Pattern, Cognition and Contemplation: Exploring the Geometric Art of Iran

Public lecture given by **Richard Henry** at the **Middle East Association**
on 27 April 2007. Published in the *Journal of the Iran Society*, 2007.

Vaulted roof of bazaar, 19th century, Kashan, Northern Iran.

In the autumn of 2006, with the support of the Iran Society, I travelled to Iran to research material for a new course that I had been invited to develop for the British Museum's World Arts and Artefacts programme. The World Arts and Artefacts programme is a joint venture between Birkbeck and the British Museum and the course was to be a practical one, focusing specifically on geometric design within the Persian tradition[1]. Whilst I have traveled widely throughout the Middle East and my own work, as a painter, printmaker and tile mosaicist, draws considerable inspiration from the extraordinary tradition of Persian geometric art, I had never visited Iran. For this reason I was very keen to visit the country and to study the patterns in both their cultural and architectural context. I was in the country for four weeks, visiting Isfahan, Shiraz, Kerman, Mahan, Yazd and Kashan, and was fortunate to have the opportunity to meet and interview a number Iranian academics, as well as local craftsmen.

I was first drawn to my study of Islamic art through an interest in mystical philosophy and Pythagorean thought in particular. For many years I have been struck by what can only be described as the numinous quality of Islamic patterns and the sense of sublime tranquility that one experiences in Islamic buildings. I have often wondered whether there is a connection between the presence of geometry and the nurturing of a contemplative state. A closely related question is whether there is a symbolic dimension to the articulation of architectural space. Such thoughts were on my mind when I first

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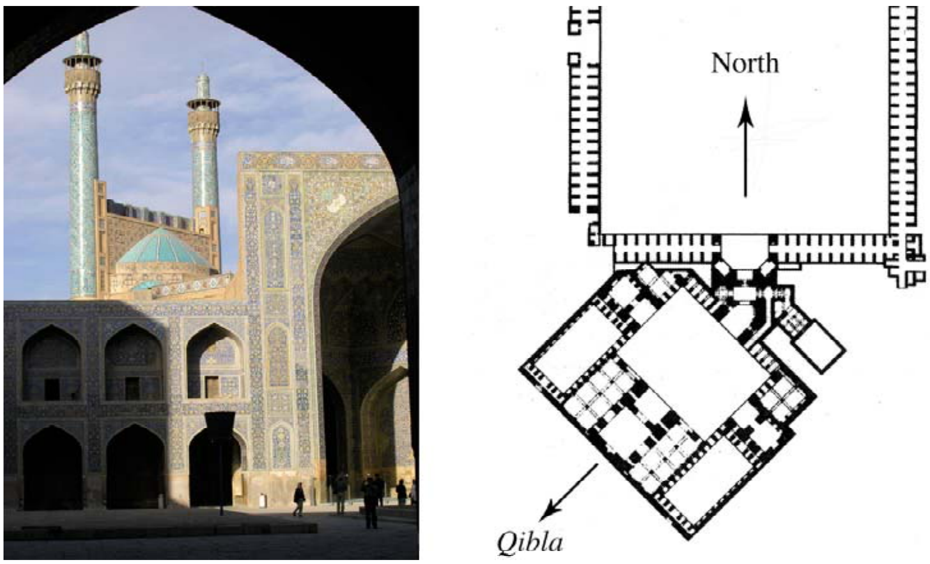
[1] I use the term Persian to denote the much larger landmass of Greater Iran encompassing Azerbaijan, Afghanistan, Turkmenistan, Tajikistan and Uzbekistan.

arrived in Isfahan. At the time I was reading Henry Corbin's "The Man of Light in Iranian Sufism", a book about the spiritual symbolism of orientation. "Orientation", Corbin writes, "is a primary phenomenon of our presence in the world. A human presence has the property of spatialising the world around it" (Corbin 1971, p. 1). Corbin is not merely concerned with our material orientation to the four cardinal dimensions, but rather "the way in which man inwardly experiences the 'vertical' dimension of his own presence" This relates to a common theme within Iranian Sufi literature: the "Quest for the Orient". This quest is not, it should be emphasised, for an orient that is located on geographical maps, but rather, "the supersensory, mystical Orient, the place of the Origin and of the Return, object of the eternal quest … the heavenly pole." (Ibid, p. 2)



North-east elevation of central courtyard in Shah mosque, Isfahan, with Northerly facing entrance to main square offset in background.

