CHAPTER 12

AN ACCUSTICAL COMPARISON OF 19-TONE SYSTEMS

On the previous pages we have seen 19-tone temperament advocated by, among others, Opelt, Würschmidt, Ariel, Kornerup and Yasser. Each of the aforementioned has a different just scale in mind which he considers fittingly represented by 19-tone temperament. On the following page is Example 45, showing what each of these men considers the proper just intonation of the 19-tone scale. In addition is Perrett's 19-tone system, which he never intended to have represented by an equal temperament, but which is there for comparison. Several other possible ways of obtaining 19 tones in the octave are also shown.

In the case of Yasser's system, only 12 pitches are shown, since he calibrates his just intonation entirely on the 12-tone supra-diatonic scale which he singles out for use from within 19-tone temperament.

As Example 45 demonstrates, the systems of Opelt, Ariel and Würschmidt differ only in a few details from one another (Kowalenkow's system, incidentally, is identical with Opelt's). All are based on combinations of fifths and thirds, and it is only in the outer members of the system that there is disagreement among the three authors. Fokker, not a specific advocate of 19-tone temperament, offers a 19-tone system rather similar to one of Würschmidt's, as

	19-tones	Ariel	Opelt	Würschmidt 1	Würschmidt 2	Fokker	¼-comma	31-tone	Yasser	Kornerup	Perrett	New System Plain	New System Septimal
					Temperament								
D	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D♯	63.2	70.7	70.8	70.7	70.7	70.7	76.0	77.4		73.5	85	70.7	71
E♭	126.3	111.7	133.2	111.7	133.2	111.7	117.1	116.1	92 W	118.9	134	133.2	119
E	189.5	182.3	203.9	203.9	203.9	182.3	193.2	193.5	166 E	192.4	204	182.3	204
E♯ or F♭	252.7	253.1	274.6	274.6	274.6	274.6	269.2	271.0		265.9	289	253.1	267
F	315.8	315.6	315.6	315.6	315.6	315.6	310.3	309.7	322 F	311.4	316	315.6	316
F♯	379.0	386.3	386.3	386.3	386.3	386.3	386.3	387.1		384.8	401	386.3	386
G♭	442.1	427.4	427.4	427.4	427.4	427.4	427.4	425.8	456 X	430.3	471	427.4	435
G	498.0	498.0	498.0	498.0	498.0	498.0	503.4	503.2	526 G	503.8	520	498.0	498
G♯	568.4	568.7	568.7	568.7	568.7	568.7	579.5	580.6		577.3	583	568.7	582
A♭	631.6	631.3	631.3	631.3	631.3	609.2	620.5	619.4	584 Y	622.7	632	631.3	631
A	694.7	702.0	702.0	702.0	702.0	702.0	696.6	696.8	708 A	696.2	702	702.0	702
A♯	757.9	772.6	772.6	772.6	772.6	772.6	772.6	774.2		760.7	787	751.2	765
B♭	821.0	813.7	813.7	813.7	813.7	813.7	813.7	812.9	814 Z	816.2	814	813.7	814
B	884.2	884.4	884.4	884.4	884.4	884.4	889.7	890.3	874 B	888.6	899	884.4	884
B♯ or C♭	947.3	946.9	955.0	925.4	925.4	925.4	930.8	929.0		934.1	969	955.0	969
C	1010.5	1017.7	1017.7	996.1	996.1	996.1	1006.8	1006.5	1018 C	1007.6	1018	1017.7	1018
C♯	1073.7	1088.3	1088.3	1088.3	1066.8	1066.8	1082.9	1083.9		1081.1	1103	1066.8	1088
D♭	1136.8	1129.3	1129.3	1120.3	1120.3	1129.3	1124.0	1122.6	1164 V	1126.5	1130	1129.3	1137
A.D.		8.8	8.2	9.8	8.9	10.3	8.2	9.2	16.0; 14.5	6.6	14.2	5.7	8.4
M.D.		9.5	9.5	11.7	9.5	16.3	16.3	17.9	25.7; 15.5	13.0	17.4	7.9	10.7

