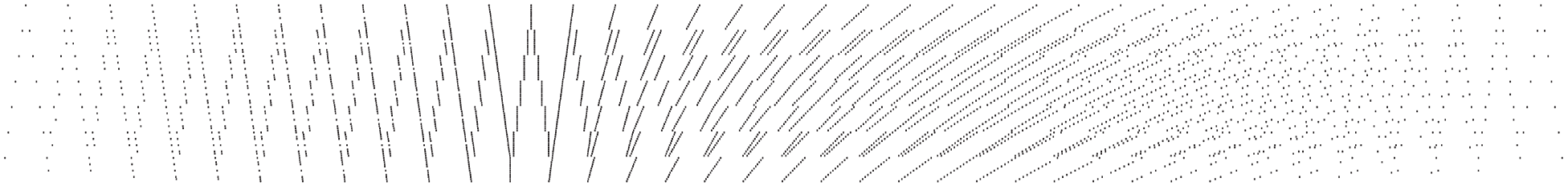


*EVERYONE SHOULD BE AWARE:*
*THE BEST TRADEMARK IN THE WORLD – IS 'LIFE'*
*Beware of Forgeries!*

— Sergei Yutkevich, *The Eccentric Manifesto*, 1922

# 1. INTRODUCTION

Inspired by the work of James Tenney, György Ligeti, Charlemagne Palestine, and Conlon Nancarrow, *Eight Studies for Automatic Piano* makes use of simple, computer-aided compositional processes to test the limits of human perception and machine precision. It relies on a bare minimum of technical means to explore notions of temporal distortion, iterative process, and elegant complexity. Presented in an immersive concert setting without the presence of a human performer, *Eight Studies* questions traditional notions of live performance and musical "life." The methods, processes, philosophy, and influences behind the work are discussed below in a series of mini-essays. An additional section provides detailed technical descriptions of each piece, followed by a series of graphical scores based on the computer's version of the "piano roll."

This document is an abridged version of the thesis submitted with *Eight Studies for Automatic Piano* in fulfillment of the requirements for the degree of Master of Fine Arts in Electronic Music and Recording Media at Mills College, 2010. The entire unabridged document, including a brief history of mechanical music and the player piano, along with a discussion of Nancarrow, Tenney, and Ligeti, can be downloaded from **www.postera.com/context**.

# 2. REFLECTIONS

### 2.1 Disklavier vs. Player Piano

*Eight Studies for Automatic Piano* was composed specifically for the Yamaha C7 Disklavier Mark III, a modern-day player piano. An important difference between the Disklavier and its earlier cousin is that it can be controlled directly and immediately by a computer using the MIDI (Musical Instrument Digital Interface) protocol, rather than requiring the composer to punch a paper roll in advance. This affords the opportunity to engage in an intimate, dynamic relationship with the instrument, instantly hearing and evaluating even the smallest modifications to a work.

### 2.2 The Sound of the Piano

The sound of the piano can be both mundane and otherworldly. From Beethoven to Yanni, it can remind you of both the lowest and highest musical achievements of humankind, conjuring terrible childhood memories or transporting you to a new aural cosmology. Conlon Nancarrow (1912-1997) spent the majority of his waking life composing music for the player piano, but he was never entirely happy with the sound of the instrument:

> *Actually, at the beginning what I would have liked to have had would have been a harpsichord, a mechanical harpsichord 'cos that's the sound I like because of the clear divisions. A nineteenth-century grand piano is not built for contrapuntal music. It's built for rich, harmonic sounds.* [1]

In an effort to make his piano sound more like a harpsichord, Nancarrow experimented with various modifications, eventually settling on a solution that involved attaching steel and leather straps to the hammers. In 1938, John Cage sought to transcend the weighty historical associations of the piano by inserting various objects between the strings, spawning several generations of "prepared piano" players. *Eight Studies for Automatic Piano* embraces the preset timbre of the piano, but it also finds ways to make it sound unlike a piano, without the insertion of straps, screws, or ping-pong balls.

### 2.3 The Basic Shape

With each study, I start with something simple: a sequence of octaves (Studies 1 and 2), a repeating note (Studies 14 and 21), a glissando (Study 4), an arpeggio (Study 99), or a very short phrase (Studies 13 and 29). I make nearly everything else by systematically copying, pasting, transposing, displacing, and/or inverting this "basic shape." Every once in a while, I push something in or out of place so that it sounds better, or different.

### 2.4 The Harmonic Series

A string, pulled taut (as on a piano) has the natural tendency to vibrate at a rate proportional to its length. It also has the tendency to vibrate at twice that rate, three times that rate, and so on. Each successive "harmonic" will sound a little closer in pitch to the one that preceded it, and will generally be a little quieter, with variations determined by the physical material of the string, the material it is connected to, and the surrounding acoustic space.

While I am interested in the acoustic principles of the harmonic series and often take them into account when arranging notes, I tend to apply the idea in the way a toddler might, one number at a time, counting in order. Digressing from any specific scientific or acoustic principle, my work reveals that a harmonic series, at its core, is nothing more than the natural numbers: one, two, three, and so on. And yet, from the simplest applications of this series to musical data (adding, subtracting, multiplying or dividing), one can derive both elegant complexity and incomprehensible garbage.

### 2.5 Hand-made Algorithms

I have been told that my music is algorithmic, although I don't really think of it that way. I don't use any math other than simple addition, subtraction, multiplication and division. I copy something (often a repeating figure), paste it next to itself, and then change it a little. Then I do it again and again, changing it by the same amount each time, and listening all the while. If it doesn't sound good, I might start over. Or I might copy half of all the copies and put them somewhere else, change that a little, then repeat the process again and again. I might also make something go backwards or turn upside-down. Whatever technique I choose, constant listening and evaluation is essential. I avoid using equations, because I never want the music to get too far away from my ear.

**2.6 Time**

*Eight Studies* focuses on simple temporal relationships, or at least closely related ones. In other words, I don't want things to drift too far apart. I like to create tension between the feeling of speeding up and the feeling of slowing down. For example, a single phrase might consist of progressively longer notes (giving the impression of slowing down), and that phrase could be repeated a number of times. Meanwhile, the overall tempo could speed up. In cases like these, it is difficult for a listener to tell what is speeding up and what is slowing down, but both directions can be sensed simultaneously from the same material. Another example: start with a steady pulse, gradually allowing it to slow down. When the pulse has slowed to half its original speed, start another pulse at double the speed (equaling the speed of the first pulse at the beginning). This process could continue for quite a while, making for an interesting effect. Similar processes occur in the traditional music of Indonesia and James Tenney's *Spectral Canon for Conlon Nancarrow* (1974).

