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Harpichord, §2: The Renaissance

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2. The Renaissance.

15th-century representations of harpichords from various parts of western Europe generally show short instruments with thick cases. Some do not appear to have a jackrail and may not have worked by means of the standard jacks described in §1 above. Instead they may have had one of the actions described and illustrated in the manuscript treatise of [HENRI ARNAUT DE ZWOLLE](#). Arnaut called his harpichord the 'clavisimbalum'. His design probably partly describes actual constructional practice of the time; he may also have wished to give the *clavisimbalum* a theoretical foundation based in geometry. This mixture of approaches resulted in some inconsistencies. The design shows four types of action. The first and third are plucking mechanisms that incorporate a swinging tongue that carries the plectrum, as in 16th-century jacks; however, the part carrying the tongue is hung on an axle in a slot in the wrestplank (first type) or is a large pivoting lever (third type). The small harpichord played by an angel in Manchester Cathedral, England (1465–8), is a convincing example of this type of jack action without a covering jackrail. The second mechanism probably plucks, but without a swinging tongue. The fourth (used in the [DULCE MELOS](#)) strikes an undamped string and was a forerunner of the piano mechanism. Three of Arnaut's mechanisms are without dampers; this may have been typical of 15th-century actions. Bird quill was probably used as a plectrum material, and possibly also metal. Arnaut's design has a compass of *B–a* and can be made with either one or two registers of strings; unusually, the second is aligned above the first, the strings being plucked successively by the same jack. Arnaut's and other 15th-century harpichords would have sounded at a high pitch, from about a 4th to an octave above the 8' pitch of the 16th century.

(i) Italy.

Although no 15th-century Italian harpichords or representations of them are known to have survived, it has been shown that Italian instrument makers were building harpichords by 1452 at the latest (Esch, H1979). Documents, manuscripts of Italian keyboard music (including organ music) and intarsias suggest that a compass of *FGA–g^a* (or *–c^{'''}* or *–f^{'''}*) was in use in the second half of the 15th century. An intarsia of around 1520 in the choir-stalls of Genoa Cathedral shows a single-register harpichord with a compass of *FGA–g^a*. Given the early date of the intarsia and the compass, it is plausible that it also represents the type of harpichord made in the late 15th century. It has a bentside with two curves, a feature otherwise known only in virginals.

45 Italian harpichords are known to survive from the period before 1590 – a greater number than from any other region. Although there were some stylistic differences between harpichords from different towns on the Italian peninsula, broad similarities justify the term 'Italian', even though there was no political unity on the peninsula until the 19th century. Slightly more than half of the surviving 16th-century harpichords were made in Venice. Guild regulations were less restrictive there than in some places (e.g. Germany). To judge by the number of Venetian instruments that made their way to other parts of Italy, the reputation of Venetian makers was considerable. Alfonso II d'Este of Ferrara had at least six Venetian harpichords, and Raimund Fugger (1528–

69) in Augsburg had five. More 16th-century string keyboard instruments survive by Domenico da Pesaro, who was active in Venice, than by any other maker, and seven of his 15 extant original instruments are harpsichords. Also in Venice, Alessandro and Vito Trasuntino enjoyed good reputations, and Baffo, Celestini and Francesco Padovano made instruments that show high quality work. Most evidence of 16th-century harpsichord making comes from Venetian instruments. Although several 16th-century virginals from Milan survive, no Milanese harpsichord from this period is known. A group of harpsichords has been recognized as coming from Naples, an important 16th-century musical centre. Harpsichords from Florence and Rome also survive.

The characteristically slender case shape of Italian instruments results partly from the practice of doubling the string length at each octave down to *f* (sometimes to *c*), but also from the use of longer bass strings than in other traditions. The case sides were usually not so deep as in instruments from other countries. Little is known about the design and layout procedures used by Italian makers. The string lines, plucking points and nuts (8' and 4') were sometimes marked on the baseboard, but the fact that such marks are usually lacking suggests the use of standardized designs and templates. Some 15th-century design traditions survived well into the 16th-century. An early 16th-century Neapolitan harpsichord (no.175, Donaldson Collection, Royal College of Music, London) has string lengths that double at each octave when measured between the plucking points and bridge; this system corresponds to the design described by Arnaut de Zwolle around 1440. The case proportions (excluding the visible part of the keyboard) of two octave harpsichords by Domenico da Pesaro (1543, Musée de la Musique, Paris; 1546, Gesellschaft der Musikfreunde, Vienna) are the same as that of the *clavisimbalum* that Arnaut described.

