Surface and Structural Generative Processes in Music

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Abstract:

The discussion examines the use of generative processes applied to musical parameters active on multiple structural levels of a musical work. Examples demonstrate application of processes to pitch, rhythm, timbre, formal structures, and proportions in the author's acoustic and electro-acoustic music. Further investigation explores how processes generate structural integration, disruption, and decay or disintegration.

1. Compositional Process

In my music processes are used to generate sequences of intervals, permutations of pitch, rhythm; or to shape phrase and formal proportions. Processes generate segments that can be expanded, contracted, abstracted with the relationship between segments often being mirrored on different levels. My general practice is to use processes that generate material; and to review and refine output using observation/evaluation, while taking into account how tools and the medium influence musical choices. As will be seen, the choice of specific processes generates diversity between individual works, while at the same time unifying those works stylistically (Soddu, Colabella, 2013).

Adopting the approach that creative thinking is a form of problem solving (Gilhooly, 1996), I will position the discussion within the context of Wallas' four stages of creative activity: preparation, incubation, illumination, and verification (Wallas, 1926) focusing mainly on the first and last stages. Generative processes are used in the first stage, preparation, where concepts and problems are identified, defined and assessed in reference to chosen materials, the medium, and large-scale proportions of the work. Processes generate material providing intermediate solutions that parse multi-dimensional problems into manageable parts. The refinement, development, and evaluation (i.e. verification) of processes, is also integral. In verification the composer can be both creator and observer, gauging the effectiveness of processes on both micro and macrocosmic levels. New processes can be created at various stages during composition and at each stage, work may be interrupted to solve problems, make refinements, or create connected alternates as the need arises (Reitman, 1965).

I often map sequences of numbers to pitch durations, or glean them from a motive, fragment or theme. In other works I employ numeric triangles, and/or the Fibonacci sequence to dictate surface rhythms or structural proportions. When these sequences are mapped to durations, the surface of a composition exhibits rhythmic variety while at the same time unfolding a larger schema of proportional segments,

structural phrases, or formal sections. In this case I find the Fibonacci sequence particularly useful since the proportions between members of the sequence approach .681, or 1.618 as the sequence unfolds making it a reliable method for integrating structural proportions between sections of a work. The proportional relationship between numeric triangles approaches 1.0 as the sequence unfolds, which dictates careful planning and limits the length of sections if particular proportions are desired. Figure 10 demonstrates the application of the Fibonacci sequence to large structural proportions in my work *Kaleidoscope*.

As a performer, improviser I am concerned with the malleability/flexibility of processes and this informs my composition, which is more formalistic. The influence of improvisation can be traced in my compositional process where invented processes generate the surface of a work. This method enables the shaping of segments that are easily perceived, and grouped into hierarchical structures integrating recursive elements on multiple levels. This is a well understood trait of historical music illuminated by Schenkerian analysis, and the Generalized Theory of Tonal Music (Rowe, 2001).

2. Composing with schema

The example from *Character Study IX* for solo guitar exemplifies the approach. The work is composed around a master sequence of interval classes that unfolds over the course of the work. In the excerpt below IC5, IC4 are the main constituents. Other intervals arise as embellishments, parts of a transpositional schema, as completions of gestures, or as a segment of the master sequence. Unfolding the sequence slowly limits interval content, and freely composed phrases operate within this limit. Figure 1 below demonstrates.

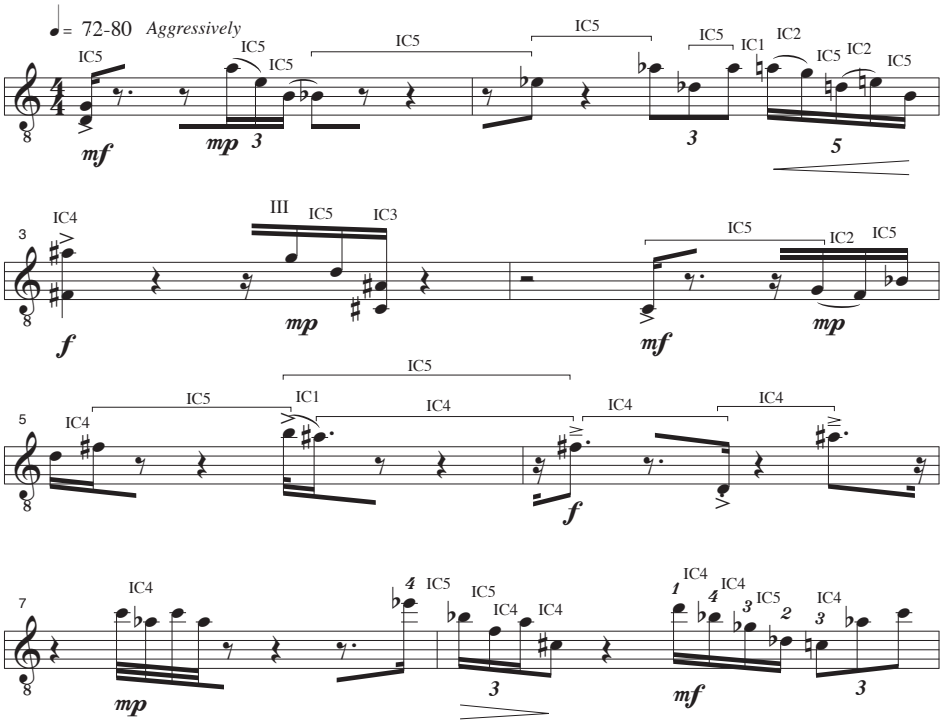


Figure 1: *Character Study IX* for solo guitar, mm. 1-8.

As this work progresses the master sequence emerges as all interval classes are introduced. The composition of the surface of the work is informed by preparation and observed in verification. Results are continually monitored and reshaped to control density, proportion and ensure adherence the pre-compositional plan.

In the example below new intervals are introduced in mm. 21-ff and the master sequence begins. Compare the figure below with the opening of the work where IC5 and IC4 the first two intervals of the sequence are presented over two measures. The process gradually unfolding a theme in smaller segments is termed epiphanic. (Shiff, 1998) It is an integrative process used in both *Character Study IX*, and *String Quartet*.

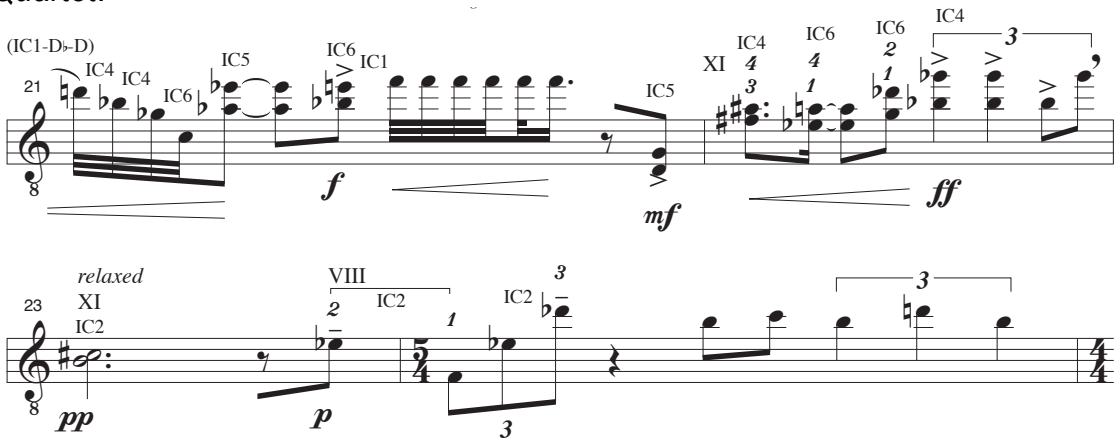


Figure 2: Character Study IX for solo guitar, mm. 21-24

3. Generative Sequences

In much of my concert music I employ numeric sequences such as numeric triangles, the Fibonacci sequence, or Pi to generate surface textures. The next few examples will demonstrate their use in *String Quartet* (2011), *Gestures I* (2012), *Kaleidoscope* (2007), and *Artifacts* (2014).

Often numeric triangles or the Fibonacci sequence are used to generate rhythmic durations. In the opening of *String Quartet* numeric triangles are mapped to sixteenth note durations.

