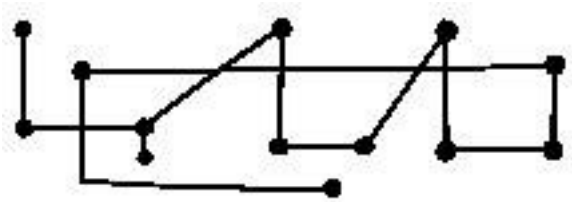

Review: Toward the Expansion of Our Concepts of Intonation
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New Music with 31 Notes by Adriaan D. Fokker ; Leigh Gerdine
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TOWARD THE EXPANSION OF OUR CONCEPTS OF INTONATION

Pitch Notation and Equal Temperament: A Formal Study. By Eric Regener. Berkeley and Los Angeles: University of California Press, 1974.

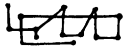
New Music With 31 Notes. By Adriaan D. Fokker (translated from the German by Leigh Gerdine). Düsseldorf: Gesellschaft zur Förderung der Musikwissenschaft, 1974.

Xenharmonikon: An Informal Journal of Experimental Music, Volume I, No. 1, 1973. (Privately issued, but available through University Microfilms, Ann Arbor, Michigan.)

The Scalatron. Manufactured by Motorola Inc., Chicago.

The Archifoon. Manufactured by Hendrik Van der Horst, Wilp, The Netherlands.

JOEL MANDELBAUM



During the two-century hegemony of 12-tone equal temperament over Western music, there has been a constant stream of writers speculating on the advantages of other systems of intonation. Their ranks have occasionally been augmented by instrument builders and even composers; however, they have existed almost entirely either at the periphery of our profession or outside it entirely. Their writings are almost invariably privately issued or in publications associated primarily with disciplines other than music. And except for a brief fling in the 1920's of modest fashionability for quarter-tone music, composers seeking alternatives to 12-tone equal temperament have not gained respectability, regardless of their attainments. There are indications that this has begun to alter in the last decade or two, with the belated and grudging recognition finally being accorded to Harry Partch and the development of some interest in the microtonal side of such composers as Ives and Badings. The growth

of interest in microtonal intonation has proceeded until now at a glacial pace uncharacteristic of our century of instant communication. However, the growth of interest seems to be accelerating and the new publications, compositions, and instruments, seem to have found the beginnings of a market which was simply not present a few years ago.

The writers and manufacturers cited in this review share an openness to systems of intonation other than 12-tone equal temperament. Their philosophic positions range from that of Lou Harrison who maintains (in *Xenharmonikon*) that the entire period of 12-tone hegemony was one of decline and that it is wrong for any single intonation system to dominate to the exclusion of others, to that of Fokker who advocates a single system, 31-tone equal temperament, from which the reader can infer that he does not share Harrison's sense that there is a need for a proliferation of intonation systems. The instrument builders reflect the philosophic diversity of the writers. The Archifoon is a 31-tone tempered instrument designed to realize music based on Fokker's ideals. The Scalatron's strength lies in its ability to change its intonation with ease and accuracy. Regener and the Xenharmonists (other than Harrison) take a position between Fokker's and Harrison's. They are interested in many intonation systems, though with a strong emphasis on equal temperaments. They may assert, as Ivor Darreg does (*Xenharmonikon*), that each of many equal temperaments is especially appropriate to a certain mood. But even here, whether by theoretical implications (as in Regener) or the frequence of references (Erv Wilson and Darreg), it would appear that at this time for all of them 31-tone equal temperament has become at least a *primus inter pares* among the microtonal systems. This is all to the good because even if one accepts Harrison's position on the merits of multiplicity, there has to be an agreed upon starting point if large numbers of musicians are ever to be persuaded to look beyond 12-tone equal temperament, and in the 31-tone tuning that point of departure may have been found.

I.

