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AUTHOR: Hermann, Richard
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ABSTRACT: In an article entitled "Relating Sets: On Considering a Computational Model of Similarity Analysis," *Music Theory Online* 1.2 (1995), Thomas Demske criticizes some older published similarity relations and points to some general problems of analysis in post-tonal music. This response sketches a new analytical method for post-tonal music that places those similarity relations and other theoretical tools of the recent past in the context of some recent research and, in so doing, replies to some of the issues Demske raises.

INTRODUCTION

[1] In his article "Relating Sets: On Considering a Computational Model of Similarity Analysis," *Music Theory Online* 1.2 (1995), Thomas R. Demske seeks to use techniques of cluster analysis upon similarity relations found between pc-sets "abstracted from post-tonal analysis." He finds that the evaluation component that would define the boundary values for cluster analysis (which group similarity function return values between sets into rough equivalence classes) most difficult to find, that "the similarity relationship is too abstract to imply guidelines for its own application," and that "other potential criteria resist formal implementation." He further states that "other more commonly used tools in post-tonal analysis are susceptible to the concerns raised here."

[2] Demske raises some important issues about the inherent nature and limitations of similarity relations, computational models, and typically used analytical techniques for post-

tonal music. This response briefly reviews some his concerns but will not alleviate them. Instead, this response places similarity relationships into broader contexts and then suggests how they might reasonably be used with other post-tonal theoretical tools of fairly recent vintage. While my suggested approach might ease his discomfort somewhat, other interesting issues arise. Unfortunately, due to the broad issues summoned by Demske and due to the limitations of space in this forum, my response can only broadly sketch the approach. It is hoped that this response might spark continued responses upon the issues surrounding post-tonal theory; recent composition; history, analysis, perception and perhaps even the sociology of post-tonal music that Demske reopens or implies.

FOUR OF DEMSKE'S DISSATISFACTIONS WITH ABSTRACT SIMILARITY RELATIONS

[3] 1) The author seems to find fault with the fact that similarity relations lack transitivity, although he does not mention the transitive property in his essay. See his footnote three where he writes "Blind subset polling is a basic source of such barriers. Two REL calls with the same pivot may yield identical results, and yet differ with respect to the types of subsets counted. Ignoring the degree of this difference when comparing REL value spreads strikes me as questionable." Similar thoughts are found in paragraph [10].

[4] By definition, similarity relations lack transitivity. Thus, if transitivity is valued so highly that its lack becomes a standard for rejection of a theory, then much of value will be lost to post-tonal analysis. For instance, similarity relations might just be the class of tools best used to describe how change is accomplished from one process or segment to another differing process or segment within a work. Similarity relations might also be of analytical use in describing interesting instances of variation such as might occur in Schoenberg's concept of developing variations. Other compelling uses will be discussed shortly.

[5] 2) Demske sees as flawed a situation where some collection of set-classes can be grouped together in different ways by the similarity relation REL depending upon which pc-set is selected as the "pivot" set-class. Again, see his third footnote and paragraph [10]. The pivot set-class is the set-class which is held as a constant in measuring the similarity relation with each of the other set-classes.(1)

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1. Lewin has noted that Demske's use of REL is not completely in accord with Lewin's definition. Instead of a single pivot set-class, Lewin uses a collection of set-classes called TEST selected from the local context. REL measures similarity of other analytically interesting set-classes, collectively called COMPARE, with those from TEST. See Lewin's mto-talk message of 22 Mar 1995 and especially his "A Response to a Response: On PCSet Relatedness," *Perspectives of New Music* 18.1-2 (Fall-Winter 1979, Spring-Summer 1980): 498-502 where the definition of REL is found.
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[6] The flaw described in paragraph [5] above could be seen as a virtue. For instance, when a member of set-class 3-11 [037] is found at a temporal posterior border of an octatonic

collection and as a temporal anterior border of an abutting diatonic collection, it seems reasonable and even desirable for formal and abstract similarity relations to yield different return values between the octatonic collection and the member of set-class 3-11 and between the diatonic collection and the 3-11 member in that context. The passage of time through the passage does change the "color" of the member of 3-11.

