SIX MACROTONAL ETUDES
FOR ELECTRONIC MUSIC MEDIA

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BY

STEPHEN WEIGEL

DR. JODY NAGEL - ADVISOR

BALL STATE UNIVERSITY

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Six Macrotonal Etudes for Electronic Music Media: Half the Tunings, Double the Fun!

by Stephen Weigel

"It is my fervent hope to have found something that will inspire generations of composers to enrich the repertoire of expressive music – something that will give a truly progressive direction to the music of the future." –Easley Blackwood

The smooth part writing, compositional methods, and neoclassic nature of Easley Blackwood's *Twelve Microtonal Etudes for Electronic Music Media* were the impetus for this creative project. Blackwood's *Etudes* have strong elements of seemingly old-fashioned and new-fashioned styles: old-fashioned to those who find simply metered and pitched music not to be modern enough, and new-fashioned to those who are not used to xenharmonic music. I personally find the piece so engaging that I have created a complementary piece: the *Six Macrotonal Etudes for Electronic Music Media.* The word "macrotonal" exists purely as an antithesis to "microtonal," meaning the scale steps are larger than the ones used in 12-equal.

As homage, I made my etudes very much like Blackwood's (but with vital differences), and I even followed similar approaches with many of his procedures and preferences. These differences are either necessitated by improved techniques of electronic music composition, the aesthetic considerations, the tunings themselves, or increased knowledge of the xenharmonic phenomena. To fully explain the process of writing my piece, I give an account of xenharmonic historical context, relevant performance practice and stylistic implications, electronic logistics, and Blackwood's own opinions and goals. Then, I provide harmonic analysis on his most relevant etudes, which I model. I then explain some of my own chord progressions and emulative choices.

I. MEANING AND EVOLUTION OF THE WORD "XENHARMONIC"

It is quite possible that Easley Blackwood never knew of the word "xenharmonic" in his heyday, though perhaps he does now, since the word and movement have become more popularized. Interest in microtonal music is as old as music itself, but 12-equal really took over as a standard tuning past 1850, and it suddenly became more fringe to mention alternative tuning systems. In the late 19th and early 20th centuries, two main thought processes emerged: one interested in quartertones and 12(n) equal tunings, and another interested in "just" intonation and/or temperament. It is worth noting that quartertones became popular because they are very easy to adapt from 12-equal instruments, such as with pianos tuned a quartertone apart. An example of this can be found in Charles Ives' *Three Quarter-Tone Pieces*. As for just intonation, it had been known of since antiquity, but Harry Partch re-popularized it in the United States, leading to a craze among certain composers. Partch taught Ben Johnston, who then taught Kyle Gann. These three composers all prefer just intonation.

The quartertone movement reached its peak in the 1950's, Partch died in 1974, and the xenharmonic movement was born in-between these times due to Partch's spark and the advocacy of others. Perhaps it happened in the late 1960's or early 1970's, according to John Chalmers.[1] Ivor Darreg, founder of the Xenharmonic Alliance and inventor of the term "xenharmonic," created instruments and music in non-12-equal tuning, like Partch. Unlike Partch, however, he used many different kinds of tuning systems, instead of one justly tuned system of monophony. He was also one of the first individuals to entertain highly original and insightful truths about drawing compositional material from a variety of

[1] John Chalmers, "Darreg, Ivor (Kenneth Vincent Gerard)," *Grove Music Online.*

tuning systems, truths that microtonalists recognize and often find on their own before discovering Darreg (including Blackwood). Among these thoughts are: the idea that tunings have inherent moods, the idea that tunings sounding unlike 12-equal are fertile ground for exploration, that no tuning serves every musical purpose, that restricting one's self to 12-equal is missing out on compositional opportunity, and that the word "xenharmonic" conveys these essential, unique ideas. Another of these ideas is that "xenharmonic" is not simply about making steps *smaller,* but also about the possibility of making steps *larger.* The word "microtonal" might solely imply "making steps smaller," unless one assumes that "microtonal" more generally refers to "any non-12-equal tuning."[2]

So, though Blackwood was living in the right time period to see xenharmonic origins (his *Etudes* were written in 1979-1980), it is quite possible that he was not in contact with the Xenharmonic Alliance. He never mentions the word, and his *Etudes*, plus two other compositions, are his only ventures into xenharmonics. The Alliance was also localized in California, until Internet advances made it possible for them to migrate conversation to the Mills College emailing list, to the Yahoo!-tunings group, and finally to Facebook. The informal journals *Xenharmonikon* and *Interval* were also created to spread knowledge, music, and tapes, and these were recognized by the academic community more so than casual conversation around the topic.[3] Thus, contextually, Blackwood exists in a time period where interest in alternative tunings has just taken off, causing a variety of different approaches, many of which could now use electronics to realize such things more quickly.

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[2] Scott Wilkinson, *Tuning in: Microtonality in Electronic Music: a Basic Guide to Alternate Scales, Temperaments, and Microtuning Using Synthesizers* (Milwaukee, WI: H. Leonard Books, 1988), 6.
[3] Joel Mandelbaum, "Toward the Expansion of Our Concepts of Intonation," *Perspectives of New Music* 13, no. 1 (1974): 216.

The *Etudes* contain an extreme amount of diverse sounds, though many parameters of the music are highly restricted. The piece almost seems archaic for some, as it does not take advantage of the electronic medium to use registers that would be unreachable on traditional instruments, etc. This makes it seem rather dated today, but electronic music was in its infancy at this time, meaning that the standard of finding extremely un-acoustic sounds had not been established. There are several main reasons that the *Etudes* are very regularly constructed and easy to follow: (1) Blackwood had limited time, not only in his access to the instruments, but also in handwriting the pieces, as it took him thirteen full days to barely complete the piece, (2) he wanted to provide forms which made sense to listeners, as the twelve-tone-method composers also aspired to do, and (3) he wanted to focus on the unique qualities of each tuning. Numbers (1) and (2) are fairly self-evident, and (3) becomes obvious when we examine everything Blackwood himself discussed. Rhythm, timbre, and other considerations are rarely mentioned – the discussion is focused around pitch.[4] Numbers (2) and (3) also go hand in hand, since new listeners can perceive xenharmonic sounds as out-of-tune if the relevant scale is not repetitively demonstrated aurally. Thus, accessibility and narrowed focus foster understanding of the tuning system used at the time – a smart choice on Blackwood's part, as noted by several critics and reviewers.[5]

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[4] Douglas Kieslar, et al., "Six American Composers on Nonstandard Tunings," *Perspectives of New Music* 29, no. 1 (1991), 182.

[5] Conrad Cummings, Reviews of *Musique Numérique* by Daniel Arfib; *Hybrid Musics* by Larry Austin; *Twelve Microtonal Etudes for Electronic Music Media* by Easley Blackwood, *Computer Music Journal* 5, no. 3 (1981), 86.

II. PERFORMANCE PRACTICE AND STYLISTIC CONTEXT OF BLACKWOOD'S *ETUDES*

Twelve Microtonal Etudes thus has characteristics more indicative of 18th- and 19th-century pieces than 20th-century pieces, if we assume that characteristics of 20th-century-like pieces are generally less concerned with imitating the past. None of the etudes are controversial with respect to form, which is a neoclassic attribute. Blackwood calls himself at home in a traditional tonal style, and his pieces use tried-and-true forms from Baroque, Classical, and Romantic music, such as the *Suite for Guitar* in 15-equal.[6] Furthermore, Blackwood's tempo markings also suggest older music, because they do not have metronome markings. In the 19th century, metronome markings were a large concern because many musicians felt that mandating a specific value ruined the nuance of taking things at different tempos.[7] It is also unwise to assume specific metronome values for any given tempo marking in the 19th century. Blackwood understands the value of these historically appropriate tempos, and neglects to put a metronome marking precisely to honor this time period. We know this because there is no reason for him not to indicate it, since his pieces are electronic.

