Examining Safavid Biomorphic Patterns in Design

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Abstract

This study explores the ways in which Islamic biomorphic patterns can be utilised within modern designs. The term "biomorphic patterns" refers to stylised natural forms that are used to decorate architectural surfaces and objects. These patterns have been used since the 7th century in Islamic architecture, but biomorphic patterns is still an understudied research area in the literature on Islamic art. The research primarily aims at developing an understanding of rules and principles of biomorphic patterns during the Safavid period (1502–1722) in Islamic Persia.

As a practicing artist and researcher, I employ a practice-based research methodology which includes experimenting with ceramic tile techniques and analysing Safavid biomorphic patterns produced on ceramic tiles of two prominent mosques: Sheikh Lutf Allah and Shah Mosques in Isfahan. My in-depth analysis of these patterns incorporates examining the underlying geometric structures; identifying forms of symmetry and the way motifs are multiplied; and investigating the structuring elements of those motifs in detail to determine the relationship between the underlying rules and the potential for artistic interpretation and elaboration.

The outcomes of the thesis is a listing of biomorphic pattern principles and a motif database both of which can help artists and designers create their own biomorphic patterns. The analysis shows that the underlying geometry is essential to the overall pattern organisation, but it is not the only part of the pattern making process. The placement and the execution of motifs require a trained eye and a skilful hand. The thesis is concluded with two practical examples on how the motif database can be used, putting into practice and proving the necessary relationship between the biomorphic motif database and the formal construction process.

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Dedication

To my beloved grandfather, Naji Al Shafie (1936-2018), who believed in the power of education and always believed in me as an accomplished artist and researcher.
May he rest in peace.

My grandfather and I (5 April 2015).

Chapter 1: Research background

1.1 Introduction

Islamic patterns have long fascinated me. My interest started seven years ago when I attended a workshop with "Art of Islamic Pattern" and tried out drawing a simple geometric pattern. My primary motivation was to become more acquainted with my rich Islamic heritage, but that class has led me to a path I have never anticipated.

Shortly after that class, I enrolled in various courses offered by the Prince's School of Traditional Arts in London and also went on several study trips organised by art specialists to study Islamic art in its historical contexts, such as in Spain, Morocco, Turkey and Iran. During that exciting period, patterns kept me mesmerised wanting to learn and draw more. Then I decided that rather than copying the work of the Islamic art masters, I wanted to create my own artwork. This was the beginning of my interest in analysing and reproducing biomorphic patterns, and specialising in this particular area of Islamic art.

The structure of patterns did not make much sense to begin with, but gradually the more I practiced drawing, the more I could see how patterns are constructed and connected, and eventually, I started uncovering the underlying grid. I specifically love the application of biomorphic patterns on ceramics in mosques. The vast array of interconnected shapes and vibrant colours add immense beauty to the space and create a world of their own. This experience with biomorphic patterns, as a learner and an artist, has encouraged me to research this subject. I have chosen to focus in my study on the biomorphic patterns of the Safavid period (1502–1722), in particular, because of my study trip to Iran in which I witnessed the great monumental architecture of that dynasty.

1.2 Aims of the research

The main aim of this research is to develop an understanding of design principles and rules of biomorphic patterns used to enrich the surface of ceramic tiles of Safavid mosques. Additionally, the research aims at examining the practice of making ceramic tiles in the Safavid period. Another aim of the research is to uncover the surface biomorphic patterns by probing into the reproduction of a pattern from a geometric grid to the finished product providing guidelines and illustrations for pattern analysis. The final aim of the study is to propose a database of motifs extracted from two prominent Safavid mosques that can be utilized by researchers, artists, designers and practitioners.

1.3 Research questions

The primary question that this research attempts to answer is:

How to reproduce biomorphic patterns that appear on ceramic tiles of Safavid mosques and use them in design?

Specifically:

1. What are the production techniques of ceramic tiles in the Safavid period?

2. What are the rules and principles of the biomorphic patterns that appear on ceramic tiles of Safavid mosques?

3. How a database of motifs of Safavid biomorphic patterns is used in design?

1.4 Significance of the research

Ornaments have been used for centuries in the Islamic world embellishing textiles, carpets, manuscripts and objects and also the ceramics of mosques. Ornaments of ceramic tiles of Safavid mosques not only hold a great historic and artistic value but also the images depicted on the tiles are “a source and site of knowledge and understanding” because in art practice research “images operate as texts, artifacts, and events that embody individual and cultural meanings” (Sulivan 2005, p. 119). However, the studies of biomorphic patterns, included in such visual ornaments, have not been sufficient in the literature on Islamic art and this motivated the current research.

In the Islamic world, architectural drawings and pattern knowledge were guarded and treated like a secret and 'theoretical treaties' were not made publically available. Thus, when drawings of Islamic architecture and geometry are found, they are immensely valuable. One of the very few examples we have is the Topkapi scroll, which is a treasure kept in the Topkapi Palace in Turkey, that informs the world of Islamic geometry. This scroll has been studied by the scholar researcher, Necipoglu (1995). However, records of the production of biomorphic patterns have not been found anywhere and having such a record is needed to decipher the code and reproduce them. Therefore, this thesis is an attempt to record and understand the Safavid visual language in order to generate a database of motifs to reproduce more patterns applying the Safavid ways.

The research provides a pattern analysis that includes a detailed account and guidelines illustrated with diagrams to study biomorphic patterns not only the Safavids but also of other different Islamic ruling periods. The research will focus on reintroducing Islamic patterns for use in design, especially the unique style of ceramic ornamentation enhanced with biomorphic patterns developed in the Safavid period, proposing a database of motifs extracted from two prominent Safavid mosques that can be utilized by researchers, artists, designers and craftspeople.

Unlike the Islamic biomorphic patterns of the Ottoman period that are equally appealing and have been studied in depth, the Safavid biomorphic patterns have received less recognition in academic research. This research will contribute to the literature in the field of Islamic patterns by addressing an under researched area that is the biomorphic patterns, and their production during the Persian Islamic Safavid period (1502–1722).

In conclusion, the research attempts to fill a gap in the literature on Safavid biomorphic patterns and provide art historians, art practitioners and other specialists with a set of guidelines and a database of motifs they can utilize to recreate biomorphic patterns and employ them in their designs in a way that articulates the underlying principles of producing biomorphic patterns in the Safavid period.

Chapter 2: Literature review

2.1 Introduction

(Nasr, 1987, 1993, 2008; Necipoğlu, 1990, 2015, 2016, 2017)

This chapter examines the fundamental literature that discusses the subject of Islamic biomorphic patterns and the Safavid period. This will be divided into an investigation of four topics: Islamic art, ornamentation in Islamic art, Islamic patterns and the Safavid period.

The first topic is mainly concerned with the general publications in the field of Islamic art. I discuss the various perspectives on Islamic art that appear in the literature written specifically in English. As a bilingual speaker of Arabic and English, I have access to resources written in these two languages. However, the Arabic literature on Islamic art and architecture is scarce and most of it is translated English work. There are few Arabic resources that I included in the study. There are also some resources in Persian and Turkish but since I do not speak these two languages, I used few of the illustrated work written in them or the research by Persian and Turkish scholars that is written in English.

The second topic is a more specific review of publications that are written on ornamentation in Islamic arts followed by a discussion of Islamic patterns that starts with geometric patterns, as that is the most work available. The final topic is on the Safavid period, and the publications that have been written studying that historic period and the resulting art, architecture and craft. As will become evident, the existing literature on Islamic art is neither adequate nor comprehensive. The study of Islamic biomorphic patterns is particularly limited, so this research will contribute to enhancing and enriching the field of Islamic arts in this specific area.

2.2 Islamic art

At the end of the 19th century, European and American scholars developed an interest in a newly invented field of study they called “Islamic art” (Vernoit, 2000). They enclosed the various

forms of arts produced in all of the Islamic lands since the eighth century under the term “Islamic art” (Blair and Bloom, 2003).

Two of the earliest books on the subject of Islamic art were written by Ernst Kuhnel’s in German *Islamic Art and Architecture* (1962) and *The Minor Arts of Islam (1963)*. Both were translated to English by Watson (1966; 1970). Kuhnel worked as an art history professor at the University of Berlin and the director of the Museum of Islamic Arts in Berlin. In his book *Islamic Art and Architecture* (1966), Kuhnel divides all the art and architecture from the Islamic lands into three categories: Early Islamic Art (661-1110), Medieval Islamic Art (909-1517) and Islamic Art in the Modern Period (1400-1800). The Safavid period, which is the focus of this research, is placed in the last category. Kuhnel justifies the use of the word “Islamic” in association with “art” because it is the strongest connection between all the Islamic lands, and that religion is stronger than any cultural or racial bonds.

In the same vein, David James (1974), a historian of Islamic art, in his book *Islamic Art* agrees with Khunel’s approach. James clarifies that even though the residents of the Islamic world come from different ethnicities and speak different languages, the arts produced across the Islamic worlds are unified. However, he does not address those unifying factors and the contributions from various Islamic periods.

The term “Islamic art” is defined by Titus Burckhardt (1976) in the introduction of his book *Islamic Art:*

> By general and tacit consensus the expression the 'Arts of Islam' or 'Islamic Art', refers to all the arts of the Muslim peoples, whether those arts by religious or non-religious, which the analogues expression the 'The Arts of Christianity' raises immediately the questions as to what extent, and according to which criteria, the arts of the West can be so defined (1976, p. 31).

Burckhardt has a valid point in questioning the use of the term "Islamic" since it diminishes the contribution of arts, crafts and architecture in all the Islamic lands and across a long period of time from the 7th to the 19th centuries.

On the contrary, Rice (1965) believes that it is fair to use the term "Islamic" since he thinks that all the art of the Islamic lands is a product of the same artistic instinct and style. He writes that art and architecture in Christian lands should not be referred to as such because it is very varied and it deserves the different distinctions unlike Islamic art. Rice also presumes a lack of curiosity and imagination in Muslim artists because they did not seek unfamiliar and new ways of art like in the Renaissance.

In Kuhnel's second book *The Minor Arts of Islam* (1971), he clarifies that: "Islamic art knows no distinction between the religious and the profane. Divine service consists essentially in prayer and needs no sacral or liturgical objects for its celebration" (p.1). This is a problematic statement, as Kuhnel also minimises the value and vastness of Islamic arts and crafts over time and geographical locations and indicates that Islamic art is inferior to European arts and understates the importance of ornaments by calling them decorative and the only option that Muslim artists had.

Burckhardt (1976) disagrees with Kuhnel and states that Islamic art is sacred because there is no separation between religion and the rest of life in Islam and that the act of beautifying and making art is a form of connecting to the Divine. Burckhardt defends his statement by explaining that Islam is a rounded system of thought and expressions, and arts is part of that expression that has been guided by God. This concept is also a neglected factor by European art historians, who study the Islamic art as a separate entity rather than an extension of the Islamic thought embraced by craftspeople and the makers. Christian historians assessing Islam is a delicate matter that created a legacy of inconsistent scholarship and misunderstanding (Blair and Bloom, 2003).