[7] 3) Demske finds that intuition can be mightily strained in attending, in the abstract, to all of the possible similarity relations that occur between all of the set-classes. See his paragraph [12].

[8] While we need to be aware of the potentialities of similarity in the abstract, we only need in analysis to attend to those reasonable relationships pertaining to the piece or segment under consideration.

[9] 4) The author seems to resist context sensitive criteria such as a selected collection of set-classes to be used as the metaphoric yardstick such as Lewin's TEST from which to measure similarity. See his paragraph [13] and footnote number four in that regard.

[10] Context sensitive criteria seem reasonable when the repertoire under study has already shown that individual pieces inhabit the post-tonal pc set world in very different ways. Also, certain segments at various levels of formal design within the same piece may also inhabit that world in significantly different ways.

TWO PROBLEMS ENCOUNTERED IN THE ESSAY

[11] 1) At times Demske appears to veer between formalist theoretical statements or claims and phenomenological or perceptual observations and desires. He judges one by the values of the other. In paragraph [16] he writes: "The idea that any formal evaluation procedure could embrace all of the [analytical segmentational] possibilities seems untenable. On what bases would a partial set of possibilities be selected for implementation? Since the different criteria may address different---and possibly conflicting--aspects of perception, how would the application of one criterion be coordinated with that of another?"

[12] All analysts must make decisions about what strikes them as the most salient or important features of the piece and then select the appropriate "formal evaluation procedure" designed to address those features. Certainly to run all possible theoretical tools at the piece in an analysis would quickly overwhelm the analyst with a plethora of analytical observations upon the data: most observations are likely to be true, but many may be of little significance, aural or otherwise. Thus, the selection and use of theoretical tools for analysis acts like a set of filters upon the analyst and the piece at hand. It seems then that Demske's disagreement may well lie with the selection of tools--that is, with what is to be considered perceptually important, rather than with the nature of the formalist tool itself.(2) If a carpenter selects a hammer to cut a board, then poor results can be expected.

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2. In his mto-talk message of 30 March 1995, David Lewin writes: "While the word [similarity] is suggestive, it might be a good idea to stop using it in formal theoretical discourse, because the intuitions it invokes are not all that reliable. (Except we probably can't stop using it at this stage of matters, ..."
I suggest that we retain the use of the word *similarity* for formal relations that possess reflexivity and symmetry, but lack transitivity as mathematicians would have it: see Seymour Lipschutz, *Discrete Mathematics*, (New York: McGraw-Hill, 1976): 28. We then might use Robert D. Morris's phrase *aural similitude*--from his "A Similarity Index for Pitch-Class Sets," *Perspectives of New Music* 18/2 (1979-80): 445-60, as Demske acknowledges in his paragraph 5--when we wish to discuss perceptual matters. I also propose that, following a suggestion of Morris's, we use the term *resemblance relation* when we discuss relations that model inclusion relations whether or not they are formally similarity relations. These relations then potentially model some modest sense of "aural similitude" in the abstract. Whether or not these relations actually do model perception in a specific passage depends upon whether the passage exhibits its materials in such a way that encourages its perception with that tool by a reasonably experienced listener.
See Richard Hermann, "A General Measurement for Similarity Relations: A Heuristic for Constructing or Evaluating Aspects of Possible Musical Grammars," Ph.D. Dissertation, Eastman School of Music, University of Rochester, 1994: 1-119 for a classification system for resemblance relations and a mathematical and historical evaluation of published resemblance relations. See pages 123-36 for discussion and classification of all possible classes of resemblance relations.
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[13] 2) In the essay, the reader may get the sense that Demske expects too much from any given class of theoretical tools such as the here discussed similarity relations. For example, in traditional tonal music the theory of harmony fails in explaining supertonic expansions through voice- exchange and in progressions found within some sequences. Consider, for example, Mozart's *Piano Concerto* number 9 in E-flat major, K. 271/II at measures 28 through 30 as an instance of supertonic expansion, where a supertonic harmony at measure 28 is followed by a tonic in measure 29 (an "illegal" harmonic elision); or Bach's *Little Prelude*in C major, BWV 924, at measures one through three, as an instance of a sequence where the harmonies go "backward" along the circle of fifths (I-V-II- VI-III, "illegal" harmonic retrogressions). These can be found respectively on pages 132-33 and 253-254 in Aldwell and Schachter's *Harmony and Voice-Leading*, 2nd ed. New York: Harcourt Brace Jovanovich, 1989. The problem here is not so much with the theory of harmony--although it does have its well-known problems--but rather with knowing when the use of the theory of harmony is appropriate. In these tonal instances, the effects of structural outer voice counterpoint, form, rhythm and so forth inform how the theory of harmony--*Stufen* in this case--is reasonably to be employed. For instance in the case of the Mozart, analysts need to realize that the tonic harmony is not functional but rather is the result of harmonizing a deeper layer passing tone with an incomplete neighbor--a contrapuntal relation--between the outer voices.