Blackwood's attention to tempo is also important because of its ties to pitch. Many of his aesthetic tempo decisions seem to derive from the tuning itself, which is abundantly evident not only from the liner notes, but also from how Blackwood himself puts it whenever he has the chance to talk publicly.[8] This happens to be a twist on popular later-Romantic conventions, as tempo changes not only became more extreme in that time period, but also came to be associated with pitch material. The popular notion of this

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[6] Keislar, "Six American Composers on Nonstandard Tunings," 209.
[7] Clive Brown, *Classical and Romantic Performing Practice 1750-1900* (Oxford University Press, 1999), 284.
[8] Easley Blackwood, *Microtonal Compositions,* Cedille Records 1994, CDR 90000 018, liner notes, 3.

period was that any given melodic idea had an optimal tempo associated with it, which, when played at that tempo, would make it the most expressive. This caused performers to create fluctuations of tempo at a local level, and tied in with the widespread usage of *rubato*.[9]

Similarly, Blackwood works from the top-down, with the given pitch material informing most of his other choices including the rhythmic ones. Thus, his mentality matches the aforementioned Romantic notion of pitch informing rhythm. However, the etudes do not feature heavy *rubato*, so it may be inappropriate to call them Romantic pieces exactly. I make this connection because its methods of composition share close kinship with contemporary 19th-century ideas. Blackwood did say that the *Etudes* would be better if played by live electronic instruments. This statement, and the tempi changes of his other works, make it safe for us to assume that he would want more *rubato* in the *Etudes* if he had more time to work with them. There are markings in the music for tempo changes, but they fall on cadence points, and not as *rubato* within the music. A good example of this happens in the 17-equal etude, which ends with a *rallentando*.[10]

The *Etudes* seem like 19th-century pieces because of the conservative choice of virtual instruments, which correspond to common Western acoustic ones. We know that Blackwood was thinking of real instruments because he wrote them in the score either as general categories, or not. For example, we see "brassy, oboe, bells, piccolo," and also characteristics for more abstract instruments like "light, mellow, reedy." In the 20th century, and definitely in the 21st, it is rarely recommended to use sounds of acoustic-like

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[9] Howard Brown and Stanley Sadie, *Performance Practice: Music after 1600* (New York, NY: W.W. Norton 1990), 406.
[10] Blackwood, *Microtonal Compositions.*

instruments unaltered as fixed media, as a "live" performance is generally considered to be the better experience. This is not only because playing music is more satisfactory with a live group, but also because electronic sounds are more inexpressive and dead sounding than those of a performer.[11] Sounds of acoustic instruments in electronic music, when used, are often samples that are transformed to create new sounds, imitated in physical modeling, or utilized for microtonal music that will not be played by individuals. One can certainly justify microtonality as a workaround for the challenges of using acoustic instruments, as many composers and computer programmers have, such as the creators of the Dynamic Tonality software in Max/MSP.[12]

Granted, Blackwood was working with an analog synthesizer, so it certainly would have been possible to create some very inharmonic sounds. It seems that he was not interested in matching upper partials to the tuning system, as Wendy Carlos and spectralists are famous for doing.[13] Although Blackwood's sounds seem quite dated, he has a strong ear for what timbre he wants to use, often using it to disguise discordant sounds when he is forced to due to the tuning. He tends to use frequency-rich high sounds to enhance brighter intervals, which he finds purer, such as in the 19-equal and 22-equal etudes. The sounds Blackwood uses are always harmonic, and likely come from simple combinations of sounds. This is why I ultimately decided to use Absynth for version one of the *Macrotonal Etudes* – it does not physically model an analog synth, but its user interface allows combinations of sine, square, saw tooth, and pulse waves. However, Absynth also

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[11] Mark Jenkins, *Analog Synthesizers: Understanding, Performing, Buying: From the Legacy of Moog to Software Synthesis,* (Focal Press, 2007, 1st edition), 154.
[12] Anthony Prechtl. "A MIDI Sequencer that Widens Access to the Compositional Possibilities of Novel Tunings," *Computer Music Journal* 36, no. 1 (2012): 43.
[13] William A. Sethares, "Consonance-Based Spectral Mappings," *Computer Music Journal* 22, no. 1 (1998): 56.

has built-in sampled sounds to deconstruct, as well as more computational ability like any digital synth nowadays.

The way Blackwood treats register in the *Etudes* is actually strikingly similar to the way organ registration is treated in 19th-century performance practice, and actually sounds more like what an organ would play than the instruments indicated. Blackwood does not (at least not evidently) add sounds from different octaves to existing sounds to change any individual monophonic track's registration mid-piece, but dynamic choices reflect organ practice because of the change in timbre. For example, in Germanic early Romantic practice, when higher partials were added to a manual, it was expected that more 8' stops (the principals at the same octave level) would also be added. [14] Similarly, when Easley Blackwood brings in high-register instruments, the corresponding texture will get thicker to compensate (like in the 16-equal etude in m. 9, and the 14-equal etude in m. 39 and 43 when he takes instruments away). When there is a sudden change of dynamic, organ players, especially conservative ones, would be expected to change registration to reflect that.[15] We see this textural effect in the *Etudes* too, throughout, such as in the 15-equal and the 19-equal.

Changing stops were associated with changing tempo, which makes sense with earlier 19th-century notions of pitch and tempo association. Blackwood uses similar timbres at similar tempos, which is very indicative of this mentality. The only etude where he actually calls any of his instruments the "organ" though, is the 24-equal one at the beginning – specifically labeling it the "Romantic organ."[16] These treatments constitute a

[14] Brown, *Performance Practice: Music after 1600,* 382.
[15] Ibid, 382.
[16] Blackwood, *Microtonal Music.*

clear kinship with the organ-registration-based thinking of the 19th century. Unfortunately, Blackwood is never asked about this aspect of his *Etudes*, whereas he is frequently asked about the microtonal-pitch aspects.

The creation of these microtones was a very difficult process for him, not only because he had to use analog synthesis, but also because he had to notate everything by hand, as well as come up with a notation system for each equal tuning. The equal tunings that are easy to notate come from perfect fifth-based structures, such as 17 and 19. The more difficult ones, though, have significantly differing aural interpretations from contemporary practice (of which there is not a consensus). Interestingly, he does not choose to notate 7-equal in his 14-equal notation as the white keys with accidentals in between. Rather, he was concerned with having at least one exact 12-equal analogue, unless that was impossible. This caused him to notate 16-equal as chains of fully diminished sevenths offset, and 18-equal as chains of whole-tone scales offset. Thus, his notations for 13 and 23 are particularly odd. He discusses his rationalizations for the 15-equal notation in an issue of *Perspectives of New Music*.[17]

[17] Easley Blackwood, "Modes and Chord Progressions in Equal Tunings," *Perspectives of New Music* 29, no. 2 (1991): 187-189.

III. THE ELECTRONIC CREATION OF BLACKWOOD'S *ETUDES*

The synthesizer Blackwood used was the Polyfusion synthesizer, housed at Webster College, Saint Louis, where the project was funded. An analog synthesizer typical of the time period, it existed just before the rapid and commercial spread of digital synthesizers.[18] Thus, Blackwood was able to play his music, through a Halberstadt re-tuned keyboard, into the synth. The Polyfusion itself has a long and rich history of being a vintage model, as it was an early competitor of the original Moog synthesizers. Dr. Robert Moog is generally considered to have invented the modern analog synthesizer in the early 1960s.[19] Analog synthesizers did not become popular until the 1970's though, because of certain popular musicians, most notably Emerson, Lake, and Palmer, using them onstage.[20] The reason the Moog was such an innovation was because it (a) introduced voltage control, which was stable unlike manipulation of electrical current or capacitance, and (b) because it attached a Halberstadt keyboard to the user interface, making it a lot easier for musicians to use.[21] Beforehand, manipulated oscillators tuned to the exact right spots were the method to generate pitches, not keyboard control. Thus, initially much was possible, but the interface was vastly more difficult, and this was the situation in which Milton Babbitt found himself while writing electronic music in the Columbia-Princeton studios (e.g., "Reflections" for piano and tape, 1974).[22]

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[18] Jenkins, *Analog Synthesizers: Understanding, Performing, Buying: From the Legacy of Moog to Software Synthesis,* 97.
[19] Jenkins, *Analog Synthesizers: Understanding, Performing, Buying: From the Legacy of Moog to Software Synthesis,* 48-50.
[20] Ibid, 54.
[21] Ibid, 52.
[22] John Peel and Cheryl Crarner, "Correspondences and Associations in Milton Babbitt's Reflections," *Perspectives of New Music* 26, no. 1 (1988): 147.

