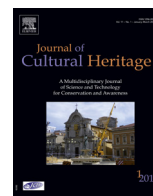




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Critical study of the use of a length unit in the design of 16th to 18th century Italian violins

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ABSTRACT

Until now, the question of geometrical construction (or: reconstruction) of the violin form has been the subject of numerous hypotheses. Without doubt, instruments were designed using the tools of that period, namely, a ruler and a compass and applying the ideas of Pythagoras or Vitruv, to achieve a perfectly balanced instrument. In particular, the question of a “standard unit” is of importance. Previous research mostly dealt in geometrical construction and not in a “standard unit”. Based on our recent discoveries of tools and drawings, we suggest that instruments of the Brescian and Cremonese schools might have used a standard length unit that could have been the Roman oncia. This unit was applied to the Stradivari instruments, later to all Cremonese violins. But initially, the relationship between the proportions did not emerge, until a completely, new construction system, using concentric circles, was applied. Consequently, all necessary markers for the construction and the radii of the outline can now easily be detected. The construction might be also applicable to violas, violoncellos and even the smaller violins, too. Also the violin scrolls were successfully analyzed.

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1. Research aims

The main aim of this study is to propose and discuss the relevance of a historical unit, named the Roman oncia, that might have been used by some violin makers to design their instruments. The design of the Italian violin is a well discussed topic and many different approaches have been used over the last two hundred years. To understand the way of constructing an instrument, the knowledge of the used measuring unit is essential. Although several researchers have been looking for this unit, no persuading one has yet to be found. Based on the information Najmon [1] has given regarding investigations on brass rulers of A. Stradivari, a unit of 18.66 mm was chosen. Subsequently, this unit was identified as the Roman oncia, a unit used by architects, engineers and craftsmen from the Renaissance to the beginning of the 19th century. Another aim, was to find a possible method to construct the outline of the violin based on this unit and using the tools of that period – ruler and compass. Furthermore, the construction should be compared to existing instruments and other items such as templates and forms.

2. Introduction

How were objects designed in the 16th to 18th century?

There are plenty of writings dealing with beauty and proportion in architecture, based on the ideas of Pythagoras. This concept states that beauty lies in the perfect balance of numbers and proportions, common in all arts and crafts, even in beautiful sounding music with ratios like the fifth or the fourth. Also, the most famous painters of that time, Leonardo da Vinci, Albrecht Dürer were discovering and publishing ideas about the relationship between harmonics, ratios & the aesthetic, beauty to be found in the architecture of human beings. The use of numerical proportion is well documented for buildings, paintings, furniture and even the construction of cities [2]. However, with musical instruments, being the most obvious objects related to musical proportions, only very few sources survived. The earliest and only plans for constructing a lute and harpsichord, are the drawings of Arnould de Zwolle [3] showing the outline and internal bracing of the belly of a lute. Unfortunately, no other plans have survived, but a lot of templates and forms from the workshop of Stradivari do. These implements have at least preserved some traces of the measurement techniques used, like compass marks and give an insight into the techniques employed at that time. It can be said, that the use of a compass for design and measuring was very important; one of the earliest portraits of a luthier, Kaspar Tieffenbrucker,

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depicts the master surrounded by various instruments, holding a compass in his hand. Calculations or other divisions made by a compass are seen on several sketches of Leonardo da Vinci, too, and the use of a compass during the construction of buildings, furniture, book paintings and doors is very well documented [4].

Besides the utilization of the compass for designing instruments, the knowledge of the applied unit is also crucial. Firstly, to understand the construction, because the simple comparison of measurements does not reveal in all cases its design. Secondly, to have a possibility to attribute instruments to certain regions or instrument makers.

Studies on the proportions of historical instruments are an integral part of the education at the luthiers school in Hallstatt, Austria. Students learn to measure and draw historical instruments and to understand the geometrical background of the renaissance and baroque. Many different instruments such as lutes, viola da gambas, vihuelas, among others, were successfully analyzed, but a clear and practical method for the violins was missing. With the students of the third year, a research project was initiated for the construction of the f-hole, based on the information Sacconi [5] provided and the original sketches of Stradivari.

Najmon had investigated two brass rulers of the Stradivari workshop and proposed a possible measuring unit of 18.66 mm, but he also mentioned the Roman oncia, being very close to this value (18.58 to 18.75 mm). Pabst [6] tried all relevant units linked to Cremona, including the unit Najmon had discovered and was looking for whole number values in the measurements of violins – in 13 of 22 cases the value of 18.66 mm was fitting. Therefore, this unit was chosen for further investigations. Later, a method to construct the violin, based on the Roman oncia, was developed and compared with the measurements of original Cremonese and Brescian instruments.

