CHAPTER 7

MULTIPLE DIVISION WITHOUT EQUAL TEMPERAMENT

Most of the writers advocating multiple division have been interested in equal temperament. They have sought out multiple division as a means of attaining acoustical niceties lost through 12-tone equal temperament while retaining the advantages of equal-temperament in general. But, as the previous chapters have shown, there is no such thing as a perfect equal temperament. However much the acoustical consonance of the intervals may be increased by the judicious choice of an equal temperament involving multiple division, it is possible, obviously, to raise higher standards of accuracy, or to insist on the inclusion of higher and higher partials, or both. There have been a number of writers who have preferred the perfection of some interval combinations in their systems to the transposability of all. Within the field of multiple division they occupy a position akin to that held by the advocates of just intonation within the diatonic and 12-tone systems.

The category "multiple division without equal temperament" can include such historical events as the many meantone systems involving split keys. Within the last century these have not been revived, however, and experiments in multiple division without equal temperament

have taken one of two directions. The first has been the building of systems of fifths, either pure or altered by only 1/8 of a schisma (less than ⅛ of a cent). These systems have been mentioned, above, in Chapter 1, and again in Chapter 5 in the discussion of 53-tone temperament, which, because of its near-perfect fifths, represents a kind of completion or fulfillment of all of these systems. The number of authors who have proposed systems of this kind, especially in the 19th century, is great, and many instruments embodying perfect or near-perfect fifths in 24- or 36-fold profusion have been built. Debate over their relative merits has filled the pages of many a 19th century German periodical. The goal of most of the exponents of systems such as these seems to have been the perfect intonation of all fifths (and frequently of the thirds as well) that might be called for in the music in general use. For such purposes, a basic 12-tone Pythagorean system, with one or two alternate tones for each member, a comma higher or lower, would be sufficient.

Among the exponents of 24-tone systems of this kind are Helmholtz and more recently Clark Jones, both of whom are aware of the advantages of forming pure thirds by eight sub-schismatically altered fifths.

36-tone systems of this kind number among their supporters at least one important contemporary figure, Eivind Groven of Norway, who has made some tape recordings

from an organ built to contain 36 sub-schismatically altered fifths. Among earlier users of 36-tone systems of fifths are Puhlmann, whom Groven credits as the first, and Bitz, who also proposed a similar system with, oddly, 52 tones to the octave.

Other, similar systems have been proposed as follows: by Brandsma, 48 tones; by Würschmidt (before his interest in 19-tone temperament developed), 50 tones; by Eisleben, 55 tones. The list is undoubtedly much longer, but the systems do not differ markedly from one another. A greater range of difference is found in the instruments designed to realize these systems.

The second basic category of multiple division without equal temperament includes those systems based in part on intervals not included in a series of fifths. Two leading exponents of such systems in this century have been Wilfrid Perrett in England and Harry Partch in the United States, both of whom have built instruments to bring their systems into practical reality and have published their theoretical doctrines.

PERRETT

Wilfrid Perrett began publishing his Some Questions of Musical Theory in 1926. A series of thin volumes followed one another at varying intervals of time. The volumes seem invariably to have been bound separately, and

as there were only 150 copies printed, copies of some of the volumes are quite rare. Perrett appears to have been a highly learned man; he also published works on phonetics, spelling reform, and the antecedents of Shakespeare's King Lear.[1] His erudition is apparent in a vast number of learned citations, including a quotation from Plutarch in Greek. It is, in fact, the interpretation of Plutarch which is at the heart of Perrett's hypothesis: that the Greek enharmonic genus was formed from the combination of two diatonic scales related by a septimal ratio.