The role religion played in Islamic art has originated from the profound differences between the measure of arts and skill level in Europe and the Islamic lands. In European arts the human figure is seen as the pinnacle of artistry whereas in Islamic arts figures are not the focus. Human

life and the human body are only one stage of life and the focus is on the eternal heaven after death, and that is represented clearly in architecture and books through foliage, geometry and calligraphy (Burckhardt, 1976).

As we know, art is subjective, and personal feelings and beliefs impact the way art is understood. Since Burckhardt converted to Islam, his views hold a unique perspective that carries a deeper understanding of Islamic arts that scholars such as Khunel did not have. Burckhardt (1976) explains the difference between the European and Islamic view to the arts:

> From a European point of view all the arts subordinated to architecture are only decorative arts and therefore arts of secondary importance and of limited creativity. In the world of Islam these arts occupy the place reserved elsewhere for figurative arts, for whose absence they compensate while at the same time they have a completely different function in that they transform the raw materials giving it a nobler, almost spiritual, status made of crystalline regularity and vibration of light (p. 33).

Oleg Grabar (1929–2011) was the Professor Emeritus at the Institute for Advanced Study in Princeton University and an important scholar in the field of Islamic art who published some substantial work on the subject of Islamic art, such as his book *Formation of Islamic art* (1973), in which he expresses his frustration with the term 'Islamic art' because it includes all the art, craft and architecture from the eighth to the eighteenth century and from Spain to India. Graber argues that generic books on 'Islamic art' cannot convey the full picture and are sometimes meaningless; however, very specialised books did not have an audience either; therefore, this way of categorising art with the word 'Islamic' remained.

A different approach to Islamic art is suggested by Brend (1994) in which the term "Islamic art" changes based on the person who defines it and as result it means different things to Muslims, non-Muslims, tourists, curators and artists. The definition of 'Islamic art' that Brend uses is "the art produced for rulers or populations of Islamic culture" (p. 10). The merits of this approach

might be appealing taking into consideration the various audiences; however, I think there is a need for a fixed definition to avoid misunderstanding from happening.

In *Islamic art and architecture*, Hillenbrand (1999) attempts to approach the subject of Islamic arts through categorising each period of Islamic art based on the ruling political power similar to Khunel's (1966) and Rice's (1965) work in order to make the subject more manageable, which is a big task for only 280 pages. Hillenbrand provides some invaluable information, such as craft development and highly regarded buildings, but there were many subjects that were still untouched, such as Islamic patterns.

The trend of generic 'Islamic art' books has continued through the 21st century, where some scholars neglect adding information altogether and limit their work to publishing pictures of Islamic monuments, such as *Making Sense of Islamic Art & Architecture* by Barkman (2015). Barkman undervalues the scholarly work and has a random selection of Islamic arts and architecture without a clear narrative or correlation. This represents an example of how the area of Islamic art is still undefined and misunderstood by some European art historians.

The term "Islamic art" is still used without serious questioning; however, there are some recent efforts by Shaw (2019), who is on a quest to understand the religious aspects of Islamic arts. Shaw discusses the idea that Islamic arts have been categorised and studied in a Eurocentric way that imposed its own rules on it with arrogance. She points out to the root of misconception:

> This limitation emerges through a double translation intrinsic to art history; first that of European pre-modern cultures into modern frameworks; and secondly, that of other cultures through the resulting Euro-normative category called art (p. 2).

Shaw's (2019) views are in line with Burckhardt (1976) views, who states:

> Islamic art is far less a way of expressing emotion than a science and that a Muslim artist will willingly subordinate his individuality to the, as it were, objective and impersonal beauty of his work. Europeans of our day are distrustful of any canon that is imposed

> upon art and they are all too ready to regard it as an obstacle to 'creativity', especially when this canon can be translated into a mathematical formula. (p. ix).

I believe this is a sound argument highlighting the European misconception of art produced in the Islamic lands. Pope (1965) advises that the study in the field of Islamic art should be concentrated on one historic period, if not on one architectural monument at a time, because that is the best approach in studying areas of arts and crafts of the Islamic lands, and that will at least produce a meaningful understanding of the subject. I agree with Pope and I narrowed down my research to study the Safavid biomorphic patterns of just two mosques.

Some scholars are not concerned with the debate about Islamic art and highlight the sacredness of Islamic art as suggested by Seyyed Hossein Nasr, an Iranian Professor of Islamic Studies at George Washington University, who is considered to be one of the prominent figures in the field of Islamic and religious studies. In *Islamic Art and Spirituality* (1983), he points to:

> Islamic art is gradually coming to be understood for what it is, namely a means of relating multiplicity to Unity by means of mathematical forms which are seen, not as mental abstractions, but as reflections of the celestial archetypes within both the cosmos and the minds and souls of men (p.6).

Nasr believes in the spirituality that frames the thoughts of Islamic art and he states that "Islamic spirituality could not but develop a sacred art in conformity with its own revealed form as well as with its essence" (p.6). Nasr's perspective influenced other researchers such as Keith Critchlow (1989) who framed his Islamic art research in accordance with Nasr's views on Islamic spirituality and symbolism underpinning the essence of Islamic art.

Regrettably, from my research in the area of Islamic art I observed that Muslim researchers have not produced enough literature in the field of Islamic art in general, and the area of biomorphic patterns, in particular. Their insider perspective of Islam as their religion and awareness of the sociocultural context of Islamic art would have been different to many of the current discourses and the conditioned artistic gaze. In addition, Muslim women researchers have not contributed

much to the study of Islamic art and biomorphic patterns until the late 20th century with the breakthrough work of the Turkish American professor: Gulru Necipoglu (1990, 1995, 2015, 2016)) and the illustrated work of Inci A. Birol (2014) that will be discussed in the following section. However, as Turkish scholars, most of their writings are about the Ottomans and their art and architecture.

2.3 Ornamentation in Islamic Art

Ornamentation as a concept "is culturally conditioned" (Hukmat and Uzunahmet, 2020, p. 111). While the Eastern perspective to ornamentation considers it as an essential element of structure, Western culture has perceived it additional or a supplementary part (Burckhardt, 2009). As a result, Garber (1973) provides a distinction between the word "ornamental" and "decorative" since the word "decorative" carries negative connotation that minimises the importance of Islamic ornaments. In the same vein, Pope (1965) pinpointed the perspective of western thinkers:

> To the twentieth century Western mind, words like 'ornamental' and 'decorative' too often suggest something of secondary importance. In architecture, simple and massive forms certainly have independent value of their own but they also provide the substructure for ornamentation (p. 132).

The reason for the Western perception of ornamentation as an additional component is explained by Trilling (2001) who specifies that since the ornaments of the world were studied in a European context, they were forced into the European moulds:

> When it came to charting the evolution of styles, Western ornament was the model, everything else was ancillary. Today this attitude is unacceptable, not because of political correctness, but because we are closer to seeing the whole world (p. 8).

Recognising cultural conditioning to ornamentation by an increasing number of researchers is a positive change of perspective to pattern study. However, even with that insight, Trilling himself thought that Islamic patterns were strict and not imaginative.

Baer (1998) indicates that ornaments in Islamic arts and architecture tend to be ignored or overlooked in the literature. She attempts to understand Islamic ornaments; however, her views are similar to Kuhnel's (1963) who considers Islamic art inferior to European art and minimised the importance of ornaments by calling them decorative and the only artistic option the Muslim artist had. Similar to other researchers , Baer's use of the term "ornament" includes vegetal, geometric, figural compositions and calligraphy. She presents a vegetal pattern development composed of three periods that will be useful to include in Section 4.3 that discusses pattern development through Islamic history.

Necipoglu, the Islamic art and architecture Professor and Director of the Aga Khan Program at Harvard University since 1993, indicated that in the 20th century, the categorisation of Islamic patterns as decorative was common. Nonetheless, there was a general fascination with such patterns. The major flaw that predominated the scholarship of Islamic patterns was separating the pattern from its social and cultural context and treating it as an art form on its own. On the contrary, patterns and artworks were deeply personal in the medieval Islamic world because they were the only ways of self-expression and identity, aside from poetry. She explained in *Histories of Ornament*:

> The agency of ornament activates and transforms interactions between humans, portable objects and built environment, thereby promoting a new kind of perceptual and bodily experience that complement rather than negate semiotic significance ((2016, p.132).

In accordance with Necipoglu's views, Clevenot (2000) asserts that whilst ornaments might appear as an additional second skin on top of architectural surfaces, they are, in fact, a fundamental part of the complete architectural vision. Agreeing with that, Trilling (2001) noted:

> Ornament should once again speak for itself, as it did universally for thousands of years. The problem is that a few people remember the language of ornament well enough to enjoy it let alone use it creatively (p. 6).

I tend to agree with Trilling's perspective; we have certainly lost our connection and understanding of ornaments, which include both motifs and patterns. This is in line with my views and drives me to explore Islamic patterns further to unfold the underlying meaning of the patterns in order to understand the visual language since they are a significant aspect of the architectural structure.

2.4 Islamic patterns

“Islamic pattern” is a term used to describe three types of patterns that occur in the art and crafts of the Islamic lands: geometric patterns, biomorphic patterns and calligraphy (DeLong, 2017). The earliest example of Islamic patterns in the literature that is written in English is *The Grammar of Ornament* by Jones (1856), which is an illustrated account of the most common national, international and tribal patterns. One of Jones's objectives, as he states, is to inspire architects of the time to stop copying one particular style and to widen their horizons. The selection process of the ornamental arts in the book is to present the most prominent patterns and motifs from every historic period. Further, the chapters are organised based on an ethnographic categorisation rather than on patterns systems, symmetries or motifs. The relevant chapters of this plethora of patterns to the current thesis are the Arabic ornaments, Turkish ornaments, Moresque ornaments and Persian ornaments.

Even though Jones’ book is a good visual resource that presents some common shapes and discusses their underlying patterns, it does not include an explanation, a method of drawing or a discussion on the use of grids since the work is a reference rather than a construction manual. This is unfortunate because Jones clearly had the knowledge and expertise to provide useful instructions to draw the patterns with precision.

This type of illustrated books has been reproduced and there was a number of resources that followed that with the prevalence of images and drawings over text and description, such as *Persian Design and Motifs for Artists and Craftsman* (Dowlatshahi ,1979), *Arabic Art in Color* (D'Avennes, 1978) and *Islamic Designs in Color* (Simakov, 1993). The issue with such books is that they only showcase artwork rather than provide any direction or clarification of why and how things were done in a certain way. They are merely collections of inspirational images and sketches that artists can trace and include in their work, but the lack of descriptions and instructions make it rather difficult to reproduce the patterns with correct proportions and accuracy. However, an earlier book examined patterns in depth *Geometric Concepts in Islamic Art* (1976) that is written by an Iraqi architect, Issam El-Said (1938–1988), and a Turkish chemist, Ayse Parman. Their mathematical background has assisted the authors in probing into and highlighting the geometry of Islamic patterns.

