Wannamaker, R. (in press 10/2007). North American Spectralism: The Music of James Tenney. In Reigle, R. & P. Whitehead (Eds.*), Istanbul Spectral Music Conference, Nov. 18–23, 2003*. Istanbul, Turkey: Pan Yayincilik.

NORTH AMERICAN SPECTRALISM:

THE MUSIC OF JAMES TENNEY

Robert A. Wannamaker

INTRODUCTION

Since 1971, the works of American-Canadian composer James Tenney have exhibited many of the technical and stylistic earmarks of what has since come to be called "spectral music." In particular, his *oeuvre* includes very early examples of instrumental music involving orchestrations of the harmonic series and of pitch relationships derived from it, "instrumental synthesis" based on spectral analysis, the orchestration of electro-acoustic sounds, structural concepts derived from acoustics and psychoacoustics (including Shepard tones, difference tones, harmonic fusion, and residue pitches), gradual formal processes, and a general preoccupation with the phenomenology of sound. This paper provides an introduction to this important and under-recognized body of work, relating it to an American phenomenological aesthetic descended from John Cage and Harry Partch. Tenney's work is considered as representative of a previously unacknowledged indigenous North American school of spectral music composition that also includes such composers as Larry Polansky and John Luther Adams.

PRECEDENTS

Among James Tenney's compositional output since 1971 are over forty significant works that can properly be regarded as spectral music. His multifaceted explorations of perception in many ways parallel, in some instances anticipate, and sometimes interestingly contrast with musical developments in Europe. This paper considers Tenney's work and its influence as representative of a significant and virtually unacknowledged tradition of spectralist composition whose technical and aesthetic roots are distinctly North American.

Tenney's spectralism is the product of a long and complex personal history reflecting his ongoing interests in both science and music. Born in 1934 in Silver City, New Mexico, his early academic studies included engineering at the University of Denver (1952–54) as well as piano with Eduard Steuermann at the Julliard School (1954–55), and composition and conducting at Bennington College (1956–58) with Lionel Nowak and Henry Brant, respectively. His compositions from this period betray the influences of Arnold Schoenberg, Anton Webern and Edgard Varèse, as well as a characteristic pithiness and conceptual clarity.[1]

In 1961, Tenney earned a Master's degree in composition from the University of Illinois at Urbana-Champaign, where he studied composition with Kenneth Gaburo and electronic music with Lejaren Hiller. His Master's thesis, entitled *META + Hodos: A Phenomenology of 20th-Century Musical Materials and an Approach to Form* (Tenney 1988 [1964]), applied principles of Gestalt psychology to the perception of musical forms and has proven widely influential. During this period, he also played in Harry Partch's Gate 5 Ensemble, and Partch's harmonic theories (Partch 1974 [1949]) have been one inspiration, among others, for Tenney's own theory of harmonic perception (Tenney 1993 [1983]).

From 1961–64 Tenney was employed as a member of the technical staff at Bell Telephone Laboratories (now AT&T Bell Laboratories) in New Jersey. While there, he composed some of the earliest substantial pieces of computer music and conducted pioneering research on algorithmic composition, psychoacoustics, timbre modeling, and computer sound

[1] Most of Tenney's major works completed between 1960 and 1980 receive detailed examination in Larry Polansky's book-length analytical study of his music (Polansky 1983), which still constitutes the single most important scholarly resource for anyone interested in Tenney's work.

generation, with Max Mathews.[2] The detailed technical experience that he acquired with acoustics, psychoacoustics, spectral analysis, signal processing, and information theory during this time period has informed much of his subsequent compositional work, and his spectralist music in particular.

During this time, Tenney also studied composition privately with Chou Wen-chung (1955–56) and informally with Carl Ruggles (1956–58), Edgard Varèse (1956–65), and John Cage (1961–69). Exposure to Cage's Zen-related phenomenological attitude towards "letting sounds be themselves" (Cage 1961) had already made a strong impression on the young composer before this time. Tenney has said that "... people having difficulty with 20th-century music are not hearing sound because they're not in a frame of mind to simply listen to sound for itself. That's why Cage is indispensable ..." (Tenney 1984). In this attitude one finds significant commonality with the empirical orientation of the psychoacoustician, who also creates, attends, refines, compares, and contemplates sounds. The obvious difference is that for a composer such as Tenney the exploration of sound-as-heard offers not only an opportunity for conceptual refinement but also an affecting sensuous experience and an avenue to heightened self-awareness. An attraction, both intellectual and sensuous, to sound as a phenomenon—to differentiating, experiencing, and appreciating its facets, and to personally becoming more fully aware of how the perceiving self is constituted—would bring him to employ spectralist means in the exploration of timbral and harmonic perception.

During the 1960s, Tenney was peripherally involved in the Fluxus art movement and was also an original performing member in both the Steve Reich Ensemble (1967–70) and the Philip Glass Ensemble (1969–70). While his interest in gradual formal processes precedes his involvement with these so-called "minimalist" composers (appearing earlier in certain of his computer music compositions), his work since 1967 has frequently embraced unidirectional processes of the sort also recognizable in, for

[2] Tenney's recorded musical works from this period are available as *James Tenney: Selected Works 1961–1969*, New World Records CD 80570. An analytical survey of these works is available in (Polansky 1983), a version of which constitutes the liner notes to the CD release (Polansky 2003). In (Tenney 1969), the composer himself has published analyses of these works and an account of his time at Bell Labs. Technical aspects of the research that Tenney conducted on sound synthesis and timbral modeling there appears in (Tenney 1963), one of the very first publications regarding computerized sound synthesis directed towards musicians.

