



RAYMOND PARKS

## RESEARCH IN FOCUS

### *Inharmonicity, Harpsichords and the Falkener* by Raymond Parks and Darryl Martin

For many years the teaching of the Acoustics elements of the BMus Degree has been covered by Physics Department staff, and Murray Campbell and Clive Greated together have a long history of successfully teaching students who didn't need to have Maths or Physics as entry qualifications. Half of them can't count, so how can you tell them about harmonics?! This carries forward a tradition from the days of Professor John Donaldson, whose students had even less foundation in such areas. Well, it certainly can be done, and the textbook "The Musician's Guide to Acoustics", has shone a fresh light on the world for many a graduate. Tuning and temperament for keyboard instruments is a difficult area, and one where artistic judgement is often in the end more relevant than theoretical calculations.

The basic theory is that when you pluck a string the sound has a satisfying musical quality because it is behaving in a very orderly way. There is a family of frequencies which are exact multiples of the lowest one - 1, 2, 3, 4, etc. Then just when the poor students are getting their minds round that, we have to say "But actually it's not like that, they depart steadily from exactness, it's 2 and a wee bit, 3 and a wee bit more, 4 and even more, etc". We call this "INHARMONICITY". This happens because of the bending stiffness of the wire; the thicker the wire and the tougher the material the stronger the effect. However, it's not a bad thing, it's what gives a distinctive flavour to the note - except that, as the Marmite jar used to say "Too much spoils the flavour".

This all has a bearing on the recent decisions about a complete re-stringing of the Falkener harpsichord (1773). The Falkener was restrung by J J K Rhodes and W R Thomas in the 1950's, a time when the view was widely held that harpsichords should make a more robust sound. So they used thicker wire of a tougher material, giving a significant increase in the inharmonicity. Unfortunately, this also involves increased string tension, with a risk of distortion of the frame and soundboard. For a while now the view here has been that the change in stringing was detrimental to the tone, and that the instrument should be returned to something as close as we can judge to the original stringing.

As to that original, we have a starting point - a rare

example of historical practice in a table published by Falkener. However, nothing is ever that simple, and our instrument has some gauge markings in ink which differ from the table. Although we cannot say for certain whether these markings date from when the instrument was built, clearly these were the gauges used at a quite early stage in his history. Figure 1 shows a comparison of the Inharmonicity Coefficient (Fletcher's "B") for the heavier stringing of Rhodes and Thomas (upper curve) and the lighter gauges in Falkener's table (lower curve). Only numbers on a graph, but we can say they correspond to a marked contrast in timbre.

"...as the Marmite jar used to say - 'Too much spoils the flavour'..."

There's a further twist to this tale: many harpsichords have two sets of strings sounding the same pitch but with subtly different character, making an interesting flavour when played together. For example, differences in plucking position affect the timbre, giving increased or decreased proportions of higher frequencies in the tone. Because of the layout of the keys, jacks and strings, the two strings for each unison have slightly different lengths, and so they have different inharmonicity - the families of frequencies don't quite match, and it's a bit of a compromise to tune the unison.

Over the years, various ideas have been tried for improving this, and on re-stringing this instrument Rhodes and Thomas used a slightly thicker gauge of wire for the shorter string, with the aim of getting a closer match. For years John Raymond has been saying that this instrument has in fact a poorer match of unisons than most comparable instruments.

To be fair to Rhodes and Thomas, they didn't have much help from the literature of their time, and they had no computing power. The definitive paper on Inharmonicity was not published until 1964, more than a century after Donaldson's

time, and on that foundation we have now been able to build a lot of measurement and analysis techniques. With a spreadsheet, once you've convinced your computer that you know what you want, it's no trouble to get the tedious sums done for 50 notes.

So, with the aid of such computing power we find we arrive at a different view: for a closer match of inharmonicity the shorter string should have a thinner wire. As a quick check, we swapped the wires round on a selection of notes, leaving others unaltered for comparison. Yes, the two strings gave more closely similar sounds, and tuning the unison was much easier.

Fig. 2 shows how the unisons match over the

range, for three variants of stringing: the middle curve using the same gauge for both strings as in normal practice; the upper curve as Rhodes and Thomas with thicker wire for the shorter string; the lower curve with thinner wire for the shorter string. So much for calculations, but isn't it time to return to artistic judgement?

How the instrument should actually be strung is based on a variety of factors. The most important aspect is the place of the instrument within the Collection, but, as the Collection is used for teaching (within several departments of the University), there is a case to be made for stringing in a particular way to illustrate a specific point.