Harpisichord case-slides were usually thin (4–6 mm) and made of cypress, although maple was occasionally used, particularly in Naples. Elegant mouldings at the top and bottom of the case, typical of Italian harpsichords, have proved an important means of attributing unsigned work. These thin-cased instruments were rarely painted but were provided with a separate, decorated outer case, and are therefore often referred to as 'inner-outer' harpsichords. Supports for outer cases survive in a variety of forms, some with simple, turned baluster legs, others carved, painted and gilded. The thin cheeks at either side of the keyboard were reinforced by gluing on a second piece of wood as thick as the case; these were then cut to scroll or other shapes, never being left square or slanted. Inlaid stripes of contrasting colours, forming geometrical patterns of Arab origin, were used on the nameboard and the inside case above the soundboard in the best Venetian instruments. Fine examples are the 1574 Baffo (Victoria and Albert Museum, London) and an unsigned harpsichord (no.1883.718, Kunstgewerbemuseum, Schloss Köpenick, Berlin). The nameboard, made of wood as thin as the case and removable, was sometimes panelled with mouldings. The maker's name, if it appeared, was usually in small Roman capital letters. Internal bracing usually comprised two to three stiffening rails nailed and glued to the bottom boards; triangular blocks (called knees) maintained the sides perpendicular to the bottom boards. One to three knees on the spine side and five to seven on the bentside was a common arrangement. Since the case sides were thin they were glued to the sides of the baseboard for rigidity, rather than to the top surface of the baseboard as in other countries. In a few south Italian (probably Neapolitan) instruments the baseboard is about 5 mm above the bottom edge of the case sides, presumably so that it is freer to vibrate. Diagonal struts from the bentside liner to the bottom boards were also used, either with knees or, in some Venetian harpsichords, as the only support for the sides. A decorative rose was often set into the soundboard, made usually of three or four layers of thin wood veneer or sometimes of parchment, in gothic or geometrical designs. A few instruments had three or four roses, echoing illustrations of 15th-century harpsichords from elsewhere in Europe and Arnaut de Zwolle's manuscript.

Keyboards were usually made of quartered beech; maple was used in some south Italian harpsichords. The end of the key-lever was guided by a wooden tongue in a vertical slot on the rack. The travel of the keys was arrested by cloth padding on the front key-frame rail or by the jacks reaching the padding on the jackrail, or probably sometimes by a combination of the two. Although no unaltered action survives, the amount of sharp projecting above the natural-key covers indicates a fairly shallow depth of touch (5–6 mm) in many instruments. The natural keys were usually covered with boxwood, or with ivory in especially fine instruments; only rarely were dark woods such as ebony used. Sharp keys were normally made of black-stained pear wood topped with a thin slip of ebony.

Italian jacks were usually of a pear-like wood and about 5 mm thick, thicker than those used in other countries, adding weight to compensate for their short length. Small springs of flat brass

strip were used rather than boar-bristle. The centrally-placed tongue enabled a damper slot to be cut on both sides. Most instruments had quill plectra and a one-piece boxslide about 2.5 to 5 cm deep. These were often made by gluing small blocks of wood to a thin strip, with the correct spacing for the thickness of the jacks, and then gluing another strip on the open side. The jackrail was usually decorated with the same mouldings as employed on the case. To hold it in place, slotted blocks were glued to the inside of the case. Many harpsichords (mostly from Venice) had the line of the jacks running not at 90° to the long side, but at such an angle that the jackslides were nearer the front of the instrument at the treble end. Makers may have chosen this arrangement because it reduces the amount of curve in the bentside (if other factors of scaling and plucking points are unchanged).

