BRIDGES
Mathematical Connections
in Art, Music, and Science

Bridges between Antiquity and the New Turkish Architecture in the 19th Century

Zafer Sagdic
Faculty of Architecture, History of Arcitecture Dpt.
Yildiz Technical University
Yildiz, 80750, Istanbul, TURKIYE
sagdic@ yildiz.edu.tr

Abstract

From the beginning of the 19th century, the Ottoman Empire went through a phase of intensive economic and socio-political transformation aimed at modernising the old system. A series of social and institutional reforms based on the Western models, was attempted in order to re-structure the Ottoman Empire. One of the major areas where this transformation took place was the New Turkish Architecture.

The term "New Turkish Archtecture is used to describe the products of a movement which claimed to be a big step forward and which was predominant in the Tukish Architecture in the 19th century, especially during the reigns of Sultan Abdulmecid (1839-1861), Sultan Abdulaziz (1861-1876), and Sultan Abdulhamid the 2nd (1876-1909).

Throughout the 19th century, it can be seen that architecture was dominated by Neo-classical features. In this period, archiects both of muslim and non-muslim origin, attempted to trigger a renewal movement through the use of mainly traditional Ottoman motifs. Thus, local elements were exploited within the frame-work of the trends and schemes current in Western architecture.

These trends included certain principles previously tried out by the French "Beaux-Arts" school, and the Gothic style, which was adopted in many Western countries with a concern for national expression, and the Orientalist movement, which encourged the adaption of the traditional Ottoman motifs.

Besides the fact that the new designs were in line with modern Western concepts, they expressed to be accepted in the eyes of the West (Usul-i Mimari-i Osmani contained theoretical ideas and incorporated Ottoman Architecture in the context of the architecture of the civilised world, tracing its history back to antiquity. Traditional styles were approached with a reference to the Antiquity and they were subjected to new interpretations).

Thus, some bridges between the Antiquity and New Turkish Architecture in the 19th century were established: These bridges included the integrations of the Antique Western architectural elements were seen/ identified in the Traditional Turkish Architecture; but nature and historical elements were maintain in local practices.

It can be said that with the use of elements from the antiquity the New Turkish Architecture was re-structured in the name of modernism and transformed as a whole in the eyes of a European-centered history of theory and style.

1. The First Bridge between Usul-i Mimari-i Osmani and Antiquity

The first bridge between Usul-i Mimari-i Osmani and the Antiquity: Usul-i Mimari-i Osmani was the name given to the architectural order which was re-arranged for the Vienna World Exibition in 1873. Within the arrangements made for the Vienna World Exibition, the most important architects of the Ottoman Empire prepared a book, which did not only have texts about the history and basic principles of Ottoman Architecture, but which also contained many drawings of important buildings. Thus, the book was also named "Usul-i Mimari-i Osmani", which was written in three languages of the Empire: Ottoman Turkish, German and French.It can be said that Usul-i Mimari-i Osmani established bridges between "The Ten Books" of Vitruvius, "The Four Books" of Alberti, and "The Ten Books" of Palladio as the conceptual approach to architectural design. In all of these books, the system of architectural orders relating to their respective periods were described and the principles of creation were examplified with different architectural compositions.

As is well known, Vitruvius wrote about the orders of antiquity in the Chapter on the Principle of "Décorum". In this chapter the connection between the specific orders and the specific divine characters (the contents) was explained. Unornamented Doric order was created for some gods, such as Athena, Ares, and Heracles to show the dominant masculine aspect of their characters. Florally ornamented and feminine Corinthean order was created for some goddesses such as Afrodite, Flora, Proserpina and for the nymphes. Finally, graceful-temples of semi-ornamented Ionic order were created for Hera, Artemis, and Dionysos because of their powerful and graceful-looking characters.

Alberti explained the nature of there orders: Doric order represented power and strength; the Corinthean order represented beauty and coquettish desires, and the Ionic order represented the graceful-style, which took its place in the middle of the other two orders. Palladio re-examplified the principle of propriety in the principle of "Décorum" as mentioned by Vitruvius.