3. Historic origin and use of the Roman oncia

The situation of the Italian metrology is quite complex, many different local units for different materials were existing and various subdivisions in palmo (hand), piede (foot) and braccio (arm) were common. For Rome, or more specifically, the Vatican City State, 3 to 4 different sizes were existing. Namely, palmo romano architettonico, was used for all normal measurements of objects, buildings and woodwork [7].

Thus: $\text{Canna architettonico} = 2.2319 \text{ m}$, divided in 10 palmo architettonico, then each divided in 12 oncia, then divided in 120 decimo.

The Roman oncia in the 18th century is thus a unit corresponding to 18.62 mm".

The palmo romano is documented in many drawings and plans of architecture, for instance, in the construction of St. Peter's Cathedral in Rome, and it varies between 223–225 mm [8]. Another interesting detail in these plans has come to light: Vignola, the architect of the Palazzo Farnese in Pienza, was still using his Roman oncia, but trying to simplify these measurements for the Pienza braccio as well [9].

Also, the use for instrument making is documented in the writings of Galeazzi [10]. He talks about the best properties of a violin bow and states, that the length of an ideal bow should have 25 pollici Parigini or 37 once del palmo architettonico.

Due to the historical variations of this unit (18.58–18.75 mm), for this study, a value of 18.66 mm for the Roman oncia was chosen, based on the studies of Najmon. He indicates that this value was the most probable size for a unit, due to the brass rulers of A. Stradivari he had investigated. The Roman oncia will be abbreviated with the sign ["].

4. Materials and methods

4.1. Corpus under study

4.1.1. Photographs

Thirty-eight photographs of violins, violas and violoncellos of high quality [11–18] were scaled and calibrated to the exact measurements. Furthermore, the pictures were adjusted to take into account the geometrical distortion of the camera's objective. This was necessary in order to discover a possible geometrical design. Only measurements taken with a caliper were used because violins are often measured over the arch and these values cannot be used for our purposes. Most instruments were chosen from Cremona, a few from Brescia and also instruments from Jakob Stainer, because of his possible education by Cremonese instrument makers (see Table 1).

4.1.2. Drawings, templates and sketches

Stradivari's templates published by Sacconi and Pollens [19] were calibrated to their true size and measured with the Roman oncia and compared with the construction.

4.1.3. Parchment

A parchment of Cozio di Salbue, now owned by the National Museum of Music, showing concentric rings was investigated (Fig. 1).

4.1.4. Rulers of A. Stradivari

Najmon had investigated two brass rulers attributed to the workshop of Stradivari. The rulers are named parziale and perimetricale, from the parziale certain values could be identified and were indicating the use of a unit of 18.66 mm. Unfortunately, the owner of these rulers is nowadays unknown, so only the pictures could be studied (Fig. 2).

4.2. Method of geometrical analysis

4.2.1. Ancient sources and previous constructions

Geometrical analysis of the shape of an instrument is based on the idea that luthiers have made conscious use of numerical proportion. Whilst this approach is well studied in architecture, because of a considerable body of historical documents written by architects themselves [4], such sources are missing in lutherie. But it can be assumed that an object serving to make music could be designed using the omnipresent ideas of Pythagoras and using musical intervals as proportions. The only historical source for instruments is a manuscript from Arnould de Zwolle in 1452, showing how to draw a lute, a clavichord and a little organ, using numerical proportions and a compass. No other writing or plan of this time is yet to be discovered, but lots of templates and sketches from the Stradivari workshop have survived, showing the use of compass and the construction of the f-holes, but hardly any numbers or instructions remain.

Just a few decades after the decline of the Cremonese school, an interest had risen in the construction of the violin, and led to a publication in 1782 by Bagatella, [20] dividing the length of the body in 72 sections, but showing only a very, roughly defined shape without corners. From this point, numerous attempts to understand the design of the violin were published, some of them oversimplifying the topic, others, complicating it.

An example of the latter, is the construction by Simone Sacconi, a system, well known and often tried. He used the Cremonese Braccio (9 units) for the length, but the construction itself is very complicated and includes several mistakes.

The important work by Heyde [21] gives an overview for all kinds of instruments and of certain possible methods of proportions

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