
JOURNAL OF MUSIC THEORY PEDAGOGY

Volume Five, Number One
Spring 1991

School of Music
The University of Oklahoma

JOURNAL OF MUSIC THEORY PEDAGOGY

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Journal of Music Theory Pedagogy
School Of Music
University of Oklahoma
Norman, OK 73019

Subscription Rate (2 issues/yr.):

Individual: \$20.00
Student/Emeritus: \$12.50
Library/Institution: \$40.00

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ISSN 0891-7639

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A COMPARISON OF PEDAGOGICAL RESOURCES IN SOLMIZATION SYSTEMS

TIMOTHY A. SMITH

INTRODUCTION

I was recently asked to present a seminar on a topic of my choice, but with the following proviso: the topic must be theoretical, and sufficiently provocative to inspire lively debate. Well, could there be any doubt—what more controversial topic to choose than solmization? Musicians have been unable to agree on this subject for six hundred years; it ought to spark quite a discussion, I thought—and it did.

Among theory teachers there is disagreement, sometimes antagonistic, about the value of solmization within the ear-training curriculum, particularly about which system to use. Most agree that the teaching of solmization is beneficial, but when it comes to the selection of one system, we hear little consensus and much opinion. Everybody has a preference and everybody wants to pump his preference into heads of students who are often passed from teacher to teacher—system to system—until perplexed beyond repair. Sight-singing manuals, other than presenting a cursory explanation of each system, usually advocate no one system, deferring instead to the teacher.

PURPOSE

Upon what basis do theory professionals choose a system? Typically, they resort to one of the following arguments to buttress a predisposition for one system over another. The first argument is Newtonian: “I was taught this system, and I don’t have time to learn something else” (i.e., a body at rest tends to stay at rest). The second argument is geographical: “the system I use is taught in Europe, therefore it is superior.” (This truth is considered self-evident—so evident, in fact, that it matters not whether the vaunted system is truly superior, only that the right people believe it to be so.) The third argument gives expression to the instincts of the herd: “All great performers use such-and-such” (sort of like “All great conductors are men”). Even if such a claim were true, it would prove nothing.¹

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The selection of a method ought to be justified by its potential as a pedagogical resource, not in terms of what or where the teachers were taught. Judicious application of a system presumes a high regard for contexts, purposes, and outcomes, not sacred cows. The right solutions require that we ask the right questions—questions like: what does each system help students to learn and how? how is each system easy to use; how is it difficult? what rudiments does each system *not* teach, and why? in what setting might one system out-perform the others?

In training the ear we desire to promote musicianship throughout the music curriculum. But because the teaching of solmization happens within the context of the theory curriculum we especially desire to nurture an aspect of musicianship that is within the particular domain of theory—that is, analysis. Too often ear training is considered an adjunct of performance, its curriculum created within the arena of interdepartmental turf warfare. As a matter of fact, there are those within every department who would content themselves with an ear-training strategy intended only to produce facile readers. From the theorist's point of view, the purpose of ear training is broader—to produce musicians who can perceive, understand, and analyze music with utmost intelligence and skill.

In what forum are these issues most likely to be resolved? Ultimately, the answers must come from experimentation and research. Through research we know a great deal about how the ear perceives the elements of sound. Scientific inquiry into the nature of acoustical phenomena can be traced in this century most notably through Seashore, back to Helmholtz, Rameau and a host of composers, scientists, and pseudo-scientists to antiquity. But researchers have not yet tackled the problem identified in this proposal, that problem being, "what are the comparative values of pedagogical resources within each solmization system?". The perceptual, co-variable, and cross-disciplinary connotations of such a study are daunting, to say the least—which is not to say that it cannot be done, but to suggest why it has not been done.

Lack of hard data notwithstanding, there remains the avenue of philosophical argumentation (as we have seen, when it comes to this subject a smidgen of logic cannot hurt). A systematic and rational comparison of the theoretical resources of solmization systems can serve, in the absence of definitive experimental data, at least to steer us in the right direction. This paper is such a comparison. Consider the method to be dialectical and speculative, in the main—that is, it is primarily a comparison of theorems and not a comparison of experimental results. If anyone can be forgiven for this, it is theorists—those who delight in navigating the uncharted oceans of hypothesis. It falls to future research to decide whether this theory has spied the new world, or sailed over the edge.

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ASSUMPTIONS

The efficacy of solmization as a teaching device is historically established. There are reasons why musicians have been using vocables since classical antiquity, and reasons why many systems have evolved. (For those reasons, whatever they be, we ought to credit some good to each system.) Having hedged somewhat, I hasten to confess that this paper is an attempt to persuade and to convince; it is a flotilla of arguments for one system—"do-tonic" movable "do"—which means that readers are invited to roll out the big guns and decide for themselves which arguments truly float.

It is herein hypothesized that solmization works because it associates phonemes with various musical constructs that, with repetition, enable students to audiate sound from sight, and perceive sound to sight.² Syllables give names to structures that would otherwise have no names. In the context of the ear-training curriculum the ideal solmization system ought to provide the following resources:

1. Analytical orientation: In accord with the primary goal of music theory, the ideal solmization system will contribute to the analytical vocabulary and percepts of the student. Syllables ought to convey meaning in terms of musical structure, and the user must have perceived the structural function of a pitch, through analysis, before naming that pitch.

2. Aural orientation: The ideal solmization system will facilitate the recognition of musical structures and their transfer to written symbols. Students are better served when they learn first to recognize sounds, then the symbols, and not the reverse. The ideal solmization system will be oriented toward the ear, not toward the eye, causing students to become absorbed first with sounds, second with symbols.

3. Consistency: The ideal solmization system will be consistent in its phonemic association of musical structures with syllables. Pitch (frequency) is not a musical structure. Pitch is an *aural* structure, the production of which is necessarily part of making music, but pitch itself is not music. Rather, pitch is an attribute of sound. To be musical, pitches must first have been organized into contextual configurations, such as tonic, dominant, leading-tone, etc.

4. Singability: Since one of the goals of solmization is to improve sightsinging, it stands to reason that the ideal system should be singable. A singable system will be mono-syllabic, so as not to destroy rhythmic

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relationships. A singable system will use a variety of beginning consonants and sustaining vowels, so as not to be boring and provide for distinct phonemes and articulations. A singable system will not be cluttered with diphthongs and ending consonants.

5. Stylistic flexibility: The ideal solmization system will lend itself not only to the singing of simple diatonic music, but also to modulating, chromatic, and atonal music.

FIXED "DO" SYSTEMS

The first solmization systems were based on a movable concept.³ The Greeks devised a system that, allowing for differences in ancient and modern diatonicism, is remarkably similar to our movable "do." Twenty centuries later, Guido's hexachord (ut, re, mi, fa, sol, la) put "ut" upon C, F, or G—representing the tonic. The purpose of the medieval hexachord was to consistently identify the semitone by the syllables "mi fa," which meant that "ut" would move within the context of a single scale, and would not always represent the tonic. Seventeenth-century musicians, seeking to accommodate the increasing prominence of the leading tone, modified the Guidonian syllables, adding "si" for the seventh scale degree, and "do" which came to represent the tonic.

During the *bel canto* period, singers adopted the syllables of solmization and used them to construct vocal exercises—called *vocalizzo*, or *solfeggio*—in which the syllables served to aid the singer in uniting vowels and consonants. This led to the consistent association of certain syllables with fixed registers and has evolved into the system of fixed "do." The fixed system is used in much of the world as the only method for naming pitches; alternatively, we name pitches by using letters: "A, B, C," etc. (So, Americans, who tend to be unnerved by European musicians who can spit forth strings of syllables, shouldn't be. Most Americans can do the same thing with letters.)

Seven-syllable fixed "do" (with chromatic inflections)

The south-European fixed "do" system uses seven syllables (do, re, mi, fa, sol, la, si) to represent the natural pitches C to B, and all chromatic inflections. Thus A-flat, A-sharp, and A-natural are all solfèged "la." This method provides no phonemic distinction between the pitches of any scale

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(major, minor, or modal) beginning on A-flat, A-sharp, or A-natural; twenty-one diatonic scales can be solfèged by the sequence "la, ti, do, re, mi, fa, sol." Indeed, a chromatic scale on "A" would use nearly the same sequence.

While the seven-syllable fixed "do" system offers certain advantages (e.g., it has the fewest syllables to learn), it is defective in this respect: all major, minor, and modal scales, starting on a given pitch, use the same series of syllables. Conversely, diatonic scales of the same class, starting on different pitches, would use a different series of syllables. The anomaly applies to intervals too; a m3 might be called "do-mi," or "re-fa," or "mi-sol," or "fa-la," or "sol-ti," or "la-do," or "ti-re," while the same combinations might be used to name a M3, d3, or an A3. Paradoxically, in seven-syllable fixed "do," it is customary for identical structures to be given identical names, the process of differentiation depending entirely upon notation instead of sound.

As a consequence, seven-syllable fixed "do" is a language of pitch "regions," therefore a language that is impotent when describing tonal structures, or conditioning the ear to discern those structures. A pedagogy based on seven-syllable fixed "do" offers no unique advantage over a pedagogy that simply trains students to sing the letter names they already know. Seven-syllable fixed "do" is minimally helpful as a pitch naming scheme, and tonally ambiguous. With the abandonment of diatony it becomes necessary to use a twelve-syllable system that accounts for the fully chromatic tendencies of modern music.

Chromatic fixed "do" (with solfeggio syllables)

In chromatic fixed "do," sharped pitches are named by changing vowels to "i," and flatted pitches by changing vowels to "e" (with the exception of "re," which becomes "ra"). A chromatic scale on "C" would be sung: (ascending) "do, di, re, ri, mi, fa, fi, sol, si, la, li, ti, do," (or descending) "do, ti, te, la, le, sol, se, fa, mi, me, re, ra, do." Because each of the twelve chromatic scale degrees has its own syllable, chromatic fixed "do" is sometimes called "twelve-syllable fixed do," but this is a misnomer. Twenty-one syllables are actually required to negotiate every possible flat, natural, or sharp permutation on the keyboard, after which the system has still to account for double sharps or flats.

If the purpose of a chromatic syllable arrangement is to provide a name for all chromatic situations, the system has imperfections. How does the singer navigate through enharmonic alterations like E-sharp, B-sharp, C-

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flat, and F-flat, not to mention double sharps and flats? While C-flat and F-flat could be called "de" and "fe," the system is pushed to the brink of absurdity in its attempts to name the others.

Chromatic fixed "A" (with alphabetical names)

The third type of fixed "do" solmization dispenses with the traditional *solfeggio* syllables in favor of letter names. Thus a D-Major scale would be sung: "D, E, F-sharp, G, A, B, C-sharp, D." The advantage of this system is that North American students already know the letter names of pitches; if one must teach a fixed system in this country, alphabetical fixed "do" is an attractive compromise. This system improves over twelve-syllable fixed "do" by providing names for double sharps and double flats. The disadvantages are four: 1) chromatic alterations are bi-syllabic; 2) vowel resources are meager and they include diphthongs; 3) the phoneme for "F" ends in a consonant; and 4) students who do not use syllables may have difficulty communicating with the rest of the world that does.

Fixed "do" as a resource for training the ear

Consider what fixed systems do, and do not do, well. Chromatic fixed "do" can account for chromatic pitches within the rubric of monosyllables.⁴ Furthermore, it is argued that fixed "do," more than any other system, is at home with atonal or modulating music, where the imposition of an artificial tonality or the continual movement of "do" may be unnecessary or counter-productive. It is on this round that the advocates of fixed "do" connect their case most convincingly. Movable "do" is indeed slower when applied to tonal modulations (with atonal music this is debatable). But one must parry with two arguments. Does the average musician encounter a sufficient proportion of atonal music in a lifetime to warrant the exclusive use of fixed "do?" Should not a student proficient in movable "do," which trains one to fix "do" anywhere one chooses, be able to constrain "do" to the pitch "C" in situations where atonal considerations require it?

Many musicians believe that fixed "do" facilitates the development of a strong sense of absolute—some use the word "perfect"—pitch. It is argued that singers, especially, can be trained to use fixed "do" like a vocal fingering chart in which placements, registers, and pitches are associated with corresponding syllables. The tacit implication is that it is essential for singers to acquire a sense of absolute pitch if they are to become competent

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readers, and that the best way to develop that sense is through Pavlovian repetition of syllables.

These beliefs seem plausible to most people, and are seldom disputed, in spite of the fact that no one has proven that practitioners of fixed “do” really do acquire a stronger sense of absolute pitch, or that an acute perception of specific frequencies really does make one a more musical reader.⁵ Conceding the disputed outcome temporarily, we should at least challenge its underlying premise—is it indeed necessary for musicians to attain absolute pitch before they can become good readers? If so, is the practice of fixed “do” the best way to attain it? Not knowing the answer we can only surmise that absolute pitch is helpful, most people would agree, but essential?—most people would probably not.

Defects of fixed “do” as a resource for training the ear

Critics of fixed “do” raise three objections. The first is based on a historical interpretation of the word “solmization.” The second objection is based on the technical difficulties of twelve-syllable fixed “do” in tonal music. The third objection concerns the paucity of meaning that fixed systems carry with respect to analytical processes.

Consider the following interpretation of what it means to “solfège.” Musicians, until the eighteenth century, were used to designating scale degrees by syllable; syllables were therefore movable, and carried structural meaning. It was the singers of the *bel canto* age who attached a second function to syllables, as vocalizations. Until recently, musicians have recognized a distinction between *solmization*, which has meant the use of syllables to name scale degrees, and *solfeggio*, which has meant the use of syllables to perfect vocalization. In *solmization*, syllables were employed to teach musical structure, whereby the student learned to read and write. In *solfeggio*, syllables were employed to teach vocal placement, whereby the student learned singing technique. In *solmization* the musician recognized the musical function of a pitch before giving it a name, and the syllable was a byproduct of analysis. In *solfeggio* the singer named a pitch without considering its function, and the syllable became the agent of vocal technique.

This distinction has been maintained in reference works until recently. The operative definition in the important dictionaries, prior to 1980, is that solmization is a method of identifying pitches by *scale degree*.⁶ One might argue, therefore, the historicity of a point of view that regards fixed “do” as *solfeggio* (a scheme for naming frequencies), and not as *solmization* properly

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understood. Admittedly it uses solmization syllables, but not according to historical usage—that is, to identify pitches by scale degree. The syllables of fixed “do” describe frequencies and notational positions, but not functions.

If the historian has an interest in maintaining the distinction between *solmization* and *solfeggio*, so has the theorist. As a system for naming pitches, fixed “do” is wanting. Seven-syllable fixed “do” is simplistic, ambiguous, and inaccurate. By contrast, the “twelve-syllable” system is more precise, but, with its twenty-one syllables, the most complicated solmization system imaginable. The student who wishes to solfège even simple diatonic music in all keys must know all twenty-one syllables. In the United States, at least, fixed “do” is alien and heuristic insofar as it requires students to substitute an old-world lexicon of pitch names for names they already know.

The most serious objection to fixed “do” is that it does not identify pitches by tonal function, therefore it cannot reinforce the perceptual structures of tonality, neither can it be used as a language to describe tonal structures. Mentioned earlier, this criticism bears repetition inasmuch as it is the essence of the argument against the use of fixed “do” in the context of theory pedagogy. For the ear-training specialist, whose task is to conceptualize musical structures aurally, and to train students to hear differences in structures, it is advantageous to name the structures themselves, not merely the pitches used to write them.

One might argue that pitch notation is irrelevant to music, which necessarily exists prior to, and independent from, printed marks. Notations are symbols for sounds; they do not disclose the function of those sounds—that is done through analysis. Musical function is ultimately defined by sound itself and captured cognitively by means of analytical and aesthetic processes that have nothing to do with notational symbols. When a student learns to recognize and name sounds by ear, he moves closer to a mastery of symbols, *ergo* the reduction of sound to symbol (writing music) and production of symbol to sound (reading music). Reading and writing are recursive processes that require an ability to perceive and name sounds and symbols both, but sounds first.

By perceiving and naming the sounds of music, not the symbols, we do more than perceive and name frequencies; we perceive and name musical style itself, a creature that cannot be caged by scratchings on a piece of staff paper. Contrary to the way we often use the word, “music” cannot be seen, it can only be heard. The conventional symbols of pitch, rhythm, meter, dynamic, articulation, and timbre, are, at best, approximations of what happens in a musical performance. Whether the process is reading symbols to sound, or writing sound to symbols, both depend on the perceiving and

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the naming of musical structures, and both are surely enhanced by analysis but hindered by unthinking recitation of pitch notation.

A matter of aesthetic awareness

Is aesthetic response based primarily on the perception of pitch, or the perception of tonal relationships? There is no way we can practically separate the two, but we can theorize distinctions nonetheless, distinctions that are germane to this proposal. The perception of frequency is a sentient power that enhances the aesthetic experience physiologically and only to a degree that is sensual or pleasant to the ear. Perception of frequency alone is therefore sensory, sensual, acoustical, and aesthetically incomplete. By contrast, complete aesthetic perception is cognitive, and affective, and dependent on the processing of sensory data—processing that is intellectual, emotional, analytical, and much more sophisticated than acoustical perception.

The type of listening that is purely pitch perceptive (if that were possible) would be primarily acoustical. And the type of listening that is purely relationship perceptive would be primarily aesthetic according to this view. Actually, both processes are essential to aesthetic perception; the first is the faculty of the ear to perceive and to differentiate sounds, but the second, being the learned ability to assign musical significance to those sounds, is more inherently musical, therefore aesthetic. True aesthetic perception requires an awareness of the syntactic rules of pitch formation, rules that are defined by musical styles and musical works of art. Were it possible to be cognizant of pitches only, without cognizance of pitch relationships, such a mode of listening would be non-aesthetic.

For the sake of argument, let's presume momentarily that the syllables of fixed "do" name frequencies, but the syllables of movable "do" name tonal functions. We must then ask which type of perception (frequency, or tonal function?) is more important to hear, therefore more important to teach. While the fixed "do" musician's perfect recognition of pitch may promote the perception of frequency, one must question the degree to which it promotes the perception of musical structure, therefore equipping the musician to process sounds aesthetically. Is not the perfect processing of musical structure a skill more informative than the perfect perception of pitch, and therefore a more useful step toward the goal of truly proficient reading and writing?

If one considers frequency an attribute worth naming with a high degree of specificity, then fixed "do" is an exercise not wasted. To be sure, the perception of frequency is essential to the perception of music. But

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naming frequencies?—even the precise naming, contributes little to the cognition of musical structure; to wit, most animals respond to frequency more acutely than humans, but animals (so far as we know) do not perceive music aesthetically. If, on the other hand, one considers musical structure worth naming to a high degree of specificity, then fixed “do” is an exercise in futility. Fixed “do” cannot do it.

A matter of nature or nurture

The perception of pitch and perception of musical structure are inter-dependent processes, both important to the musician, and both matters relating to the fields of theoretical psychology and aesthetics. But this proposal is pedagogical, and concerned not so much with the issue of nature, as with nurture. To what extent is the teaching of each process possible?

On the motor side, teachers naturally desire to cultivate and monitor the maturation of hearing within students. But data show that hearing development, if not musical aptitude itself, is nothing more than biological maturation, or nature. Gordon concluded that by the age of nine a child’s developmental aptitude for music is normally fixed, and that what follows is a process of achievement.⁷ Seashore showed that the physiological boundaries of the ear increase neither with training, nor with age.⁸ Hearing, like seeing, has matured in most people by the age of six. Seashore found that practice may improve a person’s ability to recognize the musical operations of pitches, but not to modify the capacity of the ear to hear them better.

Is it possible for the average student to acquire perfect pitch, as some musicians claim? The research does not support such a claim.⁹ Correctly understood, perfect pitch is more than an ability to name any key struck on the keyboard, but an ability to differentiate, and quantify, deviations in pitch as small as one cent.¹⁰ Thus defined, absolute pitch is extremely rare, not limited to individuals with musical training, and probably inherited. What often passes for perfect, or absolute, pitch is an acute sense of relative pitch, that involves the comparison of pitches to one or two frequencies consistently and reliably recalled. Upon this basis it is safe to say that absolute pitch cannot be taught or learned, but that relative pitch can be.

So called “ear training” is really a process of training the mind, not the ear. If the physiological limits of the ear are fixed by age six, and musical aptitude by age nine, they are of secondary concern to the ear-training specialist. The primary concern is with developing the mind, that which has continual potential for musical growth, and that which yields the greatest

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educational return. The goal of the music educator is to take what nature has given, the ability to recognize and produce deviations in pitch, and to nurture sympathetic mental responses to that which is aesthetically satisfying.

While some students can acquire a sense of absolute pitch, few do. We cannot assume, and neither should we expect, that every student will. As Seashore wrote: "fortunes have been spent and thousands of young lives have been made wretched by application of the theory that the sense of pitch can be improved with training. It is the cause of the outstanding tragedy in musical education."¹¹ Instead of relying on a technique predicated upon a skill attainable by the minority, we should rely on a technique that develops skills attainable by the majority. Returning to an earlier question—is the precise recognition and naming of frequencies a trick worth teaching? True, a sense of absolute pitch can be taught to some musicians, but does it deserve a priority status in the ear-training curriculum? I think not. We don't listen to music that way—"ah! I hear an "A," now a "B," now a "C-sharp!"—neither should we train the ear that way.

A matter of musicianship

If we don't listen to music that way, neither do we play music that way (at least not after the fifth grade). Musicianship requires a great deal more than putting the right fingers over the right holes and blowing. Returning to the problem of perceiving and naming symbols, what advantage is there to the student blessed with perfect pitch, who can peruse a score, see the symbol for A-440, and name it "la" in a fixed system? Having done this does not necessarily mean that he can produce the frequency "A" in a manner that is musically informed, even if he is able to produce the pitch in the relative range of 440 hz. To produce a musical pitch he must first have recognized the function of that pitch in the aesthetic scheme of things and then have interpreted the pitch accordingly. Having recognized the function, why not give the function a name? If sightsinging and dictation are the activities teachers use to assess the degree to which a student is apprehending musical structure, so can be the naming of those structures in movable syllables.

The definitive test of the efficacy of any solmization system must be a measure of what it brings to the listening experience. To what extent does fixed "do" inform a musician who is listening—without score—the musician whose only connection with music is sound itself. To what extent does fixed "do" clarify, illuminate, and intensify the listening experience? To what extent is fixed "do" an analytical resource for the listening musician?

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How many musicians proficient in fixed “do” use the system at all when listening to music? How many fixed “do” musicians are able to use the system when taking dictation? Unless the musician has perfect pitch, the answer to all of the above is “None, or not at all.”

Fixed “do” is a language that names the symbols for frequencies, but does not name the tonal assemblies they represent. Calling a pitch “la” in fixed “do” yields no clue as to how it might be functioning within its musical setting. The system of fixed “do” is purely nominal, notational, and visual; it names pitches, but is deaf to their tonal meanings and functional contexts. Fixed “do” proceeds from written symbols to musical production, but cannot reverse direction unless the user has perfect pitch. As a consequence, fixed “do” is of no help in the dictation process. In the theory classroom, fixed “do” is a language that sees, but does not hear, and absolutely does not analyze.

MOVABLE “DO” SYSTEMS

Number singing, movable “one”

Having considered the “pros and cons” of fixed-pitch systems, we now consider movable systems. If historic solmization is a method of identifying pitches by scale degree, then its most practical variation would be to have students identify scale degrees by number, forgetting *solfeggio* syllables altogether. In number solmization the tonic is identified by the number “one” regardless of mode. The first advantage to this system is that students are not required to learn *solfeggio* syllables—sufficient reason for some people to adopt the system pronto. A second advantage is that it brings a greater degree of consistency in the naming of some musical structures. For example, the tonic and dominant are always sung “one” and “five,” regardless of the key or mode.

On the negative side, solmization by number provides for no phonemic distinctions between modal scale degrees (super-tonic, mediant, sub-mediant, and leading-tone), which are called by the same names in minor or major, even though aurally distinct. The number system is incapable of modal differentiation, all modes are sung “one, two, three, four, five, six, seven.” In this respect number solmization resembles seven-syllable fixed “do.” The inability of both systems to distinguish phonemically between a major and minor seventh, or a major and minor scale, or a major and minor triad, is a serious flaw.¹²

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"La-minor" movable "do"

The "la-minor" system, strongly promoted in music education today, is descended from the English system of tonic sol-fa, developed in the mid-nineteenth century by Sarah Glover and John Curwen, and adopted by the Germans as "Tonika-do." "La-minor" is the system advocated by Kodály. In "la-minor" the tonic of a major scale is called "do," but the tonic of a minor scale is called "la." Each mode requires a different syllable to represent the tonic.

Two advantages over other systems are worthy of immediate recognition. First, sophisticated theoretical knowledge is not needed to solfège "la-minor" at sight, explaining why the system is advocated by teachers of young students. Beginning singers, liberated from the constraints of notation, are free to solfège what they hear before having learned its visual cognates. This advantage applies to all movable systems, and is as it should be. Second, in the "la-minor" system alone, the singer who has progressed to the reading stage, and who can identify the tonic pitch (major) of each signature, calling that pitch "do," can sing any of the seven modes associated with that signature. The young singer need learn only seven syllables to sing diatonic music in any mode.

Because the pitches of all keys sharing the same signature also share the same syllables, "la-minor" is sometimes called "key-signature" movable "do." By this we recognize that the "la-minor" system operates on the relative relationship between modes, allowing singers to move unencumbered from major to the relative minor without having to incorporate syllabic modifications that account for a new tonal center. Modulations that do not involve a change of signature are negotiated simply, without the student knowing that a modulation has happened. Modulations to other key signatures require the shift of "do" to a new pitch.

What is presented here as an advantage to young students may be viewed as a defect by the college theory teacher, who must insist that students be cognizant of modulations from major to relative minor. From the theorist's perspective, "la-minor" insinuates a dependence on the major to define the minor, as if to suggest that minor cannot exist independently of its relative. This is a simple objection: that a student might begin to consider a minor scale as a major scale, only starting on the sixth scale degree, whereas in reality that which exists in the pure minor ought to be appreciable in its own right without analogy to the major.

According to "la-minor," half-steps in all modes are defined and named by their relationship to the relative Ionian mode. Thus "mi-fa," and "ti-do" are always semitones, regardless of the mode, but located on different scale degrees in each mode. In this regard "la-minor" is similar to

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Guido's "ut, re, mi" scale. While both methods of identifying semitones in diatonic systems are uncomplicated, both methods, as a consequence of their simplicity, tend to neglect the aural and notational differences between modes. By inference, they tend to portray all modes as infratypes of Ionian, diminishing the significance of modal variation to the degree that other scale degrees are implied to behave as tonic.

A grasp of the relative relationship between a scale and its relatives sharing the same signature is necessary if one is to identify structural links between sections of a work, but when it comes to aural perception of functional harmony, a more useful comparison is found in the relationship between a major scale and its parallel minor. With so many aural structures belonging both to major and to minor, it is instructive to bring shared features together, *calling them by the same names*. As for the differences, we know that when functional harmonies become more complex, homogeneous major and minor tonalities tend to vanish, while androgynous tonalities, having characteristics both major and minor, tend to appear.

It is in this context of secondary chromatic relationships and modal borrowings, that the deficiencies of "la-minor" manifest themselves most clearly. "La-minor" gives seven meanings to each *solfeggio* syllable: "ti" could be the leading tone of a major scale, the super-tonic of an Aeolian mode, or the dominant of a Phrygian scale, etc. Structures that are the same in each mode, like the tonic, dominant, and leading tones, ought to be called by the same names. But according to the "la-minor" system, the leading tone in Ionian is called "ti"; in Aeolian it is called "si"; in Dorian it is called "di"; in Phrygian it is called "ri"; in Mixolydian it is called "fi." Mercurial phonemic relationships tend to confuse static musical relationships that inhabit every mode. Thus, while "la-minor," *vis a vis* fixed "do," names musical structures more consistently, it is nevertheless erratic in its naming from one mode to the next.

"Do-tonic" movable "do"

The only way to identify musical structures consistently, from one mode to the next and from one key to the next, is to name the tonic "do" regardless of the mode or key. "Do-tonic" accounts for lowered second, third, sixth, and seventh scale degrees by calling them "ra, me, le," and "te" respectively. The raised fourth degree of the Lydian mode is called "fi." Like twelve-syllable fixed "do," the "do-tonic" system has the capacity to negotiate chromatic configurations, but unlike fixed "do," it accounts for double sharps and flats, while at the same time identifying the structural meaning of every pitch that has a structural function. The syllables "di, ra,

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ri, me, fi, le," and "te" will get a function through just about any chromatic situation, secondary or borrowed.

In contrast, with "la-minor," which is happy in the company of its relative scales, the "do-tonic" system is happier with parallel relationships, and is therefore better suited to teach the aural particulars of major and minor. Unlike "la-minor" system where "mi-fa," and "ti-do" were always half steps (but located on different scale degrees), the "do-tonic" system provides different phonemes for half-steps that necessarily occur at different places in each mode. Students are not confused, therefore, by having to make comparisons with Ionian when singing non-Ionian modes.

Consider how students are taught to recognize key and mode in written theory. Whereas the key is essentially defined by the location of the tonic pitch, mode is defined by the number of accidentals in the signature. A change of tonic, with the signature remaining unchanged, effects a change of key and mode. Conversely, a change of signature, with the tonic remaining unchanged, effects only a change of mode. The "la-minor" system is equivocal when it comes to maintaining this key/mode relationship. In "la-minor," a change of tonic (signature remaining unchanged) does *not* require the renaming of the tonic pitch; conversely, a change of signature (tonic remaining unchanged) *does* require the renaming of the tonic pitch. Both processes may involve modulation or modal mutation. Thus the "la-minor" system admits a curious inconsistency where some modulations and mutations require renaming of the tonic, but other modulations and mutations do not.

By contrast, in the "do-tonic" system, the tonic is always called "do," regardless of where the tonic pitch is or the number of sharps or flats in its signature. Because in "do-tonic" solmization, structures that are the same in each mode are always called by the same name when in the same places, it presents the ideal vocabulary for teaching functional harmony and melody. The "do-tonic" system facilitates the teaching of aural skills because it names structures the way students hear them. This is extremely important, because in musical performance the size of an interval is defined by its tonal context.

To be sure, the "do-tonic" system imposes its own challenges. Students must learn five new syllables to negotiate modes other than Ionian (in "la-minor" these syllables were only necessary for chromatic alteration). Like "la-minor," the "do-tonic" system is fully functional for singing students in the absence of the printed page. Unlike "la-minor," "do-tonic" requires that reading students be able to interpret set-up information to correctly identify the pitch that is tonic, in order to call it "do," in all modes. This requires theoretical acumen beyond the level of beginning students.

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If the “do-tonic” system has a greater affinity for the notation of music than does its variant “la-minor,” what proves to be a disadvantage from the sightsinger’s perspective is an advantage to the student who is taking dictation. In the case of the former, one must use notational cognates to name structures before they are heard, but in the latter, one can name structures as they are heard, before reference to notation whatsoever. It is for this reason that the “do-tonic” system is superior to other systems for the promotion of writing ability while the “la-minor” system may excel in the promotion of reading ability (at least for younger students).

Every movable system must find ways to overcome the impediment of tonal modulation, this being the most frequent criticism of such systems. What about modulation? If one takes the view that the purpose of syllables is to teach a student to read a modulation passage quickly, then movable “do” may be inferior in the short run. To sing a modulating melody, the student must first analyze the melody to determine what syllables to apply in each key. The analyzing takes time, therefore the reading is slower. If one takes the view, however, that the purpose of syllables is to help students to analyze, then movable “do” is superior in the long run. Teaching students how to locate the point of modulation, apply the appropriate pivoting syllables, and continue in the new key, is precisely analogous to the way we teach modulations in written theory. It is appropriate to apply the same technique in ear-training.

Is movable “do” unsuitable for singing modulations? To the contrary. In terms of analysis, movable “do” finds in modulation another opportunity to use the system to great pedagogical advantage. Whereas the “la-minor” system is unaware of modulations when they are between relatives, fixed “do” begs the question altogether. The practitioner of “do-tonic” solmization, in wrestling with the difficulties of naming modulatory functions, is in fact learning how modulations work. So, while it is admittedly possible for students to read modulations more quickly in fixed “do,” one must doubt the degree to which fixed “do” aids understanding the structural dynamics of modulation—indeed, to what extent fixed “do” contributes to an awareness that modulations have, in fact, even occurred.

How the “do-tonic” system accommodates interval nuance

It is a cliché, but true nevertheless, that when it comes to reading notes, what you see is not always what you get. The actual frequency of written pitches (therefore melodies, intervals, and chords) in all contexts, tonal or atonal, are interactive and relative. The tempered scale, to which we have become accustomed in theoretical terms, is an expedient compromise for

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the sake of the keyboard. It is a great credit to the musical mind that it tolerates the tempered scale at all. In truth, most musicians have never performed, and never will perform, within the constraints of equal temperament. Accomplished wind players, string players, and singers routinely give color to pitches by raising or lowering them. This process is governed in tonal music by the mental and physical attributes of tonality, and in atonal music by the pitches that immediately surround the pitch in question.

This fact, long recognized by musicians, was established in the 1930s by the seminal research of Seashore and colleagues at the State University of Iowa, and has not been disputed since. For example, in a comparison of eleven performances of a Kreutzer violin *Etude*, Greene found significant and predictable deviations from the tempered scale in intervals of the second, and third.¹³ All seconds and thirds, regardless of melodic direction, tended to be smaller than their tempered counterparts, with the exception of the M2 which tended to be larger. Fourths were more true to the tempered scale than were seconds and thirds. Seashore's comparison of vocal performance, two years earlier, had yielded similar results, leading him to conclude that musicians do not perform conventional tempered intervals but take license with pitch formations for the sake of artistic nuance. "Beauty," he wrote, "lies in artistic deviation from the rigid . . ."¹⁴

"Things are not what they seem." The ratio of 1:1 between the physical fact, such as frequency, and the mental fact, pitch, is not always exact. Thus 440 does not mean always the same pitch. The pitch would vary in predictable ways with differences in intensity, duration, and harmonic constitution of the tone, that is, with amplitude, duration, and form of the sound wave. In a predictable way, we speak of the deviation as a normal illusion. An illusion is said to be normal when all persons under similar circumstances tend to get the same result. It is called illusion because the perception does not correspond to the physical object to which it refers.¹⁵

Seashore's normal illusions have two types of pitch manifestations relevant to this proposal: first as the physical alteration of frequencies, second as the mental alteration of perceptions. As an example of the first, "A" is not always the same frequency, rather, "A" when it functions as leading tone in the key of B-flat would be predicted to be a different frequency than "A" as it functions as dominant in D Major, or the third scale

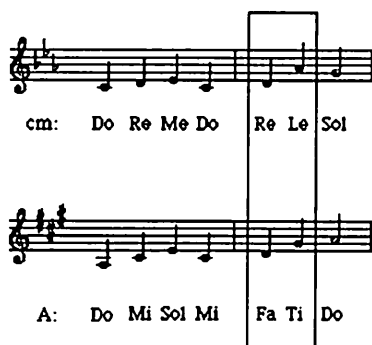
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degree in f-sharp minor, or the root of a French-sixth chord in c-sharp minor, or the flat second scale degree of a Neapolitan sixth chord in g-sharp minor.

In view of the tendency of pitches of mutate when exposed to other pitches, how is it that movable "do" provides a superior resource to the teacher? Whereas the system of fixed "do" would call said pitch "la," in each of the aforementioned contexts, the "do-tonic" system would call it "ti, sol, me, le," and "ra" respectively, more accurately representing the various functions of the pitch in its various contexts, if not more accurately representing the pitch (frequency) itself.

To the person who may be skeptical that pitches can and should have nuance of frequency, sing the two melodies in the following example. The tritones "re-le" and "fa-ti," if well sung, are predicted to be unequal in terms of acoustical formulae, in spite of the fact that they are—by enharmonic equivalent—identical.

Figure 1: Normal illusion of nuanced frequency in a tonal context.



Play the tonic pitch, solfège the first line, then play A-flat on the piano. The piano A-flat sounds sharp (assuming that the piano is "in tune"). Now do the same for the second line, then play G-sharp. The piano G-sharp sounds flat; yet, when played on the keyboard, the intervals are identical. When sung, however, the tritones are not only acoustically dissimilar, but also difficult to recognize as the same class of interval at all.¹⁶ The well-trained musician will sense that "le" compresses its interval by tendency toward "sol," and that "ti" stretches toward "do." In reality these are not identical frequencies, nor are they identical intervals. Each tritone is unique because frequencies and intervals are perceived and performed differently—depending on the context.

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Studies that take technological pains to prove the extent or the relevance of pitch nuance are grasping for that which is profoundly obvious. Enharmonic equivalencies, theoretically undifferentiated by the tempered tuning system, are practically differentiated by the sensitive musician, and never more so than in the performance of chromatic inflections, secondary inflections, borrowed inflections, and enharmonic pivots. Similar exercises would likely indicate that the rule of pitch nuance operates within harmonic and melodic constructions of virtually every kind. Pitch nuance is shaped by the fabric of tonality. It is this tonal nuance that is so successfully articulated, and consistently articulated in the “do-tonic” system.

A second of Seashore’s normal illusions is the phenomenon in which intervals are perceived to be different when they are really the same. Acoustically static intervals are often confused by students when they appear in their various tonal contexts. Seashore identified the P4 as an interval that is not normally subject to nuance of augmentation or diminution. This does not mean that the P4 is immune from normal illusion. The following exercise illustrates that truth. Each melody is in a different key, each melody begins with the same interval. Or is it really the same interval? Granted, each melody does begin with a P4, but do they really sound the same? Perhaps these fourths are acoustically dissimilar, their frequency ratios being altered by tonality, but that is not the point. Assuming that each fourth is perfectly identical we cannot escape the “illusion” that each fourth *sounds* different, not at first, but after the tonal center has become apparent.

Figure 2: Normal illusion of pitch perception in a tonal context.



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The message of the foregoing illustrations is that the various species of intervals are neither monolithic by construction nor by perception. Otherwise identical intervals may sound dissimilar, perhaps even be acoustically dissimilar, depending upon tonal context. This is disturbing to the student who has been trained to think of reading as a process of concatenating intervals. Having learned one interval in one context, they are often baffled when the same interval presents itself in a different context.¹⁷ Because intervals sound different in various contexts, the ideal solmization system will give an interval a different name for each context. "Do-tonic" solmization accounts for pitch nuance in a way that fixed "do" can not.

Not only should the ideal solmization system give intervals different names in different contexts, it must give identical contexts the same name regardless of the mode. Such a degree of consistency can only be accomplished by means of a "do-tonic" system. The "la-minor" system fails in that it would call the P4 between 5 and 1 "sol-do" in major keys, "mi-la" in minor keys, and a host of other names in other contexts. Most musicians concur, the P4 between 5 and 1 sounds the same regardless of the mode; it is logical, therefore, to name the interval consistently. If you call an interval "mi-la" (thinking 5 to 1 in a minor key) the student trained in "la-minor" might easily confuse this with 3-6 in a major key.

SUMMARY

Fixed "do" systems—whether seven-syllable with chromatic inflection, truly chromatic, or alphabetical—are nominal in that they identify frequencies and pitches without distinguishing tonal features or scale degrees. Fixed "do" systems depend on notation, and proceed first from notation to sound. Casual listeners, without a score, cannot use fixed "do" to empower the listening process (that is, unless they have perfect pitch, and then they don't need syllables).

The advocates of fixed "do" argue that it helps to develop perfect pitch. While this may be possible, one might counter with easier ways to develop perfect pitch, ways that do not require memorization of new pitch names (e.g., singing letters of the alphabet, or simply carrying around a tuning fork). Be that as it may, the advocates of fixed "do" are taking a gamble; their students may or may not develop perfect pitch (few do), and until they do, the system accrues no benefit in terms of understanding tonality.

The advocates of fixed "do" are troubled by the limitations of movable "do" systems as applied in atonal contexts. Admittedly, application of movable "do" to atonal and modulating music slows the reading down.

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The objection deserves a serious answer. First, but not to belittle the presumed ascendancy of atonal music, the average musician performs vastly more tonal music than atonal. Second, the student trained in movable "do" has the option of ignoring tonal associations, thinking in the key of C, and making the system "fixed." By contrast, the student of fixed "do" has no such option. Third, the objection that movable "do" is slower than fixed "do" in modulation represents a misunderstanding of the theorist's purpose for using syllables. Movable "do" is necessarily slower because the student must analyze before naming, precisely what the theory teacher expects—and desires to promote.

The fundamental purpose of ear training is not to produce readers, nor is it to produce musicians who can take dictation (although it does both). The strategic purpose of ear training is to train the mind to hear music completely. It so happens that the best way for the theory teacher to evaluate what the mind is hearing is to have the student read symbols to sounds, and write sounds to symbols. The well-planned theory curriculum will not neglect the tactical goals of sightsinging and dictation, because these are the two environments that best train the mind and demonstrate the trained mind. Movable systems work in both environments, but fixed systems do not.

Movable "do" liberates the user from the printed page. Musicians trained in movable "do" use the system to intensify the listening (therefore aesthetic) experience by clarifying tonal relationships and providing a language to describe those relationships. For theory students, movable "do" pays a copious dividend in improved dictation skills, the student is able to name what he hears before he writes its pitch.

Of the various movable systems, the "do-tonic" offers the most pedagogical resources and best exemplifies the ideal solmization criteria as proposed at the beginning of this paper: 1) "do-tonic" solmization helps develop analytical skills; 2) "do-tonic" solmization is oriented toward the ear; 3) "do-tonic" solmization stands alone for its consistent naming of musical structures; 4) "do-tonic" solmization is singable; 5) "do-tonic" solmization lends itself not only to the singing of simple diatonic music, but also to modulating and atonal music; and 6) the "do-tonic" system has historical precedence that stretches to antiquity.

Having indicated a preference for the "do-tonic" system of solmization, I recognize that a practical pedagogy requires the discrete and systematic acquisition of skills, and that involves the use of other systems. The first step in this process requires students to solfège tonal music in the key of C, diatonic fixed "do," first using numbers. The second step involves teaching the primary syllable names and applying them still in the key of C. The third step requires students to move "do" to other tonal centers. The fourth step

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requires complete mastery of the “do-tonic” system in all diatonic keys and the syllables used in all modes. The fifth step familiarizes students with the chromatic inflections of secondary, borrowed, and altered sonorities. The sixth step introduces the concept of pivot function in modulating music, which is beautifully illustrated in movable “do.” And the seventh step re-fixes “do” on the pitch C and introduces the remaining chromatic alterations that will be encountered in atonal music.

NOTES

¹Given the lack of empirical data, it should come as no surprise that the apostles of each system fall, sooner or later, upon their anecdotal swords. Having heard that fools tread where angels fear to follow, this writer rushes to the fray with a fourth argument—pedagogical. There should be enough material here for every reader to find something to disagree with.

²Audiate is a neologism coined by Edwin Gordon, which he defines as follows: “Audiation takes place when one hears music silently, that is, when the sound is not physically present. One may audiate in recalling music or in composing music. In contrast, aural perception takes place when one hears music when the sound is physically present.” Edwin E. Gordon, *The Nature, Description, Measurement, and Evaluation of Music Aptitudes* (Chicago: G.I.A. Publications, 1986), 13.

³It would be provident no doubt to spare the reader descriptions of each solmization system, descriptions that can be found in *Groves*, *Harvard*, or other sources. It seems likely, however, that not every reader will know all about every system (or study *Groves*). So, for the sake of those who do not, the descriptions have been included, and for the sake of those who do, the descriptions have been kept short.

⁴For example, fixed “do” uses “le” instead of “A-flat.” (two syllables), or in French “la bémol” (three syllables). For sightsinging purposes any solmization system has a rhythmic advantage over naming pitches by letter names.

⁵“More musical reader” because it shall be demonstrated that a “musical” performance requires deliberate alterations of frequency (nuance) in response to other frequencies and tonal contexts.

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⁶All editions of *Grove's Dictionary*, until 1980, defined "solmization" not only in terms of syllables applied to scale degrees, but also to tonal functions. Thus defined, solmization is the practice of using syllables to name scale degrees. The *New Grove Dictionary* (1980) broadened the definition of solmization to include syllables used to name pitches and intervals. Definitions in the *Harvard Dictionary* mirror *Grove* before 1980, and like the *New Grove*, the *New Harvard Dictionary* (1986) redefines solmization as the designation of pitches by syllable. The change of definition represents current usage. The change has the potential to confuse an important distinction that until recently was vigorously maintained.

