Composition with Pitch-Classes

by Robert D. Morris

Reviewed by Michael Cherlin

While there is no single, tight knit community of scholars and composers that fills the serious side of our musical lives at this end of the twentieth century, the closest we come to such a community, the closest we come to a tradition that sustains, stimulates and anneals creative thought in and about music, is through that body of theory and composition to which Morris makes the present contribution.[1] *Composition with Pitch-Classes* in part forms a compendious integration of work done in the theory of atonal and twelve-tone music over the past thirty years. As such, the book may be read and used as a long-needed reference work, a virtual encyclopedia of atonal and twelve-tone theory. In this respect, *Composition with Pitch-Classes* complements the valuable resource in John Rahn's *Basic Atonal Theory*. While Rahn introduces students to a central core of ideas, Morris's book addresses advanced composers and scholars. (Even though Morris carefully defines his terms as they occur, it is difficult to imagine a reader who might negotiate the book without serious, long-term preparation.)

[1]To be sure, Schenkerian and Post-Schenkerian studies have also created a family of scholars and composers who can talk to and listen to one another. But the Schenkerian and Post-Schenkerian tradition has not, and most likely cannot, generate the basis of an evolving language for musical composition.

But to characterize *Composition with Pitch-Classes* as a reference work, or even as the integration of an extensive body of theory, which is to say much more, would still miss the mark. Like Rahn, Morris has a specific, though far-reaching pedagogical program that structures his text. The goal of that program is stated partially within the title of the book: to learn to manipulate pitch-class sets and segments toward compositional ends. However, as television commercials tell us of other products, here there is much, much more. At a time when rigorous thought seems to be out of style in many circles of composers, Morris's book may serve as a reminder that fantasy and technique are not strangers to one another. Studying *Composition with Pitch-Classes* is a challenging and exhilarating enterprise. The book is a contribution of the first rank to the pedagogy of music composition.

In the first few pages of the text, Morris states his objective: to generate a comprehensive and therefore flexible theory of compositional design, neither prescriptive nor descriptive in the traditional sense of those terms. His argument is summarized nicely on page 3.

> Accordingly, a compositional theory for something larger than a small segment of today's music needs to be explicit and general at once, since, although it may be designed to help generate a certain species of music based on models of preexisting contemporary music, it must not specify, in any but a rather tentative manner, the stylistic component of the music. Thus, this kind of theory may initially seem to be speculative because it does not lead immediately to the solution of specific compositional problems. In fact, such a theory emphasizes the mutuality between doing composition and thinking about it--each activity provides problems and solutions to the other. Furthermore, such a theory cannot

> be reductive in the sense that if certain variables specified by the theory have been defined, a piece of music will emerge. This is not to say that such strictly generative theories may not be useful or attractive--some have used them to make actual music, but that they are useful only to the composer who creates the theory to generate a certain (presumably original and unique) class of pieces. What is needed is a theory at a higher level of generalization which permits theories of the specific and reductive kind to be invented. Thus a general theory is not equivalent to a manual or cookbook. Rather, a theory of compositional design that can satisfy structural requirements arising from different functions, uses, and aesthetics of music consists of a set of tools and methods for constructing and interpreting compositional plans.

The validity of Morris's observation about "the mutuality between doing composition and thinking about it," depends upon how well the composer has integrated thought 'about music' with thought 'in music.' The groundwork for such integration is at the core of *Composition with Pitch-Classes*.

Large-Scale Plan of the Text

The book comprises seven principal chapters. The first chapter introduces the topic of *compositional designs*, abstract, two-dimensional compositions of pitch-classes (or time-point classes), and succinctly considers various options for their realization. The chapter is proleptic in nature, anticipating the book's final goal and placing the chapters that follow into a perspective that shows where they are leading. Thus, the opening topic foreshadows its own in-depth treatment, which is basic to the central argument of the text.

Chapters 2 through 5 lay the groundwork for generating **compositional designs** through an extensive study of the concepts of musical space, musical functions and musical objects that will generate and fill those designs. Chapter 6, in many ways the centerpiece of the book, integrates the functions and objects studied in Chapters 2 through 5 to generate **eight compositional** designs. After each design is presented and analyzed in its specificity, a more general approach is suggested toward composing the types of structures and functions within the design. This entails a creative integration of all that has preceded. Chapter 7 deals principally with the problems of transforming pc-space into pitch-space and with the correlation of temporal and pitch dimensions.

