

Re-creating the Clavisimbalum of the Minden Cathedral Altarpiece

The earliest iconography of stringed keyboard instruments can be found in a 40 cm long section of a circle of angel musicians around an image of St Mary in an altar piece from Minden (Lower Saxony, Germany), now in the Bode Museum in Berlin, carved for the cathedral of Minden in 1425 (Figure 1). Within this lime wood and polychrome panel we find angels playing a small boars' head psaltery (trapezoidal with two incurving sides), a clavisimbalum (early harpsichord), and a clavichord. The fourth angel is playing a rumbling pot (rommelpot) and is possibly holding a second small bowl that would carry water for wetting the fingers that stroke the stick (Figure 2). For the purposes of this article we will focus on the two keyboard instruments, and particularly the clavisimbalum. These are both the earliest and among the finest representations of keyboard instruments from the 15th century outside of the remarkable manuscript of Henri Arnaut de Zwolle¹, as they portray features in sufficient detail to allow us some understanding of the finished form and keyboard compass from early in its appearance. Bernard Brauchli² establishes the appearance of the clavichord in the last half of the 14th century. Additionally, Edward Kottick proposes one Hermann Pol as the possible inventor of the clavisimbalum in the late 14th century, from a document dating to 1395, though Pol as the primary inventor remains in some dispute³. No string keyboard instruments are extant from this time, and adoption of the keyboard married to stringed instruments from the time would have been limited by a lack of precedent, communication, and availability of craftsmen to construct them, so the appearance in 1425 of an image of two keyboard instruments together in the same grouping is fortuitous.



Figure 1, Golden Table Altarpiece from Minden Cathedral



Figure 2, complement of Minden altar players, Bode Museum, Berlin (courtesy A. den Teuling)

To the modern eye, the first notable feature of the two keyboard instruments is their size; both appear small to us and can hardly have spanned more than two octaves. This small size is well represented in other iconography and intarsia of the 15th century, and in fact all the keyboard instruments of the 15th C identified in The New Grove Musical Series “Early Keyboard Instruments”⁴ and including the extant clavicytherium at the Royal College of Music are small instruments of four octaves or less, with most of the very earliest appearing to span about two octaves. While it is possible to dismiss the size seen in the Minden Alter piece as artistic interpretation, the uniformly small relative proportions and wide geographic distribution in which these images are found, including what is now Germany, Sweden, France, and England, have led Kottick to conclude that the earliest stringed keyboard instruments were invariably small and therefore tuned to a relatively high pitch.

That said, the flugel (wing) shaped clavisimbalum in the Minden altar is very small indeed. From the position we see it being held, it appears to be played while in the angels’ lap, or at least on a low table. The rendering by the artist is particularly well done for the time, in lime wood and plaster with a polychrome and gold leaf finish. The drape of each of the angels’ robes, hair, the proportions of the figures, the shaping of the eyes and mouths, and the placement and setting, are quite realistic in appearance, and show an attention to detail and lack of stylization that prefigures the more observational and less stylized art to come later into the renaissance. The boars’ head psaltery is proportional to later extant antique instruments and modern replicas. Even the possible presence of the water bowl in the rommelpot players’ hand would seem to show that the artist was taking the image from life and not from some more abstracted vantage point.

We immediately see that the clavisimbalum is flipped along its longitudinal axis, with the treble to the left and the bass to the right (Figure 3). This has been shrugged off as simple artistic license, but at least two other images from the first half century of keyboard tradition also show a reversed keyboard⁵. It seems too easy to simply brush this apparent image reversal aside as due to the needs of the composition.



Figure 3, detail of clavisimbalum
(courtesy A. den Teuling)

Indeed, while the whole instrument would not fit exactly without adjusting the angels' position, we can see in Figure 4 that with some creative Photoshop reversal, the composition is not particularly hurt with a convention treble arrangement. The artist was obviously facile enough to have rearranged his figures as needed for a different shape clavisimbalum. Arnold den Teuling, who has written extensively on this subject and provided photographs used in this paper, disagrees with this argument and suggests the mirroring remains a puzzle. With the great majority of keyboard iconography having a traditional treble arrangement even dating back to Roman period water organs, as den Teuling points out, we cannot state with certainty that this instrument is not an artistic reversal. That point being well made, I suggest that the convention of having the treble at the right, and the bass to the left, was not yet so solidified that a reverse layout was unthinkable.



