DIVINE PROPORTIONS

The forms of the 'Plowden' Guarneri 'del Gesù' and the 'Titian' Stradivari show how the violin makers of Cremona's golden age turned away from the design principles of their predecessors, says FRANÇOIS DENIS

The acoustical and technical procedures involved in the birth of the violin are part of a creative evolution which, from antiquity, blended ideas from East and West. These innovations in lutherie were developed in the medieval Iberian peninsula, where Greco–Arab, Greco–Latin and Jewish cultures co-existed, and where ancient geometric principles were common knowledge.

The archives of Toledo Cathedral in Spain throw fascinating light on early violin construction methods. One document from 1627 describes the content of a Masters degree examination in musical instrument making. The candidate should, it states, know how to draw the patterns for a vihuela, a harp and all of the instruments of the violin family using only 'a compass, a ruler and a T-square, the use of any template being prohibited'.

At the time when the use of a compass was still commonplace, designing an object consisted of defining in a pragmatic way the limits of what were called 'the whole and its parts'. The plan for creating a bowed or plucked stringed instrument was transcribed on to a single surface, which we will call the framework. The principles of this framework are identical to those used in architecture of the period. The framework, its divisions and its symmetry were all based on three types of relationship between two joined dimensions (**figure 1**). This concept, now outdated, was fundamental to the ancient conception of shape.

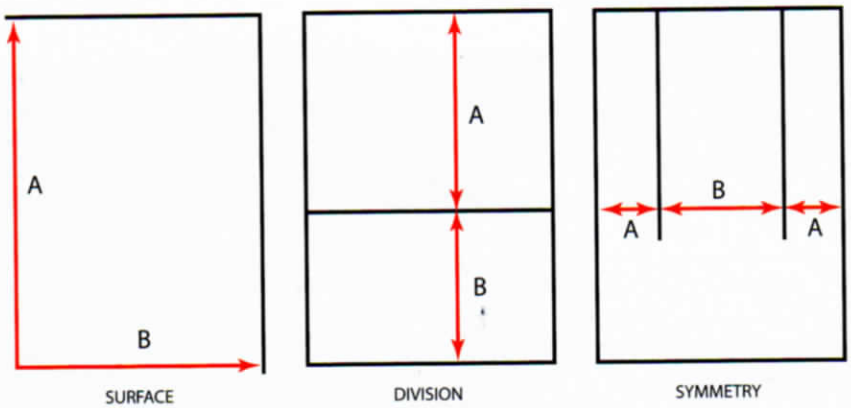


Figure 1 Three types of relationship between two joined dimensions are used to construct the framework

These geometric principles depended for their survival on the oral transmission of knowledge. But towards the end of the Middle Ages, such seemingly solid concepts were shaken to their foundations by two events. The first was the invention of the printing press, which caused a significant decline in oral communication. The second blow came from a small number of scientists who began to question the restrictive nature of the philosophical foundation of their disciplines. From the time of the Renaissance, the relevance of certain principles relating to the concepts of measurement and proportion came under scrutiny and completely new theories took hold. These developments came first to the intellectual classes; only later did luthiers and other craftsmen feel their effects. Our modern conception of measurement is derived completely from this new approach, but the geometry of the violin, since the instrument was developed in the 16th century, must be seen as the last extension of certain ancient principles. It is the depth of these ancient roots that partly explains our difficulties in uncovering them.

Before looking at the outlines of the 'Titian' and 'Plowden' violins, it is worth noting that in drawings of any stringed instrument – with the exception of the lute, which has a particular elliptical shape – the contours are composed of a series of circles. The values of the radiuses of these

circles correspond to the distances between the divisions on the axes, and the limits of the contour are naturally those of the surface on which the drawing has been made. Historically this technique was usually illustrated with the drawing of an ovum (egg shape) (**figure 2**).

It is known that diagonals were used to set type in the earliest days of printing. A page of the Gutenberg Bible (**figure 3**) illustrates the principle.

Figure 4 shows an example of Maggini's framework. The principal widths of the form (points M, N, O) are set by diagonals following the same process used in the Biblical page layout (figure 3). The proportions of Brescian instruments clearly apply to the exterior contours, rather than to the moulds as in the case of Cremona instruments. Nonetheless, the guiding geometric principles are the same.

