CHAPTER 9

THORVALD KORNERUP

The 20th century has produced three writers who have written extensively in advocacy of 19-tone temperament. Two of these men have used the medium of books to present their views. Kornerup's advocacy, however, has taken the form of a series of pamphlets. There are thirteen, dating from 1922 to 1938, and they show a gradual evolution in Kornerup's emphasis and interest, balanced against a consistent viewpoint throughout. He is at all times a thoroughly convinced advocate of 19- and 31-tone temperament. Here is a list of his pamphlets from 1922 to 1938, all of them published in his native city of Copenhagen.

1. Musical Acoustics based on the Pure Third System, 1922
2. Akustische Gesetze für die Akkordbildiung, 1930
3. Das Tonsystem des Italieners Zarlino, 1930
4. Die Vorläufer der gleichschwebended Temperaturen (zu 19- and 31 Töne), 1930
5. Die Hochteilung der Oktave, als Ablösung des syntonischen Quint-Terzen Systems, 1930
6. Die akustische Atomtheorie ausgewandt auf das pythagoräische Tonsystem, 1931
7. Von der Ur-form 5-töniger Skalen zu den goldenen Tönen, 1931
8. Indisches Tonsystem aufgeklärt durch tertiäre Teilung, 1931
9. Acoustic Methods of Work, 1934
10. Acoustique theorique, 1934
11. Das goldene Tonsystem, 1934
12. Equilibre entre les sons perfectionnes (dores) et les sons naturels, 1936
13. Acoustic Valuation of Intervals, 1938

Kornerup's militant writings are not confined to music. They include proposals for political and calendar reform.[1] Throughout his works, Kornerup writes as though he were a debater, scholarly and thorough with all data tending to support his conclusions, oblivious to all contrary data.

In his early writings, Kornerup is concerned with refuting the Pythagoreans. The small fifths which characterize 19- and 31-tone temperaments are desirable, to Kornerup, because they make possible relatively pure thirds. In the writings of what might be called his middle period Kornerup is interested in ancient and oriental musical systems as models for a 19- or 31-tone system. Finally, in his later works, he is preoccupied by an almost mystical conception of a musical application for the golden mean. This is his most original and challenging proposal, and it leads, as do his other doctrines, to the advocacy of 19- and 31-tone temperaments. We shall look at representative works of each period.

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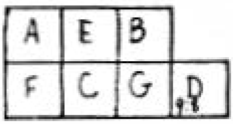
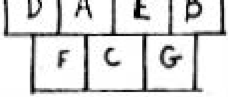
[1] In the political sphere, Kornerup's proposal is for a compromise between two methods of counting ballots for proportional representation. He presents a mathematical mean between two generally considered plans, one of which is alleged excessively to favor the large political parties, the other the small ones. Kornerup's proposals for calendar reform involve the equalization of the months with leftover "monthless" days.

PURE THIRDS ALTER A SECOND

The basic proposal of Kornerup's first pamphlet, Musical Acoustics Based on a Pure Third System, is that the supertonic generally attributed to the just scale, 9:8, is fundamentally wrong and should be replaced by 10:9. In showing how this view evolves from the more traditional concept of the just major scale, Kornerup first reproduces diagrams of the traditional scale based on fifths and thirds.

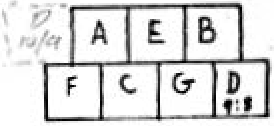


He then cites what he considers to have been an improvement in this pattern by Shohe Tanaka in 1890. In this diagram, Tanaka staggers the thirds, giving to major and minor thirds equal importance.



Kornerup points out that with Tanaka's revision the horizontal aspect of the system is symmetrical. However, he believes Tanaka's system to be deficient in one respect: the tonic is not at the center of the symmetry. In order to make C the center of a symmetrical pattern similar to

Tanaka's it is only necessary to substitute the D lying a fifth below the tone A in the system for the D lying a fifth above the tone G.

