CREATING A WELL BALANCED RING
Part 3 - Oddstruckness

In our attempt to create a reasonably 'well-balanced' ring at Worcester, over a period of months we altered the swing times of several of the bells (Part 1) and then altered the clappering (Part 2). We then looked at removing 'oddstruckness'. There are a number of good articles on this subject (see reference section at end) so this article does not reproduce them – it focuses on what we have done at Worcester.

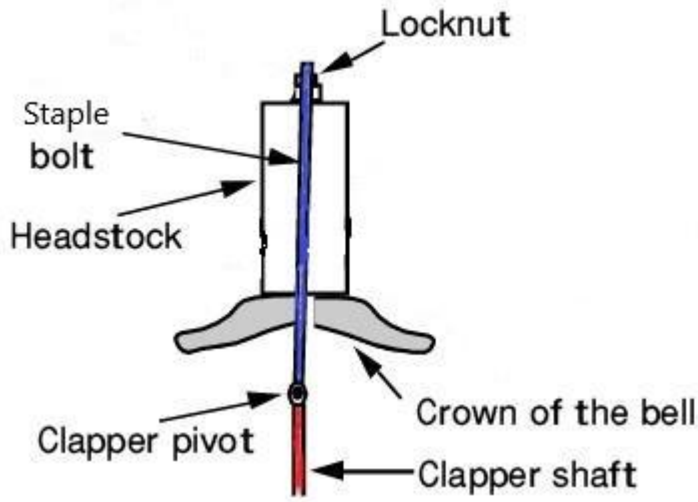
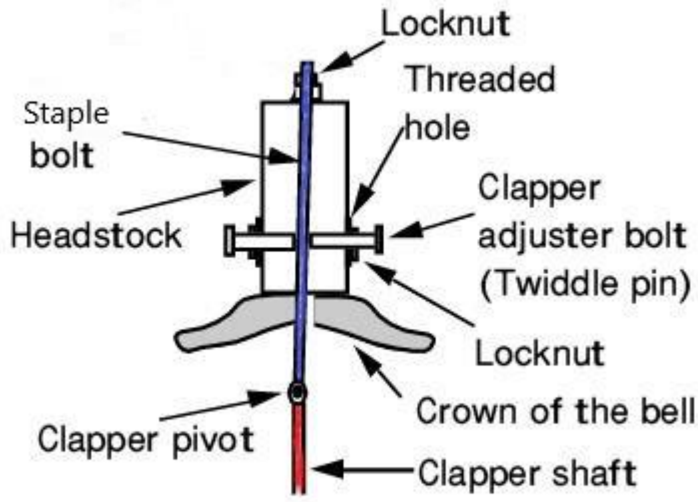
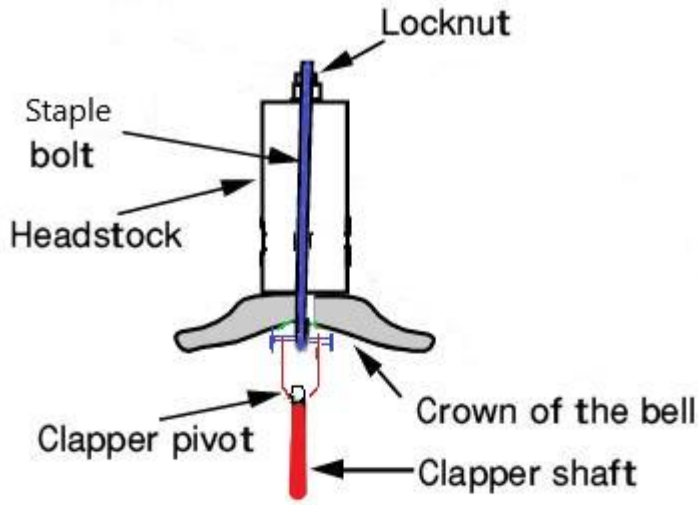
ODDSTRUCKNESS is where the clapper takes longer to contact one side of the bell than the other, so that to strike it correctly the ringer has to shorten one of the strokes and lengthen the other. This can be anywhere between a little uncomfortable and very awkward depending on the severity of the difference between the two pulls. A difference of 10 milliseconds (ms) or less is regarded as ideal, but most of us cannot spot the problem until there is a 20+ ms gap between the two strokes.

To put this in context, ringing at Worcester is usually done at 4-hr peal speed, or 21 changes per minute, meaning that a row takes 2.86 seconds and that the gap between each bell is 0.238 seconds or 238 ms. When ringing on an ABEL simulator 'perfect' ringing still has a measured error rate of at least 10% which the human ear cannot detect, which is 24ms in this case.

