XI. Spectral CANON for CONLON Nancarrow for Harmonic Player Piano (1974)

Although I believe this work was composed, or at least concieved in 1972, it was not realized until a little later because of the various technical difficulties involved. First, the roll had to be punched, and because of the very precise durational algorithms involved (worked out on the computer), it most likely presented an arduous task. Nancarrow himself punched the roll on his custom-built machine, as a favor to Tenney, and Gordon Mumma helped him record the piece on an old player piano found somewhere near Santa Cruz, Cal. In the recording that now exists, one can even hear the electric pump faintly in the background.

The player piano is tuned to the harmonic series on triple low A, up to the 24th harmonic double high E. For the first time in his harmonic series-related works, Tenney was able to use the overtones in their natural octave placement. There are accordingly, 24 voices in the canon, each having the same durational structure, and the nature of the canonic configuration is interesting to explore. The key is to understand the analogy Tenney draws between durational ratios and harmonic ones (as in Henry Cowell's Rhythmicon). The successive durations for any given voice in this piece are determined by the logarithm of the ith superparticular ratio in the harmonic series:

$$Di = k \log2 \ (i+8)/(i+7)$$

(where Di is the ith duration in the sequence)

In other words, starting with the ratio 9/8, durations decrease exactly as do the pitch intervals in the harmonic series between "successively higher terms". "k" is a constant chosen to make the initial duration in any given voice 4 seconds, and can be determined by simple algebra:

$$\begin{aligned} k \log2 \ (9/8) &= 4 \\ k &= 4/\log2 \ (9/8) \\ &= 4/.1699 \\ &= \text{(approx.) } 23.54 \end{aligned}$$

One rather startling ramification is that this durational series, primarily because of the logarithm (which maintains the relationship to frequency, or at least our psycho-acoustic perception of frequency) forms temporal octaves at the same places that the pitch series would - 8, then 16, 32, 64 durations/pitches etc.. Put another way, the sum of the first eight durations is equal to the sum of the next sixteen and so on, just as it takes "more and more" superparticular ratios to add up to an octave the higher in frequency one goes. This fact is the basis for all the simultaneities in the piece. An intuitive way to see it is to look at the sum of certain simpler higher ratios, for example:

$\log2 \ 17/16 + \log2 \ 18/17$

$= \log2\ 17 - \log2\ 16 + \log2\ 18 - \log2\ 17$ (by the properties of logarithms)
$= \log2\ 18 - \log2\ 16$ (simple algebra)
$= \log2\ 18/16$ (log properties)
$= \log2\ 9/8$

- so that the first two durations at the "higher" temporal octave are equal to the first in the "lower". This indicates how the successive voices enter, the equation for the starting time for any given voice being:

$$ST(n) = k \log2 V(n)$$

- where ST is the starting time of voice n, and k is as before. Looking at this more closely, we see that the starting time of the second voice (n=2) is ST(2) = k log2 2 = k (since log2 2 = 1), and that successively higher octaves (4,8,16) begin after 2,3, and 4 times the value of k (log2 4 = 2; log2 8 = 3; etc.), or at the temporal octaves corresponding to their durational octaves. Note that at any point in the first part of the piece the first voice is moving twice as fast as the second, three times the third, and so on; and that these ratios are true for any pair of voices corresponding to their harmonic number. The same thing holds for other intervals (the third voice enters after a durational "twelfth", the fifth after a durational "double octave and major third", etc.). To see these non-octave relationships, we can examine the relationship of the durations of a higher voice to that of the first, as follows (leaving out k):

For voice 3, the starting time is ST(3) = log2 3, and this is equal to a sum of successive durations in the lowest voice which can be expressed as:

$$\sum_{i=1}^{j} \frac{(i+8)}{(i+7)} = 3$$

this can be proved by writing out the successive terms in this series, and remembering the property of logs:

log2 a/b = log2 a - log2 b, thus (again leaving out k):

$\log2\ 9/8 + \log2\ 10/9 + \log2\ 11/10 + \log2\ 12/11 \ldots + \log2\ 24/23$

$$= \log2\ 24/8 = \log2\ 3$$

- because any number which is in <u>both</u> a numerator and a denominator gets cancelled out by the occurrence of opposite signs, and only the "outer" two, 8 and 24, are left. This means that after 16 terms (an "octave and a half", since the 2nd voice enters after 8 terms and the 4th after 16 <u>more</u>, or 24 terms of the lowest voice), the third voice enters. At this point the duration of the third voice is k log2 9/8. The k "cancels", and we have the following equation:

$\log2\ 25/24 + \log2\ 26/25 + \log2\ 27/26$

(the first three durations of the first voice at the entrance of the third voice)

= log2 27/24 (by explanation above)

= log2 9/8 (first duration of <u>any</u> voice)