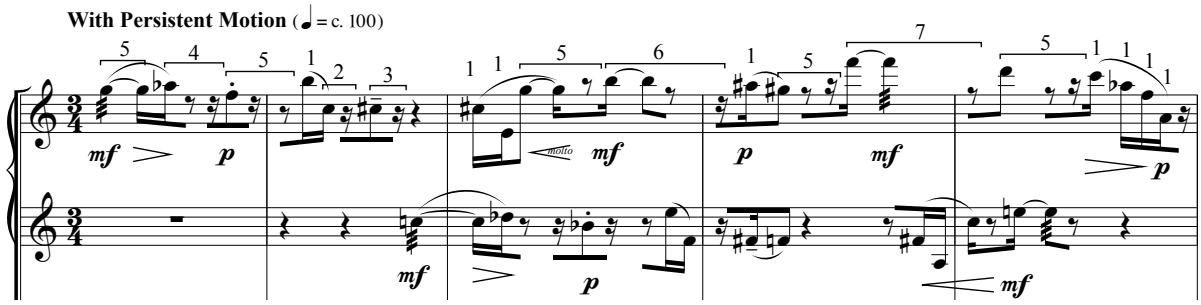


Figure 3: Triangles 3, 6, 10 used as basis for rhythmic durations violin I

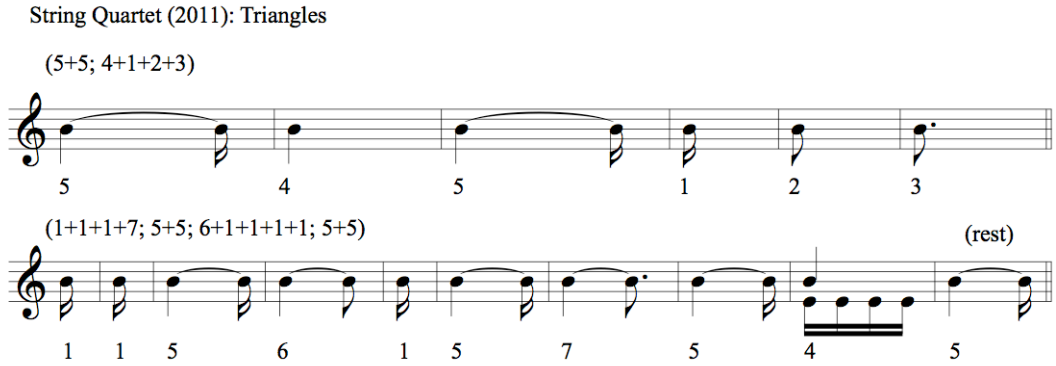
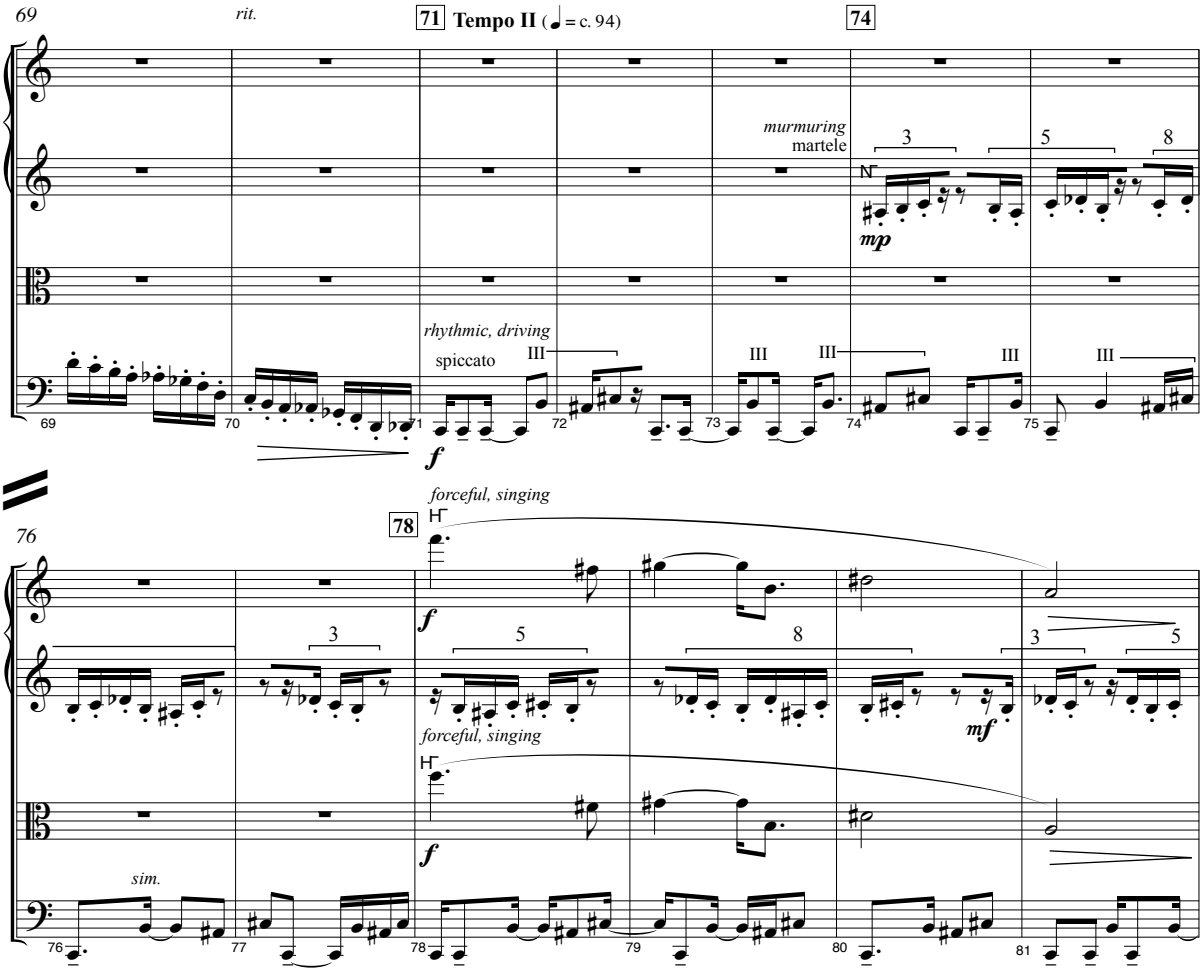


Figure 4: Triangles 3, 6, 10 shown as single durations

The Fibonacci sequence is employed in a similar manner later in the work. In mm. 74-ff violin II uses a repeating sequence of 3, 5, 8 sixteenth notes. The violoncello uses durations of 1-3 sixteenth notes freely in counterpoint with violin II, while violin I and viola perform a slow melody that unfolds the interval sequence (m. 78: Ordered PC intervals: 1, 2, 3, 4, 6; m. 86: IC 1, 2, 3, 4, 5; m. 94: IC 1, 2, 3, 4, 5, 6, 7).



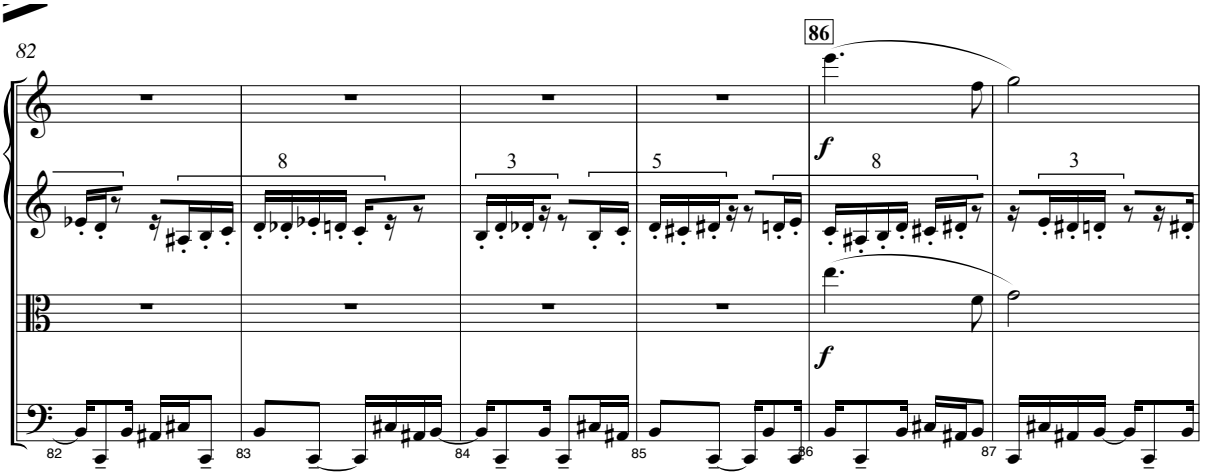


Figure 5: String Quartet Fibonacci sequence, mm. 74-ff in violin II.

String Quartet (2011) also employs an interval series using permutations that unfold gradually into increasingly complete statements; Ordered PC intervals 1, 2, 3, 4, 5, 6, 7, 8. OPCi: 1-7 shown below.

