Microtonal Techniques in the Music of Harry Partch and Ben Johnston

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Publication Info

Published in Music Research Forum, Volume 7, 1992, pages 14-37.


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Microtonal Techniques in the Music of Harry Partch and Ben Johnston

Richard Maltz

Experiments with microtonal techniques by twentieth-century Western composers have generally fallen into one of two paths. One method is to divide the chromatic scale into equal microtones, as in Charles Ives' *Three Quarter-Tone Pieces for Two Pianos*. This "chromatic microtonality" keeps the skeletal structure of Western tradition intact. Microtones are used as melodic embellishments and add color to harmonic structures.

This article deals with the second use of microtones in music, in which the tones of a diatonic scale are adjusted to avoid the acoustical imperfections found in equal temperament. This is shown by Harry Partch in his *And on the Seventh Day Petals Fell in Petaluma* and by Ben Johnston in his *Fourth String Quartet*. This "diatonic microtonality" is achieved by pulling down the upper partials of a note and embedding them in a scale which results in new divisions of the octave. In this system, microtones are not just simple embellishments, but components of the basic musical structure.

**HARRY PARTCH**

Harry Partch, a self-taught composer and instrument maker, was born in Oakland, California in 1901 and died in San Diego in 1976. His works, composed mostly for the theater, borrowed from American folklore, African and Oriental literature, and mystical and pre-Christian magical thought. In his compositional style, the essence of proportionality is that the relationship between the elements of a system is determined by comparing their values to each other as ratios. Partch divided the octave into 43 unequal parts beginning with eight pitches based on just-interval ratios. The following diagram shows these ratios and the number of cents of each corresponding pitch as compared
with its equal-temperament counterpart. With octave divisions not based on equal temperament, frequency ratios instead of letter names are necessary for identifying pitches.

<table>
<thead>
<tr>
<th>Just ratios</th>
<th>G</th>
<th>B-flat</th>
<th>B</th>
<th>C'</th>
<th>D'</th>
<th>E-flat'</th>
<th>E'</th>
<th>G'</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1/1</td>
<td>6/5</td>
<td>5/4</td>
<td>4/3</td>
<td>3/2</td>
<td>8/5</td>
<td>5/3</td>
<td>2/1</td>
</tr>
<tr>
<td>Just cents</td>
<td>0</td>
<td>315.6</td>
<td>386.3</td>
<td>498</td>
<td>702</td>
<td>813.7</td>
<td>884.4</td>
<td>1200</td>
</tr>
<tr>
<td>Equal temp.</td>
<td>0</td>
<td>300</td>
<td>400</td>
<td>500</td>
<td>700</td>
<td>800</td>
<td>900</td>
<td>1200</td>
</tr>
</tbody>
</table>

Diagram 1. Comparison (in cents) of eight just-interval ratios and their equal-tempered counterparts.¹

The 43-tone scale consists of eight tones derived from just-interval ratios and 35 interpolated tones. All 43 are either eleven-limit ratios or multiple-number ratios. An eleven-limit ratio is one in which both the numerator and denominator are numbers no higher than eleven. A limit is chosen according to the belief that the smaller the number of the proportion is, the more consonant the interval will be. Multiple-number ratios result from the multiplication of two ratios within the eleven-limit ratio. For example, the second ratio in the diagram of the 43-tone scale is 81/80. It is the result of multiplying the two eleven-limit ratios, 9/5 and 9/8. 9/5 x 9/8 is 81/40. 81/40 transposed an octave so that it lies within the range of the scale is 81/80. The third ratio in the diagram is 33/32. It is the result of multiplying the two eleven-limit ratios, 3/2 and 11/8. 3/2 x 11/8 = 33/16 (33/32).

1. 1/1 2. 81/80 3. 33/32 4. 21/20 5. 16/15 6. 12/11 7. 11/10 8. 10/9 9. 9/8 10. 8/7 11. 7/6 12. 32/27 13. 6/5 14. 11/9 15. 5/4 16. 14/11 17. 9/7 18. 21/16 19. 4/3 20. 27/20 21. 11/8 22. 7/5 23. 10/7 24. 16/11 25. 40/27 26. 3/2 27. 32/21 28. 14/9 29. 11/7 30. 8/5 31. 18/11 32. 5/3 33. 27/16 34. 12/7 35. 7/4 36. 16/9 37. 9/5 38. 20/11 39. 11/6 40. 15/8 41. 40/21 42. 64/33 43. 160/81 44. 2/1

Diagram 2. Frequency ratios of Harry Partch’s 43-tone scale²


²Ibid., 133; the eight just-interval ratios are: 1. 1/1, 13. 6/5, 15. 5/4, 19. 4/3, 26. 3/2, 30. 8/5, 32. 5/3, and 44. 2/1.
The first half of the 43-tone scale is a retrograde of the second half. The interval ratio between pitches 1 and 2 and between pitches 43 and 44 is the same, as is the one between pitches 2 and 3 and pitches 41 and 42, etc.