Morris lays the groundwork for considering objects and functions by first defining different types of musical space. The dimension of pitch space is divided into three primary types, exhausting relative space, linear (measured) space and cyclic space. Each type of space may be either **ordered** or **unordered**. Only relative differences among pitches obtain in **contour space (c-space)**. Thus, every pitch x is higher than, lower than or equal to every pitch y. **Unordered c-space** does not comprise actual contours, which require ordering every x before or after every y, but is rather a more abstract source for generating contour, just as unordered sets of pitches are an abstract source for generating ordered pitch segments. Measured or linear space includes two species. Intervals in **pitch space (p-space)** proper are measured on a scale with equidistant increments between its adjacent members. The primary example, of course, is our tempered twelve-tone system. Systems that have unequal intervals between elements, such as in diatonic modes, are placed in **u-space.**[2] Each species of linear space has a cyclic analogue which collapses that linear space into modular congruences. Cyclic p-space is **pitch-class space (pc-space)** and cyclic u-space is named **m-space.** Like c-space, the linear and cyclic spaces can be ordered or not, respectively defining segments or sets of notes. Generally speaking, the musical operations most familiar in the literature of music theory transform elements in any of these spaces into other elements within the same space but not into elements in another space. The latter type of transformation is of course vital to composers, and it is a topic that Morris addresses primarily in the final chapter of the text.[3]

As the title of the book indicates, pc-sets and pc-segments are of primary concern. Chapter 3 surveys the field. In describing relations and transformations within pc-space, Morris chooses wisely and extensively from the impressive literature on pc theory that has accrued over the past thirty years. To be sure, that literature includes his own significant contributions to the field. The reader is impressed throughout by the ways Morris integrates the contributions of so many major theorists. The topics are too many to consider here, even in a sketchy way, but they include various alternatives in defining pc-set equivalence classes, various types of similarity relations, and some preliminary work on twelve-tone operations and ordinal permutations as they affect pc-sets and

[2] U-space is little utilized in the course of Morris's text because he is concerned primarily with compositions in p-space. Nonetheless, the concept is a valuable one for work in many areas of musical research. For example, in much nineteenth-century music, altered scale degrees may be understood to express alternate ways to fill some discrete interval of variable u-space.

[3] The discussion of **epimorphic** mappings in Chapter 3, pp.60-61 is also interesting in this respect.

segments. In addition, Morris defines and constructs arrays that tabulate intervallic multiplicity within and between sets, as well as arrays that tabulate the affects of operators on pc sets and segments.

Chapter 4 is concerned with operations per se and principally, though not exclusively, with the twelve-tone operators (TTOs). Like the treatment of pc theory, that of TTOs is fairly exhaustive, including group-theoretic properties, commutativity, periodicity, cyclic representation, and the transformation of subgroups into cosets or other subgroups (automorphisms). Toward the end of the chapter, pp.170 and following, there is consideration of 1-to-1 operations that are not equivalent to TTOs. Since TTOs are normatively the basis for defining pc-set equivalence, the most standard being Allen Forte's canonical operations of transposition or inversion plus transposition, non-TTO transformations can map one set-type onto another. Moreover, such non-TTOs form subgroups of equivalence classes determined by those subgroups of nonmultiplicative TTOs with which they commute.[4] This property alone opens an exciting field of inquiry for theorists and composers alike. The chapter concludes with consideration of permutation operators where the objects being transformed are conceptualized as ordered positions rather than pcs. The correlation of ordinal operations with pc operations, given a permutational system, is highly cogent, a fact recognized early on by Milton Babbitt. Morris's treatment of such correlations is an important aspect of the book and should be especially helpful in suggesting approaches toward those particularly knotty problems. (The solution to the problem

[4]This property follows from theorem 4.12.4, p.126.

studied in Design III of Chapter 6 is particularly brilliant in this regard.)