Whilst it is generally reckoned to be ideal if the clapper takes the same time to do both strokes this is not a universal opinion, with some ringers preferring slightly slow handstrokes so that they automatically have to work the sally more, and some preferring slightly slow backstrokes because the bell then doesn't have to go up so far, meaning that they have to work the sally less!

GETTING THERE is conceptually easy but often tricky in practice. Assuming the bell is hanging evenly on its headstock, and that the clapper and staple are symmetrical, the pivot of the clapper within the staple needs to be in the exact centre of the bell measured along its swing. As there is a certain amount of tolerance in the bell and headstock holes that the staple bolt passes through (simply to be able to install the clapper assembly at all), it is possible to move the pivot across the bell to cure oddstruckness.

Depending on the type of clapper assembly this movement can be achieved in different ways. At Worcester we have three types -

	**Traditional Clapper** Staple and staple bolt are a single unit. Use a tapered washer or shim between staple and bell to tilt staple towards ‘slow’ side. **BELLS 1-8, 12, 5#, 6b, 9#**
	**Twiddlepin Clapper** Same as traditional assembly but staple bolt can be pushed across by lockable twiddle-pins each side of headstock **BELL 2#**
	**Wheeler Clapper** Staple independent of staple bolt – can be moved across it inside bell. Same concept as twiddle-pins but moving staple not staple bolt. **BELLS 9,10,11**

Diagrams courtesy of John Harrison, edited by BHT

PROBLEMS Although repositioning the clapper should be simple some bells are particularly awkward to get 'spot on'. One reason can be that the interaction of the inside surface of the bell with the flat end of the staple is not good, even with the use of leather washers. Another is that the clapper and staple may not be perfectly symmetrical. Sometimes the bell and headstock are not actually 'true', if this is the case a bellhanger should be consulted.
Probably the most common issue is the tendency for the staple to drift back to its original position over time however well the nuts on the headstock are tightened. So it is worth reviewing at least annually.

MEASUREMENT – David Bagley has designed an Oddstruck Meter (OSM) to take all the guesswork out of measuring oddstruckness. It times the gap between reflective tape on the bell-wheel passing the sensor (when the bell is bottom dead centre of its swing) to the clapper striking (as heard on its microphone).

All the detail of how to use it is on David's website but a **word of warning** – it is vital that the reflective tape stuck onto the wheel is precisely opposite the sensor when the bell is down and at rest with no rope weight on it. Forgetting to remove the rope weight when attaching the tape is an easy error to make, which will result in the reflective strip being too high on the wheel – so the OSM will under-measure the backstroke. The diligent steeplekeeper then 'corrects' to get the two strokes reading the same and ends up with a bell which is slow at back. This may be marginal with short ropes but at Worcester we have 20 metres of rope weight.

There are two other methods to assess oddstruckness. The first is to measure the distance from the lip of the bell to the strike point of the clapper from both sides when the bell is down (and the weight of the rope removed). They should be identical. Calipers tend to lead to a more accurate measure than using a tape, and care should be taken not to move either bell or clapper when taking the measurements. In this case forgetting to remove the weight of the rope during measurement will lead to a bell which is quick at back when the clapper looks central.

The second method is to remove the rope, ring the bell part way up using the wheel until it is striking both sides and then let it lower. As it goes to striking one side only it should miss first one side and then the other equally. If there is a discrepancy, the side missing most is the slow one and the clapper needs to be adjusted towards it.

At Worcester we have relied on the Bagley OSM, especially for the back bells where ringing them up by wheel is not realistic.

TARGET – ideally the **difference between the Handstroke and Mean times should be no more than 5ms** so that the difference between Hand and Back is always in single figures. In practice having 10ms as the upper limit (so the gap between the strokes is 20ms or less) is practical.

RINGERS' OPINIONS - It is worth collecting a selection of ringers' opinions to see whether they corroborate the data. There is the issue that in some cases a bell feels oddstruck when the data says it is not, but it is always worth double- and triple-checking the data. Two examples may help.

In the case of our **7th** it felt more slow at backstroke than the data suggested – rechecking the data showed that the clapper had moved slightly and needed to be adjusted again. This bell is quite awkward to get right because the staple does not fit flush against the inside of the bell, even with a leather washer, and is a good example of why checking for oddstruckness does need to be done more often than once! We have the same problem with the **5th** which has the additional feature that the clapper assembly is not perfectly symmetrical – it is important for this bell that both the staple and the clapper within the staple are the 'right way' round!