Other scholarly books on Islamic patterns are published by a British scholar in Islamic arts, Professor Keith Critchlow (1933–2020). He founded the Visual Islamic and Traditional Arts School in 1984, which was transferred from the Royal College of Art to The Prince's Institute of Architecture in 1992–1993, where he was the director of research, and contributed immensely to the study of Islamic arts. Critchlow published *Islamic Patterns* (1983), a book dedicated only to Islamic patterns and their constructions, in which he asserts that geometric forms are meaningful and not just abstract and obsolete. In the book he sheds light on the meaning of every geometric manoeuvre. For instance, the circle is not only a round line; he indicates that "The circle is also, then, the primary cosmological symbol, one of wholeness and unity" (p.8). Moreover, he identifies the concept of balance in Islamic designs, "Islamic art is predominantly a balance between pure geometric form and what can be called fundamental biomorphic form… representing the formative forces behind vegetation and vascular form" (p.8). Most importantly, the book provides an in-depth instructions on geometric patterns and how they can be drawn. In fact, it is not an easy book to digest, but the guidelines it presents can be comprehended by a keen mind that appreciates mathematics and pure form. A second work by Critchlow is *The Hidden Geometry of Flowers* (2011), which is an insightful reference on how geometry and patterns are embedded in everything. He highlights that geometry is an integral part of our lives.

He also views flowers as unique patterns, which I will discuss when I analyse floral patterns in Chapter 6.

Further, a number of books were published on the subject of Islamic patterns discussing various geometric patterns such as *Islamic Designs for Artists and Craftspeople* (Wilson, 1988); *Islamic Design* (Sutton, 1999); *Drawing Geometry* (Allen, 2007); *Arts and Crafts of the Islamic Lands* (Azzam, 2013); *Islamic Geometric Design* (Broug, 2013) and *The Geometric Language of Anatolian Seljuk Art* [Anadolu Selc¸uklu Sanatının Geometrik Dili] (Sönmez, 2020). The focus of all of these pattern books is only on the geometric Islamic patterns with just brief reference to bimorphs and their forms. Additionally, in such publications the geometry of Islamic patterns is treated as a mathematical puzzle that was taken out of its cultural and historical context. In conclusion, as Bier (2016) noted, the construction, analysis and the traditional methods of geometric patterns were the main aims of scholarly efforts and most publications while biomorphic patterns did not receive much interest. Therefore, this thesis will contribute to the literature with respect to biomorphic form, pattern and analysis relating it to the historical and cultural context.

One of the few invaluable and comprehensive resources on biomorphs and the important role of ornaments is *Islamic Geometric Patterns* by Bonner (2017). He discusses Islamic geometric patterns and their relationship with biomorphs asserting that "The role of geometry within the tradition of Islamic floral ornament is primarily structural: providing symmetrical order upon which the stylised tendrils, flowers, and foliation rest" (p.3). Bonner identifies three types of symmetries: reflective symmetry, bilateral symmetry and rotational symmetry, which I will explain and utilize in Chapter 6: Pattern analysis. In the same vein, Pope (1965) emphasises the importance of biomorphic patterns, which touches the mind beyond the visuals. He states:

> That which to a hurried Western viewer may seem a surfeit of opulence is to the Persian, who values contemplation, an invitation to leisurely exploration, a promise of endless delight. Familiar with the decorative language, he can read the ornamentation as if it were a poem, or he can lose himself following, unravelling its subtly planned intricacies (p. 134).

During my visits to Iran and Turkey in 2015, I visited a number of bookshops in attempt to find resources that might help me understand the biomorphic patterns from a Muslim perspective, and there were few useful illustrated books that provide an overview of such patterns. The Islimi and Khatei book series illustrated by the Iranian artist Amir-Houshang Aghamiri (2004) include most Islamic pattern motifs and their organisation within a pattern. The books focus on the motif language, but they do not discuss the origin of pattern, names of motifs, nor geometric grids. Nonetheless, they are the most useful books to recognise the motif language of Persian patterns. Other important authors on the subject in Persian are designers: Honarvar and Khonyagar with their book *Design and Ornaments of Eslimi and Khatei Pattern in the Carpet designing and Illumination* (2009; updated 2013). The motifs used in the book originate from Iranian carpet designs and illuminated manuscripts, which offer an interesting mix of motifs. The book includes a list of motifs, which is helpful to follow for drawings. The outcome of this thesis will be similar; however, the types of flora and shapes understudy are those found on ceramic tiles, not the ones in carpets and manuscripts.

Most of the literature concerning Islamic tiles and ceramics from the Islamic lands in the English library is a collection of pictures and historic essays without any reference to the actual motifs or the patterns drawn on the tiles. For example, books such as *Islamic Tile*s (Porter, 1995), *Iznik Tiles* (Denny, 2004) and *Damascus Tiles* (Millner, 2015) are predominantly historic accounts infused with some images of tiles lacking in-depth discussion or tile pattern analysis. Even Golombek's book *Persian Pottery* (2013), that is solely dedicated to the study of Persian pottery as the title states, does not add much on the subject because its main focus is pottery ceramics, not the tile ceramics which is the focus of the current research. This calls for more research to bring those motifs and patterns to life. The growing literature on Islamic art lacks resources that discuss Islamic Persian tiles and the biomorphic patterns embellished on them.

However, one resource in the Turkish language, partly addressed ceramic patterns and motifs, called *Turk Tezyini Sanatlarinsa Design Tasarimi* meaning *Motifs in Turkish Decorative Arts* by a female doctor at Marmara University, Inci A Birol, and Professor Çiçek Derman at the same university (1991, 2007, 2011). The book was published in the beginning of the nineties (1991)

and reprinted several times until it reached its 8th edition in 2011 and is still being printed. This reflects a high demand for the book since it is an important reference book for artists and designers interested in images of Islamic patterns and motifs. It is written in Turkish, which is a language that I only have a very basic understanding of, but the illustrations and the unofficial Goggle translation have helped me comprehend the general picture. It was also translated to English in 2007. A similar reference book is published by the same researcher, Birol (2014), *Pattern Design in Turkish Decorative Arts: Drawing Technique and Its Types* [Türk Tezyini Sanatlarinda Desen Tasarimi: Cizim Teknigi ve Cesitleri]. The book includes an introduction specialising in motifs that are featured in Ottoman designs, some of which appear on ceramics. These two references provided a clear explanation of the basic motifs and that assisted with the categorisation of the database of motifs I developed in Chapter 7.

The director of the Prince's School of Traditional Arts in London, Dr. Khaled Azzam (2013) edited a book: *Arts and Crafts of the Islamic Lands*, which is a brief summary of the curriculum of the Traditional Arts Master's programme. The book includes a useful chapter on geometry and biomorphic patterns, along with other practical chapters that serve as an introduction for the modules taught by the school. The biomorphic pattern chapter is written by Adam Williamson, who is one of the contemporary pioneers in analysing and constructing biomorphic patterns. Although Williamson's chapter is brief, he suggests applying the basics could lead to more discoveries. I will discuss one of his patterns in Chapter 6: Pattern analysis. The efforts of the Prince's School continues with the book: *Curves*, written by Dr. Lisa DeLong (2013) which is part of the Wooden Books series. Even though it is only 58 pages, it includes a motif library and a general guidance on including bimorphs within geometric designs.

A modern book on Islamic biomorphic patterns was published in 2018, *The Arabesque: An Introduction*, edited by Dr. Heba Nayel Barakat, with a foreword by Dr. Azzam. This book serves as a catalogue for Albukhary Foundation Gallery of the Islamic World and the Arabesque Exhibition at the British Museum. The book is aesthetically pleasing presenting interesting examples and some pattern analysis. However, the same issue applies that all of the information is brief and it does not work as a guide for designers to create their own design inspired by the historic examples. Therefore, in this thesis I intend to provide an informative text along with

drawings and a database of motifs, which is essential if we aim at spreading the usability of those historic patterns and motifs. This thesis will serve as a complementary research to all aforementioned resources.

Since the literature is very limited on Islamic biomorphic patterns, this thesis will rely on pattern analysis from mosque patterns. Ceramics of the mosques works as a large canvas for the patterns and motifs, which have enabled me to see the grids and their connections clearly rather than manuscripts and textiles. Those ceramic tiles have also withstood the test of time and remained glorious for us to learn from them. More on the selection of the mosques will be mentioned in Chapter 6.

2.5 The Safavid Period

The Safavid period took place between 1502 and 1722, mostly in Iran and surrounding countries. The ruled areas during the period differed from one ruler to another. According to Brend (1991), the Safavid period had a strong impact on the visual culture and the arts of Iran that had grown and flourished.

Bonner (2017) states in reference to the Ottoman, Safavid and Mughal Empires:

> During the 16th and 17th centuries, floral ornamentation was progressively given far greater emphasis over geometric design in each of these empires (p. 150).

In the same vein, Necipoglu (2015) asserts in her book *Topkapi Scroll* that the 15th century was the last period that gave geometry its utmost focus and after that period, there was a strong drive towards floral motifs that populated architecture. These statements are additional evidence that the Safavid period is a good period for the study of biomorphic patterns especially that it was favoured by the royal patron, which made art, in general, and ornamentation and ceramic work, in particular, flourished at that period. This section of the literature review will highlight major

publications that studied this period. The aim is to discuss literature about the ceramics, patterns, and motifs used in the Safavid Period.

When Islamic art and architecture books mention the Safavid period, they usually dedicate a single chapter to the whole time period and try to cover its history, architecture, and arts and crafts all in that one chapter such as in: *Islamic Architecture in Iran Volume 2* by Hutt and Harrow (1978) and *Islamic Art and Architecture* by Hillenbrand (1999). Having only one chapter is very limiting to the amount of information that can be conveyed. Additionally, biomorphic patterns are rarely mentioned in such books.

One of the major publications on the Safavid period that discusses it thoroughly is *The Golden Age of Persian Art* (Canby, 1999), where she outlines the entire history of the Safavid period between 1502 and 1722, starting with the Sufi belief system that inspired the religious shift in Iran from Sunnism to Shiasim from Shah Ismail to the seventh generation of the same family, and the fall of that golden age. The book tracks all the major historical events, the change of rulers and all the wars they participated in. However, the discussion on arts and crafts is limited.

Canby also wrote *The Golden Age of Persian Art* (1999), which covers the same Safavid period, but it is dedicated to the arts and crafts that were produced during the lifetime of every Safavid ruler. This book is a delight and traces the major development of arts and the contributions of every ruler, including the two mosques: Sheikh Lutf Allah and Shah Mosques that I intend to study their ceramics in this thesis. Although the information provided is brief and there is no emphasis on ceramics, Canby provides an overall understanding of the artistic value of this period.

Pope (1930) is one of the few scholars to cover Persian art and architecture in depth in his book *Introduction to Persian Art*. It is the most comprehensive book on the subject. Pope is concerned with artistic expression rather than politics and power changes. Of the literature I have read, his book is the most insightful, and has been the most helpful in this thesis, particularly in understanding the biomorphic surfaces. The book includes 12 chapters, and the first three are the

most relevant: Historical Outline, Architecture and Architectural Ornaments, and Ceramics. The remaining chapters discuss other arts and crafts in Persia.

Additionally, another valuable resource on the subject is Pope's book *Persian Architecture; The Triumph of Form and Colour* (1965), which tracks Persian history from the earliest civilisation of Achaemenid Empire dating to 500 BC up to the Safavid Period. In this work a huge amount of history is compressed into 300 pages, with only 30 pages dedicated to the whole Safavid period. However, Pope highlights a significant cultural aspect of Persian ornaments that is "in no other architecture has ornament played such a vital and creative role as in Persian" (p. 132).