Perrett quotes Plutarch as follows:

φαίνεται δ' Ὄλυμπος αὐξήσας μουσικήν, τῷ ἀγένητόν τι καὶ ἀγνοούμενον ὑπὸ τῶν ἔμπροσθεν εἰσαγαγεῖν, καὶ ἀρχηγὸς γενέσθαι τῆς Ἑλληνικῆς καὶ καλῆς Μουσικῆς

Admitting that this passage can be interpreted in different ways, Perrett states his view that Plutarch means that Olympus created a scale none of whose tones were the

---

[1] The titles of Perrett's other works in question: Some Questions of Phonetic Theory, Peetickay: an Essay towards the Abolition of Spelling, and The Story of King Lear from Geoffrey of Monmouth to Shakespeare.

same as those of the national scale, but whose contours were the same, that is to say Dorian in mode, since Olympus used the new scale to compose in that mode. Since the term enharmonic means "fitted in," Perrett concludes that the enharmonic genus represented the "fitting together" of the two Dorian scales. Having proceeded this far on an interpretation of a statement by an historian and an etymological deduction, Perrett approaches the most difficult part acoustico-aesthetically. He notes that if the paramese used by Olympus had been tuned 7 cents lower than normal (by "normal" Perrett is referring to Ptolemy's diatonic genus), it would have completed an interval of 7:5 with another member of the system. This interval Perrett considers extremely beautiful and notes that Tartini considered 7:5 to be the best augmented 4th.

Having found the slightly lower paramese by accident, postulates Perrett, Olympus used it to generate several of the principal tones of the second scale of which, however, it was not a member. Perhaps this can be made clearer by reconstructing Olympus' system as suggested by Perrett.

The original system, based on the Dorian scale of E (but calculated in cents by Perrett from the generating tone A) is: E 720; F 814; G 1018; A 000; B 204; c 316; d 520. In the original system, the note B is accidentally tuned seven cents flat, i.e., lowered to 197. This creates the pleasing interval 7:5 between F and B (7:5 = 583 cents).

From the generating tone B 197, a perfect fifth upward is measured, yielding a septimal Gb (to be called ^{7}Gb) 899. From this ^{7}Gb a just major third and then another perfect fifth are measured, finally yielding ^{7}F 787. This septimal F is the starting tone for the Dorian Octave of the new scale (it is interesting to see how Perrett's theory parallels the traditional theory of alternate tunings on E and F). As this tone is 85 cents higher than E, the two scales are essentially identical in form and separated from one another by 85 cents (representing the ratio 21:20). If the two scales were completely identical in form, Perrett's 14-tone system would be as follows:

^{7}F 787; ^{7}Gb 899; ^{7}Ab 1103; ^{7}Bb 85; ^{7}C 289; ^{7}Db 401; ^{7}Eb 605; ^{7}F 787

B 702; F 814; G 1018; A 00; B 204; C 316; D 520; E 702.

16:15 9:8 10:9 9:8 16:15 9:8 10:9

Perrett makes one alteration in the new scale, however. Where two whole-tones are placed consecutively, between ^{7}Db and ^{7}F, Perrett reverses the order of major and minor tones by lowering the pitch of ^{7}Eb a syntonic comma from 605 to 583 cents. This gives him a 14-tone system consisting of the following pitches (in cents):

0
85
204
289
318
401
520
583
702
787
814
899
1018
1103
1200

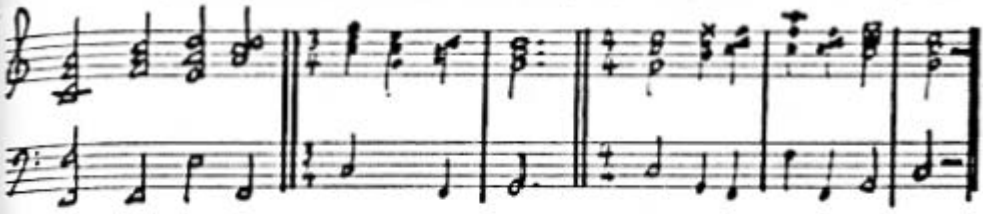
Basic to Perrett's approach is the desire to avoid uniformity. The alteration of ^{7}Eb adds to the number of combinations available but limits the number of exact transpositions which are possible. As Perrett points out, only two major scales, (C and ^{7}Db) are available in his system, and their forms are not identical. Perrett is delighted to find present in his system such Ptolemiean tetrachords as 28:27, 15:14, 6:5, and 21:20, 10:9, 8:7, as well as a number of enharmonic tetrachords. Using russet-brown keys for his two new tones, and a special system of notation,[2] Perrett notes several progressions involving Ptolemiean tetrachords.