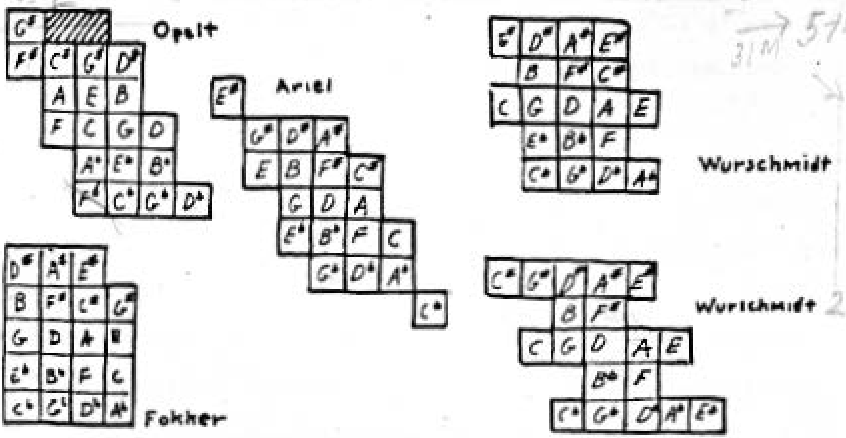
① Should be 457.0 to correspond with "2nd system" layout on p 324

Example 45;

X See 2nd system p. 324 and p. 385

example 45 shows. Example 46 shows the five systems offered by those five authors in diagram form.

Example 46: Five 19-Tone Systems



Ariel's system uses the same constructing intervals as Opelt's (hence the same mean deviation), but its intervals are better when measured from a single central tone (hence Ariel's average deviation of intervals is somewhat smaller than Opelt's). The mean deviation of the two systems is 9.5 cents, a figure which compares favorably with the mean deviation for just intonation in the 12-tone system (over 20 cents). Würschmidt's second system is similarly constructed (of twelve instances of the interval 25:24, four of 128:125 and three of 648:625). The latter interval represents the difference between four 6:5's and an octave, and is particularly close to 1/19. Würschmidt's first system involves four constructing intervals; the additional one is 135:128, representing three fifths and a third (less two octaves). The diesis, 128:125, the most out-of-tune of the intervals from the standpoint of equal temperament, is used six times instead of four, causing the mean deviation to increase to 11.7 cents.

As to the average deviation of the different intervals of the system, Ariel's involves the least due to maximal use of superimposed minor thirds from the central tone, D. The minor third being a diagonal, \ , it is clear from Example 46, that this interval is most evident in Ariel's system, less in Opelt's, still less in Würschmidt's second system, and least present in Würschmidt's first and Fokker's systems. The average deviation parallels the use of the minor third, as might be expected. Ariel's is smallest, 6.6 cents, followed by Opelt's, 8.2, Würschmidt's second and first, 8.9 and 9.8, and Fokker's 10.3. Of the just 19-tone systems proposed which are based on fifths and thirds, Ariel's is the closest to equal temperament.

As mentioned in several earlier chapters, 1/3-comma temperament is almost exactly equal to 19-tone temperament. The approximation is sufficiently close as to require no chart for 1/3-comma temperament in Example 45. As the alteration of the fifth is decreased from 1/3-comma, the deviation of the system from 19-tone equal temperament is increased. In Aron's ¼-comma temperament, as shown in Example 45, the mean deviation is 16.3 cents, a high figure, owing to the disparity of the two constructing intervals, the 76-cent chromatic semitone of the meantone system and the 41-cents diesis. The average deviation of the intervals from a central tone in ¼-comma temperament is relatively small, however, owing to the regularity with which the large and small constructing intervals alternate in forming as equal as possible a scale.