DEMSKE'S EXAMPLE OF ABSTRACT SIMILARITY RELATION FAILURE IN A PASSAGE FROM THE FIRST MOVEMENT, *LITURGE DE CRISTAL*, OF MESSIAEN'S *QUATUOR POUR LA FIN DU TEMPS*

[14] In paragraphs [14] through [17] and their accompanying figures,

Demske notes that--within the repeating sequence of 29 chords--his intuitions of aural similitude run counter to the rough agreement found in the analytical results of Lewin's REL, Rahn's ATEMB, and Morris's ASIM similarity relations upon this chordal sequence. Their results are elegantly displayed in Demske's Figure 5.(3) In the context he has shown, Demske's complaint that these abstract similarity relations yield poor results from the vantage of aural similitude is clearly on target: the master's hammer was the wrong tool indeed. Brian C. Robison, in responding to Demske's intuitions, brings his own more appropriate tool to bear upon the passage: it deals more directly with pitches of the score and gives a plausible explanation for Demske's intuitions.(4) Clearly, ASIM, ATEMB, and REL are too "coarsely grained" for this particular situation while Robison's more "finely grained" work is here more suitable. Perhaps in some other post-tonal music with frequent octave duplications the more coarsely grained tools would better reflect aural similitude than Robison's tool.

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3. See John Rahn, "Relating Sets," *Perspectives of New Music* 18.2 (1979-80): 488-97 for information on his ATEMB. See footnote 1 above for information on Lewin's REL and footnote 2 above for information on Morris's ASIM.

4. See Robison's mto-talk postings of 29, 30, and 31 March 1995 in this regard. For a more in depth look at his theoretical work employed in those postings, see his "Modifying Interval-Class Vectors of Large Collections to Reflect Registral Proximity Among Pitches," *Music Theory Online* 0.10 (1994).
For other theoretical work capable of addressing Demske's concerns in this chordal sequence, see Robert D. Morris, "Equivalence and Similarity in Pitch and their Interaction with Pcset Theory," an unpublished mss. delivered at the Society for Music Theory Annual Conference held at Tallahassee, November, 1995 and Richard Hermann, "Theories of Chordal Shape, Aspects of Linguistics, and their Roles in Structuring Berio's *Sequenza IV for Piano*," an essay from *Concert Music, Rock, and Jazz since 1945, Essays and Analytical Studies,* Elizabeth West Marvin and Richard Hermann, eds. Rochester, New York: University of Rochester Press, forthcoming.
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TWO FURTHER COMPLAINTS OF MINE ABOUT EXISTING RESEMBLANCE RELATIONS

[15] 1) Until quite recently, resemblance relations have typically concerned themselves with resemblance between pitch-sets through the powerfully reductive concepts of pitch-class and set-class. Resemblance relations that address musical dimensions such as pitch-space, time, timbre, sound source direction, and so forth have just recently begun to appear.