In his 14-tone system, Perrett has five gaps which are wider than 85 cents. Four are as large as 119 cents while the other is smaller, 97 cents, the result of the

---

[2]Triangular note-heads signify black keys higher in pitch than the standard white ones, while x-shaped note-heads are played on the russet-brown keys below F and C in pitch.

Example 37: Progressions Cited by Perrett[3]



rearrangement of the modes. Perrett adds five additional tones to his system to fill these gaps. These tones are added at a distance of 70 cents (25:24, the difference between the major and minor third) above or below one of the already existing tones. The new tones are E^{b} 632, 70 cents below E, Ab and Bb, similarly located with respect to A and B and a septimal D and a septimal G, each located 70 cents above the neighboring septimal flatted tones. As a result of these additions, many of Perrett's configurations are transposable to many additional keys.

Perrett calls his enlarged scale a tierce-tone scale; it possesses 19 tones to the octave, and its intervals range in size from 27 to 85 cents. With this scale, Perrett is delighted to discover that he can harmonize the enharmonic tetrachord of Archytas.[24]

---

[3] Some Questions of Musical Theory, pp. 20-21.

[4] Ibid., appendix to Chapter 4.

Although some transposition is possible in Perrett's system, it is not his goal to make transposition easy. He considers it to have been a great virtue of the Greeks that they associated specific intervals with specific pitches. Such an association obviously cannot be made in a transposable system. In order to enjoy free harmonization of all of the tones in his system and to use them all as tonics, Perrett claims to require 62 tones, using occasional schismatic compensation.[5] This would still not achieve a closed system; for this an equal temperament of 171 tones to the octave would be necessary.

The creator of an instrument, the Olympion, named after the supposed inventor of the enharmonic genus, and the author of a highly imaginative if occasionally extravagant treatise, Perrett belongs among the best of the speculative theorists of our day. His inquiries were motivated by a conception of the beautiful which he always kept foremost in mind, and a reverence for his subject.

PARTCH

Perrett's obscure book did not go entirely unnoticed. Among its most avid readers was Harry Partch, who had already embarked on the development of a musical system which resembled Perrett's in many respects but which was far more

---

[5] Ibid., pp. 132-3.

ambitious.

Partch's attainments as composer and instrument builder have dwarfed his work as a theorist. Nevertheless, in Genesis of a Music, Partch puts forth as forcefully as ever has been done the case for just intonation in principle, multiple division in general, and his own system of 43 tones to the octave in particular.

The basis for Partch's musical system is a concept which he calls monophony. This concept allows the derivation by simple ratios of all tones from a single source. From one central tone is built what Partch calls an otonality, which is the reduction within the octave of the first 11 members of the harmonic series whose fundamental is the central tone. From this same tone is also built a utonality, consisting of the exact inversion of the otonality; the utonality is given a standing within the total system exactly equal to that of the otonality. Discounting octave replicas there are 6 tones in each otonality or utonality, representing every odd number from 1 to 11. Arranged in ascending order, the tones of an otonality, reduced to within a single octave, proceed by the sequence 6:7:8:9:10:11:12, with 8 representing the generating tone. The utonality consists of these same figures as denominators with a fixed numerator.

The entire system of 43 tones is built from the simple phenomena of otonality and utonality in two stages.

The first stage is the completion of a system of monophonic ratios wherein each of the six basic values relates to each of the other five both as numerator and as denominator. In the process, each tone of the initial otonality serves as unity for a utonality, while each tone in the original utonality serves as unity for an otonality. Example 38 shows the complete repertoire of monophonic ratios arranged in what Partch calls the tonality diamond. The ratios are shown in their most basic form. In actual practice octave displacements are used to narrow the range.

Example 38: Partch's Tonality Diamond

Otonalities....read down
Utonalities....read across.