instance, Reich's *Come Out* (1966). In particular, between 1965 and 1971 Tenney composed a series of ten so-called *Postal Pieces*, which he printed on postcards in 1971 and sent to his friends. Several of these simple but very effective little pieces exhibit such gradual unidirectional formal processes and also bear other proto-spectral features. For instance, *Swell Piece No. 2* from 1971 asks performers to sound A_4 (440 Hz), repeatedly entering *dal niente*, increasing in intensity, and then fading back out *al niente* in a manner rhythmically independent of one another. With sustained communal concentration, the intonation of the ensemble will progressively improve so that successively higher harmonics of A_4 will begin to ring out,[3] encouraging listeners to "hear-out" these partials within the composite harmonic spectrum.[4]

EARLY SPECTRAL WORKS

Although Tenney's *Postal Pieces* share a phenomenological orientation and the use of gradual formal processes with the more paradigmatically spectralist music he soon began writing, his experiences at Bell Labs in the early 1960s were probably a more direct precedent for this compositional development. Indeed, his next work was an orchestration of the Shepard-tone concept. Tenney knew of the associated phenomenon from his sojourn at Bell Labs alongside cognitive psychologist Roger Shepard—after whom the phenomenon is named—during the period of time when Shepard first investigated it.[5] In 1969, Tenney had produced an electro-

[3] Note that all pitch specifications in this paper follow the Acoustical Society of America's pitch designation system, so that A_4 is 440 Hz, the pitches in the octave including and above middle C are C_4–B_4, and the lowest C on a conventional 88-key piano keyboard is C_1.

[4] The reason is that if the fundamental frequencies of two complex tones in a unison dyad are mistuned by a frequency difference f_2-f_1, (which will be the frequency of beating between them) then the n-th harmonics above these fundamentals will be mistuned by a frequency difference nf_2-nf_1=$n(f_2$-$f_1)$. Thus, once the intonation has improved sufficiently so that the rate of beating between lower harmonics is no longer distracting, the beating between relatively higher harmonics becomes noticeable due to its greater rapidity.

[5] A Shepard tone is a collection of sine tones, separated in pitch by octave intervals, all of which are *glissad*-ing or stepping upwards together at a common rate in semitones per second. Each tone is individually subjected to an identical amplitude envelope such that it gradually "fades in" beginning at some given bass pitch, attains

acoustic piece based on the phenomenon entitled *For Ann (rising),* and in 1971 he undertook an orchestration of that work.

FOR 12 STRINGS (RISING) (1971)

The result was *For 12 Strings (rising),* scored for two contrabasses, three cellos, three violas, and four violins.[6] In this work each instrument executes an ostinato consisting of an upwards *glissade,* but the instrumental parts are carefully dovetailed in both pitch and dynamic to give the impression of a collection of overlapping tones smoothly rising more than five octaves from F_1 to A_6 and separated by intervals of a tempered minor sixth.[7] The audible effect of the piece cannot be reliably assessed, since it has never been performed. If the electro-acoustic *For Ann (rising)* is any indication of what to expect, then the texture, although physically quasi-static, will prove audibly complex and unstable as the ear skips between voices, compulsively creating its own non-deterministic melodies and counterpoint despite the uniformity of the objective stimulus. *For 12 Strings (rising),* while it addresses a specific phenomenon apparently not explored in other spectralist instrumental works, clearly bears many of the principal earmarks of spectral music as it is described in the literature (cf. Fineberg 2000). It is, for instance, a deliberate orchestration of a particular spectrum, undertaken with attention to phenomenology rather than semantics, and exhibits a process-form and expanded temporal scale that facilitate exploration of the music as a phenomenon. Furthermore, like many other

---

a dynamic plateau, and then "fades out" as it approaches a given treble pitch. The impression imparted to a listener is that of a tone rising continuously in pitch without getting higher; see (Shepard 1964).

[6] Scores for those of Tenney's works that were composed before 1986 are available from Smith Publications http://www.smith-publications.com/. Works composed during 1986 or thereafter are available from Frog Peak Music http://www.frogpeak.org/ or the Canadian Music Centre http://www.musiccentre.ca/. As of June 2006, a fairly complete list of Tenney's works to July 2002 as well as a discography and bibliography are available on the World Wide Web at The Living Composers Project, http://www.composers21.com/compdocs/tenneyj.htm.

[7] Note that the outcome differs from a conventional Shepard's Tone, in which the interval between sine waves is an octave. In the electro-acoustic *For Ann (rising)* this difference results in a correspondingly more complex phenomenon, with combination tones, beating and ephemeral artifacts audible in the musical background.

spectral compositions, it is an orchestration of electro-acoustic source material.

CLANG (1972)

Tenney's next work was *Clang* for orchestra, of 1972. In addition to the formal and aesthetic features already observed in *For 12 Strings (rising)*, *Clang* exhibits several more that are also characteristic of much other music described as "spectral." For instance, it takes the harmonic series as a point of reference and employs microtonal tunings in order to approximate intervals within that series. It also applies filtering-like operations to pitch materials. Finally, a distinctive relationship between pitch sets that is observable in many purportedly spectralist works is found in *Clang*. Suppose that by the term "conceptual fundamental" we refer to the highest pitch, sounding or not, of which all tones in a given pitch set may be regarded as harmonics. Then an important structural principal appearing in *Clang* involves the use of successive pitch sets whose conceptual fundamentals progress by octaves. Tenney's structural use of such relationships in *Clang* predates their use by such composers as Gérard Grisey, in whose music these increases or decreases of the conceptual fundamental by octaves Françoise Rose (1996) associates with motion towards "harmonicity" or "inharmonicity," respectively.