Figure 4, with the clavichord flipped to a conventional arrangement

We can make out other important details as well. The plaster is lost from the wrest plank and jack area, but we can conclude they were covered, and there are three roses in the sound board, two in the form of a trefoil and one a simple circle. The use of multiple roses, of from three to five, appear in most if not all early flugel soundboards, most notably in the technical drawing of Henri Arnaut de Zwolle and dating from about 1440 (Figure 5), and the images of Albert the Painter (Albertus Pictor) in Sweden⁶. A somewhat larger flugel clavichord by Albertus Pictor is given in Figure 6, this one about the size of the clavichord in the Arnaut drawing.

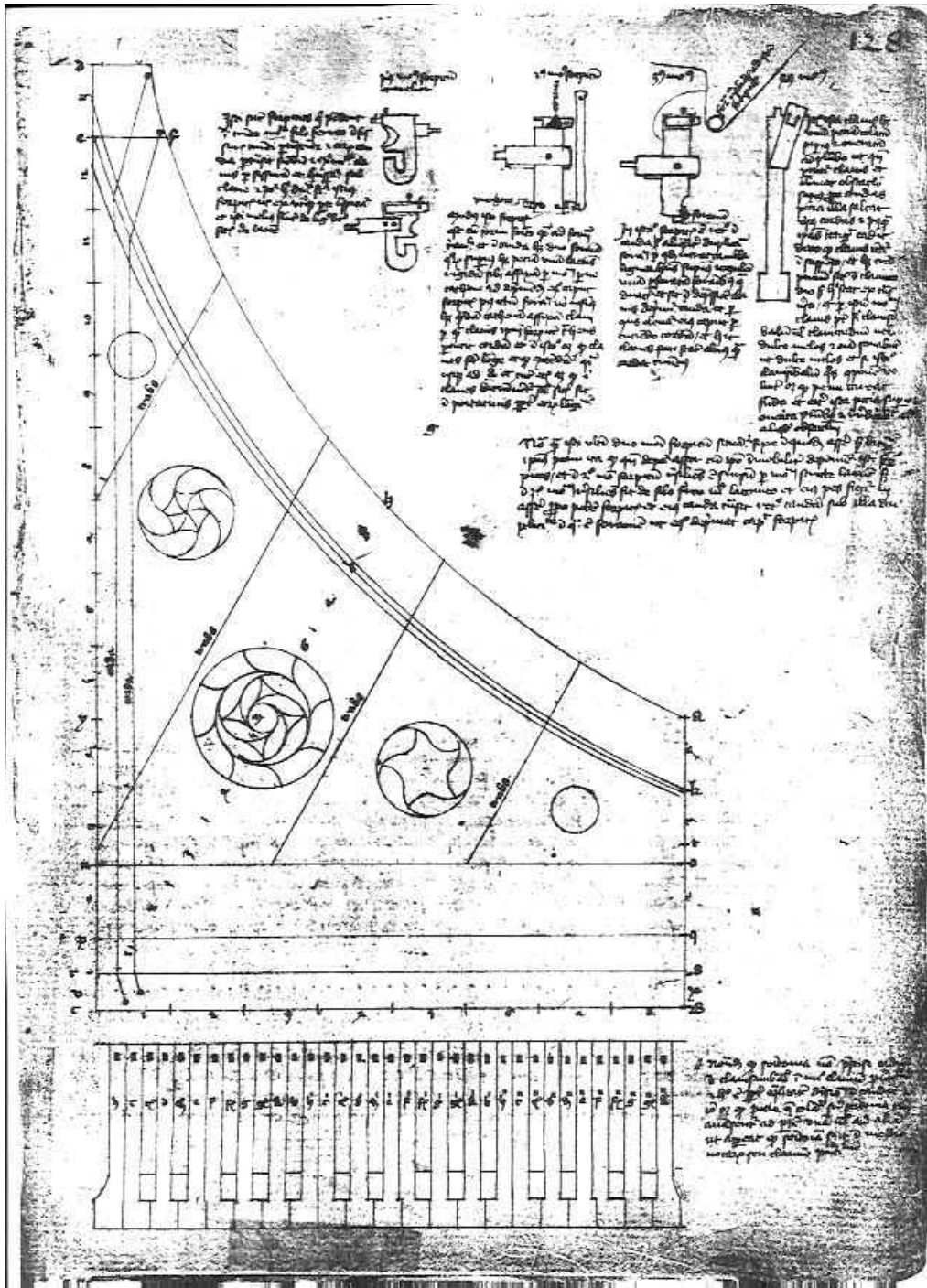


Figure 5, clavisimbalum of Henri Arnaut de Zwolle



Figure 6, clavisimbalum, Albertus Pictor, vault ceiling, church of Häverö, c.1480 (courtesy A. den Teuling)

