Orbital Collisions

by

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This thesis is about seven compositions which develop and explore musical concepts and human perception of musical sounds. This work was prepared as part of a Senior Thesis project in the Wesleyan University Department of Music. The project is rooted in musical ideas, but has several components which extend beyond conventional musical composition and discourse. The compositions are intended as performance art. They draw on a broad spectrum of musical influences, from the polyrhythms of West African percussion, to the cycle-based frame-flexing structure of Javenese Gamelan, to the open and highly articulable for contemporary creative and experimental musics, to the ‘new’ sounds and processes available through electronic recording and processing. However, they are also directed explorations of the possibilities formed from the interaction of tempo, pitch, timbre, sonic-density, cycles, phases, progressions, decision making—broadly, improvisation—and how the mind processes and compensates for changes among these structures. The design of some of the compositions draws on mathematical relationships among integers and prime numbers. The language of the compositions is an extended analogy to the quantum physics of atomic systems, and to the tension between chaos and process.
The style of this presentation is a linear exposition, but the use of repeated phrases, bold face, and italics is intended to give the paper a flavor of a composed musical piece.

The first part of this thesis develops the framework of ideas and techniques underlying the compositions. The second part describes each composition in detail, explaining the goal of each piece, the steps taken to produce the composition, and the modifications made along the way to give a better result.
Sound is an experiential medium. The genetic machinery which enables us to experience this perceptual phenomenon is an apparatus which measures the current level of air pressure and records it to memory. Any single instant holds no aural perceptual content. Context for this sensor comes with flow of time, and the constantly changing relationship between the current measurements of air pressure and past measurements of air pressure.\(^1\)

We tend to think of our perception of time as a steady linear progression; a minute always feels the same, and seems to last the same amount of time. Standardized divisions of time (hours, minutes, seconds) are all proportionally relative to natural cycles experienced on various scales, like years, lunar months, days, and heart-beats. Is rhythm only relevant or discernable because of its proportional and

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\(^1\) If we think of our recorded hearing memory as on a graph that represents air pressure over time, then the experience of hearing can be seen as an algorithm which relates the current pressure to air pressure at each quantized unit of time.]
symbolic relation to natural cycles and other rhythms? Or is there some kind of internal time-scale by which we interpret rhythm?

By observing sound across a wide range of frequencies, we find three different categories of perception. Pulses slower than 20 Hz are heard as a series of discrete quantized instances, between 20 Hz and 20000 Hz register as pitch, and above 20000 Hz are inaudible. Music is commonly classified by rhythm, pitch, and by extension, timbre as distinct entities—combinatory building blocks for the generation of a sound-space—based on subjective, psychoacoustic observations. Instead, these categories are perceptual interpretations of a single phenomenon, namely, cycles, as iterated across a wide range of frequencies. This is evident through listening to a pulse with a frequency less than 20 hz which gradually accelerates past the threshold, becoming audible as pitch.

This concept of sound—as a 2 dimensional (time and amplitude) medium constructed entirely from the overlay and repetition of a single, uniform atomic unit, which manifests across all conceivable scales—is fundamental to my compositional framework. In order to understand and manipulate within a given parameter, in this case, amplitude, it is necessary to orient yourself around perceivable periodic uniformities. In this paper I will use the term "cycles" for these periodic uniformities—

Cycle: (n) A recurrent round or course (of successive events, phenomena, etc.); a regular order or succession in which things recur; a round or series which returns upon itself.
Using this definition of cycle, I feel justified in freeing the term cycle from its normative time-dependent connotation; cycles exist on planes of their own, that is, planes are two-dimensional frameworks whose scale and dimensionality are defined proportionally to a perceivable cycle. The dimensions of this plane consist of (1) the intensity/energy/amount of the substance whose regularity implies a cycle, and (2) the parameter which, when varied gradually, allows for the cycle to manifest.

As a given parameter gradually shifts, any recurring phenomena indicate a cycle on the plane of that parameter. To identify a cycle is to generate an atomic unit within a given parameter that standardizes its scale, which is to say, the scale of a parameter is structured in proportion to perceived recurring uniformities. (i.e. The setting of the sun recurs as time progresses forward; the note C was repeatedly heard as the frequency increased). Thus, cycles provide context for a perceptual framework.

My aim is to manipulate the uniformity of this constitutive sound-substance through the construction and layering of multi-planar cycles, which through their combined motion cause shifts in perceptual frameworks for performers and listeners.

—Intersecting cycles; each an atomic unit whose internal rhythms and symbolic-implications are perceived as a singular entity when rearticulated verbatim; repetitions serving as markers in time, the non-
uniform space between repetitions creates wobbling in the perceived flow as the mind struggles to interpret the inconsistency as a regularity in relation to natural cycles and perceptual borders, the effect of which is multidimensional as cycles on different planes are compounded. As shifts in perceptual framework provide new contexts for perceiving the interplay of these varied components, meaning is accrued and altered over time—

Taking meaning to be rooted in the dense layering of perceptual frameworks—highly articulated and particulate points of reference from which all perceived data is proportionally related via quantized uniformities: cycles, and their combined interaction—in **Orbital Collisions**, meaning is generated over the course of a piece.
Cycles

In analyzing any rhythmic dialogue, it can be difficult to rely completely on listening. It is impossible to accurately conceive of the entire structure at one time, because we perceive of sound in the context of the passing of time. When listening to a phrase, or replaying it in your head, you are experiencing an instantaneous chunk of sound. Each moment is insubstantial in its particular constancy, and therefore is coherent only when seen in the context of the passing of time. We can recall and reproduce the phrase as heard, but we have no way to conceive of a literal whole. For this, one must recontextualize the information present in a sounded phrase.

My studies in West African Drumming and Music with Abraham Adzenyah beginning in Fall 2008, first pointed my attention toward the possibilities of cycle interaction. This music is built upon a lattice of interconnected repeating cycles. Some of these parts allow for the playing of predetermined variations, which are played at the musician’s will before they return to the basic rhythm. The ensemble is split into the three types of players. There is a Bell player—aka key, conductor or Gonquogui—players who maintains the tempo and implies the pulses to which the rest of the ensemble is locked; the supporting drummers,
whose web-like interlocking builds a stable metric grid; and the lead drummer, who plays many different preset phrases throughout a piece, which serve as cues for dancers and drummers alike. In addition to leading the ensemble in the sense of adjusting tempo and cuing the structural transitions in a given piece, the different rhythms articulated throughout a lead drum part are spread out in various ways across the cycle so as to emphasize different pulses. When maintaining a solo part and focusing on the lead drum, your sense of pulse can change, providing a different perceptual framework for analysis of rhythms.

Many of these pieces have a poly-metric nature; parts whose rhythms imply different pulses intersect to form a complex unified metric environment. These parts and their interlocking nature may be easier to understand with some kind of visualization aid. However, this music is transmitted aurally. In analyzing any rhythmic dialogue, it can be difficult to rely completely on listening. It is impossible to accurately conceive of the entire structure at one time, because we perceive sound in the context of the passing of time. When listening to a phrase, or replaying it in your head, you are experiencing an instantaneous chunk of sound. Each moment is insubstantial in its particular constancy, and therefore is coherent only when seen in the context of the passing of time. We can recall and reproduce the phrase as heard, but we have no way to conceive of a literal whole. For this, one must recontextualize the information present in a sounded phrase.
The notation style I began to develop in the Fall of 2008 is a useful tool for conceiving of a rhythm or ensemble of interacting rhythms. The passage of time throughout a single instance of a cycle is represented visually on a sheet of graph paper with each grid-block representing an equal unit of time. Hence, grid-units are atomic units with respect to the relative positions of strokes; that is, the number of grid-blocks is the least possible number of evenly spaced strokes which, when played along with the cycle, intersect with every stroke within the cycle. (i.e. The intersection of part C which plays four even strokes throughout a cycle, and part D which plays 5 strokes throughout a cycle would require 12 grid-blocks.) [Appendix II.]

In order to sustain a steady rhythm and keep in sync with the ensemble, Abraham stresses the importance of staying relaxed and maintaining a steady pulse. On the surface, these suggestions seem pretty straight forward—at first, I interpreted, ‘keep your muscles relaxed so you won’t get tired and lose technical accuracy, and tap a steady beat with your foot or in your head.’ After hearing this basic two-clause dialog repeated periodically over the course of three years—

—Intersecting cycles; each an atomic unit whose internal rhythms and symbolic-implications are perceived as a singular entity when rearticulated verbatim; repetitions serving as markers in time, the non-uniform space between repetitions creates wobbling in the perceived flow as the mind struggles to interpret the inconsistency as a regularity in relation to natural cycles and perceptual borders, the effect of which is multidimensional as cycles on different planes are compounded. As shifts in perceptual framework provide new contexts for perceiving the interplay of these varied components, meaning is accrued and altered over time—

—I now interpret these suggestions in a broader sense.