Many 16th-century harpsichords have cypress soundboards, usually made of quartered timber, but spruce and what appears to be fir were also used. Maple, whose mechanical characteristics are similar to those of cypress, appears in some Neapolitan harpsichords. Cypress was frequently used for the bridge when the soundboard was of cypress; walnut and beech were also employed. The bridges were always parallel-sided with a moulding on the top edge; the cross-section was normally smaller than in instruments from other countries. The height of the bridge was usually reduced towards the treble. Double-pinning with a high hitch-pin rail was not used in 16th-century Italian harpsichords. Instead of the sawn or bent curve of the bridge in the bass found in other countries, Italian harpsichords usually had a small piece mitred at an angle to the main bridge for the last few notes. Nuts were usually of the same material and finished to the same dimensions as the bridge, which has enabled the detection of many later alterations. They were either fixed on a straight line, or in a curve with its inside facing the jacks. A curve in the opposite direction results from later shortening of the strings. With the scales and plucking points chosen by Italian makers, the two nuts in a 1 × 8', 1 × 4' disposition lay quite close to each other, making it impractical to locate the 4' tuning pins between the 4' and 8' nuts (the commonest practice outside Italy). Instead, holes were drilled through the 8' nut so that the 4' strings could reach their tuning pins at the edge of the wrestplank. One of the few harpsichords of this type to have retained its original 8' nut is by Francesco Padovano (1561; Deutsches Museum, Munich). The 4' hitch-pins were sometimes simply driven into the soundboard and secured with a drop of glue. This practice is only possible with a relatively dense wood such as cypress (not with spruce or fir), but thin 4' hitch-pin rails glued to the soundboard were also used. The 8' strings were hitched to the soundboard liner in the conventional way.

The nut was placed on (or near) solid timber in all known 16th-century Italian harpsichords and does not contribute to the audible vibrations. Some earlier sources incorrectly interpreted the cypress veneer (c̄6 mm thick) that is often found on wrestplanks as being an additional soundboard.

Ribbing systems have been found with three or four crossbars running at an angle from the spine towards the front of the instrument and crossing under the bridge, where they are usually undercut to leave the soundboard free. Others have a cut-off bar, with or without additional crossbars. Some harpsichords seem to have been made without any bars at all. The impossibility of access to the inside of many instruments makes it difficult to establish how rigidly makers followed these systems; exceptions can be found. These barring systems are found in Italian harpsichords from the 16th century to the 18th; no feature can be categorically assigned to one period, and no specific conclusions can be drawn about the sound of a harpsichord simply from the type of barring used.

The point at which a string is plucked is important in determining the character of the instrument's sound. When the plucking point is near the nut (close plucking) the sound is nasal; nearer the middle of the string (centre plucking) it is rounder. In Italian harpsichords of all periods the plucking point of the back 8' register (furthest from the player) lay at close to a third of the string length at $\frac{c}{3}$. At the extreme treble the plucking point was nearer the middle of the string. In the bass the plucking point was, in order to avoid over-long key lengths, relatively close to the nut. Italian harpsichords with a 1 × 8', 1 × 4' disposition had the 8' in the back register with the jacks plucking to the left. 21 examples of this disposition are known from before 1600. A comparison between this arrangement and that of Ruckers's harpsichords (see §3(i) below) reveals a basic difference of design, and hence of sound: Ruckers harpsichords have the 8' plucking to the right and in the front register, giving a more nasal sound. The Italian harpsichord is a little sweeter, and in 1 × 8' instruments the 8' register was generally in the same position and had the same plucking point as in the disposition with 8' and 4'.

Italian harpsichords are typically described as having a bold sound with a more pronounced attack than in other harpsichords, but this judgement has chiefly arisen from listening to brass-strung 17th- or 18th-century harpsichords. Since practically every 16th-century Italian harpsichord has been modified in some way that affects tone, even the few playable examples are not a reliable guide to how these instruments would originally have sounded. Moreover, most 16th-century harpsichords were intended for iron stringing (see below); iron-strung instruments tend to have a more brilliant sound with a longer decay time than brass-strung ones. Because the majority of the harpsichords that survive from before 1600 were made in Venice, with only a few from elsewhere in Italy, it is not possible to generalize about regional differences in harpsichord tone.