The following diagram shows the eleven-limit tonality diamond which illustrates the frequency ratios from which Partch derived twelve primary tonalities.

Diagram 3. Frequency ratios of Harry Partch's eleven-limit tonality diamond.3

The twelve primary tonalities consist of six "major" tonalities and six "minor" tonalities. The generating tone (written as the ratio 1/1) is the root of a triad built in thirds, as seen in diagram 4. Partch chose G below middle C as the generating tone.

\[
\begin{align*}
1/1 & \quad G \\
      & \quad 5/4 \quad B \\
      & \quad 3/2 \quad D'
\end{align*}
\]

Diagram 4. Harry Partch's "major" triad.4

The ratio of the major triad is 4:5:6 [4/4(1/1): 5/4(5/4): 6/4(3/2)]. Extending the triad to include the seventh, ninth and eleventh degrees results in

---

3Ibid., 159.
an eleventh chord generated from the root, G, as seen in diagram 5. The eleventh chord is the fundamental chord of Partch’s tonal system—its ratio is 4:5:6:7:9:11.

\[
\begin{array}{ccccccc}
1/1 & 5/4 & 3/2 & 7/4 & 9/8 & 11/8 \\
G & B & D' & F' & A' & C'
\end{array}
\]

Diagram 5. Harry Partch’s “major” eleventh chord.\(^5\)

The same ratio, that of the generating tone 1/1, is the fifth of a minor triad built in thirds, as seen in diagram 6. The thirds in the minor triad extend in the opposite direction from the thirds in the major triad (see the tonality diamond).

\[
\begin{array}{ccc}
1/1 & 8/5 & 4/3 \\
G & E-flat & C
\end{array}
\]

Diagram 6. Harry Partch’s “minor” triad.\(^6\)

The ratio of the minor triad is 1/4: 1/5: 1/6. Extending the minor triad to include the seventh, ninth and eleventh degrees results in another eleventh chord generated from the ratio 1/1, as seen in diagram 7. Its ratio is 1/4: 1/5: 1/6: 1/7: 1/9: 1/11.

\[
\begin{array}{ccccccc}
1/1 & 8/5 & 4/3 & 8/7 & 16/9 & 16/11 \\
G & E-flat & C & B-flat & F & D-flat
\end{array}
\]

Diagram 7. Harry Partch’s “minor” eleventh chord.\(^7\)

Although the theory of extended thirds is intact, the ratio 8/7 is labeled B-flat instead of A. In equal temperament the ratio 8/7 is actually closer to B-flat than it is to A. Partch defines a total of 28 tonalities which stem from the generating tone 1/1 (twelve primary and sixteen secondary tonalities). The sixteen “secondary” tonalities are so called because none include the generating tone 1/1. While the twelve primary tonalities all contain the six tones, the

\(^5\)Ibid.
\(^6\)Ibid.
\(^7\)Ibid.
sixteen secondary tonalities contain anywhere from three to six tones. The various possible combinations of the six major tonalities (or minor) yield twenty types of triads, fifteen types of quadrads and six types of quintads, as seen in diagram 8. Using the major eleventh chord generated from G as an example, the numbers one to six represent the pitches G, B, D, F, A, and C, respectively.