Regener states in his preface that his initial intent was to "attempt to derive quantitative mathematical models for events in tonal music, in the manner of the physical sciences." In this he has succeeded with a vengeance. He does not open new ground musically, but, in examining the observations of others he demonstrates with a masterly hand why musical phenomena work as they do. He manages to develop and explain the interrelatedness of different aspects of our tonal musical language as it is notated in a way that is usually clear, obviously accurate, and often fascinating even to a reader who, like this one, finds the purely math-

ematical statements (of both formulae and proofs) frequently incomprehensible. Fortunately Regener is "bilingual" in that nearly all of his statements in "mathematic-ese" are immediately translated into understandable English.

Central to Regener's approach is a set of coordinates for intervals based on what he calls diatones and quints. Diatones are the number of steps in the diatonic scale between the two points, and quints are the number of perfect fifths which separate them following the circle of fifths. For example, a major third has the coordinates 2,4 (there are two diatonic steps in any kind of third, and four perfect fifths in the series C-G-D-A-E). Downward fifths have negative coordinates (a minor third is 2, − 3). Regener is evidently fascinated by the rich, ordered fabric of relationships which bind together augmented, major, minor, and diminished intervals; double flats, flats, naturals, sharps, and double sharps; and which order the quint-groups from F through C,G,D,A and E to B.

It is a world of careful distinction between a minor seventh (6, − 2) and an augmented sixth (5,10). Mr. Regener clearly is, as he acknowledges, referring specifically to *tonal* music.

Throughout, the perfect fifth (4,1) takes on a primacy in Regener's calculations. When, in his later chapters he examines various intonation systems (the most interesting part of the book), he selects as his "determining constant" the logarithmic proportion of the octave which represents the perfect fifth (in 12-tone equal temperament that is, of course, 7/12). This would seem to imply a Pythagorean approach, and indeed, he develops his conceptual explanation of just intonation from a Pythagorean model, and relates other just intonation systems to this model. However, paradoxically, at a certain point Regener departs drastically from the Pythagorean approach (which is of course to build all intonation around beatless perfect fifths) by imposing a criterion for "regular systems" which precludes any system with a perfect fifth larger than the 700 cents of 12-tone temperament (the just perfect fifth is about 702 cents).

This criterion is that "the frequency-ratio of the augmented prime shall be not less than that of the diminished second and not greater than that of the minor second." This is the most controversial aspect of Regener's book, as it places outside of "regular systems" such music as Ben Johnston's, Eivind Groven's, the much-advocated 53-tone equal temperament, and most current practice in string and vocal intonation. This is an important factor in discussing Regener's book, because the exclusion from the ranks of "regular" systems seems to represent a meaningful negative evaluation by Regener. "I *reject* [such] systems because they are universally agreed, even by their proponents to be notationally inconsistent," says Regener (italics mine). He points out, correctly, that in 53-tone

temperament, the excellent approximation of the interval ratio 5:4 is not achieved by the major third (2,4) but by the diminished fourth (3, − 8). Whatever designation he wishes to make for such a system (I do not object to his calling it "irregular" if he wishes), its usefulness to some composers has been demonstrated, and a theory which doesn't contain it is thereby rendered incomplete. The problem of notationally inconsistent intervals is, in any case, not confined to the intonation systems Regener has "rejected". Users of 31-tone temperament with its close approximation of the frequency-ratio 7:4 often will, quite understandably, refer to this interval as a seventh. Regener takes Fokker to task for doing precisely that. In 31-tone temperament the logarithmic fraction which approximates the frequency-ratio 7:4 is 25/31, which is not a minor seventh (6, − 2) but rather an augmented sixth (5, 10). But in using that interval as a "consonance," one will probably not be thinking "augmented" in a functional way. What Regener refers to as "notational inconsistencies" certainly cause problems for composers using these systems, but far outweighing the problematic aspects are the opportunities for expression provided by the very ambiguity of these "notationally inconsistent" relationships. Perhaps Regener, with his mathematical ingenuity, can enlarge his conception of the "regular" to embrace these phenomena in the future, or at least to explain them in a more complete way.