**2.7 Emergence**

Rather than hearing these studies as compositions, I want the listener to hear the sounds, patterns, textures, and forms that emerge from them. If it is unclear whether these overlapping entities are forming in the music itself or in the mind of the listener, whether they are intentional or coincidental, all the better.

The concept of emergence can be applied to simple ideas in tonal music, such as a chord arising from multiple notes, or to aural phenomena such as acoustic beating and difference tones. An example in the visual realm is the moiré pattern, exploited at length in the Op Art of the 1960s and countless "psychedelic" videos. Moiré patterns can also be observed in daily life, for example when light passes through folds in silk fabric, or in nature, when the feathers of a parrot overlap. Often, as a result of the application of strict processes in my music, the visual view of the notes resembles a moiré. I am especially excited if listening to the music inspires a similar feeling.

**2.8a Human Music, Living Music**

Music composed by humans or listened to by humans is always, by definition, human, but the "life" of music need not resemble human form, nor must it be "warm." Cold-blooded animals are alive, as are trees. One might also say the planet itself is alive, even the cosmos. Why stop at a scientific definition of life when evaluating something as non-scientific as music?

Many people have argued that the "human element" is missing in automated and/or electronic music not involving human performance, and that this is a bad thing. But as Milton Babbitt said in defense of electronic music without human performers:

> *Never has music been more human. It begins with a human composer who tries to realize his conception of the musical work in every sense. Except for the intervention of the speakers, the only limitations on the other side are those of the human perceptor.*[2]

I would simply argue that certain compositional approaches lend themselves to interpretations by human performers while other types do not. Both are equally valid, and both are equally human.

**2.8b Living Music, Live Music**

It is all too common that musicians attempt to bestow "life" upon their music by finding a way to make it "live." We live in an age where the "liveness" of music is complicated by layer upon layer of technological mediation, and the caveman's definition of live music is no longer enough. Perhaps it is time to admit that many efforts to make music "live" are just for show (and there's nothing wrong with a good show).

Steve Reich has said that the life of his music originates in the "micro-variations" introduced by human performers[3]. While performers have certainly added life to his music, I disagree that its life originates there. Admittedly, there are many cases where the performance of music by humans causes a composer to rethink his or her approach —indeed, reshaping the life of the music. There are also many cases where the life of music is inexorably linked to human performance—for example, the African music that inspired Steve Reich. In all cases, music comes to life when it is experienced by a human listener, but the performer of the music need not be alive.

Rather than relying on a human performer for "micro-variation," *Eight Studies* exploits those micro-variations that exist in vibrating strings, acoustic space, and human perception. The machine acts as an equalizer; if we know that the music is being reproduced with superhuman precision, we are free to focus our perception on other aspects of the resulting sound. In deference to Steve Reich's 1968 essay "Music as a Gradual Process," this kind of "live" music shifts the listener's attention "away from *he* and *she* and *you* and *me* outwards towards *it*."[4]

### 2.9 Electronic Music

My background is in electronic music. I started with synthesizers, drum machines, turntables, and tape recorders, before pianos or even notes. Part of my approach to the piano involves simulating certain common effects in electronic music such as the crossfade, the echo, the loop, and the splice. It turns out this is not very difficult when using a computer-based sequencer to compose.

When dealing with aggregates of notes, I treat the piano like a sound designer might approach a synthesizer, shaping attacks, sustains, decays, and velocities, and paying close attention to the resulting acoustic interactions, so that the boundaries between notes might either dissolve or combine to create the perception of something new. In the end, it strikes me that the distinction between acoustic and electronic sound may be smaller (and more complicated) than it seems.

### 2.10 Immersion

The audience members should allow themselves to become immersed in the impressions that the sounds and the accompanying visual patterns make on their senses. Generally speaking, I don't want to create a situation in which the listener must mentally sift through the notes, apart from his or her direct experience in the performance space. Nor do I want the listener to relate what they hear to specific emotional events in their life (nostalgia) or the life of the composer (transference of nostalgia). Ultimately, these things cannot be controlled, but it is worth making an effort.

### 2.11 The Visual

Often, the music I make generates striking visual patterns when the notes are depicted as a "piano roll." I use the computer's piano roll like a canvas, manually moving chunks of notes around on a two-dimensional plane. Seeing the notes arranged in this way (as opposed to traditional Western notation) helps me understand the structures that they combine to create. In some cases, these structures are also clearly visible on the piano keys—always a pleasant surprise. Sometimes I have an idea that generates a beautiful visual pattern on the piano roll, but when I send that pattern to the piano, it just sounds like a bunch of notes. I save those ideas for later, but I don't let other people hear them.

### 2.12 The Concert

The idea of watching a piano play by itself on stage is still disconcerting to many, even after all these years. Just a few years ago, Rex Lawson, pianola expert and personal friend of Conlon Nancarrow, wrote:

> *It was clearly the memory of a lifetime to stand in Nancarrow's studio and marvel at the sounds emanating at high volume from the nearby upright piano, no doubt accompanied by a gleeful expression on the face of the composer. It is quite another matter to sit in serried ranks in a smart concert hall and listen to a piano with no-one sitting at the keyboard. Human audiences need human performers. For five minutes it is quite fun to see the keys going up and down on their own, but the excitement soon fades. Reproducing piano concerts need entertaining and careful presentation.*[5]

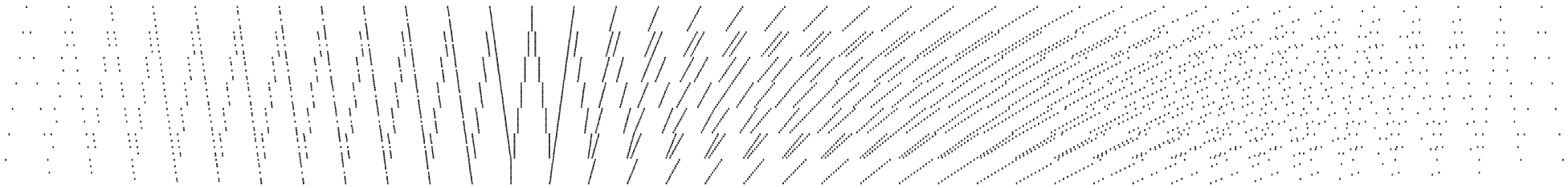
While I agree that careful presentation is essential, I disagree with the general sentiment.