<table>
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<tr>
<th>Twenty triads</th>
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<tbody>
<tr>
<td>1-2-3</td>
<td>1-3-5</td>
<td>2-3-4</td>
<td>2-5-6</td>
</tr>
<tr>
<td>1-2-4</td>
<td>1-3-6</td>
<td>2-3-5</td>
<td>3-4-5</td>
</tr>
<tr>
<td>1-2-5</td>
<td>1-4-5</td>
<td>2-3-6</td>
<td>3-4-6</td>
</tr>
<tr>
<td>1-2-6</td>
<td>1-4-6</td>
<td>2-4-5</td>
<td>3-5-6</td>
</tr>
<tr>
<td>1-3-4</td>
<td>1-5-6</td>
<td>2-4-6</td>
<td>4-5-6</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Fifteen quadrads</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1-2-3-4</td>
<td>1-2-4-5</td>
<td>1-3-4-5</td>
<td>1-4-5-6</td>
</tr>
<tr>
<td>1-2-3-5</td>
<td>1-2-4-6</td>
<td>1-3-4-6</td>
<td>2-3-4-5</td>
</tr>
<tr>
<td>1-2-3-6</td>
<td>1-2-5-6</td>
<td>1-3-5-6</td>
<td>2-3-4-6</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Six quintads</th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1-2-3-4-5</td>
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<td></td>
</tr>
<tr>
<td>1-2-3-4-6</td>
<td>1-3-4-5-6</td>
<td></td>
</tr>
<tr>
<td>1-2-3-5-6</td>
<td>2-3-4-5-6</td>
<td></td>
</tr>
</tbody>
</table>

Diagram 8. Harry Partch’s triads, quadrads, and quintads.\(^8\)

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And on the Seventh Day Petals Fell in Petaluma

*And on the Seventh Day Petals Fell in Petaluma* was written between 1963 and 1966. Its form is unique in conception. It consists of 34 one-minute sections which Partch calls “verses.” Each of the first 23 verses is a duet or trio. Then, by electronic synthesis, the first twenty are combined in pairs, creating verses 24 to 33 as quartets and quintets; finally, verses 21–23 are combined, producing a septet. This formal design literally repeats the first 23 verses in a compressed manner, creating seemingly new material of increased timbre and texture. Though all are one minute in duration, the parts

of the combined duets and trios most often do not share the same metrical structure, and they often have different time units as the beat.

In order to realize his theory in sound, Partch found it necessary to build his own instruments. *And on the Seventh Day* uses 24 instruments, mostly idiophones and chordophones.\(^9\) With the new instruments a need for new notational procedures arose. Partch uses a mixture of ratio tags (assigned to all the pitches calculated from his starting point G), as seen in example 1, and number notation that determines which part of the instrument is referred to, as seen in example 2.

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Harry Partch carefully divided the octave into 43 parts, producing a justly tuned melodic and harmonic language. It is ironic, however, that in *And on the Seventh Day* this language is more often than not carelessly treated in an ambiguous fashion. This is done by the inclusion of almost every pitch along

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\(^9\)For a detailed description of Partch's instruments, see his *Genesis of a Music*.

\(^{10}\)Harry Partch Foundation, c/o Danlee Mitchell, 4809 Felton Street, San Diego, California, 92116.
the pitch continuum. The 43 pitches of the octave are often used merely as starting and stopping points at which glissandi connect all the pitches in between.

Partch’s string instruments (a variety of homemade harps and zithers) are precisely tuned within the 43-tone system but are often played in manners which encompass many more pitches. In addition to using glissandi, strings are struck with sticks and plucked with fingers, thus causing wavering of the pitches. Often, many strings are struck simultaneously, creating a complex spectrum of overtones that are allowed to sustain over a period of time.

The “keyboard” percussion instruments include marimbas and xylophones made from a variety of materials including wood, bamboo and glass. They are also precisely tuned to the 43-tone system. Although the accuracy of their pitches is not altered by the way in which they are played, their sound is characterized more by timbre than by their actual pitch. The brittle sound of the xylophone, the breath-like quality of the bass marimba, and the delicate thud of the bamboo marimba, combined with each instrument’s lack of sustaining power, contributes to a quality of sound which is rich in color but unfocused in pitch.

Partch’s organ is the instrument best designed to put the melodic and harmonic theories of the 43-tone system into practice. The precisely tuned reeds do not waver in pitch, and the organ also has the ability to sustain its tones. When included in the instrumental texture of his music, it provides harmonic stability. Unfortunately, most of the music in And on the Seventh Day does not include the organ and is, therefore, harmonically unstable.

Verse 24 (combined verses one and two) illustrates this harmonic instability. The improvised stretching and striking of strings in verse one results in wobbling pitches that stray far from precisely determined pitch theory. In verse two, the snapping of strings results in microtonal waverning and the parallel glissandi of six-note chords involves many more than 43 pitches. Although what is sounded by the combination of verses one and two is colorful, it is also ambiguous.