In any case, Regener has made a most valuable contribution. By limiting the systems considered to those which lie within the boundaries established by his criterion, he gives us a most thorough examination of all equal temperaments of 259 or fewer tones with perfect fifths no larger than the 700 cents of 12-tone temperament (where the augmented prime is the maximum permitted as it is equal to the minor second) and no smaller than the 694.7 cents of 19-tone temperament (where the augmented prime is the minimum permitted as it is equal to the diminished second). Between these two limiting cases, the only equal temperament with fewer than 50 tones to the octave is . . . 31-tone equal temperament. He makes no explicit case for this temperament, nevertheless, it implicitly emerges as the most useful new system under his criteria. The chief pleasure of Regener's book lies in the precision of his mind, and the richness he finds in the supposedly extinct world of diatonic relationships.

II.

Fokker, in contrast, is a most explicit advocate of 31-tone temperament. Before turning to music relatively late in his highly productive life, the late Professor Adriaan D. Fokker (1887–1972) was a physicist whose work in relativity, first under Einstein and then on his own, won him international renown. During the final three decades of his life, Fokker

directed the construction of several keyboard instruments in 31-tone equal temperament including an elaborate pipe organ at Teylers Museum in Haarlem; organized the foundation which now bears his name (Stichting Huyghens-Fokker); arranged to have music composed in the temperament (a competition and later commissions to composers such as Henk Badings and Hans Kox who have responded with excellent works); established contact with the international musicological community; composed basic studies under the pseudonym Arie de Klein; became a source of personal encouragement to everyone interested in studying or using 31-tone temperament; and wrote a series of books, articles, and pamphlets articulating various aspects of musical theory as it pertains to 31-tone temperament.

New Music with 31 Notes appeared originally in German in 1966. It is a distillation of the ideas which have punctuated his theoretical writings and makes a fine introduction to the works of this seminal figure.

The book is in two parts, the first narrating the history of Fokker's involvement in 31-tone temperament and the early fruits of this interest. The longer second part is theoretical and deals with aspects of the temperament which have especially preoccupied Fokker.

Particularly fascinating in the first part, is the acknowledgment of the importance to Fokker of the earlier advocacy of 31-tone temperament by Christiaan Huyghens, a 17th-century Dutch mathematician. Fokker appears to have come upon his musical writings while dutifully keeping up with the gradual publication of Huyghens' immense complete works by the Dutch Maatschappij der Wetenschappen. This was nearly a century-long undertaking, and the writings on music were not published until 1940. Shortly thereafter, Fokker was on his way. The scholars of the Maatschappij der Wetenschappen could hardly have guessed the extent of the creative ferment they would cause by their publication of the works of a 17th-century figure.

The second part proceeds from a derivation of the 31 pitches from just intervals into a dazzling array of possible bases for scalar and harmonic structures in the temperament. Though Fokker has a great number of ideas and covers a wide range, there are three overall procedures which seem to dominate. The first is the use of Euler's *Genera Musicum* for scale building (a procedure I followed very precisely in my first 31-tone work). In the Euler *Genera Musicum* as interpreted by Fokker, scales are made by combining specific numbers of perfect fifths, major thirds, and natural sevenths (those are the three vectors—any one or two can be omitted in a specific *Genus Musicum*). The second procedure is the use of addition chords and chords formed by other numerical relationships of their members. The third procedure is the building of progres-

sions out of mirror symmetries using fixed tones within the structures as pivots.

Composers considering the possibility of writing in 31-tone temperament should read and digest this book thoroughly. Fokker's ideas make useful experimental starting points. They crop up frequently in the 31-tone works of Kox and Badings. Once Fokker's ideas have been absorbed, their value will vary. To some they will be only marginally useful while others will find them indispensable.

Theorists will find in this book a rich harvest. Fokker's ideas on the basis of scales and chords deserve to be considered next to those of the major figures of the past. He is respectful of his predecessors and open to their ideas, but he is a truly original thinker, and many of his suggestions are quite new. All readers will find an excitement arising from the intensity of Fokker's absorption in his material and in the exploration and cultivation of the new musical terrain he has had such a hand in discovering.

