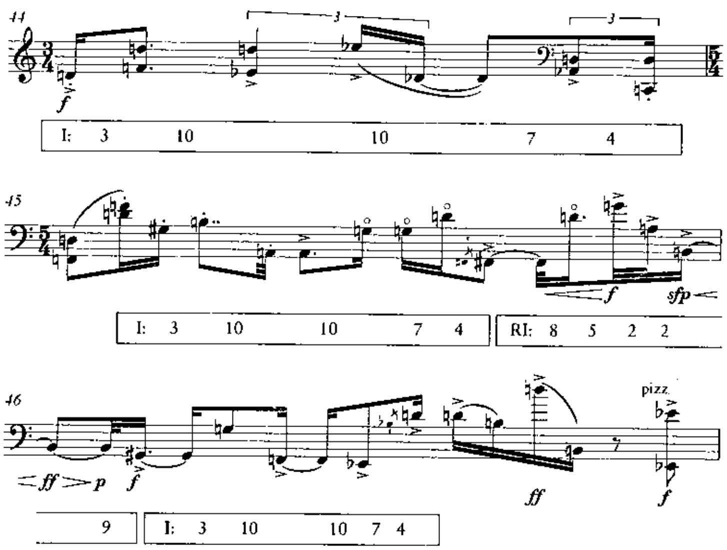
[8] Wuorinen's interest in and exploitation of pitch centers is well documented. Karchin has pointed out the importance of pitch centricity for Wuorinen's *Speculum Speculi*—composed just two years after *Cello Variations*—and underscored Wuorinen's view that such centers are a means of "bringing back an aspect of tonality which may have been abandoned unnecessarily" (1989–90, 60). Kresky indicates that Wuorinen has an "oft-stated interest in a reconciliation of the general twelve-tone way with the tonal past," which may "involve various kinds of 'tonicization' of these successive underlying set pitches, as well as the more fundamental promotion of the zero pitch [i.e., the first pitch] of the set. (Indeed, even in earlier pieces his sets tend to unfold slowly at first, often with special emphasis on the first pitch, which is likely to be heard in this way again at the end)" (1987, 416). More recently, Straus has also drawn attention to centricity in Wuorinen's music, noting that his "multi-level conception of the serial organization brings in its wake a strong sense of orientation towards specific pitches, and this interest in pitch centricity is a persistent feature of all of Wuorinen's music" (2008, 372).

[9] "S" refers to "set" and is Wuorinen's perferred designation for what is normally called "prime" (P) form.



EXAMPLE 3
R and RI operations in *Cello Variations*, mm. 44–46
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of these passages combines row-forms whose interval successions are what Wuorinen calls "reverse complements" of each other (i.e., the interval series of R comprises the mod 12 complements, in reverse order, of those found in S).[10] Thus the work's first fifty-two measures use all four fundamental operations and, in so doing, exhaust all the possible pc-interval successions that arise therefrom. Yet, as Wuorinen points out, these operations may be "supplemented by new ones" (1979, 84).

Further Operations in *Cello Variations*

Simple Composition discusses two further operations that Wuorinen regards as the "next level of transformation" (1979, 80) beyond Schoenberg's basic four: *multiplicative transformation*, which transforms a pc set's interval content, and *rotation*, which reorders an ordered set's pcs.

The rotation principle is a much-discussed feature of works by Stravinsky, Krenek, and others.[11] It also provided the impetus for Wuorinen's own *A Reliquary for Igor*

[10] For an earlier discussion of this relationship, see Babbitt 1960 (258).

[11] See Straus 2009 (28–40) for further discussion.

Stravinsky (1975).[12] But it is the multiplicative operation that will be our main concern in *Cello Variations*. Howe offers an early definition of this operation's effects on a pc set: "By a *multiplicative operation Mn*, performed upon a PC coll *x*, we mean the substitution, for each PC *m* in *x*, of the PC obtained by *multiplying m* by *n*. 'n' is a modulo 12 integer" (1965, 50). He goes on to state:

> Multiplicative operations, when performed upon PC colls, can be defined as mappings of the set of PCs onto itself. If the set of PCs is written in numerical order, then M1 exhibits the cycle of minor seconds, M5 the cycle of perfect fourths, M7 the cycle of perfect fifths, and M11 the cycle of major sevenths. Since these are the only single-interval cycles capable of generating the entire set of PCs, it follows that other multiplicative operations may fail to preserve the number of distinct PCs of a PC coll upon which the operation is performed. M1, M5, M7, and M11 are one-one mappings. (54)

In *Simple Composition*, Wuorinen points out that M7 has a natural affinity with the fundamental transformations: "it is clear that M7 is quite close to the fundamental operations of R, I, and T and, like them, may be considered a permutation operation" (1979, 100). Rahn explains further that the M5/M7 operations are "useful in producing pc set *invariance*....For example, T_0M7 leaves every *even* pc number the same, and maps every *odd* pc number a tritone away (adding 6), so that both 'whole-tone scales'—or $(0, 2, 4, 6, 8, 10)_{T_n}$ type sets—map into themselves as *sets* of pc[s], in an interesting musical way" (1980, 55).[13] Finally, note also that the M7 operation can equivalently be applied to a pc set's intervals.[14]

Cello Variations makes clear use of the invariance properties discussed above. My analysis will take a cue from *Simple Composition* by focusing on the effects of M7 on intervallic successions. Example 4 presents the eight hexachordal interval sequences that Wuorinen uses in *Cello Variations*, as generated by the four fundamental transformations and their M7 counterparts. As shown, the M7 operation yields interval sequences with clear, structurally significant associations to their fundamental counterparts. For example, when Wuorinen subjects the original S hexachordal series to the M7 operation, he creates its abstract complement, a new hexachordal set class with an *identical* interval-class

[12] Karchin (2001) offers a comprehensive analysis.

[13] Note that Rahn defines M5 as "the circle of fourths transform" and M7 as "the circle of fifths transform" and stresses that these two are naturally related (e.g., M5[S] = M7[I]) (1980, 53–54). For consistency and simplification, this analytical discussion will always use M7. For more on the multiplicative operation see: Howe 1965, Regener 1974, Starr 1978, Rahn 1980, and Morris 1987 and 1991.

[14] Rahn mentions that "M1, M11, M5, and M7 are the only possible operators on the 12 pc that are '*isomorphisms*' in the group-theoretical sense. Among other things, this means that (informally) *when you operate on two pc[s] you operate identically on their interval*" (1980, 55; emphasis in original).