Although a number of 16th-century harpsichords now have two 8' registers, many of these have had a register added to what was originally a 1 × 8' disposition. An example is the harpsichord of 1521 by Jerome of Bologna (Victoria and Albert Museum, London; see [HIERONYMUS BONONIENSIS](#)), previously thought to be the oldest surviving harpsichord. This status is now held by an instrument inscribed as being started on 18 September 1515 by Vincentius. It too probably had a single 8' register, with a compass of *FGA–g'''a'''* or perhaps *C/E–f'''*. Since the majority of 1 × 8', 1 × 4'; harpsichords were built in Venice the 4' stop might appear to be a Venetian invention, but the paucity of evidence from other towns imposes caution. In any case, given the prevalence of 15th-century instruments at 4' pitch it may be more accurate to say that an 8' stop was added. Many 16th-century Venetian harpsichords had their 1 × 8', 1 × 4' dispositions altered to 2 × 8' after about 1630 (see §3(iv) below). The 1574 Baffo is one such instrument. Later scholarship recognized that of 50 harpsichords known from before 1600 only eight were made with two 8' registers and nine with a single 8' register. The earliest dated 2 × 8' specification was built by Domenico da Pesaro in 1570. It is likely that the four 'gravicembali doppi' used in Florence in 1565 at the wedding celebrations for Francesco I de' Medici were 2 × 8' harpsichords. The earliest known 2 × 8' harpsichord (signed 'Bortolus') was made probably in the 1540s for the court of Ercole II d'Este, Duke of Ferrara. An unusual type of 2 × 8' harpsichord had the jacks facing each other on either side of a narrow-spaced (3 mm) pair of strings (e.g. Celestini, 1569; Royal Ontario Museum, Toronto). This required an unusual S-shaped end to the key levers. Both registers had strings of almost identical length; the system may have been intended to improve tuning stability (Wraight, H1993; Lee, A1996 and A1997). Although many instruments were built in the 15th century at 4' pitch, only two 16th-century octave harpsichords are known, both made by Domenico da Pesaro (mentioned above).

A discussion of compasses must take into account the alterations that obscure the original condition of many instruments, first noted by Barnes (in Ripin, A1971). Only one of the known 16th-century Italian harpsichords has not had its compass, disposition or scale altered (Wraight, H1997). The compasses described here as the original ones are mostly not the present ones.

Around 1500, harpsichord compasses probably still began with *FGA*, that is, lacking *F#* and *G#*. These compasses may have reached as high as *f'''*, as in the Urbino intarsia clavichord of around 1476 (see [CLAVICHORD](#), [not available online]), or only to *a*" (probably without *g#*"") or *c'''*". An intarsia of a virginal (probably made in 1496 by Lorenzo da Pavia) in the *grotta* of Isabella d'Este's study in Mantua shows a compass of *C/E–c'''*", which could also have been used for harpsichords at this time. In the 16th century the most common compass for harpsichords or virginals was *C/E–f'''*". The *C/E–c'''*" compass was used in only a third of surviving harpsichords. An early harpsichord with an exceptionally wide range and low pitch is the 1579 Baffo (Musée de la Musique, Paris), which originally had a compass of *C/E–c'''*", although the sounding range was *G'–g'''*". Chromatic bass octaves were apparently not used before 1600 and were rare thereafter. It is unlikely that harpsichords were made with a compass of *G'/B'–c'''*" before 1600, although several instruments, previously *C/E–f'''*", were later modified to this range (e.g. the 1574 Baffo in fig.4 below). A compass of *G'/A'–c'''*" was known from the 1630s and was common towards the end of the 17th century, but probably was not used in the 16th century. The inventory dated 1700 of Medici instruments lists a harpsichord of 1538 made by Domenico da Pesaro with a 50-note compass of *G'/A'–a*", but this may have been the result of an alteration of a 50-note *C/E–f'''*" compass.

Temperaments of the 15th century to the 17th (see [TEMPERAMENTS](#), §§1–5) often gave chromatic notes that were not enharmonically equivalent (e.g. *G* or *A* , which were not at the same pitch); to provide keyboards with the missing notes, extra chromatic keys (usually *D* and *A*) were

sometimes added. This practice seems to have originated in Italy, where organs were furnished with at least one split key in some octaves as early as 1468 (Wraight and Stembridge, H1994). Although there was interest in this approach in other countries, such keyboards are found mostly in Italian harpsichords and virginals beginning about 1620. The earliest surviving harpsichord made with split keys for $D\sharp/Eb$ and $G\sharp/Ab$ was built for the court of Alfonso II d'Este at Ferrara around 1570 (no.1883.718, Kunstgewerbemuseum, Schloss Köpenick, Berlin). For discussion of the most important experiments with enharmonic keyboards, see [ENHARMONIC KEYBOARD](#).

