IN SEARCH OF THE 'TIME-LESS' IN ARCHITECTURE

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ABSTRACT

While the use of geometry as surface decoration in Islamic architecture is evident and well documented, an aspect about which not enough is known and understood is the use of geometry in the design of the buildings themselves. This paper will, therefore, endeavour to focus on the use of geometry in the ordering and design of the architecture – plan, elevation and section. In addition it does so from the point of view of a practising architect attempting to develop ways of employing these methods in contemporary practice, based not only on a knowledge of their traditional use but also their artistic function – which is to create an architecture which reflects something of the 'time-less' quality of all great art.

This paper consists of an Introduction, briefly outlining the relevance of the study of traditional architecture and what we can learn from it. Part I gives the theoretical and philosophical background to the design principles of Islamic architecture. Part II offers a theoretical model for looking at traditional architecture in terms of a *language* with a *grammar* and a *vocabulary* in the context of which the *principles* of design and practical *methods* of geometry are employed. Part III gives a Historical Overview of the connection between Architecture and Geometry. Part IV consists of a presentation of geometric methods used in Islamic Architecture taking Timurid architecture of Iran and Turan as a case-study. In Part V, a Mughal building and a Master-mason's plan drawing of a mosque are analysed in the light of the methods discussed in the preceding section. In conclusion, in Part VI a contemporary project of a community mosque in Lahore is presented, where some of the methods studied are applied.

Keywords: Islamic Architecture – Geometry – Timeless

INTRODUCTION

It can be argued that the message and philosophy of traditional art is culturally relevant and appropriate as a valid artistic expression for our context. At the level of technology also, for us in the sub-continent, it makes great sense to learn from this tradition. Especially when we see that the technological solutions of traditional architecture are economically viable and environmentally sustainable for many types of buildings. But it is above all, the message of traditional art, whose harmony and beauty aim at reflecting something of the "time-less", which I believe is relevant and meaningful not only in our cultural context but at all times and in all places.

PART I: BACKGROUND – CONCEPT OF BEAUTY

The Traditional[1] principles of design within which traditional architecture works embody a concept of beauty and form based on a sacred understanding of the world and of the human being. This world-view sees both the created macrocosm and the human microcosm in relation to their common Divine Origin[2]. This metaphysical conception and its relationship

1 The word Tradition in this paper will be used to signify such cultures whose foundations are based on Principles and Truths of Divine Origin, which are then applied over time to various domains from metaphysics and cosmology to art and science.

2 Examples from Islam's foundational texts expressive of the idea that the cosmos is a reflection of God's Qualities are the Hadith Qudsi: "I was a hidden treasure and I loved to be known, so I created the world so as to become known;" and the Quran: "Wheresoever you turn there is the Face of God". There is also the famous Hadith from Bukhari: "God created Adam in His image".

with art is extremely well developed in the Islamic philosophy of art and aesthetics. An example from a classical source illustrating how the concept of proportion and harmony was understood within this worldview is Imam Ghazali speaking of the relationship.

"That exists between the essence of man's heart and the transcendent world, which is called the world of spirits (*arwah*). The transcendent world is the world of **loveliness** and **beauty**, and the source of loveliness and beauty is **harmony** (*tanasub*). All that is harmonious manifests the beauty of that world, for all loveliness, beauty and harmony that is observable in this world is the result of the loveliness and beauty of that world…." (Nasr, S.H., 1987. Pp. 168-169)

Another example is the words of a contemporary master mason *Ustad Haji* Abdul Aziz (1917-2002) discussing the proportioning of different types of domes:

"Everything should be proportionate. The way God has proportioned man, that if a person is tall his limbs and head are proportionate to his height and so on. If they are not we immediately know.... Thus if you decrease the height of the main dome by bringing down its center, you will accordingly have to reduce the proportions of the finial and so on."[3]

The forms of traditional art along with serving a useful purpose also aspire to formal perfection or beauty. The traditional concept of formal perfection sees it as having two aspects:

a. An aspect of *regularity* or *rigor*,

b. An aspect of *mystery* or *infinity.*

In other words a 'geometric' aspect and a 'musical' aspect. One can say, using traditional terms, that Perfection i.e. *Kamal* comprises a balance of *Jamal* (Beauty) and *Jalal* (Majesty).[4] It is these two complementary aspects which the traditional rules for artistic forms embody.[5] It can be argued that the principal means or method employed to achieve these design ideals in Islamic architecture is geometry or 'geometric harmonization'. *Figs. 1 & 2* are examples illustrating the use of both these design principles – 'regularity' and 'musicality'- from a contemporary craftsman's drawings. Behind the musicality and flow of forms – *Jamal* - exists a regulating geometry- *Jalal* – giving rise to formal balance and perfection i.e. *Kamal*.[6]

In the Islamic conception, geometry is linked to the concept of numbers – whose qualities and relationships it is seen to manifest. Numbers themselves are viewed as symbols of divine archetypes, rooted ultimately in the Divine Qualities. Regarding their treatise on music – music was considerd a part of mathematical studies – the Ikhwan al-Safa write: (Nasr. S.H., 1978)

'One of the aims of our treatise … [is] of demonstrating clearly that the whole world is composed in conformity with arithmetical, geometrical and musical relations….The world resembles…the unique system of a single man or a city which shows also the Unity of its maker.'

PART II: LANGUAGE OF TRADITIONAL ARCHITECTURE - GRAMMAR, VOCABULARY AND METHODS

Universally, across cultures and across time, for all traditional peoples, architecture was seen

3 Anjuman Mimaran, *Newsletter* 1, 2002. As part of Anjuman Mimaran's program to document, learn and publish traditional building methods and techniques used by hereditary Master Craftsman, a series of sixteen colloquiums were conducted by 83 years old master mason *Ustad Haji* Abdul Aziz from February to June 2000. Topics covered included, polygons, arches, domes, minaret, and geometric patterns.

4 These two aspects of formal ordering in the final analysis are a reflection of two complementary aspects comprised in the Divine Unity. The Islamic doctrine expresses this by dividing the names of God into those of rigor (*jalali*) and those of beauty (*jamali*). The Chinese Yin-Yang is another example of this complementary principles within the Divine Unity.

5 This complementarity of principles, according to the traditional doctrine, reflects the inner reality of the world itself, which comprises an element of geometry and an element of musicality.

6 It should be kept in mind that the geometry doesn't only serve a regulating function it is also needed as a practical tool for example to construct an arch or a dome.

both as reflecting a cosmology and as a symbol of Heaven (Bukekhardt, T., 2002). It is on this essential idea that the "Grammar" of traditional architecture is based.

Grammar of Architecture – the nine-square plan-form. A ground-plan (*fig.3*) that finds expression in various traditional architectures is the 'Nine-square Mandala' or 'Cosmogram', the *Vastu-Purusha Mandala* of Hinduism, the *Ming-tang Square* of Chinese architecture or again the *Hasht Bihisht* (Koch, E., 1991) (Eight Paradises) plan-form of Persianate Islamic architecture. As its name and significance in various traditions demonstrates this plan-form is ultimately a symbolic image of the Cosmos in its qualitative aspect.[7]

The archetypical form of this plan is a central square surrounded on the four major axes by four rectangles and in the corners by smaller squares. Geometrically this is derived by the intersection points of two rotated squares at 45 degrees to each other, which also give the regular octagon (see fig.3a & fig.3b.). In addition to playing a pivotal role in the organization of the plan (fig.4) the typical divisions of the elevation are also projections of this division of the plan (fig.5). This archetypical division is employed at all scales from the division of individual facades to elements within facades. The consistent application of this arrangement generates a sense of unity and wholeness typical of traditional architecture.

The Hasht Bihisht plan-form is often adjusted according to imperatives of time and place but its basic essence remains the same.

