The GEMS series

Matthew H. Fields

Contents

to Amy J. Cannaday,
who bore with much along the way

GEMS

Prologue

Computer networking is one of the amazing feats of engineering of the late 20th century. Vast, all-encompassing networks now make it possible for data to be shared among people world-wide. Three basic services are now commonly available:

1) Electronic mail: person-to-person text communication. A message I type here in Michigan can be read on a computer screen in New Zealand in minutes.

2) FTP (File Transfer Protocol): general data-sharing. Libraries of programs and other data have been created in various parts of the world in such a way that any user can browse or copy these programs to their own computers at high speeds.

3) Network News. Of the tens of thousands of computers networked worldwide, some thousands of them form the backbone of a system for mass-distribution of information in a newsletter format. Any user can read this news, and many users can post news articles to the closest participating computer, which in turn mails copies of these articles to other computers. Vast amounts of information is shared this way, and eventually, some of it has to be retired or deleted.

To make network news more manageable, it is grouped hierarchically into *Newsgroups*. New newsgroups are created when enough people agitate for their existence. Currently, most sites carry over a thousand newsgroups.

In the summer of 1992, the newsgroup <*rec.music.compose*> was proposed by Joshua Barinstein as a forum for the discussion of all kinds of musical composition. The discussion regarding its creation centered on the issues: were the communication needs of composers being served by newsgroups devoted to musical performance or synthesizers, and could these needs be met by these groups without the overhead of a new newsgroup. Several people argued convincingly that mixing “apples with oranges” would force many participating computers to perform the redundant job of separating composition articles from the others, and so the overhead of using existing newsgroups would be substantial. But the more obvious concern was that composers would not use newsgroups not devoted to composition. I participated in that discussion as an advocate of the group.

In July 1992, a vote was taken, in which the idea received overwhelming support, and in August 1992, <*rec.music.compose*> came into being. After a rocky start in which the participants worked to distinguish the group from existing groups, some heavy discussion of

the complex relationship between compositional craft and intuition emerged. In that climate, I posted a short message offering to write a series of educational articles regarding bits of compositional wisdom that had been passed on to me over the years, with the following proposed contents:

1) Drama and Climax
2) About Parallel Fifths
3) Shortcuts for Theory Homework
4) Strategies for Canon and Fugue
5) About Serial Materials

In the discussion that followed, the phrase "gems of wisdom" became a sort of *leitmotif*, so the idea hatched in my mind to use the word GEMS as the title of the article series, as a way of saying "these are the articles that I promised." A variety of people wrote news articles or sent me electronic mail strongly encouraging me to write and post the series.

The readership of the group ranged from musically-illiterate novices to top-notch musical scholars, making every kind of music under the sun, from pop songs to serial music to musical happenings and so forth. For me, this posed some challenges, because, while my articles had to be clear and readable to a variety of novices, the slightest misrepresentation or oversimplification could lead to a flurry of corrective and explanatory articles, at great expense to the computer network. On top of this, I wanted to make sure that my articles would be of interest specifically to composers, but at the same time, be appealing to a wide variety of composers. My prose style had to be at once rather precise and quite informal, in keeping with the informal nature of computer network news.

The series subsequently came to be archived for FTP access in several sites around the globe; it was made available to the more user-friendly *Gopher* network service; a volunteer undertook an Italian translation in Rome; and others used it as a classroom pamphlet with my blessing.

Disclaimers: I am presenting the material here mainly as my opinion. If you try to make use of my suggestions and they don't help you write fabulous music, I don't accept any liability. Likewise, it is strictly to your credit and none of mine if you do write fabulous music before or after reading these posts. Plenty of the ideas I will be discussing in this series have been mentioned before, and some theorists may even wish to lay copyright claim or patent claim to some of them. However, I claim that the core ideas have been known to composers and used by them long before anybody published any writings on them, and these ideas are therefore basically in the public domain.

On the other hand, I actually sat down and wrote these texts, and retain copyrights to them.

In writing these articles, I am indebted to the many teachers who have prodded me towards quality work, especially Richard Hoffmann of Oberlin College, Ross Bauer, Alfred Lerdahl, and Leslie Bassett of the University of Michigan.

—Matthew H. Fields, A.Mus.D.

Dramatic Shape

I have chosen to present this topic first because it seems the most useful to the greatest number of people, and, of all the topics I've offered to write about, it is the least tied to a particular style.

Abstract. In this article, I will explore several basic hints for writing pieces with convincing climaxes.

Introduction. One way in which I like to classify music is into two kinds: pieces which move from a beginning towards a climax, and pieces which don't. Really, the only way which a piece can avoid a sense of climax is to keep a fairly consistent level of intensity throughout. Many pop/rock songs do this, and pop/rock composers may feel that this article is irrelevant to their art. On the other hand, such artists often compose a series of their songs or performances as an album side, a dance set, or an uninterrupted portion of a concert, and on this scale they often seek to create a motion to a climax across many songs. Therefore, perhaps this topic will be interesting to them and performers in general, too.

Definitions. Now, by intensity, I refer to a rather abstract psychological variable, something on the order of "level of frenzy". Typical ways of expressing increasing intensity are: a) getting louder (making a more emphatic music); b) moving towards extremes of pitch, both high and low (again, imitating spoken expressions of strong feeling); c) adding additional instruments to those playing (in classical music we call this "thickening the texture") d) interspersing melody with more and more irregular, frequent rests (in emulation of shortness of breath) and so forth (you may always use your imagination to find more ways to use in addition to these).

Sometimes, people will refer to the dramatic curve of a composition as its "form". This is a tricky word to use, at least in English, because it can also refer to what I call a rhyme scheme for a piece (is it made of repeating verses with a bridge, is it sonata-allegro form, is it ABA form, rondo, or what?)... So, if I were called upon to discuss dramatic shape as a kind of form, I would have to distinguish between "dramatic form" and "rhetorical form". The two can have clear correlations; e.g., in a form that goes Refrain-verse-Refrain-verse-Bridge-Refrain, the climax might typically be towards the end of the Bridge; however, there's no rule

that says the climax has to be in any particular part of the rhetorical anatomy of a piece. In sonatas, climaxes typically come at the beginning of the recap, or at the beginning of the coda, or at the beginning of the recapitulation of the second key area, or at the very end, or...

Four basic suggestions. OK, so by now, I'm assuming you have a basic idea what I'm talking about. What are the hints that I can offer on this material?

1. Strongly consider having only ONE main climax. You can have lots of subsidiary climaxes, but if you make one peak just this much more intense than all the others, this may give your piece a sense of having really argued its point, having really expressed its emotion, etc. If you have two nearly-equal main peaks, you run the risk of the second one seeming tedious. Consider making the second one bigger/louder or gentler/softer than the first.

2. *Do something assertive at the beginning of your piece.* This needn't be loud or sharp, but if you start too soft or mild in the hopes of then gradually cranking the intensity up, you run the risk of failing to grab the listener's attention.

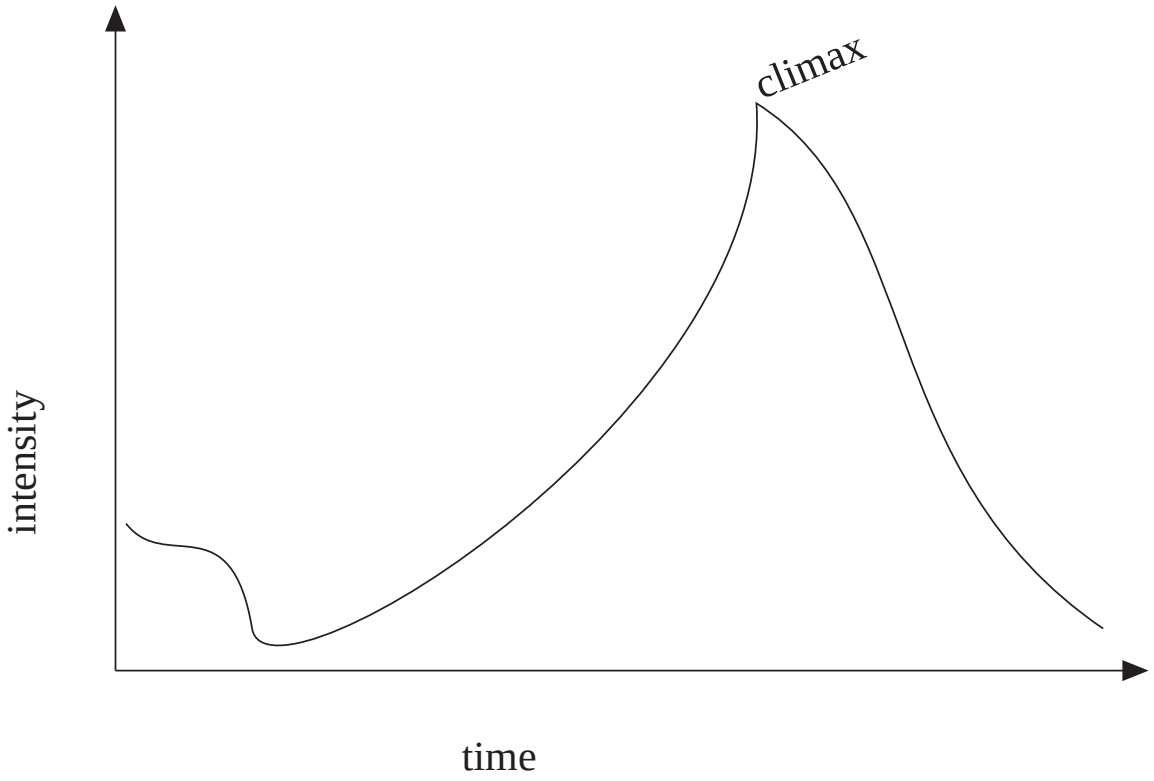
Let me tell a little story. Once, several years ago, I took a composition lesson with a famous New England composer who will remain nameless. Fresh off a plane from his backwoods home, still wearing his coonskin cap, stinking of cheap whiskey and cigarettes, he arrived having had less than 2 hours sleep in the previous 2 days. After listening to a few minutes of my recent compositions, he said, "Well, I can see that I don't have to encourage you to get to know any basic mechanical transformations for your material, Matt."

Then he reached over and yanked me to my feet by my collar. "Your music has to grab me like this, and *not let go until the very end!*" With this, he ended the lesson. Perhaps I experienced Zen enlightenment in that moment; perhaps not.

In any case, the suggestion is to save your softest music for just a little ways into your piece, or for the ending.

3. In works of longer than 30 seconds duration (this figure is chosen somewhat arbitrarily, but the exact number is irrelevant), the main climax does not come at the beginning. It does not come at the middle. It comes anywhere from 60% of the way through the piece to right at the end. Otherwise you run a terrible risk of having your listeners get bored with the gradual denouement of your work.

4. Having gotten good at implementing suggestions 1-3, you may still feel that your climax is somewhat disappointing. Let's say you now have a piece which works like this:



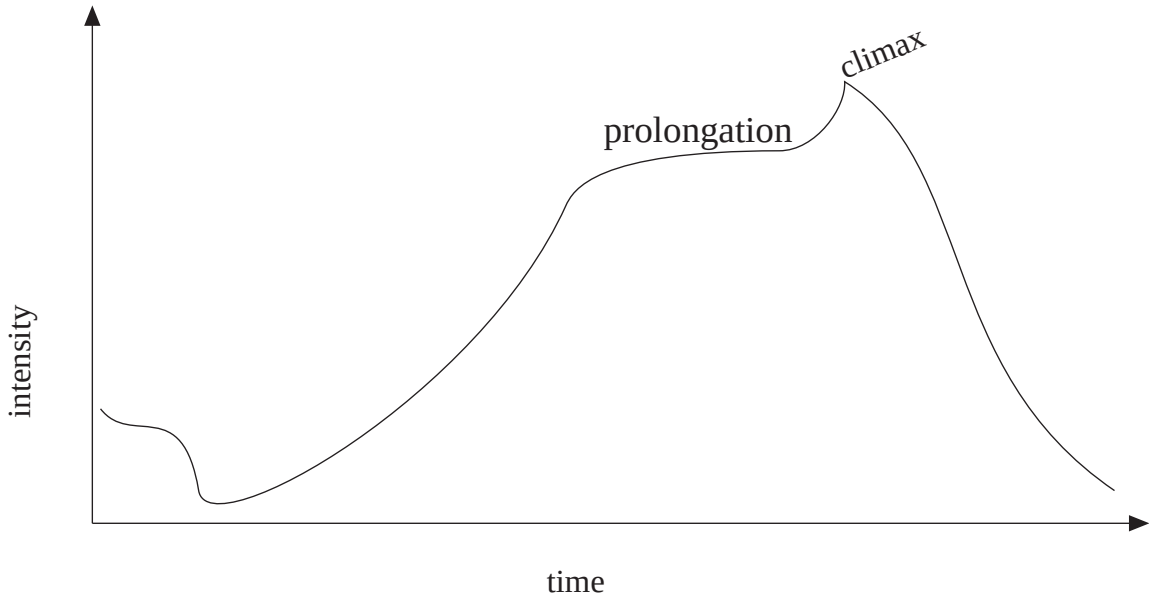
An easy method that often makes the climax less disappointing goes by the name "prolonging the climax". What it often is is a prolongation of the music just before the climax, and how it works is like this:

1) Make sure the music just before the climax strongly suggests that the climax is coming;

2) Write and insert more of it—possibly a lot more of it. In classical music, this is accomplished by such technicalities as dominant pedals, deceptive cadences etc. My favorite example from pop music is one almost everybody has heard: Lennon/McCartney's HEY JUDE. It works up to a frenzy, then spends about half the cut repeating the frenzied verse over and over. 2 minutes later, the industry-standard fade-out is applied. When this single was released, the crowd went wild.

