Quarterly No. 100, July 2000

FoMRHI Quarterly

COMMUNICATIONS

FELLOWSHIP OF MAKERS AND RESEARCHERS OF HISTORICAL INSTRUMENTS
Honorary Secretary:
Retiring: Jeremy Montagu, 171 Iffley Road, Oxford OX4 1EL, U. K., From next Quarterly:
Lewis Jones, London Guildhall University, 41-71 Commercial Road, London E1 1LA, U.K.

FoMRHI Comm. 1716 Denzil Wraight

The Design of an Early Italian Harpsichord at the RCM.

An Italian harpsichord no. 175 of the Donaldson Collection, Royal College of Music, London has, like many Italian harpsichords, undergone a number of changes. Although my analysis of the original compass (F,G-f^3 instead of John Barnes' C/E-d^3,e^3) produces a satisfactory synthesis of the available evidence and explains the positioning marks **behind** the present bridge position, the scaling remains non-Pythagorean and is thus atypical of Italian instruments[1]. This note examines the scaling further.

Following experience with deriving the original scaling by working back from the bentside curve in another instrument (W39 'Berti'-Cristofori), the scaling of this RCM harpsichord was investigated. A hypothesis was tested that the original bridge would have been parallel to the bentside. The reader should know that I found traces on the soundboard (as reported in my thesis) between the present bridge position and bentside which suggested that the bridge had previously been nearer the bentside.

Lines for the original c strings were constructed on the museum drawing parallel with the spine and various distances marked off at 90° from the bentside curve to cut these string lines. In this way it could be established that if the centre bridge line were 107 mm from the bentside then a Pythagorean scaling for the notes c^1-c^3 resulted when measuring from the bridge centre line to the **plucking point** of the original back 8'(plucking left, towards the spine). It is significant that this hypothetical bridge position coincides with the positioning marks I found on the soundboard, as reported (see note 1). Thus, this hypothetical position is **nearer** the bentside than the present bridge.

bridge-plucking point F,G-f^3 compass		C,D-c^3	sounding string lengths (bridge-nut)
f^3	96 mm	c^3	151 mm
c^3	133	g^2	203
f^2	200	c^2	292
c^2	266	g^1	375
f^1	400	c^1	530
c^1	534	g	671
f	827	c	968
c	1140	G	1283
F	1268	C	1413

It could also be clearly established that a Pythagorean scaling would **not** result if the edge of the soundboard, the edge of the wrestplank (nearest the jacks), or the original nut position were

---

[1] *See D. Wraight, 'The stringing of Italian keyboard instruments c.1500-c.1650', Ph.D. dissertation, The Queen's University of Belfast, 1997, Part 2, pp. 337-340 [order no. 9735109, UMI Dissertation services, http://www.umi.com]. The dissertation as a file written in WordPerfect 5.1 (mostly readable with Word) can be obtained from me by email: denzil@t-online.de*

taken as the end of the string nearest the keyboard. This shows how much information is contained simply in the shape of the bentside curve and its position relative to other parts of the instrument.

The deviation from a theoretical Pythagorean scale for the bridge to plucking point is remarkably small, especially considering manufacturing error, case distortion, and the possible errors which could have accumulated in making a drawing. Nevertheless, there is a significant error in the magnitude of f^3. Considering how well the string lengths for c^1-c^3 double, it seems appropriate to place all the error at f^3, which is only 3.75 mm and to assume an intended scale (for an F,G-f^3 compass) of c^2 = 266 mm or f^2 = 200 mm; this would make f^3 = 100 mm. This implies that the intended top string length might have been 155 mm instead of the present 151 mm. All calculations below have been made using the actual sounding length of 151 mm.

If a simulated bridge is laid out on the drawing and aligned with the **correct** spacing (i.e. 107 mm) from the bentside, it has the effect of moving the mitred tail section of bridge towards the tail so that it also is also about 107 mm from the case. The F string length was measured assuming this bridge position 107 mm from the tail.

Since the strings double accurately at the lower octave, it is evident that the c string is too long by about 70 mm. I cannot presently explain this except as the result of a layout error: the maker might have used the **correct** length for c, but placed it at the wrong note, i.e. at c#. It may be that there is some aspect of the scale design which has not yet been understood since the clavicytherium in the Donaldson Collection (mentioned below) also has a c which is **longer** than required by the Pythagorean scaling. Possibly we have to see this part of the register as the point where the scale has to be lengthened in order to compensate for the actual foreshortening.

The Scaling Design

Although the instrument was evidently designed using a Pythagorean scaling between the plucking point and bridge, the position of the original nut (marked on the baseboard, as noted by Barnes in his unpublished museum report) yields a complete, sounding string length which produces a non-Pythagorean scaling, as shown above. For whatever reason, the maker did not produce a Pythagorean scaling of the **sounding lengths** of strings.

This design is remarkable among surviving Italian harpsichords, which usually only yield a Pythagorean scaling for the complete sounding string. However, the early history of the harpsichord yields some parallels. The south German clavicytherium in the same collection has an approximate Pythagorean scaling, when one measures from the **edge of the soundboard** to the bridge. Furthermore, as John Koster informed me, Arnaut de Zwolle's *clavisimbalum* also uses exactly the same procedure[2]. In consequence, both instruments have a non-Pythagorean scaling for the **sounding lengths** of strings.