The English translation by Leigh Gerdine is thoroughly serviceable. By staying very close to literal translations wherever possible to be certain of the meaning, he occasionally allows the English usage to be a bit awkward, but I find that this perhaps overmodest approach to translation works quite well in this instance. Both the German and English versions have benefited from the editorship of Dr. Martin Vogel of Bonn who has established himself as the leading member of the international musicological establishment to evince an abiding interest in microtonal intonation. (He has written an outstanding dissertation on the history of the seventh partial.)

III.

The *Xenharmonikon* calls itself "an informal journal of experimental music." John Chalmers notes—in his Prospectus—a long tradition in other fields of "amateur publication. . . . The journals they produce are marked by affection, enthusiasm, and immediacy, virtues not always present in academic journals."

Each author not only submits his own, unedited copy in his own format, but he is also responsible for its full reproduction (25 copies for Volume I, however University Microfilms will undertake to supply additional copies to anyone wishing them). The result is wide divergence in the nature of submissions despite the compactness of the circle from which the authors are drawn.

Featured is an elegantly hand-lettered communication from Lou Harrison entitled "Four Items." Item three, longer than all the others com-

bined, catalogues types of instruments Harrison feels can and should be built to explore wide varieties of timbres and intonations. The other Items together constitute a polemic against uniformity of intonation and against the aesthetics of the era which fostered such uniformity.

Ivor Darreg, "the founder of the feast" as Chalmers calls him, has been privately publishing in this field for many years. Here he submits excerpts from his writings, including a tentative "Xenharmonic Bulletin Volume 1" dated 1966. I found most interesting among his submissions a page of excerpts from his compositions in various temperaments. Darreg has probably tried out more tuning systems than any of the other three composers and he evidently likes them all, each for its own particular qualities. His music will turn off some listeners for its disregard of the contemporary vernacular with respect to texture, registration, and rhythmic complexity. All of these elements have reverted to the simplicity of "other centuries" in order that Darreg may single-mindedly concentrate on pitch. Darreg is most certainly not alone among microtonalists in doing this. It is, in milder form, indeed a distinguishing mark of most if not all composers working in this area. Darreg's is merely a more extreme or purer form of a widespread tendency among the microtonally involved to eschew much of what supposedly constitutes "up-to-dateness" in other aspects of style, while concentrating on pitch content which has no parallel in past or present practice though it tends to grow out of an expansion of the language of traditional *tonal* music (much as the theory does . . . see notes on Regener).

To me, the most valuable piece in the *Xenharmonikon* is Erv Wilson's brief but well-illustrated article, "The Bosanquetian 7-Rank Keyboard after Poole and Brown." In it, Wilson expounds the generalized keyboard design of R.H.M. Bosanquet (1876) as the best one of many he has examined or considered.

Wilson summarizes Bosanquet's contribution as "integrating the 7-white-5-black into a single open pattern which permits modular extrapolation." Wilson is referring to the capacity of the Bosanquet keyboard to absorb larger scales without essentially changing the function of each of the keys or greatly changing the size of any of the intervals. Fokker's 31-tone keyboard is based on the same generalized principle, but Wilson is right in observing that Bosanquet's "is *the* one which least modifies . . . treasured fingering habits."

I have long considered Bosanquet's keyboard design the best I have encountered. I regard Wilson's confirmation as significant. Wilson is nothing if not thorough, and he has probably tried out in practical use keyboard designs which nobody else has even imagined. He has in other writings, incidentally, offered proposals for pitch notation in microtonal music which far exceed in subtlety and potential usefulness any others which

have come to my attention. Those writings are, as far as I know, unpublished. Perhaps in a future *Xenharmonikon?*

Wilson is incorrect in assuming that Bosanquet neither published sketches of his keyboard nor constructed an instrument using it. In fact, he did both. The instrument still exists today but is not in condition for use, according to William Coates who has seen it. It is currently in the storage facilities of London's Museum of Science. Its refurbishing, or the building of a new instrument to its specifications (but with variable pitches), would be a splendid way to mark the centenary of a publication which stands apart in splendid isolation as prophetic to all who take microtonal music seriously.

