David Lewin and the Complexity of the Beautiful

David Lewin: *Generalized Musical Intervals and Transformations*. Originally published 1987; reprint, New York: Oxford University Press, 2007.

David Lewin: *Musical Form and Transformation: 4 Analytic Essays*. Originally published 1993; reprint, New York: Oxford University Press, 2007.

Review Article by Julian Hook

Music is complicated. Layers of profound and intricate structure lurk within the music of the iconic minimalist Reich, the implausibly terse Webern, and the too-simple-for-children Mozart. If Occam's razor is to be believed, we are supposed to value simplicity, but it is hard to escape the impression that much of the beauty of music rests in its complexity—that complexity is what draws us to music and makes some of us want to spend many of our waking hours studying it. As analysts, our job is often a reductive one—to explain away some of music's complex features and to make them look simpler—but we should not deny the complexity, nor operate under the conceit that our reductions are the aesthetic equals of the more elaborate originals.

Few writings on music illuminate both its technical and aesthetic aspects, and the relationship between beauty and complexity, as do those of David Lewin (1933–2003). Renowned for his mathematical formalizations of musical structure, Lewin can be forbiddingly abstract, his pages laden with impenetrable notations and recondite chains of definitions and proofs. But one cannot read much of Lewin without encountering his other side, the deeply human and fervently musical side, the Lewin whose every formalism has its origin in musical intuition, who time and again wants to share with us his personal ways of listening and performing. Or perhaps there are not two sides: for Lewin himself, they may have been inseparable. Thus when Lewin devotes four full pages to a study of the first *six notes* of the last movement of

Webern's Piano Variations, he is detailing the structure of a Generalized Interval System, but is also recounting a dynamic, phenomenological process in the mind of an idealized listener, an unfolding awareness of pitch and time relationships among those notes. When he expatiates for some 63 pages on Debussy's four-minute "Feux d'artifice," he is providing a brilliant display of transformational fireworks, but in the process he reveals that Debussy's concluding *Marseillaise* quotation (in addition to its extramusical role as an expression of French nationalism) is a logical culmination of a process that began many measures before and which unites the many seemingly heterogeneous strands that make up this enigmatic Prelude; Lewin shows us how we may hear these connections if we try.[1]

Lewin's books, *Generalized Musical Intervals and Transformations* (hereafter "*GMIT*," 1987) and *Musical Form and Transformation: 4 Analytic Essays* ("*MFT*," 1993), have been out of print for a number of years, but both have rightfully attained the status of classics in the modern music theory literature, and there has been a small but continuing demand for them. The reprinting of both books by Oxford University Press is therefore an occasion for some celebration. Together with Oxford's 2006 publication of another collection of Lewin's writings, *Studies in Music with Text*, the reprints give us a new Lewin trilogy, a compact summation of much of the most important work of one of the leading music scholars of his, or any other, generation.[2]

GMIT and *MFT* will be familiar to many readers of this article, and both enjoyed many reviews after their initial printings. (See, for example, Rahn 1987, Vuza 1988, Clough 1989, and Cohn 1989 for *GMIT*; Lambert 1994, Morris 1995, and Cook 1996 for *MFT*. Klumpenhouwer 2006 cites and comments on several additional

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1 Lewin, *Generalized Musical Intervals and Transformations*, 41–44 (Webern); *Musical Form and Transformation*, 97–159 (Debussy).

2 About half of the essays in *Studies in Music with Text* were published previously; the rest appear in print here for the first time. Two other posthumous Lewin publications deserve mention: Lewin 2004 forges a new mathematical-musical connection by finding application for a branch of mathematics unrepresented in *GMIT*, projective geometry; Lewin 2008 is analytical, much in the spirit of the *MFT* essays.

reviews of *GMIT*.) Not wishing to rehash the books' contents yet again or encroach too much upon the territory staked out by the previous reviewers, I will confine myself here to a few assignments. In an extended opening section, I will make some suggestions in regard to how I think Lewin's writings might best be approached by readers, or taught to students, who have yet to come to terms with them—offering along the way some comments about the nature of the transformational enterprise and comparisons with other analytical approaches, particularly the Schenkerian. I will then discuss a common perception about transformation theory that I believe is somewhat distorted; will briefly describe some features new to the 2007 printing of *GMIT*; and will offer some concluding speculations on the current—and future—state of the field.

I. A way in (and a Schenkerian digression)

GMIT is a famously difficult read. The book begins with a chapter of "mathematical preliminaries" whose intent is to acquaint non-mathematicians with some of the apparatus that the rest of the book will require; we are led from the basic definitions of functions, groups, semigroups, and equivalence relations through concepts such as homomorphisms, quotient semigroups, and semigroup congruences. By one way of thinking, this strategy is apt and logical: much of the content of the book is mathematical, and many readers will need a primer. On the other hand, Lewin understandably wants to keep the "preliminaries" short, in order that they not consume a disproportionate share of the book. He manages to condense the chapter into fifteen pages, but thereby produces an exposition considerably denser than what one might find in a typical abstract algebra text. If Chapter 1 has driven away potential readers, it is not hard to see why.[3]

[3] Their musical motivations notwithstanding, a surprisingly large number of the concepts in *GMIT* are in effect pure mathematics, could be developed at length with no mention of music, and could lend themselves to applications in fields other than music. Thus, one can easily imagine Generalized Interval Systems used to model spatial relationships among physical objects, or transformation networks whose objects are numbers and whose transformations are mathematical functions of various kinds. As pure mathematics, Lewin's work is not groundbreaking (Vuza [1988] has shown its close relation to concepts already present in the mathematical

Lewin admits in his introduction that he is unhappy with this way of beginning; he suggests that readers may skip Chapter 1 on a first pass, using it for reference as needed. This is sensible advice, and the examples of musical spaces and ways of measuring intervals with which Chapter 2 begins are surely a more inviting initiation for most musically oriented readers than the abstraction of Chapter 1. But the difficulties have only begun; as readers discover soon enough, large parts of the book will require them to negotiate not only abstract concepts and forbidding notational complexity, but also an uncompromisingly formal Definition-Theorem-Proof-Corollary-Remark style typical of advanced mathematics texts.

John Clough, in his 1989 review, observes that the many musical analyses in *GMIT* are more approachable than the purely theoretical sections, and suggests that browsing the analyses (of which a handy catalog is provided in Cohn 1989, 58–59) is a good way to assimilate the flavor and scope, if not all the technical details, of Lewin's work. The relative accessibility of the analytical sections is manifest, interestingly, not only in the central presence of the musical examples around which the discussions coalesce, but also in a noticeable relaxation in Lewin's way of writing. Whereas the theoretical sections are dense, formal, and to the point, the analytical excursions are comparatively loose and expansive; some of them meander off on charming side trips, and in some of them even the book's section-numbering seems to be temporarily suspended.

Clough suggests in particular that the analysis of Beethoven's First Symphony, which spans the final pages of Chapter 7 and the beginning of Chapter 8, could be a good place to start. Indeed, this analysis, based mainly on intervals between chord roots, is one of the most digestible in the book. It provides several handy illustrations of transformation graphs and networks and the difference between them; shows how a larger transformational structure may be constructed as a quasi-hierarchical assemblage of smaller structures; touches on the important distinction between the structural logic of a musical passage and its chronological

literature); its pioneering aspects lie in the specific ways in which the definitions are tailored to musical applications.

presentation; and reveals some perhaps unsuspected commonalities in the harmonic structure of the two passages under consideration—the openings of the first and third movements of the symphony.