⁷Edwin E. Gordon, *The Nature, Description, Measurement, and Evaluation of Music Aptitudes* (Chicago: G.I.A. Publications, 1986), 9.

⁸Carl E. Seashore, *Psychology of Music* (New York: McGraw-Hill, 1938), 58.

⁹Most how-to-learn perfect pitch strategies are based on a fitfully tortured analogy between the perception of pitch, and the perception of color. It is a wrongfully analogy that has no scientific or logical basis.

¹⁰Seashore stipulates that the test for absolute pitch must be carried out immediately after the person awakes, before any other sounds have been heard. Carl E. Seashore, *Psychology of Music* (New York: McGraw-Hill, 1938), 62.

¹¹Carl E. Seashore, *Psychology of Music* (New York: McGraw-Hill, 1938), 58.

¹²Lesser criticisms include: the number "seven" is bi-syllabic, the number "one" sports the ugliest vowel in the English language, while "one, five, six," and "seven" all end in consonants.

¹³The analyzed passage was comprised entirely of seconds, thirds, and fourths. Paul C. Greene, "Violin performance with reference to tempered, natural and Pythagorean intonation," *Iowa State Musician* IV (1937): 232-251.

¹⁴Harold G. Seashore, "An objective analysis of artistic singing," *Iowa State Musician* IV (1935): 12-157.

¹⁵Carl E. Seashore, *Psychology of Music* (New York: McGraw-Hill, 1938), 63.

¹⁶Nuanced temperament, as exemplified in this problem, is perhaps the ultimate goal of musicianship training—a powerful argument for doing sight singing and dictation away from the keyboard.

¹⁷I have observed that students who are able to identify non-contextual P4s consistently, will often mistake the contextual P4 from "mi" down to "ti" for a tritone.

A HARMONY-BASED HEURISTIC MODEL FOR USE IN AN INTELLIGENT TUTORING SYSTEM

JOHN WILLIAM SCHAFFER

INTRODUCTION

Teaching many musical tasks often requires a level of subjective understanding lacking in much traditional drill-and-practice computer-assisted instruction (CAI). Fortunately, advances in artificial intelligence now have made possible the development of *Intelligent Tutoring Systems* (ICAI) based on domain-specific, knowledge-based representational strategies. Most existing examples of such systems have been developed on expensive mainframe computers, thus severely hampering their dissemination. The power of today's microcomputers, however, has finally enabled the development of intelligent systems structured around accessible technology. This paper will examine the three key elements central to the development of a working system for tutoring the concepts of harmonic progressions: 1) the knowledge representational scheme; 2) the heuristics, or basic organizational strategies, for bringing a higher level of meaning to the knowledge; and 3) the inference engine developed to coordinate the interaction of these rules.

OVERVIEW

The program *HARMONY COACH* is an amalgamation of three interrelated coaching modules that were originally developed to demonstrate the feasibility of creating an intelligent tutorial for the coaching of music theoretical skills within a widely accessible microcomputer environment (Schaffer 1988). Two of the modules coach the writing of non-modulatory, tonal harmonic progressions, aiding the student in the creation of an acceptable harmonic progression based on either an unfigured bass line or melody. The third module coaches the student in the voice-leading of any of their previously harmonized exercises using a traditional four-voiced model. The remainder of this paper will focus on the domain representation of those modules tutoring harmonic progressions.¹

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Any well-designed knowledge base must contain sufficient information to represent effectively the complete domain of the knowledge being tutored. The implementation of such a structure, however, also requires the development of appropriate heuristic strategies to utilize and access the representative knowledge effectively. Unfortunately, since expert systems are only capable of encapsulating facts, rules, and relationships within and between each other, and since our understanding of harmony and its numerous intricacies is not wholly solidified, the knowledge domain of the tutorial, by definition, cannot be complete. It can, however, be quite comprehensive within the scope of existing precepts. Obviously, the coach cannot analyze thoroughly all extant diatonic compositions, since undefined anomalies will always appear. In reality this is not a serious hindrance. Since the tutorials are designed to teach and not analyze, they do what most of us do all the time: we teach those things that are definable first, saving the anomalies for later. Intelligent tutorials cannot always deal effectively with the intangible aspects, but they can coach the normative conventions.

Defining an expert model also can prove problematic, since every theorist tends to view harmonic practices through their own tinted glasses. Ideally, one should be able to put five theorists in a locked room and have them pool their collective knowledge with one resulting point of view. Human nature being what it is, however, this approach would most likely be unproductive! Traditional textbooks, on the other hand, do exhibit a surprisingly high level of correspondence. To test the effectiveness and thoroughness of the knowledge base, as well as the ability of the program to actually coach students in their comprehension, textbooks were selected as the fundamental source to define the expertise of the tutorials. Six books, each representing a distinctive approach, were digested, correlated, and codified into a single comprehensive rule base—comprehensive, that is, within the confined domain delineated by the textbook precepts. The textbooks employed were Allen Winold's *Harmony: Patterns and Principles* (1986), Allen Forte's *Tonal Harmony in Theory and Practice* (1979), Stefan Kostka and Dorothy Payne's *Tonal Harmony* (1984), Edward Aldwell and Carl Schachter's *Harmony And Voice Leading* (1989), Robert Ottman's *Elementary Harmony* (1983), and Bruce Benward's *Music: In Theory and Practice* (1985).

THE KNOWLEDGE STRUCTURE

HARMONY COACH is built on a knowledge base designed around a three-tiered heuristic inference engine. The lower two levels of the model

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represent diatonic tonal harmonic progressions—one expressing the broader concept of classifying harmonies into general chord classes, the other structuring the lower levels of information specific to distinctive chord groups. This part of the rule base contains all the factual and relational information necessary to represent the knowledge domain of the program.

This two-level “patterning” scheme forms the foundation for modeling common and effective student strategy for learning complex musical tasks. Allen Winold, in the preface to *Tonal Harmony: Patterns and Principles* (1986), describes the approach used in the book:

... a patterned approach ... involves the presentation of a limited number of basic chord progressions as the core materials. ... After learning to analyze, write, play, and hear these progressions in their basic form, the student learns to adapt them and to integrate them into longer, more varied musical contexts. This approach is similar to modern methods of teaching foreign languages, in which students learn basic phrases and then learn to vary them and use them in longer patterns of thought (1986, vii).

Specifically, by starting with small atomic elements and coalescing them into larger conceptual packets—or patterns—a student is able to reduce the amount of information required at any given stage, thus simplifying the conceptualization process. Similarly, just as patterns are formed and associated by students during the course of learning a complex task, a knowledge structure designed to coach those same students also can be defined around such principles. Clearly, a well constructed cognitive learning strategy should translate into an effectively organized expert model capable of the same sort of flexible, yet simple, level of comprehension.

Unlike the lowest two levels, which embody the factual and relational knowledge of the program, the third level constitutes a forward-referencing inference engine operating on a reverse-looping design. This level is employed to trigger control of those particular knowledge structures appropriate for dealing with a given student query from the lower two levels.

THE THREE-TIERED MODEL

The first, or lowest, level asserts facts and precepts that define specific aspects of harmonic structure and interaction. These precepts, in essence,

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represent a collection of all those commonly held tenets that make up the bulk of most theory textbooks.² Through evaluating the cumulative materials of the five theory texts previously mentioned, eleven general rule categories defining the textbook conventions of diatonic (i.e., non-modulatory) harmonic progressions emerged. A list of these precepts is given in figure 1.

Figure 1. Harmonic Precepts:

1. phrase-level harmonic motion,
2. general chord classifications,
3. root progressions,
4. first-inversion functions,
5. second-inversion functions,
6. general seventh-chord functions,
7. dominant-seventh chords,
8. other sevenths,
9. harmonic rhythm,
10. harmonic succession, and
11. linear harmonic functions.

Many of these categories coincide on a one-to-one basis with typical chapter headings and frequently represent closed precepts. Other categories exemplify an amalgamation of seemingly disparate facts pulled from various topical areas. For example, precepts about dominant-seventh chords can be relatively self-contained. The harmonic and voice-leading functions of these chords are tightly defined and, within the limited domain of the tutorials, tend to operate consistently regardless of their contextual situation. On the other hand, precepts defining the nature of inversions, for example, are often strongly contextual and must rely heavily on precept interaction, forcing the inference engine to monitor closely other factors in a given exercise. For example, a cadential tonic six-four chord functions quite differently than a passing dominant six-four chord. Similarly, the bass note of a first-inversion triad may have a strong predilection to resolve by step unless the chord following it represents a different formulation of the same harmony. In this case the resolution would likely be by leap. In many cases, precepts at this level aim at being distinctly non-chord specific, generalizing instead on classes of chords. *HARMONY COACH* uses the four class categories defined by Allen Winold (1986). Specifically, these are Tonic class, Dominant class, Subdominant class, and Linear class. (A

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complete listing of all the first-level precepts appears in Table 1 at the conclusion of the article.)

The second (or middle) heuristic level, acts essentially as a traffic manager for the first-level precepts. Once a specific chord is assigned to a chord class, the primary function of this level is to coordinate which level-one precept(s) should be applied and tested for any given situation and to determine the order in which they will be evaluated (or "fired"). Heuristic precepts at this level are designed specifically to function with adjacent chord pairs (discussed later). Since the third, or highest, heuristic level deals primarily with interrelationships between multiple harmonies, it is essentially the job of the middle-level precepts to coordinate the individual chord-pair functions that subsequently are linked together during the final stage. Figure 2 shows one example of a middle-level precept. (A complete listing of all middle-level heuristics appears in Table 2 at the conclusion of the article.)

Figure 2.

PRECEPT 11.1a: A root-position Tonic-Class triad may harmonize the given bass note...

IF a chord moves to another chord with the same root **AND** rules...

(2.1a [Tonic-class chords may move to chords of any class] **AND** 4a [a progression from any root-position chord to the same chord in first inversion is acceptable] **AND** 9 [two adjacent chords sharing the same root must not be separated by a bar line] **AND** 1a [the last chord of a progression must be a tonic, dominant, or submediant] are observed...)

OR two chords are **NOT** the same **AND** rules...

(2.1a [Tonic-class chords may move to chords of any class] **AND** 1a [the last chord of a progression must be a tonic, dominant, or submediant] are observed.)

[(same chord **AND** 2.1a **AND** 4a **AND** 9 **AND** 1a)

OR (NOT(same chord) **AND** 2.1a **AND** 1a]

This example reads as follows: A root-position Tonic-Class triad may harmonize the given bass note **IF** the chord moves to another chord with the same root **AND** if it follows the rules controlling the motions of a (T)onic-Class chord to chords of the same chord class **AND** it progresses from a root position to the same chord in first inversion **AND** the two adjacent chords sharing the same root are not separated by a bar line **AND** if either chord is the last chord of a progression (i.e., a cadence), it must be a tonic, dominant, or submediant; **OR** the two chords do **NOT** share the same root **AND** it follows the rules controlling the motions of a (T)onic-Class chord to chords of the different chord classes **AND** if either chord is the last chord of a progression (i.e., a cadence), it must be a tonic, dominant, or submediant.

It might be obvious to assume that there are four precepts such as these to define each of the four chord classes. Some situations, however, demand more specificity (for example, as stated earlier, a linear-class passing dominant six-four chord). Both chords are of the linear class, yet their functions cannot be united. Given this and similar situations, it seemed more productive to isolate various sub-class groups and to assign specific middle-level heuristics where appropriate. Since this specificity is critical to the ability of the knowledge base to respond effectively to student inquiries, the more finite each precept, the better able the program is to respond to individual queries.

Finally, the highest heuristic level triggers consultation decisions based on the location of a specific chord-pair choice within the context of a given exercise. As implied earlier, this level contains no specific factual knowledge. Instead, it functions to link the specifics of an actual exercise to the lower two levels of the rule structure. For example, regardless of chord classification (such as tonic or dominant), the positioning of a particular chord within a cadence, as opposed to elsewhere in a specific harmonic progression, might significantly affect which precepts need to be consulted. Additionally, the heuristics at this level must take into account previous successful student choices. Obviously, the selection of a particular chord at a given position within a progression will be more restrictive if an adjacent position is harmonized than if it is not. Since the Coach allows students to harmonize an exercise in any order they wish, it cannot assume that each chord choice will have immediate successors or predecessors present in the progression. Whenever a new chord is inserted into the exercise, existing chords on both sides of the entry are rechecked, taking into consideration the newest entry. This action insures that all previous choices are updated in relation to any new information in the knowledge base. If a previously acceptable harmonization now becomes problematic in relation to some new choice elsewhere in the progression, the student is informed of the

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problem and has the opportunity to correct it by changing either or both of the offending harmonies. (A listing of the highest-level heuristic appears in Table 3 at the conclusion of the article.)

In developing the heuristic strategies for this level, one significant problem became apparent immediately: how to develop a control heuristic that could coordinate the middle-level heuristics to account effectively and efficiently for a number of various situations. For example, a chord may appear at the beginning of the piece, in which case there will be no chord of preparation; likewise, the final chord of the exercise will have no chord of resolution. A harmony in the middle of the progression might or might not have a previously asserted harmony on either or both sides of it; and, if one of the adjacent notes is or is not harmonized, how many additional notes on either side of it are or are not harmonized. Unfortunately, the list of possibilities is extensive. To deal with this complex side effect, a forward-referencing, reverse-looping inference engine was developed that overcomes this problem rather directly. Recall that all middle-level heuristics are chord-pair referenced. In other words, each harmony is compared with one and only one other harmony at any given point—in most cases the chord of resolution. Designing the precepts around a forward-referencing scheme such as this eliminates much of the unnecessary complexities of a rule structure that must take into account all of the various situations outlined a moment ago. In this case, each precept needs to know only where it is going, not from where it is coming.

Conversant musicians, of course, should be able to see the weakness in this rather myopic view. If, however, the forward-referencing model is employed as part of a multiple, reverse-looping design that sequentially shifts the chord-pair reference point forward and backward, all of the notes necessary to evaluate the relevant portion of the progression are, in effect, covered. This heuristic approach effectively accomplishes the task of looking forwards and backwards from any point in the progression while maintaining the simplicity of the original forward-referencing model. Figures 3 and 4 will serve to clarify the process through several simple hypothetical examples.

Figure 3a represents a typical beginning melody the program might present to a student for harmonization. In this instance, the entire melody is preset to an initial harmonization of *null* (not currently harmonized). *HARMONY COACH* is explicitly designed to allow a student to begin anywhere. In this case, however, our hypothetical learner begins at the beginning by asserting a root-position tonic chord as harmonization for the melodic D natural shown in Figure 3b. The upper-level heuristic begins by calling the first relevant middle-level precept. Since all middle-level

functions deal with forward-referencing chord-pairs, the asserted chord is checked against the nest position. In this example, finding a *null* harmonization causes two actions to occur. First, every time a *null* is encountered, the note in question is checked in relation to the existing chord preceding it. Then, an attempt is made to see if it has the potential to support a harmonization suitable for the chord pair in question. Second, the control mechanism must reposition the reference pointer one position to the right and, then, check the next chord pair to insure that any of the hypothetical solutions to the first *null* are also capable of progression to the next harmony. In this instance, a second *null* in an adjacent position halts the forward succession of events and triggers a reverse-loop that moves the reference position from its current location two position to the left, ending up on the immediate predecessor to the original position on the first note. At this point another middle-level precept is called to deal with the new chord pair. Since no note exists prior to the first one, the process is halted and the program responds positively to the student.

Figure 3.

Figure 3 consists of five musical staves, labeled a) through e), each showing a sequence of notes and chords in a key of two sharps (F# and C#). The staves illustrate a process of identifying and resolving 'null' harmonizations.

- a)** A single staff with a sequence of notes: G4, A4, B4, C5, D5, E5, F#5, G5. There are no chords indicated.
- b)** A staff with the same notes as a). Below the notes, there are four 'null' labels. Above the first 'null' is a box containing 'I'. Above the second 'null' is a box containing 'null'. Arrows point from the 'I' box to the first 'null' and from the 'null' box to the second 'null'.
- c)** A staff with the same notes as a). Below the notes, there are four 'null' labels. Above the first 'null' is a box containing 'vi'. Above the second 'null' is a box containing 'null'. Above the third 'null' is a box containing 'I'. Arrows point from the 'vi' box to the first 'null', from the 'null' box to the second 'null', and from the 'I' box to the third 'null'.
- d)** A staff with the same notes as a). Below the notes, there are four 'null' labels. Above the first 'null' is a box containing 'vi'. Above the second 'null' is a box containing 'null'. Above the third 'null' is a box containing 'V'. Above the fourth 'null' is a box containing 'vi'. Arrows point from the 'vi' box to the first 'null', from the 'null' box to the second 'null', from the 'V' box to the third 'null', and from the 'vi' box to the fourth 'null'.
- e)** A staff with the same notes as a). Below the notes, there are four 'null' labels. Above the first 'null' is a box containing 'ii6'. Above the second 'null' is a box containing 'V'. Above the third 'null' is a box containing 'vi'. Arrows point from the 'ii6' box to the first 'null', from the 'V' box to the second 'null', and from the 'vi' box to the third 'null'.

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Next, as in Figure 3c, the student asserts a root-position submediant chord as a harmonization for the second melody note. As in the previous example, a middle-level precept checks the chord pair in positions two and three. Any further forward references are halted after testing the *null* in position three and checking it against position four. Reverse looping is triggered again and the chord pair starting in position one is checked for acceptability.

As can be seen in Figure 3d the student next decides to jump ahead to the cadence and asserts a dominant chord in the penultimate position of the exercise. Again, a forward-reference check is made and halted at the *null* harmonization of the final chord. Reverse looping moves the reference point one position to the left and another check is undertaken. At this point, a *null* in the first position of the chord pair causes an additional reversal to occur, which, in turn, checks the forward-referencing progression from the root-position submediant in position two against the *null* in position three. This additional step is essential since any hypothetical solutions for harmonizing the E-natural in position three must form an acceptable progression with the existing chord preceding it. Two situations are possible at this point, both of which would stop the reverse looping. First, a *null* harmonization in position two would indicate a complete *null pair* between positions two and three. Further checking beyond this point would be unproductive, since the number of possibilities would expand exponentially, thus making any further concrete assertions unproductive. Second, the presence of a chord in position two, as is the case here with the previously asserted submediant, indicates that checking has already occurred between chord pairs to the left of this position, thus making any further checks at this level redundant.

Finally, as seen in Figure 3e, the student fills the gap by supplying a harmonization for the E-natural in position three. A forward reference checks position three against position four, then position four against the *null* in position five. A reversal occurs and position two is checked against position three. Finally, the student completes the exercise by supplying the tonic in the last position, the last checks are made and final evaluations are undertaken.

While this example is not meant to be comprehensive, it does show the working of the forward-referencing, reverse-looping heuristic at the most simple level. The same principle can also be applied to the examination of larger gestures or more complex problems. Keeping in mind the phrase-level domain of *HARMONY COACH*, however, such usage is limited to a relatively small number of precepts. Again, a simple example will suffice.

Figure 4.

Figure 4 consists of five musical staves, labeled a) through e), each showing a sequence of chords and their functions. The chords are: V, I, vi, ii⁶, V, vi, IV⁶, I⁴₆, V⁷, I. The staves illustrate different points in the sequence where a search for dominant harmonies begins and ends, indicated by arrows and boxes.

- a) The search begins at the first V chord and ends at the final I chord.
- b) The search begins at the first V chord and ends at the first V⁷ chord.
- c) The search begins at the first V chord and ends at the first V⁷ chord.
- d) The search begins at the first V chord and ends at the first V⁷ chord.
- e) The search begins at the first V chord and ends at the first V⁷ chord.

Upon completion of an exercise such as the one shown throughout Figure 4, several checks might be undertaken to assess the overall performance of the student. One obvious point to examine might be the structural integrity of the phrase in terms of the final cadence, the early establishment of a key, and the motion from the incipit to the close of the phrase. The check begins when the third-level heuristics trigger those precepts designed to deal with phrase structure and organization. Figure 4a shows the precept beginning its check between the final chord-pair of the piece. Once satisfied that the cadence is in order, reverse looping takes place and the position pointer is moved to the initial note of the exercise, as shown in Figure 4b. At this point, forward-referenced chord pairs are examined sequentially until the precept is satisfied that the tonic of the exercise is established relatively early in the phrase. Again, only one check is required in this example. To insure that the student has written an exercise that exhibits a satisfactory balance between repetition and variety, yet does not contain an excess of cadential material, the precept begins a forward-referencing look at the intermediary chords to determine if any additional dominant harmonies occur. If the chords do appear, their possible function in the progression is examined. In Figure 4c, the search encounters a dominant fairly early on. Immediately, as in Figure 4d, the position pointer is moved forward to position five and a second forward-referenced search is undertaken to

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determine the nature of the remaining progression. This time, no tonic is found prior to encountering the final cadence. A quick scrutiny of the intervening harmonies determines that a larger-scale dominant prolongation has occurred between positions five and nine. Finally, satisfied that the cadential properties of the exercise are in order, the precept re-positions the pointer to position five—the beginning of the dominant prolongation—and initiates a simple forward-referencing, reverse-looping examination of the remaining harmonies. The process continues in this manner until all desired assessments are made.

CONCLUSIONS

The heuristic inference engine in the *HARMONY COACH* is sufficient to allow the program to fulfil successfully the basic criteria so essential to the functional ability of the program to coach. First, the program contains the domain knowledge in a manner consistent with our recognized teaching tool; second, it can function to recreate student learning processes by representing its knowledge in a manner similar to that of a pseudo-student; and finally, it can access the domain knowledge to solve domain problems, explain the logic behind *how* the problem was solved and *why* the choice is acceptable, and similarly explain *why* a choice is not acceptable, as well as explain the logic underlying that assessment.

As mentioned earlier, since the inference engine in *HARMONY COACH* functions in a teaching environment aimed specifically toward the development of relatively low-level skills, it does not explicitly include extensive knowledge on larger-scale harmonic structures. As was shown in the examples above, however, the pattern approach of grouping multiple smaller structures into a reduced number of larger patterns—a concept so integral to the heuristic model—would certainly be capable of supporting such expansion.

Finally, while the particular knowledge base being discussed here is designed specifically for the storage and dissemination of principles related to harmonic progressions, the three-tiered organizational structure of pattern building has shown itself to be sufficiently flexible to allow for its use in numerous musical applications. I hope the information in this paper can be of some value to others interested in the application of expert system technology to the study and pedagogy of music.

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Table 1. Rules of Harmonic Progressions.

Regarding basic harmonic motion, the following precepts apply:

- 1a: The last chord of a progression **MUST** be a tonic, dominant, or submediant chord.
- 1b: If the last chord of a progression is a tonic then the next to last chord **MUST** be a dominant, subdominant, or leading tone.
- 1c: If the last chord of a progression is a submediant then the next to last chord **MUST** be a dominant chord.

Regarding incipits (beginnings), the following precepts apply:

- 1.1a: It is **PREFERRED** but not essential that the first chord of a progression should be a tonic or dominant chord.
- 1.1b: If the first chord isn't a tonic then the first bass note capable of supporting a tonic chord **SHOULD** be harmonized by a tonic chord.

Regarding chord classifications, the following precepts apply:

- 2a: Tonic and submediant chords (root position & 1st inv.) are considered to be (T)onic-class chords.
- 2b: Dominant and leading-tone chords are considered to be (D)ominant-class chords.
- 2c: Subdominant and supertonic chords are considered to be (S)ubdominant-class chords.
- 2d: Mediant and 2nd-inversion triads are considered to be (L)inear-class chords.

Regarding general motion between classes, the following precepts apply:

- 2.1a: (T)-class chords move to chords of any class.
- 2.1b: (S)-class chords **SHOULD** move to (D)-class chords. A subdominant chord may also move to a tonic chord.
- 2.1c: (D)-class chords **MUST** move to (T)-class (or V-IV⁶ in minor).
- 2.1d: A chord of one class **MAY** move to a different chord of the same class.

NOTE: Each (L)-class chord moves according to its own precept(s).

Regarding Preference of root motions, the following precepts apply:

- 3a: Root motion down by a 5th is preferred to all other motions.
- 3b: Root motion up by a 2nd is preferred to all motions except those of precept 3a.
- 3c: Root motion down by a 3rd is preferred to all motions except those of precepts 3a-b.

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- 3d: Root motion up by a 5th is preferred to all motions except those of precepts 3a-c.
- 3e: Root motion down by a 2nd is preferred to all motions except those of precepts 3a-d.
- 3f: Root motion up by a 3rd is least preferred.

Regarding first-inversion chords, the following precepts apply:

- 4a: A progression from any root-position chord to the same chord in first inversion is ACCEPTABLE and DESIRABLE.
- 4b: A progression from any 1st-inversion chord to the same chord is ACCEPTABLE, but NOT PREFERRED.
- 4c: A progression from any 1st-inversion chord to a chord whose bass note lies step-wise above or below the current bass note is both ACCEPTABLE and DESIRABLE.

Regarding specifically the first-inversion mediant and submediant:

- 4.1a: These chords should occur ONLY in descending step-wise progressions (see specific precepts for each chord).

Regarding the cadential six-four, the following precepts apply:

- 5a: A 2nd-inversion tonic triad MUST move to a root-position dominant or dominant-7th chord.
- 5b: A 2nd-inversion tonic triad should ONLY be preceded by a (T)onic- or (S)ubdominant-class chord, NEVER by a (D)ominant-class chord or another 2nd-inversion tonic chord.
- 5c: It is preferable for a 2nd-inversion tonic triad to be approached by step-wise motion in the bass.
- 5d: A tonic six-four chord should ONLY appear as part of the final cadence of the phrase, but NEVER as the last chord.

Regarding the rhythmic placement of a cadential six-four chord:

- 5.1a: A 2nd-inversion tonic triad MUST appear on a stronger beat than that of the next chord.

Regarding metric stress (accent), the following precepts apply:

- 5.2a: Beat one of a measure is ALWAYS the strongest.
- 5.2b: The last beat of a measure is ALWAYS the weakest.
- 5.2c: In quadruple meter, beat three is stronger than beat two.

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Regarding triad /7th-chord motion, the following precepts apply:

- 6a: Motion from a triad to a 7th chord built on the same root is ACCEPTABLE.
- 6b: Motion from a 7th chord to a triad built on the same root is NOT ACCEPTABLE.

Regarding the dominant seventh, the following precepts apply:

- 7a: The V⁷ chord MUST resolve to a (T)onic-class chord or to another dominant-7th chord.
- 7b: A tonic resolution of the dominant-7th chord is preferred to a Submediant (deceptive) resolution.
- 7.1a: When a dominant-7th is approached by scale-degree 5 in the bass, the preferred preparation is by a V⁽⁷⁾ or I^{6/4}.
- 7.1b: When a dominant-7th is NOT approached by scale-degree 5 in the bass, common preparations include the supertonic, subdominant, and submediant.

Regarding dominant-seventh chords in inversion:

- 7.2a A 1st-inversion dominant 7th MUST resolve up by half-step to a root-position tonic chord.
- 7.2b: A 2nd-inversion dominant 7th MUST resolve by step to either a root-position or 1st-inversion tonic chord.
- 7.2c: A 3rd-inversion dominant 7th MUST resolve down by step to a 1st-inversion tonic chord.

Regarding the supertonic-seventh, the following precept applies:

- 8: The supertonic-7th chord MUST resolve to a (D)ominant-class chord, OR a 2nd-inversion tonic triad.

Regarding harmonic rhythm, the following precepts apply:

- 9a: It is preferable that the harmony change with each note of the exercise.
- 9b: It is strongly suggested that two adjacent chords sharing the same root should not be separated by a barline.

Regarding successions of inversions, the following precept applies:

- 10: Any bass progression of three or more notes DESCENDING BY STEP may be harmonized by 1st-inversion chords REGARDLESS of the resulting progression.

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Regarding specifically the mediant chord:

- 10.1: A root-position mediant chord **MUST** progress to a sub-dominant, or root-position submediant triad.

Regarding passing six-four chords, the following precept applies:

- 11a: A 2nd-inversion Tonic or Dominant chord **MAY** harmonize the middle note of a three note step-wise progression **IF** the outer two notes are harmonized by one root-position and one 1st-inversion form of the same chord.

Regarding neighbor six-four chords, the following precept applies:

- 11b: A 2nd-inversion Tonic or Submediant chord **MAY** harmonize the middle note of a three-note progression **IF** the outer-two bass notes are the same as that of the middle note **AND** the outer two notes are harmonized by the same root-position chord.

Regarding both six-four chords, the following precept applies:

- 11.1: All passing and neighbor six-four chords must appear on a beat weaker than the preceding beat.

Table 2. Middle-Level Control Heuristics.

(Rule numbers appear in '[..]')

"T" can harmonize a note **IF**

the next note is not harmonized **AND**

the next note is capable of supporting an acceptable chord

OR

it follows the rules for movement within a class [2.1d] **AND**

it does not repeat across a barline [9b] **AND**

if relevant, it follows the rules about cadential chords [1a-c]

OR

it follows the rules of (T)onic-class movement [2.1a] **AND**

it is **NOT** the same chord **AND**

if relevant, it follow the rules about cadential chords [1a-c] **AND**

if relevant, it is a proper preparation for a V⁷ [7.1a-b].

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"T⁶" can harmonize a note IF

the next note is not harmonized AND

the next note is capable of supporting an acceptable chord

OR

it follows the rules for movement within a class [2.1d] AND

it does not repeat across a barline [9b] AND

if relevant, it follows the rules about cadential chords [1a-c]

OR

it follows the rules of (T)onic-class movement [2.1a] AND

it is NOT the same chord AND

if a 1st inversion, it is preferred to resolve by step [4c] AND

if relevant, it follows the rules about cadential chords [1a-c]

OR

it follows the rules of (T)onic-class movement [2.1a] AND

succession_of_inv AND

if relevant, it follows the rules about cadential chords [1a-c]

OR

it follows the rules of (T)onic-class movement [2.1a] AND

it is NOT the same chord AND

if a 1st inversion, it is preferred to resolve by step [4c] AND

if relevant, it follows the rules about cadential chords [1a-c] AND

if relevant, it is a proper preparation for a V⁷ [7.1a-b].

"T^{6/4}" can harmonize a note IF

the next note is not harmonized AND

the next note is capable of supporting an acceptable chord AND

it must be part of a cadence [5d]

OR

it must resolve to a root-position dominant [5a] AND

the chord preceding it should be acceptable [5b] AND

it should be approached by step [5c] AND

it must resolve to a weaker beat [5.1a] AND

it must be part of a cadence [5d]

OR

it follows the rules for passing six-fours [11a] AND

it must be on a weak beat [11.1]

OR

it follows the rule for neighbor six-fours [11b] AND

it must be on a weak beat [11.1].

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"V" can harmonize a note IF
the next note is not harmonized AND
the next note is capable of supporting an acceptable chord
OR
it resolves to a V^7 [6a] AND
it does not repeat across a barline [9b]
OR
it follows the rules for movement within a class [2.1d] AND
it does not repeat across a barline [9b]
OR
it follows the rules for movement within a class [2.1d] AND
it is NOT the same chord
OR
it follows the rules for (D)-class movement [2.1c].

"V⁷" can harmonize a note IF
the next note is not harmonized AND
the next note is capable of supporting an acceptable chord.
OR
it progresses to the same chord AND
it does not resolve to a triad of the same class [6b] AND
if relevant, it is a proper preparation for a V^7 [7.1a-b] AND
it progresses to the same chord in inversion [4a] AND
it does not repeat across a barline [9b]
OR
it must resolve to a (T)-class chord [7a].

"V⁶" can harmonize a note IF
the next note is not harmonized AND
the next note is capable of supporting an acceptable chord
OR
it resolves to a V^7 [6a] AND
it does not repeat across a barline [9b]
OR
it progresses to the same chord AND
it shouldn't move to the same chord in root position [4b] AND
it does not repeat across a barline [9b]
OR
it follows the rules for movement within a class [2.1d] AND
it is NOT the same chord
OR

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it is part of a descending succession of inversions [10]

OR

if a 1st inversion, it is preferred to resolve by step [4c] AND

it follows the rules for (D)-class movement [2.1c].

"V^{6/4}" can harmonize a note IF

the next note is not harmonized AND

the next note is capable of supporting an acceptable chord

OR

it follows the rules for passing six-fours [11a] AND

it must be on a weak beat [11.1].

"V^{6/5}," "V^{4/3}," or "V^{4/2}" can harmonize a note IF

the next note is not harmonized AND

the next note is capable of supporting an acceptable chord

OR

if relevant, it is a proper preparation for a V⁷ [7.1a-b] AND

it resolves correctly [7.2a-c].

"VII⁰⁶" can harmonize a note IF

the next note is not harmonized AND

the next note is capable of supporting an acceptable chord

OR

it follows the rules for movement within a class [2.1d] AND

if relevant, it is a proper preparation for a V⁷ [7.1a-b]

OR

it is part of a descending succession of inversions [10]

OR

it follows the rules for (D)-class movement [2.1c] AND

if relevant, it is a proper preparation for a V⁷ [7.1a-b] AND

if a 1st inversion, it is preferred to resolve by step [4c].

"IV" or "II" can harmonize a note IF

the next note is not harmonized AND

the next note is capable of supporting an acceptable chord

OR

it progresses to the same chord AND

it progresses to the same chord in inversion [4a] AND

it does not repeat across a barline [9b] AND

if relevant, it follows the rules about cadential chords [1a-c]

OR

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it follows the rules for movement within a class [2.1d] AND
it is NOT the same chord AND
if relevant, it follows the rules about cadential chords [1a-c]
OR
it follows the rules of (S)ubdominant-class movement AND
if relevant, it follows the rules about cadential chords [1a-c] .

"TV⁶" or "II⁶" can harmonize a note IF
the next note is not harmonized AND
the next note is capable of supporting an acceptable chord
OR
it progresses to the same chord AND
if shouldn't move to the same chord in root position [4b] AND
it does not repeat across a barline [9b] AND
if relevant, it follows the rules about cadential chords [1a-c]
OR
it follows the rules for movement within a class [2.1d] AND
it is NOT the same chord AND
if relevant, it follows the rules about cadential chords [1a-c]
OR
if a 1st inversion, it is preferred to resolve by step [4c] AND
it is NOT the same chord AND
OR
it is part of a descending succession of inversions [10]
OR
it follows the rules of (S)ubdominant-class movement AND
if relevant, it follows the rules about cadential chords [1a-c] .

"TV^{6/4}" can harmonize a note IF
it follows the rules for neighbor six-fours [11b] AND
it must be on a weak beat [11.1].

{"II" same as "IV"}

"II⁷" can harmonize a note IF
it follows the rules for movement within a class [2.1d] AND
it does not repeat across a barline [9b]
OR
it does not resolve to a triad of the same class [6b] AND
it does not repeat across a barline [9b]
OR
it resolves to a (D)-class chord [8].

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{**"II⁶"** same as **"IV⁶"**}

"II^{6/5}" can harmonize a note IF

it follows the rules for movement within a class [2.1d] AND

it does not repeat across a barline [9b]

OR

it does not resolve to a triad of the same class [6b] AND

it does not repeat across a barline [9b]

OR

if a 1st inversion, it is preferred to resolve by step [4c] AND

it is NOT the same chord AND

it resolves to a (D)-class chord [8]

OR

it resolves to a (D)-class chord [8]

OR

it is part of a descending succession of inversions [10].

"VI" can harmonize a note IF

it follows the rules of (S)ubdominant-class movement AND

it cannot be penultimate to a tonic final [1b] AND

if the final chord, it must function as a deceptive cadence [1c] AND

if relevant, it follows the rules about cadential chords [1a-c]

OR

it follows the rules of (T)onic-class movement [2.1a] AND

it cannot be penultimate to a tonic final [1b] AND

if the final chord, it must function as a deceptive cadence [1c] AND

if relevant, it follows the rules about cadential chords [1a-c].

"VI⁶" can harmonize a note IF

it is part of a descending succession of inversions [10].

"III" can harmonize a note IF

it must progress to a subdominant or submediant [10.1].

"III⁶" can harmonize a note IF

it is part of a descending succession of inversions [10].

INTELLIGENT TUTORING SYSTEM

Table 3. Highest-Level Control Heuristics

ATTEMPT TO ASSERT A CHORD AT A GIVEN POSITION IF

the note is in the LAST position of the exercise AND /* last position */
the chord choice harmonizes the given note AND
the previous chord is not NULL AND
reverse loop and try position POS-1 ==>
[SUCCESS!]

OR

the note is in the LAST position of the exercise AND
the chord choice harmonizes the given note AND
the previous chord is NULL AND
check for allowable cadence choices ==>
[SUCCESS!]

OR

the note is in the FIRST position of the exercise AND /* first position */
check all forward-referenced chord pairs ==>
[SUCCESS!]

OR

the note is in the MIDDLE of the exercise AND /* middle positions */
the previous chord is not NULL AND
check all forward-referenced chord pairs AND
reverse loop and check chord pair(s) position POS-1, etc. ==>
[SUCCESS!]

OR

the note is in the MIDDLE of the exercise AND
the previous chord is NULL AND
check all forward-referenced chord pairs ==>
[SUCCESS!]

OR

[FAILURE!]

/* failure */

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NOTES

¹For a more comprehensive overview of the program refer to the article "Harmony Coach: An Exploration of Microcomputer-Based Intelligent Tutoring Systems in Music," *Journal of Computer-based Instruction* 18 (Spring 1991).

²As an aside, it is unfortunate that these are the elements too often taught to beginning harmony students in a manner that simply informs them of the *what*, but due to lack of instructional time, are not always followed up with the *how* and *why* of the application of that information. The primary role of the *HARMONY COACH* is to do just that—namely to coach the application of a previously learned skill in such a manner as to imitate the subtle help an observant teacher might give a student in a focused individual tutoring session.

REFERENCES

Aldwell, Edward, and Schacter, Carl. *Harmony and Voice Leading*. 2nd edition. New York: Harcourt, Brace, Jovanovich, 1989.

Benward, Bruce. *Music: In Theory and Practice*. 3rd edition. Dubuque, IA: Wm. C. Brown, 1985.

Forte, Allen. *Tonal Harmony in Theory and Practice*. 3rd edition. New York: Holt, Reinhart, Winston, 1979.

Lugar, George, and Stubblefield, William. *Artificial Intelligence and the Design of Expert Systems*. Redwood City, California: The Benjamin/Cummings Publishing Company, 1989.

Kostka, Stefan, and Payne, Dorothy. *Tonal Harmony*. New York: Alfred A. Knop, 1984.

Ottman, Robert. *Elementary Harmony*, 3rd edition. Englewood-Cliffs, N.J.: Prentice Hall, 1983.

Sell, Peter S. *Expert Systems: A Practical Introduction*. New York: John Wiley & Sons, 1985.

Winold, Allen. *Harmony: Patterns and Principles*. Englewood-Cliffs, N.J.: Prentice Hall, 1986.

LOGO AS A MEDIUM FOR EXPLORING ATONAL THEORY

J. KENT WILLIAMS

INTRODUCTION

Logo, a widely used educational computer programming language, can serve as a medium for learning and exploring basic concepts and techniques of atonal theory and analysis. The discussion begins with a consideration of the unique characteristics of computational media as educational environments and then continues with a brief overview of the Logo language, the educational philosophy on which it is based, the attributes that distinguish it from other high-level programming languages, and possibilities for its use. Finally, I present an approach for using Logo in college-level courses that introduce atonal theory and analysis.

COMPUTER ENVIRONMENTS AS INSTRUCTIONAL MEDIA

Advocates of electronic technology have often contended that such media are merely neutral transmitters of the information that is provided to them as input. Such answers are often made in response to critics who claim that a given medium has a corrupting effect on those who use it. While it is true that instructional media can and do transmit any program that is couched in a suitable format regardless of its educational, aesthetic, or moral value, it does not follow that they are entirely neutral transmitters of that information. For, as Patricia Greenfield has noted, each medium is like a filter with its own technical and formal characteristics, and as a result, "transforms information while communicating it, emphasizing particular aspects of events and ideas, deemphasizing others. As a consequence, each medium presents certain types of information easily and well, other types with difficulty or relatively poorly."¹ Greenfield asserts that printed media excel at conveying a person's inner thoughts, audio media "make dialogue and figurative language salient," while television and films have particular strengths in presenting actions, both successive and simultaneous, in three-dimensional space. Computer technology "has a great strength in allowing

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users to interact with complex systems having multiple, interacting, dynamic variables."²

Other theorists have focused on the microcomputer as a medium for representing and manipulating systems of symbols, and for creating products (e.g., drawings, poems, pieces of music) within those systems. Karen Sheingold notes that computers offer unique possibilities for dynamic interaction, programmability, and cognitive support.³ Jeanne Bamberger sees the computer as a medium that "reflects back to us images of our commonsense ways of making *things* and making *sense*,"⁴ one that, in Sheingold's words, "can help us discover and reflect on what we already know intuitively . . . and see familiar actions and objects in new ways."⁵

One of the foremost advocates of computer-aided problem solving and discovery learning has been Seymour Papert of MIT. Papert's book *Mindstorms: Children, Computers, and Powerful Ideas*⁶ is the definitive statement of the so-called Logo philosophy of educational computing. Beginning from the Piagetian premise that learners are builders of their own knowledge structures, and that, when provided with the proper materials, they can learn without being formally taught, Papert goes on to describe how students can use computers to solve intellectual problems, explore various domains of human knowledge, and in the process, confront some of the truly powerful ideas in science, mathematics, and the art of cognitive model building.

Fundamental to Papert's vision is the idea that students should learn to control computers, rather than be controlled by them.⁷ While the current generation of personal computers can be controlled in a number of different ways, the highest and most expressive degree of control is still achieved through the medium of a programming language. It follows, therefore, that those who wish to realize the computer's maximum potential as a tool for intellectual discovery should learn to write programs.

Support for Papert's position can be found in recent articles by Roger C. Shank and Robert Farrell of the Yale Artificial Intelligence Project,⁸ and by Jeffrey Bonar of the Learning Research and Development Center, University of Pittsburgh. Bonar begins his article with the bold assertion that

Within ten to twenty years all educated people in jobs with any amount of professional responsibility . . . will be programmers. That is, as part of their job they will regularly adapt and extend computational tools to meet the particular demands of their jobs.⁹

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Bonar calls such people "casual programmers," as opposed to professional programmers, and clarifies this distinction as follows:

Just as the typical literate person does not write novels, the typical computer user will not write major programs. Nonetheless, the typical user will be able to write the equivalent in programs of the typical literate person's 1 to 20 paragraph documents. These programs may not be elegant or efficient (in the narrow sense of running fast on a particular machine), but they will be an important extension of the user's intentions on the machine.¹⁰

CHARACTERISTICS OF LOGO

To make casual programming as accessible and rewarding as possible, Seymour Papert and others around MIT, circa 1968, developed Logo.¹¹ They modeled it on Lisp, a language that has particular strengths in the areas of symbol manipulation and list-processing. Most of the early work with Logo was done at MIT in the Artificial Intelligence Laboratory and the Division for Study and Research in Education.¹² The first microcomputer implementations appeared in the early 1980s and, since then, Logo has acquired a large and devoted following among teachers and learners at all levels.

Logo is most closely associated with turtle graphics, a computational medium in which users (usually children) learn basic concepts of computer programming and plane geometry by typing commands which cause a triangle-shaped cursor to move about on the display screen, leave a trail, and draw simple figures.

The acceptance of Logo at the secondary and college levels has been hampered, ironically, by its widespread success at the elementary level. The notion prevails that Logo is little more than a graphics environment for children to play in until they grow up and are ready to learn a "real language." As David Thornburg has noted,¹³ this attitude is regrettable because Logo is very much a real programming language. In fact, when educational and cognitive factors are given high priority, it can reasonably be argued that Logo is among the most "powerful" of the popular high-level languages. Among its features are several that make it eminently suited as a computational medium for exploring atonal theory:

1. It is an interpreted language. This means that Logo programs can be run as soon as they are written. The

user need not go through the tedious process of compiling, linking, debugging, and executing what is endured by developers of commercial software who use compiled languages to obtain greater speed and efficiency. Logo's brief turnaround time enables a high degree of interaction between the learner and the computer which, in turn, allows for more efficient learning. Of course there is a tradeoff. Logo programs run more slowly, and they are not, as a rule, stand-alone applications. As a result, they must be run in the Logo environment.