The deviation of ¼-comma temperament within the framework of 19-tone temperament is interesting for two reasons. In the first place, it is often postulated that the earliest 19-tone instruments, those mentioned by Zarlino and Praetorius, were constructed for ¼-comma temperament.[1] The chart discloses that while the smallest intervals within the two systems are quite different, the larger ones, especially those having simple, diatonic relationships, are quite similar in the two systems. The second reason why the relationship of ¼-comma to 19-tone temperament is interesting

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[1] A comparison with Barbour's figures for the mean deviation of Aron's temperament in the 12-tone system is revealing. The mean deviation of ¼-comma temperament is 20.0 cents according to Barbour, a figure only slightly larger than that for the mean deviation in 19-tone temperament. These figures suggest that the advantages of a 19-tone instrument for the performance of ¼-comma temperament involve greater range within the cycle of fifths only, in the same way 18, or 20 pitches would. On the other hand Zarlino's 2/7-comma temperament would involve much smaller discrepancies on a 19-tone instrument. The system in Example 45 which most closely resembles Zarlino's is Kornerup's and the deviations are about the same.

is that many advocates of 19-tone temperament have suggested that 19-tone temperament is but a natural step in an evolution toward 31-tone temperament. As was shown in chapter 2, ¼-comma and 31-tone temperaments are nearly identical. There is sufficient difference however, to have justified the inclusion of both systems in Example 45. 31-tone temperament is a bit farther removed from 19- than is its relative, ¼-comma temperament.

The discrepancies between the intervals of 31- and 19-tone temperaments are large enough to suggest that should 19-tone equal temperament ever become as standard a tuning practice as 12-tone equal temperament is now, it may again be difficult to break through the acoustical barrier to the new temperament. Yet the discrepancies are not large enough to preclude the possibility of organic relationship between the two temperaments. The average deviation between the various intervals of the two systems (as calculated from a central tonic) compares favorably with most of those of the just systems offered as the basis for 19-tone temperament.

Since the twelve tones of Yasser's supra-diatonic scale use F as their tonic, the average deviation is calculated from that tone. The figure would be even larger if D were used as the starting point, but 16.0 is high enough to indicate that Yasser is not concerned with acoustical precision in the same way as Opelt and Ariel. The mean deviation, calculated in this instance by comparing each of the 12 stepwise intervals with their unequal equivalents in 19-tone temperament, is likewise extremely high. Considering that Yasser emphasizes the modal contours of melody and the use, without octave displacement, of the 12-tone scale as a scale, the difference between that scale justly rendered and that scale as part of the temperament Yasser advocates is large indeed.

Of the two sets of figures involved in Example 45, the first and higher set is probably the more accurate as it assumes Yasser's "Y" to be the equivalent of Ab, an assumption clearly justified by Yasser's other letters and the equivalents they form. It is also justified by Yasser's other charts and by his assertion that the auxiliary tones will form a diatonic scale, an event which does not occur if "Y" is held to represent G#. But so out-of-tune is "Y" (with respect to the Ab of 19-tone equal temperament) that it is much closer to G than to A both in Yasser's system and in the tempered tuning. The second set of figures assumes G# to be the equivalent to "Y" and shows a resulting improvement in the averages.

It is quite clear from the figures that Yasser's just supra-diatonic scale and the 19-tone temperament he advocates are two very different systems. Why, then, does he advocate them concurrently as one? It is possible, of course, that the temptation to build a musical system out of the hitherto unexploited higher partials proved too much to resist and interfered with his reasoning. He is quite critical, however, of Schönberg's use of the upper partials to explain the 12-tone system because of the great discrepancies between the two.[2]

The explanation for Yasser's tolerance of such large discrepancies in his own system can probably be more accurately explained in light of his doctrine of melodic determination of a musical system. It is Yasser's basic conviction that consonance is psychological and not acoustical, and his conviction that it is based on the simultaneous use of alternate members of a musical scale, that lead him into the dilemma of the disparate systems. For, with the perfect fifth and minor third falling outside the realm of consonances, Yasser actually feels compelled to seek out-of-tune intervals in the just representations of 5/19 and 11/19. While other writers might regret that 19-tone temperament does not offer a sufficiently pure fifth or major third, Yasser's greatest concern is that 19-tone temperament might offer too pure a fifth and too pure a minor third. This forces him to turn to less suitable higher partials which involve him in large discrepancies between the just and tempered systems.