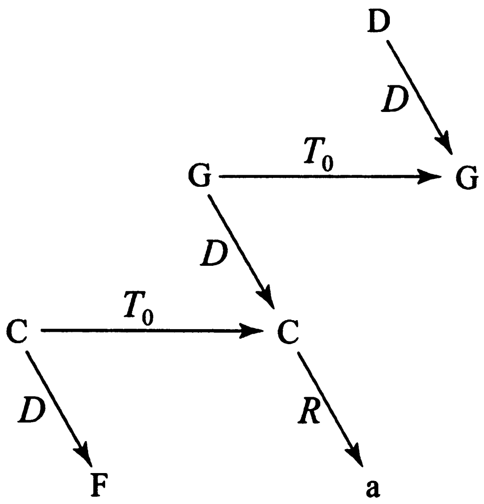
With the intent of following Clough's suggestion, I have assigned Lewin's Beethoven analysis as required reading in several classes, both graduate and undergraduate. The results have not been what Clough probably would have expected: perceptive students, especially those with some training in Schenkerian theory, are willing and able to criticize this analysis on numerous grounds. The exercise has been an illuminating one, as the students' protests have led to some lively discussions about Lewin's methods and musical insights, what his analysis actually accomplishes, and how the methods on display here differ from more familiar analytical strategies. I believe it may therefore be instructive to review some of these objections, along with possible responses to them.

Lewin's analysis, or something much like it, is summarized in Example 1. I have modernized the notation a bit, writing *D* rather than DOM for the "dominant" transformation (which transposes any triad down a perfect fifth), T_0 rather than IDENT for the identity transformation on triads, and R for the "relative" transformation that links a major triad to its relative minor.[4] Apart from such changes of notation, the only meaningful difference between Example 1 and Lewin's Figure 8.1 is that Lewin models the relationship between C major and A minor using the "mediant" transformation *M* (or MED) rather than R. As I have discussed at length elsewhere,[5] R and *M* are not the same transformation, but the difference between them is of little consequence here, and R will be more familiar to readers acquainted with neo-Riemannian theory. The network describes the passage in question—or rather

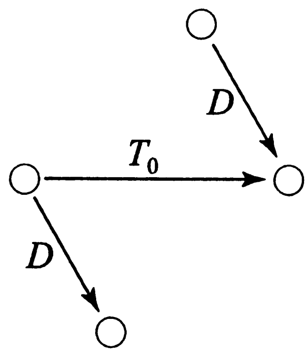
[4] Since the development of neo-Riemannian theory in the 1990s, the shorter names for these transformations have come into widespread use, and in fact Lewin himself began using them soon after the appearance of *GMIT*. The change does bring with it a need to exercise care in distinguishing italic *D*, the dominant transformation, from Roman D, the D major triad.

[5] See Hook 2002, 89–92, and Hook 2007, 27–28.

Example 1. Transformation network analysis of Beethoven, Symphony No. 1, mvt. I, mm. 1-4, and mvt. III, mm. 1-4 (after Lewin, GMIT, *176, Figure 8.1)*



Example 2. A transformation graph occurring within Example 1 (after Lewin, GMIT, *172, Figure 7.10)*



the passages, as it applies both to the first movement of the symphony and to the third as well—as three V–I cadences (C–F, G–C, D–G) moving systematically through musical space by intervals of a fifth, the dominant of one cadence becoming the tonic of the next; the middle cadence is augmented by an A minor "tail." Lewin abstractly models the motion from one V–I progression to the next by a graph like that of Example 2. He shows how the network of Example 1 may be constructed by forming two concrete realizations of Example 2 and merging them, and also observes that the tonics of the four cadences in those two realizations (F, C, C, G) may be arranged to form yet another instance of Example 2.

By skipping over the first few pages of Lewin's analysis, I have bypassed a number of objections that students commonly raise in response to the earlier versions of his network analysis (pp. 170–73), in which transformations are represented as interval ratios (2/3, 1, and 5/6 in place of D, T_0, and R, respectively). For one thing, these ratios suggest that the chord roots must be actual *pitches* rather than pitch classes, thereby implying, for instance, that the root of the D chord must be a thirteenth above the root of the F chord (rather than a sixth above or a third below). A second complaint is that the interval ratios do nothing to explain why the chord on A is opposite in mode to the others. These are good objections; the first can be answered only by a rather fussy detour into group theory,[6] and the second is effectively unanswerable. Lewin concedes that this first representation of intervals is "not quite adequate" (p. 170). This representation does, however, offer a good opportunity to start thinking of intervals as transformations; those unhappy with it can simply be redirected to the more

[6] One can conceive of intervals in pitch-class space as ratios, not within the full multiplicative group $\mathbf{R}^+$ of all positive real numbers, but instead within the quotient group $\mathbf{R}^+/G$, where G is the group consisting of all integral powers of 2. In this way, any interval may be represented by a real number between ½ and 1 (or alternatively between 1 and 2). The real numbers may be replaced by the rationals if only integer ratios are desired, or by a subgroup of the rationals if only *some* integer ratios are desired. In fact, Lewin (p. 36) has already described a quotient GIS with this essential structure, in which the only intervals are those generated by pure major thirds and perfect fifths.

satisfactory version of the analysis, resembling Example 1, that emerges a few pages later.

The next cavil is that Lewin's analysis of chord roots is not correct. In the first movement, there is no C chord corresponding to the second C in the network; in the third movement, the first supposed G chord is not really a G chord but consists only of a passing B and D over a tonic (C) pedal. I overrule this objection on the grounds that it is in the nature of analysis to be reductive, and Lewin's is no more so than many others with which all of us are comfortable. We regularly ignore non-chord tones and treat incomplete harmonies as if they were complete; in Schenkerian graphs we align events that are not actually simultaneous and parenthetically supply scale degrees missing from *Urlinien*. Lewin's fictions may be different from others we have learned, but it is not hard to hear the excerpts as he asks us to: that is, to hear the deceptive move to A minor in relation to the more usual triad of resolution, C major, and to hear the B–D dyad as a very quick, degenerate sort of dominant chord.

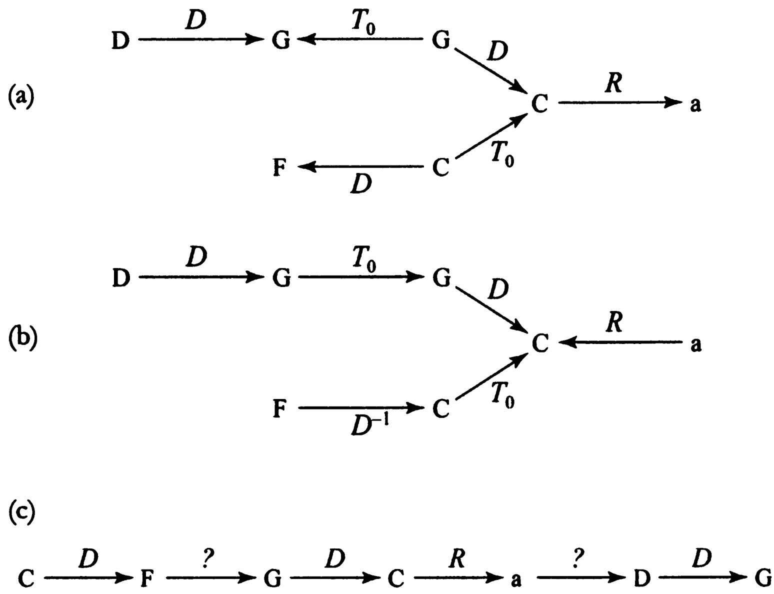
Next, it is said that the progression represented by the network is so generic, and so readily handled by familiar methods, that its appearance in two different places is unremarkable and the development of customized high-powered tools to describe it is unjustified. Why not just label it I–IV–V–I–vi–V/V–V and be done with it? What more, exactly, does the network analysis tell us? Such complaints are nothing new for Lewin and his work. Hard on the heels of his first published article (Lewin 1959) came a testy letter to the editor (Swift 1960) in which Lewin's work is called "musically trivial," his use of language is said to be "intended to intimidate the reader," and his mathematical apparatus is likened to "killing a gnat with a pile-driver." Whatever one's take on the virtues of simplicity, the notion that it is possible for a theory to be "too powerful" still exudes the air of a flimsy cop-out, a shirking of the responsibility of getting one's mind around something different and possibly difficult, like criticizing a dictionary because it contains many more words than one will ever need to look up. In any case, Lewin's analysis *does* call our attention to relationships that would probably be overlooked in, for instance, a Schenkerian study of the same music, not only because of a general reluctance among Schenkerians to consider inter-movement connections but also because (as the discussion below will clarify) some of those relationships would not be tenable in a Schenkerian conception. Moreover, the analysis serves additional purposes by dint of its placement within the broader narrative of *GMIT*: it analyzes Beethoven's music, to be sure, but also it illustrates concepts such as graphs, networks, and isomorphisms, concepts not yet fully developed in the text, and sets the stage for a further exploration of specifically *triadic* transformations, which immediately follows and which we may regard from twenty years' remove as the *de facto* birth of neo-Riemannian theory, among the most influential pages in all of Lewin's writings.