When presenting *Eight Studies* to an audience, I remove extraneous sensory input in order to draw attention to the abstract nature of the piano keyboard and its associated sound. By controlling the lighting with a single spotlight and providing a video projection of the light reflected on the keys, the keyboard is displayed as a simple row of lines and dots. At the beginning of the concert, I enter the stage to press the "play" button on the Disklavier, but this is my only intrusion into an otherwise entirely mechanical performance. A live performance of this kind involves plenty of real-time interaction, but the focus of such interaction shifts from the actions of a human performer to the connection between the instrument/object/performer and the perceptual faculties of the audience. To some extent, the audience is forced to confront their own opinions concerning the role of the composer, performer, and themselves in a concert setting like this.

Mechanical musical instruments are able to repeat their performances ad infinitum, with very little variation, and without asking questions. This affordance raises the question of why I choose to present *Eight Studies* as a concert rather than as an installation, where the audience is allowed to come and go at will. In fact, at a seated concert, we are also *allowed* to come and go at will, but it is generally assumed that we will stay and experience the whole thing together, from beginning to end. In that sense, *Eight Studies* benefits from the benevolent subjugation that a concert hall provides.

## 3. CD TRACK LISTING

| | | | |
|---|---|---|---|
| I | [A] | Study No. 14: Arch Study for the Highest Eight Notes | 05:18 |
| II | [A] | Study No. 4: Sixteen Diatonic Glissandi Moving at Harmonic Rates | 02:22 |
| III | [B] | Study No. 2: An Approximate Series of Approximate Harmonic Series | 06:05 |
| IV | [D] | Study No. 13: Echoes | 03:57 |
| V | [C] | Study No. 21: Bells | 05:20 |
| VI | [B] | Study No. 1: Octaves, Systematically Filled and Folded | 05:46 |
| VII | [D] | Study No. 29: Tentacles | 04:26 |
| VIII | [C] | Study No. 99: Strumming Machine | 12:31 |

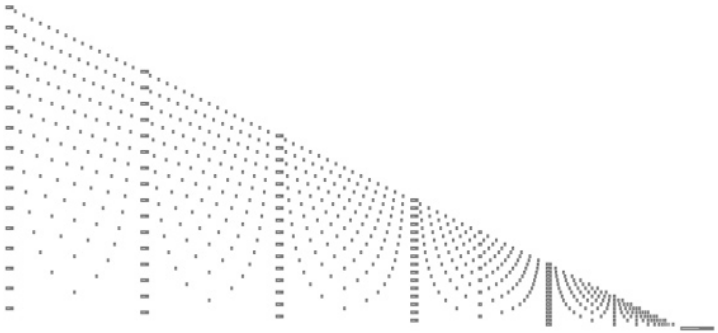


# 4. DESCRIPTIONS

Ideally, the listener should be able to enjoy these works without a prior understanding of the technical processes, technologies, or conceptual framework at play. While not a required precursor to listening, these descriptions may enhance the understanding and appreciation of the work. *Eight Studies* can be divided into four thematic classes, proceeding from most to least strict regarding the application of transformational processes. In order to facilitate understanding, I have grouped the descriptions under each class heading. Please note that this order differs from the accompanying compact disc.

**Figure 1.** Study No. 14: Arch Study for the Highest Eight Notes: mm. 1-16

**Figure 2.** Study No. 4: Sixteen Diatonic Glissandi Moving at Harmonic Rates: Final five measures



**CLASS A:**
**IDEALIZED SYMMETRICAL FORM [14, 4]**

The highest level of symmetry and objective process is maintained, the final result resembling an idealized mathematical form. Intuitive decisions are limited mainly to high-level parameters. Gradual global tempo shifts are commonly employed.

**Study No. 14:**
**Arch Study for the Highest Eight Notes**

This piece is a strict study in polyrhythm that exploits the unique sonic qualities of the highest eight notes. The large-scale form is symmetrical: at the mid-point, the piece proceeds in reverse, mirroring the first half. The basic shape is a steady pulse occurring simultaneously on each of the top eight notes. The lower seven of these notes pulse at related rates: the lowest note pulses at a base rate, the second lowest note pulses at one half the speed of the lowest note, the third lowest note pulses at one third the speed of the lowest note, and so on (Figure 1). The highest note, however, starts at the same rate as the lowest note and incrementally slows down to match the rate of the succeeding notes. After each match, the corresponding lower note disappears. The relationship between these rates, which is determined by a continuous series of whole number fractions (x/2, x/3,x/4, etc.), can be called "subharmonic," as opposed to the "harmonic" rhythmic relationships explored in Study 4, which are determined by whole number multiples of a base rate (2x, 3x, 4x, etc.).

To understand the evolution of the piece, a simple explanation is helpful. Imagine the highest note engaged in a competition with its lower seven companions: it successively attempts to emulate the pulse of each of its competitors, causing the faster pulses to fall away, one by one. Meanwhile, the global tempo speeds up, creating an interplay between the global tempo and the relative tempos of the individual pulses. At the midpoint of the piece, only the top two pulses remain, sounding in unison for a split-second. By now, the global tempo is so fast and the velocities so high that the two pulses sound like a continuous flutter. After this climax, the competition proceeds in reverse, ending at its own starting line.

**Study No. 4:**
**Sixteen Diatonic Glissandi Moving at Harmonic Rates**

Like Study 14, the large-scale form of this piece is symmetrical, but while Study 14 proceeds in retrograde at its midway point (reversal of time), this piece proceeds in inverted retrograde (inversion of pitch and reversal of time). That is, while time is mirrored on a vertical axis at the temporal "center" of the piece, the pitches of the second half are also mirrored along a horizontal axis at the center of the keyboard. In even simpler terms: the second half is the same as the first, but turned backwards and upside-down.

The basic shape is a glissando using only the white keys of the keyboard. At the beginning of the piece, sixteen glissandi begin simultaneously, starting at the top-most note and ending at the bottom-most note. The glissandi proceed at harmonically related rates: the first glissando moves down at a rate of one note per measure, the second at two notes per measure (double the base rate), the third at three notes per measure (triple the base rate), and so on, up to the sixteenth glissando. The fastest glissando finishes first, the second fastest second, the third fastest third, and finally, at the midpoint, only the slowest glissando remains. Meanwhile, the global tempo accelerates in competition with the relative tempos of each glissando and the cascading patterns that form between them (see Figure 2). At the midway point, the missing glissandi reappear in reverse order as the piece races to a close, converging on the lowest note. The slowest glissando is the only one to make its way from the beginning to the end of the piece, as it forms its own retrograde inversion.