Clang is 15'30" in duration and successively presents two gradual processes, the first accumulative and the second dissolutive. These are separated in time by a single fortississimo percussive attack or "clang," with similar "clangs" initiating and concluding the piece. The pitch gamut employed is restricted to the first eight prime-numbered harmonics of an E fundamental and their octave equivalents, which together constitute a sort of just-intoned octatonic scale. The intonation of these pitches is approximated using tempered quartertones.[8] The score is divided into 17 sections cued by the conductor, which indicate different sets of pitches available to the players using a scheme that the composer dubs an "available pitch process." The score to Clang describes the process as follows:

> ... the notation indicates available pitches to be played by sustained-tone instruments (including rolls on the percussion instruments) in the following way: each player chooses, at

[8] The demanded accuracy of intonation has increased over the course of Tenney's output, stabilizing at an ideal tolerance range of plus-or-minus 5 cents in the mid-1980s.

> random, one after another of these available pitches (when within the range of his or her instrument), and plays it beginning very softly (almost inaudibly), gradually increasing the intensity to the dynamic level indicated for that section, then gradually decreasing the intensity again to inaudibility ... After a pause at least as long as the previous tone, each player then repeats this process ...

Here, then, is an important attribute distinguishing *Clang* and many of Tenney's other works from most European spectral music: a post-Cageian espousal of indeterminacy with regard to certain musical features such as timbre and texture, albeit carefully constrained so as to ensure that the resulting variety displays desired aspects of uniformity and evolves in a deliberate fashion.

The opening accumulative formal process begins from an available pitch set comprising E_4 alone. The compass of this available set expands in stages, almost as though the bandwidth of an ideal bandpass filter were being gradually increased to pass more and more frequency components. A massive dissonant noise-like sonority thus gradually unfolds, its texture and timbre constantly fluctuating as instruments enter and leave. The expansion concludes and the second "clang" sounds when all pitches in the just-octatonic set between E_1 and E_7 are available.

At this point, the conceptual fundamental of the entire available pitch set is an infrasonic E_{-3}. The available pitch set in the next section retains only those pitches regarded as harmonics of E_{-2}, deleting some of the lower pitches from the available set so that the conceptual fundamental rises by an octave. The conceptual fundamental is similarly raised by one octave in each successive section; that is, the fundamental of the available pitch collection progressively rises so that the texture grows increasingly consonant and recognizably "harmonic." This transition from a noise-like sonority to a tonal (in the sense of "pitched") sonority provides the large-scale formal trajectory of *Clang*'s second half. Pitches in the pitch class E are treated specially insofar as they are not deleted from the available set, so that at the music's close the sounding pitch collection comprises all of the E's between E_1 and E_7. As this conclusion is approached, the highest sounding pitches become perceivable alternately as discrete tones or as gradually fluctuating timbral colorations of the lowest sounding E (E_1), since they all coincide with harmonics of this pitch.

Figure 1 shows two successive available pitch sets from the second half of *Clang*. For the first set (i.e., in Section 9 of the score) the nominal fundamental is E_{-1}. In the second set (Section 10), it is E_0. Accidentals in parentheses represent quarter-sharps and quarter-flats. Filled noteheads

correspond to pitches that will be deleted from the available pitch set in the next section, when the conceptual fundamental will be E_1.

Like *For 12 Strings (rising)*, *Clang* was published but never received a concert premiere, although it was given a promising reading by the Los Angeles Philharmonic shortly after it was composed.

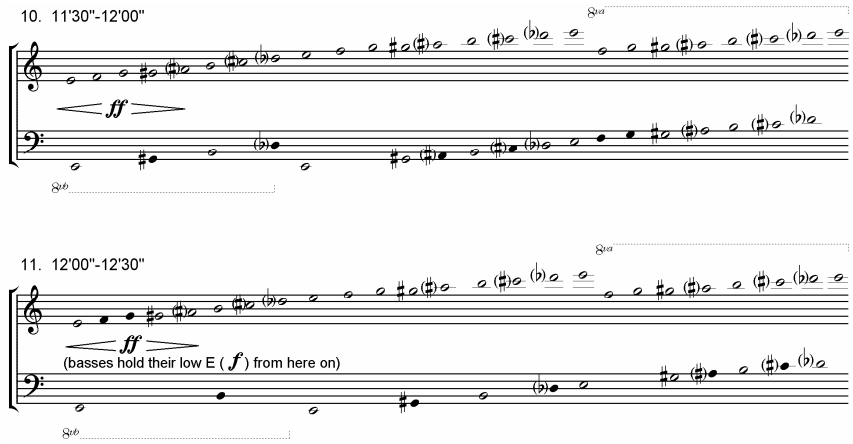

Figure 1. Two successive available pitch sets from *Clang*. Quarter-sharps and quarter-flats are indicated using parentheses. (Copyright 1972 by Sonic Art Editions. Used by permission of Smith Publications, 2617 Gwynndale Ave., Baltimore, Maryland 21207.)

QUINTEXT (1972)

Quintext, also composed in 1972, is a suite subtitled *Five Textures for String Quartet and Bass*, of which the first, third, and fifth parts exhibit spectralist aspects. The fifth, entitled *Spectra for Harry Partch*, is a particularly remarkable construction that achieves very precise tuning of intervals in the harmonic series above F_1 using an ingenious system of *scordatura*. The bass tunes its E string to this F, then plays odd-numbered natural harmonics on this string (up to the eighth) to which the other instruments then tune their open strings. Throughout most of the piece, the bass plays a drone on this open F, while the other instruments play only open strings and natural harmonics up to the seventh. In this way, very accurately tuned harmonics of F_1, as high as the 105^{th}, are attainable. Rhythm is notated proportionally but pitch is fully specified, with increasingly higher

harmonics being gradually (but irregularly) introduced over the course of the piece. The score indicates that tones other than the *mezzo forte* bass drone should be very soft, "hovering near some threshold between being heard as individual tones at all, on the one hand, and being heard simply as intensifications of some harmonic in the spectrum of the bass's low F." The evolving result is an austere and unearthly textural web—a meditation on the unstable relationship between pitch and timbral perception as the sounds of the various instruments alternately fuse and segregate.