$\frac{1}{1}$	$\frac{1}{3}$	$\frac{1}{5}$	$\frac{1}{7}$	$\frac{1}{9}$	$\frac{1}{11}$
$\frac{3}{1}$	$\frac{3}{3}$	$\frac{3}{5}$	$\frac{3}{7}$	$\frac{3}{9}$	$\frac{3}{11}$
$\frac{5}{1}$	$\frac{5}{3}$	$\frac{5}{5}$	$\frac{5}{7}$	$\frac{5}{9}$	$\frac{5}{11}$
$\frac{7}{1}$	$\frac{7}{3}$	$\frac{7}{5}$	$\frac{7}{7}$	$\frac{7}{9}$	$\frac{7}{11}$
$\frac{9}{1}$	$\frac{9}{3}$	$\frac{9}{5}$	$\frac{9}{7}$	$\frac{9}{9}$	$\frac{9}{11}$
$\frac{11}{1}$	$\frac{11}{3}$	$\frac{11}{5}$	$\frac{11}{7}$	$\frac{11}{9}$	$\frac{11}{11}$

It will be observed that there are 36 ratios (6 x 6) in the above diamond. Of these, the six comprising the diagonal from the top left turn out to be the same, 1:1.

Two others prove equal to 3:1 and two to 1:3. All of the remaining intervals intervals are distinct, however, so that the number of distinct monophonic ratios proves to be 29. These ratios, when arranged within the octave, give Partch his basic scale of 29 tones. These tones are marked with an asterisk (*) in Example 39, below.

Somewhat concerned over the discrepancy in size between the various intervals which separate the monophonic ratios when they are arranged as a scale, Partch adds 14 additional tones to fill in the larger gaps. In the process he adds to the number of available transpositions for his basic otonality and utonality as well as to the number of available scale patterns. The range of intervals in Partch's original system of monophonic ratios is between 14.4 cents (121:120) and 150.6 cents. 14.4 cents remains the smallest interval in the complete system, while the largest interval is 38.9 cents (45:44).

It will be seen from Example 39 that the discrepancies between Partch's intervals and those of 43-tone equal temperament are considerable. From the 9th to the 34th tone in Partch's system is 737.6 cents, nearly 40 cents larger than the tempered interval involving as many degrees. Transposability is a commodity available only in limited quantities within the Partch system.

Nevertheless, those musical features such as o- and utonalities, which Partch deems most essential to his musical

Example 39: Partch's System

	Ratio	Cents	tempered equivalent		Ratio	cents	tempered equivalent
0	1:1	* 0.0	0.0	22	10:7	*617.5	614.0
1	81:80	21.5	27.9	23	16:11	*648.7	641.9
2	33:32	53.2	55.8	24	40:27	680.5	669.8
3	21:20	84.5	83.7	25	3:2	*702.0	697.7
4	16:15	111.7	111.6	26	32:21	729.2	725.6
5	12:11	*150.6	139.5	27	14:9	*764.9	753.5
6	11:10	*165.0	167.4	28	11:7	*782.5	781.4
7	10:9	*184.4	195.3	29	8:5	*813.7	809.3
8	9:8	*203.9	223.3	30	18:11	*852.6	837.2
9	8:7	*231.2	251.2	31	5:3	*884.4	865.1
10	7:6	*266.9	279.1	32	27:16	905.9	893.0
11	32:27	294.1	307.0	33	12:7	*933.1	920.9
12	6:5	*315.6	334.9	34	7:4	*968.8	948.8
13	11:9	*347.4	362.8	35	16:9	*996.1	976.7
14	11:4	*386.3	390.7	36	9:5	*1017.6	1004.7
15	14:11	*417.5	418.6	37	20:11	*1035.0	1032.6
16	9:7	*435.1	446.5	38	11:6	*1049.4	1060.5
17	21:16	470.8	474.4	39	15:8	1088.3	1088.4
18	4:3	*498.0	502.3	40	40:21	1115.5	1116.3
19	27:20	519.5	530.2	41	64:33	1116.8	1144.2
20	11:8	*551.3	558.1	42	160:81	1178.5	1172.1
21	7:5	*582.5	586.0	43	2:1	*1200.0	1200.0