Verse 25 (combined verses three and four) is a good example of the effect that the organ has in stabilizing the harmony. Verse three consists of string instruments only. The active striking and strumming of the strings and the extensive use of glissandi results in many uncontrolled and undetermined pitches. When combined with verse four, the organ supplies harmonic stability for the wandering pitches in the strings, and it becomes more clear to
the ear just where the pitches of the strings are wandering from. Verse 25 is a combination in which the whole is superior to its individual parts.

Verse 26 (combined verses five and six) demonstrates the characteristic use of the keyboard percussion instruments in this piece. Constantly articulated sixteenth notes in ostinato patterns abound. The marimbas in verse five sound more like graduated sizes of wood blocks than definite pitches. The marimba used in verse six is clearer in tone but slightly overshadowed by the ringing of glass bowls. Whatever clarity of pitch emerges from the instrumental texture of verse six is almost completely submerged in the combined texture of verse 26.

Example 2. *And on the Seventh Day Petals Fell in Petaluma*, verse 26. © by Harry Partch Foundation, all rights reserved. Reprinted by permission.

The combination of verses seven and eight into verse 27 has favorable musical results. The presence of the organ as a unifying harmonic force and the combinational approach to meter and tempo contributes to this success. Verse seven is in 10/8 time at \( * = 150 \). Verse eight is in 18/16 time at \( * = 90 \). Because of long pitch durations, verse seven sounds like it is in a slower tempo than verse eight. The 10:18 polymeter cycles with each measure, and it is further defined by clear rhythmic groupings according to the metric divisions. By mixing slow and fast tempi, verses seven and eight retain some of their identity while contributing to a more complex time structure.
Example 3. *And on the Seventh Day Petals Fell in Petaluma*, verse 27. © by Harry Partch Foundation, all rights reserved. Reprinted by permission.

The polyrhythmic structure in verse 28 is more complex. Verse nine is in 3/4 time at \( \star = 90 \). Verse ten is in 20/16 time at \( \star = 96 \). The cycling of the polymeter 3:10 does not occur regularly as found in verse 27, but a haphazard result is avoided by the use of a constant quarter-note pulse in verse nine and a steady sixteenth-note articulation in verse ten. The rhythmic persistence in each verse provides conviction in the combination of the two. Verse 28 is one of the few examples in which the string and percussion instruments convey pitch accuracy without the help of the organ. The quarter-note pulses of the strings in verse nine occur slowly and are cleanly articulated. The overall instrumental texture is sparse enough that the ear can clearly distinguish the tones. In general, the simpler the instrumental texture, the more focused the individual sounds. Verse ten uses an ascending and descending melody in the marimba part that moves by small intervals. The simplicity of melodic shape helps focus any discrepancies between adjacent pitches.
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The harmony in verse 29 (combined verses eleven and twelve) is not well-rooted, but the mixture of different tempi, sparseness of texture, and melodic expression contribute to its musicality. As was true of verse 27, the overlaying of slow and fast tempi allows the component verses to retain some of their identity while contributing to a more intricate whole. Because verses eleven and twelve have relatively sparse instrumental textures, their combination in verse 29 is not overwhelming—it allows individual voices to be heard. The koto in verse twelve is the most important of those voices. Microtonal inflections embellish its melody with great expression. In other verses, that expression is buried under a cloud of sound; here, the sparseness of texture allows its expressive nature to be heard.

Verse 30 (combined verses fifteen and sixteen) is a successful combination of musical elements for many of the reasons we have seen before. The blurring of pitch in the string instruments of verses fifteen and sixteen is focused by the presence of the organ. The sparse texture of the combined verses allows the subtle microtonal pitch inflections of the koto to speak; those inflections of pitch are in turn anchored by the steadiness of pitch supplied by the organ. Verse fifteen is in 3/4 time at * = 90. Verse sixteen is in 5/4 time at * = 150. Because of the steady pulsation in both verses, the 3:5
polymeter is clearly defined. The mixture of slow and fast tempi again brings about favorable results, and the long sustained chords of verse fifteen provide a distinctive background for the constantly articulated percussive attacks in verse sixteen.

Example 5. *And on the Seventh Day Petals Fell in Petaluma*, verse 31. © by Harry Partch Foundation, all rights reserved. Reprinted by permission.