SPECTRAL CANON FOR CONLON NANCARROW (1974)

The *Spectral CANON for CONLON Nancarrow*, completed in 1974, is a work of singular musical impact and highly sophisticated construction.[9] Written for a player piano retuned to sound the first 24 harmonics of A_1, it is a canon in 24 voices. Each voice implacably reiterates just a single pitch from the given harmonic set while executing a smooth accelerando. The sequence of time durations between successive attacks is identical in each voice, but successively higher-pitched voices enter at successively later times. The sequence of durations between the first attack in a given voice and successively later attacks in that voice is a logarithmic sequence, just as the harmonic series is a logarithmic sequence in units of tempered pitch. Thus, an ingenious isomorphism exists between the pitch and rhythmic structures of the piece. In fact, a more detailed analysis than is practical here reveals that the entrance times of the various voices are carefully specified, so that the temporal pattern of attack-time coincidences between any given set of voices is identical to the pattern of pitch coincidences between harmonic partials within the set of tones concurrently attacked.

As successively higher voices enter, they combine in increasingly complex polyrhythms, eventually resulting in a chaotic maelstrom of sound. At the instant when the highest voice enters, the lowest voice begins to retrograde, decelerating. Successively higher voices also begin retrogrades, but at successively later times. Slowly an unexpected transformation unfolds in the form of harmonic glissandi sweeping progressively higher in pitch, and the instrument begins to ring as though sounding a single shimmering

[9] The following recordings featuring Tenney's *Spectral CANON* are available: *Cold Blue*, Cold Blue Music CB0008, compact disc; also *Donaueschingen Musiktage, 1994*, col legno WWE 3CD 31882, compact disc; also *Musicworks* 27 Cassette. A score is available in (Tenney 1976) and *Musicworks* 27 magazine.

harmonic complex (see **Figure 2**). Just as the lowest voice finishes its retrograde—at which time it turns out that the highest voice is just about to begin its retrograde—all 24 voices attack simultaneously for the first time in the piece, which concludes with this coincidence. Due to the precise harmonic relations obtaining between the coincident pitches, this final attack does not sound like multiple voices. Instead, it sounds like a single fused harmonic tone originating from a sort of "hyper-piano," which has been produced by means of additive instrumental synthesis from 24 constituent piano tones. It is as though the components of this final tone, heard in separation at the opening of the piece, are forcefully smashed back together into a unified percept at its conclusion.

One might suppose that correspondences between pitch and temporal structures would be conceptually attractive to composers of spectral music seeking means of organizing rhythm. Tenney appears to have been unique, however, in exploring this compositional avenue. Precedents for rhythmic analogues of harmonic series relationships can be found in the works and writings of Henry Cowell (Cowell 1996 [1930]) and Conlon Nancarrow (Gann 1995), but these composers did not attempt detailed structural integration of pitch and rhythm. After composing the *Spectral CANON*, Tenney went on realizing such integration in other ways, using live performers in the *Three Harmonic Studies* (1974) for orchestra, *Septet* (1981) for six guitars and bass, and *Song 'n' Dance for Harry Partch* (1999) for Partch-instruments, strings, and percussion.