S_0 pcs: 5 2 4 6 11 7	M7(S_0) pcs: 11 2 4 6 5 1
Intervals: 9 2 2 5 8 (10)	Intervals: 3 2 2 11 8 (10)
I_0 pcs: 5 8 6 4 11 3	M7(I_0) pcs: 11 8 6 4 5 9
Intervals: 3 10 10 7 4 (2)	Intervals: 9 10 10 1 4 (2)
R_0 pcs: 7 11 6 4 2 5	M7(R_0) pcs: 1 5 6 4 2 11
Intervals: 4 7 10 10 3 (2)	Intervals: 4 1 10 10 9 (2)
RI_0 pcs: 3 11 4 6 8 5	M7(RI_0) pcs: 9 5 4 6 8 11
Intervals: 8 5 2 2 9 (10)	Intervals: 8 11 2 2 3 (10)

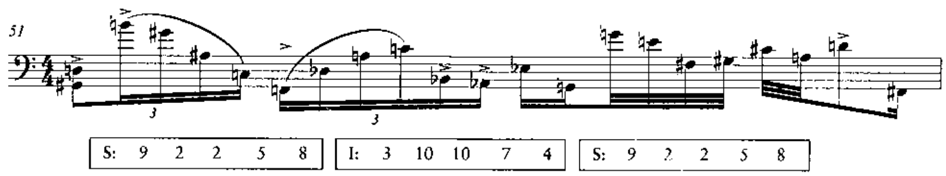
EXAMPLE 4
Cello Variations' palette of interval sequences (in bold); Interval values in parentheses denote the distance traveled to return to the original pitch-class of the series.

vector (i.e., S = 6–Z40, M7[S] = 6–Z11).[15] The relationship between the S_0 and M7(S_0) pitch successions in Example 4 illustrate this quality. In addition, the example emphasizes that M7 retains a whole-tone interval succession between operational counterparts (e.g., S_0/M7[S_0]).

Wuorinen's use of M7 in *Cello Variations* helps to articulate a new, large formal section of the work (m. 53). Examples 5 and 6 show the moments just before and after this division: in the latter, S and I are replaced by M7(S) and M7(I).[16] Thereafter, Wuorinen systematically introduces M7-derived materials—M7[R] in m. 57, M7[I] in m. 63, and M7[RI] in m. 93—in the *same order* as the fundamental operations on which they are based (i.e., S, then R, then I, then RI). Thus, this music can itself be seen as a blueprint for the organization of *Simple Composition*, since the manual introduces M7 as a natural extension of the fundamental operations.

[15] Note that this need not be the case: of the fifty hexachordal T_n/T_nI set classes, only twenty-four have interval class vectors invariant under M7. Three pairs—6–Z40/6–Z11, 6–Z38/6–Z6, and 6–Z44/6–Z19—are Z-related, while the eighteen remaining set classes are transformed into themselves by M7.

[16] When the new formal section begins (m. 53), Wuorinen delays the first clear instance of the M7 operation (m. 55) with several bars of freer pitched and rhythmic material. Though the global strategy of pitch centers will be discussed later in this article, the reader should note that the double-stop F/F♯ exclamation in m. 53 simultaneously announces the pitch centers for the two arriving unstable formal sections of the work: Sections 3 and 4. As will be seen, Section 3 loosens the prevailing serial procedures, and mm. 53–54 establish this break.



EXAMPLE 5
S and I operations in *Cello Variations*, m. 51
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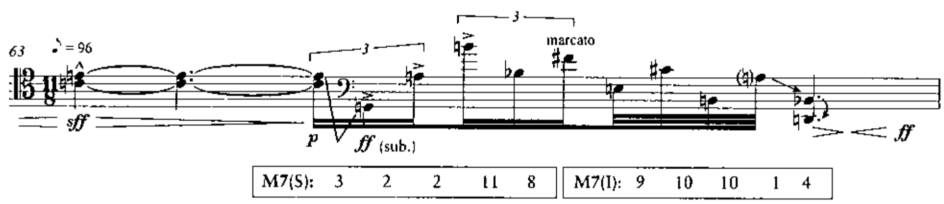

EXAMPLE 6
M7(S) and M7(I) operations in *Cello Variations*, m. 63
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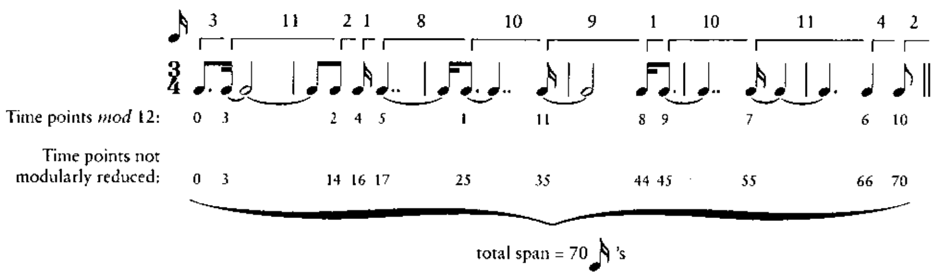
Examples 5 and 6 also demonstrate that Wuorinen's realization emphasizes the invariant whole-tone segment between M7 counterparts: the intervallic transformation <2, 2> → <10, 10> engendered by the juxtaposition of S and I row forms (Example 5) is retained by the succession of M7(S) and M7(I) rows (Example 6). As a result, Wuorinen renders an abstract pc relationship aurally perceptible. Examples 5 and 6 thus illustrate that Wuorinen seamlessly transitions from fundamental to M7 operations: he introduces not only the series's closely connected, Z-related set class but also uses a prominent intervallic invariance to temper the transition.

Time-Point System in *Cello Variations*

Wuorinen's treatise gives a central role to the potential isomorphisms of pitch and rhythm first explored by Babbitt (1960). He writes, "While it is perfectly possible to continue to make rhythmic choices by contextual and intuitive means, we should nevertheless have available a somewhat more precisely organized way of deciding rhythmic gestures—one that is correlated with the pitch relations of the 12-tone system" (1979, 130).



EXAMPLE 7
Example 96-c from Wuorinen's *Simple Composition* (p. 134), with annotations
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EXAMPLE 8
Example 100-a from Wuorinen's *Simple Composition* (p. 137), with annotations
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Intervallic relationships remain the focal point of Wuorinen's time-point discussions. He explains that pitch relations are transferred into time by linking "pitch intervals" to "time intervals" (1979, 130). As Wuorinen puts it, "time and pitch have one critical element in common: They are both continuums which are divided up for musical purposes by *intervals*" (131–32). That is to say, although the two domains are not inherently isomorphic, a composer may posit an isomorphism by dividing the time continuum in a manner analogous to pitch, with twelve equal divisions correlating one-to-one with the twelve pcs of the equal-tempered octave.[17] Rhythmic patterns are then organized in conjunction with the distances between time points, or what Wuorinen calls locations "in the flow of time" (131). His Example 96–c in *Simple Composition* (see Example 7) illustrates this in a mod 12 context. The source twelve-tone row behind this example is <A, C, B, C♯, D, B♭, A♭, F, F♯, E, E♭, G> with the ordered pc-interval sequence i<9, 0, E, 1, 2, T, 8, 5, 6, 4, 3, 7> = 3, 11, 2, 1, 8, 10, 9, 1, 10, 11, 4, and 2 (from pc 7 back around to pc 9). The ordered pc-interval sequence then yields the rhythmic pattern shown: absolute

[17] For more explanation of and perspectives on the time-point system, see Babbitt 1962, Mead 1987, and Morris 1997. Straus analyzes the extended use of the time-point system (into the nesting method) in Wuorinen's Piano Concerto No. 3 (2009, 124–29).

durations between time-points correspond one-to-one with the series's ordered pc-interval sequence. Here Wuorinen's original example has been annotated above the rhythmic notation to highlight the total amounts of modular divisions (sixteenth note) elapsed between attacks.[18] Example 7 is thus a straightforward illustration of an isomorphism created between the pitch and time domains.