However, many people felt the **3rd** was quick at backstroke when the data suggested it was not – in fact the bell is still currently slightly quick both strokes for its position in the ring because we have not yet altered the staple. So if the data is fine why do several ringers think it is oddstruck? It's probably perception - people notice the need to wait at backstroke because it is harder work than waiting at handstroke. We have 20 metres of rope between ringer and bell at Worcester and the 3rd is the only bell which has to operate 3 pulleys on the way up to backstroke – however well they are set up and maintained the rope will always provide noticeable drag, and more drag than any of the other bells. Of course there is the option to make the bell deliberately oddstruck (slow at backstroke) to compensate a bit. But some things you just have to accept.

Conclusion

Oddstruckness is not difficult to correct and even if it cannot be removed, it can usually be reduced. For bells with metal headstocks and independent clappers there really is no good reason why it should even exist. So why is there so much of it about?

There are probably two issues here. The first is the design and quality of the fittings – whilst those of us working with kit over half a century old might not expect it to be state of the art, it does seem as though 'state of the art' hasn't moved on very much. Ask for a new clapper and staple and it will be virtually the same as the one your grandfather would expect, and possibly not even as good. One small changes could make a lot of difference, making the staple adjustable against the staple bolt. Another might be to use ball bearings in the pivot if the stress factor is not too high. It is also not at all obvious to the layman that much modelling of clapper functionality takes place, the evidence being the number of breakages in heavy bells. So it would be nice to see some data from the experts as to how this should be set up. Have our alterations at Worcester been sensible or not?

The second is the ringing community – across the country we put up with oddstruck bells for years and do nothing about it, even though it affects the quality of our public performances. There is plenty of technical advice available (see the web references below) and it really isn't difficult to do the work. We've done a bit more at Worcester than many steeplekeepers might want to take on, but a great deal of it has been really quite simple, and where we've not been sure we have consulted people.

Leaving aside a few tasks outstanding from the Covid-19 lockdown the Cathedral's bells now do form a better-balanced ring with smooth gradations of swing times and strike times and with no oddstruckness. If that can be done with a heavy twelve in a heritage frame then it is likely to be possible with many other rings.

So now we will turn our attention to a very different animal - St. Martin's in the Cornmarket - a ring of ten whose total weight at 1.8 tonnes is about the same as the cathedral's 11th. We will examine all the same stuff and see whether the same approach can make any positive changes. Should be interesting!

Bernard Taylor,
Steeplekeeper

8 May 2020

References -

David Bagley's guide to his Oddstruck Meter (OSM)
http://www.ringing.demon.co.uk/osm/osm.htm
RW 2019 pp 840-1 (30 Aug issue)

From the Oxford DG
http://odg.org.uk/wordpress/wp-content/uploads/2020/01/tbc03_correcting_oddstruckness-3.pdf

A guide to correcting oddstruckness, from the G&BDA
https://www.bristolrural.co.uk/gandb/Oddstruck_bells_Malcolm%20Taylor.pdf

An article from the 'The Learning Curve' series in the RW Nov 2004 covers an aspect of Oddstruckness but is mainly about ringing with it -
https://cccbr.org.uk/wp-content/uploads/2016/02/200411.pdf

Appendix - Oddstruckness data

This table shows the STRIKE TIMES for Handstroke & Backstroke, and by averaging them the Mean Time for the CLAPPER STRIKE, in milliseconds (ms).

The amount of ODDSTRUCKNESS is expressed by the difference between the Handstroke and the Mean, so that a positive number indicates the bell being slow at hand, and a negative number therefore means slow at back. Oddstruckness starts becoming noticeable above 5ms, and above 10ms should definitely be corrected.

	Mar 2020		Mean	Hand	
	Strike	Strike	Strike	minus	
	Hand	Back	Time	Mean	
1	303	302	303	1	
2	312	315	314	-2	
3	312	316	314	-2	
4	333	336	335	-2	
5	364	352	358	-6	*
6			382?		*
7			402?		*
8	431	435	433	2	
9	463	460	462	-1	
10	499	503	501	-2	
11	535	535	535	0	
12	547	562	555	-8	*
2#	322	321	321	-1	
5#			360?		*
6b			382?		*
9#	465	474	470	-5	

The table is not complete because no timings were able to be done after installing the altered staples and clappers on the 5#, 6th, 6b and 7th on 24 Mar 2020. The numbers shown with a '?' are what we expect from those changes.

The asterisks indicate where work still has to be done once we are permitted to access the bells again.

When all the work is finished the plan is to have it independently measured and checked.