Vocabulary: Super-imposed on this universal grammar of architecture is the vocabulary of traditional architecture which defines its personality e.g. the dome, the parts of a dome, arches, columns and minarets and their parts

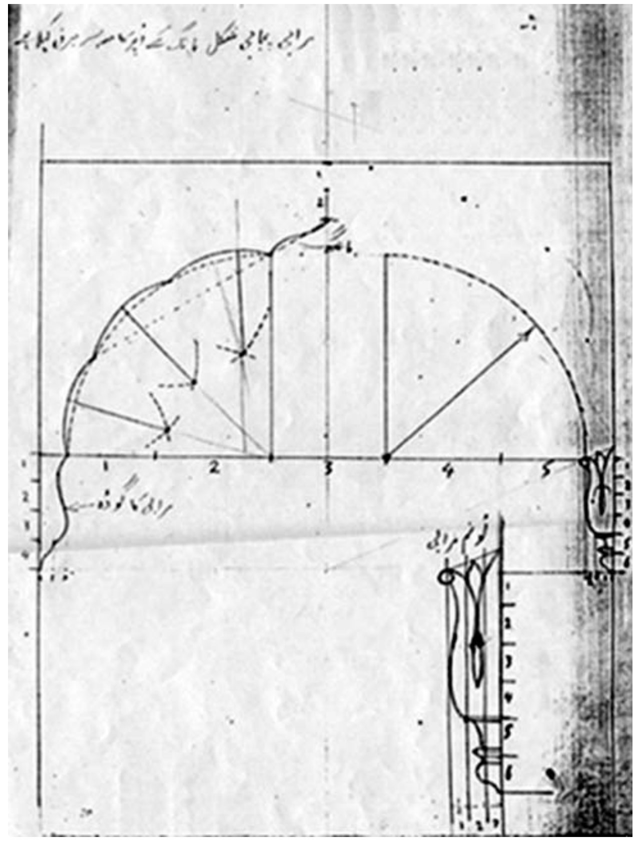

Figure 1: Pages from Ustad Rahim Bukhsh's unpublished manual, 1970s, Multan.
Source: Anjuman Mimran.

which in their turn are organized according to a syntax and grammar.

As we saw, it is within the framework of the grammar of the Hasht-Bihisht plan-form that the elements or vocabulary of architecture are placed. Similarly it is within the framework of this grammar and in part deriving from it that the aesthetic principles of design are situated. Finally there are the practical methods or tools of design used to give physical form to these principles.

7 The cosmos itself is seen as a reflection or manifestation of a Divine Principle, thus the architecture also ultimately reflects the qualities of the Divine Principle through cosmic symbolism.

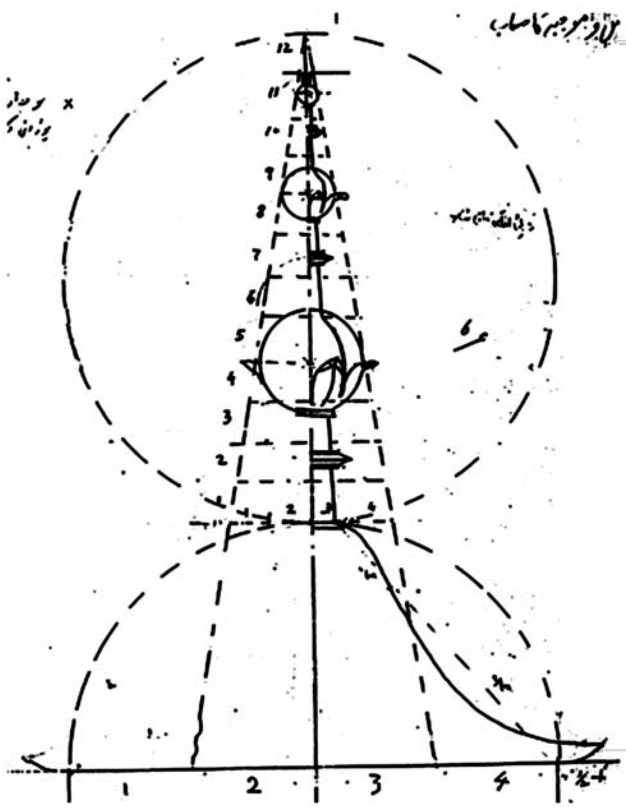

Figure 2: Pages from Ustad Rahim Bukhsh's unpublished manual, 1970s, Multan.
Source: Anjuman Mimran.

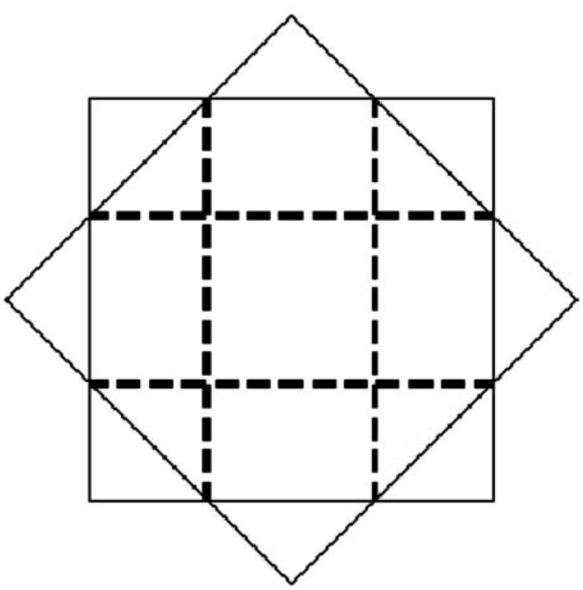

Figure 3a:

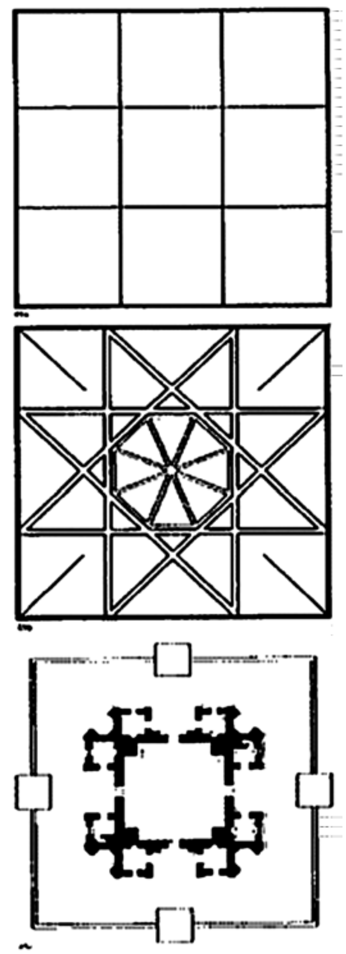

Figure 3b:
Source: Bakhtiar, L and Ardalan, N, - The Sense of Unity - the Sufi Tradition in Persian Architecture, Chicago 1973.

PART III: HISTORICAL OVERVIEW - ARCHITECTURE AND GEOMETRY

'According to the tenth century philosopher, Abu Nasr al-Farabi, the fundamentals of architecture belonged to the mathematical sciences.'(Golombek et.el, 1988. p. 137) As Golombek and Wilber state: 'Geometry was the foundation of an architect's training, and the highly skilled architect was known as a *muhandis*, a "geometer." (Golombek et. el, 1988. p. 137)

We know from historical records that architects were often highly skilled and learned not only in mathematics and geometry but also in astronomy, the classics, poetry, philosophy and

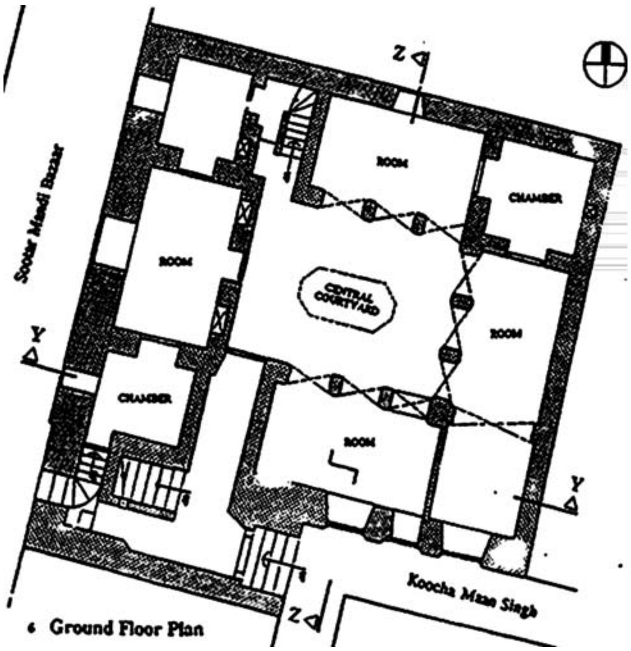

Figure 4: Lahore Walled City, House No. D/3264, Sooter Mandi Bazar, PEPAC 1993.
Source: PEPAC, Walled City of Lahore, 1993.