The depiction of the spine of the Minden alter clavisimbalum case is thicker than for the bent side, though the proportions here may have been limited by the medium in which the carving is made, as it is generally understood that the psaltery should have thin sides, and yet all the instruments share side thicknesses that are proportionally greater than would have been considered conventional. That said, we are invited once again to speculate that the artist was conveying an observation, this time noting that the case thicknesses were not uniform around the perimeter. The clavichord image shows a more nearly uniform perimeter thickness.

The main bent side of the clavisimbalum has a circular radius, implying that Pythagorean scaling was not yet being employed. Again, the early flugel shaped instruments generally employ a circular bent side radius that was straightforward to mark out. We also see a second, smaller bent side at the treble wrest plank area, and it too may be a portion of a circle. What this additional feature accomplished is not immediately clear. Is it merely decorative, did it act to reinforce the wrest plank, as an attachment point for a strap? It is, however, clearly shown and as it represented additional work for the carver, we must assume it was a feature on whatever prototype the carver had seen.

No strings or bridge is shown, but enough other details present themselves to convince us that we are looking at a real prototype. The single rose hole in the bass is shifted from center, and the trefoil rose at the treble side is rotated just enough to accommodate a bridge. A bridge layout without moving these features results in the bridge being too close to the bent side and hitch pin rail. Was a bridge originally molded in the now missing gilt plaster that once covered the soundboard? It is also possible that this instrument did not use a bridge, allowing the case wall to transmit the vibration as with the psaltery.

Comparing the clavichord carved above the clavisimbalum to other clavichord iconography from the period gives us an instrument similar in shape and size to those images. It also appears to show a lid that is closed, with two lid holes in this lid showing, similar to the clavichord with an open lid by Adriaen van Wesel, 1475-77, Rijksmuseum, Amsterdam, implying that these were not meant to represent roses (Figure 7).

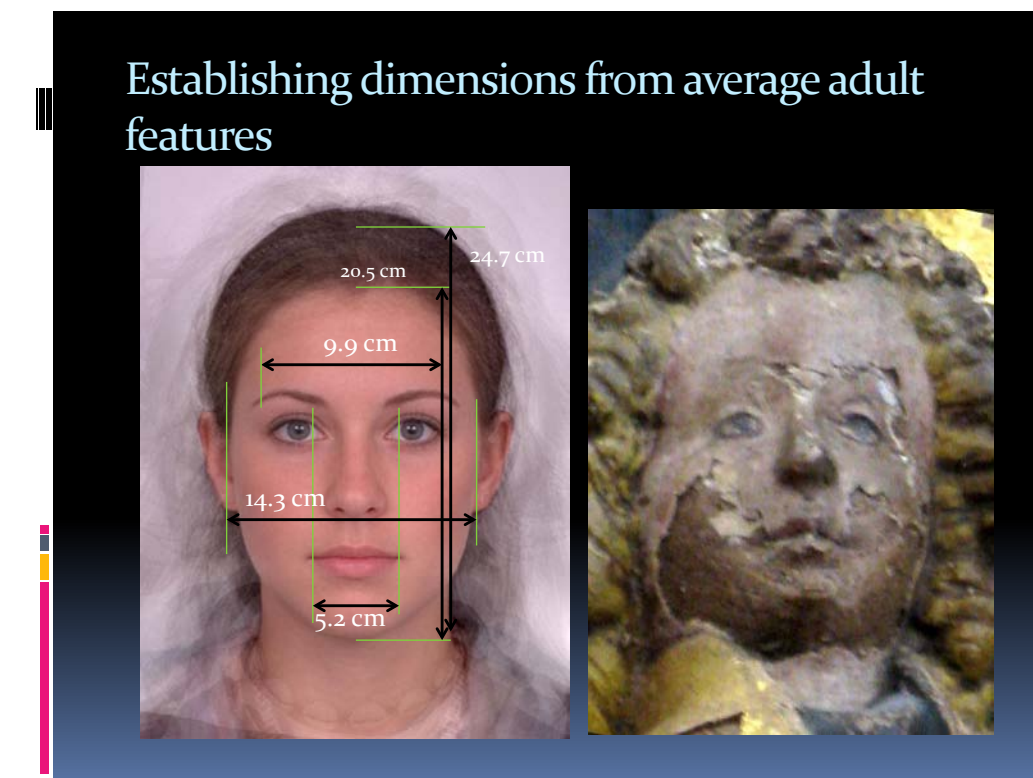


Figure 7, Adriaen van Wesel, Joseph with Angel Musicians, oak, Rijksmuseum, Amsterdam

