MetaMix:

Between Unity and Collaboration

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In this paper, I describe *MetaMix* (2002) and I analyze its ambivalent relationship to modern and postmodern thought. I offer neither a complete analysis of the work nor a deep exploration of relevant theory. Rather, I focus on the two key aspects of *MetaMix* which best exemplify its ambivalence towards modernism and postmodernism: its approach to form, and its transformation of the roles of composer, performer, and listener.

Reading this paper is no substitute for experiencing *MetaMix* directly. The accompanying CD-ROM is an install disc for Mac OS X 10.1.x/10.2.x and Windows 98/NT/2000/Me/XP. (*MetaMix* is *not* compatible with Mac OS 9 and earlier or with Windows 95 and earlier.) The disc also includes some audio examples of *MetaMix*'s output, accessible through any audio compact disc player.

1. Overview of *MetaMix*

MetaMix is algorithmic audio remixing software for Mac OS X and Windows. It is a musical composition in that it creates original music, but it consists entirely of direct quotations, and the source of those quotations is not even predetermined. It is a software tool in that it manipulates audio files, but its functionality is too narrowly focused to be of practical use, and it lacks even the built-in ability to save or record its creations. It is a digital audio player in that it plays compact discs and MP3 files, but it would take longer than the age of the universe for it to reach the end of a five-minute audio track. It is an interactive experience in that musical output is dependent on user input, but users are encouraged to set a few parameters, press play, and then let the software run without further intervention — for hours or even days at a time. And it is a work of conceptual art in that it is the stubborn realization of a single simple idea, but its intent is to communicate musical structure more than to communicate a concept.

How MetaMix Works[1]

The concept behind *MetaMix* is simple. Take an audio file. Divide it into equal-length chunks. Label those chunks with the natural numbers: `0, 1, 2, 3,….` Rearrange those chunks as dictated by an interesting (and usually self-similar[2]) infinite integer sequence. Essentially, *MetaMix* superimposes a new musical form onto pre-existing musical material.

Chunks are the basic building blocks of audio which *MetaMix* manipulates. Figure 1 shows how *MetaMix* divides an audio file into chunks by beginning a new chunk every four seconds in the audio track, which is the default setting.

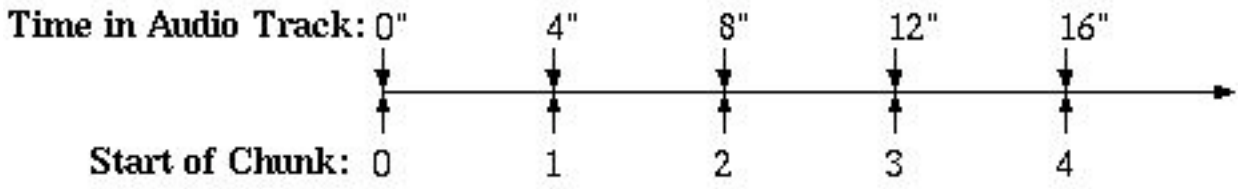

Figure 1: Division of audio track into chunks.

These chunks then have a straightforward mapping onto the numbers of one of the program's twelve integer sequences.[3] For example, the default integer sequence begins like this:

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[1] Parts of this section, and all of the figures, have been adapted from the *MetaMix* documentation. See Jason Freeman, *MetaMix* (2002), available on the accompanying CD-ROM or online at http://www.jasonfreeman.net.

[2] A self-similar integer sequence is an infinite sequence which contains infinitely many copies of itself. One example is the Thue-Morse sequence, which begins:

`0, 1, 1, 2, 1, 2, 2, 3, 1, 2, 2, 3, 2, 3, 3, 4…`

Taking every other term from the sequence produces:

`0, 1, 1, 2, 1, 2, 2…`

which is, of course, the same sequence. For a nice discussion of self-similar sequences (including a slight variation on this example), see Manfred Schroeder, *Fractals, Chaos, Power Laws: Minutes from an Infinite Paradise* (New York: W. H. Freeman and Company, 1991): 264-268.

[3] These "interesting" integer sequences are all taken from N. J. A. Sloane, editor (2002), *The On-Line Encyclopedia of Integer Sequences*, available at

0, 1, 1, 2, 1, 2, 2, 3, 1, 2, 2, 3, 2, 3, 3, 4, …

Figure 2 shows how *MetaMix* triggers the corresponding chunks from the audio track for the first four integers of this sequence:

Number in Integer Sequence	**0**	**1**	**1**	**2**
***MetaMix* triggers chunk number:**	**0**	**1**	**1**	**2**
Playback starts at:	**0"**	**4"**	**4"**	**8"**
Elapsed time:	**0"**	**4"**	**8"**	**16"**

Figure 2: Realization of integer sequence by triggering corresponding chunks.

MetaMix also overlaps chunks to make transitions between them smooth. As a new chunk gradually fades in, an older chunk gradually fades out.