2. Logo uses only a few data types: words (character strings), numbers (which are a special type of word), and lists.¹⁴ Lists, which are the most appropriate data type for representing the various sets used in atonal theory, can be nested to any degree of complexity. Figure 1a shows how a pc set would be represented as a "flat" list, a list all of whose elements are either words or (in this case) numbers. Figure 1b is a nested list which contains the pentachordal subset-types of [0 1 3 4 6 7] along with their frequency of occurrence. Careful attention to the balanced pairs of square brackets will reveal that this list contains three primary elements, each of which is itself a two-element list whose first element is a five-element list (the subset-type) and whose second element is a number (the frequency of occurrence).
3. In its unextended state, Logo consists of a finite number of "primitive" procedures that can be classified as either operations or commands. Operations are procedures that compute and output a value; commands are procedures that produce an effect, usually visible (such as displaying or printing a value) or audible (such as playing music). Primitives can be invoked, either singly or in combination, from the so-called "immediate mode." A compound invocation that would compute and display the residue mod 12 of the integer 20, is shown in Figure 2. In this example, REMAINDER is the operation that outputs its value to the command PRINT that displays the value on the screen.

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4. Programming occurs when the Logo language is extended by combining primitives to form modules of code that are termed (user-defined) procedures. These procedures are stored in the workspace, a reserved area of the computer's memory and are invoked by their user-coined names. Users are given considerable flexibility in naming procedures and variables. The act of calling a procedure into service, of directing it to perform its task, is termed invocation. User-defined procedures may be invoked by the user from the immediate mode, by other user-defined procedures, or by themselves (see number 6 below).
5. Logo procedures can accept numbers, words, or lists of any degree of complexity as primary data (see Figure 1b), and they can pass such data freely among themselves.
6. Logo procedures can invoke clones of themselves. This programming technique, which is termed recursion, enables the definition of procedures that are both general in their applicability to a wide range of problems and elegant in their simplicity.
7. A text editor is provided to define and edit procedures. Extensive and informative error messages are also supported.
8. In most programming languages a clear distinction is drawn between the program code and the data to be processed. Logo allows this distinction to be finessed by representing its procedures as lists. This enables the definition of procedures that can, in turn, define or modify other procedures.
9. The availability of music-generating primitives in certain versions of Logo makes it possible to hear the results of some musical operations.¹⁵

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Figure 1a. A pc set represented as a "flat" list.

[0 1 3 4 6 7]

Figure 1b. A nested list of the 5-element subset types of [0 1 3 4 6 7] and their frequency of occurrence.

[[[0 1 3 4 6] 3] [[0 1 3 4 7] 2][[0 1 3 6 7] 2]]

Figure 2. Compound invocation of two Logo primitives.

```
?PRINT (REMAINDER 20 12)  
8
```

Given a computational environment with the characteristics listed above, how might it be utilized as a medium for exploring atonal theory and analysis? The range of possibilities can be subsumed under three headings used for an early collection of articles on educational computing.¹⁶

The computer as tutor

In this mode, an instructor would devise a series of "request procedures"¹⁷ each of which focused on some basic analytical task (e.g., computing a certain type of interval, or transposing a pitch class). Students would use these procedures to learn how to perform the various tasks. Fully-developed procedures would judge the student's responses at all stages of the problem-solving process, and, where appropriate, provide diagnostic error messages in the manner of traditional computer-assisted instruction (CAI).

The computer as tool

In this mode, Logo procedures would be used as software tools to lighten the computational burden that is inevitably associated with atonal analysis. Such procedures could be predefined and fully operational in which case the student could be given the Logo code listings and then

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instructed to define and debug the procedures. The extent to which tool procedures should be "user-friendly" is of major concern here. On the one hand, procedures that included "bullet-proofing" and error-checking routines would be easier for novices to use. On the other hand, they would be longer and more involved, and hence, more difficult to key in and understand.

The computer as tutee

This mode of usage is most consonant with the Logo philosophy as espoused by Papert and others. The student is seen as the tutor who devises instructions for the computer (the tutee) to execute. These instructions must, of course, ultimately be couched in a language that both the student and the computer understand, which in this case is assumed to be Logo. Implicit in this approach is the assumption that students' understanding of a problem is enhanced when they are required to describe in precise terms a possible solution to that problem. In stereotypical programming, these terms are assumed to be the lowest-level primitives of the language. Since Logo is extensible, however, students may be shielded from its primitives and, instead, be provided with "scaffolds," or "black boxes," previously-defined procedures that can be invoked either from the immediate mode or from higher-level, user-defined procedures. Thus, for example, rather than defining basic tool procedures (such as those that compute intervals or transpose sets) in terms of Logo's primitives, students may be provided with working versions of such procedures. After using these procedures enough to understand the tasks they perform and the data they require, students may then ascend a rung on the conceptual ladder by defining higher-order procedures in *these* terms.

The extent to which students should be required to learn the vocabulary and syntax of a programming language and, by extension, basic concepts of computer science, and to generate their programs "from scratch" are major issues in implementing this type of computational environment. In this regard, it should be noted that the Logo language was designed (and has proven) to be relatively easy to learn and use, at least in comparison with other high-level languages, and that while there is a price to be paid for doing so, the reward is greater expressive power and enhanced understanding, both of general techniques of problem solving and, usually, of the subject as well. Ultimately, the issue of whether to write programs or use ready-made applications can only be resolved by individual instructors who must take into account all the factors relevant to their teaching situation.

The approach to using Logo I will describe might best be termed pragmatic in the sense that I have incorporated certain aspects of orthodox Logo philosophy but have modified others. More specifically, I generally subscribe to the idea that programming expertise can develop more or less concurrently with one's understanding of a subject domain. Ideally, both should proceed gradually and at the student's own pace from the simple and perceptible to the more complex and abstract. This implies a preference for the "bottom-up" as opposed to the "top-down" approach to program development generally advocated by proponents of "structured programming."

The second principle is that emphasis should be placed on developing Logo procedures, and on understanding how they work, rather than on merely using them. In particular, the process of defining, testing, and debugging should be viewed as an opportunity to refine one's conception of a problem and understanding of Logo syntax, rather than as a reminder of one's intellectual limitations and lack of familiarity with the language.

Finally, students should be encouraged to recognize underlying similarities among seemingly different problems and to acquire a repertoire of techniques for solving such problems. Educational research has shown that transfer is a difficult objective to achieve in any teaching/learning environment. Papert's claim that Logo programming enhances transfer has been subjected to considerable testing that has yielded mixed results to date.¹⁸

My differences with Papert are those of most teachers who have used Logo in a highly structured setting. The luxury of a free and open computing environment in which students may pursue practically any topic of their imagination and are motivated primarily by the excitement of their own discoveries is simply not feasible in my current teaching assignment. To address the need for structure and accountability, I have devised a combination text/workbook that has been used during the atonal segment of an undergraduate course in twentieth-century theory and analysis.¹⁹ The activities I will describe are drawn from this book.

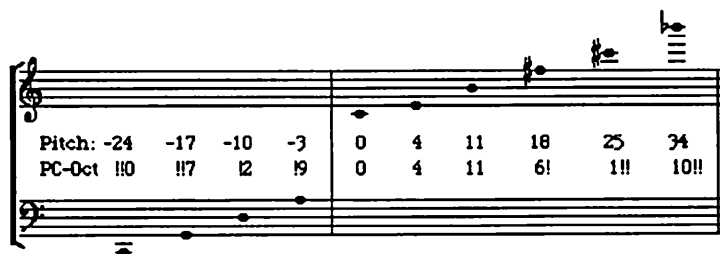
To understand the ensuing examples, it is necessary to explain a few aspects of pitch symbology. Pitches in the chromatic system (the default mode of pitch representation) are symbolized either by positive and negative integers, or by pitch-class octave symbols (see Figure 3). The default location of the reference pitch (pitch zero) is middle C, but this may be changed by invoking the KEY procedure with a pitch integer as its input. For example, the invocation KEY 3 raises the reference pitch three semitones to D#/Eb; KEY (-2) lowers it two semitones to A#/Bb.

The duration of notes and rests is also indicated with integers whose correspondence to absolute time is relative. Once a basic tempo has been established, the durational value of notes is directly proportional to the

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numerical value of their duration integers (i.e., larger numbers indicate longer durations and smaller numbers indicate shorter durations).

Figure 3. Pitch representation in the chromatic system of Music Logo.



EXPLORING ATONAL THEORY

Several years ago, the English theorist, Philip Barford, wrote a perceptive account of the process of developing musical cognition.²⁰ I take his main point to be that the process must proceed slowly and be continually reinforced by abundant experiences with musical sound. In his discussion, Barford posits three levels of understanding: percept, idea, and concept (see Figure 4). For our purposes, a percept can be defined as a sound that can be heard, an idea is a sound that can be imagined, and a concept is the unifying principle behind a group of related ideas.

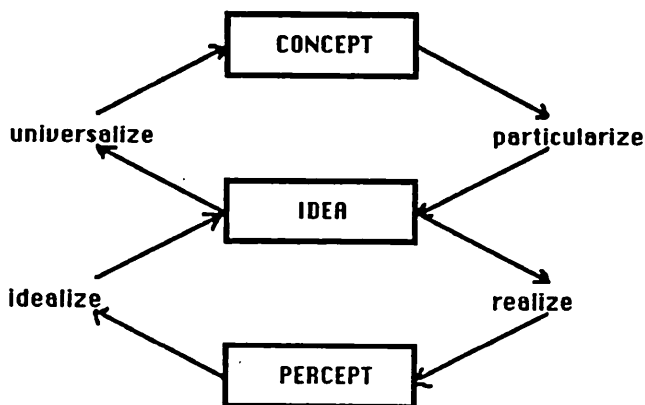
As Figure 4 illustrates, Barford also posits mental operations by which one level is transformed into the next. In going from sensory perception to mental abstraction (from bottom to top in the diagram) a percept is *idealized* to form an idea or tonal image that, in combination with other related ideas, may eventually be *universalized* to form a concept. Moving in the other direction (from top to bottom), a concept is first *particularized* as an idea that may then be realized as a perceptible musical sound.

My reason for digressing here is to present a working vocabulary for the subsequent discussion and to underscore both Barford's and Papert's concerns regarding the necessity to make haste slowly when attempting to develop theoretical concepts.

To illustrate how the task of learning Logo might be correlated with that of learning the fundamentals of atonal theory, the proposed instructional sequence will be broken down into several large units, with the implicit understanding that further subdivision is both possible and desirable. The discussion of each unit will be preceded by a statement of the objective(s) for each of the two domains.

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Figure 4. Schematic diagram of Barford's model of concept development.



Unit One

Atonal Theory

Gain familiarity and competence with integer representation of pitches and durations.

Logo

Learn the syntax for invoking primitive procedures from the immediate mode.

Understand and be able to use music-generating primitives. This means knowing a procedure's name, the number of inputs that it requires, the data type of each input, and the effect that is produced upon a successful invocation.

Students can begin by invoking various music-generating primitives from the immediate mode to play short melodic lines. Figure 5 contains verbal definitions of these primitives along with typical invocations.

In addition to playing notated melodic fragments, other activities are possible. It is relatively easy for an instructor to define "request procedures" that play melodic fragments, request the student to type the corresponding pitch numbers or pc-oct symbols, and then play the student's version along with the original fragment. Students can also be given Logo code with instructions to notate the corresponding melody on the proper staff. Having done so, they may then invoke the code to compare their

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notation with the heard melody. A third option is the identification of a familiar melody or the sightsinging of an unfamiliar one directly from its Logo code. (The reader is invited to identify the melodic segments that would be generated by the invocations of SING, SAMEDUR, and PLAY in Figure 5.) The main concern at this point is to provide varied opportunities for idealizing both musical sound and traditional notation as logo code, and for realizing Logo invocations in sound and score notation.

Figure 5. Invocations of music-generating primitives.

NOTE :P :D

Generates a note of pitch :P and duration :D

Example: ?NOTE "0! 8

REST :D

Generates a rest of duration :D

Example: ?REST 8

SING :PLIST

Generates a series of notes by matching the pitches of :PLIST with a predefined duration.

Example: ?SING [3 !11 !4 !7]

SAMEDUR : PLIST :D

Matches each pitch of :PLIST with duration :D

Example: ?SAMEDUR [10 9 0! 11] 12

PLAY :PLIST :DLIST

Matches the pitches of :PLIST with the corresponding durations of :DLIST

Example: ?PLAY [5! 9! 5! 10 1! 0! 9] [1 7 1 7 1 8 4]

Unit Two

Atonal Theory

Develop greater competence with integer representation of pitches and durations.

Use reference pitches other than middle C.

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Logo

Learn to use the text editor for defining "tuneblock" procedures.

Learn basic concepts of modular programming

naming of procedures

syntax of tuneblocks procedures

hierarchical relationships between procedures.

Since the possibilities for playing melodies in the immediate mode are quite limited, students should be introduced to the text editor as soon as possible. Once the requisite sub-tasks (invoking and quitting the editor, various editing keystrokes) are mastered, attention may be focused on musically rewarding activities. Several sets of "tuneblock" procedures should be defined with each set comprising the actual tuneblocks, i.e., those procedures that invoke the music-generating primitives to play a brief segment of music, along with superprocedures (procedures that invoke the tuneblocks or other procedures of a higher order).

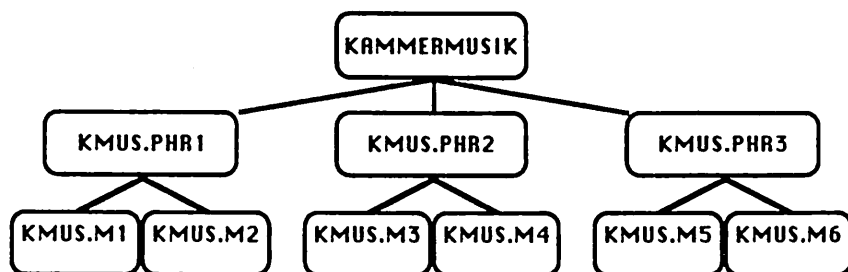
An instructor can build upon the student's conception of hierarchical motive and phrase structure in music and use that understanding as a model. It is appropriate, therefore, at this stage to use excerpts that have clearly defined motive and phrase structure and to not be overly concerned about the purity of the atonal idiom.

Figure 6 contains a schematic diagram for a set of procedures that play the opening clarinet solo to Hindemith's *Kammermusik No. 2* along with a listing of the Logo code for the first two measure-level procedures. Once defined, any of the procedures in the diagram may be invoked singly or in combination. The most efficient way to play the entire melody is to invoke KAMMERMUSIK, the "toplevel" procedure that invokes its three phrase-level subprocedures each of which invokes its two measure-level subprocedures. The tuneblocks could be also scrambled by invoking the measure-level procedures in any desired sequence.

Additional experience can be gained by defining polyphonic tuneblocks, those that play multi-voiced passages. Figure 7 contains the definitions for a set of procedures that plays the first half of Dallapiccola's "Linee" from the *Quaderno musicale di Annalibera*.

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Figure 6. Tree diagram of a set of tuneblock procedures.



(A duration integer of 1 represents a quarter note.)

TO KMUS.M1

```

PLAY [4! 4! 4!] [.5 .25 .25]
SAMEDUR [11! 8! 3! 0!] .25
PLAY [10 10 0!] [.5 .25 .25]
SAMEDUR [8 3] .5

```

END

TO KMUS.M2

```

SAMEDUR [4 6 4 6] .25
SAMEDUR [7 2! 7! 6!] .25
PLAY [5! 5! 6!] [.5 .25 .25]
NOTE "8! 1

```

END

Figure 7. Set of Logo procedures to play A section of Dallapiccola's "Linee"

(A duration integer of 1 represents an eighth note.)

To LINEE.A.TREBLE

```

REPEAT 4 [SAMEDUR [9 10] 1]
REPEAT 4 [SAMEDUR [2! 5] 1]
REPEAT 4 [SAMEDUR [7 1!] 1]
REPEAT 3 [SAMEDUR [0! 4] 1]
PLAY [0! 4] [1 4.5]
REST 1.5

```

END

To LINEE.A.BASS

```

REST 8
SAMEDUR [8 7 3 0!] 4
NOTE 10 8
REST 5

```

END

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To LINEE.A
LINEE.A.TREBLE
BEGINVOICE 0
LINEE.A.BASS
END

Unit Three

Atonal Theory

- Introduction to the concept of pitch class.
- Learn algorithms for basic pitch and pc operations
 - computing interval
 - Transposition (Tn)
 - Inversion (I)
 - Retrograde and Retrograde-Inversion (R and RI)
 - Comparison of sets for Tn, I, and R relatedness
 - Compound operations (TnI, TnR, TnRI, etc.)
 - Computing prime-by-inversion matrices

Logo

- Further experience with the "bottom-up" approach to procedure development.
- Introduction to
 - input variables
 - basic list processing primitives
 - tail recursion.

Once students are familiar with the system of pitch and pitch class representation, the music-generating primitives, and use of the Logo text editor, they can begin to develop procedures that perform basic set-theoretical operations. These would include computation of the various types of intervals and transposition and/or inversion of sets of pitches or pitch classes.

Rahn's formula for an ordered pitch interval and its realization as a Logo procedure named OPI are shown in Figure 8a.²¹ The Music Logo primitive DECODE is invoked as a subprocedure from within OPI to insure that both of the pc-oct symbols are converted to pitch numbers before subtraction occurs. Once such a procedure has been debugged and is operational, it can be invoked from the immediate mode whenever the user

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needs to have its task performed. A typical invocation is shown below the definition.

OPI can serve as a model for other interval-computing procedures. UOPI, a procedure that computes the unordered interval between two pitches is shown in Figure 8b. The only new feature here is the invocation of ABSVAL, a user-defined subprocedure that returns the absolute value of the number given as its input.

As students begin to work with pitch classes, they will realize the need for a MOD12 procedure such as that shown in Figure 8c. MOD12 provides the opportunity to introduce REMAINDER, a Logo primitive that returns the remainder of the integer division of its first input by its second input. MOD12 can also serve as an introduction to recursion, a programming technique that will prove increasingly useful at later stages. The availability of MOD12 enables the definition of OPCI (Figure 8c), a procedure that computes the ordered interval between two pitch classes.

The only remaining interval type (in Rahn's scheme) is the unordered pc interval, or interval class, the formula and procedures for which are shown in Figure 8d. Here the added requirement is for LESSER.OF, a subprocedure that compares two numbers (here, complementary ordered pc intervals) and outputs the lesser of these two values.

Figure 8. Procedures to compute intervals (after Rahn)

a. ordered pitch interval: $ip\langle x,y \rangle = y - x$

```
TO OPI :X :Y
  OUTPUT ( DECODE :Y ) - ( DECODE :X )
END
```

```
?OPI 0 4
RESULT: 4
```

b. unordered pitch interval: $ip(x,y) = |y - x|$

```
TO UOPI :X :Y
  OUTPUT ABSVAL ( OPI :X :Y )
END
```

```
TO ABSVAL :N
  IF :N < 0 OUTPUT - :N
  OUTPUT :N
END
```

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c. ordered pc interval: $I \langle a, b \rangle = (b - a) \bmod 12$

```
TO OPCI :A :B
  OUTPUT MOD 12 ( :B - :A )
END
```

```
TO MOD12 :N
  IF :N > -1 OUTPUT REMAINDER :N 12
  OUTPUT MOD12 ( :N + 12 )
END
```

d. unordered pc interval:
 $i(a,b) = \text{smaller of } i\langle a,b \rangle \text{ and } i\langle b,a \rangle$

```
TO UOPCI :A :B
  OUTPUT LESSER.OF ( OPCI :A :B ) ( OPCI :B :A )
END
```

```
TO LESSER.OF :X :Y
  IF :X < :Y OUTPUT :X
  OUTPUT :Y
END
```

Figure 9 lists another set of basic tools, those that transpose and/or invert a single pitch or pitch class.

Figure 9. Procedures for transposition and/or inversion of pitches and pitch classes.

Pitch transposition
 TO P.T :N :P
 OUTPUT (:P + :N)
 END

Pitch class transposition
 TO PC.T :N :PC
 OUTPUT MOD12 (:PC + :N)
 END

Pitch inversion
 TO P.I :P
 OUTPUT (- :P)
 END

Pitch class inversion
 TO PC.I :N :PC
 OUTPUT MOD12 (- :PC)
 END

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```
Pitch inversion followed by  
transposition  
TO P.TI :N :P  
  OUTPUT P.T :N (P.I :P)  
END
```

```
Pitch class inversion followed  
by transposition  
TO PC.TI :N :PC  
  OUTPUT PC.T :N (PC.I :PC)  
END
```

With these tools at hand, it now becomes possible to define a class of superprocedures each of which operates on a list of elements. At this point one enters the realm of list processing, the heart of the Logo language.

Most of Logo's list processing primitives fall into either of two categories: Figure 10a shows invocations and results of four procedures that reference specific elements of a list. Figure 10b shows another set of four procedures that construct new lists.

Figure 10. Invocations of Logo list-processing primitives.

a. Procedures which reference elements of a list

```
?FIRST [0 1 4 6]  
Result: 0
```

```
?LAST [0 1 4 6]  
Result: 6
```

```
?BUTFIRST [0 1 4 6]  
Result: 1 4 6
```

```
?BUTLAST [0 1 4 6]  
Result: 0 1 4
```

b. Procedures which construct new lists

```
?SENTENCE 2 [4 7 10]  
Result: [2 4 7 10]
```

```
?LIST [2 3] [4 7 10]  
Result: [[2 3] [4 7 10]]
```

```
?FPUT 3 [4 5 9]  
Result: [3 4 5 9]
```

```
?LPUT 3 [4 5 9]  
Result: [4 5 9 3]
```

Nearly all user-defined procedures that invoke list processing primitives to operate upon lists utilize recursion. Recursion can be defined as a technique of solving a problem by repeatedly reducing it to simpler versions of the same problem until the solution becomes trivial. To illustrate, let us consider a typical operation in atonal theory, that of transposing a set of pitch classes. As Figure 11 shows, the problem of transposing the set [0 1 4] can be reduced to the problem of transposing pc 0 and concatenating the result with the transposition of the set [1 4]. This problem can, in turn, be

reduced to transposing pc 1 and concatenating the result with the transposition of the one-element set [4], which, in turn, can be reduced to the problem of transposing pc 4 and concatenating the result with the transposition of the empty set. The strategy, then, is to invoke a list referencing primitive to obtain an element of the input list (typically the first element), perform the requisite operation upon that element, and then invoke a list-constructing primitive to add the result to a new output list.

In the procedure shown in Figure 11, the list constructing primitive SE (abbreviation for SENTENCE) is invoked to add the newly-transposed pc to a new list. SE takes a default number of two inputs. If both inputs are literally present, it combines them to form a "flat" list. Here, however, the second input to SE is not a literal list but an invocation of a clone of PCS.T, the procedure that will output the next transposed pc. That procedure, will, in turn, invoke a clone of itself, which will invoke a clone of itself, etc. When the original input list is finally exhausted, the stop condition will have been met and the current invocation will output the empty list as directed. Each prior invocation of PCS.T will then output its transposed pc, placing it at the head of the new list. Since the procedures will output their values in reverse order of their invocation, the list of transposed pcs will be constructed from end to beginning.

Understanding a tail-recursive procedure that outputs a list is probably the most difficult task for the student of Logo at the intermediate level. The Logo community recognizes this fact and provides metaphors, games, and other teaching aids to help students overcome this conceptual hurdle.²² As with any other task, some students get the hang of recursion before others. My experience has been that with the help of the TRACE function nearly all students understand the process within a few days.

The culmination of this unit should be a series of projects in composition and/or analysis in which students use their new software tools to do something that is both musically interesting and analytically substantial. An appropriate project would be the modeling of a brief musical work, that is, the definition of a set of Logo procedures that describe the work in terms of a few elements and operations upon those elements and which, when invoked, generate and play the work.

Generality, the extent to which a computer program can be utilized for various instances of a given class of problems, is a major concern of computer programmers. The ideal objective is to isolate a process (the task to be performed) from the data (the information to be processed) by defining the task in terms sufficiently general to enable the processing of any valid set of data.

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Figure 11. Recursive invocations in the transposition of a pc set.

(OUTPUT is abbreviated as OP in this and succeeding examples.)
(BUTFIRST is abbreviated as BF in this and succeeding examples.)

PCS.T 6 [0 1 4]

IF (EMPTY? :SET) OP []

OP FPUT (PC.T 6 (FIRST :SET)) (PCS.T 6 (BF :SET))

PCS.T 6 [1 4]

IF (EMPTY? :SET) OP []

OP FPUT (PC.T 6 (FIRST :SET)) (PCS.T 6 (BF :SET))

PCS.T 6 [4]

IF (EMPTY? :SET) OP []

OP FPUT (PC.T 6 (FIRST :SET)) (PCS.T 6 (BF :SET))

PCS.T 6 []

IF (EMPTY? :SET) OP []

outputs []

outputs [10]

outputs [7 10]

outputs [6 7 10]

Music students often have difficulty distinguishing between the basic pitch materials of a work and the process(es) to which those materials are subjected. They can begin to appreciate this distinction by redefining their tuneblock procedures more generally.

The extent to which the pitch materials of a work determine its essential nature is a major concern of music theorists and the effect of varying these materials can be dramatic in the case of a twelve-tone work. Consider, for example, Dallapiccola's "Fregi" (No. 6 from *Quaderno musicale di Annalibera*), a work nearly all of whose pitches can be derived by various operations upon the 12-ps set that unifies the entire opus. The task of modeling this piece in sets of Logo procedures might be broken down into three stages.

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The first stage would be the definition of a set of procedures that play the entire melodic line when given the first twelve pitches as input. Since all of the realization of the basic 12-pc set are related by the pitch (as apposed to pc) operations, this is a relatively easy task. The student uses OPI and OPI.PAT, the ordered pitch interval and interval-pattern computing procedures, to discover the operation and the interval of transposition by which each of the succeeding melodic phrases can be derived from the first phrase²³ then utilizes that knowledge in the definition of the tuneblock procedures. Figure 12 lists a set of Logo statements that define this process. Note that the durational and pitch patterns are assigned to variable names in the FREGI.SETUP procedure and then invoked by those names in the tuneblock procedures.

Figure 12. Set of procedures to generate melody of "Fregi"

