Contributors' Notes

My Computer-Composed Instrumental Works of the 1980s

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During the 1980s, I produced a series of compositions for live players using programs both to organize the forms and to select the notes. The series included *Crystals* (1980) for string ensemble, *Protocol* (1981) and *Gradient* (1982) for piano, the *Eleven Demonstrations* for clarinet, *Undulant* (1983) for seven players, *Excursion* (1984) and *Artifacts* (1984) for amplified guitar, *Maze* (1986) and *Concurrence* (1986) for violin and *Metaplex* (1993) for flute. In each case, my concrete objective of producing original works was supplemented by a transcendent purpose: to conduct an introspective investigation of compositional decision-making. Almost all of the pieces listed above were paired with articles documenting what my programs did and why [1]. The programs were invariably developed from scratch for each new project. Many relied on artificial intelligence search strategies that leavened "black-and-white" constraints with "shades-of-gray" heuristics.

My emphasis on live instruments rather than computer-generated sounds in the pieces up to and including *Undulant* was necessitated by lack of access to sound-synthesis technology. Beginning with *Excursion* and *Artifacts,* however, I came to embrace my late mentor Lejaren Hiller's view of instrumental idioms as resources to be exploited. Where my earlier programs forced the music to conform to instrumental ranges, hand spans, etc., the material for *Excursion* and *Artifacts* was actively driven by guitar idioms [2]. For *Excursion,* this meant generating a catalog of chords from which the program could choose. *Artifacts* took idiom even further by mapping out each note on the fingerboard and making note selection contingent on the program's ability to derive a plausible fingering. (Since the program's fingerings were only plausible, not optimal, I refrained from indicating them in the score.)

The two guitar pieces also saw the maturation of the method of realizing compositional balances that I call "statistical feedback." There is a synthetic tonality at play in these pieces, wherein passages are characterized by distributions of weights accorded to the chromatic notes. Statistical feedback allowed my programs to realize these distributions in an active way. In effect, it was as if the program were constantly monitoring its own choices and telling itself when to try something new.

The performance of *Artifacts* by Douglas Hensley on the accompanying compact disc is the work's first published recording. It is also the work's first performance by a live player.

References and Notes

1. These articles were published, for the most part, in *Interface: Journal of New Music*. For an overview of techniques, read "Quantifying Musical Merit," *Interface* **21**, No. 1, 53–93 (1992).

2. The programs developed to generate *Artifacts* and its companion *Excursion* are described in "Two Pieces for Amplified Guitar," *Interface: Journal of New Music* **15**, No. 1, 35–58 (1986). A graph profiling *Artifacts* appears on page 50.

Charles Ames is a composer and theorist who has been a pioneer of computer-aided composition and the use of probability theory in music. Through his many pieces and theoretical articles (published in Leonardo, Leonardo Music Journal, Perspectives of New Music, Interface *and* Computer Music Journal), *he has made an important contribution to the history of mathematical and computer-based composition. Ames is the author of the computer-music language Compose.*

Microtonal and Structural Aspects of *My Monodies I and II*

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Tuning

My Monodies I and II is a set of two pieces for microtonal guitar that Larry Polansky requested I compose for him. When Polansky asked me to write the compositions, I wondered how I could write a microtonal piece for normal guitar, given the nature of its fretting. It occurred to me that even though the fretting might be fixed, implying that each string would be in 12-tone equal temperament, the overall tuning of the instrument need not be. My first thought was that if, for example, each successive string on the guitar was detuned by 1/6 of a semitone further than the string before it, one might end up with a unique set of pitches in 72-tone equal temperament. Similarly, if each string was detuned 1/5 of a semitone further than the one before, one could have a guitar in 60-tone tuning. I worked out what the resulting pitches would be for 72-tone tuning. The normal tuning of the guitar was used as a guide for the new tuning:

Normal tuning: E; A; D; G; B; E'
My tuning: E; A–1/6 semitone; D–2/6 semitone; G–3/6 semitone; B–4/6
semitone; E'–5/6 semitone.

In this new tuning, all 72 pitch classes of 72 tone-tuning are available, but not in every octave. Eighteen of the pitch classes occur in only one octave, while the rest occur in two octaves, but each pitch occurs in only one fret position—in other words, there is only one fingering that produces it.