The spatial arrangement of the nodes and arrows in Lewin's graphs sometimes provokes spirited discussion. The nodes in Example 1 are, in fact, arranged in chronological order from left to right, but the arrows do not always join temporally adjacent events. Both of these circumstances involve interpretive choices on Lewin's part, and those choices may be scrutinized. Example 3 shows three potential reconfigurations of Example 1, and it is instructive to inquire what makes Lewin's arrangement preferable to any of these. As an abstract network, Example 3a is identical to Example 1; nodes, arrows, and labels correspond exactly, the only differences being in matters of graphical positioning, which are extrinsic to the structure of a network. Inasmuch as all the transformations appearing in these examples belong to a group, one could go further and reverse the directions of any or all of the arrows, replacing each affected transformation with its inverse, perhaps as in Example 3b; again, the resulting network in principle says nothing more and nothing less than the original.[7] Finally, if we are to understand that chronological order is important, then we might expect that the transformations themselves should respect this order, suggesting an arrangement such as that of Example 3c.

It is true that the network structures of Examples 1 and 3a impart identical information. To see how they differ requires stepping out of the system and considering features beyond the

[7] Note that T_0 is its own inverse, as is *R*, so those labels need not be changed when arrows are reversed. Graphs in which every transformation has an inverse are called *reversible* in Hook 2007.

Example 3. Three reconfigurations of the network in Example 1.



abstract node-arrow structure of the networks. Doing so enables us to appreciate Example 1's implicit time axis, which Example 3a lacks. In Example 3b, likewise, it is true that "C-to-F-by-*D*" and "F-to-C-by-D^{-1}" are functionally equivalent, but our understanding of *D* as "what happens at a V–I cadence" is better served by presenting the transformation in that form (especially when, as here, it coincides with chronology).[8] The moral is that a good transformational analysis almost always encompasses more than just the formal structure of a network; in particular, visual presentation *can* make a difference. (The burden on the accompanying narrative is often substantial as well.) Lewin perhaps

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[8] Lewin devotes considerable effort (*GMIT*, p. 177) to explaining why *D* (his DOM) is defined so that dominants point to their tonics rather than the other way around; he goes so far as to criticize Riemann's function theory for *not* describing dominant-tonic relations in this way. Formally, either way is as good as the other, but clearly the additional layer of interpretation is of considerable importance to Lewin.

never made this point as explicitly as he might have,[9] but his analyses are generally exemplary in this regard, illustrating his remarkable aptitude for choosing graphical arrangements that communicate his intuitions about whatever musical relationships he finds significant in the excerpt at hand.

Example 3c, with its strictly chronological arrangement, does not convey the same information as the other networks. Considerable analytical power is sacrificed if only adjacent events are allowed to communicate—not only because relationships of longer span are forbidden but also because the relationships between some adjacent events may be obscure (note the two undetermined transformations in the example). Analyses of this sort, however unsatisfying, may be motivated by a discomfort with the almost complete lack of constraints on the placement of arrows in Lewin's graphs.[10] The formal theory provides no guidance about where arrows should or should not go; no rules of network formation prevent us, if we so choose, from drawing an arrow linking the F major and D major triads in Example 1, whether or not any musical intuition supports such an arrow. This blank check is seen by some not as a sign of power and flexibility but as a lack of coherent methodology, a defect in the underlying theory—a defect that might be circumvented, not very satisfactorily, by imposing rigid rules of organization like those underlying Example 3c.

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[9] Lewin's most extended discussion of the spatial aspects of network layout is found in the Stockhausen analysis in Chapter 2 of *MFT*, where he contrasts a "figural" network, whose arrangement reflects chronological progress through a piece, with a "formal" network that lays out an abstract, systematically structured musical space in which the music may move about in various directions. (He borrows the terms "figural" and "formal" from a cognitive study by Jeanne Bamberger.)

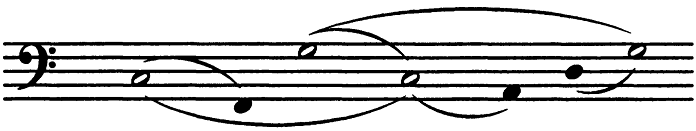
[10] The lack of constraints is only "almost complete" because of condition (D) in the definition of transformation graphs (*GMIT*, p. 195), which requires products of transformations along multiple paths joining the same pair of nodes to match. I have dubbed this constraint the ***path consistency condition*** (Hook 2007), and have argued that as a general requirement for transformation graphs path consistency is unnecessarily restrictive, and that in fact non-path-consistent graphs can be musically revealing.

This point of view, I believe, betrays a misunderstanding of what the theory does and does not attempt to be. Transformation theory is a large and varied toolbox; there are only some minimal instructions for using the tools, and no designs at all for what one can build with them. Schenkerian theory, in contrast, is a smaller and more specialized toolbox, but it comes with more instructions and even some partial sets of blueprints. If we assign a piece to a class and instruct them to "do a Schenkerian analysis," the students will not all produce identical (or equally good) graphs, but we have a reasonable idea in advance of the steps they will go through and the results they will get, because they will all be using the same tools and reading from the same plans. If we give instead the instruction "do a transformational analysis," we can have no such preconception; the results will be as diverse as the students' imaginations. If it is possible to use transformational tools badly, we should not conclude that the tools themselves are at fault, any more than we blame the musical instruments for a bad performance.

Widely separated events may be joined by slurs in a Schenkerian graph, but not, of course, at random; interpretive decisions are required on the part of the analyst. The same is, or should be, true of transformation networks. Even if we are *allowed* to draw an arrow from the F major to the D major triad, surely we should not do so unless we can articulate some structural or perceptual connection between the two that we want our network to portray. While Schenkerian analysts have (fairly) rigorous guidelines and well-honed intuitions for making the required decisions, transformational analysts may not. We may be able to arrive at such guidelines and intuitions, but only after making some more fundamental decisions about what types of objects and transformations will be used in a network, and probably only after acquiring some experience at working with these objects and transformations in a variety of situations. An analytical approach in which each analysis must write its own rules may seem inefficient, but pays dividends in the varied insights it can provide and in its casual disregard for stylistic boundaries; indeed, such an approach may well be imperative in those broad swaths of the post-tonal repertoire in which it seems that each *piece* writes its own rules.

To some extent, the carte-blanche quality of transformation theory is attributable also to the newness and rapid growth of the field. Frontiers are lawless places. The explosion of activity that began with the publication of *GMIT* has produced a great variety of techniques and approaches, none of which have been extensively standardized or codified. It could reasonably be claimed that in the most thoroughly explored provinces of transformation theory, such as neo-Riemannian theory and Klumpenhouwer networks, standards have begun to take hold—but not to an extent remotely approaching the standards of Schenkerian theory, which after all enjoys the benefits of a decades-long head start and a larger population of proponents.