Detailed studies to determine the original pitches of Italian harpsichords began in the 1960s. Ascertaining their pitch is essential to understanding their musical function. Although many instruments were at 8' pitch or its octave, some others were a fourth higher or lower than 8'; the purpose of such instruments and how they combined with other instruments is still a matter for study. Pitch is related to string length and also whether the instrument is strung with brass or iron wire: the string material imparts a specific timbre to the tone. The alterations that have been made to surviving instruments have tended to complicate discussions about pitch. Italian string lengths in virginals and harpsichords ranged from about 15 cm to 42 cm measured at c'' (the short end of this range mostly being small virginals), but the usual range for 8' instruments was about 25.5 cm to 36 cm. Thomas and Rhodes (1967) suggested that iron wire, which permits a higher pitch, was used for instruments with longer scales and brass for those with shorter ones; Barnes (1968; in Ripin, A1971; Barnes, H1971) argued that brass wire was used for all instruments and that pitches varied among instruments in proportion with string lengths. Later scholarship provides better data about the original scales of many instruments. It might at first appear that the wide range of string lengths among instruments allowed for considerable latitude of pitch, particularly because it is possible to tune a string over a range of pitches below its breaking point and still produce an acceptable tone. Wraight's work (*Early Keyboard Journal*, H2000), however, suggests that among 16th-century instrument makers in Venice (where the majority of surviving instruments were made) a range of 8' pitches ($a' = c440-490$) was in general use. It appears that these makers regularly and accurately used the same scales, with closely defined string lengths; there was agreement on this not only within individual workshops but also among different makers. Some later modifications to 16th-century instruments show that makers considered it desirable to alter the scale of an instrument even when changing its pitch by only a semitone.

There is clear evidence that 18th-century makers such as Cristofori, Ferrini and Solfanelli used both iron and brass wire to string some of their instruments, and that a ratio of nearly 5:6 for the lengths of brass wire and iron wire at the same pitch was consistently employed (O'Brien, A1981, and Wraight, H1997). The range of scales found before 1600 would seem also to allow for the use of either brass or iron wire, and documentary sources establish that both were used; the problem is to identify the stringing material for each individual instrument. In general, 16th-century Italian instrument makers seem to have preferred iron strings regardless of instrument type, size or compass; in any case, the stringing material of chamber keyboard instruments in this period was not exclusively linked to compass or scale. Most 16th-century harpsichords originally had c'' at about 30 to 35 cm. Many of these instruments had a 4' stop and a compass of $CIE-f'''$; available evidence indicates that both harpsichords and virginals with scales of this length were intended for iron strings. Galilei, in his *Dialogo della musica antica e della moderna* (1581), suggested that the 'gravicembalo' had iron strings in the treble and brass in the bass, although he did not specify how far into the bass the iron stringing extended. The scale design of these harpsichords would require brass wire only for the last few notes and implies that iron-strung, long-scaled harpsichords would have stood within the normal 8' pitch range. (The name *gravicembalo* does not, as it might appear, indicate a low-pitched instrument at this period; it might originally – around 1500 – have meant a harpsichord at 8' pitch as compared to the prevailing 4' pitch of chamber keyboard instruments of the time.)

A few harpsichords have a scale with c'' at about 30 cm, but are without a 4' stop and have compasses that do not reach to f''' . The Italian tradition of scale design indicates that these were also intended for iron strings; like virginals with the same scale length, they were pitched a tone above those instruments where c'' is at 33 cm. Some harpsichords with very long scales, c'' being at 41 to 47 cm (e.g. the instruments by Baffo, 1574 and 1579, and Francesco Padovano, 1561, mentioned above), would have been pitched a 4th lower than those with c'' at 30 to 35 cm, even if strung with iron wire. Harpsichords with short scales, where c'' is at 27 to 29 cm, might at first appear to be intended for brass wire at normal 8' pitch. Wraight's analysis of the scale design, including the bass strings, implies that all such instruments were probably intended for the

higher 8' pitch ($a' = c520$) with iron wire. Examples are the 1521 Hieronymus Bononiensis instrument (discussed above) and the 'Rigunni', probably of 1584 (Stearns Collection, Ann Arbor, Michigan). There seem to be a few harpichords that were pitched a 4th above 8' pitch if iron stringing is assumed (e.g. Celestini, 1608, Museum für Kunst und Gewerbe, Hamburg; Celestini, 1596, Royal Ontario Museum, Toronto). Octave pitch, for example in the harpichords of 1543 and 1546 made by Domenico da Pesaro, was the highest pitch in normal use in the 16th century.

The coordination and standardization in scale length among Renaissance harpichord makers in Venice need not imply that performance pitch was as well organized; there were enough intermediate sizes of instrument that pitch incompatibilities in performance could easily have arisen. A striking feature of many Renaissance Italian compasses is that they end on either c''' or f''' . Some scholars of the 1960s linked this with scaling, suggesting that harpichords and virginals ending at f''' tended to have longer scales and were pitched a 4th lower than those ending at c''' . It is now clear, however, that most of these instruments sounded at 8' pitch and that the compass ending on f''' simply reflects the Italian tradition of extending the musical range only in steps of a 4th (or 5th) and much less frequently by individual notes (e.g. from c''' to d'''). The high f''' , sounding a high pitch, would have facilitated the performance of music at octave pitch (printed music rarely went into this range).