Now, this suggestion doesn't guarantee a fix. If you're expecting a solo flute playing in its lowest octave to sound climactic during a symphony band piece, you may need to rethink other aspects of the piece. However, it works so remarkably well so much of the time that it's worth trying, at least part of the time.

Concerning the dramatic shape we saw above, suggestion no.4 would revise it to look like this:



Another famous way of carrying out the same procedure is to get almost to the climax, then suddenly cut back to a very low level of intensity and build back up to the climax in just a few seconds of music. In fact, there are so many variations and permutations on variations of these techniques to be explored that you can have endless fun being creative with them. As a composer, you might want to listen to a variety of works which you feel have powerful climaxes, and see how they address the motion to the climax.

Other concerns. Now, I haven't mentioned how words create or don't create climaxes of their own; a favorite suggestion of mine is to experiment with the possibility that in the midst of a rising vocal line, the climactic text is suddenly sung very softly, or whispered, so that the text is understated, and then the accompaniment may or may not state the climax just afterward. This can be a particularly spooky, frightening effect.

A lot of people feel that they should compose a piece from the beginning to the end. Obviously, suggestion no.4 above says that you needn't feel constrained to do so (in this way, composition differs from improvisation, in which, once you've played, you can't go backwards in time and adjust things). This is a general admonishment of mine: don't feel constrained to work in sequential order! You're the composer, so you can work in whatever order is best for you. In particular, when you have a great idea for some part of your piece which is out of sequence, by all means record it (on tape or in writing), so you can use it when the time comes. Along with this admonishment comes another basic one: no note is absolutely sacredly unchangeable, not one of yours, not one of mine, ... heck, I can even imagine that some day there might be someone who could improve compositions that were

originally written by Mozart. Finally, there are two important admonishments: 1) a word to beginning composers: begin! and 2) sooner or later, you're going to have to be satisfied with how well you've polished your piece, so you might as well call it "done" and play it for someone, then start a new piece.

The previous paragraph of admonishments will apply well to techniques that I describe in detail in future articles, too.

Listening Assignment. For those who are interested, a work to get to know and study which demonstrates a lot of what I've been talking about is *TREN OFIRAM HIROSZIMY* (Threnody for the Victims of Hiroshima), by the living Polish composer Krysztof Penderecki (composition date: about 1964). This piece is scored for 52 violin-family instruments (violins, violas, cellos, and basses), who play a variety of massed sounds, screeching noises, scratching noises, etc. The piece has no regular beat, and no recognizable melodic shapes; really, the main feature of this work is its undulating, shifting level of sound density, intensity, and emotional fervor. After a few subsidiary climaxes, the piece comes to a point about 65% of the way through its length where the players drop out one by one until, after a brief cello solo, there's a couple seconds of silence. Then, a renewed build of intensity leads to several minutes of almost-climax, a brief pause, and a final climactic ringing chord.

The sounds of this piece are not friendly, but rather fierce. They are not deeply grounded in the Western Classical Tradition, or in any folk music either, for that matter. But the dramatic curve of the piece as a whole is as classical as the motion to a climax in a Shakespeare play.

The piece can be heard on several recordings, including a current CD from Warsaw on Conifer Records.

Written assignment. For those who like to practice principles in little studies, here's one which I've assigned to beginning students.

Write a composition for 1-4 players. Limit your duration to about a minute. Use only "found sounds", that is, noises made by non-musical objects that you have handy. Notate your piece with a graphical notation of your own devising, NOT incorporating any conventional music notation. Preface your piece with a legend or key so that your players can quickly decode your notation. Stage a small performance and perhaps even a recording session of your new work.

Suggestions: don't be overly specific about matters of time or pitch: this tends to delay your premiere and make you ponder extra considerations other than dramatic shape. DO seek out interesting sounds, like attaching a contact mike to a string from which a wire hanger is dangled. DO seek to express yourself, even with these (possibly) unfamiliar restrictions on sounds/materials. DO try to build a convincing climax to your piece. DO try to throw in something special to mark the end of your piece, if your piece continues beyond its climax. DO experiment with prolonging the climax.

If you try this assignment and feel moved to violate some of its rules, relax! There will be no penalty.

11 August 1992—Matthew H. Fields, A.Mus.D.

Parallel fifths and octaves—why I bother about them

I have chosen to present this topic here in my sequence because my later articles will be written assuming you have some idea of my biases regarding contrapuntal issues. This article will not contain any hints or suggestions regarding composition, but will instead talk about some meta-issues of perception.

Abstract. In this article, I will describe a perceptual basis for being careful concerning the use of parallel octaves and fifths. I don't expect to convince anybody to take on such a concern, and I most especially will not hand out any rules, generative or proscriptive, on this matter. On the other hand, it is my intent to argue that this concern is not obsolete but current, and not a matter of abstract rule-making, nor a matter of mystical invocation of physics, but rather a matter of hearing and musical expression.

Introduction. Parallel octaves and fifths: we hear of a 'proscription' against them in our music theory classes. Then we find out that Bach's organs had 8-foot, 4-foot, and 3-foot stops, so that every melody he played could be sounded out in parallel octaves and fifths. Even worse, we discover that parallel octaves are ubiquitous in ensemble music and piano music. And then, as we delve into musical history, we discover early forms of organum in which singers always sang in parallel fifths.

Why, then, is a big deal made about these things in theory classes? And why these intervals, only, and not thirds, sixths, and sevenths? What is the role of dogma and propaganda in this matter?

As I so often do — perhaps it's a Jewish habit? — I'll begin my answer with a story. No, not "we were slaves in the land of Mitzrayim", but rather: once, I was teaching the rudiments of aural skills to a total beginner, and he was working on the game of "name that interval", meaning that given the sound of two pitches played either sequentially or simultaneously, he was to name the interval between them. He complained at one point that he was having a bit of trouble hearing octaves and fifths when the notes were played simultaneously, and he said it sounded like the upper pitch was somehow 'hiding' behind the lower pitch. I probed him a bit on this observation: had he noticed this phenomenon outside of his work with the aural-skills software? Yes, he had started noticing it in all the music he heard. Did it apply to other intervals? Yes, especially strongly to the unison, and quite weakly to the major third.

I was, of course, surprised to hear a beginner mentioning such a phenomenon. He had never heard of any rule which made a big deal about parallel octaves and fifths, and was quite surprised by it when it came up in his theoretical studies—after all, parallel octaves are ubiquitous in piano music. But he was a diligent student, and promptly proposed an abstract theory in which parallel octaves and fifths were somehow purely timbral events of physics, while other parallel intervals were events of multiple melodies.

Many authors continue to describe the harmonic series and say, without further explanation, that it is the cause of the concern with parallel fifths and octaves. I think that such a description of the physical world is not sufficient to describe how certain composers have treated these materials, but coupling that description with some purely *subjective* observations (like the ones my student complained of) may actually bring us closer to an understanding of the matter. Even that will not be enough to explain the concern with parallelisms, though, since parallelism is a matter of melodic motion, not of how we perceive individual intervals.

Definitions. Before I go any further, let's make sure we're all talking about the same things.

When I say that two parts are in *unison*, I mean that they are sounding the same pitch at the same time, i.e. in the same octave. For the acoustically-minded out there, this means that within tolerances that our ears define, they are sounding the same fundamental frequency (where applicable).

When I say that one note is *an octave higher* than the other, I mean that it sounds the eighth ascending diatonic step from the other, or is at an ascending distance of seven diatonic steps, or twelve half-steps (in 12-tone equal temperament). For the acoustically- minded, this means tolerably close to a frequency ratio of 2:1, so A-880 is an octave above A-440, and A-1760 is an octave higher than that. Naturally, if I say that a note is an octave *lower* than a second note, this means just that the second one is an octave higher than the first. Carrying out the arithmetic, we find that the first note is seven diatonic steps below the second note, or twelve half-steps below the second note, or tolerably-close to a frequency ratio of 1:2 with the second.

When I say that one note is a perfect fifth higher than another, I mean that there is an ascending distance of 7 half-steps between them. I don't give this definition in diatonic steps, because while the fifth diatonic step in the C-major scale over C is G, at a distance of 7 half-steps, the fifth diatonic step over B is F, at a distance of only 6 half-steps. So, I'm saying that I care about the distance being 7 half-steps, regardless of where it sits in the scale. For the acoustically-minded, the frequency ratio this time is 3:2. In 12-tone equal temperament, this ratio (which can be precisely expressed in decimal form as 1.5) is approximated by the seven-twelfths power of 2 (~1.498307077, or a little more than 1% flat).

Finally, by *compound interval*, I mean an interval augmented by the addition of one or more octave to its distance. In the case of a perfect fifth, the first few compoundments of it are the perfect twelfth and the perfect 19th, or distances of 12+7=19 and 24+7=31 half-steps, or frequency ratios of 3:1 and 6:1 (within tolerances).

The tolerances I mention above have been the topic of quite a lot of debate over the years, so I'm not going to pin them down, partly because doing so would not add any vital information to this article. Mathematicians out there are asked to please refrain from the temptation to say 'Let epsilon be any positive real number'. If anybody is tempted to do that, would they please agree that our tolerances are less than 2% of the lower frequency for the sake of this article? OK. I'm not going to talk about quantitative acoustics much more in this article, because I think it's time to talk about psychological phenomena.

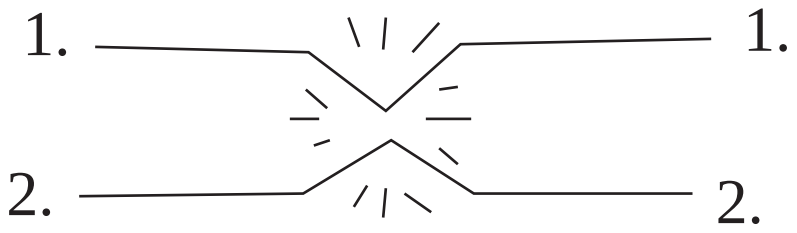
So what's the big deal? All right, we're getting to that. But first, let's talk about melody.

I thought this was about parallel fifths. Yes, but we're coming to that, and we have to back up and visit melody and polyphony on the way.

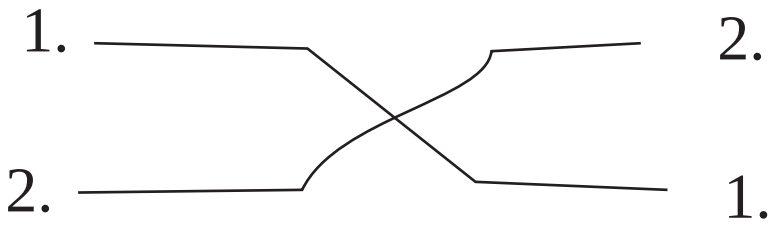
A long time ago, somebody first started coming up with the notion of 'a nice melody' or 'a nice melodic shape' that some of us still use today (it's the first thing you now study when you learn species counterpoint). The basics of this concept were things like: it had one and only one climax point, which was typically its highest note, or sometimes its lowest note; it started on, ended on, and generally circled around a main note which was supposed to express a sense of repose; it moved mainly by step, occasionally by third, and rarely by fourth or fifth — any time a string of notes was constructed that leaped a lot up and down, this was perceived not as a single melody but rather as a sort of time-sharing between two or more melodies, each of which moved stepwise (co*mpound melody*).

Long before people were experimenting with what we now call harmony, they had gotten pretty good at building interesting and exciting things that were single melodic lines. After a while, folks tried two crucial experiments that forever changed the way people made music: 1) Two folks got together and sang the same melody at the same time; 2) Two folks got together and sang different melodies at the same time. Of course, this last sentence is a gross oversimplification of history, and is not a documented event anywhere in the world. But let's consider the consequences of the two experiments anyhow. In the first case, perhaps the people had the same voice range the first time they tried this, in which case they sang in unison, and the sound reverberated larger than either of them. Or perhaps, the first time they tried this, they had such different voice ranges that they sang in octaves (Perhaps an evolutionary theorist could explain our ability to recognize melodic content after transposition in terms of our needing to recognize the same intonation pattern from adults and children?). Now, the first people to try singing two different melodies together had a much more complicated result. Certain combinations of tones came to be called pleasing-sounding, and others, anxious-sounding; from these basic notions, a variety of complex systems of consonance and dissonance were developed—which were different in different eras—and plans were developed for ways in which various consonances and dissonances could be strung together to express something vaguely analogous to a sentence-structure. Meanwhile, folks were listening to, and enjoying, two melodic shapes at once. At one point, the two shapes crossed through the same note, perhaps.