**Figure 3.** Study No. 1: Octaves, Systematically Filled and Folded: Basic shape (mm. 1-12)

**Figure 4.** Study No. 1:Octaves, Systematically Filled and Folded: 12 copies of basic shape, transposed and offset (mm. 133-144)

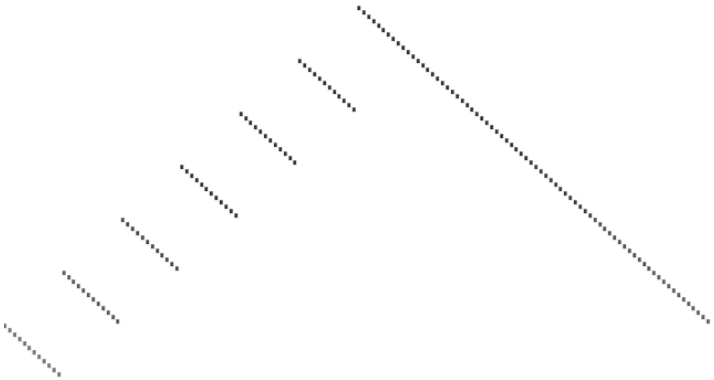
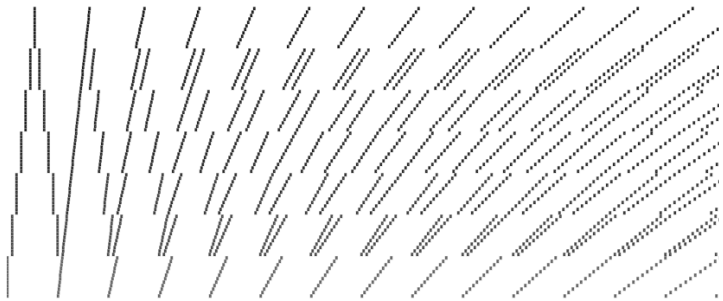


**Figure 5.** Study No. 1: Octaves, Systematically Filled and Folded: "Turning point"



The main inspiration for this piece came from the "Rhythmicon" instrument (conceived of by Henry Cowell in the late 1920s and built by Leon Theremin in 1931) and James Tenney's *Spectral Canon for Conlon Nancarrow* (1974), which was itself inspired by the Rhythmicon. Cowell explored the idea of correlating pitches with rhythms extensively in his writings, and the Rhythmicon marks his first and only attempt to realize this idea in a mechanical instrument. The Rhythmicon uses a 17-key piano-style interface which

> *can produce up to sixteen different rhythms—a periodic base rhythm on a selected fundamental pitch and fifteen progressively more rapid rhythms, each associated with one of the ascending notes of the fundamental pitch's overtone series. Like the overtone series itself, the rhythms follow an arithmetic progression, so that for every single beat of the fundamental, the first overtone (if played) beats twice, the second overtone beats three times, and so forth. Using the device's keyboard, each of the sixteen rhythms can be produced individually or in any combination. A seventeenth key permits optional syncopation. The instrument produces its percussion-like sound using a system, proposed by Cowell, that involves light being passed through radially indexed holes in a series of spinning 'cogwheel' discs before arriving at electric photoreceptors.*[6]

James Tenney's 1974 piece is a sublime realization of Cowell's idea, making use of 24 pure harmonics on a custom-tuned piano and adding a brilliant twist: the same ratios that connect pitch and rhythm are also applied to a logarithmic arc of increasing and decreasing durations.

My own piece disregards the pitch-rhythm correlation, instead focusing on the narrower application of harmonic ratios to rhythmic pulses. While directly correlating pitches and rhythms may provide worthwhile material for organizing compositions (and makes for a fantastic effect in Tenney's piece), I do not believe the perceptual connection between these two timescales can be easily heard, except when the boundary between them is crossed.[7]

**CLASS B:**
**CONSTRUCTED BINARY FORM [1, 2]**

This form consists of two sections: an exposition and a development. In the exposition, a basic, repeating shape is introduced and systematically copied, transposed, and rhythmically offset against itself. When all copies of the basic shape have been introduced, the development begins by incrementally shortening the length of each repeating shape, producing a rhythmic phasing process.

**Study No. 1:**
**Octaves, Systematically Filled and Folded**

The basic shape of this piece is a procession of ascending and descending octaves moving at a rate of one note per measure (see Figure 3). A systematic process of layering occurs: while the original shape repeats, a transposed and rhythmically displaced copy of the repeating shape is introduced after one repetition, another after two repetitions, and so on, until 12 overlapping layers, or "loops," have been created, representing all 12 chromatic pitches. The completed shape appears as stepped series of descending chromatic octaves on the way up, and a continuous line on the way down, connecting the "dots" between the original octaves (see Figure 4). As the shape is filled, the global tempo decreases. Or simply stated: as the rhythm speeds up, the tempo slows down.

At the end of the exposition section, each copy of the basic shape is shortened incrementally. As a consequence, the notes of all 12 layers line up in perfect vertical columns (see Figure 5). The global tempo decreases so that the "turning point" can be clearly heard. As the tempo ramps back up and the shortened layers begin to repeat, the direction of the

**Figure 6.** Study No. 2: An Approximate Series of Approximate Harmonic Series: Basic shape

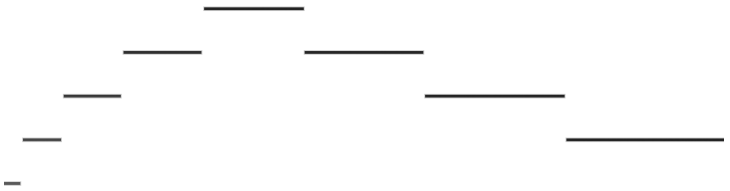


**Figure 7.** Study No. 2: An Approximate Series of Approximate Harmonic Series: "Sprouts" forming from the basic shape

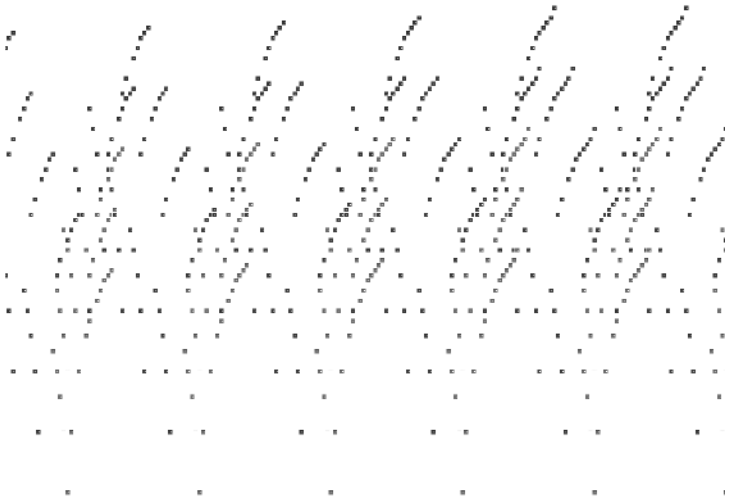


**Figure 8.** Study No. 2: An Approximate Series of Approximate Harmonic Series: "Turning point"

original shape is reversed. Complex phasing relationships develop as the "lines" of notes stretch and fold over each other, forming a visual moiré pattern.