Having worked out the possibilities for this tuning, I wondered if this sort of unique positioning of each pitch would occur in other tunings. I decided to try out the following 24-tone equal temperament tuning: E; A–1/2 semitone; D; G–1/2 semitone; B; E'–1/2 semitone.

This produced a pitch set in which all pitch classes occur in more than one octave and many pitches can be produced by more than one fingering. It was apparent, then, that each different tuning would produce a different set of voicing and register possibilities for its scale. This would affect the melodic contours available in a particular tuning.

I then realized that if one played pitches occurring only on every second, third or fourth fret of the fret-board, one could also play in tunings that were subsets of the original scale. For example, playing every second fret in 60-tone tuning would result in 30-tone tuning; every third in 20-tone tuning; every fourth in 15-tone tuning. Taking into account all the possibilities for detuning strings by 1/6, 1/5, 1/4, 1/3 and 1/2 semitone, we find that the following equal temperaments are possible on a normal guitar: 6-, 8-, 9-, 12-, 15-, 16-, 18-, 20-, 24-, 30-, 36-, 48-, 60-, and 72-tone tunings. While this is not an exhaustive list of equal temperaments by any means, and still does not allow for just intonation (which would require unequally spaced frets), it struck me that this was nonetheless an impressive list of tunings possible without refretting the guitar. (Applying this method to a refretted guitar such as one tuned in 19-tone equal temperament would produce a further set of unusual scales.)

Program

Having decided on my tunings (72-tone for *My Monodies I* and 24-tone for *My Monodies II),* I decided that I would make the pieces by using a composing program that I would write. I was intrigued by the way James Tenney had used lattice-like structures with 72-tone tuning to produce a music that was extremely close to just intonation and yet still allowed for modulation that would return to a home point on the lattice. Many intervals in 72-tone equal temperament are extremely close to just intonation. Seventy-two-tone tuning offers the sound of just-intonation intervals with the structural characteristics (such as modulation and chains of equal intervals) of an equal temperament. I decided that I would make a four-dimensional lattice, each axis of the lattice being one 72-tone interval that was very close to a just-intonation interval. The guitar's monophonic melodies would consist of wanderings around this four-dimensional lattice. For this piece, the four intervals I chose were 23 steps, 383 cents (3 cents flat of 5/4); 37 steps, 617 cents (exactly in tune with 10/7); 47 steps, 783 cents (1 cent sharp of 11/7); and 61 steps, 1017 cents (1 cent flat of 9/5). In traditional musical terms, this meant that the melodies consisted of movements by just major thirds, augmented fourths, flat minor sixths and just minor sevenths. However, the voicing of these intervals (within an octave, or leaping over one or more octaves) was determined by the pitches available in the given tuning.

The program generated melodies in the following way. First, a Chosen Melodic Set was derived from the Source Set (the four intervals described above). The Chosen Melodic Set consisted of four elements, each of which was an interval from the Source Set. Any of the intervals could be chosen for any of the elements, so duplications could occur. For example, a particular melody might be generated by a Chosen Melodic Set consisting of two 23-step intervals and two 61-step intervals. The next melody might be generated by a Chosen Melodic Set of one 37-step interval, one 47-step interval and two 61-step intervals. All melodies began at pitch 0 and would end when 0 recurred. To produce a melody, I numbered the elements in a given Chosen Melodic Set from 1 to 4. An integer from 1 to 4 was chosen by equally weighted random selection. The interval corresponding to that number in the Chosen Melodic Set was then added to or subtracted from the previous pitch to produce the value of the next pitch. For example, if 23 was the first interval chosen, the first pitch after 0 would be the twenty-third step in the scale. This procedure was repeated to obtain each pitch of the melody until pitch 0 was reached again and the melody ended. Various factors were built in to ensure that no melody was shorter than three notes or longer than 83 notes.