Example 4. A quasi-Schenkerian reconfiguration of the network in Example 1.



Example 4 recasts the analysis of Example 1 yet again, this time in a format resembling a Schenkerian bassline sketch. The conversion is straightforward—the nodes have become noteheads, the arrows slurs—but as a Schenkerian graph, Example 4 is ill-formed. The C–C slur marks the intervening G as structurally subordinate, while the G–G slur marks the second C as subordinate. Either slur is possible by itself, but the two are incompatible. In transformational theory, such associations are perfectly permissible; it is up to the analyst to decide when they are meaningful. In this way, at least, the transformational analysis is more flexible and less prescriptive than the Schenkerian; the transformational approach suggests a reading to which a rigidly Schenkerian approach may have blinded us, and is certainly more amenable to the possibility of accommodating multiple interpretations within a single analysis. It is also arguably more explicit, because of the transformational labels in Example 1. (Of course, every slur in a good Schenkerian graph has a clear meaning; students inclined to sloppiness might be well advised to label every slur.)

It is, in the end, a mistake to regard "transformation" and "prolongation" as antithetical conceptions. The clear correspondence between the graphic elements of Examples 1 and 4 suggests, correctly I think, that transformational analyses can accommodate prolongational structures, and even that Schenkerian concepts such as prolongation, expansion, progression, and unfolding are transformational in spirit.[11] Indeed, analyses that relate prolongational (specifically Schenkerian) and transformational (specifically neo-Riemannian) methodologies have proliferated in recent years. Cook (1996, 146) points out that Lewin's own analysis of "Feux d'artifice," or at least his terminology, displays an "increasingly Schenkerian" bent, extending as far as references to *Züge* and a "middleground beam" (*MFT*, 149). An early example of a transformational analysis displaying a clear hierarchy of transformations in several levels is Brian Hyer's analysis of the "Magic Sleep" chords from *Die Walküre* (Hyer 1995, 113). Cohn 1999 fuses neo-Riemannian transformations with more traditional concepts of tonal structure in a study of Schubert's B-flat major sonata, and Kopp 2002 includes many transformation networks presented in a quasi-Schenkerian format, each slur bearing an arrowhead and a label. Samarotto 2003 perhaps finds more to differentiate the two approaches than to integrate them, but still concedes that "the application of a series of transformational operations does not automatically entail a departure from tonal coherence." Rings 2007a (among other articles in a special issue of the *Journal of Schenkerian Studies* devoted to the intersection of Schenkerian and neo-Riemannian methods) offers valuable commentary on the apparent dichotomy between the two approaches and, ultimately, a reconciliation in the form of a virtuoso hybrid analysis that captures aspects of the tonal structure of Schubert's E-flat major Impromptu that are not adequately modeled by either approach in isolation.

The above digression may serve to confirm Clough's impression that Lewin's analyses are a good point of entry into his methods, inasmuch as even the simpler analyses lend themselves to

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[11] See *GMIT*, 217–18, and Cohn 1989, 57, for similar sentiments. Cohn observes that Lewin's transformations are to some extent antithetical to *classification* in the sense of Fortean pitch-class set theory, but not to prolongation.

wide-ranging discussions and have many points of contact with other methodologies. This point was evidently not lost on Lewin himself, for in the introduction to *Musical Form and Transformation* he expresses the hope that the more extended analyses to be found there might be read with profit by "a reader who may not have read *GMIT* or even heard of it" (nor was it lost on whoever first dubbed *MFT* the "movie version" of *GMIT*). Nicholas Cook, for one, was able to take Lewin at his word, and produced an insightful review of *MFT* (Cook 1996) despite having been by his own admission "frightened off" *GMIT* by its mathematics. I have had classes successfully navigate the first three essays in *MFT* after only brief acquaintance with a few parts of *GMIT*, and all three can be enthusiastically recommended for readers new to Lewin. (If the Debussy analysis of Chapter 4 is a bit much for a transformational neophyte to swallow, that is due more to length than to any inherent difficulty.)

In particular, the study of Dallapiccola's "Simbolo" in Chapter 1 makes an effective complement to the Beethoven analysis just discussed. It is the shortest and most accessible essay in *MFT*, but unlike any of the analyses in *GMIT* it engages the structure of a complete piece. It deals with an atonal repertoire in which the use of transposition and inversion operators is commonplace, and indeed Lewin uses these operators—but hardly in a commonplace way. He puts off any mention of the twelve-tone row on which the work is based for as long as he can, instead defining his operations on "configurations" of a sort unique to this piece, consisting of three lines (two of them overlapping) and an "odd-dyad-out." Some instructive exercises for the reader:

1. Construct a traditional twelve-tone row analysis of the piece.

2. Construct a transformation network showing all the row forms in the piece and $T_n/I/R$ transformations relating them as appropriate, and verify that the product of all the transformations from the first row form in the piece to the last is the identity. (It must be, because the first and last rows in the piece are the same, and the $T_n/I/R$ group acts in simply transitive fashion on the 48 row forms. Demonstrating that the product is the identity, however, requires a good understanding of the algebra of $T_n/I/R$ operators.)

3. Compare the "classical" twelve-tone analysis with Lewin's analysis, and identify aspects of the piece that Lewin's captures better. (There are several, starting with the clear appearances of the segments of Lewin's configurations in the score, while linear row statements are completely absent.)

4. Explain how the contextual inversion operator that Lewin calls "*I*" (inversion about the odd-dyad-out) differs from the usual inversion operators T_nI, and how "*I*" is similar to the neo-Riemannian operators *P*, *L*, and *R*. In particular, explain why the two appearances of "*I*" in Lewin's Example 1.5 do not correspond to the same T_nI operator in the classical analysis.[12]

5. Is Lewin's analysis of the section beginning at m. 17, where the type of configuration changes, as successful as his analysis of the first part of the piece? (I think not, and Lewin's footnote on page 10 suggests that he thinks not as well.) Can it be improved? In particular, could some alternate segmentation be devised for the configurations in this section to account for the continuing prominence of the B-A-C-H motive? Is our understanding of the piece compromised in any way by Lewin's inability to define transformations relating the two types of configurations? (This is why the network of his Example 1.5 consists of two separate components, disconnected from each other.) Is he cheating when he claims that his contextual inversion operator "*I*" is defined on both types of configurations? Is his claim that the second part of the piece is a "variation" of the first unduly shaped by the visual layout of his network?[13]

And so on. In this as in many other cases, we can learn much by taking Lewin's analysis on its own terms, and even more if, rather than considering his analysis perfectly finished, we take it as a work in progress, a springboard for further exploration.

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[12] Those of us who like to illustrate pitch-class sets as overlays on an overhead transparency of a clock-face diagram have at hand a particularly convenient representation of the difference between fixed and contextual inversion operators. For a fixed inversion operator such as T_nI, the axis of inversion is drawn on the same transparency with the clock face. For a contextual inversion such as *P*, *L*, *R*, or Lewin's "*I*," the axis of inversion is drawn on the same overlay with the set being inverted.

[13] Both Lambert 1994 and Morris 1995 offer extended commentary on the Dallapiccola analysis, engaging several of the points raised in my exercises 4 and 5.