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Though the importance of physical relaxation is unquestionable, it may be most useful with respect to cognition. Syncing a rhythm with what is heard requires a specific kind of listening. This is not the kind of focus you employ when trying to pick out a faint speech among general din. This focus requires a quieting of the stream of consciousness; periodic and aperiodic cycles of thought-stream make unnecessary connections to, distract attention from, and distort the perception of the rhythms as sounded. Instead of listening to the rhythm, actively interpreting an external phenomenon, relaxation forces you to hear, that is, let the sound flow into your ears and activate your consciousness in a participatory rather than observational way. This way, the rhythms mark out and orient—create—your inner sense of time, rather than tangentially just expressing a relation proportional to your internal time-sense. This aggregation of internal and external cycles is necessary for maintaining a steady pulse.

I like to think of pulse as the fundamental unit of internal cycles. The way your pulse lines up with a sounded rhythmic cycle organizes your perception of the sound. Pulses break up the cycle into even **rhythmic cells**—blocks of time between pulses, usually subdivided into 3 or 4 grid-units. This allows you to not have to count each individual grid-unit, as we can naturally feel subdivisions of 3 and 4.\(^2\)

\(^2\) Brian Parks has suggested that 2 and 3 are the only inherent subdivisions humans can inherently feel/understand, which could be why in West African pieces (or at least the ones Abraham teaches), there are never subdivisions of 5, 7, 11, etc. However, in the Braxton large ensemble
To play a supporting part in a West African drum ensemble, you must understand how the bell part and your own rhythm relate to the pulse—how pulses directly line up with some strokes and are subdivided by others—as well as a sense of the dialog between these parts for the purposes of entering at a corresponding place in the cycle. Enter by feeling the pulse as implied by the bell, and come in at a common point in the cycle. To stay synced-in to the ensemble and maintain the cycle over slight unintended shifts in tempo and flubs or technical inaccuracies, it is important to continually recalibrate the pulse according to the subdivisions present in the piece—all of the strokes heard between two pulses coincide with the pulse’s subdivision, so if they are perceived not to line up with your internal pulse-subdivision, you must slightly alter the placement of your next pulse so as to coincide with the ensemble. This process takes place pretty much unconsciously, and it may be more accurate to say that the strokes heard between pulses are the subdivisions that create your sense of pulse. Either way, people who have a good sense of time and maintain a steady pulse on their own may not be able to stay locked-in to the class, many of the pieces we play contain poly-metered phrases, like 5:2s (these 5 notes in the space of 2 beats), which are displayed in western staff notation with a bracket above the notes, which are evenly spaced. For all of these subdivisions, especially 7s and 11s, the focus is on the target down-beat, that is, your intention is to aim for the pulse, squeezing out the correct number of notes (hopefully spaced evenly) and landing on the pulse at the same time as the conductor. Playing pieces like these, and learning passages subdivided by fives for David Nelson’s Solkattu class spring 2010 has led me to believe that, with practice, these other prime subdivisions can be felt and played.
ensemble, because through inevitable human slipping in tempo, *it is the ability to recalibrate pulse, not the maintaining of constant internal time which holds the ensemble together.*

The notion of pulse as a reference point around which to organize/analyze rhythms played in relation to rhythms heard is especially powerful in this music because of the multiplicity of possible pulses. The *Agzierbo* supporting ensemble is divided into 24 grid-units, which can be pulsed in a number of different ways. In appendix II. B, I provide three different examples of possible pulses and the rhythmic cells they imply. When feeling a specific pulse, rhythms are interpreted—and locked into—as framed by the rhythmic cells indicative of this pulse. For instance, in figure A, the cycle is divided into 8 pulses which each subdivide by three. The periodicity of the Kagan-Shaker dialog from this framework—each cell being exactly the same—shows how these rhythms imply the 8-pulse cycle. When maintaining this pulse, these are the rhythms to focus on and recalibrate with. However, when feeling the cycle in 6 pulses as notated in figure B, this same Kagan-Shaker dialog is seen as a split into three separate rhythmic cells, a sub-cycle which is articulated twice in the greater cycle. To lock into this pulse, it is more useful to focus on the bell and Kiddi parts, whose sub-cycle, consisting of two rhythmic cells, takes three repetitions to fill the greater cell.

The real importance of the multiplicity of pulses is as a cross-perceptual support system. When playing a part that implies a specific
pulse, such as the Kagan rhythm, it is easier to stay in sync with the ensemble when feeling the cross-pulse; that is, a part containing a periodic sub-cycle is more sustainable when played from a reference framework which obscures its period. When playing a part which is, essentially, a direct translation of the pulse felt, there is less context for locking and recalibrating, as the rhythm you are playing is at the same time creating and relying on this pulse. Thus, a stable drum ensemble is one which is supported by the notion of cross-pulse—players who feel pulse A play rhythms which imply pulse B, and vice-versa.

As I mentioned earlier, the lead drummer accentuates different pulses over the course of a piece. If you are locked into his rhythmic stream when he transitions between patterns that imply different pulses, your sense of pulse can instantaneously realign, and the context for your individual rhythm and its relation to the overall cycle will have inverted/flipped. This is an unconscious process, and anyone who has experienced this phenomenon is aware of its unique character. The initiation of this psychoacoustic phenomenon is an instantaneous articulation of the central goal of Orbital Collisions: shifts in perceptual framework.

Just as the study of West-African drumming provided the experience of and tools for instantaneous shifting, the use of gradual shifts in perceptual frameworks in my work comes straight out of my experience with Javanese Gamelan, beginning in the Spring of 2010 under the Pak Sumarsam (and Pak Harjito Fall 2010).
Like West African drum music, Javanese Ghending—Gamelan music—is constructed on a foundation of overlapping and layered cycles. This music is evocative of vast numbers of possible frames of reference, which allow for symbolic interpretation and contextualization. As this music is viewed as an open source of possible meaning for complex and quantitatively ambiguous questions—those on spiritual, supernatural, or cognitive planes—the inner rhythmic and harmonic relations between parts must have a non-intuitive complexity; in contrast from the directly proportional relations in most West-African drum tradition.

Each elaborating part is said to express an individual character or follow a defined idiom. There is a central orbit (or inner/implicit melody) around which all of the embellishing parts rely. These instruments play parts which are derived from and imply or anticipate the notes of the implicit melody. Relation to this implicit melody obeys the standards of a non-uniform idiom; they are processes that can manifest in different ways depending on context. Even though it does not always follow a straightforward schema, the music is held together by “three themes of flexibility, appropriateness, and interconnectedness.” (Brinner, 94)

From this model, I took the idea of assigning parts with personal rules and processes for player, which were designed in such a way so
as there is a sense of interaction and dialog, or that the choices made by one decisions have an effect on other musicians’ parts.

The time-synching phenomena in this music which were especially influential on my work consist in the effects of the acceleration and deceleration of the drum part, which the Gamelan locks into. As a relatively fast pulse gradually slows down, certain elaborating instruments double the rate of their rhythmic motion, thus evenly subdividing the pulse. The dialog between drummer altering the tempo, and elaborating musician responding through stratification is a powerful example of the interrelation of parts whose underlying processes act upon different parameters.

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3 This model has strong influence on the basic components of the game and Orbital 3.
4 These concepts translated to my system in all instances of grouped activated acceleration, especially in Orbital 2—in which I play pulses on the drum which direct the volume and tempo of the ensemble; I thought of my role in this piece as being the same as the drum player in a gamelan orchestra—and Orbital 3. Also, the doubling/halving effect of the prelude is a manifestation of the stratification of pulse by elaborating parts.
Compositions

Orbital: (n) A partial description of the quantum state of an electron (or other particle) orbiting the nucleus of an atom. Different orbitals have different shapes and orientations, depending on the energy of the electron, its angular momentum, and its magnetic number. Orbitals have no clear boundaries; the shape of an orbital, as depicted graphically, shows only the regions around the nucleus in which an electron has a relatively high probability of being found. No more than two electrons (each with opposite spin) can coexist in a single orbital because of the Pauli exclusion principle.

Orbital 0 (atom smasher // selective sampling // game // collective coincidence)

The generalized chance for cycle interaction without any confines came through experimentation beginning in April of 2010. I suggested the basic concept, but the specific implementation was arrived at collectively. The game, in essence, is a web of interconnected cycles on many different scales. It appears, at any moment, to be in a steady state, but is actually the articulation of a gradually changing phase—

Phase, (n) Physics. A particular stage or point in the cycle of a periodic phenomenon (esp. an alternating current or a light wave), or in a recurring sequence of changes or movements, considered in relation to a particular reference position or time, or to the state of another cycle or system with which the first may or may not be in synchrony. In phase (with), having the same phase (as); in the same stage of variation at the same time (as); in synchrony (with).

5 In this paper, I describe phases between cycles (A:B) numerically, 3:2. Take this to mean that for every three iterations of cycle A, cycle B recurs twice.
Phase, (v) trans. Physics, Electrical Engin., etc. To adjust the phase of (an oscillation, alternating current, etc.), esp. in order to bring it into phase or synchrony with something else. Also with up or in. Also (occas.) intr.: to undergo such a change of phase.