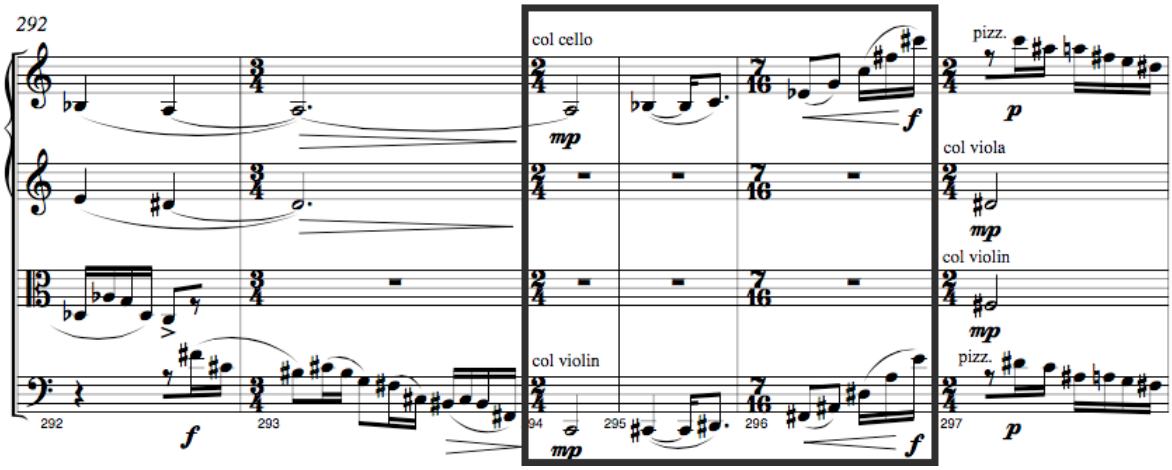


Figure 6: *String Quartet*: interval series, m. 294.

In early portions of the work, the interval series is abstracted and appears in forms that are distributed within and between parts. In the figure below notice the gradual accretion of interval classes 1-6. Violin 1 and 2 imitate each other, as do the viola and cello at IC5. The rhythmic offset of imitative voices combined with transpositions generates all intervals in mm. 3, 4-5. Variations of this type appear throughout the work, with the full series only being revealed later.

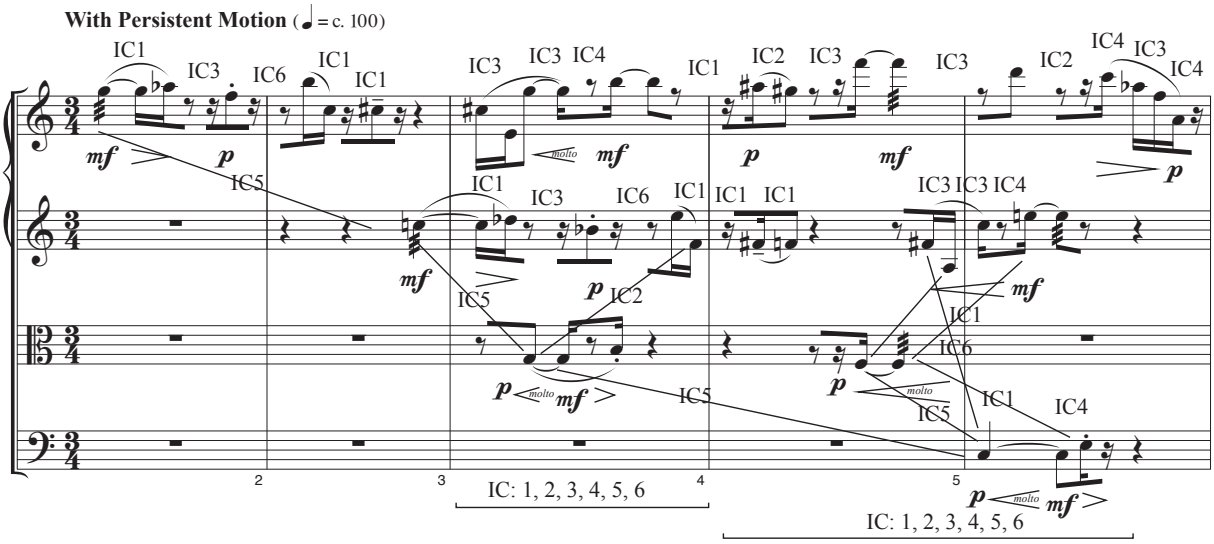


Figure 7: *String Quartet*: interval series, mm. 1-5.

Another striking example of the interval series appears in mm. 503-507. In m. 503 violin I presents OPCi 1-8, and in mm. 504-507 the violoncello, viola and violin II play sonorities using the interval series to expand outward from the central set (014) in m. 505. The expansion results in the inversion of the original set $T_{11}I$ (014; 7TE).

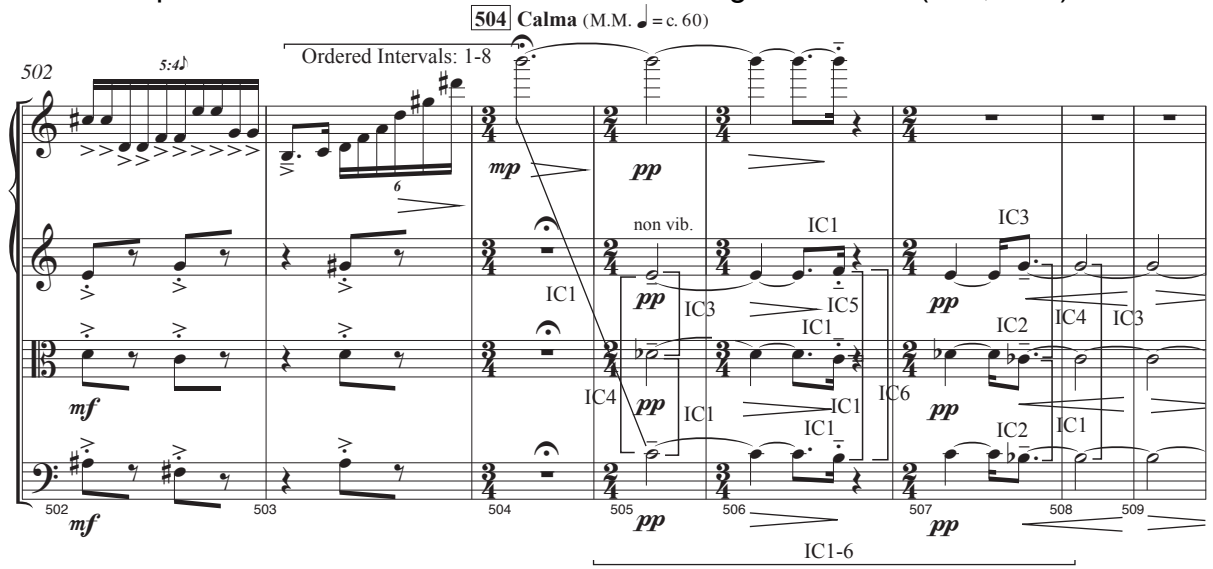


Figure 8: *String Quartet*: interval series, mm. 503-507.

Kaleidoscope for alto saxophone and piano is another example where the Fibonacci sequence is used to generate longer and shorter durations. The work also employs the sequence to generate sectional proportions. The example shows the beginning of the work where the saxophone's sustained pitches use durations of sixteenth notes generated by Fib. Stabbing rhythms in the piano are often, but not consistently 3, 5, 8, or 13 sixteenths. Contrasting rhythmic durations between parts parses them into perceivable slow and fast layers.

