Worcester Cathedral's harmonic minor ten – a musical analysis

by Chris Kippin

Worcester Cathedral possesses a very fine ring of twelve bells, tenor 48 cwt in B. As is quite usual, the ring also includes a flat sixth, which allows a lighter ring of eight with the 20 cwt ninth as the tenor. Most unusually, however, there are also two further ringing bells, a sharp fifth (8 cwt in B sharp) and a sharp ninth (16 cwt in E sharp). These bells were cast as part of the 1928 restoration of the Cathedral bells and were included to enable a greater range of tunes to be played on the carillon (no longer in use). Why they were hung for ringing, rather than just for chiming, is not clear.

These additional semitone bells allow two further rings to be used. First of all there's a ring of eight with the 35 cwt C sharp eleventh as the tenor, which uses both the sharp fifth and sharp ninth. And then there's the harmonic minor ten: this has the same tenor and uses the sharp ninth, but has the flat sixth instead of the normal sixth. The sharp fifth is not used in this ring. The harmonic minor ten produces a sound described by tower captain Mark Regan as 'haunting and powerful', and in this article I hope to identify the features which produce this effect. If you haven't experienced this ring you can hear a short excerpt of Stedman Caters on the Worcester Bells website.

Those of you still with me are probably already wondering exactly what the harmonic minor ten is, so I'll try to explain. Worcester Cathedral bells are tuned in the scale of B major. Those of you who play a keyboard instrument will know that this a very difficult key as it has five sharps, and uses all the black notes on the keyboard. In order to simplify things we'll transpose Worcester Cathedral bells up a semitone. I'm sure Mark won't mind, as this will make them more like Bow. The ring of twelve thus transposed will use all the white notes, from G through C down to the next lower C. The sharp fifth will be C sharp, the flat sixth B flat and the sharp ninth F sharp. These extra notes allow the keys of F major, G major and D major to be used, though it's not possible to produce an octave in G major without a sharp second (also F sharp) which we don't have.

Using the eleventh as the tenor it's possible to produce three types of minor-sounding ten from these bells. The first uses all the white notes, from F through D to lower D. This is known as the Dorian mode, and can be produced on any ring of twelve. The second substitutes the flat sixth for the ordinary sixth, ie B flat for B natural. This is the descending scale of the melodic minor mode and can be produced on any ring of twelve with a flat sixth. The final one takes this a stage further and substitutes the sharp fourth for the ordinary fourth: this is the harmonic minor scale. If you have access to a keyboard it's worth trying all of these out and listening for the differences.

The Dorian ten sounds a bit unfinished, largely I think because the ear expects the fourth note to be flattened. I doubt whether this scale has been much used for change ringing, though the ring of nine at All Saints' Basingstoke was installed as such so that the Dorian mode of the front eight could be rung in Advent and Lent. Substituting the flat sixth for the ordinary sixth makes the scale sound much more natural, and this scale has been used for change ringing on occasions, notably at St Peter Mancroft Norwich, where peals have been rung on the minor eight.

Substituting the sharp fourth for the normal fourth produces the harmonic minor ten, whose descending scale is F E D C# Bb A G F E D. Although sharpening the second in the minor mode is common in western music, the scale itself sounds a bit peculiar. This is because there's a gap of a minor third between the fourth and the fifth. All the other scales we use comprise consecutive intervals of a semitone or a tone: this larger gap tends to make the descending scale sound a bit oriental. Indeed, scales with similar intervals are found in the music of other cultures. And a descending harmonic minor scale can clearly be heard towards the end of the first movement of Mozart's Symphony No 40 in G minor.

Now if we only ring rounds this would probably be the end of the matter. But in change ringing the bells may follow each other in any order, and what our ears probably focus on is the intervals between succeeding bells. It's possible that some listeners' ears may focus on longer strings of bells than two, but for the moment we'll just consider pairs of succeeding bells.

The tables below show the intervals, in semitones, between each of the bells in a normal, major ten and those in the harmonic minor ten. In order to make the comparison clearer I've transposed the latter to C as it's the intervals which matter, not the key note.