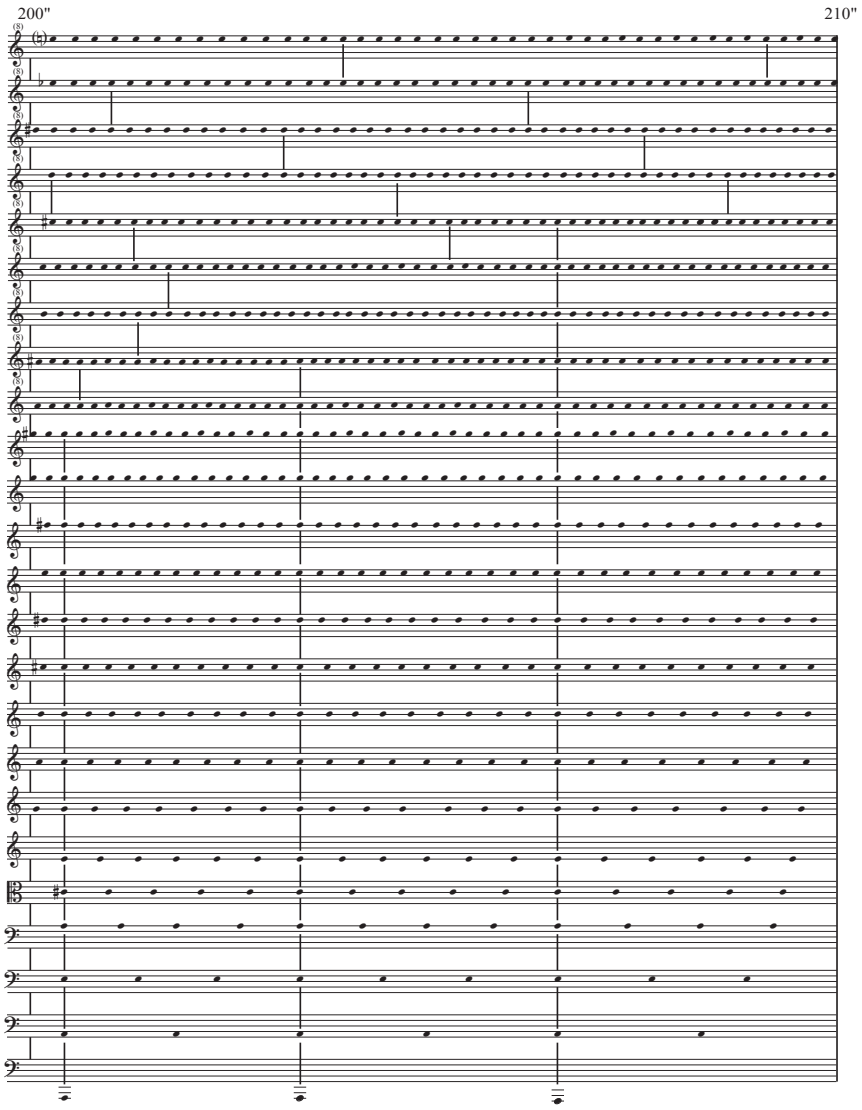

Figure 2. The penultimate page of the score to *Spectral CANON for CONLON Nancarrow* (redrawn). Vertical lines indicate precise attack-time coincidences. Note the increasing pitch compass of both the coincidences between lower voices and the harmonic glissandi that flank

them. (Copyright 1974 by Sonic Art Editions. Used by permission of Smith Publications, 2617 Gwynndale Ave., Baltimore, Maryland 21207.)

OTHER EARLY SPECTRALIST WORKS

Tenney produced several other significant spectralist works around this time. Among these is the *Chorales for Orchestra* of 1974, which presents eight lyrical melodic lines in rhythmic unison moving in parallel motion over the "just-octatonic" set used in *Clang*. Each line begins on a different pitch class of the set so that at any given instant all eight possible pitch classes are sounding, with changes in the initial voicing and the instrumentation taking place between sections of the work. Two striking impressions coexist upon hearing this unique piece: that of lyrical melody and that of a single modulating spectrum.

Two important but unpublished works also date from 1974. The *Orchestral Study* bears some formal resemblance to *Clang*, but employs spectrally colored noise textures in addition to tones in order to effect gradual transitions between noise and pitch. The *Three Harmonic Studies* for small orchestra explore, among other concerns, filtering-like operations on orchestrations of the harmonic series and analogies between pitch and durational structures.

Beginning shortly after this, Tenney began to explore the use of tape delay systems in combination with live instruments in order to produce dense spectra with smaller instrumental forces. His first work in this vein was *Symphony* (1975) for woodwind quintet and tape-delay system, but the composer describes this work as currently "withdrawn" due to dissatisfaction with its notation. Tenney's most sophisticated work in this vein is the elaborate three-voice canon for ensemble and multiple tape-delay systems entitled *Voice(s)*, dating from 1983. However, the simpler 1978 composition *Saxony* for one or more saxophonists and tape-delay system exemplifies the technical concept underlying these pieces well, and has been repeatedly recorded.[10]

The score of *Saxony*[11] fits elegantly on a single page. It allows for realizations by multiple saxophonists, but it has almost always been

[10]Tenney, James. *Saxony*, on Ulrich Krieger, *Walls of Sound*, oodiscs 32, compact disc; also on Henrik Frisk, *Inventions of Solitude*, Hornblower CD HR 96101, compact disc; also on David Mott, CRI LP SD 528, vinyl record.

[11] The title, literally regarded, refers to a cloth or tapestry woven from a fine variety of wool.

performed by a single performer switching between baritone, tenor, alto, and soprano saxophones. An available pitch process is again employed drawing upon pitches in a harmonic series, specified in the score using conventional notation with deviations in cents from equal temperament indicated above the notes. The score indicates that it "is intended as the basis for an improvisation which—though quite free in many respects (rhythmically, melodically, expressively, and even stylistically)—is totally controlled *harmonically*." The notes indicate that the tape-delay's delay-time-interval should be about 12 seconds and that its fade-out time should be long—it's on the order of a minute in the recorded versions. Thus, the tape system repeatedly reintroduces pitches previously played.

The piece is divided into nine "segments"; with successive segments increasing in nominal length from two minutes to three minutes and then decreasing symmetrically back to two minutes. The total resulting duration is 22 minutes, but Tenney indicated that in performance these timings should be regarded as flexible. **Table 1** shows the complete progression of available pitch sets over the course of the piece, along with their conceptual fundamentals and nominal starting times. The first four segments of the score are shown in **Figure 3**.

Table 1. The sequence of available pitch sets in *Saxony*.

Segment	Nominal Starting Time	Conceptual Fundamental	Available Pitches (Harmonics of Conceptual Fundamental)
1	00'00"	E-flat$_2$	1
2	02'00"	E-flat$_2$	2-3
3	04'15"	E-flat$_2$	4-7
4	06'45"	E-flat$_2$	8-15
5	09'30"	E-flat$_1$	16-32
6	12'30"	E-flat$_1$	8-15
7	15'15"	E-flat$_1$	4-7
8	17'45"	E-flat$_1$	2-3
9	20'00"	E-flat$_1$	
End	22'00"	E-flat$_1$	