Yet we clearly see what looks like the inside walls of the clavichord case outlined, which may simply mean a lid that does not cover the sides but is hinged from inside the case, or with a batten. Regardless of whether this is meant to show a clavichord with a closed lid or not, a general comparative size between the two instruments and other contemporary images of clavichords gives us a good reason to accept the clavisimbalum as being shown full size as well. The clavichord in the Minden alter would appear to have a compass of no more than two octaves, similar to the span for instance of the keyed monochord in the 'Liber notabilis Musicae'⁷.

The rose holes of the Minden clavisimbalum feature an additional detail of a ring about each one, probably meant to portray some form of decoration around the rose. The hands of the player present the four fingers of each hand, with the thumbs possibly below the level of the keys, so that it is possible the thumbs were not employed in playing. For an instrument of this size however, this would present no obstacle to the instrumentalist.

From the proportions of the heads and hands of the carved angels, some idea of actual size of the instrument can be deduced. Obviously, no exact dimensions can be derived, and even with the technical drawings of Arnaut, the unit of standard length is left to the builder when he writes "...the width we intend to give this instrument...", here referring to the scale of the key width or octave span, which is left to the discretion of a builder. Our ability to obtain measurements of the features found in the Minden altarpiece is additionally limited to the relative foreshortening perspective allowed to the photographer, as requests to physically measure the features have not been accepted to date. However, a good direct view was obtained by Arnold den Teuling as shown in Figure 2 and 3, and is used for this analysis.



**Figure 8,
Establishing
instrument
dimensions**

Assuming a few average sizes for human features (a width of 8 cm for an adult hand measured at the knuckles, or about 21 cm for the length of the adult face from chin to hairline at the forehead for instance), we come away with a proportional length of some 43 to 46 cm for the instrument, or 17 to 18 inches (there may be an issue of foreshortening in the photograph as taken). This then gives a width of about 38 cm (15 ") including the second radius section at the treble. Of this width, about 31-32 cm is useable for key levers to fit into the case. Since the keys protrude from the front of early instruments, the octave span can be larger than the key lever space allowed, with the outside keys ranging outside of this dimension. This establishes the basic dimensions of the instrument, and we could allow for it to be bigger or smaller by perhaps 10% of the dimensions given.

