Synthesis of Performer and Instrument: Analytical Issues in Interactive Multimedia and Christopher Burns' *Sawtooth*

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Abstract

Interactive multimedia offers unique challenges to researchers and theorists. These works often defy standard practice analysis methods. Works are often improvisational or aleatoric, with an emphasis on the technology used. In this paper and presentation, different analytical problems unique to interactive multimedia are presented. A taxonomy of different styles of interaction are presented, followed by a methodology and approach to analyzing interactive pieces. Information regarding methods of analysis are synthesized from research of several writers, mainly John Croft, Barry Truax, and Dennis Smalley, as well as research into analysis of informational systems. Research into the analysis of jazz improvisation is also included as one avenue to approach a piece that lacks a fixed score. Gunther Schuller's 1958 article "Sonny Rollins and the Challenge of Thematic Improvisation" is used as a model for approaching the analysis of improvisation. Using all these materials, a multi-faceted approach is created and implemented into an analysis of Christopher Burns' *Sawtooth*. The goal of this particular analysis was to show how the interactive system directly influences the improvisational choices creating a repeatable structure. This limits the improvisation of the piece without the use of notation. Using only four basic elements and their interactions, Burns was able to create a fixed gesture carried structure that influences the possible outcomes of the improvisation in the environment.

Introduction

Interactive multimedia offers unique challenges to researchers and theorists. These works often defy standard practice analysis methods. In terms of musical description, there is no common nomenclature or common practice of analysis or composition with which to approach a modern interactive work. Technological factors enter into the conversation in terms of analyzing the environment and instrument design factors influencing the performance. This leads to the questioning of the purpose of interactivity and the significance of live performance. Finally, these works often operate without a set score or are fully improvisational. The same issues that plague researchers in studying other improvisational methods such as Jazz rear their heads in interactive multimedia. This paper sets out to create a general methodology one can use to approach analyzing interactive multimedia. For this discussion, Christopher Burns' *Sawtooth* will be used as an analytical case study.

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Where to Begin – Environmental factors

Interactive multimedia is a term that gets used with different nuance in a variety of situations. In this discussion, the definition shall be limited to the use of technology as a core factor. A piece of interactive multimedia is any project or piece of art that combines more than one specific media with interaction between the performer and the artwork creating a dynamic form of communication. This means traditional forms of interactive multimedia, such as theater, are disregarded due to lack of interactive technology. Other forms offer only one-way communication between technology and performer. These art pieces are limiting factors in this discussion due to their small amount of interaction, that of the performer to a fixed environment.

Other writers have tackled the problem of creating a taxonomy of interactive multimedia. John Croft's "Thesis of Liveness" offers a set of five paradigms of the relationship between performer, instrument, and electronics: Backdrop, or remote relationship; accompanimental, in a traditional sense of electronics following the performer; responsorial/proliferating, or a more antiphonal relationship, either through precomposed methods, or treatment of the performer; environmental, or creation of acoustic environments by electronic means; and instrumental, or the creation of a composite instrument where electronics are a natural extension of the instrument.[1] These archetypes of interaction are one entry point, however there is a lack of specificity regarding nuance between forms of interaction. Croft leaves out the possibility of the interactive environment being self-sufficient or determining input on its own without the need of constant performer interaction- in other words a more computer led system or even equal relationship between the performer and electronics. Croft focuses on the performer being the leader.

Instead, the following taxonomy of interaction in multimedia technology arts may prove more useful:
1. Performer using a fixed score with fixed media;
2. Performer using an open ended score with fixed media;
3. One or more performers using fixed effects only. These effects may change over time, but they are repeated with the same time domain in every performance, following a fixed score;
4. Two performers, one on electronics, performing from fixed scores;
5. Two performers, one on electronics, performing from open ended scores;
6. One or more performers, one portion of the electronics fixed or performed, another portion of the electronics variable due to programming effects;
7. One or more performers, electronics fully variable, either through interaction with the various elements or through use of changing elements, creating an ephemeral, improvisatory performance

Identification of the level of interactivity is important in discerning attributes of a piece to analyze. After identifying a level of interactivity, a researcher can begin analysis of content. If the system is fixed and repeatable, the researcher can move into analysis of specific interactions of performer and electronics. When there is a live performer, one must move into

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[1] Croft John, "Thesis of Liveness", *Organised Sound*, 12(1), 2007, p. 62.