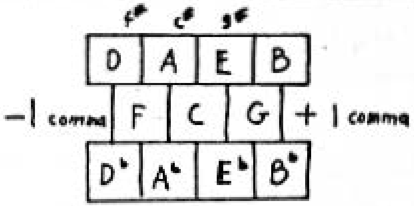


The D in the above diagram has a value of 10:9 as computed from C. Once Kornerup has replaced D 9:8 with D 10:9, the rest of his argument for 19-tone temperament falls into place easily for it is with the supertonic 9:8 that 19-tone temperament suffers most in comparison to 12-tone temperament.

Example 42: The Just Major Scale Compared to 12- and 19-Tone Temperaments

Tone	JUST	12-tone	19-tone	error:12	error:19
C	00	00	00	00	00
D 9:8	204	200	189	04	15
D 10:9	182	"	"	18	7
E 5:4	386	400	379	14	7
F 4:3	498	500	505	2	7
G 3:2	702	700	695	2	7
A 5:3	844	900	884	16	0
B 15:8	1088	1100	1074	12	14
Total error with D as 9:8				50	50
Total error with D as 10:9				64	42

Kornerup extends the system beyond diatonic confines by adding another group of tones below the row F-C-G in the diagrams, making C the central point of a symmetry which affects the vertical as well as the horizontal patterns. Within the bottom two rows, C is the center of a scale which Kornerup calls the doric minor.



It is part of Kornerup's opposition to everything Pythagorean that he considers the above values and those related to them by thirds to be the tones <u>not</u> commatically altered. Tones to the right of those shown above Kornerup considers to be raised by a comma (or more), while tones to the left are commatically lowered.

The result of Kornerup's theory of the Pure Thirds is the relative de-emphasis on the 3rd partial, and with it the minimization of the importance of the one acoustical area in which 19-tone temperament is inferior to 12-.

HISTORICAL JUSTIFICATIONS

Having established an acoustical basis for his recommended reform of musical temperament, Kornerup turns his primary attention to historical precedents for the flat fifths he is recommending. He devotes special attention to three of the meantone temperaments, those involving the alteration of the fifth by ¼, 2/7, and 1/3 comma respectively. He attributes the 2/7 comma temperament to Zarlino (an attribution which is generally supported) and the other and the other two to Arnold Schlick (both of which are generally contradicted).[2] He cites the early construction of 19-tone instruments, without conceding that they might have been tuned to systems hardly even approximating 19-tone equal temperament. His principal and most valid point concerning the tuning systems of late Renaissance theory is that they countenanced a considerable reduction in the size of the perfect fifth for the purpose of improving the thirds. His pamphlets abound with charts showing how the fifths of his own proposed systems compare closely with those advocated by the disciples of meantone temperaments.

THE GOLDEN SYSTEM

In his early writings Kornerup underlines his view that the acoustical bases for music are threefold, the three bases being the 2nd, 3rd, and 5th partials.[3] He is aware,

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[2]Barbour ascribes ¼-comma temperament to Pietro Aron, 1/3-comma temperament to Francisco Salinas.

[3]Kornerup likens these three values to the three primary colors, declaring that theorists such as the Pythagoreans who fail to recognize one of these values are the musical equivalent of color-blind. _Musical Acoustics based on a Pure Third System_, column 29.

of course, that the series created by the powers of the three numbers must proceed toward infinity without ever meeting, and that any relationship between values based on one series and values based on another can only be approximate. But this troubles him because he is anxious to have a universal basis for measurement that will provide answers to questions of right and wrong in tuning systems. He finds such a universal basis in the age-old mathematical concept of the golden mean.