Major

		1	2	3	4	5	6	7	8	9	10
		E	D	C	B	A	G	F	E	D	C
1	E										
2	D	2									
3	C	4	2								
4	B	5	3	1							
5	A	7	5	3	2						
6	G	9	7	5	4	2					
7	F	11	9	7	6	4	2				
8	E	12	10	8	7	5	3	1			
9	D	14	12	10	9	7	5	3	2		
10	C	16	14	12	11	9	7	5	4	2	

Harmonic minor

		1	2	3	4	5	6	7	8	9	10
		Eb	D	C	B	Ab	G	F	Eb	D	C
1	Eb										
2	D	1									
3	C	3	2								
4	B	4	3	1							
5	Ab	7	6	4	3						
6	G	8	7	5	4	1					
7	F	10	9	7	6	3	2				
8	Eb	12	11	9	8	5	4	2			
9	D	13	12	10	9	6	5	3	1		
10	C	15	13	12	11	8	7	5	3	2	

Music in the major is usually thought of as being happy whereas that in the minor is often assumed to depict sadness. The feature which most defines these differing qualities is the interval of the third above the tonic note of the scale, ie the major third C to E in the major, and the minor third C to E flat in the minor. A major third is four semitones and a minor third three, and these intervals can be seen in the tables above. Intervals of a twelfth (major 16 semitones, minor 15 semitones) have the same properties as a third, but stretched by an octave – try this out if you have a keyboard. The major scale also has similar major third intervals above the two next most important notes – the dominant (G) and the sub-dominant (F). The harmonic minor scale has a minor third above F but a major one above G, and this, to my ear at least, is one factor contributing to the scale's particular sound..

This contrast between major and minor third can be taken further. In the tables the 3s denote minor thirds: the major scale has four of them, all on the less important notes of the scale. The harmonic minor scale has six, three on the most important notes, as already noted, and three others. But it also has as many major thirds – the 4s in the tables, coloured green – as the major scale. On the face of it this seems odd, but it's probably another key to what we're looking for. In the major scale these 4s are all on the important notes, as we've already seen, but in the harmonic minor scale a majority are on the less important notes, notably the third, sixth and, particularly, the seventh of the scale. I think that this contrast between expected minor thirds and unexpected major thirds is one of the scale's main identifying features.

Let's now look at the 8s, coloured yellow. These are, in effect, upside-down major thirds* – think of E flat up to G and G up to E flat. Once again there are more of these in the harmonic minor scale, and involve the same degrees of the scale as the major thirds.

There are a couple more intervals which are more common in the harmonic minor than the major – the semitone and the tritone. Both can be thought of as a bit discordant – think of ringing up treble and second of a ring of eight together. In the major scale there are only two, between C and B and between F and E (the 1s in the tables) but in the harmonic minor ten there are four.

The tritone (three tones, six semitones, so the 6s in the table, coloured red) is sometimes known as the ‘devil in music’ because of its astringent sound. In the major scale there’s only one, between B and F. The harmonic minor ten has this one, but also two occurrences of D to A flat.

So far we’ve just considered the relationship of two bells following each other. Those with sharper ears might pick out sequences of three or more bells. The major and harmonic minor scales both contain common major or minor triads, eg CEG (major) or CEbG (minor), and their rotations, as well as dominant sevenths, eg DFGB. But the harmonic minor scale also contains two other triads which do not occur in the major scale, the diminished and augmented third. The diminished third comprises minor thirds stacked on top of each other, eg DFAb, FAbB, AbBD, whilst the augmented third consists of major thirds built up in the same way, eg EbGB, GBEb. The latter emphasise once again the concept of major thirds on less expected notes in the scale, particularly the seventh, which we saw earlier. And perhaps it’s also pertinent that the seventh note (B), a semitone below the tonic, occurs in both of these triads.

One could go on and look at sequences of four or more notes, but I think that the pairs of consecutive notes and sequence of three notes described go a long way towards explaining the harmonics minor ten’s ‘haunting and powerful sound’.

*In musical parlance these are actually known as minor sixths, since an interval is always measured from its lower note, though in this particular context they sound like major intervals. It’s not only ringing which has arcane terminology.