Finding your ut-re-mi-fa-sol-la on a monochord, and making simple drinking straw reedpipes

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In this class we will construct notes and intervals in several different ways, and learn a little bit about how people thought about music in the middle ages.

Micrologus

Micrologus is a textbook for boys learning singing and music, written by **Guido of Arezzo** in the early 11th century (Babb, 1978).

Guido is primarily discussing plainchant. As chants was part of religious practice, people were concerned that the same chants be sung everywhere, and that the chants not mutate over time. Notker the Stammerer, in Charlemagne's time, tells a story of Rome sending ten monks highly skilled in church singing (Thorpe, 1969, p. 103). To everyone's horror, these monks were found to all be teaching different songs (an envious plot against the Franks!). So Charlemagne sent two monks of his own to Rome to learn the proper chants.

So much easier to be able to send a book of music.

It's not clear how much of Micrologus was Guido's own invention and how much was simply a description of musical theory of the time. The construction of musical intervals using fractions dates back to at least Pythagoras. However this textbook has a clarity and a willingness to discard irrelevant theory that makes it highly accessible, and it had a huge influence on how people thought about music during the middle ages.

http://commons.wikimedia.org/wiki/File:Guido_d%27Arezzo_apprenant_monocorde_Theobald.jpg

Guido of Arezzo (left) with Bishop Theodolus to whom Micrologus is dedicated, holding a monochord which shows the gamut of notes.

Guido is credited with the invention of the musical staff notation, which is able to record the pitches of notes exactly, replacing the older system of neumes which merely indicated, inexactly, rises and falls in pitch. He is also credited with inventing a system of hexachords as an aid to singers and as a tool for thinking about music, and a related memory aid called the “Guidonian hand”. Description of these is not present in his surviving works, but many subsequent authors describe them in detail.

Dividing the monochord

Instruction	Starting note	Ratio	Obtained note
After marking Γ at the beginning,	Γ	1/1	Γ
divide the space beneath the string from there to the other end into nine parts, and at the end of the first ninth put A, with which all the ancients began.	Γ	8/9	A
When you have likewise measured a ninth part from A to the far end of the string, in the same way place the letter B.	A	8/9	B
After this, going back to the Γ, divide the string from there to the end by four, and at the end of the first quarter you will find C.	Γ	3/4	C
By a similar division into quarters, just as C was found from Γ, in the same way you will find successively			
D from A	A	3/4	D
E from B	B	3/4	E
F from C	C	3/4	F
G from D	D	3/4	G
a from E	E	3/4	a
b-flat from F	F	3/4	♭
The following notes are all easily obtained one after the other as halfway points from notes similar in sound and same in letter:			
so, halfway from B to the far end of the string you put another ♮.	B	1/2	♮
Likewise C will point out another c, [etc]	C	1/2	c

He also offers some shortcuts, which I omit since his first method, above, is clearer.

The method of tuning that results from this is a **Pythagorean tuning**. We have the white keys on a piano keyboard over two and a bit octaves, plus one black key, b-flat.

Having constructed the notes on the monochord, Guido goes on to introduce the intervals, explaining that the intervals of the octave, perfect fourth, perfect fifth, and major second (using modern terms) arise from divisions of the monochord. However the semitone, and major and minor thirds, "although they connect notes in singing get no dividing point".

Interesting! The scale was constructed using only factors of 2 and 3, but we usually understand the major third to be a factor of 4/5 in wavelength, and a minor third a factor of 5/6, and the semitone to be 15/16. But with the way the monochord has been constructed, the actual ratios are ugly fractions that only approximate these, and so musical theory at this time does not have much to say about these intervals.