Yasser's just system should be judged with the

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[2]A.M.S. Journal, 1953: p. 56. Schönberg's views are set forth in Modern Music XI, p. 170.

realization that it is the most ambitious of the systems considered, and that it involves a revolutionary change in our aspect toward the consonances and dissonances of music. It is the first theory of 19-tone temperament which takes cognizance of Schönberg's dodecaphonic theories and attempts to construct a parallel alternative. Its many premises are rigorously applied throughout. If the deviations do indeed represent a defect, the defect is the result not of careless application but of a possibly faulty premise: that consonance within a musical system is melodically determined.

Kornerup's version of just tuning is based on his Golden System. It shares with ¼-tone and 31-tone temperaments the characteristic of having only two constructing intervals for the 19-tone scale, and of having a great distinction between the mean deviation of the single steps (high) and the average deviation of intervals measured from a single central tone (low). In the latter category it compares well with Ariel's as the most suitable system for representation by 19-tone temperament. If the mean deviation is considered, however, it is inferior to the systems of thirds and fifths which possess three and four constructing intervals.

The golden system by its very nature is designed for that series of equal temperaments 12-19-31- etc. and is so constructed that its accuracy will improve greatly with each increase in the number of tones belonging to this series. By Kornerup's chosen standards 19-tone temperament is a distinct improvement over 12-tone temperament. The only questionable aspect of his theory is that Kornerup selected his temperament eight years before he evolved the standards on which its defense is based (1922 vs. 1930).

Perrett's system alone among the 19-tone systems cited is intended as a tuning in itself, and not as a representation for 19-tone temperament. Perrett eschews the principle of equal temperament, and his tuning system is included only as a basis for comparison. Despite its having been conceived from a viewpoint opposed to equal temperament, its deviation from equal temperament on both counts is less than that of Yasser's system, which is conceived with equal temperament in mind.

THREE ADDITIONAL SYSTEMS PROPOSED

In addition to the numerous systems, derived from many sources and viewpoints, which have been presented and compared on the preceding pages, I should like to present three new interpretations of 19-tone temperament. I do not consider them to be better than the systems already shown, but each one shows a slightly different aspect of the particular properties of 19-tone temperament, and together they reinforce the conclusion that for any and every specific purpose a different just intonation can be found.

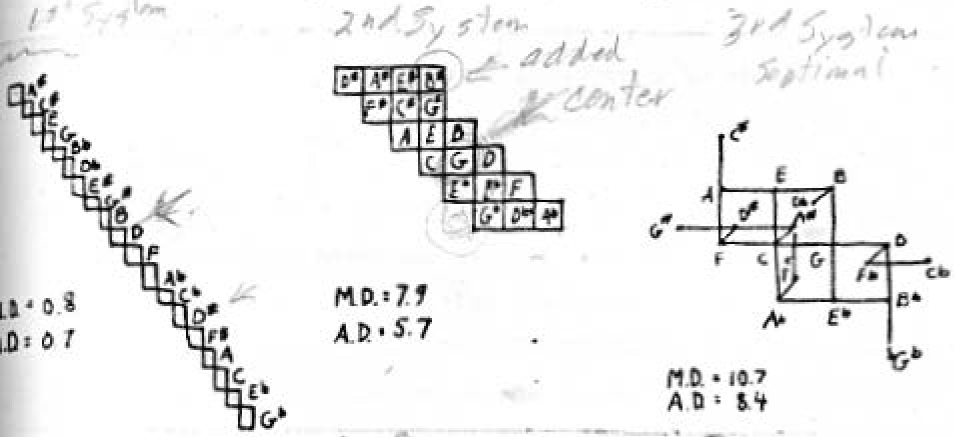
Example 47 shows diagrams of the three systems. The third is intended to be three dimensional and so uses points instead of squares. The first system is a structural absurdity. It consists simply of a system of 19 minor thirds. Taken together, the 19 minor thirds leave a comma of