The listeners became confused, because just after the crossing, it was hard to tell whether the voices had bounced off each other like this

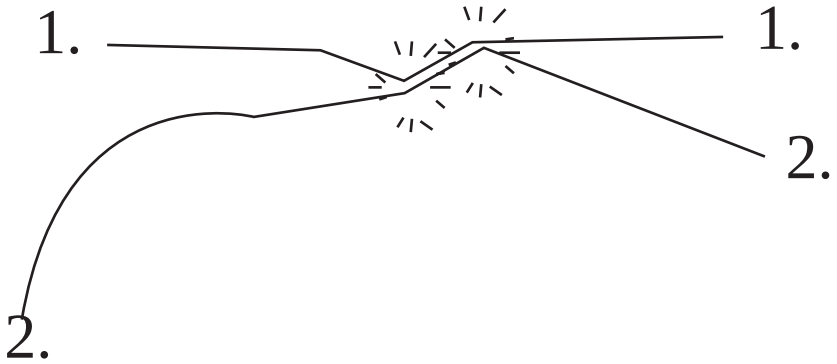


or crossed through each other like this:



Some folks complained that trying to keep the melodies clear in their heads detracted from their appreciation of the individual melodies as well as their appreciation of the consonances and dissonances that arose between them. So some musicians tried to find pairs of melodies that eliminated the second possibility altogether, so after a while, everyone would get used to hearing things the first way anyhow.

Sooner or later, it was bound to happen: the two melodies passed through two notes in a row exactly the same:



People had gotten used to keeping the two melodies clear in their heads for one shared note, but two in a row was just too hard for many people. It sounded like one of the melodies had momentarily gone silent while the other had momentarily gotten stronger or louder. At about the same time, ideas of perspective, shadows, and occlusion were being developed in the visual arts, and people had analogous ideas brewing regarding making foreground and background shapes all equally visible and readily enjoyable. So, some musicians decided that in their compositions, one was the largest number of consecutive notes in a row on which two melodic lines would sound in unison, the better to allow the listeners to follow the shapes of each of the lines up and down.

But the situation in music was more complex. Some folks, like my talented student, felt a sense of conjunction and aural occlusion at not just the unison, but the octave as well, and its compoundments. These folks decided that when two players were supposed to be playing different musics, they'd never have two consecutive octaves with each other, again so the melodies wouldn't seem to hide one behind the other for too long for their enjoyment of each melodic shape by itself as well as the overall composite. Some folks had the same experience with the fifth and its compoundments, and foreswore parallel fifths from their multiple-melody expression (counterpoint). Perhaps some folks even experienced the same perception with parallel fourths, thirds, and sixths; if so, those folks probably got disgusted with the whole thing and went into something like mathematics or geography, where great new things were being uncovered every day.

Meanwhile, the consequences of experiment number 1 above were still brewing. Having worked out several melodies to sound simultaneously, people sometimes had more resources than melodies. They quickly found that two violins playing the same melody could balance one bass or cello playing another melody better than one of each (due to the differences in inherent size and loudness of the instruments). Furthermore, individual melodies could be played by pairs of players playing in octaves, often without changing much about the effect of the music except its perceived loudness and strength. Harpsichord builders and organ builders made automatic doubling at the upper octave a feature of their instruments, essentially a simple way of getting a stronger sound with the same number of perceived melodies. Orchestrators eventually decided on a rule for groups of players, which still seems to work pretty well: octave doubling above the highest melody, and below the lowest melody, but no octave-doubling of inner melodies, as such doubling was perceived as still confusing to the ears—except when it was provided by highly-controlled, automated means, like organ stops, harpsichord stops, or 12-string lutes and guitars. Organs even came to have extra pipes to produce parallel 12ths (compoundments of fifths) for an even brighter, stronger tone.

So, for a great deal of western polyphonic (multi-melody) music, parallel octaves and fifths were considered as falling into two categories: features of a single melody—often highly desirable reinforcements of a melody that contributed to its tone color and perceived loudness; and momentary interactions between two melodies—usually considered undesirable, because they interfered with some listeners' ability to enjoy both melodies to the fullest.

Some people continue to hear in these terms, and find ways to treat these 'sensitive' parallelisms as either constant features of their music or things that rarely or never occur in their music.

Composers of the classical era worked out some highly elaborate ways of constructing contrapuntal music so that it avoided parallel octaves and fifths—yet didn't sound (to them) highly artificial. The study of the methods and tricks used by these composers (which involved the resolution of a lot of other preferences and conventions as well as the avoidance of or isolation and control of these special parallelisms) eventually blossomed into our modern discipline of classical counterpoint and harmonic theory. This field and course of study is now so loaded with interesting tidbits of musical thought that the concept of parallel octaves and fifths is often dismissed with the shorthand comment "they're forbidden"—occasionally with a brief mention of the harmonic series, or of the vague idea that they interfere with independent motion. But, of course, the truth of the matter is a bit more subtle.

Listening assignment. Once again, the assignments are purely optional.

Give serious consideration to playing around with parallel fifths and octaves. Do your ears tell you anything about them? Do you have an attitude about them? How do you perceive music that avoids them? (Try the first or second fugue from Book One of the Well-Tempered Clavier of J.S. Bach) music that uses them constantly? (Try the sarabande from *Pour le piano* by Claude DeBussy) music that uses them indifferently? (Supply your own example) music that uses them constantly for long stretches, then not at all, but never indifferently (try the Tenth fugue in e minor from book one of the Well Tempered Clavier of J.S. Bach) ? See if you can find sources and recordings documenting the effect of different tuning systems on the sound of the music. Do your discoveries suggest anything for your own compositional preferences?

Written assignment. No written assignment this time. Go compose.

—4 September 1992 Matthew H. Fields, A.Mus.D.

Shortcuts for undergraduate theory homework

Abstract. We're composers, and we want more time to compose. But those of us in conventional conservatory programs spend a lot of time mastering 4-part harmony and choral counterpoint. This takes time.

Can these shortcuts help? Maybe.

Introduction. These hints worked for me, although I no longer consciously think of them or any other methodology when doing that sort of problem.

Definitions. I'm not defining anything this week. If you're in Freshperson Theory, you're probably already bogged down in definitions.

Three Basic Suggestions. Try these on one or two examples. If they help, they help, if not, discard them and stick to the instructions in your theory book.

The bass line can either move by step/7th, third/sixth, or 4th/5th.

1. If the bass moves by step, try moving the other 3 voices as little as possible, in contrary motion to the bass. If it moves by 7th, treat it as if it were moving by step and the second note just got moved to a different octave—then apply this rule.

2. If the bass moves by 3rd or 6th, try holding on to as many common tones as possible.

3. If the bass moves by 4th or 5th, try modeling the progression on the tail of a familiar cadence formula.

Listening assignment. Play and listen to your solutions. Don't just work them out on paper. This is not a chess game: it's a craft that may be useful to you some day. Train your ear to tell you when you've made a mistake.

Written assignment. You've already got enough written assignments.

—14 September 1992 Matthew H. Fields, A.Mus.D..

Hints for composers of canon, fugue, and other intellectual materials

If you are rigidly opposed to the application of intellect to creative processes, you may wish to skip this article. If you expect this article to take the place of a theory text on contrapuntal devices and conventions, you will be disappointed, since I will be mainly addressing issues of interest to composers, and will assume that you can find definitions and rough descriptions of various intellectual musical procedures in plenty of existing textbooks.

Abstract. In this article, I will attempt to address the role of intellectual techniques in the composer's mental toolkit. Along the way, I will make some general suggestions that I think may be helpful whether you're working in serialism, Fibonacci numbers, canon at the twelfth at 3-3/4 beat delay, or whatever. I expect to also explain some details of specific techniques, mainly to use them as examples of the general principles I will be describing.

Introduction. In musician's core theory classes, beyond 4-part harmony, all further exploration tends to be analytical. By that dense sentence, I mean that most people are taught how to analyze music, but not how to go about trying to construct it themselves.

Occasionally, a theorist will be talented at fugue or serialism, and will inspire the composers among her/his students to figure out how to use such materials themselves. On rare occasions, composition classes are taught which combine rigorous planning of material with general compositional strategy.

For those of you who are thirsting for such guidance but have not found it yet, may this article serve as a primer on the matter.

Definitions. I'm going to use, without definition, a lot of terms from the standard jargon of classical music theory. The definitions are omitted mainly to save space and time. If you want, you can look up these words in e.g. the New Grove Dictionary of Music and Musicians:

Canon	Intervals	Stochastic Music
Fugue	Serial Music	Inversion
Sequence	Fibonacci Numbers	Stretto
Parallel Motion	Algorithmic Music	etc.

A model of a compositional process. Many composers have spoken of a search for the El Dorado of algorithms, the rigorous method which, if applied, always yields great music. The way I compose certainly feels methodical to me, but when I consider the oft-voiced goal of automating my work on a computer, I realize that what I do is very hard to quantify or describe in clear categories—that is, clear enough categories to form the basis of a computer program. Why might this be so?

It helps to remember that two of the most widely accepted measures of "good" music are that it is A) entertaining to people who don't already know all about it, and B) memorable. Entertainment value, by which I mean entertainment in the widest sense—not just light entertainment but also tragic, spiritual, and other kinds of entertainment—is essential if the listeners are going to pay much attention. Memorableness is essential if you hope the listener will ever seek to hear your piece a second time. As it turns out, both entertainment value and memorableness are tricky quantities which psychologists are still just starting to classify, so I don't expect anybody to turn up a mathematical formula mapping patterns of notes or sounds to specific values in either domain. You're just going to have to try to judge for yourself how well your music meets these goals. So any serious methodology which I propose for composition is going to have to incorporate these unexplained, unquantified judgements.

So, let's suppose that I'm doodling with a melody, and I decide that it might be neat to try to make a convincing piece in which this melody is a subject of a four-part fugue. If I'm not really all that knowledgeable about fugue, I

1. *Study the category of materials* that I'm thinking of using, to see whether it stimulates my imagination. At about the same time, I may begin to

2. *Play with the materials* that I might use, and try to learn as much as I can about their qualities.

In the case of my fugue subject, I may decide that I'm looking for 3 counter-subjects, so when all four parts are playing, they are all playing material that can be heard elsewhere in my piece. Soon, I realize that these subjects not only have to form decent 4-part harmony with each other, but also, to be interesting and to be easily recycled into other parts of the piece, they have to form decent harmony when parts are exchanged (counterpoint is inverted) so lower parts become upper parts, outer parts become inner parts, etc. (this means that music is transposed by, e.g., an octave or two when it is assigned to a different player or melodic strand).

Now, depending on my mood and the nature of the materials, I might either want to

2a. refamiliarize myself with (or learn) the principles resulting from my decision, or

2b. begin immediately trying to construct music based on the ideas in my head, then fix it as I go along.

If, in the example of the fugue, I choose No.2a, I'll go back to look at invertible counterpoint at, e.g., the octave, and find out its consequences for parallel fifths: parallel (or direct) fourths become parallel (or direct) fifths after revoicing, so if I'm trying to avoid parallel fifths, I better not allow any parallel fourths either. Knowing that ahead of time can save me some time on process No.2b, which I'll eventually have to confront anyhow.

So now I'll try to build the first such countersubject, by laying out my main subject on a stave, with a blank staff above and another one below. I can now go into the following cycle:

> 2b1. Have I written enough music for this subject? If so, I can quit this cycle, else I continue.
>
> 2b2. Add a note to the subject. Put it in the upper staff, and at the same time, transpose it down an octave and put it in the lower stave.
>
> 2b3. Consider, in isolation, my countersubject so far. Does it groove? Does it sound OK? If not, erase this note from both staves, and go back to 2b2.
>
> 2b4. Consider the music in the upper two staves. Does it violate any of the rules I've discovered in step 2a? avoidance of parallel fifths and octaves) that I've decided to stick to? Is it in any way less than optimal in grooviness or some similar nameless quantity that I want to preserve? If the answer to any of these questions is yes, erase the note and go back to 2b2.
>
> 2b5. Apply the same rules as from 2b4 to the music in the lower two staves (remember, we have 3 staves here: countersubject above, main subject, and countersubject below).
>
> 2b6. If we get to here, this note is one we're going to try to stick with, for now. Go back to step 2b1 to continue building more of the countersubject.

This procedure looks like a backtracking algorithm, but notice that none of the aesthetic judgements are quantified. With a little struggle, it can probably be adapted to quite a wide variety of musical structures. I've used a sort of variant on it as a way of working out serial music, and as far as I can tell, it hasn't failed me there.

The important test: DOES IT SOUND GOOD? DOES IT GROOVE? is the glue that holds this method together.

3. *Solve the most intellectually difficult part first.* In the case of my four-part fugue, I'm going to try to construct music in which the subject and all three countersubjects sound together, and verify that every pair of them fits in good invertible counterpoint together. In so doing, I'm going to use all the tricks I have from steps 1 and 2.

4. *Consider exploiting your solution from step 3* when constructing other parts of your piece.

Now, by simply copying this music to a fresh sheet of paper (or a fresh range of measures in my notation program, or a fresh notelist file in my sequencing program, etc.), maybe transposing it, maybe revoicing it, maybe erasing one or more voices, I can come up with an incredible number of musics with slightly different feelings to them, different textures and densities, but all with a sense of relatedness to each other. I don't have to be at all careful about (e.g.) parallel fifths because I already arranged that they wouldn't arise back at step 3. So, out of my quartet texture, I can pull 23 other quartets by merely rearranging the voices; 24 trio textures, constructed by erasing one voice and permuting the others; and 12 duet textures, obtained by erasing two of the voices, and optionally inverting the counterpoint of the two voices I have left. Plus, I can try putting the music in a different mode (e.g. major or minor), transposing it, etc. In all these cases, I'm taking advantage of all the work that went into step 3, so I don't have to work hard to get any of these materials.

Since the materials are so closely related, if I construct a piece mainly out of these materials, it will have a sort of redundancy that may help drive the melody into the listener's memory in a more effective manner than mere repetition.