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the analysis of the ways in which the environment interprets the actions and sounds created by the performer.

Barry Truax explains that in an interactive system, various parameters combine to form a whole that is more important than any single parameter. How the groups of data are combined have a profound effect on the performer. The greatest challenge of a programmer is how to provide powerful controls for such interrelated data sets so that intelligent correlations can be made.[2] Truax was discussing composition using programming languages and visual programs, however the idea rings true in case of a performer using a newly created instrument. Truax lists three questions in relation to interaction in a system: What is the form and modality of user input and program output; how are the data structures at various levels represented to the user and how easily can changes be made; and does the user have access to results at any stage?[3] Croft tackles these issues as well in discussing his Instrumental Paradigm. He lists that the response of the computer must be proportionate to the performers' actions, share some energetic and morphological characteristics, have a synchronous onset, a timbral continuum or fusion, and a stable, scrutable, and learnable relationship with a high level of fine-grain control.[4]

Along with Truax and Croft, Denis Smalley addresses questions of relation of performed sound and energy with his discussion of surrogacy. Smalley defines surrogacy as the relationship between the identity of sound and its changes. Surrogacy gets broken into three levels; First Order where a sound retains enough of its identity to be related to the original sound source; Second Order where a sound is surmised through the energetic profile of another sound, but no causal relationship is discerned; and Remote where surmised links between two sounds are progressively loosened until there is absolutely no relationship.[5] These different levels of surrogacy show different levels of connection between sound and their original source. In the case of interaction, this translates to the connection between the performer and the sounds emanating from the speakers.

Understanding the elements of the interactive system can elucidate details of an art works form and structure. In terms of improvisation, learning the available elements and effects of the interaction can give analyzers a framework as to the operation of the instrument. Given that systems are often multi-timbral, being aware of the orchestrational possibilities of the instrument as well as the possibility of multiple timbres occurring simultaneously is important for understanding the total sounds available to the performer. The interaction can also define possibilities in combining musical lines and use of counterpoint. Understanding the interactive system is an important first step in understanding any of the musical and performance factors that can occur.

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[2] Truax Barry, "Computer Music Language Design and the Composing Process", in *The Language of Electroacoustic Music*, ed. Simon Emmerson, London, Palgrave Macmillan, 1986, p. 157.

[3] *Ibid*, p. 158.

[4] Croft John, *op. cit.*, pp. 64-65.

[5] Smalley Denis, "Spectro-morphology and Structuring Process", in *The Language of Electroacoustic Music*, *op. cit.*, pp. 82-83.

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Musical Factors

Gunther Schuller, in his article "Sonny Rollins and the Challenge of Thematic Improvisation", states a single fact which every researcher and theorist should be guided by: "Genius does not necessarily need organization, especially in a strict academic sense, since it makes its laws and sets its own standards, thereby creating its own organization."[6] Schuller was discussing an entry point into the analysis of improvisation, however the viewpoint is pertinent in this post-modern age of music. It is of great import to allow the improviser to inform the analysis, not force the improvised material into a set theoretical framework defined as the norm for a genre of music.

Schuller's analysis of Sonny Rollin's improvisation, he moves away from analyzing Rollin's solo using common practice ideas. Instead, Schuller identifies primary themes and their pitch material. The analysis then moves into areas of post-tonal analysis. This is taking theories used in one genre, post-romantic twentieth century European composition, and using it to identify features of in a Jazz composition.[7]

Scores and directions provided by the composer offer the quickest entry point into understanding a piece. However, in the electro-acoustic medium, and particularly in interactive multimedia, there may or may not be a score available. Instead analysis relies upon the ears of the analyzer. Some analysis methods need a different approach to listening to be able to fully integrate their methods. An example would be the timbre and structure driven models proposed by Denis Smalley.[8]

A piece with static or repeated features gives the ear, and researchers, reference points in the piece. These static features can give a clue as to the relationship between other functions in the music. In an interactive multimedia artwork, these static or repeated features are often not direct repetitions of musical lines, but may instead be specific timbres associated with interactions, or events that are triggered through perceivable means. These discernable, identifiable, and lucid moments can give clarity as to a deeper musical structure. Any limiting factors, such as a set number of timbres, specific pitch content, or relation of specific musical gestures to physical gestures can lead an analyzer deeper into a piece without the need of programming knowledge.