The framework can be broken down into a series of segments made up of the radius measurements (for example, R1=XP) (see **figure 5**). These radiuses are linked together by their centres, in the same fashion as an articulated arm. ▸

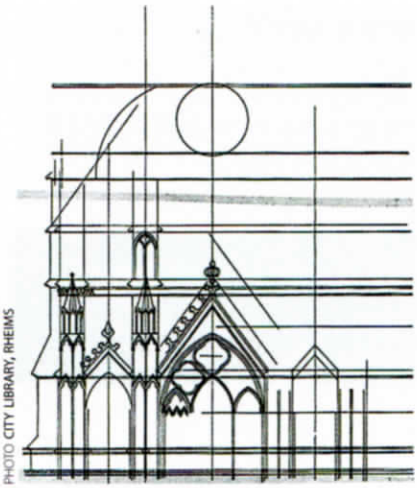
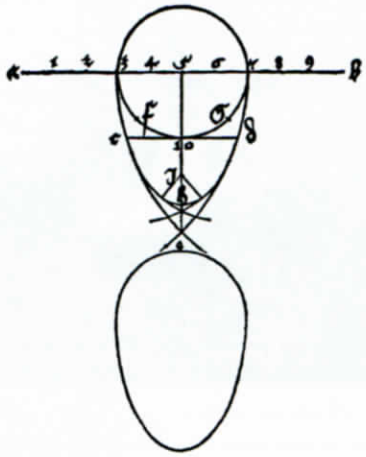


PHOTO CITY LIBRARY, RHEIMS

◂ The Rheims palimpsest is one of the few surviving plans of a medieval cathedral. It clearly shows a framework and should be read from right to left and from top to bottom. It indicates the different stages of design, beginning with the most general relations and ending with details of the decoration



◂ **Figure 2** The divisions of an orthogonal frame provide the radius measurements (after Dürer)

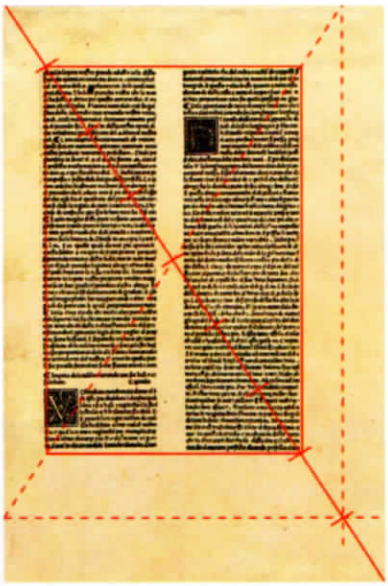


Figure 3 This Gutenberg Bible page shows diagonals used when print setting (after Adolf Wild, Cahier GUTenberg no.22, September 1995)

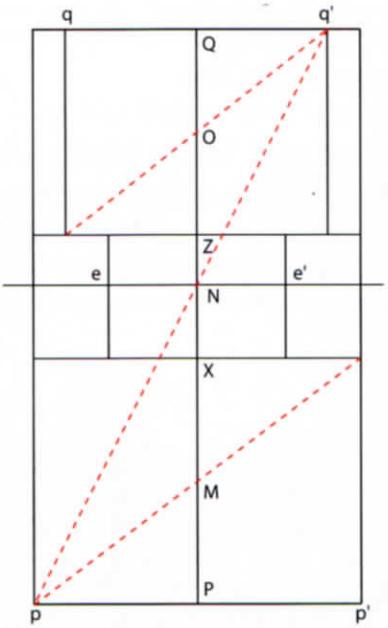


Figure 4 An example of Maggini's framework

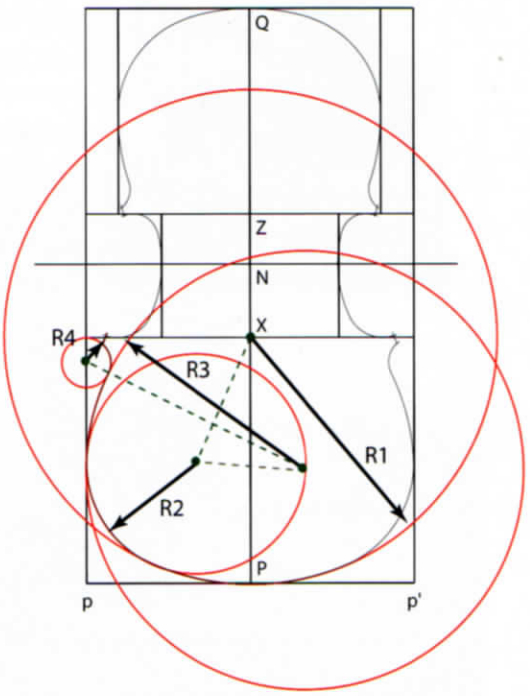


Figure 5 The framework can be broken down into a series of segments made up of the radius measurements (for example, R1=XP)

