Using the Root Proportion to Design an *Oud*

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Abstract: Oud is a plucked pear shaped instrument. It is the most popular instrument in the Middle Eastern music. The European lute originates from the Arabic instrument known as the *ŪD*. The neck of *oud* has not frets. The most ordinary string combination is five pairs of strings tuned in unison and a single bass string, although up to thirteen strings may be found. Another typical feature of the *oud* is its head, with the tuning pegs bent back at an angle to the neck. On the other hand, the root proportion is a sequence of irrational numbers (√2, √3, √4 and √5), each of which possesses its own individual characteristics. These have been used in designing musical instruments and we used √2 to design body outline of *oud*. The rational underlying this study was to use root proportion in designing an *oud*. Computer Aided Three-dimensional Interactive Application (CATIA) multi-platform CAD/CAM/CAE commercial software was used to draw the mentioned designs.

Keywords: Lute, *Oud*, Root Proportion, Musical Instrument Design, CATIA Software

1 Introduction

The singular importance of the lute as a key musical instrument of the renaissance is attested to not only by the enormous wealth of music it engendered, but also by the poets and writers. For all twentieth century lute makers, the sources of information about the old lutes are limited; paintings, the surviving lutes, the music and a handful of contemporary tutors. Paintings and drawings are only sometimes accurate, but used with care; they have provided considerable information about stringing, shapes, sizes, materials and chronology. By considering in surviving paintings, we can understand that during the history, lute makers have used different proportions and calculations to design new forms of lutes such as: Hans Frei, Giovanni Hieber, Matteo Buechenberg, Jacobus Henricus Goldt, etc.

In this paper, we present a new method in designing *Oud* by using the root proportion. The rest of the paper is organized as follows. The representation of *Oud*, root proportion and CATIA software marshally will be given in sections 2, 3 and 4. And section 5 describes our methodology to designing an *Oud* by using the root proportion.

2 Oud

2.1 History

Lute (Arabic ūd; Persian Barbat; Greek Outi; Fr. luth; Ger. laute; It. lauto, liuto, leuto; Sp. Laŭd) is a plucked-string, pear shaped wooden instrument of Eastern origin. It flourished throughout Europe from medieval times to the 18th century. The European lute originates from the Arabic instrument famous as the *ŪD*. The principle meaning of this noun is not wood, as generally supposed, but flexible stick. The Arabic lute was introduced into Europe by Moors during their conquest and occupation of Spain (711-1492). The oriental lute was and is played with a plectrum and at first the same method was applied in Europe. Pictorial evidence depicts Moorish *ŪD* players and the 9th and 10th century reports inform of visits of famous players such as *Ziryab* to the court of the Andalusian emir *Abd al Rahman II* (822-52).

According to *Farabi*, the Oud was invented by *Lamech*, the sixth grandson of *Adam*. The myth notifies that *Lamech* hung corpse of his son from a tree. The first oud was inspired by the shape of his son's bleached skeleton. The oldest pictorial evidence of a lute dates back to the *Uruk* time in Southern Mesopotamia, Iraq – *Nasiriyah* city at the present time – over 5000 years ago on a cylindrical seal found by Dr. *Dominique Collon* and nowadays housed at the British Museum. The picture shows a woman crouching with her instrument upon a boat, playing right-handed. This instrument comes into view many times throughout Mesopotamian history and again in ancient Egypt from the 18th dynasty onwards in long- and short-neck varieties. One may observe such examples at the Metropolitan Museums of New York, Philadelphia, Cleveland, and the British Museum on clay tablets and papyrus paper. This instrument and its close family member have been a part of the music of each of the ancient civilizations that have been in the Mediterranean and the Middle East area, including the *Sumerians, Acadians, Persians, Babylonians, Assyrians, Armenians, Greeks, Egyptians,* and *Romans*. The *Oud* applied in the Arab world is slightly different to that found in Turkey, Armenia and Greece. Different tunings are applied and the Turkish-style *Oud* has a brighter tone than its Arab counterpart.