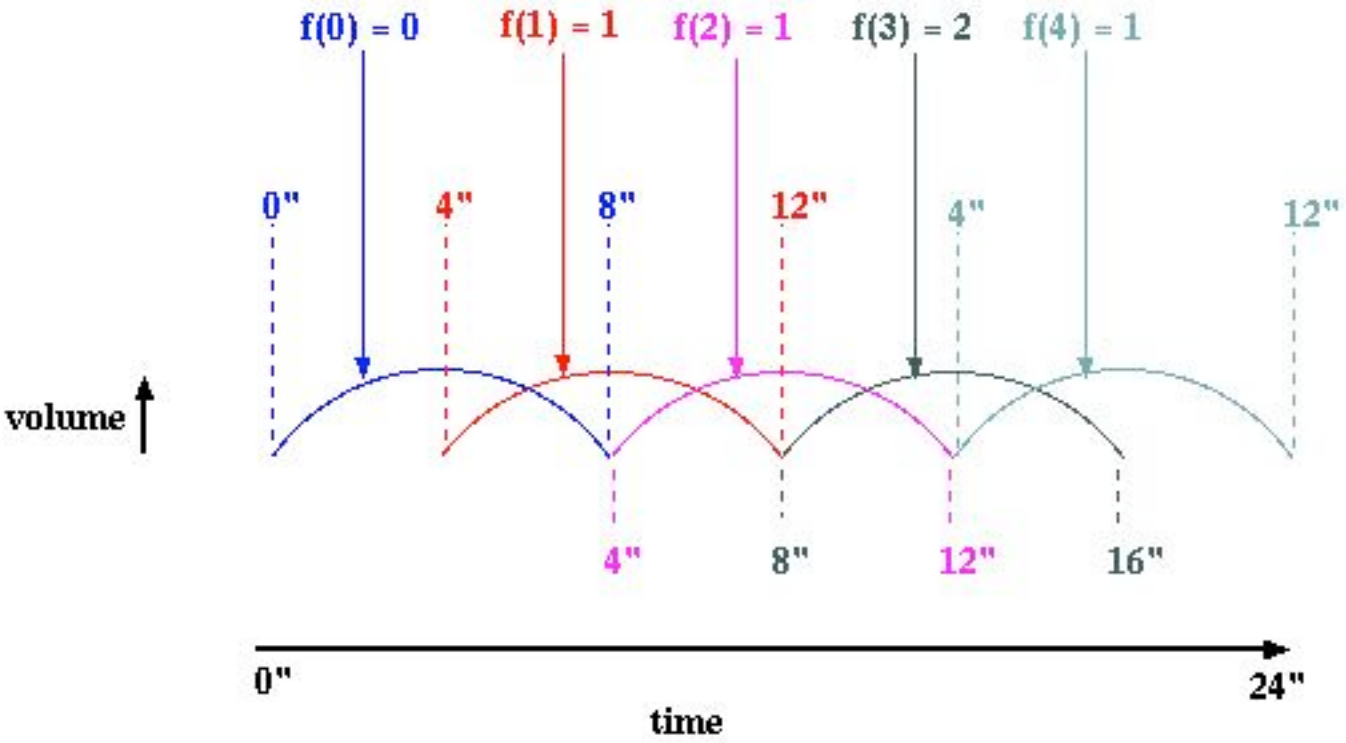

Figure 3: Layering chunks.

Figure 3 shows how this layering process works with two simultaneous layers, which is the

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http://www.research.att.com/~njas/sequences/.

default setting. (Up to six simultaneous layers are possible.) Each arc represents a single chunk: the higher the curve, the louder the chunk. Labels of the form `f(n) = v` show how each chunk maps to a successive number from the integer sequence: `n` is the index in the sequence, and `v` is the value at that index in the sequence. Because two layers play simultaneously, *MetaMix* plays each chunk for eight seconds but triggers a new chunk every four seconds. Each chunk fades in during the first four seconds it plays and fades out during the last four seconds it plays.

While these explanations of *MetaMix*'s algorithms may seem complicated, the process itself is actually quite simple. *MetaMix* makes no attempt to analyze the audio track or to intelligently divide it into meaningful chunks. *MetaMix* makes no effort to relate musical form to musical content. In fact, it is quite strange and wonderful that the music *MetaMix* produces often seems so fluid and continuous in spite of (or because of?) the blind process to which it stubbornly adheres.[4]

User Interaction[5]

While *MetaMix* is not meant to be constantly manipulated, it does require initial user input to set an audio source file and some basic parameters. The user imports an audio source via a standard open file dialog box, and he or she may also specify a specific starting point within the file. The user chooses the integer sequence. (Each sequence is accompanied by a brief description.) Several parameters of the algorithm have default settings but may also be modified: the number of simultaneous layers; the rate at which new chunks are triggered to play; and the

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[4] For an interesting perspective on the role continuity and discontinuity play in a similarly simple process in Steve Reich's *Piano Phase*, see Paul Epstein, "Pattern structure and process in Steve Reich's Piano phase," *The Musical Quarterly* LXXII/4 (1986): 494-502.