Performance Issues

As stated earlier, some interactive multimedia works of art focus not on a fixed score, but instead on improvisation. This creates an issue in regards to the purpose of the analysis as well as how to perform an analysis. What is the purpose of analyzing an improvisational piece? Will any deeper truths about the piece be discovered if the performance is ephemeral? This issue pops up in Jazz on a regular basis. Some critics and researchers are content on

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[6] Schuller Gunther, "Sonny Rollins and the Challenge of Thematic Improvisation", *The Jazz Review*, 1(1-2), 1958, p. 6.

[7] *Ibid*, pp. 6-9.

[8] Smalley's article "The Listening Imagination: Listening in the Electro-acoustic Era" expounds upon his thoughts regarding different styles of listening required in electro-acoustic music.

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doing in depth analysis of a single musical artifact- a recording.[9] In Jazz, this analysis is often more critical toward the performer than composer. In interactive multimedia, however, in depth analysis can give a large amount of information regarding more than just the system.

In the case that there is little to no documentation, learning the interactive system can only occur through repeated listening or through performance. For those more technically able, looking at the environment from a programming stance can be informative, but this requires that the analyzer be of a similar level of technical expertise of the original programmer. Acquiring the environment and taking time to interact with it may also be of great use, but this may require some level of technical ability as well as some level of performance ability related to the medium. Instead, an in depth listening analysis centered on repeated ideas and careful attention to the levels of surrogacy, Croft's questions regarding an Instrumental Paradigm, and deep listening via Smalley's ideas of morphology may lead the observer to understand the interactive system without technical knowledge.

The vice-versa is also applicable. Once an interactive environment has been analyzed, its effect on the improviser can then be analyzed. In much the same ways chord symbols and style limit a Jazz musician in performance, interaction of materials, the style of interactive system, fixed parameters and functions, and programming limitations can heavily influence a performance. This can lead to similarities in performances even without a score due to the limitations presented by the environment.

Ephemeral analysis can also be of use in approaching an improvisational work. If one's analysis is based upon a single performance or occurrence of a piece, then those initial reactions can give a great deal of information. Critics operate on this style of ephemeral analysis, latching onto key portions of a piece and centering their arguments on only those key portions. This can lead an analyzer to find an analytical angle from which to approach the piece.

Sawtooth as Gesture Carried Structured Improvisational Environment

Sawtooth by Christopher Burns is a performance environment with few directions regarding performance. In the performance notes, Burns notes his own criteria for a good performance:
    a) Attentive to the quality of movement, animation, sound, and their interplay;
    b) Convincing form: often gradually revealing all the different behaviors of the software;
    c) Expressive use of the multipoint interface: activating multiple areas of the interface simultaneously (though not necessarily all the time);
    d) Yours may vary![10]

The final statement gives insight into the leeway Burns gives in performance. However, the interface creates a limiting factor, which greatly influences the possibilities of improvisation.

Background information is readily available on *Sawtooth* regarding its interactive environment. Burns describes fixed elements available in the environment are described, the way a performer activates each element, and the interaction available between the elements.

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[9] A prime example of this is Schuller's analysis that appears later in his 1958 article.

[10] Burns Christopher, *Sawtooth*, 2009.

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The system works by using motion capture and video analysis through a custom program built in the programming environment Processing. The raw data is processed into video in Processing, and sent to another environment built in Pure Data for the audio portion. Both of these occur in close synchronicity. Processing creates a 2D grid and maps the motion of the camera onto the grid to create the information. Pitch and timbre are governed by spatial location as well as varying over time. Color is determined randomly at first, and then changes in color are derived from interaction between elements. Visual material occurs in the grid as visual feedback for the performer and audience.