The contrast between a heavenly orientation and a more earthly one is most clearly realised in the city plan of Isfahan, where the main square (Naqsh-e Jahan) is orientated according to the cardinal directions and the Shah mosque at the southern end of the square has its main axis offset according to *qibla* (direction of Mecca). Titus Burckhardt, in his extensive monograph *Art of Islam – Language and Meaning*, observes that this shift marks "the transition from the outward to the inward world, a swift re-orientation of the soul." (Burckhardt 1976, p. 171)

It's worth comparing this symbolic orientation with that of the Christian church, where the central axis is aligned towards the rising sun at the Spring equinox (the symbol of the risen Christ). Whereas the axes of all oriented churches run in parallel, the axes of all mosques and the direction of prayer converge on a single geographical point of the Ka'ba in Mecca. It is only when a gathering of the faithful bow down in common prayer in close proximity around the Ka'ba that this convergence becomes most strikingly apparent. It is important to remember that Ka'ba actually means cube, and the cube is linked to the very idea of the centre, its six faces integrating the four cardinal directions, with the zenith and the nadir, that is, the ontological axis linking Heaven, Earth and underworld. The Ka'ba does not entirely correspond to this scheme, as its four corners more closely correspond the cardinal directions, but this does not detract from a primordial symbolism which predates Islam. According Burckhardt, the ‘axial’ character of the Ka’ba is affirmed according to a well known Muslim legend in which the ‘ancient house’, first built by Adam, was destroyed by flood and then re-built by Abraham and is situated at the base of an axis which traverses the heavens (Burckhardt 1976, p.4). The rite of circumambulation (*tawaf*) is seen to reproduce the rotation of the heavens around this polar axis, which, in terms of geometric symbolism, could be seen as the archetypal reconciliation of heavenly circle with earthly square.

As I collected visual samples of the many different symmetries employed in the decorative schemes of the buildings in Isfahan, I was very aware of the variety of ‘sunwheel’ (swastika) motifs, commonly displaying both a clockwise and an anti-clockwise turn, or ‘spin’. This motif occurs across a range of cultures. Far from being an exclusively Eastern symbol, the motif is found both in the Far East and Far West, existing amongst indigenous American tribes as recently as the early 20th century. It is often said to symbolise the rotation of the four elements or seasons around a motionless centre. In Isfahan, I was told that it is essentially a Shi’a symbol, an example of *pili* – a design in which the name of *Ali* is encrypted, rotated and reflected. The great Sufi scholar and metaphysician Rene Guenon offers a more a esoteric reading of the design in which it is said to represent the “sign of the Pole” (Guenon 2004, p. 55), the motionless heavenly axis around which the Earth, represented by a cross, revolves, the trailing arms signifying the direction of rotation, or ‘spin’. This direction is, of course, is reversed depending upon whether one is considering the North or the South pole, and both directions of spin are very often represented together in the buildings of Iran.

Examples of ‘pole star’ patterns (left to right). Moareq tile work, Molla Ismael mosque, Yazd; Painted ceiling, Ali Qapu ('Gate of Ali') palace, Isfahan; Cut-stone work, Jameh Mosque, Isfahan.

Aside from wishing to uncover something of the symbolic dimension of the geometric motifs, it was also essential for me to study the practical aspects of designing and building with this visual language. Through my contacts at the University of Isfahan, I was very fortunate to have a number of meetings arranged for me with craftsmen and artisans in the area of Isfahan. The first two images below are from a *moaraq* (tile mosaic) craft workshop. In this technique each individual piece is cut from a ready glazed ceramic tile to a precise shape with a sort of ‘twin beaked’ hammer. The numbered pieces are then assembled jigsaw fashion face down on the floor, before plaster is poured onto the back of the mosaic to create one solid piece. This can then be dispatched and carefully installed on-site. It is a mark of the precision of work achieved by these craftsman that fine pieces of detailed biomorphic design can be assembled seamlessly, leaving no mortar line. I have visited similar workshops in Morocco, where the same procedure is used for creating *zillij* work. In Morocco, the tasks are performed by children and the general set-up is rather more hierarchical. A child might, for example, spend a couple of years simply marking out tiles, before later moving up to the more skilled task of precise cutting. The twin-beaked hammer is, however, exactly the same. The design of this tool dates back at least at least to the Roman era and is used to cut the marble *tessarae* of traditional Roman mosaic. It can still be purchased in Italy.