The golden ratio, which Kornerup also refers to as Kepler's "Proportio Divina" is that proportion between two values, "a" and "b" where "b" is greater than "a," which is capable of being repeated exactly in the proportion between the larger term, "b," and the sum of the two terms, "a + b." In an algebraic equation, the precondition for the golden ratio is as follows:

$$\frac{a}{b} = \frac{b}{a + b}$$

The value, $\frac{a}{b}$ is generally referred to as ω, and the equation can, after several simple substitutions, be expressed as follows:

$$\omega^2 + \omega - 1 = 0.$$

Solving for ω, we obtain the value 0.618034. It is Kornerup's basic postulate to let the chromatic and diatonic semitones differ from one another by the ratio ω. It is relatively easy, algebraically to solve for a and b (chromatic and diatonic semitones respectively) such that $\frac{a}{b} = .618034$, while $a^5 \cdot b^7 = 2$ (five chromatic semitones plus seven diatonic semitones equals an octave). The resulting values, in cents, for a and b are 73.5 cents and 118.9 cents respectively. These values are fairly close to just values for these intervals which are, respectively, 25:24 = 70.7 cents, and 16:15 = 111.7 cents.

Because of the special nature of the golden ratio, the tone, which represents the sum of the two kinds of semitones, will represent the value "a + b," which will be a denominator in a fraction equal to ω when the diatonic semitone is the numerator. This tone, "a + b," is 192.4 cents, which is approximately the mean between 9:8 and 10:9. The ratio, ω, also represents the relationship between the major second and the minor third, "a + 2b." This minor third is 311.4 cents in size. The ratio, ω, also represents the relationship between the minor third and the perfect fourth, 2a + 3b. The golden fourth measures 503.8 cents. The entire hierarchy of intervals from the chromatic semitone to the perfect fourth can be expressed as follows:

$$\frac{\text{chromatic semitone}}{\text{diatonic semitone}} = \frac{\text{diatonic semitone}}{\text{tone}} = \frac{\text{tone}}{\text{minor 3rd}} =$$

$$\frac{\text{minor third}}{\text{perfect fourth}} = 0.618034$$

If the values represented by the five intervals are added together, the sum will be exactly equal to an octave.

If just the last term (perfect fourth) is omitted, the result is the golden fifth, 696.2 cents. If the last two terms are omitted, the result is the golden major third, 384.9 cents. This is how Kornerup brings the disparate values for third, fifth, and octave into a single universal basis for measurement. The golden third, fifth, and octave cannot relate to one another by ω, but rather as sums of values each related to one another by ω.

Kornerup carries the golden ratio through intervals smaller than the chromatic semitone (although the smaller values are not included when members of the series are added together to form the major third, perfect fifth, or octave). Proceeding from large to small, the first two values after the chromatic semitone, which Kornerup calls golden molecules, are 45.4 cents (the golden diesis) and 28.1 cents (the golden comma). At the commatic level the golden interval seems excessively distorted to be of any acoustical value (the syntonic comma is 21.5 cents, nearly 25% smaller), but the larger intervals are approximated sufficiently well to render the golden system at least discussable.

Kornerup claims for his system of intervals at a fixed ratio to one-another that it is capable of serving as a basis for acoustical valuation of musical systems.[4] This

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[4]The intensity with which Kornerup expresses his advocacy of the golden tone, and the extent of his claims for it, can only be shown with a direct quotation: "The relations of the golden division are like a <u>kingly</u> thought

seems a somewhat extravagant assertion in view of the fact that nature has supplied its own basis for acoustical valuation in the intervals of small-number ratios. Barbour, who considers the golden system an "Ignis Fatuus" points to the rather substantial error in the golden fifth and third.[5] The fifth is nearly 5.8 cents in error; an error greater than that of ¼-comma meantone temperament. The third is 1.4 cents in error, but it is an error on the side of flatness which is an aggravating factor to Barbour and others who prefer a large third.

The golden system is probably more realistically appraised when it is considered not as a universal basis for measurement but as simply another proposed musical system, sharing with equal temperaments the imperfection of all intervals other than the octave. As do equal temperaments, the golden system offers compensating advantages for its acoustical inaccuracies. These advantages must be weighed against the extent and importance of the inaccuracies. The advantages of the golden system are less tangible than those of an equal-tempered system. Not even Kornerup has advocated the use of pure golden intonation, since it would take a proliferation of tones to render such a system transposable. Rather, it is asserted

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which shows Beauty and Justice as two forms of the same, a latent natural fundamental law, at the same time both aesthetic and ethic." Acoustic Valuation of Intervals, p. 9.