Four kinds of set audio/video material are generated: Small Tiles, Spinners, Sweepers, and Large Tiles[11]. Small Tiles are created through simple movement, create small tiles on the projection and create a simple sine wave tone. Spinners occur after a Small Tile has been activated three times in a short time. The duration of the spinner is based on time lapse between tile activations. This creates a triangle, which spins out radially from the small tiles, attracted to large movements. Spinners create a frequency modulation synthesis generated tone. Sweepers are started by collections of Small Tiles and Spinners. They change visually from triangles to lengthening linear extensions. Sweepers create a sustained FM sonority. Large Tiles are created when large amounts of Small Tiles are activated. These create, as their name suggests, large blocks. At first they have no audio, but upon subsequent activations, cause audio feedback circuits with other Large Tiles, as well as Sweepers and Spinners.[12]

There is a limitation of four basic elements. The majority of musical and visual material is created through the interaction of these four "simple" elements. All of the elements are fixed in their general effect, timbre and shape, even if their pitch and color can alter. The material is generated through a single performer interacting with an electronic environment. *Sawtooth* is therefore the seventh category of interactive multimedia described earlier in the paper. Some elements are fixed directly to the performer's actions, other portions are completely fixed, while other elements may shift in a variable time-domain per every performance.

An ephemeral analysis of a single performance can begin with background material, alleviating some of the mystery regarding the process through which the performer creates the piece. This analysis is over the August 6th, 2009 performance, video available on YouTube.[13] Burns begins the performance with a series of simple audio/visual gestures. These simple gestures are mapped directly to small simple hand movements made by Burns. A call and response is set up between the two hands acting as two separate voices of the same instrument. A second audio/visual gesture enters shortly afterwards- this one a more static figure based on Sweepers. A third audio/visual gesture enters, this time in the form of Large Tiles and noise feedback loops in relation to the Sweepers. From this moment on, the improvisation is based upon the interaction between these three simple gestures. Burns carefully builds the musical texture until creating an over saturation of audio/visual noise. The

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[11] See Appendix A, Examples 1-4.

[12] Burns Christopher, "*Sawtooth*: Interactive Clarity and Aesthetic Complexity", *CHI 2010, April 10-15*, Atlanta (Georgia), 2010, pp. 2979-2984.

[13] Burns Christopher, *Sawtooth*, YouTube, 08/06/09, www.youtube.com/watch?v=U2h8zavq9IQ&feature=youtu.be, (Accessed 11/27/11).

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audio/visual material then subsides ending with Burns repeating the opening audio/visual gesture as a simple closing.[14]

Burns' performance highlights the limitations placed upon the performer by the environment. All the audio/visual material is generated through action – either by the action of the performer or by the interaction of the different materials based upon the programming. This relates directly to Smalley's idea of a Gesture Carried Structure. Smalley defines a Gesture Carried Structure as being an almost tangible link with human activity with actions that direct the piece from one goal to the next. Gesture Carried Structure is linked to causality, not only of physical invention, but also to natural and engineered events. This is opposed to Texture Carried Structures built more upon internal behaviors of long, static music changing over time. Instead of being provoked to act, Texture Carried Structures merely continue behaving.[15]

In *Sawtooth* all the audio/visual materials have release times. Though the release time can vary, the video images fade to black and the audio releases to inaudibility. The program does not allow for sustained drones without reactivation through a gesture. There is also a limitation upon timbral material available to a performer. A long form improvisation based upon spectro-morphological changes is not possible. The environment itself inherently leads a performer to a Gesture Carried Structure. Without the ability to create a sustained musical texture that alters slowly through time, it is not possible to create a sustained Texture Carried Structure. This is not to say that the improvisation cannot include large musical texture changes, but this differs from a Texture Carried Structure.