```
TO FREGI.SETUP
```

```
  KEY (-2)
```

```
  MAKE "RPAT1 [1.5 2 2 1.5 1.5 3 1 1 1 1.33 1.33 1.33]
```

```
  MAKE "RPAT [1.33 1.33 1.33 .75 .75 .75 .75 1.33 1.33 1.33 .66 3.33]
```

```
  MAKE 'FREGI.PSET [0! 1 !5 !8 !10 !4 !3 !7 !!9 !2 !11 6]
```

```
END
```

```
TO FREGI.MELODY
```

```
  FREGI.SETUP
```

```
  FREGI.A1
```

```
  FREGI.A2
```

```
  FREGI.B1
```

```
  FREGI.B2
```

```
END
```

```
TO FREGI.A1
```

```
  PLAY :FREGI.PSET :RPAT1
```

```
END
```

```
TO FREGI.A2
```

```
  PLAY (PS.TR 7 :FREGI.PSET) :RPAT2
```

```
END
```

```
TO FREGI.B11
```

```
  PLAY (PS.TI:FREGI.PSET) :RPAT1
```

```
END
```

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TO FREGI.B2

PLAY (PS.TRI (-6) :FREGI.PSET) :RPAT2

END

The second stage might involve the definition of a procedure that would take two inputs: an ordered set of twelve pcs, and a list of octave numbers. The student could invoke the procedure with Dallapiccola's pcs and octave numbers to generate the melody of "Fregi," but could also invoke the procedure with other pcs or octave numbers to generate pieces that retained "Fregi's" processes, but varied its pitch or pc content.

The third and final task would be to define a set of procedures that would generate the notes of the dyadic accompaniment of "Fregi." This could lead to the development of a new variant of the PS.TI procedure, the one that inverts a list and transposes a list of pitches.

Unit Four

Atonal Theory

- Unordered pc sets

- Normal form

- Set types.

- Recognize and validate T and TnI relations

- Compute and compare ic vectors.

Logo

- Further development of analysis tool procedures

- Use of "black box" procedures where appropriate.

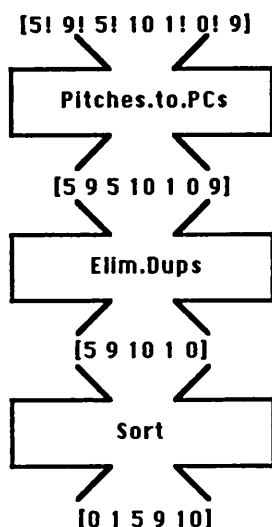
- Development and use of programs that solve complex problems.

- Use of discovery learning to refine theoretical concepts.

The step into the realm of unordered pc sets is, as David Beach has noted,²⁴ one of the giant steps in the study of atonal theory. For although the notion of unordered pc sets is more general and conceptually powerful than that of ordered sets, it is also considerably more abstract. In most cases, it is more difficult to particularize and realize one's way from an unordered pc set or set-type back to real music because there are so many possible realizations. Although a Logo-based approach offers no panacea for this dilemma, it can offer general strategies for coping with it.

First, the instructor and student should attempt to embody all stages of the idealizing and generalizing processes (see Figure 4) in Logo procedures so the route from sensory perception to cognitive abstraction may be traced. This should include the definition of a set of procedures that convert an ordered list of pitches into an unordered pc set. A "plumbing diagram" for such a program is shown in Figure 13.²⁵

Figure 13. "Plumbing" diagram of a program to convert an ordered list of pitches or pc/oct symbols to an unordered pc set.



Second, whenever possible, procedures that embody the particularizing processes (see Figure 4) should also be developed so that students might see and understand how abstract entities such as unordered pc sets can be transformed into the pitches and durations of real music. The feasibility of doing this, would ultimately depend, of course, on the nature of the musical specimen under analysis and the degree of abstraction involved.

Underlying the above considerations is the even more fundamental need to use the computer and Logo in ways that enhance understanding of the analytical process. It may very well be, at this stage, that the development of programming skills will begin to lag behind the students' growing competence in atonal theory. As a result, the instructor may need to provide more help in defining procedures, or simply give the students segments of Logo code with the understanding that such procedures are to be treated,

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for the present, as “black boxes.” Whatever policy is adopted, understanding is more likely to evolve if programs are developed gradually with adequate time devoted to comprehending at least the task and data requirements (if not the internal workings) of each. Merely getting the right answer or computing every possible characteristic of an object under analysis should never be stressed at the introductory level.

In cases where comparisons and judgements must be made, it is often better to develop a network of procedures that compute the necessary data but leave the actual decision up to the student. When the problem has been solved repeatedly, and the criteria for making the final decision are well understood, the judgment process can then be encoded and superimposed upon the original program.

One instance of this approach would be the development of a network of procedures that determine the set-type of a list of pitches. Figure 14 illustrates how such a network can be built by assembling smaller modules. The module named UOPC.Set at the top of the left column would embody the entire process of deriving an unordered pc set from a list of pitches; that is, all of Figure 13 would be nested within this module. The final stage, a procedure named Tn. TnIType, which accepts the Tn-type and the TnIType as inputs and determines which is the set type, would be added to the network only after students had grown familiar with the functions of the other procedures and had successfully chosen the set-type several times themselves.

Unit Five

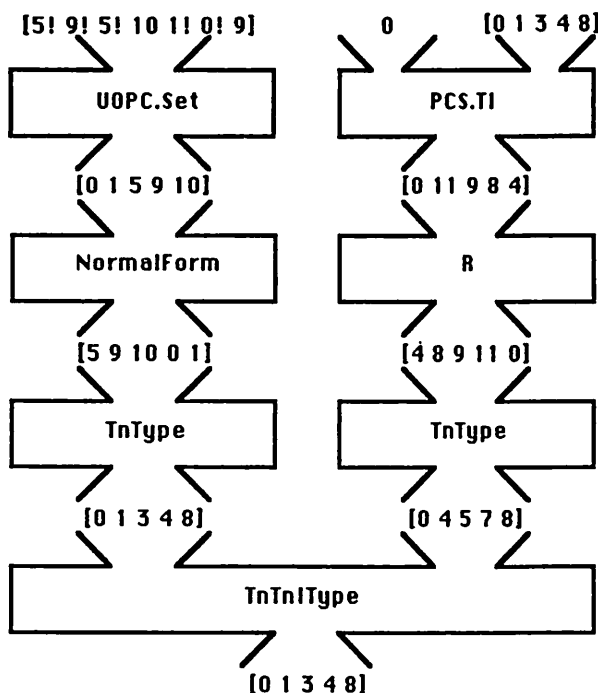
Atonal Theory

- Advanced analysis projects
- Generative composition of pieces using variables
- Theoretical investigation
 - Set union, intersection, complementation
 - Compute and compile a table of set-types
 - Inclusion relations

Logo

- Develop additional tool procedures
- Develop capacity for independent and creative theoretical and analytical work

Figure 14. "Plumbing" diagram of program to determine the set type of a list of pitches.



As students become more comfortable with the computer, with Logo, and with the basic concepts and operations of atonal theory and analysis, they can pursue theoretical, as opposed to compositional, or analytical work. Having become gradually aware of the universe of pc sets, they can embark on expeditions into that unfamiliar realm. Although this type of activity is the most abstract, it can also be the most intellectually stimulating.

One large-scale project appropriate for this stage is the construction of a table of set-types. Instead of being given such a table, or told to consult one in a standard text, class members could develop one of their own. In the process of doing so, they would not only learn a great deal about pc sets and their relationships, but would also experience some of the excitement of doing ostensibly original research. An approach to such a project is outlined in Figure 15. Obviously, the work would have to be divided up among the various class members and done over a considerable period of time.

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Inclusion relations, the microworld of subsets and supersets, is another interesting and pertinent topic. In fact, a model for the concept of inclusion is already present in the nested structure of Logo's subprocedures and superprocedures.

Figure 15. Outline of a class project in compiling a table of set-types.

1. Have each class member devise a strategy for determining the twelve trichordal set-types.
2. Compare the various strategies and select the most efficient. (As an alternative, students could be given a list of "raw sets" and instructed to determine the set-type of each and then tabulate the results.)
3. Utilize the same method to determine the set-types for 4 and 5-element sets.
4. Study the concept of complementation at both the literal and abstract levels.
5. Use complementation to determine the set-types of 9, 8, and 7-element sets. This would be done by finding the set-type of the literal complement of each 3, 4, and 5-element set in the table.
6. Review the concept of unordered pc interval (interval class). Compute the ic vectors of the set-types in the table. Compare the vectors of set-types of the same cardinality and of complementary set-types. Use the ic vector as a means of determining the degrees of symmetry of each type.
7. Apply knowledge gained from the above activities to determine the set-types of hexachords and to investigate their properties.

The first task might be the development of a procedure that accepts a set of cardinality C and outputs the subsets having $C - 1$ elements. Doing so involves processing the original set C times and excluding a different pc each time. This indicates a need for a new list-referencing "primitive," one that returns all of the elements of the set given as its second input save the one specified as its first input. Figure 16a shows some typical invocations

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for a procedure named AB (for ALLBUT) that enables the definition and invocation of SUBSETS (see Figure 16b), a procedure that computes the C - 1 subsets of an unordered pc set.

Figure 16. Tool procedures for computing subsets.

a. Invocations of ALLBUT

?AB 0 [0 1 4]
[1 4]

?AB 1 [0 1 4]
[0 4]

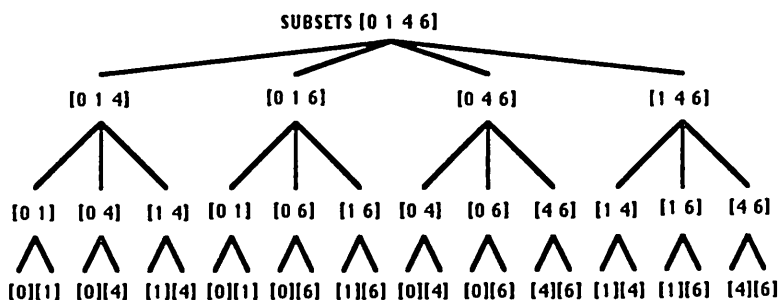
?AB 4 [0 1 4]
[0 1]

b. Invocation of SUBSETS

?SUBSETS [0 1 4]
[[0 1][0 4][1 4]]

The next task, that of obtaining the smaller subsets, is particularly interesting from a problem-solving point of view. It would seem the problem could be solved recursively; that is, if one can compute the C - 1 subsets of a set, then the C - 2 subsets would be subsets of those, the C - 3 subsets would be subsets of those, etc. It should be possible, then, to define a recursive procedure that computes something like the family tree of a set. A tree diagram of the output from such a procedure is shown in Figure 17. Careful inspection of the subsets listed in the lower nodes reveals a flaw in this strategy. For although each subset can indeed be derived from its parent set, there is an increasing number of duplicates at successively lower levels.

Figure 17. Tree diagram of output from recursive invocations of SUBSETS.



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The presence of this bug compels one to rethink the problem. Upon closer examination, it becomes clear that we are really interested at any given level in finding the *set* of subsets of cardinality X , where X is less than C and greater than zero. Therefore, in those cases where one is computing subsets from a list of subsets (e.g., in computing the 2-element subsets of a tetrachord from its 3-element subsets), it will be necessary to check for duplicates before adding a newly-computed subset to the list.

SUMMARY AND CONCLUSIONS

The underlying theme for these activities is that computers and programming languages can be valuable tools for learning the fundamentals of atonal theory, but that they can and should be used in ways that foster understanding of the musical data, analytical processes, and theoretical concepts of that domain. My experience has led me to believe that this objective can be achieved through the medium of an educational programming language, one that provides appropriate data types, encourages modular and hierarchical thinking, and is relatively easy to learn and use.

The broadest definition I know for the verb "to program" is "to communicate with a computer in a language that both the user and the computer understand." Under this definition, it is possible to program computers on a number of different levels. Logo offers the novice or casual programmer the possibility of building a multi-leveled model of an intellectual problem and of communicating with the computer at any of those levels. This feature makes it possible for teachers to design computational environments in which students can address the computer at their own level of expertise.

It would appear that, as computer usage permeates elementary and secondary education, more and more students will be entering music schools having learned the fundamentals of "computer literacy" and programming. It should be possible, therefore, to build upon that foundation and use it as a platform for nurturing the development of music-theoretical knowledge and thought processes. My experience with Logo leads me to believe that it deserves serious consideration as the most appropriate language for this task. I encourage instructors of atonal theory to explore the language and its literature, and to develop professional contacts with the Logo community.

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NOTES

¹Patricia Greenfield, "Educational Technologies, Education, and Cognitive Development," in *Applications of Cognitive Psychology*, ed. Dale E. Berger, Kathy Pedzek, and William P. Banks (Hillsdale, NJ: Lawrence Erlbaum Associates, 1987): 18.

²Greenfield, "Educational Technologies," p. 19.

³"The Microcomputer as a Symbolic Medium," in *Mirrors of Minds*, ed. Roy D. Pea and Karen Sheingold, (Norwood, NJ: Ablex, 1987): 202-203.

⁴*The Computer as Sandcastle*, (Technical Report No. 20, New York: Bank Street College of Education, 1983):1.

⁵Sheingold, "The Microcomputer as a Symbolic Medium," p. 204.

⁶New York, Basic Books, 1980.

⁷For a critique of Papert's *Mindstorms* see John Davy, "Mindstorms in the Lamplight," in *The Computer in Education: A Critical Perspective*, Douglas Sloan, ed., (New York: Teachers College Press, 1984).

⁸"Creativity in Education: A Standard for Computer-Based Teaching," *Machine-Mediated Learning* 2 (1988): 175-194.

⁹Jeffrey Bonar, "Everyone Will Be a Programmer," *Technology and Learning* 1 (May/June 1987): 1.

¹⁰*Ibid.*

¹¹Details of the development process are related in Robert W. Lawler, "Learning Environments: Now, Then, and Someday," in *Artificial Intelligence in Education, Volume One: Learning Environments and Tutoring Systems*, ed. Robert W. Lawler and Masoud Yazdani, (Norwood, NJ: Ablex, 1987): 10-12. See also Joel E. Bass, "The Root's Logo's Educational Theory: An Analysis," *Computers in the Schools* 2 (1985): 107-116.

¹²For a summary of this work, see the *Logo 86 Bibliography* (Cambridge, MA: Massachusetts Institute of Technology, 1986), Section 4.

¹³See David D. Thornburg, "Logo: A Computer Language at the Crossroads," *A+ 4/3* (March 1986): 78-84.

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¹⁴More sophisticated versions of Logo also support objects, arrays, and (in the case of the Macintosh) data types such as cursors, menu bars, and regions of the display screen.

¹⁵*Object Logo for the Apple Macintosh* (Paradigm Software Inc., P.O. Box 2995, Cambridge, MA) provides low-level primitives for music synthesis and MIDI support. *LogoMusic* (for IBM-PC and Macintosh systems with MIDI keyboards) has been developed by Jeanne Bamberger of MIT and is used extensively in music courses and workshops there.

¹⁶Robert Taylor, ed., *The Computer in the School: Tutor, Tool, Tutee*. (New York: Teachers College Press, 1980).

¹⁷Logo request procedures are programs that pause at certain points during their execution to accept input from the user.

¹⁸See Gavriel Salomon and D. N. Perkins, "Transfer of cognitive skills from programming: When and how?," *Journal of Educational Computing Research* 3/2 (1987): 149-169; Gavriel Salomon, "AI in Reverse: Computer Tools That Become Cognitive." Paper presented at the Annual Meeting of the American Educational Research Association, April 5-9, 1988. ERIC Report ED 295610; Roy D. Pea and D. Midian Kurland. "On the Cognitive Effects of Learning Computer Programming," *New Ideas in Psychology* 2/2 (1984): 137-168; and various authors, "The Cognitive Effects of Computer Learning Environments," *Journal of Educational Computing Research* 2/4 and 3/1 (1986).

¹⁹*Exploring Atonal Theory with Music Logo*, Greensboro, NC, 1987. By the author.

²⁰See "Preface to the Study of Music Theory," *Music Review* 33 (1972): 24-28.

²¹See John Rahn, *Basic Atonal Theory* (New York and London: Longman Inc., 1980): 20-31.

²²Patrick C. Less and Margaret A. Mitchell, "Demystifying Logo Recursion: A Storage Process Model of Embedded Recursion," *Computers in the Schools* 2/2-3 (Summer/Fall 1985): 197-208; Max R. Martin, "Recursion—A Powerful But Often Difficult Idea," *Ibid.*, pp. 209-217; and Brian Harvey, *Computer Science Logo Style*, Vol. 1 Intermediate Programming (Cambridge, MA: The MIT Press, 1985), Chapter 5.

²³Before this can be done, the student must discover the relationship between the interval patterns of ordered sets and the serial operations by which such sets can be derived from one another. To be more specific, it would seem, intuitively, that two sets which exhibit R-related interval patterns could be mapped onto each other

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discovery of this counter-intuitive relationship, students should then attempt to explain it.

²⁴See David Beach, "Pitch Structure and the Analytic Process in Atonal Music: An Interpretation of the Theory of Sets," *Music Theory Spectrum* 1 (1979): 8.

²⁵These "plumbing" diagrams are modeled upon others found in Brian Harvey's *Computer Science Logo Style*.

REFERENCES

Bamberger, Jeanne. *The Computer as Sandcastle*. New York: Bank Street College of Education, 1960. Technical Report No. 20.

Barford, Philip. "Preface to the Study of Music Theory." *Music Review* 33 (1972): 22-33.

Bass, Joel E. "The Roots of Logo's Educational Theory: An Analysis." *Computers in the Schools* 2/2-3 (Summer/Fall 1985): 107-116.

Beach, David. "Pitch Structure and the Analytic Process in Atonal Music: An Interpretation of the Theory of Sets." *Music Theory Spectrum* 1 (1979): 7-22.

Beckwith, Sterling. "Talking Music With a Machine." *College Music Symposium* 15 (Spring 1975): 94-99.

Bonar, Jeffrey. "Everyone Will Be a Programmer." *Technology and Learning* 1 (May/June 1987): 1-3; 5.

Burke, Michael P. and Roland, Genise L. *Logo and Models of Computation*. Menlo Park, CA: Addison Wesley, 1987.

diSessa, Andrea. "Artificial Worlds and Real Experience." *Artificial Intelligence and Education, Volume One: Learning Environments and Tutoring Systems*. Edited by Robert W. Lawler and Masoud Yazdani. Norwood, NJ: Ablex, 1987.

Friendly, Michael. *Advanced Logo: A Language for Learning*. Hillsdale, NJ: Lawrence Erlbaum Associates, 1985.

Goldenberg, E. Paul and Feurzeig, Wallace. *Exploring Language with Logo*. Cambridge, MA: MIT Press, 1987.

LOGO AND ATONAL THEORY

Greenberg, Gary. "Becoming a Knowledge Engineer: A Musician's Approach." *Academic Computing* 1/1 (1987): 42-44; 70.

Greenfield, Patricia M. "Electronic Technologies, Education, and Cognitive Development." *Applications of Cognitive Psychology: Problem Solving, Education, and Computing*. Edited by Dale Berger, Kathy Pedzek, and William P. Banks, Hillsdale, NJ: Lawrence Erlbaum Associates, 1987.

Harvey, Brian. *Computer Science Logo Style*. 3 vols. Cambridge, MA: MIT Press, 1985, 1986, 1987.

Lawler, Robert. "Learning Environments: Now, Then, and Someday." *Artificial Intelligence in Education, Volume One: Learning Environments and Tutoring Systems*, pp. 1-25. Edited by Robert W. Lawler and Masoud Yazdani. Norwood NJ: Ablex, 1987.

Less, Patrick C., and Mitchell, Margaret A. "Demystifying Logo Recursion: A Storage Process Model of Embedded Recursion." *Computers in the Schools* 2/2-3 (Summer/Fall 1985): 197-208.

Lough, Tom, ed. *LOGO 86 Bibliography*. Cambridge, MA: MIT, 1986.

Martin, Max R. "Recursion—A Powerful But Often Difficult Idea." *Computers in the Schools* 2/2-3 (Summer/Fall 1985): 209-217.

Masterson, Fred A. "Evaluating Logo: A Case Study in Requirements for Student Programming Languages." *Computers in the Schools* 2/2-3 (Summer/Fall 1985): 179-196.

McArthur, David. "Developing Computer Tools to Support Performing and Learning Complex Cognitive Skills." *Applications of Cognitive Psychology: Problem Solving, Education, and Computing*. Edited by Dale Berger, Kathy Pedzek, and William P. Banks, Hillsdale, NJ: Lawrence Erlbaum Associates, 1987.

Papert, Seymour. *Mindstorms: Children, Computers, and Powerful Ideas*. New York: Basic Books, 1980.

Pea, Roy D., and Kurland, D. Midian. "On the Cognitive Effects of Learning Computer Programming." *New Ideas in Psychology* 2/2 (1984): 137-168.

Pea, Roy D. "Integrating Human and Computer Intelligence." *Mirrors of Minds: Patterns of Experience in Educational Computing*, pp. 128-146. Edited by Roy

JOURNAL OF MUSIC THEORY PEDAGOGY

Proceedings of the MIT Logo Conferences. Cambridge, MA: MIT, 1984-1986.

Rahn, John. *Basic Atonal Theory.* New York and London: Longman Inc., 1980.

Sheingold, Karen. "The Microcomputer as a Symbolic Medium." *Mirrors of Minds: Patterns of Experience in Educational Computing.* Edited by Roy D. Pea and Karen Sheingold, Norwood, NJ: Ablex, 1987, pp. 198-208.

Salomon, Gavriel. "AI in Reverse: Computer Tools That Become Cognitive." Paper presented at the Annual Meeting of the American Educational Research Association. April 5-9, 1988. ERIC Report ED 295 610.

Salomon, Gavriel and Perkins, D. N. "Transfer of Cognitive Skills From Programming: When and How?" *Journal of Educational Computing Research* 3/2 (1987): 149-169.

Schank, Roger C., and Farrell, Robert. "Creativity in Education: A Standard for Computer-Based Teaching." *Machine-Mediated Learning* 2 (1988): 175-194.

Thornburg, David. "Logo: A Computer Language at the Crossroads." A + 4/3 (March 1986): 78-84.

Williams, J. Kent. *Exploring Atonal Theory With Music Logo.* Greensboro, NC: By the author.

_____. "Talking Music Theory With a Computer and a Human Being." *Journal of Computer-Based Instruction* 16/2 (Spring 1989): 71-79.

Various authors. "The Cognitive Effects of Computer Learning Environments." *Journal of Educational Computing Research* 2/4 and 3/1 (1986).

A PHENOMENOLOGICAL APPROACH FOR TEACHING 20TH-CENTURY MUSIC ANALYSIS

GREGORY DANNER

INTRODUCTION

One of the main challenges in music theory instruction today is to offer meaningful methods for understanding 20th-century music. By meaningful, I am referring to concepts and techniques that would prove useful in educating music students in general. Theory courses that cover 20th-century music most often focus on the materials of the composition, procedures for manipulating the materials, or even notational matters, rather than the experience of the music. The sounds, the techniques, and the notational symbols are all important aspects of music, but they are not music itself. Music, by any definition, requires human participation at some level. With the diversity of today's undergraduate curriculum coupled with the difficulty inherent in understanding many styles of recent music it seems appropriate to stress the listeners' perspective, particularly as a means of introducing what for many students is an unfamiliar area. Understanding the complex activity of experiencing music is at the heart of phenomenological method.

Kurt Koffka, in his book *Principles of Gestalt Psychology*, states that "a good description of a phenomenon may by itself rule out a number of theories and indicate definite features which a true theory must possess. We call this kind of observation "phenomenology," a word that means as naive and full a description of direct experience as possible."¹ Gestalt psychology was an early 20th-century movement that placed an emphasis on direct perception and how these perceptual processes affected physical sensation.

In applying phenomenological method to music theory, the writings of James Tenney, Thomas Clifton, and Benjamin Boretz, (see bibliography) among others, provide the groundwork for approaching music in this way. Phenomenological description of music amounts to much more than mere report of musical effects or technical aspects. To state it simply, this method of description purports rather to indicate what is essential, or primary, in the experienced perception of the given musical event. Phenomenological description is neither completely objective nor subjective. It cannot be

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totally objective because of the involvement of a "self" rather than the antiseptic environment of notes on a page. It is not totally subjective because by striving for "essences" it avoids prejudicial, overly personal description.

A classroom application of phenomenological method is not without certain problems. Since phenomenological method involves verbal description, one may imagine the theory class degenerating to a spirited exchange of opinions on good days and a shouting match on others. Instruction in music analysis has traditionally relied on symbolic representation of structural principles. Particularly in disseminating theoretical concepts at the undergraduate level, it seems desirable to use a non-verbal system to provide the most basic analytical technique for phenomenological description. The system terminology outlined below is grounded in the writings of Tenney in particular.

ANALYTICAL CONSTRUCTS

Early papers by Kurt Koffka and Max Wertheimer focused on visual perception, noting two factors that figure prominently in grouping elements (visual Gestalts). The first factor is proximity, which, stated simply, maintains that in a collection of *similar visual elements, those close together in space will naturally tend to form groups in perception*. A second factor in the formation of visual groups is the factor of similarity, which states that *in a collection of visual elements, those which are similar will tend to be grouped by the eye*.

Figure 1. Factors of proximity and similarity in visual groupings.



The analogy for music perception in both of these examples is obvious. By substituting time for space and sound elements, then sounds separated by a relatively short interval of time or contiguous will form units (temporal Gestalts), while longer time intervals between sounds create segregations. This is a function of the factor of proximity. An example of the factor of similarity in perceiving musical events would include the observations that sounds played in the same instrument or groups of instruments (timbre) or in the same pitch register, or where any musical parameter is the same, tend

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to be perceived as connected and thus form groups.

The first example shows the opening of the fourth etude from Elliott Carter's *Eight Etudes and a Fantasy*. The music begins with a motive at the octave and in same rhythm in all voices. A relatively long duration of silence follows the initial statement, and then a progressive shortening of the delay time until the music is completely polyphonic and other perceptive forces enter into play. The primary factor of cohesion/segregation in this musical gesture is proximity.

Figure 2. Factor of proximity as a primary Gestalt in Carter's 8 *Etudes and a Fantasy*, for Woodwind Quartet (IV, mm. 1-6).

Vivace ($\text{♩} = 168$)

The musical score is presented in two systems, each with four staves for the woodwind quartet: Flute (Fl.), Oboe (Ob.), Clarinet in Bb (Cl. in Bb), and Bassoon (Bsn.).

System 1 (Measures 1-3):

- Fl.:** Starts with a *ff* dynamic. The melody begins with a quarter note, followed by a half note, and then a quarter note.
- Ob.:** Starts with a *ff* dynamic. The melody begins with a quarter note, followed by a half note, and then a quarter note.
- Cl. in Bb:** Starts with a *ff* dynamic. The melody begins with a quarter note, followed by a half note, and then a quarter note.
- Bsn.:** Starts with a *ff* dynamic. The melody begins with a quarter note, followed by a half note, and then a quarter note.

System 2 (Measures 4-6):

- Fl.:** Starts with a *mf* dynamic. The melody begins with a quarter note, followed by a half note, and then a quarter note.
- Ob.:** Starts with a *mf* dynamic. The melody begins with a quarter note, followed by a half note, and then a quarter note.
- Cl. in Bb:** Starts with a *mf* dynamic. The melody begins with a quarter note, followed by a half note, and then a quarter note.
- Bsn.:** Starts with a *mf* dynamic. The melody begins with a quarter note, followed by a half note, and then a quarter note.

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In Figure 3 the music is organized on a very different perceptual plane. This excerpt from the first movement (Premonitions) of Schoenberg's Op. 16, *Five Pieces for Orchestra* shows a musical gesture where there is relatively little break in sound. Aural groupings occur by noting different timbre units, range usage, and melodic-rhythmic units. Similarity within a group produces cohesion. A new, dissimilar group creates segregation, even though no break in sound or only a short pause is in the rhythmic music. (Schoenberg's *Hauptstimme* indications serve to highlight the timbral function in this passage.)

Figure 3. Factor of similarity as a primary Gestalt in Schoenberg's *Five Pieces For Orchestra* (I, mm. 1-6).

Molto allegro $\text{♩} = 88$

Fl. I, II
Ob. I, II
Cl. I, II in A
Bsns.
C. Bsn.
Hrns.
Vcl. consord.

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The image displays a musical score for a symphony orchestra. The staves are labeled on the left: Fl. I, II; Ob. I, II; Cl. I, II in A; Bsns.; C. Bsn.; Hsns.; and Ucl. The score is written in a single system with three measures. The first measure features a trill (tr) on the first staff, marked with a forte (f) dynamic. The second measure continues the trill and includes a slur over a series of notes. The third measure shows a trill on the first staff, a forte (f) dynamic, and a marking for the horns (H) indicating a 'concord' (consonance). The score includes various musical notations such as trills, slurs, and dynamic markings like 'f' and 'p'.

Before moving into a more "operational" analysis, several other concepts in music perception must be mentioned. The above-mentioned factors of proximity and similarity are the primary factors in determining cohesion and segregation of musical material. Secondary factors are the following:

1. **INTENSITY.** This is defined as the tendency for an accented sound (a variation of magnitude in some parameter) to be heard as the beginning of a grouping.

2. **REPETITION.** If any parameter is repeated, then this alone may produce a division in the perceptual unit.

3. **OBJECTIVE SET.** This is defined as expectations or anticipations arising during a musical experience that are produced by previous events occurring *within the same piece*.

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4. SUBJECTIVE SET. This is defined as expectation or anticipations arising during a musical experience that are the result of experience *previous to those occasioned by the particular piece of music now being considered*.

Before applying these primary and secondary factors in a symbolic analytical system, several other concepts require explanation. Tenney uses the word "parameter" in a very broad sense, defining it as "any distinctive attribute of sound in terms of which one sound or sound-configuration may be distinguished from another. Frequently encountered parameters are pitch, loudness, timbre, duration, temporal density (the number of *successive* elements distinguishable in a given time unit), vertical density (the number of *simultaneous* elements perceptible in a given time unit), and time-envelope (shape of the attack/delay component in a sound)." Parametric focus refers to the "directing of attention toward a particular parameter." This is generally the parameter that involves the highest rate of change. The term "clang" is given a rather original application by Tenney as "a sound or sound-configuration which functions as a primary musical unit or aural Gestalt." A clang is an immediately perceivable temporal unit, usually only a few seconds duration or less. The term "element" refers to "component parts of a clang, either one of several successive parts which form a clang or one of several concurrent parts which form a clang." A "sequence" is "a succession of clangs which is set apart from other successions in some way so that it has some degree of unity and singularity, constituting a musical Gestalt on a higher level." The notion of "perceptual level" or "temporal scale" refers to "the distinctions between the gestalt-organization and perception of configurations of the order of the clang (a few seconds or less) and those that span longer periods of time and are therefore less immediately apprehended as Gestalten."²

The perception of time is a primary concern in applied phenomenology, and perhaps one of the most difficult areas to address. There is a distinction between chronological time and the time a piece of music evokes.³ Although a fascinating area for speculative theory, the analytical method proposed here will be concerned only with quantified time relations. Tenney and Polansky provide an algorithmic model for partitioning a piece of music into its component TG's (temporal Gestalt units) and, through a rather complicated parametric weighting program, provide a clang-sequence-segment-section (segment and section are correspondingly larger temporal units) analysis for several musical works. They point out that "questions of function are left entirely up to us to interpret as we will.

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What the algorithm does purport to tell us is where the temporal Gestalt boundaries are likely to be perceived—surely a prerequisite to any meaningful discussion of the musical “function” of the TG’s determined by these boundaries.”⁴ Since the methodology that follows is intended for use in the undergraduate theory class, a simpler, more experiential method will be used for determining temporal Gestalt units. Also, the analysis will focus on temporal Gestalts at the clang and sequence level, since these are more readily apprehended. Even so, it will become apparent that the notion of “function,” in the sense of discussing formal attributes of perceived phenomena, is not beyond this rather elementary procedure.

MODEL ANALYSIS

In indicating the cohesive and segregating Gestalt factors (that is, the internal unification and separation of clangs and sequences), the following abbreviations will be used:

C = Clang (numbered and with bracket)
S = Sequence (numbered and with bracket)

Clangs and sequences will be further defined according to the primary and/or secondary factors of cohesion/segregation. If one of the primary Gestalt factors determines the TG, then the following abbreviations will follow the clang designation:

P = Proximity
S = Similarity

If a secondary factor is the determinant, then a lower case letter will be used:

i = intensity
r = repetition
o.s. = objective set
s.s. = subjective set

(In certain musical situations, both a primary factor and one or more secondary factors may operate simultaneously in determining a TG.)

A final descriptive abbreviation in categorizing a temporal Gestalt will involve the parametric focus. Abbreviations for this feature will include but not necessarily be limited to the following:

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p = pitch
l = loudness
t = timbre
d = duration
t.den. = temporal density
v.den. = vertical density
t.env. = time envelope

To relate this methodology to the earlier examples of temporal Gestalts, the Carter excerpt (first clang) would be labelled C1: P,d since it is the first clang of the movement; it is segregated from the next by the factor of proximity and its parametric focus (fastest changing feature) is duration (see Figure 2). The first clang in the Schoenberg excerpt (Figure 3) would be labelled C1: S,t since it is segregated from the next by the factor of similarity (the next clang is dissimilar), and its parametric focus (fastest changing feature between the two clangs) is timbre. When proximity functions as a primary Gestalt factor, further descriptions need only relate to the temporal Gestalt under consideration. When similarity is the primary factor, then comparison between the temporal Gestalt under consideration and that which immediately follows is necessary in qualitatively describing the aural phenomenon.

The work to be considered as a paradigm for analysis is the first movement ("Emerson") of Ives' Second Piano Sonata (the "Concord" sonata). Ives comments on the music in his *Memos* as follows:

Here the music grows, or works naturally, to a wider use of the twelve tones we have on the piano, and from them (always in a aural kind of way) building chordal combinations which suggest or imply (and of course to the aural imagination only, when played on a piano) an aural progression which physically is not in the piano strings, but may be implied by the mind and ear as a thing of musical sense.⁵

Ives own description suggests that the meaning of the music is more than what can be seen in the technique alone—that what Ives terms "manner" or technique itself, is secondary to "substance," which exists "underneath the music." The analysis that follows, by focusing on the listening act, should present the student with the tools to form judgments of an aesthetic rather than a purely technical manner. It should be pointed out that phenomenology does not ignore the role of technique. Rather, it

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views the understanding of technique as only one part—the empirical part—in the theoretical process of understanding music—a basically non-empirical, expressive form. Because of the length and complexity of this movement a thorough study is beyond the scope of this paper. The analysis will highlight several sections of this work to illustrate various perceptual concepts.

Figure 4 shows a clang segmentation for the opening “measure” of the work. Since there is no break in the sound, but an obvious increase in complexity from the opening simple octave to the complex vertical and contrapuntal music that follows, the primary factor of cohesion/segregation is most often similarity. That is to say, that within each bracketed area (clang) the sound-configurations have a definite parametric similarity.

The Beethoven Fifth Symphony motto that may be traced through the entire movement is heard at the end of the first line of music (clang 4). The repetition of that motto in clang 5 is perceived through this secondary factor of cohesion. In describing the parametric focus of this section, note that the attention seems to shift quite rapidly. Clang 1 and 2 focus on pitch, while clang 3 is primarily rhythmic, with vertical density functioning as a secondary parameter. Clang 4 and 5 emphasize pitch with the “motto” interval of a minor third sounding; however, because this is a quote of some familiarity, the notion of subjective set enters the perceptual analysis. Clang 6 is segregated from the music that precedes and follows by stressing pitch within a dense chordal texture.

The next clang is interesting in that the parametric focus shifts to temporal density. Here the successive durational elements in the clang vary rapidly, particularly with the “nested” triplet figure stating the motto and the slower music that follows. The final clang under consideration is much simpler than those that preceded, with the focus shifting back to pitch, but with loudness (the mezzo-forte indication is the lowest volume level to this point) functioning as a significant secondary parameter. One of the interesting features of this highly complex musical message is that it is characterized by a rapidly changing parametric and textural focus. The music is nearly overwhelming to the uninitiated listener due to the rapidly changing parametric profile.

Figure 4. Opening clang segmentation.

The musical score for Figure 4 is divided into three systems. The first system, marked 'Slowly', features a treble staff with a melodic line and a bass staff with a harmonic accompaniment. Annotations include 'C1:S,p' above the first measure, 'C:2S,p' above a bracketed section, '3' above a triplet, 'faster' above a section, 'C3:S,d(v.den.)' above a section, and 'ff' below a measure. The second system continues the piece, with annotations for 'C4:S(s.s.),p' above the first measure, 'C5:x,p' above a measure, 'C8:S,p(v.den.)' above a section, 'slightly slower' below a section, 'faster' above a section, 'C7:S,l.den.' above a section, '3' above a triplet, 'slower' above a section, 'ff' below a measure, and 'mf' below a measure. The third system at the bottom shows 'C8:S,p(l)' above a section.

The next passage (Figure 5) is from p. 3 of the movement and warrants very careful study. Tenney considers this section in *Meta + Hodos* as an example of a polyphonic sequence. Polyphony is defined here as a temporal Gestalt where "the attention is divided or distributed among two or more clangs simultaneously at certain moments."⁶ The mere existence of two or more parts in a contrapuntal texture, however, does not necessarily mean that the passage is polyphonic by this definition. Here there must be a perceptible parametric difference between the individual monophonic ideas. In reading the analysis given in Figure 5, note that each clang is given a letter as well as a number designation. The letters (a, b, c, and d) refer to the separate lines in the musical texture, or monophonic sequences. In other words, each clang designated with the letter "a" shares the same parametric focus (and motivic structure), and so forth for the other designations. The primary factor in the creation of polyphonic differentiation is the factor of

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similarity. Each monophonic sequence (letter designate) is distinguished by a characteristic loudness, vertical density, and pitch component. Descriptors are given for the first clang in each sequence only, since the following clangs are similar with regard to Gestalt factors.

Figure 5. Polyphonic sequence.

The musical score for Figure 5 is a polyphonic sequence consisting of three staves. The top staff features two circled sections. The middle staff contains several groups of notes, each labeled with a letter and a descriptor: C1b:S.v.den., C1c:S,p, C2c, C3a, C3c, C4a, C3d:S,p, and C4d. The bottom staff has a group of notes labeled C1a:S,1 and C2a. A detailed view of the C1a and C2a groups is shown in a separate box on the left, with C1a:S,1 and C2a labels below it.

The next two examples show comparatively simple perceptual (and structural) patterns. The analysis given as Figure 6 ("Emerson") demonstrates the factor of similarity operating in phrase-like sequence patterns. Sequence 1 melodic structure has a definite shape and cadence that is transformed in Sequence 2. The section resembles an antecedent-consequent phrase relation but without the functional tonal implications. In Figure 7 ("Emerson"), proximity is the primary factor of cohesion/segregation in the clang succession. Here the contrapuntal texture is not polyphonic as in Figure 5, since there is no parametric conflict to create a segregation within the measure. Rather, the individual lines seem to work together,

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culminating in a resonance that creates a sort of interim break between clangs. Those clangs that follow the first are also perceived through the secondary factor of repetition. As in Figure 6, pitch is the focal parameter in this relatively uncomplicated pattern.

Figure 6. Factor of similarity at sequence level.

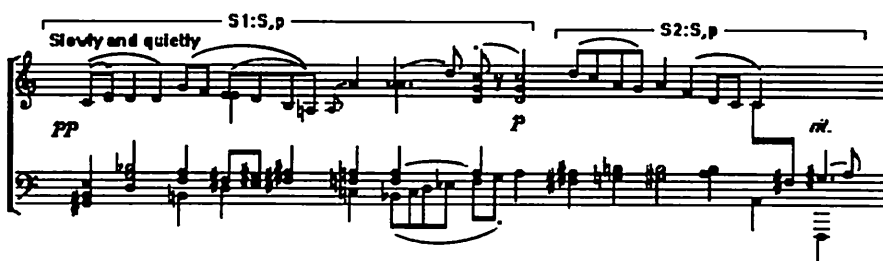


Figure 7. Factor of proximity at clang level.



The analysis presented in Figure 8 ("Emerson") shows an interesting, typically "Ivesian" feature. The first two clangs present the diatonic melody from p. 5 of the score. After this statement, the music alternates from this material to other, wider-ranged melodic fragments. It is intensity in the pitch parameter (higher register) that functions as the chief segregating force in this excerpt.

The final sequence of the movement is shown in Figure 9. These closing sounds are striking in the simplicity of the musical materials, yet fascinating in their perceptual organization. Once again, Ives' has designed a polyphonic sequence, with the dichotomy defined by the two distinct parametric values operating between treble and bass staves. Those clangs

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designated with the letter "a" are focused around pitch, stating variants of the Fifth symphony motto. These clangs are comprised of two elements—the melodic quote and a droning bass counterpoint. The clangs designated "b" have the aural effect of creating a distinct timbre, due to the increasingly quiet dynamic indications and the performance direction "to be heard as a kind of overtone," which should elicit a most delicate attack. Truly a remarkably effective ending to one of the most complex movements in piano literature.

Figure 8. Factor of intensity in pitch parameter.

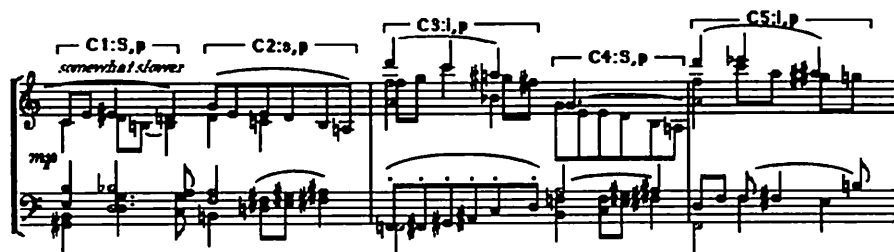
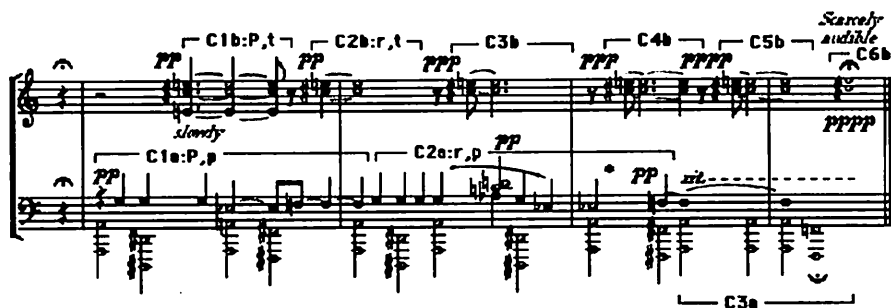


Figure 9. Closing sequence.



•) to be heard as a kind of overtones

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CONCLUSION

The analysis presented above and the phenomenological approach in general does not profess to be complete with regard to explaining music as perceived. It does, however, assist a listener in thinking about the *experience* of the music. Introducing new music, in particular, warrants special attention. If we, as theory instructors, focus only on the empirical evidence of a composition—its melodic organization, harmonic language, compositional strategy, etc.—then the student comes to think of new music as merely abstruse technique. This is what Schoenberg noted in a letter to a student who had commented on set structure in the *Third String Quartet*.

You have gone to a great deal of trouble, and I don't think I'd have had the patience to do it. But do you think anyone's better off for knowing it? I can't quite see it that way. My firm belief is that for a composer who doesn't yet quite know his way about with the use of series it may give some idea of how to set about it—a purely technical indication of the possibilities of getting something out of the series. But this isn't where the aesthetic qualities reveal themselves, or, if so, only incidentally. I can't utter too many warnings against overrating these analyses, since after all they only lead to what I have always been dead against: seeing how it is done; whereas I have always helped people to see: what it is!⁷

Phenomenological method offers a means for describing the increased aural complexity characteristic in much recent music. As mentioned earlier, one of the main challenges in music theory instruction today is to offer meaningful methods for understanding 20th-century music. Phenomenology can provide the procedure for analyzing and comparing the many divergent styles of music in our time, including even the most experimental electronic and computer music, since traditional notation is not at the heart of the theory—only sound alone.

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NOTES

¹Kurt Koffka, *Principles of Gestalt Psychology* (New York: Harcourt, Brace, and World, 1963), 73.

²James Tenney, *Meta + Hodos*, pp. 71-77.

³See Thomas Clifton, *Music as Heard*, p. 81-136.

⁴James Tenney with Larry Polansky, "Temporal Gestalt Perception in Music," *Journal of Music Theory* 24/2 (1980): 218.

⁵John Kirkpatrick, ed., *Charles E. Ives Memos* (New York: W. W. Norton and Company, 1972), 193.

⁶James Tenney, *Meta + Hodos*, p. 75.

⁷Erwin Stein, ed., *Arnold Schoenberg Letters*, p. 164.

REFERENCES

Boretz, Benjamin. "A Note on Discourse and Contemporary Musical Thought." *Perspectives of New Music* 4 (1966): 76-80.

_____. "Meta-Variations: Studies in the Foundations of Musical Thought (I)." *Perspectives of New Music* 8 (1969): 1-74.

Clifton, Thomas. *Music as Heard*. New Haven: Yale University Press, 1983.

_____. "Training in Music Theory: Process and Product." *Journal of Music Theory* 13/1 (1969): 38-65.

_____. "Some Comparisons Between Intuitive and Scientific Descriptions of Music." *Journal of Music Theory* 19/1 (1975): 66-111.

Ives, Charles. *Essays Before a Sonata and Other Writings*. Edited by Howard Boatwright. New York: W.W. Norton and Company, 1962.

JOURNAL OF MUSIC THEORY PEDAGOGY

Langer, Suzanne K. *Feeling and Form*. New York: Scribner, 1953.

Tenney, James. *Meta + Hodos—A Phenomenology of 20th Century Music and an Approach to the Study of Form*. New Orleans: Inter-American Institute for Musical Research, 1964.

_____. "Temporal Gestalt Perception in Music." With Larry Polansky. *Journal of Music Theory* 24/2 (1980): 205-242.

TEACHING SET THEORY IN THE UNDERGRADUATE CORE CURRICULUM

DAVID MANCINI

In recent years many music programs have recognized the importance of strengthening course offerings in 20th-century music. Rather than forcing the student to wait until the third or fourth years of a music program to take a course in 20th-century music, many schools have increased coverage of this repertory in the basic undergraduate theory program. This set of core theory courses in many institutions is generally charged with introducing the student to a wide range of music literature from as many different style periods as possible.

At this relatively early stage of college-level instruction, and especially after a thorough and systematic treatment of tonal music (often occupying as many as three or four semesters), the typical one-semester or shorter introduction to 20th-century music frequently strikes the student (and instructor) as superficial and limited in scope. Of course, some of this reaction is engendered simply by the stylistic variety and eclecticism found in the 20th-century repertory—characteristics that, for the instructor, may make course design especially problematic and, for the student, may create difficulties in the organization of such a large body of theoretical information.

Nevertheless, a considerable proportion of student difficulties result, I believe, from the lack of precise theoretical and analytical tools traditionally available to students at this level. We can only sympathize with those students who, after learning to describe tonal harmonies in a variety of ways, no longer possess a method that allows them to discuss in precise terms the properties of pitch collections found in examples of 20th-century music. The curious students discover, all too soon, that terms like *polychord* or *mixed-interval chord* can only take them so far analytically. They soon feel the need for a systematic method of presenting analytical conclusions. Set theory, properly distilled and efficiently presented, can provide such a method.

My purpose in this paper will be to suggest some techniques that I have found particularly useful in confronting the problems instructors typically face in presenting elementary set theory to college analysis classes.¹ We will explore how the authors of various undergraduate theory textbooks deal with some of the pedagogical issues involved, and finally I will present

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sample analyses that could be undertaken with undergraduate students who possess a basic knowledge of set-theoretic principles.

I believe that several fundamental problems confront the instructor who attempts to present set theory to a beginning class in 20th-century theory or analysis. I am sure many instructors have become frustrated when, in the presentation of an analytical method, the class seemed to be "out of touch" with the actual sounds of the piece. We tell our students that analysis must somehow illuminate the music, which must therefore be the necessary starting point. Nevertheless, we discover that students sometimes lack a basic familiarity with the music to which set-theoretic methods are most frequently applied. Given the traditional contents of many of today's concert programs as well as the nature of pre-college instrumental and vocal instruction, our students often have not listened to or performed this music to any great degree.

Of course, it is not the theory faculty alone who have the responsibility for actively promoting 20th-century music; we can, however, help in a number of ways. For instance, when discussing the elements of music in a beginning theory or rudiments class, we might use examples from 20th-century compositions. Or we might take advantage of opportunities in the classroom to show students how compositional techniques of earlier style periods carry over into the 20th century. At the very least, we must always be ready to encourage students to study and perform 20th-century music outside of their classroom responsibilities.

Another problem involves the very nature of set-theoretic concepts and terminology. These may seem to many students novel, esoteric, and unrelated to anything they have encountered in their previous musical training.² They may have difficulty thinking about musical relationships in terms of integers, the traditional symbols of set theory. A particular stumbling block for some students is modulo 12 arithmetic. (A discussion of "clock" arithmetic often helps here.) A sensitive instructor should be aware of not only these specific difficulties, but of the frustration emanating from them as well. An extra bit of patience can do much to carry the reasonably prepared music student over these obstacles.

The last problem I would like to mention here involves course organization. The great amount of time spent in developing set-theoretic concepts in the classroom and refining students' computational skills often means less time spent with actual music—a sacrifice many instructors are unwilling or unable to make. Given many students' unfamiliarity with 20th-century music, instructors often find the initial 20th-century theory course to be more a general introduction to this literature rather than a more detailed analytical study. In a situation such as this, we must ask whether it is wise to trade the more intuitive aspects of musical awareness for

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theoretical rigor. The following remarks will demonstrate my contention that, in a class situation, it is possible to make some of the seemingly abstract concepts of set theory more musically relevant and thereby avoid an unnecessary trade-off between theory and musical reality.