[5] Please see the appendix for screen shots of the three main windows of the *MetaMix* graphical user interface.

circumstances under which chunks play backwards (e.g. a negative integer value).

Additional controls and displays emphasize *MetaMix*'s connection to traditional audio playback equipment. There are tape-style "transport" buttons: play, stop, pause, fast-forward, and rewind. (The fast-forward and rewind buttons instruct *MetaMix* to skip forward or backward in the integer sequence by a factor which varies according to the structure of each sequence.) *MetaMix* also has an enhanced counter display which shows all currently playing chunks, their positions in the audio source track, and their relative volumes as they fade in and out.

2. Form in *MetaMix*

Motivations

One of my primary motivations for creating *MetaMix* was to aurally render an interesting process as clearly as possible. I have long been fascinated with using integer sequences to generate large-scale musical forms. The sequences usually originate from strict poetic forms with interlocking repetitive patterns[6] and from infinite, self-similar integer sequences. But using these sequences as large-scale forms in my instrumental compositions was often problematic. It was difficult to maintain coherence between sections while keeping each section unique and easily recognizable. And it was also difficult to vary repeated sections enough to maintain linear momentum while also maintaining the identity of each recurring section over the course of the piece.[7] In short, my compositional goals were often at odds with the compositional forms I

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[6] The sestina, the pantoum, and many other such poetic forms are described in John Hollander, *Rhyme's Reason: A Guide to English Verse* (New Haven: Yale University Press, 1989). Other books are more comprehensive than this, but none are as much fun to read.

[7] This issue is fairly easily addressed in a traditional theme and variations form, since there is usually only one theme. But it is much more problematic here, where there are many

wanted to use, and one or the other often had to be compromised a bit.

MetaMix, in its own twisted way, manages to circumvent many of these problems. Because the user chooses the source material, each chunk (section) of material is familiar and recognizable. Thus the large number of different chunks demanded by the integer sequences is not problematic. Since all of the chunks are extracted from the same audio source, *MetaMix*'s output also has a certain inherent coherence; in fact, *MetaMix* often serendipitously exposes unexpected relationships between distant chunks in the source file.[8] And since *MetaMix* is intended for a causal (and often background) listening experience rather than for a performance in a concert hall, the exact, static repetitions are not problematic for me. In a sense, *MetaMix* is more successful at realizing these integer sequences than my instrumental compositions because it expresses pure structure with no "interference" from the composer.[9]

Interpretations

While some of the ways in which *MetaMix* employs musical form go against the grain of modernist thought, the legacy of modernism is clear: the scientific approach to creating a logical and systematic musical form, the centrality of that form to the work, and the assumption that the perception of that form is proof that something meaningful has been communicated by the

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different themes and variations intertwined with each other.

[8] For example, one chunk may prolong, embellish, or change the harmony of another; it may create a syncopated metrical relationship; it may add a new contrapuntal voice to the texture; or it may serve as a new consequent to an antecedent phrase which was cut short.

[9] This does not mean that *MetaMix* makes better music; it just means that *MetaMix* is more successful in its attempt to depict the integer sequences.

composer to the listener.[10]

A favorite story of mine exemplifies the preoccupation of many modernist composers with the creation and perception of form. A "modernist" teacher at a summer festival once told me that he often sat down with his daughter and analyzed rhythmic processes at work in songs by RadioHead. When I asked him if knowing about these structures made him enjoy the music more, he said no: he did not enjoy the music more, but he felt more *justified* in enjoying it. By discovering that there was something subtle, logical, and systematic about the music, he proved to himself that it had been constructed with care and that he was listening to it with care. Since he could explain a plausible method by which one aspect of the music had been constructed, he believed that something important had been communicated between the composer and the listener. No matter that he could describe no effect that the transmission of this abstract information had had on the rest of his understanding of the music. Its only purpose for him was to justify that this popular music was indeed worthwhile to listen to at all.

Like postwar serialism, the approach to form in *MetaMix* is scientific, systematic, and logical. It presumes that the listener can perceive the forms it creates; it even assists the listener in this task, both with its included descriptions of each of the integer sequences and with its counter display, which visually shows exactly what chunks are playing and how they relate to the sequence. And *MetaMix* is built on the assumption that the perception of these musical forms is essential to understanding the work. While the presumed line of communication from composer

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[10] For a discussion of communication and modernism, see Jonathan D. Kramer, *Postmodern Music, Postmodern Listening* (Unpublished manuscript, 6/14/01): 110-111. For a good, brief discussion of Babbitt and the connection between scientific study and postwar modernism, see Georgina Born, *Rationalizing Culture: IRCAM, Boulez, and the Institutionalization of the Musical Avant-Garde* (Berkeley: University of California Press, 1995): 47-56.

to listener is not as clear as in a RadioHead song or a Babbitt piano piece (an issue I will return to in the next section), there is an implicit belief that the decisions made by all the creators (myself, the user, and the creator(s) of the source material) deeply affect the listener's perception of the music and its meaning.