2.2 Structure

The neck of *Oud* is made of light wood, with a veneer of hardwood (usually ebony) and it does not have fret. This lets the players to play more expressive slides and vibrato and also allow them to the microtones of the *maqam* system. This progress is almost recent, as *Oud*s still had frets in AD 1100, and they gradually lose them by AD 1300. The *Oud*'s peg box is bent backwards at a 45-90° angle from the neck of the instrument (figure 1), probably to help hold the low-tension strings firmly against the nut, which is not traditionally glued in place; it is only hold in place by strings pressure. The tuning pegs are simple pegs of hardwood, somewhat tapered, that are held in place by friction in holes drilled through the peg box. The sound box of *Oud* is assembled from wooden staves of hardwood (maple, cherry, ebony, rosewood or other tone woods) named ribs; attached edge to edge with glue to form a deep rounded body for the instrument (figure 1). The soundboard or belly is a teardrop-shaped thin flat plate of resonant wood, like spruce or pine. In all Ouds the soundboard has single or sometimes triple adorned sound holes under the strings, named rose or sound hole (figure 1). The bridge is joined to the soundboard; it does not have a separate saddle but has holes bored into it to which the strings attach directly (figure 1). The most usual string combination is five pairs of strings tuned in unison and a single bass string. The Strings were historically made of gut or sometimes in combination with metal, and are still made of gut or a synthetic substitute, with metal windings on the lower-pitched strings. Modern producers make both gut and nylon strings, and both are in common use. Gut is more authentic, though it is also more susceptible to irregularity and pitch instability due to changes in humidity. Nylon, less authentic, offers greater tuning stability but is, of course, anachronistic.

Figure 1: *Oud* made by Mr. Ahanali Jahandideh with this new method.

3 Root Proportion

The root proportion is a sequence of irrational numbers (√2, √3, √4 and √5), each of which possesses its own individual characteristics. Figure 2 shows the simple geometric generation of the root rectangles (√2, √3, √4 and √5) from the original unity of the square. We have already met the value of √2, as produced by the diagonal of a square; by dropping this diagonal down and retaining a short side of one, our new rectangle will have ratio of √2 (1.4142). The diagonal of this rectangle will promote a √3 (1.732) rectangle, which in turn promotes a √4 (2) rectangle (the double square), whose diagonal will give us a √5 (2.236) rectangle in the same way, and so on. These have been used in designing musical instruments and we used √2 to design the body outline of Lute.

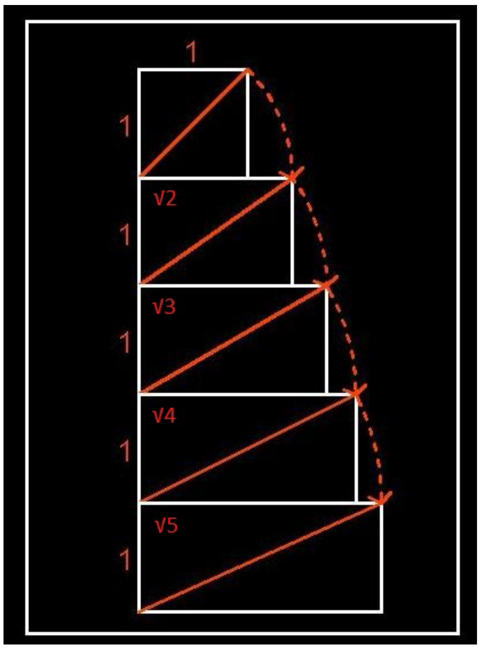

Figure 2

4 CATIA Software

CATIA (Computer Aided Three-dimensional Interactive Application) is a multi-platform CAD/CAM/CAE commercial software suite extended by the French company Dassault Systems and marketed worldwide by IBM. It has been written in the C++ programming language.

The software was produced in the late 1970s and early 1980s to extend Dassault's Mirage fighter jet, and then was implemented in the aerospace, automotive, shipbuilding, and other industries.

5 Methodology

Root proportion has been used in designing of musical instruments but it has not been used in designing *Oud*. Here, we design an *Oud* by applying Root proportion in all its parts for the first time. Our design was drawn with CATIA software, although it can also be drawn by simple design tools such as ruler and compass.

5.1 System definition

We began by defining length A as 72cm. We divided A by √2 repeatedly to generate some useful ratios, as shown in Figure 3.

A=72cm……………………….....total length of lute (sound box and neck without nut)