One of the simplest ways to introduce set-theoretic concepts is to link them in the student's mind to concepts covered earlier in the theory program. Several of the available undergraduate texts dealing with set theory adopt this strategy. Ralph Turek's *The Elements of Music* presents transformations of interval cells in terms of traditional motivic operations, although he claims that greater freedom exists in the manipulation of interval cells.³ This approach reminds us of Schoenberg's emphasis on the motive as a way of understanding compositional process not only in tonal music, but in atonal and serial music as well.⁴ Earl Henry's *Music Theory* also begins with a discussion of basic operations, defined as transposition, inversion, inclusion, and complementation.⁵

One may go further, however, in drawing connections between the principles of set theory and those of tonal theory. The postulate of the unordered set, for example, can be related to the function of a scale in a tonal piece. Students can easily see that whether or not its pitches appear in direct order, a scale serves as a "reservoir" of pitches for a given passage. For many examples of 20th-century music, this idea can be expanded to any pitch collection with provision made for the application of transposition and inversion to subsets and supersets of the original collection.⁶ Another link between set theory and traditional harmonic theory can be found in the relationship of a pitch-class (pc) set in normal order to a root-position triad: both structures exhibit a similar arrangement with the smallest interval from first to last pcs.⁷ The concept of interval classes can easily follow an elementary presentation of intervals and their inversions. The typical introduction to triad types actually involves chord analysis through the use of interval vectors, since we generally require students to learn the total interval content of these sonorities. Even the inclusion relation has its analog in tonal theory with the relationship of the leading-tone triad to a dominant-seventh of the same key. Of course, examples of transposition and inversion abound in the tonal literature.

A simple step for classes beginning a study of set theory is the initial avoidance of integer notation. Although making the issues of octave and enharmonic equivalence somewhat more difficult to manage, this strategy has the advantage of keeping students closer to the actual musical relationships. For the same reason, so-called integer maps (complete integer representations of pieces) should probably be avoided in the earlier stages of instruction. Both Turek and Bruce Benward, the latter in his *Music in Theory and Practice*, determine normal orders with pc sets in staff notation.⁸

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Interval vectors, of course, can easily be derived from traditionally notated sets, as can set types. The latter designation uses integers, but, as in Turek and Benward, these integers represent intervals above the initial pc of the normal order rather than pcs.⁹

One of the most effective tools in the teaching of set theory is the successive-interval array or SIA, first discussed comprehensively in the literature by Richard Chrisman.¹⁰ The SIA possesses two basic qualities of any efficient analytical tool: it is simple, and it is powerful. Figure 1 shows two pc sets in normal order with their corresponding SIAs, which are merely representations of the successive intervals of the sets, including the interval from last to first pc.¹¹

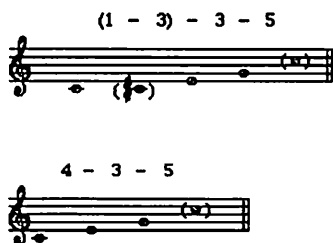
Figure 1.



Although more cumbersome, the SIA can be used in place of the set type designation or the Forte name to represent a class of sets equivalent under transposition or inversion. The SIA can also greatly facilitate the determination of normal order, since this form of the set always begins with the pc to the right of the largest interval of the SIA. When this largest interval is then inverted, it becomes the smallest boundary interval of the set, thereby guaranteeing normal order.

The inclusion relation can easily be understood through the use of the SIA. Figure 2 shows the omission of the C# from the first set of figure 1.

Figure 2.



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This results in the combination of the two intervals formed by this pc; that is, C-sharp no longer subdivides the interval between C and E. The resulting new SIA denotes one of the subsets of the original collection. The advantage of this treatment of inclusion is two-fold: subsets of a collection can be systematically determined by manipulation of the SIA alone, and the pcs forming a particular subset are readily at hand. The latter situation greatly assists in the comprehension of nonliteral inclusion, since the student can easily go beyond the name or SIA of a subset to its actual pcs in the larger set. This leads the student from a relatively abstract analytical construct to a focus on the actual notes in a passage.

The inversional relation is one of the more difficult aspects of set theory to teach. Fortunately, the inversional equivalence of two pc sets is fairly easy to describe using SIAs. As previously noted the two sets of figure 1 are inversionally related. Note the reversal of the first three entries of the SIA. Students familiar with the traditional process of motivic inversion will understand the notion of directional reversal in an interval succession. Given the ascending direction of a normal order, they should then be able to see how placing a set in normal order, after deriving it through the reversal of interval directions, will result in the kind of SIA correspondence shown in figure 1. Of course, the important point to note is that once all of this is explained to students, they will be able to uncover inversionally equivalent sets at a glance.

Recognizing the inversional relation, however, sidesteps the issue of the true nature of inversion. As you may recall, Forte sets up a fixed, one-to-one correspondence (mapping) between each pc integer and an inverse, with pcs 0 and 6 mapping onto themselves.¹² Thus, 0 inverts to 0, 1 to 11, 2 to 10, and so on. In this way, to derive a particular inverted form of a pc set, one might need to transpose after inverting the pcs of the original set. An alternative to this approach involves the reliance on the inversional index to describe the relation between inversionally equivalent sets.¹³ As figure 3 shows, the two sets of figure 1 (rewritten in integer notation with C=0) can be rearranged so that the sum of all corresponding elements is the same. This sum is the inversional index.

Figure 3.

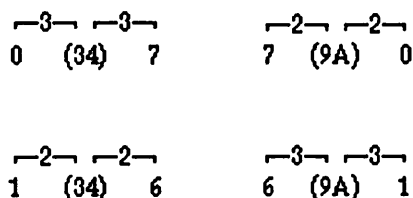
0	1	4	7
7	6	3	0
7	7	7	7

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By establishing a particular index, one can derive an inverted form of a pc set by simply subtracting each of its elements from the index without recourse to transposition.

In addition, knowing the index provides the inversional centers or axes, that is, the single pcs or semitone dyads a tritone apart that bisect all intervals formed by corresponding elements of the inversionally equivalent sets. Figure 4 shows the two inversional centers of the sets in figure 1 and how they relate to the other dyads formed between the sets.¹⁴

Figure 4.



Of course, in sets having fewer than 12 elements, one or both of the inversional axes may not actually be present. Nevertheless, as David Lewin has pointed out, inversional axes are often singled out for special contextual emphasis.¹⁵ A familiar example illustrating the significance of inversional axes is the second movement of Webern's *Piano Variations*, op. 27, in which pairs of row forms invert about the axis pcs A and E-flat. In this example, thinking about the row-form pairs in terms of inversion about the initial pc of the row followed by transposition obscures the more fundamental relationship and adds an additional, abstract, and unnecessary step to the analytical model.

At this point I would like to present three analyses that apply the techniques discussed above and that would be suitable for a beginning class in set theory. The first excerpt, shown in figure 5, consists of the opening 10 measures from the fourth movement of Webern's *Five Movements for String Quartet*, op. 5. In the figure 1 have labeled certain pitch collections with Forte names.¹⁶

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Figure 5. Webern, Op. 5, No. IV, mm. 1-10.

Sehr langsam (♩ = 58) zögernd im tempo

am steg pizz. am steg

mit Dämpfer am steg

mit Dämpfer am steg

mit Dämpfer am steg

mit Dämpfer am steg

6-5 [B03456] 5-7 [67B01]

5 rit. tempo so weit als möglich

4-17 [8B03]

3 3 3 3 3 3

5-30 [AB246]

rit. 10

3 3 3

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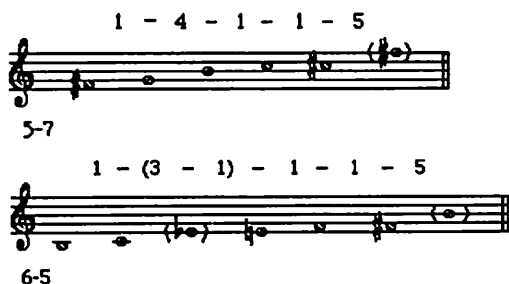
This passage provides excellent examples of inclusion relations, as well as the more general feature of sectional contrast based on interval content.

At first glance, the middle section of the piece, measures 7 through 9, embodies contrasts of primarily rhythm and articulation. Set structure, however, acts as a further means of differentiation. The melodic set, 4-17, is a subset of neither pc sets 5-7 nor 6-5 found in measures 1 through 6. The accompanimental set, 5-30, is also not a subset of 6-5; moreover, it shares no common interval vector entries with 5-7, a situation described by Forte as maximum intervallic dissimilarity (the R_0 relation).¹⁷

The second violin line of measure 6 and the viola line of measure 10, both forms of pc set 7-19, act as transitional passages between sections. The initial four pcs of each set, a form of 4-16, constitute a significant subcomponent of the larger set. George Perle has pointed out that these four pcs in measure 6, C-E-F-sharp-B, reiterate the opening four pcs of the first violin in measures 1 and 2.¹⁸ The importance of these pcs, however, extends beyond this relationship. Pc set 4-16 is the only subset shared by 5-7 and 5-30, thus providing a link between pitch components of two separate sections. Furthermore, the two forms of 4-16 in measures 6 and 10 share the invariant pcs B and E, which are emphasized through their occurrence as sustained pedals throughout measures 7-9 in second violin and cello.

The inclusion of 5-7 of measure 4 in 6-5 of measures 1 and 2 provides an opportunity to demonstrate how the use of the SIA can help to better conceptualize this relationship. Figure 6 shows the SIAs of both sets and the grouping of the intervals in the SIA of 6-5 to derive the SIA of 5-7.

Figure 6.



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We see from this that the omission of E-flat from 6-5 results in a form of 5-7. In musical terms, we can argue that Webern strongly emphasizes this inclusion relation through the difference in articulation and the registral separation between the cello E-flat and the tremolo dyads in the violins, which constitute a form of pc set 5-7.

The next passage I would like to examine is from Bartok's "Bulgarian Rhythm," contained in the *Mikrokosmos*, vol. IV, number 115. Figure 7 shows some of the pc sets in this passage.

Figure 7. Bartok, "Bulgarian Rhythm," *Mikrokosmos IV*, No. 115, mm. 8-17.

The figure displays two musical staves from Bartok's "Bulgarian Rhythm." The top staff contains measures 8-11, and the bottom staff contains measures 12-14. Brackets below the staves identify specific pitch-class (pc) sets:

- Top staff, measures 9-11: 5-32 [9A146], 5-35 [9B146], 5-32 [01469]
- Bottom staff, measures 12-14: 5-32 [01469], 5-32 [9A146], 4-26 [1469]

The two forms of 5-32 used here are inversionally related. Bartok makes this relation explicit in the melodic contours of measures 9 and 13. As figure 8 demonstrates, these forms of 5-32 have an inversive index of 10 with axes or centers of 5 and 11.

Figure 8.

9	A	1	4	6
<u>1</u>	<u>0</u>	<u>9</u>	<u>6</u>	<u>4</u>
A	A	A	A	A

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Despite the fact that neither axis pc is present in the sets themselves, Bartok strongly emphasizes pc 5 (F) in m. 12, where the interruption of the previously consistent rhythm helps to create a cadential effect. The resultant agogic accent is one of several types of accent accorded this pitch, the others being the notated dynamic accent and the isolated registral placement. Another factor contributing to the significance of F at this point in the piece is its exclusion from the first 11 measures. Also of interest in this excerpt is how, in the second line of the example, Bartok immediately juxtaposes the two inversionally equivalent forms of 5-32 and then isolates their invariant subset, pc set 4-26.

My last excerpt is from Bartok's *Bagatelle*, op. 6, number 6. This passage, shown in figure 9, provides an interesting contrast between the diatonic and nondiatonic—a contrast that can be quite audible, even at a relatively elementary stage of instruction.

Figure 9. Bartok, Op. 6, No. 6, mm. 1-10.

The larger collections in measures 1-2 and 3-4 are forms of pc sets 7-Z38 and 8-18, respectively. By two of the usual measures of pc set similarity, neither one of these sets is closely related to the diatonic collection, pc set 7-35: 7-Z38 and 7-35 share only one common interval vector entry, while 8-18 contains no forms of 7-35. One of the striking aspects of these opening four measures is the way Bartok achieves a strong B orientation despite the relative scarcity of diatonic components. (Of course, we might perceive the

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notes C and E-sharp as modally influenced colorations of a basic diatonic collection.) The interplay between D-sharp and D-natural leaves unresolved the question of major or minor.

At measure 5 the music takes on a clearly diatonic profile: pc set 4-22 is a subset of the diatonic collection, 7-35. Moreover, 4-22 in this context embodies a strong triadic reference. Although pc set 3-11, the major or minor triad, is not the only trichordal subset of 4-22, it is certainly the most strongly emphasized due to its placement on the majority of the strong beats in measures 5 through 7.

Figure 10 shows the closing measures of the piece.

Figure 10. Bartok, Op. 6, No. 6, mm. 21-25.



With the entrance of E-sharp in the last measure, we might expect a resolution on F-sharp, which Bartok does not provide. One way to understand this cadence relates to the diatonic-nondiatonic polarity mentioned earlier: This cadence, identical to the form of pc set 4-Z29 appearing in measure 2 of figure 9, is a subset of the diatonic collection. Even though this set first appeared in m. 2 with the addition of D-natural at the end of the measure, it is only at the final cadence that its independence is asserted. In an immediate sense, the last E-sharp does not resolve. In a deeper sense, however, the cadence on 4-Z29, a subset of *both* the nondiatonic 7-Z38 and the diatonic 7-35, resolves our original diatonic-nondiatonic opposition.

In the three preceding analyses, I have attempted to show that set theory can be a powerful tool for describing the musical relationships within the passages. I must emphasize the word *musical* in my last statement, for in a theory or analysis class, numbers by themselves are meaningless unless they assist the student in developing and articulating analytical conclusions. Set theory, I believe, is not fundamentally incompatible with other modes of analytical reasoning. The essential element is an instructor who can select the necessary tools and present them to a class in a pedagogically effective and musically significant way. The goals of analysis must never be confused with its tools. This is as true for a beginning theory student as it is for the professional theorist.

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NOTES

¹Despite the title of the paper, my suggestions should prove useful in the graduate analysis class for the general music student without an extensive background in the analysis of 20th-century music.

²This, of course, does not apply to students who have some background in the sciences or mathematics.

³Ralph Turek, *The Elements of Music*, vol. 2 (New York: Alfred A. Knopf, Inc., 1988), 327-29.

⁴See, for example, Schoenberg's *Fundamentals of Music Composition* (London: Faber and Faber, 1967), chapter III ("The Motive") and "Analysis of the Four Orchestral Songs Opus 22" [*Perspectives of New Music* 3, no. 2 (Spring-Summer 1965): 1-21]. In his 1941 essay "Composition with Twelve Tones" [in *Style and Idea*, ed. Leonard Stein (Berkeley: University of California Press, 1975), 214-45], Schoenberg states that the basic set in a composition "functions in the manner of a motive" (219).

⁵Earl Henry, *Music Theory*, vol. II (Englewood Cliffs: Prentice-Hall, Inc., 1985), 340-47.

⁶The reader will note that I have just informally characterized the operation of a nexus set [see Allen Forte, *The Structure of Atonal Music* (New Haven and London: Yale University Press, 1973), 101].

⁷The analogy does not hold, of course, with seventh chords.

⁸Turek, *Elements*, 332; Bruce Benward, *Music in Theory and Practice*, 3rd ed., vol. 2 (Dubuque: Wm. C. Brown, 1977), 333.

⁹Turek, *Elements*, 332; Benward, *Theory and Practice*, 330-31. This contrasts with the traditional formulation of the set type or prime form as found in Forte, *Structure of Atonal Music*, 12. There the integers of a prime form represent not intervals, but pitch-classes derived through transposition of another form of the same set type. Allen Winold takes this approach in *Harmony: Patterns and Principles*, vol. II (Englewood Cliffs: Prentice-Hall, Inc., 1986), 252-53.

¹⁰Richard Chrisman, "Identification and Correlation of Pitch-Sets," *Journal of Music Theory* 15, nos. 1 and 2 (1971): 58-83 and "Describing Structural Aspects of Pitch-Sets Using Successive-Interval Arrays," *Journal of Music Theory* 21, no. 1 (Spring 1977): 1-28.

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¹¹In the Forte nomenclature, both sets of figure 1 are forms of 4-18: their inversive relationship will be discussed below.

¹²Forte, *Structure of Atonal Music*, 8. Although Forte assumes 0 is C, the validity of the mathematical relationships, of course, do not depend on a fixed pitch-integer correspondence.

¹³See John Rahn, *Basic Atonal Theory* (New York and London: Longman, 1980), 49-51.

¹⁴In this and subsequent examples, $A = pc\ 10$ and $B = pc\ 11$. Note that the integers of each axis sum to the inversive index of example 3 or its mod 12 equivalent, 19.

¹⁵David Lewin, "Inversive Balance as an Organizing Force in Schoenberg's Music and Thought," *Perspectives of New Music* 6, no. 2 (Spring-Summer 1968): 1-21.

¹⁶The labeling of the pc sets in this and subsequent examples follows the conventions in Forte. With sets containing six or fewer pcs, the pcs included in the set are given in square brackets; with sets containing more than six pcs, the pcs excluded from the set are given in parentheses.

¹⁷Forte, *Structure of Atonal Music*, 49.

¹⁸George Perle, *Serial Composition and Atonality*, 5th ed. (Berkeley: University of California Press, 1981), 16.

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SOME PROBLEMS AND RESOURCES OF MUSIC THEORY

DAVID LEWIN

Many years ago I had a student at the keyboard realizing figured bass, while the rest of the class was writing down Roman numerals. At the end of one phrase, the pianist saw Figure 1a and played something like Figure 1b. The rest of the class uniformly reported hearing Figure 1c.

Figure 1.



I had the pianist repeat the realization a couple of times, but nobody else heard anything to change about Figure 1c. Finally I put Figure 1a and the soprano line of Figure 1b up on the board, much to the class's surprise. "But you shouldn't be surprised," I said. "Just a few days ago I was talking about 6-chords, including why our text says not to double the bass. If you remember, I said the idea behind the rule was to keep the bass of the 6-chord from asserting itself as a root. Then I talked about exceptions to the rule. One exception was when the root function would be idiomatic, for instance in the cadence formula $ii^6 - V$. And here is just that formula. That's why you all heard a IV root for the ii^6 , especially with the bass of the ii^6 doubled in the soprano here, preceded by its own leading tone."

There was a considerable silence. Then one student raised his hand and said, "Yeah, but that was just theory."

Thirty years later I am still unable to disentangle the genius of that remark from its imbecility. Both involved the way in which the theory lecture attempted to describe a conceptually structured sound-world that was categorically prior to any particular musical event, score, or experience.

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The occasion must have influenced my prose some seven years later in 1968, when I wrote that music theory “attempts to describe the ways in which, given a certain body of literature, composers and listeners appear to have accepted sound as conceptually structured, categorically prior to any one specific piece.”¹ Today I am still reasonably satisfied with that view of music theory, and I shall explore various of its aspects in some detail.

Overworked terms create problems for us in describing conceptual sound-structures, and the pursuit of those problems can be enlightening. My book on generalized musical intervals arose in part as an attempt to pursue some of the ways in which the term “interval” has been overworked.² The overworked term “minor” was the source of another interesting exploration for me, an exploration I shall begin with another pedagogical story.

Figure 2 illustrates typical errors in the exercises that one student, about twenty years ago, was submitting for a first-year class in Jeppesen-style species counterpoint. I kept correcting his papers, indicating why the *ficta* was inappropriate, and reminding him that Jeppesen forbade the MAJOR sixth leap up, while the MINOR sixth leap up was permitted. We would talk, and he would say he understood. But exercises like Figure 2 kept coming in. Finally, at one of our agonized critiques, he said to me, “But I AM leaping up the minor sixth; that’s why I need the accidentals.” When I asked him what he meant, he pointed to something like the beginning of figure 2a and said, “You see, B-flat to G, that’s G minor.” Then, remarkably, he pointed to something like the beginning of Figure 2b and said, “You see, A to F-sharp, that’s F-sharp minor.”

Figure 2.



For purposes of the first-year course, it was sufficient to remind the student that the word “minor,” in this context, describes the acoustic size of the sixth, not its modal or harmonic character. But the incident triggered interesting thoughts for me beyond that. First of all, I noticed how apt for this context was Zarlino’s way of describing sixths.³ When a sixth is regarded as a fourth plus a third, or a third plus a fourth, the smaller sixth

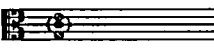
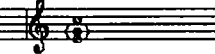
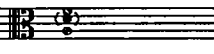
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is associated with the smaller third, and the larger sixth with the larger third. My student would not have had his problems, had he originally acquired his concepts about sixths from the historically pertinent sound-world of Zarlino, instead of from some subsequent theory that had described sixths as inversions of modally charged thirds. The point about Zarlino is especially interesting because Zarlino himself is already showing sensitivity to modal charges on thirds, both as major or minor consonances above a bass, and as major or minor third degrees in various scales.

Indeed that sensitivity seems to underlie some of the problems Zarlino has describing consonant sixths in "a conceptually structured sound-world ... categorically prior to any particular musical ... experience." For him the larger sixth is conceptually always as in Figure 3a.

This displays the large consonant sixth as composed from elements of the scenario, here 6 and 4 as divided harmonically by the mean term 5. It also displays the sixth as composed from a fourth below plus a third above. Zarlino's problem with the small consonant sixth involves an attempt to preserve both these features of his large sixth. He wants the small sixth to be composed from elements of the scenario, as in Figure 3b; there the small sixth is composed from elements of 8 and 5 of an extended scenario, divided by a "mezzano termino harmonico which is 6."⁴ From a modern point of view, we can say that he wants the small sixth of Figure 3b to stay in C major like Figure 3a, our C major here reflecting Zarlino's conceptual *Urklangwelt* of the scenario. At the same time, Zarlino wants his small sixth to be constructed by minor/major analogy with his large sixth, in a manner suggested by the analogy of Figure 3c with Figure 3a. He says that the sixths "are composed ... from the fourth plus the major third, or the minor third."⁵ But clearly Zarlino cannot both have the minor/major analogy of Figure 3c, and remain within the extended scenario as in Figure 3b. That is, he cannot so long as he wants to speak of "THE" minor sixth. Here the term "THE" is problematic, given his conceptual sound-world. Figures 3b and 3c clearly describe two distinct consonant minor sixths.

Figure 3.

a.	b.	c.
		
6:5:4 in senario; 4th and (M) 3rd	8:6:5 in (extended) senario (Bk. 1, Ch. 16)	4th and (m) 3rd (Bk. 3, Ch. 21)

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Figures 4a and 4d distinguish the sixths as a minor third plus a fourth, or a fourth plus a minor third. Zarlino could have used this terminology, had he wished to. He could also have used the terminology that distinguishes Figure 4b from Figure 4e. 4b describes one sixth as the span from third to octave in some major-3rd authentic mode, mediated by the fifth of the mode. 4e describes the other minor sixth as the span from fifth to third in some minor-3rd authentic mode, mediated by the octave of the mode. Zarlino did not, of course, have at hand the terminology that enables us to describe 4c and 4f, where the two minor sixths are distinguished as third-to-octave of a major triad, or fifth-to-third of a minor triad. There are a variety of technical reasons why it would have been awkward for Zarlino to have distinguished two minor sixths as in 4ad, or as in 4be. More important is an overriding conceptual reason: for Zarlino, each consonance must exist as one abstract universal Platonic entity, before it is allowed to enter into a variety of contexts like those of Figure 4. So in particular "THE" minor sixth must exist, if we are to treat minor sixths as consonances.

Figure 4.

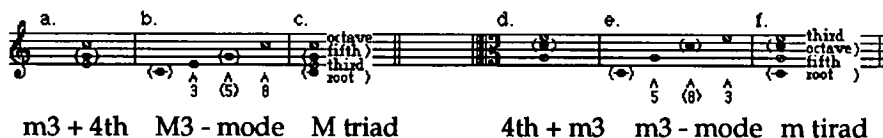
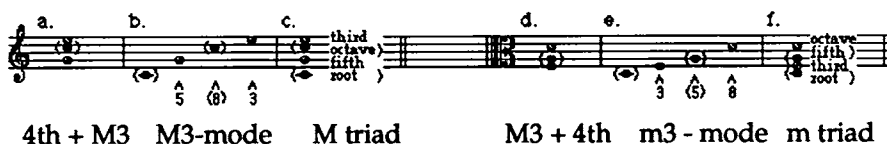


Figure 5 shows that the same critique can be applied to "THE" consonant major sixth, even though Zarlino has no technical problems with that interval. The distinction between two different major sixths is illustrated by the student's analysis of Figure 2. The student analyzed Figure 2a as "B-flat to G, that's G minor." This follows the model of Figure 5def. The student then tried to analyze Figure 2b according to the same model: "A to F-sharp, that's F-sharp minor." But this analysis is malformed in a way the other was not. Evidently the A-F-sharp leap of Figure 2b conforms to the model of Figure 5abc, not 5def. However the student was unable to say "A to F-sharp, that's 5-3 in D major." He couldn't say that precisely because he was trying to relate all the things he called minor sixths—that is, all the things we call major sixths—to minor modes and triads. Even sweeping up after the student, we still find the terms "minor" and "major" to be over-worked. And, perhaps yet more serious, the term "THE," when applied to "minor sixth" or "major sixth," is improperly restricting the pertinent conceptual sound world. To more fully explore that world you can ask yourself these questions: in what ways is Figure 5abc the analog of Figure

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4abc? And in what ways is Figure 5abc the analog of Figure 4def? Exploring those questions, you will soon hear the four consonant sixths interrelating conceptually among themselves in a very complex way.

Figure 5.

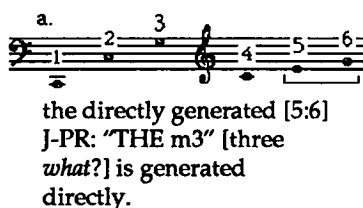


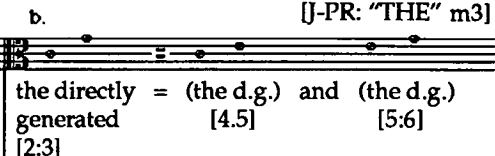
I call Figures 4 and 5 “consonant” sixths because I can imagine the analysis of (b), (c), (e), and (f) being applied, in a more modern context, to various “dissonant” sixths. A large dissonant sixth, for example, is spanned between the 4th degree and the 2nd degree of a major or minor scale. This sixth extends within a dominant seventh harmony, from the seventh of the harmony up to the fifth; it articulates naturally into an augmented fourth below plus a small third above. One hears the sixth when Tamino sings “wie noch kein Auge je gesehen,” following the motive of “Dies Bildnis ist bezaubernd schoen.” Other dissonant sixths, small and large, extend within dominant ninth harmonies, from the major or minor ninth of the harmony up to the seventh. Such a sixth is spanned from the 6th degree of its scale to the 4th degree, as divided by the 2nd degree.

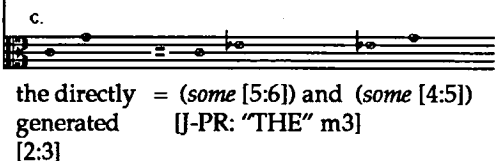
I pointed out earlier that “for Zarlino, each consonance must exist as one abstract . . . Platonic entity, before it is allowed to enter into a variety of contexts like those of Figure 4.” That involves what I shall call “the Platonic THE” of Zarlino’s locution, “THE minor sixth.” The world of music theory is full of such Platonic THEs, improperly constraining the discourse.

Figure 6 shows how a Platonic THE confuses Rameau’s discussion of “THE minor third” in the *Traité* (Book I, Chapter 3, Article 5). According to Rameau’s earlier discussions, the E-G dyad of Figure 6a should either be assigned a C root, or else no root at all. The same is true for the E-G dyad as it appears in Figure 6b. There is no reason to assign this E-G dyad the root E. On the other hand, we can intuit good common-sense reasons for assigning the C-E^b dyad of Figure 6c the root C. By confounding the two different theoretical dyads under one Platonic rubric, Rameau believes he is able to assert of something called “THE minor 3rd,” both that it is directly generated, like the E-G of figures 6ab, and that it has its lower note as a root, like the C-E^b of figure 6c.

Figure 6.

a. 

b. 

c. 

J-PR says that 6c may be derived from 6b, by intervallic "inversion," since both [4:5] and [5:6] are "thirds." [Three *what?* See Lewin, *GMIT*, Appendix A, esp. 246-247.]

Aristoxenus, who was born about the time of Plato's death, is already sensitive to the Platonic THE in music theory. He writes: "... the same notation is employed for the tetrachords hyperbolaion, neton, meson, and hypaton. Thus the signs fail to distinguish the functional differences, and consequently indicate the magnitudes of the intervals, and nothing more. But ... mere knowledge of magnitudes does not enlighten one as to the functions of the tetrachords, or of the notes, or the differences of the genera, ... or indeed anything else of the kind."⁶ Aristoxenus's specific critique is relevant to present-day discussions of "THE fourth," when we attempt to use that Platonic rubric to cover both the dyad G-C and the dyad C-F in the context of C tonicity.

Fétis may well have been sensitive to Aristoxenus's general critique, when, in the *Traité*, he presented his theory of 19th-century European tonality.⁷ Intervallic magnitudes, he asserts, do have specific fixed Platonic attributes. But so do the degrees of a given scale or mode. Composing in a key involves matching the Platonic characters of the vertical intervals above the bass, with the Platonic characters of the scale-degrees in the bass. A mismatch gives rise to modulation. Thus, to illustrate "THE perfect fourth" as a "natural interval," free from any tonal context, Fétis displays the dyad C-F.⁸ However, when "THE perfect fourth" is to be displayed as *consonant in the C major system*, Fétis represents it by the dyad G-C.⁹ In tonal music, the character of Fétis's Platonic fourth matches the character of his Platonic fifth degree in the bass, not his tonic degree. The Platonic charac-

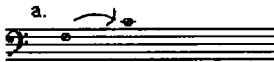
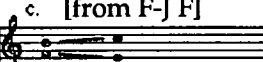
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ters that Fétis assigns his intervals and scale degrees seem to be his readings of cultural conventions.

I forgo discussing a host of technical and ideological problems with Fétis's system. The theory does respond to the problem that worried Aristoxenus; it provides a context in which vertical intervals of the same acoustic size can have a variety of functional meanings, depending on the scale-degrees over which they appear. But Fétis, when he assigns Platonic THEs to scale-degrees, still falls victim to the more general problem of Platonic rubrics.

Figures 7a,b, and c show that there are at least three different paradigmatic 4th degrees in C major, even restricting our attention to the bass. The descriptions that underlie the figures are mine. I see no reason why the 4th degree of Figure 7b can not be raised as well as pure. Fétis runs into conceptual difficulty when he tries to identify all three figures with one paradigmatic Platonic object, "THE 4th degree." The commentary under Figure 7 gives some sense of his troubles.

Figure 7.

a.	b.	c. [from F-J F]
		
"THE 4th deg." that lies a dominant interval below the tonic note in the bass.	"THE 4th deg." that prepares a cadential dominant in the bass.	"THE 4th deg." that neighbors scale degree 3.

FJF talks about *one* object called "THE 4th degree," that has *one* "character." This *caractère* "does not exclude the idea of momentary repose." [p. 15; FJF is hearing 7a, I think.] "But it may happen that the repose may not occur . . . so that the 3rd, the 5th, the 6th, and the octave can equally well accompany [i.e., sound above] this note." [pp. 15-16; FJF is hearing 7b, I think.] The augmented 4th, which is a consonance for FJF, may also accompany "THE 4th degree." FJF gives 7c as an example (p. 16). THE character of THE 4th degree is now getting pretty hard to grasp. The augmented fourth of 7c must obey its "appellative" character by continuing as shown, to the event it summons. Is the E of 7c then momentarily reposeful? No, for "THE tonal character of THE third degree [in the bass] is absolutely opposed to any sentiment of repose." [p. 20; as in 7c??] And so forth.

The citations are from Francois-Joseph Fétis, *Traité de l'harmonie*, 12th ed. (Paris: Braudus et Cie, 1879).

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In my article on phenomenology and music theory, I went so far as to challenge the Platonic THE in expressions like "THE B-flat in measure 12." I also challenged the word "IS" in statements like "THE harmony of measure 15 IS such-and-such."¹⁰ The issue in greatest generality might be termed "Hidden prior restraints in common linguistic conventions."

Let me turn now to the subject of music theory as a source for analytic metaphors. When we describe the ways in which musical sound seems conceptually structured, categorically prior to any one specific piece, we nevertheless intend our conceptual sound-worlds to be rich in potential metaphors for analyzing specific pieces. At least most of us do. Marion Guck and others have been drawing our attention for some time now to metaphorical discourse for music analysis.¹¹ But I think it is not generally appreciated how deeply and necessarily metaphorical a music theory becomes, when it is used as the basis for an analysis. The accent is on "necessarily." It is not a question of our intending metaphorical discourse or not, when we bring a theory to an analysis. We cannot help it. A spectacular example, to my mind, is afforded by the opening of Milton Babbitt's *Philomel*.

Figure 8a is an annotated short score and Figure 8b provides a row-matrix, both courtesy of Richard Swift.¹² The tape voice, which returns again and again to the pitch class E, sings vocalese on the vowel eeeeeee. Looking at measure 1 of Figure 8a, we see that the voice sings only the first note of row P0; the accompaniment provides the other eleven notes. In measure 2, the voice sings F-E, the first two notes of row P1; the accompaniment provides the other ten notes of P1. In measure 3 the voice sings E^b-D-E, the first 3 notes of row P11; the accompaniment provides the other nine notes of row P11. And so forth.

Figure 8b provides a theoretical construct that underlies the compositional procedure. The voice sings the first entry on the matrix, and the accompaniment finishes off the first row of the matrix. Then the voice sings the first two notes of the second matrix row, and the accompaniment finishes off the second row. Then the voice sings the first three notes of the third matrix row, and accompaniment finishes off the third row. And so forth.

Figure 8b suggests a metaphor: the pitch-class structure of the piece is a loom, and the tape voice enters this structure in the act of beginning to weave a tapestry. The metaphor is suggestive and powerful, because weaving a tapestry is a paradigmatic act for the mythic Philomel.

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In Ovid's story (*Metamorphoses*, Book VI), Philomel was raped by Tereus, the husband of her sister Procne. Tereus then cut out Philomel's tongue. But Philomel wove a tapestry depicting the outrage, and sent the tapestry to Procne. Procne understood the tapestry, killed the son she had borne to Tereus, and served the flesh to Tereus in a pie. The sisters fled through the woods of Thrace, pursued by Tereus. All three were magically transformed into various birds.

John Hollander's text for Babbitt's piece depicts only Philomel's transformation: the mute woman, rushing through the woods, becomes a night-ingale. But Hollander writes that he had earlier had a particular interest in the weaving scenes for a possible opera. The tapestry was to be replaced by a wild expressionist painting, but the literary idea was the same.¹³

Hollander's special interest in the weaving scenes echoes the view of Karl Philip Moritz, an 18th-century art historian and aesthetician. Figure 9 cites relevant material from Moritz; I shall put a few excerpts from my translation into the main text here.

As Moritz says of the tapestry, "the severed tongue spoke through the eloquent web. . . . nothing lay *closer* to the misfortune of the weeping innocent, nothing was so intimately connected with it, as just this laborious work of her hands. In that medium alone could she portray her being, and make known her sufferings." Just so, I claim, is Babbitt's Philomel speaking through the web of the serial matrix, through those painstakingly interwoven threads. Nothing lies *closer* to her than the laborious work of composing her piece, through Babbitt as a medium. In that manner alone can she portray her being, and make known her sufferings. To sing Babbitt's piece is to weave her tapestry.

Figure 10 cites Moritz again, talking later on about the narrative power of visual art. The entire citation applies as well, I think, to Babbitt's serial loom.

The metaphor works both ways, emphasizing that Philomel's loom is a metaphorical matrix. An English dictionary entry, under "matrix," begins: "That which contains and gives shape or form to anything, *Anat.* the womb."¹⁴ In literary classical Latin the word "matrix" means "mother" in the figurative sense, as a source or generator, as opposed to the literal sense used of the human female parent; however the anatomical sense of the word was increasing in medical and in vulgar usage, and was clearly in place by the time of the later Empire.¹⁵ Philomel's loom, as matrix, gives birth to her tapestry, the fruit of her horrible union with Tereus. Procne, reading and understanding the tapestry, denies her human parenthood, murdering her own biological son. The metaphor of Babbitt's matrix thus brings us into the heart of a sexual relationship between the two sisters.

Figure 8.

a. P_0 P_1 P_{11}

Tape Voice

Tape

P_0 P_1 P_{11}

P_3 P_3

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b.

		I											
TAPE	P	0	11	1	9	4	6	3	2	7	8	5	10
	voice	1	0	2	10	5	7	4	3	8	9	6	11
		11	10	0	8	3	5	2	1	6	7	4	9
		3	2	4	0	7	9	6	5	10	11	8	1
		8	7	9	5	0	2	11	10	3	4	1	6
		6	5	7	3	10	0	9	8	1	2	11	4
		9	8	10	6	1	3	0	11	4	5	2	7
		10	9	11	7	2	4	1	0	5	6	3	8
		5	4	6	2	9	11	8	7	0	1	10	3
		4	3	5	1	8	10	7	6	11	0	9	2
		7	6	8	4	11	1	10	9	2	3	0	5
		2	1	3	11	6	8	5	4	9	10	7	0

E= 0-diagonal

Figure 9.

Karl Philipp Moritz, Schriften zur Ästhetik und Poetik, ed. Hans Joachim Schrimpf (Tübingen: Max Niemayer Verlag, 1962).

DIE SIGNATUR DES SCHÖNEN / In wie fern Kunstwerke beschrieben werden können? (1978; pp. 93-103). My thanks to Reinhold Brinkmann for drawing this essay to my attention.

The double virgule (/ /) indicates a new paragraph.

Als *Philomele* ihrer Zunge beraubt war, webte die die Geschichte ihrer Leiden in ein Gewand, und schickte es ihrer Schwester, welche es aus einander hüllend, mit furchtbarem Stillschweigen, die gräßliche Erzählung las. // Die stummen Charactere sprachen lauter als Töne, die das Ohr erschüttern, weil schon ihr bloßes *Daseyn* von dem schändlichen Frevel zeugte, der sie veranlaßt hatte. // Die Beschreibung war hier mit dem Beschriebenen eins geworden—die abgelöste Zunge sprach durch das redende Gewebe. // Jeder mühsam eingewürkte Zug schrie laut um Rache, und machte bey der mitbeleidigten Schwester das mütterliche Herz zum Stein. // Keine rührende Schilderung aus dem Munde irgen eines Lebendigen, konnte so, wie dieser stumme Zeuge, wirken. // Denn nichts lag ja dem Unglück der weinenden Unschuld *näher*, und war so innig damit verwandt, als eben dieß mühsame Werk ihrer Hände, wodurch sie allein ihr *Daseyn* kund thun, und ihre Leiden offenbaren konnte. // Eben darum konnte es seiner schrecklichen Wirkung nicht verfehlen. (p. 93)

[When Philomel was robbed of her tongue, she wove the story of her sufferings into a tapestry, and sent it to her sister, who, unrolling it, read the grisly tale in frightful silence. The mute characters spoke louder than sounds assailing the ear, since their very *existence* bore witness to the despicable outrage that had been the cause of their production. Description, here, became as one with the thing described—the severed tongue spoke through the eloquent web. Every painstakingly interwoven thread cried aloud for revenge, and hardened to stone the maternal heart of the concurrently offended sister. No moving description from the mouth of any living person could have produced the effect made by this mute witness. For indeed nothing lay *closer* to the misfortune of the weeping innocent, nothing was so intimately connected with it, as just this laborious work of her hands. In that medium alone could she portray her being, and make known her sufferings. Exactly for that reason it could not fail to produce its horrible effect.]

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Figure 10.

... unsre ganze Aufmerksamkeit mehr auf die Beschreibung selbst, als auf die beschriebene Sache gezogen wird, die wir durch die Beschreibung nicht sowohl kennen lernen, als vielmehr sie in ihr *wieder erkennen* wollen. (Moritz, p. 99)

[...our entire attention is drawn more to the description itself, than to the things described. We do not so much come to know those things through their description; rather, through the description, we desire much more to *apprehend* the things [as if (? DL)] *once more*.]

This approach to the piece opens up a host of suggestive critical questions. Does the live singer weave the piece, like Philomel, while the audience listens like Procne? And does the singer, as weaving Philomel, imagine how Procne will respond when she hears the piece? Or does the singer, like Procne, read an already-created piece? The roles of the two sisters seem to interpenetrate in the live singer, weaving in and out, both telling and reading the story. Is the tape Philomel a different psychological level of the singer? Or is Philomel-on-the-tape an analog for Philomel-in-the-tapestry? Both tape and tapestry unroll, to tell their stories. It seems clear to me that there are elements of all these ideas in the drama, and that is one thing which makes the piece so theatrical. Since the taped voice is always Bethany Beardslee's, the issues are very keen for those of us who first heard Beardslee as the live singer, and are now hearing other sopranos in that role.

Figure 11a, to explore other theoretical metaphors, transcribes the main theme from the first movement of Schubert's G major quartet. Figures 11b through 11e provide my analysis using Schenkerian techniques and hence, Schenkerian metaphors. The analysis purports to show how the theme elaborates the structure of an underlying G major triad. The underlying triad is shown at level (e). The analytic method presumes that there IS such a phenomenon, and tells us how to go about constructing or reconstructing it. According to this presupposition, the G major at the end of the theme projects THE SAME (e)-level PHENOMENON as does the G major at the beginning of the theme. The end of the theme thereby metaphorically RETURNS to something from which it departed. More

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precisely, the end of the theme triggers a dialectic process whereby we can synthesize the ending and the beginning G majors into one higher level phenomenon, THE G major triad of level (e). Here, the term THE is perfectly correct. A special power of the system is that we can metaphorically identify the conceptual triad of level (e) with the acoustic signal that opens the quartet. An enormous structural significance can thereby be projected metaphorically by an almost instantaneous acoustic event.

Figure 11.

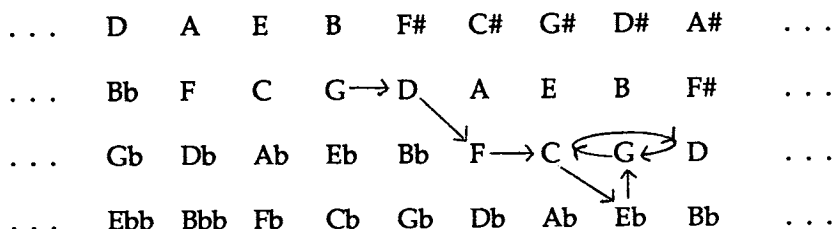
Figure 11 displays five systems of musical notation, labeled a through e, illustrating a dialectic process in music theory.

- System a:** Shows a melodic line starting at measure 15 (marked 'a. 15') and ending at measure 24 (marked '24'). The notation includes notes, rests, and a 'pp' (pianissimo) marking. A bracket labeled '(ext.)' spans measures 19 to 24.
- System b:** Shows a melodic line starting at measure 5 and ending at measure 1. The notation includes notes, rests, and a 'Zug 6-3' marking. A bracket labeled '4' spans measures 4 to 3.
- System c:** Shows a melodic line starting at measure 5 and ending at measure 1. The notation includes notes, rests, and a 'Zug 6-3' marking. A bracket labeled '4' spans measures 4 to 3.
- System d:** Shows a melodic line starting at measure 5 and ending at measure 1. The notation includes notes, rests, and a 'Zug 6-3' marking. A bracket labeled '4' spans measures 4 to 3.
- System e:** Shows a melodic line starting at measure 5 and ending at measure 1. The notation includes notes, rests, and a 'Zug 6-3' marking. A bracket labeled '4' spans measures 4 to 3.

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Figure 12 analyzes the theme as a journey on a map of chord or key relations promulgated by Hugo Riemann.¹⁶ A step east on the map moves the root of the harmony a fifth up; a step south moves the root a major third down. Even in equal temperament, the different G's on the map represent different conceptual places. Hence the theme, according to this theoretical metaphor, ends IN A DIFFERENT PLACE from where it began, rather than RETURNING to its beginning, or metaphorically projecting ONE higher-level phenomenon. We can even say that the theme MODULATES, from G-in-row-2 of the map, to G-in-row-3.

Figure 12.



The modulation is carried out by a repeating harmonic progression at the opening of the theme, a progression represented by a strong visual motif on the map-journey. The motif comprises a step east and then a step southeast. It projects a threat to wander off indefinitely east-by-southeast over the map, never centering around any tonic. Carl Dahlhaus feels the power of this metaphor when he writes that the progression from E-flat to G yanks the harmonic motif "forcefully back from its progression, or regression into the infinite."¹⁷ Dahlhaus is apparently not sensitive to the metaphorical modulation on Figure 12, when he hears the theme coming "back" to the final G on Figure 12. I think he is mixing metaphors; the idea that there is only ONE Hegelian G-major triad associated with the theme is strongly present in Figure 11, but just as strongly absent from Figure 12.

It would be the reverse sort of metaphor-mixing, to try to capture the Riemann motif on the Schenker sketch. Among other things, it would lead to excruciating contrapuntal fifths at the same level, as on Figure 13. Compare Figure 11b and c, where the structural upper voice descends in parallel sixths, not fifths, over the bass.

Figure 13.



Early on, I spoke of music theory as describing “a conceptually structured sound-world that was categorically prior to any particular musical event, score, or experience.” I should like now to show how immediately an abstract feature of the conceptual world can impinge upon practical musical performing experience. Figure 14 shows what Elizabeth West Marvin, in a strong and suggestive recent *Spectrum* article, calls a “dseg.”¹⁸ That is the numerical series <02113>.

Figure 14.

dseg class <02113> contains (for instance) the durational series



The dseg designates the class of all 5-event durational series whose first event is shortest, whose third and fourth events, of equal duration, are longer, whose second event is longer yet, and whose fifth event is the longest. A specimen durational series belonging to the dseg class is also shown in Figure 14.

If the first, third, and fifth events are extracted from any durational series in this dseg class, clearly the first event will be shortest, the third event next shortest, and the fifth event longest. The three-event subseries will then necessarily belong to dseg class <012>. The top half of Figure 15 shows such subseries for various durational series of dseg class <02113>; all the subseries are of class <012>, as they must be. Marvin, in her text, calls <012> here a “noncontiguous dsubseg” of <02113>, observing correctly that the notion is of very limited musical interest.

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Figure 15.

dseg class of noncontig. subser.			
noncontiguous subseries of <ord 1, ord 3, ord 5>			
durational series (each in dseg class <02113>)			
grouped partial summing as <ord(1+2), ord (3+4), ord 5>			
dseg class of partial sum series			

Marvin's pertinent musical example, however, confuses this notion with a notion of great musical interest, one I shall call a *grouped partial summing* from a given durational series. Given a five-note durational series, we can, for instance, construct one grouped partial summing by considering the sum of the first and second durations, then the sum of the third and fourth durations, and finally the fifth duration. The bottom half of Figure 15 shows these grouped partial summings for the various durational series of the figure. Even though all three five-note series are of the same dseg class, the grouped summings belong to different dseg classes.

The bottom row of Figure 15 thus *refines* the rhythmic contour description of the three five-event series. Indeed by means of the bottom row we can *distinguish* each series from the others. Even though all are in the same five-event dseg class, they are in distinct three-event dseg-classes as regards the partial sum series formed under the indicated grouping.

Similarly, the various 3-event series of Figure 16 can be distinguished, not by their overall dseg classes, which are all the same, but by the various dseg classes of their partial sum series formed under the indicated group-

ing. This can be a very practical aid to a performer, and not just a performer of recent music. Figure 16 suggests that, to get the dotted figure of column B precise, you can imagine it as if in 6/8 meter or Franconian third mode, and then check that the two parts of the gesture feel of equal duration. If the latter part of the gesture feels too long, you are erring in the direction of column A; lengthen your dot. If the latter part of the gesture feels too short, you are erring in the direction of column C; shorten your dot.¹⁹

Figure 16.

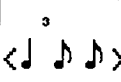
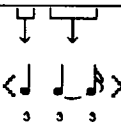
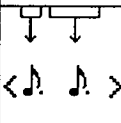
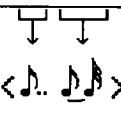
	A	B	C
durational series (each in dseg class <201>)			
grouped partial summing as <ord 1, ord (2 + 3)>			
dseg class of part. sum series	<01>	<00>	<10>

Figure 17 applies the theory to a very specific practical problem, that of performing the opening measure from Stockhausen's first piano piece. The music is given in Figure 17a. Figure 17b gives a pertinent mensural series, assigning a unit duration to the opening note of the music. Figure 17c gives the dseg which pertains to figure 17b. 17c does not give us much help in preparing a performance.

But partial sum groupings do. Figure 17d shows a grouping indicated by the composer's notation: the duration of the entire septuplet grouping is equal to the duration of the preceding low E^b and F combined. Figure 17e gives the mensural series <1,5,5> into which the measure is thereby articulated. Figure 17f gives the dseg class of that gesture, <011>: something shorter is followed by two instances of something longer.

Figure 17e projects a large rhythmic feeling for the measure but is too coarse; figure 17b is accurate but too fussy. A very useful intermediate grouping of partial sums can be found in figure 17g; the mensural series of sums is given by Figure 17h. Figure 17h renotates the sums for easier comparison. The fourth number of 17h' is a bit more than the third; the fifth

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number is a bit less than the second. Figure 17h" tries to capture the idea by using the symbols alpha, beta, beta-plus, and alpha-minus; here alpha and beta sum to 5; so do beta-plus and alpha-minus.