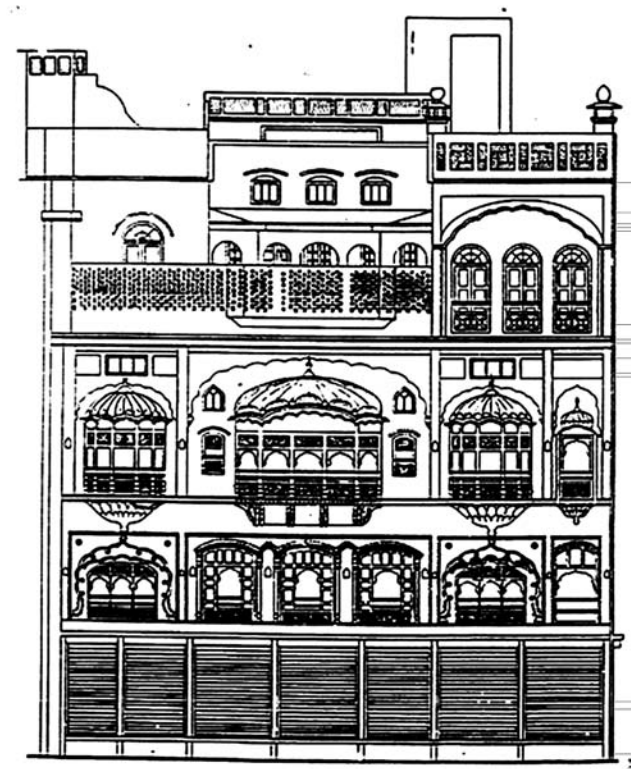

Figure 5: Lahore Walled City, Lal Haveli, Lohari Mandi Bazar, PEPAC 1993.
Source: PEPAC, Walled City of Lahore, 1993.

religious studies. Ustad Ahmed Lahori of the Shah Jahan period, Mimar Sinan of Ottoman Turkey and Qavam al-Din of Shiraz (15th century) (Golombek et el, 1988. pp. xxi-xxii) are amongst such well-known architects whose names have come down to us.

'Early Arabic treatises on mathematics pay special attention to the needs of the architect, and it is in these works primarily that the aesthetics of architecture are discussed…. There are texts dealing with geometry for the architect, geometric designs for the craftsmen, and comments throughout general texts on mathematics that are relatable to architectural practices' (Golombek et el, 1998. P. 137).

The connection of architecture and geometry, which is evident enough, is borne out by the existence of these texts. The same is confirmed, in the case of Timurid architecture for example, by the analyses of the buildings. In the words of Golombek and Wilber:

'… a pervasive influence of geometry on many aspects of the architecture: its plans and elevations, its vaulting, and its decoration. Through a system of proportions the harmony of a work of art could be achieved. This notion of harmony was central to the thinking of many Muslim philosophers, as Bolatov has noted' (Golombek et el, 1988. P. 211).

PART IV: DESIGN METHODS:

a) Design Process;
b) Geometrical Systems;
c) Mathematics & Architecture

The following presentation of geometric methods used in Islamic architecture is primarily based on the study of Timurid architecture of Iran and Turan, by (Golombek et el, 1988). Their comments in turn, are based on the monumental

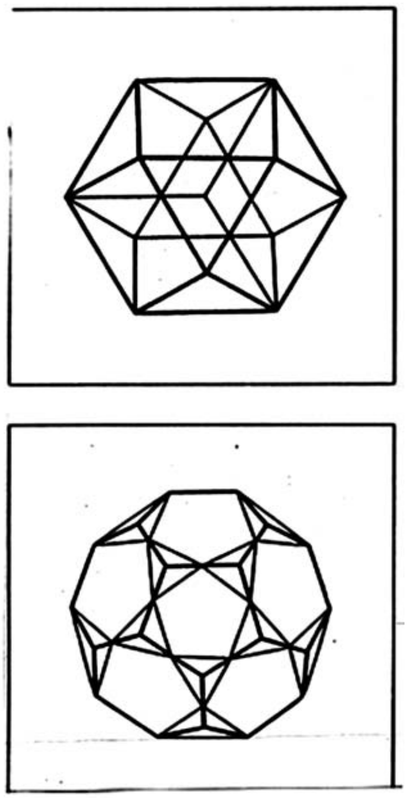

Figure 7: Abu-l Wafa 'al-Buzjani (940-98) from Holod, R (1988).
Source: Holod, Renata, in theories and Principles of Design in the Architecture of Islamic Societies, Cambridge, Massachusetts, 1988.

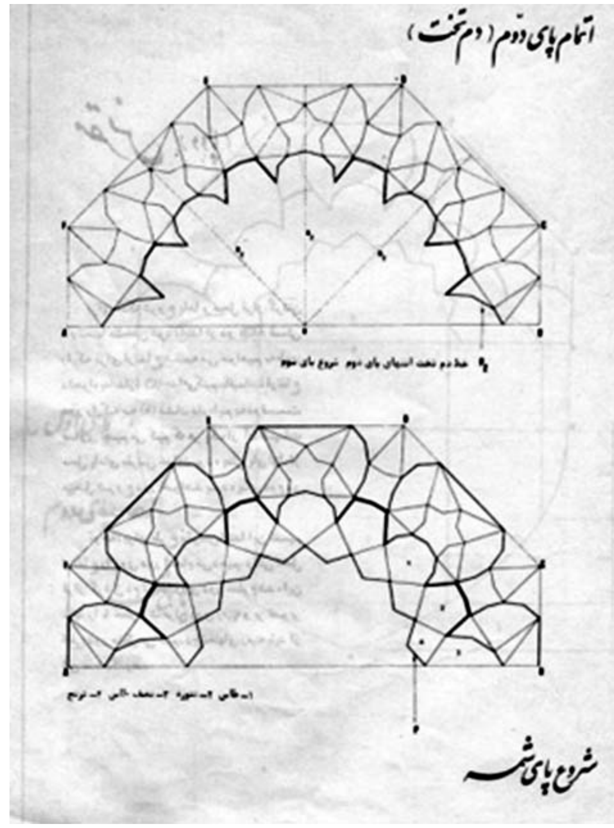

Figure 8: 'Muqarnas' plan by contemporary Iranian craftsman. From: Mehnaz Rais-Zadeh & Hssain Mufid, Ihya Hunari az Yad-i-Rafta, Tehran (1374 AH).
Source: Mehnaz Rais-zadeh & Hssain Mufid, Ihya Hunari az Yad-i-Rafta, Tehran (1374 AH).

work of Uzbek scholar M.S. Bulatov on the theme of geometric harmonization in Central Asian architecture from the 9th to the 15th centuries. (Bulatov, M.S., 1978) The reason I have considered their conclusions as representative of Islamic architecture in general is based on a couple of considerations. Firstly the obvious similarity of 'spirit' which Islamic architecture conveys universally, which I believe is due to the particular message of the Islamic tradition. Secondly, given the shared universe of intellectual and scientific discourse in the Islamic world, one can hypothise that similar design methods may have been used. This obviously has to be verified by further studies but a general survey of a few of the existing studies accessible to me support such a hypothesis (Jamshaid Iqbal, 1988), Yassen Tabba, 1988).

a) Design Process:

Typically the design process for a traditional Islamic building (Golombek et el, 1988), (Holod, R., 1988) would begin with the intent of a patron who would often, 'describe the ordering of buildings in terms of features considered most significant (Holod, R., 1988. p.11).

According to Golombek and Wilber the parameters for the architect included, 'the function of the building, its budget, often a schedule, and the scale of its most significant parts.' (Golombek et el, 1988. P. 138). The design of the building would utilise two processes simultaneously, namely '**geometric**' and '**analytical**' (Golombek et el, 1988. P. 138).

Thus, the design was first drawn more or less theoretically, according to geometric proportions. Then, the analytical process was applied, and one dimension within the design was selected as a module. This module would be equal to, or commensurate with the *gaz*.[8] In Timurid buildings the module was equal to the wall thickness. The module was sub-divided into units commensurable with it for details. The smallest unit was equal to brick size plus a rising joint. The architect could therefore specify measurements in terms of real numbers or number of bricks. Approximations of irrational numbers were also used. (Golombek et el, 1988. P. 139).

That two systems, analytical and geometric, were used is borne out by the analysis of buildings, which have both proportional and modular systems. The same is also attested to by the drawings of the so-called Bukharan master (*figs 9, 10 & 11*). (Golombek et el, 1988. P. 139), (Holod, R., 1988. P. 5). The use of graph paper shows that the draftsmen worked with compasses and straight edges (Holod, R., 1988. p. 6). Set- squares, adjustable set-squares and a devise for drawing ellipses were also used. (Golombek et el, 1988. p. 139).