[5] Tuning and Temperament, page 128.

for the golden system, the use of a constant ratio between the various sizes of component intervals provides an almost mystical harmoniousness. The parts are alleged to harmonize with one another. The comma and diesis are no longer just left-over parts. They belong to a series which also contains two kinds of semitones, the tone, the minor third and the perfect fourth of the system. Supplementing the sense of unity in a system where the great and the small are part of a single series is the mystique of the ratio of the golden mean itself. The object of great respect and even awe of brilliant men for many centuries, the golden mean is said to be embodied in nature in the construction of certain leaves[6] and in much of the world's greatest architecture as well.[7]

Whether or not the reader finds the mystique of the golden mean and of the single hierarchy of intervals appealing as a musical element, he may be impelled to ask what use it could possibly have if Kornerup's initial claims for it are rejected. Not even Kornerup has proposed its use in practice. What value might it have if it is acoustically unsuited to be the basis for valuation?

There is a close organic relationship between the

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[6]Kornerup gives a moderately extensive bibliography of non-musical writings about the golden mean in Acoustic Valuation of Intervals, page 21.

[7]Kornerup's source is Macody Lund, Kathedralen i Nidaros, Oslo, 1919.

golden system and a certain series of related temperaments, the Fibonacci series[8] ... 12, 19, 31, 50 ... . It can be proved that the limit as $n \to \infty$ of $\frac{n}{n - 1}$ in any Fibonacci series is none other than , 0.618034. It can likewise be shown that the golden intervals represent the exact tuning of that system which is the limit of the series ... 12, 19, 31, 50 ... . This having been established, the golden system, as advocated by Kornerup, becomes, essentially, a means of advocating the expansion of tonal resources by means of this particular series. The higher one proceeds within this series, the closer the ratios between the component parts approach the limit ω . Although there are discrepancies between the intervals of any finite tempered system and those of the golden system, such discrepancies become increasingly small as the number of tones employed increases. The table below shows the discrepancies between certain intervals in 31-tone temperament and the equivalent intervals in the golden system.[9]

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[8] A Fibonacci series is a series of numbers in which any given number is the sum of the two preceding numbers, or $n = (n - 2) + (n - 1)$.

[9] For a similar comparison between golden intervals and 19-tone temperament, see below, chapter 12, page 314, for a chart, followed by a general discussion.

	31-TT	Golden
Diesis	38.71	45.4
Chromatic semitone	77.42	73.5
Diatonic semitone	116.13	118.9
Tone	193.55	192.4
Minor Third	309.68	311.4
Major Third	387.68	384.9
Perfect 5th	696.8	696.2

Except for the smallest unit of the system, 31-tone temperament represents a rather faithful rendering of golden tuning. Therefore, in the most practical sense, the case for the golden cut is a part of the case for 31-tone (and to a lesser extent for 19-tone) temperament. Whatever attractive mystique may rest in the principle of the golden mean can, with very slight discrepancies, be attributed to the equal temperaments of the aforementioned Fibonacci series,[10] without altering the acoustical advantages or disadvantages of the temperaments within the series.

It is unnecessary to concern ourselves here over the many other uses Kornerup makes of the golden series as the basis for musical measurement.[11] Whether or not it is regarded as deciding, the value of the golden cut as an

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[10] As chapter 12 will show, some weaknesses are present in the application of the Golden system to 19-tone temperament which do not apply to 31- or 50-tone temperament.