Verse 32 (combined verses seventeen and eighteen) suffers from lack of dynamic control. The use of the guitar in verse seventeen provides a fresh timbre—it is used expressively, as a melodic instrument. When combined with verse eighteen, however, other string and percussion sounds subordinate the guitar's color and the melodic expression of the entire verse.

The musical success of verse 33 (combined verses nineteen and twenty) is due to clear polymeter, mixture of slow and fast tempi, sparse texture, and melodic expression. The resultant 6:5 polymeter is clarified by the use of steady metric pulses and the coincidental cycling of those pulses with each measure. The texture of verse 33 retains the individuality of the longer durations in verse twenty. The dialogue resulting from the combination of verses nineteen and twenty speaks clearly because of the sparseness of texture—this is very important in verse 33 because there is no organ to secure the tonality. Partch wisely allowed the expressive voices of the koto and the jaws harp to be heard.
Example 6. *And on the Seventh Day Petals Fell in Petaluma*, verse 33. © by Harry Partch Foundation, all rights reserved. Reprinted by permission.

The final verse, 34 (combined verses 21, 22, and 23) combines many of the elements previously heard throughout the piece. Because nothing is held back, the resulting combination of these last three verses is, not surprisingly, chaotic—it is a noisy collaboration of percussion and string sounds. The most interesting part of verse 34 is the use of the organ in verse 22. Here, the most complete representation in sound of Partch's 43-tone scale is found. The organ plays melodic lines which ascend and descend by step. The accuracy of pitch of this instrument can most be appreciated in this verse, although the 43 divisions of the octave are so close together in pitch they can just barely be distinguished. The beauty of this sound scarcely survives the combined texture of verse 34. All of the carefully designed components of the full orchestra, in an intricate rhythmic and metric structure, produce what seems to be a haphazard result.
Example 7. *And on the Seventh Day Petals Fell in Petaluma*, verse 34. © by Harry Partch Foundation, all rights reserved. Reprinted by permission.

Harry Partch’s system of “monophony” is not capable of parallel transposition or modulation in a traditional sense; because of his diatonic microtonal conception, however, it is capable of modulations in just
intonation, thus offering 28 possible tonalities.\textsuperscript{11} Tonal inflection is an integral technique in this composition. Chords whose tones create a solid tonal structure (main and secondary tonalities) are delicately contrasted by other corresponding elements that are only microtones apart.\textsuperscript{12}

The piece is subtitled “Studies in Techniques, Timbres, Double Rhythms, Double Tonalities.” The less successful studies were due to a lack of attention paid to dynamics and instrumental balance. The timbres are fresh but sometimes lost due to the density of instrumental texture. Double rhythms (or polymeter) were more successful when kept steady in pulse and coincidental in the cycling of metric accent. Double tonalities (or polytonality) were most successful when the organ was included as a stabilizing force.

**BEN JOHNSTON**

Benjamin Burwell Johnston was born in Macon, Georgia in 1926. He attended the Cincinnati Conservatory (1949–50) and the University of California at Berkeley (1950); he also studied microtonal theory and instruments with Harry Partch (1950–51), and composition with Darius Milhaud at Mills College (1951–52) and Claire Richards at the University of Illinois (1953–55). One year in New York (1959–60) brought him in contact with Otto Luening and Vladimir Ussachevsky at the Columbia–Princeton Electronic Music Center and introduced Johnston to John Cage. He has experimented with just intonation, microtones, serialism, and indeterminacy.

Like Harry Partch’s music, Ben Johnston’s works are organized proportionally; however, he carries proportionality beyond Partch, relating rhythmic construction to the organizational procedure. In order to expand his perception of pitch vocabulary, Johnston found it necessary to train his ear to precisely discern a definite number of harmonic pitch relations and many combinational variants. He also learned to grasp the microtonal scale pattern formed by adjacent pitches which are inflections of the larger intervals of a seven or twelve-tone scale—for example, the D’ which is two perfect fifths above C and the D which is a perfect fifth and a minor third below C.\textsuperscript{13}

\textsuperscript{11}Ibid., 158.
\textsuperscript{12}Friedman, “Tonality in the Music Of Harry Partch,” 17.
Fourth String Quartet