[Oxford English Dictionary]

—Musicians, each articulating an individual cycle, take turns dropping out of and reentering this phase. As the motion of turns is around a circle, the long-form structure is suggestive of a cyclical gesture. On each turn, the musician stops playing, listens to the current sonic environment, and reenters with a new cycle; ideally one which locks proportionally into some rhythmic aspect of what he or she can hear. Every turn from here on out begins with a period of silence during which the musician should listen to the sonic environment, and hear in his or her head the phrase they intend to play, noticing how it should lock in, before beginning. This goes on until directed to stop or, more often, the end is arrived at unanimously by the members of the ensemble.

Upon Anthony Braxton’s suggestion that this generative model was symbolically—and literally—related to the CERN Large Hadron Collider, I incorporated one of the research project’s central pursuits—the creation of/discovery of/search for the “Higgs Boson,” a theoretical particle believed to generate matter—into the game. Generation, in this case, can be seen as an analog for form/idiom, framework shifting, and sound-space generation.
Taking functional cues from the particle accelerator—particles’ velocities are gradually increased to a high speed before being guided into a collision—the game can be rearticulated with the requirement that the time between turns and the length of each turn should gradually and constantly diminish, until the turn taking motion around the circle accelerates to the point where musicians are perpetually taking their turn. As each musician is now constantly in the process of changing how he or she is rhythmically/ harmonically lining up with each-other, there are no longer any stable sounds to lock into; the piece’s design no longer has any direct application for the musician. However, the common psychological mindset borne out of the rhythmic-locking, focused listening, and perception shift directs and unifies this ‘improvisation.’ Thus, this particle collider model for the game generates a common jumping off point for free improvisation iterated with a specialized kind of focused listening and gradient-propulsion.

In a more general sense, the game’s open possibilities made it a generative framework for the conceptualization of new forms. Any possible interactions between musicians could be possible within the confines of the game. (i.e. A performance of a symphony could be seen as every member of the orchestra choosing to play 35 minute cycles which happen to coincide as heard.) Once this notion of the game—as a framework upon which parameters could be added and altered to
create any possible body of sound— was understood, an experimental investigation of possible parameters could begin.

Over the course of the next 10 months, many different articulations of *game* were conceived played. The first of these articulations was Orbital I [Appendix III]. Using gridded notation, I wrote out the basic supporting drum rhythms of a Ghanaian drumming piece, Sikyi, as taught by Professor Adzenyah. It contains a total of 6 rhythmic parts. The *game* would be fleshed out in five sections, each section lasting for two turns (two long-form cycles.) In section I of the *Sikyi-game-varient*, players select any of the parts to play repeatedly and in consistent tempo. When layering new phrases at the beginning of a turn, the parts must be lined up as notated.

In part II, musicians can now vary the relations between their fully articulated phrases (they can be at different places in the origin score at the same time). Part III opens up the possibility of playing fragments or complex fractions of the original phase, but only those that are quantized by the grids-units. (i.e. the first half of a phrase, or 1.25 times through phase; any possible quantized sample of a repeated loop of the original phrase). In part IV, ratio-metrically proportional relations between tempos are also allowed. The piece was first attempted on May 19th, 2010 with Donovan Arthen, Brian Parks, Branco Sekelegga, and myself. Unlike the open format for *the game*, in which the choice of what to play and how to line up with the ensemble
is driven by aesthetics, Orbital I is driven by the intention of generating new phases from old content.

When my ensemble attempted this piece in December 2010 with the addition of melodic content, section II proved to too hard for those uninitiated into the focused style of listening developed in Abraham’s class, and was abandoned for more efficient exploration of similar concepts. Even though it was never performed, this exercise was still useful for ear and focus training.

For me, the most exciting phenomenon which can organically arise from *The Game’s* open framework of possible rhythmic links is the perception of a phase between two seemingly un-synced meters—x:y, where x and y are each integers large enough so that their rhythmic overlay is incomprehensible to the ear/brain’s poly-metric sensibility, or in which borders between the smallest possible quantized units of x and y are offset from each other so that there are no direct rhythmic intersections between the two phrases, and no comprehensible cohesion. (I say comprehensible, because, in both examples, there still exists a theoretical though incalculable and non-useful quantized grid which accurately represents the rhythmic relationships sounded).

What we perceive as an incompatible phase is actually linked via one or perhaps a chain of intermediary rhythmic links. For example, take the highly simplified case of a phase in *the game* between four parts. The phase from part one to part two is 2:3. The phase from part two to three is 2:5. The phase between part three and four is 2:3. The
final system consists of 8:12:30:45, with the incompatible phase 8:45 at its ends. The listener can observe the internal consistency of each of these two parts, and when honing in on these two voices, he or she may begin to infer generalized relations, as our brains naturally try to interpret and organize incoming data by its perceived regularities. In this case, one might see the rhythm as a near 1:6 with the slower pulse gradually slipping earlier and earlier.

The possibilities for incomprehensible yet discrete relations become much more complex when the phrases are built from both sounded units and rest units. In a three cycle phase-system between cycle A: 8 units [1..1..1..], cycle B: 3 units [11..], and cycle C: 5 units [1..1..] with A:B as 9:8 and B:C as 5:6, the full system can be expressed 45:40:48. The outer cycles here each contain an uneven division of strokes, and, in addition, they are incompatibly phasing.

The possibilities obviously abound, but what is most interesting about these incompatible phasing strategies, is not necessarily the hearing of the precise phase clarity as generated by a computer program, but the ability of live musicians to lock into previously unplayable phases with the help of an intermediary or set of intermediary links. It is of great interest to hear real people attempt to play these complex phase-chains in a setting where its inner components are held steady, and even more interesting in the Game setting to hear how people attempt to maintain their consistent tempo
and incompatible phase when an intermediate part drops out at the end of their turn.—

Now that the rhythms have lost their direct connection to each-other, it is as if the musicians have entered free-fall, or that their sense of relativity drops out from underneath. The natural human tendency toward regularity and synchronicity takes over, and a complex phase recalibrates to a simpler nature.—

“That to me is the most interesting thing about the game. the fact that it makes you consider, you know, your role in the ensemble...you have to consider it quite closely or you risk f***ing up a potentially really good vibe. You know, especially when the band really gets going. Like, everybody’s really like picking up on interesting riffs and the band is really gelling, you don’t want to f*** that up” (Bernstein)

Orbital 2 (loop maze // threshing mill // ticking clock // mobius strip) [Appendix V]

For this piece, I was interesting in setting up a cycle transformation through a seemingly random process that eventually reverts it back to its original form, or transforms it through a special articulation of this original form. The origin cycle in this piece consists of the C and D major pentatonic scales composed into a 24 beat cycle. These tone-sets, when overlaid, form a C Lydian scale.
The first two sections of the piece are developments generated from the original cycle through different implementations of loops. In the score, loops are represented by colored squares surrounding a note or set of notes. The number above a loop represents the total number of times the material within the loop should be played.

After the first line of the piece is played in unison, each of the five musicians play through the next three lines following independent loop paths, perpetually offsetting their progress from one another.

[appendix IV] This creates a series of chord clusters in C Lydian when heard all together, though if one listens to snippets of each part individually, progress through the original phrase is still audible. This is something like a round, with non-proportional and variable offsetting between the voices; the term ‘fragmentary canon’ may be

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6 (I make a distinction here from the standard notion of a repeat, where the number associated tells how many times a phrase will be played following its initial statement. Repeats imply steady forward motion throughout a piece. As measure numbers increase upon each repetition, the composition is seen by the musician as a single continuum from beginning to end which use repeats as notational shorthand. Loops are conceived more along the lines of a recorded sample. With this notation, I intended for the musician to feel that he or she was locked into a single time-space throughout the entire loop. This was an attempt to break down notions of constant forward motion throughout a composition. The real time-space of this kind of composition is what is seen on the page, or what would be heard if the composition was played ignoring the loops. This alters the way a musician senses progress while playing through a piece, with looped sections representing a pause in this progress. These loops are a way of offsetting cycles by freezing a musician in a particular point in the music while maintaining his or her metric relation to the rest of the ensemble).
appropriate. These loops are arranged so that the musicians all line up in unison for the playing of the 5th line.


This composition is designed around a central phrase. This 7 grid-block melodic cycle consists of the 7 tones of a Lydian scale composed with the intention of implying numerous possible harmonic relations. My goal was to set up 5 cycles, which begin in unison, and when phased, would arrived at the combined playing of this central phrase—followed, for the purposes of symmetry, by the reflex of this process, but for 3 cycles instead of 5. Working backwards from the central phrase to derive the cycle phrases involved the application of a 5 grid-unit rhythmic device—so as to create an artificial unity between the number of musicians and the length of the rhythmic device in order to disguise—

*Disguise: (v) To alter the appearance of (anything) so as to mislead or deceive as to it; to exhibit in a false light; to colour; to misrepresent. [OED]*

—the underlying processes. The scheme consists in splitting the central phrase into 5 grid-block rhythmic cells of which every third and fifth subdivision is unsounded. Notation-wise, this required plotting five iterations of the central phrase, and erasing the ‘unsounded’ grid-blocks. The result of this process is a 35 grid-beat
cycle—**implied phrase**—which has a perceptual character independent of the **central phrase** even though an overlaying of the two cycles (5:1) would maintain melodic unison. The next step was to design a phase whose partial **articulation** would register as a transformation from **implied phrase** to **central phrase**.