$$\frac{19,073,486,328,125}{19,042,491,875,328} = \frac{5^{19}}{3^{19} \times 2^{14}},$$

which is small enough (about 3 cents) but rather complex as a "just" ratio. The system is therefore a kind of Pythagorean system without the logical argument of the Pythagoreans that their one interval has an acoustical right to primacy. The system is presented, however, because it is the most accurate approximation of 19-tone temperament among the "just" systems. Just as Barbour concluded that the "best" just intonation among 12-tone systems was that which approached Pythagorean tuning, so the most accurate "just" representation of 19-tone temperament is that which approaches a single string of minor thirds. In each case the limiting system is based on the exclusive use of that interval which is least out of tune in the temperament.

The average and mean deviations of the first system are well under 1 cent. I offer this as an artificial system. Dodecaphony is, acoustically, an artificial system, and it is possible that in 19-tone temperament a meaningful if artificial system of music could be constructed based on cycles of minor thirds.

Example 47: 3 New 19-Tone Systems



The second system is constructed, as was the first, with the primary purpose of limiting the average and mean deviations from equal temperament to the lowest possible figures. It is a compromise between the all-but-perfect-but-absurd first system, and the seriously proposed system with the lowest deviation (Ariel's). Its basic tone lattice consists of five minor thirds, with each group of six tones so created separated by one of two perfect fifths. This accounts for 18 tones, and one tone is added. The system requires four constructing intervals and is not symmetrical. Nevertheless, because of its heavy reliance on minor thirds, it possesses the great advantage of relative equality of intervals. The mean deviation of 7.9 cents is smaller than that for any of the seriously proposed systems, as is the average deviation of its intervals from a more-or-less central tone, 5.7 cents. The system presents the closest approximation to 19-tone equal temperament in which just intervals can be perceived as the basis of at least the consonances.

For a third system, I should like to propose a tuning involving ratios using the seventh partial. The deviations will have to be larger in this instance, for this partial is approximately 21 cents out-of-tune in 19-tone temperament. Nevertheless, this does represent an improvement of 10 cents over 12-tone temperament, and it is possible that some musicians might prefer to make corrections of this magnitude when singing or playing stringed instruments in order to make use of the 7th partial as a consonance. Although Yasser and Perrett have built 19-tone systems with the 7th partial, this third system is offered to demonstrate that it is possible to reduce the deviations of their systems considerably without relinquishing this acoustical phenomenon.

The compactness which, at least to some extent, characterizes Fokker's 31-tone and 53-tone septimal systems is missing here.[3] The seventh partial, like a soft but

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[3] It is all but impossible to construct a plan for 19-tone temperament involving the seventh partial which is compact in the manner of Euler's genera, because the 7th partial is made from the bisection of the perfect fourth, and the two intervals are therefore too interdependent. In 19-tone temperament, Fifth = 2 sevenths minus octave, and seventh = two fifths plus two thirds. No parallelepiped is possible.

Example 46: Septimal Just Tuning: 19-Tone System

	Ratio	Cents	Deviation
C	1:1	00.0	0.0
C#	25:24	70.67	7.5
Db	15:14	119.5	6.8
D	9:8	203.9	14.4
D#	7:6	266.8	14.1
Eb	6:5	315.6	0.2
E	5:4	386.3	7.3
Fb	9:7	435.1	7.0
F	4:3	498.0	7.4
F#	7:5	582.5	14.1
Gb	36:25	631.3	0.3
G	3:2	702.0	7.4
G#	14:9	764.9	7.0
Ab	8:5	813.7	7.3
A	5:3	884.4	0.2
A#	7:4	968.8	21.5
Bb	9:5	1017.7	7.2
B	15:8	1088.3	14.6
Cb	27:14	1137.1	0.3
C	2:1	1200.	
		average	8.4