In Usul-i Mimari-i Osmani under the third sub-heading In the first chaper of (Technical Documents) are listed three orders in the Ottoman architecture: the Mahruti order (échanfrine-schragkantig); the Müstevi order (bréchiforme-breccienförmig); and the Mücevheri order (crystallisé-kristallförmig). In this book it is claimed that there are specific bridges between Ottoman Architecture and the antiquity. This relationship was not limited to the descriptions of the architectural orders; the selection of the orders or the milieu were created according to the principles of "Décorum" in the Antiquity.

The Mahruti order referred to as the Doric order, was used in tekkes (the dervish lodges), in arastas (commercial centers), in stores and in buildings where simplicity should be emphasized. The Mücevheri order, which took its reference from the Coritnhean order, was generally used in the buildings where magnificence and an imposing appearance were desired. The Müstevi order, which was in the middle of the two other orders like the Ionic order, was used in the arcades of the buildings and in tombs.

2. The Second Bridge Between Usul-i Mimari-i Osmani And Antiquity:

The principles set by the Usul-i Mimari-i Osmani for using different orders on the same façades and within the same buldings are created conforming to the contepts in antiquity. Vitruvius wrote that the stoas which covered the squares and the coloumns on the ground-floor should be higher and thicker than the columns on the upper floors. According to Palladio, the strongest order is the one in which the ground-floor was created to carry all the load of the composition as a whole. In the antiquity, the Doric order, the Ionic order, the Corinthean order, and the Composit order were all used in this way. Thus, in Usul-i Mimari-i Osmani, the Mahruti order, the Müstevi order, and the Mücevheri order were used according principles applied in antiquity. (However, different variations on the arrangement of these orders could be seen in some examples of Usul-i Mimari-i Osmani).

In Usul-i Mimari-i Osmani, the Ottoman Architectural orders were presented as the original elements of the national architectural dialec, which was brought to the peak by Architect Sinan. Thus, it can be said that the main aim of the Usul-i Mimari-i Osmani was to create an original national style, as did the other nationalities and that the Usul-i Mimari-i Osmani was expected to be a part of the history of Western architectural theory. It was also emphasized that the national dialec of architecture had the same principles with the international architectural dialectics. Thus, Alberti adopted the same approach when writing his book; he claimed that the Composit order was Italian, in order to prove that the Italians did not owe anthing to foreigners.

3. The Third Bridge between Usul-i Mimari-i Osmani and Antiquity:

It was also pointed out in Usul-i Mimari-i Osmani that the Ottoman Architecture had some connections with mathematics in the same way as the architecture of Antiquity had some relationships with mathematics.

In general, it was can be said that both Usul-i Mimari-i Osmani and the Architecture in Antiquity, used some common systems of proportion.

Now that we are celebrating the 700th anniversary of the establishment of the Ottoman Empire, it would be timely and useful to study the unique and magnificent architecture of this Empire as well as its military and political achievements on three continents. Within Ottoman architecture, the examples of the 19th century architecture occupy a particular place, especially regarding its aesthetic qualities and highly advanced structural characteristics. The relationship between design and mathematics is also significant in these examples and deserved to be studied in depth. In order to show why, a general review of the relationship between architectural design and mathematics is helpful.

Mathematics can be roughly divided into two main parts: one is "practical mathematics", such as the operations we use in daily life; the other is "pure mathematics", which is used in establishing the complex mathematical relationships in the positive sciences. The study of the relationship between architectural design and mathematics depends on "pure mathematics".

We must first accept that all the objects in nature and the relationships between these objects are governed by rules of geometry. As Galileo stated, nature has a certain mathematical design: "the book of nature can only be read by those who know its language, which is mathematics". Thus, if we accept "pure mathematics" as a kind of game, it can be said that nature is the medium in which this game is played, and the constituent parts of nature are the symbols used in mathematics; in other words, they are the pawns used in the game. Throughout the game, by further developing the metaphor, we can assume that the single symbols will come together to form groups of symbols. As a result of these formations, we can see the geometrical rules governing the symbols, that is, the groups of objects existing in nature. To put it more clearly, the rule(s) governing the relationship between architectural design and mathematics can be found among the rules of governing the relationships in nature.