[16] 2) Apart from some work on serial music, I am aware of no work yet in print that simultaneously addresses resemblance relations in more than one musical dimension. In order to get a better fit between formal models and aural similitude for some important pieces in the repertoire, multidimensional resemblance relations need to be investigated.(5)

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5. For some first steps in that direction, see Larry Polansky, "Morphological Metrics: An Introduction to a Theory of Formal Distances," in Proceedings of the International Computer Music Conference (San Francisco: Computer Music Association, 1987) and Richard Hermann, "A General Measurement for Similarity Relations:..": pp. 120-78 and "An Approach to Multidimensional and Multisubdimensional Similarity for Post-Tonal Music" delivered November 1995 at the Society for Music Theory annual conference, Tallahassee, Florida. Subdimensions can informally be understood through some examples: subdimensions from the dimension of time are duration, metric position, attack-point position, and so forth.
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[17] Another way of looking at this situation is in speculating that some sort of unknown or partially known "grammar" may well dictate when and where various existing post-tonal analytical tools are to be best employed. If that grammar is even partially known, it might even suggest where gaps in our knowledge need to be filled. It may be possible now to start the discussion of how some recent tools might fit together with older ones within an overall sketch of a new post-tonal analytical method. That we are likely to disagree on this sketched method is highly probable; note how difficult it is/has been to obtain general agreement on a precisely specified teaching methodology for tonal analysis. And that lack of agreement is over a repertoire that has enjoyed several hundred years of intense theoretical contemplation and analytical study. Nonetheless, we gain insight into what is lacking by evaluating how various methods of combining tools fare. As pieces inhabit the post-tonal worlds in different ways, I suspect that multiple methods of combining and selecting tools will be necessary.

[18] Discussion of Demske's complaints about some abstract similarity relations has shown that in order to get formal analytical results that correlate with our sense of aural similitude, our tools must be employed at the correct level of precision. In the Messiaen example, the pitch-class/set-class similarity approach was counter-intuitive while a pitch-space approach was more successful. Recent developments in contour theory and investigations into different kinds of musical spaces now suggest that post-tonal analysis can have a variety of spaces available to it ranging from the most diffuse on up to the most precise.(6) On the most diffuse extreme, spaces whose elements lack identifiable intervals between them--called "preintervallic"--have been investigated and those investigations have yielded interesting insights into form and instrumental/relative register assignments.(7) More precise are spaces inhabited by the relative or ordinally based intervals found in the various contour theories. Here, only inequalities can rank the elements within the space. Note that Marvin and Hermann have also extended contour theory to musical dimensions other than pitch.(8) Next in precision are those intervals such as the familiar interval-classes that are collapsed from an infinite space onto a finite space through modulo arithmetic. And yet greater in precision are the absolute intervals, such as the distances between equal-tempered pitches. Certainly other kinds of intervals lurk in between these: see the Morris and Lewin writings of footnote six above. Recent theoretical developments in post-tonal theory occurring since ASIM, ATEMB, and REL have widened the scope for development of resemblance relations in other musical dimensions and subdimensions and have even started to show how they can be coordinated. See footnotes two and five above. With research continuing in the fields of musical spaces, resemblance relations in other musical dimensions, and multidimensional or multisubdimensional similarity, analysts will

soon have a greater variety of tools to select in order to best model their perceptions of aural similitude.

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6. See Robert D. Morris, *Composition with Pitch-Classes*, (New Haven: Yale University Press, 1987): pp. 23-7 and David Lewin, *Generalized Musical Intervals and Transformations* (New Haven: Yale University Press, 1987): pp. 16-30 for discussions of interval--of varying kinds--based spaces in several different musical dimensions.

7. See Richard Hermann, "On 'Preintervallic' Spaces and on Their Interactions with Some Intervallic Spaces,"unpublished mss. delivered November 1994 at the Society for Music Theory annual conference, Montreal, Canada.

