About the Tunings used on “Medicine River”

The “Medicine River” album uses a non-standard tuning system. In fact a tuning system that belongs to all cultures and none. It’s like you’ve taken a flute and you’ve placed the holes at equal intervals. Or you’ve made the frets on a guitar equal distance from each other instead of getting smaller as you go down towards the belly of the instrument.

Equal fretting is probably the earliest, most primitive tuning system you’ll find; “primitive” in the positive sense of something that goes back to the origin, something that hasn’t been corrupted by intellectual sophistication.

This system of tuning was re-discovered by an Irish musicologist name of Kathleen Schlesinger and it’s expounded at great length and in great depth in her book “The Greek Aulos” (published 1939 and now out of print). In this book she tells the story of how she came across this scale when she was measuring the holes in flutes from all sorts of classical (Greek), ancient (Egyptian and Sumerian) and contemporary indigenous cultures (Inuit, Peruvian, Balkan).

The mistake she makes is trying to use this primitive system as a template for the whole structure of classical Greek tuning theory. And of course this was junked by other musicologists who had their investment elsewhere.

What probably happens is that the person in the village who makes flutes or tunes lyres will just do it according to his or her ear. It’s only later that the theorists, Pythagoras, Archytas, Erastothenes, Didymus, Ptolemy, Boetius, Terpander and their ilk overlaid this sense of “what sounds right to the ear” with measurement and theory.

This approach carried on in the mediaeval cultures of the middle east with theorists like Al Farabi, Ibn Sina (aka Avicenna), Ishaq al Mausili, Zalzal, and so forth that developed into the system of maqam still in use in cultures from Morocco through Turkey and Iran to Central Asia.

Christian Europe simplified the profusion of tunings into the church modes (Dorian, Lydian, Phrygian etc) eventually narrowing them down even further to major and minor. Except in the music of the Orthodox Church where the original complexity of modes is still maintained and also in the much of the folk music of Eastern Europe and the Balkans.

Having reduced the range of Greek modes to major and minor only, the only way to move forward was to develop a system of changing key so that any note could be used as the tonic or home note. But in order to do this it was necessary to iron out all the subtle differences between the notes and make all notes equal. The system of equal temperament was born. And that is the one that is programmed into your synthesiser, that is fretted on your guitar, that is tuned into your piano.

Returning and retuning to a system using simple whole number ratios between the notes (Just Intonation) means working with the same material as the harmonic series.

The simple number ratios allow greater possibilities of harmonic colour, greater subtlety of tension and relaxation and a greater melodic richness.

Music is revealed as the mathematics of emotional expression.

The tuning I used on the Medicine River album is based on Schlesinger's tuning, using a Modal Determinant of 20. However due to the tuning capabilities of the Korg M1 which only gives plus or minus 50 cents from any equal tempered note, it was necessary for a couple of notes to use a Modal Determinant of 40. The scale gives the possibility of using ratios up to a prime limit of 19 but in practice, a prime limit of 13 was used.

Various tonal centres and various modes were taken from this pattern of global possibilities to create the pieces on this album.

Medicine River Tuning

MD (modal determinant) 40
(prime limit 13)
Calculated by Brian Lee

ratio		identity	cents	note
40 / 40	1/1	5	0	C
15/14	15/14	7	119.44	C#
40 / 36	10/9	3	182.4036	D
40 / 33	40/33	11	333.0407	D#
40 / 32	5/4	2	386.3137	E
40 / 30	4/3	5	498.045	F
40 / 28	10/7	7	617.4878	F#
40 / 26	20/13	13	745.7862	G
40 / 25	8/5	5	813.6864	G#
40 / 24	5/3	3	884.3586	A
40 / 22	20/11	11	1034.996	A#
40 / 21	40/21	7	1115.533	B
40 / 20	2/1	5	1200	C

Prime number

A prime number is a whole number that can only be divided by itself and 1.

1 is prime
2 is prime
3 is prime
4 is 2 x 2 (or 2^2) so it's a composite number
5 is prime
6 is 2 x 3
7 is prime
8 is 2 x 2 x 2 (or 2^3)
9 is 3 x 3 (or 3^2)
10 is 2 x 5
11 is prime
12 is 2 x 2 x 3 (or 2^2 x 3)
13 is prime
14 is 2 x 7
15 is 3 x 5
16 is 2 x 2 x 2 x 2 (or 2^4)

etc

In metaphysical terms, each new prime number is a new energy, a new vibration.
In holistic terms (for those of you with some degree of right-brain dominance, synaesthesia or Asperger's syndrome) prime numbers feel different from composite numbers and you have to relate to each new prime number in a completely new way.