Architects, while analyzing the designs of various buildings, almost always turn to nature, observing it carefully and transforming their observations into design elements. Consequently architects create their designs by studying the geometrical rules that establish the various natural correlations with a concern for architectural style. In that sense, architects can be defined as the organizers of the relationships between the forms and functions of buildings. As Monroe Beardsley said, "The form of an aeshetic object is the total web of relations among its parts". In this way, the geometrical rules in nature can be taken as the rules of "Beauty". It is known that, throughout the history of design, architects have always created their designs to create "artifical environment" within the framework of the geometrical rules.

In the light of this preface, the question of how the mathematical rules (symmetry, proportion, geometry, etc.) affected the 19th century Ottoman Architecture can be answered more clearly. However, consider the question in a certain framework, a few more basic questions should be answered. What are the structural and aesthetic rules that were used in the 19th century Ottoman architecture? Why is it still important today to take these rules into consideration?

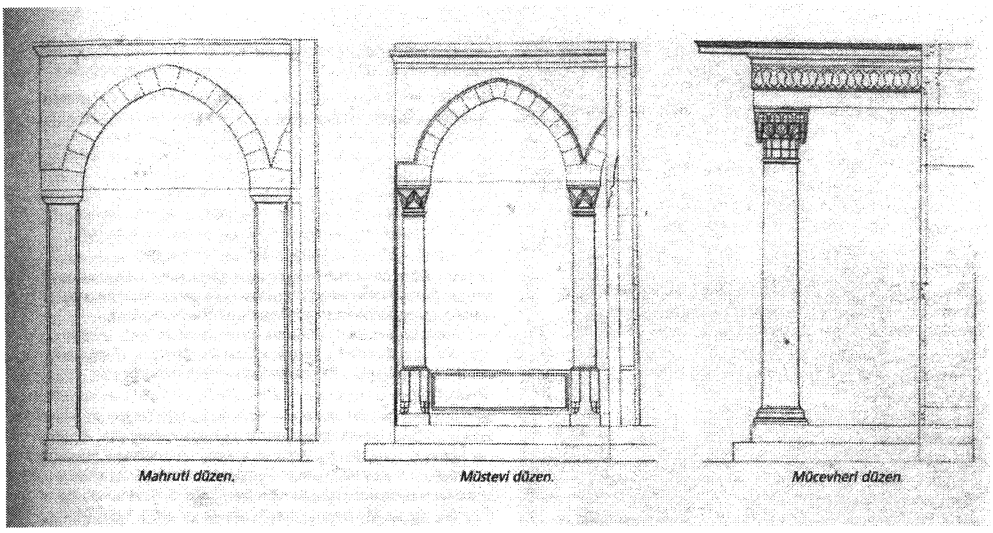

Fig.1 The mahruti order Fig.2 The müstevi order Fig.3 The micevheri order

Generally, it can be said that in the examples given in Usul-i Mimari-i Osmani, the width of the capital on a column inside the mosque is taken as the module. The height of the columns used in monumental buildings is usually 10 to 18 times the radius of the capital. In all the orders used for columns, the radius at the bottom is the size of six modules and the radius at the top is five-and-a-half modules. In this connection, it might be useful to remember the orders used in columns: the conical order (*tarz-i mimari-i mahruti*); the multiple-plane order (*tarz-i mimari-i müstevi*); the stepped/crystal order (*tarz-i mimari-i mücevheri*). In order to define these orders briefly, it can be noted that the conical order has columns whose maximum height is six modules. In the multiple-plane order, the height of the whole column, including the base and the capital is ten modules. The stepped/crystal order, which is both spectacular and sophisticated, the maximum height of the column together with the base and the capital is eighteen modules.