5. Sooner or later, I've got *enough material*, and it will be time for me to *stop playing with material and start organizing a composition.*

Under this heading I include all the ideas from GEMS 1, including top-down planning of a dramatic push towards a climax, choosing an assertive gesture to start the piece, finding a convincing and special-sounding ending to the piece, prolonging the climax, etc. I already have a sketchbook loaded with both explicit materials and ways I've found to make materials that I want to use, so now it's merely a matter of choosing among these materials, linking them together, and taking a step back to look at the big picture.

Does it groove? If not, it doesn't matter how perfectly I've applied my intellectual technique: I'm going to have to go back and adjust the eigenvalues or coefficients, prolong the climax a bit more or less, and maybe throw in a contrabass clarinet solo for good measure—whatever it takes to make it finally sound good.

6. *Remember, by mechanical means it's easy to produce more variants than you'll need.* If I systematically presented all the duets, trios, and quartets that I could extract from my 4-part fugue exposition, my piece would probably get to be quite long and boring. I may only want 3, or 5, or 7 or 8 of the variants that I've found. That may be enough to build a fairly long, dramatic piece. It's all right for me to know that all the other variants exist and all work perfectly well as counterpoint or whatever, but I don't get any brownie points for cataloguing them all to the audience. So I'm going to have to just learn to let go of, cross out, and ignore most of the variants which I have generated, once I've used all the ones that fit my piece. Or, I might separately create another piece out of some of the leftover scraps of fabric. But unless I'm incredibly clever, I should never have both of these pieces played on the same concert.

Matt rants on. While I'm on the soapbox, let me remind folks that our listeners hope to be entertained. We can't count on them reading program notes, so they're going to have to get something out of the music without any of the knowledge that could be imparted there, whether it amounts to an explanation of poetic allusions, an intriguing essay on the intellectual techniques underlying your piece, a story that the music is supposed to tell programmatically, or whatever. If the listeners are interested enough in the music, they may be a bit more likely to read the program after hearing it, and if they're really interested in the music, they may pour over the program looking for information on how to buy a recording of the music. At that time, they may learn something about the music which may, after the fact, enhance their appreciation of it. But you just can't count on them gleaning the important fact from the program notes which turns their listening experience from a mystified sitting through a wash of sound into an enlightened experience of a scientific principle. The music has got to draw them in and get them interested all on its own.

On the other hand, even the worst concert-goers (with the exception of a few psychotics) go to concerts to have a good time, and will try to have a good time with your piece. So, your relationship with your audience is not necessarily adversarial... although some listeners will bring a healthy skepticism (or a pathological fear of anything new) to their listening. While it's certainly reasonable to simply not worry about the few who have already prejudged your music on the basis of the fact that it's new to them, and to not worry about reaching the few who will groove simply on the fact that any sound is being made at all, it would not be a good idea to ignore the middle of the audience, the folks who don't yet know whether they can dig your music. If you can guide them into your way of hearing things, it doesn't matter whether they can describe your piece in theoretical terms: at some human level, they're following along with the course of your musical argument, and they stand a chance of getting something out of it.

Listening assignment. Here I list some of my favorite examples of beautifully passionate but rigorously intellectually-structured music. Most emphatically, let me repeat that you can gain a great deal by looking at the score while listening.

I recommend two compositional publications by J.S. Bach as informative sources on musical intellection (and sources of delight and wonderment, as well): The Well-Tempered Clavier, which is a set of 48 preludes and 48 fugues arranged in two sets of 24 each, where each set cycles through all 12 major and all 12 minor keys; and Art of Fugue, a collection of some 16-odd fugues and 8-odd canons for unspecified instruments (plus an arrangement of two of the fugues for keyboard duet), all based on variants of a single melody (and a fairly small set of counterpoints to that melody). If you really cannot read music, for about twice the price of the scores to these works, you can acquire CD's of performances of them (on WTC, I recommend the harpsichord performances of Gustav Leonhard or Kenneth Gilbert; on Art of Fugue, I recommend the performance by Musica Antigua Köln, who have also produced a superb recording of another recommended Bach piece, The Musical Offering—but unfortunately, this recording is out of print now).

Other great examples that come to mind are Bela Bartok's Music for Strings, Percussion, and Celesta, and Arnold Schönberg's Variations op.31.

Part of what I hope listeners to these works will come to realize is that for composers who use such intellectual material all the time, the intellectual structure eventually becomes so basic to their art that the focus of the art is on how they improvise expressive shapes in, with, and around these materials, rather than how they assemble these materials themselves.

Written assignment. For those inclined to think harder when there's a written assignment, here is a short one. But don't forget to work on your current opus!

Compose a piece of 8-40 bars in two melodic lines, using one of the following: invertible counterpoint of the octave, twelfth, or tenth.

Decide whether to work in tonality or not. Decide what rules to apply.

After some number of bars, swap parts between the melodic lines.

Add whatever is needed to the beginning, the middle, or the end to make a convincing piece. Consider only using additional material that is relatively simply derived from the other material of your piece.

Sculpt this music to provide a convincing climax, where applicable.

Choose a keyboard, or, preferably, two voices and/or instruments to play your piece; if necessary, either adjust your choice of instruments to meet the demands of the piece and the availability of players, or adjust your music to meet the demands of writing for these players, or both.

Stage a performance of the piece. Perhaps record it.

—17 November 1992 Matthew H. Fields, A.Mus.D.

What are serial materials?

This article took me much longer to produce than the preceding four. The main reason is that I had to really struggle with what to present and what to leave out. Finally, I decided to dispense with all but the barest sketches of history, say fairly little on the musical literature, condense and simplify the discussion of tonality, atonality, and modality, put very little energy into preaching to the inconvertible, and concentrate on what fascinates me most about this topic: the materials themselves.

Introduction. One of the most frustrating aspects of bringing up serial materials is the way it has been taught in times past. For a brief time, roughly 1954-1963, music-compositional academe gave in to a sort of herd mentality following the leadership of a few successful serialists. Many teachers went so far as to require their students to work in Viennese-style 12-tone serialism exclusively. In the rush to be academically stylish, "simplified" misrepresentations of the materials were developed ("First you choose a tone row...."). One particularly vociferous subculture argued that serial materials were supposedly new, scientific, rational, and somehow emancipated from traditional Western culture, which they (the members of this subculture) saw as a monolith stretching from Gregorian Chant to World Wars I and II. In fighting a tradition which they associated with Fascism, they enforced an oppressive approach of their own. Naturally, their students rebelled, and when they in turn became faculty members (say starting 1965), serialism abruptly became taboo in many corners of musicianship—or the subject of ridicule. It became associated with unfeeling intellectualism, disdain for tradition, and the madness of the artist or scientist who perpetrates horrors upon the world out of "unfeeling curiosity"—and all these associations were, naturally enough, caricatures of the actual stances of the previous generation. Gradually, the furor subsided.

Meanwhile, a fairly small number of people continued working on and passing on a concept of serialism from the 1920's, a concept closely bound with the traditional objective of matching fascinating intellectual patterns with passionate expression. It is this approach I wish to talk about here.

Where serialism comes from. As many of us know, serialism was Arnold Schönberg's 1921 answer to the question of how to structure atonal music. So what is atonality, and where did it come from?

To answer this question coherently, we must first ask what we mean by tonality, in order to ponder what the absence of tonality could possibly be. More to the point, we will have to ask what musicians in the 1920's understood by tonality. Now, many of us tend to use the phrase "tonal music" interchangeably with "music that I like", and when pressed for an explanation, say that it's music that is restricted to seven-note scales. There are several reasons why those are NOT the explanations we will use in this article:

1. Many of us know a lot of music we like that is all for unpitched percussion, or is some special kind of folk music; in either case the terminology of tonality never arises.

2. The meaning of "tonality" that was current in the 1920's referred primarily to 18th-century classical style as exemplified by Haydn, Mozart, Bach, and others; use of more than 7 pitches was more the rule than the exception in this style, and in fact was a fairly common though not constant feature of that musical tradition for the preceding 500 years. Composers like Gesualdo and Monteverdi cultivated chromatic styles of modal practice that, in many ways, sound very much like the late-nineteenth-century and early-20th-century romantic styles of Schönberg, Strauß, and DeBussy—and used 12 or more families of pitch in the course of a single work.

What qualities of 18th-century style can we point to as defining tonality? This is quite a technical question, but to give a flavor of the answer: tonal music was built out of a fairly small number of standard melodic shapes and patterns of chords (CADENCES), each of which was treated in a manner roughly approximating a piece of sentence structure (clause, phrase, subordinating clause, sentence-completion, etc....). And here's the catch: these formulas could be hierarchically nested. So a C chord could be decorated by motion to and from a G chord, and the same G chord could be decorated by motion to and from a D chord... and each melodic shape in each of the several melodic strands expressing these chords could be decorated by various phrases that could stand in place of either a single note or a pair of adjacent notes... and all these complications were further subject to considerations of counterpoint like I spoke of back in GEMS 2, so all the melodic strands would make themselves manifest to the listener...

Like I said, it gets quite technical when you really sit down to try to understand it. So what did musicians starting in 1907 mean when they spoke of "atonal" music? Well, any music NOT organized around the fairly narrow set of concepts present in the music of Haydn and Mozart.

What led musicians to stray from the practices of Haydn and Mozart?

To reflect on this it helps to get just a little bit technical. In tonal (in our narrow sense) music, while a core major or minor scale reigned, a key part of standard rhetoric was *modulation*, a calculated shift to a *different* major or minor scale. Modulation functioned as part of the hierarchy: once a C chord had been elaborated into the chord sequence C-G-C, this could be further elaborated by replacing each chord with a whole segment of music in the *keys* of C, G, and C. The move to G involved the substitution of $F_{\sharp}$ for F in the scale.

So the appearance of this F♯ was potentially an important event, since it marked a turning point in the grammar and rhetoric of the music.

As musicians worked with this grammar in the 19th century, they gradually extended it in all directions, first by applying all the available transforms to every possible moment, then by adding some phrases from folk musics (which remained true to earlier traditions) to the set of possible transforms... then adding more transforms. Each such extension brought with it more and more frequent use of notes outside the basic seven-note scale. Finally, the act of expanding a single pitch into a chord, and a chord into a key, and thence into an audible hierarchy of keys, became more of a post-hoc explanation for expressive musical practices. New pitches occur often enough in, e.g., the prelude of Wagner's Tristan und Isolde, that they no longer have the specialness, the markedness, the rhetorical power that the turning-point F♯ had in a C-major composition 100 years before. Many musicians were using other traditional means of organizing their works:

a. around the rhetoric and poetic images in a sung text;

b. around a story or drama;

c. around a surge to a climax, without reference to a specific story;

d. around motifs—short bits of melody, harmony, rhythm, and tone color which were repeated and endlessly varied throughout their compositions, so any given piece would continuously evolve and at the same time continuously state its identity.

Organization principle d above was known as "organicism", from the concept that an entire composition grew "organically" from the seedling of one or two simple, memorable motifs.

These principles were also actively used by the composers of Mozart's days… and for hundreds of years before (Mozart's generation used them in conjunction with the narrow grammar and conventions of tonality). But the language evolved idiosyncratically until some of its organizing principles were no longer recognizable, while others came to dominate.

Since Arnold Schönberg (1874-1951) first expressed (in his Suite op.25) the concepts we're talking about here, let's look at the values Schönberg wished to preserve:

1. Organicism, the building of compositions from repetition and recognizable variation of small, cellular, distinctive segments.

2. Awareness of the push and pull between consonance—the perception of synergy among several sounding tones—and dissonance—the perception of disbalance among several sounding tones, with the understanding that these tones belonged to melodic strands that would soon move into a state of consonance. The exploration and constant redefinition of consonance and dissonance and motion between them was an area of continual experimen-

tation in the previous 8 or so centuries.

3. Constant expression of forward motion or dramatic change through the constant introduction of "new" pitches, i.e. a continuance of features we might hear in the Tristan Prelude we looked at a few paragraphs ago, or the pitch language of e.g. early Baroque-era madrigalists like Gesualdo.

4. Familiar patterns of drama, verse-structure, and other overall forms.

5. A fluid perspective on melody (sequential tones) and harmony (simultaneous tones). Schönberg wrote that he felt melody could melt smoothly into harmony and vice versa, through the persistence of memory. He was referring, of course, to the concepts of arpeggiation (playing of the tones of a chord sequentially), compound melody (timesharing between two separately-perceivable melodies played or sung by one sound source), and similar devices which had been developed over the preceding 600 years. What was perhaps new about Schönberg's attitude, as we shall see, was an interest in using patterns of arpeggiation of a small number of chords as the melodies in a work— a new attitude towards organicism that he hoped might make non-tonal music stick better in the listener's memory. The several melodies in a contrapuntal texture might each be an arpeggiation of a chord similar to each of the chords arising in the music, for instance. Or, a tune could be presented with each tone sustained somehow, so the final effect would be of a ringing chord.

6. Some sense of markedness, of something special announcing a turning point or structural point in a piece. Since his style now called for using all possible tones most of the time, the classical idea of the New Pitch (e.g. F♯ in a piece otherwise in C) wouldn't be very effective. Schönberg took a backwards approach and suggested that the return of an Old Pitch Class that had been momentarily absent might sound like a milestone or marker. In 12-tone equal temperment, an arrangement of all twelve pitch classes would be simply the longest phrase you could build before having to return to an old pitch. So even years before he started working with 12-tone rows, Schönberg noticed a tendency for his phrasings to be clumpy, with each clump containing ten, or eleven, or twelve different pitch classes.