The compositional designs of Chapter 6 are generated from more basic two-dimensional arrays of pitch-classes in which the rows are normatively, but not necessarily read as successive events and where the columns typically represent simultaneities. The composition of such arrays as well as a series of transformational techniques and associative concepts that transform those arrays into more complex and specific compositional designs are studied in Chapter 5.

As already noted, Chapter 6 draws on the cumulative techniques and concepts that have been developed earlier throughout the text. Even the simplest of the designs involves a rather complex integration of material. Thus, Morris shows by these models how to synthesize a knowledge of set properties and group properties of operations toward achieving desired compositional results. Through understanding those techniques and constraints in a more general way, the advanced student of composition is challenged to achieve a similar mastery and integration within his own musical imagination. For this reader, that challenge in the context of a study that helps the student to meet it, is the most significant achievement of Morris's book.

The final stages of interpretation require that various spatial and temporal dimensions of musical imagination interrelate and communicate. The problem is multifaceted, and particularly difficult because as we move toward specificity, individual contexts and requirements play a more and more important role. The problem is complicated by the fact that choices in one dimension will be affected by constraints of another. Exhaustive treatment would require another text, as ambitious as the present one. Or, perhaps, it is here where we move from theoretical text to musical composition itself. Nonetheless, Morris provides inroads, discussing, for example, difference routes (much like flow-charts) for moving from pc-sets to pitch segments (pp.286-289). In addition, Morris defines and examines ways of thinking about time that correspond to each type of pitch space; relative, linear and cyclic. (Of course, he is aware of the profound differences between the two dimensions and also of the mutual conditioning of the perception of one by objects and functions in the other.)

Some Fundamental Concepts and Techniques

In the early 1970s Bo Alphonce did some ground-breaking work on the applications of pc matrices in studying pc invariance between a segment and its transpositions or inversions.[5] Morris extends the use of matrices to study a wide diversity of relations in every type of pitch space and in every type of time space that correlates with those pitch spaces.

Stated abstractly, matrices are two-dimensional arrays that tabulate ordered intervals from elements in a segment represented on the vertical axis (X) to one represented on the horizontal axis (Y), where the ordered intervals obtain by applying some function

[5] Bo Alphonce, "The Invariance Matrix," Ph.D. dissertation, Yale University, 1974.

mapping X into Y.[6] Generalizing these properties, the X and Y axes of a matrix can each hold any number of objects (or any kind of objects), and the function and hence intervals mapping X to Y can be any defined function. Thus, for example, intervallic relations between any sized segments in any of the various pitch-spaces or time-spaces can be studied on a matrix. Ingenious application of such matrices is a conspicuous feature throughout the text. In our context here, we will cite two short examples.

In Chapter 4, pp.139-141, Morris studies Operator Invariance Matrices. The columns and rows of these matrices comprise strings of operations. The matrices are used to discover

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[6]For those not conversant with Alphonce's work, some thought on the properties of the standard 12-tone matrix may be helpful. The usual 12-tone matrix names the first pitch-class of its Y axis 0, and measures ordered intervals along the Y axis in ascending semitones relative to 0, mod.12. The X axis is derived by taking the ordered residues mod.12 of Y (values of 12-y, mod.12 for every y in Y). In standard TTO nomenclature, X is $T_0I(Y)$. The entries in the matrix measure intervals from X to Y mapping by summation. Since every column of entries is derived by adding a constant to X and since every row of entries is derived by adding a constant to Y, the resulting columns and rows preserve the intervallic structures of X and Y respectively. In other words, they form the familiar set of 12 transpositions and 12 transposed inversions of the source row Y. Yet, there is another way to orient oneself to such a matrix. Segments that are inversionally related have a constant sum between their corresponding pcs (or pitches for that matter). For example, two segments that invert about 0 will sum to 0. This is because every pc +n from 0 in segment S will be reflected by one -n from 0 in segment $T_0I(S)$ and every (0+n)+(0-n)=0. Thus, each entry measuring <x,y> by summation maps the inversion of x transposed by the interval denoted in the entry onto y. Now, ordered elements in X mapping onto ordered elements in Y will form diagonals in the matrix. Thus, for example, the "main diagonal" in a standard 12-tone matrix comprises all 0's reflecting the property that T_0I of X is Y. By isolating and studying the various diagonals in such matrices, invariant segments held between transposed inversions of X and Y may be discovered. In a similar way, a matrix whose entries are tabulated by taking differences between every x in X and every y in Y will show transpositional relations between members of x and those of y.