THE 'TITIAN' STRADIVARI OF 1715

A study of the outline of this violin shows that it was built from the Stradivari P pattern, which is currently housed in the Civic Museum of Cremona. There is reason to believe that Stradivari created his models from geometric archetypes inherited from the 16th century. Thus there came about a series of patterns that bear the letter of the archetype from which they were conceived. The archetype in question here is the 'P', whose construction is shown in **figure 6**, as it might have been transmitted to Stradivari by Nicolò Amati. It has been asserted that the P pattern, as shown in **figure 7**, corresponds closely to this theoretical proportional model.

The sketch of this framework is based on a type of surface, a proportional geometrical construction, often described in the Renaissance as a 'drawing by diagonals'. The secret of the proportions produced by the diagonals of the square and the double square is associated for good reason with the practice of medieval builders. These particular proportions offer artisans a number of advantages, notably allowing them to simplify their calculation of measurements. Such practical applications, above all else, justify the usage of these proportions since antiquity.

In 1550, for example, the German Hans Blum published one of the numerous architectural treatises of the time. His drawings of columns appear to be made on the same basic geometry as the violin. These drawing techniques can be reproduced on any scale, as demonstrated by my live drawing of a P form during the KlangGestalten exhibition in Stuttgart in July 2008 (left).

Comparing the outline of the 'Titian' with the P pattern and the P archetype, the only notable differences in the upper corners inside the C-bouts could be a result of visible wear (**figure 8**). ▹

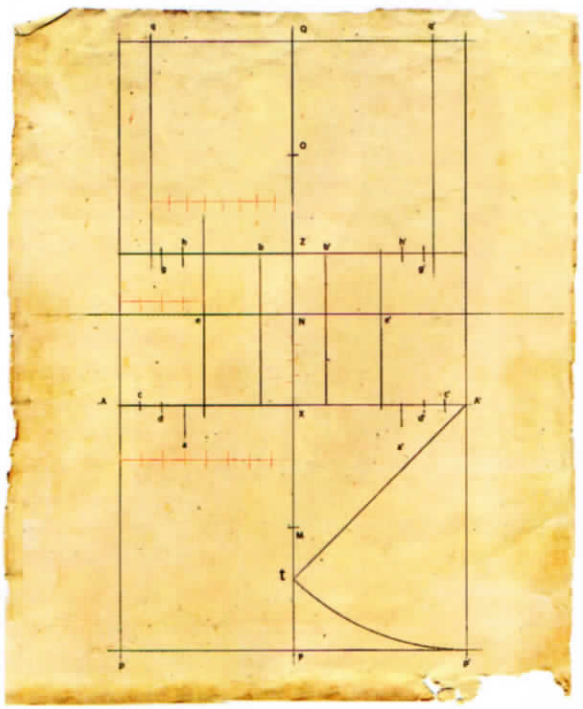


Figure 6 The archetype for the Stradivari P pattern

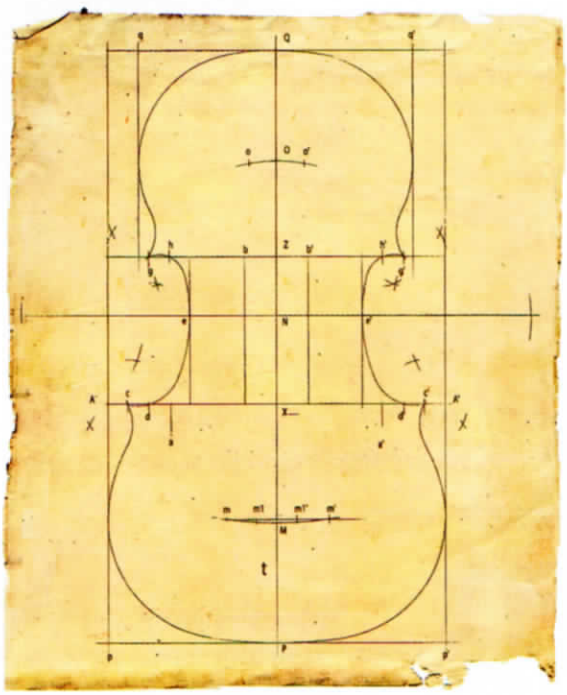


Figure 7 A drawing of the outline of the P form

Figure 8 The outline of the 'Titian' compared with the P pattern and the P archetype. The only notable differences in the upper corners inside the C-bouts could be a result of visible wear