This curious scaling procedure can lead us in one of two directions: either we accept the string lengths as they are, or we re-define the nature of the instrument, as Kukelka has reportedly done[3]. Kukelka suggested that this clavicytherium was "really" a clavichord, in wing form. In other words, the sounding string length was from the tangent to the bridge, with the portion from the tangent to the nut being damped. This suggestion does not quite agree with the instrument since the Pythagorean scaling is between the **edge of the soundboard** and the bridge, and clearly no tangent can strike the string at the soundboard edge. However, this hypothesis **could** apply to the RCM harpsichord.

Thus, following Kukelka, we could see the RCM harpsichord as a wing-shaped clavichord, at least in concept, if not in execution, where the Pythagorean scaling results only when the tangent strikes the string[4]. One difficulty in accepting that this was intended to be an **actual** clavichord lies in the fact that it was originally single strung, and that all known early clavichords (albeit in rectangular form) are double strung. The construction is evidently suited to a harpsichord and no indication that it might have had a clavichord action survives. However, this does not require us to discard the insight about the scaling.

The original compass

In my earlier analysis I suggested that the original compass was F,G-f^3 since this matched the probable number of original notes (48) and also placed the positioning marks at the c notes. Positioning pins in 16th-century Italian instruments were predominantly at the f notes when the compass reached to f^3, and at the c notes when the compass was reached to c^3. Instruments with orientation marks (including lines on the baseboard) at c and f notes are also known.

The positioning marks are at the g# notes of the **present** C,D-d^3 compass (not C,D,-c^3,d^3 as stated in error in my thesis). This rendered Barnes' hypothetical original compass of C/E-d^3,e^3

---

[2] *As drawn to my attention by John Koster's forthcoming article "Some Remarks on the Relationship Between Organ and Stringed-Keyboard Instrument Making", to appear in the Early Keyboard Journal. The analysis given here of no. 175 was inspired in a large part by a conversation John and I had in Vienna in October 1997, which also clarified another problem: Alfons Huber had told me on two occasions some years ago that, according to Peter Kukelka, the string lengths were Pythagorean from the bridge to the* ***plucking point****. My measurements from the drawing in 1988 showed that this is not exactly correct but the serendipitous discussion with John soon revealed for me the correct facts: they are more nearly Pythagorean when measured to the* ***edge of the soundboard****, as stated by John.*

[3] *In his lectures on musical instruments in Vienna. Personal communication from Alfons Huber.*

[4] *A general discussion of the nature and origin of these early instruments was given by John Koster, 'Toward a History of the Earliest Harpsichords' at the October 1997 congress in Vienna on the Austrian harpsichord, forthcoming in published form.*

unlikely, since it would require that the positioning marks occur at the b♭ notes, which is highly unlikely.

In my thesis I rejected the alternative hypothesis for a 48-note compass, the compass C,D-c^3, since the original keyplates would be incompatible with it. This expression was imprecise, another idea having not been explicitly expressed: the original keyplates of F-b^2 are compatible with **either** hypothesis, but if the original compass reached to C then it is not clear why it should have been necessary to make **new** covers for C, D and E. The compass starting on F explains why new C, D and E plates would have been necessary. The F,G-f^3 compass fits some of the available evidence better than a C,D-c^3 compass. Furthermore, C,D-c^3 is also rare as an original compass[5].

The Scaling and Pitch

If we see the RCM harpsichord as a conventionally-strung, plucked instrument then the pitch must be low: Given a compass of F,G-f^3, and calculating from the most highly stressed top string, c^2 has the **equivalent** length of 403 mm, which is exceptionally long for an instrument with such a short case, although it is found in such instruments as the 1574 Baffo harpsichord in its original form[6]. In fact the RCM harpsichord resembles a virginal from the point of view of the foreshortened scaling.

An attraction of the C,D-c^3 hypothetical compass is that the scale becomes virtually 'normal': referred to c^2 it is 302 mm when calculated from the longest string, c^3. Even for this pitch the bass strings are relatively short. A disadvantage of the C,D-c^3 hypothetical compass is that it requires us to suppose that the positioning marks I found, if they are original, occur at the g notes. W351, a harpsichord in Fenton house (origin unknown, but possibly from the Milan-Brescia area), has construction marks for the c and g notes, so the procedure is not unknown[7].

There are few clues in the construction of the instrument which might help sway the balance between these two hypothetical compasses (F,G-f^3 and C,D-c^3), but one is the tail bridge section: it has 6 original bridge pins, which would cover C-F# of the C,D-c^3 compass, or F-B (i.e. the whole bass octave) of the F,G-f^3 compass. This latter arrangement offers a more convincing scale design logic, where the compass c-c^3 is Pythagorean for the bridge to plucking point measurements, and only the bass octave strings are foreshortened.