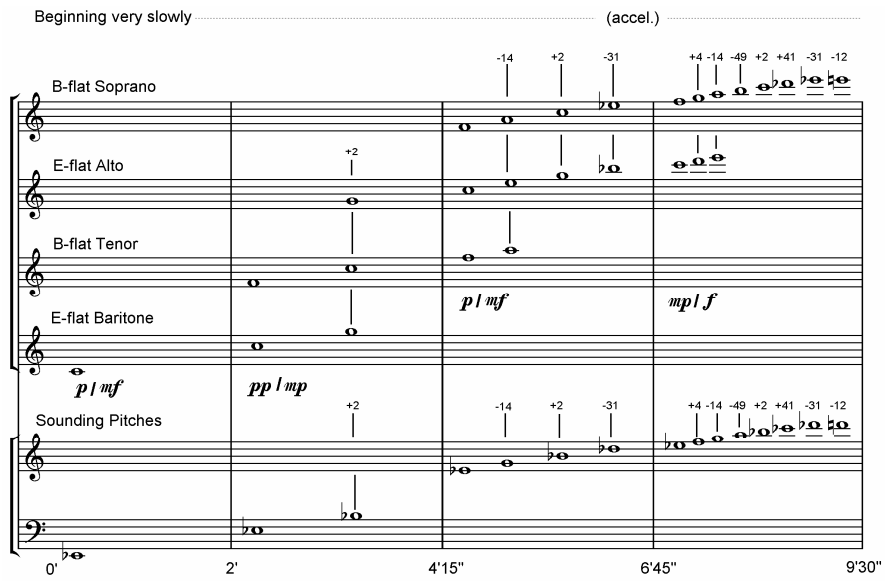

Figure 3. The first four segments of the score to *Saxony*. Non-zero deviations from equal temperament are indicted in cents above the notes. (Copyright 1978 by Sonic Art Editions. Used by permission of Smith Publications, 2617 Gwynndale Ave., Baltimore, Maryland 21207.)

The available pitch set ascends the harmonic series above E-flat$_2$ in stages, ascending to the fourth octave above the fundamental over the course of 9'30". Lower pitches become unavailable as higher ones become available so that the texture, which initially is a steady drone on E-flat$_2$, becomes increasingly dissonant as the pitch intervals between sounding tones decrease in size. This is accompanied by an increase in dynamic and rate of pitch selection. The score stipulates that "as progressively higher pitches are introduced, there should be a gradual increase not only in the average dynamic level and tempo ... but of melodic activity and improvisatory freedom as well, reaching a peak in Segment 5, where virtually 'anything goes' (although an ideal realization would maintain the same precision of intonation here as elsewhere...)."

In the middle segments of the piece the pitch intervals between sounding tones are very small intervals located high in the harmonic series, resulting in vivid difference tones (Moore 1997) becoming audible in the

now-unoccupied low register. Since frequency differences between pitches in a harmonic series are integer multiples of the fundamental frequency of the series, the pitch of each difference tone will itself correspond to that of some harmonic (physically sounding or not) in this series, provided that the intonation of the instrumentalist is accurate.

In Segment 5, the available pitch range does not change. Instead, the conceptual fundamental of the collection drops to E-flat$_1$, a pitch that is never physically sounded but which is potentially heard as a difference tone and residue pitch (Moore 1997). The precipitous drop in the low-frequency bound of the sounding difference tones and the attendant increase in their density at 9'30" as the conceptual fundamental plummets are audibly very striking—even alarming. The available pitch set then begins to descend the harmonic series of E-flat$_1$ over the course of 12'30", beginning from the fifth octave above this fundamental and concluding one octave above it. The texture returns to its earlier simplicity and calmness as the piece draws to a close, although one discovers that the ear's awareness of the constituent harmonic partials of each tone has been greatly heightened, having heard their frequencies repeatedly articulated throughout the preceding music.

FROM SPECTRALISM TO HARMONIC PERCEPTION

Also dating from this period of Tenney's work is the ongoing sequence of *Harmonium* pieces. The simplest expression of the concept underlying the series is to be found in *Harmonium #1*, which employs a gradual systematic modulation, one tone at a time, between subsets of harmonic series based on different fundamentals. A central feature of this piece is the strong perceptual fusion and relative sensory consonance of the texture which results whenever the lowest tone constitutes the conceptual fundamental of the collection—a phenomenon that Tenney describes as "the sudden making of sense" of harmonic relationships between tones.

Two crucial developments in Tenney's work have sprung from the seed of this early sensitivity to harmonic relationships. The first is conceptual, taking the form of a published semantic history of the concepts of consonance and dissonance (Tenney 1988) as well as a sophisticated theory of harmonic perception only a small portion of which has so far seen publication (Tenney 1993 [1983]; 1987-88 [1983]). The second development is a body of compositions exploring the perception of harmonic relationships between tones, including *Bridge* (1984) for two pianos/eight hands, in a microtonal tuning system, *Koan* (1984) for string quartet, "*Water*

on the Mountain...Fire in Heaven" (1985) for six electric guitars, and the monumental *Changes: 64 Studies for 6 Harps* from 1985. While these pieces represent an outgrowth of Tenney's spectralist work and betray concerns that are in many ways continuous with it, they represent a complex conceptual development that cannot be addressed in detail here.[12] They should be recognized, however, as a compositional path away from classic early spectralist processes, which retains their radical and characteristic attention to phenomenology and perception without being deflected by such competing objectives as the desire for a quasi-narrative formal elaboration.