demands, are transposable into a number of keys. The fourteen tones which Partch adds to those representing the original 29 monophonic ratios provide for a considerable increase in the number of musical phenomena which are transposable and in the number of keys into which already transposable phenomena can be placed. An example of the former is the Ptolemeian diatonic scale, performable in one key only using the original monophonic ratios (that key which uses 4:3 as the tonic). It is, in the complete system, available in at least five keys. The tonics of the major form of this scale include 4:3, 1, 16:9, 8:5, and 6:5.

Partch tackles directly one of the most often advanced arguments against systems of just intonation: that based on double employment. To those who complain that the supertonic of the diatonic scale represents a tone a comma higher when it is employed in dominant harmony than when employed in subdominant harmony, Partch replies that there is nothing wrong at all in this situation. The shift of a comma, he claims, is far less disturbing than the poor intonation of one or both of the chords caused by an alternative, just or tempered. From this view it is apparent that Partch is, after all, a harmonist, disturbed by harmonic imperfections of minute proportions, but undismayed by the necessity of melodic adjustments many times larger. This is, of course, a thoroughly legitimate viewpoint which can

never be proved right or wrong. It is somewhat paradoxical, however, to find it presented as one of the foundations of a musical ideology whose other central points include a great emphasis on the solo human voice, the wellspring of melody. The two polar elements in Partch tend to serve as checks and balances on one another.

To perform music based on the acoustic system outlined above, Partch has adapted and built instruments of many kinds over a long period of time. Although his first instrument was an adapted viola, lavishly fretted and held as though a cello, most of his stringed instruments have been plucked rather than bowed instruments. Two huge kitharas, especially designed for the playing of hexads (presumably tuned to o- and utonalities) and simultaneous parallel glissandi; two monochord-type instruments, one of them double, each consisting of a large number of strings of equal lengths with movable bridges; and three adapted guitars, round out of the string section of Partch's basic orchestra. The wind instruments consist of two adapted harmoniums. One uses many extra keys to provide the full 43 tones to the octave. The other uses only the standard keyboard, but still provides 43 pitches to the octave, the compensation being made by deducting radically from the range of the instrument. As a result, the space usually associated with the octave represents only about a minor third.[6] These two instruments are

[6]Partch quite characteristically permits the octave coupler to remain intact, giving him parallel minor thirds as a matter of simple course.

called chromelodeons by Partch because of the brilliant colors of the keys, colors associated with the musical ratios involved in the respective pitches. The chromelodeons are tuned by ear on the basis of beats and the absence of beats. They then serve as the basis for the tuning of all the other instruments. A number of scores by Partch make use of the clarinet; the player is expected to supplement the tones available on the instrument by alternations in air pressure and the position of his lips.

The percussion instruments are of various materials, with wood tending to predominate. Marimbas, of all sizes, shapes, and tone-qualities, emit perhaps the most characteristic timbres of the Partch orchestra.

Partch's instruments have gradually gained a substantial reputation, but his equally impressive corpus of music remains all but unknown, despite the availability of recordings of complete or substantially excerpted versions of four of his major works. The recordings which have been released, in order of their publication, are Plectra and Percussion Dances, Oedipus, The Bewitched, and U.S. Highball. The order of composition is almost reversed; U.S. Highball dates from the early 1940's; Oedipus, the Dances, and The Bewitched, in that order, were composed in the 1950's.

U.S. Highball is one of a group of five works entitled The Wayward. In it are discernable most of the characteristics of Partch's music. The two predominant elements are:

energetic and somewhat asymmetric rhythms, and a mood nocturnally wistful in an almost pictorial sense. U.S. Highball is a kind of tone-poem with sung words, representing a ride on freight trains from California to Chicago. Imitations of railroad sounds and the sounds of windblown mountain nights are blended harmoniously with melismatic, distorted calls of station names in a haunting evocation. The score has a plaintive character whose impact can be very strong. The enharmonic intervals of Partch's system tend to be used in this as in his other works in very conjunct melodic patterns of intense emotional expression. The more relaxed sections tend to be diatonic, as do the relatively few disjunct melodic figures.