A significant portion of Burns' improvisation is creating textural changes. He works with three simple musical gestures within an environment that pushes performers into a Gesture Carried Structure. Burns embraces this environment not as a limitation, but as a way to explore musical texture through a series of simple events that interact with each other without his specific guidance. The piece begins with a simple audio/visual gesture- a cascade of sine tones and Small Tiles, first moving upwards in the audio/visual field, then downwards[16]. Burns then brings in a second contrapuntal line- a short drone created by activating Sweepers[17]. However, the audio/visual counterpoint does not simply occur between the two voices Burns controls with his hands. As more gestures are added in an increasingly quick manner, more contrapuntal lines are created by the interaction between the simple objects.[18] This level of counterpoint creates a thick audio/visual texture. The improvisation plays upon this interesting dichotomy of musical gesture and Gesture Carried Structure to create an increasingly chaotic and densely packed audio/visual texture. This builds until Burns explodes the screen in a series of quick movements that activate Large Tiles across the entire

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[14] A sectional description with timings is available in Appendix A.

[15] Smalley Denis, "Spectro-morphology and Structuring Process", in *The Language of Electroacoustic Music*, *op. cit.*, pp. 81-84.

[16] See Appendix A, example 5.

[17] See Appendix A, example 6.

[18] See Appendix A, example 7.

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screen.[19] The aftermath subsides, and Burns reminds us of where the structure of his performance originated, returning to a simple cascading gesture.[20]

Conclusion

The above analysis of structure, counterpoint, and texture in *Sawtooth* follows the ideas presented earlier in relation to starting points of analyzing a piece of interactive multimedia. Research into the different aspects of the interactive multimedia environment provided information regarding fixed elements, style and level of interaction between performer and environment, and the range of possibilities in creating texture and counterpoint during the improvisation. This information gathering was beneficial as it eased the amount of repetitive viewings that can cause a theorist to begin to see the nuance in bark instead of noticing s/he is in a forest. With information on the environment and method of performance, an ephemeral analysis was done. This in the moment style of analysis was used to help concentrate on the momentary nature of the performance. In the case of *Sawtooth*, it is performed as improvisation with simple guidelines provided by the composer. This lends itself to an ephemeral analysis. An in depth analysis followed focusing on a detail that was unearthed from a single viewing- the connection between the environmental factors and the structuring of the work. The style of the improvisation led to the choice of Smalley's discussion of Gesture Carried structures and a structural analysis. Due to the random changes in pitch and color, and on Burns' emphasis on counterpoint and gesture, Smalley's ideas seemed the most fitting. Looking at the work through this lens, it becomes apparent that the environment itself leads performers to a specific style of improvisation based upon combining audio/visual gestures to create audio/visual textures through the interaction of multiple lines. This approach to analysis led to a greater understanding of a single performance as well as subsequent performances. This methodology can be successfully applied to other forms of interactive media and gather similarly enlightening results.

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[19] See Appendix A, example 8.

[20] See Appendix A, example 9.

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SCHULLER Gunther, "Sonny Rollins and the Challenge of Thematic Improvisation", *The Jazz Review*, 1(1-2), 1958, pp. 6-21.

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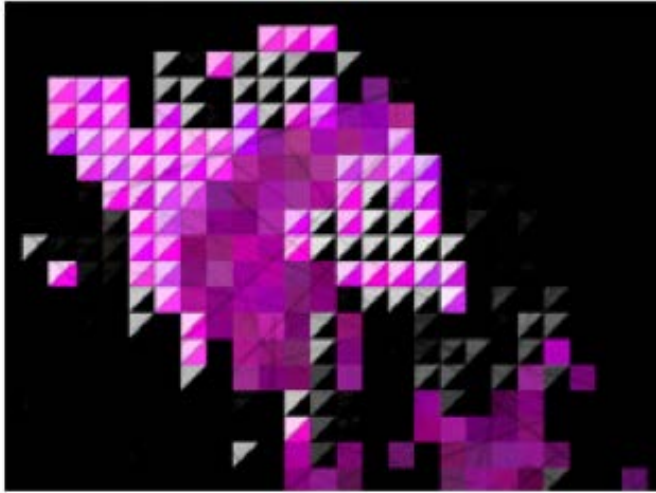
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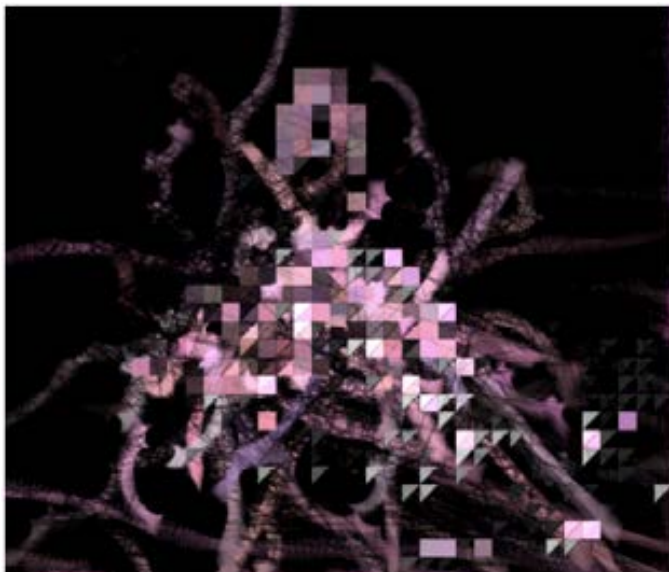
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Appendix A, Section Outline