Ben Johnston's Fourth String Quartet could be subtitled "Variations on Amazing Grace." It is in a one-movement format—the variations are not numbered in the score, but the design is obvious. The variations range from 30 seconds to a minute and 50 seconds, with an average duration of about one minute. The organization is based on the controlled fluctuating complexity of the work's proportional system. There are gradual changes in the number of octave divisions—from as few as five to as many as 22. The correlation between pitch and rhythm throughout the variations is complex—the rhythmic organization mirrors the pitch proportions.\(^{14}\) The "Amazing Grace" theme in the first two variations is based on a Pythagorean pentatonic tuning, as seen in diagram 9.\(^{15}\)

\[
\begin{array}{cccccc}
1/1 & 9/8 & 81/64 & 3/2 & 27/16 & 2/1 \\
-G & A & B & -D & E & -G \\
\end{array}
\]

Diagram 9. Pythagorean pentatonic scale.\(^{16}\)

In Pythagorean tuning, the only consonances are fourths and fifths (for example, \(-G\) to \(B\) is a dissonance). Above and below the violin's pivotal open string \(a^\prime\) are two interval ratios of 3/2; \(E^\prime, B^\prime,\) and \(-D, -G\) respectively. In the opening measures (1-16), "Amazing Grace" is stated clearly by the first violin. The second violin and viola supply the underlying harmonic structure in fourths and fifths. All of the notes (\(G, D,\) and \(A\)) are played as natural harmonics, an octave above the open strings. As in most of the cadences throughout this piece, there is no third in the one closing the opening statement. In variation one, the melody is embellished by the first violin and the cello is added to thicken the texture. In variation two, all of the accompaniment (with the exception of the bottom of the cello line) is

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\(^{14}\)For more detail on the rhythmic organization, see Randall Shinn, "Ben Johnston's Fourth String Quartet," Perspectives of New Music 15 (1977): 145-73.

\(^{15}\)The notation \(\_\) in front of the pitch differentiates it from what would normally be associated with it—it is the interval difference 81/80, or the syntonic comma. 21.5 cents. For example, \(G\) is normally 200 cents below \(A\); however, \(-G\) is only 179.5 cents below \(A\).

melodically derived from the theme. The time signatures of the instrumental parts are related to each other in the ratio 3/2: first violin, 27/32; second violin, 9/16; viola, 6/8; cello, 2/4 (and 3/2 within itself), seen in example 8.

Example 8. Ben Johnston, *String Quartet No. 4*, variation two, mm. 5–8 (3:2 ratio time signatures).\(^{17}\)
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The first scalar change occurs in variation three—G major, in just intonation, as seen in diagram 10. Thirds and sixths are now consonant.

```
1/1  9/8  5/4  4/3  3/2  5/3  15/8  2/1
-G  A   -B  -C  -D  -E  F#   -G
```


The theme is played twice by the first violin, embellished and varied each time. In variation four, the just-intonation scale is extended to include characteristic “blue” notes, as seen in diagram 17 (accordingly, the variation is twelve bars long). Such notes use the seventh partial of the overtone series, and result in a difference of 49 cents, thus lowering their pitch almost an exact quarter-tone. Those inflected notes using the seventh partial above the usual ratio are all indicated by the symbol “\(|\).” Those notes using the seventh

\(^{17}\)Ibid., 152.
partial below the usual ratio are indicated by the symbol “\( L \).” Both symbols can be attached to either the flat or the sharp sign, and in such cases the symbols are used in the same way as natural pitches.

\[
\begin{array}{cccccccc}
1/1 & 28/27 & 10/9 & 7/6 & 5/4 & 21/16 \\
\text{-G} & \text{b-A} & \text{-A} & \text{b-B} & \text{-B} & \text{C}
\end{array}
\]

\[
\begin{array}{cccccccc}
45/32 & 3/2 & 14/9 & 5/3 & 7/4 & 15/8 & 2/1 \\
\text{C#} & \text{-D} & \text{b-E} & \text{-E} & \text{F} & \text{F#} & \text{-G}
\end{array}
\]

Diagram 11. Ben Johnston’s G-major scale extended to include seventh-partial ratios.\(^{18}\)

Example 9. Ben Johnston, *String Quartet No. 4*, variation four, mm. 1–4 (“blues” scale).
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After the relaxed rhythmic activity found in variation four, complexity returns in variation five. The ostinato in the cello part is in a 36/35 rhythmic relationship (that of the symbol “\( \uparrow \)”) to the multiple-stop ostinato figure in the viola part. *Sforzato* multiple-stop chords (in all parts) are spaced throughout this variation according to the proportions of the notes of the twelve-tone “major” scale in variation four, and they mark points that

determine where two seven-tone scales alternate. The first contains seventh-
partial modal elements and the second is the just-transposed dorian mode, as
seen in diagram 12.

```
1. -G  A  b-B  -C  -D  b-E  F  -G
2.  G  -A  b-B  C  -D  -E  F  G
```