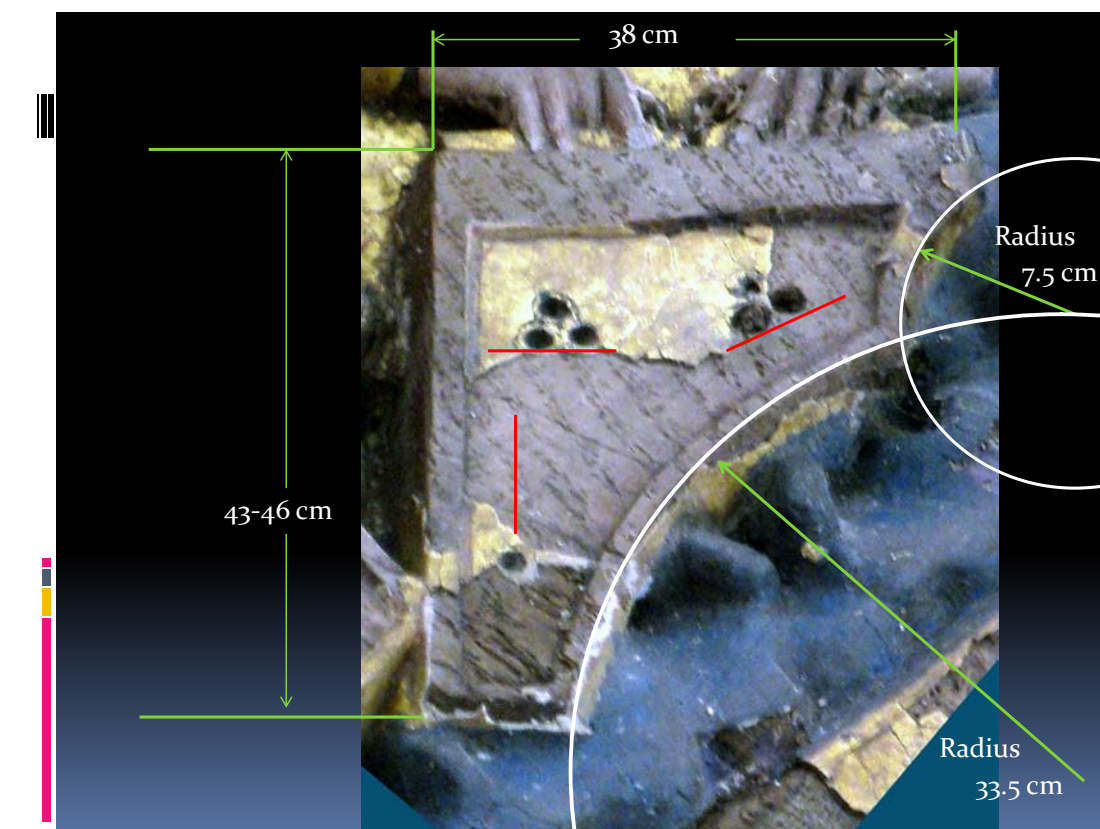


Figure 9, instrument dimension results

Next we should follow with some idea of the compass for the keyboard. The earliest extant instrument is also German in origin, the clavicytherium at the Royal College of Music, from about 1480⁸. This has been extensively researched, drawn, and copies made by the best builders. It has a keyboard compass of 528 mm for 21 naturals or three octaves, and the total number of notes compares favorably with the clavichord shown in the intarsia at Urbino⁹, and the altarpiece at Ghent. Stewart Pollens suggested a shorter compass of 502 mm for 21 naturals when discussing the Arnaut diagram, but based this measure

on an instrument of the early 16th C and so may have assumed a smaller dimension not yet in vogue¹⁰. If the wider compass is taken as a baseline, then the maximum range of this instrument is about 13 naturals, and 21 notes including sharps, just four fewer than two octaves. Using Pollen's analysis, the key width would then allow for two full octaves. While keyboard specific music is largely absent from this early period, the range of nearly two octaves corresponds with the average voice, and musical accompaniment can be improvised with this arrangement, though it would clearly not be designed for solo work.