It is also known that there is a relationship between mathematics and the dimensions of the colums used in antiquity. From the antiquity onwards, columns have been reduced in diameter towards the capital with a taper unevenly distributed over the height of them. Altough, there were some varieties the upper diameter of columns were usually 0.85 of the lower diameter in all of the there orders of antiquity, the Doric, the Composit, the Corientihean.

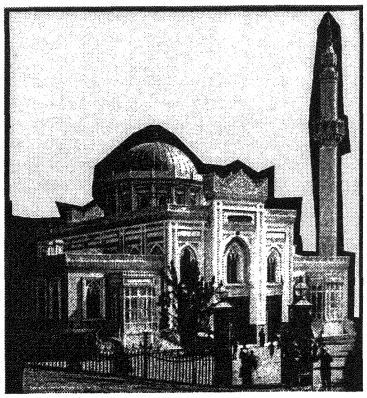

Fig.4. Yildiz Valide Sultan Mosque

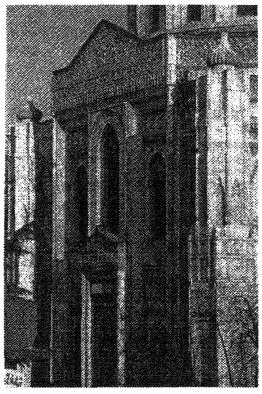

Fig.5. The facade of Yildiz Valide Sultan Mosque

Fig.6. The Sadabad Mosque

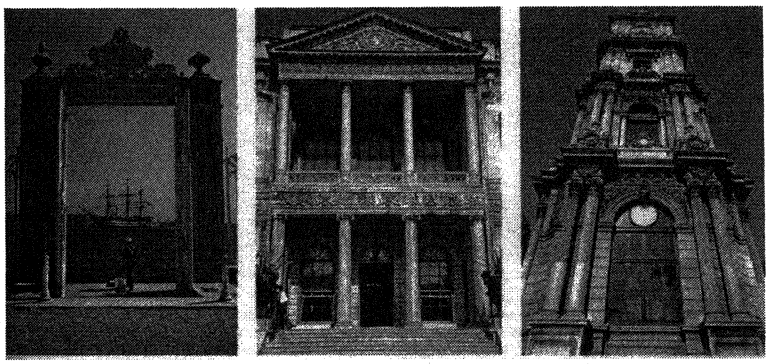

Fig. 7. The details from the Dolmabahçe Palace

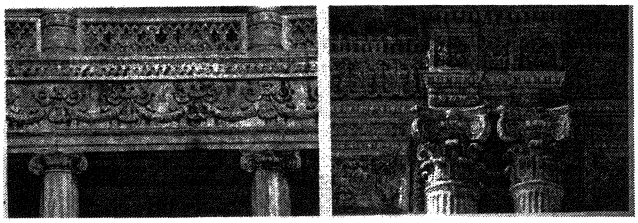

Fig. 8 The details from the Dolmabahçe Palace

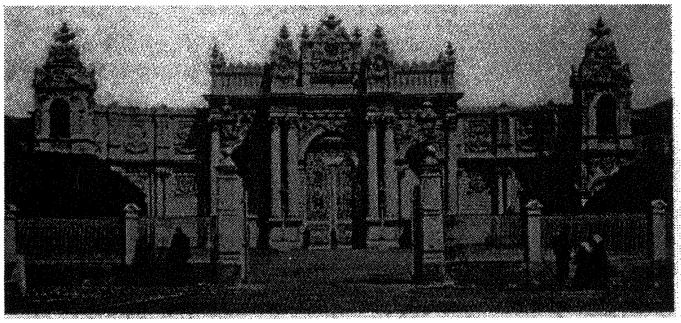

Fig.9 The Gate of the Dolmabahçe Palace

From examples are given above, it is cleary identified that the 19th century Ottoman Architecture, the Usul-i Mimari Osmani was the interpretation of the Antiquty and the Classical Ottoman Architecture, which was designed by geometrical rules. When we look into the relationship between mathematics and the architectural design found in the monumental architecture buildings of the Classical Ottoman Period, it will be observed that the certain proportional relationships were used, the existence of which cannot be denied. According to Arpat[5], these proportional relationships can be divided into two groups: those that use modules or some religious-symbolic figures as principles arrangements; those that use proportions. It can be seen that generally in the mosques of the 19th century, there were used a modular network obtained by placing an octagon within a circle with a radius of 68cm (3 *arshin*) or multiples of this unit-measure. It has also been established that the main module commonly used in all the mosques mentioned above are multipled by 3 (that is 3x3=9 *arshin*). This measure, 204cm (9 *arshin*), was also employed in establishing the design principles of such elements as the levels in buildings, the overhangs of the eaves of domes, etc. (Figures 1, 2 and 3). Another fact that it is important to emphasize here is that, in the said period, the design principles governing monumental architecture both European and Ottoman depended on some symbolic values along with functionality. In Christian architecture, the number 3 and its multiples have been used symbolically in organizing space because of the Holy Trinity. In Islam, it is believed that there are three spirits: the good spirit, the evil spirit, and a third spirit that tempts people to evil-deeds. Moreover, in the monumental religious buildings of both Christianity and Islam, a centralized plan, believed to represent the monotheistic belief in the organization of space, is commonly used.