Although Pope's books are two essential sources for the study of Persian art and architecture, they only mention patterns briefly, and there is no analysis of pattern shapes and motifs. However, the framework and the background that he provides offer a good introduction.

The only researcher who discusses the practical craft skills of Persian art is Hans Wulff's in his work *The Traditional Crafts of Persia* (1966), which was commissioned by Reza Shah Pahlavi, who was the Iranian president at that time. Wulff was working at the Technical College during this period, and this is the only book that was of great benefit in terms of understanding how ceramics are made, assembled and adorned with patterns. However, the book does not mention any particular patterns or motifs, so it will be interesting to combine that practical knowledge and ceramic history presented in the book with the visual patterns and their construction that will be researched in this thesis.

A specialized work about ceramics is Watson's (2004) *Ceramics From Islamic Lands* about Al-Sabah ceramic collection displayed in Kuwait National Museum. The focus of the book, like many Islamic ceramic books, is on pottery rather than tiles and it covers a long time span from the pre-Islamic ceramics to 18th century ceramics. The interesting aspect of this book is Watson's use of Abu Al Qasim's ceramic treaty dated to the 13th century. Abu Al Qasim, Ali Muhammad Abu Tahir, comes from a family of potters and ceramists from Kashan, Iran, which is an important city in the history of ceramic that will be discussed in Chapter 5. The translation of the treaty will be used in the thesis, but Watson does not present any additional information.

Additionally, crafts, skills and techniques are usually inherited from practice and oral traditions; hence, little has been written about the making of crafts in Persian history (Bier, 1998). Not only is the literature on ceramics scarce and limited, but also the subject itself has not been of interest to many 20th century scholars, either. Crowe (2004) points to that aspect: "sadly, connoisseurship of Safavid ceramics has progressed little beyond the appreciation of techniques and exotic" (p. 121).

According to Scrase (2003) there is a lack of literature on artisans and craft production in general. Crafts need to be studied not just as an artistic field, but also as social and economical ones in various geographical places.

2.6 Summary

The literature review has discussed four themes: Islamic art, ornamentation in Islamic art, islamic patterns and the Safavid period to provide a background for the study of Islamic biomorphic patterns. Further, the literature review has established that the term 'Islamic art' is contested and its reference can be broad or vague, but no alternative term has been suggested in the literature. The best argument offered by Pope (1965) is to niche down and narrow the name to the ruling period. Consequently, I will narrow down the research focus to study the Islamic biomorphic patterns of the Safavid era.

Chapter 3: Research methodology

3.1 Introduction

In this chapter I outline the research design that includes the research methodology and the specific data collection methods that I employ in the current study providing a discussion of each procedure. This chapter includes five sections: the practice-based research methodology, the experimentation with ceramic techniques, the case study research, pattern analysis and reproduction and the limitation of the study.

3.2 Research design

The research design of any research "links the data to be collected… to the initial questions of the study (Yin, 2009, p.19). This means that the research questions motivate the whole research from the start to data collection to the final steps of data analysis and interpretation.

The thesis overarching research question is:

How to reproduce biomorphic patterns that appear on ceramic tiles of Safavid mosques and use them in design?

Specifically,

1. What are the production techniques of ceramic tiles in the Safavid period?

2. What are the rules and principles of Safavid biomorphic patterns that appear on ceramic tiles of Safavid mosques?

3. How a database of motifs of Safavid biomorphic patterns is used in design?

To investigate how Islamic biomorphic patterns that appear on ceramic tiles of Safavid mosques are reproduced and used in design, I will employ a practice-based research methodology. This methodology includes experimenting with the production of ceramic tiles and a case study of Safavid mosques followed by pattern analysis. Finally, I will assemble a motif database from Safavid biomorphic patterns and reproduce some patterns from that database. In my research, I addressed three particular research questions and for each one I utilise a specific research method/s (see table 3.1) that I will introduce in this chapter and discuss in depth in the following chapters.

Research Question	Research Method
What are the production techniques of ceramic tiles in the Safavid period?	Experimenting with ceramic tiles production techniques in three workshops.
What are the rules and principles of biomorphic patterns present on ceramic tiles of Safavid mosques?	Case study of biomorphic patterns from two Safavid mosques, which includes a study trip to the sites, observation of the sites and the patterns, drawing sketches and taking photographs followed by pattern analysis of the biomorphic patterns present on ceramic tiles from the study sites.
How a database of motifs of Safavid biomorphic patterns is used in design?	Assembling a motif database from Safavid biomorphic patterns followed by reproducing patterns from the motif database.

Table 3.1. Research questions and the corresponding research method.

3.3 Practice-based research methodology

Practice-based research is a research methodology that I will employ in the research enquiry. This methodology is "an original investigation undertaken in order to gain new knowledge partly by means of practice and the outcomes of that practice" (Candy and Edmonds, 2018, p.1). Since this type of research is new in the fields of arts and design, its "definition and discourse" have not settled yet (Candy and Edmonds, 2018, p.1). One of the earliest practice-based researchers is Andew Stonyer who completed his PhD in 1978 on "The development of kinetic sculpture by utilization of solar energy" in which he "demonstrates the beginnings of inquiry through practice" (Gray and Malins, 2004, p. 20). Several terms have been used to refer to practice-based research, either interchangeably or with a subtle difference (Biggs and Buchler, 2008; Smith and Dean 2009), but in this study I will use the term "Practice-based research" because it is a commonly recognised term in the literature (Sullivan, 2005).

Practice-based research is now common among artists and designers who have made their own mark in research by using their own practice as a research method since it provides a first-hand experience on the matter (Gray and Malins, 2004) and " in which practice is integral to the method and not just the medium of the output" (Skains, 2018, p.86). My aim of using practice-based research was to physically practice the process of making ceramic tiles and reproducing a database of motifs derived from Safavid biomorphic patterns to understand the patterns in depth and use them in design. This kind of research has enabled me to utilise my skills and make connections with the materials to produce research. Using a practice-based approach was essential to understand the complex issue of reproducing biomorphic patterns since this approach involves "the conscious pursuit of expressive form in the service of understanding" (Barone and Eisner, 2012, p. 7).

Conducting this type of practice-based research has involved insightful material thinking which is "a way of considering the relations that take place within the very process or tissue of making" (Bolt, 2007, p. 29). As a "practitioner-researcher" (Gray and Malins, 2004, p.21), I felt immersed

in the practice of making ceramic tiles and the production of biomorphic patterns and a database of motifs in which both the materials and process of production have changed from "just passive objects to be used instrumentally" and "have their own intelligence that come into play in the interaction with the artist and creative intelligence (Bolt, 2007, pp. 29–30). Handling the materials and the process of making created a special connection and in-depth understanding that would not have occurred if I, as a practitioner researcher, was not employing a practice-based research.

A defining characteristic of the practice-based approach is the use of multiple methods of data collection (Gray and Malins, p.31). This is also called triangulation which is utilising "multiple data sources of data collection" to ensure credibility of the results of the research and consolidate the findings (Groat and Wang, 2013, p. 81). Although this may require more time, effort and resources, the use of "several complementary methods is more likely to yield a more significant, critical and holistic view than any single method alone" as illustrated in figure 3.1 (Gray and Malins p. 31). Since in research-based methodology, data collection methods are pluralist, flexible and are "mostly visual and mostly derived from practice"(Gray and Malins, p.31), I used experimentation with ceramic production techniques and a case study approach that consisted of a number of data collection methods mainly: observing, sketching and photographing the biomorphic patterns.

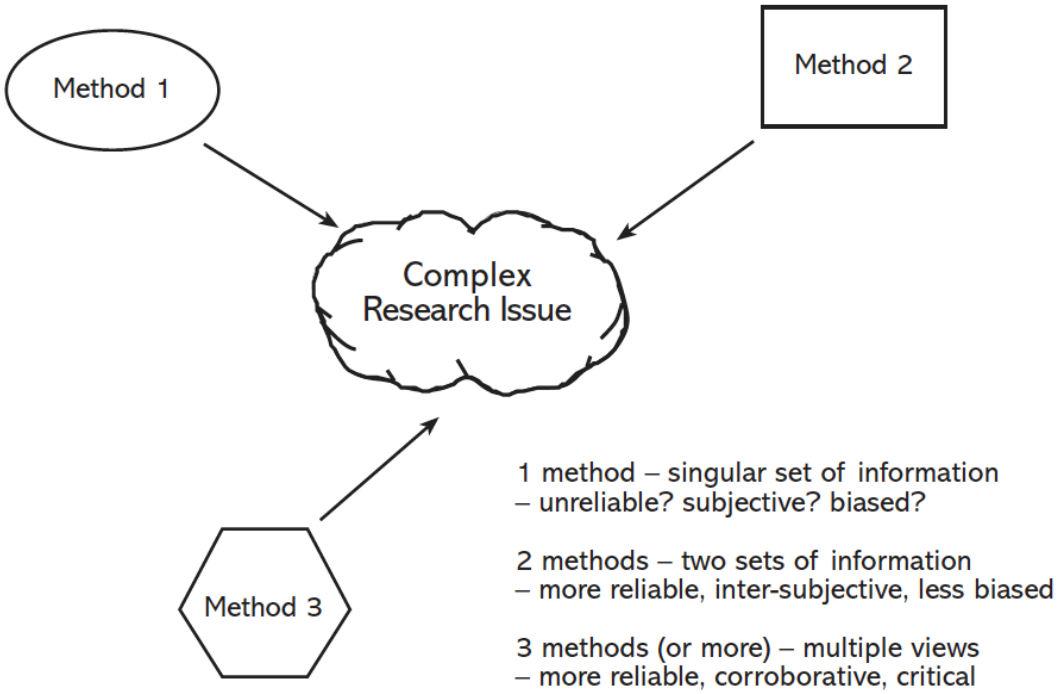


Figure 3.1: Triangulation of multiple methods of data collection (Gray and Malins, 2004, p.31).

3.4 Experimentation with ceramic techniques

Every Islamic ruling period had its own advancements and contribution to the field of Islamic art and architecture. The Safavid period had a major contribution in the world of ceramic tiles, known as seven-colours technique. Before developing this technique, Safavids used two other techniques: lustre and fiance mosaic they had inherited from the Seljuk and Timurid periods before them. Since this thesis studies Safavid biomorphic patterns that appear on ceramic tiles of mosques, it is important to understand the practical techniques involved in making ceramic tiles.

In this based-practice research, I experimented with ceramic production techniques and applied them to produce ceramic tiles. This practical aspect of ceramic production and the impact of the artists and the craftsperson have been mostly overlooked in the study of Islamic art, and the literature review has reflected that theoretical mode and the limited knowledge by scholars and

the scarce resources. The hands-on experience of making tiles not only sheds light on the process of making ceramic but also on the role of the craftspeople who are in these workshops: the master tutors and myself. Table 3.2 provides an overview of the three workshops I attended in 2016 and 2018 taught by renowned masters in Islamic art: Boris Aldrige, Adam Williamson and Ghulam Hyder Daudpota. My experience of testing these three techniques of making ceramic tiles and reflections will be thoroughly explained in Section 5.4.