A/√2=B……………………….......length of sound box

B/√2=C…………..………….…….width of sound box

C/√2=D…………………head of sound box upper end of big sound hole

D/√2=E…………..……..length of bridge; also half sound box width

E/√2=F…………………………......length of fingerboard

F/√2=G…………………………..distance behind bridge

G/√2=H…......length of where sound box linked to neck

H/√2=I……………..………………………width of nut

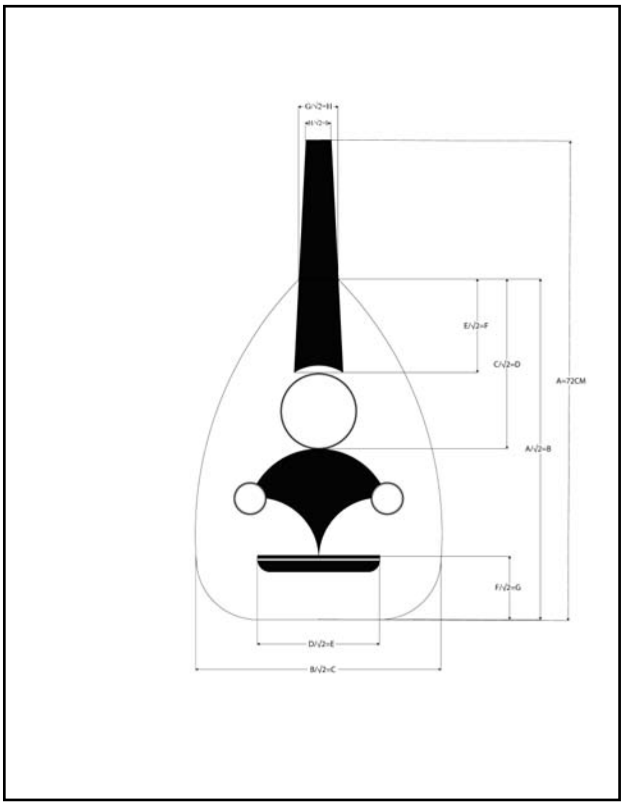

Figure 3

5.2 Designing Method

In Figure 4, we have begun to design by drawing line **ab** with length equal to **A**. then using the distance **G**, we located point **c**. Line **de** with length equal to **C** was drawn perpendicular to line **ab** (**ce=dc=C/2**), and centered on point **c**. A circle with radii **E**/2 was drawn with center at point **c**. This circle intersects line **de** to define points **f** and **g**; again from these points, two circles were drawn with the same radii (**E**/2). We have drawn lines **af** and **ag.**

By using the distance **B**, we located point **i**; and also by using the distance **F** we located point **j**. From point **j**, we drew line **kl** perpendicular to line **ab** (**kj=lj=C**) and from point **i**, line **mn** was drawn perpendicular to line **ab** (**mi=ni=H/2**).

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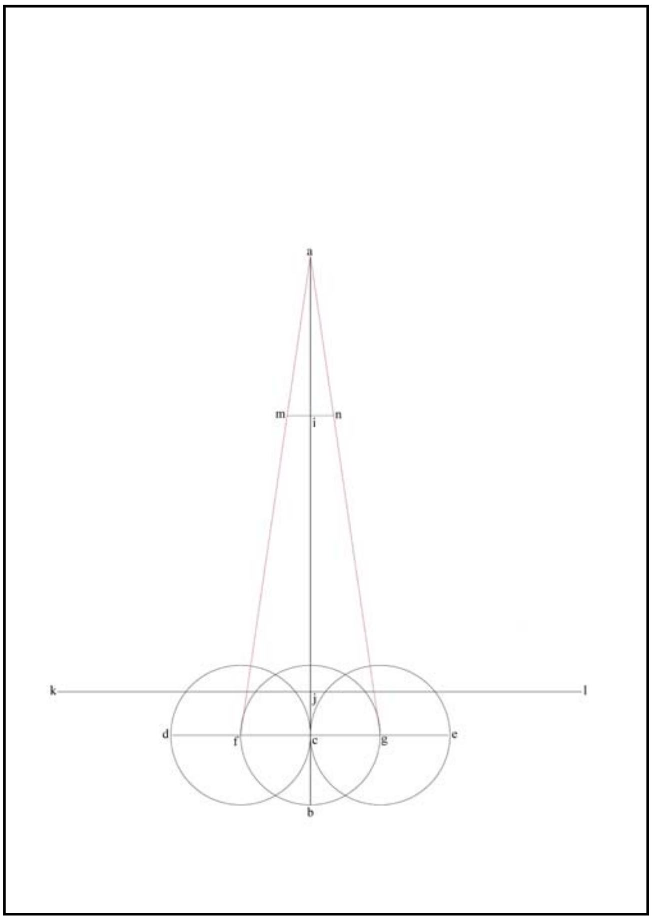