THE 'PLOWDEN' GUARNERI 'DEL GESÙ' OF 1735

Despite the fact that they were constructed on a mould, the instruments of Guarneri 'del Gesù' are known for their asymmetry. In fact, the often rough work excludes the possibility that any shape had been clearly defined at the corners. These slightly unpredictable outlines are part of the charm of Guarneri 'del Gesù' violins, but they also complicate a study of the instruments. Nevertheless, what becomes apparent is that the quick style of working is supported by a well-established design foundation that remains crucial to the overall impression (**figure 9**).

Because the asymmetry of the corners makes analysis difficult, it helps to ignore the space allotted to the wooden blocks. Once you do this, the extent of the random or intentional variation of a contour becomes more apparent. Ultimately, it is clear that the Guarneri 'del Gesù' instruments analysed here (including the 'Plowden', the 'Soil' and the 'Alard': see **figure 10**) fall into two categories, irrespective of when they were made. The outlines of the first category follow a clear geometrical construction, but in the second category, which includes the 'Plowden', this construction appears to be incomplete. In addition, the study of the first category leads to a model that is not a Guarneri 'del Gesù' innovation but rather the well-known 'Grand Amati' pattern. ▸

The 'Plowden' violin by Guarneri 'del Gesù'

PHOTO PETER BIDDULPH

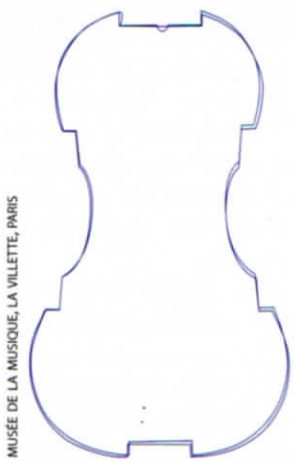


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Figure 9 Disregarding the discrepancies, these two contours (the top and back outlines of the 'Alard' Guarneri 'del Gesù' of 1742) undoubtedly proceed from the same wooden form

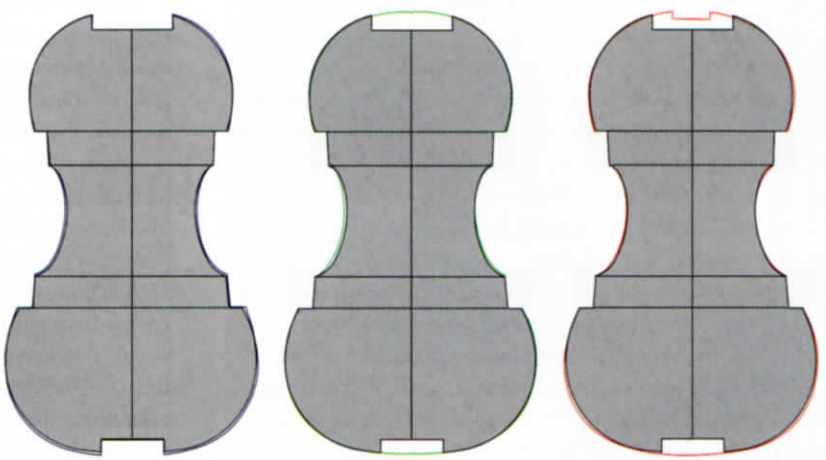
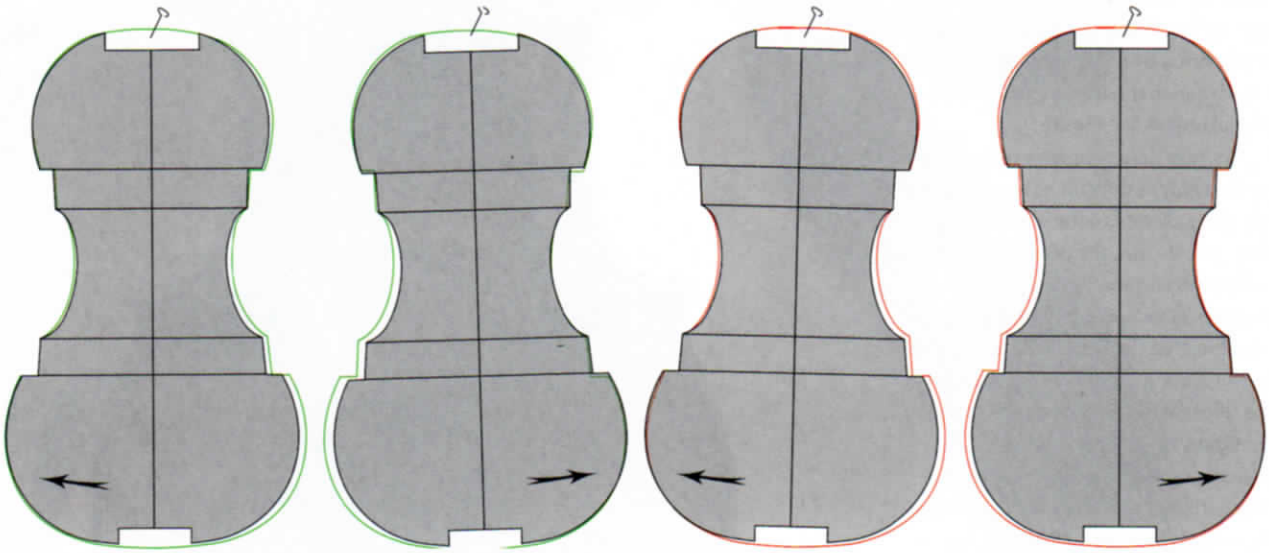