Interestingly, the analog synthesizer has become an interest of contemporary musicians who like to work with the sounds in a hands-on way, as well as preserve some realism in the sound quality.[23] Analog synthesizers are built to deal with signal flow, meaning that if you start with a sound, it goes from point A through manipulation of different parameters, all the way through to point B, at which time you would actually hear the sound. The Polyfusion is equipped with three VCO's, sequencer, quantizer, ADSR control, LFO control, and parametric EQ. All of these kinds of manipulation are considered essential today. The voltage-controlled oscillators generate the sounds themselves, from either sine, sawtooth, square, or pulse waves, and they can be connected to each other for AM or FM synthesis, too. The sequencer and the quantizer control automate beat placement of sounds, which is commonly used in groove-based music; hence why the number of slots is sixteen, a way to manifest 4/4 time. LFO control and ADSR control bring shape to the envelope of the sound, while EQ changes the sound's timbre by cutting or boosting certain frequencies using filtering. The process of creating sounds this way is known as additive/subtractive synthesis, which is exactly what Blackwood did. For his personal use, Blackwood preferred the Scalatron, which was actually a synthesizer built for playing with alternate tunings.[24] It is likely that Blackwood used the Scalatron before completing the *Etudes* to get a sense of the harmony.[25]

In the process of electronic music making, digital systems have more practical advantages than analog systems. The main differences have to do with computation and

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[23] Wilkinson, *Tuning in: Microtonality in Electronic Music: a Basic Guide to Alternate Scales, Temperaments, and Microtuning Using Synthesizers,* 87.
[24] Wilkinson, *Tuning in: Microtonality in Electronic Music: a Basic Guide to Alternate Scales, Temperaments, and Microtuning Using Synthesizers,* 87-88.
[25] Keislar, "Six American Composers on Nonstandard Tunings," 188.

the setup of the interface, which are usually relevant in "heavy-lifting" tasks such as sampling and artificial reverb. If you want to play any oscillated sound in a modular synth, you have to remember where all the cables go, and plug them in accordingly, whereas with digital synths, you can save your settings and go back to them quickly. Also, multi-tracking, or playing multiple parts at the same time, on analog synths was not possible until much later, and that was a big issue for a while.[26] Blackwood thus had to play his tracks monophonically due to the limited technology, so that is why we do not observe any polyphonic instruments in the score.

The way Blackwood would have re-tuned the interface would simply be to turn a knob for the generating interval size, which would create his desired equal temperaments when smaller than 100 cents. This meant that the keyboard would have always been mapped with adjacent notes played next to each other (for example, this would make the 13-equal octave range 13 keys, the 14-equal 14 keys, etc.). The possibility to tune equal temperaments was common because of the simple knob interface, but rarely used. (This was pre-MIDI.) The capability to play unequal scales was quite rare before 1986.[27] Analog oscillators problematically have a tendency to drift in frequency as well, and exhibit slight changes in general sound quality, compared to the perfect replicative ability of digital synths. This can be an advantage or disadvantage, as people speak of analog "warmth," for example. Blackwood thus had to let the machine warm up before tracking, and confirm things by ear. The machine also had continuous cent resolution, meaning that any hearable

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[26] Jenkins, *Analog Synthesizers: Understanding, Performing, Buying: From the Legacy of Moog to Software Synthesis,* 87.
[27] Wilkinson, *Tuning in: Microtonality in Electronic Music: a Basic Guide to Alternate Scales, Temperaments, and Microtuning Using Synthesizers,* 87.

interval could potentially be played.[28] Personally, I have mulled over the recordings, playing along, and deviations from equal-tempered values are very slight and can be considered musically appropriate de-tunings of a xenharmonic framework. This is similar to the effect one gets in 12-equal when people are realistically, but not grossly, out-of-tune; it makes the situation sound more organic, but does not defy the inherent intonation-based qualities of the tuning.

[28] "Synthesizers, Samplers, and Sound Cards with Microtonal Capabilites." Microtonal Synthesis. http://www.microtonal-synthesis.com/index.html

IV. BLACKWOOD'S MUSICAL OPINIONS, GOALS, AND METHODS

We can conclude from the methods of composition and historical context that the interface, and past traditions, had a large influence on his opinions and goals when writing the *Etudes*, such as idiomatically prescribing equal tunings for the synthesizer. As a microtonal composer, Blackwood finds certain scales in any given equal tuning to be usable, and favors equal tunings with agreeable-sounding triads. Then, an examination of usable scales informs his decisions on the general mood of the etude. For example, he states in an infamous interview with Douglas Keislar that, if two scales (Blackwood calls them modes) in any given tuning are contrasting, then that suggests a bi-thematic form where each theme is played in one of the scales.[29] Such a statement makes his process seem transparent and predictable in an enriching way. He is extremely aware about the tunings, knowing off the cuff which ones create diatonic scales, and which do not.

His method is to look for either a diatonic scale, strong instances of major/minor chords, or scales that also appear in 12-equal.[30] He then uses these to great effect, beginning with a simple scale and then modulating through chromatic areas in the middle of the piece before returning to the original key. This is characteristic of all of his works, especially the *Etudes* (with the exception of the 21-equal suite, in which the four movements are too short to employ modulation).[31] If Blackwood cannot find diatonic or triad-friendly scales, he either uses those most related to 12-equal, or dense chords to disguise the dissonances. It is a widely known fact among microtonalists that, the more notes a chord has, the more difficult it is to tell precisely in which intonation it is tuned, one

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[29] Keislar, "Six American Composers on Nonstandard Tunings," 183.
[30] Ibid, 177, 181-182.
[31] William Ayers, "Microtonality and Transformation: Analyzing Easley Blackwood's 19-notes with a Modified Tonal GIS" (unpublished manuscript, December 2017), Microsoft Word file, 16.

way or another. The etudes where Blackwood uses this strategy of density for discordance-disguise are the 13-equal, the 14-equal, the 17-equal, and the 18-equal.

Blackwood's definition of diatonic scales is logical, but historically incorrect because of untempered circumstances. In 12-equal, the diatonic scale uses a large step of 2\12, and a small step of 1\12. Blackwood calls these "whole" and "half" as do most musicians, because, unlike regular temperament theorists, he is not as interested in generalizing step patterns to non-diatonic circumstances unless the tuning forces him to do so. (In that case, he never names the step sizes, making it clear that he thinks about such non-diatonic entities quite differently, naming all non-diatonic scales "modes".) In Blackwood's tuning-math book, "The Structure of Diatonic Tunings," he goes on in detail about how a diatonic scale can be defined to have this particular configuration of steps (5 large and 2 small), which is also a scale that can be generated from perfect fifths. According to this definition, equal tunings 12, 17, 19, 22, 24, 26, 27, 29, 31-34, and 36+ support a diatonic scale.[32] This information is entirely correct and, in regular temperament theory, would simply be described as the 5L 2s continuum. That is, if a generating perfect fifth becomes higher than the 5-equal value of 720 cents, the seven notes do not support 5L 2s anymore, but instead create 1L 4M 2s (so, 1 large step, 4 medium-sized steps, and 2 small steps). If it becomes lower than the 7-equal fifth at 685.714… cents, the scale becomes 'anti-diatonic,' and thus becomes 2L 5s (See figure 1 for visualization of this concept).