But unlike postwar serialism, *MetaMix* is neither efficient nor subtle. The slow, extremely repetitive processes in *MetaMix* could never be described in terms such as Babbitt uses; there is no "increase in efficiency [which] necessarily reduces the 'redundancy' of the language."[11] In fact, *MetaMix* actually does the opposite; it takes existing music and *decreases* the efficiency and *increases* the redundancy of its language. How else could one explain the transformation of a five-minute song into a result which lasts longer than the age of the universe?[12]

By purely realizing a slow and simple process, *MetaMix* is more closely aligned with some early minimalist music than with postwar serialism. Like modernists, early minimalists rigorously used musical structures, and they believed it was essential for listeners to hear these structures. But as Reich explains, they created their music in a way which made it as easy as possible for listeners to perceive these structures:

> I am interested in perceptible processes. I want to be able to hear processes happening throughout the sounding music. To facilitate closely detailed listening, a musical process

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[11] Milton Babbitt, "Who Cares If You Listen?" *High Fidelity* VIII, no. 2 (February 1958). Reprinted in Piero Weiss and Richard Taruskin, eds., *Music in the Western World: A History in Documents* (New York: Schirmer Books, 1984), 529-534.

[12] MetaMix may be based on infinite integer sequences, but its music is nevertheless finite. Sooner or later the sequence will reach a chunk number which points to a location past the end of the audio file. But this usually takes an extremely long time. With the default parameters and a five-minute audio source, this takes about 10^{15} years. The age of the universe is about 10^{10} years.

should happen extremely gradually.[13]

And they also seemed less preoccupied with communicating meaning to the listener via that structure. For example, Reich is interested in the "mysteries" of the phasing process: "the impersonal, *unintended* [italics mine], psycho-acoustic by-products of the intended process." [14] Such aspects of the music clearly cannot have been communicated to a listener from the composer. *MetaMix* relishes in this kind of unintended meaning as well, as unexpected chance juxtapositions and connections emerge in its transformation of source material.

There is also a connection between *MetaMix*'s self-similar structures, which distort any normal sense of time,[15] and an experimentalist view of time. Georgina Born writes:

> Against the serial view of time as linear, "duration" as mathematically quantifiable, experimental composers viewed time as noncumulative, nondirectional, static, and rhythm as cyclical, repetitive, and processual…This approach is well expressed in the minimalist, process, or systems music of composers such as Terry Riley, Philip Glass, and Steve Reich, which developed out of the experimental tradition…the music sets up repetitive and cyclic rhythmic structures that permutate as the performance unfolds: a ritual process set in motion. Performances might last for twenty-four hours, and music was stripped to minimal simplicity.[16]

These connections to modernism and experimentalism are at once genuine and ironic, just as *MetaMix* itself can seem at once modern and postmodern. In writing *MetaMix*, I expressed a heartfelt belief that fascinating integer sequences could be perceived aurally and that

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[13] Steve Reich, "Music as a Gradual Process," reprinted in *Steve Reich: Writings about Music* (Halifax: The Press of the Nova Scotia College of Art and Design, 1974): 9-11.

[14] Ibid.

[15] Because self-similar sequences are invariant under scaling, they do not clearly mark progress through musical time. At any point, the sequence could be twice (or half or four times or one fourth, etc.) as far along as the listener may think.

[16] Born, 57.

the work could draw its power almost entirely from them. But within the software itself, this genuine mission is often treated a bit whimsically. Detailed mathematical descriptions accompany each sequence, explaining its derivation and meaning. But occasionally, these descriptions include a sentence or two which deliberately undermine the whole endeavor. For instance, in the description of "Palindrome I," I write: "The sequence is actually based on the 'weight of balanced ternary representation of n.' I must confess I have no idea what that means."[17] With this flippant remark, I suggest that it may not be so important to understand the mathematical roots of *MetaMix* after all. If I can be fascinated by an integer sequence without understanding the mathematics behind its derivation, then why can't a listener be fascinated by a musical result without grasping its structure? Are the integer sequences really even the essential element of the work? If not, then what is?

I also assigned playful names to each of the mathematical sequences. For instance, a group of related sequences all have names based on "Exponential Slow," because the sequences' momentum slow down exponentially over time. One of the more chaotic sequences in that group is named "Not Quite So Exponential Slow," poking fun at the minimalist nature of all of these structures. Carefully chosen source material could also lead to humorous and ironic transformations: consider a recording of Satie's *Vexations*. Examples such as this last one, though, are merely possibilities for user interaction — which leads us nicely into the next section…

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[17] Freeman.

3. The Developer and the User in *MetaMix*

Motivations

Another primary motivation for creating *MetaMix* was to make possible a meaningful interactive musical experience accessible to both musicians and non-musicians. Inevitably, this necessitated a transformation of the traditional art music roles — composer, performer, and listener. These roles continue to exist, but they do not have direct, one-to-one mappings to people or groups; the tasks traditionally associated with each of these roles are divided amongst several people, and some people take on tasks from multiple roles.[18] Some terminology from the software industry more clearly identifies the roles people play in relation to the work: developer and user. (I have already been using these terms informally throughout this paper.)