After 672 measures, several layers are selectively removed, leaving behind the notes of a dominant seventh chord. For a moment, the patterns sound "musical," perhaps even "bluesy," as our brains connect the familiar harmonic content with the jagged, syncopated rhythms that exist only as a result of the simplest mathematical combinations. As the tempo slows down further and the notes begin to sustain, a few more layers are removed to reveal the original octave shape that was there all along.

**Study No. 2:**
**An Approximate Series of Approximate Harmonic Series**

Like Study No. 1, the basic shape of this study is a procession of ascending and descending octaves. But here the durations increase incrementally throughout the measure, causing each self-contained measure to give the impression that it is slowing down, even as the global tempo speeds up (see Figure 6). Again, a systematic process of layering occurs: while the original shape repeats, a transposed copy of the repeating shape is introduced at measure two, a third at measure three, and so on, until sixteen layers have been created. The entry point of each new layer is staggered, causing an ascending set of sixteenth notes to grow like "sprouts" from the original shape (see Figure 7). Since the transpositions are added in the order of an approximate harmonic series (octave, octave plus fifth, two octaves, two octaves plus major third, and so on), each note of the basic shape "sprouts" its own harmonic series.

At the end of the exposition section, each copy of the basic shape is shortened incrementally. As a consequence, the notes of all 16 layers line up in perfect vertical columns (see Figure 8). The global tempo decreases so that the "turning point" can be clearly heard. As the tempo ramps back up and the shortened layers begin to repeat, the direction of the original shape is reversed. The discrete cascades fold into slowly evolving, interlocking patterns. After approximately ten measures of the development, various pieces of the puzzle are copied, pasted, and carved away to generate mini-recapitulations of the "turning point" in different ranges. The piece ends with another subtle intrusion by the composer, hinting at the relative minor key of c#.

**CLASS C:**
**INTUITIVE LINEAR FORM [21, 99]**

Intuitively generated elements are introduced linearly, above a steady pulse. No systematic transformations occur with the exception of gradual increases or decreases in velocity. Works of this type proceed at a steady, perceptible tempo.

**Study No. 21:**
**Bells**
A quiet, steady pulse at A4 divides this piece with machine precision like a perforated line. A sparse, unsteady melody appears above, and another below, chiming together in two-part counterpoint, with just enough space between the chimes to contemplate each as if it were alone. Gradually, connections are made. Movement is perceived. Lines are drawn. The notes get louder as time goes by, but the rate of change is nearly too slow to be perceived. As the notes get louder, their decays overlap just slightly. An octave is added above the pulse, then a fifth above that, then another octave. But thanks to the patience and precision of the machine, we are only able to perceive these changes in retrospect (unless we have our eyes open). Repetition allows the listener to focus on details that would otherwise get swept away by the music.

**Figure 9.** Study No. 99: Strumming Machine: mm. 1-4

**Figure 10.** Study No. 99: Strumming Machine: mm. 318-324

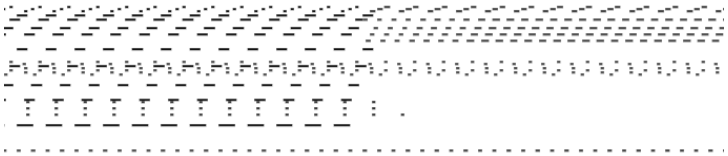


**Figure 11.** Study No. 13: Echoes Basic shape (score)

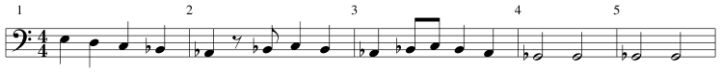



**Figure 12.** Study No. 13: Echoes: Basic shape (piano roll)

**Figure 13.** Study No. 13: Echoes: Basic shape (layered)

**Study No. 99:**
**Strumming Machine**

A 12-note arpeggio, forming an evenly dispersed harmonic series, pulses at a rate of ten notes per second, 600 notes per minute, overlapping with itself every four notes (see Figure 9). It begins quietly, played staccato. Over the course of the piece, the velocity increases very gradually, as does the depression of the pedal, transforming the ultra-precise, grid-like formation into a swarm of sound. Notes are added to both expand and cloud the harmony. Just as the ear and mind have become fully accustomed to this state of being, forgetting the notes, forgetting the piano, several layers are peeled away to reveal hidden formations.

The style of repetitive playing in *Strumming Machine* is influenced by Charlemagne Palestine's work (hence the title, a reference to his 1974 piece *Strumming Music*), but my approach here differs in two notable respects. First, whereas Palestine's work is played by alternating between the two hands (starting with one note per hand and gradually adding notes to create chords), the rhythm of this piece is created by a single, overlapping arpeggio. Second, Palestine's "strumming" style requires a human performer to feel the resonance of the piano strings and respond to them dynamically in order to bring out clouds of overtones. In this piece, the precision of the machine is unflinching and precise, yet the resulting sound inevitably becomes cloudy and unpredictable, simply because the state of a vibrating string and its resulting sound can never be predicted with complete accuracy, as long as it exists in the physical world.

**CLASS D:**
**INTUITIVE TRANSFORMATIONAL FORM [13, 29]**

Systematic transformations of a basic shape are applied intuitively, sometimes haphazardly. Suggestions of form and structure are led by the outcome of the transformations. Works of this type proceed at a steady, perceptible tempo.

**Study No. 13:**
**Echoes**

The large-scale form of this piece is roughly symmetrical, while being comprised of many smaller, roughly symmetrical parts. These parts resemble natural forms whose growth is guided by ideal principles but whose final shape is inevitably distorted by the complexity of the surrounding environment. The rhythm is marked by an incessant, syncopated stream of sixteenth notes, but the density of the middle section gives the impression of being suspended or frozen in time, drawing attention to subtle changes in the texture. Smooth, linear velocity curves are applied, causing clusters of repeating and/or related phrases to fade in and out, simulating an "echo" effect. After the dense and foggy mid-section, the piece emerges as a damaged retrograde inversion of the opening, bent out of shape by the turmoil.