Denzil Wraight

(ii) Northern Europe.

15th-century documentary evidence suggests that string keyboard instruments were first developed in northern Europe. The oldest surviving plucked string keyboard instrument, a **CLAVICYTHERIUM** of about 1480 (Royal College of Music, London), was made in Germany. Most surviving 16th-century string keyboard instruments, however, are Italian; and the earliest known from northern Europe, a harpichord made by Hans Müller in Leipzig in 1537 (Museo degli Strumenti Musicali, Rome) and a virginal made by Joes Karest in Antwerp in 1548 (Instruments Museum, Brussels Conservatory; for illustration see **VIRGINAL**, [not available online]), share many characteristics of Italian instruments made decades earlier, such as thin case sides surrounded by applied mouldings. It was thought (Ripin, A1971) that the style of Müller and Karest was derived from Italian models, but it now seems more likely that 16th-century Italian harpichord-making traditions had origins in 15th-century north European practices. The German clavicytherium of about 1480, which except for its upright form probably resembles a normal harpichord of the period, anticipates several characteristics of 16th-century Italian harpichords: thin case sides attached to the edges of the bottom board (the back in the clavicytherium), scrolled cheeks, a very acute angle at the tail and a separate outer case. The clavicytherium also resembles the *clavisimbalum* described by Arnaut de Zwolle about 1440: both had non-Pythagorean scaling (see §1 above), a relatively shallow space (5 cm in the clavicytherium) between the soundboard and the bottom board, and multiple roses in the soundboard. The lower guide in the instruments of Müller and Karest, consisting of a thin plate of wood covering the entire area over the portion of the keyboard behind the nameboard, may be a vestige of the *clavisimbalum*'s bottom board (which was placed above the keyboard in one of Arnaut's designs), while Müller's key-guiding system, with the distal end of the key lever forked for a vertical pin held by the back rail, is the same as that in the clavicytherium. Karest's instruments have multiple roses and use the proportions that Arnaut specified for his clavichord. The simplest explanation for these and other correspondences is that 16th-century traditions in both Italy and northern Europe were separate branches of an earlier northern tradition. This does not, of course, preclude the possibility of subsequent Italian influences on Northern practice.

Of a small number of surviving 16th-century keyboard instruments from northern Europe, about 20 are virginals; only two securely dated before 1590 are harpichords. Documentary sources are scant, and north European depictions of harpichords are rare compared to representations of clavichords and virginals. It is evident, however, that the major traditions of north European harpichord making became firmly established during the 16th century, although knowledge about such details as string scaling and case construction must be derived primarily from virginals. The Müller harpichord of 1537 was made in a style distinct from that of Italy. The bottom board is only 8 mm thick; it is attached to the lower edges of the sides, which are 7 to 8 mm thick

and of softwood veneered with Hungarian ash. The soundboard extends to the nameboard and has a separate mortise to guide each jack. Because the wrest plank is only about 5 cm wide, the nut is on active soundboard. Some details of the original disposition and scaling are obscured by later alterations. It was certainly made with two sets of strings and three registers, one of them a nasal (lute) stop very close to the nut. The original stop-changing mechanism (consisting probably of movable lower registers placed over the oversized mortises in the lower guide) is missing, but there are holes for knobs to project through the cheek, including one probably for an [ARPICORDUM STOP](#). The keyboard, originally *CD–g" a"*, could be shifted to change the sounding pitch by a whole tone (see [TRANSPOSING KEYBOARD](#)). There appear to have been two bridges and two sets of strings a 4th apart (Koster, F1996). Müller's scaling is foreshortened in the bass, more like that of 15th-century instruments than the typical Italian harpsichord scaling, which is Pythagorean almost to the lowest note. The foreshortened scaling may imply the use of iron strings in the treble and brass in the bass; it is also related to the reverse curve of the bridge in the bass and the straightness of the bentside from its midpoint to the tail. The ungainliness of the instrument's outline in comparison with Italian harpsichords, however, arises largely from the added width (about 7.5 cm) required by the shifting keyboard and the short length associated with scaling for a high pitch.