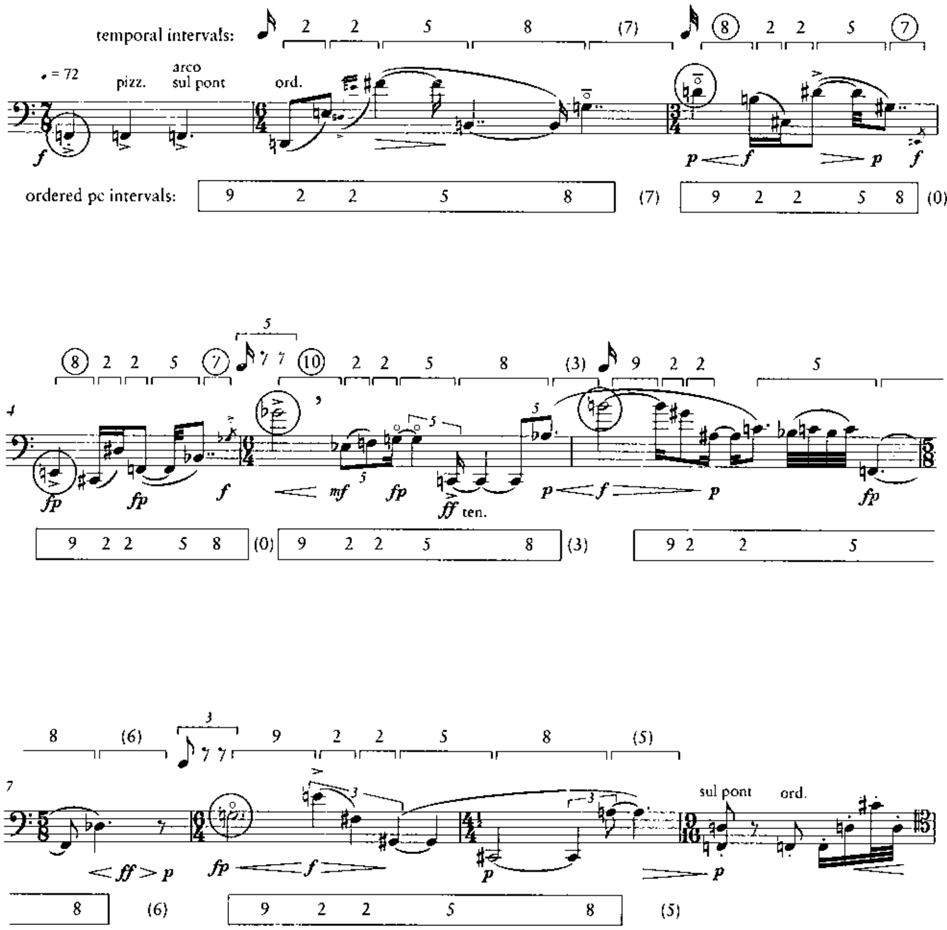
Wuorinen's Example 100–a (annotated in Example 8) illustrates the coordination of pc and time intervals. Here, the basic temporal division is the sixteenth note; this is coordinated with the pc intervals of a hexachordal series. Thus, Wuorinen's integers (below the example) serve a double purpose, indicating (1) the ordered pc-interval that produces a given note in relation to the example's opening pc (e.g., the concluding E is ordered pc-interval 5 from the opening B) and (2) the total number of elapsed sixteenth notes since the excerpt's opening, mod 12. My own annotations (along the top) present the same analysis from a different angle, in that each integer represents both the ordered pc-interval that takes each note to the one following and the duration of a given pitch in sixteenth-notes.

This example is particularly relevant, as it closely resembles Wuorinen's use of the method in *Cello Variations*. Example 9 presents once more mm. 1–9 of the work; now the source interval sequence 9, 2, 2, 5, 8, *n* represents durations (measured in "temporal intervals," shown above the staff) as well as ordered pc intervals.[19] Thus, aside from a few circled discrepancies, Wuorinen's initial statements of the source hexachord project modular time-point intervals derived from the hexachord's intervallic structure. (I address these discrepancies, along with the related fact that Wuorinen's "temporal intervals"—his basic units of time measurement—*change* continuously throughout the passage, in detail on p. 171 below.)

While expanding the time-point system in *Simple Composition,* Wuorinen is quick to point out that applying pc operations to the time dimension is logically consistent and yields noteworthy results. For example, he states that "the retrograde of a time-point succession is *not* the retrograde of the 'durations' between successive time points, it is the retrograde of the time points *themselves*" (1979, 136). Wuorinen explored the musical implications of applying R, I, RI, M, and so on to time-point rows in *Cello Variations.* He often works in a one-to-one correlation of pcs and time-points in this work, and his realization generally makes the relationships between the two dimensions aurally explicit. One of the most intelligible examples of pc-time-point coordination involves the

[18] The annotations have been added to give this example a string of temporal intervals consistent with subsequent musical examples.

[19] Here the annotated score presents durations of time that correspond to ascending interval values. Robert Morris has also used a similar method of duration-interval annotation (1997, 88; Example 1).



EXAMPLE 9

Cello Variations, mm. 1–9, annotated with temporal intervals within shifting moduli above each system and ordered pc-intervals below

whole-tone trichord subsets within the various forms of the work's series (refer back to Example 4). Focusing on this subset provides a helpful listening strategy for Example 9: notice that the time-point realization of the (024) trichords (e.g., D–E–F♯ in m. 2, B–C♯–D♯ in m. 3, etc.) produces a relative durational scheme of short, short, long(er)—no

Time-Points (mod 12) in Fundamental Transformations:

S =	0		9		11		1		6		2
Durations:				*short*		*short*		*medium*			
I =	0		3		1		11		6		10
Durations:				*long*		*long*		*medium*			
R =	0		4		11		9		7		10
Durations:						*long*		*long*		*short*	
RI =	0		8		1		3		5		2
Durations:						*short*		*short*		*long*	

Time-Points (mod 12) in Multiplicative Transformations:

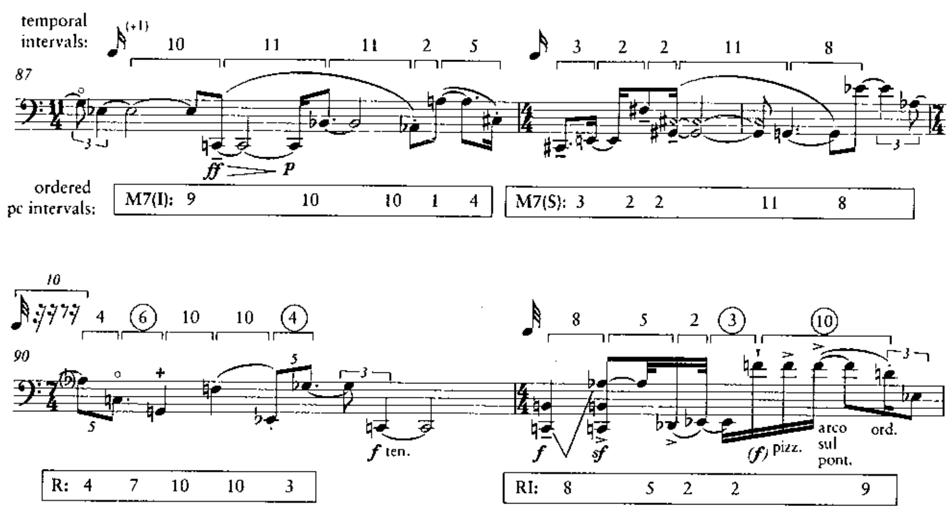
M7(S) =	0		3		5		7		6		2
Durations:				*short*		*short*		*long*			
M7(I) =	0		9		7		5		6		10
Durations:				*long*		*long*		*short*			
M7(R) =	0		4		5		3		1		10
Durations:						*long*		*long*		*long*	
M7(RI) =	0		8		7		9		11		2
Durations:						*short*		*short*		*short*	

EXAMPLE 10
Relative durational schemes accompanying whole-tone fragments (in bold) according to Wuorinen's transformations in *Cello Variations*

matter what durational value is the modular time-point unit.[20] Example 10 illustrates that from the eight transformations used in the work, the (024) trichord is associated with six different relative durational schemes.[21] Through a one-to-one correlation of

[20] Recall that the three pitches and time-points *themselves* do not produce the durations, as it takes four time-points to construct a three-part durational sequence. The pitches of the (024) trichords mark time-points: it is the intervals, initiated by these pitches, which produce the durations.

[21] For simplicity, Example 10 uses the following mod 12 scheme to characterize durations: 1–4 time units = short, 5–8 = medium, 9–12 = long. One could potentially take issue with using mod 12 integers in this example, as they do not necessarily specify one and only one duration (e.g., "2" in mod 12 = 14, 26, etc.). However, this problem does not arise in *Cello Variations*, as Wuorinen's durations are always between 1 and 11.



EXAMPLE 11

Cello Variations, mm. 87–91, annotated with temporal and pitch-class intervals
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pitch and time, Wuorinen creates a web of associative relationships between the whole-tone trichord and the consistent initiatory short-short (S, RI, M7[S], M7[RI]), or long-long (I, R, M7[I], M7[R]) durational sequence. Example 11 illustrates; notice the (024) trichords' alternation of long-long-short patterns (M7[I] in m. 87 and R in m. 90) with short-short-long ones (M7[S] in mm. 88–89 and RI in m. 91).[22] In this way, the time-point system allows Wuorinen not only to extend the intervals of his pc resources into the temporal dimension but also to generate comprehensible and memorable rhythmic relationships between these resources.

Time-Point Nesting in *Cello Variations*

Wuorinen uses time-point nesting in a relatively straightforward manner in *Cello Variations*, indicating that he was examining the method's organizational potential a full decade before the publication of *Simple Composition*. Wuorinen describes the method's conceptual backdrop as follows: "We have observed that the Babbittonian formulation

[22] In Example 11, note that the temporal intervals for M7(I) and R begin at new modular divisions. Further, though M7(I) adds one additional sixteenth duration to each of its temporal intervals and R and RI include slight temporal revisions, the relative durational contexts are maintained.

of the time-point system implies a progress of mosaic-like accretion—small units of continuity (pitch-class/time-point set-form complexes) are conjoined to make a larger continuity. The large is built up out of, and gradually emerges from, the manipulation of small entities" (1979, 150).

In the nesting method, the total duration of a piece is first calculated by multiplying the sum of a row's complete interval sequence by a fixed scaling unit.[23] The scaling unit is chosen "in accordance with a decision, made in advance, about how long the work is going to be" (Wuorinen 1979, 151). For instance, *Simple Composition's* Example 104 (not shown) uses ten quarter-note beats as a scaling unit, and multiples this by the sum of the given twelve-tone row's total interval sequence: 10 ♩ × 96 (sum of interval sequence: 8, 2, 7, 10, 4, 11, 8, 11, 10, 10, 7, 8) = 960 ♩ beats in length—or, with a metronome marking of ♩ = 60, a performance time of sixteen minutes (Wuorinen 1979, 150–51). Second, the total duration is divided into large formal sections by multiplying each of the row's intervals with the scaling unit. In the case of the interval sequence just given, the first large section would be 80 ♩ beats (10 ♩ × 8), the second 20 ♩ (10 ♩ × 2), and so on. Subsequent repetitions of this process creates lower levels of rhythmic organization, each of whose members features the same number of divisions. In other words, if a twelve-tone row is used, the work will have "12 principal and 144 smaller sections," proportionally balanced and sequenced in time and fashioned to mirror the pc intervals of the initial twelve-tone row (Wuorinen 1979, 152). Consequently, the time-point nesting method generates a musical structure that is *self-similar*, or "one whose parts recursively repeat the whole structure" (Bolognesi 1983, 26).[24] Though a self-similar structure may have many levels, *Simple Composition* suggests using three: "quantities of beats" (first-level divisions), "'measures' with 'meter signatures'" (second-level divisions), and "rhythms" (third-level divisions) (Wuorinen 1979, 153).[25]

[23] Though this method defines the global framework of a piece, it is critical to remember that "[s]ince the instant-to-instant succession of happenings in a piece is best composed in response to local needs, there will always be a gap between structural principles that can be neatly outlined and described, and the answer to the crucial question of detail: What do I do next?" (Wuorinen 1979, 38).

[24] Charles Madden, who has written extensively on the concept of self-similarity in music, mentions that "[t]he parts must scale; that is, a self-similar image has smaller pieces that are similar to each other and to the whole" (1999, 20). Hsü and Hsü (1991, 3508) further define this property, stating: "Music with self-similarity should be susceptible to analogous scale reduction."