Creating such an interactive experience also requires a new presentation format; *MetaMix* transforms the experience of listening to recorded music into a format which better suits its goals. Traditionally, a listener hears a recorded performance, digitally edited to near perfection and identical on each successive hearing. Even under the best circumstances, the excitement, the risks, and the surprises of a live concert performance are gone. But by rearranging and remixing a recording in real time, *MetaMix* tries to inject some of that excitement back into recorded music. The surprise with *MetaMix* comes not from the recorded performance, but rather from the manner in which chunks of the recording are repeated and rearranged to reveal new connections and relationships. *MetaMix* encourages users to listen afresh by extracting new meaning out of familiar sounds.

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[18] This is the opposite of a famous Cage quote: "Composing's one thing, performing's another, listening's a third. What can they have to do with each other?" in John Cage, *Silence* (Middletown: Wesleyan University Press, 1961): 15.

One of the strangest and most wonderful experiences I have had as a *MetaMix* user occurred with a transformation of a jazz piano recording. I instructed the software to begin from a passage near the end of the track. After a few hours, I suddenly heard momentary but uproarious applause creeping in from the end of this live recording. As the music continued, the applause returned for increasingly long periods of time and with increasing frequency. Each time it came back, it forced me to reconsider the music around it. Was the applause highlighting a cadence? Or was it echoed by an arpeggiation in the lower octaves of the piano? Or was it an enthusiastic reaction to a little flourish? Of course, the applause was not originally any of these things. But these strange juxtapositions forced me to reconsider what made moments in the recording special. And I began to eagerly anticipate (and even try to predict) where and when the next moment marked by applause would come.

Interpretations

With this change in roles comes a transformation or even destruction of a meta-narrative[19] of art music recordings: a composer writes the music, a performer plays it, and a listener absorbs it. In *MetaMix*, this paradigm is still important, but it no longer functions as a meta-narrative. The software, not the listener, directly absorbs the music, and it then serves as an interface through which the user accesses the music. Two different paradigms function only together, and the second happens to be a meta-narrative in the software industry: a developer creates software with which a user then interacts.

MetaMix does not fully embrace either of these meta-narratives. The recorded music meta-narrative implies that the listener is merely a passive spectator and plays no role in the

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[19] See Kramer, 45-48 for a definition and discussion of meta-narratives.

musical result, but the software meta-narrative implies that the user continuously interacts with the software and deserves primary credit for the musical result. Neither of these implications make sense under the circumstances.

Such an ambivalence towards meta-narratives links *MetaMix* to postmodern thought. Jean-François Lyotard writes: "Simplifying to the extreme, I define postmodern as incredulity toward metanarratives."[20] *MetaMix* still believes in other meta-narratives. For instance, its rigorous formal structure betrays an interest in unity and thus a link to modernism. But Lyotard's remark is relevant to the work's self-conscious treatment of the meta-narratives of recorded music and of software, incorporating them as flexible paradigms which can be reshaped and combined at will.

Reshaping these particular meta-narratives makes it difficult to identify the creator of the work. When a composer engraves a musical score with *Finale*, Coda (its developer) takes no credit for the work.[21] But when a user creates a transformation of Erik Satie's *Vexations* in *MetaMix*, many people deserve some credit: me (as developer), the user (for picking the source material and setting the parameters), Satie (for writing the original piece), the pianist (for performing it), and perhaps even the engineer or producer of the original recoding (for mixing and editing the performance). And it is equally difficult to define the work itself, since no

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[20] Jean-François Lyotard, "Answering the Question: What is Postmodernism?" in *The Post-Modern Reader*, ed. Charles Jencks (London: Academy Editions, 1992): 138-150. See also Kramer, 45, which begins its exploration of meta-narratives with Lyotard.

[21] Actually, it is not quite that simple. Coda's license agreement reads: "…MakeMusic! [the company which recently purchased Coda] retains all ownership and rights in the Software, including all rights in any portion(s) of the Software present in any output of the Software." This wording is deliberately ambiguous, and it is doubtful the company could ever legally claim ownership to a score engraved in *Finale*. But it does demonstrate that even in a seemingly clear example, legal ownership can be ambiguous. See *Finale Notepad 2003*. Coda Music Technology, Eden Prairie, Minnesota. Available at http://www.codamusic.com.

element of the work is original. The source material is a digitally exact quotation. The musical structures are taken directly from the work of mathematicians at AT&T. The graphical user interface is somewhat original, but it is more of a necessary facilitator of interaction than a meaningful component in itself.

