

A SUCCINCT HISTORICAL VIEW OF KAMANÇHE AND RECOMMENDATION OF A NEW METHOD TO DESIGN IT BY USING THE GOLDEN SECTION

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Abstract

USING THE “GOLDEN SECTION” TO DESIGN A KAMANÇHE

The kamanche is an un-fretted Persian bowed string instrument related to the bowed rebab, an earliest spiked fiddle which is predecessor to most modern European and Asian bowed instruments. The word "kamanche" is Persian. it means "small bow" (kaman, bow, and -che, small). It is widely used in the musical cultures of Iran, Turkey, Azerbaijan, Uzbekistan, Armenia and Turkmenistan, with differences significantly in the structure and sound of the instrument. In this study, we have focused on applied kamanche in different regions of Persia. It is played vertically with a variable-tension bow in the manner of the European viol, although it approximately corresponds to a viola in length. From the bottom protrudes a spike to support the kamanche as it is being played, therefore in English the instrument is sometimes named the spiked fiddle. The kamanche is an oriental musical instrument with a long history and it is extensively used in the classical and folk music of Persia. The historical view of the kamanche in Persia and its structure will be discussed and described in this paper. In addition, we will scrutinize the kamanche as described in historical books, manuscripts and Persian illustrations.

Introduction

The Renaissance was an enormous cultural progress which brought about an era of scientific revolution and artistic alteration at the dawn of modern European history. It marks a transitional phase between the end of the Middle Ages and the beginning of the modern times. The Renaissance is more often thought to have begun in the fourteenth century in Italy and the sixteenth century in northern Europe. The Renaissance artists applied the golden section widely in their paintings and sculptures to attain balance and beauty. Musical instrument designing could not have been exempted from this category, and golden section was applied in designing musical instruments by the greatest luthier of Cremona, Stradivarius. Unfortunately it was not applied in making traditional instruments. We use the golden section in designing a *kamanche* as a Persian traditional instrument and hope it will flourish in other traditional instruments. Until now, no designing procedure or acceptable ratios have been proposed for this musical instrument. The rest of the

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paper is organized as follows: The representation of the *kamanche*, golden section and CATIA software marshally will be given in Sections 2, 3 and 4. Section 5 describes our methodology to designing a *kamanche* by using the golden section.

Kamanche

History

The *kamanche* or *kamāncha* is a Persian bowed string instrument related to the bowed *rebab*, played with a variable-tension bow. The word *kamanche* means a 'little bow' in Persian (*kaman*, bow, and *-che*, diminutive). It is extensively used in the musical culture of Iran, Turkey, Azerbaijan, Uzbekistan, Armenia and Turkmenistan, with slight variations in the structure of the instrument.

Kamanche was seen in celebration and war scenes paintings from Mongolian and Timurid periods. It was one of the most important instruments in the Safavid and Qajar periods. It was an instrument which was used in celebration scenes of Safavid era. A wall fresco at Chehel Sotoun Palace in Isfahan shows a *kamanche* player among a group of court musicians at the royal court. This wall painting depicts a banquet scene of Shah Abbas II in honor of Nader Mohammad Khan emir of Turkistan in 1646. Also, another wall painting at Hasht Behesh Palace in Isfahan shows a woman playing the *kamanche*.

A *Tasnif* – a vocal piece played in the modal system of Persian classical music – has remained from the Zand period which is related to Lotf Ali Khan Zand (the last king of this dynasty), sung with the accompaniment of the *kamanche* and *ney*. Eugene Flandin, an Italian-born artist who lived in Paris, was sent to Iran on a mission in 1840 to collect information about Iran's political situation. He mentioned the *kamanche* when he put forth his observations in the Fat h Ali Shah – second Qajar king of Persia – court; and described it as a kind of violin.