[25] It is worth noting that *Simple Composition* also explains that the time-point system may be contrapuntally extended within the nesting method to stratify multiple strands of intervallic successions for a more complex, polyphonic structure. For instance, in later examples, Wuorinen layers time-point expanded intervallic successions of the fundamental transformations S, RI, R, and I on top of each other (1979, 158–59). As mentioned, however, *Cello Variations* makes use of a simpler structure, and is a precursor to what Wuorinen describes in the final pages of his book. Since it is a solo work, *Cello Variations* uses a single strand design based on the S

Section:	1	2	3	4	5	6
Measures:	1–43	44–52	53–62	63–80	81–112	113–132
duration in ♪ at ♪ = 144:	9 × 36 = 324 ♪	2 × 36 = 72 ♪	2 × 36 = 72 ♪	5 × 36 = 180 ♪	8 × 36 = 288 ♪	10 × 36 = 360 ♪
Actual tempo:	♪ = 144	♪ = 144	♪ = 120	♪ = 96	♪ = 144	♪ = 144
Real duration in ♪:	324 ♪ *(same as row 3)*	72 ♪ *(same as row 3)*	60 ♪ (72♪ × 5/6 = 60♪)	120 ♪ (180♪ × 2/3 = 120♪)	288 ♪ *(same as row 3)*	360 ♪ *(same as row 3)*
Pitch Center:	F	D	E	F♯	B	G

EXAMPLE 12
Section-level divisions for total duration of *Cello Variations* (total duration = 1,296 ♪ at ♪ = 144)

In the case of *Cello Variations*, Wuorinen would have begun by calculating the total duration of the piece. He arrives at this by squaring the sum of the source hexachord's intervals (i.e., 9 + 2 + 2 + 5 + 8 + 10 = 36),[26] yielding a total of 1,296 eighth-notes.[27] (Thus, 36 also functions as the work's "scaling unit.") As the top rows of Example 12 show, these 1,296 eighth-notes are then partitioned into six sections whose successive lengths (as shown in row 3) are equal to the source hexchord's six intervals (i.e., 9, 2, 2, 5, 8, 10) also multiplied by the "scaling unit" (36).[28]

On the title page, Wuorinen announces that the work will last nine minutes—which it would, naturally, if the opening tempo of ♩ = 72 (or ♪ = 144) were held constant for all 1,296 bars (1,296 ÷ 144 = 9). However, Example 12 reveals that only four of the six sections maintain the original tempo. As the shaded part of row 4 shows, section 3 slows the tempo by one sixth to ♪ = 120, while section 4 slows it by one third to ♪ = 96.

hexachord interval sequence to nest itself into successively smaller levels of self-similar divisions. For further explanation and analysis of the time-point nesting method and other examples of nesting in Wuorinen's music, see Romig 2000 (32–38) and Straus 2009 (124–29).

[26] The source interval sequence here includes the terminal "10" that brings us back to the starting pitch class.

[27] Note that Wuorinen's basic temporal unit here is the eighth-note, rather than the quarter-note found in his Example 104 (discussed above).

[28] This first level of division in Example 12 (in row 3) represents Wuorinen's aforementioned "quantities of beats" (1979, 153). In analysis, however, the labels for nested layers depend contextually on the size and number of layers used. This analysis labels nested layers for Cello Variations in the following manner: Sections, Subsections, Measures with Meters (or "Measures"), and Rhythms (i.e., a Time-Point analysis), respectively.

To keep the piece "on schedule," Wuorinen must reduce the number of eighth notes in these slower sections—otherwise, the work would exceed its predetermined nine-minute duration. Thus each slower section reduces its total eighth-note pulses in proportion to its reduction of the original tempo. From the shaded part of row 5, we see that the 72 beats originally projected for Section 3 are curtailed to 60 (i.e., 120/144 = 5/6; 72 × 5/6 = 60), while the 180 beats allotted to Section 4 are reduced to 120 (i.e. 96/144 = 2/3; 180 × 2/3 = 120).[29] In other words, the original tempo of ♩ = 72 acts as a "background clock," precisely regulating the overall duration of the piece, even when the tempo of events on the musical surface seem to pull away from it.[30]

Finally, we should note that the bottom row of Example 12 shows that the pcs of the S sequence—the ones contextually marked at the start of the work (see the circled pitches in Examples 1 and 9)—also act as pitch centers for entire sections of the work, creating a sense of large-scale unity. Each section will emphasize its pitch center by beginning with it and/or frequently returning to it in emphatic, multi-stop passages.

Moving on: with the initial plan of Example 12 thus laid out, Wuorinen then repeats the nesting process, thereby embedding the *Cello Variations's* sequence within itself at multiple levels of formal and temporal organization. As he found through his experimentations in this work, the size of a given (interval) unit limits the number of times it may be subjected to nesting. In *Cello Variations*, a second level of division may be identified. Using Wuorinen's descriptions from *Simple Composition*, we calculate the durational divisions for each large section in the same manner we divided the work's total duration into six large sections (1979, 151–52). First we determine a scaling unit for each section. Taking Section 1 as an example, we divide the section's total duration by the sum of the source hexachord's interval sequence.

$$\text{scaling unit, Section 1} = \frac{\text{duration, Section 1}}{\sum \text{source hexachord's intervals}} = \frac{324 ♪}{36} = 9 ♪$$

Section 1 is then divided into six sections by multiplying this scaling unit with each of the source sequence's intervals, thereby nesting a second level of six durational spans—or six subsections—within Section 1, as shown in Example 13.

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[29] Perhaps unsurprisingly, Wuorinen's stipulated duration is difficult to realize in performance; Fred Sherry's otherwise virtuosic recording of the work lasts a full 10'27".

[30] This sort of "variation" of the surface tempo within the broader context of a "background clock" recalls Elliott Carter's structural polyrhythms, which were first used in the Introduction and Coda of his *Double Concerto*, composed in 1961 (Schiff 1998, 46–47). Though Wuorinen does not combine proportional "speeds" in *Cello Variations*, the music suggests his engagement with several compositional issues prominent at the time, most notably how the ordered series may, at the background level, be maintained even through exploration of various surface speeds.

Subsection:	1	2	3	4	5	6
	9 x 9 = 81 ♪	2 x 9 = 18 ♪	2 x 9 = 18 ♪	5 x 9 = 45 ♪	8 x 9 = 72 ♪	10 x 9 = 90 ♪
Measures:	1–9	10–12	13–15	16–21	22–32	33–43
Pitch Center:	F	D	E	F♯	B	G

EXAMPLE 13
Subsectional-level divisions for Section 1 of Cello Variations (total duration = 324 ♪)

EXAMPLE 14
The F pitch center (at sectional level) plus sub-section level pitch centers in *Cello Variations*, Subsection 1
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Wuorinen also incorporates pitch centers into each subsection. These centers are sounded simultaneously with those from higher levels of formal organization, resulting in an aurally perceptible nesting of pitch centers. Example 14 shows the onset points of

Measures with Meters:	1	2	3	4	5	6
	9 x 2.25 = 20.25 ♪	2 x 2.25 = 4.5 ♪	2 x 2.25 = 4.5 ♪	5 x 2.25 = 11.25 ♪	8 x 2.25 = 18 ♪	10 x 2.25 = 22.5 ♪
♪ Value:	19	6	6	12	17	21
Measure(s):	1–2	3	4	5	6–7	8–9
Pitch Center:	F	D	E	F♯	B	G

EXAMPLE 15
Measures with meters ("sub-subsection")-level divisions of Subsection 1 of *Cello Variations* (total duration of Subsection 1 = 81♪)

Subsections 2–6 from Section 1 (compare with Example 13). Each excerpt begins with a double-stop that combines the global Section 1 pitch center (F) with the local Subsection pitch center (D, E, G♭, B, and finally G). (The onset of Section 1, Subsection 1 features no double-stop because the lower- and higher-level pitch centers are *both* F; see Example 1, m. 1.)