However, the book fails to mention that just tunings produce a diatonic scale with two different sizes of whole step (10/9 and 9/8), and that the ancient Greeks documented

[32] Easley Blackwood, *The Structure of Recognizable Diatonic Tunings* (Princeton: Princeton University Press, 1985), 254.

this.[33] This mentality renders some term usage confusing. For example, Blackwood calls overtones "basic intervals," and simply refers to quarter-comma meantone as "meantone," among a host of other odd quirks. Part of this is due to the lack of standardization, and part of this is due to ignoring certain theoretical texts, which were just starting to become more accessible. We know from this book that he knew about higher-limit just intonation (the Common Practice period goes up to 5-limit), but that he did not care to approximate these kinds of just intervals in his *Etudes.* A common xenharmonic approach today is to treat a higher-limit harmony as the main concordance, such as 7, 11, 13, or even 17-limit. (Harry Partch went up to the 11-limit, and Ben Johnston to 13-limit.) This approach, thus, is not used by Blackwood, and he really only seems to consider major and minor triads, or their extensions, to be stable entities. This makes his thought processes with the xenharmonic equal tunings that do not yield triads (13, 14, 18, 23) all the more interesting.

Clearly, Blackwood has strong opinions on equal tunings, and we know this not just from his interview with Keislar, but also from his writings on chord progressions in other equal tunings. Of course, he enjoys tunings that give good major and minor triads, which meant, predictably, that he liked 19 and 22-equal. His two unconventional favorites, though, were 15 and 21-equal. Neither gives a diatonic scale, nor well-tuned triads on "paper." However, since Blackwood preferred the sharp fifth, he found 15-equal's triads strongly likeable.[34] The major triad of 15-equal, being 0-400-720 cents, is like 12-equal's in terms of its brightness. The minor third of 15-equal, being 320 cents, is actually much closer to a justly tuned 6/5, balancing nicely with the slightly more out-of-tune perfect fifth.

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[33] Douglas Keislar, Review of *The Structure of Diatonic Tunings,* by Easley Blackwood, *Computer Music Journal* 11, no. 3 (1987): 51.
[34] Blackwood, "Modes and Chord Progressions in Equal Tunings," 186.

Blackwood specifically enjoyed the 5-equal shifts in this tuning and the major chords stemming from those kinds of progressions. He is describing something that is xenharmonic in a specific way, but also pleasing and not discordant; this seems to be his preference for sounds in equal tunings in general.

The 15-equal tuning is so special to him that he devotes a section to it in his writings on chord progressions describing his enjoyment.[35] His section on 15-equal is also longer and goes into detail about the "ten-note symmetric mode," which has 5 large steps and 5 small steps (so, 5L 5s). One could think of this like an octatonic or hexatonic scale, split 5 ways instead of into 4 or 3; this works because 15 divides by 5. Later, regular temperament theorists named the scale after him, calling it Blackwood[10], and the scale has since been found to have extremely efficient qualities when tempering triads. Blackwood even wrote another microtonal piece in 15-equal for acoustic guitar, using Blackwood[10] mostly, and the guitar is tuned in 5-equal fourths so that the interface is perfectly isomorphic. This makes it easier to play guitar in 15-equal than in 12-equal, due to a chord position of any quality having an identical fingering anywhere. (This is like playing on a Jankó keyboard.)[36]

As for other favorites, he so enjoyed 21-equal's triads and qualities that he wrote a suite in four movements featuring the tuning. None of the etudes other than the one in 21-equal has more than one movement. This suite is in the baroque style, and it includes four dance movements each with a different tempo. The first movement cycles through 7-equal perfect fifths in the bass, but the triads above make it sound like a circle-of-fifths progression with an alien melodic content. Blackwood also composed a fanfare in 19-equal.

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[35] Ibid, 186.
[36] Ibid, 199.

The fanfare is actually quite similar to his *Etudes,* but the modulations are given much more time to breathe and the melodic content is a lot less xenharmonic. The electronic instruments are also panned and grouped together by timbre.

Blackwood's thought process is entirely clear from his *Etudes* and from his writings about them, so I had all the tools I needed to emulate his work. The most difficult aspect was matching my preferences with his; they did not always line up, though we seem to share preferences for perfect fifths and thirds. The largest difference between our outlooks is that I like to use higher-limit just intonation in implied concordance. Rather simply, the method to create an Easley Blackwood-like etude is to: (1) understand which scale or collection of scales one would like to use for an equal tuning, (2) figure out which moods or 12-equal-like patterns these scales evoke, (3) decide on a fitting tempo, a lá the Romantic period or Baroque composers, without a metronome marking, (4) come up with digital sounds that also complement this chosen mood, (5) create the main theme or themes, and (6) ensure that the piece opens with the main theme, modulates through foreign territory in a melodically xenharmonic, harmonically pleasant matter, and then returns more powerfully, and with the most satisfying perceptual moment, to the original theme.

In order to create xenharmonic etudes in equal tunings smaller than 12, those that factored into 12 were excluded, because they sound like pitch collections that Westerners have heard before. Thus, the tunings that I used were 5-equal, 7-equal, 8-equal, 9-equal, 10-equal, and 11-equal, numbering exactly six, which is precisely half the number that there are in Blackwood's *Microtonal Etudes.* As in Blackwood's work, the equal tunings I chose dramatically informed my process, especially since I had fewer choices in terms of both melody and harmony. These equal tunings do not approximate justly tuned major and

minor triads well, but I found the strategy of using dyads as concordant sonorities helped many of these problems. That approach also had the added benefit of being thematically fitting; there now are a reduced number of notes in a stable sonority, just as there are a reduced number of notes to use, and a reduced number of etudes.

The 720-cent fifth, in both 5 and 10-equal, is similar enough to a just perfect fifth that it is usable as an open fifth in a closing sonority. The other tunings can be used similarly; 8-equal has the minor third, 9-equal has the septimal minor third, and 11-equal has the super-major third. 7-equal is a more difficult case, though. I personally find 7-equal to be more difficult to navigate than 5-equal, not only because the neutral third is hard to find, but also because the flattened perfect fifths are more discordant. Blackwood shares this preference with me, using 720-cent fifths and praising them in his most favored 15-equal. We also know that he did not consider the 685.714… cent fifth of 7-equal to be concordant enough to sound pleasant, because he says this of his 14-equal etude, in which that same perfect fifth is an option:[37]

> With fourteen notes, there is no way to conceal the fact that it's out of tune. It's so dissonant I couldn't bring myself to close that one of the *Microtonal Etudes* on any kind of harmony. It just closes on a single note.

Thus, I will not be treating the 7-equal fifth as a concordance either, although creative timbres can certainly disguise the sourness. Curiously, the 14-equal etude is the only one in which Blackwood has to resort to a unison ending.

After making choices about concordance, I then thought about the individual etudes: how they could compare to each other, and which ones would be like Blackwood's, so that

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[37] Keislar, "Six American Composers on Nonstandard Tunings," 200.

my analysis of a subset of the etudes could properly inform the project. Thus, because of the small and extremely xenharmonic natures of the equal tunings here, I analyzed etudes that shared helpful pitch ideas in common. The first etude that I analyzed is the 23-equal, since Blackwood resorted to using approximations of general gamelan scales called *Pelog* and *Slendro,* in response to prime number 23's challenge as an equal tuning.[38] It helped to compare this with 5-equal, which is justifiably close to Slendro, as well as 7 and 9-equal, which are similar to various Pelog.[39] The second etude that I analyzed is the 13-equal, which reveals how Blackwood deals with what he considers impure thirds and complex altered chords; I thus used similar strategies in 10-equal and 11-equal.