Figure 10 From left to right: the blue contour is the 'Soil' Guarneri 'del Gesù' from 1733, the green contour is an instrument of 1743, and the red contour is an instrument of 1733. These examples are superimposed on to a theoretical model of the 'Grand Amati' pattern (internal forms in grey). It appears that the three instruments have been made from this pattern

Instruments of the second category correspond only partially to the 'Grand Amati' model. With these instruments, the pattern appears to have been empirically generated from a previous one. Most likely a wooden form was made by moving the previous model sideways around a pivot point (**figure 11**). Another theory is that this second category could have been derived from the natural flexibility of a rib garland when detached from the wooden form. But experience suggests that the contour variations obtained in this way lead to significantly different results from what is apparent here.

Figure 11 An instrument of 1733 (green contour) appears to have been made using the same pattern as the 'Plowden' of 1735 (red contour, far right). This new form seems to have been generated by swivelling the previous model (shown in grey) left and right with respect to a point on the upper block



CONCLUSION

Both Stradivari and Guarneri 'del Gesù' were working at a time in violin history when luthiers designed few, if any, new forms from geometric principles. Some Amati models were redrawn by following the inherited technique or simply by duplication. As we have seen in the case of the 'Titian' and the 'Plowden', both violins appear to be variations of a unique proportional scheme inherited from the Amati family. Each violin maker had many opportunities to express their style, but in most instruments of the period, the main curves of the form varied little, with the exception of the corners. When a violin maker wanted to innovate, a reference mould became a drawing template and, by copying or translation (or swivelling, in the case of Guarneri 'del Gesù'), a new form was created.

The freedom taken with regard to the initial model also has an impact on the placement of the f-holes in relation to the proportions of the exterior contour. The clear geometric relationship present in the f-hole layout of the Amati brothers (and also in Brescia before 1630) is replaced here by a more empirical approach. From that, the measurements of the f-holes would be set according to the limits defined by the fully rational practice of the previous century.

The end of the golden age of Cremonese violin making coincided with the erosion of the most important parts of the Amati legacy. The loss of the last original moulds and templates made according to the processes of the Renaissance seems to mark the end of what must be called the 'post-geometric' period.

The end of Cremona's golden age coincided with the erosion of the most important parts of the Amati legacy

Since then, we have been in another era, where the model is no longer derived from the design of a wooden form but from an existing instrument. In this type of work, based on copying, the lack of a conceptual approach to the outline is sublimated into romantic and mythic discourse, which capitalises on the charisma of dominant figures and their 'secrets'. This 'romantic' period joins those of the 'geometric' and 'post-geometric' as the three important stages in the history of stringed instrument design from the 13th century to the present day.

At a time when the furthest reaches of violin history are being revealed, scientific studies such as Strad3D are presenting the sound vibrations of old master instruments as we have never seen them before. That the frontiers of our understanding are suddenly extended in these two directions assures future generations of violin makers diverse and stimulating avenues of research. ■