As in earlier studies, a basic shape generates all of the material using only a few transformational techniques, but the application of those techniques here is less strict. The basic shape consists of a short melody in the whole-tone scale (see Figures 11 and 12). The melody is never heard alone, but is immediately accompanied by seven shifted copies, forming arpeggios from each note of the original melody (see Figure 13). The material in the first four measures generates the rest of the piece using the same basic techniques of copying, pasting, transposing, offsetting, and inverting. By applying these transformations both strictly and haphazardly, the processes begin to overlap. The results of each transformation are listened to and evaluated intuitively to determine further transformations.

This way of working is influenced in part by György Ligeti, who saw composition as a continuous feedback network between the idea, the instrument, the hand, and the ear.

**Figure 14.** Study No. 29: Tentacles: Basic shape

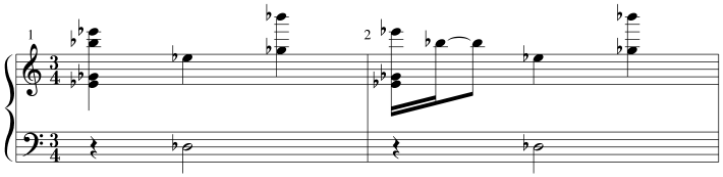
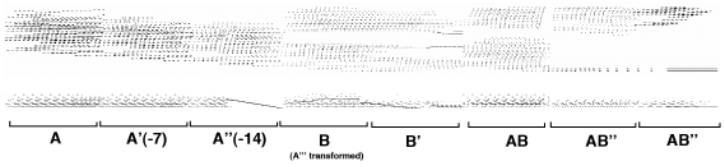


**Figure 15.** Study No. 29: Tentacles: Structural overview




**Study No. 29:**
**Tentacles**

Whereas Study No. 13 is structured symmetrically, this piece follows an obstructed linear path. One might imagine swirling pools of water forming behind rocks in a stream, occasionally breaking free, merging with larger pools. Again, the basic processes of copying, pasting, transposing, and offsetting are central. However, this study does not utilize any inversion or retrograde transformations. Instead, the large-scale form takes shape through an intuitively crafted process of splitting, splintering, and chiseling of the material.

The basic shape uses four notes: Eb, Gb, Bb, and Db (See Figure 14). These notes form exactly one half of an octatonic scale (defined by a series of alternating half-steps and whole steps). The exact same configuration of notes, moved a tritone up or down (to A, C, E, and G), will complete the scale. When sounded together as a chord, the sonority of these notes resembles either a minor seventh chord or a major chord with an added sixth (depending on the inversion). As the piece progresses, these fairly stable sonorities blur against the surrounding texture, which is formed by shifted copies of the same sonorities.

The first section of the piece resembles a sequential modulation, not moving towards a harmonic goal, but gradually spiraling, swirling, breaking apart under its own weight. Each cycle descends a perfect fifth. At the moment the fourth cycle begins, the shape splits into two (See Figure 15). For the remainder of the piece, the shape repeats, but never in exactly the same form. Instead, the tentacles that sprung up during the first section differentiate themselves, occasionally grafting together with other tentacles or breaking off completely. A contorted skeleton of a classical form appears, just barely, beneath the bubbling activity, but before it comes into view, the layers melt away, one by one.

i Conlon Nancarrow, interview by Natalie Wheen, In *The Pianola Journal: Journal of the Pianola Institute*. West Wickenham, Kent, England: Vol. 3 (1990): 6.
ii Milton Babbitt, live interview by Charles Amirkhanian, 1984, transcribed by the author. Original audio available at <archive.org/details/SOM_1984_11_15> (6 December 2010).
iii K. Robert Schwarz, "Music as a Gradual Process Part II", *Perspectives of New Music*, 20.1-2 (Autumn, 1981 - Summer, 1982): 228.
iv Steve Reich, "Music as a Gradual Process," in *Writings on Music 1965-2000* (New York: Oxford University Press, 2002), 34.v Rex Lawson, "Compositions for Pianola – Conlon Nancarrow" The Pianola Institute History Page, <www.pianola.org/history/history_nancarrow.cfm> (6 December 2010).
vi Wikipedia <en.wikipedia.org/w/index.php?title=Rhythmicon&oldid=374970998> (6 December 2010).
vii For an in-depth discussion of this issue, the reader is directed to Curtis Roads' book *Microsound*.

# 5. CLOSING THOUGHTS

All compositional activities (all human activities, even) involve some combination of process and intuition. Even the most "free" and emotionally driven musical works make use of structured techniques. Likewise, the strictest musical processes require intuitive decisions in order to be realized for an audience. *Eight Studies* conspicuously straddles the line between strict process and human intuition. The machine as performer, on stage, presents further questions: How does music "come to life"? Can a mathematical construct, performed by a machine, convey emotion?

As a composer, I do not seek conclusive answers. Nor do I consider myself the sole creator of these works. Informed by an attempt to understand perception on a collective level, my ideas are only a catalyst in a process that places the human, the machine, and the laws of nature on equal footing. I think of my role as part scientist, part explorer, part excavator, part sculptor, and part child. I try, as best I can, to listen and respond to the material as an equal rather than simply imposing my will upon it, and I ask the listener to approach this music with a similar critical distance. My intent is not to prevent the experience of emotion, but to direct it away from the individual and outwards towards something larger, more inclusive, more important. In other words, don't just listen to what I did, or what the machine did, but listen to what is happening.

Mechanical instruments can play faster, more complicated material than a human. They can also be slower, more patient, and more precise. But this series of studies is not about super-human performance. Rather, it is about non-human performance—more like an out-of-body experience than a super-body experience. After all, the machine is not a super-human; it is something different. Exactly how it is different, we cannot say for sure, but contemplating the issue can only make us more aware of our humanity.