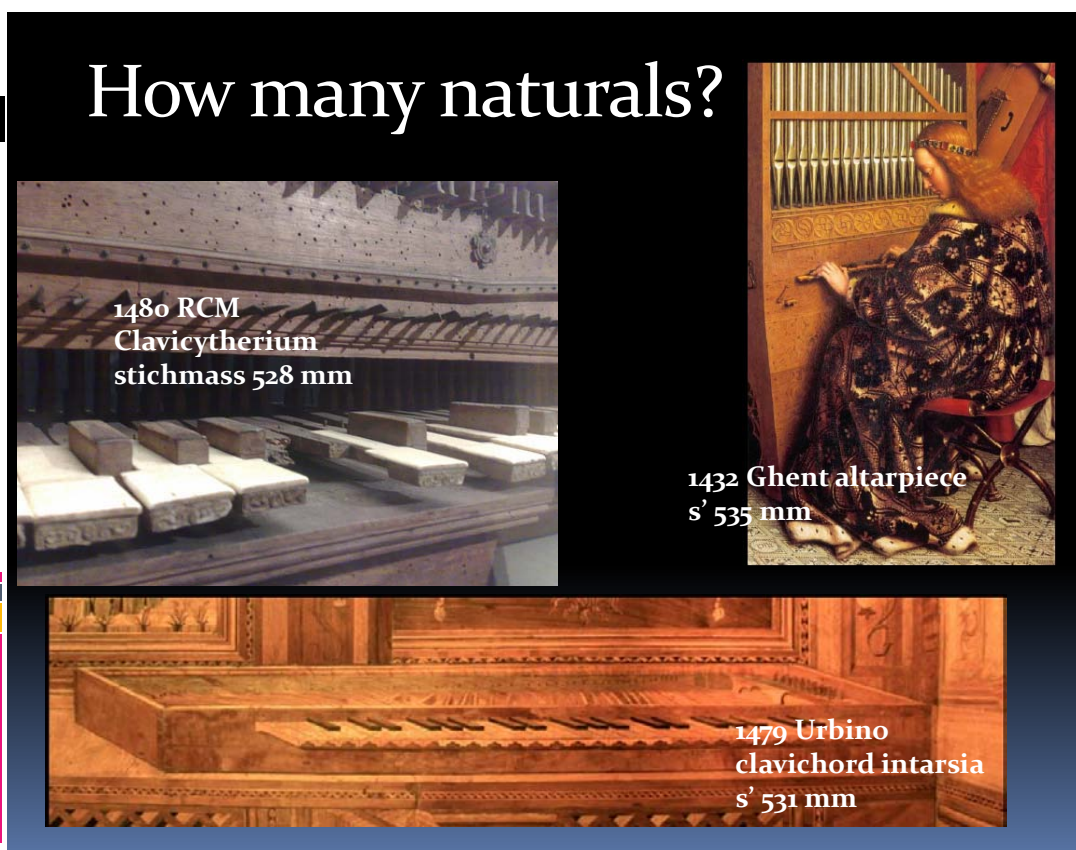


Figure 10, Contemporary key widths

What note represents the uppermost treble for the Minden clavisimbalum? Nearly the entire range of possible notes is to be found in the early iconography (when they can be made out at all) yet once we arrive at a possible nut-to-bridge length, the range of possible notes that fit this scaling shrinks somewhat. While the angels' hands cover both keyboards in the Minden altarpiece, the Arnaut instruments give the top note as b3 in the clavichord, or a3 in the clavisimbalum, and a3 in the dulce melos. The Urbino intarsia has f3 for the upper note, and the RCM clavicytherium gives g3. The possible scaling from a nut located about 2/3 the width of the wrestplank from the front, to a bridge pin about 2.5 cm from the bentside at the far treble would give a length of about 9 cm. The Intarsia of the Urbino clavichord gives f3 as ~8.0 cm¹¹. While the RCM clavicytherium goes up only to g2, halving the current value for f2 to give f3, results in a length of 8.8 cm. In the reconstruction of the instrument we will now describe, we let the top note become an f3, though other near interpretations are very likely as well.

This gives us some guidelines to dimension a case, keyboard, nut, and bridge such that an actual instrument could be conceptually drawn. Assuming a key lever length similar to that of the RCM clavicytherium of 18 cm, the 21 keys can all fit inside the case as described. The clavicytherium was designed to actuate some fairly heavy stickers integrally combined with the jacks to pluck the vertical strings, so a short key lever length will return smartly with that weight bearing down on the keys. Given the length of these keys, the keys will need to be weighted at the tail, or much undercut at the head, to allow a swift return of so short a lever. The travel of a key can be set at about 1.2 cm, and if we assume the balance rail is very near the front of the instrument, the resulting vertical travel of a jack placed at the edge of the jackrail cover as given by the artist will be fairly shallow, about 0.5 cm or so. This necessitates a short plucking distance from jack to string, so that the quill can pass and return without failing to pluck because the quill is still flexing. Small virginals and spinets have such close plucking points, and with a small soundboard and high pitch, these work quite well, with a travel on the same order of magnitude as we encounter here. No damping cloth is provided, so a slight sound will be made as the quill returns.

The final dimension, the instrument thickness, is not possible to deduce directly from the artwork. But assuming a baseboard thickness of about 1.2 cm, and allowing for key travel, the soundboard, and a bridge and jack rail, an overall height of 8 to 9 cm (~3.5") is about correct. Again, this value may be 10 to 20% off, but if we make it much thinner the action is too cramped.

These arguments were assembled into the drawing as given in Figure 11. At this stage the instrument is able to be readily built, and so what follows are some builders' points on what was encountered, and the final resulting instrument.