In the system described by Bulatov, first a Generative Unit had to be chosen by the architect. This was a single measurement from the project and was often the most prominent feature in the building. All important dimensions in plan, elevation and section would be based on it and commensurable with it. Secondary Generative units were also used, which effected dimensions closest to them. Thus the over-all length of a façade would be derived from the main Generative-unit, whereas its elements, for example portal height, would be related to the length of the façade.[9]

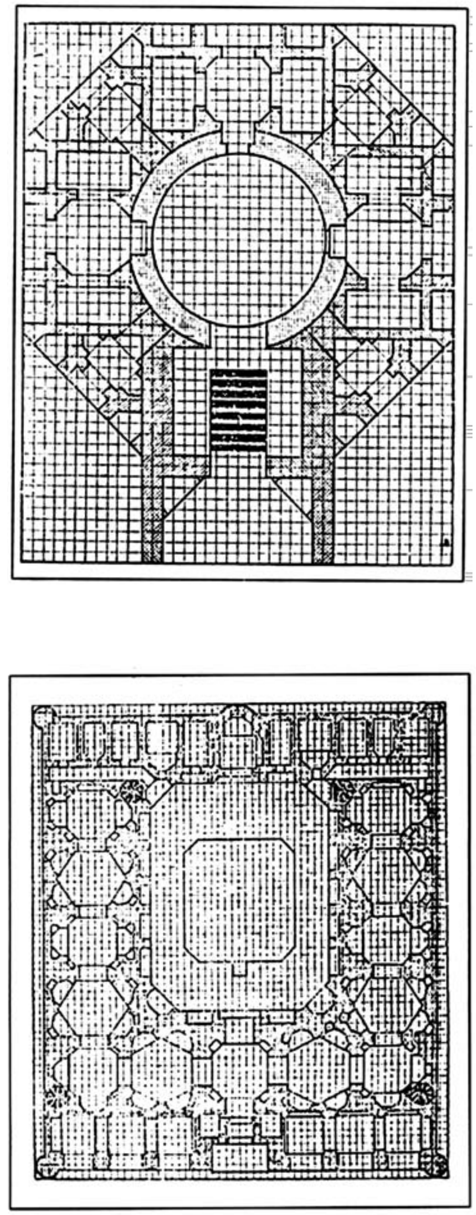

Figure 9&10: Drawing by the 'Bukharan Master' (Probably 16th C).
Source: Holod, Renata, in Theories and Principles of Design in the Architecture of Islamic Societies, Cambridge, Massachusetts, 1988.

8 The *gaz* in early Timuird buildings in Turan ranged from 60 to 66.18 cm, averaging 62 –63 cm, (Golombek et el, 1988. 139).

9 All remarks describing the Design Process are summarised from Wilber and Golombek, opcit pp 139-140, who themselves base their conclusions on, Balatov, *Geometricheskaiia Garmonizatsia*, opcit.

b) Geometric Systems Used:

The conclusion reached by M.S.Bulatov, (Golombek et el, 1988. P138), (Bulator, M.S., 1978),regarding the Islamic system of proportions is that it is a 'system of proportions which utilizes irrational numbers, … [and] is based on the geometric properties of the square, the double square, the equilateral triangle and the pentagon' (Golombek et el, 1988. P.138).

Bulatov's conclusions are based on his study and analysis of Islamic monuments of Central Asia, from the ninth to the fifteenth centuries. His work takes into account the views of the Ikhwan (Nasr, S.H., 1978. P.45), philosophical texts on aesthetics as well as mathematical treatises. (Golombek et el, 1988. Pp.137-173).

The geometric properties of these four geometric figures, give rise to 'four systems of proportion, or sets of ratios,' which could be mixed, 'although generally one system predominated.' (Golombek et el, 1988. P.138). Fig 11, taken from Bulatov's study, illustrates the use of these systems. In Wilber and Golombek's words:

'The geometric basis of design was, therefore, not comparable to Western[10] notions of proportion, which are concerned with the repetition of similar or related forms. The Islamic system, aside from its practical value as a working method, ensured a harmony of parts, whereby all parts were related to a single entity….' (Golombek et el, 1988. P. 140).

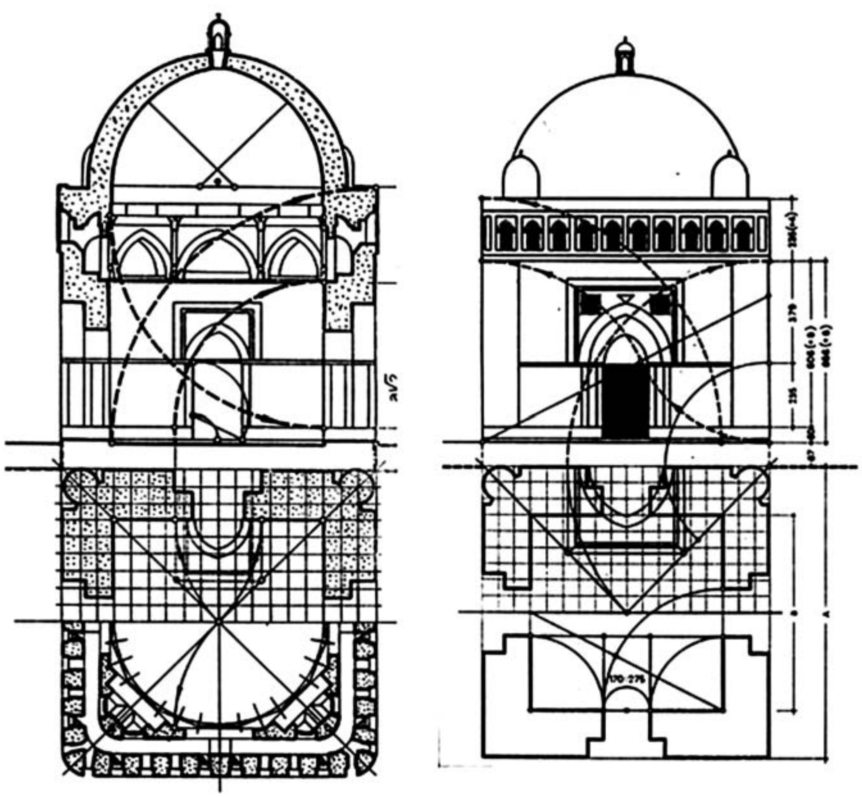

Figure 11: An example of the application of the Systems of Proportioning discussed by Bulatov in a Central Asian building - left: in section & plan; right: in elevation and plan (illustrations from Bulatov 1979).
Source: Bulatov, 1979.

10 Western here should be understood as 'Renaissance,' Cf. Wittkower, Rudolf, *Architectural Principles in the Age of Humanism*, Academy Editions, London 1973, where he categorically marks out the differences between the Renaissance approach to proportioning and that of the Middle ages. According to him the Middle Ages preferred the use of incommensurable ratios whereas the Renaissance preferred commensurable or whole number ratios.

c) Mathematics & Architecture:

A logical way of deciphering the traditional design process would be to look at the mathematical and geometric knowledge and tools prevalent at the time. As an example a method of converting irrational root functions into whole number ratios which seems to have played an important role in architectural design is discussed below.

The Diaphantine Method and the generation of whole number ratios approximating incommensurable functions**.**

'In several pre-Euclidean mathematical texts a method is given which allows for the expression of these root powers [i.e. 2, 3 & 5] as a succession of whole number ratios.... These successive ratios approach nearer and nearer to the root value with each alternation' (Lawlor, R., 1994. P. 39).

This method is attributed to the Greek mathematician Diaphantus, but is probably part of a much older mathematical knowledge' (Lawlor, R., 1994. P. 67).The works of Diaphantus were translated into Arabic by Qusta ibn Luqa in the 10th century (Nasr. S.H., 1987., p. 140).

One such method of generating the roots 2, 3 & 5 is through the use of 1:2 and 1:3 progressions. Below is the use of progressions 1:3 and 1:2 to generate approximations for 2.

Diagonal Numbers:

Origin 1:3   1   3   7   17   41   99

Lateral Numbers:

Origin 1:2   1   2   5   12   29   70

In both series a number is doubled and the previous number is added to it to form the next number. From the 1:3 series diagonals of successive squares are generated and corresponding sides from the 1:2 series (Lawlor, R., 1994. P. 68).

A similar progression is observable in the *Gaz* dimensions of the Taj Mahal as analysed in *fig 12* where the 'geometrical' proportioning is based on the properties of the square and the rotated square which involves 2.