The 81 eighth-notes of Subsection 1 certainly leave room for another level of nesting before arriving at the work's surface-level rhythms; this subdivision of the "Subsection" level results in a level that Wuorinen termed "measures within meters." Example 15 analyzes the subdivision of *Cello Variations*'s first Subsection into six such "measures." Once again, Wuorinen finds his scaling unit by dividing the subsection's total eighth-note duration (here 81) by 36; thus the scaling unit for Subsection 1 is 2.25 ♪ (i.e., 81 ÷ 36 = 2.25). And, as the first row of Example 15 indicates, the lengths of the individual "measures" arise by multiplying that scaling figure by the now-familiar integer succession <9, 2, 2, 5, 8, 10>. However, it is critical to note here that Wuorinen's term "measures" can stand for one or more actual notated bars, with the same or different meters. This can be seen in Example 16, where the brackets above the score marking out each of six "measures" of Subsection 1 can sometimes be seen to encompass more than one bar of music. What is essential is that each "measure" presents a single transposed iteration of the source hexachord.[31]

[31] When presented in quotations, "measures" will refer to this particular layer of Wuorinen's nesting method. Without quotations, the word refers to notated measures.

Examples 15 and 16 also make clear that at more hierarchically superficial levels, Wuorinen diverges rather freely from his calculated eighth-note durations. By comparing the calculated values of row 1 with the actual values in row 2, we see that "measures" 2, 3, and 4 are slightly longer than expected (e.g., "measure" 2 should be 4.5 ♪ but is actually 6), while "measures" 1, 5, and 6 are slightly shorter (e.g., "measure" 1 should be 20.25 ♪ but is in fact only 19, and so on). The reason, as Wuorinen explains in *Simple Composition*, is that at this level of nesting, "the division process will become unduly complex arithmetically unless we begin to round off...to integral numbers of beats" (1979, 152).[32] And indeed, in the broadest sense, we can see that the row-2 values have all been adjusted to eliminate the fractions of eighth-notes evident in row 1.[33]

However, this "rounding off" also affects the rhythms within each "measure." In Example 9, we saw that these hexachordal spans tended to follow the same proportional duration pattern we observed at larger levels (92258*n*), but with a few circled exceptions. We can now rationalize those exceptions (which remain circled in Example 16) according to this same ad hoc "rounding off" process. Let us begin by looking at the onset points of the three shortest "measures," nos. 2, 3, and 4 (i.e., mm. 3–5). Given the relative brevity of the "temporal interval" in these spans—a thirty-second note in "measures" 2 and 3 and one fifth of a quarter-note in "measure" 4—the use of a starting duration of nine units (as the pattern dictates) would result in some rather ungainly rhythms. Therefore, Wuorinen either rounds the would-be "9" down to "8" (mm. 3–4) or up to "10" (m. 5). Notice also in "measures" 2 and 3 (mm. 3–4) that the final temporal value is changed from the predicted "8" to a "7." The reason is that the variable duration that normally concludes each hexachordal iteration (i.e., the *n* in 92258*n*) is "lost" because the final tone of mm. 3 and 4 is a grace note—i.e., a note with no real duration and thus one that cannot be adjusted to accommodate the duration of the whole. (This flexibility is essential: had Wuorinen not adjusted these two concluding durations, "measures" 2 and 3 would have been 6.25 ♪ long, thereby defeating the very purpose of rounding each "measure" to a whole number of eighth-notes.)[34] Finally, notice that because the "rounding off" of

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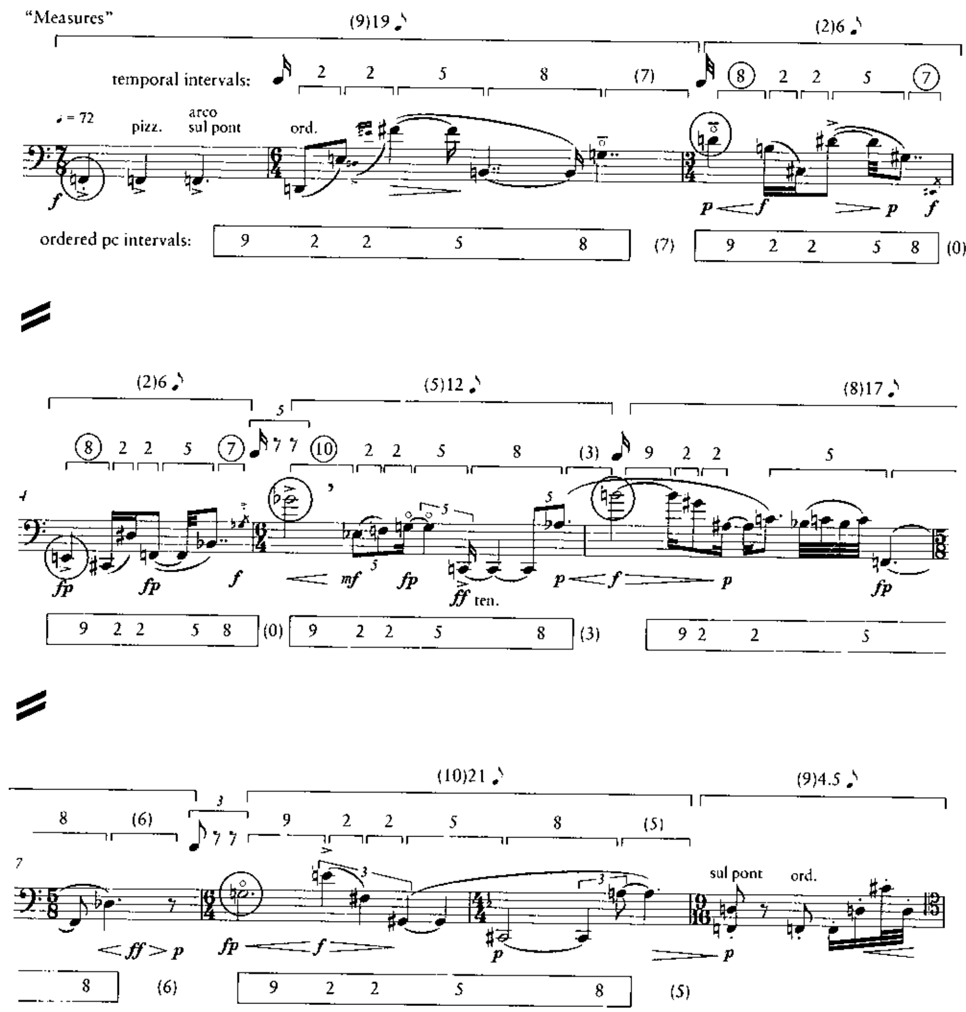
[32] Wuorinen's quote from fn. 23 is again applicable here.

[33] We are now in a position to understand why the "temporal intervals" in Example 9 changed with almost every measure: although each hexachordal iteration uses roughly the same *proportional* series of durations (i.e., 92258*n*), the absolute values of those durations must vary from hexachord to hexachord in order for the six hexachords also to manifest, in toto, the proportional duration pattern (92258*n*). That is to say, although hexachords 4 and 6 will unfold according to the same pattern of internal proportions, the unit by which those proportions are measured must be *larger* for the second of these, because its absolute duration must be about twice that of the first if they are to project the durational relation of 5:10. (In reality, Wuorinen only approximates this by having their respective lengths as 12 and 21 ♪.)

