The Learning Curve

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Know your instrument – 3

The workman needs to know his tools and the musician needs to know his instrument. What do ringers need to know about the complex instruments they use, but most of the time don't even see?

The Learning Curve asked this question in November 2004 and January 2005 (Volume 3 Chapters 11 and 13). Those two articles covered the timing of rope and sound, the problem of odd-struckness, the bell's momentum and various effects of ropes. What more is there to know when ringing the bell (as opposed to maintaining it)? This month we look at some of the things that affect the 'go' of the bells. How do you recognise the problems, and how can you overcome them?

All of the things we will look at can broadly be called 'defects' – something that deviates from the ideal. They all impair the way the bell swings, but in ways that feel different when ringing. Some things make the bell behave badly in a predictable way, while others make it behave in an unpredictable way. The unpredictability, even when modest, can sometimes be more off-putting than some more severe but predictable effects.

A well behaved bell

When the bell is up, and you ring it normally, you take it for granted that if you you pull it off at one stroke, it will happily swing up to the next stroke, ... and the next, ... and so on. It is what bells do. You expect to put a little effort on the rope to make it do what you want, and maybe a little bit 'to overcome friction', and the bell will do the rest. But that simple. predictable, effortless behaviour relies on several things being right, in order to happen.

Think about the large lump of metal upstairs, and what it actually does when it rings full circle. It starts mouth upwards, sitting above the headstock, and a second or so later, it is below the headstock the other way up. It is a lot lower than it was, having fallen somewhat more than its own height. Most things fall when exposed to gravity if you let them, but they don't normally float up again of their own accord, which is what the bell does. It takes a lot of effort to lift a heavy weight, so what makes the bell go up again?

When it falls, the energy you used to get it up in the first place is converted into movement. Downwards movement alone wouldn't be much use for lifting the bell, but being held at the pivots forces it to rotate instead of falling freely. As it does so, the downward movement turns into horizontal movement, which then turns into upward movement. If everything works as intended, that upward movement has exactly the right amount of energy to lift the bell to the height that it was before.

To you it seems effortless, but if you watch a bell while it is being rung (from a safe distance, and not near any other bells that are up) you will see that it travels very fast as it turns. Making a heavy weight go fast round a corner requires huge forces on the bearings - much more than its weight. In round figures, the downward load at the bottom of the swing is four times the bell's weight. More significantly, in the middle of the down-swing, and again in the middle of the up-swing, it exerts a sideways load of twice its weight, first one way and then the other. (That's the sort of information that impresses non-ringers when you explain how bells work.) That's why bell towers and bell frames have to be very strong.

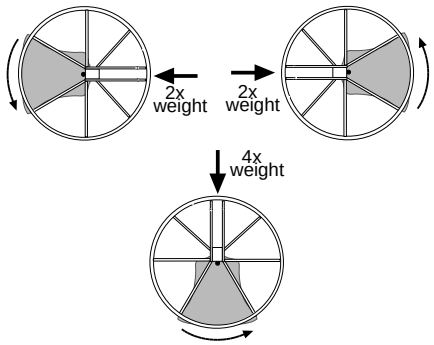

Figure 1: Forces exerted by a bell

Bells that drop

That's a bit of jargon you might not have met before. When we talk about a bell 'dropping', we don't mean it falls out of the frame onto the floor, we mean that when it swings, it doesn't go as high as it should do on the next stroke.

It can be very disconcerting to ring a bell that drops, especially if you aren't expecting it. You pull down normally at one stroke, and your hands rise normally for the next stroke, but the bell doesn't co-operate. Unless you are very quick thinking, you end up with a floppy rope, and as a result, you can't pull down very well, so the bell drops even more at the next stroke.

As soon as you realise what is happening, you must get the bell back up, which means a firmer down pull. How much firmer depends on how badly the bell has dropped – you might need to shorten your rope a little to get a good long pull. Once you know about it, it is a bit easier to cope, by pulling harder (and longer) to prevent the worst effects. It will be harder work, because you will be overpulling, and having to check a lot most of the time but at least you should be able to keep the bell in roughly the right place.

What makes the bell drop? Think back to the description above of the energy in the downward movement being converted into exactly the right amount of upward movement as the bell swings round. That only works if the pivot is held absolutely rigid. If it moves even a tiny amount, then some of the energy gets lost, and doesn't re-appear, so the up-swing is not quite strong enough to lift the bell all the way.

If the bell is hung on plain bearings that are worn, then there is a little play. If the frame is not securely fixed into the tower, or if it is not quite rigid (remember the huge forces involved) then it can move a little. Both can cause the bell to drop.

Bells with a mind of their own

Bells don't have minds of course, but it can sometimes seem like it. They ring normally for a while and then suddenly they drop, or perhaps they do the opposite and swing higher than you were expecting. Swinging higher might seem impossible. After all. losing energy is quite believable, but how can a bell gain energy out of thin air? It can't of course – the energy has to come from somewhere, and in this case it comes from other bells.

We saw above that if the frame can't resist the force of the swinging bell, and gives a little, then the bell will drop. The converse is also true – if something gives the frame a push in the opposite direction, then it makes the bell rise.

If the frame moves, then the bells can interact with each other as they swing, making one drop a bit and another rise a bit. The frame should be rigidly fixed in the tower, but what if the tower moves? All towers move a little, but some move a lot more than others. In absolute terms it is only a few millimetres, but that can be enough to cause problems when you are ringing.

To control an unpredictable bell, you need to overpull slightly, as described above, so the bell has some energy in reserve for when it drops. Keep a tight rope to ensure you feel any problems as soon as possible, and can react to compensate for them, especially to absorb the extra energy when the bell rises abnormally. It is harder work, but at least you shouldn't get caught out too often.

Quite often in towers with mild tower movement, only one or two bells suffer, depending on how they swing relative to the other bells (especially the Tenors). Also, you are more likely to get caught out on middle weight bells that normally ring only just over the balance,

Bells that stick

Another problem you might occasionally meet is a bell where something sticks. Usually it is not the bell itself, but something like the slider, a pulley or the rope. Sticking things often don't stick every time, so this is another aspect of bell behaviour that can catch you unawares.

A slider might not stick every time, because it only moves when pushed by the stay, and that only happens if you go well beyond the balance. Otherwise, the slider just gets a little nudge, and only moves a short distance in the middle of its travel. When you hold up, it moves a lot further, which is when you are least prepared for it sticking!

Sticking ropes or pulleys can be even more variable. Pulling harder might cause the rope to press against something and perhaps stick in a groove. Pulling less might let the rope flap around and catch on something. When ringing, the effect is as if someone is snatching the rope somewhere above you.

If you feel something sticking, you have to respond to that stroke, as you would if the bell suddenly dropped. But you should also try to avoid it happening if you can. Ring smoothly with a long, straight stroke. That should reduce the incidence of any problems due to rope flapping. If the problem continues, try to work out what actions cause it. You might be able to anticipate when it will happen, and be prepared for it.

Tail End

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