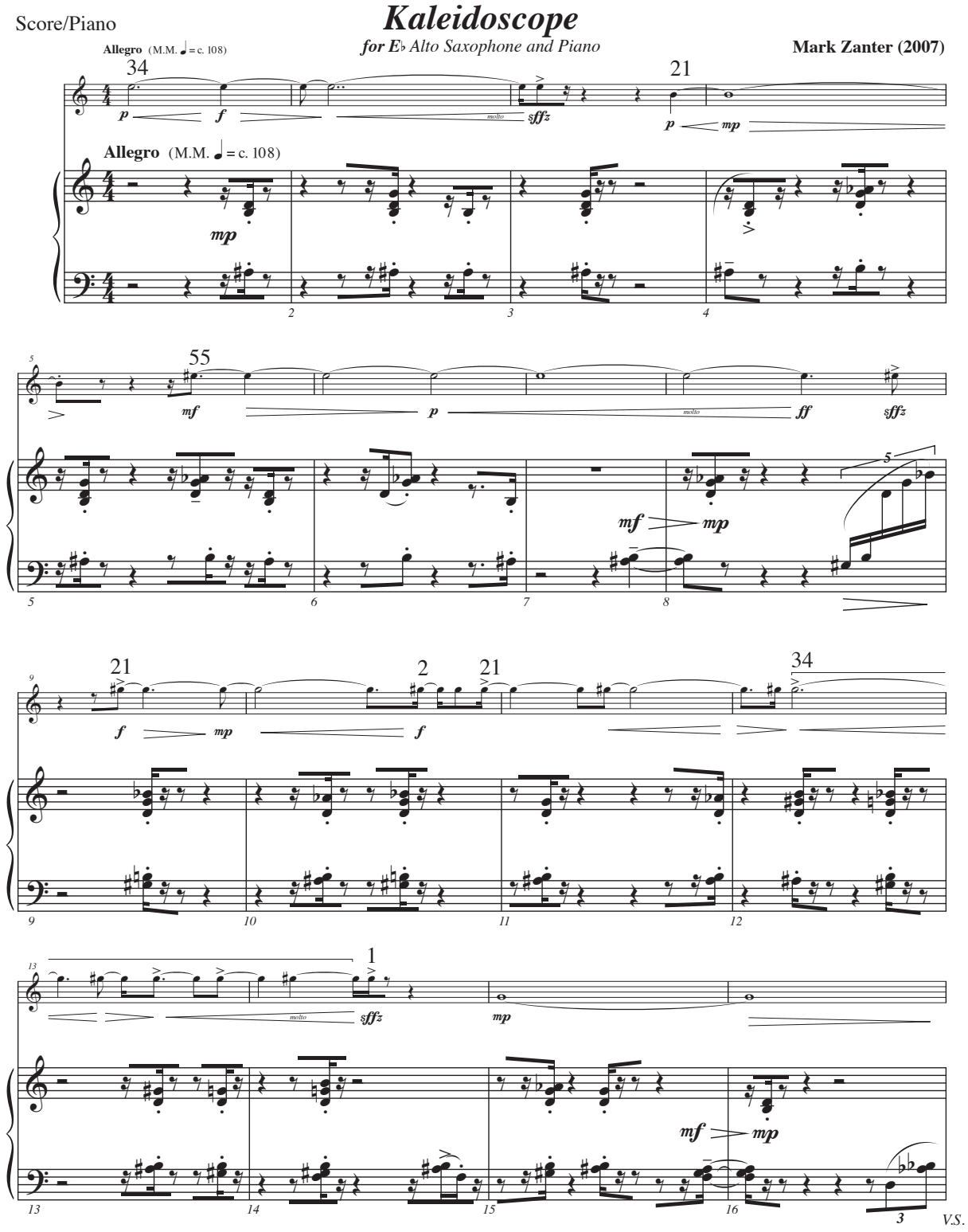


Figure 9: Kaleidoscope: Fibonacci sequence in saxophone melody, mm. 1-14.

Formal proportions in Kaleidoscope use the Fibonacci sequence throughout. The table below shows formal sections and their length in sixteenth notes. Tempi for this work were also calculated so that the durations of each section maintained the proportional relationship (A:B = B:C [B+A]).

	A:B; B:C		D:C; C:E			F:E; E:G					
Section	A	B	C	D		E		F		G	
16ths	416	258	674	416		1090		674		1764	
				258	158	694	416	416	258	674	1090
Content		Develop A (Saxophone long tone-short tone retrograded)	B’	A’	B”	C’	C”	A”	B”	E’	E”

Figure 10: Kaleidoscope: Fibonacci sequence proportions sections A-G.

In my electro-acoustic work I use processes to control/generate rhythm or pitch. In *Artifacts* (2014) a rhythmic generator using the Fibonacci sequence generates rhythmic density in the middle portion of the work. The screen shots of the Max/MSP subpatch show how Fib is used. The LH portion of the window shows the rhythmic generator. In this example Fib numbers are input into the top number box (e.g. 377 shown). Rhythms are generated by the middle portion of the patch using modulo 3-7 and rhythmic multipliers; multipliers are generated by a Fib process using values based on 75 milliseconds (150ms+225ms = 375ms; 225ms + 375ms = 600ms etc.). The RH portion of the image shows the fib mod rhythm generator, and a table of MIDI note values that is generated by a random walk object that generates table values using a range of all pitches (128) and a step size of 5 (drunk 128 5). MIDI note values trigger sounds from two sets of audio samples (bells, drums—not shown). Though the modulo portion of the patch limits the type of rhythms, each Fib number generates a distinct rhythmic texture; enabling growth/development through a sequence of rhythmic textures that are perceivably related (compare: 5, 13, 55, 610, 144; 3, 21, 987).

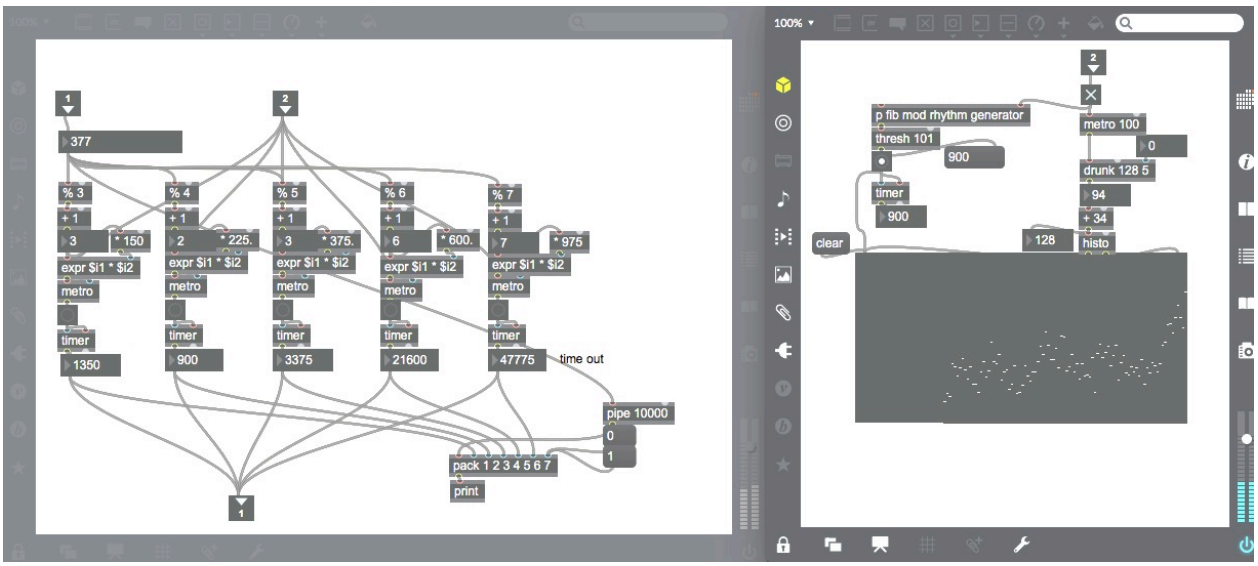


Figure 11: Max/MSP Fib rhythm generator (LH—Rhythmic Generator; RH—Pitch Generator)

Gestures I employs modular form. It uses open instrumentation and realizations of the work vary based on the number of pages chosen from page sets A-D (a minimum of four and a maximum of thirteen); and the order of pages selected by the performer.

The Fibonacci sequence is used to generate tempi and the number of events on each page. In the figure below the tempo of A1 is M.M. 100[1], while C2 is M.M. 89; and the number of events is twenty-one and eight respectively. Rhythmic activity varies considerably from page to page and performance instructions enable the mixing and matching of pages to produce varied musical textures. Pages B1, B2 both containing one event—a short composition—seed all pages. The temporal position of B in performance may influence the perception of that music as epiphanic (xxB), disrupted (xBx), or fragmented to dissolution (Bxx).

In *Gestures I*, Numeric strings from Pi generate the repeats of looped events (Pi: 3.14159**265**35897**323**8**46**26**433**832795028841971693993751058209749445923078164062862089986280**34**8253421170679821480865132823066470938446095505 8**223** etc.). Pi digit segments 265, 433 appear on A1; and 63, 223, 37, 323, 46, 34, 55 appear on C2 (the first 500 values were used throughout the work. Pair 63 does not appear within the first 138 values shown). The use of Pi strings in *Gestures I* does not take advantage of the non-repeating properties of the digits, rather in using it to dictate the number of repeats for a segment, it gives weight to the passages it supports and increases the duration of the page. Examining C2 below, some events may be repeated up to seven times. Combining that with the slower tempo and longer durations influences the duration of the page.