[34] Note one additional (and highly audible) liberty: in order to provide a marked agogic accent to the work's first



EXAMPLE 16

The stratification of self-similar layers in *Cello Variations*, mm. 1–15

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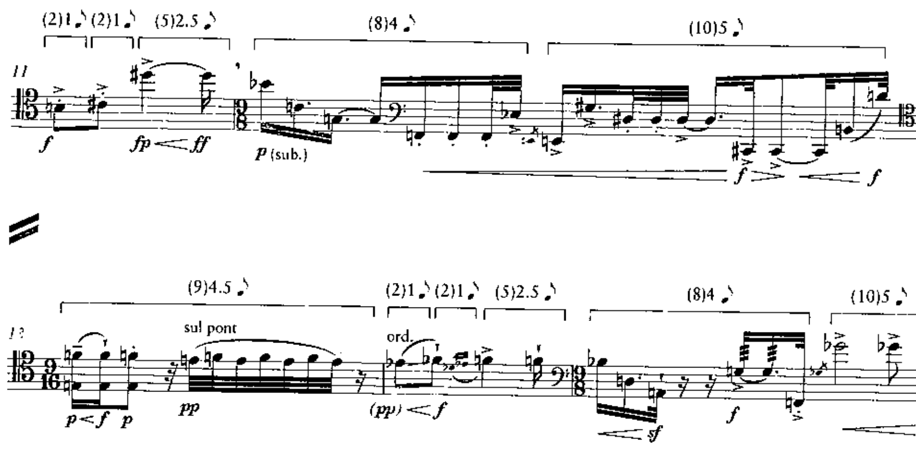
the rhythms in these shorter "measures" *increased* their overall length, the remaining "measures" (nos. 1, 5, and 6) needed to be shortened proportionally, in order to keep the overall duration of Subsection 1 at the predetermined 81 eighth-notes. In sum, *Cello*

pitch (and also its first pitch center), Wuorinen allows the opening F to last considerably longer than the nine semitones dictated by the time-point duration series. Thus, Wuorinen does not begin using 1:1 pitch to time-point coordination until the second pitch of the series, or D♮.



EXAMPLE 16
(cont'd.)

Variations shows that while Wuorinen is guided by his compositional method, he is by no means controlled by it.

Example 16 makes clear that dividing Wuorinen's "measures" one final time brings his time-point nesting method into contact with Babbitt's own time-point system. Surface events now nest themselves within "measures with meters," unifying time-point *rhythmic* and *formal* organization. However, this coordinated serialization of pcs and rhythms does not continue uninterrupted. In Subsections 2 and 3 (mm. 10–15; not shown), the music continues to feature "measures," though their internal organization is no longer based on the recursive (9, 2, 2, 5, 8, 10) time-point pattern. It is easy to see why this is so. While Subsection 1 was large enough (81 eighth notes) for Wuorinen to bring the nesting method down to surface-level rhythms, such is not the case with Subsections 2 and 3. For instance, it would be impractical, at the given tempo, to nest "rhythms" within "measure 2" of Subsection 2, since this "measure" is but 1 eighth-note in length (m. 11, first beat). Likewise, though Wuorinen by and large nests time-points within the "measures" of Subsections 5 and 6 (mm. 22–43), he omits the lowest level of nesting whenever it is impractical (e.g., mm. 25–26, or "measures" 2 and 3 of Subsection 5; mm. 36–37, or "measures" 2 and 3 of Subsection 6).[35] Thus, while several compositional

[35] The final two sentences of *Simple Composition* provide further insight into Wuorinen's decision to, at times, move away from the time-point system: "Remember always that freedom can be had only if it is earned; in art it is earned by prior submission to discipline. And remember too that freedom means nothing unless there are co-ordinates, fixed and clear, whose very immobility allows the one who is free to measure the unfetteredness of his flight" (164). In the specific case of *Cello Variations*, "measures with meters" are immobile coordinates that

dimensions—namely, pitch, rhythm, and form—may simultaneously exhibit self-similarity (as we saw clearly in Example 16), subsections may present varying "depths" of nested material, depending on their durations.

Example 17 provides a layered analysis of formal divisions for *Cello Variations*. These divisions reflect successively smaller, self-similar levels of formal organization. As the dotted arrows show, the example looks in detail at the first two sections of Divisions 1 and 2, and sections 4 and 6 of Division 3. (The latter correspond to "measure 4" and "measure 6" of Subsection 1, the two "measures" in that Subsection that nest time points most clearly.) It is worth noting here that some large sections may include different organizational plans than the recursive 9, 2, 2, 5, 8, 10 S divisions seen so often above. For example, Section 2 is relatively small, featuring only 72 eighth notes. This section thus essentially omits the "subsection" level and divides directly into the "measures with meters" level, the proportions of which are governed by the complete "I" interval sequence: 3, 10, 10, 7, 4, 2. By focusing on the nested formal layers of *Cello Variations*, Example 17 offers a summary and overall snapshot of how Wuorinen extends Babbitt's "mosaic-like accretion" to global organizational issues.

Let us now consider some additional aspects of the overall shape of *Cello Variations* in light of Wuorinen's general philosophy of musical teleology and goal-directedness. As hinted above, the serial organization of Sections 1 and 2 is relatively straightforward. Fundamental pitch transformations are used exclusively, while time-point rhythmic organization appears where a unit's size permits. The subsection levels within Sections 1 and 2 consistently provide guiding "coordinates" for musical events that fall within the time-line of these two sections. We can also consider these to be more processively "orderly" sections of the work, as Wuorinen's time-point nesting method is consistently present in at least two levels of the music (i.e., sections and subsections)—that is to say, "order" is achieved through the increased use of time-point nesting. In the same way, large Sections 5 and 6 also exhibit "order" by clearly nesting subsections within higher levels of sectional organization.[36] Sections 3 and 4, by contrast, are less "ordered." In