First two images are from a Moareq workshop in Isfahan. The last is an example of Safavid moareq from the Jameh mosque, Isfahan.

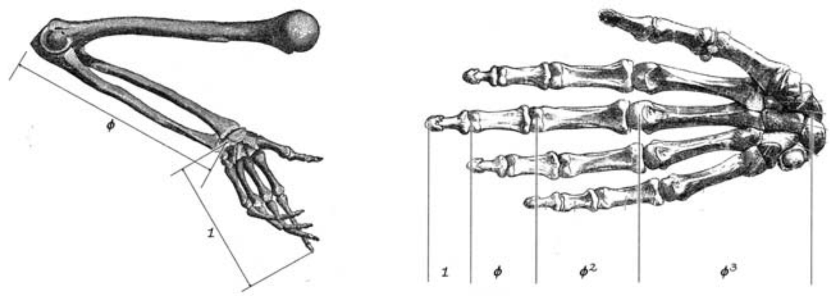
In the countryside outside of Isfahan, I visited the busy workshop of a Mr Oshaghi, a master craftsman and practitioner of *gereh-chini*, a traditional woodwork technique involving the assembly of small wooden pieces into elaborate geometric designs. He showed me his studio and was happy for me to document how he would set about constructing a traditional pattern. Mr Oshaghi had learnt his skills from his father and he was gradually passing them on to his sons (now grown men), who were always with him within the studio. I was interested to learn the similarities and differences between how he and I would go about developing a geometric design. The image below shows Mr Oshaghi demonstrating the construction of a pattern involving 10-fold symmetry. He did not work with a leaded compass, as I would myself, but would start by incising a circle into the paper with a pair of dividers. The paper had previously been left out in the sun to go brittle and lightly browned, so that the dividers would score a faintly legible line when marking it. This would then be worked over freehand with a pencil. Mr Oshaghi began with the creation of a *shamsa*, literally 'little sun'. In the case of 10-fold symmetry this would take the form of a decagram, or 10 pointed star. The decagram is progressively broken down in order to find the classical elements of 10-fold symmetry. The pattern is then developed through intelligent extension of parallels forming a network of lines, at the intersections of which the design emerges.

This technique of using compass and unmarked straight edge is essentially the one that I use myself and is common throughout the Islamic world. Mr Oshaghi also showed me some rather more innovative work involving 7-fold symmetry. He was, however, rather more reticent about revealing the method underlying these more original designs. This was perfectly natural. I would have felt the same about revealing my professional secrets to a stranger.

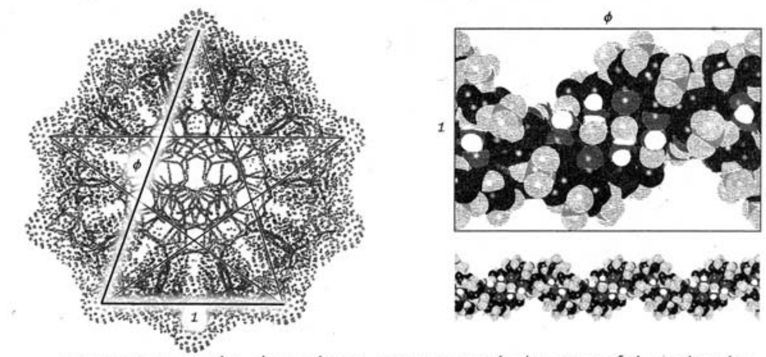

Mr Oshaghi's demonstrates a pattern employing 10-fold symmetry in his workshop.