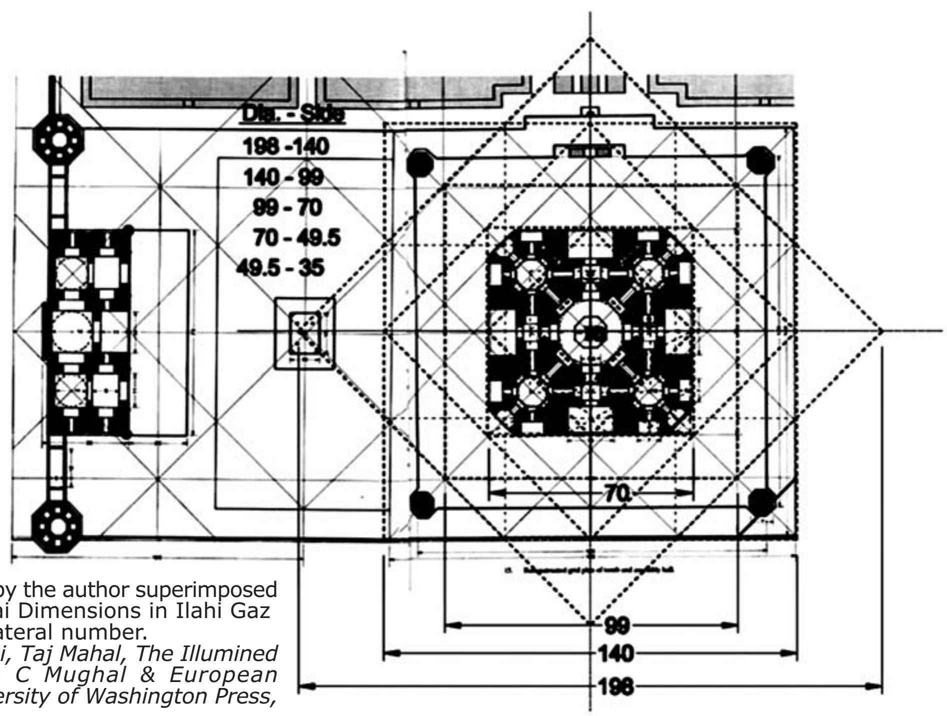

Figure 12: Geometrical analysis by the author superimposed on an analysis by Begley & Desai Dimensions in Ilahi Gaz show the use of Diagonal and Lateral number.
Source: W.E. Begley & Z.A. Desai, Taj Mahal, The Illumined Tomb, An Anthology of 17th C Mughal & European Documentary Sources, The University of Washington Press, Seattle & London, 1989.

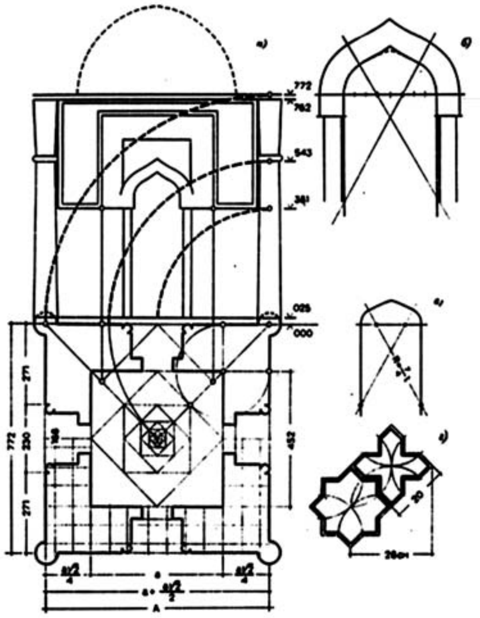

Figure 13: Grid as approximattion of irrational numbers. *Source: Bulatov, 1979*.

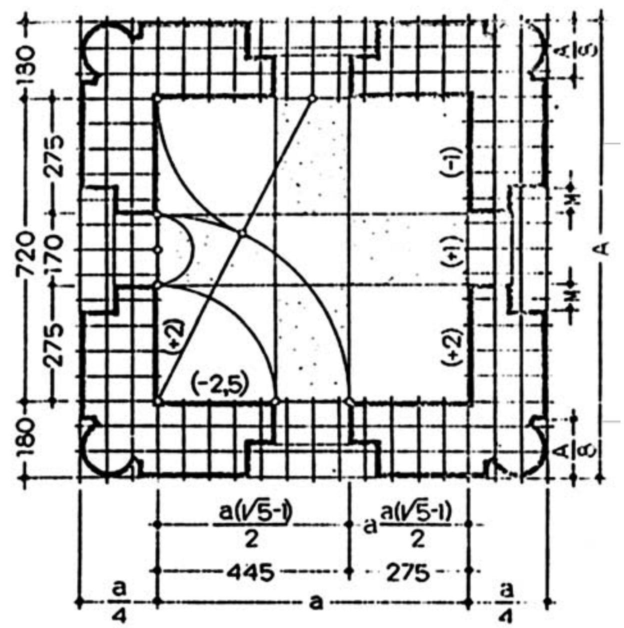

Figure 14: Grid as approximation of irrational number. *Source: Bulatov, 1979.*

In Bulatv's analyses, as for example in *fig. 13* where the 2 system and *fig.14* where the Golden Ratio is rationalised by the use of these concepts in terms of the module and its subdivisions.

These examples and methods show the use of irrational numbers as well as their whole number or fractional approximations – termed the 'geometrical' and the 'analytical' methods by Golombek and Wilber.[11] Discussed above in section a) Design Process. This points to a direct link between the methods discussed above and the mathematical training of the traditional architect.

PART V: EXAMPLES FROM THE SUB-CONTINENT - PAST AND PRESENT

Sheesh Mahal, Lahore Fort (1631-32 AD) As in other Islamic lands, Mughal buildings too were designed and constructed by highly skilled professionals. For example in *Tarikh-i-Akbari* (1580-84 AD) Muhammad Arif Qandahari while describing the *Buland Darwaza*, Fatehpur Sikri (1573-74 AD) mentions that 'Skilled engineers (*muhandisan*) and incomparable masters (*ustadan*) laid its foundation … and dextrous masters (*hunar varan*)' were employed in the project (Brand et el, 1985. P.56), (Muhammad Arif Qandhari, 1580 – 84).

Similarly a standardised system of mensuration is evidenced through historical sources, for example, Jahangir's descriptions of the Fatehpur Sikri buildings built by his father Akbar, give detailed measurements of various parts:

'The length of the mosque from east to west, including the width of the walls, is 212 yards. Out of this, the *Maqsura* (the chancel) is 25-1/2 yards broad, the middle is 15 yards by 15, the portico (*pishtaq*) is 7 yard broad, 14 yards long; and 25 yards high….' (Nur-ud-Din Muhammad Jahangir, 1624), (Brand et el, 1985. pp. 60-61).

11 Discussed above in section (a) Design Process.

My calculations show that the size of the *Gaz* in Akbar's *Buland Darwaza* (Fatehpur Sikri) and Shah jahan's *Sheesh Mahal* (Lahore Fort) are exactly equivalent i.e. 813mm or 32 inches. This shows a remarkable consistency in the measuring unit, the *ilahi gaz* from Akbar to Shah Jahan. This matches Ebba Koch's assertion that the ***Gaz*** or the Mughal linear yard (also called *zira'*) was the *Gaz-i Ilahi* introduced under Akbar which varied from 0.81 – 0.82 m i.e. 31 - 7/8" – 32 – 9/32" (Koch, E., 1991).

Figs. 15 & 16 show the 'Geometrical' and '*Gaz*-grid' analyses respectively, of the *Sheesh Mahal* built by Shah Jahan in the Lahore Fort in 1630-31 AD. The Geometrical Analysis (*fig 15*) shows that all the main divisions of the plan are derived from a series of rotating and inscribed squares.

In the *Gaz*-Grid Analysis shown in *fig 21,* the grid is of 2.5 *gaz;* the over-all length 62*gaz*; the width of the court 40*gaz*; the central Veranda of the Sheesh Mahal 20*gaz*; the side double storey verandas 10 *gaz*; the inter-columnar distances for the two verandas 6*gaz* and 3*gaz* respectively; length of the *Naulakha* Pavilion in the West 10 *gaz;* the round portion of the central pool 13*gaz*.

CONTEMPORARY CRAFTSMAN'S DRAWING (1977)

A page from *Ustad* Rahim Bukhsh's unpublished hand-book of assorted drawings, consists of traditional design elements. These drawings have been drafted by the *Ustad* himself in the 1970's. *Ustad* Rahim Bukhsh was a well-known master-mason from Multan in the Punjab province of Pakistan.

The final drawings in the hand-book dated 22 - 4 -77 are a plan drawing (*fig.17*) and a sectional elevation (*fig.18*) of a mosque. These mark a logical conclusion to the folio, for all the elements illustrated in the rest of the folio – arches, domes, *minars, chatris*, etc - metaphorically come together, to make a whole – a mosque.