I will quickly mention a few other sources that may be helpful for first-time readers of Lewin. If the discussion of Generalized Interval Systems in Chapters 2 and 3 of *GMIT* seems to get too abstract too quickly, readers may find Lewin's earlier article "A Label-Free Development for 12-Pitch-Class Systems" (Lewin 1977a) a good way to cushion the shock. In this article Lewin works with pitch classes in a more abstract way than is usual in set theory, as his object is to avoid assigning integer labels to the twelve pcs. He effectively studies pc-space as a Generalized Interval System (the GIS that will later be Example 2.1.3 on page 17 of *GMIT*), defining the interval function and establishing the GIS axioms in this special case. He shows how transposition and inversion operators may be defined without using pc labels; other GIS concepts such as interval-preserving operations and label functions (by definition, extraneous to the system developed here, but readily definable within it) are introduced as well. In short, many of the ideas to be developed further in *GMIT* put in preliminary appearances in this article, but the actual stuff under the microscope here—ordinary pitch-class space—is more concrete, and the pace more leisurely.[14]

There is not a word about music in Grossman and Magnus 1964, but the first few chapters of this short book provide one of the most reader-friendly expositions of basic group theory to be found, with emphasis on visualizing group structure through the use of graphs and symmetry. The neo-Riemannian literature (e.g., Cohn 1998 and the other articles in the same issue of the *Journal of Music Theory*) offers many readily intelligible illustrations of transformations in action, but without the level of abstraction or generality (or the full power) of *GMIT*. Finally, Satyendra 2004 offers perceptive commentary on many aspects of transformation theory, including group structure, the relationship between intervals and transformations, neo-Riemannian theory, and non-commutative GISes.

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[14] Readers with the time and inclination to do so may benefit from studying several of Lewin's other pre-*GMIT* articles as well. Lewin 1977b, 1980, 1982, 1982–83, and 1984 all introduce important ideas that later found their way into *GMIT*.

II. Is there a "transformational attitude"?

One of the most frequently quoted passages in *GMIT* occurs near the beginning of Chapter 7, in a discursive transition from the "Intervals" part of the book to the "Transformations" part. Here Lewin deliberately contrasts the two approaches. When we work with intervals, he writes,

> ... we are very much under the influence of Cartesian thinking ... . We tend to conceive the primary objects in our musical spaces as atomic individual "elements" rather than contextually articulated phenomena like sets, melodic series, and the like. And we tend to imagine ourselves in the position of ***observers*** when we theorize about musical space; the space is "out there," away from our dancing bodies or singing voices. "The interval from *s* to *t*" is thereby conceived as modeling a relation of ***extension***, observed in that space external to ourselves; we "see" it out there just as we see distances between holes in a flute, or points along a stretched string. ...
>
> In contrast, the transformational attitude is much less Cartesian. Given locations *s* and *t* in our space, this attitude does not ask for some observed measure of extension between reified "points"; rather it asks: "If I am ***at*** *s* and wish to get to *t*, what characteristic gesture ... should I perform in order to arrive there?" ... "If I want to change Gestalt 1 into Gestalt 2 (as regards content, or location, or anything else), what sorts of admissible transformations in my space ... will do the best job?" ... This attitude is by and large the attitude of someone ***inside*** the music, as idealized dancer and/or singer. No external observer (analyst, listener) is needed. (*GMIT*, 158–59)

Much has been made of the distinction that Lewin draws here. It could be said to have ramifications on almost everything in the book, going all the way back to what may be the only portion cited more frequently than the passage above: Figure 0.1 in the introduction, the famous arrow-from-*s*-to-*t*, which admits either a "static" (interval-as-extension) or a "dynamic" (transformation-as-motion) interpretation. The dichotomy between "Cartesian thinking" and "the transformational attitude" makes a few other explicit appearances in *GMIT* as well, and continues to reverberate through present-day discussions of transformation theory, from informal conversation to published scholarship.[15]

I wish to argue here that *too* much has been made of this distinction. The first evidence I shall advance in support of this claim comes from *GMIT* itself. In the paragraph immediately following the passage quoted above, Lewin proceeds to dismantle, or at least to soften, the distinction he has set up:

> Either [intervals or transformations] can be generated formally from the characteristic properties of the other. More significant than this dichotomy, I believe, is the *generalizing* power of the transformational attitude: It enables us to *subsume* the theory of GIS structure, along with the theory of simply transitive groups, into a broader theory of transformations. This enables us to consider intervals-between-things and transpositional-relations-between-Gestalts not as alternatives, but as the *same* phenomenon manifested in different ways. (*GMIT*, 159)

What Lewin's mathematics shows, to be precise, is that a Generalized Interval System is functionally equivalent to a particular kind of transformational structure: a simply transitive group of transformations acting on a set of objects. For every GIS, one can define a simply transitive transformation group (namely, the group of transposition operators within the GIS) that captures all the information inherent in the GIS structure; conversely, given a simply transitive group acting on a set, one can define a GIS whose transpositions are precisely the elements of the given group.

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[15] These points were topics of much discussion at the 2003 Mannes Institute for Advanced Studies in Music Theory, which focused on transformation theory, and on which occasion some of the present remarks were first prepared. The dichotomy considered here features prominently in two recent essays, Satyendra 2004 and Klumpenhouwer 2006. Klumpenhouwer advances the interesting suggestion that the "anti-Cartesian" philosophy of Lewin's transformational approach has its origins in writings on dream psychology by his father, psychoanalyst Bertram Lewin. The adjective "anti-Cartesian" is Klumpenhouwer's, and is considerably stronger than Lewin's "much less Cartesian." Though I claim no expertise in Cartesian philosophy, I am not persuaded that "anti-Cartesian" aptly describes Lewinian transformations; *motion*, for Descartes, is a primary property of an object, as essential to its existence as its size, shape, and location in space.

Transformation theory "subsumes" GIS theory (rather than the other way around) because some transformation groups are not simply transitive, and therefore do not correspond to any GIS.[16]

Lewin's chapter begins not with the first passage above but with the mathematical proof of the equivalence of the two approaches. It is this proof that justifies the following discussion of the "transformational attitude," which is then flanked on both sides by remarks to the effect that transformations are really only another (more powerful, more general) way of working with intervals. Here as elsewhere, Lewin's methodological remarks appear in the context of specific technical arguments, and here or elsewhere, I find little to support Klumpenhouwer's contention (2006, 277) that "the central argument of Lewin's narrative [is] that we ought to replace intervallic thinking by transformational thinking." Indeed, only a page after the second passage quoted above (*GMIT*, 160), Lewin assures us (in an example in which the relevant transformations are transpositions) that "we do not have to choose *either* interval-language *or* transposition-language," inasmuch as they are "two aspects of one phenomenon, manifest in two different aspects of this musical composition." In the remainder of the book, true to his word, Lewin does not settle on one language to the exclusion of the other, but regularly juxtaposes intervallic and transformational notations side by side: notice, for instance, the pervasive use of GIS terminology throughout the latter half of Chapter 8, ostensibly devoted to "non-intervallic transformations." The overarching narrative is one of synthesis, not antithesis; whatever the "Cartesian" status of the intervallic and transformational approaches may be, both are incontestably Lewinian.

The music theory community, to be sure, has largely come to adopt a view of transformation theory as something "different"---as something novel and promising, perhaps, or newfangled and unproven, depending on one's proclivities—but certainly as

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[16] The action of a transformation group G on a set S is simply transitive if, for any two elements x and y in S, there exists one and only one transformation f in G such that $f(x) = y$. This definition, appearing on p. 157 of *GMIT*, is a standard one in group theory. The equivalence with interval structure is Lewin's insight (but see Vuza 1988 for some related mathematical structures).

something with a distinctive outlook, and *not* as just another way of talking about intervals. As the preceding remarks should suggest, I believe that this view differs notably from Lewin's—but of course a difference in view is attributable to a difference in where one stands. Significantly, Lewin's perspective was that of someone with considerable training in mathematics, a perspective not shared by many of his readers.