In the 24-tone piece, there was a wider range of source intervals to choose from. Seven intervals were used as possible axes of the lattice. They were 2 steps (100 cents); 6 steps (300 cents); 8 steps (400 cents); 11 steps (550 cents); 14 steps (700 cents); 17 steps (850 cents); and 19 steps (950 cents). In traditional musical terms, this meant that possible intervals in the melody would be minor second, minor third, major third, perfect fifth, perfect fourth plus a quarter tone; minor sixth plus a quarter tone; and major sixth plus a quarter tone. Unlike 72-tone tuning, 24-tone tuning is neither equivalent nor close to any sort of just tuning. It is simply its own tuning with its own qualities.

The pieces are designed to be played in succession. I intended the extremely limited interval set of the 72-tone piece to produce a sense of a constrained melody that would then be followed by the varied, open quality of the more free set of intervals in the 24-tone movement.

Transcription: Musical Practicalities

The program generated melodies in the following form:

Melody No. 3
Intervals used: 61 23 47 23
0L 23U 46U 69L 44L 33L 44U 69L 46U 35L 10U 33L 22L 47L 36U 25U 2U 49L 0L
19 Notes in Melody.

"L" and "U" were used to determine which octave a note was to appear in, if there was a choice available. From this chart, a diagram of the guitar's fretboard was consulted when transcribing the piece into traditional (or microtonally adapted traditional) notation (see Fig. 1 for the score of Melody No. 3). If the leap from one note to the next was less than five frets, the second note would follow the first immediately. If the leap was five frets or greater, a rest would occur to allow the fingers time to move to the new fret. If a note was both approached and left by leaps of five frets or greater, it would exist as an isolated note with silence surrounding it. So the division of each melody into short melodic phrases and single notes was determined by the physical layout of the pitches available in that tuning. This resulted in more single notes in the 72-tone piece and longer phrases in the 24-tone piece. Each melody was separated from the others by longer silences than those that separated the phrases and single notes within the melodies.

I wrote up the following instructions for the performer:

> A piece for guitar (electric preferred) and reverb. Use reverb to make clouds of harmonies in the afterglow of each phrase.
> Softly.
> Sweetly.
> The timbral sweetness of Jim Hall or Earl Klugh with the mediative calm of Erik Satie or John Cage.
> Think of connected phrases (no matter how long) or isolated single notes as one relaxed, full breath.
> Phrase it like breathing.
> Little vibratos or bends (but not too many) may be added to notes, especially notes at the ends of phrases.

Thus we have a piece in which the tuning of the strings results in a set of pitches that affects both the melodic contours available and the rhythmic shape of the phrases. An algorithmic process used to generate melodies with particular characteristics is then subjected to the physical realities of the system it is being applied to. Whether this has anything to do with the

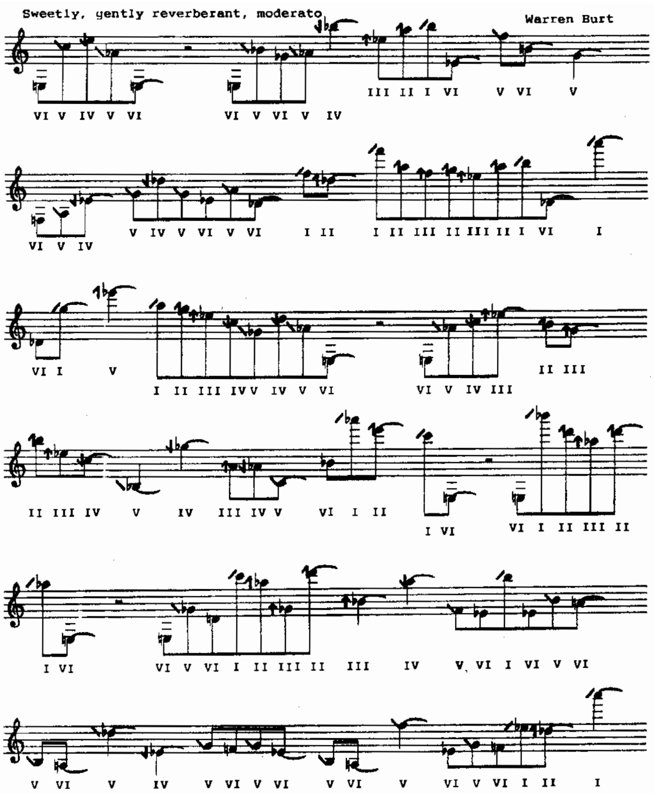

Fig. 1. Warren Burt, page 1 of *My Monodies I* for 72-tone guitar (1996). Melody number 3 begins after the half-rest on the third staff and continues until the half-rest on the fourth staff.

pun involved in the title is open to question, but perhaps this explanation can be my version of a "guide for the perplexed" [1].