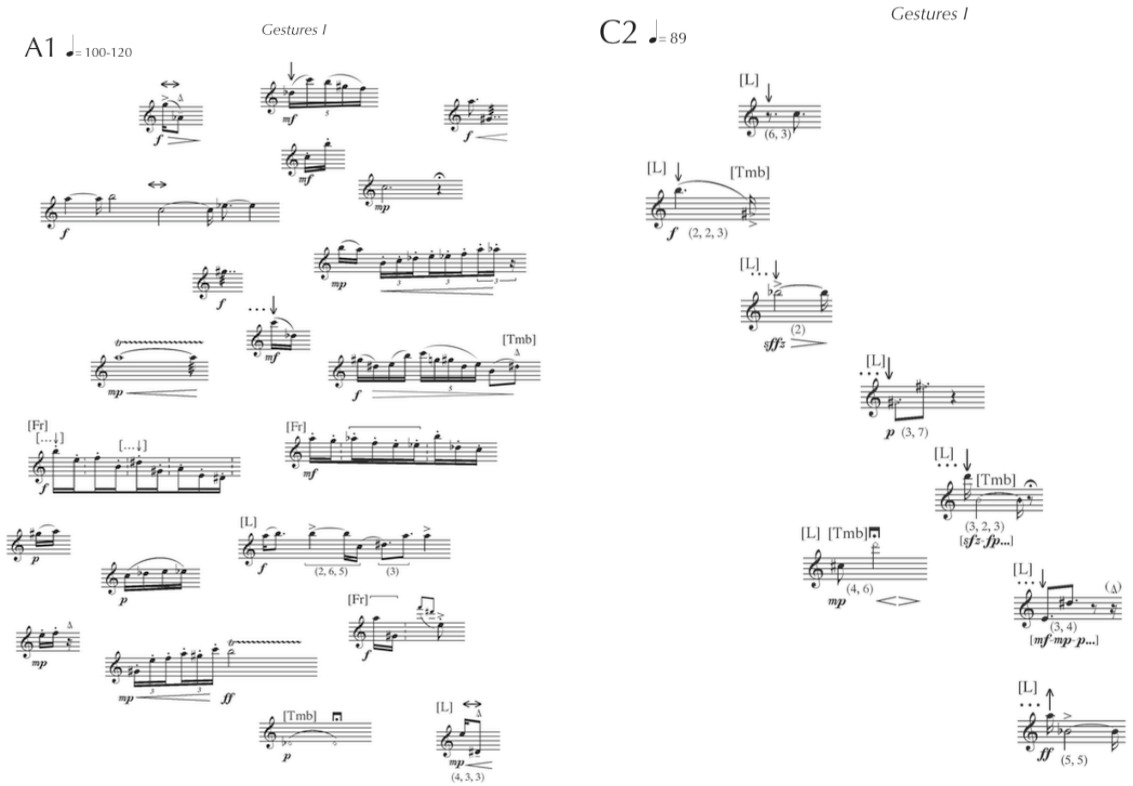


Figure 12: *Gestures I*, page A1, C2

4. Integration, Disruption, Disintegration

Scales are tonally flexible, and facilitate registral connection of pitches. They are important for generating surface pitch and structural relationships. I often use symmetrical scales; whole-tone, octatonic, those generated by transpositions of the augmented triad, or scales derived from the harmonic series. In the following examples I will focus on structural usage of scales in *Persistence of Memory* (2012) and *Donna Lee Triptych* (2009). The examples also demonstrate the cross cutting technique (Shiff, 1998)[2] which disrupts relationships that unfold in relation to each scale, or structural line (e.g. Donna Lee Triptych).

The example below shows the first part of *Persistence of Memory*, which unfolds WT0 (F#6-E6-D5-C5-Bb5-Ab5-Gb5) in the upper register and the chromatic scale in the lower register. Scale structures integrate surface motions into a unified whole while cross cutting back and forth disrupts their unfolding. The rhythmic character of material written for the scales links cross cut sections. WT0 features sustained pitches (fed into live signal processing), while chromatic passages use fast rhythms.

The first pitch G5 is a structural link for both scales on the first page. It is the first pitch in the chromatic cycle, and appears after the completion of WT0 on Gb5 in the second to last measure of the first page. The first crosscut begins on Ab4 and ascends chromatically to E5 before descending to F4. F4 leaps to E6 the second pitch in WT0. Here the chromatic and whole-tone lines are intertwined: WT0—F#6, E6, D5, C5; Chromatic: F4, E6, Eb6, D5, [C#5]. The fourth system suspends the progress of each scale prolonging elements from system two. It begins with WT0 [A#5], Chromatic: B5, G5 from system two are prolonged in the middle of system three, and it concludes with C#5 the continuation of C5, the end of system two. System five continues with a chromatic segment connecting C#5-F5; C#5-E4, while the next pitch in WT0 does not appear until system six on Bb5 with material mimicking the opening figure. WT0 continues with Bb5-Ab5-Gb5 completing the WT0 cycle and connecting chromatically to G5, which concludes the chromatic cycle on page one.

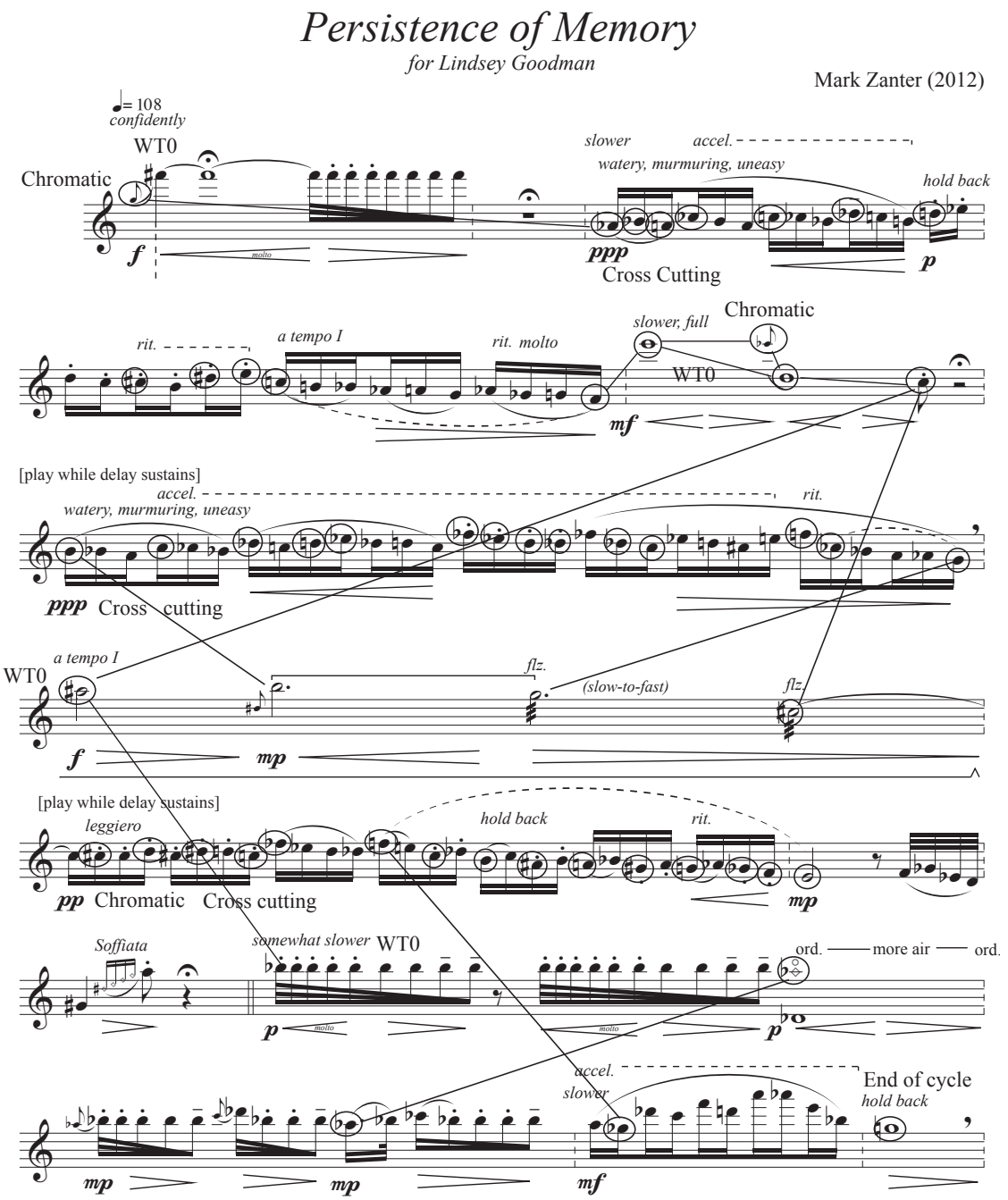


Figure 13: *Persistence of Memory* (2012)

In *Structural Models for Improvisation* (Zanter, 2001) improvisational models are constructed from structural analyses of original sources, in the case of *Donna Lee Triptych for improviser and live electronics*; Charlie Parker's *Donna Lee* (1947). Structural analysis reveals chord tone structures that support the melody. In the figure below model II closely resembles the structure of Parker's *Donna Lee* (chord symbols added to the model demonstrate a close affinity to the original). Models II, and III abstract elements of the tune with III being the furthest from the original source. In the case of this work analysis of *Donna Lee* yielded a structural line; the line was formed into a model, and the model was abstracted to create additional models.