Constructing intervals:

21:20 , 84.4 cents (used 3 times)
25:24 70.7 cents (used 5 times)
28:27 62.9 cents (used 4 times)
36:35 48.8 cents (used 7 times)

Mean Deviation: 10.7 cents.

valuable metal, is only once used in its pure state, while six times it is used as an alloy. The other intervals used with it are such as will invariably improve the intonation. The system is offered merely as a sample of septimal tuning in a 19-tone just system which is so manipulated as to have a relatively small deviation from equal temperament.

THE IMPORTANCE OF JUST TUNINGS TO TEMPERAMENT

Since, with the exception of Perrett, all of the theorists proposed equal temperament for 19-tone systems, why, it may be asked, worry about the just basis for these systems? Even were the tempered tuning always fixed and unalterable, it would be of considerable use in evaluating the tempered system to know what kind of intervals it was designed to represent, and how accurately it did so. But, as we know from our 12-tone system, a temperament is only the starting point for intonation. One's interpretation of what the just system may be in any given key of a temperament will determine whether and how far he raises or lowers the tempered pitch when singing, playing a violin or trombone, or even, in certain instances, tuning a piano. That this question may have practical importance can be seen from the ambiguity which presently affects the intonation of the major third. The present tendency seems to be to extend the major thirds toward the ideal of Pythagorean tuning, although a minority of musicians continue to prefer just thirds. One of the obstacles which advocates of 19-tone temperament must overcome, if theirs is to become a system in general use, is the direct result of this tendency. Were the compensations in 12-tone temperament in the direction of just rather than Pythagorean thirds, the margin between the present system and 19-tone or any of the negative temperaments would be smaller. In such an instance a transition from one system to the other would be much easier to contemplate.

Similarly, if 19-tone temperament is not to be regarded as the terminal tuning system of music (and none of its advocates have been so rash as to suggest it as such), then the just system toward which the tempered structure is allowed to lean might well influence the ease with which 19-tone temperament could yield to further evolution. If, as many suggest, 31-tone temperament is the logical successor to 19-tone temperament, then tunings resembling 31-tone temperament in Example 45 would appear to have an advantage over those which do not. Septimal tunings in 19-tone temperament would also have special relevance when considered with respect to possible evolutions toward 31-, owing to the excellent representation of the 7th partial in 31-tone temperament.

The determination of the most useful or the most ideal just system for 19-tone music may have to wait for a period of experimentation in practice. It is also possible that if 19-tone temperament develops it will do so with such serial practices as are used in present dodecaphony, and this will render just intonation a superfluous concept. Further acoustico-psychological research, especially on the 5th and 7th partials, would appear warranted, at least in eliminating some of the systems proposed.

CONSONANCE AND DISSONANCE IN 19-TONE TEMPERAMENT

Only two of the authors whose systems of 19-tone temperament have been presented have made studies having as an end a determination of the consonances and dissonances of the system. These authors are Ariel and Yasser, and their views clash on several of the intervals. Example 49 shows how Ariel and Yasser regard each of the nine basic intervals of 19-tone temperament (each considers the inversions of every interval to possess equivalent consonant values), together with the traditional concept of the nearest equivalent interval in 12-tone temperament (where a sufficiently equivalent interval exists).

As Example 49 shows, the three sources agree on only three intervals of the nine, two of them being the two smallest intervals, on which all are agreed that they form dissonances. The other agreement is on the major third, 6/19, which is considered a consonance. Yasser and Ariel further agree on the consonance of the major second and tritone, which represents a departure from traditional practice. This departure seems warranted, however, in view of contemporary developments in 12-tone music (it is somewhat more debatable in the case of the tritone than in the case of the major second).[4] The two authors disagree in

[4]Hindemith in particular among modern theorists continues to regard the tritone as the dissonance <u>par excellence</u>. I am inclined to agree with him and to disagree with both Ariel and Yasser as regards this interval when used in 19-tone temperament. See supplement, below p. 385.