Like the Müller harpsichord, the two surviving virginals made by Karest (1548 and 1550) have moderately thin case sides outlined with applied mouldings, a plate-like lower guide and foreshortened scaling. Although their absolute pitch levels are disputable, the instrument of 1550 is the larger and was probably tuned a 4th lower than the other (the *f'* string in the larger instrument being roughly the same length as the *c''* in the smaller). Karest and Müller may have applied the putative archaic principle that string lengths, at least in the treble, should be equivalent to the speaking lengths of organ pipes of the same pitch; that is, they may have used low-stress iron scalings, so that an instrument tuned to normal 8' pitch would have a *c''* string of about 32 cm. Karest's 1548 virginal would thus have sounded approximately a semitone above modern pitch. Some later German and Austrian instruments, stylistically similar to Müller's and Karest's, used such scalings (Kukelka, F1994).

Except for instruments made in the Low Countries after about 1575, most north European harpsichord making before the 18th century has stylistic affinities with Müller's and Karest's works. There is documentary evidence that instruments by Karest and other Antwerp makers were sent to Germany during the 16th century, which may have transmitted some of their traditions; or Müller's and Karest's instruments may simply represent a style that emerged gradually throughout northern Europe, spread partly perhaps by organ builders, who were necessarily itinerant and who also made string keyboard instruments. The term 'international style' has been applied to this group of tendencies and techniques, which include relatively thin case sides, plate-like lower guides, nuts placed on resonant soundboard, light 4' hitch-pin rails, foreshortened scalings and provision for a variety of tone colours. Although most surviving harpsichords made in this tradition, which extended from France to Sweden and from England to Austria, date from after 1600, a widespread inclination to make complex instruments is evident in early inventories. The 1566 Fugger inventory (see Smith, C1980), for example, includes an English harpsichord with several registers, an instrument made in Cologne with two keyboards for two performers, and one from the Netherlands with four keyboards for four performers.

Virginals with thick case sides and long iron-string scaling in the upper register (*c''* = c36–38 cm) made in Antwerp about 1580 by Hans Bos, Hans Ruckers and others show that the basic style practised by the Ruckers family and other Antwerp makers throughout the next century was already well established. Together with an anonymous virginal dated 1568 (in the Victoria and Albert Museum, London), these instruments show the development of the layout and internal construction of muselars and spinetten. Unfortunately, no well-preserved Antwerp harpsichords survive from this period, when harpsichord making presumably underwent analogous developments. Some idea of a transitional style of the 1560s, however, is provided by a harpsichord made in London in 1579 by Lodewijk Theeus (ii), who became a member of the Antwerp Guild in 1561 but had emigrated to London by 1568. Although some of its features, such as the use of oak for the case, the chromatic compass in the bass and perhaps the 2 × 8', 1 × 4' disposition, may be regarded as English, others presumably reflect the Antwerp style of the mid-1560s (Koster, D1980). As in the Müller harpsichord, the rear portion of the bentside is straight and the soundboard, mortised to serve as an upper guide for the jacks, extends to the nameboard, so that the nuts are on active soundboard. Because the wrest plank is narrow, the 4' wrest pins are grouped with the 8' pins, and the 4' strings pass through holes in the 8' nut. The 4'

hitch-pin rail is exceptionally light in comparison with those of later Antwerp harpsichords. The case sides are about 13.5 mm thick, and the lid is hinged to the spine. Mouldings applied to the interior of the walls give the illusion of a thin-cased inner instrument inside a massive outer case. The scaling, with the longer of the two *c*" strings about 35.6 cm, is foreshortened in the bass. The pitch, estimated from a pipe in the organ with which the harpsichord was combined shortly after it was made, is about a semitone below modern pitch. While the disposition of Theeus's harpsichord is different in detail from that of Müller's, the intention of both makers must have been to provide a wealth of tone colour. Since Theeus probably placed his 4' jacks in the central register, the 8' stops, with widely separated plucking points, would have been quite different in timbre. Stop knobs at the front of the instrument moved the lower guides to change the registration. (Movable lower guides, with the soundboard used as a stationary upper guide, were apparently also used by Müller and may have been a common north European characteristic.) A set of large bent pins in the bridge was evidently intended as a permanently engaged arpicordum stop for the shorter set of 8' strings. Although the later standard Antwerp harpsichord disposition (1 × 8', 1 × 4') is decidedly less colouristic than the dispositions of Müller and Theeus, a relish for varied timbres is still evident in the development of muselars, spinetten and mother-and-child virginals, which can be coupled together to provide an 8' plus a 4' registration. In view of these it seems possible that harpsichords with complex dispositions were made in Antwerp before Ruckers. The earliest extant Antwerp harpsichords, made about 1590, are, however, nearly identical to the standard Ruckers instruments of the 17th century in disposition and layout. They differ structurally from the Theeus harpsichord, most importantly in that the nuts are placed on a solid wrest plank and the provision of a much heavier 4' hitch-pin rail.