The image to the right above shows a very important stage in the drawing. The diamond shape is a very particular rhombus with key proportions. The ratio of its edge length to its overall height is 1 to the golden section. The golden section, also known as *Phi* (named after the Greek sculptor Phidias, who used it in the design in the Parthenon) is commonly represented by the symbol Φ and is an irrational number. Its approximate value is 1.61803…, the number of decimal places is unending. A pocket calculator will offer you an approximation if you enter the values (√5+1)/2. The Greeks, who had neither calculators nor decimals, called such numbers "unutterables". Despite this limitation, these values could be determined geometrically (through drawing) with great precision and the proportional ratios derived from them were used by the Ancient Egyptians and Greeks to proportion their architectural spaces and to generate harmonious designs (Ghyka 1977, Olsen 2006). Within the Islamic tradition such proportions underlie the designs of all architectural spaces and geometric patterning. There are, however, different regional emphases. In the Magrib and Andalucia, there is a preference for patterns based on the proportional ratios related to √2 and √2 + 1. These are used in the facades of the Alhambra in Granada, the plan of the Qarawiyyn mosque in Fez and the proliferation of patterns with 8, 16 and 32 petal rosettes throughout Morocco. In the Umayyad mosque in Damascus the walls are beautifully adorned with bold cut-stone geometric designs deploying √3 symmetry. In Iran the preference is for patterns based on the golden section and the 5 and 10-fold symmetries derived from it.

So what is it about using these particular ratios that leads to harmonious designs? One characteristic of using these proportions within patterns is that the same elements of the patterns recur at different scales. Mathematicians often describe this as the principle of 'self-similarity', an essential characteristic of fractals. 'Self-similarity' is the key to understanding the peculiar resonance between these proportions and patterns in the natural world. In animals, the most permanent bodily tissues, such as bones, teeth, horns and shells all develop through growth by accretion, where smaller elements are related to larger elements by the same proportion. The golden section itself, often rendered by the formulation 'the smaller to the larger is as the larger to the whole', is very much the signature of living forms. It underlies the proportioning of bones in the human body, as well as the structuring of the DNA spiral.



The primary bending places from fingertip to elbow relate to their neighbors by the golden section, here 1.618, found in pentagrams and the water molecule.

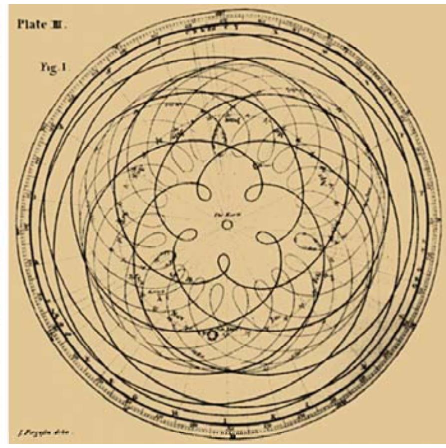


A DNA cross-section shows the 10-steps-per-spiral nature of the molecule; a single twist of DNA fits a golden-section rectangle.

From Moff Betts, *The Human Body*, Wooden Books

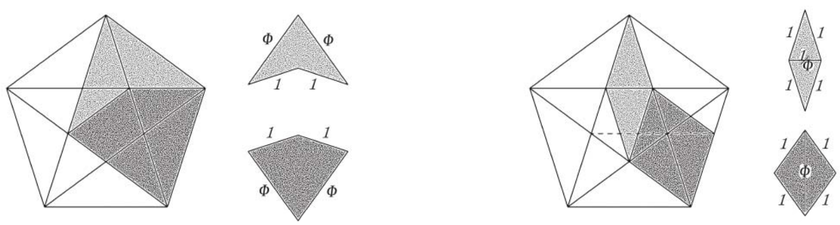
The image immediately above shows how the pentagram (five-pointed star) contains the golden section proportions within its structure. As a pictographic symbol the pentagram dates back to the Sumeric period (circa 3300 bc), although its exact meaning at the time is uncertain. According to some accounts, Babylonian priests identified the pentagram with Ishtar, the goddess of love and war. Ishtar is derived from the Sumeric goddess Inanna and both were associated with the planet Venus. Why should there be this association? One possibility is that the successive conjunctions of Venus, the Earth and the Sun plot a near perfect pentagram against the background of the Zodiac every eight years. The Venus table of Ammisaduqa, a 7th Century cuneiform tablet recovered from the library at Nineveh, offers evidence this pattern was known to Babylonian astrologers at least as far back as the 17th century BC.