**ACKNOWLEDGEMENTS:**

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**design:** Richard Chartier

# APPENDIX A: OVERVIEWS

The following four pages display visual overviews of each piece, using the computer's virtual piano roll. Each overview can be read according to the following key:

## NUMBER

### TITLE

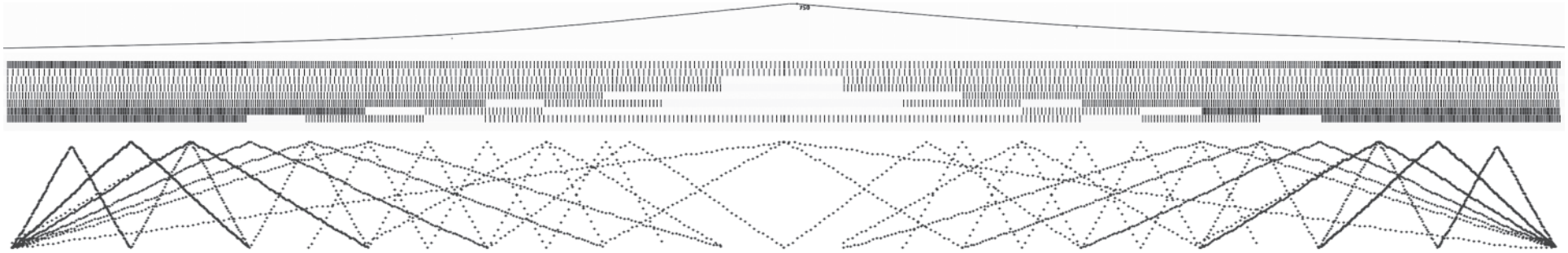
TEMPO RANGE
DURATION
CLASS

images:
*TEMPO CURVE (WHERE APPLICABLE)*
*PIANO ROLL VIEW (NOTES)*
*NOTE VELOCITIES*

# I : 14

## ARCH STUDY FOR THE HIGHEST EIGHT NOTES

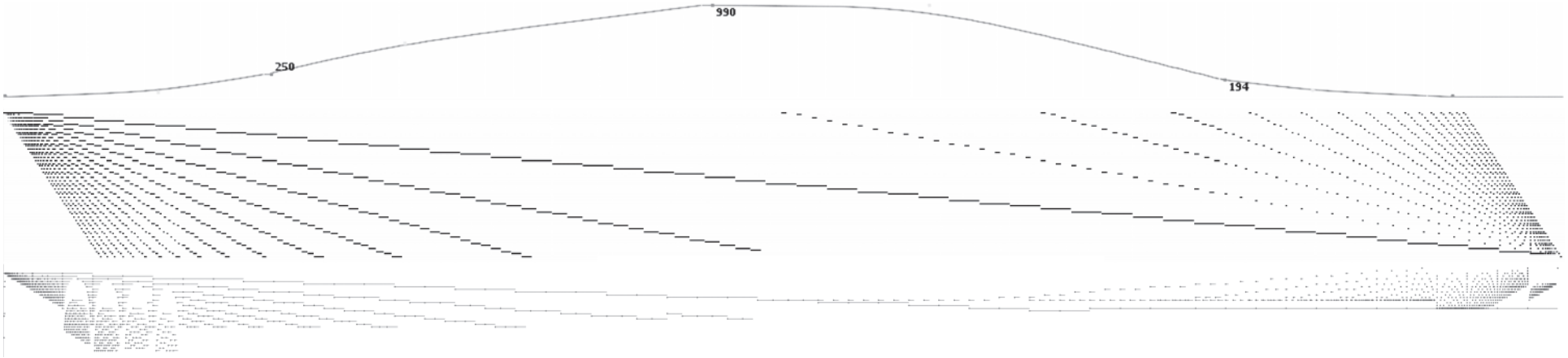
5-750
4:54
A



# II : 4

## SIXTEEN DIATONIC GLISSANDI MOVING AT HARMONIC RATES

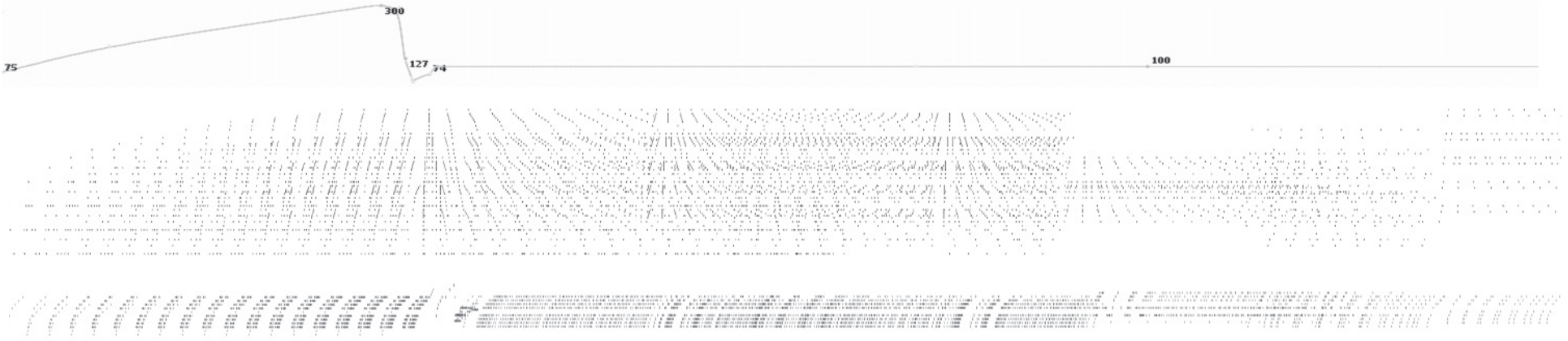