Before we watch a 12-tone row at work, it will be illuminating to see some of the ways Schönberg approached these matters in the decades *before* he formulated his "system". But to do that, we'll need some technical terminology.

Definitions. In the past my Definition section has been pretty short and minor; this time I'm loading it with some bulky, nutritious ideas, so if you're skimming, please don't skip this section.

By "pitch" I mean a single (perceived) tone; for the acoustically minded, that's a single fundamental frequency.

For the bulk of this article, I will be talking about Schönberg's approach to serialism, which assumed the use of 12-tone equal temperament, the division of the octave (acousti-

cally, the 2:1 frequency ratio) into twelve equal semitones (ratios of the 12th root of two = ~1.059463094359). So in this parlance, middle c = $b_{\sharp}$=$d_{\flat\flat}$. Most grand pianos are constructed to play 88 pitches.

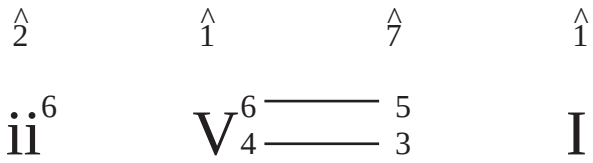
By “pitch class”, I mean the closure of a pitch under octave transposition. A pitch class can be identified by a representative. So, the pitch class of g”$_{\flat}$ is the collection of all $g_{\flat}$s, whether written as g flat or $f_{\sharp}$, without regards to octave. Most grand pianos are constructed to convey 12 pitch classes.

The grouping of phenomena into classes like this isn’t new to musical thought. In fact, the idea of referring to all octaves of $g_{\flat}$ as $g_{\flat}$ is very old.

In most of what follows, I will be speaking of pitch classes rather than actual pitches, and I may informally slip into using the term “pitch” to mean “pitch class”... but my meaning will be clear from context.

By “pitch collection” I mean an unordered set of pitches. The act of collecting them might, in the course of a composition, be expressed by playing them together as a chord, by playing them sequentially as a tune, by assigning them all to the same instrument, by grouping them all in one register while other pitches might be sounded — all much higher or all much lower than these — or by many other means that the composer finds expressive. All that is implied a priori by “collection” is that the composer is somehow going to group these pitches. So, for instance, the open-position triad C-G-e is a pitch collection — the same collection as $BB_{\sharp}$-G-$f_{\flat}$.

At this point in the basic definition process, it becomes handy to introduce numerical names for pitch classes. I will be using a bit of simple arithmetic to help formulate some of the ideas in this paper. Before I do so, let me point out that calling a pitch class “zero” instead of “C natural” does not in any way denigrate it or subvert its expressive potential beneath a mad scientist’s algebra. It’s merely a naming convention that proves expedient. In fact, I think this system of numbers is slightly simpler than the numbers used to describe Mozart’s practice. Consider a typical statement from classical theory:



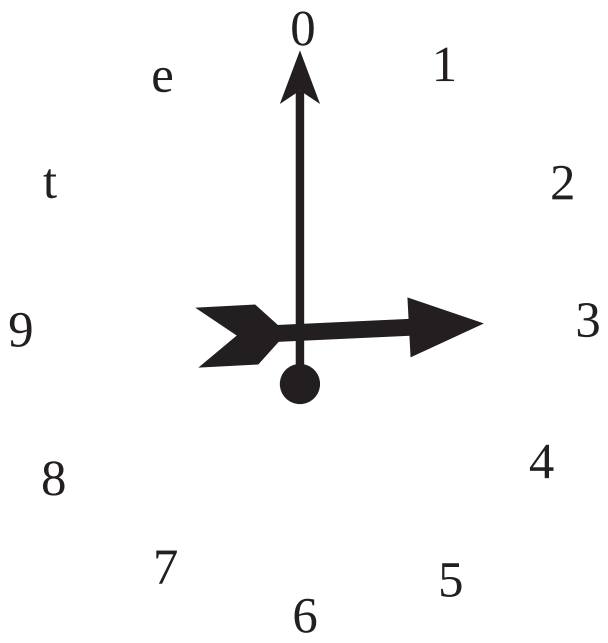
This series of symbols describes four chords, specifying their melody notes, bass notes, and providing enough information to formulate the middle notes, while at the same time stating their function relative to the rhetoric of a major key... without identifying the key. It uses carat-decorated Arabic numerals to indicate scale steps of individual tones, lower-case Roman numerals to indicate scale steps of root notes of minor and diminished chords, upper-

case Roman numerals to indicate scale steps of root notes of major chords, and unmarked Arabic numerals to indicate displacements of chord tones relative to whichever chord tone happens to be being played lowest. Numerical names for things is really nothing new. Or: musicians are accustomed to doing (or faking their way through) arithmetic to make sure the notes they've written add up to the length of a measure. We won't be looking at anything harder than that here.

As you may have guessed from the fact that we're (for the moment) using 12-tone equal temperament, I need 12 different numbers. For reasons of convenience that will become obvious later, the symbols I choose are not one through twelve, but zero through eleven. To save space, I will write "t" for ten, and "e" for eleven, so all my numerals are single digits, and can be written without spaces and without confusion between 1,1 and eleven. The set of names: {0123456789te}

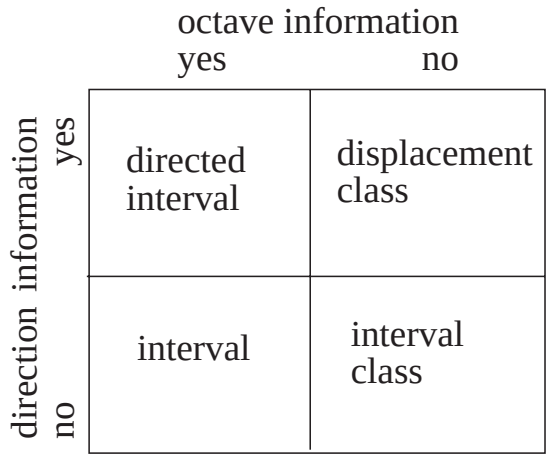
I adopt a system which I call "fixed zero" in which 0 always represents the pitch *class* $c_{\natural}$, 1 always represents the pitch class $d_{\flat}/c_{\sharp}$, 2 always represents the pitch class $d_{\natural}$, etc. Some other authors use a "moveable zero" system, in which the meaning of the number 0 is assigned on a per-composition basis, and might typically be some important pitch of a composition, like the first pitch sounded. Each system is convenient for describing certain composers' works, much as moveable- and fixed-do solfege systems each have their advantages.

The twelve pitch classes form a cycle which I like to diagram using the twelve-tone clock face, to help express the concept of modular arithmetic:



I define the *INTERVAL BETWEEN TWO PITCHES* as the distance between them, in the conventional way; the *INTERVAL CLASS* between two pitches or two pitch classes is the distance between the numbers on the circle, *the short way around*. This means that, for instance, minor 3rds and major sixths are grouped under one big family heading, IC 3 (distance of 3 semitones the short way around). So I'm ignoring octave placement for *both* tones, and considering them in terms of their pitch classes. Notice that (unisons and octaves aside) there are only 6 interval classes. Once an interval gets larger than IC 6 (a tritone) its octave complement becomes the shorter way around the circle. So, for instance, IC 5 groups together all perfect 4ths, perfect fifths, perfect 11ths, perfect 12ths, perfect 18ths, perfect 19ths, etc. Notice also that if we impose an order on a pair of pitches, we can speak of ascending and descending intervals. To capture equivalent information regarding pitch *CLASSES*, we define *DISPLACEMENT CLASS* as the modulo twelve *DIFFERENCE* between the numbers—which depends on their order. So between middle c and the second $A_{\flat}$ below it, the directed *INTERVAL* is a descending minor tenth, or minus 15 half steps; the INTERVAL CLASS is plus 3, and the DISPLACEMENT CLASS is plus 9 (which means descending minor third or ascending major sixth or some compoundment).

Remember: *INTERVAL* gives information about the number of octaves compounding an interval; directed interval gives the same interval plus a direction. Interval class gives the smallest distance between the notes without regard to octave. Displacement class gives either interval class or its twelve's-compliment, and thus gives information about order without information about octave.



If you take an ordered pair of notes and reverse their order, the interval between them is the same, but the directed interval has the opposite direction. The interval class remains the same. But the displacement class is replaced by its octave complement, that is, twelve minus the old displacement class. So if instead of descending from middle c to the second $A_{\flat}$ below it, we play the same two notes in reverse order, the interval is still a minor tenth, but the directed interval is an ASCENDING minor tenth or PLUS 15 half steps; the interval class is still 3, and the displacement class is now 3.

In a few minutes I will define a concept called *COLLECTION CLASS*. Given a pitch collection—say, for the duration of this paragraph only, we call it P—we may assess the way intervals lie in it, and find all other pitch collections V(P) that have the same interval classes lying in it in more or less the same way. This is interesting to an organicist composer because, if the composer has in mind some motif M where all the notes of M are members of P, this composer might want to look at exactly the set of variants V(M) that are suggested by V(P), as a source of materials both different from and at the same time closely related to M. In so doing, the composer will look at motif M abstractly in terms of collection P and collection class V(P) (we'll introduce some simpler notation in a few paragraphs) in order to help concentrate on the properties they wish to work with (this abstract approach may be initially uncomfortable to many musicians but will be especially attractive to those who also indulge in theoretical mathematics; again, it's no more atypical of musical thought than the concept of a tonic and dominant, which are, of course, abstractions of specific chords). Now, suppose I plot the members of P on the clock face by making a mark around the numbers of each pitch. It should be intuitively clear that the set of interval classes (distances between marks) in this set of markings is determined by the exact SHAPE of the set of markings, NOT by the particular numbers marked. The intervals involved (and thus the melodic properties, or, in some sense, the level of consonance or dissonance implied by the chord) remain the same if I pick up the set of marks and rotate it AS A WHOLE with respect to the bunch of numbers: the distances between marks remains the same. What's more, if I pick the set of marks up and flip it over so it shows it's mirror image to us, the set of intervals is STILL the same... and the way they present themselves to us differs only very subtly. Now, if I take my motif M that lies in P and carefully transpose it so that the resulting transposition preserves, to the semitone, the size of the original intervals, I get a motive T(M) that preserves some properties of M but is higher or lower. If I plot the notes of T(M) on my circle, I will see that I still have the same shape as P, but it has been rotated. So, rotation on the circle is an abstract kind of transposition. Furthermore, if I take my motif M and invert it about some center or axis, so all it's ascending intervals become descending intervals and vice-versa, I get a motif I(M) that preserves the size and proximity of intervals, but reverses their directions. In Western language, this amounts to swapping questions for answers and answers for questions... or creating a response to a call or a call for a response. If I plot the notes of I(M) on my circle, it may come as no surprise that they now form a mirror image of P. So mirror-reflection is an abstract kind of inversion.

This is getting a bit heavy, so let's take time out for a story. Richard Hoffmann, professor of composition at Oberlin College, and co-editor of the Schönberg Collected Works, explains the idea of collection class this way.

HOFFMANN: *(holds up a Swiss Army Knife)*: All right, class, what have we here?

CLASS *(ALL EXCEPT FOR FIELDS)*: A collection class.

FIELDS: A pen-knife.

HOFFMANN: *(turning to Fields)* All right, smart-aleck, NOW what do we have? *(turns his pen-knife on it's side)*

FIELDS: Um, it's still a pen-knife?

HOFFMANN: *(grinning so nobody can tell whether he's happy or has just caught Fields in a major boo-boo)* You are co-RECT! Now, class, who wants to tell me, *(turns his pen-knife upside down)* what have we here?

CLASS (ALL): A pen-knife!

I really don't know what we would have said or done if he had ever unfolded the knife. But apparently he didn't think we'd ever encounter *THAT* serial operation.

As I write this I'm nagged by the thought that many of you might not realize just how often and for how long composers have turned to these two concepts—transposition and inversion—to create musics varied within unity. Consider that when in 1750 Bach wrote Art of Fugue, the consequences of using these tools had been explored and catalogued for over 500 years. If you're really unfamiliar with these ideas, you might want to go back and listen to Art of Fugue now (I recommend Musica Antigua Köln's CD) and become aware of how Bach takes his short opening tune and subjects it to transpositions, inversions, changes of meter, changes of tempo, changes of ornamentation, etc. while always keeping it recognizable—and strings together all these variants into expressive, dramatic shapes.

OK, back to work.

Now, right here in the definition section, come the two main tools of serial thought: the serial concepts of transposition and inversion, which are abstractions based on the classical concepts with the same names, but with this reductionist octave-ignoring attitude in place. These are usually considered the main serial operations because they are the only operations which maintain the shape of ANY collection of pitch classes. Sly serial composers sometimes match special collections of pitch classes with other special operations because those operations maintain the shape of those particular bunch of notes (linear algebraists: eigenvector alert!). It is my opinion that anybody who explores serial materials can find these special operations when they are needed and useful, so I'm going to leave them out of my subsequent discussion.

And what about retrograde? Well, you're getting ahead of me here. I've been talking about unordered sets, and retrograde is an operation on ordered sequences. All in due time.