Ceramic technique	**Craftsperson**	**Year**	**Organizer/ Place**	**Duration**
Zeilj technique	Adam Williamson	2016	Art of Islamic Pattern Fez, Morocco	1 day
Lustre technique	Boris Aldridge	2018	School of Traditional Arts London	5 days
Cuerda Seca traditional method	Ghulam Hyder Daudpota	2018	School of Traditional Arts London	5 days

Table 3.2: Ceramic techniques workshops.

3.5 Case Study

A case study can be an "example of something" (Gray & Malins, 2004, p. 117) and the study of a given style, such as biomorphic patterns, requires investigation based on examples that clearly demonstrate the style (Munro, 1946). Practice-based research methodology can employ case studies besides other research methods (Gray & Malins, 2004). Therefore, the current research included case study of the biomorphic patterns of two historic buildings from the Safavid period in Iran to investigate the biomorphic architectural design surfaces that appear on the ceramic tiles of Sheikh Lutf Allah Mosque and Shah Mosque.

These mosques are located in Isfahan, a big city in Iran, inhabited by almost 2 millions. The Safavid dynasty made the city of Isfahan their capital and the gem it is today. Isfahan is referred to in Persian as "nesf-e- jahān" meaning "half the world" because of its phenomenal architecture that was mostly erected during the Safavid period. The impact of the Safavid dynasty extends to modern day Iran not only because the Safavids have set the tone of remarkable architectural styles, but also they have significantly contributed to the rise of Shia religious branch of Islam practiced in Iran today (Brend, 1991). Due to the accomplishments of the Safavids, "Persian national and religious feelings were gloriously renewed", as described by an Iranina artist, Dowlatshahi, (1979, p. 3).

Sheikh Lutf Allah Mosque and Shah Mosque were founded by the Safavid ruler, Shah Abbas, in 1593-1594 and 1611, respectively (Melville, 2016). Both mosques are located in Isfahan's city-square built by Safavids in Iran. Because of the historic and cultural value of the square, the Safavid architectural buildings in the square, including the two mosques, are protected by UNESCO as heritage sites. According to UNESCO, those buildings are "authentic in terms of their forms and design, materials and substance, locations and setting, and spirit" and "an impressive testimony to the level of social and cultural life in Persia during the Safavid era".

The two mosques are considered masterpieces in the Persian Islamic architecture (Majidi, 2014) and the highlight of the Safavid period (Utaberta et al., 2012). Each mosque is decorated

following the biomorphic practices of the 15th to 17th centuries. Pope (1965) describes Shah mosque with admiration:

> This monument represents the culminations of a thousand years of mosque building in Persia. The formative traditions, the religious ideas, usage and meanings, the plan which has slowly matured from a combining of earlier and simpler types, major structural elements and ornamentation are all fulfilled and unified in the Masjid-i-Shah, with a majesty and splendour that places it among the world's greatest buildings" (p. 210.)

This is a testimony of the importance of Shah Mosque, especially for the ornamentation it exhibited and as such I am including it in the case study besides Sheikh Lutf Allah Mosque.

The advantage of using the case study as a research method is the ability to study the particular subject in depth, which would bring strength to the study (Gray and Malins, 2004). The reasoning behind using two case studies of mosques in this research is to generate stronger results (Gerring, 2007). In general, case study research of Islamic ornaments is scarce. One study of the vegetal ornamentation in five different mosques in Turkey and Iran was conducted by Abd Al-Ameer (2016). He provided a descriptive depiction of what he recognised and then analysed connecting it with the meaning of Quranic verses, and that is very different from the current study of investigating Safavid biomorphic patterns and their use in design.

Case studies are chosen to study a subject in a realistic context, where a specific phenomenon is examined and analysed and this has occurred during the study trip I joined to learn about Islamic art and visit the historic sites in Iran. Case studies can include either qualitative, quantitative approaches or mixed methods in the assembling and analytical stages depending on the purpose of the research and the field of study (Yin, 2009). In the case studies used in this research, qualitative methods were employed because the thesis is a research-based art study. For this case study the collection of data mainly included observing, sketching and photographing the biomorphic patterns during the study trip to the sites of the case study.

During a 14-day study trip "The Turquoise Tour" organized by the Prince's School of Traditional Arts, I visited the two mosques in September-October 2015 with the guidance of three Islamic pattern specialists: Paul Merchant, Shahriar Pahlavi, and Ferkondah Ahmadzadeh. Being able to make this trip with these three scholars and experts in Islamic Arts was very impactful because they could explain patterns on a deeper level than I had found in the literature.

Observing, photographing and sketching the biomorphic patterns on the ceramic tiles at the case study sites: Shah Mosques and Sheikh Lutf Allah Mosque were the main methods of data collection and studying the patterns, and served as the main visual source for pattern analysis. Without this rich first-hand experience of the patterns using multiple methods, this study would not have been completed and effective.

Knowledge of cultures and behaviours are usually unseen and untaught; they are experienced (Spradley, 1980). Understanding a culture will lead to understanding the people that formed that culture, including the art they produced. This is an essential element in studying artwork, which is the biomorphic patterns in this study. Thus, the information and experience gained through visiting the historic sites and the country were invaluable tools and more informative than just reviewing ready materials from references. Furthermore, making observations in person on the study trip had a stronger effect than working from images.

Visiting the locations of the case studies in person gave me an advantage and equipped me with a realistic understanding, besides providing me with the opportunity to take photographs and close ups of the patterns required for the study. Being there to observe the space and how visitors interacted with patterns. The movement of people within the space and the effect of light and shadow gave a deeper understanding of the patterns, as well. I observed the patterns and redrew them to understand the elements of the patterns, the drawing styles and the underlying structure in the same sociocultural context where the patterns were originally produced and preserved and learning about the Persian culture was loaded with information.

I chose photography as a primary data collection method because it captures the patterns in two dimensions, which makes it easier to see the underlying grid after careful examination.

Photography also served as a documentation tool for the path I took to see the patterns at different sites in the mosques. There were significant spaces in the mosques that were adorned by patterns, such as the entry way and the prayer hall, along with the domed alleyways. All possible patterns were captured using a professional Nikon DSLR camera. I took almost 5400 pictures during the 14-day study trip and that included photographs of patterns and other scenes of Perisan culture, history, people and tourist attractions. After a long process of sorting and filing the pattern pictures in three sets, one of each mosque and the third of other patterns from other sites, I eliminated the unclear pictures and those photos of incomplete patterns. Finally, I selected the useful workable patterns then archived and saved them on an external hard disk to use them later for pattern analysis.

Combined with photography, sketching served as an important tool to depict the patterns in their real environment. I drew some of the patterns I saw in the Safavid historic places I visited in a sketchbook recording the date and place and registering some field notes. During the study trip, we used to reach the Safavid architectural buildings, including the two case study mosques, in the morning and mostly worked in two sessions until late afternoon to observe and study the patterns in daylight accompanied by informative workshops in which we learned about geometric and biomorphic patterns and drew them with the guidance of three scholars in Islamic art (See figures 3.1-3.4).

Moreover, I took videos at the mosques for the patterns and the setting, but because this thesis is produced in two dimensions with drawings, the medium of photography took priority. However, the three-dimensional spatial experience of the ornaments added depth to my visual experience and assisted in locating the patterns in the sites. Finally, on my travel blog “Arabian Wandress”, I documented my study trip under the subheading: “Iran” which included 13 entries highlighting the Persian culture, art and history and my travel experience. Finally, more information on each case study and analysis of the biomorphic patterns will be presented in Chapter 6.

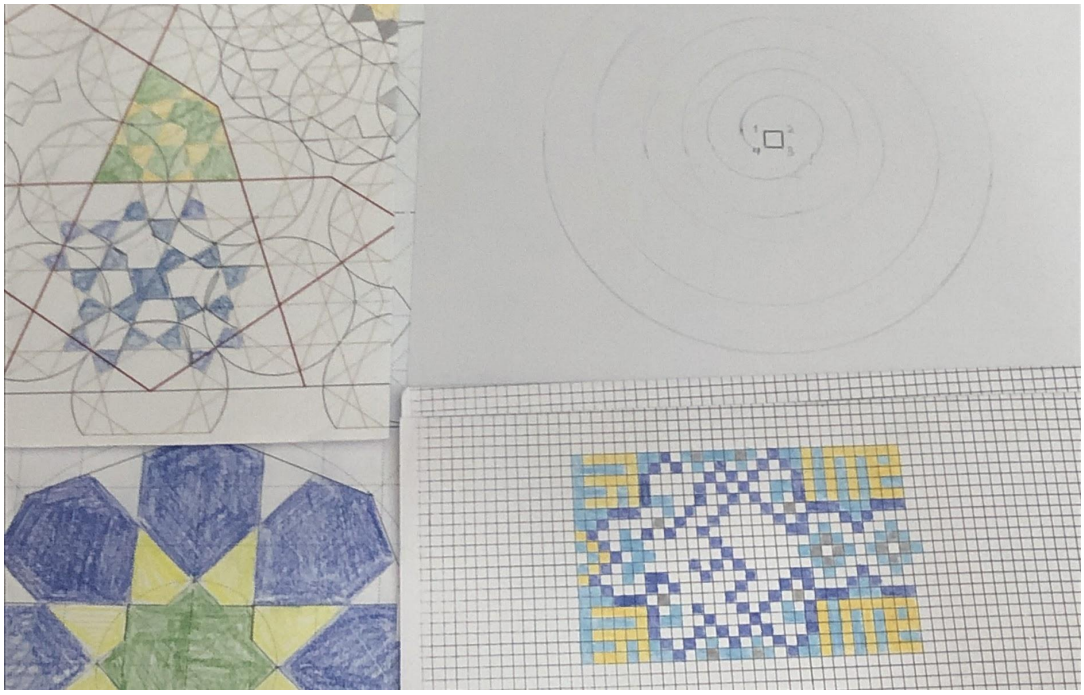


Figure 3.2: Sketches of Islamic patterns I drew during my study trip to Iran, October 2015.

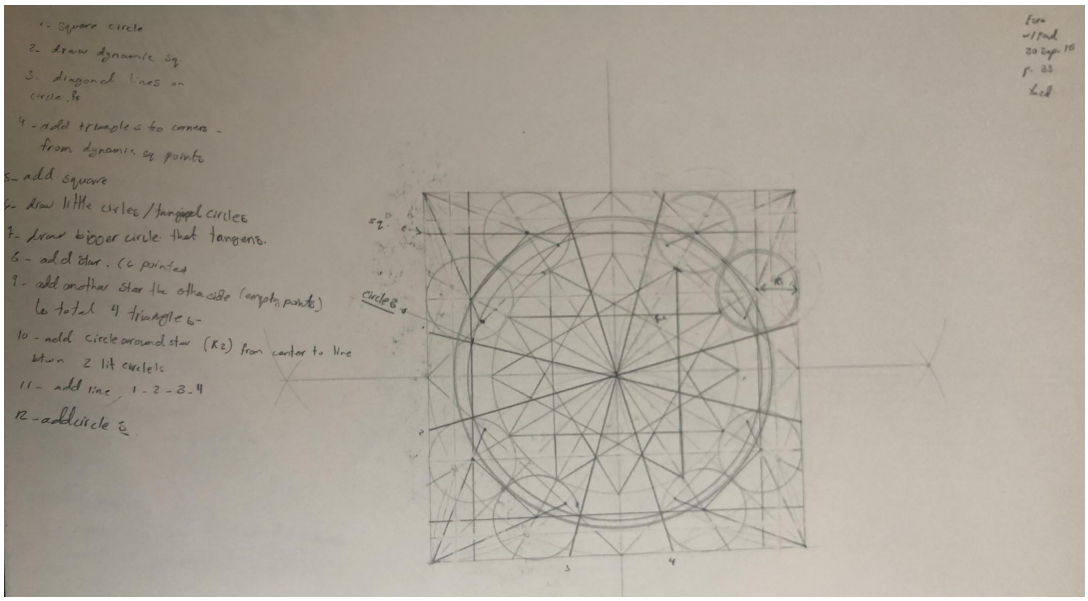


Figure 3.3: Sketch of a geometric pattern I drew during my study trip to Iran, 30th September 2015.