In performance, models guide improvisation. They may be performed in any order and segments of each model may be cross cut to and from. The improviser interprets each model as they see fit, performing the model and responding the computer improviser, which reads player's input and responds using the same pitches and rhythms in different permutations. The myriad combinations of the models, interpretations of the structural lines, and response of the system yield a work with an enormously diverse musical surface guided by the context suggested by each model.

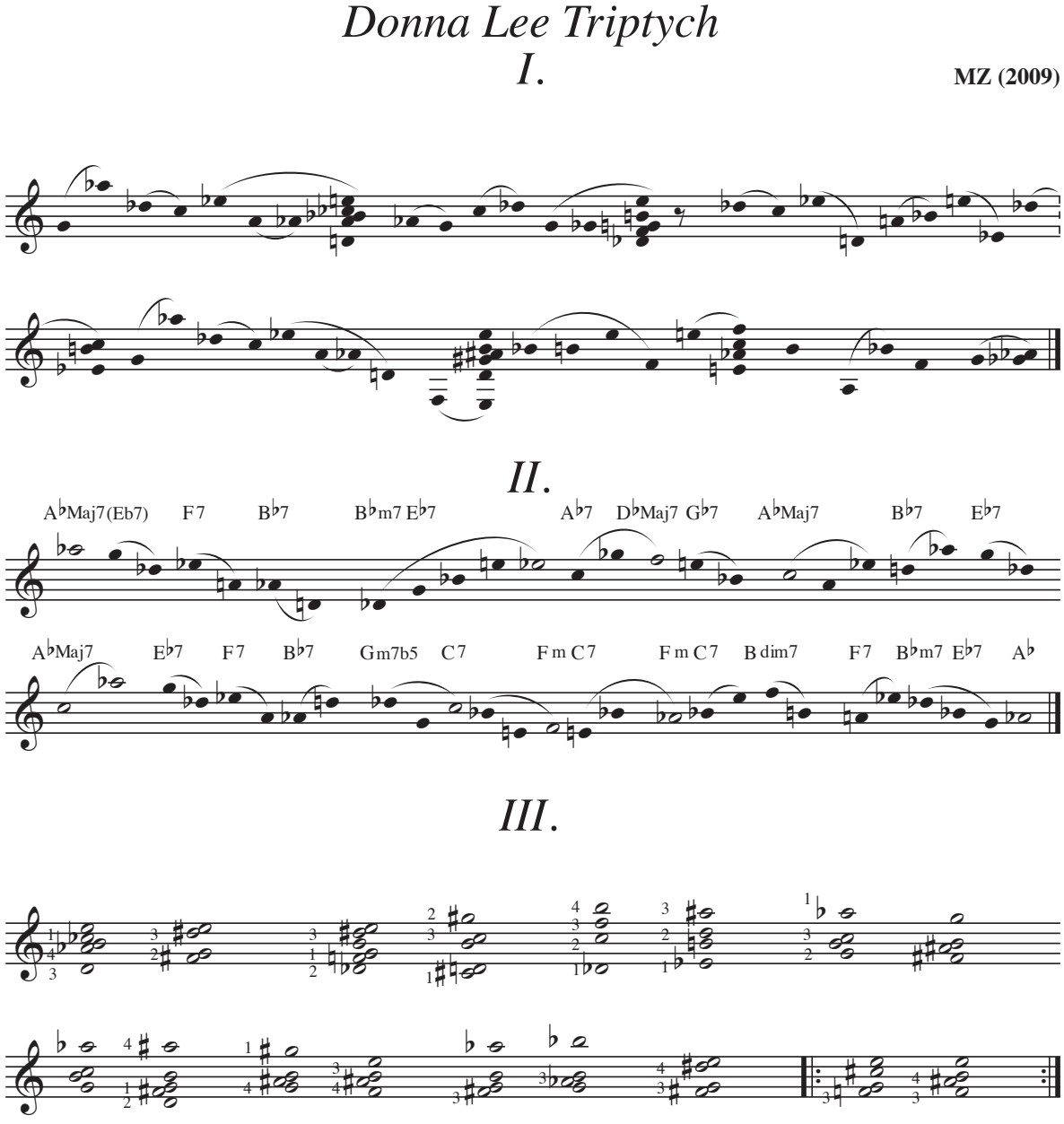


Figure 14: *Donna Lee Triptych* (2009): Model II resembles tune's melodic structure. I and III are abstractions of II each containing a different treatment of the main structure.

In the preceding examples it has been shown how processes used generate

structural integration and disruption. For the last portion of the paper I will discuss use of decay as a metaphor for structural disintegration.

Metaphors are useful tools for focusing attention while composing a work.

Decay (def.):

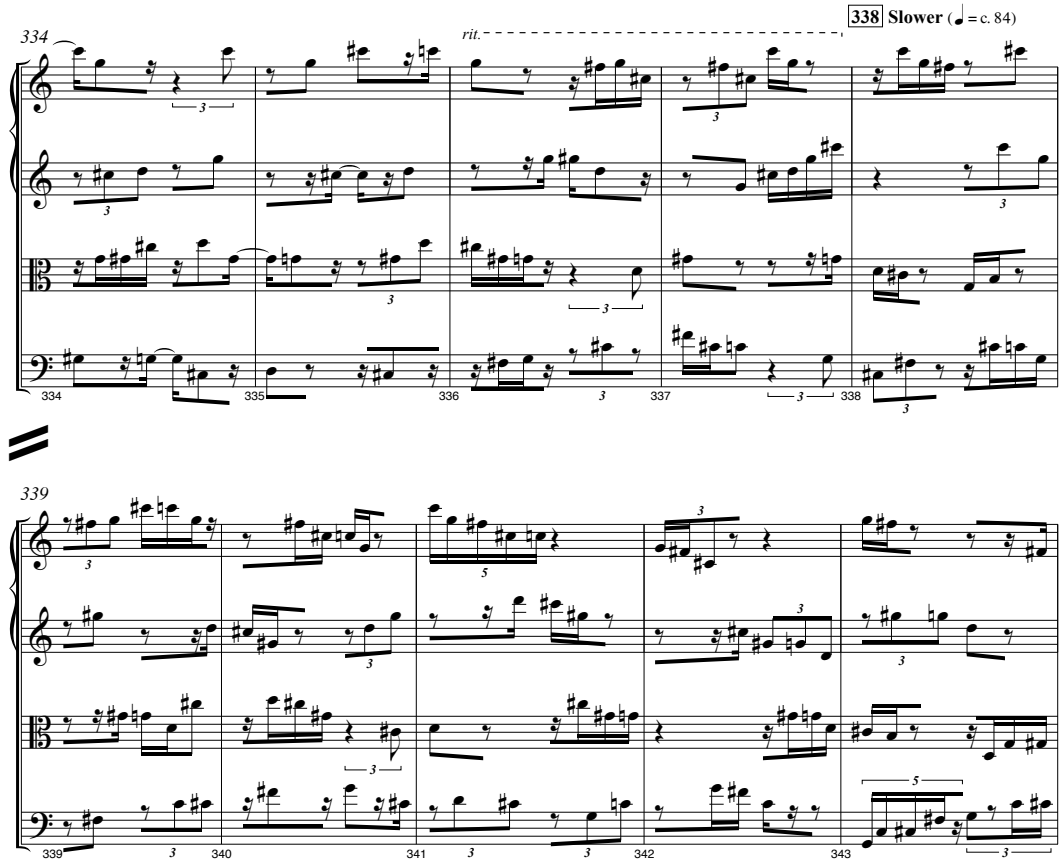
- to decline from a sound condition (deconstructing, deteriorating).
- to decrease gradually in size, quantity, activity, or force (delay).
- to undergo decomposition, or to destroy by decomposition (deconstructing, stretching)

Realized as:

- Deconstructing/deterioration (abstracted, split into coherent but altered pieces, evolution through deteriorating, diminishing, or augmenting). Signal processing, and time stretching alter timbre, and characteristics of sounds.
- Deteriorating (falling apart, segments are/become heterogeneous, decrease in size, smearing). Stretching (phrases, augmentation, tempo changes, stretching audio, transposing-sample speed adjustment)
- Decay (delay, decreasing force, activity, or size)

1. Decay processes are not prescriptive (may be realized a number of ways)
2. Decay process can be applied within other conceptual frameworks serving structural functions, as a foil to the current process, or as part of the devolution of a work.