The *Xenharmonikon,* like both the Regener and Fokker books, comes replete with pitch and interval tables. Chalmers has given his computer a thorough workout. There are over 100,000 digits in his tables, and musicians wishing to convert frequencies to cents, etc. can probably retire their slide rules forever. Regener's tables give us slightly over 50,000 digits only about half of which duplicate Chalmers. Fokker's Table of Diëses is far more modest by comparison (barely 1,000 digits), but they are sufficient for all the calculation one is likely to need in working with 31-tone temperament.

All in all, the *Xenharmonikon* is a valuable addition and one hopes it will continue publication. Wilson, Darreg, Harrison, and Chalmers are all voices which should continue to be heard. I hope that the circle of authors can be broadened without loss of the present informal flavor.

IV

Though private, hand-built instruments have been constructed during our century (including Harry Partch's splendid ensemble) capable of one or another microtonal tuning, there have been, until very recently, no commercially available instruments of such a nature. The electronic synthesizers though widely available, seem almost to have been designed to make as difficult as possible the realization of the microtonal possibilities which are so obviously within them. A microtonal composer needs an instrument which will hold its pitch once tuned and, since he is exploring delicate nuances of pitch relationships, he needs a large number of pitches at his fingertips: he cannot wait for the tape-splicing.

Recently, two keyboard instruments specifically designed to retain accurate microtonal tunings have been made available. They are, the Scalatron, by Motorola of Chicago, and the Archifoon, by Hendrik Van der Horst of Wilp, Netherlands. I must leave to others a component by component review of their technical construction. Both sound like electric organs, and neither will be selected for its singular beauty of sound. I take

it on faith that the pedestrian sound on both instruments is unavoidable and, of course, richness of timbre is not what they are about, although both have a fairly wide variety of uninteresting sounds.

What is noteworthy is what they can do with pitch. The Scalatron has pioneered the idea of instant retunability. Each manual of the conventionally designed 12-tone keyboard is tuned by a series of binary circuits controlled by buttons, 10 to each key. There are therefore a total of 240 buttons to check. With a diagram in front of you for the tuning system you wish to use (either the manufacturer's or your own), you can retune the entire instrument in about three minutes to within one cent of any specifications. Once tuned, the instrument holds its pitch splendidly. Unfortunately, the creators of the Scalatron did not originally have the imagination with respect to keyboard design that they had with respect to retunability. Also, by limiting the user to 24 pitches (and only 12 on each manual), the manufacturers overlooked one of the principal reasons one would want such an instrument in the first place. It is hoped that the manufacturers will come up with an improved model in which the tuning flexibility is harnessed to a keyboard capable, in Wilson's words, of modular extrapolation, and with at least 31 pitches per octave available.

Unlike the Scalatron, which is manufactured by a large firm, the Archifoon is still a one-at-a-time hand-crafted instrument. However, its maker is soliciting further orders. Gerdine, Fokker's translator, has recently acquired one of these instruments at Webster College, St. Louis, Missouri, where he is President. Its generalized keyboard meets all criteria for "modular extrapolation" but the instrument is not constructed for retunability. It is a 31-tone instrument, using a slightly reduced version of Fokker's original keyboard for the organ at Teyler's Museum, Haarlem. There are 11 ranks of keys with alternate spacing so that all odd-numbered ranks have keys directly behind one another while consecutive ranks relate to one-another diagonally. All keys on each rank are spaced a whole tone (5/31 octave) apart. A diagonal upward to the right raises the pitch by a large semitone (3/31 octave) while an upward diagonal to the left lowers the pitch by a small semitone (2/31 octave). To move by a single diësis one moves directly forward skipping the intervening, diagonally-placed rank. The keys are colored according to traditional function: white; black and off-black for sharps and flats, respectively; blue and grey-blue for semi-sharps and semi-flats, respectively. The design is ingenious, and the general pattern should be retained. I would suggest the following improvements, however:

1. If possible, incorporate something like Motorola's retuning principle so that tunings other than 31-tone temperament can be explored if desired.