5-990
2:59
A



# III : 2

## AN APPROXIMATE HARMONIC SERIES OF APPROXIMATE HARMONIC SERIES

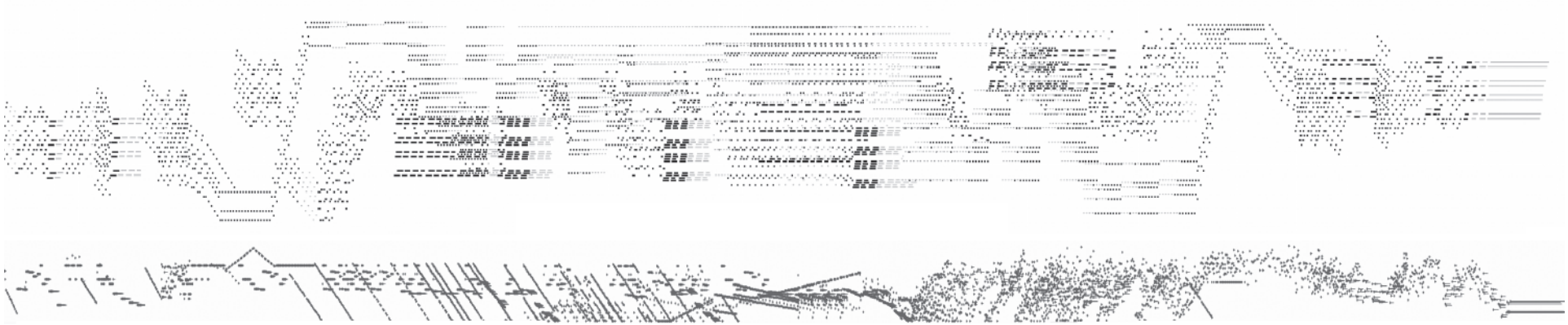
75-300
6:05
B




# IV : 13

## ECHOES

100 (FIXED)
3:54
D



# V : 21

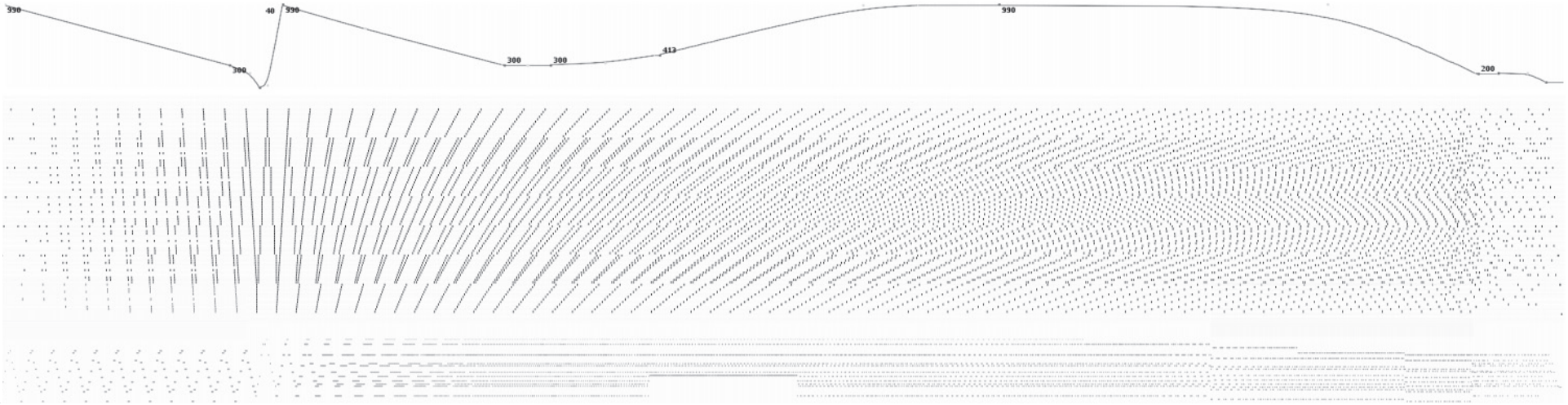
## BELLS

40 (FIXED)
5:24
C

# VI : 1

## OCTAVES, SYSTEMATICALLY FILLED AND FOLDED

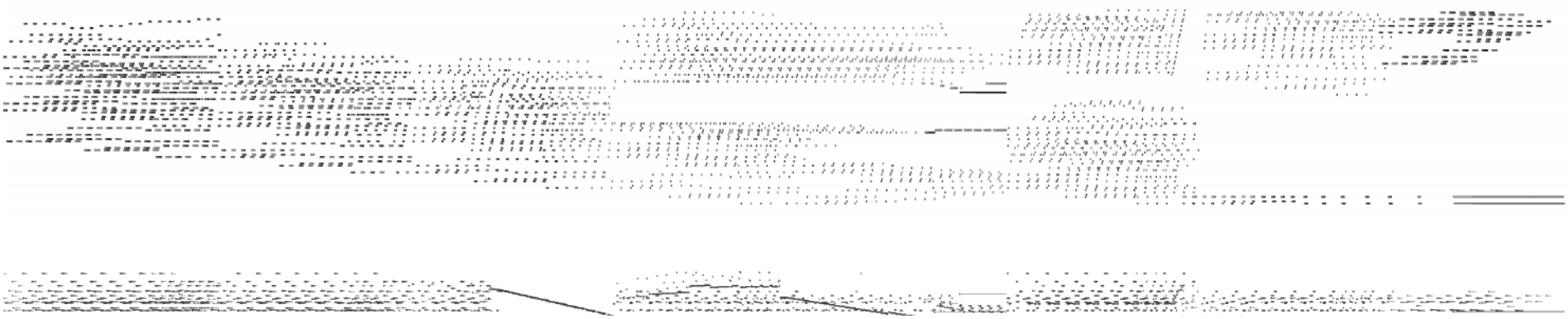
5-990
5:57
B



# VII : 29

## TENTACLES

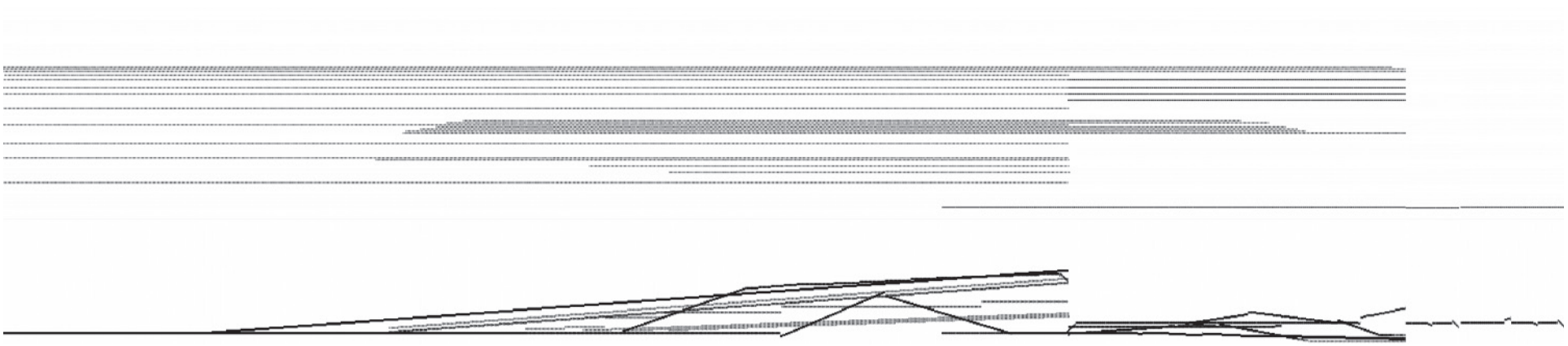
110 (FIXED)
4:22
D



# VIII : 99

## STRUMMING MACHINE

150 (FIXED)
12:30
C



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