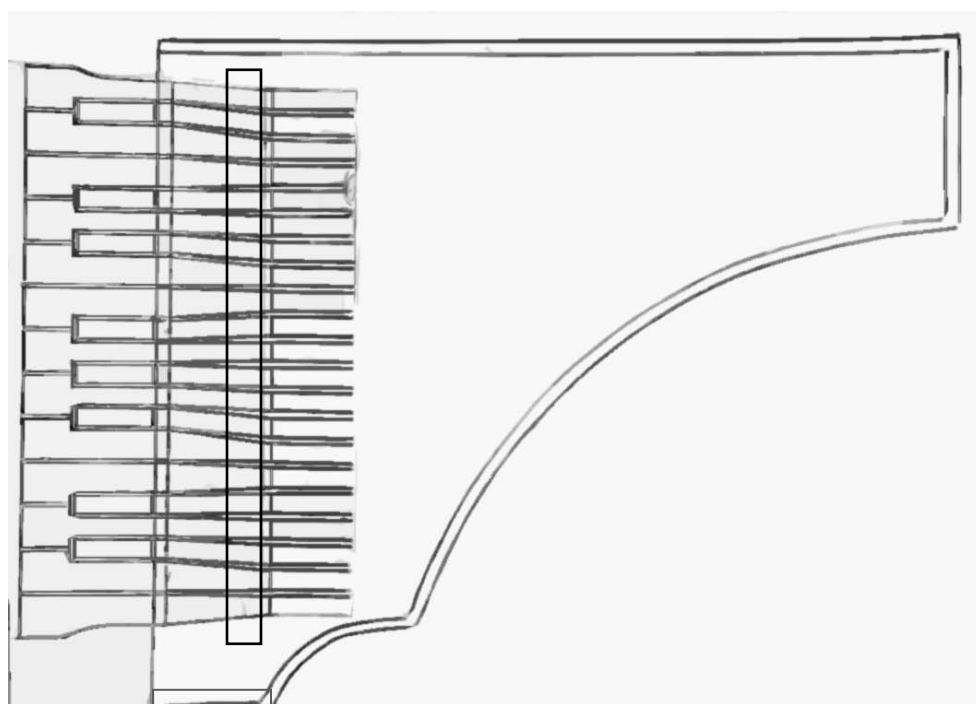


Figure 11, general conceptual drawing for Minden clavysimbalum

A choice of wood based on the earliest instruments suggests that the case of cypress or cedar is consistent with a small thin walled instrument. The plan is laid out against a base of pine, with ½ inch thickness suggested by the majority of early instruments. The interior bracing is light and simple consisting of triangular knees to support the tension on the case. The soundboard is quarter-sawn Engelmann spruce with the grain aligned with the spine. The bridge and nut are made of beech, the wrestplank of oak covered with spruce. Wrestpins were short 4.2 mm dia. iron hammered to shape and ground to a tapered end. The instrument was strung in Rose A iron wire as below:

A1 – c2 = 0.27 mm

c#2- a2 = 0.23 mm

a#2 – f3 = 0.19 mm

Construction:

We see that the bent side has a radius of 33.5 cm which is reasonably tight for bending even thin slabs of wood (6mm or so) made from cedar or cypress. Thinner sections of 4 mm can be soaked and bent and a two layer structure is readily possible. Cutting kerfs and bending is also possible, but this is a tight radius for even deep cuts without having the kerf lines 'break through' and show on the exterior of the case. Many building techniques can be employed to achieve this bent side, and so it does not represent anything out of the usual. The smaller radius at the wrest plank treble of about 7.5 cm was almost certainly sawn or carved out rather than bent. It is an easy job to hand saw this and so that would appear to be the technique of choice. Cypress wood was used for the case walls, and pine for the bottom. The liners and tail block were sawn from pear.



Figure 12, interior case of clavichord

The nut and bridge were made 0.45 cm high of beech, and the hitch pins are driven straight into the soundboard and into the liner as with Arnaut, but a separate hitch rail can be provided if desired. The jacks are connected to the key lever end by a short piece of music wire such that the key lever can help pull the ultra light weight jack back into position once actuated. Although the harpsichord mechanisms of Arnaut have been variously referred to as clumsy or overly complicated, we quickly find that for the jack to actuate in so small an instrument as described here, some spring, chain teather, or bottom connection to the key lever is required. The complex jack arrangements were solving a problem directly in front of the builder! We pinned the jack bottoms and inserted the pins into the key lever tails for a secure but flexible connection of jack to key lever.

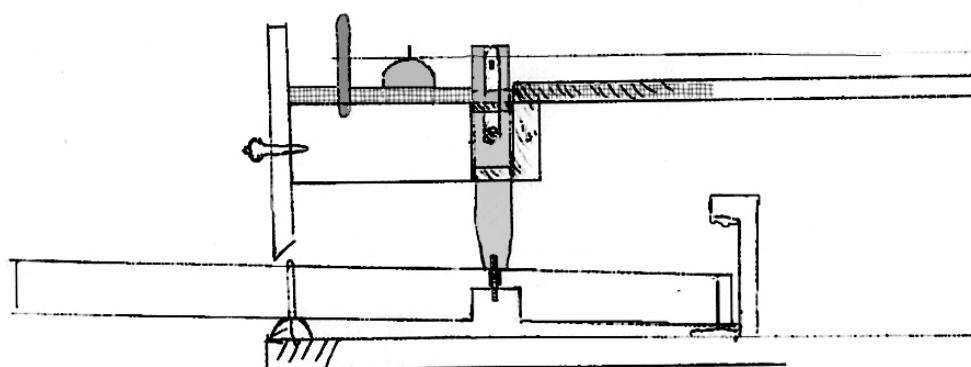


Figure 13, Action

Bracing in the interior was accomplished using simple triangular knee braces. For so light a tension nothing more is required. The choice to build the instrument as shown in the Minden alter, or flip it and allow the treble to occupy the right hand side would be left to the modern builder; we built it flipped to a conventional arrangement for convenience in practical demonstration.