VOICE-MODELING PIECES

One major subcategory of spectral music comprises works involving so-called "instrumental synthesis," in which an orchestration is made of the spectrum or spectrogram of some instrument or other sound source (Fineberg 2000). Tenney has been active in this area as well, in his own unique fashion. *Three Indigenous Songs* (1979), for two piccolos, alto flute, bassoon or tuba, and two percussionists, was Tenney's first of three attempts (so far) at instrumental synthesis of the human voice. The vocal sources modeled by the music are Tenney's transcription of a song by the early blues singer Jaybird Coleman, a transcription of Tenney's own voice reading Walt Whitman's poem "Kosmos," and finally an earlier Tenney setting of an Iroquois chant as translated by Jerome Rothenberg. The bassoon or tuba plays the fundamental of each vowel sound, and the flute and piccolos play the harmonics of this fundamental that are nearest to the centers of the first three vocal formants associated with this vowel. The formant frequencies are taken from tables published in the acoustical literature. Consonants are articulated by the percussionists using woodblocks (for 'k', 't', and 'p'), tom-toms with sticks (for 'g', 'd', and 'b'), tom-toms with brushes (for 'th', 'f', and 'h'), and suspended cymbals (for 's' and 'sh').

The preface to the score contains the following passage: "The perceptual space induced by THREE INDIGENOUS SONGS is meant to be somewhere near the threshold between music and speech. Occasionally, perhaps, some semblance of the underlying texts may actually be heard."

The prospects for actually evoking intelligible utterances by means of instrumental synthesis will not seem entirely implausible to those who have

[12] Interested readers can find detailed analytic information on these compositions in (Tenney 1987) and (Belet 1990).

heard examples of so-called "sine wave speech," in which intelligible speech is produced using only a few sine waves whose frequencies track those of the lowest-frequency formant peaks of the utterance to be evoked (Remez et al., 1981).

Tenney has refined his approach to instrumental synthesis of the voice in two subsequent compositions: *Ain't I a Woman?* (1992), based on a text by Sojourner Truth, and the first part of *Song 'n' Dance for Harry Partch* (1999), based on the composer's own voice reading from Partch's writings. True speech intelligibility remains elusive, perhaps in part because these technically difficult later pieces have yet to be performed at tempo, but the listener can certainly sustain the impression that he or she is hearing something like a slowed-down recording of speech, especially in the most recent work.

LATER WORKS

Tenney's output of the last three decades has been remarkably varied, embracing works for percussion, pieces predicated on his theories of formal perception (Tenney 1988 [1964]; 1980), works inspired by the dissonant counterpoint of Carl Ruggles, Ruth Crawford, and Charles Seeger, and even eloquent forays into ragtime music. The largest single category of his *oeuvre*, however, is spectralist, and his production in this area continues unabated to the present day.

Important individual spectralist works include the compendious suite *Glissade* (1982) for viola, cello, contrabass, and tape-delay system, *Critical Band*[13] (1988) for any ten or more sustaining instruments, and *Diapason* (1996) for orchestra, which extends the *scordatura* system that first appeared in *Quintext* more than 20 years earlier. Some works appear in sequences, such as that of *Harmonium #1-#7* (1976–2000), or *Form 1–5* (all from 1993), or *Spectrum 1-8* of (1995–2001). Pieces in the *Spectrum* series exhibit some particularly intriguing conceptual developments that combine elements of Tenney's previous work in algorithmic composition, formal perception, harmonic perception, and spectrum-based composition. For instance, *Spectrum 6* (2001) for flute, clarinet, percussion, piano, violin, and cello divides the ensemble into two instrumental groups that each present algorithmically derived pitch figurations. These groups are distinguished by independently evolving dynamic and temporal-event densities, but draw

[13] An analysis of *Critical Band* may be found in (Gilmore 1995).

their pitch materials from a common harmonic series, resulting in a contrapuntal variety of spectral music.

THE INDIGENOUS NORTH AMERICAN SPECTRALIST TRADITION

Tenney's work can be regarded as one significant focal point within the broader network of an indigenous North American spectralist tradition, a tradition that has to date been largely unacknowledged within the discourse surrounding spectral music. This tradition, like its European counterpart, has aesthetic roots in the mid-century collision between musical and scientific cultures, but also in a more specifically North American musical phenomenalism rooted in the music and thought of John Cage, and channeled, among other ways, through late-1960s American process music. Tenney was perhaps the earliest clear-cut representative of a spectralist musical current in North America, although over the past four decades a number of other composers, mostly based in or near New York City, have produced works relatable in varying degrees to spectralism. They include La Monte Young (b. 1935), Maryanne Amacher (b. 1943), Phill Niblock (b. 1944), and Glenn Branca (b. 1948) (Gann 1997).

A number of Tenney's students have also composed substantial bodies of work in a spectralist vein. Among their ranks are significant composers such as Larry Polansky (b. 1954) and John Luther Adams (b. 1953). Polansky's contrabass quartet of 1975–77 entitled *Movement for Lou Harrison* uses natural harmonics on just-tuned strings to achieve an evolving variety of pitch constellations within a given harmonic series, a technique that the composer indicates was first suggested to him by Tenney's *Quintext V: Spectra for Harry Partch* (Polansky 1994). Later Polansky compositions such as *Psaltery* (1979) for tape, and *Horn* (1989) for horn and tape, employ gradual systematic modulations between different harmonic spectra.

John Luther Adams' large-scale musical theatre work *Earth and the Great Weather* (1990-93) includes a collection of pieces for strings and digital delay[14]. Several of these employ textures, techniques and tuning systems related to those found in such Tenney compositions as *Quintext V* and *Glissade*. Indeed, Adams describes them as "an homage to Tenney" (Adams 1994). *Earth and the Great Weather* departs from strict phenomenological concerns in its attention to the evocation of place. Here

[14] Score excerpts and further information regarding Adams' work can be found in (Feisst 2001).

spectralist techniques function in part to suggest the austerity and rarefied temporal sense associated with the Alaskan wilderness where the composer resides.