The 5-cycle phase \(70:71:72:73:74\), was designed as follows. Each cycle contains two repetitions of the **implied phrase** followed by 0, 1, 2, 3, or 4 grid-units of rest. These rests serve to offset the cycles so their articulation of the **implied phrase** is uniformly stratified. Thus, the **implied phase** is first perceived to be in unison, then evenly offset by one grid-unit, two grid-units, three grid-units, etc.

The articulation of this phase allows the listener to understand what is happening at first. When the **implied phrases** are stratified by 1 grid-unit, their relation is clear. As the phase progresses, however, the polyphony takes over and disorients the listener. On the 6\(^{th}\) iteration of each cycle, the musicians are lined up in rhythmic unison, and on the 8\(^{th}\) iteration their parts combine through hocketing—

**hocket**, from French *hoquet* [Latin *hoquetus*] (= 'hiccup'); musical performance technique in which individual notes or chords within musical phrases, not the complete phrases (see antiphony), are alternated between different voices, instruments or recorded tracks. [http://www.tagg.org/articles/epmow/hocket.html](http://www.tagg.org/articles/epmow/hocket.html)

—and double-stops into a unison playing of the **central phrase**.

Thus, the parts begin in unison, slowly but clearly slipping away from each-other before descending into general chaos, followed by a one cycle in rhythmic unison and one cycle of harmonic unison,
sandwiched by one more polyphonic cycle. Once it is obvious that the **central phrase** is being sounded by the combination of parts, all of the musicians begin cycling the **central phase** in unison. At this point, two of the musicians drop out, and the other three begin playing stratifying cycles based on a 21 grid-beat **implied phrase (B)** similarly derived from the **central phase**. They enter with this cycle over the unisons playing of the **central phase**, so that their cycles are **stratified** by 7 beats. The rests this time are set up so that the **stratification** between the **implied phrases (B)** gets smaller with every cycle iteration, until on the 8th cycle, a unison playing of the **implied phrase (B)** is heard. After two cycles of this **implied phrase (B)**, the piece ends with the other two musicians entering on top of it with three iterations of the **central cycle**. These final 21 grid-beats are designed to give the listener a clear understanding of how the **implied phrases** and the **central cycle** are related.

This process produces the same overall effect as having a single musician cycle the initial phrase and applying **delay**—with the delay time increasing by one grid-unit in between every other cycle and the feedback level set to allow for 4 restatements of the source content. The difference between these two versions is in the level of perceptibility of the underlying processes.

In the delayed version, the instantaneous increase in **stratification—glitch in time**—occurs periodically with respect to **origin phrase cycle**. This effect too clearly demonstrates the
uniformity of the cycle, and the listener is well aware of how the psychoacoustic *phenomenon* occurs. In the composition, this process is disguised. The *glitching* in this case occurs periodically with respect to each individual cycle, thus expressing the constitutive 70:71:72:73:74 *phase*. This phase is too complex and on too broad of a time scale to be felt internally.


This piece was an extrapolation of the logic for Brian Parks’ *Mississippi Hot Dog Variations*, in which the phrase consisting of four eighth-notes followed by two quarter-notes is iterated in an 8:12:18:27 phase (another way of saying three sets of 2:3). When performing this piece, I was intrigued with the special kind of listening it took to lock into one of the parts and ignore all the other parts—which were likely to throw me off. I was interested from this point on in working within a ratio-metric context.

When my roommate, Hannah Overton, explained to me a demonstration she had seen in a computer music class taught by Ron Quivella, in which two square wave functions ratio-metrically locked to the proportion 2:3 are heard first as beats in a 2:3 phase, then sped up and realized as two pitches a 5th apart, I felt it was important to demonstrate this two-tiered sense of metric proportionality. In order to underscore this effect, I began experimenting with setting the
pitches in this kind of phase to the same proportion as in their polyrhythm (i.e. 2:3 sounded in fifths and 3:4 sounded in fourths). Here the same ratio is dually expressed in pitch frequency and stroke frequency.

The piece is for 5 musicians, and begins with a chain of 4:3 with staggered entrances starting with the lowest/slowest note, A-flat 3, and preceding up by 4ths to an E 5. Once all parts have entered, a 243:324:432:576:768 relation exists between both pitch frequency and tempo. All parts then stop playing in the same order they entered, except the top part, which adjusts tempo and locks in before a new 3:2 chain begins moving downward by 5ths to a bottom pitch of C 3. Thus, a different 16:24:36:54:81 proportionality is heard even though there is a consistent pattern—only varying in choice of octaves—around the circle of 5ths/4ths throughout both sections.

To fully exemplify these proportionalities, it is necessary to contrast these sterile dual-locked systems by altering certain variables while holding others constant. While pitches are held, activated acceleration—individuals slowing down and speeding up in any manner they like—is applied to allow for metric slipping. Inner pitch-frequency proportions remain constant, but the tempo-grid now undulates with unspecified possibilities.

To the listener, it is as if the lattice of interweaving cycles—
—of which we relate inherently to as a manifestation of the intersecting cycles in our lives; Just as “…the most prominent
feature of iconic power in Javanese or Balinese music is coincidence...small coincidings and large coincidings of cycling sounds, all iconic with the cycles of calendars and cosmos and thus, for the Javanese, completely ‘natural’” (Becker, 207). Music built on layered cycles, in effect, is seen as natural, due to its resemblance to the natural world—has broken down and we are now in an active space where the cycles still exist, but they no longer adhere to human/natural systems of regularity.

After sufficient exploration of this time-shifting space, the four lower parts again drop out leaving only the top cycle, which now alters its pitch-regularity variable. The phrase [1 1 2 2 3 3 1 5] is now repeated in constant tempo with a root of C. This is again proportionally articulated downward with a 2:3 fifths relation as each part enters successively, the bottom part repeating this phrase with a root of A-flat (returning to the piece’s original entrance pitch). A fully realized complete phase of this 5-cycle interaction would take eight times as long as the previous held-pitch orbital. There is added interest in this orbit because of the varied frequency proportions possible in moments when cycles intersect at different points in their phrases. (i.e. if cycle one and cycle two intersect when they are both playing a 1, their pitch-frequency ratio matches their tempo ratio of 2:3, but when cycle one plays a 2 over cycle two’s 1, a pitch frequency of 3:5 is heard. See table of potential pitch-frequency relations). As the musicians were not
instructed where in the preceding player’s phrase to enter, a large set of pitch-ratios is possible.

The structured time-space is again punctured with the use of activated acceleration, to infinitely expand the possible set of metric cycle interactions between each part. Eventually, through the use of a gradual decelerando, the ensemble slips into rhythmic unison, their phrases offset from each other in an unpredictable way flowing from the process of activated acceleration into 1:1 rhythmic locking. The musicians continue to slow down until conducted to stop.

This piece, like Mississippi Hot Dog Variations, was transmitted verbally for two reasons. First, as Brian noted and I later experienced, our similar space-time related notation systems each proved useless for ratiometric pieces past two or three parts. The first iteration of 2:3 can be notated using 6 grid-spaces. When the next iteration is added (4:6:9), the previous pattern must be played three times to complete the phase, and the scale must also be doubled to incorporate notes from the third cycle which would fall in-between the original grid-spaces (or this can be thought of as playing the original phase twice while tripling the scale). Thus, this iteration takes 36 grid-spaces to complete. Notation for this phase can still be helpful, although the next iteration (8:12:18:27), which fills 216 grid-blocks, is too large to be a comprehensible representation of these relations. This notation would also require the musician playing the lowest part to count 27 beats for each played note, which is obviously unsustainable and

The more important reason for this piece be without notation has to do with musicians being in rhythmic dialogue with each other while they maintain different inner pulses. This is a powerful way of locking in which I learned about through playing in Professor Abraham Adzenyah’s West African drumming ensemble. Abraham always stresses the importance of maintaining your own pulse when playing a specific part. Often, within a given piece, each part can be played while feeling any of a number of inner pulses, and different parts seem to emphasize or call for different inner pulses. When playing a supporting part and focusing in on the lead drummer's calls, one’s sense of inner pulse can flip or alter depending on which part of the rhythm and what kind of cycle the lead drum is emphasizing. Soon after discovering this phenomena, I experimented with manually altering my pulse while playing a supporting rhythm, and the possibilities of feeling multiple-pulses at the same time. So far, I haven’t been able to sustain more than one pulse, and those who I have discussed this subject with (mostly members of the West African ensemble), tend to agree with my inclination that humans only have the capacity to feel one pulse at a time. However, the other technique of jumping between different pulses has become the most informative
and enjoyable way to play and listen to this music, and a fruitful way to conceptualize new composition strategies.