Section	Time	Description
1	:08-:36	Cascade Small Tile gestures, theme 1
2	:37-1:21	Drone with Sweepers, counterpoint activated by Small Tile cascade
3	1:21-2:05	Spinners, Sweepers, and cascading Small Tiles
4	2:06-2:45	Large Tile Noise development
5	2:45-4:51	Contrapuntal development of Sweeper drone and Large Tile noise. Fast activations and area of effect increases. Larger gestures
6	4:52-5:38	Full Saturation, large fast gestures activating entire screen, reactivations cause Sweepers. Overflow of automatically created counterpoint, slow dissipation
7	5:39-6:09	Return of Small Tile cascade gestures

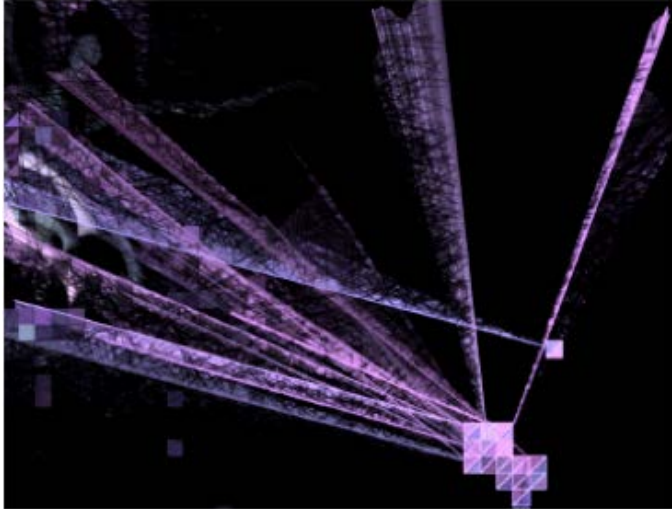Proceedings of the Electroacoustic Music Studies Network Conference
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Appendix A

Example 1- Small Tiles

Example 2 - Spinners

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Example 3 - Sweepers

Example 4 - Large Tiles

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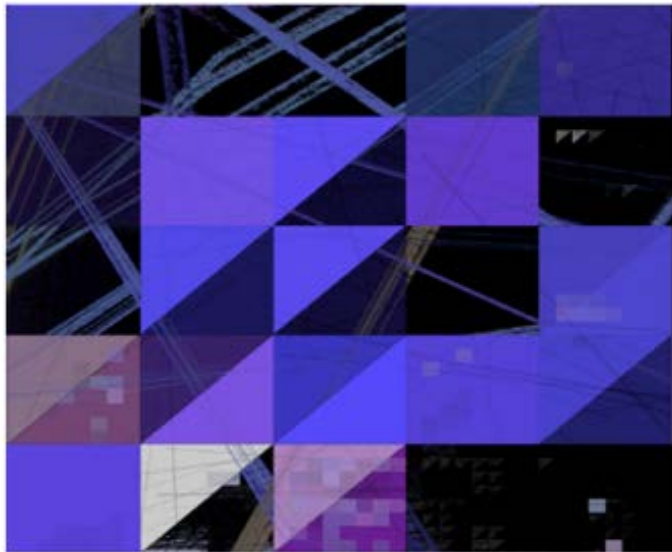
Example 5 - Cascading gesture - Time moves top to bottom