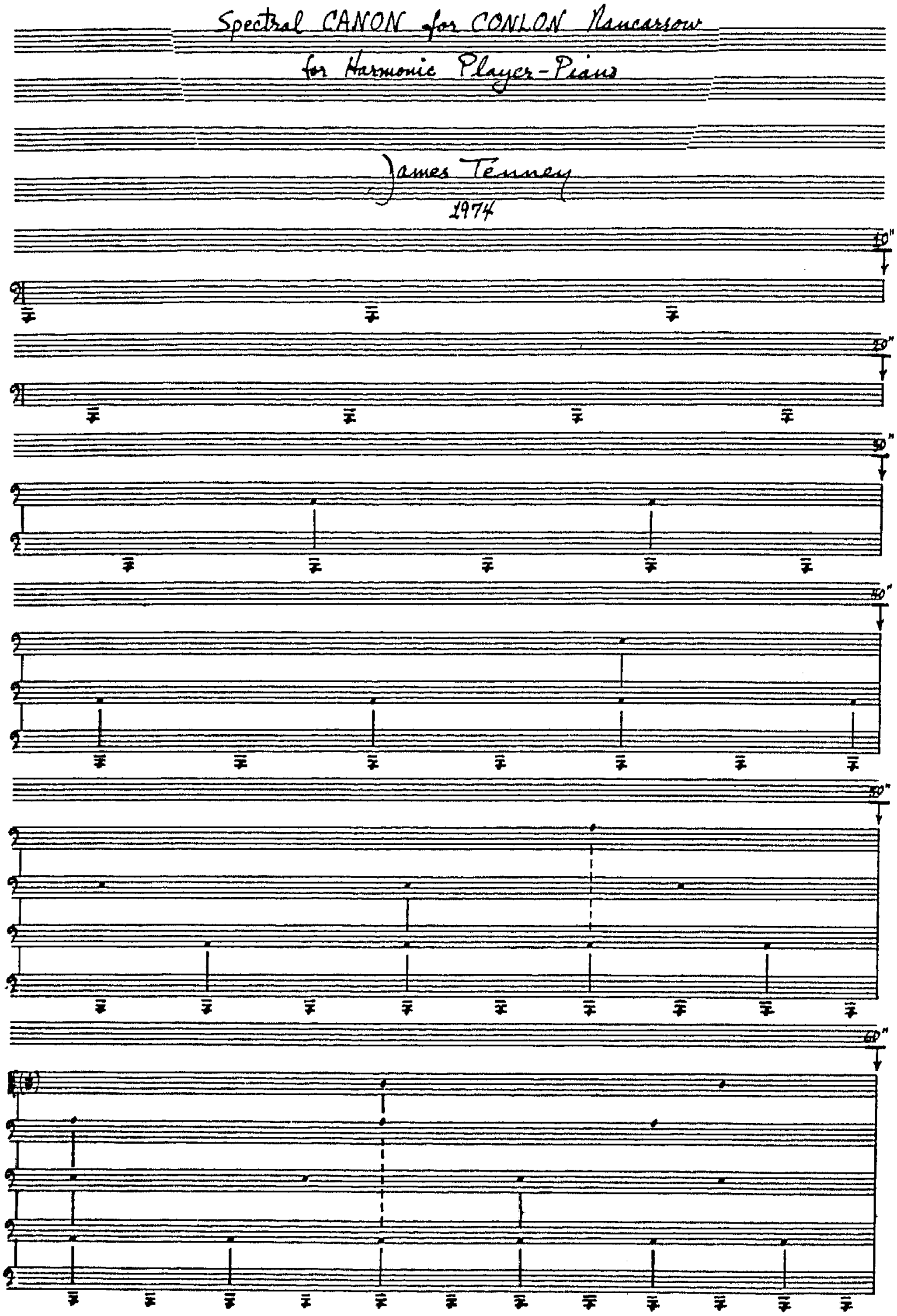
- and so at this point the first duration of the third voice is equal to three durations of the first. We could prove the same thing for all voices with relation to the first and with relation to each other (for example, at that point the third voice stands in the duration ratio 3:2 with the second, and so forth). Example XI.1 shows these relationships in the first page of the score.

The upshot of all this algebra (of which I am no fonder than the reader), is that a remarkably beautiful <u>integrity</u> is constructed using the very simple and elegant idea of the analogy of <u>pitch and duration harmonic ratios</u>, in a way unlike any I've ever seen. Like many of Tenney's ideas, it is remarkable in its simplicity but wonderfully complex and multilayered in its ramifications (perhaps this is what Philip Corner meant when he referred to Tenney's music as "resonant suchness").

The form of the piece is simple. Each voice goes through 192 terms of its series (always increasing in tempo), and then retrogrades. The 24th voice enters precisely when the first voice is beginning its retrograde (192/8 = 24). The piece terminates when the 24th voice ends its forward motion, which is, for some reason I can't quite determine, a point of <u>total synchrony</u> for all voices. This is preceeded by some breathtaking "parabolas and hyperbolas" (see Example XI.2, page 15 of the score), whose evolution I understand even less, but are somehow a natural result of the logarithmic cross rhythms. Note that no voice except the first completes its retrograde, so there is a kind of assymmetry to this aspect of the work.

Nothing I could say in this short description/explanation could ever substitute for the pure joy of listening to this marvel, which is heard once again more as a fact of nature than as a composed piece. It is, like most of Tenney's music, nearly impossible to come by, and a commercial recording done under good technical circumstances would be very welcome indeed!

Example XI.1


Spectral CANON for CONLON Nancarrow
for Harmonic Player-Piano
James Tenney
1974
10"
20"
30"
40"
50"
60"

Example XI.2