It can be easily understood from examples are given above that 19th century Ottoman Architecture defines the sophisticated relationship between the architectural design and mathematics. A specific space organization always was created in light of the structural rules and mathematical rules. By reflecting the idea of functional design onto the creation of monumental buildings in the pre-modern world, he became one of the most important and interesting master-builders in history. It may be said that, even today in our modern age, Ottoman Architecture's compostions should be observed because of their rules of functionality reflect the relationships between architectural design and mathematics.

References

Arpat, A., "Osmanli Dini Mimarisi'nde Modul ve Duzenleyici Geometri", *MTRE Bulteni*, no. 13-14 (1981), pp .29-35.

Camlibel, N. *Sinan Mimarliginda Yapi Strukturunun Analitik Incelenmesi* (Istanbul: Yildiz Technical University1998).

Edhem, P. *Die Ottomanische Baukunst*, (Constantinople, 1873).

Egli, E. *Sinan der Baumeister Ossmanischer Glanzzeit* (Stuttgart: Verlag für Architektur Erlenbach), 1954.

Freely, J. And A. Burelli. *Sinan* (New York and London: Thames & Hudson, 1992).

Goodwin, G. *Ottoman Architecture* (London: Thames & Hudson, 1997).

Haidar, S and H. Yazar. "Implict Intentions & Explicit Order in Sinan's Work, II", *Uluslararasi Turk ve Islam Tarihi Kongresi,* Cilt no. 2, (Istanbul:Istanbul Technical University1986), pp.29-42.

Kuban, D. *Sinan Dünya Mimarisindeki Yeri, Mimarbasi Koca Sinan* (Istanbul: Vgmy, 1988), pp.581-624.

Sagdic, Z., "Mathematics & Design Relationship in Architecture", *Mathematics & Design 98*, Javier Barrallo, ed. (Proceedings of the Second International Conference1-4 June 1998) (San Sebastian, Spain: The University of Basque Country, 1998), pp. 383-391.

Saner, T., "19. Yüzyil Yeni Türk Mimarliginda Antik Anlayisi", *Yapi 211*, pp.70-77.

Schemmel, A. *Sayilarin Gizemi* (Istanbul: Kabalci 1998).

Soylemezoglu, K., *Istanbul Rustem Pasa Camii*, II. Uluslararasi Turk ve Islam Tarihi Kongresi, Cilt no.2 (Istanbul: Istanbul Technical University, 1986) pp.105-114.

Tuncer, N. *Klasik Dönem Osmanli Mimarisi'nde Iç mekan ve Cephelerde Oran.* Ph.D. thesis, Yildiz Technical University, Istanbul, 1997.