transformations of those strings that will hold elements in common with one another. Morris composes two strings /F/ and /G/, where /F/ = <T_1 T_BI T_6 RI> and /G/ = <T_3 T_8 T_3I RT_2I RT_4>. The inverse of /G/ = $/G/^{-1}$ = <T_9 T_4 T_3I RT_2I R_8>. We construct a summation matrix mapping members of $/G/^{-1}$ onto members of /F/. (Morris could have constructed a subtraction matrix mapping /G/ onto /F/ with the same resulting entries.)

	T_1	T_BI	T_6	RI
T_9	T_A	T_2I	T_3	RT_3I
T_4	T_5	T_7I	T_A	RT_8I
T_3I	T_4I	T_8	T_9I	RT_9
RT_2I	RT_3I	RT_9	RT_8I	T_A
RT_8	RT_9	RT_3	RT_2	T_4

Since the entries are summations of members of $/G/^{-1}$ and /F/, they are equivalent to differences between members of /G/ and /F/. For example, T_A at entry (0,0), where the left number stands for the row 0 and the right number stands for the column 0, indicates the first member of /G/ will map onto the first member of /F/ by T_A. Comparing the first member of each string, we find T_3 for g in /G/ and T_1 for f in /F/ and indeed T_A maps g onto f. The matrix is useful for discovering ordered elements in transforms of /G/ that will be held in common with ordered elements in /F/. The entries RT_9 and T_A are particularly interesting in this respect. The diagonal of RT_9's shows that under that transformation the last three elements in /G/ will map in retrograde onto the first, second and last elements of /F/.

$$RT_9(/G/) = \langle T_1\ TB_I\ RT_0I\ RT_5\ RT_0 \rangle$$
$$/F/ = \langle T_1\ T_BI\ T_6\ RT_0I \rangle$$

The diagonal of T_A entries shows that the first, second and fourth members of $T_A(/G/)$ will map onto the first third and last members of /F/.

A very different type of matrix is exemplified in Morris's **contour graphs**, pp.283-285. In these matrices, which are **sparse arrays**, one axis denotes objects (or states) and the other denotes ordering of those objects. The matrix itself is transformed by various operations. For example, if we have an ascending set of pitches B A C D named respectively m_0, m_1, m_2 and m_3 and an ordering of those pitches $n_0 ... n_3$ so that the order is A B C D, forming contour P we can depict contour P and operations upon it by a family of graphs. (The examples are my own, but the procedure is derived from Morris, p.284. The operation X exchanges the m and n axes.)

Countour P

m_3				D
m_2			C	
m_1	A			
m_0		B		
	n_0	n_1	n_2	n_3

Contour IP

m_0		B		
m_1	A			
m_2			C	
m_3				D
	n_0	n_1	n_2	n_3

Contour RIP

	n_3	n_2	n_1	n_0
m_0			B	
m_1				A
m_2		C		
m_3	D			

Contour RP

	n_3	n_2	n_1	n_0
m_3	D			
m_2		C		
m_1				A
m_0			B	

Contour XP

	m_0	m_1	m_2	m_3
n_3				D
n_2			C	
n_1	B			
n_0		A		

Contour IXP

	m_0	m_1	m_2	m_3
n_0		A		
n_1	B			
n_2			C	
n_3				D

Contour RIXP

	m_3	m_2	m_1	m_0
n_0			A	
n_1				B
n_2		C		
n_3	D			

Contour RXP

	m_3	m_2	m_1	m_0
n_3	D			
n_2		C		
n_1				B
n_0			A	

Another formulation that is used in numerous contexts throughout the text is the representation of operators by cycles, a subject first developed by Milton Babbitt.[7] For example, the cycles for T_4 are (0 4 8) (1 5 9) (2 6 A) and (3 7 B) (where A=10 and B=11). Studying an operation's cycles can inform us about the operation itself; for example, the periodicity (i.e. the number of applications that will map S back onto itself) of a TTO is equal to

[7] "Twelve-Tone Invariants as Compositional Determinants," *The Musical Quarterly* 46:246-259.

the length of its longest cycle. Or, cycles are useful for studying mappings under those operators; for example, a set S is invariant under a TTO H if the members of S comprise only complete cycles (one or more) of H, while set S maps into a non-intersecting set Q if the members of S comprise non-adjacent pcs in the cycles of H. But, cycles are particularly interesting because of the ways they interrelate operations.