During the 16th century north European makers began to build harpsichords that were wider to allow larger keyboard compasses, and longer to accommodate longer, lower-pitched strings. The presumably typical compass described by Sebastian Virdung in 1511 was *FG–g*". As late as the 1570s some instruments were still being made with *FGA–g"a*", commonly used in organs. *C/E–g"a*" had become customary in Antwerp by the 1540s and is found even in some instruments made there in the 1590s. Karest's 1548 virginal, however, already had *C/E–c'''* which remained usual on the Continent well into the 17th century. The Theeus harpsichord (*C–c''*), as well as an English depiction of a virginal dating from 1591 and the use of low accidentals in English keyboard music of the late 16th century, all indicate that the chromatic bass octave (sometimes lacking *C#* or perhaps with the apparent *C#* key tuned to *A*') was a characteristic feature of English harpsichords.

The German clavictherium of around 1480 was probably tuned about a 4th above 8' pitch, and the Müller harpsichord of 1537, even at the lowest level afforded by its transposing devices, was undoubtedly designed for a high pitch. The Karest virginal of 1550, however, could not possibly have been tuned higher than 8' pitch and may have been significantly lower. By the end of the century, harpsichords with two keyboards, one at 8' pitch, the other a 4th lower, had been developed in Antwerp. The earliest dated survival (Händel-Haus, Halle) was made in the Ruckers workshop in 1599, but two anonymous examples (Instruments Museum, Brussels Conservatory) may date from the 1580s. In all three instruments, before later alterations, the low-pitch keyboard had a compass of *C/E–d'''*. Instruments at high pitch continued to be made; the tradition of making instruments at various high and low pitches, seen most systematically in the work of the Ruckers family, persisted through the mid-17th century.

Some 16th-century German inventories hint at the existence of harpsichords with two manuals, although the generic term 'instrument' might refer to mother-and-child virginals or rectangular instruments with keyboards for two players at different sides of the case. Even if the instruments were wing-shaped harpsichords, the two keyboards may have been at different pitches, as in the transposing doubles made in Antwerp. An 'instrument with two ivory keyboards, purchased in Frankfurt an der Oder' listed in a Dresden court inventory of 1593 (transcribed in Fürstenau, C1872), however, have been a true non-transposing two-manual harpsichord, since mother-and-child instruments are described explicitly in the same source. Given the evident north European fondness for contrasting tone colours in harpsichords and the model provided by organs with multiple keyboards, it would be remarkable if non-transposing two-manual harpsichords had never been made during this period.

John Koster

(iii) Spain.

The harpsichord does not appear in Spanish iconography until the late 15th century but documentary references date back to the mid-15th. Juce Albariel, known as the Moor of Zaragoza, was described in 1465 as a maker of lutes, clavichords and instruments. He may have been responsible for a *clavicimballo* in a black case inventoried in Zaragoza in 1469. Zaragoza was a notable centre of keyboard instrument making in the late 15th century and the early 16th, its most famous representative being another Moor, Mahoma (Joan) Mofferiz, who made instruments for royalty and the nobility, including a claviorgan with both gut- and wire-strung registers. In Seville, Maestro Enrique was building *clavicimbanos* in 1470, while before 1502 the Sevillian carpenters' guild required apprentice luthiers to learn how to make a *clavizimbano*.

Evidence for harpsichord making in the 16th century is entirely documentary. The richest source is the inventory of instruments belonging to Philip II (reigned 1556–98). His largest *clavicordio* (i.e. a plucked keyboard instrument; see Kenyon de Pascual, 1992) was about 223 cm long and the smallest (a triangular instrument) only about 42 cm. Ebony and maple are the woods most frequently mentioned in the inventory, although a small instrument (c.55.5 cm long) made by the Moor of Zaragoza was of inlaid walnut. Many of the king's instruments may not have been made by Spaniards. Following the installation of the Habsburg dynasty on the Spanish throne with the succession of Charles I (Charles V) in 1516, instruments and instrument builders were brought to Spain from the southern Low Countries, while there were close ties with southern Italy and Milan, which were Spanish possessions. One might, therefore, expect some Spanish harpsichords to have shown features found in Flemish and Italian instruments.

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