A Lewinian transformation is nothing more or less than what mathematicians call a *function.* Functions are defined on page 1 of *GMIT.* Lewin appropriated the notion of function for musical purposes because he saw it as a suitably precise way of describing relationships between objects of the sorts that music theory deals with; he also recognized that some functions were already in use by music theorists (whether they knew it or not) in such guises as transposition and inversion operators. Relating musical objects via functions would have seemed completely natural to Lewin, as it would to any mathematician.

The concept of function (or mapping, or transformation) is, like the concept of set, fundamental in all branches of mathematics, including hard mathematics, easy mathematics, good mathematics, and bad mathematics. It is so fundamental that it is hard to imagine doing any serious mathematics without it. In any mathematical writing, from an undergraduate textbook to the most esoteric research paper, functional terminology and notation may appear at virtually any moment. A mathematically trained reader will find this entirely unremarkable. Indeed, I have never heard a mathematician ask a question resembling any of the following:

"What point of view is the author adopting by using a function here?"

"What new power and vision does the appeal to function theory bring to this argument?"

"When she writes '$f(x) = y$,' does she mean that x is turning into y? That x is being replaced by y? That x comes before y? That x is moving to y? That something else is moving from x to y? Is she saying something about the distance between x and y? Is $f(x) = y$ a static statement or a dynamic one?"

If pressed on these points, a mathematician would probably say that "$f(x) = y$" does not necessarily mean any of those things, although in many cases one or more of them may be true. "$f(x) =$

y" is a precise way of making a statement about two objects x and y and how they relate to each other; the fact that a mathematician uses a function to express such a relationship should surprise no one, and is certainly of much less interest than the particular function f that she chooses for the purpose.

Functions are so ubiquitous in mathematics that one might as well question a mathematician's use of addition. Consider questions such as these:

"What point of view is the author adopting by adding these quantities here?"

"What new power and vision does the appeal to 'addition theory' bring to this argument?"

"When he writes '$x + y$,' does he mean that y is being adjoined to x? That y is extending x? That x is growing by an amount equal to y? That x and y are both constituents in the makeup of some larger entity? Is $x + y$ a static element or a dynamic one?"

If the questions are starting to sound silly, the point is that the questions in the latter set are no sillier than the former—and the former questions are the sort that music theorists, trying to come to grips with the "transformational attitude," are prone to asking. We all have a level of comfort with addition as an abstract concept that allows us to recognize that addition arises in a wide variety of contexts and can be conceived in a wide variety of ways. This comfort gives us the luxury of not having to worry too much about the subtle (or not so subtle) differences among them. The mathematics community has long ago attained the same level of comfort with the notion of function, but the music theory community as a whole has not, because as an abstraction, the concept is new to our field.

It is possible that our discipline will never reach the same level of detached objectivity about transformations that mathematics has. Maybe it shouldn't: if music theorists are by and large more philosophically oriented and more historically aware than mathematicians, we are richer for it. But thanks to David Lewin, transformational concepts are becoming part of the working vocabulary of every well-educated music theorist—I hope it is no longer possible to earn a PhD in music theory without at least some exposure to them—and perhaps before long we will all use basic transformational language with at least the same fluency and confidence with which we toss about interval vectors and prime forms of pitch-class sets. Then, rather than thinking too much about why we are using transformations or what we mean to imply by doing so, we will wonder instead how we ever got along without them.

III. What's new?

The new printing of *MFT* is unchanged from the original, save for a one-paragraph foreword by Edward Gollin (who deserves much of the credit for shepherding the reprinting of both books through to its completion). The new *GMIT*, however, comes with a bonus in the form of eighteen new pages at the front: a four-page foreword by Gollin and a fourteen-page preface by Lewin himself. Almost immediately upon publication of the 1987 edition, it turns out, Lewin was at work on a typescript he called "Updating *GMIT*," with a view toward an eventual second edition. A second edition *per se* never materialized, of course, but this document is the source of the material in the new preface.

The preface is fragmentary but stimulating: a series of short vignettes, each serving to amplify, revise, or illustrate one or more topics in the original *GMIT*. The first vignette, which revises the "Tarnhelm"/"Valhalla" analysis on pages 178–79, will be familiar to many readers, because Lewin later expanded it into an article of its own (Lewin 1992).[17] In some ways, though, the relationships between the various networks involved are presented more directly in the preface (Example 1c–f, page xv) than in the later article. (Here we may observe directly the evolution of Lewin's notation for triadic transformations. In *GMIT* he writes PAR, LT, and SUBD for the Parallel, *Leittonwechsel*, and Subdominant transformations. In the preface LT and SUBD are shortened to *L* and *S*, while PAR has become "+–". By the time of the 1992 article PAR has taken its now-familiar form *P*.)

Another section of the preface takes up an idea from Appendix B in *GMIT*, which explores two transformation groups and

[17] I have commented on Lewin's revisions to this analysis in Hook 2007, 25–28.

corresponding interval structures for an octatonic collection.[18] In the preface Lewin develops a similar pair of structures for a hexatonic collection (014589) and shows that many prominent motives in Schoenberg's *Ode to Napoleon* are related by the transformations in these groups. One group G_1 consists of the three ordinary transpositions and three ordinary inversions under which the hexatonic collection is invariant. The other group G_2 consists of operations of two kinds: three "queer" rotations that transpose the two augmented triads in opposite directions, and three "exchange" operators such as the one that exchanges each pitch class with its unique semitone neighbor.

These hexatonic structures, like the octatonic structures of Appendix B, engage several important themes that emerged in *GMIT* and have been explored further in more recent work. The transformations in G_1 are the usual "fixed" transposition and inversion operators, while those in G_2 are "contextual." Contextual operators (Kochavi 1998) play major roles in the analyses in *MFT* and, of course, in neo-Riemannian theory. The two groups are dual to each other in ways sketched in Appendix B, developed further in Lewin 1995, and detailed in great generality in Fiore and Satyendra 2005. There are several manifestations of this duality. While G_1 consists of familiar transpositions and inversions, the action of the contextual group G_2 is analogous instead to the Schritts and Wechsels of neo-Riemannian theory, which transform minor triads in ways equal and opposite to their actions on major triads. Both groups are non-commutative, but elements of G_1 always commute with elements of G_2; in group-theoretic terms, each group is the centralizer of the other. The groups are, in fact, isomorphic, although it is easier to construct an anti-isomorphism between them than an isomorphism. Each group acts on the hexatonic space in simply transitive fashion and therefore, by the equivalence shown in *GMIT*, makes that space into a Generalized Interval System whose "transpositions" are the elements of the group. If G_1 is taken as the group of transpositions defining the GIS, then G_2 becomes the group of interval-preserving operations in that GIS, and vice versa.

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[18] See Gollin 1998 and Capuzzo 2002 for applications of these octatonic transformational structures in the music of Bartók and Carter.

Two of the most substantial sections of the new preface stem from one basic idea, though their common ground is not mentioned explicitly. The idea is that there are two ways to conceive of a permutation of a sequential arrangement of objects: as a permutation of the objects themselves, or as a permutation of their order positions. Consider, for instance, permuting the string of letters *abcd* to form the new arrangement *dacb*. The arrangement *abcd* may be regarded as a mapping from the order positions 0, 1, 2, 3 to the four symbols, namely $0 \rightarrow a$, $1 \rightarrow b$, $2 \rightarrow c$, $3 \rightarrow d$, and similarly the second arrangement is the mapping $0 \rightarrow d$, $1 \rightarrow a$, $2 \rightarrow c$, $3 \rightarrow b$. To convert the first mapping to the second, we can permute the symbols according to the permutation $a \rightarrow d \rightarrow b \rightarrow a$, $c \rightarrow c$ (that is, replacing *a* with *d*, *d* with *b*, and *b* with *a*, leaving *c* unchanged). Alternatively, we may obtain the same result by leaving the symbols *a*, *b*, *c*, *d* alone but permuting the order numbers by the permutation $0 \rightarrow 1 \rightarrow 3 \rightarrow 0$, $2 \rightarrow 2$. Each system gives rise to its own permutation group, and the two groups turn out to be dual to each other in precisely the way just described: either one can be taken as the group of transpositions defining a GIS, and the other will then become the group of interval-preserving operations.