---

[5]*Only two examples of possibly original compasses are known: the "1694 De Quoco" (Smithsonian Institution, Washington) and no. 77 (Musikinstrumenten-Museum, University of Leipzig).*

[6]*Victoria and Albert Museum, London. See my thesis (op. cit., note 1) Part 2, pp. 52-53.*

[7]*See my thesis (op. cit. note 1), Part 2, pp. 332-333.*

The F string (sounding length) of the C,D-c^3 compass would be 1333 mm and the following F/f^2 and Fnorm values can be calculated using the top string as the indication of the highest pitch[8]:

C,D-c^3 (f^2 = 226.5 mm) F/f^2 = 0.736 Fnorm = 1502 mm iron wire.

F,G-f^3 (f^2 = 302 mm) F/f^2 = 0.585 Fnorm = 1189 mm iron wire.

These calculations show that the C,D-c^3 design results in an instrument with bass strings longer in proportion to the treble strings (as would be expected). Were there no foreshortening then the F/f^2 ratio would be 1. The calculations also show that the F,G-f^3 scale design resembles a virginal, slightly above the Antegnati instruments on List 2[9]. Thus, if the scale design in the F,G-f^3 compass is understood as comparable to a virginal, it is not out of the ordinary. The harpsichord part of the 1639 Valentin Zeiß claviorganum has a scale design which is even more foreshortened than that given by the F,G-f^3 hypothetical compass[10].

An Older Tradition

There is another way of approaching this scale design, which can only be mentioned briefly here. The strings of Arnaut de Zwolle's *clavisimbalum* design are identical with the clavichord, if one measures from the edge of the *clavisimbalum* soundboard to the bridge[11]. In this sense there is another Neapolitan instrument which is identical with the RCM harpsichord, and it is the clavichord no. 3 which has a corrected c^2 of 199 mm[12]. Thus, if we propose that the string on the RCM harpsichord of the same length is c^2, then the instruments are "nominally" the same, although the sounding string length of the harpsichord is longer. The compass of the RCM harpsichord would then be C,D-c^3. What this means for the **actual** pitch of the RCM harpsichord (and the *clavisimbalum*) I will discuss on another occasion.

---

[8] *F/f^2 is a ratio of the scale of the instrument at F and f^2, not of the* ***actual*** *string lengths. For example the scale of F if the string length is 1334 mm is 1334 ÷ 8, in order to relate F to the pitch of f^2, which is eight times higher. Fnorm is an expression showing the length of F* ***normalised*** *with respect to a pitch given by f^2 = 255 mm. For example, the Fnorm when F = 1413 mm is: 302 mm ÷ 255 mm, × 1413 mm = 1193 mm. These terms are explained in detail in my thesis (op. cit., note 1), Part 1, pp. 166-167.*

[9] *See my thesis (op. cit. note 1), Part 1, p. 169.*

[10] *See Kukelka, P., 'Technische Grundlagen der alten Ordnung der Musikinstrumente. Dargestellt am Beispiel eines Kielflügels von Dominicus Pesaurensis, 1546.', Festschrift for 90th birthday of Joseph Mertin, ed. Nagy, M. (Vienna 1994), p. 231.*

[11] *As observed by John Koster, see note 2, who has also noted that Herbert Heyde was apparently the first to publish this observation in Musikinstrumentenbau (Wiesbaden, 1986), p. 160.*

[12] *Musikinstrumenten-Museum, University of Leipzig. See my thesis (op. cit. note 1) Part 2, p. 134. A discussion of the origin of the instrument is given in Koster, Keyboard Musical Instruments in the Museum of Fine Arts, Boston (Boston, MA, 1994), p. 10.*

Conclusions on the Scaling and Compass

The only secure conclusion from this recent analysis is that the scale design is Pythagorean for the string length between the plucking point and bridge. The original compass is still unknown, both F,G-f^3 and C,D-c^3 are possible.

Modifications to the instrument

As Grant O'Brien has already suggested, the moulding of the later nut shows that the instrument could have been modified by Cristofori or Ferrini[13]. Comparison of the arcade (by photographic means) shows that it is closest to arcades found on a harpsichord I now attribute to Ferrini[14]. Thus, it appears that Ferrini may have executed the modifications described by Barnes as State 2.

Version history
This PDF was created on 13.05.2024 in order to correct the communication number to 1716 (from 1717). The tabulation under the compass C,D-c^3 (p. 20) was improved to a single column. No changes have been made in the text.

---

[13]Private communication, 1983. More recently he has argued that the slides were made using the Florentine foot. See Grant O'Brien, 'The use of simple geometry and the local unit of measurement in the design of Italian stringed keyboard instruments: an aid to attribution and to organological analysis', The Galpin Society Journal LII (1999), pp. 146-148.

[14]No. 89 in the Musikinstrumenten-Museum, University of Leipzig. At the time of writing my thesis I was not able to prise a distinction between Ferrini's and Cristofori's contributions, until in 1997 with David Sutherland's assistance, we were able to confirm his hypothesis that the Stearns no. 1332, Ann Arbor, Michigan, was made by Ferrini, and thereby establish other Ferrini attributions.