Example 49: Consonance and Dissonance in 19-Tone Temperament

Interval	Ariel	Yasser	12-Tone equivalent
1/19	D	D	D
2/19	D	D	D
3/19	C	C	D (mild)
4/19	D	C	none
5/19	C	D	C
6/19	C	C	C
7/19	D	C	none
8/19	C	D	C
9/19	C	C	D

regard to the perfect fourth and the minor third, which Ariel regards as consonant, and the two intervals unparalleled in 12-tone temperament, which Yasser considers to be consonant. Clearly it is Yasser on whom the burden of proof must lie. For further discussion of this matter the reader is referred to the chapters on Ariel and Yasser and to the first supplement.

MISCELLANEOUS DATA AND CONJECTURES ABOUT 19-TONE TEMPERAMENT

Augusto Novarro has published a complete list of interval ratios for 19-tone temperament which may prove useful to anyone seeking to build a 19-tone scale on a monochord or on a multi-stringed instrument built on monochordal principles. The ratios are as follows:[5]

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[5]Novarro, op. cit., p. 161.

1.0000	1.4403
1.0372	1.4938
1.0757	1.5493
1.1157	1.6068
1.1571	1.6665
1.2001	1.7285
1.2447	1.7927
1.2909	1.8593
1.3389	1.9284
1.3887	2.0000

Novarro has completed similar tables for nearly every other possible equal temperament, and the reader is referred to his excellent book for the ratios of other temperaments.

A rather unusual 19-tone scale has been proposed by R. M. Frye and Esther Tipple,[6] consisting of the following degrees of the 53-tone tempered system: 1, 4, 6, 9, 13, 15, 18, 20, 23, 26, 28, 31, 35, 37, 40, 43, 45, 59, 52. It is not the closest approximation to 19-tone equal temperament which is possible in the 53-tone system, since it contains intervals of 2, 3, and 4 units of the latter system. It would be possible to build a more equal 19-tone scale using only 2 and 3-unit intervals. Assuming the tone numbered 1 to be the proposed tonic of the scale, the best fifth would be 32, which is missing. Complete diatonic scales can be built within the 19-tone framework beginning only on tones 6, 18, 23 and 40. Unfortunately there is no detailed explanation of the aesthetic behind Frye and Tipple's choice of a 19-tone

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[6]Frye, R. M., and E. W. Tipple, Data Supplement to A Graphic Introduction to the Harmon.

scale drawn from 53-tone temperament.

Among the scales occasionally mentioned as a desirable aspect of multiple division systems is the quasi-equal pentatonic. Among the seriously proposed multiple divisions, only 50-tone temperament has a real equal-tempered pentatonic scale within it. But Wyschnegradsky mentions with some enthusiasm the quasi-equal 5-tone scale as one of the unique and attractive scales possible in 24-tone temperament. A scale quite similar to that which Wyschnegradsky cites is available within 19-tone temperament as is shown by Example 50.

Example 50: Three Pentatonic Scales

5-tone equal.	Approx. in 24-tt	Approx. in 19-tt
0	0	0
240	250	253
480	500	505
720	700	695
960	950	947
1200	1200	1200

Both 19- and 24-tone temperaments offer the composer a bridge between the Western diatonic scale and practices of the _salendro gamelan_ of Indonesia. It is possible that an eventual criterion for a suitable multiple division system might be that it represent a common denominator between the scales of different musical cultures.

CRITICISMS OF NINETEEN-TONE TEMPERAMENT

Among the writers interested in multiple division, several, including Partch, Barbour, and Fokker, are quite critical of 19-tone temperament. Partch stresses the weakness of the perfect fifths (nearly 7.3 cents in error). Of the interval 694.7 cents, Partch says,[7] "It somehow borders on the absurd to be asked to consider it as the strongest consonance in music next to 2:1." Novarro is likewise hesitant about endorsing the fifths of 19-tone temperament. Opelt and Handschin admit to uncertainties about the fifths but conclude that the error is not great enough to disturb the sense of consonance.