[11] Kornerup finds values for the higher partials on the basis of combinations of golden intervals. His seventh partial is some 6 cents too flat, and is the sum of the golden tone, minor third, and perfect fourth, minus the golden diesis. Kornerup also uses the golden system as a starting point in some Socio-musicology, declaring, for example, in his Indisches Tonsystem..., page 7, that the majority of Indian intervals are very close to golden intervals.

argument in favor of 19-, 31- or 50-tone temperament, supplementing but not replacing acoustical considerations, deserves to be taken into consideration. Because of this, Kornerup's theory of the golden cut must be regarded as an important contribution to the theory of multiple division even though his basic premise for its use is extravagant to the point of invalidity.

A final note should be added about the broadness of scope of Kornerup's work in acoustics and multiple division. In his pages appears the most detailed chronology of the advocacy of 19-tone temperament to have been published;[12] one of the most thorough treatments of the subject of the different possible ways of dividing a string into musical intervals;[13] and a most sensible proposal for the universal naming of tones.[14] His pamphlets contain many charts, often as illuminating concerning his viewpoint as many pages of text. Several such charts are appended here.[15]

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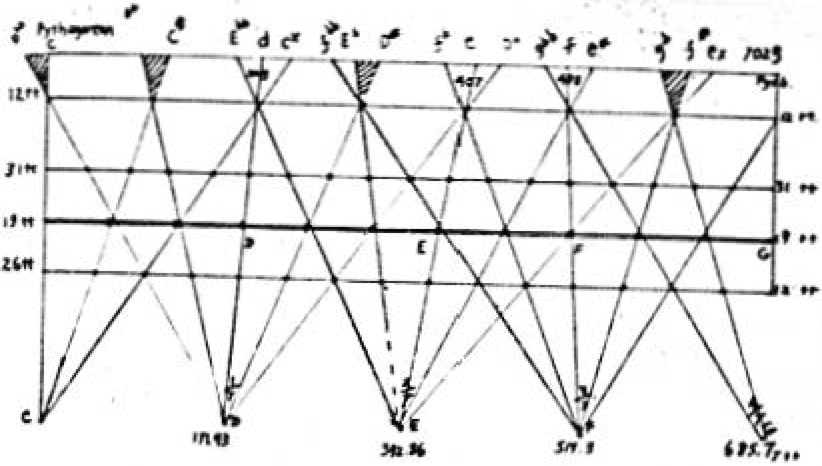
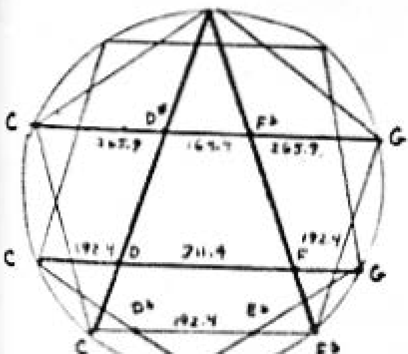
[12] Such chronologies appear in several of his pamphlets. Of the important early writers only Woolhouse is omitted. There is, however, a tendency to attribute advocacy of 19-tone temperament where no such advocacy is implied as in the case of Elsass, the builder of the early 17th century Clavicembalo Universale.

[13] Kornerup's treatment of this is particularly useful and thorough. It is one of the chief subjects of Acoustic Methods of Work.

[14] Kornerup proposes the use of the German suffixes is and es to denote sharps and flats respectively, but the elimination of the letter h from the roster of tone designations, and the use of b to denote b natural.

[15] From Die Vorlaufer..., page 5.

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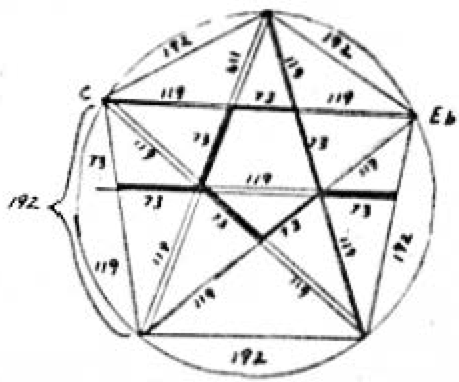
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