The soundboard thickness would have been quite thin. We have used a soundboard about 3 mm thick in the spine and bass end, tapering to 4 mm in the front and extreme treble. Making the soundboard thinner by up to 1 mm over the range would be acceptable as well, and would give more volume, though the original prototype of 1425 was probably not thicker than we have used ,and gives us an idea of the sound at something like maximum thickness. The jacks were made of pear wood with conventional tongues, although Arnaut does not show a movable tongue, and with the jack pinned to the key lever a tongue can be dispensed with. The key levers are of poplar, and key coverings were made a bit fanciful with exotic yellow-wood and stained red pear for naturals and sharps. After all, we cannot see the keyboard, and while waxed and unstained box wood for the naturals, and the same, but stained dark for sharps may have been more of an original choice, we are allowed flights of fancy with such liberal recreations now and again! The enthusiast who chooses to reproduce this work can create as his taste dictates.

Results and conclusions,

The resulting sound of the Minden clavisimbalum is reedy and light, a fine high voice with some distinction. It does not sound quite as rounded as a small Italian virginal in the authors collection, nor like the Arnaut clavisimbalum also in the collection. The close plucking point can be made stiff enough to bend the notes slightly before release, so a distinct character at higher overall volume is imparted by this further sort of voicing. Voicing lighter eliminates the bend at the loss of assertiveness and character. It sounds balanced when used in concert with a psaltery and small rommelpot, but would not have overpowered a clavichord.



Figure 14, Completed Clavisimbalum with jack rail removed

My conclusion is that a working instrument based on the general proportions is possible, and therefore probable that the artist was carving what he saw. This can be a serious musical instrument and therefore should be treated as a working representation of the earliest harpsichords.



Figure 15, the instruments compared

Acknowledgements:

Thanks to Arnold den Teuling for providing the photographs of the Minden Alter Rose section that feature the musicians, and of the vault ceiling painting of Albertus Pictor, as well as several lively debates on technical points presented here. Thanks also to John Watson of Colonial Williamsburg and David Hackett with Friends of Square Pianos for their editorial input and suggestions.

¹ 'Les Traite's d'Arnaut et de divers anonyms' (Paris; Bibliotheque Nationale ms. Latin 7295) facsimile edition with transcription and commentaries by G. Le Cerf and E. R. Labande (Kassel: Barenreiter, 1972),XII.

² 'The Clavichord', Bernard Brauchli, Cambridge Musical Texts, 1998

³ 'A History of the Harpsichord', Edward Kottick, Indiana University Press, 2003, pg. 10

⁴ 'Early Keyboard Instruments, New Grove Musical Instrument Series', Edwin M. Ripin ed., W.W. Norton and Co. NY, 1980

⁵ 'Keyboard Instruments: Studies in Keyboard Organology', 1500-1800, Edward Ripin, ed.Dover Publications 1971. Figures 21 and 31 of 'A Checklist of Fifteenth Century representations show a reversed treble and bass orientation.

⁶ Melin, Pia (2007), *Fåfångans förqänqlighet (Vanishing Vanity: Allegory as Speculum in Paintings by Albertus Pictor)*

⁷ 'Liber Notabilis Musicae', Johannes Gallicus, British Library, Add. MS 22315 fol. 14R

⁸ RCM web site accessed July 29, 2011

<http://www.cph.rcm.ac.uk/Catalogues/keyboard%20catalogue/Harpsichord%20family/RCM%201%20Clavicytherium>.

⁹ 'The Clavichord', Bernard Brauchli, Cambridge Musical Texts, 1998, pg. 34-36

¹⁰ 'The early Pianoforte' Stewart Pollens,Cambridge Musical Texts, 1995, pg. 19

¹¹ 'Reconstruction of the Urbino Clavichord', Pierre Verbeek, 10th International Clavichord Symposium, Magnano7-10 September, 2011 (pierre.verbeek@skynet.be)