Figure 4

In Figure 5, we have drawn arcs **md** and **ne** with radii **lm=kn** centered at points **l** and **k** which meet point **d** and **e**.
From point **a**, we drew line **op** perpendicular to line **ab** with length equal to **I** (**oa=pa=I/2**).
A circle with center at point **c** intersects line **ab** to define point **q**. from point **q** a circle was drawn with radius=**qf**. This circle intersects line **ab** to define point **r**, center of big sound hole.
By using the distance **C** we located point **s,** from which a circle was drawn with radius=**sf**. This circle intersects line **ab** to define point **t**. Line **rt** is the radius of big sound hole.
By meeting circles with centers at points **s** and **f**, point **u** is defined, and by meeting circles with centers at points **s** and **g**, point **v** is defined, small sound holes centers. By meeting line **af** and circle with center at point f, point **w** is defined and also by meeting line **ag** and circle with center at point g, point **x** is defined. Two circles with radii **uw=xv** were drawn with centers at points **u** and **v**, small sound holes.
We drew lines **om** and **pn**, then drew lines **my** and **nz** perpendicular to line **mn** with length equal to **F** and drew arc **yz,** with radii **ry=rz** centered at point **r.**
We drew line **y′z′** passing through two circles with centers at points **f** and **g** to complete the body outline.

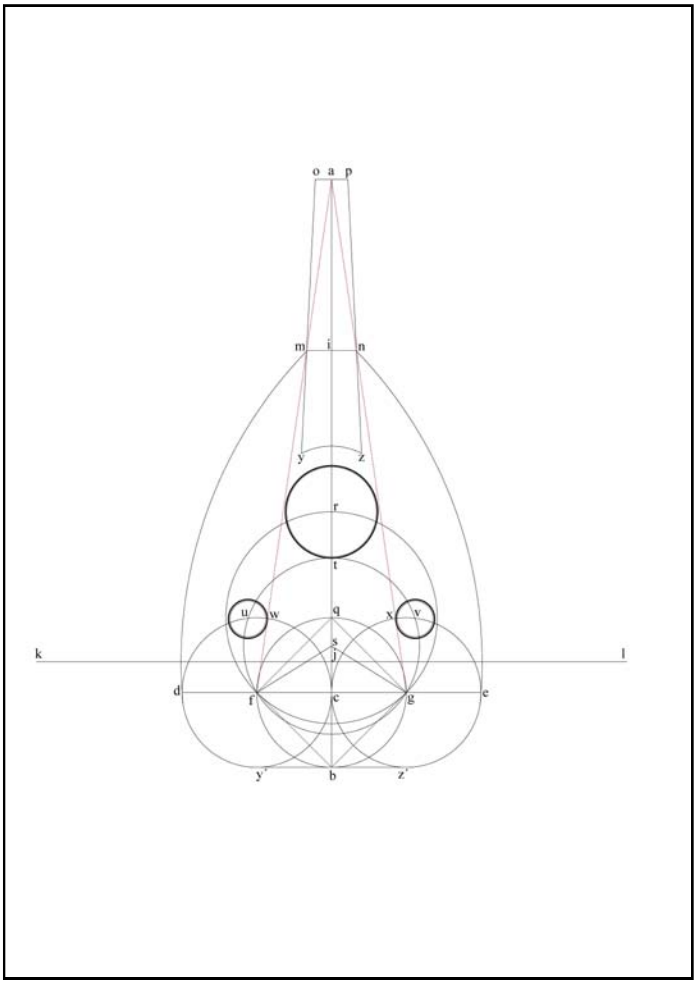

Figure 5

6 Conclusion

The new method of designing *Oud* presented in this paper was based on an essential principle and that was keeping origin of the voice and the body of *Oud*. In order to develop the present method, other methods were also studied. The *Oud* has been designed in different ways during the musical instrument designing history. But this new method tried to design an *Oud* with precise formulas, and because of highlighted effect of sound box on the musical instruments voice, we focused on designing sound box and then flourished it in whole parts of *Oud*. We expanded√2 (as a root proportion ratio) throughout whole of instrument body. Then, based on the fact that the shape of musical instrument affects the sound, we tried to design a proportionate shape as well as possible. Some complementary acoustical experiments can help us to show the real effect of this new method on voice of *Oud*. Future works will include acoustical experiments on this new method of designing *Oud*.

References:

1. Curt Sachs, *The History of Musical Instrument*, W. W. Norton & company. Inc, 1940
2. Andreas Schlegel, *The Lute in Europe*, The Lute Corner, 2006
3. Douglas Alton Smith, *A History of the Lute from Antiquity to the Renaissance*, Lute Society of America, 2002
4. Robert Lundberg, *Historical Lute Construction*, Guild of American Luthiers, 2002
5. Kevin Coates, *Geometry, proportion and The Art of Lutherie,* Oxford University Press, 1985