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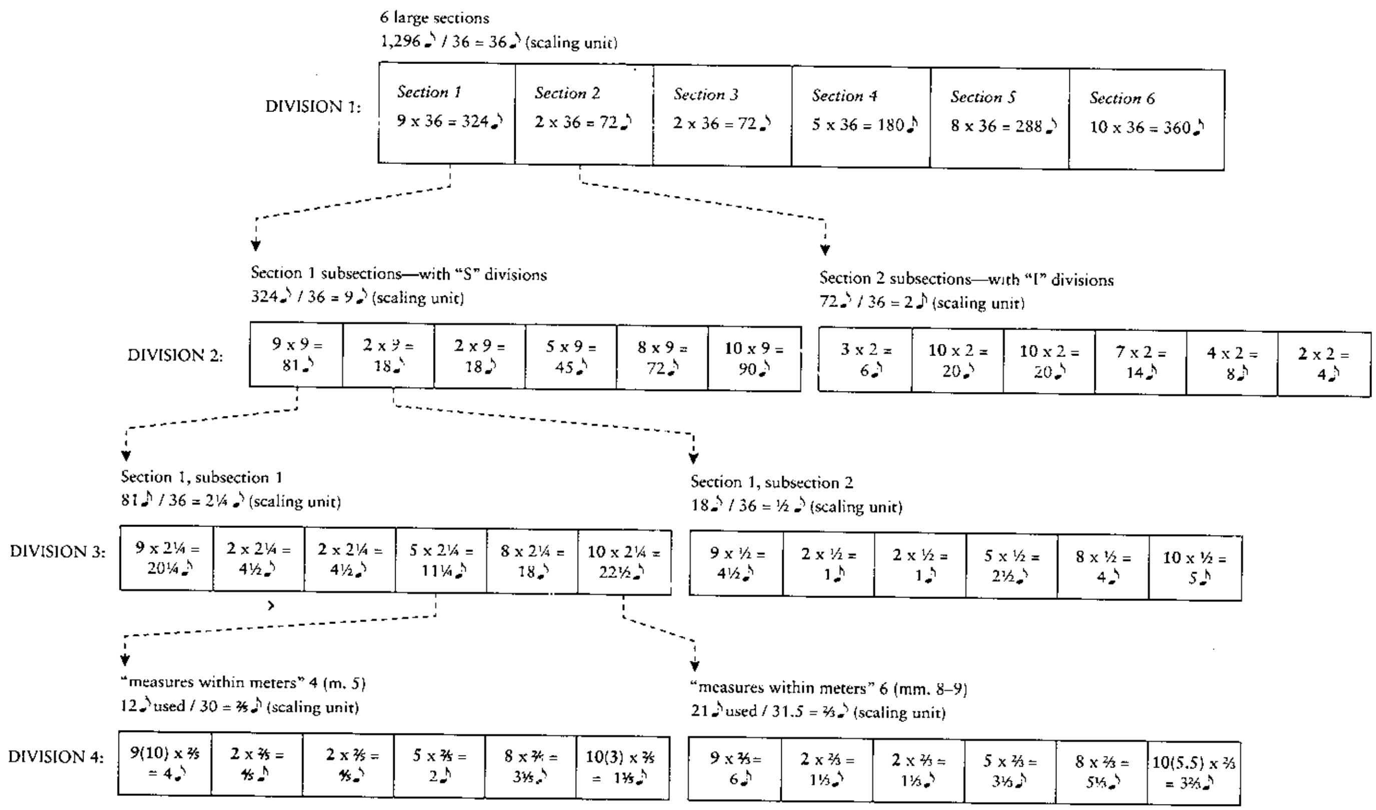
guide Wuorinen's compositional process. Once he feels he has the room to nest "rhythms" within "measures" (e.g., Subsections 1, 5, and 6), he does so.

Examples of Wuorinen's return to combined, one-to-one serialization of pitch and rhythm within "measures" during Subsections 5 and 6 include: mm. 22–24 (R), mm. 27–35 (S→R→S→R), and mm. 38–43 (R→R→R). Note that, in mm. 44–52, (large Section 2), Wuorinen is not as committed to such a coordination of pitch and rhythm, as, overall, he has less time to work with. Also note that in any one-to-one coordination of pitch and rhythm in Section 1, Wuorinen allows himself to modify slightly the rhythmic realization of sequences (though most time-point rhythms do retain a strict one-to-one correlation).

[36] Furthermore, the first level of nested material in Sections 5 and 6 "mirrors" subsection organization within Sections 1 and 2. That is, Sections 1 and 2 break down immediately into time-point formal expansions of S (9, 2, 2, 5, 8, 10) and I (3, 10, 10, 7, 4, 2), respectively, and Sections 5 and 6 break down into I- and S-controlled subsections, respectively.



EXAMPLE 17
Time point nested layers in *Cello Variations*

particular, these internal sections lack the following features that lend "order" to the outer sections: (1) precisely calculated nested layers, (2) clear, accented double-stops on downbeats that mark nested pitch centers, and (3) consistent use of the work's familiar primary pc intervals (i.e., Example 4).[37] This view of the work's overall trajectory—two "orderly" outer sections framing a freer middle section—suggests that Sections 3 and 4 are an intervening musical digression. Indeed, such a reading of *Cello Variations* resonates with Wuorinen's comments on his connection with older music: "we (in the West) assign a definite beginning to the universe—our literature, all of our artistic traditions, and of course our music, are all teleological, goal-directed, or directed in some way so that one returns to a starting point. I've never given that up" (Oteri 2007, 4).

To conclude, let us review some of the ways in which analyzing *Cello Variations* through the lens of *Simple Composition* has given us insights into Wuorinen's workshop habits and given us a deeper appreciation of his contributions to the development of the twelve-tone method. First, as my analysis has aimed to show, the time-point nesting method is Wuorinen's most significant extension of twelve-tone principles, one that builds upon and develops techniques established by Schoenberg and Babbitt while integrating them within a larger architectural vision that is entirely Wuorinen's own. Second, although the nesting method by design requires "prior submission to discipline," the pre-compositional planning *guides* rather than *controls* the compositional process. Like Schoenberg and Babbitt before him, Wuorinen thus allows himself a degree of freedom within clearly defined serial parameters. Third, we have seen that Wuorinen's "pitch centers" are critical anchors for demarcating the levels generated by the nesting method and even, from one standpoint, a vestige of earlier tonal practices.[38] Finally, the isomorphic mapping of intervals across multiple musical elements leads to self-similarity, bringing the twelve-tone technique in contact with such late-twentieth-century practices as fractal-based composition.[39] In consideration of Wuorinen's important contributions

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[37] In fact, Section 4 commences by announcing a shift in tempo, not by boldly stating its centric pitch, as other sections do (the pitch center for Section 4 is stated at the outset of Section 3).

[38] The notion of considering Wuorinen's "pitch centers" as precise carryovers from the tonal system is indeed a slippery slope. His "pitch centers" do not possess the same hierarchical qualities as a tonic pitch, for instance. My suggestion of this vestige is inherited from Kresky and Karchin (see fn. 8 above).

[39] Indeed, Wuorinen's serial experiments with self-similar structures during the 1960s and early 1970s led him to research the musical realizations of Benoit Mandelbrot's fractal geometry at Bell Labs during the late 1970s (Burbank 1994, 14).

In an interview with Wuorinen in Burbank (1994), the composer states that when considering "ideas of non-integral dimensionality and self-similarity of parts...[i]t occurred to me (certainly other people have considered it in more detail than I have) that this is a basic characteristic of music and that it is, in fact, proved that in well-composed music the same kinds of things tend to happen in the large as in the small" (1994, 14). Fractal perspectives such as the degree of self-similarity [e.g. exact/statistical (Milne 1992, 39)] in Wuorinen's works, to the twelve-tone technique, his music merits further investigation. Hopefully, the foregoing discussion has revealed that *Cello Variations* is, in its own way, a "simple composition" and one that we can use as a foundation for future analytical endeavors.

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as well as comparison of his nesting method to processes used in his fractal geometry inspired works, shall be reserved for another essay.

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