There were so many groups of jiggers called *dāsteh* in Zand and Qajar periods some of which were courted and the others non-courted. The most famous of this *dastehs* were master Zohreh and master Mina Dasteh under Fath Ali Shah monarchy. Zohreh and Mina were two famous female singer-players in this period who used the *kamanche* as one of the most important instruments in their *dasteh*; although from the era of Lotf Ali Khan, the last king of the Zand dynasty, these *dastehs* decreased but *kamanche* stood up as one of the most important instruments in these groups. All these accounts reveal the importance of the *kamanche* in the history of Persian music. However, from the end of Mozafaridin Shah monarchy the *kamanche* became less important with the advent of the violin to Iran. During the recent decades, by the efforts of Ali Asghar Bahari, the *kamanche* became revived among other Persian instruments

Some famous *kamanche* players in and after Qajar period are: Khoshnavaz Khan, Agha Motaleb, Esmail Khan, Hossein Khan Esmail-zadeh, Gholi Khan, Musa Kashi, Mirza Rahim, Javad Khan Ghazvini, Bagher Khan Rameshgar, Alireza Changi, Mirza Gholamhossein, Safdar Khan, Hossein entitled Karim-Kur and his daughter, Vajihah, Farmanfarma the Uncle of Naser-al-Din Shah, Jamileh (the female student of Esmail Khan), Ali Khan, Reza Khan Nikfar, Hossein Yahaghi

and his sister Keshvar Khanum entitled Farah-Lagha, Ali Asghar Bahari, Ardeshir Kamkar, and Kayhan Kalhor.

Kamanche in historical writings

Kamanche as a leading Persian bowed instrument was given mention in many books from different centuries. Ebn-e-Faghih is the earliest who pointed to this instrument in the tenth century. Also, some Persian poets (such as Masoud-e-Sa'd) have used the word *kamanche* in poetry. Allameh-Ghotb-al-Din Mohammad Shirazi, in his well-known book *Dorrat-al-Taj*, mentions this instrument by the name *komajeh* which is possibly a variant of *kamanche*. The famous musician and theorist, Abd-al-Ghader Maraghi describes the *kamanche* in his well-known book *Jame'-al-Alhan* and expresses that the sound of the *kamanche* is more attractive than that of the *ghezhak*, another Persian bowed instrument played in Sistan-Baluchistan of Iran and is interrelated to the Indian *sarangi*. Hassan Kashani's book, *Kanz-al-Tohaf*, is probably the only historical book on the making of musical instruments, describes how the *kamanche* and its accessories are made. It is very interesting to notice that the writer of the book gives this instrument the name *gheshak* (another variant of *ghezhak*). Another book mentioning the *kamanche* as a perfect instrument is *Behjat-al-Ruh*. The famous historian composer - theorist Ruh-al-Allah Khaleghi describes the *kamanche* in his famous historical book, *Sargozasht-e-Musighi-ye-Iran*:

'The sound of the *kamanche* is nasal, while the sound of the violin is closer to nature. As the violin had four strings, after it was introduced to Persia, another string was added to the *kamanche* to imitate the violin. Furthermore, in view of the fact that the violin was very similar to the *kamanche*, many *kamanche* players became violin instructors. Other factors that lowered the importance of the instrument were the lightness and portability of the violin and its good-looking shape; therefore the *kamanche* was gradually replaced with violin and today nobody plays the *kamanche*. It is always natural that incomplete instruments will be replaced by the further improved ones. Similarly, the *ney* was replaced by the flute or *sorna* by oboe.'

Structure

The *kamanche* has a long neck including fingerboard which is shaped as a truncated inverse cone for easy bow moving in down section, peg box on both sides of which four pegs are placed, and finial. Its body also has a lower spheroid chamber made from gourd or coconut shell or wooden staves such as blackberry, blackberry root, walnut, pear, maple, cherry or sourcherry – depending upon the geographic region where *kamanche* maker lived – as a sound box, which is usually covered on the playing side with skin from a lamb, goat, deer or fish. Oddly, the instrument's bridge runs diagonally across this membrane. At the bottom of the instrument protrudes a sort of spike to support the *kamanche* while it is being played. Therefore in English the instrument is sometimes referred to as the spiked fiddle. It is played while sitting down and is held like a viol. The end-pin can also rest on the knee or thigh while being seated on a chair. As mentioned in several books written in the Persian language, it seems that *kamanche* had only two strings. Although we do not know when the third string had been added to it, we know that in the Qajar period, the *kamanche* had three strings. Also the *kamanches* seen in ancient Persian paintings have three strings. It is supposed that the fourth string was added in the early twentieth century as the result of the introduction of the European violin to Iran.