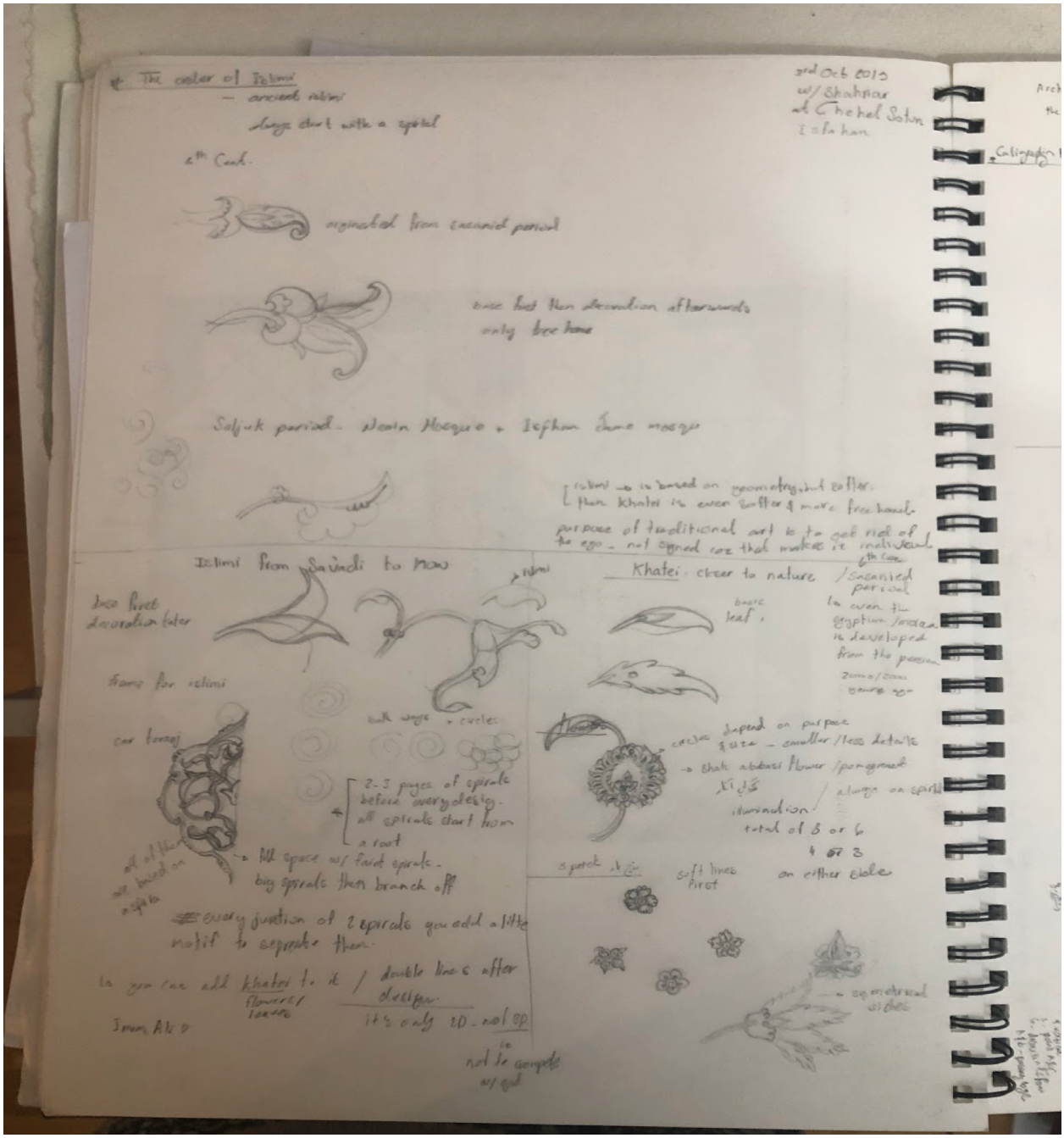


Figure 3.4: Sketch of a geometric Islamic pattern I drew during my study trip to Iran at Chehel Sotoun in Isfahan, 3rd October 2015.

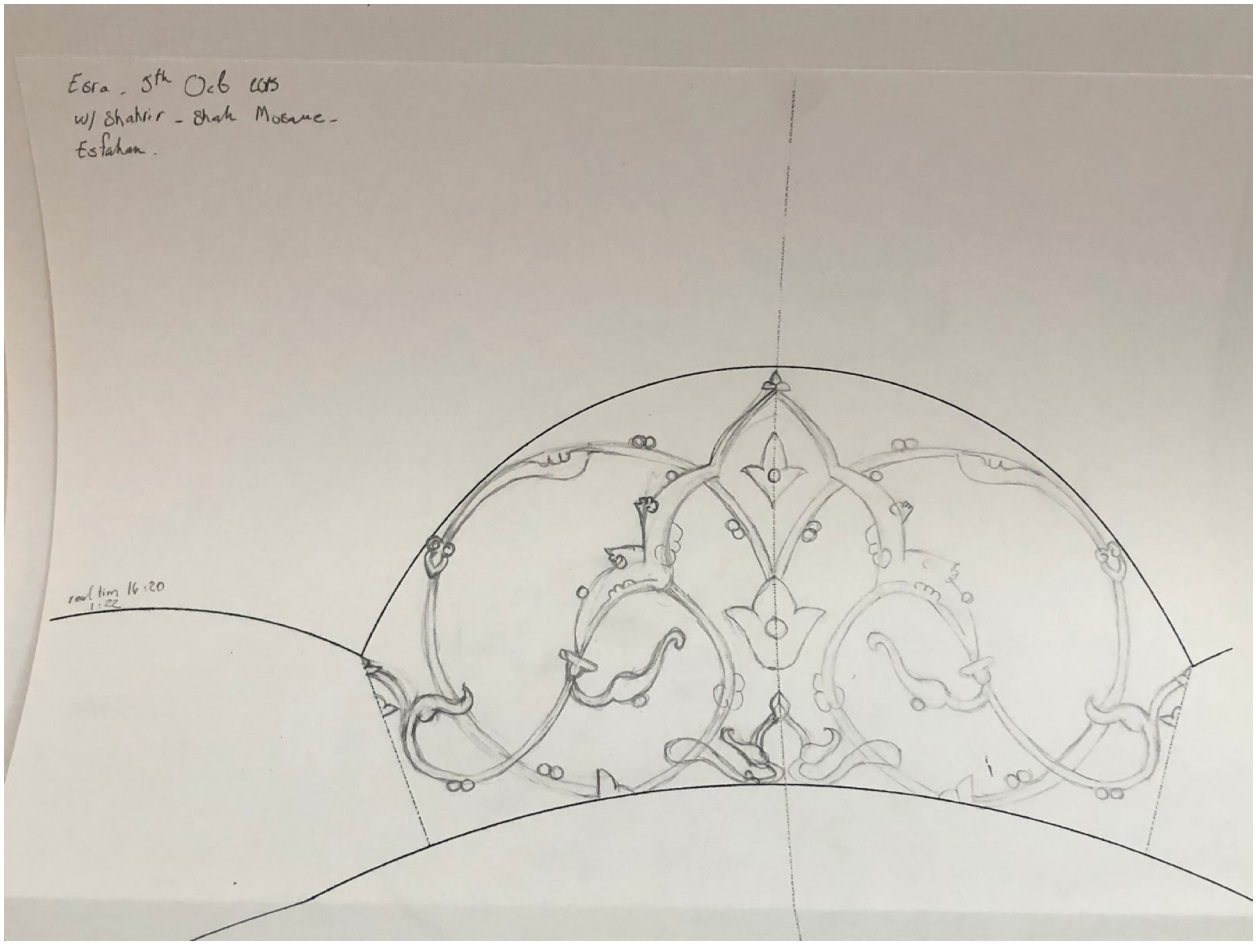


Figure 3.5: Sketch of a geometric Islamic pattern I drew during my study trip to Iran at Shah Mosque in Isfahan, 5th October 2015.

3.6 Pattern analysis and reproduction

Although data analysis is a crucial component of every research design (Gray, 2014; Yin, 2009), it plays a pivotal role in the current research. The form of analysis used in this study is related to the analysis of biomorphic patterns in order to gain an understanding of the rules and principles of patterns reproduction that assist in assembling a motif database. Pattern analysis and reproduction provide the final outcome of this research, which is to produce a motif database that will be a valuable visual resource for creating future patterns that art specialists and practitioners can use in their own patterns. I briefly introduce the process of pattern analysis in this section, but the whole process and steps of pattern analysis are presented at length in Chapter 6.

To approach ornaments and patterns, Trilling (2001) suggests two steps: first learning to recognize them through careful observation and then analysing them. He indicated "the only way to appreciate ornament is by seeing it, which is just what we have not been trained to do" (p. 6) and "- to appreciate a pattern we need to know how it is put together – and with certain kinds of ornaments such as interlace, it is the real key to understanding" (p. 34). The method of pattern analysis and reproduction that I implemented included identifying patterns through observation and then reproducing them. The observation of the mosques during the study trip I had was an informative stage not only to examine the patterns but also to understand scale, direction, empty spaces and the distribution of patterns and motifs.

Pattern analysis required samples taken from a certain location which includes the biomorphic patterns and that place should be in line with the historic period I intended to study, the Safavid era. Therefore, I selected two Safavid prominent mosques as case studies, as discussed in the previous section. In qualitative methods of research, such as this research-based study, the samples are relatively small and selected purposefully in alignment with the aim of the research (Patton, 1990), which is to examine the rules and principles of reproducing biomorphic patterns.

The selected patterns for analysis were the focal point within the mosque. In Sheikh Lutf Allah Mosque, two sets of patterns were chosen: the patterns in the hallway and the ones in the prayer chamber including the dome. These patterns retain the most authentic sample of the original structure. The façade has been restored multiple times, which changed its appearance to a certain extent. In Shah mosque, the façade has been chosen for the rich variety of the patterns and floral motifs that it provides. The patterns of the domed arches have also been selected for their versatility and visual impact. The mosque was under renovations in 2015 during my study trip; therefore, parts of it were not photographed. Even though there appeared to be a big number of patterns in those two mosques, a lot of them have been repeated in multiple locations. I thoroughly analysed two sets of biomorphic patterns from each mosque taking into consideration the features of symmetry they displayed and their underlying geometric patterns and grid. I supported that with guidelines for analysis illustrated with diagrams for every step I followed (See Chapter 6).