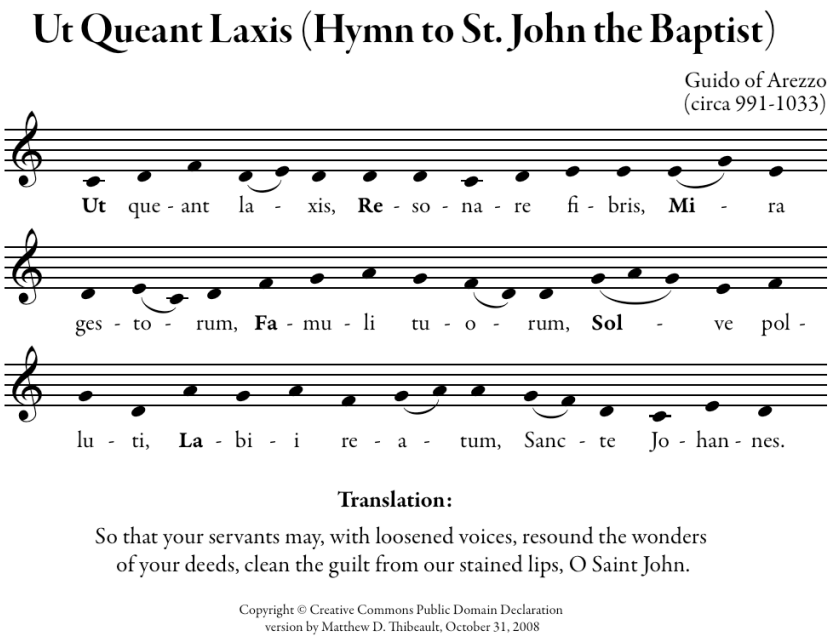
With this Guido launches into explanation of the affinities of notes, and of modes, and of what makes a good chant, and a way to construct a melody by assigning a set of notes to each of the vowels, and some very basic two-part singing.

Singing with hexachords

Having located the notes on the monochord, we can now accurately reconstruct any melody. However a singer who needs to discreetly pluck a monochord is sure to be noticed, so for singers to be able to sing without any aids, we use a system of overalapping **hexachords** (six tone scales), each with the same pattern of intervals: tone-tone-semitone-tone-tone. If a singer can master this pattern, they can use overlaps between hexachords to navigate the full gamut.

Γ A B C D E F G a ♭ ♮ c d e f g a ♭ ♮ c d
a ♭ ♮ c d
ut - re - mi fa - sol - la
ut - re - mi fa - sol - la
ut - re - mi fa - sol - la
ut - re - mi fa - sol - la
ut - re - mi fa - sol - la
ut - re - mi fa - sol - la

The syllables derive from a hymn:



Source: http://en.wikipedia.org/wiki/Ut_queant_laxis

This is an interesting way of thinking about music. A hexachord represents a local context for a segment of melody. The melody can modulate into a different hexachord via notes shared between the hexachords. With a careful path through these hexachords we can even “change key”, navigating here through a hexachord with b-flat and later through a hexachord with b-natural, say.

Drinking straw reedpipes

Having divided up the monochord, let us now divide up something different: air in a tube.

Use the template to locate holes in the straw and cut them with scissors.

Next we need to make a "reed" for the drinking straw.

- Draw the end over sandpaper on both sides. The reed will now sound if you blow into it.
- Dip the drinking straw in hot water and squash the end. It should now require less breath pressure and lip pressure to play. Do some further sanding if you wish to.
- For a further refinement, wrap some brown packing tape up to about 3/4 of a the reed-width below the tip of the reed.

This design plays a major scale. But there's something odd about the placement of the holes, compared to the monochord. The first hole should 1/9 of the total length up from the bottom, but it seems to be a lot higher up than that. There are two things going on here. The first is that the open hole doesn't fully truncate the tube. When the hole is open, the tube has an effective end point somewhat below the position of the hole. The hole size is also important, the smaller hole the less it is able to shorten the tube. The second is that the reed seems to have some virtual length of its own, adding about 15% to the true length. The wind instruments are not as simple as strings!

One way that the reedpipe is simpler than the monochord, however, is that the [effective] length of the reedpipe is one quarter of the wavelength of the sound waves it produces. On the monochord the waves travel at a different speed than they do in the air (adjustable by adjusting the tension of the string). On a reedpipe you can look at the size of it and say the waves that come out of it are about four times that length per cycle.

References

Babb, W. (1978) *Hucbald, Guiodo, and John on music.* Yale University Press.

Thorpe, L. (1969) *Einhard and Notker the Stammerer: Two lives of Charlemagne.* Penguin Books.