For example, the powers of any TTO form a cyclic group of operations and where the order of the cyclic group is not prime, the group contains cyclic subgroups of orders that integrally divide it (p.151). Thus cyclic properties display hierarchical relations that may be compositionally cogent. Another interesting property of cyclic groups allows **secondary segments** that also display the cyclic properties to be embedded in some primary dimension (pp.154-155). For example, T_3 can generate a cycle of <037> transforms which embed secondary segments of <061> transformed by the group. Of course, the dimensions can be reversed.

S_0 = 037	secondary:0 = 061
S_3 = 36A	3 = 394
S_6 = 691	6 = 607
S_9 = 904	9 = 93A

Yet another use for cycles is in defining non-TTOs. Morris is particularly interested in creating non-TTOs that commute with subgroups of TTOs. To do this, he applies another cyclic property: if the set of cycles for an operation is invariant under some other operation, the two commute (see p.134 and p.171). One example is set H:

$$(081)(B3A)(627)(594)$$
$$A \quad B \quad C \quad D$$

H commutes with T_6, mapping cycles A-C and B-D, with T_5I, mapping A-D and B-C, with T_BI, A-B and C-D and with T_0. If H is applied to the members of some set-class, where set-class is defined by equivalence through transposition or inversion plus transposition, the collection of H forms sub-collections that are related by the TTO subgroup with which H commutes.[8]

A concept closely related to cyclic operators is that of equivalence classes formed by subgroups (or cosets) of operations.[9] For example, the subgroup /J/{T_0 T_6 T_2I T_8I} forms the

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[8]This topic is discussed in some detail on pp.170-177. Unfortunately, there are numerous typographical errors throughout this section of the book, mostly involving labels, making the task of understanding unnecessarily difficult. Two of the more crucial sets of typos are on pages 175 and 176. The example on the top of p.175 is based on the operation H forming the cycles (017)(5)(34) (2B8)(6)(9A). The equations at the top of the example should read:

X:	3984A =	RT_6HX
T_6X:	.....	RHX
T_1IX:	.....	RT_7IHX
T_7IX	.....	RT_1IHX

On page 176, a new non-TTO is defined as G (081)(B3A)(627)(594). The subgroup of TTOs with which G commutes is mislabelled on this page and on the next. It should be: {T_0 T_6 T_5I T_BI}.

[9]A mathematical group requires closure (so that any composition of operations within the group maps onto an operation within the group), that every operation have an inverse (an operation that "undoes" the transformation of the first), and that there be an identity operation. The inverse for any transposition of pcs is its complement mod.12. Each T_nI is its own inverse. A group is a subgroup of a larger group when all of its members are members of that larger group.

equivalence classes {17}, {0628}, {B539}, {4A}. This is displayed by reading the verticals in the example below.

T_0: 0 1 2 3 4 5 6 7 8 9 A B
T_6: 6 7 8 9 A B 0 1 2 3 4 5
T_2I: 2 1 0 B A 9 8 7 6 5 4 3
T_8I: 8 7 6 5 4 3 2 1 0 A B 9

In cyclic groups, equivalence classes are cycles of the generator of the group. And generally, the equivalence classes of a group are partitioned into the equivalence classes of its subgroups. Morris studies transformations of such equivalence classes as they are mapped into cosets of subgroups, and into automorphisms.[10] The topic is extremely cogent both in studying classical twelve-tone technique, such as the relations among quartets of rows that inform so much of Schoenberg's music, and in studying techniques developed by Babbitt and subsequent generations of composers.