A bit of notation. I'm about to start using some notation, so let me give you some idea what I'm talking about. By example:

PITCH CLASSES

PC0 Pitch Class 0

COLLECTIONS OF PITCH CLASSES

{014} The unordered collection of 3 pitch classes: PC0, PC1, PC4

{401} Same as previous

CLASSES OF UNORDERED COLLECTIONS OF PITCH CLASSES

(014) The collection class (shortly to be defined) having {014} as its canonical representative. Also called CC014.

ORDERED SEQUENCES OF PITCH CLASSES

[014] The ordered sequence of three elements, where the first element is PC0, the second element is PC1, and the third element is PC4.

[401] The ordered sequence of three elements, where the first element is PC4, the second element is PC0, and the third element is PC1.

CLASSES OF ORDERED SEQUENCES OF PITCH CLASSES

401 The sequence class (shortly to be defined) having [401] as its canonical representative element. This has the least punctuation on it because I plan to use it a lot.

Transposition. If you have any group of pitch classes marked out on the twelve-tone clock face and you rotate it so the number 0 is now where the number N (for any N in Z_{12}) used to be, you will have TRANSPOSED your group of pitches N steps. The operation you have performed is modulo 12 addition: you added N to all the numbers you started with, and subtracted 12 from any that went higher than eleven. We write:

T_N {abc}={a+N b+N c+N} ... (modulo 12 operation is implicit)

So a B major triad, B-D♯-F♯ or {e36}, could be transposed up a minor third (IC 3) by this operation:

T_3{36e}={269} = D-F♯-A, a D major triad (see, it does what we expect it to).

T_4 3 = 7, i.e. transposing the note E♭ up a major third gives G.

Arithmetic check: we said this rotation should move the number zero to the number N. T_N 0 =0+N =N, so everything we've said is consistent.

Since we are working in modulo 12 arithmetic, it should be clear that I've defined 12 T operations:

T_0 (the do-nothing operation), T_1, T_2, ... T_9, T_t, T_e.

My choice of the numbers zero though eleven instead of one through twelve should now be clear: I chose my set of numbers so I could cheaply steal the existing language of modulo arithmetic to express myself.

We should notice that the index N of the transposition operation T_N is not a pitch name, but rather a measure of the absolute interval through which a pitch class must be rotated clockwise on the clock.

And remember, while there are twelve transposition levels, there are only six interval classes: zero doesn't count as an interval class, and 6 is the greatest distance between two points on the clock face.

It may prove handy to get a small disk of transparent material and mark our chosen set on that while holding it in front of the clock face. Then we can freely rotate the transparent disk relative to the clock.

Inversion. Or we can pick up the disk and turn it over so we see the mirror image. Let's choose an axis on which to flip it over. This axis will pass through its center, and will either lie on a line connecting two numbers that are 6 places apart from each other (e.g. a line from 2 to 8), or it will lie on a line that passes between two numbers (e.g. a line from halfway

between 2 and 3 to halfway between 8 and 9). Once again, it should be clear that there are 12 such axes, and each of them exchanges position 0 with a different position on the clock.

If we have some set of pitches marked on our clock (or on our transparent disk which we superimpose on the clock) and we flip them into mirror image in such a way that the numbers 0 and N would trade places, the new marked set of pitches is the Nth inversion of the original. We write:

$I_N\{a,b,c\}=\{N-a,N-b,N-c\}$ and note that the operation of mirror imaging is accomplished by subtracting from a constant.

Arithmetic check: We said the Nth inversion makes pitch classes 0 and N swap place.

$I_N\ 0 = N-0 = N$ $\qquad$ $I_N\ N = N-N = 0$

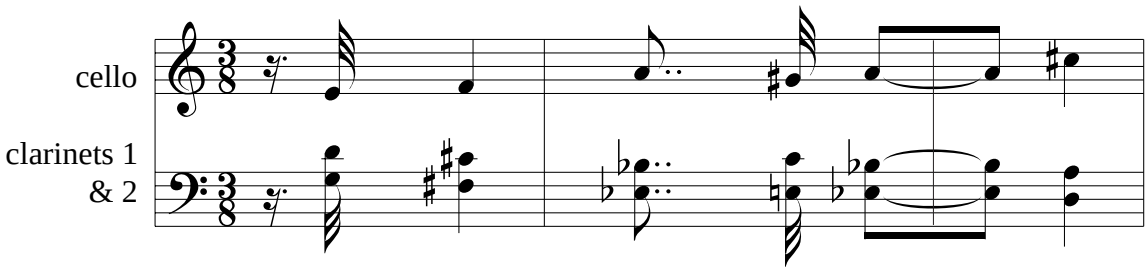
so again our arithmetic appears to do exactly what we said it does.

Collection class. Now we can, working backwards to get what we want, define collection class. Given any pitch class collection P, the collection class generated by P is the closure of {P} under transposition and inversion.

What are these collection classes? Well, for one thing, all members of a given class have the same number of different pitch classes in them. In some sense, they all have the same distribution of interval classes within them... and so in a sense they are all at a single level (or narrow band of levels) of consonance and dissonance.

Let's look at a typical collection class: (037) This class is named for its canonical representative, a c-minor triad. It includes ALL minor triads, by transposition; by inversion, it contains all *MAJOR* triads as well. So this class contains 24 different unordered collections. We choose a standard representative so that we can tell easily whether two chords belong to the same class (by comparing the standard representatives of their classes). The canonical form of a collection is found by plotting it on the circle, finding (inspection is usually as good a means as any) the shortest bracket which wraps around all the marks on the circle, rotating the marks so the counter-clockwise end of the bracket is at zero, and optionally flipping the marks into mirror image so the counter-clockwise end of the bracket remains at zero and most of the marks cluster towards the lower numbers... the formal literature gives a formal definition of canonical form, and I think it's a bit too much of a technicality to warrant my dwelling on it much here.

Collection classes in action—a few bars of Schönberg Op.16.



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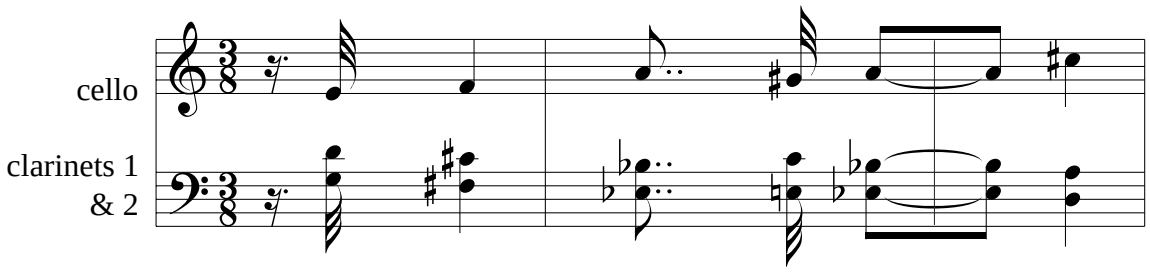
Thus (with a scampering motion in the contrabassoon and contrabass clarinet) begins the first of Arnold Schönberg's Five Pieces, Op.16, a work from 1908 (revised 1922), 13 years before his first work of twelve-tone serialism. It is not at all irrelevant to consider that Schönberg had already completed most of his smash hit oratorio, Gurrelieder, and had completed voluminous amounts of unpublished works demonstrating his adeptness as a romantic, late–nineteenth-century–style composer. Late in the working out of the last movement of his second string quartet, he announced an awareness that while he was working from organic principles, he was no longer using vestiges of 18th-century tonality as guiding principles. His settings for mezzo-soprano and piano of Stefan Georg's Poems from the Book of the Hanging Garden continue a firmly romantic, lush sound while further exploring the ramifications of non-tonal organicism. And then we have these five orchestral pieces, each depicting a different mood while elaborating on a different experimental approach to organicism. By considering just these first three bars in terms of collection class, I hope to at once intrigue you to listen to and explore the entire set (look for performances with, e.g., Pierre Boulez conducting), and also to shed light on the thinking that preceded the use of tone rows.

Let's look at that 3 bars again, and see what we observe.



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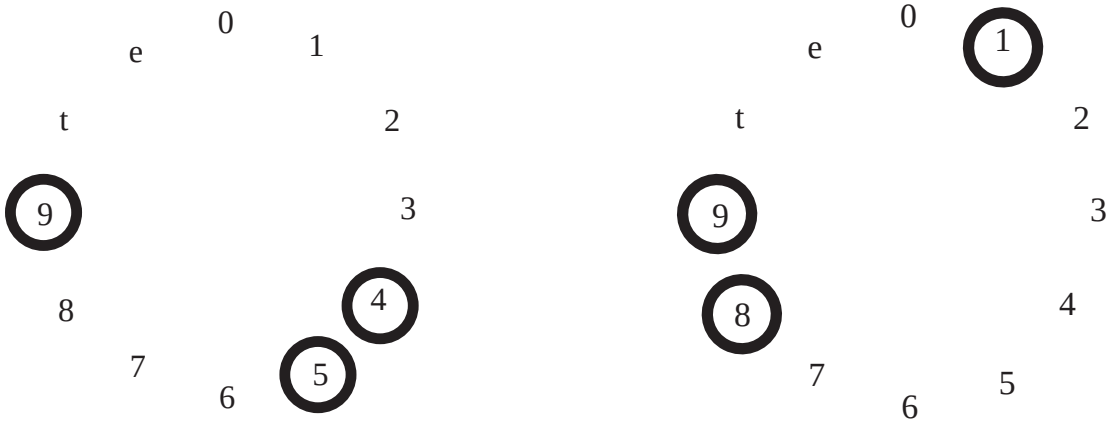
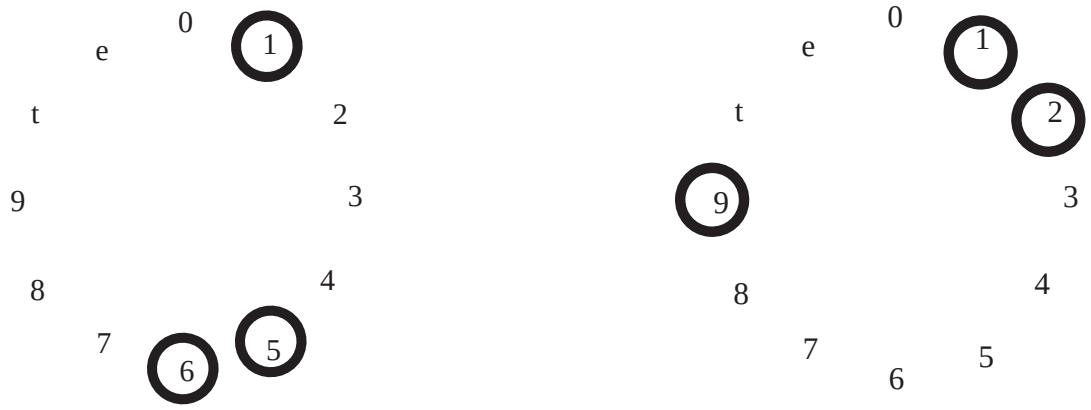
Well, the second clarinet seems to be moving in contrary motion to the cellos, with similar, though not identical, intervals. The first clarinet is moving in parallel fifths with the second clarinet (as you may recall from GEMS 2, classical composers either use parallel fifths constantly or not at all)... but then there's the odd note out, the concert middle c in the middle of the second bar. Suppose the first clarinet had gone to B instead, and thus maintained its parallel fifths with the second clarinet. Then, suddenly, in the middle of the bar, the 3 sounding notes would be g♯, B, E: an E major triad, or a very restful sound in the middle of the phrase. Schönberg has apparently adjusted the first clarinet part by a semitone to keep the phrase moving forward into the third bar.

Another thing that strikes the ear is that the cello line consists of two statements of a 3-note motive, with the second statement transposed up a major third (4 half steps). Both statements of the motive are from (015), as you may verify by plotting the notes on the twelve-tone clock. But the first and last sustained chords—the second beat of m.1 and the second beat of m.2—are also from (015), as again you can verify. It's worthwhile at this moment to sit down and play those two chords, and also play out the tune. The chords are derived from the tune, and the tune from the chords. Trichords of the cello melody:



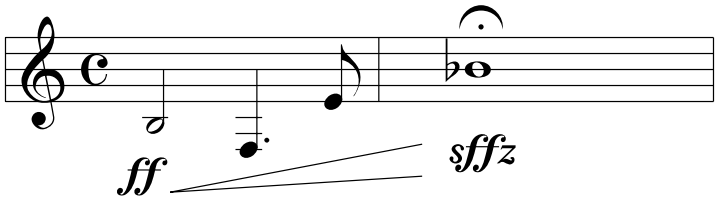
First and last sustained chords of the phrase:



So, in a way, Schönberg's construction resembles a crossword puzzle. Such tightly-woven multidimensional construction is typical of classical music—it's exactly the kind of thinking that goes into counterpoint.

Just a couple more observations should suffice to give the aroma of his thinking. The three-note cello motif that starts the piece is one of 5 motifs presented in the 25-measure introduction, all of which saturate the rest of the movement from then on. The form of (015) that ends the opening 3-bar phrase—the chord c♯-A-D—is sustained as a triple pedal point (drone) from m.26 to the end of the movement in m.128. So, in a sense, the chord at the end of the phrase foreshadows the 102-measure drone that ties together the bulk of the piece. The movement has the programmatic title "Vorgefüle" (fore-sensations, that is, premonitions)... and the opening 25 bars present all the materials—all the threats—that are realized in the main drama of the piece.