These problematic identities of the work and its creator(s) point to another link with postmodern thought, particularly in it relationship to technology. Steve Holtzman summarizes the connection nicely in an explanation of why interactive digital technology is well-suited for postmodern expression:

> The digital experience is interactive, not passive. Digital worlds respond to you, pull you in, demand your participation. The unique creation that results is not simply a "work" produced by an artist held high on a pedestal, but the interaction between you and the possibilities defined by the artist…Two experiences created from a broad field of possibilities may bear little resemblance to each other. As in jazz improvisation or the live performance of music, it's the uniqueness of each interpretation that is the essence of the digital aesthetic.[22]

Holtzman makes an interesting comparison to live musical performances, but it is important to remember that interactive works tend to create much more problematic definitions of the "work" and the "creator" than conventional musical performances (even in jazz). Jonathan Impett focuses on this problematic identity of the work itself and offers a suggestion:

> In the case of interactive music, the blurring of the boundaries between composition and performance, work and environment, is an essential characteristic. It could even be considered…the material itself.[23]

But *MetaMix* does not go as far as many postmodernist thinkers. Andreas Huyssen, though speaking neither of music nor of technology in specific, argues that even asking questions

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[22] Steve Holtzman, *Digital Mosaics* (New York: Simon and Schuster, 1997): 128.

[23]Jonathan Impett, "Situating the Invention in Interactive Music," *Organised Sound* Vol 5, No. 1 (April 2000): 27-34.

like "Who is writing?" is no longer relevant, because these questions are "tied by mere reversal to the very ideology that invariably glorifies the author as genius…" [24] By retaining the idea of a primary creator, even if that creator's role is diminished, and by retaining the recorded music paradigm, even if it is no longer a meta-narrative, *MetaMix* keeps itself within both postmodernist and modernist worlds without quite fitting in either.

4. Connections

So *MetaMix* incorporates a strange duality — a unified (modernist) structure combined with a disjunct (postmodernist) creative process. The formal structure and the interface are predetermined, while the specific content and some parameters of the algorithms are decided at the moment of interaction. Content is completely divorced from form, but the work attempts nonetheless to be coherent and unified.

A similar approach has found its way into other works of mine. For instance, in *The Locust Tree in Flower* (2000), an interactive gallery installation, users read phonemes which become the inputs into a complex digital signal processing algorithm, and the resulting sounds are mixed, layered, and repeated according to a predetermined formal layout. In *Telephone Etude #1: Shakespeare Cuisinart* (2001), a telephone caller's voice is transformed into a piece of *musique concrete*; the piece is created via a complex hierarchy of random decisions, structured in such a way that the overall shape of the music follows one of a few different possibilities. And in *peopletank* (2001), a work for dancers with live electronics and floor sensors, the rhythms of dancers' feet act as gates to prerecorded sound files, creating rhythmic gestures which are looped, layered, and transformed according to a predetermined form. In all of these works, the

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[24] Andreas Huyssen, "Mapping the Postmodern," in *The Post-Modern Reader*, ed. Charles Jencks (London: Academy Editions, 1992): 40-72.

structure is mostly fixed, and the interaction or performance consists of "filling in" structure with content.

There are many similar examples beyond my own work. In John Cage's *Imaginary Landscape No.5* (1952), a graphical score specifies precisely how to assemble the work from forty-two phonograph records but leaves the choice of records up to the "user." The result is a short work for electronic tape.[25] Alvin Lucier's *I Am Sitting In A Room* (1970), for voice and electromagnetic tape, is based on a simple but rigorous process: playing and re-recording a spoken voice recording again and again until the voice eventually gives way to "the natural resonant frequencies of the room." While this piece is best known in a version which Lucier recorded himself, the score leaves virtually all elements of the work (except the process itself) up to the performer. It directs the performer to "choose a room the musical qualities of which you would like to invoke;" to "use the following [supplied] text or any other text of any length;" and to "continue this process through *many* [italics mine] generations." Lucier even suggests possible variations to the "parameters" of the process: moving the location of the microphone within the room for each successive recording; moving to a different room for each successive recording; or using multiple readers with texts in multiple languages. He even suggests different methods of dissemination: the work may be documented as a piece for tape or may be produced as a live performance.[26]

While there are certainly examples of this approach in instrumental compositions as well, the particular combination of rigorous structure with the uncertainty of "user" interaction seems

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[25] John Cage, *Imaginary Landscape No. 5* (New York: Henmar Music, 1961).

[26] Alvin Lucier, *I Am Sitting In A Room*, reprinted in *Sound By Artists*, ed. Dan Lander and Micah Lexier (Toronto: Art Metropole and Walter Phillips Gallery, 1990): 191-192.

particularly well suited to works which employ technology in unusual ways.

5. Conclusions

Though I have identified an approach which is important in many of my recent works, it nonetheless carries with it contradictions and limitations with which I constantly struggle. I want to open up the possibility for systems to be used in ways I could not imagine, but I also want to ensure that even "inept" users can create something interesting. I want each experience to be unique, yet I also want each to be recognizable as something for which I was the principal creator. In short, I am fascinated with giving up control because I am a control freak at heart.