Finally, I examined the 15-equal etude, since it is Blackwood's favorite, and makes use of five-way symmetry. This is relevant to my etudes, which use the two 5(n) equal tunings of 5 and 10-equal. Incidentally, Blackwood himself writes in detail about 19, 17, 16, and 15-equal.[40] My approach in the brief analysis is to freely switch between referring to pitch class with letters and numbers, and to give an explanation of what happens throughout the piece moment-to-moment. The accompanying figures are straightforward and chiefly descriptive of pitch material, with contrasting colors occasionally used to group hard-to-see motives together. Pitch classes and Blackwood's notation can be found in the formal reductions, with cent values added by myself. I notate his non-standard accidentals using simple arrows, as the circular part of the design is not needed in text to see which way it points.

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[38] Blackwood, *Microtonal Compositions,* liner notes, 4.
[39] Sethares, *Tuning, Timbre, Spectrum, Scale,* 73.
[40] Blackwood, "Modes and Chord Progressions in Equal Tunings," 168-199.

V. ANALYSIS OF BLACKWOOD'S TWENTY-THREE EQUAL ETUDE

The system of 23-tone equal tuning, being prime, does not lend itself to familiar diatonic pitch material, as do earlier prime equal tunings. This may also be one of the stranger etudes melodically, as it is full of colorful arpeggiations, and sometimes the melody gets lost or seems like background for timbre-based reasons. When Blackwood mentions Pelog and Slendro, he notes that Slendro's intervallic pattern is 5-4-5-5-4, while Pelog's is 3-7-3-3-7.[41] When I describe Pelog and Slendro with letter names, I refer to the aforementioned modes as the starting point, and this is not necessarily the same as pitch centricity. For example, C Slendro starts on pc 0, and adding up the consecutive steps as 5-4-5-5-4 yields 0, 5, 9, 14, and 19 as pitch classes. Although any of the pc's can be a tonic, always calling it "C Slendro" keeps the mode consistent. Indonesian ensembles, from which these scales are derived, vary their tunings by region. Nothing suggests that Blackwood is culturally appropriating, as he is simply using these scales to help him write in 23-equal. Sometimes, the perfect fifths and fourths he uses, which are far from justly tuned in 23-equal, sound rough if the timbre is too much like a saw-tooth wave. Out of the instruments in this etude, the tuned gong is by far the most realistically evocative of contemporary gamelan.

This etude seems tonally aimless at times, and when melodic content is introduced, it is difficult to tell which note is tonic, though it is easy to tell that a simple scale of five or so notes is being used. This lack of center is somewhat aided by the quasi-equal nature of the scales involved: although Blackwood cites Pelog and Slendro and 5-note scales, there is also a 7-note version of Pelog. In gamelan music, 5 notes from the Pelog are used as main

[41] Keislar, "Six American Composers on Nonstandard Tunings," 199.

notes, while 2 others are considered auxiliary tones.[42] This makes the 23-edo Pelog pattern used 3-4-3-3-3-4-3, although it is rarely used melodically in its entirety (and sometimes, other auxiliary tones split up the 7-step differently as well). One can see how these generalizations of Slendro and Pelog are similar to 5-equal and 7-equal as mentioned before. Blackwood uses these auxiliary tones from Pelog to introduce seemingly out-of-key perfect fifths in the lower parts, and interestingly, these perfect fifths are not notated in a heptatonic manner (i.e., not all seven letters are used). This occurs as the upper instruments, 1, 2, and 3, are arpeggiated in the high part of the ostinato. He additionally uses auxiliary tones and perfect fourths/fifths to provide common tones for moving between scales at certain sections. At other times, he simply jumps from one scale to another, obviously on the beat.

The form is a shortened ternary, forming an A-B-A'-B'-A pattern. The start of each A-section is quite distinct because of instrument 3's lonely entrances and timbre. Instrument 3 always plays a rapid, light, lyrical melody. The melodic contour is such that it rises and falls, but this becomes background material soon in the wake of the denser main texture. Instruments 1 and 3 establish arpeggios, while fifths juxtapose it in the bass, starting at m.5 (see figure 2). "Exotic voices, " as Blackwood calls them, carry the melody in Pelog. This first Pelog scale, used in all of the parts from m. 1-15, is D🡻, Eb, G🡻, A🡻, and Bb, or, in pitch classes, 3, 6, 13, 16, and 19. Auxiliary tones first appear in the initial fifths as E🡹 and B🡹 (pitch classes 8 and 21). It sounds like the tonic could be on Eb because of the melodic content in the exotic voices, but this is not revealed in a cadential manner. The perfect fifths

[42] Sethares, *Tuning, Timbre, Spectrum, Scale,* 211.

used in the bass at m. 1-15 all come from the scale. These fifths span 13 steps of 23-equal (so, 13\23), and thus I call them 'Pelog fifths,' at about 678 cents.

When our exotic voices re-enter the texture with melodic content, the scale changes to Slendro, using C↑, Eb, F, Ab, Bb, or 1, 6, 10, 15, and 19. The common tones (6 and 19) are used to provide smooth transition, so that the listener might not hear that a different scale is being used at m. 16 (see figure 3). Our auxiliary notes E↑ and B↑ (21 and 8) are also shared between these two scales and used as Pelog fifths again. Although Slendro proper does not really have auxiliary tones, Blackwood uses them to springboard between scales. One could say that this beginning music is in the key of D↓ Pelog and F Slendro. For the rest of the A section, these two scales are juxtaposed in various fixed ways. At m. 23-26, the pitch content switches once each bar, continuing to retain the common tone of Eb. This choice, plus others, led me to think that Eb could be an implied pitch center. This is done without clear melody so that the listener can hear the harmonic rhythm change (see figure 4). At m. 27, we return to D↓ Pelog, but now our two auxiliary tones have been replaced with C↓ and F↓ (9 and 22).

The first B-section begins at m. 30 with the attack of the tuned gongs. At this point, scales are arpeggiated rapidly in instrument 3 as the exotic voices engage in appropriate counterpoint. The texture is constantly ascending, due to the contour of the melody, and the rapid rate at which scales change. We begin starting simply in Eb Pelog, which is close to D↓ Pelog, but then we switch to another Pelog. At m. 34, F# (12) bleeds into this new A↑ Pelog sonority of 5, 8, 11, 18, and 21. The B section then switches between this A↑ Pelog, harmonized with the D# + A↑ fifth, D Pelog with auxiliary tones, harmonized with the G↑ + D fifth, and other scales. This seems to be a climax, and the epitome of what

Blackwood means by "chromatic modulations" in his statements on 23-equal.[43] Melodic motion also makes use of smaller intervals to give this chromaticism away, such as at m. 34 when the Eb moves up 2\23 steps to the E↑. The A↑ Pelog happens at m. 34-35, and m. 38, while D Pelog happens at m. 36 and 39. These chromatic tones, elisions between scales, and non-pelog/non-slendro scales only occur in the B sections. The rest of the etude is pretty "diatonic" in either Pelog or Slendro. At m. 40-42, we encounter two different Slendro scales, preparing us for a return of the A theme (A') in Slendro instead of Pelog at m. 43. At m. 40 and 42, we hear Bb Slendro, while F Slendro is arpeggiated in m. 41. The two have only one note of difference; Eb is featured in F Slendro while Bb Slendro uses D#. The dynamic also builds so that the texture change of the returning A'-section is more dramatic (see figure 5 for a more in-depth look at this B-section).

Now we have A' starting at m. 43, and the texture and timing, while identical to before, is simply rendered in Bb Slendro instead of D↓ Pelog. This gives it a slightly more neutral and less angular feeling. Instead of Pelog fifths in instruments 10 and 11, we now have Slendro fifths, which are 14\23 notes wide instead of 13\23, and are thus about 730 cents. Throughout the rest of the section, Slendro fifths appear as auxiliary tones in whatever scale is currently being used, and then those auxiliary tones become common tones of the next Slendro scale visited, or vice versa (see figure 6 for examples). This causes a more dramatic shift between adjacent Slendro scales than at m.40-42; Slendro scales in 23-equal without auxiliary tones can share four common tones between each other. Giving Slendro scales auxiliary tones is a way for Blackwood to emulate the first A-section without using unfitting perfect fifths. Eventually, after visiting three Slendro scales, we get back to

[43] Blackwood, *Microtonal Compositions,* liner notes, 4.