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Example 6 - "drone" texture

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Example 7- contrapuntal textures between voices

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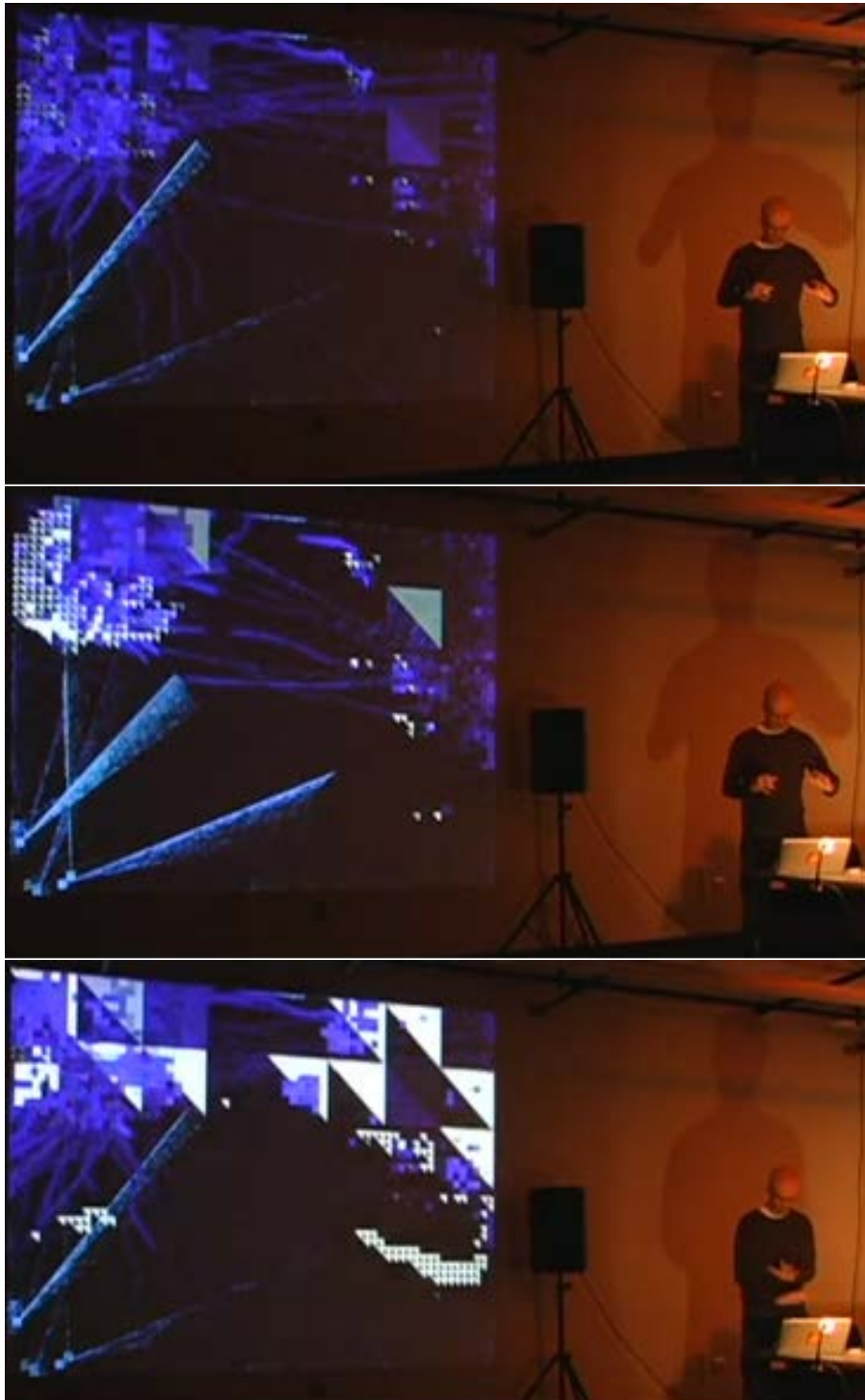
Example 8 - Large Tiles - Sonic and Visual overload