In rehearsing *Orbital 6*, my plan was to have one person keep a steady tempo while all others build ratio-metrically off of each other, having an inner pulse locked to the musician ahead of them. This proved difficult, as any slight fluctuation in the tempo of the initial part would cause a ripple throughout each of the other parts, increasing in magnitude as it progresses outward. To deal with this issue, we learned to stabilize the structure with a kind of metric-inertia. This meant for the players to maintain as near a steady tempo as possible, making sure not to rapidly accelerate or jump in order to stay locked into the part they were listening to, but to gradually shift until the cycles realigned. This decreases the chances of a hiccup in one part causing a total collapse. Because of the structure of the piece, players must be able, at different points, to lock into either the part above or below them. During one of our early poly-metric experiments, Sam Friedman noticed the most worthwhile thing about playing with this emphasis, “it’s very interesting listening to the top instead of to the bottom.” Therefore this piece, like many of the Orbitals, while still offering some aesthetic or intellectual pleasure for the audience, is mostly designed for the enjoyment and training of the musicians playing it.

This kind of ratiometricity is informed by computer music, and is perhaps most often heard in the context of a computer rendering. In
these kinds of iterations, there is a sterile precision, which contains beauty in an intellectual kind of way, but not on a human level. As Matt Bernstein put it;

“I’d be really interested to...hear what it would sound like in a sequencer or something...I’m so used to hearing it with us playing it. I actually think the variables, it makes it...more interesting...like when we’re all trying to get it. I think sometimes its more interesting to hear a group of people struggle than it is to hear them succeed....There’s a lot of potential for depth in that... there’s something really compelling about that struggle, of any kind, when you’re trying to make something sound good.”

The slight hiccups and false-entrances in this piece are what provide for the most insight into the mechanics of the music—

—this is in stark contrast to disgui\textit{ing} techniques, which synthetically tie nonsynchronous components together; thus altering the frameworks by which we perceive psychoacoustic phenomena in a way which attracts our attention away from the underlying or central processes.

\textbf{Human error}, on the other hand, blasts a hole in the structural framework of a system, through which one can perceive the system’s internal design and inherent unanticipated outside implications. This central \textbf{polarity}—between unnaturally pristine systems designed by, intended for, and articulated by people, and the blunt arbitrary character of human fallibility—is what piques my interest in live performance of process music. The perception-altering potential of disgui\textit{sing} techniques pale in comparison to the vast possible set of unintentional, unknown, or unforeseeable
connections which may arise through human error. The meaning imbedded in the design of a system can only give us insight into the thinking of the designer; but the breakdown of that system, a mortal gesture, can be expressive of natural meaning in its enunciation of the unimaginable underlying processes at work around and within us—

—These glitches also permeate outwards, like the butterfly effect, to all parts that are supported by the glitch-generator. This reactionary self-governance of proportion is only possible in a live—human—setting.

Orbital 8 (5-pitch permutation // inverted mirror // tone-set jumping // partial ascension) [Appendix IX]

Written after all of the others, this piece is the most disconnected of the set from the central concepts which unify all of the other pieces. It is loosely connected in its gridded notation and process-based enunciation, but with compositional decisions chosen for their aesthetic effects. The harmonic content of this piece grew out of the discovery from Orbital 2 that pentatonic scales, when combined, form other scales.

Pentatonic scales set one whole step apart form a Lydian scale beginning on the lower root. The only other set of intersecting pentatonic scales which fit into a diatonic tone-set are those a 4th (or
5th) apart, which lay out the first six notes that could make up either of
two diatonic scale. Sam Friedman and I experimented with these
relations; locked into a unified pulse, we improved on various
pentatonic scales, and took turns switching to a new tone set. At first,
each new pentatonic selection would have to be either a whole step,
4th, or 5th apart from the other person’s current set, so as to cohere to
a diatonic construct. When we decided to drop this tone-set selection
schema, and choose any pentatonic we wanted, the options opened up
dramatically. As only two notes are played at the same time, any
possible relation will still fit into at least one diatonic scale, the only
difference is that now the scale implied by the harmonies has the
potential to change with every pulse.

This model clearly has a vast set of possibilities, and I wanted to
find a process by which to systematically thresh through some of these
options. As the basic tone-set contains 5 pitches (we’ll label them here
from 1 to 5), there are 125 possible permutations. I decided the piece
should consist of all of these permutations put forth in a systematic
way. The most basic system I could think of (12345, 12354, 12435,
12453, 12534, 12543...) fit the requirements of my process, but would
put too much emphasis on the 5-note structure when heard, as the
beginning of each of these new iterations is the same as the iterations
around it. In order to disguise my process from the listener, I decided
to utilize this system, but also change what I considered to be the ‘1’
upwards after every permutation (i.e. 12345, 23415, 34152, 45213,
51423, 12543...). This system provided no repeats for the first 96 iterations, followed by an exact repetition of the first 24 permutations. I then had to go through the painstaking process of finding the 24 permutations that had not yet been articulated, and aligning them somewhat randomly so that it continued the ascending pattern of the first note of each permutation. The four excess permutations left over, which each began on the same number, were then inserted at the end of every set of 24 permutations, where the process caused a skip of two notes rather than one (...32145, 43215, INSERT, 15234, 21354...).

If the two pianists in this piece played through the permutations in this matter, but over different tone sets, the interval choice between the two sets would be obvious to the listener. To disguise this process, I decided that one player should be playing the reflex of the other’s permutation—(12345, 23415, 34152... becomes 54321, 43251, 32514...). This detail also provided for a kind-of counterpoint, with the two voices always employing contrary motion except when jumping to a new tone set.

For the choice of which pentatonic tone-set each musician should play, and when, I decided to begin by systematically threshing through all 12 diatonic keys, ascending by whole step, then jumping down by a 4th and descending by whole step, before assembling a somewhat randomized harmonic ascension with each player moving up by half-steps one every 3 permutations and the other every 5 permutations. The systemized harmonic threshing was spread out over
the section of the piece with the purely processed—except for the 4
insertions—permutation scheme, the first 96 permutations. The
harmonically unstable 3:5 phase was set on top of the less systematic
final 24 permutations.

Aesthetically, this piece turned out much nicer than I would’ve
assumed given the layered density of processes and semi-arbitrary
decisions. The steps taken to disguise the underlying schema were
successful. The inner structure of 5-pulse blocks is not evident to the
listener, and the permutation process manages to hide the specifics of
when the parts are ascending in relation to each other during the
chaotic end of the piece (a general sense of the ascending motion,
however, is evident). Instead of hearing a representation of the layered
complexity involved in the piece’s creation, the listener observes two
voices somehow locked into a contrapuntal orbit—due to the perpetual
contrary motion—with sections of relative stability punctuated by slight
and sudden alterations until the final chaotic ascension.

For the players, every change in tone-set represents a shift in
perceptual framework, thus providing a new context for assessing the
interrelation of the two lines.

**Orbital 3 Prelude (4:5:6 // up the ladder // free fall //
accelerated quantum-locking)**

—Many of the strategies employed in the central portion of
the **prelude**—and throughout **Orbital Collisions**—grew out of a
recording project for MUSC 451, which I took in the fall of 2010 with Daniel St. Claire. At this time, I was in the early conceptual stages of composing Orbital Collisions. I knew I was interested in cycles, experiments with the game were underway, and the gridded notation system was pretty much complete. I didn’t realize it at the time, but working on this project—in which I took a recording of a single leaf-crunch, and experimented by altering its speed and applying delay—was the first time I actually had a chance to manipulate sound; to generate cycles, and phase them against each other.

The cycle used in this recording—sound work I [see CD B track 1]—was happened upon by luck. I experimented with a sound-editing program called Audacity, repeatedly speeding the crunch sound up by a consistent ratio, the effect of which is exponential. A cycle was formed by the recurring pattern of speeding up and slowing down. This experience alone—of generating a cycle by via process—has clearly played a large role in the development of my composition. However, even more important to my work was the phasing of two slightly differently proportioned iterations of this cycle, which yielded, through the process of the project, conceptions of tempo-pendulums, activated acceleration, and glitching (I called it ‘freezing’ at the time).
The prelude mirrors and embodies sound work I, paying respect to the process that produced it and the successive generative period in time, with respect to my compositional framework—

Not so much the articulation of a single phase or system, this prelude is designed as a sampling of different kinds of cycle interaction which precess in the form of a single cycle, from gridded phasing through rhythmic incomprehension and back again, meanwhile foreshadowing the underlying rhythmic strategies which frame Orbital 3. Performed on two drum-sets, as far apart on the stage from each other as possible, this prelude, in essence, is an expression of symmetry. It begins with the unison playing of a 60 grid-beat cycle consisting of 3:4:5 phase; hi-hat every 3 grid-units, snare every 4 grid-units, and bass drum every 5 grid-units. [see appendix X]

My plan was to stratify these parts in a way that was not as clear to the listener as was in Orbital 4. I searched for a level of stratification which would result in the filling up of every grid-unit—tiling the set—so that there would be no grid-units of rest. This search did not yield any fully tiled results, but I did find out that stratification by prime numbers tended to cause fewer unsounded grid-units. Therefore, after one iteration of the cycle, one drummer instantly jumps ahead—glitching—by 7 grid-units. After two more times

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7 When listening to a sped up recording of the prelude [CD B track 2], in relation to sound work I [CD B track 1], it is amazing how similar the processes and effects are, especially since I didn’t realize the correlation until well after the Orbital Collisions premiere.
around the cycle in this configuration, the stratification increases to 11 for two more cycle iterations.