The evolution of compositional impulses into a twelve-tone row. OK, so it's Monday morning, and Composer X wakes up shouting this tune:



"Blammo. Hmmm." After a sip of coffee, the language centers in Composer X's brain begin to stir.

"French horns," he mutters, "four french horns. Maybe six. In unison. Cool."

After another sip, he goes and picks up his cello, and plays the notes.

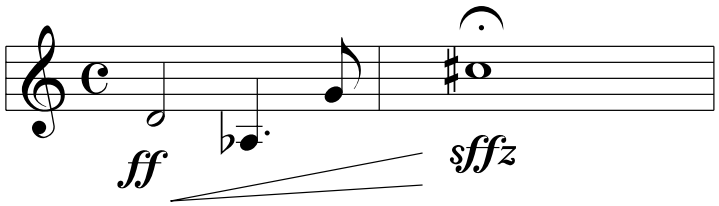
"Mmmm. Not going to work very well as a tonal tune, nooooo....."

A cat appears, rubs his leg, meows, jumps up on his shoulder, and glowers. As he runs downstairs and feeds the cat, he continues working.

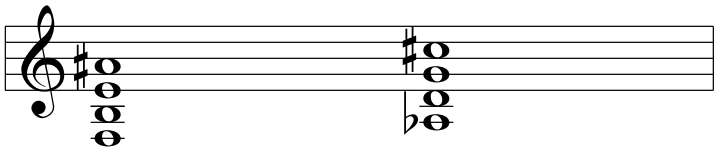
"I like the assertiveness of that four-note motive. I think I'll call it the Check-Mark motive because of the melodic shape it takes.

"Eeeeeee, fiiive, four-TEEEEEEEEEEEEEEE! Hmm. It's from (0167). So it'll invert onto itself, like this: Fooooooour, teeeeee, eee-FIIIIIIIIIIIIIIIIVE. This also reverses the order of the dyads [e5] and [4t], but keeps the notes within each dyad in its original order. Cute. The operation is I— um, I3 [e5 4t] is [4t e5], but I also have I9 [e54t], which is [t45e]. And I have T6 [e54t], which is [5et4]. So that gives me 3 operations relating this motif to a permutation of its pitch classes while retaining the sequence of its intervals. Well, not really the sequence of intervals, but each either has all the same displacement classes in order, or it has all the complements of the displacement classes in the same order. So I get either Checkmarks within these four notes, or upside-down Checkmarks in the same four notes."

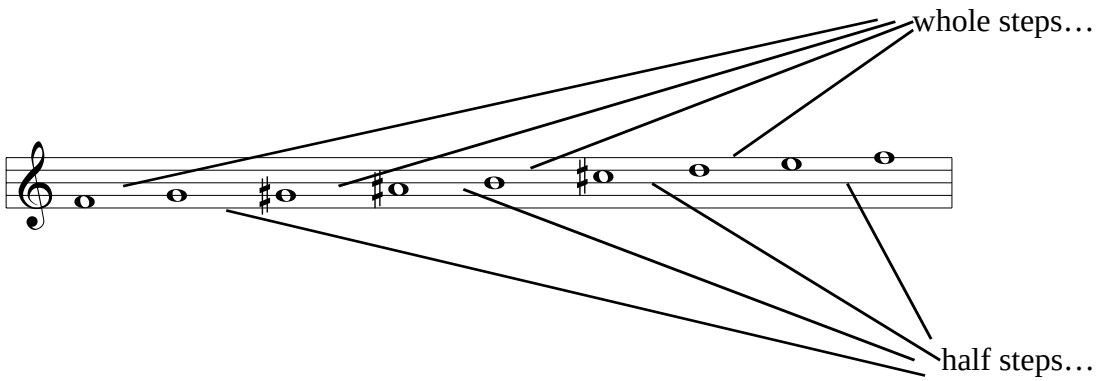
Kitty meows at him as if to say, why are you blathering at me like that. He ignores Kitty and goes over to the piano. First he plays his little motif, sustaining the notes with the pedal, then looks up in glee and says "Let's try T3." He plays the same notes up a minor third:



The pedal is still down. He thinks he hears something he likes, so he plays the two tetrachords over again quickly:



And then it dawns on him. "It's a @#$ @#$(*& octatonic!" Just to make sure, he reorders the notes in scale order, to verify that they alternate whole-step, half-step, whole-step, half-step...



"Miu?"

"Oh, look, kitty, this is simple stuff, but it sure is fun. And I was dreaming of big natural forces when I got going on this tune, so that'll be the program for the piece.

"And I like the idea of following up Checkmark with T3 of Checkmark to make an octatonic. But unless I want to write yet another commentary on Messaien's Abyss of the Birds, I'm sooner or later going to have to bring in the other four pitch classes. Lessee, an aggregate, take away an octatonic, leaves what? A full-diminished seventh. c, e♭, f♯, a, I don't know what order yet. I think I'll be a bit flexible about the order of that T3 of Checkmark, too, because I might stumble on some reason to rearrange it. OK, so I have a kind of music going on here that uses a lot of different pitch classes, maybe all of them. So it's going to organize into little clumps, where the beginning of a new clump is kinda marked by the return of a tone from the previous clump. All the clumps are going to have so many tones in them that I really can't worry anymore about distinguishing one from another based on which tones they do and don't have in them, like I could with major and minor scales. About all I have to work with is the order of the tones within each clump."

"Mew."

"Yeah, I know. Big deal. But let's see what I've got now.

[e54t]

"This is ordered in a definite order, because I started out with it as the checkmark motive. It's a member of (0167)."

{1278}

"Unordered, for now. I'd like it to be a recognizable form of the Checkmark Motive. I'ts another (0167)."

{0369}

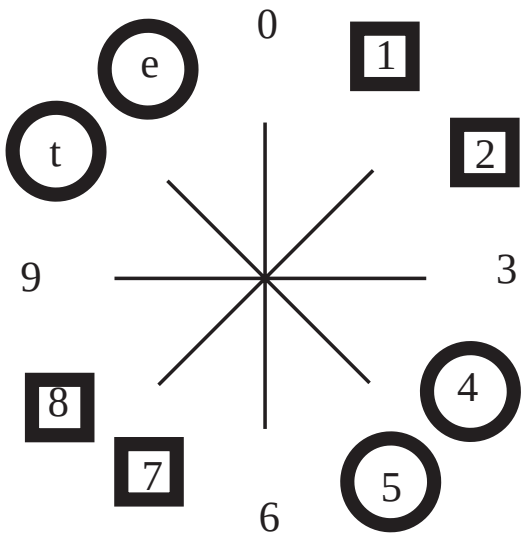
"Unordered: (0369) in canonical form. But I don't like it in this context. Uh, oh."

"Let's look at these on a clock face, and see what else I learn."

The three tetrachords:

E,F,B♭,B={45te}=circles. C♯,D,G,G♯={1278}=squares. C,E♭,F♯,A={0369}=unmarked.

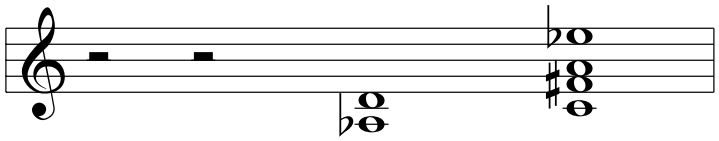
Diagonal axes fix all sets; rectilinear axes fix unmarked while swapping circles and squares.



"My first four notes sound so strong, and so do my next four notes. But my last four notes are a full-diminished seventh. They sound so wimpy. How could I fix that? Well, I can think of two ways right off the bat. I could change my choice for the middle four notes so I'd get different notes for the last four notes...but then I'd be giving up that lovely octatonic. Or I could promise myself that I'd always sound an additional note or two from the middle four notes when sounding the last four notes. Let's see."

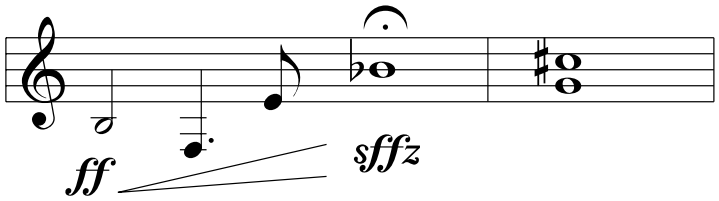
Composer X dabbles around at the piano, playing a full-diminished seventh with his left hand, while adding tones with his right hand. He soon realizes that he gets the same 5-note collection class no matter what one note he adds to the (0369). Any way he looks at it, it's (0147t). "So what."

He starts picking notes from his middle tetrachord to go with the dim7. "Why should the extra notes come from the middle tetrachord? Well, because it's already right next to that last tetrachord. Wait, what's this?"

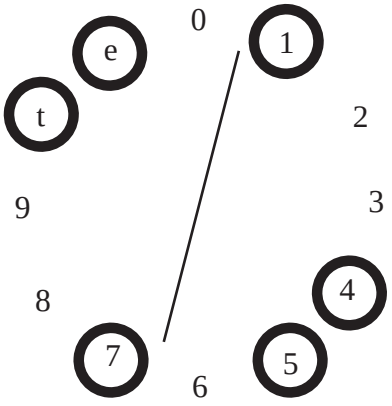


"What a pretty little hexachord. Sounds familiar. Oh, yeah, Stravinsky popularized the same notes (down a whole step) in his ballet, Petruchka, and so it's called a Petruchka chord. And Stravinsky made a big deal of the fact that you can regroup it into two major triads, with their roots a tritone apart. In this case I have a D major triad and an A♭ major triad. If I transpose it by a tritone, I get the same six notes. OK, so what do the OTHER six notes look like?"

Checkmark motif two more notes



"OK, well, that's like an e minor triad on top of a B♭-minor triad, again with a tritone between e and B♭. So I'll call this a "minor Petruchka chord", and call the other one a "major Petruchka chord" to distinguish them. I know the inversion of a major triad is a minor triad, and vice versa, so I bet some inversion will relate these two hexachords. Let's plot it out on a circle and see what it is."



Kitty jumps on Composer X's lap, sprawls on the music paper pad, and looks contented.

"Yes, you're right, kitty, I1 of circle is unmarked ., and I1 of unmarked is circle. Let's see where I've gotten. I started with my Checkmark Motif,

[e54t]

and then I added four more notes up a minor third to make an octatonic:

[e54t] {1278}

"Then I realized that I would eventually want the remaining four pitches, so I could move beyond that octatonic:

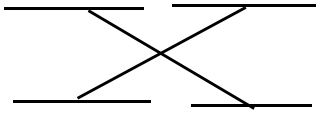
[e54t] {1278} {0369}

"Then I got annoyed at the last four notes, and decided to combine them with two notes from the middle four to get a Major Petruchka chord; gratis, I got that the first six notes would be Minor Petruchka chord.

Draft-series: [e54t] {17} {28} {0369}

"So I could move from music based on the Checkmark Motive to Petruchka chord music just by bringing in two more voices. And I noticed that I1 would swap the left and right hexachords:

Draft-series: [e54t] {17} {28} {0369}



I1 Draft-series: [2896] {03} {e5} {147t} .

"So I could use that relationship to 'modulate' to a new set of notes for my Checkmark Motive, while maintaining the hexachords. I'd achieve this 'modulation' by first adding two more voices so I'd shift my emphasis to hexachords, then substitute I1 of my material so I'd get the same hexachords in the opposite order, then shift my emphasis back to tetrachords.

"And I remember from Figure 4 that T6, I3, and I9 maintain the content of my Checkmark while permuting its order. What do they do to the partial order I've got so far for all twelve notes?

Draft-series:	[e54t] {17} {28} {0369}
T6 Draft-series:	[5et4] {17} {28} {0369}
I3 Draft-series:	[4te5] {28} {17} {0369}
I9 Draft-series:	[t45e] {28} {17} {0369}

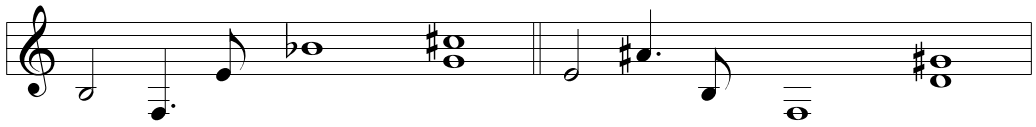
"T6 rearranges the notes within their groups, but leaves the groups in the same order. I3 and I9 both swap the middle diad. What happens to the hexachords, then? The first 6 notes now spell a *MAJOR* Petruchka chord, Bb major plus E major, while the last six notes now spell a minor Petruchka chord, C minor plus F♯ minor. So if I am ambiguous about the order of the first four notes I play, and, say, play them [e54t] at one time and [t45e] another time, I can, lessee, if these are horns, I can bring in a couple bassoons playing either {17} or {28}, so I have my choice of major or minor sonorities. Right, Kitty? —Kitty?"

Kitty comes running from beyond a doorway and looks up expectantly. Composer X strokes Kitty a bit while. "Ah. There you are. Did you get all that?"

"Mrrrrrrrrrrrrr."

"Let me play that last bit for you at the piano, just to make sure it sounds right."

Minor Petruchka Chord Major Petruchka Chord



"OK. Now, what part of my material has the least order already imposed on it? Well, the last four notes make a chunk of length 4 with no particular order, {0369}. I'm beginning to really look at order a lot here, so it'll help if I have names for the POSITION of notes in this order. Just for fun, I'll number THEM zero through eleven too.