The approach I employed in pattern analysis and reproduction is based on both my study of geometry and Islamic patterns and also on my experience with patterns as an artist producing artwork in Islamic illumination and patterns. When analysing patterns, I usually start by determining the type of the geometric grid that is used, such as if it is based on the construction of five, six or eight-pointed stars. From there, the used motifs and spirals are assembled assisted by the geometry and by freehand skills. This is where the role of the craftsperson comes into play. Even though a lot of the patterns are logical and assembled with mathematical skills, there is an aspect that includes free-form drawing that I had to experiment with.

Necipoğlu (1995) emphasised the importance of drawing patterns when she discussed the historic Islamic scrolls that contain geometry and patterns stating "they testify to the often underestimated role of drawings in establishing a certain degree of visual unity among the distinctive local building traditions of distant countries" (p. 27). Therefore, for reproducing the patterns, I drew sketches especially during the Islamic art tour. However, for sharing the drawings in the thesis, I have used the Apple pen along with a drawing software called Procreate. When arranging all the steps together, further softwares were used, Photoshop and Illustrator. The use of the digital applications was encouraged by their clear and organised outcome. Not only can the images be conveniently composed digitally, but also edited, modified, coloured and annotated when needed. The data in the form of images can be saved and retrieved easily but needs a hard disk memory to accommodate it. As an artist and designer I have been using these programs for a long time and that added the
advantage of having professional competency in using them.

Since the analysis falls under the practice based method which mostly adopts qualitative approaches, there is the question of reliability rather than validity. The validity of art is objective and it cannot be proven like it would in scientific research; thus a better line of enquiry is assessing the reliability of the method, which means that the same results can be achieved and reproduced if the same method is applied under the same conditions (Carmines and Zeller, 2008). If the results are consistent then the method is reliable and can be used by other practitioners. Finally, to ensure the reliability of the results of the current study, including pattern

analysis, I used two case studies to consolidate the findings and employed various data collection methods for triangulation (Figure 3.1).

3.7 Limitation of the study

Every academic research has its limitations and the two that were of most concern were the language barrier and travel constraints. Being bilingual in Arabic and English, I have access to resources only in these two languages. However, this has posed a challenge due to the fact that the languages spoken during my Islamic art study trips to Turkey and Iran during the period of research were Persian and Turkish. There are some familiar words and phrases in parts of those languages to Arabic that made them possible to navigate to a certain extent, but I was limited to illustrated texts without being able to utilise those two languages in the published work in these two languages. To compensate for that, I read the work of some researchers of Turkish and Persian origin written in English.

Another challenge was the political issue between Saudi and Iran that limited my travels as a Saudi to Iran and stopped me from investigating sources that are only available in Iran, like revisiting the study sites and searching for resources that are not accessible online. However, the outcome of these two challenges has led me to practice the patterns personally to get the practical understanding instead of relying on sources that I cannot access.

Finally, I faced an unexpected obstacle. Not only has the Covid breakout interrupted my life plans, but also affected my research. Consequently, my experimentation of the ceramic production techniques was on hold because the art studios at the university had to close from March 2020 up to the submission of the thesis; therefore, I did not have any access to a kiln to conduct further ceramic testing of biomorphic patterns. As a result, I could only refer to the three experiments of the ceramic techniques that I conducted before the Covid outbreak, as discussed in Section 5.4.

Chapter 4: Islamic patterns

4.1 Introduction

This significant chapter of the thesis provides a theoretical background to the analysis of the Safavid biomorphic patterns that I will conduct in Chapter 6. This chapter includes four sections. In the first section I provide an account of various perspectives to ornaments and then focus on the biomorphs. I trace the biomorphic Islamic pattern development in three historic periods in the second section. The third section is about the qualities of patterns and a collection of guidelines to inform the visual merit of a pattern. Finally, I inspect the spirituality of Islamic patterns and how patterns are viewed on a deeper level in relation to God and to the metaphysical world.

4.2 Ornamentation and biomorphic patterns

The form of ornamentation has changed based on the cultural and belief system of the period; therefore, the application and the motifs in ornamentation are subject to alteration and modification in various sociocultural contexts. Picon (2016) indicated that, "ornament has its origins in an impulse that is initially universal but takes a different form from one society and one era to another" (p. 13). Ornaments act as a compressed visual storage of our histories, explains Philips (2003):

> Ornament is memorious. It acts as a house of memory uniting us with nature. It carries this information in the particular mode by identifiable visual quotation of transformed reality, and, in the general mode, by embodying essences such as plantness and animalness (p. 79).

The term "ornament" needs defining and that definition differs based on the scholar's perspective to its meaning and role in architecture and design. Biomorphic patterns or "arabesque", as Burckhardt (2009) refers to them, are a visual expression of rhythm. They are

stylised from nature with a geometrical basis. The interlacing of patterns is a unique quality of Islamic patterns that is developed based on a set of calculated proportions within a plane. Another definition of ornament with a connotation to its role as an accessory decoration is suggested by Trilling (2001) as,"the elaboration of functionally complete objects for the sake of visual pleasure" (p. 6).

The term "ornament" and how it is used linguistically carries significant information. In the Arabic language, the equivalent of "ornament" is used. In fact, there are two Arabic words that mean ornamentation: *zakhrafah* زخرفة and *zeinah* زينة, and are used interchangeably in some contexts. Both words are mentioned in the Quran, such as: *"We made what is upon the earth an ornament for it, to test them as to which of them is best in conduct"* (Quran 07:18).

According to the Arabic dictionary *Arabi Arabi*, the word "*zeinah"* is a noun meaning "the thing used for adornment or as a form of beautifying". In the *Ghani* dictionary it is referred to as "the display of happiness". Thus, the meaning changes based on the location of the word and use.

The aforementioned Qur'anic verse uses "*zeinah* زينة" meaning ornament. When the Earth is covered with *zeinah* it is improved and beautified. Another example, when a tree flourishes with fruit then it includes *zeinah*. The word "*zeinah"* encompasses all types of adornments. For example, the day of *Eid* is known as the day of the *zeinah* because people take care of their appearance and wear their best clothes to look beautiful and decorate their houses and mosques with ornaments.

The term *zakhrafah* comes from the root word *zukhraf* زخرف. According to *Arabi Arbia*, it means "artistically decorating". The plural is *zkharef* زخارف. The word could also mean "gold". *Alwaseet* defines it as "the art of ornamentation and adding details with carving, detailing or filling a space beautifully". Although the two Arabic words can be used interchangeably in some contexts, "zeinah" is broader and more general in meaning while "*zakhrafah"* is more specific referring to the art of ornamentation.

Lesan AlArab Dictionary includes a narration of Prophet Muhammad (peace be upon him) regarding the meaning of the word: "It is narrated that the prophet did not enter the *Kabah* until he ordered that it gets '*zukhraf*" a beautiful design. It is reported that the prophet said: '*Al Zukhraf*' are inscriptions and detailing and images to decorate the *Kaba*." He ordered it to be in gold.

As for the use of the term "biomorphic patterns" in Arabic, AlQuraishi (2017) identifies three commonly used words: Rashq رشق, Tawshe'h توشيح, and Tawriq توريق . Rashq رشق is a noun meaning arch or arrow, which refers to fine details. Tawshe'h توشيح is a noun that was invented by the people of Andalusia, which refers to poetic compositions of branches and it was invented because it also describes detailed coloured textiles. Tawriq توريق is the closest to nature because the root of it is waraq ورق, which refers to the tree leaf and the use of paper because both leaves and papers are the same word in Arabic.

These three words: Rashq رشق, Tawshe'h توشيح, and Tawriq توريق describe biomorphic patterns perfectly and refer to the growth of nature that occurs within a given pattern (AlQuraishi, 2017). The specific word "Tawriq" makes the most sense because of the extensive use of leaves within Islamic ornaments (Abdullah, 2009). Furthermore, the word "Nabati", which means plant-based, is also used to describe these patterns. In summary, this highlight of the use of the terms "ornament" and "biomorphic pattern" indicate the importance of these terms in Arabic and the richness of the Arabic language expressing this artistic style.

Additional names are used to refer to the bimorphs in Turkish and Persian, such as Islimi, Rumi, and Khatei. The word "Islimi" is the Persian word to describe organic motifs that have not been stylised from an exact shape in nature. The same shapes are referred to as Rumi in Turkish. In the West, these are referred to as Arabesque, but that term is not accurate since it means Arab style and the Islimi forms were mainly popular under the Timurid, Safavid and the Ottomans and not one of these dynasties is Arab.

In short, all the terms discussed above describe the biomorphic pattern and its characteristic smooth, flowing quality, which is inspired from plants, trees, produce and leaves. This artform

confirms the relationship between humans and nature. There are many styles within vegetal designs – some are simple and clear, but most are woven within each other where it is not clear where a branch starts or ends. The patterns are mostly representative of growth rather than a realistic representation of form. It is considered a freeing style for the artist (Ahmad, 2006).

From all the different words above, there are two I will be mainly using in this research: islimi and khatei. Islimi motifs specifically describe the organic forms, where the khatei is used to describe floral forms (figure 4.1). The natural language of the khatei motif is valuable and various stages of the plant's life are represented within khatei starting from the bud and these stages are a reflection of the stages of human life (Fischbach, 1873).

Figure 4.1: Example of islimi and khatei motifs (Alhamal, 2020).

Khatei floral motifs include certain floral types that have been documented and named by Birol and Derman (2007). The first is *pence*, which means the number five in Turkish and Persian and

it refers to all flowers that have rotational symmetry even if the number is below or above five as the name suggests. The second is *hatayi* and it is determined by the vertical bilateral symmetry and it is the most common type used on tiles as the motif database will display. Both types of flowers are stylised based on a bird's eye view. The third is *goncagul* meaning rosebud, but it is not limited to only roses and it is inclusive of all types of flower buds. These terms are used in Turkish text and by Turkish artists, however, they are not always understood or recognised by non-Turkish practitioners of biomorphic patterns.

The origin of islimi and khatei motifs is not clearly documented. Necipoglu (2016) reported a story from a Safavid period text that explains the origin and difference between the two motifs. A group of Chinese artists came to Imam Ali, the first Shia leader, cousin and son-in-law of the prophet for an art challenge. China was formerly known as Cathay. Those artists have adorned a scribe with their lotus floral style. They challenged Imam Ali to draw something and he drew organic inspired shapes that can be a form of foliage. From that day, the divide between the two types of biomorphic patterns started. The styles by the Cathay men eventually became Khatei, which is a phonetic spelling for the former word. The Cathy men classified the drawing of Imam Ali as Islami, which meant Islamic, but it was later changed to Islimi to take the religion out of the design equation.