In order to let the listener know that the two drummers weren’t merely playing the same cycle and offsetting it at random, I decided to insert a cymbal crash into the notation in every-grid unit which otherwise would be rested. This gives a sense that the parts are planned and locked together (as each drummer will be crashing their cymbal at the same time). Also, the non-uniform pattern formed by the number of grid-units between successive cymbal crashes—12, 3, 9, 3, 12, 21 for the 7-stratification and 9, 12, 3, 12, 10, 15 for the 11-stratification—seemed especially random for being the result of a clearly defined process, and thus was begging for a unifying articulation.

Intersecting cycles; each an atomic unit whose internal rhythms and symbolic-implications are perceived as a singular entity when rearticulated verbatim; repetitions serving as markers in time, the non-uniform space between repetitions creates wobbling in the perceived flow as the mind struggles to interpret the inconsistency as a regularity in relation to natural cycles and perceptual borders, the effect of which is multidimensional as cycles on different planes are compounded. As shifts in perceptual framework provide new contexts for perceiving the interplay of these varied components, meaning is accrued and altered over time. (page 3)

The next section of the piece enters immediately after the second iteration of the 11 grid-unit stratified cycle. It begins with both drummers in unison, articulating a pulse—taking as its initial tempo as 2 grid-units from the previous section—which consists of the combined playing of hi-hat, bass drum, and rim-click on the snare. This pulse
persists throughout this section as articulated by both bass drums, though its tempo fluctuates according to the performers’ wills. Once this pulse is stabilized, one drummer begins playing strokes on the hi-hat and snare that subdivide the pulse by 2. After this sets in, the other drummer begins articulating a pulse sub-division of 3 with the same combined rim-click and hi-hat stroke, forming a 2:3 polyrhythm that is articulated once per pulse. Thus, emerges a progression—

(n) Continuous action conceived or presented as onward movement through time; progress or advancement through a period, process, sequence of events, etc.; movement towards an outcome or goal; (also) such a process; a course (of action, time, life, etc.); a proceeding or process.

of drummers glitching back and forth, subdividing the pulse by an integer whose value increases by one with every glitch; this pulse-slicing leap-frogging quantized acceleration counterbalanced by the human limit of technicality naturally imposing itself on the system, forcing a decelerating pulse. Here lies a segmented vertigo effect; as the pulse slows down, the tempo of each drummer’s successive strokes remains approximately constant, all the while the theoretical grid stretches to accommodate more and more subdivisions—which advances all the way up to 10:11. This process is a systematic threshing of polyrhythms which builds up unit-over-unit and causes a perceptual shift from a comprehension of rhythmic relationships to their shrouding in ambiguity.
In its early stages, 1:1 through 4:5, performing this progression involves hearing and locking in to the combined strokes as a single rhythm—the other player’s strokes articulate a pulse that is subdivided by the integer you are currently on. The other drummer’s current integer describes the number of these pulse-subdivisions between each of your strokes. (i.e. if you play 4 strokes against the other drummers’ 5 strokes, the pulse implied by their strokes is subdivided by 4 units, with your strokes lining up every 5 of these units).

At later stages, this progression becomes much more difficult to play as inner subdivisions are too fast and complex to be helpful. Performance now requires playing a consistent stroke with which to count the space between pulses, and the calibration of tempo so as to sync bass drum strokes. In practice, this means that if your bass drum stroke is offset from the other drummer’s by a given amount of time, you should slightly alter your tempo so as to diminish the gap by one half, and assuming the other drummer follows the same practice, you will sync together. This final 10:11 polyrhythm, however, represented the limit of my and Matt Hurwit’s ability to sustain our parts, but even if it were possible to push this limit further through the progression, I don’t think it would be worthwhile.

At a certain point, somewhere around 8:9, the effect of the overlay stops registering as proportional, and begins sounding like a phrase slowly slipping past itself, in the fashion of Steve Reich’s Piano Phase. Also, by this time, the pulse has slowed to such a degree that
the perceived consistency of its tempo may come in to question. Any more complex polyrhythms here would replicate this same slipping impression. Therefore, our physical 10:11 limit is as good a place as any for the progression to be broken down by the technique of activated acceleration.

This activated section of the prelude contains the same single-impulse snare and hi-hat stroke device, but allows the drummers to gradually alter the rate at which they perpetuate a stroke. They are locked into a specialized kind of communal dialog whose only improvisational parameter is tempo. One satisfying effect which commonly arises from this interplay is what I call a tempo-pendulum. Both drummers cyclically swing back and forth between slow and fast tempos, synced by way of a polarity. Their acceleration-deceleration cycles are offset from each other by \( \frac{1}{2} \) cycle; they are always accelerating in opposing directions. The two parts here seem to orbit around each-other—or through; this effect is meant to imply a sense of conservation of energy and of sonic density.

The activated acceleration eventually slows down, and the two drummers lock into a 2:3 polyrhythm. As the tempo edges up, the drummers alternately cut their tempos in half, a glitching device which creates a back and forth between the polyrhythms 2:3 and 3:4 whose underlying pulse is gradually speeding up. For symmetry, the reflex of this process then occurs, the same alternation of polyrhythms is heard while the tempo slows and drummers double their tempos one
at a time. This doubling and halving segment of the piece serves to
reorient the listener with familiar poly-rhythmic relations, before the
4-rim-shot cue signals the final 9:10 phase of the prelude.

The two cycles of this march-like phase—[appendix XI]—are
linked by a common hi-hat stroke every two grid-units. Each cycle
consists of the same basic rhythmic cell [bass snare bass snare two
grid-units each] and either one or two grid-units of rest, so that one
drummer’s phrase will slowly and repeatedly lap the other’s. This
section marks a return to the gridded rhythmic phasing also expressed
with the 3:4:5 opening segment of the prelude, and thus this drum duet
is seen to run one full iteration of a cycle, moving from a grid phase
articulated with quantized glitching, through poly-metric
disorientation and activated acceleration before routing back through
polyrhythmic-glitching and arriving at quantized-phasing. These
interactions are interesting on an aesthetic level, but more powerful in
their proportional relation to the shifting of harmonic intervals.

We can imagine that if this progression were recorded and sped
up into the audible frequency range, we would hear a held fundamental
(bass drum pulse) complemented by a run up the harmonic series, two
pitches at a time. [i.e. A2 fundamental underpinning by C3 2(1),
then G3 over C3 (3:2), all the way up to F#5/E5 (11:10).] [appendix cd
for sped up versions, some of which seem to imply this harmonic
suggestion, and some of which are even more exciting] However, the
human-limited inaudible frequency range of this section is a perceptual
limit that serves to disguise the piece’s underlying harmonic
implications.

**Orbital 3 (phase-fragment construction // divergent
acceleration // chaotic system // path hopping)**

Of all of the pieces in this concert, **Orbital 3** most embodies the
Rube Goldberg controlled-chaos mentality of designing and layering as
many components—

—cycle interaction, shifts in perceptual framework, phasing,
  progression, hocketing, disguising techniques, glitching,
  stratification, strict-parameter improvisation, activated
  acceleration, chaotic systems, signal logics,...—

—as you can think of, in an attempt to push the limits of complexity.
The instrumentation for this piece calls for 2 ensembles each made up
of 4 musicians. Every ensemble part has a mirror-image in the other
ensemble; an avatar who plays the same material and goes through the
same processes articulated in minutely different ways, all within in the
context of his own band. The initial goal for this piece was an
exploration of **grouped activated acceleration.** I wanted to have
two bands articulate the exact same cycle, first in unison, then
following different acceleration paths. (I think of this as being in the
same family as the canon, though with an unspecified and constantly
changing level of **stratification.**)

Many strategies would be attached to this system through
experiment and rehearsal, but the first task was the design of a **central**
cycle [appendix XII] with relatively consistent rhythmic density, fragments of partially articulated phases—these being implicative of pulses which don’t evenly subdivide the cycle—and low perceptibility of the interaction between any two distinct parts; that is, in the playing of one of the parts in such a cycle, it would be impractical to focus in on the dialog between one other part and your own as a means for staying synced with the ensemble. In order to lock into this non pulsed cycle, it is essential to feel the passage of every grid-unit—a uniformly weighted atomic pulse—and recalibrate your inner sense of time based on the combined ensemble rhythmic grid.