Diagram 12. Ben Johnston’s minor just-intonation scale compared with just-
transposed dorian mode.\(^{19}\)

The first violin carries the theme, recognizable only by its contour. About halfway through the variation the cello part switches to an open-string
harmonic ostinato stabilizing the tonality on -G. This new ostinato creates a
quarter-tone fluctuation between the cello and the viola parts and underscores a
quote of Harry Partch’s *First Greek Study* in the enharmonic mode, as seen in
example 10 (in the second violin part).

```
-D  b-E  b-E  -G  A  b-B  b-B  -D
```

Diagram 13. Enharmonic Greek mode.\(^{20}\)

Example 10. Ben Johnston, *String Quartet No. 4*, variation five, mm. 20–22
(Harry Partch’s *First Greek Study*).
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\(^{19}\)Ibid., 154-55.

\(^{20}\)Ibid., 155.
The mode is constructed of two identical enharmonic tetrachords, each containing two quarter-tones and a major third. Variation six is a less rhythmically complex elaborated inversion of the theme. The twelve-tone “major” scale has been internally inverted to form a twelve-tone “minor” scale, as seen in diagram 14. This technique parallels Harry Partch’s process of tonality—inverting scalar ratios in just intonation to achieve various tonalities. The only common tones between the “minor” and “major” scales are -G and -D.

\[
\begin{array}{cccccccc}
1/1 & 16/ & 8/7 & 6/5 & 9/7 & 27/ & 81/ \\
15 & 12 & 9 & 20 & 56 \\
-G & b-A & L-A & b-B & L-B & C & \#C \\
3/2 & 8/5 & 12/ & 9/5 & 27/ & 2/1 \\
-D & b-E & L-E & F & \#F & -G \\
\end{array}
\]

Diagram 14. Ben Johnston’s twelve-tone “minor” scale.\textsuperscript{21}

The scale used in variation seven is the 22-tone combination “major–minor” scale, as seen in diagram 15.

\[
\begin{array}{cccccccc}
1/1 & 28/7 & 16/15 & 10/9 & 8/7 & 7/6 & 6/5 & 5/4 \\
9/7 & 21/16 & 27/20 & 45/32 & 81/56 & 3/2 & 14/9 & 8/5 \\
L-B & -C & C & \#C & \#C & -D & b-E & b-E \\
5/3 & 12/7 & 7/4 & 9/5 & 15/8 & 27/14 & 2/1 \\
-E & L-E & F & F & \#F & \#F & -G \\
\end{array}
\]

Diagram 15. Ben Johnston’s 22-tone combination “major–minor” scale.\textsuperscript{22}

\textsuperscript{21}Ibid.
\textsuperscript{22}Ibid., 156.
Example 11. Ben Johnston, String Quartet No. 4, variation seven, mm. 1–7
(22-tone “major–minor” scale).
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The rhythmic complexity returns, as seen in example 11. Each
instrumental part has one less note per measure than the one above it. The
melodic activity fills in one of three fourths (–D to –G, –G to –C, or A to –D)
with permutations and combinations of the Greek tetrachords—diatonic: two
whole steps and a half-step; chromatic: a minor third and two half-steps; and
enharmonic: a major third and two quarter-tones. The interval combinations
change every measure, but they are the same in all of the parts in any given
measure. Towards the end of the variation, the original theme appears in the
cello part and provides a serene contrast to the frantic rhythmic activity.

Variations eight and nine are formally linked. Multiple-stop chords are
spaced throughout the two-variation unit in the same proportions as found in
variation five. Variation eight contains the most complex pitch combinations
in the piece. Both the twelve-tone “major” and the 22-tone combination
“major–minor” scales are used. The melody (in the first violin) is a fantasy-
like elaboration of the hymn. In variation nine, the scalar materials (and the
rhythmic complexity of variation eight) are gradually simplified. The theme is
clearly stated using the twelve-tone “major” scale. In the final measures, the
seven-tone major scale predominates. The final cadence is plagal—a
subdominant seventh chord, a pause, and the tonic -G chord (without the third).
Throughout the variations, the harmonic content flows and shifts as the intonation changes hue. In his music, Johnston achieves great variety by way of different proportional systems, and some unity is provided by the variation technique. By using a large variety of scales, the music risks being oversaturated with musical materials. By restricting himself to the use of only one or two scales, he might have been able to achieve more unity of musical expression. In using a variation form, the bombarding effect of excessive musical materials is lessened. To increase the perception of a sense of continuity, the listener can listen to the recurring hymn—the musical texture stems from the hymn and transcends it. Distinguishing between the original substance and the transformation is difficult; the hymn, however, is at least vaguely recognizable in all of the variations.