In String Quartet the slower tempo, increasing rhythmic variation, variation of phrase length; give the impression of falling apart, the gradual disintegration of the preceding section.



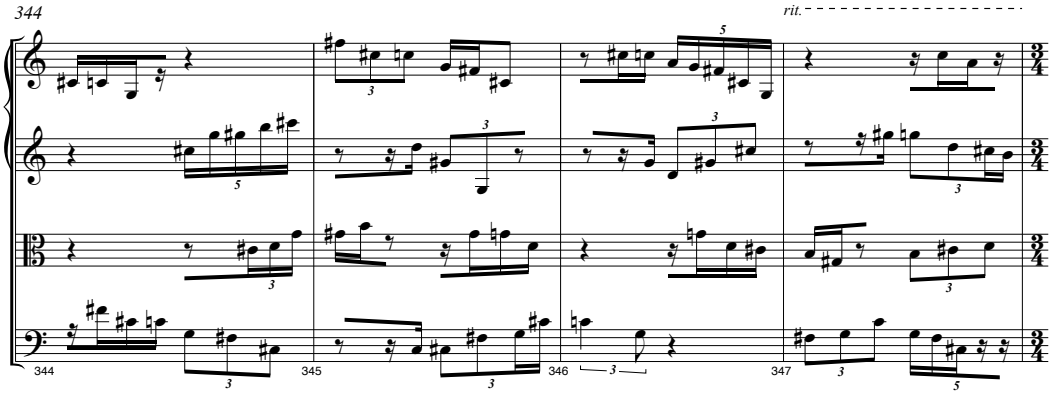


Figure 15: *String Quartet* (2011) disintegrating texture:

The last section of *Lament and dream* (2013) for string orchestra, piano and percussion also deteriorates in the final bars of the work. In both cases deterioration serves the structural function of terminating a section or work. In this example a timbral shift is also employed.

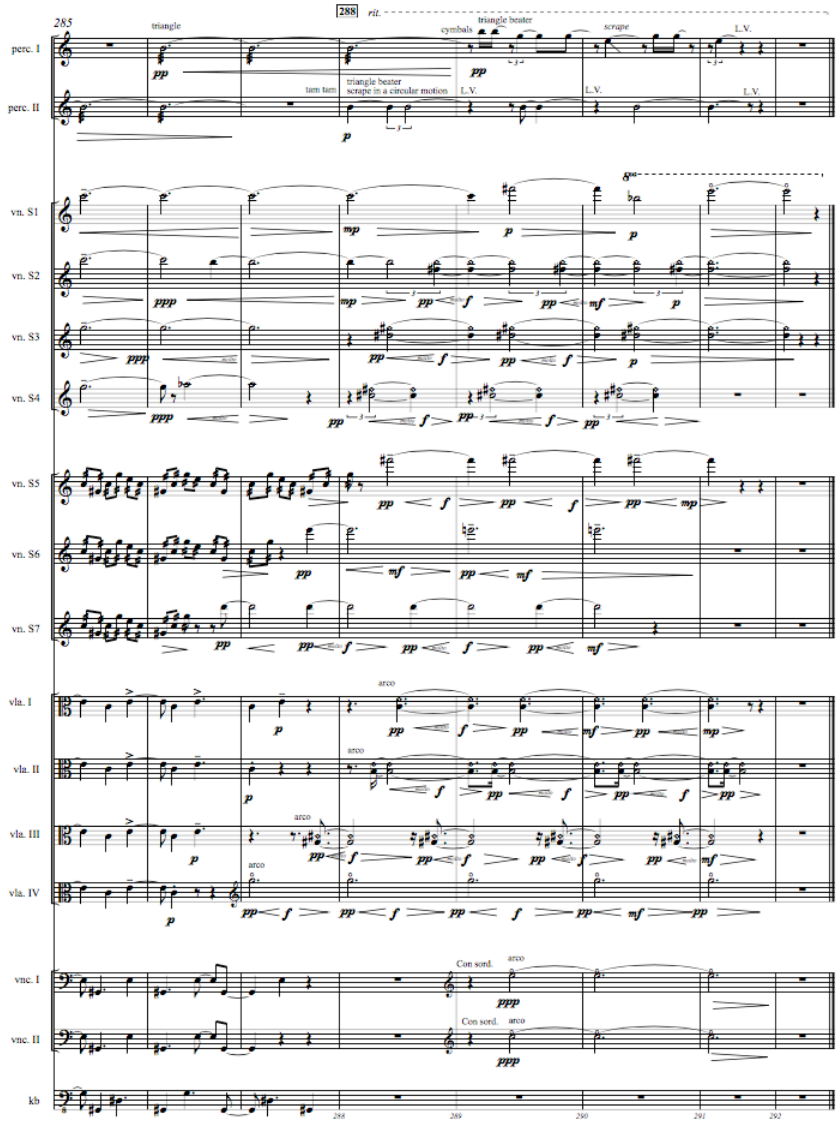


Figure 16: *Lament and dream* (2013), final bars

Three Movements for five cellos use delay (imitation), and augmentation to deconstruct mvt. III. Delay effect: Direct imitation accompanied by decrescendo. The idea is spatialized in the ensemble.

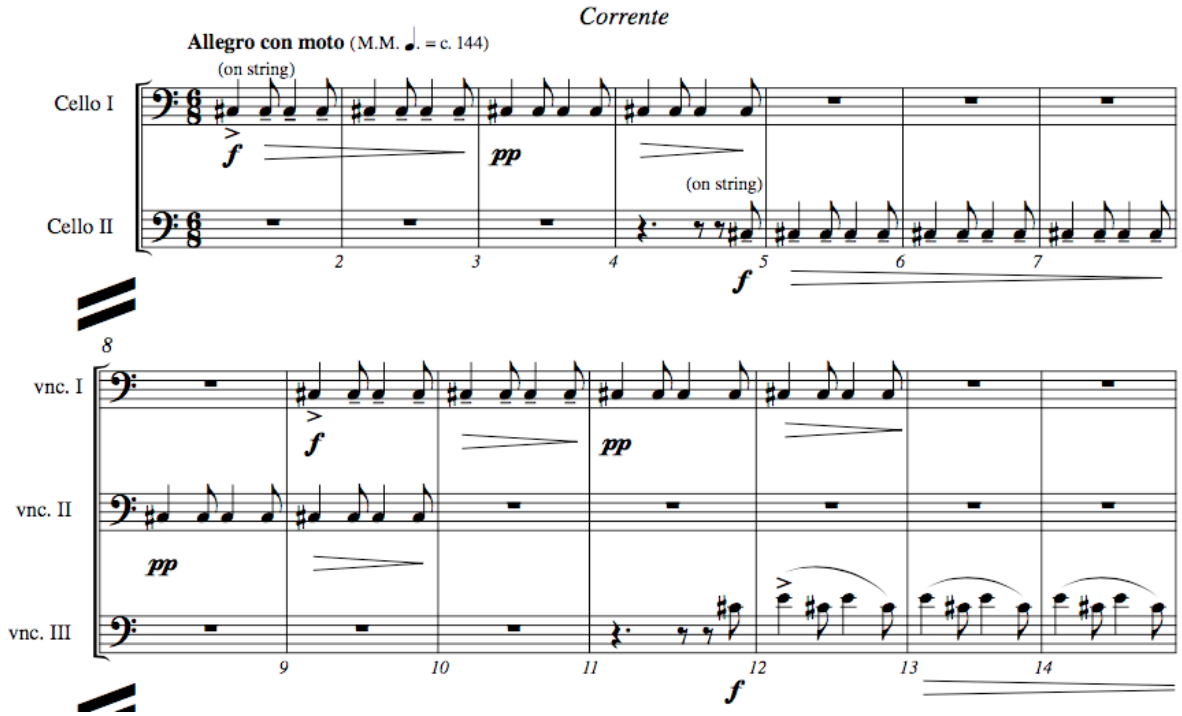


Figure 16: *Three Movements for Five Cellos* (2007), delay effect, Mvt. III

Augmentation/expansion of the delay figure in violoncello II, III.