2. Change the color of four keys. The keys for C-flat, F-flat, E-sharp, and B-sharp are colored according to the enharmonically equivalent semi-

sharps or semi-flats. This coloring renders them less useful in any retunings which might be tried. On the basis of Regener's theory it is doubtful that semi-sharps and semi-flats have any theoretical validity anyway. Except for the four pitches referred to above, all semi-sharps and semi-flats in 31-tone temperament are enharmonic equivalents for double flats and double sharps, respectively. These double accidentals do, of course, have theoretical validity and would continue to be represented by the blue and blue-grey keys.

3. Find a way to texture at least some of the keys so that the fingers may feel out the colors as on the piano. It is too difficult to read music when one must always look at every operation of the fingers.

4. If possible, slant the entire system as is done by Bosanquet. This will not fundamentally change the system, but will make its application far easier to learn.

Even though one wishes that the two instruments had somehow been combined, and hopes they eventually will be, it should be noted that we order and use other equipment before the final word is uttered on model efficiency; there is no reason why music schools should not possess one or both of these instruments at this time. Each one, in its own way, offers opportunities to study aspects of the history of intonation, and possibilities for a rich future. These are important studies and cannot be accomplished nearly as well in any other way.

Addendum:

After the above words were written, and before they were put into print, several events occurred which relate to them.

1. A second issue of *Xenharmonikon* has appeared, which makes it easier to get a sense of where this publication is heading, since all its initial contributors have written again, and with generally sharper focus than the first time. Darreg, whose initial contribution was somewhat attenuated by a scattershot approach to too many topics, has this time concentrated on a detailed discussion of 24-tone temperament. It is a perceptive evaluation of the tuning: somewhat more favorable than my own, but an excellent introduction to quarter-tones from the perspective of a comparative intonationist. In it he mentions having translated Ivan Wyschnogradsky's *Manuel d'harmonie a Quarts de Ton* (1933). This is a fascinating pamphlet and it would be of considerab'e worth to have it available in English.

2. Spokesmen for Motorola indicated that an instrument quite similar to my suggested specifications was, in fact, being custom built for George Secor, a young composer from Chicago. I have recently inspected the instrument and am happy to report that it is far and away the best microtonal device so far. It uses a Bosanquet keyboard design (with 31 keys

rather than Bosanquet's 53 per octave), with textured keys, and five colors (my second objection to the Archifoon is the only one not met successfully by this instrument, but that change would be routine, if desired). Secor's instrument is being combined with traditional synthesizer components to extend timbre and other possibilities. It is hoped that with the aid of much-to-be-desired grants, additional instruments of a similar nature can be constructed and distributed to university music departments as a resource to enhance the study of historic intonation systems as well as current theoretical models, and as an instrument for performance and composition.

Wilson has elaborated his ideas about Bosanquet's keyboard with useful diagrams. He also mentions without explanation that he now favors "positive tunings" exclusively, putting him directly at odds with Regener.

It is not surprising to see fundamental differences in opinion between those favoring small-fifth temperaments (like Regener) and those favoring large-fifth temperaments (like Wilson). They reflect differences of opinion on the relative merits of consonant (small) major thirds and "intense" (small) semitones. In a larger sense they may be thought to reflect the differences between those who see the chord as the generating source of tonal music and those who assign that role to the scale. Mark Lindley delivered a fascinating paper at the November 1974 American Musicological Society meeting on Elastic Temperaments of the 17th, 18th, and early 19th centuries. These were, according to Lindley's impressive evidence, far more prevalent than had been hitherto thought. In these temperaments the white-note keys have "negative" temperaments and the black-note keys "positive" and emphatically so. Lindley demonstrated with specially tuned instruments that music which sounded effective in the right key could sound astonishingly ineffective in certain wrong ones. The issue drawn between positive and negative temperaments is therefore not merely a theoretical or ornamental one, but may well, for an individual composer, determine whether his innermost and most basic musical impulses will be nurtured by the intonation thrust upon them or contradicted and perhaps even utterly destroyed by it. Not many can, like Darreg, jump among the tuning systems as Bach once jumped nimbly among the "well" but not necessarily equally tempered keys.