D🡻 Pelog at m. 63. The scales in this section use Slendro first, then Pelog, which is the reverse of the initial A-section. At m. 72-75, we have the analogous moment where the scale switches once per bar (which is also what happened at m. 23-26). At B' starting at m. 77, we have the same situation where the two scales reverse spots, but the transpositions are not exactly the same, and some shifts differ by a 23-equal semitone. For example, the Slendro fifths in the bass at m. 81-82 and m. 83-84 are E + B🡹 (7, 21) and A + E🡹 (17, 8), which differ by 10\23 as parallel fifths, instead of by 9\23 like at their analogous spot in m. 34-37.

The final A-section, starting at m. 90, begins the same way the piece started, though this time the material is not drawn out as much, and the rate at which scale material changes is generally quicker. One could view it as a condensed version of what happens in the initial A-section, with certain redundant bars skipped and certain melodic material omitted. At m. 90 we start in D🡻 Pelog with the same orchestration, but it only takes us eight bars to get to F Slendro at m. 98, with a glissando in the exotic voices leading us there from m. 96. By m. 103, we are back in D🡻 Pelog. Starting at m. 105-109, we hear the scale change once per bar, including the tuned gong. It is difficult to say whether Blackwood considered this a miniature B-section, as the material is similar. Instrument 3 also changes its arpeggiations slightly to match repeated leaps more than lyrical contours. Ultimately, the reason I have chosen to call it an A-section is because the exotic voices melodically act like they are in the A-section, with clear homophony. The time it takes up is also too short, there is no build and release like at the ends of B-sections, and the harmonic rhythm is straightforward, as in the A-sections. Our final changes, starting at m. 110, cycles through D🡻 Pelog, a two-bar Slendro with auxiliary tones, F Slendro, and then lands in D🡻 Pelog,

fading away after a final glissando in the melody at m. 118. Perhaps the strange choice of scales at m. 111-112 is a cadential move (see figure 7). The 23-equal etude showcases the expressive power of contrasting Pelog and Slendro approximations within a fairly limited set of textures and a quasi-traditional ternary form.

VI. ANALYSIS OF BLACKWOOD'S THIRTEEN-EQUAL ETUDE

Unlike the 23-equal etude, the 13-equal etude has chaotic rhythms, and extremely driven, focused chord progressions. Knowing Blackwood's strategies, he likely wanted to obscure the discordant intervals of the tuning by creating a plurality of sounds. In the 13-equal, he uses certain bell-like instruments at moments where the chords either have a dominant-like function, or could be construed as dissonant because of a "fifth." However, put too many notes in the chord, and the ear cannot keep track of what is familiar. These "complex altered chords" that Blackwood refers to in the liner notes are tetrads, sometimes pentads, which play specific roles in the perceived resolution of climactic sections. The "strange mode that can only be described as 'sub-minor'" that he refers to is an octatonic scale with 5 whole and 3 half steps (so, 5L 3s).[44] At times, this scale is evenly distributed, and sometimes not. In temperament theory, the evenly distributed type of 5L 3s is now known as Father[8]; it is a melodically smooth, but often harmonically unfamiliar, scale.

The 13-equal form is demarcated by dramatic change in texture, and, exactly like the 23-equal etude, the 13-equal etude is an A-B-A'-B'-A. We can think of the A-sections as opening up each of the three parts, but the last A-section is just short, and ends the piece. Each A-section begins with a duet of the soft instruments 4 and 5 in a 5L 3s scale. In the first A-section from m. 1-13, we are in Ab, or, we start on pitch class 9. The interval between Ab and Cbb, or the 3 between pitch classes 9-12, is the interval that Blackwood is considering our "sub-minor" third, clocking in at about 276 cents. In the opening section, he does use the distributionally even version of 5L 3s, where the steps line up in this specific combination: LsLLsLLs. Our scale here is thus: Ab-Bb-Cbb-Dbb-Ebb-E-F#-G#-Ab, and in

[44] Blackwood, *Microtonal Compositions,* liner notes, 4.

pitch classes, it is 9, 11, 12, 1, 3, 4, 6, 8, 9. These are the only pitches used in the first A-section. The initial entrances begin a duet at the "fifth," although an acceptable perfect fifth is not approximated in this tuning. One should see this as a subject + countersubject that fades into the background, and/or chains of suspensions engaging in call-and-response. Blackwood uses the 5 or 6 interval to represent a perfect fourth-like function throughout the piece. In this opening canon, and later, Ebb is used as a fifth-approximation, which appears in our Father[8] scale (see figure 8). When the duet is established, m. 6 sees the entrance of disjunct ethereal pipes, which create a sense of mystery. We get used to the sound of its melodic contour quickly, and the magic horn comes in at the end of this section to provide a countermelody.

At m. 14, we arrive at the first B section. I choose to mark the B-section here because (a) the ethereal pipes change their contour to be non-angular, and (b) the bass line arrives with instrument 14. These simultaneous textural changes impact the sound of the moment clearly, and we also see "chromatic" notes outside of Father[8] around the corner. Now that we have a low bass line and more voices, as well as a melody and countermelody, a couple important tonalities start to emerge. The two melodies we have continue to move, mostly stepwise through Father[8], and the endings of their phrases use the same notes within their respective parts. The ethereal pipes end their phrases on Ab, while the magic horn ends its phrases on Dbb. This creates a sense of call-and-response as well as tonality on the two notes (see figure 9). The ethereal pipes give the tonic (Ab) and the magic horn gives a subdominant-like note, Dbb. Ab to Dbb is the smaller "fourth," the 5, which is "diatonic" in Father[8].

The bass line starts with notes from our Father[8] scale, using the closest analogue to a minor seventh chord in 12-equal. This m7 analogue is the most resolved-sounding tetrad in the complex texture. Quickly, the music escalates into a surprising moment as we hear our first strikingly chromatic entity at m. 18. This is made more obvious by accompanied by harp sounds in instruments 10-12, as well as the fact that the bass line is moving up 1 from Cbb to C. From there, we switch between two chromatic leading chords that sound vaguely subdominant-like and dominant-like, respectively. These two chords can be spelled as the pentad C-Bb-Dbb-E-Ab, or 0, 11, 1, 4, 9, occurring at m. 18-19 and 21, as well as the more dominant-like tetrad Ebb-F#-Ab-C, or 3, 6, 9, 0, occurring at m. 20 and 22. To explain these chords in 12-equal terms is cumbersome, so I have provided more voicing information in figure 10. The qualities of these chords are hard to distinguish because of the other non-chord tones in associated instruments constantly moving, and because the thirds stack and are thoroughly alien to 12-equal. Perhaps what the ear gravitates towards the most are the bass and the melody/countermelody, which are far enough apart from each other in register that there is no sense of discordance, but of implied destination.

These chords then set up a complex resolution culminating in m. 25 (still in Figure 9) that has to do with different instruments acting out respective aural cues. The Ebb that has been sitting in the bass has carried a dominant-like quality with it, so that our ear still expects to resolve to Ab. With that implication in place, instrument 10, one of the bells, also reminds us of Ab whenever it is presented in our C pentad. When the melodies start holding on C and E, however, things take a turn because those new notes being melodically emphasized prime the ear for a significant shift. There are multiple ways that one could

interpret the melodic devices. The Ebb-F#-Ab notes register as a twisted diminished chord, while the C on top acts like a scale degree 4 that wants to resolve down (even though the distance between Ebb and C is a large sixth). However, because our C is now acting as this "fourth," the key we get pulled towards is no longer Ab, but G#, at least in its analogous Father[8] scale, where our scale degrees starting from C would proceed C-Bb-A#-G#. This is exactly what happens in the melody when we resolve to m. 25, so this melodic urge is fulfilled.