Figure 17i gives a dseg for 17h, modified according to some ideas of Larry Polansky.²⁰ Here "1 plus" signifies that the fourth duration is about equal to the third, but just a bit longer. The modified dseg interprets the music as a short event, followed by a long event, followed by an event of middle length, followed by a slightly elongated middle-length event and a slightly abbreviated long event. Figure 17j fleshes out the idea. Here, tempo 2 should be chosen so that beta-plus feels like a slightly ritarded beta-span, while alpha-minus feels like a slightly accelerated alpha-span, as it were "going into" the barline of measure 2. We can have those feelings even though written eighth equals written eighth throughout tempo 2.

Figures 17g through j explore only one grouped partial summing, one from among many theoretically available groupings. The particular grouping of 17j interacts strongly with the pedaling and with the hexachordal structure of measure 1, a structure that carries on into the piece as a whole.

So the apparently austere machinery of the conceptual a priori theory impinges upon this specific musical experience so as to engage notions of musical grouping, of feeling a bit shorter, of feeling slightly accelerated, going into the barline, and so forth. And yet the partial sums were indeed, as my harmony student said, "just theory." We theorists know from experience how to tolerate the sarcasm of that remark, but we shall also feel some professional pride in the honor it implicitly confers upon us.

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Figure 17.

a.



b. < 1 3 2 (5/7) (5/7) (5/7) (15/14) (5/14) (5/7) (5/7) >

c. <2541113011>

d. < 1 3 2 | everything else | >

e. < 1 5 | 5 | >

f. <011>

g. < 1 3 2 (5/7) (5/7) (5/7) (15/14) (5/14) (5/7) (5/7) >

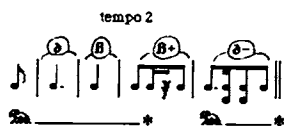
h. < 1 3 2 3 X (5/7) 4 X (5/7) >

h'. < 1 (21/7) (14/7) (15/7) (20/7) >

h''. < 1 ∂ β β^+ ∂^- >

i. < 0 2 1 1+ 2- >

j.



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NOTES

¹David Lewin, "Behind the Beyond, A Response to Edward T. Cone," *Perspectives of New Music* 7.2 (Spring-Summer 1969): 59-72. The quoted material is on page 61.

²*Idem*, *Generalized Musical Intervals and Transformations* (New Haven: Yale University Press, 1987).

³Gioseffo Zarlino, *Institutioni harmoniche*, 2nd ed. (Venice: Senese, 1573). Facsimile reproduction (Ridgewood, N.J.: Gregg Press, 1966).

⁴*Ibid.*, book 1, chapter 16 (p. 33). "Mezzano termino harmonico" COULD simply mean a whole number lying between 8 and 5. Coming where it does, though, the expression seems arch if not tendentious. It recalls the same expression, used to describe the "mezzano termino harmonico" 5 that lies between 6 and 4. In that context, we are surely to understand the "mezzano termino harmonico" as a "harmonic mean."

⁵*Ibid.*, book 3, chapter 21. "sono composte . . . della Diatesseron et del Ditono, over del Semiditono; . . ." (p. 131).

⁶Oliver Strunk, *Source Readings in Music History* (New York: W. W. Norton & Company, Inc., 1950), 30-31.

⁷Francois-Joseph Fétis, *Traité de l'harmonie*, 12th ed. (Paris: Braudus et Cie, 1879).

⁸*Ibid.*, table "des intervalles naturels," p. 6.

⁹*Ibid.*, table "des intervalles consonants," p. 9.

¹⁰David Lewin, "Music Theory, Phenomenology, and Modes of Perception," *Music Perception* 3.4 (Summer 1986): 327-92.

¹¹Marion Guck's key article is "Musical Images as Musical Thoughts: The Contribution of Metaphor to Analysis," *In Theory Only* 5.5 (June 1981): 29-42.

¹²Richard Swift, "Some Aspects of Aggregate Composition," *Perspectives of New Music* 14.2/15.1 (1976): 236-48. The score and matrix are on pages 242-43.

¹³John Hollander, *Vision and Resonance*, 2nd ed. (New Haven: Yale University Press, 1985), 294-97.

¹⁴Funk & Wagnall's, *Standard Universal Dictionary* (New York: Garden City Publishing Co., Inc., 1946), 491.

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¹⁵J. N. Adams, *The Latin Sexual Vocabulary*, Paperbacks edition (Baltimore: The Johns Hopkins University Press, 1990), 105-08.

¹⁶Hugo Riemann, *Grosse Kompositionslehre*, vol. 1 (Berlin and Stuttgart: W. Spemann, 1902), 479.

¹⁷Carl Dahlhaus, "Sonata Form in Schubert," trans. Thilo Reinhard, in *Schubert, Critical and Analytical Studies*, ed. Walter Frisch (Lincoln: University of Nebraska Press, 1986), 10.

¹⁸Elizabeth West Marvin, "The Perception of Rhythm in Non-Tonal Music," *Music Theory Spectrum* 13.1 (Spring 1991): 61-78.

¹⁹The eighth-note duration of figure 14 is crucial here, not just the preceding long-short pattern. For that reason Marvin's footnote 13 is not directly engaged, though it is interesting in this context.

²⁰Larry Polansky, "Possible and Impossible Melody: Some Formal Aspects of Contour," lecture at the meeting of the Society for Music Theory in Oakland, CA, November 11, 1990.

ANALYSIS AND PERFORMANCE OF THE FLUTE SONATAS OF J.S.BACH: A SAMPLE LESSON PLAN

CYNTHIA FOLIO

INTRODUCTION

A recent article by Janet Schmalfeldt closed with an appeal to performers and analysts for greater commitment toward a liaison based upon an increased understanding of shared and separate tasks.¹ Some books and articles listed in the bibliography (at the end of this essay) have taken important steps toward that liaison, most notably those by Cone (1968) and Berry (1989). But because of the tenuous relationship between analysis and performance, this very interesting subject is often ignored. The study of how interpretive decision follows the analysis of form and structure remains subsidiary to other interests of music theorists and performers. One reason *performers* tend to avoid making connections between analysis and interpretation is that many of them view theory as a dull and somewhat abstract exercise; some are even afraid of theory, with memories of unsuccessful experiences in their classes. One reason *theorists* avoid this area of study is the fear of having to make subjective decisions. As Schmalfeldt emphasizes in the above-mentioned article, there is no single, one-and-only performance decision that can be dictated by an analytic observation. This makes study in this area exciting, but a little dangerous.

In this presentation, I propose to offer some practical suggestions on the subject of analysis and performance, much of which can be implemented in the theory class. The first part of the essay shares sample assignments and class projects and offers an introduction to the topic of analysis and performance. Then, it presents a sample lesson in the form of a lecture/performance that demonstrates the direct application of analysis to interpretation in several of Bach's flute sonatas.² A bibliography of books and articles on the subject is provided at the end of the essay.³

Most theory teachers have had the experience, at least once, of hearing the question from a skeptical student: "but what does all of this have to do with music?" In the midst of mastering the fundamentals and learning the

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terminology, the relevance of music theory often eludes the student. Our task is made more difficult if the students' private instructors fail to make any references in lessons to historical or theoretical issues. So it becomes our responsibility to suggest to students the important connection between theory, music history, and performance. The following is a sample list of assignments and class projects I have used to encourage students to apply what is learned in theory class to their own practicing and listening:

1. Assignment: Find an example of _____ in the literature for your own instrument or voice.
 - a. Certain forms—binary, ternary, sonata, rondo, theme & variations.
 - b. Certain chromatic chords—N6, Aug6, mode-mixture chords, etc.
 - c. Certain compositional techniques—sequence, development of rhythm/pitch motives.
2. Assignment: Write a composition in the style of _____, to be performed in class. A few measures in a particular texture, or a complete melody could be given to get them started. A composition in "Mozart style" not only provides a welcome relief from the SATB assignments, but also seems more closely related to their performance repertoire.
3. Class: After analysis of a passage, ask the student how the knowledge gained might affect the performance of that passage.
4. Class: Play several different recordings of a piece or passage studied in class and ask them to evaluate and compare, based on information acquired through analysis.
5. Class: In general, include live performances in class whenever possible, either on the student's major instrument or at the piano;⁴ also have the class sing whenever there is an opportunity.
6. Class: Ask students to bring their instrument to class and hold a masterclass on a piece studied in class; ask the students to contribute ideas toward interpretation and have the instrumentalist try different solutions.

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BERRY'S QUESTIONS

As Berry points out, there are only two broad categories in which a performer has interpretive choice: these are in matters of tempo and articulation.⁵ Within these broad categories, however, are many complex and subtle choices that a performer makes. "Tempo" of course includes acceleration and deceleration (i.e., rubato), while "articulation" includes all adjustments of individual events: dynamics, duration, color, and such idiomatic techniques as pedalling, vibrato, and bowing. Berry also discusses twelve questions that arise in relating analysis to performance and that deal with specific issues that affect the performer's decisions:⁶

1. What note do I play?
2. Assuming I do not get in its way, is the motive self-evident, or does it require some deliberate projection?
3. What about dynamic inflection where none is indicated?
4. Are there not times when deliberate effort is needed to convey the sense of a significant, not necessarily explicit, voice-leading connection?
5. Performance decisions are elucidated at critical times by analytical awareness of place in a formal process.
6. What decisions concerning groupings of events may reasonably follow from the analysis of form and structure?
7. Where a texture may be interestingly complicated by an implicit, relatively disguised imitation, is it possible and desirable for the performer to communicate this?
8. How about the critical issue of tempo in its fundamental, "metronomic" aspect?
9. This question concerns concepts of surface metric fluctuation and primary metric downbeat.
10. Is there anything the performer can or should do about a piece's broadest tonal (background) structure?

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11. Where music is used descriptively, as often in text settings, how do analytical findings concerning descriptive elements condition interpretation?
12. Does not a probing, just analysis reveal to the performer an attitude appropriate to the character of a piece?

Number 10 above represents an often-asked question in a class that introduces Schenkerian principles. Rothstein reveals Schenker's attitude by pointing out that Schenker did not believe that the tones of highest structural significance in a composition are to be given any special emphasis as a general rule. In fact, sometimes just the opposite is the case, and the structural tones are actually to be underplayed.⁷ The subtle relation between the tonal background and performance, however, is an important one, as Berry suggests in the following statement: "The details of an interpretation are conditioned by a grasp of broad lines and of whole. This is a most critical point of relation between analysis and performance, between the cognizance of large-scale structural functions and continuities and reasoned decisions of interpretation."⁸

SAMPLE LESSON

Keeping some of these preliminary questions in mind, I will now turn to the analysis and performance of several excerpts from J.S. Bach's flute sonatas. This presentation could serve as a sample lesson for an advanced theory class, a class in analysis and performance, or Schenkerian analysis.⁹ Some of the analytical decisions lie on the surface and are easy to understand and interpret, such as the recognition of appoggiaturas, sequences, cadences, and rising and falling step progressions. But the more interesting analysis occurs on a deeper level—discovering hidden lines, motivic and structural connections, and hidden repetitions.

Figure 1 is the first page in Bach's manuscript of the Partita in A minor for solo flute. The two circled areas, from measure 17 and measure 41, represent parallel passages in parts one and two of the binary form, but present a problem for the performer—namely, Berry's question #1, "what note do I play?" The F-sharp in the first part is inconsistent with the B-flat in the second part. Does Bach mean to vary the harmony the second time around? Or did he neglect to cancel the F-sharp in measure 17? Or is the B-flat a mistake? Given the fact that Bach is consistent in this MS in canceling

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out accidentals when they appear earlier in the bar, the F-sharp could very well be intended. So we are left with a decision that might better be solved through analysis. Figure 2a is a copy of the two passages in question from the complete works edition; notice that this editor has "corrected" the F-sharp to make it match the B-flat.

My analysis below (Figure 2b) shows two possible ways of viewing the passage in measure 17 (both using the F-natural), based on two different phrasings.¹⁰ Both analyses reveal a series of tonicizations, including a V⁷ of N⁶. Both, however, have problems in my opinion: in the first, the F-natural disrupts the series of falling minor thirds (an F-sharp would maintain the sequence); the second phrasing disrupts the pattern of dominant sevenths to introduce an It+⁶ of I. An F-sharp would substitute the diatonic II for the Neapolitan and continue with a V⁷ onto I. However interesting the F-natural may be, I prefer the sound of the F-sharp (and the corresponding B-natural in bar 41).¹¹ Whatever conclusion the performer reaches, at least the analysis could be helpful in making an informed decision.¹²

The last movement of the B minor sonata is divided into two seemingly unrelated parts, separated by a half cadence. (The beginning of each part is shown in Figure 3a, with an analysis in 3b.) The first part is in cut time; the second part is in 12/16 and differs in texture, character, and thematic material. But a number of subtle relationships exist between the beginnings of each part, linking the two sections. The first seven notes of the flute melody in the second part are all taken (in order) from the first part; the upper line of the compound melody outlines scale degrees 6-5-4-3-2 in the first phrase of the first theme and the second phrase of the second; and the circled notes also reverse roles and reverse direction.

This technique of linking is similar to Bach's technique of inverting the opening motive in the second half of his gigues. The contrasting meters of the two parts, however, are reminiscent of the dance pair, such as Allemande/Courante or Pavanne/Galliard. In addition to the melodic connections, the two passages share a similar harmonic progression.¹³ To underscore the connection, the performer should try to make the compound melody clear, especially by connecting the line from G to C-sharp. Another suggestion is to diminuendo when the line descends and crescendo when the line ascends. Although this is an obvious intuitive response, a deliberate exaggeration of the dynamics results in a clear reversal of the diminuendo/crescendo pattern, thus reflecting the reversal of the theme. Another implication for interpretation relates to tempo: because of the connections between the two parts, it is imperative they share a common pulse, so the half-note in part one is equal to the dotted-eighth in part two.

Figure 1.



Teil des 1. Satzes der Partita BWV 1013. Abschrift (BB Mus. ms. Bach P 968, Bl. 18^v).
Originalgröße: 31 x 26,5 cm

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Figure 2.

a.

Allegro

Flauto traverso

17

F#?

41

Bb?

b.

6 2 6 2 6 2 6 2 6

e: V V IV V III V V V I IV ...

6 2 6 2 6 2 6 +6 6

e: V V IV V III V N Ital. I IV ...

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Figure 3. J. S. Bach: Sonata in B minor (BWV 1030)—last movement.

a. **Part I**

Presto

A musical score for a piece titled 'Presto'. The score is written for two staves, both in treble clef. The key signature is one sharp (F#), and the time signature is 4/4. The tempo is indicated by the word 'Presto' in a bold, italicized font. The music consists of a series of eighth and sixteenth notes, with some measures containing rests. The notation is in a standard musical font, with a clear and legible layout.

Part II

84

Handwritten musical score for 'The Rose Tree'. The score is written on three staves (treble, alto, and bass clefs) in G major (one sharp) and 3/4 time. The melody is in the treble staff, with the alto and bass staves providing harmonic accompaniment. The piece is marked with a 'C' time signature and a key signature of one sharp (F#). The score includes a repeat sign at the beginning and a double bar line at the end. The tempo is marked 'Allegretto'.

b. Part I

Part II

The musical notation for Part II is shown on a single staff. It begins with a treble clef, a key signature of one sharp (F#), and a 12/8 time signature. The melody consists of several measures, with some notes circled and connected by lines to the corresponding notes in the Part I staff above. The notation includes eighth and sixteenth notes, as well as rests.

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E-MAJOR SONATA

The last part of this essay is devoted to a more extensive analysis of the first movement of the E-major Sonata. Figure 4 summarizes some of the surface features, by making an analytic point (on the left) and then suggesting possible implications for performance (on the right). Figure 5 offers more detailed observations (that come from further analysis) and their implications for performance. Many of these performance suggestions from Figures 4 and 5 are translated directly into markings on the music (Figure 6).

I'd like to point out that it was the "surface" foreground events that initially inspired me to examine the piece more closely, confident that more detailed analysis would uncover more subtleties relevant to performance. This led to a graph of the piece (see Figure 7a, 7b, and 7c—foreground, middleground, and background, respectively).¹⁴ The reader is encouraged to compare the observations from Figures 4 and 5 with both the music (Figure 6) and the graphs (Figure 7).

The excerpts in Figure 8 illustrate several of the details in Figures 4 and 5 and should be performed in class. Figure 8a takes the first two measures and shows the skeletal arpeggiation of I and V, and marks the double-neighbor figure, marked "DN." As suggested in Figures 4 and 5, the top notes of this arpeggiation should be brought out, either through dynamics, vibrato, or a slight tenuto on the DN motive.

Figure 8b isolates the parallel tenths in measures 6-7 through a simple rhythmic reduction. A comparison between this "skeleton" and the actual music makes the parallel tenths (and the performance suggestions in Figure 4) fairly clear.

Figure 8c illustrates how the V⁷-I at the beginning of the B section (measure 9) reverses the direction of the opening two measures. It also reveals a subtle motivic connection between the flute and continuo line (see first item in Figure 5). The performance suggestions include: 1) the flute and continuo should be aware of the arpeggiation of the chord (perhaps reversing the dynamics of the opening); and 2) flute and continuo should match color, dynamics, articulation, to make the motivic connection apparent.

Figures 8d and 8e show more motivic connections between flute and continuo. In 8d the flute's rhythm is substantially altered from the continuo's but the notes are exact (5-7 over an E dominant-seventh chord). Note that both flute and continuo arrive on the root (E), but the continuo fills the leap with melodic diminution. In 8e, the flute and continuo take turns outlining the V chord; the flute literally "spills" into the continuo line.

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Figure 4. Surface Analysis and Performance Implications.

<u>Surface Features</u>	<u>Performance Implications</u>
Form = A B Coda cadence in V (m. 8)/3-2-1 cadence in I (m. 17)/3-2-1	new section: pause; contrasting dynamic slight rall. at cadence slight rall. at cadence
1st 2 bars/ arpeggiation of I and V chords	bring out chord outlines, especially G#-F#-A-G# (top notes)
eighth-note appoggiatura figure	emphasis on dissonance/dim. to resol.
rising bass (to m. 5) deceptive cadence	cresc./accel toward cadence relax at deceptive cadence
parallel 10ths (m. 6-7) step prg. in flute (m. 6-7; 15-16) high point in flute at m. 7	tenuto on 10ths; cresc. emphasize B-C#-D# in flute cresc. toward D#; linger on D#
beginning of B section (m. 9) V7-I reverses I-V of m. 1-2 inverts outline of V7	contrasting dynamic (p) & color bring out outline of chords
sequence up by step (m. 9-10 = 11-12)	increase intensity 2nd time
falling 10ths (m. 13-16)	bring out 10ths; diminuendo
Coda; "surprise" C-nat. (m. 18) again F-nat. (m. 19)	softer dynamic; "pale" color; slight pause before C & F
high point in flute (m. 19) resolves D# L. T. from m. 7	cresc. to E; linger on E (enjoy the view!)
General: motive of rising 3rd (and occasionally falling 3rd) also appears in continuo part many times [bracketed]	emphasize motive; cresc. through 3rd

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Figure 5. Detailed Analysis and Performance Implications.

<u>Subtle Features</u>	<u>Performance Implications</u>
motivic connections btwn. flute/cont.	play slightly louder; match color/articulation
prevalence of rising-3rd motive: G#-A#-B (m. 4-5; 5-6; 6-7; 11- 13; 16); E-F#-G# (m. 5-6; 15)	(same as above)
double neighbor motive ("DN") fgd: m. 3, 4, 5, 10, 12, 13, 14 (see fig. 6) mgd: m. 1-2; 3-4 (fig. 7a) bgd: m. 1-9; 14-16 (fig. 7b)	tenuto on the DN
grace note in continuo (m.4): triad motive; also relates to fl and is part of DN in continuo	play it (with conviction)
grace note in fl (m. 7) = continuation of E-D# motive	emphasize; place ON beat
ascending lines/reaching over m. 4-5 par 10ths (8ve transfer)	cresc.; bring out lines connect G#-A#-B thru dynamics, color, intensity; slight accel to bt. 3 of m. 4 & bt. 1 of m.5
m. 9-12: series of 5-7/4-3	cresc. from 5-7; dim. from 4-3
parallel 10ths in m. 13-16 are interrupted by another 3rd progression in contrary motion	dim. on last beat m. 14; slight rall. sub. p on 1st beat of m. 15: "negative accent" (created by softness rather than force; dynamic stress in m. 16 ("arrival"))
<u>Coda</u> : completes registral space: high point E (resolves D#) end reaches low E (from m. 10) beg. (inner voice) B from m. 1 and m. 8 rising 3rd motive; 8-1 progression	match color from m. 7 (D#) match color from m. 10 (E) match color from m. 1; slight pause before entrance to highlight connection bring out 8-7-6-5-4-3-2-1 (last 2 measures)

Figure 6.

Adagio ma non tanto

Flauto traverso

Continuo

Devote Neighbor (DN)

(mf)

6

6

6

5

6 5 4

DN

DN

cresc.

play grace note

E10 D#

(rall.)

(n) 3 cresc.

L rall.

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Handwritten musical score, first system. The notation includes a treble and bass staff. The treble staff features a melodic line with a trill (tr.) and a fermata. The bass staff includes a triplet of eighth notes and a sixteenth-note triplet. Performance markings include "E to D tr" with an arrow, "cw" (crescendo), "(f)" (forte), and "(fall)" (decrescendo). Fingering numbers 7, 5, 6, 9, 8, 3, 4, 3, 5, 6 are present.

Handwritten musical score, second system. The notation includes a treble and bass staff. The treble staff features a melodic line with a trill (tr.) and a fermata. The bass staff includes a triplet of eighth notes and a sixteenth-note triplet. Performance markings include "(color)" (coloratura), "4-3", "5-7", "mf" (mezzo-forte), "DN" (diminuendo), "(p)" (piano), "mp" (mezzo-piano), "3 mt" (three measures), and "(accel)" (accelerando). Fingering numbers 9, 5, 7, 4, 3, 3, 4, 6, 4, 3, 2 are present.

Handwritten musical score, third system. The notation includes a treble and bass staff. The treble staff features a melodic line with a trill (tr.) and a fermata. The bass staff includes a triplet of eighth notes and a sixteenth-note triplet. Performance markings include "(color)" (coloratura), "tr." (trill), "DN" (diminuendo), "(mf)" (mezzo-forte), "cresc." (crescendo), and "6-5". Fingering numbers 11, 6, 5, 4, 4, 6, 5, 7, 6, 7, 6 are present.

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Figure 6. (con't)



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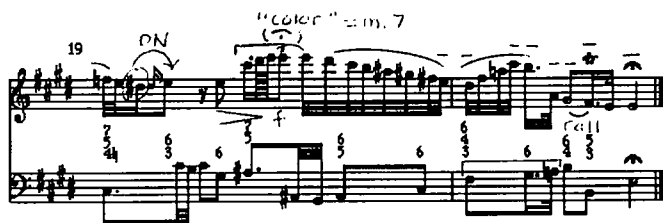


Figure 8f shows the DN at two levels—as an ornamental figure in the flute and as a longer rhythmic figure in the continuo. Also, both flute and continuo arpeggiate the V, but the flute motive is nested within the continuo's. As pointed out in Figure 5, an important implication for performance is that the F-sharp grace note in the continuo line should be played (with conviction!); many recorded performances omit this grace note, perhaps viewing it as a superfluous ornament.

Figure 8g is a rhythmic reduction of measures 4-6, in which the parallel tenths are more hidden because of register transfer and the constant reaching over. Since the tenths outline a rising line, a crescendo and acceleration are recommended in Figure 5. A further recommendation is to hesitate slightly on the three 4-3 suspensions; this would not only compensate for the accelerations, but also bring out the voice-leading connections and allow the performer to linger on the dissonances. Again the "skeleton" should be performed and compared with the original passage.

Figure 8h is a rhythmic reduction of the flute line from the opening of the B section, illustrating the sequence of 5-7/4-3. The recommendation is to crescendo on the 5-7's and diminuendo on the 4-3's. Rothstein points out that Schenker's editorial markings were most consistent when the seventh of a V⁷ harmony is approached from the fifth of the same harmony; such a motion almost always receives a crescendo.¹⁵ The diminuendo on the 4-3 suspension is in accord with the well-known practice of emphasizing the dissonance in relation to the resolution.

One of the most interesting passages in this sonata movement is sketched in Figure 8i: the descending parallel tenths originating in measure 13-14 are suddenly interrupted by another third-progression (also in parallel tenths) from below. This requires a "negative accent" (an accent created by special softness rather than by added force) at the point of interruption, and a dynamic stress in measure 16, at the point of arrival (see Figure 5). Note that this "interruption" occurs because the D-sharp in the continuo part (measure 14) is not allowed to resolve to E, but instead introduces B-sharp, resolving to C-sharp. The two contrary third-progressions converge on the E/G-sharp of measure 16, making this arrival especially strong.

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Figure 7.

a.

A

3 5 7

10-10 10-10 10-10 10-10 10-10 10-10 10-10 10-10 10-10 10-10

Double-Neighbor Double-Neighbor (Dec. cad)

B

9 13

5-7 4-3 5-7 4-3 5-7 4-3 5-7 4-3 10 10 10-10

Expected Resolution is

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16 3 2 1 CODA 18 (m. 7)

10)

delayed

b.

c.

3 (cf. m. 1) N 3 2 1 3 3 2 1

delayed

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Figure 8.

a. m. 1 (flute)



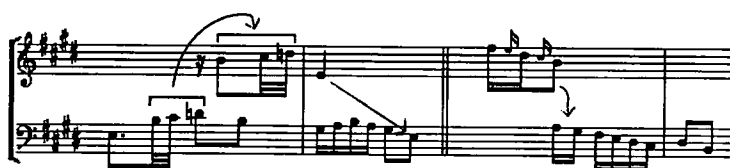
b. m. 6-7

c. m. 9



d. m. 9

e. m. 1



f. m. 3



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g. m. 4



h. m. 9-12



i. m. 13-16



Bach's short coda is filled with interesting details that can be enhanced by the performer, beginning with the "surprise" C-natural in the flute (m. 19). This C is not only a dissonant neighbor note on the local level, but could also be heard as a neighbor to the B from the opening. It is also in the coda that the flute reaches the highest note of the movement, "resolving" the previous high point—leading-tone D-sharp—from measure 7. The lowest point (E) is also restated in the last few measures, in which scale degrees 8 to 1 are outlined, filling out the entire two-octave registral space of the movement.

Several performance implications arise from knowledge of the "broadest tonal structure" of the piece as well (see Figure 7). The overall motion of I to V in the first section and V to I in the second part suggest a kind of

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background double-neighbor figure (see Figure 7c). The interruption and arrival in measure 16 (discussed above) is followed by a quick descent of the fundamental line in measure 17. The four graphed levels also make clear several hidden repetitions (most of which are bracketed), especially the DN motive and the rising third motive. The graphs also point out voice-leading connections and motivic relationships between flute and continuo—awareness of which should result in a more cohesive performance.

SUMMARY

The suggestions above are offered only as a step to further thought and discussion. It is important to be flexible in recommending performance suggestions in class, encouraging other ideas (even conflicting ones) from the students. The point is not that every analytical detail suggests one-and-only-one interpretation, but that the analysis gives rise to many possible implications from which the performer can choose.

It is this choice among possibilities that can generate lively discussions, even debates, in the classroom. Such exchanges are proof that theory is not cold, scientific, and objective, but relevant and very much alive. As students become aware of the connections between analysis and performance, they not only become more interested in the subject of music theory, they also begin to approach performing and listening more actively.

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NOTES

¹Janet Schmalfeldt, "On the Relation of Analysis to Performance: Beethoven's Bagatelles Op. 126, Nos. 2 and 5," *Journal of Music Theory* 29/1 (1985): 31.

²This paper was presented at the 1990 joint meeting of the Texas Society of Music Theory and the South Central Society of Music Theory, as well as the 1991 meeting of the College Music Society. Both presentations concluded with a complete performance of the first movement of Bach's Sonata in E major for flute and continuo.

³To keep the scope of the bibliography more focused, I have omitted (or weakly represented) two areas that could be viewed as related to analysis and performance: 1) writings on performance practice; and 2) citations by "classical" theorists, such as Riemann and Matthey.

⁴For example, after an assignment in which they write out a simple realization of a figured bass for violin and keyboard, have a violinist in the class play the melody, a cellist play the bass line, and the student play the right hand or both hands of the realization. Upon trying this in my sophomore theory class, one "non-pianist" exclaimed, as he struggled through his realization, that this was one of the few opportunities he had to play chamber music!

⁵Wallace Berry, *Musical Structure and Musical Performance*, p. 3.

⁶This chart is a summary of chapter 2 (pp. 7-44) of *Musical Structure and Musical Performance*.

⁷William Rothstein, "Heinrich Schenker as an Interpreter of Beethoven's Piano Sonatas," *19th Century Music* 8 (1984): 14.

⁸Wallace Berry, *Musical Structure and Musical Performance*, p. 65.

⁹I have used parts of this presentation in a graduate Schenker class (consisting mostly of performance majors) with positive response from students.

¹⁰The first phrasing groups the four beamed sixteenth notes into 2+2; the second (which corresponds more to the phrasing throughout the piece) assumes groups of 1+3.

¹¹This passage brings up the important suggestion that intuition plays a large role, not only in decisions about performance, but also about analysis. In this matter of the value of intuition in analysis and performance, I disagree with Berry, who leads us to believe that only rational decisions can form the basis for meaningful performance. For a discussion of this topic, see the Larson/Folio review of Berry's *Musical Structure and Performance*.

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¹²This passage has been the subject of several debates in the *Flutist Quarterly* (the official magazine of the National Flute Association). See especially, Richard Trombley's Letter to the Editor, "A Cause for Reasonable Doubt," *Flutist Quarterly* XI/3 (Spring 1986): 5-8.

¹³I would like to thank Lynn Rogers for bringing this to my attention and for contributing several editorial suggestions to an early draft of this paper.

¹⁴I want to thank Steve Larson for his assistance in the analysis of this movement; also some of his ideas have influenced aspects of this essay in intangible ways because of our many conversations on the topic of analysis and performance. When I started graphing the piece I began to feel uncomfortable with my initial choice of 3-2-1 as background structure, because of the many ascents through A# to B. Steve and I both noted, however, that our "background" decision of 3-line versus 5-line does not affect specific aspects of interpretation as much as the analysis of foreground and middleground events.

¹⁵Rothstein.

BIBLIOGRAPHY

Atlas, Raphael. "Spelling in Early 19th-Century Piano Music: A Guide to Performance." *Journal of Music Research* 10/3-4 (1991): 199-255.

Barra, Donald. *The Dynamic Performance: Guide to Musical Expression and Interpretation*. Englewood Cliffs, N.J.: Prentice-Hall, 1982.

Beach, David. "The first Movement of Mozart's Piano Sonata in A minor, K. 310: Some Thoughts on Structure and Performance." *The Journal of Musicological Research* 7/2-3 (1987).

Berry, Wallace. "Formal Process and Performance in the Eroica Introductions," *Music Theory Spectrum* 10 (1988): 3-18.

_____. *Musical Structure and Performance*. New Haven: Yale University Press, 1989. Reviewed by Rink in *Music Analysis* 9/3 (1990): 319-39; Clarke in *Music and Letters* 72 (1991): 86-8; Larson/Folio in *Journal of Music Theory* 35 (1991).

_____. "Sense and Sensibility: What Can We Know about Music? What Do We Want to Know?" in *Fact and Value in Contemporary Music Scholarship*. Boulder, Colo.: College Music Society (1986): 9-14.

ANALYSIS AND PERFORMANCE

_____. *Structural Functions in Music*. Englewood Cliffs, N.J.: Prentice-Hall, 1976; reprint, New York: Dover, 1987. Reviewed by C.M. Joseph in *Notes* 33/3 (1977): 600-1; J. Samson in *Tempo* 122 (1977): 20-4; J. Rushton in *The Music Review* 44/2 (1983): 147-9.

Biringer, Gene. "Musical Metaphors in Schoenberg's *Der Kranke Mond* (Pierrot Lunaire, No. 7)." In *Theory Only* 8/7 (1985): 3-14.

Burkhart, Charles. "Schenker's Theory of Levels and Musical Performance." *Aspects of Schenkerian Theory*, ed. by David Beach. New Haven: Yale University Press (1983): 95-112.

Clemens, Holly O. "Mario Davidovsky's *Synchronisms No. 1*: An Analysis and Performance Guide." *The Flutist Quarterly* XV/4 (Fall 1990): 13-17.

Clynes, M. *Sentics: The Touch of the Emotions*. New York: Anchor Press/Doubleday, 1978.

_____. "What Can a Musician Learn About Music Performance from Newly Discovered Microstructure Principles (PM and PAS)?" In Gabriellson, A. (ed.), *Action and Perception in Rhythm and Music*. Stockholm: Royal Swedish Academy of Music (1987): 201-233.

Cone, Edward. "Beethoven's Experiments in Composition: The Late Bagatelles." *Beethoven Studies* 2, ed. Alan Tyson. London: Oxford University Press, 1977.

_____. *Musical Form and Musical Performance*. New York: W.W. Norton, 1968. Reviewed by Berry, *Perspectives of New Music* 9/2 and 10/1 (1971): 271-290.

_____. "Musical Form and Musical Performance Reconsidered," *Music Theory Spectrum* 7 (1985): 149-58.

_____. "Three Ways of Reading a Detective Story—or a Brahms Intermezzo." *Georgia Review* 31 (1977): 554-74.

Cook, N. "Structure and Performance Timing in Bach's C Major Prelude (WTC I): An Empirical Study." *Music Analysis* 6/3 (1987): 257-272.

Dunsby, Jonathan. "Guest Editorial: Performance and Analysis of Music." *Music Analysis* 8/1-2 (1989): 5-20.

Ernst, Roy and Douglas M. Green. *Structure and Performance: A Guide to Interpretation of Repertoire for the Flute* Vol. 1. Canandaigua, N.Y.: Ergo Publications, 1978.

JOURNAL OF MUSIC THEORY PEDAGOGY

Folio, Cynthia. "A Performance Analysis of Berio's *Sequenza for Flute*." *The Flutist Quarterly* 15/4 (Fall 1990): 18-21.

Gabrielsson, A. "Interplay Between Analysis and Synthesis in Studies of Music Performance and Music Experience." *Music Perception* 3/1 (1985): 59-86.

Greybill, Roger. "Towards a Pedagogy of Gestural Rhythm." *Journal of Music Theory Pedagogy* 4/1 (Spring 1990): 1-50.

Hefling, Stephen E. "'Of the Manner of Playing the Adagio': Structural Levels and Performance Practice in Quantz's *Versuch*." *Journal of Music Theory* 31/2 (1987): 205-223.

Hermann, Richard. "Some Uses of Analysis Towards a Performance of Webern's Op. 22 Movement I." *Winds Quarterly* 1 (Spring 1981): 24-38; and (Summer 1981): 19-23.

Jonas, Oswald. "Die Kunst des Vortrages nach Heinrich Schenker." *Musik Erziehung* (1962): 127-29.

_____. "Schenker und grosse Interpreten." *Osterreichische Musikzeitschrift* 19 (1964): 584-89.

Kirkpatrick, Ralph. *Interpreting Bach's Well-Tempered Clavier: A Performer's Discourse of Method*. New Haven: Yale University Press, 1990.

Kraehenbuhl, David. "On the Nature and Value of Theoretical Training: A Forum." *Journal of Music Theory* 3 (1959): 31-69 (see especially, Stanley Fletcher's contribution: "For the Performer" pp. 38-49).

Larson, Steve. "A Tonal Model of an 'Atonal' Piece: Schoenberg's Opus 15, Number 2." *Perspectives of New Music* 25 (1987): 418-33 and performance on accompanying cassette.

_____. "On Analysis and Performance: The Contribution of Durational Reduction to the Performance of J.S. Bach's Two-Part Invention in C Major." *In Theory Only* 7/1 (1983): 31-45.

LaRue, Jan. "Style Analysis for Performers—An Initial Report." *College Music Symposium* 19/2 (1979): 107-110.

Leinsdorf, Erich. *A Radical Orthodoxy for Musicians*. New Haven: Yale University Press, 1990.

ANALYSIS AND PERFORMANCE

Lester, Joel. *The Rhythms of Tonal Music*. Carbondale: Southern Illinois University Press, 1986. Reviewed by R.O. Gjerdingen in *Journal of Music Theory* 34/1 (1990): 101-7.

Levy, Edward. "Analysis Applied to Performance." *College Music Symposium* 19/1 (1979): 128-138.

Lewin, David. "Music Theory, Phenomenology, and Modes of Perception." *Music Perception* 3 (1986): 327-92.

Lockhead, Judy and George Fisher. "The Performer as Theorist: Preparing a Performance of Daria Semegen's Three Pieces for Clarinet and Piano (1968)." *In Theory Only* 6/7 (1982): 23-39.

Lussy, Mathis. *Traite de l'expression musicale*. Paris, 1874 (English translation, 1885).

MacKenzie, C.L., VanEerd, D.L., Graham, E.D., Huron, D.B., & Wills, B.L.A. "The Effect of Tonal Structure on Rhythm in Piano Performance." *Music Perception* 4/2 (1986): 215-226.

Meyer, Leonard B. *Emotion and Meaning in Music*. Chicago: University of Chicago Press, 1956.

_____. *Explaining Music*. Chicago: University of Chicago Press, 1973.

Narmour, Eugene. "On the Relationship of Analytical Theory to Performance and Interpretation" in *Explorations in Music, the Arts, and Ideas*, ed. E. Narmour and R.A. Solie (Stuyvesant: Pendragon): 317-40.

Nygren, Dennis. "The Chamber Music of Berg." *Clarinet Magazine* (Spring 1986): 26-31.

Pierce, Alexandra. "Climax in Music." *In Theory Only* 7/1 (March 1983). Reprinted in *Spanning*.

_____. "Juncture." *In Theory Only* 3/6 (1977): 23-34. Reprinted in *Spanning*.

_____. "Structure and Phrase" *In Theory Only* (Part 1) 4/5 (Oct. 1978); (Part 2) 5/3 (July 1979). Reprinted in *Spanning*.

_____. *Spanning: Essays on Music Theory, Performance and Movement*. Redlands, California: Center of Balance, 1983.

JOURNAL OF MUSIC THEORY PEDAGOGY

Planer, John H. "Sentimentality in the Performance of Absolute Music: Pablo Casals' Performance of Sarabande from Johann Sebastian Bach's Suite No. 2 in D Minor for Unaccompanied Cello, S. 1008." *The Musical Quarterly* 73/2 (1989): 212-48.

Rink, John. "Conference Report: Music and Rhetoric: Style and Communication in Western and Non-Western Musics." *Music Analysis* 8/3: 359-64.

Rothstein, William. "Heinrich Schenker as an Interpreter of Beethoven's Piano Sonatas." *19th Century Music* 8 (1984): 3-28.

_____. *Phrase Rhythm in Tonal Music*. New York: Schirmer, 1989.

_____. "Phrase Rhythm in Chopin's Nocturnes and Mazurkas." In Jim Samson (ed.) *Chopin Studies*. London: Cambridge University Press, 1988.

Schmalfeldt, Janet. "On the Relation of Analysis to Performance: Beethoven's Bagatelles Op. 126, Nos. 2 and 5." *Journal of Music Theory* 29/1 (1985): 1-31.

Schenker, Heinrich. *Beethovens neunte Sinfonie*. Vienna, 1912.

_____. "A Contribution to the Study of Ornamentation," trans. Hedi Siegel. *Music Forum* 4 (1976): 1-139.

_____. *Chromatische Phantasie und Fuge: Kritische Ausgabe von Heinrich Schenker*. 2nd ed., rev. Oswald Jonas. Vienna, 1969.

_____. *Erläuterungsausgabe der letzten fünf Sonaten Beethovens*. 2nd ed., rev. Oswald Jonas. Vienna, 1971-2.

_____. "Organic Structure in Sonata Form." Trans. Orin Grossman, *Readings in Schenker Analysis and Other Approaches*, ed. by Maury Yeston. New Haven: Yale University Press (1977): 38-53.

_____. "The Largo of J.S. Bach's Sonata No. 3 for Unaccompanied Violin [BWV 1005]." Trans. John Rothgeb, *Music Forum* 4 (1976): 141-59.

_____. "The Sarabande of J.S. Bach's Suite No. 3 for Unaccompanied Violoncello [BWV 1009]." Trans. Hedi Siegel, *Music Forum* 2 (1970): 274-282.

Stein, Erwin. *Form and Performance*. New York: Limelight Editions, 1989 (originally pub. Alfred A. Knopf, 1962).

Tanenbaum, Faun. "The Sarabande of J.S. Bach's Suite No. 2 for Unaccompanied Violoncello, BWV 1008: Analysis and Interpretation." *Theory and Practice* 1 (1980): 40-56.

ANALYSIS AND PERFORMANCE

Thompson, William Forde. "Composer-Specific Aspects of Musical Performance: An Evaluation of Clynes's Theory of Pulse for Performances of Mozart and Beethoven." *Music Perception* 7/1 (Fall 1989): 15-42.

Thurmond, James Morgan. *Note Grouping, A Method for Achieving Expression and Style in Musical Performance*. Camp Hill, Pa.: JMT Publications, 1982.

Wason, Robert. "Webern's Variations for Piano, Op. 27: Musical Structure and the Performance Score." *Integral* 1 (1987): 57-103.

Wintle, Christopher. "Analysis and Performance: Webern's Concerto Op. 24/II." *Music Analysis* 1/1 (1981): 73-99.

Wuorinen, Charles. "Notes on the Performance of Contemporary Music, *Perspectives of New Music* 2 (1964). Reprinted in Benjamin Boretz and Edward T. Cone (ed.), *Perspectives on Notation and Performance*. New York: W.W. Norton & Co., Inc. (1976), 51-62.

Yeston, Maury. "Rubato and the Middleground." *Journal of Music Theory* 19 (1975): 286-301. Reprinted in Yeston, ed., *Readings in Schenker Analysis and Other Approaches*. New Haven: Yale University Press (1977), 94-106.

PITCH-CLASS POKER

LORA L. GINGERICH

Pitch-Class Poker is a game that utilizes familiar analytic tools and concepts from atonal pitch-class set theory. Playing Pitch-Class Poker challenges the music theorist or composer to view these tools and concepts from an unusual perspective, leading to a different and hopefully deeper understanding of the theory. The beginning player must be able to calculate the interval vector for a collection of pitch-classes. Thus, for a student learning the basics of atonal theory the game provides an interesting way to practice finding the total interval content of a collection of pitch-classes. An experienced player will find that developing a strategy for the game requires a more subtle and sophisticated understanding of abstract inclusion relations in atonal theory. The rules of Pitch-Class Poker resemble the rules of traditional poker. The procedure for dealing, betting, and playing is identical in both games.¹ However, in Pitch-Class Poker a new method for ranking hands from high to low based on the total interval content or interval vector of the pitch-class set represented by the cards held in each hand replaces the traditional ranking scheme where four of a kind ranks higher than a full house, but lower than a straight flush.² Draw poker, stud poker, and other variations of the basic traditional game can be played depending on the interest of the players.

Two to nine may play, although the game is best for five to seven players. Eight or nine can play only Pitch-Class Stud Poker variations of the game.

A deck of 48 cards is required. Each card shows a specific pitch in a specific register and clef. C2 (cello C) through B2 are shown in bass clef, C3 (viola C) through B3 are shown in tenor clef, C4 (middle C) through B4 are shown in alto clef, and C5 through C6 are shown in treble clef. The four clefs replace the four suits in a traditional deck, so a normal five-card poker hand represents a pentachord chosen from a gamut of four octaves. Note, however, that when calculating the interval vector for a hand, the register and clef of each pitch is ignored and the four-octave representations of each pitch class are considered equivalent. Within each clef or suit, B is considered the high card, while C is the low card.

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Alternately, a regular deck of 52 cards may be used if the four Queens are removed. Each card represents a pitch-class: King=C natural, Ace=C sharp or D flat, two=D natural, and so on until Jack=B natural or C flat. Suits might indicate the clef and register of each pitch, but need not be formally designated as such since the interval vector is calculated using pitch classes. Using a traditional deck the King, representing pitch class 0, is the low card, while the Jack, representing pitch class 11, is the high card. In the basic version of Pitch-Class Poker, called Tritone Trump, the hand with the most tritones (interval class 6 or ic6) in the interval vector ranks highest. If no hand contains a tritone, the hand with the most perfect fourths or fifths (ic5) wins the game. Similarly, if no hand contains ic5 or ic6, the hand with the most ic4's wins, and so forth. Figure 1 shows a specific case.

The hand (C#,E,F,F,B) or (A,4,5,5,J) using traditional cards has the interval vector <111111> and ranks higher than the hand (C,E,F,G,G#) or (K,4,5,7,8) with the interval vector <212320>. It is important to remember that a duplicate entry in the hand, such as the F or five in the hand above, is not included in the calculation of the interval vector, just as a repeated pitch class in a pitch-class set is not included in the calculation of an interval vector. In the first example the hand with only four distinct entries ranks higher than the hand with five distinct entries, not because it contains a pair as in traditional poker, but because it includes an ic6.

Figure 1.

<u>Hand</u>	<u>Interval Vector</u>	<u>Rank</u>
(C#, E, F, F, B) or (A, 4, 5, 5, J)	<111111>	higher
(C, E, F, G, G#) or (K, 4, 5, 7, 8)	<212320>	lower

If two hands are equal with respect to ic6, the higher rank will be assigned to the hand with the greater number of ic5's. Again, if the hands are equal with respect to ic5, the hand with the greatest number of ic4's will rank higher, and so forth. If two hands have identical interval vectors, the higher rank is assigned to the hand that contains the highest card. If the highest cards are identical, the next highest cards are compared, and so forth down to the final card. Figure 2 shows a specific case.

(C#,D,F,G,Ab) or (A,2,5,7,8) representing the interval vector <212122> ranks higher than (C,C,D,F#,G#) or (K,K,2,6,8) representing the interval vector <020202>, since the first hand contains two ic5's, while the second

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contains no ic5's, although both hands contain two ic6's. However, the hand (C,F,F#,A,B) or (K,5,6,9,J) representing the same interval vector as the winning hand above <212122> ranks highest of these three hands, since the B or Jack ranks higher than A^b or 8. If the hands are identical in all respects, there is a tie. Perhaps, if using a deck of cards showing clefs rather than suits, the hand containing the card in the highest register could break the tie. House rules can be developed for these rare situations if the players do not want to chance a tie game.

Figure 2.

<u>Hand</u>	<u>Interval Vector</u>	<u>Rank</u>
(C#, D, F, G, Ab) or (A, 2, 5, 7, 8)	<212122>	higher
(C, C, D, F#, G#) or (K, K, 2, 6, 8)	<020202>	lower
(C, F, F#, A, B) or (K, 5, 6, 9, J)	<212122>	highest

To determine the potential strength of a particular hand before placing a wager, a player must be acquainted with the distribution of ic6 within all possible interval vectors for pentachords, tetrachords, trichords, and dyads, since a five-card Pitch-Class Poker hand could contain a pair (thus representing a tetrachord) or three, or four of a kind (thus representing a trichord or dyad). Examining a list of interval vectors reveals that of the 81 distinct interval vectors of collections of two, three, four, or five pitch classes, nine contain two ic6's, and 38 contain a single ic6.

A traditional list of interval vectors does not contain enough information for a Pitch-Class Poker player, however, since each interval vector can be represented by a large number of poker hands depending on the cardinality of the pitch-class set represented by the hand as well as the symmetric properties exhibited by that set. The list given in Figure 3 ranks the 81 possible interval vectors according to the rules for Tritone Trump. Each entry shows an interval vector, the potential number of hands that represent that interval vector, and the percentage of hands that are lower than a hand representing the given interval vector. For reference the set name and prime form for each interval vector are also listed, or in the case of the Z-related sets both set names and prime forms associated with the interval vector are listed.

Figure 3. Ranking of Pitch-Class Poker Hands for Tritone Trump.

<u>Vector</u>	<u>Set Name</u>	<u>Prime Form</u>	<u>Hand Rank</u>	<u># of Hands</u>	<u>% Hands Below</u>
310132	5-7	(0, 1, 2, 6, 7)	1	24576	98.56%
220222	5-15	(0, 1, 2, 6, 8)	2	12288	97.85%
212122	5-19	(0, 1, 3, 6, 7)	3	24576	96.41%
200022	4-9	(0, 1, 6, 7)	4	9216	95.87%
122212	5-28	(0, 2, 3, 6, 8)	5	24576	94.44%
114112	5-31	(0, 1, 3, 6, 9)	6	24576	93%
040402	5-33	(0, 2, 4, 6, 8)	7	11288	92.29%
020202	4-25	(0, 2, 6, 8)	8	9216	91.75%
004002	4-28	(0, 3, 6, 9)	9	4608	91.48%
211231	5-20	(0, 1, 3, 7, 8)	10	24576	90.04%
122131	5-29	(0, 1, 3, 6, 8)	11	24576	88.61%
221131	5-14	(0, 1, 2, 5, 7)	12	24576	87.17%
202321	5-22	(0, 1, 4, 7, 8)	13	12288	86.45%
121321	5-30	(0, 1, 4, 6, 8)	14	24576	85.02%
113221	5-32	(0, 1, 4, 6, 9)	15	24576	83.58%

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032221	5-34	(0, 2, 4, 6, 9)	16	12288	82.87%
212221	5-Z18/5-Z38	(0, 1, 4, 5, 7) or (0, 1, 2, 5, 8)	17	49152	80%
131221	5-24	(0, 1, 3, 5, 7)	18	24576	78.56%
311221	5-6	(0, 1, 2, 5, 6)	19	24576	77.13%
123121	5-25	(0, 2, 3, 5, 8)	20	24576	75.69%
222121	5-Z12/5-Z36	(0, 1, 3, 5, 6) or (0, 1, 2, 4, 7)	21	36864	73.54%
321121	5-5	(0, 1, 2, 3, 7)	22	24576	72.1%
110121	4-16	(0, 1, 5, 7)	23	36864	69.95%
200121	4-8	(0, 1, 5, 6)	24	18432	68.87%
210021	4-6	(0, 1, 2, 7)	25	18432	67.8%
122311	5-26	(0, 2, 4, 5, 8)	26	24576	66.36%
221311	5-13	(0, 1, 2, 5, 8)	27	24576	64.93%
213211	5-16	(0, 1, 3, 4, 7)	28	24576	63.49%
231211	5-9	(0, 1, 2, 4, 6)	29	24576	62.06%
223111	5-10	(0, 1, 3, 4, 6)	30	24576	60.62%
322111	5-4	(0, 1, 2, 3, 6)	31	24576	59.18%
012111	4-27	(0, 2, 5, 8)	32	36864	57.03%

Figure 3. (Con't.)

<u>Vector</u>	<u>Set Name</u>	<u>Prime Form</u>	<u>Hand Rank</u>	<u># of Hands</u>	<u>% Hands Below</u>
102111	4-18	(0, 1, 4, 7)	33	36864	54.88%
111111	4-Z15/4-Z29	(0, , 4, 6) or (0, 1, 3, 7)	34	73728	50.57%
210111	4-5	(0, 1, 2, 6)	35	36864	48.42%
112011	4-13	(0, 1, 3, 6)	36	36864	46.27%
100011	3-5	(0, 1, 6,)	37	14976	45.39%
020301	4-24	(0, 2, 4, 8)	38	18432	44.32%
232201	5-8	(0, 2, 3, 4, 6)	39	12288	43.6%
030201	4-21	(0, 2, 4, 6)	40	18432	42.52%
112101	4-12	(0, 2, 3, 6)	41	36864	40.37%
010101	3-8	(0, 2, 6)	42	14976	39.49%
002001	3-10	(0, 3, 6)	43	7488	39.06%
000001	2-6	(0, 6)	44	336	39.04%
032140	5-35	(0, 2, 4, 7, 9)	45	12288	38.32%
122230	5-27	(0, 1, 3, 5, 8)	46	24576	36.89%
132130	5-23	(0, 2, 3, 5, 7)	47	24576	35.45%

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021030	4-23	(0, 2, 5, 7)	48	18432	34.37%
202420	5-21	(0, 1, 4, 5, 8)	49	24576	32.94%
212320	5-Z17/5-Z37	(0, 1, 3, 4, 8) or (0, 3, 4, 5, 8)	50	24576	31.5%
222220	5-11	(0, 2, 3, 4, 7)	51	24576	30.07%
101220	4-20	(0, 1, 5, 8)	52	18432	28.99%
012120	4-26	(0, 3, 5, 8)	53	18432	27.91%
021120	4-22	(0, 2, 4, 7)	54	36864	25.76%
111120	4-14	(0, 2, 3, 7)	55	36864	23.61%
010020	3-9	(0, 2, 7)	56	7488	23.17%
101310	4-19	(0, 1, 4, 8)	57	36864	21.02%
322210	5-3	(0, 1, 2, 4, 5)	58	24576	19.58%
102210	4-17	(0, 3, 4, 7)	59	18432	18.51%
201210	4-7	(0, 1, 4, 5)	60	18432	17.43%
332110	5-2	(0, 1, 2, 3, 5)	61	24576	16%
121110	4-11	(0, 1, 3, 5)	62	36864	13.84%
211110	4-4	(0, 1, 2, 5)	63	36864	11.69%
001110	3-11	(0, 3, 7)	64	14976	10.81%
100110	3-4	(0, 1, 5)	65	14976	9.94%

Figure 3. (Con't.)

<u>Vector</u>	<u>Set Name</u>	<u>Prime Form</u>	<u>Hand Rank</u>	<u># of Hands</u>	<u>% Hands Below</u>
122010	4-10	(0, 2, 3, 5)	66	18432	8.86%
011010	3-7	(0, 2, 5)	67	14976	7.99%
000010	2-5	(0, 5)	68	672	7.95%
000300	3-12	(0, 4, 8)	69	2496	7.8%
432100	5-2	(0, 1, 2, 3, 4)	70	12288	7.09%
212100	4-3	(0, 1, 3, 4)	71	18432	6.01%
221100	4-2	(0, 1, 2, 4)	72	36864	3.86%
101100	3-3	(0, 1, 4)	73	14976	2.98%
020100	3-6	(0, 2, 4)	74	7488	2.55%
000100	2-4	(0, 4)	75	672	2.51%
341000	4-1	(0, 1, 2, 3)	76	18432	1.43%
111000	3-2	(0, 1, 3)	77	14976	0.56%
001000	2-3	(0, 3)	78	672	0.52%
210000	3-1	(0, 1, 2)	79	7488	0.08%
010000	2-2	(0, 2)	80	672	0.04%