Ratio

A ratio is a relationship between two things. For example between two string lengths. If one length is 30 and the other is 15, the ratio is 30/15 or 2/1

If one frequency is 600 Herz (vibrations per second) and the other is 400 Hz, the ratio is 600/400 or 3/2.

Whole number ratios are used to describe certain scales. They are no use to describe irrational scales such as equal tempered scales or those used in Indonesian gamelan music which are tuned to avoid ratios and thereby avoid overtone clashes.

To move from one ratio to another you multiply or divide. For example, in just intonation, to work out what note you get when you play two perfect fifths (3/2) one on top of the other:

3/2 x 3/2 = 9/4

This is bigger than an octave (2/1) so divide by 2 to get 9/8

The same calculation in cents goes like this. A perfect fifth is 701.955 cents

701.955 + 701.955 = 1403.91

This is bigger than an octave so subtract 1200 to give 203.91.

A fifth in equal temperament is 700 cents, only 1.955 cents flat of a perfect fifth and near enough for most purposes unless the composer's concern is the emotional and metaphysical accuracy of the interval where near enough is not good enough.

Modal Determinant

Schlesinger scales are easy to generate and calculate. You divide a piece of string (or column of air) into equal divisions. It's best to choose an even number in order to get an octave.
So if I choose 16 as my number, I get a nine note scale like this:

16/16	16/15	16/14	16/13	16/12	16/11	16/10	16/9	16/8

If I simplify these ratios I get:

16/16	16/15	16/14	16/13	16/12	16/11	16/10	16/9	16/8
1/1	16/15	8/7	16/13	4/3	16/11	8/5	16/9	2/1

In this scale 16 is the Modal Determinant or MD.

Prime Limit

If I choose a higher Modal Determinant such as 24 I get a scale like this

24/24	24/23	24/22	24/21	24/20	24/19	24/18	24/17	24/16	24/15	24/14	24/13	24/12

which gives me prime numbers higher than I want to deal with for whatever reason.
So I filter out for example prime numbers over 13 giving me

24/24		24/22	24/21	24/20		24/18		24/16	24/15	24/14	24/13	24/12

So this scale has an MD of 24 but a prime limit of 13.

Composers choose different prime limits to construct their scales.

The Pythagorean system uses a prime limit of 3 (all the notes and intervals in Pythagorean are multiples of 2 and 3)
Alain Daniélou in his analysis of North Indian Ragas uses a limit of 5.
Lou Harrison uses 7.
Harry Partch uses 11.
Elsie Hamilton uses 13.
La Monte Young uses up to 31 and beyond.

Identity

The identity of a note is the highest prime number used in the ratio.
For example, 4/3 has an identity of 3.
16/9 also has an identity of 3.
8/5 has an identity of 5.
25/16 has an identity of 5.
8/7 has an identity of 7
25/22 has an identity of 11

Cents

With ratios you multiply and divide to get from to another, with cents you add and subtract. They are in fact a logarithmic scale.

There are 100 cents to an equal tempered semitone and 12 semitones to an octave, therefore there are 1200 cents to an octave

so value in cents = 1200 log(ratio)/log 2.

for example 5/4 as a cent value is

value in cents = 1200 log(5/4)/log 2 = 386.317cents

To convert cents to ratios the best way is to look up in table and find the nearest ratio. Harry Partch includes such a table in his book “Genesis of a Music”.

There is also a website that can do the calculations for you.

http://members.tripod.com/~tuning_archive/on_site_tree/robertwalker/cents_to_from_ratios.html

Space

Using higher modal determinants (say for example MD 160) it is possible to extract a number of subsets of pitches that share the same identity. These pitches create a space defined by that identity

For example in the Medicine River scale quoted above, the following perfect fifths (3/2s) can be found:

D – A	(2 space)
A – E	(2 space)
F – C	(5 space)
B – F#	(7 space)
F# - C#	(7 space)
D# - A#	(11 space)

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