Quite why there should be an elaboration of the pentagram motif on the inside of the 11th century north dome of the Jameh mosque in Isfahan remains something of a mystery. This Seljuk work is the earliest example of decoration on the cavity of a domed surface. The ribbing and the dome were constructed together, so the full geometric scheme must first have been thought out and worked through during the design process, most likely starting from a two dimensional drawing, which was then projected into 3 dimensional space. It is part of Isfahani folklore that Omar Khayyam was the designer behind this innovative work and Alpay Ozdural from the Eastern Mediterranean University, North Cyprus, argues persuasively that there may well be some substance to this (Ozdural 1998). Ozdural's analysis of surveys of the dome suggests that this part of the building was constructed with an extraordinary accuracy, even by modern standards let alone those of the 11th century, pointing to the presence of the poet and brilliantly skilled mathematician overseeing the design and build.



Taj-Al-Mulk North Dome, Jameh mosque, Isfahan, built1088, alongside detail showing the path of Venus from James Ferguson's, *Astronomy Explained Upon Sir Isaac Newton's Principles,* 1799 ed., plate III, opp. p. 67.

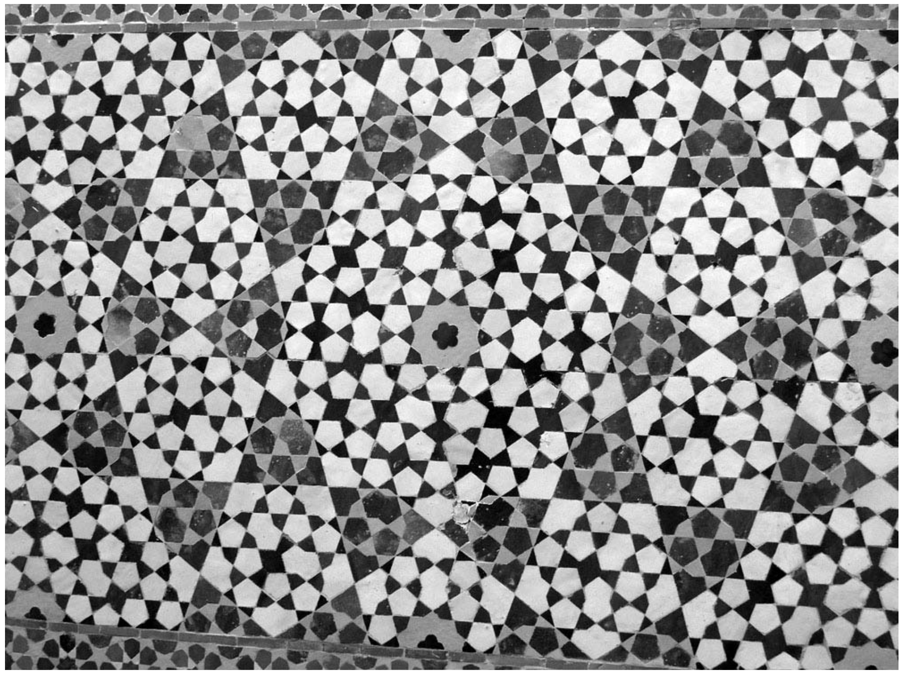
A more recent study by the structural engineer Mehrdad Hejazi at the University of Isfahan indicates how the curvature of the dome is optimized for maximum strength, a significant virtue in a land subject to earthquakes, and is based upon the golden section (Hejazi 2005). Hejazi believes that the designer chose to use the pentagram motif for the ribbing as a way of encrypting the underlying design principle within the visible decoration of the structure itself.



From Scott Olsen's *Golden Section*, Wooden Books

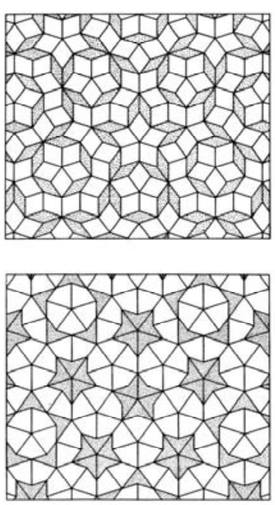
The figures above shows how the pentagon containing the pentagram can be broken down to create a range of tiles. All of these are based around the *phi* proportion and, together with a closely related family of shapes derived from the decagram (or 'shamsa'), can be tessellated to fill the plane seamlessly and create symmetrical ('periodic') tilings. A knowledge of this principle dates back at least to 11th Century Iran, and it became the basis for the development of a sophisticated range of designs employed throughout Iran and across the Muslim world. Interestingly, there appears to have been little or no understanding outside of the Islamic world of how to create tilings using 5-fold symmetry until Kepler's work in the 17th century, a fact which is conspicuously absent from most histories of art and mathematics.