Another central topic arises out of the methodological steps that immediately precede the composition of pc designs in all of their complexity. This requires composing, expanding, modifying and combining more simple arrays of pcs. We will consider only the last topic here, techniques for combining arrays. Morris develops three basic functions by which arrays are combined with other arrays. The most general of these is a function named MERGE. MERGE involves keeping the integrity of the columns and rows of two arrays intact as the arrays are combined. For example, one simple MERGE(A,B) would be as follows.

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[10]A coset results from mapping a subgroup into a non-group by some operation not in the group (see p.164). An automorphism results from mapping a subgroup into itself or into another subgroup (see pp.167, 168).

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A: AAA  B: BBB  MERGE(A,B): A A A
   AAA     BBB                B B B
                             A A A
                              B B B
```

Two more examples of MERGE(A,B):

```
AAA      AA A
AAA      AA A
   BBB     B  BB
   BBB     B  BB
```

The full notation for MERGE names the arrays to be merged, places some position in A relative to some position in B, and denotes the pattern of rows and columns for A and B.[11]

Another function "superimposes" columns and a third "concatenates" rows. Two simple examples of each follow.

```
SUPER (A,B)            CAT (A,B)

AAA  or AAA            AAABBB  or AAA
AAA     AAA            AAABBB     AAABBB
BBB  BBB                             BBB
BBB  BBB
```

The functions that combine arrays are themselves combined with a family of other techniques and functions that allow the

[11] The full notation for MERGE is given on page 226, however the notation is applied inconsistently throughout the text. The inconsistency arises because at times the row design is denoted before the column design while at other times this order is reversed. Several of the MERGE functions are also marred by typographical errors.

composer to creatively transform pc arrays with great flexibility and specificity. To be sure, it is these transformational techniques that allow source arrays to be useful as the basis for compositional designs.

Some Observations on the Theoretical Approach

Despite Morris's statement that a compositional theory "must not specify, in any but a rather tentative manner, the stylistic component of the music," and other statements like it, Morris's work is highly conditioned by his own attitude toward composition. Nor should it be otherwise. As we have noted from the beginning, Morris is clearly allied with a specific tradition of thought in and about music. The constraints that help to define a community of thought bring expressive freedom to those who operate comfortably within the community. Yet, a conflicting sense of historical and cultural relativism is evidently a strong component of Morris's self-awareness. This sense causes Morris to step outside of his own tradition, and to recognize how its freedoms are constrained by its assumptions. Thus, within the text, at times there is a tension between two conflicting urges, one being grounded in the assumptions and requirements of a specific community and the other reminding the reader that any or all of those assumptions may be trashed.

Morris's compositional predilections are implied throughout his discussions of musical objects and functions, and they are made fairly explicit in his compositional designs. Near the beginning of

Chapter 6, the text notes "The designs were composed to bring up a number of issues that often interest composers and theorists alike." A footnote is appended to this sentence, and it reads like a legal disclaimer: "None of these issues is to be taken as a mandatory requirement for a normative attribute of 'successful' designs." Disclaimer nonetheless, the "issues," especially given the designs that follow, might have been described as "desiderata." Such desiderata are not separable from the kinds of objects and functions that have been described earlier in the book. They are basic aspects of the musical language that one becomes conversant with as one masters the ways of thinking about music that Morris's book is about. Thus, we find **coherence**, a sense of sonic unity, **closure** and **saturation**, for example through set completion and overlapping, **hierarchization**, as in the subsumption of smaller temporal units into larger ones, and **heterarchies** (Douglas Hofstadter's term), associations that are not hierarchical in nature, such as previews and recollections. It is safe to say that every one of these issues informs each of the compositional designs in the book. Yet the point remains, that such ideas and techniques are extremely flexible and can be extended to apply in extraordinarily diverse ways.

Another interesting and recurrent concern of the text is generated by the desire that its rigorous formal thought may result in aurally lucid music. Although Morris's book is not a theory of musical perception, neither is it a book about abstract formalisms. Thus from time to time, Morris stands back from the formalisms and thinks about ways to articulate formal properties in real compositional contexts. Of course, the concern is essential. However, many of the formalisms are not meant to be perceptible in exact "real-time" analogues. In other words, there is often a disparity between method and result, between **efficient cause** (making the thing) and **material cause** (the thing that is made). In such cases, it is the **result** of applying functions to objects that concerns the composer primarily, and the formal function, in correct perspective, is a means to an end.[12] Morris is sensitive to this problem and he addresses it, for example, in his discussion of non-TTOs.

> Like TTOs which include M, it is not necessary for these operations to have direct aural effect. Their prime importance is that they can help produce interrelations (especially order interrelations) among entities related by TTOs.

In many instances a more "analytic" notation might bridge the gap between formal functions and compositional results. Such notation would name relations and transformations that are aurally cogent in a specific context, although it might not have the general systematic and specifically group-theoretic properties that Morris wants. In a similar way, a more context sensitive notation for pitch and pc space would not necessarily have a fixed 0 reference.[13]

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[12]It may be argued that even "the thing that is made" is once removed from an even more basic requirement in composition; that "the thing made" be suitable for its functional context within a composition. Following through in Aristotelian terms, the composer needs to correlate **efficient, material and final causes.**

[13]This topic is considered in depth by David Lewin in Chapter 3 of *Generalized Musical Intervals and Transformations*, (New Haven: Yale University Press, 1987).

Some Practical Difficulties in Reading and Applying the Text

First on the list of practical difficulties is an unusually large amount of typographical errors and editorial slips, virtually all of which involve integers. Most of the typos are easy enough to spot and correct, however some are quite disorienting. One hopes that Yale University Press quickly publishes a list of errata. And one hopes that the list be made available to those who have already purchased the book. We will point out only two errors, whose correction should be helpful in reading the respective passages.

The example on the bottom of p.193 seems to be the wrong example, it should be something like:

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  0137
0 0137
2 2359
6 6791
```