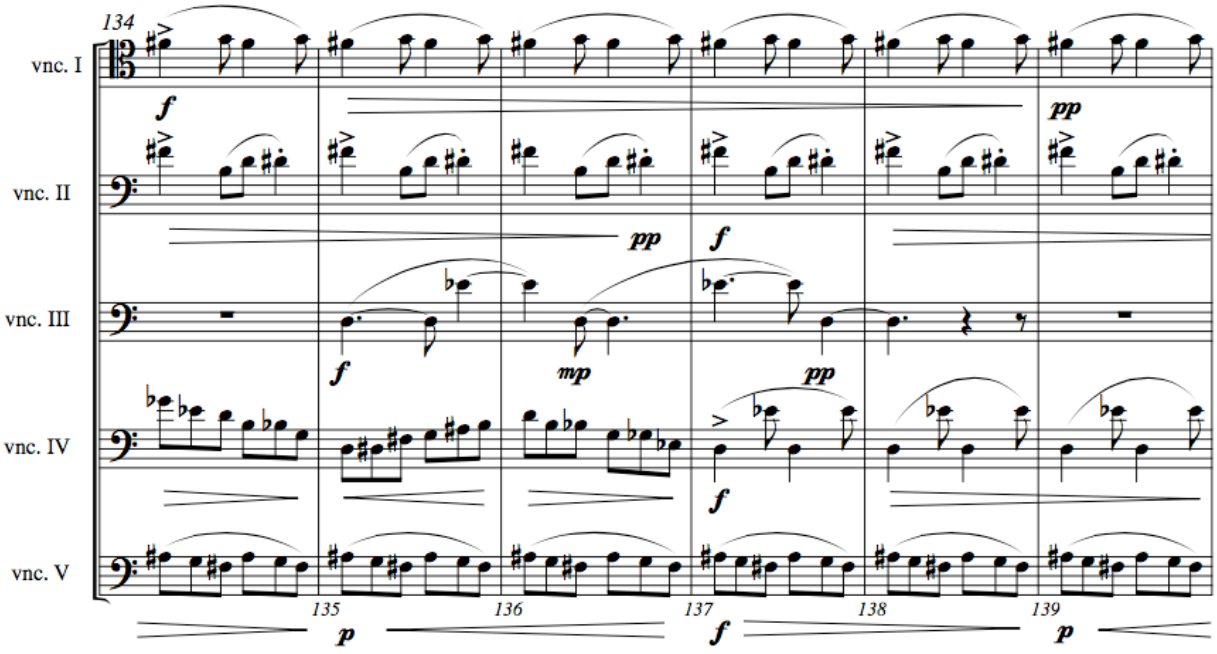


Figure 17: *Three Movements for Five Cellos* (2007), Mvt. III.

Truncated figures, slowing tempo, soft dynamic, and weak articulations result in smearing the onset of each pitch contributing to the perceived deterioration at the end of mvt. II.

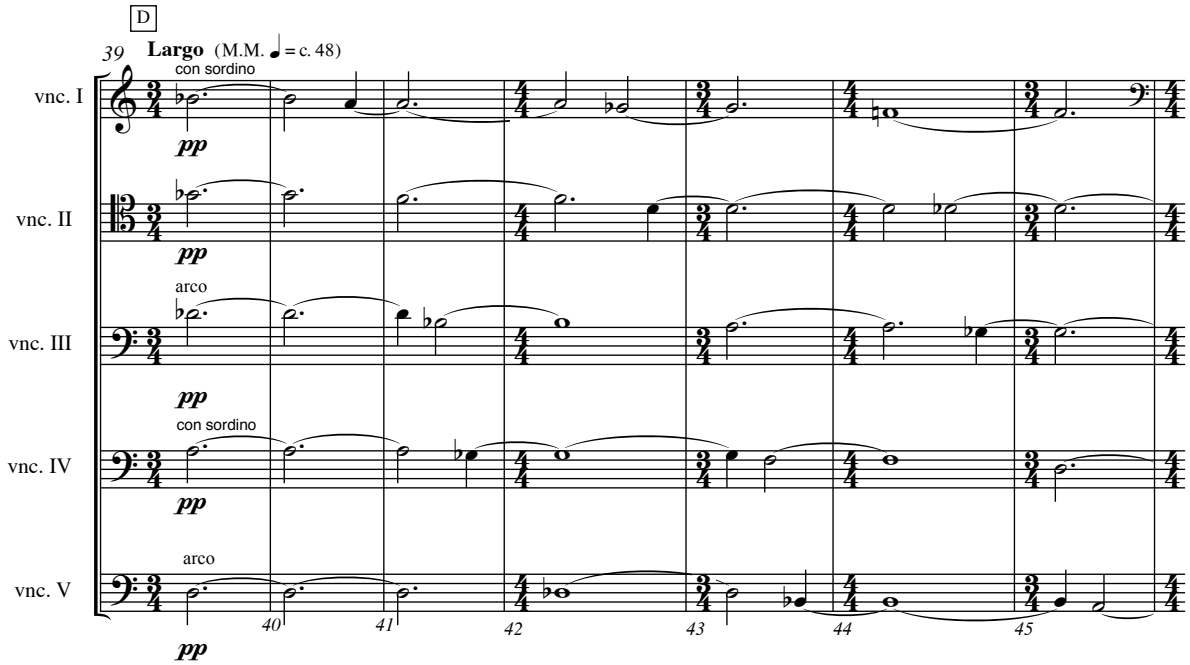


Figure 18: *Three Movements for Five Cellos* (2007), Mvt. II

Stretching phrases through the addition of or variation of material in the interstices between tones of the initial thematic statement. I have used this technique as early as 2001 in *Impromptu Variations* for solo piano, but have since used it in *Disappearing Ink* and *Persistence of Memory* both from 2012. The example that follows shows how this works in the beginning of *Disappearing Ink* through several statements of the opening figure.

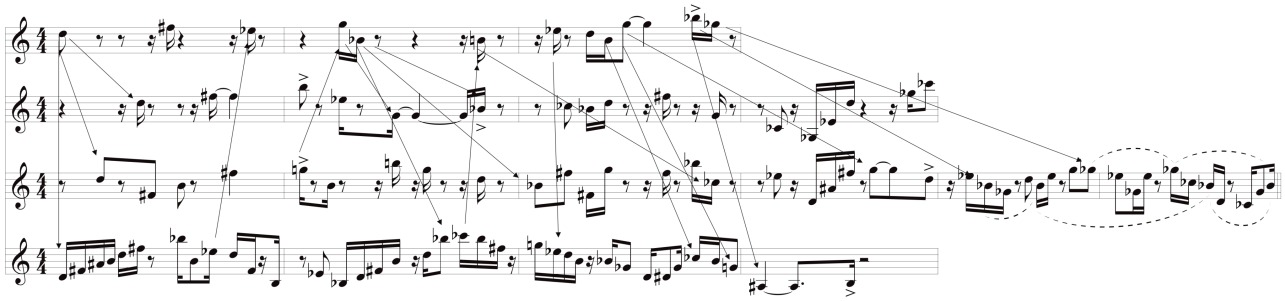


Figure 19: Disappearing Ink (2012) Thematic statements and expansion

The discussion herein has addressed the application of Generative Processes in compositional preparation, and development in verification; and examples have illuminated the trace of these in the musical surface and structure in ten of my works. Further discussion demonstrated their use for integration, disruption, and decay or disintegration.

Notes:

[1] Gestures I, page A1 surface rhythms are often 6:4; 9:8 increasing the perceived rate of rhythmic events to be 1.25 to 1.5 times faster than sixteenths at the original tempo of M.M 100. If one pleases tempi between M.M. 125-150 may be interpreted as Fib 144.

[2] Cross Cutting describes the cutting back and forth between shots in film. The technique is common in Elliott Carter's music, but was/is also used extensively in the music of Carl Stalling (Warner Brothers: Looney Tunes), and John Zorn.

References:

[1] Collins, David: A Synthesis Process Model of Creative Thinking in Music Composition, Psychology of Music 2005; 33; 193, New York: Sage Publications, 2005.
[2] Gilhooly, K.J.:Thinking: Directed, Undirected and Creative. London: Academic Press, 1996.
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[6] Soddu, Celestino and Colabella, Enrica: Why Generative Art? Proceedings of Generative Art Conference GA2013, http://www.generativeart.com/, 2013.
[7] Zanter, Mark: Structural Models for Improvisation, DMA diss, University of Illinois, 2001.