8. The following is a bibliography of recent writings on contour theory by theorists: Michael L. Friedmann, "A Methodology for the Discussion of Contour: Its Application to Schoenberg's Music," *Journal of Music Theory* 29, 2 (Spring 1985): 223-248; Morris, *Composition with Pitch-Classes*, 26-32; Elizabeth West Marvin and Paul A. Laprade, "Relating Music Contours: Extensions of a Theory for Contour," Journal of Music Theory 31, 2 (Spring 1987): 225-267; Michael L. Friedmann,"A Response: My Contour, Their Contour," *Journal of Music Theory* 31, 2 (Spring 1987): 223-248; Elizabeth West Marvin, "The Perception of Rhythm in Non-Tonal Music: Rhythmic Contours in the Music of Edgard Varese," *Music Theory Spectrum* 13 (1991): 61-78; Larry Polansky and Richard S. Bassein, "Possible and Impossible Melodies: Some Formal Aspects of Contour," *Journal of Music Theory* 36, 2 (Fall 1992): 259-279; Robert D. Morris, "New Directions in the Theory and Analysis of Musical Contour," *Music Theory Spectrum* 15, 2 (Fall 1993): 61-78; Richard Hermann,"A General Measurement for Similarity Relations: ...": 123-43; and Elizabeth West Marvin, "A Generalization of Contour Theory to Diverse Musical Spaces: Analytical Applications to the Music of Dallapiccola and Stockhausen," in *Concert Music, Rock and Jazz since 1945: Essays and Analytical Studies*.
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[19] When faced with music by composers such as Peter Maxwell Davies, Morton Feldman, or Ralph Shapey--to give only a few examples in which there is no known or reasonably convincing and widely accepted "grammar" to act as a guide in analysis--how might we more profitably proceed?(9)

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9. Much of the musical "grammar" has been well established and accepted for the serial works of composers such as Schoenberg, Webern, Berg, and Stravinsky and for those serial composers such as Babbitt. So perhaps this methodological sketch has less import for that galaxy of the post-tonal universe. For a veritable *summa* of serial technique, see Robert D. Morris's *Composition with Pitch-Classes*. For an important and more recent study that greatly extends serial combinatorial theory through a partitional approach, see Brian Alegant's *The Seventy-Seven Partitions of the Aggregate: Analytical and Theoretical Implications*, Ph.D. Dissertation, Eastman School of Music of the University of Rochester, 1993.
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[20] After the analyst becomes thoroughly familiar with the music's sound and symbol, the first issue to be faced is

segmentation: into what units should the piece be divided? Recent work by Polansky and Uno, following work by Tenney, use principles of Gestalt psychology to create computer-based formal procedural models for segmentation. These models are explicitly multidimensional. After Tenney, formal segments are called temporal gestalt units, and these formal units can nest within one another several layers deep. Gestalt psychology investigates the role of shape in perception. Thus, these shape oriented theories of segmentation are likely to coordinate well with the new contour space theories because they are also concerned with shape in various dimensions. In this light, contour theory can profitably be thought of as a kind of abstract master dimension. Segmentations that arise from formalist theories sensitive to the perceptual issues of shape will go a ways towards eliminating Demske's complaint of "blind subset polling." Lefkowitz and Taavola, Brinkman, and Hasty have also made contributions to this developing area of segmentation in post-tonal theory.(10)

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10. See Larry Polansky, "Morphological Metrics: An Introduction to a Theory of Formal Distances," in Proceedings of the International Computer Music Conference, San Francisco: Computer Music Association; Yayoi Uno, "The Roles of Compositional Aim, Syntax, and Design in the Assessment of Musical Styles: Analyses of Piano Music by Boulez, Cage, Babbitt, and Xenakis Circa 1950," (Ph.D. dissertation, University of Rochester, 1994); David S. Lefkowitz and Kristen Taavola, "Generalizing Segmentation: A Multi-Dimensional Approach/Piece-Specific Weighting System," unpublished mss. given at the 1993 New England Conference of Music Theorists; Christopher F. Hasty, "Phrase Formation in Post-Tonal Music," *Journal of Music Theory* 28, 2 (Fall 1984): 167-190; and Alexander R. Brinkman, *Pascal Programming for Music Research*, (Chicago: University of Chicago Press, 1990), 783-97.