The central cycle is subdivided by 25 grid-beats. [appendix] As 5 is the only factor of 25 (besides the irrelevant 1 and 25), any phrase or cycle which implies a number of subdivisions other than 5 grid-beats will not fit evenly into the cycle. These parts then must contain disruption of their inherent/implied cycle, which registers as a glitch. This overlay of implied cycles, which instantaneously reorient themselves so as to be offset from their assumed path, can be seen as constituting the perception of a fragmentary or glitching phase, whose components suggest the articulation of numerous phases throughout different segments of the cycle; or of a single phase which appears, over the course of time, to be skipping around to different points in its full articulation. *

The parts were written from the top down, each generated through the setting in motion of a rhythmic pattern that, in almost all
cases, require **glitching** to fit into the cycle. As I wanted a cycle with a limited number of grid-units of rest, the first stroke of each part was designated to fall on a grid-unit that would otherwise pass unsounded. The top line consists of the only uniform cycle subdivisions; a single stroke which recurs every 5 grid-units [5,5,5,5,5]. The second line expresses a cycle of 6 grid-unit subdivisions, which **glitches** twice, shortening the pulse by 2 and 3 grid units [6,4,6,6,3]. These top two lines make up the alto saxophone and harmonic parts.

The third and fourth lines—in unison—also imply a 6 grid-unit pulse, but with only one **glitch**, which stretches the pulse by one grid unit [6,6,6,7]. More than any other, the 5th line imposes its **pulse**, of 3 grid-units, on the cycle. It registers this way because it only contains one **glitch** that inserts a single grid-unit of rest [3,3,4,3,3,3,3,3]. These middle three lines then seem to imply comping via double-stops and line-5’s near uniform rhythmic stratification of the cycle. This being the case, these lines were assigned to the two comping instruments available in the ensemble; piano and guitar.

The last two lines are less dense than the others, which is appropriate as they combine to form the bass part. Also, as these lines were filled in after the rest, the layout of their strokes decided more or less with the aesthetic goal of a relatively uniform density of sound. Thus, the 6th line is not as clear an expression of a specific pulse—as it only contains two instances of a uniform span of time between successive strokes (7 grid-units). However, its form may suggest a
sense of approximate regularity in the 7-8 range. [7,7,8,3]. With the exception of one stroke that is offset by a single grid-unit, line 7 is the exact same as line 6, translated over by 3 grid-units [7,7,7,4].

In assessing this piecemeal process of cycle construction which is based on relatively arbitrary choices—

—I’m uncomfortable justifying so-called random choices be they aesthetic or process; however, I find it useful to experiment within parameters I have yet to understand, and non-systematic devices can lead to new possibilities and effects—

I find comfort in the fact that my goal of uniform density was achieved8—

Orbital 3 flows directly out of the prelude. The articulation of final 9:10 phase of the drum duet serves as a cue for the rest of the

8 If the cycle is subdivided into 5 rhythmic cells, marked by the periodic strokes of the 1st line, and lines 3 and 4 are treated as a single part—as they should be—then the number individual strokes per rhythmic cell is, from left to right, 6, 7, 5, 5, 6. Therefore, the density is relatively consistent over time. We can derive a value for the average density of the cycle, by taking the total 29 strokes and dividing it by 25 grid-units, which comes out to a density of 1.16. This is around what I was hoping for; just enough density so that only one grid-unit throughout the cycle is rested. The few double and triple stops (in addition to the always present combination of parts 3 and 4) also form a unique effect. Densities slightly higher than this tend to have too many double and triple stops that can imply harmonic progressions, and densities much higher than this result in expressing, by way of dense clusters, the modality of a cycle’s tone-set. Low-density cycles may actually be of most interest—in a sparse sound-scape, every sound seems to take on extra significance. I hope to develop this notion of cycle density and rhythmic-cell density by way of a series of compositions whose processes are directed towards changing levels of rhythmic density.
ensemble to come onstage. Once everyone is in position, a cue from either of the drummers—consisting of 4 snare cracks, one per grid-unit—sets the central cycle into motion. More specifically, the beginning of the cycle is offset from the drum cue by one grid-unit of rest. The playing of this cue by either drummer throughout this piece always brings the cycle back to its origin state. Thus, the unit of rest between drum cue and cycle is both a glitch in a literal perceptual sense, and as single unitized symbolic effect of the actual instantaneous shift in perceptual framework—

—from any number of possible configurations and interrelations; forced back into the familiar order from which your current state arose; in an instant, vanished all memory of the path that carried you to this current point in a singular progression; irretrievably lost are the possibilities and implications of later stages, as former, stable conditions reassert themselves, time-warp amnesia sets in—

—experienced by every member of the ensemble upon the sounding of a cue.

In the notation [appendix XIII], this cue, at letter B in the notation, is seen as 4 circles that lead into the main cycle. The numeral 5 scrawled above the box exemplifies the same notational device as was used in Orbital 2 and Orbital 6, in which the number designates how many times a box will be played before the musician moves on to the next material, in this case, the box at letter C.

Unlike the previous section, in which every musician plays 5 iterations of the central cycle, at letter C, musicians phase cycles of
different length. These parts are fragments of the central cycle—all formed by the re-notating of the first X grid-units of this central cycle. Thus, this section consists in a phase between fragments of cycles—which normal configuration results in the perception of what I have called a fragmentary phase.

*This generation via reorganization process—of sampling and rearranging segments of phases to form non-uniform cycles which can then be phased against each-other, re-segmented, phased, cycled...—has vast potential for musical exploration, but in the mean time, w]

Part C consists of a 100 grid-beat phase between fragments of the central cycle. The fragment lengths were picked so as to evenly fit into these 100 grid-beat. Thus, the phase in part C is between cycles of the following lengths: 25 grid-units, 20 grid-units, 10 grid-units, and 5 grid-units. After these 100 grid-units, a new device for slight indeterminacy is utilized at letter D.

The idea for a chaotic system came on the fly while I was writing out the initial charts for Orbital 3. Chaotic systems—notated as two (or more) stacked rectangles linked by a bracket—allow the musician to choose between two phrases. Upon reaching the end of a given phase, the musician again can choose which part to play. This, regrettably, is an instance of a fairly arbitrary and undirected parameter, but I think the chaotic system is a device that has the
potential to generate fresh possibilities when better understood and more precisely articulated.

I should take this time to mention the role of the drummers in this composition. Throughout sections B, C and half of D, the drummers articulate half of a tempo-pendulum. Following the opening cue, drummer I—borrowing the dually articulated (rim click and hi-hat) stroke device from the prelude—starts by playing at a consistent tempo that maps and defines the grid-units as seen by ensemble members. Soon, drummer I begins to gradually speed up, and the ensemble locks onto his pulse articulation. When the increase of tempo has gone on for a while, and is nearing the limit of the ensemble’s technical ability, drummer II enters so that the two are lined up in rhythmic unison. Drummer I stops playing at this very instant, allowing drummer II to gradually slow down. Once his pace has sufficiently diminished, drummer I reenters, gradually speeding up again.

This cycle—with drummers articulating individual yet mirror-image process, passing the role of time-keeper back and forth—defines the tempo for the entire ensemble. As the ensemble plays though the various processes of sections B, C and D, they are mutually locked into an ever-changing tempo path, the arbiter of which is periodically alternating. The layering here gives the listener a clear picture of how the ensemble players are following the changing tempo. The system at this stage is already fairly chaotic and unpredictable, but the rift which
occurs in the transition to section E, amps up the density of layers and of sound.

Once the chaotic system in section D has been in motion for some time, the drummers each begin to **actively accelerate** on top of the polyphony of scarcities. This signals the entire ensemble to begin to utilize individual **activated acceleration**. The standard 4-hit drum cue eventually cuts through this soundspace, signaling section E and aligning all eight musicians together, but only very briefly, as the ensemble is now split into two separate bands—[one consisting of Matt Hurwit on drums, Matt Bernstein on electric guitar, Owen Callahan on Alto Sax and Daniel Hymanson on electric bass, the other of myself on drums, Gabe Gordon on piano, Sam Friedman on harmonica and Zach Rosen on acoustic bass]. During the rest of the piece, drummers **actively accelerate** as they did in the 3rd portion of the prelude while members of each of their bands lock-in to their rhythms.

The inherent notion of chaotic energy provided by this particular arrangement of processes—as a method of disguise—guides the listener's attention away from the specific aspects of the music instead forcing them to observe the chaos as a whole. To stay locked to a given 'band' over this hectic environment seems like a hard task at first, but with a little practice in **focused listening**, the ensemble quickly adapted. As Daniel Hymanson explains,

“Before we started playing it I was expecting to be more distracted by the sounds around me...just hearing about it theoretically, but then when we actually started playing and I learned
that it was like, it came kind of naturally...it was easier for me to key into a specific tempo, or direct my ear towards something than I had anticipated.”