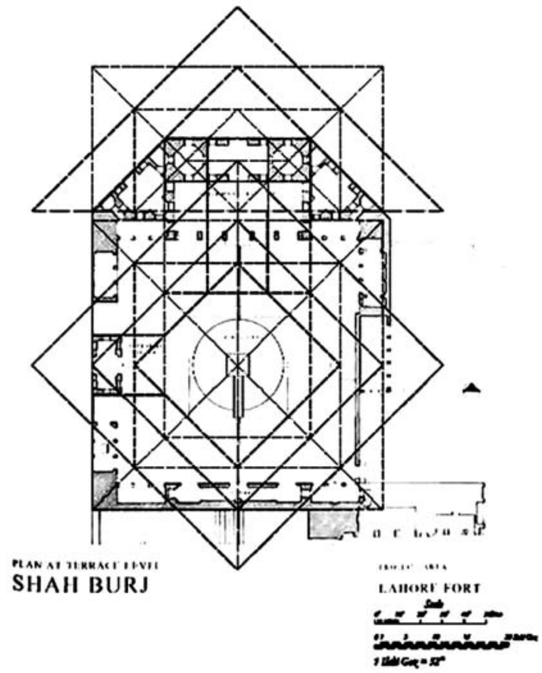

Figure 15: Geometrical Analysis (Analysis by the Author)
Drawing Source: M. N. Mir, M. Hussain, James L. Wescoat (eds), Mughal Gardens in Lahore - History & Documentation, by Dept. of Architecture, UET, Lahore, 1996.

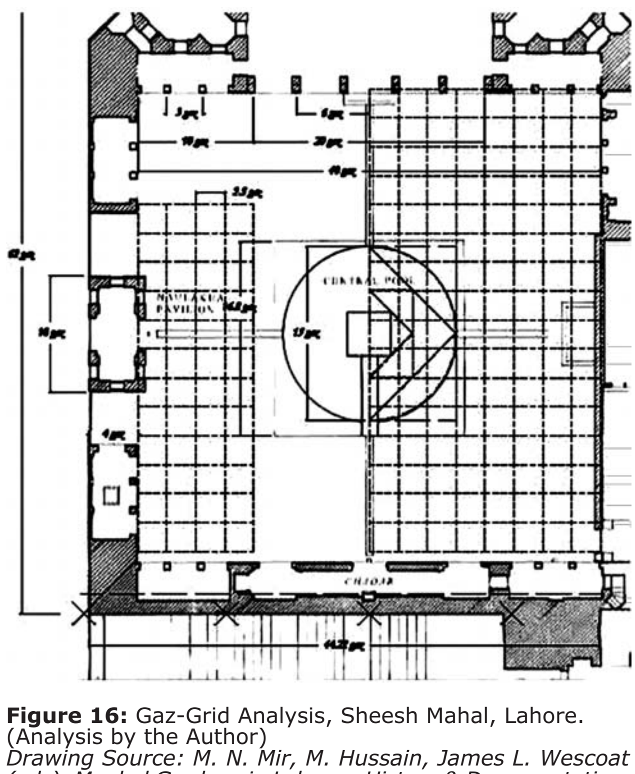

Figure 16: Gaz-Grid Analysis, Sheesh Mahal, Lahore. (Analysis by the Author)
Drawing Source: M. N. Mir, M. Hussain, James L. Wescoat (eds), Mughal Gardens in Lahore - History & Documentation, by Dept. of Architecture, UET, Lahore, 1996.

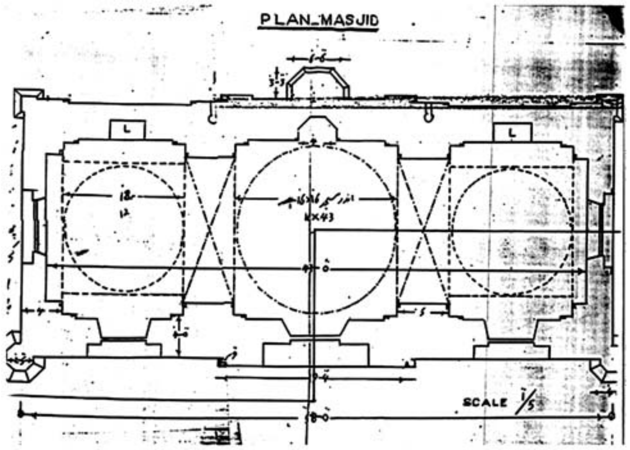

Figure 17: Plan of Mosque drawn by U. Rahim Buksh.
Source: Anjuman Mimran.

In the margins of the ground plan is a note of instructions, which is translated below:

'As many feet as is the length of the mosque, half of that much in inches, should be the base of the Minar. [i.e. the base of the Minar is 1/24th of the length of the mosque]

The central bay -Taj - should be one-third of the length of the mosque.

As many feet as is the Taj, half of that much in inches, should be the base of the small-minar. [i.e. the base of the small-minar is 1/24th of the length of the Taj, which itself is 1/3rd of the total length of the mosque].

What the width of the mosque is on the inside, one-fourth of that should be the thickness of the walls.

The two interior walls should be one-fourth more than the outer walls. The foundation should be one-third of the interior width.

To state the main observations on the drawing (illustrated in fig.19) in the light of the design process outlined by Bulatov, one can see that for the interior organisation of spaces, the side of the central prayer room acts as the 'Generative unit'. The mihrab, side rooms, and wall thicknesses are all related to this 'Generative unit.'

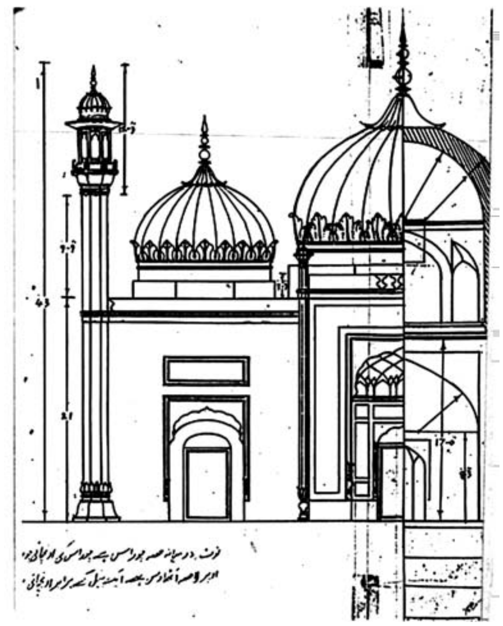

Figure 18: Elevational Section of Mosque (Part) drawn by U. Rahim Bukhsh.
Source: Anjuman Mimran.

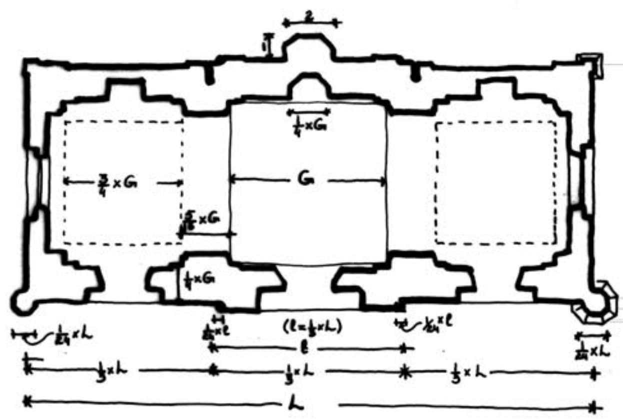

Figure 19: Analysis of Ustad Rahim Bukhsh's marginal note regarding the mosque proportions.
Source: MA Dissertation. De Montfort University, Leicester, UK. 1999.

For the elevation the ratio of the bays to each other is 1:1:1, although the central bay is raised to mark it out as the Taj. What is more subtle is that the ratio of the base of the main Minar to the total length of the mosque is the same as the ratio of the small minar to its own bay i.e. the Taj. This is an example of relating a 'microcosm' to a 'macrocosm' through the use of a discontinuous ratio, of the type a : b : : A : B.

It is extremely interesting to note that the ratio between the overall length and width of the Mosque 58ft : 24ft, accurately expresses the relationship A : A (v2 – 1) which is the ratio between the side of a square – in this case 58ft - and the side of an Octagon inscribed in it – which becomes the width of the mosque. Geometrically this can be arrived at by two rotating squares as shown in *fig 20a*. The square on side 24' and its rotated square give a few more elements: the size of the main opening and the approximate size of the main chamber. The plan also follows a whole number modular grid of 2ft (*fig 20b*).

