
The tuning of hand-made microtonal instruments

Justly Intoned Pelogs and Slendros

My 1/1 (or fundamental tone) is 'A' at 110 Hz or multiples thereof.

1/1, 8/7, 7/6, 4/3, 3/2, 12/7, 7/4, 2/1

I chose this mode after studying Lou Harrison's Just Intonation tunings in his biography and in editions 7 and 8 of the journal *Xenharmonikon*. They are relatively easy to sing which opens the door to writing for voice, chorus and some conventional orchestral instruments. I then settled on three slendros. These have a 9:8 step size between 4/3 and 3/2 and either 7:6 or 8:7 step sizes between the other tones:-

Si Aptos - 1/1, 8/7, 4/3, 3/2, 7/4, 2/1

Mills - 1/1, 8/7, 4/3, 3/2, 12/7, 2/1

Unnamed - 1/1, 7/6, 4/3, 3/2, 7/4, 2/1

I've nicknamed the Unnamed slendro *Faraway* after the name of my house.

Next came Lou Harrison's "Nature's Own" with the beautiful minor triad on 4/3, 19/12, 1/1:-

19/12, 1/1, 9/8, 7/6, 4/3, 19/12 (partials 12, 14, 16, 19, 27).

After auditioning several pelogs (using an Ensoniq ASR-10 with Jeff Scott's L'il Miss Scale Oven tuning software), two pelogs were chosen:-

Kyai Udan Arum - 1/1, 16/15, 7/6, 4/3, 22/15, 47/30, 9/5, 2/1 (partials 30, 32, 35, 40, 44, 47, 54)

Lou Harrison's - 1/1, 13/12, 7/6, 17/12, 3/2, 19/12, 7/4, 2/1 (partials 12, 13, 14, 17, 18, 19, 21)

Harrison states that this tuning is that of the 18th century gamelan "Kyai Gunter Sari". The 17/12 is a very prominent blue note. Only occasionally are these pelogs used strictly as pelogs in composition, ie in sets of five tones. The steel tube marimbas have tubes tuned to all of the slendro and pelog tones. The zithers, though retunable, are most often set up with the 36" and 48" six course zithers tuned to Faraway and the 36" eight course to Kyai Udan Arum.

I've used one psaltery tuned to Faraway down the right hand strings and Nature's Own down the left. Psaltery 2 has Kyai Udan Arum down the right and Nature's Own down the left. The giant mbira or rumba box, a difficult instrument to tune accurately, but worth the effort, normally has two octaves of the Faraway slendro on the top row and two octaves of Kyai Udan Arum on the bottom row. The long gongs are tuned (ascending) $4/3$ (below A =110), $3/2$, $1/1$ and $7/6$. In using the zithers and psalteries as prepared instruments in combination with electronics, the tunings are less critical because the preparations, by their very nature, interfere with the freely vibrating string lengths. I adhere to the tunings nonetheless for two reasons - I enjoy the ritual of tuning the strings accurately and some of the most beautiful music can be made by simply bowing or beating the instruments gently, allowing the tunings to breathe.

Tetrachords

I chose the following tetrachords for the steel tube marimbas.

- Avicenna's 13 limit Diatonic - $1/1$, $14/13$, $7/6$, $4/3$, $3/2$, $21/13$, $7/4$, $2/1$
- Barbour's (re-arranged) Chromatic - $1/1$, $9/8$, $8/7$, $4/3$, $3/2$, $27/16$, $12/7$, $2/1$
- Al Farabi's Diatonic - $1/1$, $49/48$, $7/6$, $4/3$, $3/2$, $49/32$, $7/4$, $2/1$
- Ptolemy's Homalon or Equable Diatonic - $1/1$, $12/11$, $6/5$, $4/3$, $3/2$, $18/11$, $9/5$, $2/1$
- Avicenna's 11-limit Diatonic - $8/7$, $40/33$, $4/3$, $32/21$, $12/7$, $20/11$, $2/1$, $8/7$

Eikosanies

In 2002 I began working with this elegant and versatile twenty tone tuning system, first on tunable fm synthesisers, then on an unfeasibly large hand-built steel tube marimba covering over two octaves of a complex interleaved double Eikosany tuning. This was too much too soon, and besides, because of my ineptitude as a craftsman, it played like a piano with the dampers off, shimmering wildly and preventing me from playing clear lines or harmonies. I regained some ground by using the shimmer as a textural layer in various electroacoustic compositions. Then I dismantled it and packed it away.

The Eikosany was devised by theorist Erv Wilson and has been developed over many years by composer, instrument builder and theorist Kraig Grady, whom I eventually met in person in 2013 and to whom I am indebted for advice and guidance over the years. Using this tuning, in 2004 I composed the 8 channel work *Hannah Throwing Stones* - a version for electronics and a version for double string quintet. In 2005 I wrote *Slow Kotekans Breaking* for tuned sine waves. From 2007-2009 I designed and built a quartet of 5-string bowed zithers which gave me the twenty tones of the Eikosany in a homogenous string ensemble. For this quartet of instruments I wrote *music born of solitude* in 2010. For a clear understanding of the Eikosany, and it's worth the effort if you're looking for new musical resources, an article from the Anaphorian archives (pdf) will explain everything.

Resources

Instrument Making

Making Simple Musical Instruments (Lark Books 1995) - Bart Hopkin.

Sound Designs: A Handbook of Musical Instrument Building (Ten Speed Press 1995) - Reinhold Banek and John Scoville.

Genesis of a Music (Da Capo Press 1974) - Harry Partch.

Tuning

Divisions of the Tetrachord (Frog Peak Music 1993) - John H. Chalmers Jr.

Harmonic Experience (Inner Traditions 1997) - W.A. Mathieu.

Tuning, Timbre, Spectrum, Scale (Springer 1999) - William A. Sethares.

Acoustics

On the Sensations of Tone (Dover Publications Inc. 1954) - Hermann Helmholtz.

Fundamentals of Musical Acoustics (Dover Publications Inc. 1990) - Arthur H. Benade.

Web

The Anaphorian site - Kraig Grady's archive of seminal theoretical documents on Just Intonation tuning systems (all generously made available for free download). Kraig has been an inspiration and a friend throughout this project.

Cris Forster's site - this is how my instruments were meant to look.