100000	-21	(0, 1)	81	672	0%

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To become an accomplished player requires subtle strategic thinking, with an understanding of the abstract subset and superset relations among pitch-class sets. Various inclusion relations have been defined in the theoretical literature, focusing mainly on the subset structure of a set-class or the relations between two set-classes.³ The superset structure of a specific set-class has been addressed, but in less detail. The practical value of understanding the superset structure as well as the subset structure of a collection is clear, for both structures are engaging musically and analytically. When playing Pitch-Class Poker, the superset structure for a given collection of pitch classes is as critical or even more critical than the subset structure of a collection. To introduce these concepts, a practical, intuitive approach for developing a winning strategy in Tritone Trump will be discussed.

In draw poker, after the initial wagers are placed, each active player must determine which cards might be discarded to improve the original hand with replacements from the deck. The player must determine which subset of the original hand should be retained to increase the odds of obtaining more tritones and large intervals. Intuitively, a player knows that a duplicate pitch class forming a pair should be discarded, retaining the card that represents the pitch class in a higher register, if house rules favor higher pitches. Furthermore, the player realizes that any pair of cards that represent a tritone should be retained, and possibly any pair that represent ic5. If each of the four intervals a card forms with the other cards in the hand is less than ic5, the card might be replaced in hopes of obtaining a ic6 or ic5. If each of the four intervals is less than ic4, the card will very likely be discarded.

These intuitive guidelines for determining whether a card should be retained in the hand or discarded are based on the probabilities for obtaining each interval-class with a given card when choosing at random from the other 47 cards in the deck. There are three other cards that duplicate its pitch class, four cards that form ic6 with the given card, eight cards that form ic5 with the given card, as well as eight cards each that form ic4, ic3, ic2, and ic1 with the given card. Of the 47 intervals that could be formed with a given card, 27 are smaller than ic4.

The advice to discard any card that forms only intervals smaller than ic4 with the other cards in the hand is based on the knowledge that odds are slightly less than even (43% or 20 out of 47) for obtaining an interval greater than ic3 when choosing a second card at random. Thus, if all the intervals formed by a particular card in the hand are less than ic4, it will probably be worth the risk to replace the card with a new card from the deck. Moreover, the advice to retain a card that forms ic5 or greater is sound since only 12 of

47, or 25%, of the cards, will produce ic5 or ic6. These guidelines may be sufficient to play the game, but a curious or cautious player may wish to explore the issue further before placing any substantial wagers.

One might consider the numerical odds for improving the hand based on the cards the player chooses to retain to confirm that appropriate cards were discarded from the hand. That is, the player might examine all the potential five-note supersets for the subset represented by the cards retained after the initial discard. This is not the same as considering all the subsets of the original five-note hand.

Intuitively, one expects the subset and superset relations to be similar. However, as can be shown by example, there are differences, and the differences are significant. Given two sets X and Y such that X is smaller than Y , the number of times X is contained in Y is defined as the number of different subsets of type X that are contained in a single instance of set Y ; this is Lewin's embedding function. The number of times Y is a superset of X is defined as the number of times sets of type Y occur when additional elements are added to a single instance of set X ; this is Lewin's covering function.⁴ A specific six-note collection such as the whole-tone scale includes two augmented triads as subsets, yet a specific augmented triad has only one six-note superset that is a whole-tone scale.⁵

Appreciating the distinction between the process of finding supersets and the process of finding subsets is critical in understanding atonal theory and in playing pitch-Class Poker. The intuition that the embedding and covering functions are opposite or complementary processes may be misleading, yet is not entirely false since the covering function of two sets is equal to the embedding function of the complements of the same two sets.⁶ The covering and embedding functions also correspond when both equal zero, but when their values are greater than zero they will not necessarily be equal.

An example from Pitch-Class Poker will help clarify the situation. If a player is dealt the hand (C, D, E, B^b, B^b) with the interval vector $\langle 030201 \rangle$ ranking higher than only 42.5% of the other Tritone Trump hands and follows the intuitive strategy outlined above, the player will choose to keep the pitches that form ic6 in the hand (the E and the B^b in the higher register) and choose to discard the B^b in the lower register. The player must decide what to do with the C and the D . The C forms ic4 with the E and ic2 with the D and the B^b , the D forms ic4 with the B^b and ic2 with the C and the E . Assume the player retains both the C and D in the hand and thus draws one additional card from the remaining 43 unknown cards in the deck. The deck will actually contain fewer than 43 cards since each player holds five cards, but the probability for improving the hand (C, D, E, B^b) when drawing a single new card is based on the number of unknown cards in the deck, not

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the actual number of cards left to deal. Figure 4 shows the potential hands that the player may obtain after receiving a new card.

The player may be dealt one of the three remaining C's, D's, or E's in the deck, or one of the two remaining Bb's. In this case there would be no change in the interval vector. The player may receive one of four remaining C#'s, changing the interval vector to <232201>, and improving the hand only 1%, to rank higher than just 43.6% of all hands. The player may be dealt one of the four remaining B's or four remaining D#'s, changing the interval vector to <231211>, and improving the hand to rank higher than 62.1% of all hands. The player may be dealt one of four A's or four F's, changing the interval vector to <131221>, and improving the hand's rank to 78.6%. The player may be dealt one of four G's, changing the interval vector to <032221>, and improving the hand's rank to 82.9%. Finally, the player may be dealt one of four F#'s or one of four G#'s, changing the interval vector to <040402>, and improving the hand's rank to 92.3%. In 15 of 43 cases the hand will not improve substantially, in 8 of 43 cases the hand will improve somewhat, and in 20 of the 43 cases the hand will improve substantially.

Figure 4.

<u>Hand</u>	<u>Interval Vector</u>	<u>Rank</u>	<u>Odds</u>
(C, D, E, Bb)	<030201>	42.5%	11/43
(C, <u>C</u> #, D, E, Bb)	<232201>	43.6%	4/43
(C, D, E, Bb, <u>B</u>) or (C, D, <u>D</u> #, E, Bb)	<231211>	62.1%	8/43
(C, D, E, <u>A</u> , Bb) or (C, D, E, <u>F</u> , Bb)	<131221>	78.6%	8/43
(C, D, E, <u>G</u> , Bb)	<032221>	82.9%	4/43
(C, D, E, <u>F</u> #, Bb) or (C, D, E, <u>G</u> #, Bb)	<040402>	92.3%	8/43

The procedure outlined above, adding each of the remaining pitch classes to the existing tetrachord, call it $X=(C,D,E,B^b)$, is a practical example of finding all the pentachords, call them Y , for which Lewin's covering

function $\text{COV}(X,Y)$ is greater than 0.⁷ Some of the pentachords may be formed by more than one additional pitch-class, for example, the pentachord representing the interval vector $\langle 231211 \rangle$. Specifically, $X=(B^b,C,D,E)$ may be covered by $Y1=(B^b,B,C,D,E)$ or $Y2=(B^b,C,D,D^\sharp,E)$, two distinct forms of set-class Y . In this case $\text{COV}(X,Y)=2$.

The situation becomes more complicated if the player considers replacing two cards in the existing hand. The C or the D might be discarded in addition to the duplicate B^b . In both cases, the remaining trichord would be set-type 3-8, (D, E, B^b) or (C, E, B^b) . Assume C is discarded; the player retains the trichord (D, E, B^b) , with the interval vector $\langle 010101 \rangle$, and draws two new cards. This trichord ranks higher than 39.5% of the hands in Tritone Trump, only 3% lower than the original rank of 42.5%.

The player has not sacrificed much to begin with a trichord rather than a tetrachord before the draw. It remains to be seen if the odds for improving the hand will increase after starting with the trichord. There are 78 distinct pairs of pitch classes in the 43-card deck that remains. Finding all the sets that cover 3-8 by including each distinct pair with the original set, as in the example above, is tedious. Using a computer generated list that indicates the number of ways a smaller set can be covered by a larger set saves time.

Figure 5 shows vectors that represent the covering function for trichords and tetrachords as well as trichords and pentachords, while Figure 6 shows vectors representing the covering function for tetrachords and pentachords.⁸ These tables are read by first locating the smaller set, the set to be covered, or the set represented by the cards retained in the player's hand, in the left-hand column of the table. For example, set-type 3-12 is at the bottom of Figure 5. Next, one must locate non-zero entries in the vector representing the covering function (for example, the 6 and the 3 in the Tetrachord Covering Function for set-type 3-12). The 6 is found in the 19th place of the vector, while the 3 is found in the 24th place of the vector. This indicates that set 4-19 covers 3-12 six ways, and set 4-24 covers set 3-12 three ways. The covering functions for other trichords and tetrachords can be read from the vectors on these tables in a similar manner. Once players are aware of the potential covering sets for the set represented by the cards they choose to retain in the playing hand, those sets can be located in Figure 3, and the player can determine if there is a good chance of improving the hand by retaining those particular cards. I caution you that each covering set can be formed by a variety of cards, since the full deck contains four versions of each pitch-class.

Figure 5. Pentachord and Tetrachord Covering Function for Trichords.

<u>Set Name</u>	<u>Prime Form</u>	<u>Tetrachord Covering Function</u>	<u>Pentachord Covering Function</u>
3-1	012	22022100000000000000000000000000	342442212020221000000000000000000212
3-2	013	11100000011110000000000000000001	23222001131110021111002121111010000100
3-3	014	01110010000100101110000000000000	10310201122011031210310001010112000111
3-4	015	00011011001001010011000000000000	0021132010111101203311101201100000012
3-5	016	00001101100010101000000000000001	00012250110112110142010100111110000201
3-6	024	020000000020000000000000220100000	102000024021200000000002402200200321200
3-7	025	00010000011010100000011001100	00110100121102000010003131212112012111
3-8	026	00001000000100110000100110101	00011111210021210111000212041211310001
3-9	027	00000100000002020000022000000	00002020002004101202004200204200013200
3-10	036	000000000002200002000000000210	00020001020100020220010022022082010202
3-11	037	00000000000001001111010001101	00001000002010021112311121311113011112
3-12	048	00000000000000000060000300000	00000000000060003000630006000600300030

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Figure 6. Pentachord Covering Function for Tetrachords.

[illegible]

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4-16	0157	00000010000001100101000100001100000000
4-17	0347	0000000000200002000020000000002000000
4-18	0147	00000000000000010110010000000011000101
4-19	0148	00000000000010001000210001000100000010
4-20	0158	00000000000000000002200000200000000002
4-21	0246	00000001200000000000000200000000210000
4-22	0247	00000000001000000000001100100100011100
4-23	0257	0000000000002000000002000002000002000
4-24	0248	00000000000020000000000002000200200000
4-25	0268	0000000000000200000000000040000200000
4-26	0358	0000000000000000000000020200002001010
4-27	0258	00000000000000000000000011011011010001
4-28	0369	000000000000000000000000000080000000
4-Z29	0137	00001000000010010011000110010000000000

In the example from Pitch-Class Poker, the player is specifically interested in the pentachords and the tetrachords that cover (D,E,B^b). There are 36 pentachords and 9 tetrachords that cover any particular trichord. Some of these may be duplications, as in the specific example under consideration now. Figure 5 reveals that (D,E,B^b), set-type 3-8, can be covered by the supersets 4-5, 4-12, 4z15, 4-16, 4-21, 4-24, 4-25, 4-27, 4z29, 5-4, 5-5, 5-6, 5-7, 5-8, 5-9 twice, 5-10, 5-13 twice, 5-28 four ways, 5-29, 5-30 twice, 5-31, 5-32, 5-33 3 ways, 5-34, and 5z38. These sets can now be located in Figure 3 to determine which covering sets will improve the hand dramatically and which will improve the hand only slightly. All the covering sets will rank higher than the trichord 3-8 with the interval vector <010101>.

The probability for obtaining each of these covering sets is calculated by first considering the odds for obtaining any particular pair when drawing two additional cards at random from the remaining 43. There are $903 = (43 \times 42) / 2$ unordered pairs of cards in the 43-card deck that remains. To calculate the odds for obtaining a particular set, for example 5-7 (the highest ranking hand in Tritone Trump), one must first determine which pair or pairs of pitch classes will complete a version of set-type 5-7 when included

with the original D, E, and B^b. Since 5-7 covers 3-8 just once, the only possible pair is E^b and A. All four E^b's and all four A's remain in the deck of 43 unknown cards, thus there are 16 ways to find this pair. Thus, about 1.8% of the 903 different hands that could result when the player draws two new cards will represent the interval vector <310132> or set-type 5-7. When the player discards only one card, it is not possible to obtain an equivalent hand.

Similar calculations can be performed for all 45 sets that cover 3-8 to reveal the following statistics: 26% of the new hands will rank higher than 90%, 14% will rank between 80% and 90%, 8% rank between 70% and 80%, 17% rank between 60% and 70%, 14% rank between 50% and 60%, while 17% rank between 40% and 50%. About 3% of the new cards dealt will duplicate pitch classes from the original trichord, and the player will keep the interval vector <010101>. These are better odds than when four cards were retained and just the duplicate B^b exchanged.

Finally, the odds for improving the hand are calculated when the player retains two cards, E and B^b, and discards three cards, B^b, C, and D. While there are $12,341 = (43 \times 42 \times 41) / (3 \times 2)$ potential hands when retaining two and drawing three new cards, there are 175 sets of cardinality three, four, or five that cover the dyad 2-6, including duplications of the same set-types. There are 41 different set-types or hands that rank higher than 2-6 (39.04%) in Tritone Trump, each of which covers set-type 2-6 at least once.

Calculating the odds for obtaining each of these 41 sets will be tedious, so only the odds for the 10 sets that rank above 90% will be computed. 5-7 again serves as an example. There are eight ways for some form of the highest ranking set-type to cover the dyad E-B-flat: (4,5,6,10 11) will occur 64 times, (3,4,5,9,10) will occur 64 times, (4,5,9,10 11) will occur 64 times, (2,3,4,9,10) will occur 48 times, (3,4,5,10 11) will occur 64 times, (3,4,8,9,10) will occur 64 times, (0,4,5,10,11) will occur 48 times, and (3,4,9,10,11) will occur 64 times, for a total of 480 hands that represent set-type 5-7 and include the original B^b and E, almost 4% of the 12,341 potential hands.

Thus the odds of obtaining a hand representing set-type 5-7 are greater when discarding three cards than when discarding only two. Repeating these calculations for the other nine high-ranking sets shows that 2,816 of 12,341 hands will rank higher than 90%, but this is only 23%, less than the percentage of hands ranking above 90% when just two cards were discarded. Thus, although the chances of obtaining the best possible hand are greater when discarding three cards, the chances of obtaining a hand ranking above 90% are greatest when just two cards are discarded.

Calculating the exact odds for improving a given hand is tedious, and the game can be played successfully with only an intuitive understanding of which cards to retain and which to discard. But finding the exact

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probabilities for a few examples helps develop a stronger sense of how pitch classes and interval classes interact, and aids the player in understanding theoretical inclusion relations.

An alternate version of the game, called Semitone Sweep, in which the ideal sonority contains as many semitones or small intervals as possible can also be played. For this game the basic techniques and strategy resemble Tritone Trump, however the player seeks to maximize the number of icl's in the hand, or the number of small interval classes, rather than maximizing ic6, or large interval classes.

To conclude, I would like to remind you of the musical implications of the game. Playing Tritone Trump is similar to comparing sonorities that include five pitches chosen at random from a gamut of four octaves. In this game the ideal sonority contains as many tritones as possible, or as many large interval classes as possible. In the draw poker version of the game each player may replace one or more of these random pitches by other almost random pitches hoping to increase the number of desirable interval classes in the sonority.

To become adept at either game the player must learn to recognize interval classes and learn to modify a given collection to maximize a specific interval class. The random method of choosing replacement pitches will not insure players an ideal sonority, but will develop an understanding of interval vectors, supersets, and subsets regardless of whether the game is finished with the highest ranking hand.

NOTES

¹Albert H. Morehead and Geoffrey Mott-Smith, eds., *Hoyle's Rules of Games*, second revised edition (New York: New American Library, 1946, 1983), 34-63.

²Instructions for calculating the interval vector of a pitch-class set may be found in Allen Forte, *The Structure of Atonal Music*, (New Haven: Yale University Press, 1973), 13-15.

³Examples may be found in David Lewin, *Generalized Musical Intervals and Transformations* (New Haven, CT: Yale University Press, 1987); Allen Forte, *The Structure of Atonal Music* (New Haven, CT: Yale University Press, 1973); and Robert Morris, *Composition with Pitch-Classes* (New Haven, CT: Yale University Press, 1987).

⁴David Lewin, *Generalized Musical Intervals and Transformations* (New Haven, CT: The Yale University Press, 1987), 105-120.

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⁵Formula 1): Given $n \geq j$ and $0! = 1$, the number of subsets of cardinality j in a (super)set of cardinality n (n things taken j at a time) is: $C(n,j) = n! / (j!(n-j)!)$.

Formula 2): Given $n \geq j$ and $0! = 1$, the number of supersets of cardinality n for a (sub)set of cardinality j ($12-j$ things taken $n-j$ at a time) is: $P(n,j) = (12-j)! / ((n-j)!(12-n)!)$.

⁶ $COV(X,Y) = EMB(\text{comp}(X))$. Lewin, 1987, p.120; Morris, 1987, p. 90.

⁷David Lewin, *Generalized Musical Intervals and Transformations* (New Haven, CT: Yale University Press, 1987), 120.

⁸To save space the vectors for dyads covered by trichords, tetrachords, or pentachords are not included here. For a complete table of covering functions see also Robert Morris, *Composition with Pitch-Classes* (New Haven, CT: Yale University Press, 1987), 330, note 46; or Bo Alphonse, *The Invariance Matrix*. Ph.D. dissertation, Yale University, 1974, contains a subset and superset list. A computer generated list by Stephen Haflich in 1979 differs from the Alphonse list in that it distinguishes among the number of sets embedded in a nexus set and the number of ways a nexus set can be covered by a superset. For the present context this is a crucial distinction.

CONTEXTUAL EAR TRAINING

PAULA TELESKO

The development of aural analytical skills is a must for anyone who desires a thorough understanding of musical form and structure. It is, of course, an integral part of that study we call music theory—it is the wedding of the aural experience to abstract musical constructs. As both a theorist and a theory teacher, I believe that to hear music is to analyze it and to analyze music is to understand it more fully. This I would, above all, like to impart to my students. Unfortunately, this is easier said than done. So what is the best way to approach an ear training, or aural skills class? I have pondered that for a long time, and as a result, have developed and implemented some new and more successful strategies that I would like to discuss here.

One vexing problem for many aural skills teachers is the study of intervals. Do students need to be proficient at identifying random intervals before they can move on to something else? No, I don't believe so.¹ Do they need to be proficient at hearing scale degrees and relationships within the context of a key? Most certainly. Many students do not do particularly well with random interval identification, but can do well with other aspects of aural analysis. Nevertheless, the identification of intervals seems to be a major component of many ear training and sight-singing texts, CAI music software, and presumably, most ear training programs. But at the same time, many aural skills teachers question their importance—or the value of the method by which they are most often taught. A similar situation exists with regard to triads. Is there more to the study of triads than recognizing the four qualities as isolated events and hearing which voice has the root? These are the questions and concerns I will address here, and I will argue for a contextually-based approach to teaching intervals and triads in an ear training program.

Over the past several years I have experimented with different strategies for teaching aural skills, all of which emanate from my basic beliefs about exactly what skills I am trying to teach, how to integrate them with written theory, and how to do it in the most efficient way.

What skills *am* I trying to teach? There are different opinions about the purposes and goals of sight-singing and ear training,² so aural skills teachers must decide which goals they are pursuing before developing a program of

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study. With that image in mind, all activities must be coordinated to work towards that end. My goal is to produce musicians who can hear and think about music equally well—musicians who can understand and see what they hear and hear and understand what they see. I am not trying to provide merely a service by producing better sight-readers for the choirs and ensembles. If improved sight reading is a consequence, so much the better—a felicitous by-product, but not the point of the exercise.

The underpinning of my approach to teaching aural skills is that nothing a student learns in written theory or aural skills exists in a vacuum, independent of anything else. Theory and ear training are flip sides of the same coin—every component works to reinforce every other one. Consequently, everything in theory and ear training should be as coordinated and interrelated as possible. It is unfortunate that as a practical matter, the written portion of a standard theory class progresses much more rapidly than the aural skills portion, so there is a lag between what one has learned in theory and what one is learning in aural skills at the same time. This is not to say that examples of whatever is currently being taught in theory should not be played in class: quite the contrary. This is one of the best ways to interrelate the two and reinforce for the students the idea that hearing, seeing, and understanding go hand in hand.

One caveat: the strategies I am proposing are without question biased towards tonal music. Since most of a music major's two year theory sequence (at least 1 1/2 years in most schools) concerns itself with music of the common-practice period (i.e., Baroque through Romantic), this bias seems justified. Also, in light of the fact that this music is still very much with us in the concert hall, as well as in the music school, and because I believe that later styles can profitably be studied as outgrowths of, or reactions to, the tonal system, this emphasis seems warranted.

Since I am proposing a "holistic" approach, the discussion of intervals and triads needs to be prefaced by a discussion of what I believe should be the goals of sightsinging, and how best to work towards that end. My goal, when teaching sightsinging, is for students to learn to hear the functional relationships between notes in a key: their relationships to each other, and their relationship to tonic. Ideally, scale degree numbers should be sung, but since that would be too cumbersome, especially when alterations are added (which I think are absolutely imperative—^b6, #4, etc.), the monosyllabic solfege system is a very happy compromise.

I believe practicing sightsinging is one of the best ways to practice ear training. To memorize what certain patterns sound like from singing is to recognize them when listening. Learning position within a key by singing with that in mind becomes a tool one can use in either the classroom setting (taking dictation), or, more importantly, in any analysis one embarks upon,

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wherein one begins by listening to the music in question. Thus, sightsinging is an extremely important facet of ear training—it is how one begins to learn to hear music analytically.

Since I am advocating sightsinging to teach students to hear and recognize scale degrees (a skill I believe to be far more important than learning to hear isolated intervals), then only one method of sightsinging will be appropriate: the moveable-*do*/tonic-*do* system (*do* is tonic for both major and minor keys). Moveable-*do* has as its goal the learning of the tonal system, unlike the fixed-*do* system, or the moveable-*do*/minor-*la* system. Fixed-*do* can work towards improving reading skills, since the same line or space on any given clef always has the same syllable. But it imparts no functional meaning or significance to any note. *La*-minor is an interval approach. It measures the distance between syllables: *ti* to *do* is always a half step, whether in a major key functioning as the all-important, key-defining leading-tone to tonic relationship; or in its relative minor key, functioning as the much less critical supertonic to mediant relationship. At best, this system requires learning two sets of syllables to signify the same functions: one set for the major key, and one for the minor key. At worst, this system encourages hearing all minor keys in relation to their relative majors, rather than as independent keys of equal stature and validity. A tonic *la* is in actuality heard as being two steps below *do*, as opposed to being heard as a tonic in its own right.

Beginning exercises in my sightsinging classes stress learning to hear and retain tonic. At first, everything is done from *do* to emphasize tonic as the reigning entity and to develop a sense of tonic retention and centeredness. For example, after learning to sing a major scale with syllables, students begin singing each note of the scale from *do*: *do-re-do*, *do-mi-do*, etc. One sightsinging text that correlates well with this approach is the Berkowitz/Frontrier/Kraft *A New Approach to Sight Singing*,³ the text we use at Butler University. It begins with stepwise major-key melodies, all of which start and end on *do*—again, developing a sense of the primacy of tonic. Next, the text introduces melodies with skips in the tonic triad. Thus, major and minor thirds, perfect fourths, perfect fifths and even major and minor sixths are introduced early on, as the residual intervals, or resultant distances, between notes of the tonic triad in its various guises, as opposed to being introduced as intervals for their own sake. In fact, one need not even refer to intervals at this point. Students are simply learning to sing from one note of a tonic triad to any other note of that same tonic triad. This skill is fundamental: to be able to recognize and sing a tonic triad in any of its presentations as soon as possible.

A different approach employed by some sightsinging and ear training texts is one in which melodies are categorized and presented according to

interval content.⁴ These books progress by adding melodies with successively larger intervals: seconds, thirds, fourths, etc. However, I contend that singing a third in a ii, IV or vi chord, for example, is much more difficult for a beginning sightsinging student than singing a third in a tonic chord. Why? Because a beginning aural skills student has not yet progressed to hear internally all those different harmonies within a tonal framework.

There is a critical distinction here that lies at the heart of my approach to teaching intervals and triads. A sightsinging program that progresses by interval reinforces the "interval" way of hearing tonal music, which I don't believe is the primary way most of us really process music.⁵ In tonal music, intervals have no meaning outside of the context of a harmony and/or key, and in this tonal context, like intervals can sound very different. The major third from *do* to *mi* (as part of a tonic harmony) is the epitome of stability, and should be experienced as such, whereas the major third from *sol* to *ti* (as part of a dominant harmony) is anything but stable. It is the antithesis of the tonic third and needs to resolve to tonic. The urgency of the upper note of this third, the leading-tone, to resolve up by half-step to tonic is palpable. This is not at all paralleled by the major third from *do* to *mi*. Or, to cite a different kind of example, think of the case of enharmonic intervals. Out of context there is no difference, but in a tonal context there is a world of difference between, say, an augmented sixth and a minor seventh. Similar examples abound in tonal music.⁶

So what is the purpose of teaching intervals *per se*? I would argue that we should instead be teaching students to hear the larger relationships: scale degrees, harmonies, and the affinities of notes for each other. Intervals should be taught and understood only as parts of harmonies, not as discrete units to be recognized in the absence of a tonal context. Clearly then, when practicing sightsinging with these harmonic goals in mind, one should progress not by interval, but by harmony. Consequently, after practicing melodies with skips in the tonic triad, one would proceed to melodies with skips in the dominant or subdominant triad, and so on.

Since I have, for a number of years, taught sightsinging in this manner, I realized that to be consistent, I needed to approach ear training and dictation in the same way: to wit, intervals are the distances between scale degrees, not isolated events. Moreover, since the same interval can have very different tendencies, and even different meanings, depending on the context and the scale degrees involved, I wanted to develop a method of practicing scale degrees and intervals that would make the students aware of and sensitive to these different tendencies. Interval practice therefore begins in ear training almost immediately, but, similar to sightsinging practice, without referring to intervals as such. It is only after intervals have been taught in written theory that they are referred to specifically in ear

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training. This approach therefore de-emphasizes intervals while stressing scale degrees, tendencies, and tonic retention.

Scale-degree exercises are done as follows: a key is established, generally by playing a short cadential pattern. Students are asked to sing *do*. Some other scale degree is then played, and students are asked either to sing from that scale degree up or down to *do*, or to sing *do* and then sing up or down to that scale degree. They then identify that scale degree (by syllable). In between each exercise, students are asked to sing tonic. Thus, not only are they learning scale degrees in relation to tonic, but they are also learning, through constant repetition, to retain tonic and to use it as a constant reference point. Naturally, the students are hearing and singing intervals (from tonic to scale degree “x”), but they are not yet labeling them as such.

This exercise also lays the foundation for the next one, another scale degree/interval exercise done without reference to intervals, at least at first. Now instead of hearing one scale degree in relation to tonic, students hear two scale degrees (one of which may still be tonic). For example, after establishing tonic, I may play *ti-re*. Students first sing *do*. They then sing the two pitches they heard, usually on a neutral syllable, and sing up or down from tonic until they find the two pitches, which they then sing on syllables. They are again singing an interval, but more importantly, they are learning the relationship of two scale degrees to each other, and to tonic. As students learn intervals in theory, we gradually add in the interval names for the scale degrees. At this point when students sing “*ti-re*,” they also sing “minor third”:

Figure 1.



Lastly, we listen for the interval's tendency to resolve, if there is one. In this case, the resolution is to tonic, so I would have the students sing tonic after they sing the interval.⁷

In addition, and I believe this to be a crucial point, I don't randomly choose any two scale degrees. I choose scale degree pairs where the corresponding interval is most often, or very often encountered. And, I might add, I don't choose them for the sake of the interval, but for the purpose of familiarizing students with important relationships in tonal music. So, for example, the ascending perfect fourth from *sol* to *do* is

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practiced frequently, because of its all important key-defining characteristic—the V to I relationship encountered so often in bass lines (whether as a primary relationship or a secondary relationship: *re-sol*, for example, is still *sol-do*, but on a secondary level). Conversely, I rarely practice perfect fourths from *ti* to *mi*, because that fourth has little or no significance, at least in terms of frequency. (Mediant chords in a major key are rare as it is, and a tonicized mediant is rarer still. The most typical usage is, of course, in a circle-of-fifths progression.)

The point I want to stress to my students is that even though most diatonic intervals can be found in several or many places in a key, certain intervals are encountered much more frequently in certain harmonies, or on certain scale degrees, than others. A minor seventh, for example, can be found diatonically in five different places, but its most important function is to define tonic, as part of a V7, from *sol* to *fa* (or acting as *sol* to *fa* on a secondary level).

Here, then, is a chart to illustrate the scale-degree pairs I use most often, along with their corresponding interval labels. (The scale-degree pairs that are starred get a bit more attention.)

Let me re-emphasize that I am not concerned with teaching intervals as discrete aural phenomena, but teaching important tonal patterns that can be given interval labels.

The next step in the process is to relate these intervals to triad types and harmonies. I begin this while students are learning about triads and harmonies in theory. Students first need to learn what syllables/scale degrees are in each diatonic triad. I, in fact, give written quizzes on this, to encourage them to learn these quickly. We then start talking about what harmony a particular scale degree pair most likely belongs to. So, for instance, after establishing tonic, I may play *ti-re*. The students sing back "*ti-re*, minor third." I then ask them what harmony this particular scale degree pair/interval most likely belongs to. The obvious answers are V and vii⁰. We also consider the possibility that two different harmonies may be involved. If I instead played *re-ti*, then ii-V becomes a possibility as well. My hope is that with this type of approach, the skills learned in ear training will transfer more directly to work in theory and performance: if the student sees, for instance, an ascending perfect fourth in the bass line of a Baroque composition, the student will think and hear *sol-do*, and recognize it as some kind of V-I relationship, whether primary or secondary.

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Figure 2.

I. Pairs used for ascending intervals found in major keys:

m2: *Ti-do, mi-fa	M2: *Do-re; re-mi, *fa-sol; sol-la
m3: *Ti-re; *re-fa; *mi-sol	M3: *Do-mi; *fa-la; *sol-ti
P4: *Sol-do; do-fa; re-sol	
P5: *Do-sol	
TT: *Ti-fa; *fa-ti	
m6: *Mi-do	M6: *Sol-mi
m7: *Sol-fa	M7: Do-ti; fa-mi

II. Pairs used for ascending intervals found in minor keys:

m2: Re-me; *sol-le	M2: Me-fa
m3: *Do-me; *fa-le	M3: *Me-sol
m6: *Sol-me	M6: *Me-do
d7: *Ti-le	

III. Pairs used for descending intervals found in major keys:

m2: *Do-ti; *fa-mi	M2: *Re-do; *mi-re; sol-fa
m3: *Re-ti; *fa-re; *sol-mi; do-la	M3: *Mi-do; *la-fa; *ti-sol
P4: *Do-sol; fa-do	
P5: *Sol-do	
m6: *Do-mi	M6: *Mi-sol
m7: *Fa-sol	M7: Ti-do

IV. Pairs used for descending intervals found in minor keys:

m2: Me-re; *le-sol	M2: Fa-me
m3: *Me-do; *le-fa	M3: *Sol-me
m6: *Me-sol	M6: *Mi-sol
d7: Le-ti	

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I approach the study of triads in the same way. While I believe that a certain amount of "triad quality" recognition should be present, especially at the beginning stages, quality alone is not sufficient. Just as it is with intervals, so it is with triads. Like-quality triads, in the context of a key, may not sound the same at all. For example, take the case of the ii chord, a minor triad in a major key. In context, whether in root position or first inversion, this chord does not to my ear sound nearly as "minor" as either a minor tonic or a minor subdominant in a minor key. I believe Rameau's assertion that a ii⁶/5 is really a subdominant chord with an added sixth, and by extension, that ii⁶ is a subdominant chord with a sixth replacing the fifth, and I really do experience it that way. Having the strong subdominant note in the bass with a major third above it gives this ii⁶ chord a quality somewhere between major and minor, and arguably closer to major. So very soon after introducing triads in theory and introducing the sound of major, minor, augmented, and diminished triads, we start identifying single triads in the context of a major or minor key. I again establish a key with a short cadence and have the students sing *do* frequently to keep that focal point in their inner ear. Then as a triad is arpeggiated, the students sing the syllables and identify the triad by Roman numeral, inversion, and type. Their beginning chord repertoire includes the following chords and inversions:

Figure 3.

I/i, I ⁶ /i ⁶ , I ⁶ ₄ /i ⁶ ₄	ii/ii ^o , ii ⁶ /ii ^{o6}	IV ⁶ ₄ /iv ⁶ ₄
V, V ⁶	vii ^o , vii ^{o6}	

I coordinate this harmony identification practice with their sight singing in several ways. One is by analyzing the melodies in their sight singing text before singing them, looking for any harmonies that they recognize. Another is by singing harmonic progressions, in the form of exercises I have given to the students on handouts.⁸ One handout is a melodically written out circle-of-fifths progression in both a major and a minor key. A Roman numeral is placed under each harmony:

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Figure 4.



The purpose is to make explicit the harmony students are singing when they sing a particular group of syllables. The emphasis is again on scale degrees and harmonies in context, not just quality of the triad or where the root is. An added benefit of this particular exercise is that it presents a good opportunity for students to see melodic lines as written-out chord progressions, or, stated another way, to see harmonies horizontalized. It helps reinforce the notion that, Bach chorales notwithstanding, most tonal melodies do not present a series of pitch classes to be harmonized individually, but rather successive groups of notes that belong to a single harmony. This type of harmonic practice has another benefit as well: it feeds right into the practice of taking harmonic dictation.

Given the type of scale-degree practice and triad/harmony practice that a student would have had up to this point, it makes sense to begin harmonic dictation as a logical extension of that practice. I introduce it when students are learning about harmonic progressions in their written theory (i.e., what chord successions are likely or unlikely in this style). We begin with bass lines. Students hear a short bass line, sing it back on syllables, and determine the most likely chord progression or progressions that would fit that bass line. We discuss the possibilities of, say, a *do-fa-sol* bass line.⁹ The most likely progressions are of course I-IV-V, or I-ii6-V. Without any further information, the second chord remains in question, but the first and third chords can reasonably be assumed to be I and V, respectively. The next step is to play the soprano. If *do* is the second note, then the second chord must be IV. If *re* is the second note, the second chord must be ii6.¹⁰

Students work for a while exclusively with bass and soprano lines as a way to learn typical tonal patterns or clichés that suggest certain chord progressions, and also as a way to learn to distinguish bass and soprano lines from each other, and from the other notes that will be present later in three- and four-voice chords. When only two voices are played, triad quality cannot be ascertained with 100% accuracy (i.e., is it IV or ii6 if *la* is in the soprano?), but students learn instead to concentrate on what the possible chord choices are, given a particular bass and soprano line and a tonal context, and they realize that the choices are limited indeed. Natu-

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rally, when other voices are added, chord quality becomes a factor, and provides additional information, but it is neither the only information nor the most important information to be processed. I discourage listening primarily for chord quality and location of the root since that encourages vertical listening and thinking, almost to the exclusion, it would seem, of hearing the individual lines in a musical texture. Rather, by combining the various pieces of information that the student has (bass and soprano notes, knowledge of typical tonal chord progressions, and the chord qualities), the student can make an informed decision that will be at worst, reasonably accurate.

Obviously, the more information students have, and the more they know about what to expect given this information, the more they will be able to recognize and understand what they have heard. Working in stages by playing just the bass line first, adding in the soprano next, adding in the complete chord last, and stressing the need to integrate this aural information with the information being taught in written theory helps students tremendously in working with chord dictation.

Without a systematic approach, such as the one I am proposing, students often feel frustrated and lost when trying to do chord dictation. They do not know where to begin or how to determine what any particular chord or chord progression might be. They often do not realize that in a typical, tonal 5-chord progression (e.g., I - ii⁶ - I⁶/4 - V - I), not every possible chord is a choice for each of the five chords. But knowing the bass and soprano note for every chord eliminates many of the possibilities, and knowing something about musical grammar and syntax narrows down the choices even further. What remains are reasonable choices. If *fa* is in the bass and *la* is in the soprano and the student still can not discern whether the chord is ii⁶ or IV, the error is not so egregious. Both would be equally likely and possible, and distinguishing between them is not nearly as crucial as between, say, a ii⁶ and a vi⁶/4, chords that are neither interchangeable nor equally likely to appear in any given context.

As a cautionary note, I would like to paraphrase Karpinski and point out that my goal when teaching harmonic dictation is not to produce musical shorthand takers.¹¹ It is to produce students who can hear a passage of music and recognize and understand what is happening harmonically. There is much to be gained by students through the working out of the solution to the harmonic progression they have heard. It is vitally important that students learn to use all the information they have when listening to music in order to know and understand what they are hearing. Probably more than any other exercise normally practiced in an ear training class, taking harmonic dictation forces students to integrate the aural information they are receiving with the theoretical information they al-

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ready have in order to come up with the correct answer (or at least a very plausible answer).

To illustrate, let's assume a student hears a harmonic progression and is unsure of chord #4. The student must first remember what was heard and then sing it back silently. Say in chord #4, the student heard *le* in the bass and *fi* in the soprano, and heard both notes move outward by half step to a dominant octave. Further, let's assume that the student knows that the defining characteristic of an augmented-sixth chord is the interval of an augmented sixth, which typically resolves outward to the dominant octave. Our student has a lot of information, both aural and theoretical, on which to base a decision. Bringing all that information to bear on this progression, our student can reasonably assume that the chord in question was an augmented sixth. On a subsequent playing the student will be expecting an augmented-sixth chord and will listen with that expectation and perhaps now hear at least two chords as a musical unit: the augmented sixth and the V to which it resolves, and which *ipso facto*, helps to hear the augmented sixth *as* an augmented sixth.

Summary

I have attempted to offer suggestions for some new strategies that I have found useful and successful in teaching ear training, especially regarding the thorny issue of how to teach intervals in ear training, if at all. In my own teaching, I have been particularly encouraged in my approach by students who have already had some high school or college level ear training, and who therefore have a basis for comparison. They comment that this type of systematic, contextual approach has been much more beneficial to them than the less methodical non-contextual approach they were exposed to previously. I continue to experiment and try out new strategies, and hope that the foregoing discussion will persuade others to do likewise.

NOTES

¹See, for example, William Thomson's "What is an Interval?". *JMTP* 2/2 (Fall 1988): 321-324; and Michael Rogers' "Beyond Intervals: the Teaching of Tonal Hearing," *Indiana Theory Review*, 6/3 (Spring 1983): 18-34.

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²I believe the label "ear training" encompasses all the activities that take place in an ear training, or aural skills class, including sightsinging. However, for the sake of clarity, my use of that term here will include all activities *but* sightsinging. I will always refer to sightsinging separately as such.

³Berkowitz, Sol, Frontrier, Gabriel and Kraft, Leo. *A New Approach to Sight Singing*, 3rd ed. (New York: W. W. Norton, 1986).

⁴For a review of recent sightsinging and ear training texts, see Gary Karpinski's "Five Recent Sight Singing Texts," *JMTP* 2/2 (Fall 1988): 275-296; and "Ear Training and Integrated Aural Skills: Three Recent Texts," *JMTP* 3/1 (Spring 1989): 127-149.

⁵This assertion would seem to be substantiated by, among other things, Gary Potter's experiment, detailed in his article "Identifying Successful Dictation Strategies," *JMTP* 4/1 (Spring 1990): 63-71.

⁶Michael Rogers, op. cit.

⁷This sense of instability/resolution is not only an aural phenomenon, but is, of course, dependent in part on a knowledge of tonal chord progression. At this point, however, since students will not yet have encountered that topic, the discussion of tendencies is limited for the most part to the 1/2 step phenomenon: *ti* has a strong tendency to go to *do*, *fa* has a tendency to go to *mi*, and together they have a very strong tendency to go to the *do-mi* major third.

⁸I would like to thank Michael Rogers for this idea.

⁹The students must at this point have learned what syllables are in each diatonic triad.

¹⁰I say "must" because I'm working at an elementary level. In doing this type of practice, I do limit the student's chord choices. I begin with a small repertoire of chords and inversions, and gradually add in new chords and inversions. I want students to be informed listeners, and so to that end I encourage students to make educated guesses, in keeping with the choices they have. Thus, neither *ii*6/5 nor *vii*°6/4, for example, would be a possibility at this point. In addition, at these beginning stages, and even at a more advanced level, any time a new chord is introduced, I keep what I call a "determining" note in the soprano. By this I mean simply a note that makes clear what the chord is. If *fa* is in the bass, I will play *do* in the soprano for a IV chord, and *re* for a ii chord, making the chord choice unequivocal. *La* or *fa* in the soprano would not be an unequivocal choice, and so would not be used *initially*.

¹¹Karpinski, Gary, "A Model for Music Perception and its Implication in Melodic Dictation," *JMTP* 4/2 (Fall 1990): 191-229.

REVIEW OF RALPH TUREK, *THE ELEMENTS OF MUSIC*

KENNETH STEPHENSON

A colleague of mine recently related to me that he had been shocked several years ago when asked, on a graduate entrance exam, to perform a harmonic analysis of a passage from a Mozart piano sonata—shocked because in four years of undergraduate theory, he had never learned that harmonic analysis could be applied to anything other than a Bach chorale. Fortunately, the scope of beginning theory classes in this country, as well as of the textbooks used in these classes, is increasing. Piston's inclusion of passages from Wagner and Chopin in *Harmony* and Kraft's incorporation of modified Schenkerian methods in *Gradus* provide notable examples from previous stages in the process.

This broadening of subject material is due in part simply to changing ideas about what "theory" means. But it is also due in part to logistical necessities of teaching undergraduate theory in today's college or university. With ever growing demands from accreditation agencies, state education boards, and general-education committees, music programs are no longer able (assuming they find it desirable) to require four or even three years of theory. The two trends are violently opposed: instructors feel they must teach their students much more than just harmony—forms, counterpoint, twentieth-century techniques, reductive analysis, etc.—and they have less time to do it. Still instructors seem reluctant to let students graduate from a theory program without some solid skills in four-part writing. Thus, recent textbooks for beginning theory courses often emphasize harmony, while including a few chapters on other topics. Kostka and Payne's *Tonal Harmony*, for example, includes chapters on period structure, "levels of harmony," and twentieth-century music.¹ Benward and White's *Music in Theory and Practice* includes chapters on melodic structure, form, Renaissance and Baroque counterpoint, and twentieth-century music.²

Ralph Turek's *The Elements of Music*, provides a third example.³ Turek's goals, as indicated in the preface to the instructor, indicate that the text is intended to fulfill the needs of the modern undergraduate theory program:

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If, at the end of a two-year course of study using this text, students possess a command of essential compositional/analytical skills (including a strong grounding in four-part writing) and have an understanding of the ways in which the various musical elements interact to create form and style, then the goals of this text will have been realized (I, xi).

We must leave aside the question whether these goals are feasible; in many schools it is imperative that the instructors at least try to achieve them. In such a situation, this book is highly appropriate.

One of the great strengths of this text is the abundant use of passages from the literature both as examples in the body of the text and as starting points for exercises. The student is almost always aware of the relationship between the concepts learned and actual music. In Chapter Three, "Scales, Key, Mode and Intervals," Turek implies (the instructor must make the point explicit) that the description of preexisting music is the primary purpose of each conceptual segment of music theory. Major and minor scales, for example, are presented as pitch sources for "most of the music composed in Europe and the United States during the past three hundred years or so" (I, 43). Alterations in the minor scale are to be learned because they occur in actual music; Turek's use of the past tense strengthens the point: "In actual practice, [the natural minor] scale was rarely used without certain alterations" (I, 51).