Lewin's first application of this idea is a fairly simple one, motivated by work by Daniel Harrison, since published (Harrison 1988). Here the objects are lines in a contrapuntal texture, and the "order numbers" are voices, registrally ordered. Lewin constructs two transformation groups, TPERMS ("tune permutations") and VPERMS ("voice permutations"), and analyzes the triple counterpoint in Bach's D Major Three-Part Sinfonia and A Major Prelude (*WTC* book I) within each system.[19]

The second application is more complex. In twelve-tone theory we know some transformations that act as pitch-class operations on rows (transposition and inversion), and others that act as order operations (retrograde and rotation). One can define groups of pc operations and algebraically isomorphic groups of order

[19] A persistent rumor (see, for instance, Schubert and Neidhöfer 2006, 287) has it that Bach never used all six of the possible permutations of triple counterpoint in one piece. In fact, he did so in the D Major Sinfonia, as Harrison's and Lewin's analyses clearly demonstrate.

operations; a group of either kind may be non-commutative, but pc operations always commute with order operations. The isomorphism has been studied at great length by Andrew Mead (1988 and 1989). Lewin, in his preface, explores one small tract within this vast realm, focusing his attention on rows of two specific types that can be defined by equivalent behavior under certain pitch-class and order-number operations. A row of the first type, called "special" by Lewin, has the property that its rotation by four order positions is the same as its transposition by T_4; for example, the row 0b56439a8712 has this property. A row of the second type, here called "semi-Mallalieu" following Mead, has the property that the row obtained by taking every third note is the same as the T_4 transposition; the row 0b45732681a9 illustrates this second property.[20] The upshot is that the "special" rows and the "semi-Mallalieu" rows each support a natural GIS structure, and the two GISes are again dual to each other as described in the previous examples.[21]

In addition to the "Updating GMIT" document, Lewin also left a list of errata, and Oxford has undertaken to make the indicated corrections in the new printing. The intent is laudable, but the outcome stands as something of a mixed blessing. It was not possible to make changes on the original pages, so all of the affected pages had to be recreated from scratch in electronic format, with two unfortunate side effects. First, although every effort was made to match the font and design of the original printing, the match is not perfect, and perceptive readers will learn to tell the new pages apart at a glance. More seriously, the rekeying has inevitably resulted in the introduction of new errors, which seem to be roughly comparable in number to the old errors being corrected. (Future changes to these pages should be easier, and

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[20] This is the row of Lewin's own piano piece *Just a Minute, Roger*, which he uses to illustrate; the same piece is cited in Mead 1989. By studying this row, the reader should be able to figure out exactly what "every third note" means after one has passed through the twelve notes the first time. The transformation can be conceived as a multiplication operator on order numbers mod *13*, not mod 12.

[21] Lewin 1966 and Lewin 1976 are also relevant to the "semi-Mallalieu" rows. See Guerrero 2006 for an application of properties of the Mallalieu type in the music of Luigi Nono.

Oxford has indicated the possibility of making further corrections in subsequent printings.)

Most of the new errors are unlikely to cause serious misunderstandings (improper capitalization, unmatched parentheses, and so on), but there is a small epidemic of potentially more confusing ones on pages 54–56, which warrant clarification here:

On page 54, in the statement of Theorem 3.5.6, part (C), I_n^v should be I_u^v. (The subscript should be *u*, not *n*.)

In the eighth line of the proof of the same theorem, the word "and" should be inserted between $T_n I_u^v(s)$ and $I_x^v(s)$.

On the fourteenth and thirteenth lines from the bottom of page 54 we find the equation $T_n^{-1} = T_n^{-1}$, which is of course a tautology. This equation should read $T_{n^{-1}} = T_n^{-1}$: that is, the mapping that transposes any element of a GIS through an interval which is the inverse of some interval *n* is equivalent to the inverse mapping of transposition through the interval *n* itself.

On page 56, in the statement of Theorem 3.5.8 and twice more in the proof, we encounter a transformation written as $P_{im}^{-1} T_k^{-1j}$. This should be $P_{im^{-1}} T_{k^{-1}j}$. (P_{im}^{-1} is not the same transformation as $P_{im^{-1}}$, and T_k^{-1j} does not make sense since *j* is a GIS element, not an integer.)

These errors occur in what is already one of the most difficult parts of the book. The subject matter is the relationship between transformations T_i and interval-preserving operations P_i. The distinction between the two becomes meaningful only in the case of a non-commutative GIS—in itself a rather unintuitive concept, as the most familiar GISes are all commutative.[22] Moreover, the

22 I have sometimes wished that Lewin had reserved the word "interval" for the commutative case, in which intervals tend to behave in intuitive ways, and had devised some other term—Span System? Linkage System?—for the more general case allowing non-commutativity. Only in Chapter 4, some 25 pages after the passage under consideration here, does Lewin (with some effort) construct an interesting example of a non-commutative GIS. Of course, once the equivalence of GIS structure and simply transitive groups is established in Chapter 7, many examples are at hand, including the GISes corresponding to the Schritt/Wechsel group of neo-Riemannian theory, the *T*/*I* group acting on the 24 pc-sets in any asymmetrical set class, the serial *T*/*I*/R group acting on the forms of a twelve-tone row, and the various pairs of dual groups discussed above.

discussion is highly sensitive to the choice of left-to-right or right-to-left functional orthography, and Lewin is here using right-to-left, which many readers may find confusing. A few small errors in the 1987 edition have now been corrected in these pages, but as Clough noted in his review, this is the only part of the book in which Lewin allowed his own mathematics to go astray several times, and these mathematical lapses remain uncorrected in the new printing. The confusion arises in applications of Theorem 3.1.2, which (as stated correctly on page 31) gives the general formula $\mathrm{int}(s, t) = \mathrm{LABEL}(s)^{-1}\mathrm{LABEL}(t)$, valid for any LABEL function (defined by any referential element) in any GIS. On several occasions Lewin gets this formula backward, mistakenly concluding that $\mathrm{int}(s, t) = \mathrm{LABEL}(t)^{-1}\mathrm{LABEL}(s)$. This happens twice in the proof of Theorem 3.5.3 on page 53, once in the proof of part (C) of Theorem 3.5.7 on page 55, and twice in the proof of Theorem 3.6.3 on pages 58–59. These errors may cause readers to stumble but have no lingering consequences, as they have a way of canceling each other out; all the theorems are correct as stated despite the errant proofs.

IV. Transformation theory comes of age

The discipline that was born with *GMIT* turns 21 in 2008. Its youth and adolescence have been full of precocity and promise, and it has attained a level of visibility quite remarkable for one so young. Thumb through virtually any issue of any leading music theory journal published in the last five years, and you are almost certain to find, somewhere in its pages, a citation of Lewin or some mark of his influence: a neo-Riemannian operator, a transformation graph, a Klumpenhouwer network, a GIS, a *Tonnetz*.