In *MetaMix* and other similar works of mine, the development process is a natural extension of traditional composition; just as an instrumental composer must imagine how his notation will sound when performed by other people, so I must imagine how my systems will sound when used by other people. This element of prediction, guesswork, and uncertainty continually fascinates me and renews my interest in composition.[27] As composers, our ability to mentally bridge this gap between conception and performance improves as we gain more experience and learn from past mistakes, but the uncertainty never completely vanishes.

In the future, I hope to extend this approach to works which provide deeper, more meaningful interactive experiences. To do so involves many risks: it may become yet harder to identify the work and its creator(s); the risk of "bad" results may increase; and the work may even be viewed by some as a tool rather than as a work of art. But continuing to search for the best balance between developer and user could also lead to works which are increasingly meaningful, engaging, and creative experiences.

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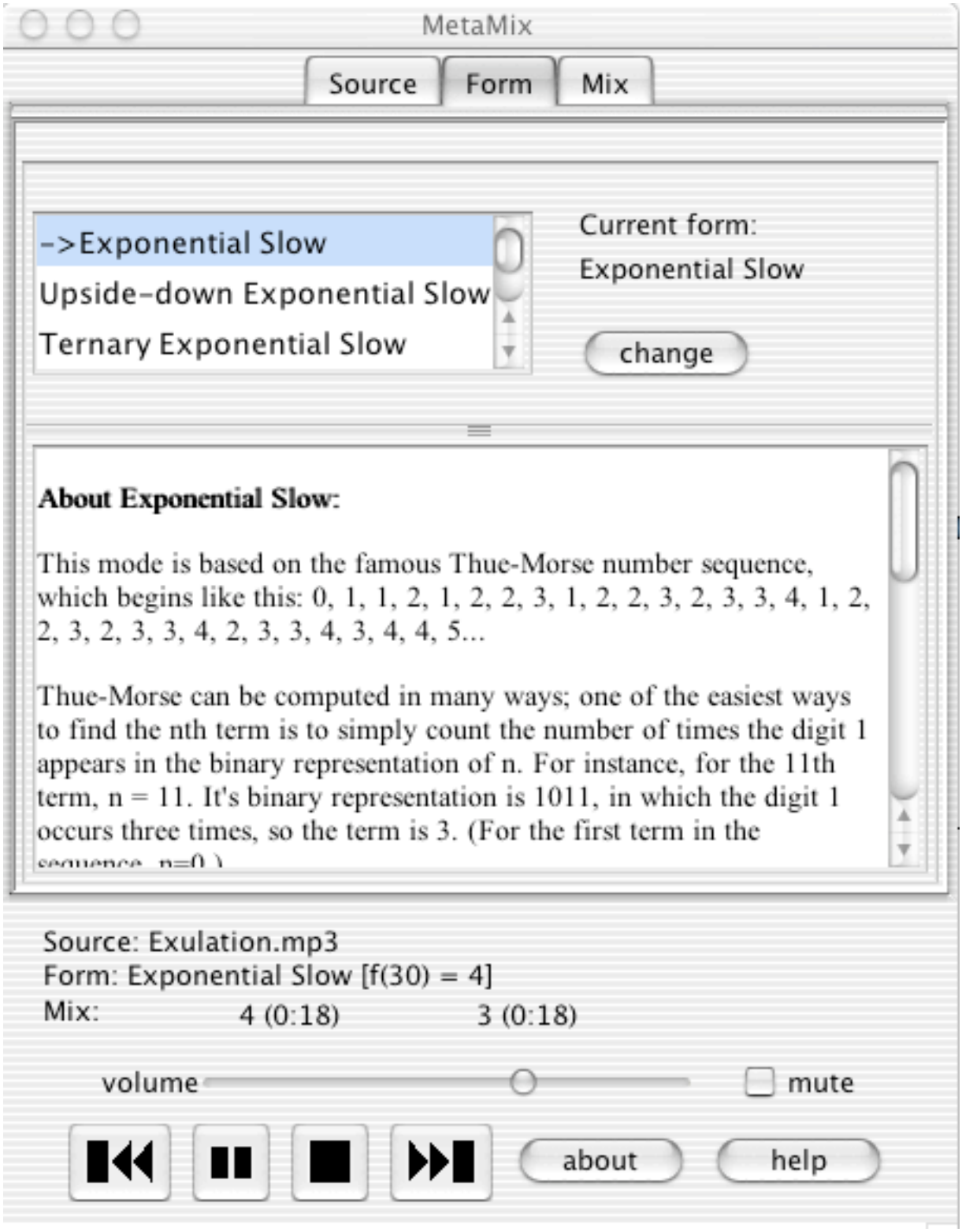
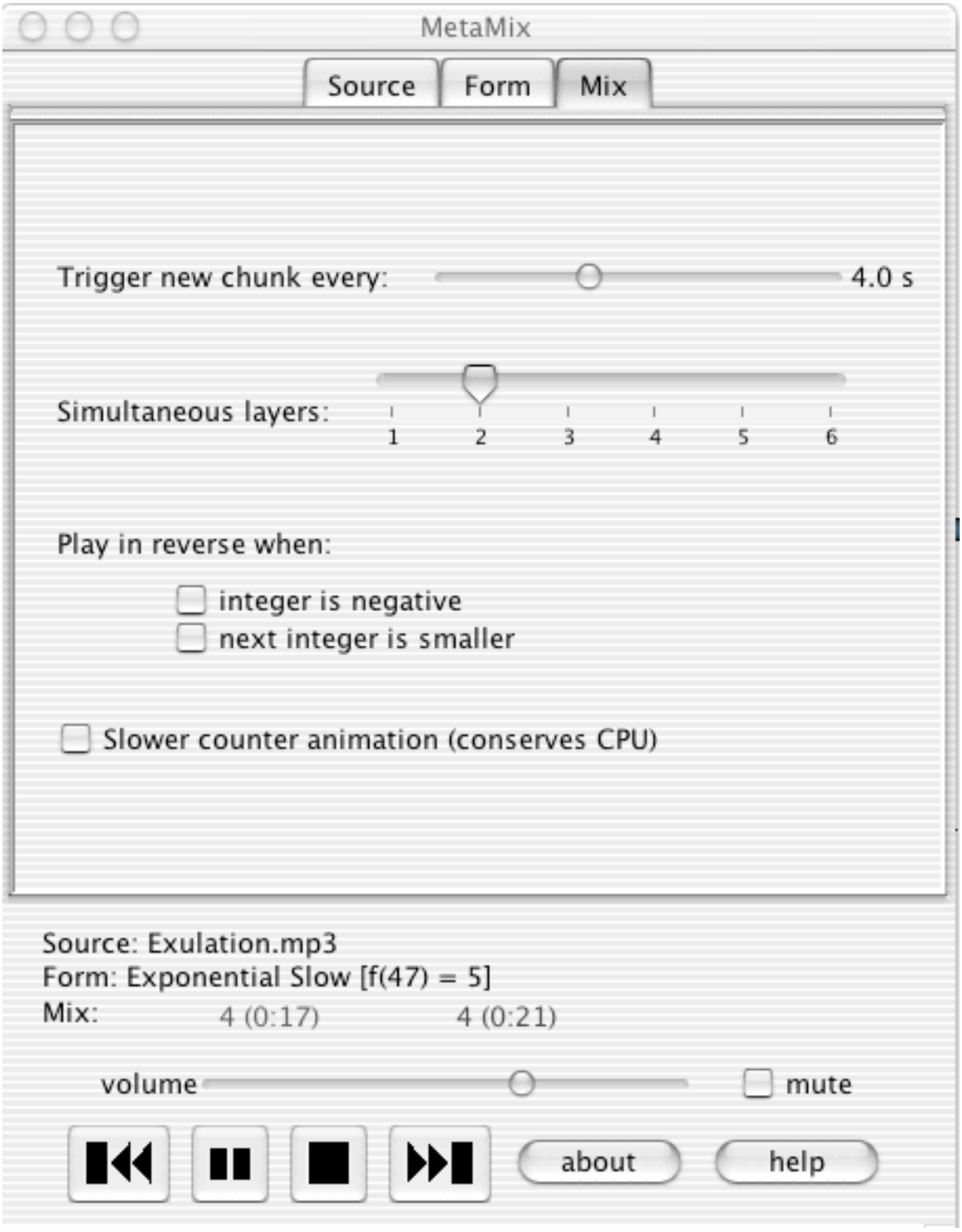
[27] In fact, it is the *lack* of such an element when writing works "for tape" which has discouraged me from pursuing that medium.