From 1976 to 2000 Tenney lived and taught in Toronto, Canada, where his influence has been felt by a number of young Canadian composers such as Paul Swoger-Ruston (b. 1968), Josh Thorpe (b. 1975) and the author (b. 1967).

The influence of Tenney's music and thought deserves broader recognition than it has generally received, especially within the discourse surrounding spectralism. Analytical studies of his work in preparation by the author and others will hopefully begin to fill the scholarly lacuna, but the dearth of good performances and recordings of his spectral music remains vexing. Many of his most important and striking works, including *Clang*, *Quintext*, *Glissade*, and *Changes*, await an opportunity to become more widely known.

REFERENCES

Adams, John Luther. 1994. Essay in booklet accompanying *Earth and the Great Weather*, New World Records CD 80459. (Downloadable on 2006-06-25 from the World Wide Web at http://www.newworldrecords.org/linernotes/80459.pdf)

Belet, Brian. 1990. "An Examination of the Theories and Compositions of James Tenney, 1982–1985." Ph.D. diss., University of Illinois at Urbana-Champaign, 1997.

Cage, John. 1961. "Experimental Music." In *Silence: Lectures and Writings by John Cage*. Hanover, NH: Wesleyan University Press, 7–12.

Cowell, Henry. 1996 [1930]. *New Musical Resources.* Cambridge, UK: Cambridge Univ. Press.

Feisst, Sabine. 2001. "Klanggeographie—Klanggeometrie: Der US-amerikanishe Komponist John Luther Adams." *MusikTexte* 91: 4–13.

Fineberg, Joshua. 2000. "Guide to the Basic Concepts and Techniques of Spectral Music." *Contemporary Music Review* 19: 81–113.

Gann, Kyle. 1995. *The Music of Conlon Nancarrow.* New York, NY: Cambridge University Press.

-----. 1997. *American Music in the 20th Century*. New York: Schirmer Books.

Gilmore, Bob. 1995. "Changing the Metaphor: Ratio Models of Musical Pitch in the Work of Harry Partch, Ben Johnston, and James Tenney." *Perspectives of New Music* 33: 458–503.

Moore, Brian C.J. 1997. *An Introduction to the Psychology of Hearing*. San Diego, CA: Academic Press.

Moore, Brian C.J. and B.R. Glasberg. 1986. "Thresholds for Hearing Mistuned Partials as Separate Tones in Harmonic Complexes." *Journal of the Acoustical Society of America* 80: 479–483.

Remez, R.E., P.E. Rubin, D.B. Pisoni, and T.D. Carrell. 1981. "Speech Perception Without Traditional Speech Cues." *Science* 212: 947–950.

Partch, Harry. 1974 [1949]. *Genesis of A Music, 2nd Ed*. New York, NY: Da Capo Press.

Polansky, Larry. 1983. "The Early Works of James Tenney." *Soundings* 13: 114–297.

-----. 1994. Essay in booklet accompanying *Larry Polansky: Simple Harmonic Motion*. Berkeley, CA: Artifact Records CD ART 1011.

-----. 2003. Essay in booklet accompanying *James Tenney: Selected Works 1961–1969*, New York, NY: New World Records CD 80570. (Downloadable on 2006-06-25 from the World Wide Web at http://www.newworldrecords.org/linernotes/80570.pdf)

Rose, François. 1996. "Introduction to the Pitch organization of French Spectral Music." *Perspectives of New Music* 34: 6–39.

Shepard, Roger N. 1964. "Circularity in Judgements of Relative Pitch." *Journal of the Acoustical Socitey of America* 36: 2346–2353.

Tenney, James C. 1963. "Sound-Generation by Means of a Digital Computer." *Journal of Music Theory* 7: 25–70.

-----. 1969. "Computer Music Experiences, 1961–64." *Electronic Music Reports #1*. Utrecht, The Netherlands: Institute of Sonology.

-----. 1971. *For 12 Strings (rising)* Baltimore, MD: Sonic Art Editions.

-----. 1972. *Clang.* Baltimore, MD: Sonic Art Editions.

-----. 1972. *Quintext.* Baltimore, MD: Sonic Art Editions.

-----. 1974. *Spectral CANON for CONLON Nancarrow*. Baltimore, MD: Sonic Art Editions.

-----. 1976. "Spectral CANON for CONLON Nancarrow." In *Pieces, an Anthology*, ed. Michael Byron. Vancouver: Aesthetic Research Centre.

-----. 1978. *Saxony.* Baltimore, MD: Sonic Art Editions.

-----. 1979. *Three Indigenous Songs* Baltimore, MD: Sonic Art Editions.

-----. 1987. "About *Changes: Sixty-Four Studies for Six Harps.*" *Perspectives of New Music* 25: 64–87.

-----. 1987-88 [1983]. "John Cage et la théorie de l'harmonie." Translated from English by Eric De Visscher. *Revue d'Esthétique* 13-15: 471-85.

-----. 1988 [1964]. *META + Hodos: A Phenomenology of 20th-Century Musical Materials and an Approach to Form, 2nd Ed.* Hanover, NH: Frog Peak Music.
-----. 1988. *A History of 'Consonance' and 'Dissonance.'* New York, NY: Excelsior Music Publishing Company.
-----. 1993 [1983]. "John Cage and the Theory of Harmony." In *Writings about John Cage*, ed. Richard Kostelanetz. Ann Arbor, MI: University of Michigan Press. 136–61.
-----. 2003, 28 August. Interview by the author. Valencia, CA.
Tenney, James C. with Larry Polansky. 1980. "Temporal Gestalt Perception in Music." *Journal of Music Theory* 24: 205–241.