The above analyses of the Sheesh Mahal and Ustad Rahim Bukhsh's drawings illustrate a remarkable continuity of principles and methods well into the 20th century. These analyses also point to a commonality of design principles and methods between the Subcontinent and Central Asia. By the same token it can by hypothised that this commonality can be extended to Islamic architecture in other Islamic lands as well.[12]

One aspect of these on-going studies by the author is to show the methods described by Bulatov can be used to study the methods of design used in the Mughal Architecture of the subcontinent.

PART VI: METHODS OF DESIGN - CONTEMPORARY APPLICATION

Figs 21 and 22 show the geometric scheme for a small community mosque designed by the author in Sally Town, a new housing development in Lahore. The overall design of the mosque was based on a survey of the various taditional and historical mosque-types in Lahore. The plan geometry was inspired by the Mughal period Bhangianwali Mosque; the elevational scheme is based on the now demolished Chinianwali Masjid and the domes, on the Shah Jahan period Tibbi Bazar mosque.

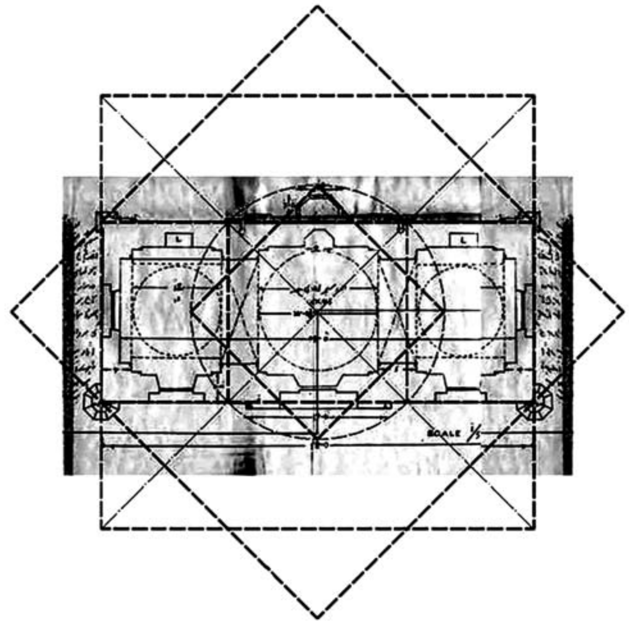

Figure 20a: Geometrical analysis of U. Rahim Buksh's Mosque Plan. Analysis: Author.
Drawing Source: Anjuman Mimran.

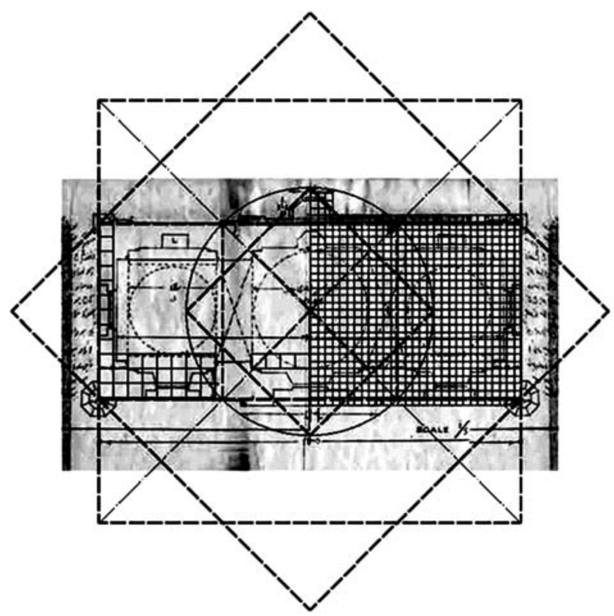

Figure 20b: Modular analysis - 2ft grid and 1 ft grid - of Mosque Plan by U. Rahim Buksh.
Drawing Source: Anjuman Mimran.

12 As discussed earlier in Part-IV: Design Methods.

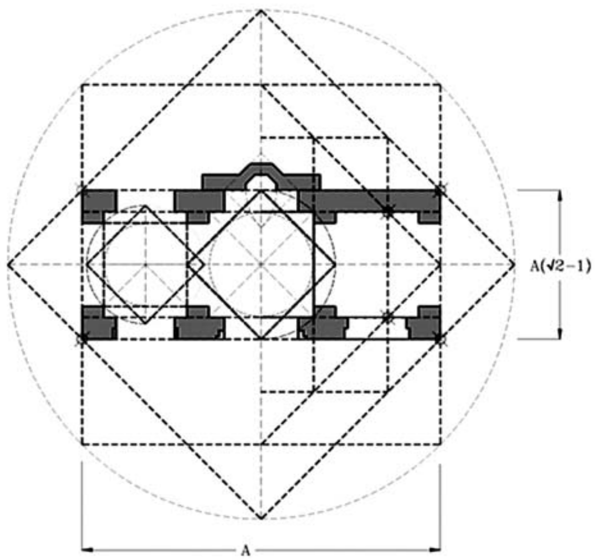

Figure 21: Basic Geometic proportions for Sally Town Mosque based on rotating squares.
Drawing: Author

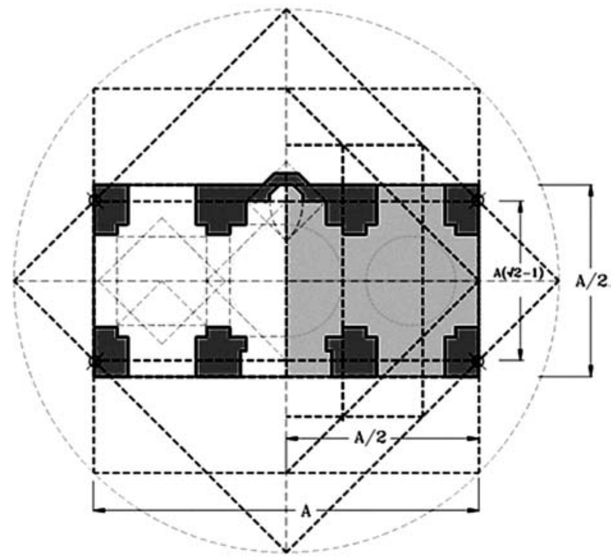

Figure 22: Final Geometic proportions for Sally Town Mosque with depth increased to 1/2 of length (A).
Drawing: Author

The elevational geometry of the Sally Town Mosque was based on an analysis of the historic and now demolished Chinianwali Mosque (1669 AD), Mohallah Chabaksawaran, Walled City Lahore. The geometrical analysis was reconstructed from a published plan and a photograph of the elevation in Abdullah Chughtai's book on the mosques of Lahore (Chughtai, Dr. M. Abdullah, 1976). The central archway is arrived at by the use of the Golden Cut as shown by the thicker dotted lines while the rest of the divisions are derived from this cut coupled with various cuts derived from rotated and inscribed squares with the length of the façade as starting point.

CONCLUSIONS

In the context of our[13] design practice we have been exploring and applying the theoretical frame-work of traditional design on all types of projects, including residential, religious and institutional. The motivating factor behind undertaking studies of traditional design methods is to creatively apply these methods and principles in our contemporary design work with the aim of achieving something of the 'time-less' quality of traditional architecture.

In the beginning of this paper we designated the constituent elements of traditional Islamic architecture as: 'Grammar of Architecture' as embodied in the Hasht Bihisht nine-square Mandala plan-form; 'Principles of Design' which include symmetry, harmony and emphasis on the centre; 'Vocabulary of Elements' like arches, geometric patterns, domes etc.; and finally 'Methods of Design' which include geometrical proportioning, as discussed in this paper.

In our practice we have been able to employ the traditional 'Principles of Design' to all aspects of design from the organization of the plan to the ordering of elevations / section and their constituent elements.

'The Grammar of Architecture' embodied in the Hasht Bihisht nine-square Mandala plan-form, is also always used in our designs. Although in residential projects it is interpreted in the context of contemporary living, building by-laws and construction methods which often do not allow

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the traditional spatial typologies. But the essential idea of organizing the building around a national centre remains, translated often to a central double-height atrium space figures 28 & 29 illustrate such a space in a Karachi house designed by our office (see also figure 26 & 27). In buildings which perform traditional functions like mosque or tombs we are able to use the traditional grammar in a purer form. On the other hand we find that we are using the traditional 'Vocabulary of Elements' more and more freely in all buildings types. These include designs for doors, ceilings, floor-patterns, jharokas, arches, lattices etc.