Conclusions

Partch and Johnston believed that the “chromatic” microtonality achieved by multiplying the available number of pitches (as practiced by Ives) complicated the pattern of harmonic organization. Rather than enlarging the pitch vocabulary, they found it more desirable to expand the order in which it is actually perceived. They built “diatonic” microtonal scales that extend just intonation in an attempt to avoid the acoustical imperfections found in equal temperament. Johnston stated that Harry Partch “turned my music in the direction that most strongly characterizes it.” 23 Partch was Johnston’s mentor in proportional systems; their developments, however, are quite different. Johnston’s purpose is not to “Europeanize” Partch’s ideas. 24 Partch was a genuine revolutionary whose attitude towards most of the traditions of Western music was one of disdain and indifference. Conversely, Johnston has a deep respect and love for a wide range of Western music from the Middle Ages to the avant-garde.

Harry Partch and Ben Johnston used proportional organization as a compositional procedure. Partch used the same 43-tone octave division as the basis of all his music (having 28 “tonalities” inherent in the system to which he chose to modulate). In his Fourth String Quartet, Johnston used a variety

of octave divisions (from five to 22). Modulation is redefined in proportional systems that relate all frequency ratios to a single generating pitch. Partch defines modulation by the particular ratios he selects from one overall system; Johnston defines it by the choice of different octave divisions within the same piece of music. Partch makes greater use of the entire pitch continuum than does Johnston, not only because of the greater number of divisions of the octave (his 43 outweighs Johnston's), but also because of his frequent inclusions of glissandi that expose more of the pitch spectrum on a microlevel. He uses the fixed pitches of his 43-tone scale as "bookends" that contain the sliding frequencies. Johnston's use of glissandi on the stringed instruments is very limited.

Composers will most likely continue to experiment with microtonal music, but there are many obstacles to further development. One important problem is the lack of a suitable notational system. Different octave divisions require different solutions. Partch found interval ratios and number-notation to be most accommodating—Johnston uses various symbols to specify certain pitches.

New tunings may also create a need for new instruments. Partch created new instruments, thus also requiring new performance practices in order to accommodate his 43-tone scale. Johnston's goal is to get traditionally trained performers to alter their performance practices sufficiently to play just-tuned music elaborated to the point of microtonality. He treats the string quartet conservatively as a performance medium but adds uniquely forbidding demands upon the players' performing skills. With Johnston's music, human error is a great pitfall in the accurate realization of notated pitches. The exactness of the fixed pitches built into Partch's instruments eliminates that problem.

The variety of Partch's instruments allows for much more timbral diversity than that found in the music of Johnston. Depth of expression is conveyed by the various articulations of the stringed instruments—sliding, bending, plucking, picking, strumming, stretching, and snapping. The variety of timbres, ranging from the brittle sounds of the wooden-mallet percussion instruments to the twang of the stringed instruments, allows for a variety of pitch implications by way of the different overtone spectra. With Johnston, rhythmic exploration is equal in importance to the experimentation with new pitch systems, but Partch's music seems more diverse than Johnston's—not

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25 Ibid., 226.
only are pitch and rhythm complex components of his music, but the timbral variety offered by his instrumentation opens up new possibilities as well.\textsuperscript{26}

Whether composers build their own instruments or adapt existing ones to accommodate their melodic and harmonic theories, it seems certain that some will continue to look at the possibilities of microtonal music in order to express their musical thoughts. Although microtonal scales are conceived chromatically or diatonically, there are myriad possibilities for their construction. The more composers experiment with and create microtonal music, the narrower the gap between conception and realization will become.

\textbf{Bibliography}

\textbf{Books}


\textbf{Articles}


\textsuperscript{26} Discussing the use of rhythm in the works of Partch and Johnston is a worthy subject, but one beyond the scope of this paper.


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Scores