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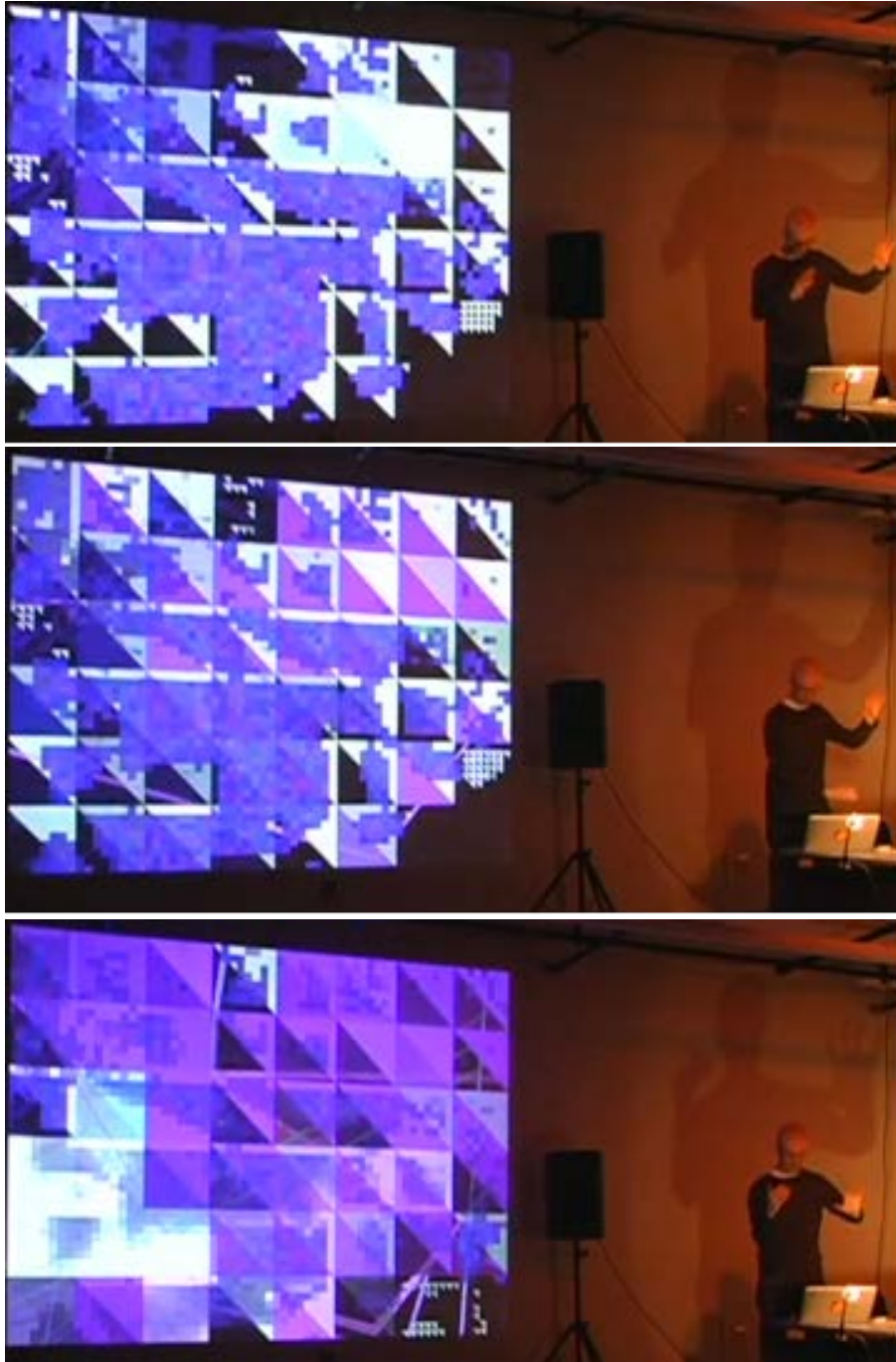
Example 9 - final "cascading" gesture