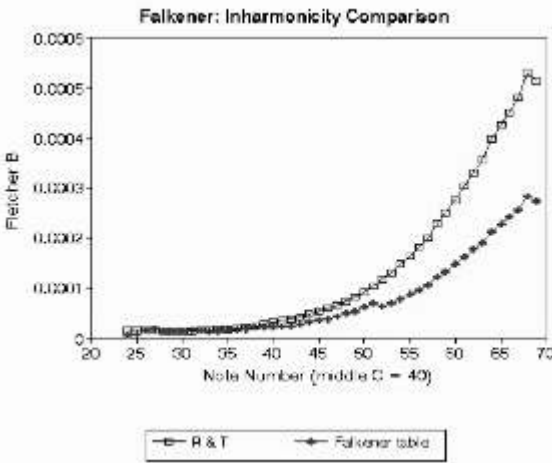


Figure 1

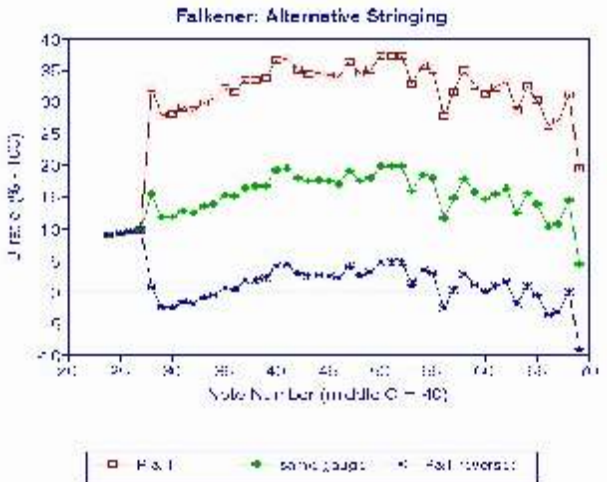


Figure 2

*'putting  
technology  
into  
practice'*

Four possibilities were identified: 1) to retain the ideas of Rhodes and Thomas, but using more appropriate stringing materials and thicknesses, 2) to reverse the practice of Rhodes and Thomas so that the two sets of strings are more closely matched at the changeover points between gauges, 3) to match the gauges found on the instrument, 4) the match the gauges as listed in Falkener's table. A further complication exists with the actual diameter of the wire to use in the restringing. Many old strings from 18th-century England have been measured and from these figures it is possible to take averages of the diameters represented by the written gauge numbers. As the best modern wire (made by Malcolm Rose in East Sussex) is made in different diameters it is essential to calculate the original tensions of the instrument and then replicate them with the nearest equivalent modern diameters. By doing this the actual changeover points between the gauges are not the same, although the overall tensions are very similar between the original and replacement strings.

## “..then we decided to go a little further”

As with any project involving original instruments, there was much discussion and it was decided to reject the first two possibilities as there was no historical precedent for following the practices of Rhodes and Thomas or of reversing the method. The other two possibilities caused more problems in theory, especially as the actual diameters would be compromised. Although the table is Falkener's work, there is no way of knowing when he actually developed the particular stringing list, or if he ever altered it later. The gauge numbers on the instrument (although they can't be positively shown to be from Falkener) are surely contemporary with the period of historical use, and it was decided to use the actual gauge numbers of the instrument as the most appropriate choice.

However, then we decided to go a little further. It is becoming increasingly well known that 18th-century English pitch was about a half-semitone below modern pitch. As many harpsichords must be used with other instruments on occasion and brass and woodwind are relatively inflexible with altering their playing pitch, most of the instruments in the Russell Collection are commonly tuned to pitch levels which allow their use with other instruments, for example the common “Baroque pitch level” of A415 - an exact equal-tempered semitone below modern pitch.



*Double-manual harpsichord by Burkat Shudi (London, 1766) which formerly belonged to Rhodes and Thomas and is now in the Raymond Russell Collection.*

As there are other instruments in the Collection which play at this level, it was decided to replicate the original as far as possible. To do this we ordered wire to be specially made to match the exact diameters found in original instruments, and once it arrived the instrument was tuned to the 18th-century pitch.

Although this might limit the instrument's use slightly, this is offset by the fact that it is now sounding as close to the original as can possibly be achieved.

The idea of stringing an instrument according to the principles used by Rhodes and Thomas has not been discarded completely. There are perhaps other instruments in the Collection (including the Shudi harpsichord which actually belonged to Rhodes and Thomas) which might be more appropriately restrung in this manner.

### *References*

Harvey Fletcher “Normal Vibration Frequencies of a Stiff Piano String”, *J.A.S.A.* vol 35 no 1, pp 203-209, Jan 1964 (+ errata, pp 1214-1215).

Lance Whitehead “Robert Falkener: an 18th century Harpsichord Builder, Music Publisher and Malfeasant?”, *G.S.J.* vol LV, pp 310-331, April 2002.

Supplementary information connected with inharmonicity is available at: [www.music.ed.ac.uk/euchmi/friends/documents/inharmonicity.pdf](http://www.music.ed.ac.uk/euchmi/friends/documents/inharmonicity.pdf)

*•Having retired 17 years ago from a career in measurement engineering which spanned an amazing range of disciplines including aerospace, steelworks, earthquakes and spuds, Raymond Parks drifted into Edinburgh University's Physics Department “just to amuse myself on musical instruments” and was drawn into Acoustics research and teaching. He is now an Honorary Curator in EUCHMI, helping with measurements, cataloguing and workshop drawings.*

*•Darryl Martin has been working with early keyboard instruments full time since moving to Britain from Australia in 1986. In 2003 he completed his PhD at Edinburgh University on the subject of English virginals. In addition to making instruments and carrying out research he is also active as a restorer and conservator. Darryl works as a cataloguer at EUCHMI, in addition to carrying out conservation, display and storage work for the Collection.*