Other factors that aid this perceived resolution are (1) the metric stasis of the previous chords (2) the bell's Ab sounding as if it should resolve down to G# (3) the change of the melodic contour right before the resolution, and (4) the role of the bass. The bass is the most important here, as it cycles through ascending "fourths." F# to B# (m. 23-24) is the 6-sized fourth, and B# to E is the 5-sized fourth (m. 24-25). This is significant because the 5-size "fourth" not only establishes our new Father scale, but also contrasts sufficiently with the 6-fourth to reveal a new chromatic plane of harmony. Additionally, the bass from m. 22-24 can be thought of as arpeggiations of a big "V-chord," if we spell that B#-Ebb-F#. Then, our Ebb's tendency to "want to resolve" shifts to being a leading tone's; going to Ebb-E instead of back to Ab. This works since E-G# is in m. 25, forming part of our resolved sounding entity in this area, the m7 analogue.

When we get to this new key area, the E-G#-Bb-D chord then heads into the territory of a different 5L 3s scale that is not Father[8], but a different combination and mode of 5L 3s, LsLsLsLL, Our A'-theme actually elides with the ending of the B-section at m. 34, in instruments 4 and 5 starting on the CX-E sonority. This is our "fourth" size of 5 steps from earlier, so the piece has modulated to the subdominant area of CX/Dbb (pitch class 1)

from Ab (pitch class 9). The countermelody that enters in thirds at m. 37-38 is, thus similarly, an entrance at the minor second (see figure 11). By the time we add the ethereal pipes again at m. 46, the scale has subtly changed over time to become Father[8] again, this time with F# as the tonic instead of Ab. Our B'-section, starting at m. 51, is thus identical to the first B-section, but simply transposed to F# (down 3 from before). At m. 58, the chords subtly shift down 2 from their expected course, so that the progression ends up back in Ab-Father[8]. This also causes the overall chord progression to be a transposition 5 notes lower than in the original B-section, instead of 3 like it was in m. 51-57 (see figure 12 for comparison). The only other differences between the B sections are a few of the counting values in the inner voices, and a few different bass notes leading into longer chords. The last A-section begins at m. 74, eliding with the other texture as in the first B-section. After a canon at the fifth, the soft sounds fade into quietness, closing with a hexad containing Ab-Bb-Cbb-Ebb-F#-G#. This clustered, ambiguous sonority is best analogized to 12-equal by calling it a minor-major seventh with an added ninth and 'sixth'. The 13-equal etude showcases the newfound capabilities of Father[8], which are vibrant, strongly functional, and highly unlike 12-equal.

VII. ANALYSIS OF BLACKWOOD'S FIFTEEN-EQUAL ETUDE

The 15-equal tuning, however, is much easier to explain in 12-equal terms, though it is still quite xenharmonic. Blackwood's 15-equal etude is almost entirely triadic, and set at the slowest tempo of all the etudes at Lento. The form is not intuitively obvious, as it is with the other two etudes analyzed here. This is because the rhythmic motifs, dynamic points, phrasing, and "relative major arrival" all contribute to crucial structural points, but happen at different places. We are ultimately dealing with a ternary form, with two A-sections that continue in a drastically different manner after stating the opening theme. From extensive listening to the piece, I am choosing to call the A-section m. 1-11, the B-section m. 12-23, and the A'-section m. 24-39. At m. 1-2, the rhythm is straight eighth notes in a hexatonic scale subset of the 5L 5s scale, known as Blackwood[10], providing an accompaniment as well as an establishing bed of sound (see figure 13). Blackwood himself calls this decatonic scale the "ten-note symmetric mode," of which 15-equal's major-scale-approximation is a subset.[45] This accompanying texture also becomes more drawn out and obvious at points where we cadence on D-down, our key. These conspicuously on-rhythm parts, often with long notes in the melody featured by instrument 2, are starkly juxtaposed to the more melodic sections where we travel through chords that sound in between diatonic and chromatic at several instances. Because of this, the A and C sections are more similar to each other than they are to the B section.

Our A form almost entirely uses the Blackwood[10] scale only, and some of the triads that can be reached within it. Blackwood uses this decatonic scale as minor-like, so it is best described as a scale starting on D🡻, with the notes D🡻, D, E🡻, F, F#🡻, G, A🡻, Bb,

[45] Blackwood, "Modes and Chord Progressions in Equal Tunings," 193.

B𝅝, C; these notes in pitch classes are 2, 3, 5, 6, 8, 9, 11, 12, 14, 0. There are a few non-chord tones in instrument 5, though, used to approach notes that exist in Blackwood[10], such as at m. 5, and then m. 6, where G𝅝 and A𝅝 are used (see figure 14). The A-section makes the choice of using almost exclusively minor chords, though an equal number of major and minor chords are accessible in Blackwood[10]. This contrasts with major chords adding surprising turns in the B and C-sections. It is also likely that this was done to avoid ii-V-I, which Blackwood found to be horribly disagreeable in 15-equal.[46] Our major chords in 15-equal are 0-5-9, and our minor chords are 0-4-9. This causes D𝅝 minor to be spelled as D𝅝-F-A𝅝 as our tonic minor triad.

The A-section plays with functions of chords that could have multiple meanings in 12-equal, which is a quintessentially xenharmonic tactic. The progression from m. 1-5, for example, utilizes this progression: D𝅝 minor, A𝅝 minor, B𝅝 minor, F#𝅝 major. This can sound like "i-v-bvii-IV" or "i-v-vi-III," because the most displacing shift happens from A𝅝 minor to B𝅝 minor. From a regular temperament theorist's perspective, it could be said that the chord progression fails to temper out the syntonic comma. B𝅝 minor's third is D, not D𝅝, so that lack of a common tone causes reinterpretation of the chord and where it moves. Similarly, our progression definitely sounds like it moves to a predominant area, but this is only because F#𝅝 and G𝅝 are the same in 15-equal. In m. 7-8, we get another short example of xenharmonic function, as we have something that could be interpreted as "v-ii-iv-i." However, fourths can be spelled as two versions in Blackwood [10], G𝅝 and G. Here, G is part of the chord E𝅝 minor, while G𝅝 is part of the chord G𝅝 minor (see figure 15 for a visual explanation of the nature of this progression). Blackwood then repeats this

[46] Ibid, 193.

kind of motion by chromatic mediant chords, using E𝅝 minor and B𝅝 minor (with a D in the bass) to approach D𝅝 minor. The bass in the B𝅝 minor chord acts like a b2 scale degree relative to D𝅝, and many of the chord progressions that drift by a semitone act in a plagal manner.

The adherence to the symmetrical scale creates a sense of consistency and establishes a tone for the B section, beginning at m. 12. Beforehand, m. 11 closed with a plagal-like cadence (from m. 8), emphasizing D𝅝 minor as the tonic again. In this section, the harmony is entirely chromatic, and moves between chords that are either a perfect fifth (9 steps) away, or a chromatic mediant away (-5 steps). The key tonicized seems to be F𝅗𝅥 minor, which is confirmed by subsequent harmonic motion. Eventually, more major chords start to phase in, until we arrive at F𝅗𝅥 major at m. 19. The move from F𝅗𝅥 minor to F𝅗𝅥 major accomplishes two things. First, the Picardy third foreshadows the later change from D𝅝 minor to major (parallel keys). It is also likely that Blackwood hinted at F𝅗𝅥 major to parody traditional forms' usage of "i-III-i" in the famed sonata-allegro, i.e. heading to the relative major of the original minor key. Interestingly, however, F𝅗𝅥 is a major third higher than D𝅝 in 15-equal, as subtle drift from older chord progressions was used to accomplish that change from our expected F𝅗𝅥. This feeling is mainly accomplished with a 5-equal circle of fifths progression, consistent with xenharmonic tuning systems' tendencies to displace 12-equal chord progressions by a tone (for detail on this, see figure 16).