Primary strings were made of guts or silk. Modern strings may be gut, solid steel, stranded steel, or various synthetic materials, wound with various metals. *Kamanche* strings are produced in the countries where the instrument is played, but they are often of low quality and in view of this fact, many players try to apply violin or viola strings to their *kamanche*.

Kamanche is usually tuned like ordinary violin (G, D, A, E), but it may alter depending on Persian music *dastgahs* and the region of the country where it is played.

Golden section

History

The number $\phi = \frac{1+\sqrt{5}}{2} = 1.61803398 \dots$ $\Phi = \frac{1+\sqrt{5}}{2} = 1.61803398 \dots$ names the golden ratio. It is also known as the golden mean, golden section, divine proportion or divine ratio. The term golden section appears first to have been applied by Martin Ohm in his textbook *Die Reine Elementar Mathematik* in 1835. The first person who used this term in English is James Sulley in his article on aesthetics in the ninth edition of the *Encyclopedia Britannica* in 1875. It seems that the symbol "ϕ" was first applied by Mark Barr at the beginning of the twentieth century in honor of the Greek sculptor Phidias, who, as a number of art historians declared, made a wide application of the golden ratio in his works.

It may be supposed that the golden section has perhaps been discovered and rediscovered in the course of the history, which makes clear why it goes under a number of names. An early user of Phi such as: Phidias (500-432 BC), a Greek sculptor and mathematician, deliberated phi and used it in the design of the Parthenon. Plato (428-347 BC), in his views on natural science and cosmology considered the golden section to be the key to the physics of the cosmos. Eukleides (365-300 BC), in his book *Elements*, referred to separating a line at the point of phi as "separating a line in the extreme and mean ratio". This later gave rise to application of the term 'mean' in the golden mean. He also related this number to the construction of a pentagram.

Leonardo Fibonacci, born in Italy in 1175 AD, discovered the properties of the series the Fibonacci sequence, but it is not clear whether he understood its relationship to phi and the golden mean.

Golden Section in Music

The golden section emerges numerously in music; the great classical composers like Mozart had a consciousness of the golden ratio and applied it in composing some of his well-known sonatas. Also Bartók, Debussy, Schubert, J. S. Bach and Satie applied the golden section in their compositions. Surprisingly, musical scales are based on Fibonacci numbers and musical frequencies are based on Fibonacci ratios. Golden ratio has been applied in designing some musical instruments, for example Stradivarius applied the golden ratio in his violin, and Baginsky used the golden section in his method of constructing violins.

Geometry of Golden Section

A line segment is divided into two sections such that the ratio of the original segment to the larger section is equal to the ratio of the larger section to the smaller section. If **c** is the original segment, **b** is the larger section, and **a** is the smaller section, then $c = a + b$ and $c/b = b/a$. Thus, **b** is the geometric mean of **a** and **c**; the ratio is well-known as the ‘divine proportion’.

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.

Methodology

Golden section has been used in designing the violin and other musical instruments but it has not been used in Persian instrument designing. For the first time, we used this ratio in designing an Iranian instrument. This ratio was used on the entire body of the instrument and a *kamanche* was made by using obtained plans. Because of highlighted effect of the sound box on the musical instrument's timbre, we designed its sound box by using a golden section. Our design was drawn with CATIA software, although it can be drawn by simple design tools such as ruler and compass.

System Definition

We began by defining length **A** as 50cm – conventional length among Persian *kamanche* makers. We divided **A** by $\Phi = 1.618$ repeatedly to generate some useful ratios, as shown in figure 1.

| | |
|--|--------------------|
| 50 ‘total length of neck’ | A=50cm |
| $50 \div 1.618 = 30.9$ ‘fingerboard length’ | $A/\Phi = B$ |
| $30.9 \div 1.618 = 19.09$ ‘depth of sound box’ | $B/\Phi = C$ |
| $19.09 \div 1.618 = 11.79$ ‘peg box; also width of skin’ | $C/\Phi = D$ |
| $11.79 \div 1.618 = 7.29$ ‘Finial; also skin behind bridge’ | $D/\Phi = E$ |
| $7.29 \div 1.618 = 4.5$ ‘skin in front of bridge’ | $E/\Phi = F$ |
| $30.9 + 4.5 = 35.4$ ‘resonance length or distance between bridge and pawl’ | $F + A$ |
| $35.4 \div 1.618 = 21.8$ ‘width of sound box’ | $(B + F)/\Phi = G$ |