Indeed, as Gollin notes in his foreword to the new *GMIT*, Klumpenhouwer networks and neo-Riemannian theory in particular must be counted among the notable developments in post-GMIT transformation theory, and both can trace their origins to Lewin. Neither of these areas, however, has been immune to criticism. Neo-Riemannian theory describes relationships among triads, but arguably does not do so in a way that sheds much light on most triadic music or lends itself to the analysis of complete pieces (because, for instance, it pays no heed to chord roots, tonal centers, or diatonic implications—not to mention the difficulties that arise when occasionally but inevitably it runs up against chords that are not triads). Klumpenhouwer networks facilitate the description of relations between pc-sets that are not related by transposition or inversion, but, it has been claimed, enable such relations so "promiscuously" that to posit such a relation is to say very little—or at least, to say something much simpler than the network makes us believe.[23] These shortcomings are, I believe, very real—real enough to make me suspect that, in another two decades, both neo-Riemannian theory and K-nets will be regarded very differently from the way we see them today. Whether this will be because they evolve into something else or are superseded by something else I can only guess, but certainly the tools of general transformation theory are flexible enough to allow for either outcome.

I will close with a short and haphazard rundown of a few other subfields of transformation theory, other related areas, and general methodological concerns that are presently attracting much attention, or which I believe may be ripe for further work.

Tonality and diatonicism. Much transformational attention has been paid to harmonic structure in music that is broadly tonal. While this work at its best offers formal elegance and tantalizing glimpses of analytical potential, it has had limited success as a general analytical method for complete pieces. Some of the reasons have already been alluded to, but many of them involve the difficulty of accommodating even the simplest diatonic behavior in analytical models that are fundamentally chromatic in their construction. The inability of any established transformational system to explain why the minor-key counterpart to I–IV–V–I should be i–iv–V–i rather than i–iv–v–i (or i–IV–v–i or something else) is, bluntly, an embarrassment. Another challenge is the "arrow of time" problem: if all transformations are invertible, then I–IV–V–I should be no better than I–V–IV–I. Some of transformation

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[23] For criticisms of neo-Riemannian theory, see Lerdahl 2001, 83–85. I have attempted to address some of Lerdahl's objections in Hook 2002, but am sympathetic to others. For a persuasively reasoned critique of K-nets, see Buchler 2007, an article that provoked a small swarm of replies in the following issue of *Music Theory Online*.

theory's most revealing insights about tonal music have appeared in the context of hybrid analyses, like those cited previously in which transformational and Schenkerian tools are used side by side. But the idea of a completely transformational theory of tonal harmony exerts a powerful appeal—especially for those dissatisfied with some aspects of the Schenkerian conception of tonality—and it seems likely that such theories will meet with increasing success.[24]

Rhythm and meter. Looking at *GMIT* afresh in preparing this essay, I was frankly surprised to see how much of the book is about rhythm. Fully half of the GIS examples constructed in Chapter 2 inhabit the domain of time points and durations rather than pitches and pitch classes; so does the non-commutative GIS of Chapter 4. Among the analyses, those of Webern's Piano Variations, Carter's First Quartet, Chopin's B-flat Minor Sonata, Brahms's G Minor Rhapsody, and Mozart's G Minor Symphony all significantly engage rhythmic and/or metric features. All but the last of these are in the early ("intervals") part of the book; the later ("transformations") chapters do not emphasize rhythm to as great an extent, nor do any of the analyses in *MFT*. Rhythmic considerations seem to have received short shrift in post-*GMIT* transformation theory (as in most other music theory, it might be noted).[25] The examples in *GMIT* make it clear, though, that transformational approaches have much to contribute on the subject.

Geometry of musical spaces. Geometric representations of musical relationships have been with us for centuries, but have taken on new life with the *Tonnetz* of neo-Riemannian theory and the "voice-leading spaces" of Roeder 1994, Morris 1998, Cohn 2003, and Callender 2004, among others. Lewin's role in these developments is not a direct one, but it is hard to imagine how this work could have taken shape without the mathematical foundation and visual metaphors of *GMIT*. The current state of the art in this area is represented by the ongoing work of Callender, Quinn, and

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24 I have made a preliminary sortie in this direction in Hook 2006, but the most exciting work is that of Steven Rings (2006 and 2007b).

25 Chung 2006 is a noteworthy exception to this generalization, with its transformational accommodation of both the grouping and displacement patterns characteristic of complex metric structures.

Tymoczko (2007), which (among its other ambitious goals) describes a "space of all chords" in which both harmonic and linear relationships are visible geometrically and in which the *Tonnetz* and many other familiar depictions of musical relationships appear as subspaces, projections, and cross sections. Also of note is Quinn's study (2006 and 2007) of chord quality in general equal-tempered systems, one of whose most significant insights grew out of the five "Fourier properties" first enunciated enigmatically by Lewin almost half a century ago (Lewin 1959).

Relaxation of mathematical constraints. Transformation groups are elegant structures, and that elegance is an important part of the attraction of the theory. They are also rigid structures, and that rigidity is sometimes a source of difficulty. Dmitri Tymoczko has expressed on several occasions the view that groups are insufficiently flexible for many music-theoretic purposes toward which they have been applied: groups demand kinds of symmetry that musical structures need not possess, or they simply fail to provide a vocabulary for discussing much of what we want to discuss.[26] Of course, Lewin does not always require a group structure. On many occasions he allows for transformations to form semigroups (a less stringent condition), and the basic definition of *transformation* does not even require a semigroup structure. Moreover, even which he relies on groups, the narrative portions of Lewin's analyses generally far transcend the logical consequences of the group structure. Nevertheless, I believe that Tymoczko's point is well taken, and that much is to be gained by relaxing some of the mathematical strictures that Lewin has imposed. I have done this in several ways in Hook 2006 and 2007, constructing a transformational system that is not a group and proposing generalizations of Lewin's definitions of *transformation* and *transformation graph*—but many other extensions suggest themselves. Of the many ways in which we use the word *interval*, some are effectively modeled by GIS structures, but others are not: consider "undirected intervals" (by which, for example, int(C, E)

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[26] See, for instance, Tymoczko 2008, and footnote 26 in Tymoczko 2005. While Tymoczko 2008 is ostensibly a reply to Hook 2007, I am in general agreement with many of its points, but part company with Tymoczko's contention that generalizations such as those suggested here are fundamentally "anti-Lewinian."

and int(E, C) could both be 4),[27] or Tymoczko's suggestion that the interval between two points need not always be uniquely determined. Even the basic idea that transformations must be *functions*—specifically, functions of a single variable—might be called into question. Such a function is a special kind of relation between two objects; relations that are not functions are surely useful, as are relations involving more than two objects.[28] (The simple concept of "passing motion" is most naturally a relation among three objects, and cannot be described in transformational terms except by a three-node network whose adequacy at depicting the "passing" quality of the middle event is debatable at best.) The challenge here is to increase flexibility as needed without unduly increasing complexity, decreasing usability, or—one would hope—doing too much violence to the formal elegance of Lewin's theory.

When the subjects are a scholar as prodigious as Lewin and a *magnum opus* as seminal as *GMIT*, there is a temptation to adopt the stance of a strict constructionist—to conclude that Lewin's is the One True Way to do transformation theory, the yardstick by which all subsequent work shall be measured. I will close by cautioning the transformational community against taking this point of view too seriously. I read the enormous differences in style and approach from one Lewin analysis to another, and the fact that he was contemplating revisions to *GMIT* almost before the ink was dry, as signals that he saw the field as a living organism, forever a work in progress or even in infancy, growing and maturing in response to the quirks and complexities of the musical works or phenomena under consideration. Lewin, who after all devoted far more pages to *doing* transformation theory than to *talking* about it, would perhaps have been uncomfortable with some of my suggestions in this essay, but on this point I like to think that he would agree.

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27 The mathematical notion of *metric* captures some of the sense of an undirected interval, but introduces its own restrictions, particularly in allowing only for real-valued interval functions.

28 In fact, quite a number of demonstrably useful "transformations" in the literature are *not* well-defined as mathematical functions. Examples include Bernard's (1999) *flip*, *spin*, and *glide* moves and Santa's (1999) MODTRANS.

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