On p. 259, rows 1 and 2 in the F system of Design V evidently were shifted. The correct display is:

	Q	Q	Q	Q	Q	Q	Q	Q
1)	5		B	9436 2				0
2)	9	3			1	8 7A	6 4	
3)								

In addition, we will note that poset graphs on pp. 201, 209, 212, 214, 216 and 265 contain errors. The reader who has followed Morris's discussion should easily be able to correct these.

Another difficulty in the physical make-up of the book is in the use of italics in many examples to distinguish some integers from others. Given the typeface in which the book is set, it is extremely difficult to distinguish italic integers from those in normal print. Thus, examples that contrast numbers in italics with numbers in normal printface are unnecessarily difficult to read. Perhaps a second edition of the book might consider some more vivid change of printface within such examples.

A different set of problems arises because of difficulties intrinsic to the subject matter and because of the concise mode of presentation. There are numerous places where Morris either presents information, or composes an example where desired properties obtain, without explicitly stating how the information was derived or how the example was fashioned. In most instances, the reader should be able to fill in the missing steps either by using information previously presented or by extrapolation. This kind of interaction with the book is a necessary and rewarding aspect of working through it. Keeping this in mind can also be useful for teachers who may use the book with advanced students.

A related sort of interaction is helpful in coming to terms with the generalizations of the techniques and problems involved in composing specific compositional designs. Whereas elsewhere in the book Morris provides formal algorithms (for example in his discussion of **chains of** SCs on p.90 and following), here the discourse is through straight descriptive prose along with examples. One senses that Morris is avoiding the "cookbook" approach about which he remarks in Chapter 1, and that is a wise decision. Nonetheless, because the problems, especially in some of the more complex designs, are rather difficult, it is helpful for the reader to break down Morris's discursive language into a number of discrete steps. Such an approach would be especially helpful if the designs are used to generate a set of compositional exercises.

Conclusion

In *Composition with Pitch-Classes* Robert Morris restricts himself to a specific subset of music theory in the twentieth century. That subset however forms an integral body of theory with vast ramifications which even here, the author would surely agree, are barely touched upon. Although composers may value other composers for "what they have done," a more profound evaluation is based on "what they suggest." To the degree that a creative enterprise is suggestive of further enterprises, it is open-ended. The richness of this book is in its open-endedness.[14]

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[14] In working through *Composition with Pitch-Classes*, I have benefited from lengthy conversations with my friends and colleagues Steven Cahn, Stephen Dembski and Joseph Straus.