POSITION NUMBERS	0123	4-5	6-7	8-e
Draft-series:	[e54t]	{17}	{28}	{0369}

"OK, the tetrachords at positions 0-3 and 4-7 are both members of (0167). If I take the {28} that lives at positions 6-7 and combine it with {39}, which I'll take from the notes in positions 8-e, I get {2389}, which is *ANOTHER* member of (0167). OK, so that means I'll put {39} in positions 8-9, and in positions t-e I'll have {06} left over. That's also neat, because if I repeated the series immediately, {69} would be followed by [e5] and those FOUR notes would again add up to a member of (0167). So now I have a more specific ordering of pitch classes, that has my Checkmark Motive for the first four notes, a variant on it for the

next four notes, an octatonic for the first 8 notes, a Minor Petruchka chord for the first six notes, a Major Petruchka chord for the last six notes, a variant of the Checkmark Motive in positions 6-9, and another variant of it in positions t-e plus 0-1."

POSITION NUMBERS 0123 4-5 6-7 8-9 t-e

Second-Draft-series: [e54t] {17} {28} {39} {06}

"Now, here's an interesting effect of my choices. Each of the pairs, in *POSITIONS* 0-1, 2-3, 4-5, 6-7, 8-9, and t-e... each of those dyads is a tritone, i.e. a member of Interval Class 6. So if I wrote a music out of that for two players, where each diad between the players was one of *THESE* dyads, they could be in parallel motion.

```
player 1     e     t 7 8 9 6        5 4  1 2 3 0...

player 2       5 4   1 2 3 0       e   t 7 8 9 6...
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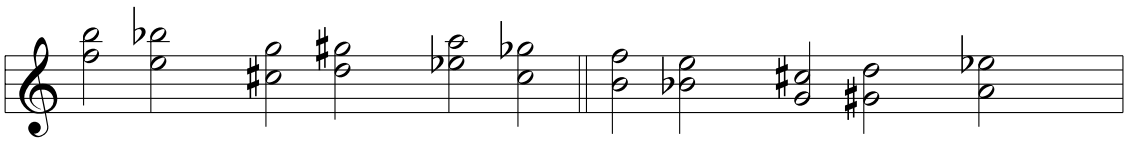
Let's play that at the piano:



"If somebody plays that really really fast, that'll make nice swirling motions... which I could programmatically associate with winds and turbulent rivers, to continue my metaphor of forces of nature.

"Speaking of tritones... Well, I was speaking of tritones, wasn't I?... I noticed that each hexachord, positions 0-5 and 6-e, was made of a pair of similar triads. Let's see if I can do something to bring those triads to the fore. Lessee, the first six notes contains an e-minor triad, E-G-B, or {4-7-e}. Where are those tones? Well, PC e is in location 0, and PC 4 is in location 2. I can't wedge PC 7 between them because I'm already committed to delaying PC 7 to positions 4 or 5, so I can have my Checkmark Motive in positions 0 to 3. But I could have PC7 in position 4, and now I've got a pattern: every second note is a member of this triad.

Hmmm... Suppose I were to write the notes alternating between short clipped high notes for the piccolo and percussion, and long low notes for some other group, and I did it so that the major and minor triads came out.

```
piccolo [e   4   7   2   9   6]

others    [5   t   1   8   3   0]
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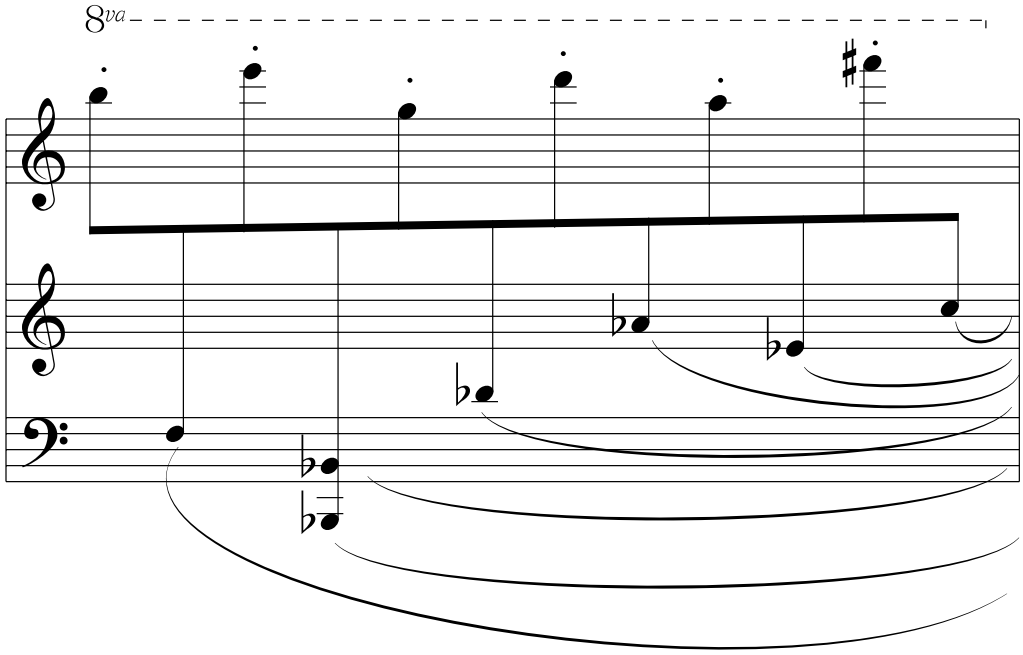
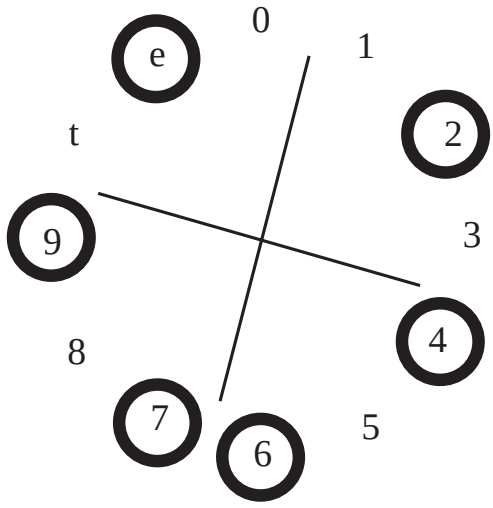
"Let me try it at the piano. I'll play the piccolo line in the top octave, and spread the other notes out down low, and I'll sustain them with the pedal so I can hear those triads more clearly.



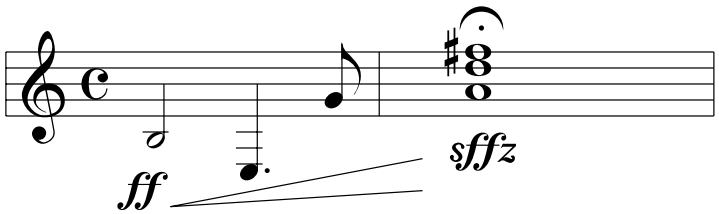
"Sounds kinda pretty to me. It looks like I have another hexachord to work with, a diatonic hexachord, one note short of a diatonic scale. Let's look at it on the clock face."



"Well, that's cute. So what have I got? Each of the unordered dyads that I used to have just acquired a definite order. So my pitch classes now go like this:

Prime Series (P): [e54t71289360]

"or, B, F, E, B♭, G, C♯, D, G♯, A, E♭, F♯, C. I can't impose any further order on these pitch classes. So, that means, what? It means that so long as I build material from chunks of P, or transpositions of P, or inversions of P, or... lessee, yeah, if I play P backwards I get pretty much the same stuff, so that goes for retrogrades of transpositions of P and retrogrades of inversions of P... If I do that, I can have my Checkmark motif followed by a variation of it, which adds up to an octatonic, with another variation of it made by the last two notes of the first variation and the next two notes, and another made by the remaining two notes and the first two notes that I originally started with...and I get an easy transition to major and minor Petruchka chords, my whirling tritones, and finally, an easy gateway to the diatonic hexachord music... all with chunks of music with all 12 pitch classes in them, so the chunk-breaking event of an old pitch class returning happens as infrequently as possible, and the music can give the impression of larger smooth phrases... and I just noticed that when I shift to the diatonic hexachord, the notes come up in a shape that closely resembles my Checkmark Motif:



"Well, I think that about makes enough material to build a pretty fancy piece, don't you, Kitty? What? No, I haven't cleaned your litter box yet today. Of course not: I've been busy playing with compositional materials, and I've just reached step 3 from GEMS 4, the point at which I've solved the most difficult part and have an idea how to use my solution to make all the different parts of my piece. No, don't climb on my lap right now, I'm busy composing. It's time for me to string my ideas together into a... Oh, all right, you can get on my lap, but—no, wait, don't squat on me like that—why you #@$)(*)(* cat!"

Serialism as experimental modality. As the somewhat degenerate story above suggests, a serial composer doesn't use a tone row as *JUST* an ordering of pitch classes, but rather as an ordering *PLUS* a bunch of connotations, groupings, purposes, and meanings that they have put *INTO* the tone row so those things will be there, handy, when they are called for.

The situation is somewhat like that of a mode or tonality, which, we will recall, consists of more than just a set of 6, 7, or 8 pitch classes. A mode is a comprehensive package, that comes with the idea of one of it's tones being a point of rest; the standard church modes

originally came bundled with a small repertoire of standard melodic fragments, each connoting a particular kind of grammatical phrase or rhetorical device, and these phrases later got augmented into standard chord sequences when polyphony became popular. For a brief while, in the 18th century, the set of standard phrases of Western music was reduced to a minimum, called Tonality... Almost immediately, composers became interested in bits of earlier modal practices that had survived in folk musics and liturgical musics, so musical "romanticism" was born. In the early 20th century, individuals like Bela Bartok added more "exotic", non-Western-sounding modal practices to the set of available ideas, and experimented with choosing new groupings of pitches and establishing new patterns within them that would serve as "artificial modes". Since the phrases and patterns such composers created were usually *NOT* standard phrases that everybody used, such composers took on the job of making such phrases *SOUND* standard—or sound right in the context of a given piece. This, of course, meant repetition and variation, for these are the main devices for driving something into a listener's memory (No, I haven't just quantified memorability, because the recognizability of a *variation* is still unquantified here).

Seen in this light, what Arnold Schönberg sought to do with his already extremely chromatic and chunky music begins to make a lot of sense. He organized it into phrases and chords which may not have been part of a standard practice before-hand, but by the time you got done listening to a piece of his, the phrases began to really *SOUND* standard—to the particular piece.

For those who are curious, yes, Composer X's tone row has in fact been used in a piece, with exactly the set of groupings listed above. The piece is copyrighted, but the row and groupings aren't and can't be.

Natural extensions. Everything I've said so far could certainly be used in sets of pitches other than twelve notes equally tempered in an octave. What makes material serial is that we have some operations of transposition, etc. that take a motive and yield a recognizable variant—and that the motives we start with can be overlapped in such a way as to grow smoothly out of each other, with the consequences that we become interested in organizing and ordering chunks of music larger than the motives themselves. These larger chunks then serve as a helpful midpoint between organizing the notes of the motives and organizing a piece as a whole.

So, for instance, if you were working in some other temperament than equal temperament, you could group things all the ways I've described above, PLUS get the added connotations that the NON-equivalence of the intervals might supply. Suppose, e.g., that I limit myself to a pentatonic set, e.g. only the black keys of the piano. Well, I still get five transposition levels—each with a different quality because of the inequality of the intervals—and five inversions, again each with a different quality.

Or suppose you divided the octave into more than 12 parts. So you could, perhaps, sound more than 12 pitch classes without returning to one—but if you divided the octave too finely, and tried to use all the divisions, it might SOUND like you had returned to an old pitch class

when actually you'd gone to one of its neighbors, so you might not want to compose with chunks any longer than, say, nineteen tones, even if you divided an octave into, say, 120 equal (or unequal) parts.

I could say a lot more about neat, easy ways of using serial materials to build expressive musical statements—using chains of rows with one or more notes overlapped or shared to build segments larger than a single row, using "proximal" forms of a prime row to help present e.g. a now-familiar tune in a new harmonic context, etc. But I think I've said enough, and some would argue that I've said far too much on this topic. For those who want to pursue this topic further, John Rahn's "Basic Atonal Theory" would be a good place to start (his notation differs from mine somewhat). For everybody else, I hope this exploration has proven thought-provoking, if not immediately imagination-stirring.

—And I hope to interest some of you in some of the standard literature of serial music.

Listening assignment. As usual, these assignments are provided strictly for those who want them. You get no special Brownie Points for doing them, and no special Karma Points for not doing them.

Here are a couple of different serial works that I think merit listening. As you listen, a couple of questions to ask yourself might be:

1. Is this music expressive of a mood?
2. Does it feel like it expresses a tension between variety and unity?
3. Can I pick out the main motifs out of which it is built?

Alban Berg: Violin Concerto
Arnold Schönberg: Variations for Orchestra Op.31
Anton von Webern: Second Cantata
Luigi Dallapiccola: Quaderno di Annalibera

Written assignment. For those who really want one, here's one.

Find a short tune of your own. Experiment with the consequences of moving some of its pitches into different octaves. Experiment with transposing and inverting it. Do the variants you get from this process stimulate your imagination? Can pairs of them be fit together contrapuntally? Do any of them suggest another motive that you might cause to emerge from them?

—13 May 1993 Matthew H. Fields, A.Mus.D.