Many of the 5-fold patterns in Iran show an incredible virtuosity of design combined with extraordinary spatial reasoning and vision. The pattern below from the *Vakil* mosque in Shiraz employs a 'substitution' principle in which self-similar shapes are recursively broken down into proportionately smaller copies of themselves. Known as *gereh*, or 'knot' patterns, such designs suggest a harmonic resonance between macrocosm and microcosm and have a strong meditative power.

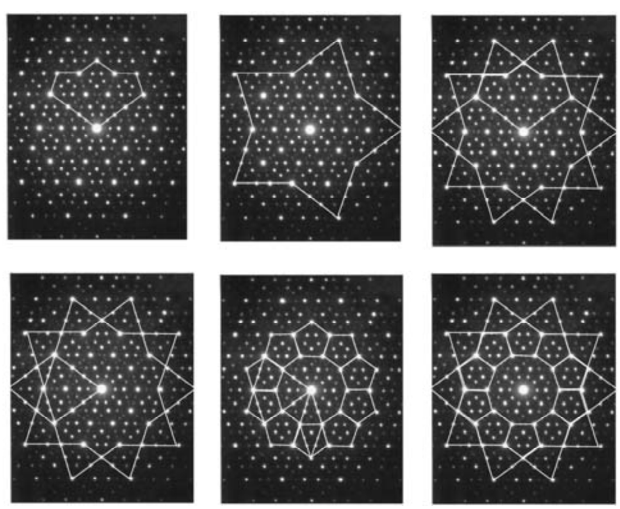


Vakil (Regent's) mosque, Shiraz (Qajar period)

In the 1970's the Oxford mathematician Roger Penrose discovered that by using a subset of tiles generated from the same principles as the pattern above and assembling them according to a pre-defined set of 'matching rules', it was possible to create *non-periodic* tilings of the plane, that is, patterns with only local symmetry, which can be extended indefinitely without repetition. These patterns also have a close connection to quasi-crystals, a new type of metallic alloy discovered in the 1980's, which has revolutionised the field of crystallography (Senechal 1995). Below, to the left, are two examples of Penrose tilings. To the right are images of a quasi-crystal with classical Islamic geometric motifs superimposed. All these shapes can be found in the Shiraz pattern above.



Two 'Penrose' tilings



Analysis of quasi-crystal diffraction diagram. R Henry 2007

It has recently become a matter of some controversy as to what extent the early Muslims knew of the possibility of using their tiles to create non-periodic patterns. The Harvard physicist Peter Lu, through studying the 12-15th century patterns of Iran and Central Asia, has recently published a paper in *Science* arguing that in a number of key areas the understanding of geometry in medieval Iran anticipated Western science by 500 years (Lu & Steinhardt, 2007). Some mathematicians that I have spoken to have been swift to dismiss Lu's findings. A key problem appears to be whether or not the designer/craftsmen of the time, and the mathematicians who collaborated with them, were aware of Penrose's matching rules. If they were not, then any early examples of non-periodic tilings that are discovered may well have been achieved through accident rather than design.

There is, however, another possibility. Seyyed Hossein Nasr suggests that the patterns do not arise from an analysis of matter in the manner of modern physics, but actually have their origin in subtle states. He writes, "they are the results of visions of the archetypal world by seers and contemplatives who then taught the craftsmen to draw them on the surfaces of tiles or alabaster…these patterns serve as a key for understanding the material with which the architect deals while unravelling also the structure of the cosmos before the eyes of the beholder" (Nasr 1987). From this perspective, the true function of the patterns may be to make us more sensitive to the subtle harmonies within the natural world and remind us, ultimately, of the Hermetic principle that 'that which is lowest symbolises that which is highest'.

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