[Daniel Hymanson, personal interview]

As if this level of density wasn’t high enough already, the final segment of the piece, as cued by a hi-hat flowering, allows two of the musicians, Sam Friedman and Owen Callahan, to improvise on top of this system. I asked them, in their solos, to try to trade back and forth, and lock into one or the other (or alternate between) present tempos. In the performance, this locking didn’t really come across, except for Sam in a few places. I’m not particularly attached to the combination of process and improvisation here; the overlay is not based on any clear intention or compositional goal. The solos may be cohesive and interesting on their own terms, and even satisfying and stimulating to listen to, but they do not seem to be in synch with kind of energy that permeated the rest of the concert. Maybe with practice, people could figure out how better to improvise on top of shifting structures—like in Orbital 3—in a way which seems to be aesthetically linked. Even though the results were not as far reaching as I had hoped, I do not regret setting up this improvisatory framework; in that the set up was worth it just to find out what would happen.

The end is signaled by what at first sounds like the standard 4-crack drum-cue, but actually continues to crack after the 4th stroke. As soon as the ensemble picks up on this ending signal, they begin repeating a note in rhythmic unison. Eventually, the two drummers
begin to accelerate in opposite directions, all the while gradually fading in volume. The aggressive contour shifting and

**Orbital 7 (ratiometric slipping // double pendulum // tidal delay // plural decay)**

This orbital was adapted from a 15 bar chord progression [see appendix XIV] I composed on a piano in August, 2010 made up of octave bass notes in the left hand and four-part voicings—mainly drop-twos and clusters—in the right hand. I wanted to apply the device of linking intervals to polyrhythms by proportion from **Orbital 6** to this chord progression. I decided to arrange these voicings for two electric guitars, each of which was to articulate a polyrhythm as derived by proportion from the ratio between pitch frequency. To insure that the guitar parts did not include any 2nds, whose frequency would require an 11:12 polyrhythm, I split the parts so that the top note and 2\textsuperscript{nd} lowest note formed one part while the bottom note and 2\textsuperscript{nd} highest note formed the other.

I wrote out the polyrhythms prescribed by each interval in grid-notation, alongside the scale-tones articulating that interval [see appendix XV]. The most complex intervals/rhythms in the piece were the tri-tone (5:7) and minor third (6:7), which took 35 and 42 grid-blocks, respectively, to notate. A full extension of this proportional relation would require phasing between the two guitars so as to accurately represent the ratios present in each four-part voicing. This
locking proved too difficult to initiate and maintain, and therefore, for the purposes of feasibility of performance, layering of frameworks, and process disguise, I decided that each guitar player should maintain only their assigned polyrhythm-harmony relation while employing activated acceleration.

In performance, each chord articulation begins with a cue signaling the simultaneous entrance of both guitars. Borrowing from Orbital 3, the guitars participate in a tempo-pendulum for every phrase they play. This pendulum gradually diminishes in amplitude, that is, the range from highest tempo to lowest tempo articulated within a single pendulum cycle steadily gets smaller and smaller until the it reach a state of approximately constant meter. The guitarists then follow a cue to stop what they are playing, and wait for the cue which signals their next phrase.

If the articulation of a uniformly accelerating tempo is thought of as a progression through a series infinitesimal moments, then each moment represents a tempo which is slightly faster than the moment before and slightly slower than following moment. With this view, we can see an accelerating tempo as being a brief articulation of all of the possible tempos in between its slowest and fastest extremes. Thus, when we think of the tempo pendulum between any of these guitar polyrhythms, we should be aware that every time their cycles slip past each other, there exists a moment when their tempos are perfectly aligned, with respect to the frequency proportionality
between their pitches. Ideally, as the pendulum slows, the two guitarists should approach this synced ratio-metric state.

In this piece, the central guitar orbital experiences two collisions; a phase is layered upon it by the bass part and a process—delay—is applied to it. The bass notes from my original composition were adapted for electric bass and clarinet and stratified by one octave. The playing of each of these notes consists the articulation of a tempo pendulum with cued entrance and exit. If we take each bass entrance as a recurring phenomena which outlines the bass cycle, and each guitar entrance as defining the guitar cycle; then it can be said that in Orbital 8, a phase is articulated between these two cycles such that during their first cycle iteration, the guitar phrase is heard before the bass phrase, and in their last iteration, the reflex is heard. This means that the period of a bass cycle is less than the period of a guitar cycle, the effect of which is the perception that these two cycles are passing or threshing through each other.

Borrowing slightly from the delay scheme that I use as an analogy for Orbital 4 (page 21), over the course of this progression, delay is increasingly applied to both guitar parts. With their delay times set to slightly different specifications, the effect level for each guitar is manually increased by the same amount in between every guitar exit and entrance. Thus, at the beginning of the piece, there is no audible delay, but at the end of the piece, delay level is as loud as or louder than the source level.
This process of quantized increase in delay level serves two purposes, the first of which is to orient the piece with the guitar cycle at its center. For the listener, this implies that the bass cycle is phasing over the stable guitar cycle, and not vice versa. Secondly, the delay serves the function of **disguising** the guitar players’ specific polyrhythms and their **activated accelerating** interaction as the piece proceeds. As the rhythmic phases played by the guitarists are made up of recurring notes in the first place, the addition of delay into the system makes it hard to tell what is source sound and what is delayed sound. Matt Bernstein explained the difficulty involved in maintaining the articulation of a tempo pendulum between these complex polyrhythms, especially with the increasing delay level:

“That variable time thing made it so hard to play a complicated rhythm and then like edge up the tempo, and its interesting because as you’re edging up the tempo, the pattern just kind of falls apart, cause its all about this very precise relationship between two different rhythms, and your just ramping up the tempo and that relationship is like never really consistent cause its like impossible...an interesting exercise in running up against your own limitations...At a certain point the delay would get so intense that it was like, not really clear if you were speeding up or slowing down, because there was so much information. You strike a note, and there’s so many repeats, its hard to distinguish between what you’re doing and what the delay is doing. It just goes from incredibly dense to even more dense.”

**New Directions**

I frame this project with a recent recording experiment with Matt Berstein. With no plan in mind, we used a series of delay pedals,
to manipulate sound in exponential ways. *Just as sound work I was generative of* Orbital Collisons, *I intend for this sound work II [cd B track 3], to be generative of the next cycle—*
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Orbital Collisions

Orbital 2 (loop maze // threshing mill // ticking clock // mobius strip)


Orbital 0 (atom smasher // selective sampling // game // collective coincidence)

Orbital 8 (5-pitch permutation // inverted mirror // tone-set jumping // partial ascension)

Orbital 3 Prelude (4:5:6 // up the ladder // free fall // accelerated quantum-locking)>

Orbital 3 (phase-fragment construction // divergent acceleration // chaotic system // path hopping)

Orbital 7 (ratiometric slipping // double pendulum // tidal delay // plural decay)

The Cyclic Ensemble
Matt Bernstein
Owen Callahan
Sam Friedman
Gabe Gordon
Matt Hurwit
Daniel Hymanson
Jon Myers
Zach Rosen

I would like thank my mentors on this project, Anthony Braxton, Brian Parks, and Dan St. Clair, for reeling in my chaotic ideas, pointing me in the right direction, and inspiring me through their own work and methodologies, as well as my other teachers over the last four years (Abraham Adzenyah, Pheeroan Aklaff, Noah Baerman, Neely Bruce, Bill Carbone, Jay Hoggard, Tony Lombardozzi, David Nelson, Tyshawn Sorey, Sumarsam), all of whom exemplify deep musical understanding and idiomatic mastery in their daily lessons, and who have expanded the rhythmic/sonic imagination

Thanks also to my parents, housemates, and friends for their unending support and encouragement

Thanks for listening, I look forward to your thoughts

reception to follow in lobby
Fwd: horrible bell player

P— <p—@wesleyan.edu> Thu, Apr 7, 2011 at 7:20 AM
To: —

Ringers,
Whoever is responsible should (must) go to see Olivia Drake (third floor of South College) immediately and apologize. I heard the bells, too, at ten past one, and the sound was painful. Please have respect for others who may not think it clever to play loud and tunelessly. And please let me know who the miscreant is.
P—

From: "o—"
To: “p—“

Date: Thu, 7 Apr 2011 12:45:35 -0400
Subject: horrible bell player
Thread-Topic: horrible bell player

P— or M—,
Who is playing bells today? He/she is playing the same two notes, back and forth, for 20 minutes straight now. Driving us all in South College crazy. It’s probably the same person who played last Thursday or Friday, who played random notes for an hour and a half straight.

Can you say something to this person? Maybe he/she are experimenting, but it’s a huge irritant to us in South College. It’s not music, not song. Just makes us want to pull our ears off.!!

Thanks,
Going Bonkers from Under the Bells,
O—

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Citations


Friedman, Sam. "Orbital Collisions." Personal interview. 5 Feb. 2011.