Designing Method

In Figure 2, we have begun to design the cross-section of the sound box by drawing line **ab** with length equal to **C**. Then, using the distance **D** we located point **c**. Line **de** with length equal to **G** was drawn perpendicular to line **ab**, and centered on point **c**. In figure 3, we have located points **f** and **h** on line **de** using G/Φ . Two circles with radii $eh = df$ were drawn with centers at points **f** and **h**. These circles intersect line **de** to define points **m** and **n**. Also, at the intersection of these circles with line

ab , point g is defined. In figure 4, we have drawn arcs st , tj and sj , with radii $en=dm$ centered at points g , m , and n . From point b we drew line op perpendicular to line ab to complete the outline of the sound box.

Conclusion

The new method of designing the *kamanche* presented in this paper is based on an essential principle and that was for preserving the true sound and the body of the *kamanche*. In order to improve the present method, other traditional methods were also studied. The traditional methods in designing the *kamanche* were based on empirical methods and have not employed exact calculations. But this new method tried to design a *kamanche* with precise formulae, and because of highlighted effect of sound box on the musical instrument's timbre, we focused on designing the sound box and then applied it all parts of the *kamanche*. In fact, the traditional methods give their place to this novel method with more prestigious discipline with keeping them original and making a step toward more comfort. In our opinion, the made instrument has a warm timbre. In comparison with the traditional shape, our instrument has taken a more proportionate shape.

Until now, no designing procedure or acceptable ratios have been proposed for this Iranian musical instrument. In addition, we expanded the golden ratio throughout the instrument's body. Then, based on the fact that the shape of the musical instrument affects the sound, we tried to design a proportionate shape as much as possible. Some complementary acoustical experiments can help us to show the real effect of this new method on timbre of the *kamanche*. Future works will include acoustical experiments on this golden *kamanche*.

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References

- A Dunlap, Richard. 1997. *The Golden Ratio and Fibonacci Numbers*. America: World Scientific Publishing.
- Azarsina, Mehdi. 1371. *Shive-ye-Kamanche Navazi*. Iran: Soroush Publication.
- Binesh, Taghi. 1371. *Seh Resale-ye-Farsi Dar Musiqi*. Iran: Markaze Nashre Daneshgahi.
- Binesh, Taghi. 1382. *Brief History of Persian Music*. Iran: Nashr-e- Havay-e-Tazeh.
- Coates, Kevin. 1985. *Geometry, proportion and the Art of Lutherie*. Oxford: Oxford University Press.
- Ebn-e-Safiaddin, Abdolmoemen. 1346. *Behjat-al-Ruh*. Tehran: Bonyad-e-Farhang.
- Haddadi, Nosrat Allah. 1376. *Farhangnameh-ye-Musiqi Iran*. Iran: Tutia Publication.
- Emam Shushtari, Mohammadali. 1348. *Iran Gahvare-ye-Danesh Va Honar*. Iran: Vezerat-e-Farhang Va Honar.
- Gardner, Helen. 1384. *Art through the Ages*. Iran: Agah Publication.

- Khaleqi, Ruh-al-Allah. 1333. *Sargozasht musiqi*. Iran. Iran: Mahoor.
- Maraghi, Abd-al-Ghader. 1366. *Jame'-al-Alhan*. Iran: Moassese-ye-Motaleat Va Tahghighat-e-Farhangi.
- Mashhon, Hassan. 1380. *The History of Persian Music*. Iran: Farhang-e-Nashr-e-No.
- Massoudieh, Mohammadtaghi. 1384. *Persian Instruments*. Iran: Zarrin Va Simin Publication.
- Massoudieh, Mohammadtaghi. 1365. *Mabani-e-Ethnomusicology*. Iran: Soroush Publication.
- Sachs, Curt. 1940. *The History of Musical Instrument*. America: W. W. Norton & company. Inc.