Note

1. The pun refers to Moses Maimonides, author of *The Guide for the Perplexed* (New York: Dover, 1956).

Warren Burt was born in the United States and studied there. In 1975, he moved to Australia, where he is a freelance composer, writer, radio producer and video and computer-graphics artist. He has received a number of fellowships and residencies and has occasionally taught. He both performs his own music and writes for others.

NOTES ON "*. . . STILL PLENTY OF GOOD MUSIC . . .*"

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Ambiguity, where it arises, signals a difficult relation between sense data and cognitive process, but not a property intrinsic to sense data by itself. Artists, as contrivers of sense data, may choose, in any given aspect of their work, either to court ambiguity or to shun it in pursuit of clarity. A turn to ambiguity represents a decision to dwell on the cracks of human perception, and this means directing one's art to that form of intelligence peculiarly human; seeking clarity instead means making art in the service of a more robust model of intelligence. In a practical sense, this may seem an empty distinction, what with no other kind of intelligence but human to consume art (and perhaps no other kind at all). Even so, we possess the ability to posit and contemplate alternative intelligences without human quirks, and also to decide, as artists, whether and when we find the mind more interesting doing what it does well or doing what it does poorly.

The status of ambiguity depends on the medium. The acuity of the human vision system, even when untrained, with respect to parsing and categorizing the constituents of the visual scene means that the creation and exploitation of ambiguity in the visual arts comes at a premium. By contrast, the untrained ear has noted difficulties analyzing complex configurations of sounds—especially the sorts of sounds that traditionally constitute music, so one must work very hard to convey musical ideas clearly.

As a composer, I do generally aim to convey complex structural ideas as clearly as possible, even to ears without any special training beyond that which comes, ideally, from repeated and informed listenings to the particular piece in question. Thus, I usually view sound as a carrier for the beauty of structure, rather than structure as a tool in service of the beauty of sound. As such, I avoid fragile effects that could render my structural ideas illegible. That said, the guitar piece "*. . . still plenty of good music . . .*", written and dedicated to Larry Polansky, represents something of a departure for me. Indeed, the original impulse from which it springs has the shape of a psychoacoustical question: what do we hear when we listen to a steady metrical pulse gradually degrading?

Cognitive psychology suggests one way to approach the phenomenon. Because the initial unvarying durations generate a provisional expectation of continuing constancy, we can model that perception with a Bayesian prior distribution [1] having zero variance. Then, on account of that prior, we can expect the mind to filter the first, most minor, disturbances to the uniformity of the event sequence. In effect, the mind will dismiss the changes as imperfections, not of the rendition, but of its own perceptual apparatus. Filtered, these deviations either produce no conscious effect at all or they somehow color our experience, but not in a way the mind consciously connects to the rhythmic instability. For each given listener, at some point the pulse will degrade sufficiently to cause a catastrophic perceptual phase change. With the durational variation suddenly undeniable, we will perceive the instability directly. We will update our prior accordingly, introducing positive variance. Later, further degradation will bring a moment for each of us when we lose the sense of pulse entirely.

One question leads to another. How would these cognitive intricacies affect the efforts of a human performer attempting to reproduce the gradually destabilizing rhythm? What differences would the changes the human performer unwittingly introduces make to our perception of sequence?

All this demands the obvious caveat: a work of experimental music does not constitute a scientific experiment. The artist and the scientist seek different sorts of knowledge: the artist, in particular, pursues the intrinsically private knowledge generated by the interaction of direct experience and memory, about which science passes over in silence.

The composition of this piece involves some further conceptual layers. Indeed, the overall form derives from a kind of pun. One may describe a steady stream of uniform durations as degenerately random in two opposite ways: either as independently occurring but unvarying durations, or as variable but fully correlated durations. So I made a round trip from order to chaos to order, coming and going by divergent routes to expose the double meaning of unchanging constancy.

In more technical detail, during the first half of the piece, the durations, measured on a logarithmic scale, conform to a