For earlier foundational work in this area, see James Tenney, *Meta + Hodas and META Meta + Hodas*, 2nd ed. (Oakland: Frog Peak Music, 1988); James Tenney and Larry Polansky, "Temporal Gestalt Perception in Music," *Journal of Music Theory* 24, 2 (Fall 1980): 205-241 and their *Hierarchical Temporal Gestalt Perception in Music: A "Metric Space" Model* (Toronto: York University Press, 1978).

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[21] The next issue to be faced might best be described by the question: What levels of precision--that is what kinds of musical space--best capture the intuitions of relatedness and dissimilarity in the piece? Here, multidimensional or multisubdimensional similarity relations can act as a heuristic to narrow the number of interesting, potentially applicable musical spaces to those likely to yield the best results. Those multidimensional or multisubdimensional similarity relations yielding probabilistic return values scaled through standard deviation techniques can do an analysis of the potentials of the spaces themselves in the abstract, an *a priori* analysis. Then, those results can be compared with empirically derived results from the score: an *a posteriori* statistical and probabilistic analysis. Where the two sets of results do not significantly correlate, important features of a relevant grammar may have been identified. Follow up analyses of the segments--selected by shape based segmentation theories--could then be done using equivalence class analysis, resemblance relations, and so forth, designed for those specific musical spaces.(11) Relations, operations, and transformations that significantly preserve shape are preferred to those that do not preserve shape. This analytic process seems likely to reveal a good ratio of "hearable" structures to other less

"hearable" structures. The fruits of those tailored analytical processes can then be organized as strings of operators, networks of various kinds, and so forth as is appropriate to the music.(12)

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11. This approach has been employed with Luciano Berio's *Sequenza IV for Piano solo*. See Hermann, "A General Measurement for Similarity Relations: ....": pp. 201-34 and 252-54. The use of a redesigned contour theory along with a probability based similarity relation scaled by statistical techniques gives the flexibility to be able to deal simultaneously with various different kinds of musical spaces of differing cardinalities in an n-dimensional probability space.

12. See Morris, *Composition with Pitch-Classes* for technical information on groups of operators and their use in compositional designs; and David Lewin, *Generalized Musical Intervals and Transformations*: pp. 157-254 for technical information on the design of networks for analytic use, and his *Musical Form and Transformation: 4 Analytic Essays* (New Haven: Yale University Press, 1993) for extended analyses using networks.
Many of the issues raised in this response have been commented upon by Jay Rahn. See his "From Similarity to Distance; From Simplicity to Complexity; From Pitches to Intervals; From Description to Causal Explanation," *Music Theory Online* 0.9 (1994). Other pertinent works of his are found in that article's reference list.
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CONCLUSION: A WISH

[22] As these formalist techniques are all easily amenable to computer implementation--and many have been so implemented--I wish that these tools could all be found in one big sophisticated suite of software. Pieces could be encoded and loaded into database-like structures so that analysts could then follow their intuitions and call up the needed software tools designed for the specific kinds of musical spaces desired and use them on the work.(13)

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13. A database structure for electronically "holding" encoded scores is already available. See Alexander R. Brinkman, *Pascal Programming for Music Research*, (Chicago: University of Chicago Press, 1990): pp. 137-154, 751-812, and 825-915.
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[23] Although much theoretical work has been done since ASIM, ATEMB, and REL made their first appearances in 1980--and only a small amount of the work could be cited here--much more yet remains to be done in understanding the various musical spaces and designing appropriate equivalence class and resemblance relation tools for them. One benefit of continuing this line of research is that "updating" ASIM, ATEMB, and REL for use in other dimensions and for use in multidimensional and multisubdimensional analysis is possible. Marvin and Laprade have already updated ATEMB for use with their contour theory (see footnote number eight). While other quite important contributions and issues such as timbre theory, atonal voice-leading, and the influence of feminist thought, among others, upon analysis of this repertoire can only be barely mentioned or imagined here, it is time to start the discussion of how and when it is appropriate to use various combinations of these theoretical entities. Demske's reminder

about these issues deserves our serious attention, and calls for discussion to begin.

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