Appendix: Screen Shots


MetaMix
Source
Form
Mix
->Exponential Slow
Upside-down Exponential Slow
Ternary Exponential Slow
Current form:
Exponential Slow
change
About Exponential Slow:
This mode is based on the famous Thue-Morse number sequence, which begins like this: 0, 1, 1, 2, 1, 2, 2, 3, 1, 2, 2, 3, 2, 3, 3, 4, 1, 2, 2, 3, 2, 3, 3, 4, 2, 3, 3, 4, 3, 4, 4, 5...
Thue-Morse can be computed in many ways; one of the easiest ways to find the nth term is to simply count the number of times the digit 1 appears in the binary representation of n. For instance, for the 11th term, n = 11. It's binary representation is 1011, in which the digit 1 occurs three times, so the term is 3. (For the first term in the
Source: Exulation.mp3
Form: Exponential Slow [f(30) = 4]
Mix: 4 (0:18) 3 (0:18)
volume
mute
about
help


MetaMix
Source
Form
Mix
Trigger new chunk every:
4.0 s
Simultaneous layers:
1
2
3
4
5
6
Play in reverse when:
integer is negative
next integer is smaller
Slower counter animation (conserves CPU)
Source: Exulation.mp3
Form: Exponential Slow [f(47) = 5]
Mix:
4 (0:17)
4 (0:21)
volume
mute
about
help

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