I would be even more enthusiastic had Turek taken the same empirical approach with rhythm and meter. Showing that the concept of compound meter is necessary for explaining much music that the student knows and loves goes a long way, I have discovered, to mollifying the traditionally negative response to the topic. The introductory chapter on harmony is also uncharacteristically devoid of examples from actual literature, except in the exercises.

After the first four chapters, a passage from actual literature can be found on nearly every page in the body of the text, and on many pages in the exercises. Most of the examples are taken from keyboard literature; occasionally a symphonic passage is found, generally in piano reduction. Examples are used even where not necessary. The student is asked to name the harmonic intervals in a Lassus passage, for instance, just for the sake of extra practice in naming intervals.

Another of the strengths of this text is that by virtue of its layout and of its incorporation of study aids, it facilitates learning the content and it encourages good study habits. The books are bound with plastic rings; they

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may be ragged by the end of two or three semesters, but the pages lie flat on a piano music rack. Every page of text has a wide, 2-1/3" margin for notes. Every chapter is clearly organized with the names of main topics printed in bold in the margins, and principle terms are printed in italics in the body of the text. At the beginning of every chapter is a list of terms to know. For instance chapter 8 of volume I, "Functional Tonality; Principles of Harmonization," begins with the following list:

- arpeggiated six-four chord
- cadential six-four chord
- functional tonality
- harmonic rhythm
- passing six-four chord
- pedal six-four chord
- pre-dominant
- progression
- repetition
- retrogression
- seventh chord
- six-four chord (I, 188)

Interestingly, Turek often leaves out an obvious term. The list at the beginning of the chapter entitled "Voice Leading," for instance, does not include the term "voice leading." A glossary of terms is in the back of each volume. (No entry for "voice leading" exists.) At the end of most chapters (why not all?) is a self-test, the answers for which are found in the back of the volume. Of course, few students will voluntarily take advantage of these aids, but none could use them if they were not present.

For the instructor in a program that requires only two years for some or all of its students, the greatest strength of these volumes is their inclusion of a broad range of topics. Material on melodic structure, including a section on reductive analysis, is included in volume I. Chapters on counterpoint, including a brief introduction to species counterpoint, are included in volume II. Both volumes include chapters on form. Many chapters place compositional techniques in a historical context, and volume II contains in chart form a summary of the historically evolving use of chromatic harmony. Appendices cover such topics as acoustics, instrument transpositions, and jazz harmonies. And volume II includes six chapters on twentieth-century music. Even harmony is treated more broadly than in the past;

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in addition to sections on analysis and figured-bass writing, most chapters on harmony include a section on harmonization of a melody.

The chapters on melody begin right after the chapters on what is commonly called “fundamentals.” Thus, Turek begins his look at living music through the topic of melody. Balance of tension and repose, motivic development, period structure, tonality, and embellishing tones (passing tone, suspension, etc.) are all introduced in the context of melody. The student is not only saved from thinking that “theory” means “harmony”; she is also introduced to some very important foundational ideas in the non-intimidating context of the single line. At this point, the student only needs to know enough harmony to know whether a melodic note fits the current chord (identified by letter name, not roman numeral).

While the material is more accessible (and more valuable) in this form, Turek does not shy away from complicating an issue when necessary. Relative strength of cadences provides a good example. When taught in terms of harmony, cadences usually are said to come in three gradations of strength: a cadence may be a half cadence, an imperfect authentic cadence, or a perfect authentic cadence. While many books mention differences in metrical placement, most label such cadences with sexist terminology (the students generally object to the terms, too) without explaining the value of the concept. Turek steers away from mere exercises in labeling, mentioning several factors that affect the strength of a cadence, and even implies that one listener’s interpretation may differ from another’s (notice the phrases “usually sounds” and “can weaken”):

Between the most and least conclusive sounding cadences lie gradations. Following are some factors that affect the conclusiveness of a cadence.

1. Pitch: The tonic is the most conclusive of all cadence pitches.
2. Harmony: A pitch accompanied by the tonic triad usually sounds more conclusive than one accompanied by another chord.
-
3. Metric position: Other factors being equal, a metrically strong cadence pitch sounds more conclusive than a metrically weak cadence pitch.
4. Rhythm: An immediate continuation of rhythmic motion in the melody or continuing motion in the

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accompanying parts can weaken an otherwise conclusive-sounding cadence. (Vol. I, 107-108.)

(Musical examples accompany each of these statements.)

The reduction technique described in chapter 6 is a simplified method in which notes are assigned to one of three levels of importance: structural tones, supporting tones, and embellishing tones. (I object to the use of the word "importance" in this context. Turek himself demonstrates in this chapter that some very different melodies may be based on the same skeleton of structural tones. Thus, the embellishments can be said to be the more important tones in a melody in the sense that they are what distinguishes one melody from another.)

Structural tones, explains Turek, "tend to be":

1. longer and/or metrically stronger than other pitches.
2. more important by virtue of their positions at the beginning or end of a phrase or as the highest or lowest pitch of the phrase.
3. supported by the underlying harmonic structure. (I, 148)

(Note that Turek implies an argument against strict pigeon-holing by the use of the phrase "tend to be.") Supporting tones, says Turek

1. are usually (not always) members of the underlying harmonic structure.
2. are generally longer and stronger than embellishing tones.
3. are sometimes elaborated by an embellishing tone. (I, 148)

Earlier, he explains

Embellishing tones are tones of secondary importance in a melodic line. they are usually not part of the harmonic structure and are therefore called nonchord tones when they appear in a harmonic context. They are usually of short duration and receive little emphasis through pitch and metric placement. They usually create a dissonance [footnote deleted] against a more important pitch in another voice, and they usually resolve by step to a more important pitch in the same voice. (I, 139)

It is very refreshing to read in an undergraduate textbook an explanation of embellishments in which their status as nonchord tones is secondary. When students learn about embellishments in the context of chorale-style harmony, they are lost in a sea of circular reasoning when they later look at piano music or other music of a more complex texture: being able to find nonharmonic tones means being able to know what the prevailing harmonies are, but determining harmonies means being able to distinguish harmonic tones from nonharmonic tones. In the case of even normally complex musical textures, listeners must (intuitively, at least) understand the concept of embellishment before they can hear harmonies. Similarly, the student analyst needs to learn to recognize embellishments before she can analyze harmonies.

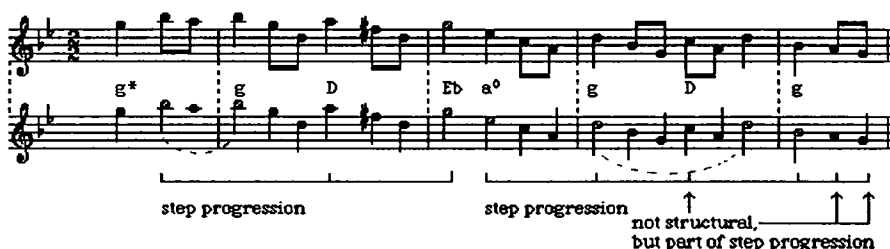
Turek notates a melodic reduction using half notes for structural tones, quarter notes for supporting tones, and noteheads for embellishing tones. A prolongation of a single tone is marked with a dotted tie. Step progressions are marked with brackets. (See figure 1.)

The chapters on twentieth-century styles cover mainly music from the first third of this century; the last chapter, "Recent Musical Developments," deals cursorily with indeterminacy, prepared piano, "textural counterpoint" (the term is loosely defined; the example is Penderecki's Threnody), and "unusual effects" (George Crumb). I will hazard the guess, since I would probably have done it the same way, that Turek wanted to treat mainly technical, objective matters, and felt that multiplicative operations and metric modulation were too complicated for sophomores. Chapters 11-13 treat the use of church modes, pentatonic scales, whole-tone scales, synthetic scales, planing, quartal harmony, extended tertian harmony, added-tone harmony, pandiatonicism, bitonality, polymeter, and asymmetric meter through examples from the work of Debussy, Ravel, Ives,

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Stravinsky, and Bartok, and explain these techniques as “logical extensions of traditional practices” (II, 263). The language of this music from the early part of the century is called “non-functional tonality” (II, 249) or “freely-tonal” (II, 285).

Figure 1. Turek’s melodic analysis of J. S. Bach: English Suite No. 3, BWV 808 (Gavotte I). (I, 151)



*Harmonies are indicated by letter name designations.

Chapter 14, “Intervallic Organization,” is actually a very clear 7-page introduction to set theory with a 4-page application of the ideas to the third of Webern’s Fünf Satze für Streich-quartett. The chapter begins with a historical explanation of the atonal or pantonal (both terms are applied) music of Schoenberg, Webern, and Berg as a strand of music history separate from that represented by the composers named above, a strand tracing back to the chromatic music of Wagner. The following chapter, “Serial Procedures,” starts with these three Viennese composers, but, as a demonstration of what varied types of music might be written with serial procedures, continues with examples from Stravinsky, Dallapiccola, and Babbitt. While the exercises in these chapters are mainly technical—the student is asked to spell quartal harmonies, identify sets, and build matrices—Turek constantly makes reference to the subjective, bringing up such issues as what aural image a quartal harmony presents and why, why composers might have wanted to use sets to organize their work, and for what kinds of music different rows would be appropriate.

Turek’s progressive bent is revealed in not only the broad scope of the included topics, but in the way he talks about these topics as well. For instance, the augmented-sixth chord is introduced as a sonority formed by melodic tendencies. An example in c minor is given first (the theme from

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Beethoven, Thirty-Two Variations in C Minor). Then Turek notes, "At m. 5, the push toward the dominant is enhanced by the altered tone f-sharp in the upper voice" (II, 70). Later, he adds

Like the Neapolitan sixth chord, the augmented sixth chords are found most often in minor keys at the approach to a cadence, preceding the dominant or the tonic six-four chord. Their nature is linear—that is, they are the result of a chromatic alteration designed to create a strong melodic push toward the dominant.

(A minor criticism: I wish Turek had used a hyphen in the phrase "augmented sixth chord.") Of course, in all practicality, nearly every student needs a step-by-step method for spelling these sonorities as harmonies, a method that, no matter how clear, many will struggle with, and some will never see beyond. Turek does provide such a method, but only on the third page of the section, after providing the student with an example and with a concept of a sound and of a context.

The main problem with this text has to do with the exercises: simply not enough exist. Volume I begins promisingly with several rather large exercises devoted to identifying pitches on a staff. But by chapter 4, "Harmony," the exercises are already too small. For example, the student is given ten sonorities on a grand staff and asked to tell whether they are triads and, if they are, the root and quality of the triad. Three of the sonorities are not triads, so the student is left with only seven to identify; one-hundred would not have been too many. A later exercise presents twenty triads in root position on a single staff for identification by letter name and quality; again, more would have been welcome, and, in any case, with this exercise the student does not receive any more practice in rearranging notes into stacked thirds. No exercises exist at all that ask a student to construct a triad given a key and a roman numeral, although this is the chapter in which roman numerals are introduced.

Workbooks containing supplementary exercises are available for each volume. Turek explains in the introduction to the workbook for volume 1, "Workbook exercises have been designed to complement those of the text by offering subtly different approaches to the theoretical problems" (workbook, I, v). This extra source solves the problem to some extent, but the "subtly different approaches" often make the exercises in the workbook more complicated than the exercises in the textbook, too complicated, in fact, for most students.

For instance, Turek asks students to re-notate in three-four a passage

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originally in five-eight (workbook, I, 12); to name scales in which the three notes of a given trichord appear (workbook, I, 24; the first trichord given is f, b, c-sharp); to write triads of various qualities from a note given as a third or a fifth (workbook, I, 30; the student is asked in the textbook to spell only twenty triads, five of each quality, from a note given as the root); and to determine a key and construct a Neapolitan sixth chord from a given bass note (workbook, II, 19). All of these exercises would be valuable if the student had first been given fifty to one-hundred of the very most basic exercises possible for a given topic: re-notating from three-four to three-two; writing and recognizing complete scales; writing triads of each quality from given roots; and writing and recognizing Neapolitan chords in a given key. The teacher can always create her own supplementary exercises, but then part of the reason for textbooks is to save instructors the trouble.

The first chapter's exercises are well-designed also in that the student can do the first few exercises after reading only a few pages. But for chapter 14, "Rounded Binary and Ternary Forms" (I wonder if some students might not be misled by the absence of the hyphen in this case), the student must read the entire chapter and understand both forms before he can do exercise 1, which asks him to "provide a complete analysis of the following works." The instructions continue:

FORMAL STRUCTURE

Be certain to explain why the piece is a rounded binary and not a ternary form, or vice versa.

MELODIC/RHYTHMIC STRUCTURE

Consider phrase-period structure, large-scale melodic motion, motivic structure, and rhythmic character.

HARMONIC/TONAL STRUCTURE

Be careful to distinguish between modulations and tonicizations.

TEXTURE/ARTICULATION/DYNAMICS

Do not neglect the important part these elements may play in creating the similarity and contrast that defines many forms (I, 308-309).

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Again, the teacher can always alter the directions, using the pieces provided but asking students to perform simpler tasks. But in my experience, departing from the written word where homework instructions are concerned always causes trouble.

A final complaint about the exercises: most chapters are divided into parts designated by capital letters. Many of these chapters have exercises organized in a parallel fashion: assignments for part A, assignments for part B, etc. The individual exercises themselves are designated by letter, also. Thus the instructor is constantly asking students to do part B, exercise A. I hope this confusing system of labeling will change in future editions.

The deficiencies in the exercises do not, in my opinion, outweigh the advantages of the broad range of topics, the study aids, the clear definitions, the progressive explanations, and the abundance of examples from real literature. For the institution that teaches a wide spectrum of topics in a few semesters of a core theory sequence, *The Elements of Music* is highly recommended by this reviewer.

NOTES

¹Stefan Kostka and Dorothy Payne, *Tonal Harmony, With an Introduction to Twentieth-century Music*, 2nd ed. (New York: Knopf, 1989).

²Bruce Benward and Gary White, *Music in Theory and Practice*, 4th ed., 2 volumes (Dubuque, IA: Wm. C. Brown, 1989).

³Ralph Turek, *The Elements of Music: Concepts and Applications*, 2 vols. plus workbooks (New York: Knopf, 1988). References to textbooks are made by volume number and page number. References to workbooks are made using the word "workbook," volume number, and page number.

REVIEW OF THREE TWENTIETH-CENTURY TEXTS

JOEL PHILLIPS

Stefan Kostka. *Materials and Techniques of Twentieth-Century Music*. Englewood Cliffs: Prentice Hall, 1990.

Joel Lester. *Analytic Approaches to Twentieth-Century Music*. New York and London: W. W. Norton, 1989.

Joseph Straus. *Introduction to Post Tonal Theory*. Englewood Cliffs: Prentice Hall, 1990.

The three books discussed in this review, all theoretical in nature, are designed to meet the needs of undergraduate music majors who take a class that introduces them to twentieth-century music. Two of their authors, Lester and Straus, take a more restricted approach to the subject to achieve greater depth, while Kostka explores a wide range of basic materials in what must be, of necessity, a more superficial manner. Human nature being what it is, it seems safe to say that some of my remarks will seem inevitable: I would like to see the more focused discussions broadened and the survey approach more focused.

All three of the texts deal with aspects of set theory to a greater or lesser degree, confirming the tendency by many to present this material at the undergraduate level. Because these new textbooks are consolidating material that once had to be gathered from a number of sources, some teachers may see less need to draw from additional sources such as the introductions to Forte's *The Harmonic Organization of the Rite of Spring*¹ and Schmalfeldt's *Berg's Wozzeck*², or to develop their own course handouts.

I believe strongly that every effort should be made to ensure that a textbook's material is organized and presented in a manner that is of maximum benefit to the student. Therefore, when examining each book in turn, I will first summarize its contents and organizational aspects, and then discuss its physical attributes. I will conclude my remarks by focusing on some of the features that distinguish the content of each book. In addition,

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I will interject several asides that relate to pedagogical considerations as they arise.

KOSTKA

Stefan Kostka's book is by far the most general text of the three examined in this review. His book is comprised of fifteen chapters loosely organized by compositional technique. Each chapter contains a number of subtopics that can be easily located by examining the table of contents. At the conclusion of each chapter there is a summary, bibliographic notes, and a series of exercises that cover fundamentals, analysis, and composition using the materials discussed in that chapter. Important terms are italicized in the body of the chapter. There are numerous musical examples from a variety of composers.

The book's physical design and layout is beautiful. The text is large and easily readable. There is plenty of margin for annotations and, believe me, you will want to write things in these margins. A great many examples of all kinds are very attractively presented; the musical examples, in particular, are reproduced as clearly as any I have ever seen.

Kostka's chapter titled "Classical Serialism" is perhaps the best chapter in the book. The basic material is presented with clarity and simplicity, though not without error. Kostka states "the matrix or 'magic square' allows you to see all 48 versions after writing out only 12 [sic] of them" (p. 209). Teachers will find that the materials in some of the other chapters, such as the chapters on rhythm and acoustical timbre and texture, to also be very useful. Throughout the book there are numerous widely used terms that are defined and illustrated with short musical examples from a variety of sources. Moreover, the book is the only one of the three to discuss, rather than simply mention, some important topics such as electroacoustic music.

Despite such merits, however, my impression of the book is colored by a perception that in many places the approach is simplistic and dated. This impression is compounded by the author's tendency to present the information in a manner that may be characterized as imprecise or misleading.

Consider the following: "The actual spelling of the octatonic scale is optional . . ." (p. 34). "If it [the octatonic scale] has a weakness, it is its symmetrical construction, a characteristic it shares with the whole-tone scale, which can make establishment of a tonal center more difficult" (p. 35). "Bass notes usually want to be roots of a chord, if they can . . ." (p. 52). "The analysis of atonal music has largely become a process of identifying and labeling . . . important pitch sets . . ." (p. 186). "Minimalism opposes the atonal ideals of the incessant recycling of pitch material . . ." (p. 322). No

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doubt these and other statements throughout the book are the result of a commendable effort to communicate more meaningfully to students, but their unintentional effect is to reinforce the weakness of expression that is already found in the writing of most students.

The first quarter of the book is disappointing. When discussing chords and scales the author himself does not seem to grasp the fundamental differences in the way composers have dealt with pitch materials in this century. We find ourselves grappling with ways in which to seek traditional patterns, such as triads, in contexts that may no longer warrant such observations. In this realm Kostka discusses items such as chords with "split members," that is, notes added a minor second away from triad or seventh chord members (p. 55). Referring to Henze's *Elegy for Young Lovers*, Kostka determines a chord to be comprised of the notes A, C-sharp, E, F, C, E-flat, B-flat and G-sharp. He reads this chord as an A-major triad with "split roots," "split third" and "split fifths." Alternate readings, I suppose, would have to include an F dominant 7th with split 3rds, split 5th, and split 7th and a B-flat half-diminished 7th with split 3rd, split 5ths, and split 7th! Aside from the question of musical relevance, the degree of subjectivity inherent in this system would surely be a source of consternation and frustration to both student and teacher.

Kostka discusses another construct, the "open-5th chord," which he defines as a "triad without a third" (p. 58). I experienced some difficulty distinguishing this "chord" from an interval. He goes on to say that the "sound of open 5ths rapidly becomes tiresome, so extended passages on this chord are rare." "Typically they [open 5th chords] are used to create an impression of the Orient or of the distant past" (p. 58). Can remarks such as these offer real insight to students who struggle to understand twentieth-century music?

Later Kostka spends several pages pondering a means of representing quartal and quintal harmonies. He settles on a system that can be illustrated by his example of a "3X4 on B" (p. 59), meaning a three-note quartal harmony built above the lowest pitch of B. Are these quartal harmonies comprised of only perfect fourths, or can they contain diminished or augmented fourths as well? Kostka admits that "the use of diminished 4ths and augmented 5ths in quartal and quintal chords can lead to perplexing questions, since the intervals sound like 3rds and 6ths." [The perplexing question raised in my mind was: why does the author wait another 120 pages before introducing a theory that removes any doubt as to what to call a sonority?] Kostka goes on to cite two examples of Scriabin's "Mystic Chord," labeling them both as "altered 6X4 chords" because they contain diminished fourths, but allows that "other voicings might lead to other

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analyses" (p. 62). From the student's perspective this presentation is certainly more confusing than enlightening.

Kostka spends an inordinate amount of time merely attempting to label a sound because he considers its mutable traits, like spacing or spelling, to be distinguishing features. Anyone familiar with the basics of set theory would have no trouble labeling either version of the "Mystic" chord with the *same* name, 6-34 (013579), and would do so in short order. After all, the name is perhaps the least "mystical" feature of Scriabin's chord.

Given the developments in music theory in recent decades, it seems unfortunate that Kostka devotes such a large proportion of his text to techniques that perpetuate the tortuous ambiguities that plagued previous generations of music theorists. When Kostka finally does offer an introduction to set theory halfway through the book, he does so without the benefit of integers, to which he adds the burden of traditional interval names and the implication that students will be able to locate the definition of "pitch-class" in a footnote to chapter one. This timing, coupled with the cumbersome approach, diminishes the potential usefulness of the ideas.

Part of my frustration with this text arises because I believe the more general approach to the material adopted by Kostka is precisely the approach that would likely meet the needs of the greatest audience. However, until such time as his book is carefully revised, I would have difficulty recommending that students read anything but selected portions.

LESTER

Joel Lester's book is comprised of some 300 pages divided into four units: 1) introductory materials, 2) set theory, 3) twelve-tone theory, and 4) music since World War II. Each of the sixteen chapters is divided into several subtopics that are listed in the table of contents. These subtopics appear as highlighted text when found in the body of the chapter. When chapter subtopics are themselves divided, the smaller topics are found as boldfaced inserts to the beginning of the paragraph in the body of the text. The author includes one Appendix on the topic of Combinatorial Hexachords and a glossary of foreign terms used in pieces studied in the text.

At the beginning of each chapter Lester has a list of important terms or concepts covered in that chapter. In the body of the chapter terms or important concepts are italicized and often followed by their definitions, which are listed in parentheses. Each chapter has a "Suggestions for Further Study" section as well as "Exercises" and "Points for Review." The exercises deal with fundamental concepts, musical analysis, and composi-

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tion projects. To his credit Lester begins many of his exercises with the word "listen," a word that appears frequently in the body of text as well. Many examples in the book use pitches (or pitches and integers) rather than integers alone; students will surely find this practice to be helpful. The "Suggestions for Further Study" are very nicely done and offer students many opportunities to explore other pieces in ways that are both appropriate and realistic at the undergraduate level.

The book's physical appearance suggests a text destined to be a classic, though, like many Norton texts, I find the paper's yellow tint, when combined with the size of the text, to produce some eyestrain after awhile. The musical examples are plentiful and readable, but not as crisp as those printed in the Prentice-Hall books.

Lester's aim is to introduce the material with as "little jargon as possible" and he chooses to include topics "of the greatest relevance to a student beginning work in this field." Lester brings a sensitivity to his discussion that is almost poetic at times. His genuine fondness for this music, while acknowledging its complexities, is evident throughout the book and instills a sense of appreciation in the reader. The following passage in which Lester is discussing Webern's Op. 28 *String Quartet* is typical:

The resulting musical continuities, however, are anything but abstract—an intense and dazzling array of notes and small groupings of notes, timbre, registers, rhythm and articulations that follow one another in unique ways.

The first unit of Lester's book is a general introduction to the elements of twentieth-century music. The author compares the use of pitch, rhythm and meter, texture and timbre, and form in tonal music with that of twentieth-century music. The first chapter, *Pitch in Tonal and Nontonal Music*, is a particularly good transition into the subject. This chapter includes a "no-nonsense" rationale for using pitch-class sets when examining twentieth-century music. He also takes care to define tonality so that the differences between common-practice music and twentieth-century music are apparent. Lester's chapters on rhythm and meter and timbre are also very good. Discussions of this type are often overwhelmed by what may be viewed as a preoccupation with pitch in the discussion of music. The chapter on form is a bit perfunctory, but defines form in a way that is very useful when viewing much of the literature of the last century.

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The second unit of the book concentrates primarily on pitch-class sets in a way that emphasizes practical application over abstraction. Though appreciative of his attempt to keep the focus on the music, I believe that at times a more rigorous approach would be desirable. Lester follows the convention of naming a set by using the format $[0,1,4]$ which he calls "lowest ordering." He does not use or refer to Forte's³ set-class numbers. Lester uses both moveable-zero (any pitch-class may be designated zero) and fixed-zero (all Cs are 0, C-sharps are 1, and so on) integer notation of pitch classes in his discussions, preferring moveable-zero for most examples. When he turns to twelve-tone music in the third unit, he uses a third system, that of fixed-*do* pitch-class names, for the elements of the row instead of integers. Lester glides easily from system to system, but it seems likely that students will be uncertain as to when to use which system and will incur a number of errors in their own work due to confusion between these systems. There is no list of sets in the book so students have no way of checking their work unless they do as Lester suggests and consult either Forte or Rahn⁴ (p. 107). His suggestion seems unnecessarily cumbersome; students would clearly benefit if the book included an appendix like Straus' Simplified Set List.

In discussing intervals Lester forsakes a degree of clarity with the informality of his approach. In the course of his exposition there emerge three methods for calculating intervals, though students would have to read very carefully to make this determination. What appears to the student to be the definitive means for calculating intervals (pp. 68-69), actually turns out to be the means for calculating *harmonic* intervals only. Unfortunately, students do not discover this important distinction until they encounter it in the "Points for Review" at the end of the chapter (p. 76). Because he does not adequately distinguish one interval type from another in his discussion of examples, Lester sometimes leaves the student guessing as to which type of interval he refers.

Analyzing an excerpt from Schoenberg's Serenade, Op. 24, the author states that "all intervals are indicated below the melody." Are these intervals "melodic intervals between pitches" or "melodic intervals between pitch-classes?" In one place he mentions "skips of interval 4 (both rising and falling)" (p. 74). In this case "interval" means *melodic interval between pitches*. Later in the analysis he says that "interval 4 is also the interval between the lowest and highest pitches," D3 and F-sharp4. This time "interval" must be interpreted to mean *melodic interval between pitch-classes*.

One cannot help but draw a comparison between Lester's exposition of pitches, pitch classes, and intervals and that of Rahn. Rahn's presentation⁵, which is limited to the same number of pages as Lester's, is more

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comprehensive and ultimately more comprehensible. If Rahn's presentation seems too "technical," why not summarize its common-sense observations? Intervals can be figured between either pitches or pitch-classes. Those intervals can either be ordered or unordered. Each of these four possibilities has potential for aiding the analyst. In that light this information of Lester's chapter seems quite obvious, but it is important to bear in mind that it is unlikely that students will have had the benefit of reading Rahn prior to reading Lester.

Once people grasp an idea it is difficult, if not impossible, to imagine what the initial exposure to the topic was like. Yet both teacher and author must continually make every attempt to recreate that first experience in order to explain an idea with a maximum of clarity and efficiency. When we lose sight of this perspective, as is inevitable, it is easy to make slight omissions which, in turn, may puzzle the student.

For example, when Lester describes the Fibonacci series (p. 143), explaining that the ratio of two adjacent numbers in the series approaches .618, he fails to include an explanation as to why this proportion has any significance in music. In a more important presentation, when Lester demonstrates the steps necessary to determine a set's "lowest ordering" (pp. 85-87), he again does so more from the perspective of one who knows than one who needs to know. An experienced teacher would probably glance over Lester's steps and think that his procedure seems well-defined because the procedure is, after all, quite simple. However, from the point of view of the completely inexperienced student, Lester's steps can seem confusing. Let us see why. Lester says that "you can figure out the lowest ordering of any pitch-class set by following the three steps given here" (pp. 85-86):

Step 1: Notate all the pitch classes in ascending order within an octave. You can start on any pitch-class . . .

Step 2: Find the largest interval between consecutive pitches. (Remember to consider the interval from the last note up to the first note in the next octave . . .) Reorder the pitches, beginning with the upper pitch of the largest interval. Number from 0. this gives you the lowest number between the first and last pitch-classes . . .

Step 3: If the last interval in your step 2 result is larger than the first interval, then you already have the lowest ordering. But, if the last interval in step 2 is the same

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size or smaller than the first interval, rewrite the pitches from right to left, write the complement of each number, and transpose to begin on 0. Compare this new result to that of step 2 to find the lowest ordering.

It is likely that students will falsely perceive a disparity between the number of steps and the number of instructions required to complete their task. Ostensibly there are three steps, but up to nine instructions may have to be performed prior to obtaining the answer. Lester's procedure would certainly be more comprehensible to the novice if the goals of steps two and three were clearly stated. I am sure that students would not find it immediately apparent that the goal of step two is to compact the set and the goal of step three is to determine which result is most packed to the left. If these goals were stated explicitly, the instructions contained within steps two and three would be viewed more obviously as the means to accomplish these goals. Implicit is the understanding that students will memorize this procedure and apply it to music hereafter. Consideration must therefore be given to the format of the presentation.

Would not the instructions be more easily assimilated if given in the form of an outline—a format preferred by students—rather than as prose? Lester does follow this format elsewhere (see p. 109) no doubt to the delight of the student reader. It is important that the reader understand at this point that these examples are the exception in Lester's work, not the rule, and have been chosen merely to indulge this reviewer in picking some pedagogical nits. I hope that these examples remind us all of the enormous difficulties and challenges we encounter when attempting to convey ideas to one another.

The unit on twelve-tone music provides a good introduction to the topic. It is within this section that Lester seems most at home. The author wisely chooses to gradually unfold the various techniques associated with this literature and continues to give preference to the musical element over the technical, and that which is literally expressed in the music over that which has the potential to be expressed. Lester projects an attitude of exploration which I believe students will find most engaging.

Perhaps the most enjoyable chapter in this regard is titled "Common Elements." Lester begins by advising students that "labeling series in a score and trying to hear those series in the music (were that possible) is a rather poor way to try to learn about this music" (p. 189). Many earlier presentations of twelve-tone music falter once it is assumed that students can label the rows. It is from this point on, however, that Lester makes his

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greatest impact. All of the illustrative analyses that follow, such as the openings of Schoenberg's 4th Quartet and of the second movement of Webern's *Variations for Piano*, are eminently accessible introductions to the works. Though teachers may wish for more detail in these analyses, it is probably better that Lester chooses not to overwhelm his audience.

The last unit is comprised of a single, brief chapter that deals with music composed after World War II. Though terms like aleatoric music, minimalism, and electronic music are mentioned in passing, Lester disappoints the reader with what comes across as an afterthought rather than an integrated part of the text. Lester provides no analysis exercises for this chapter "since it is hard to predict the availability of scores and recordings of recent music in any given music library." This excuse seems weak given the fact that he has reproduced scores for the analysis sections in other chapters. However, the chapter is by no means without merit. Its high point is an analysis of aspects of Peter Maxwell Davies' *Ave Maria Stella*. In a future edition of the book I hope Lester will devote more attention to recent music, particularly if his presentation reflects the insight and sensitivity that characterizes much of the book.

STRAUS

Straus' book is divided into six chapters—a chapter that introduces the basic materials, two chapters that deal with pitch-class sets, a chapter that discusses tonality and referential pitch collections, and two chapters that explore twelve-tone music. Each chapter has several subtopics that are listed in the table of contents and set apart in the body of text with capital letters. Each chapter concludes with exercises that reinforce basic concepts and analyses that examine portions of two pieces in light of the recent discussion. The analyses at the end of each chapter are written at a level very much appropriate to the undergraduate student's ability. The bibliography at the end of each chapter reflects more recent developments in the field and provides many important references to the development of contemporary theoretical ideas as well as excellent points of departure for the more advanced student.

The Appendices in Straus are very useful aids to the analysis techniques on which he concentrates. There is a List of Set Classes, a Simplified Set List and a List of Index Vectors. The list of set classes is like Forte's list but also includes indications for transpositional and inversional symmetry of the sets. The Simplified Set List is one of the handiest features of the book. By simply putting a set's members into ascending order, students can discover the set's normal order, prime form, and set-class name without

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performing any computations. Though lists like this have circulated for years, it is desirable for students to have a copy that they are unlikely to misplace given the cost of textbooks these days.

The appendices could have been more easily used if their layout had received just a little more attention. With the exception of the tetrachords, the lists of set classes are each split across two pages. This inconvenience could have been avoided by placing the trichords and tetrachords on one page, the pentachords on a second page, and the hexachords on a third page. Students would benefit from labels at the top of each column of information in all the appendices, particularly in the Simplified Set List. The text of the Simplified Set List is clear, if microscopic, but there is no means to assist the eye in reading across the page; it would be easy to make a reading error if one did not use a straightedge when using this table. In removing many tiny obstacles such as these, students are less likely to get bogged down by the mechanics of the process and are more likely to think about the meaning of musical relationships.

A few additional features in the physical layout of Straus' book want some attention from the publisher. The text and figures, though beautiful and crisp, seem small. The ratio of black to white on the page is high; I am told by a learning specialist that this makes a text seem intimidating to the student. The margins are very small so it is difficult to make any annotations on the page. It is interesting to note that Kostka's book, also from the same publisher, is much larger, uses a much larger type, has larger margins and will be perceived by students, purely on visual terms, as an easier book to use. Greater sensitivity to these admittedly picky, yet important details can only benefit those students who will use these books.

It is difficult to imagine a simpler presentation of the basic materials of set theory (pp. 1-11). Straus has succeeded in translating Rahn into the vernacular! Though his tone is informal, Straus cuts right to the point in laying the ground for further discussion. In addition to the standard repertoire of "stupid set tricks," such as transposition and inversion, Straus also makes use of the concepts of index number (p. 37) and index vector (p. 63), which, like many aspects of theory, may initially seem arcane to the novice, but prove themselves useful and practical tools, especially to the composer. These concepts are also presented sensibly and enthusiastically and lay a foundation for further study of newer works, such as Morris' *Composition with Pitch-Classes*⁶.

Like Lester, Straus makes use of multiple systems of pitch-class notation. Straus uses the fixed-zero system of integer notation when discussing pitch-class sets and the moveable-zero integer notation when discussing twelve-tone music, yet offers no explanation to the student as to why this change is necessary or desirable. Despite the many logical reasons

for using multiple systems, and with all due respect to Babbitt⁷, Lewin⁸, Wourinen⁹, and others, pedagogues may eventually conclude that using a single pitch system for both set theory and twelve-tone theory may ultimately be of greater benefit to students who are new to the subject.

For a number of years I taught a course in which I switched from the use of fixed-zero when discussing set theory to moveable-zero when studying twelve-tone theory, just as Straus does. It was necessary to dedicate some portion of my class time to reorient the students and this process always produced confusion and a host of careless mistakes in their papers. In recent years I retain fixed-zero throughout the course because the continuity not only preserves some of my instructional time but also improves my students' performance. Though certainly a matter of opinion, I believe that retaining a single system keeps the focus on the musical element as much as possible.

One intriguing, yet controversial, feature of this book is Straus' discussion of non-contiguous pitch classes spanning large distances in organizing the larger structure of a piece. He says that "one of the most potent means of assuring large-scale coherence in post-tonal music involves projecting pitch-class sets over large musical spans" (p. 72). He echoes David Beach¹⁰ when he suggests that "There are many different ways of projecting a pitch-class set . . . all that is necessary is that the notes that make up the set . . . be associated in some musical way" (pp. 72-73).

His first example of such a span (p. 73) is found in the opening bars of Schoenberg's Op. 11, No. 1, a piece to which Straus refers throughout the book. Having established the significance of set 3-3 (014) in prior musical examples, the author illustrates a linear span of set 3-3 (014) in both the highest and lowest voices of the passage. Pitches B, G, and G-sharp, of which the upper span is comprised, are distinguished by the fact that they are the highest pitches in their respective phrase segments. For the lower span Straus selects three of the four pitches in the lowest voice of the first 11 measures, G-flat, B-flat, and G, and associates them because they share a common register and articulation. Some might argue that, despite the contrast in the music, the G-sharp that intervenes between the G-flat and B-flat for some 5 measures also shares the same register and articulation as the other notes and clouds Straus' interpretation.

Straus goes on to discuss another example, Stravinsky's *Oedipus Rex*, in which the composing out of set 3-3 (014) occurs over the entire duration of the work. Each statement of Stravinsky's so-called "Fate motive" begins with a different element of the great 3-3 (014) itself. In such a brief exposition Straus' examples may not convince the reader of the merit of this idea, but I believe that the idea is both tantalizing and ripe with potential, perhaps more for composers than theorists. Some contemporary composers do

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exactly as Straus proposes and weave their pitch material into larger spans in their compositions. It seems entirely possible that earlier composers may have sometimes followed this practice themselves. Because this premise does seem to have the potential for shedding new light on some pieces, I hope it will be explored with greater depth and clarity in a future edition of the book.

Straus presents a useful distinction between *tonal* music (music characterized by traditional voice leading and functional harmony) and *centric* music (music that focuses on referential centers). He states that "all tonal music is centric, focused on specific pitch-classes or triads, but not all centric music is tonal" (pp. 89-90). "When twentieth-century composers create a tonal sound, they usually do so by using nontonal means" (p. 89). A thorough understanding of this concept would no doubt improve many of the well-meaning, yet misguided, analyses of the twentieth-century's "tonal" music.

Straus is successful in communicating to undergraduates in a way that is both concise and precise yet without diluting the material or seeming to condescend. Because his book focuses primarily on set theory and twelve-tone theory, and his examples are limited to the music of Schoenberg, Webern, Bartok, Stravinsky, Berg and, to a small degree, Babbitt and Boulez, Straus' approach may be too constrained to meet the needs of classroom teachers who must cover a broader range of topics. Though he "makes no pretense to comprehensiveness," I found myself wishing that Straus had discussed a wider range of topics in twentieth-century music with the same lucidity and enthusiasm given the material that is covered in his book.

It is encouraging to see that there are now several new, theoretically-oriented texts from which to choose when teaching a twentieth-century course, but because of the limitations of each text, some instructors may still choose to teach without a text, preferring to send their students to the myriad books and articles that constitute the primary sources in this field. Still others may choose to select one book from this list as well as a separate text that deals more with the aspects of history and literature, like Morgan's *Twentieth-Century Music*.¹¹ (Given the fact that many teachers require the purchase of scores or Wennerstrom's *Anthology*¹² for such a course, the latter may be not possible due to the financial burden placed upon the student. Furthermore, this much information would be overwhelming unless the course were a year-long endeavor.)

I suspect that many instructors may choose instead to make one of these books the central source of their course material and simply reduce the number of outside readings required of their students. Whatever the case, students will likely benefit from the efforts of these authors, either directly

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or indirectly, for it is in considering the ideas of others that we teachers each improve our own perspective.

NOTES

¹Allen Forte, *The Harmonic Organization of The Rite of Spring* (New Haven and London: Yale University Press, 1978), 1-12.

²Janet Schmalfeldt, *Berg's Wozzeck: Harmonic Language and Dramatic Design* (New Haven and London: Yale University Press, 1983), 1-24.

³Allen Forte, *The Structure of Atonal Music* (New Haven and London: Yale University Press, 1973).

⁴John Rahn, *Basic Atonal Theory* (New York and London: Longman, 1980).

⁵Rahn, pp. 20-21.

⁶Robert Morris, *Composition with Pitch Classes* (New Haven and London: Yale University Press, 1987).

⁷Milton Babbitt, "Twelve-Tone Invariants as Compositional Determinants," *Musical Quarterly* 46/2: 246-59. Reprinted in *Problems of Modern Music*, edited by Paul Henry Lang (New York: W. W. Norton & Co., 1962), 108-121.

⁸David Lewin, "A Label-Free Development for Twelve-Pitch-Class Systems," *Journal of Music Theory* 21/1: 29-48.

⁹Charles Wourinen, *Simple Composition* (New York and London: Longman, 1979), 82.

¹⁰David Beach, "Pitch Structure and the Analytic Process in Atonal Music: An Interpretation of the Theory of Sets," *Music Theory Spectrum* 1 (1979): 15.

¹¹Robert Morgan, *Twentieth-Century Music* (New York and London: W. W. Norton, 1991).

¹²Mary Wennerstrom. *Anthology of Twentieth-Century Music, 2nd edition* (Englewood Cliffs: Prentice-Hall, 1988).

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Lora L. Gingerich is Associate Professor of Music Theory in the School of Music at The Ohio State University. She holds Ph.D. and M.Phil. degrees from Yale University in music theory, and a B.A. from Wellesley College in music and mathematics. Her publications appear in *Music Theory Spectrum*, *in theory only*, and the *Journal of Music Theory Pedagogy*. Her research and teaching interests include tonal and atonal analytic techniques, music of twentieth-century American composers, mathematical models of music, and music theory pedagogy.

David Lewin

David Lewin, who teaches music theory at Harvard, has a background in piano, mathematics, and composition. He was president of the Society for Music Theory from 1985-1988; his article here is the keynote speech he delivered at the Cincinnati meeting of the Society in 1991.

Joel Phillips

Joel Phillips is an Associate Professor of Music Theory at Westminster Choir College in Princeton, NJ. He holds a D.M.A. and a B.M. from the University of Alabama and the M.M. from the Eastman School of Music. In addition to his teaching duties Phillips is Co-Director of the College's Music Computing Center.

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Ken Stephenson holds a M.M. in Theory from Baylor University and a Ph.D. in Music Theory from the University of Iowa. He is currently an Assistant Professor of Music Theory at the University of Oklahoma, where he was voted Outstanding Teacher in the College of Fine Arts by the Student Association in 1989. His current research involves using artificial-intelligence programming as an aid in the search for algorithms for identifying the key of a given passage from the common-practice era or from the recent popular repertoire.

Paula J. Telesco

Paula J. Telesco is an Assistant Professor of Music Theory and Coordinator of the Aural Skills Program at Butler University. Previously, she taught at Wayne State University in Detroit, where she was also the Coordinator of Aural Skills. She holds a B.A. in Music from S.U.N.Y. College at Buffalo and an M.M. in Theory from the University of Arizona. She currently is a Ph.D. candidate at The Ohio State University. Her research interests include enharmonicism in 18th-century music, the history of theory, and music theory pedagogy.

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