Oedipus is the most contrapuntal of Partch's offerings to date. The plaintive note, as might be imagined, predominates, and rises to an apotheosis in an antiphony between Oedipus, a deep bass, and the chorus of women. The choral music is mostly diatonic, while Oedipus sings a mixture of diatonic and microtonic intervals.

The Plectra and Percussion Dances include Castor and Pollux, which is purely instrumental. Here the rhythmic element prevails, although the sliding sonorities of the kitharas which begin both of the two parallel sections suggest that other dominant strain of Partch. A typically direct melody of a very simple, tuneful character develops out of a music in which textural and rhythmical elements

had previously prevailed. In Ring Around the Moon, the second of the dances, a more whimsical side of Partch is revealed in full. This lighter aspect has prevailed in the works offered since, especially in The Bewitched. In these latest works, a level of technical mastery of the novel instrumental media is achieved which makes "experimental" seem an inappropriate label for the music.

The Bewitched has been particularly successful in broadening the base of Partch's following among musicians.[7] Like Oedipus, a work of large proportions, The Bewitched seems to be more influenced than Partch's earlier works by external developments in Western music. The use of four standard instruments (cello, clarinet, bass clarinet, and piccolo) undoubtedly contributes to the more standard effect. As always in Partch the idiomatic features of the specific instruments tend to determine the style. In most cases reorchestrating any section of a Partch score would be entirely out of the question.

As this is written the world premier of Partch's latest work, Revelation in the Courthouse Park, is

---

[7]Suzanne Bloch and Peggy Glanville-Hicks, two musicians of considerable reputation, wrote letters to the New York Times when it failed to publish a music review of The Bewitched after its New York performance in 1959. "Several years ago I reacted to Mr. Partch's music with great antagonism. This time I found myself deeply impressed," says Miss Bloch. "His insight and action are as basic to contemporary music's real crisis as the activities of most of his contemporary 'innovators' are irrelevant," says Miss Glanville-Hicks, a composer not yet noted for the use of microtones.

being awaited. It will be interesting to see whether the recent preoccupation of the composer with satire and whimsy has been continued (as is suggested by the title) and whether the apparent tendency toward reconciliation with other musical systems in our society has been continued.

In an age that has accepted as its own the complex statement in a simple tonal system, Partch has insisted tenaciously on the simple statement in a complex tonal system. Partch has explored the path in multiple division that lies at the opposite end from Haba's. With his 43 tones, superceded in strength of impact by his novel timbres, Partch has attempted to show that multiple division can by its real complexity liberate music from the necessity of contrived complexity.

It is quite likely that in the era of the assembly line, where the finished product is the result of the work of many hands, Partch's individual hegemony over his entire domain from theory, from instrument construction, to composition and performance, may be an obstacle to his recognition. Partch seems to leave his fellow composers (and judges) no room to share and feel important in his movement.

If Partch has, by turning away from traditional instruments in favor of his own, renounced the practical possibility of being a leader of a specific musical style, he remains America's leading figure in the field of multiple division, and his music could still serve as a stimulant

toward the expansion of microtonal music in general. In his book Partch argues repeatedly for a pluralistic approach to musical systems,[8] hailing as pioneers even those advocates of unusual theoretical systems with which he is in disagreement.

As a specific system, Partch's monophony may well be too closely tailored to his individualistic impulses to outlast the lifetime of its creator as the basis for musical composition. In a broader sense Partch's chances for success seem much greater. He has taught by example the duty of the student of music to "question the corpus of knowledge, traditions, and usages that gave us a piano . . . the music on its rack . . . and the philosophies that are responsible for these things."[9] His work is of great importance to all who contemplate a revision in our tuning procedures.

---

[8] "In a healthy culture differing musical philosophies would be co-existent, not mutually exclusive." Op. cit., p. xi.

[9] Op. cit., pp. ix-x.