Thus far, Blackwood has managed to disguise many of the odd twists and turns in melodic content through triadic harmony, but at measure 21 he intentionally creates a xenharmonic melodic and harmonic moment. 15-equal lacks a whole tone, but it does have a neutral second, or "small M2nd" (160 cents) and a 5-equal tone or "large M2nd/small m3rd"

(240 cents). At measure 21, he planes the F🡅 major chord down to an Eb🡅 major chord. This moves by the 240-cent step (-3 steps), and sounds quite unusual to a Westerner outside of the context of smooth part writing. We know how intentional this is not only because of the strong contrast between this maneuver and the rest of the etude's behavior, but because he (a) writes a crescendo into that point, (b) talks about that exact kind of chord progression in his writings on 15-equal, and (c) calibrates that point for the listener to notice it (if he had planed up a 240-cent interval instead of down, that could more easily slip by the Western ear).[47] Plus, the tones of the Eb🡅 major chord sound chromatic at this point of the piece. Blackwood writes about planing triads by the 240-cent interval in 5-equal, and other tunings that split the perfect fourth in half, such as 19-equal. We have heard the 240-cent step a lot in this piece already, but these were part of the context of a pentatonic scale or Blackwood[10] movements, like at the beginning of the piece, and thus did not register as bizarrely (see figure 17 for comparison).

Immediately afterwards, our B-section exhibits a quasi-cadence at the end of m. 23 on F🡅 major, but the previous key, D🡇 minor, simply returns in a big moment at m. 24. I have chosen to label this the A'-section because it is an arrival, and Blackwood has written in "Largamente." It is also rhythmically similar to the opening two measures, unlike the other point arriving at D🡇 minor around m. 30. This causes it to function as a return to the main theme, although only harmonically. Like in the B-section, similar-sounding chords are grouped together, but they are "chromatic," relative to Blackwood [10], this time. The leading, ambiguous two chords at the end of m. 24 are B🡇 minor and D minor, thus the resolution sounds a little Phrygian or subdominant-like, similar to the resolution used at m.

[47] Blackwood, "Modes and Chord Progressions in Equal Tunings," 191-192.

9 and 10. At m. 25, that changes to G𝅻 minor, our true subdominant in this key. It is no accident that this chord is stronger, because then the chord leads to D𝅻 major instead, continuing the heavy usage of relative/parallel keys and plagal movement. Then the triads move by fifth again, sometimes moving a second away, until at m. 29 we use the same Phrygian-like cadence (B𝅻 minor, D minor) to get back to D𝅻 major at m. 30.

For the rest of the piece, D𝅻 major is approached by subdominant and plagal entities, such as a major "ii" (V/V) of E𝅼 major, and G𝅻 major/minor. This chord change draws from the same contradiction that is formed in the A-section, that is, E𝅼 major's third is the same as G𝅻 major's root, which does not work in 12-equal, say, if we were to try and analogize it to E major going to G major/minor. We even briefly see G minor having an added sixth of Eb𝅼 (pc 4) at m. 36 before the final chord. The C-section is chromatic, too, but not as much as the B-section. One could describe it by saying that the scale is still based on Blackwood[10] as minor-like scale, but with a borrowed Picardy third for the I-chord with F𝅼 (pc 7). An analogue to ii-V-I is not presented in the entire work, consistent with Blackwood's views on smooth part-writing in 15-equal.[48]

[48] Blackwood, "Modes and Chord Progressions in Equal Tunings," 190-191.

VIII. EMULATIVE CREATIVE CHOICES IN MY *MACROTONAL ETUDES*

Blackwood's approach to changing texture is clear; as he normally sticks to easily followed phrases, clear entrances of themes, and climactic moments in the middle of pieces. Due to the difficulty of emulating his style, I also directly followed the formal blueprints of some of his given etudes, with a pinch of proper aural diversity and creativity. I have learned that often my approach is radically different from Blackwood's when left to my own devices, except that we both relish melodic material of a foreign kind. In my etudes, I generally use few notes so that modulation is possible. In the 10-equal etude, I refrain from using 5-equal too heavily as a subset since there is already an etude in that tuning. I also modeled my etude order on Blackwood's, which, according to what I know about his preferences, seem to intentionally juxtapose tempi as well as discordant vs. concordant tunings. The order for *Six Macrotonal Etudes for Electronic Music Media* are thus:

(I) 5 notes: Grazioso
(II) 11 notes: Larghetto
(III) 9 notes: Allegro
(IV) 10 notes: Maestoso
(V) 8 notes: Grave
(VI) 7 notes: Vivace

The difficulty of my writing has come through the sparseness of the material and the search for finding just the right expressive virtual instruments. Tempi were easier to correspond with tuning, based on the relatively simple harmonic and melodic options. Etudes with more potent harmonic combinations needed to linger, and thus be on the slower side.

There are a few kinds of textures that Blackwood likes to use. Almost all of the Blackwood etudes have an ostinato, and all have clear melodic content. He rarely puts a melody in the actual bass voice, to conceal wolves against his ostinato. However, melodic content can show up in a middle voice. Establishing this kind of three-part texture in the

same specific ways Blackwood did is the key to making the etudes sound like his work. The groups of texture patterns, as I see them, are as follows:

(1) Constant ostinato, with call-and-response melody/countermelodies – 16, 17, 20, 13, 21
(2) Constant ostinato (multilayered or not) with one melody – 23, 15, 22
(3) Call-and-response texture alternating ambiguously with melody + ostinato – 18, 14
(4) Canon – 24
(5) Contrapuntal texture alternating with melody + ostinato – 19

I should briefly mention that this approach generalizes many textures, for example, canon occurs in 13-equal's ostinato part, and the 22-equal could be considered homophonic enough that a separate ostinato and melody cannot be perceived. However, this categorization still lays bare the important connections between etudes. Most are contrapuntal to at least a small extent, except for perhaps the 22-equal.

Blackwood's tuning opinions are reflected in his texture choices for the more dissonant equal tunings. For example, the 18-equal, 14-equal, and the 13-equal are intentionally melodically and rhythmically chaotic to disguise the out-of-tune sensation that inexperienced listeners receive. The 18-equal and 14-equal (category 3) are thus most erratic with textural change. I decided to make my 7-equal etude mirror Blackwood's treatment of the 18-equal, by giving it textures that change more over time than the others. The technique of constant change is also more necessary to sustain interest, since 7-equal (1) is a tuning that gets tiresome quickly with a constant ostinato, and (2) there is little chromatic possibility with extended harmony. 5-equal brings more rhythmic interest, while 7-equal, more textural interest. This is again tailored to the lack of options; 5-equal needs to work with rhythm the most for melodic ideas because of its extreme sparseness. Since category 3 is an outlier, I also used similar melodic and counter-melodic ideas from the other categories to balance out impressions of similarity across all six movements.

The 8-equal and 9-equal only have an ostinato and a melody (category 2), with the melodic instrument never changing its timbre. Both are at opposing tempos, so this was a good opportunity to explore how the texture similarity operates under different conditions. The 10-equal and 11-equal used ostinato, melody, and countermelody together (category 1). The 10-equal used more immediate imitation, alternating bars (like the 21-equal suites), while the 11-equal dealt with more long-term entrances (like the 13-equal). This decision, like the others, is tailored to tempo. The 10-equal etude, being faster, seems more suited to echo itself, while the slower 11-equal etude simply features a melody entrance followed by a countermelody entrance. Notice that Blackwood uses this same kind of tempo-based decision making in his etudes when it comes to how quickly the focus on melodic content is shifted. Faster etudes (17, 21) switch melodies faster, while the slower ones (20, 13, 16) have more drawn-out entrances. This is even true of etudes that are not in category 1, such as the 19-equal etude.

Two slow movements are not often presented right after the other, but two fast movements can be. The traditional alternation between slow and fast is preserved in both Blackwood's etudes and my etudes. I hope that my macrotonal etudes are something that you relish as a listener, and that the xenharmonic sounds arouse your curiosity about the emotional, dramatic, and infinitely diverse affective capabilities of different tuning systems.

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