It is the thirds, rather than the fifths, which draw the strongest criticism from Barbour.[8] "To modern ears, accustomed to the sharp major thirds of equal temperament, the thirds of 379 cents, 1/3-comma flat, would sound insipid in the extreme."

While Opelt, Würschmidt and Ariel advocate 19-tone temperament based entirely on thirds and fifths, Yasser, eloquent advocate of 19-tone temperament that he is, ques-

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[7] Partch, op. cit., pp. 304-5. In spite of his fundamental disagreement with 19-tone temperament, however, Partch remains sympathetic to its being tried. "Ambitious composers have, in Yasser's book, a plan that has been widely approved, and it can be had for the asking. From the standpoint of slow evolution of existing materials, ideas, and thought habits, Yasser's proposal is . . . credible and adaptable."

[8] Tuning and Temperament, p. 116.

tions the value of the temperament in dealing with traditional diatonic music which is, after all, based on thirds and fifths. "With reference to the diatonic system, an impartial opinion would probably deny much, if any, harmonic advantage in the 19-tone over the 12-tone temperament, while the mechanical disadvantage of the increased number of frequencies to the octave is unquestionable, in this instance."[9]

Fokker, who treats 19-tone temperament at some length in his book, Rekenkundige Bespiegeling der Muziek, takes issue with the representations of the harmonic seventh, the tritone, and the two kinds of semitone. The seventh partial is a whole comma too small, he asserts, the tritone (which he evidently thinks should be based on 7:5) is 2/3 of a comma too small, and the two kinds of semitone are too different in size, the one being twice the size of the other.[10] Fokker also shows his awareness of the inaccuracy of the representation of many of the higher partials (as does Partch) and includes the following chart of the sizes and errors of various intervals involving small-number ratios. The intervals are measured in hundredths of a unit of the temperament, that is to say 1/1900ths of an octave.

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[9] Letter from Yasser to John Redfield, May 1, 1933.

[10] "De harmonische zevende is een heele komma mis, wanneer hij hierin gespeeld wordt, te klein. De tritonus valt 2/3 komma te klein uit. Het verschil tussen grote en kleine halve toon wordt in deze stemming overdreven, de ene wordt twee maal zo groot als de andere." Rekenkundige Bespiegeling der Muziek, p. 185.

Example 51: Fokker's Chart of Small-Number Ratios

	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	20
2	0	1112														
3	-12	0	788	1400												
4		12	0	611		1535										
5		00	-11	0	500	924	1290	1610								
6				00	0	424				1660						
7			-35	-24	-24	0	364	687	975	1230	1470	1700				
8				10		36	0	323		873		1330		1720		
9				-10		13	-23	0	288	551		1010	1210		1575	
10						25		12	0	263		622				
11					+40	-30	-27	49	37	0	237	459	661	848	1030	1640
12						30				-37	0	221				
13						00	-30	-10	-22	41	21	0	203	389	566	1180
14								-10		39		-03	0	187		
15							-20			-48		11	13	0	177	
16								15		-30		34		23	0	

In the face of these valid criticisms it is difficult to claim for 19-tone temperament anything better than the compromise status which is traditionally claimed for 12-tone temperament, not that this is not enough. Leigh Gerdine, in writing to Yasser, lists the following as assets of 19-tone temperament: it includes within its framework the "good" music of the past; it allows for indefinite extension; it affirms the validity of the natural harmonic system; it makes possible a future in vocal as well as instrumental music. It seems to me that with a slight reservation on the first of Gerdine's four points, they make the most effective and valid case for 19-tone temperament that can be made with words. The writing of and familiarization with 19-tone music would have to be the next step in the dialogue.