Lastly, in the case of applying traditional 'Methods of Design' we usually have a modular grid which works both in plan and in elevation / sections. In the use of geometrical proportioning we have so far found it easier to apply these in the more traditional buildings like mosques and tombs (see figures 23, 24 & 25 for Sally Town Lahore and figures 29 & 30 for a Mazar in Karachi). This is so because in these buildings, we have been able to successfully use traditional buildings materials, methods and vocabulary. Although as we get a better understanding of the traditional methods of proportioning through our on-going research, the challenge now is to apply these methods creatively to all categories of buildings.

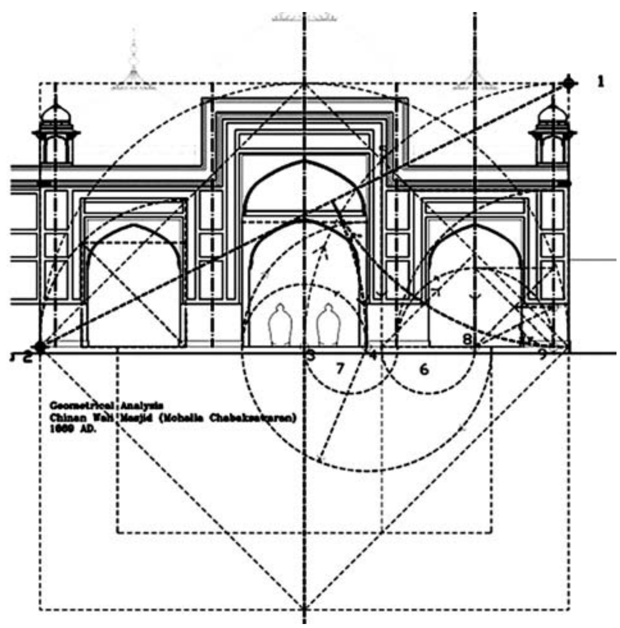

Figure 23: Partly hypothetical Analysis of Chinianwali Mosque (Mohallah Chabaksawaran 1669 AD). *Drawing: Author.*

Figure 24: Front elevation Sally Town Mosque Lahore, 2009. *(Photo: Author).*

Figure 25: Interior Sally Town Mosqe, 2009. *Source: Iqbal Alam's photos on Flickr.*

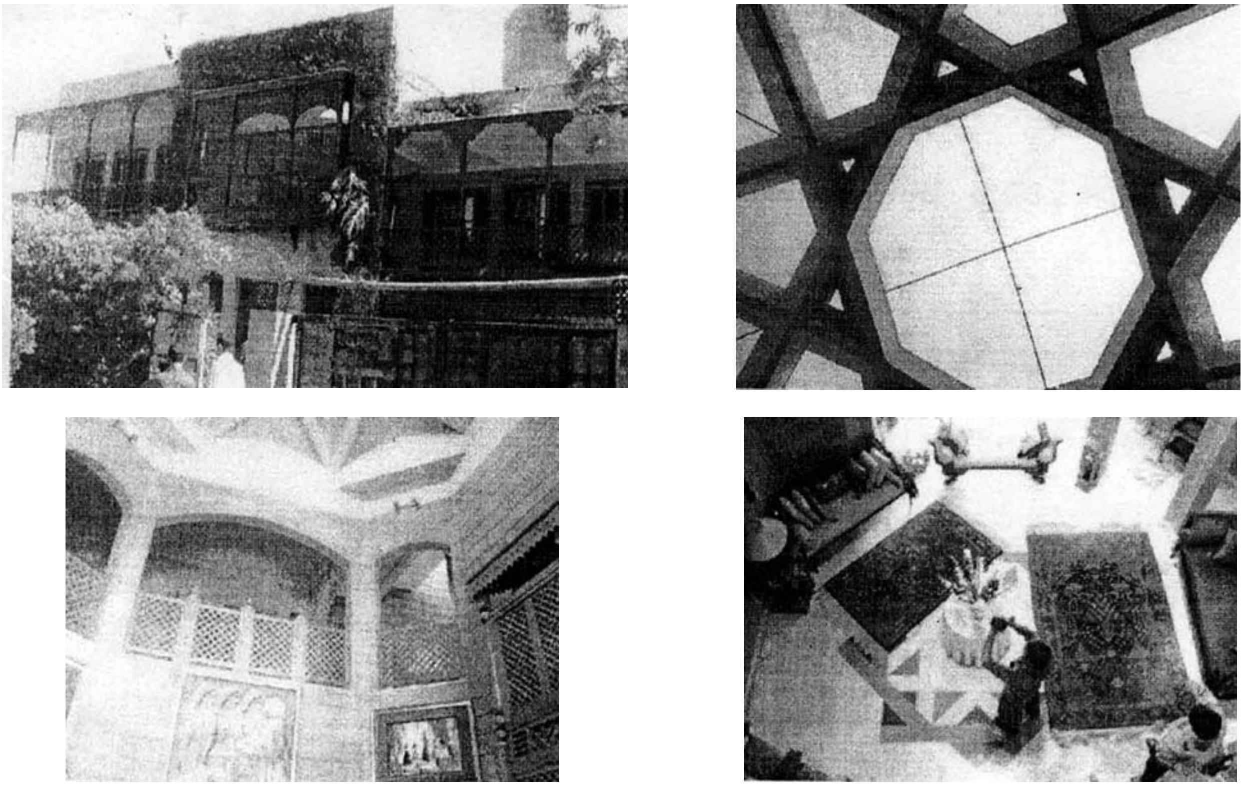

Figure 26 - 29: Azra Shaheen House, Khayaban-e-Hilal, Phase-VI, DHA, Karachi. finished in 1998. Organized around a central atrium. Fig 28 & 29 the house uses fair-faced load-bearing concrete block walls and pyramidical domes supported by concrete beams. *Photos by Hassan Abbasi, 3rd Year, Dept. of Architecture, NED.*

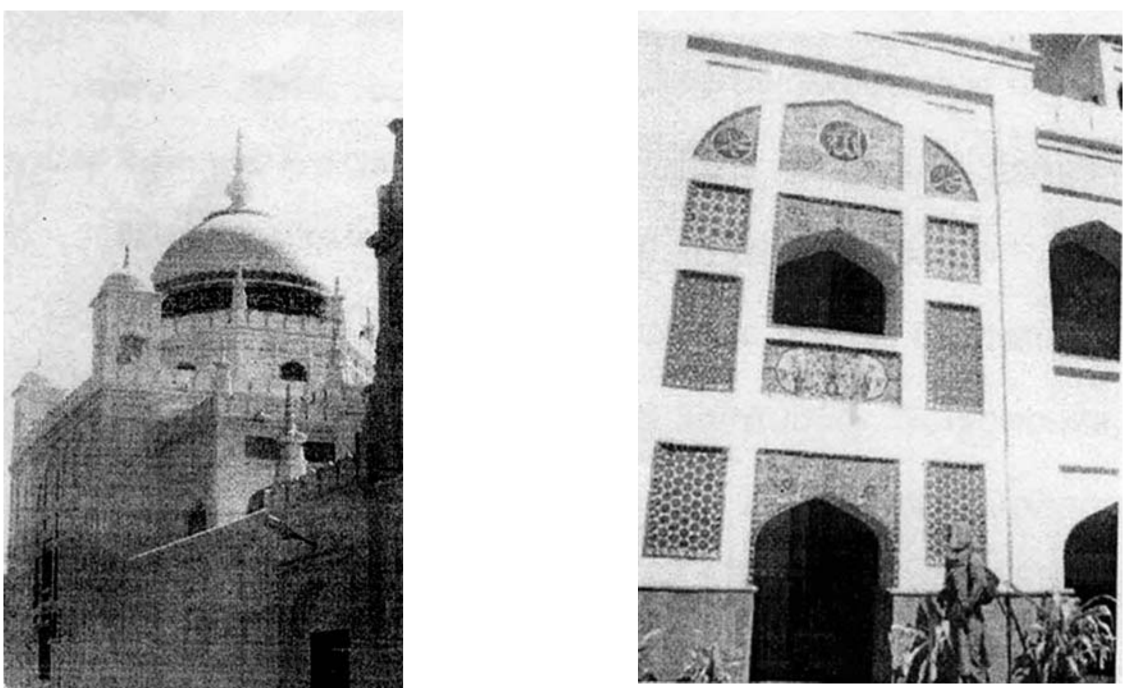

Figure 30 - 31: Hazrat Ahmed Sahib Mazar in Sakhi Hasan Graveyard, Karachi, finished in 2010, utilizes Geometrical Proportioning methods along with traditional vocabulary and elements. The tile-work was manufactured by traditional craftsmen from Nasrpur, Sindh. *Photos by Hassan Abbasi, 3rd Year, Dept. of Architecture, NED.*

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