Necipoglu states that the story was probably conceited by the Safavid belief system to encourage people to be more loyal to the Shia faith. There is no evidence for either case, so it might or might not be true. According to the writings of Nasser (1987), Imam Ali's importance is not only reserved to religion and politics, but he is also considered the first Arabic calligrapher that wrote the first Quran. Therefore, adding an illustration to that is not far fetched. Regardless of origin, both styles were used heavily. The floral style has flourished in particular in Central Asia and Persia after the Mongol invasion, who became part of the Islamic world in the 13th century and contributed to the floral decorative language throughout their artwork (Necipoglu, 2016).

4.3 Development of Islamic patterns

Garber (1992) points out the uniqueness of the geometry utilized by Islamic art confirming that "even though most cultures used geometry, Islamic art alone spread it so consistently throughout its creativity" (p.152), which is a testimony that Islamic patterns are a worthy field of study.

Islamic patterns were used on the surfaces of architectural monuments in the Islamic world, and three types of patterns were used: geometric, biomorphic and calligraphic patterns. The presence of these three elements offers the monuments a unifying factor and gives mosques across the Islamic lands a similar aesthetics (Abd Al-Ameer, 2016).

Explaining the nature of Islamic patterns, Pope (1930) indicates : "In Islamic times the panels are carefully proportioned to the whole surface, and by their precise definition give an effect of sharply articulated units which impart an emphatic architectural quality; and at the same time they make the structure appear thicker, heavier and more active" (p. 31). This statement helps understand the intentional nature of patterns.

However, the types of the geometric constructions, the motifs used in the bimorphs and the font, tend to be different based on the historic period and geographical area. While the variations may not look obvious to the untrained eye, once the viewer is versed in patterns she can see the identifying differences clearly.

An adorned mosque was the sign of a wealthy and pious ruler, so not every mosque included the luscious biomorphic patterns and the tile work. Thus, this section will highlight one or two monuments that have been adorned from various Islamic periods to give a very brief overview of how the motifs of the patterns changed, but it is beyond the scope of the research to fully analyse each period. Even with the limitations of in-depth research, this section will provide a look into biomorphic patterns.

There are three distinctive periods, according to Baer (1998), that should be highlighted for the development of vegetal patterns:

- The formative period from the early 7th century up until the 10th century.

- The ornamental integration period between the 10th and 13th centuries.
- The final development period between the 14th and the 17th centuries.

The Islamic periods that I will cover are highlighted in Figure 4.2.

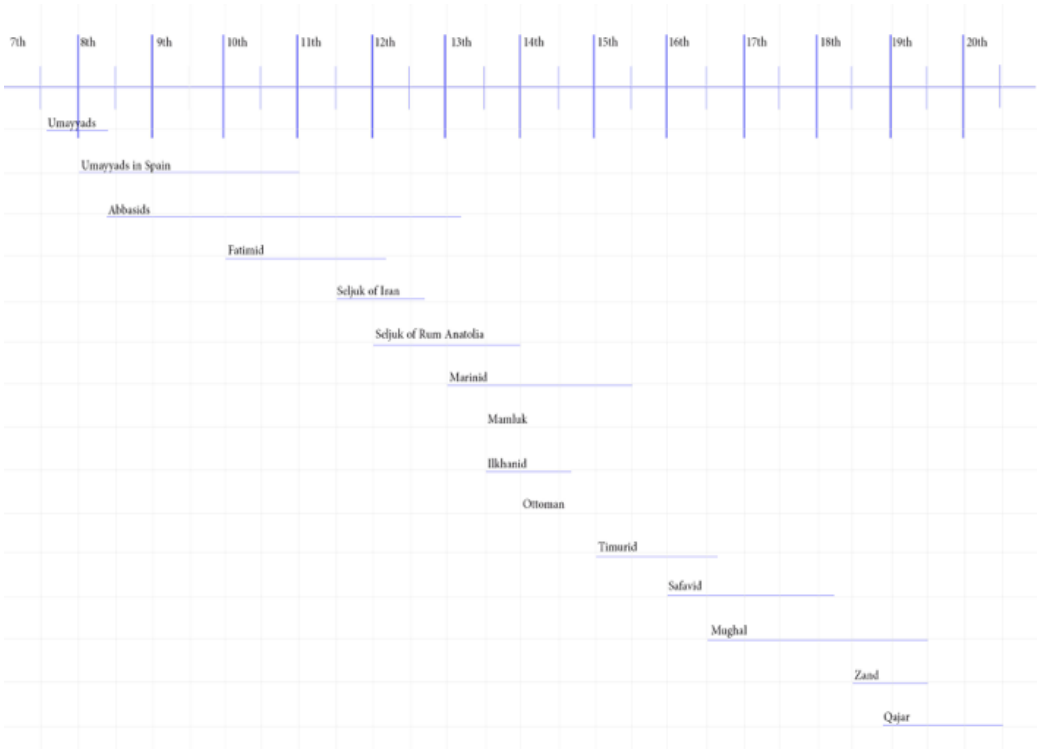


Figure 4.2: Timeline of Islamic dynasties (Alhamal, 2019).

4.3.1 The Formative Period

The first Islamic monument that includes biomorphic patterns, as we know them now, is the Dome of the Rock in Palestine. They adorned the interior of the dome and the walls (figure 4.3). The Dome of the Rock was built in the late 7th century during the Ummyads period (661-750). However, the craftspeople that erected it were the Byzantine Christians of the Levant.

Figure 4.3: Sketch from a wall biomorphic pattern (Alhamal, 2020).

4.3.2 The Ornamental Integration Period

Few centuries later, during the Fatimids period (909 - 1171), the biomorphic patterns appeared again to adorn the Azhar Mosque in Egypt (figure 4.4). It was erected in 970, but has been restored and expanded in almost every century since then. Looking at the oldest part of it under the ornamented dome gives us a lot of visual insight.

Figure 4.4: Biomorphic pattern from the prayer niche in Azhar Mosque (Alhamal, 2020).

The biomorphic patterns were not consistently found – of the many monuments of the Great Seljuk period only a few had interior spaces that included bimorphs. The Ardistan mosque in Iran, for example, was erected between the 10th and 11th centuries; however, the dome and the

Iwan were completed in the 12th century. The biomorphic forms are carved into stone and they have a simple elegance.

The 12th century witnessed a significant change in the execution of patterns. The biomorphic patterns were still carved into wood and stone, but they were combined with colourful tiles. This was represented in two periods: Marinind in North Africa, and Nasrid in Spain. Two monuments that are ideal examples are the Bu'inaniya Madrasa in Fez (figure 4.5), which dates to 1350, and the Alhambra Palace in Granada that was built in the same century (figure 4.6).

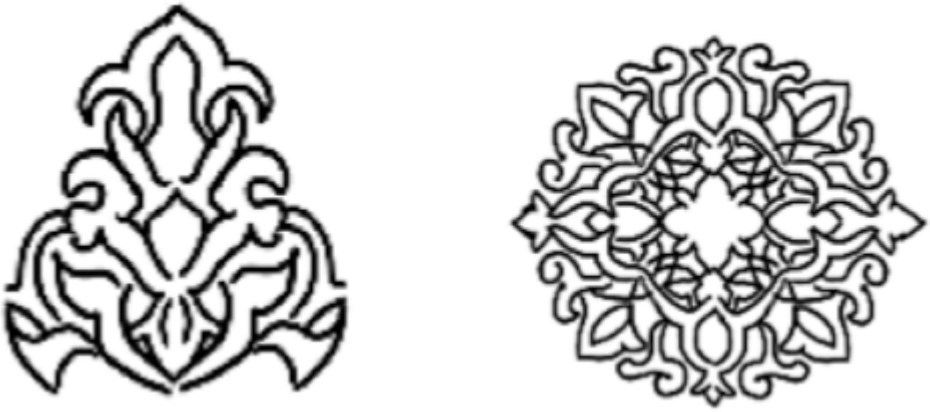


Figure 4.5 : Biomorphic stone carving in Bu Inaniya Madrasa (Alhamal, 2020).

Figure 4.6: Biomorphic stone carving in Alhambra (Alhamal, 2020).

4.3.3 The Final Development

A century later, the style of colourful ceramics had travelled to the Eastern part of the Islamic world and were prevalent in the Timurid period (1370–1506) in the monuments that spread in Iran, Uzbekistan and Afghanistan. Registan in Samarkand and Gawhar Shad Mosque in Mashhad, Iran, for example, were erected between the 14th and 15th centuries. The painted biomorphic tiles are rich in details and in colour.

The Timurid style was adopted and refined under the Safavid period, and that will be the focus of this thesis. The maturity of the biomorphic Safavid patterns will be apparent in the Chapter 6.

4.4 Qualities of patterns

Patterns, according to Wade (1982), are embedded into our whole existence. They exist within everything, including the world of science, and they are significant throughout human history. Wade explains:

> Pattern and symmetry so thoroughly permeate the fabric of our universe that it is hardly surprising that they should be prominent in any understanding or description of it. This is why patterns are 'discovered' by scientists and 'created' by artists. In science a familiarity with the law of symmetry underpins atomic physics, crystallography, chemistry and much else; in the realm of art there has probably never been a culture that has not used pattern (p.1.)

Motifs can be categorised into three types: free form, geometric and representational (Trilling, 2001). The later type includes floral ornaments, figural ornaments and ornaments depicted from objects such as architectural elements and artefacts. Figure 4.7 illustrates these three types of motifs.

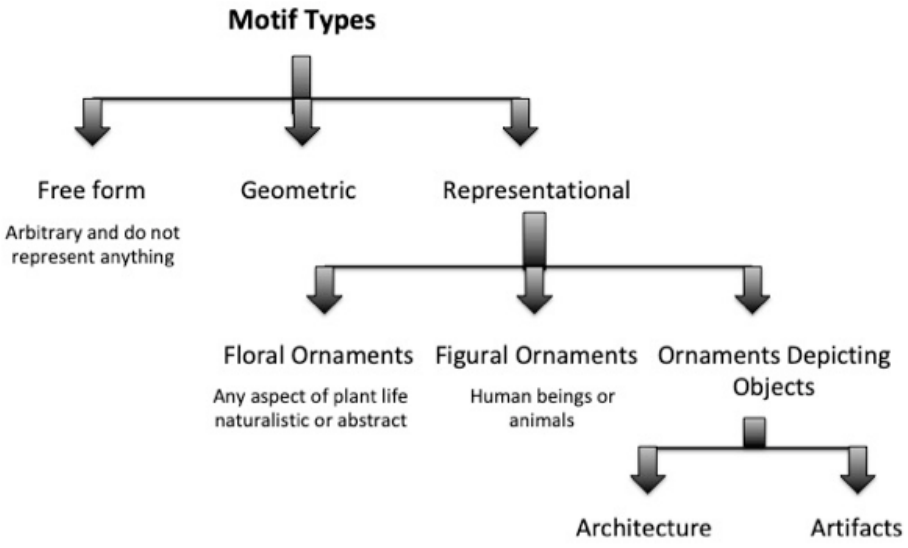


Figure 4.7: Types of Motifs (Trilling, 2001, p.36).

Islamic biomorphic patterns include all three types of motifs and each pattern reflects a geometric order, free form motifs and representational shapes. However, the majority of the representational motifs are from floral forms, but not always limited to that, as you will be evident in Chapter 6.

Just like motifs, when biomorphic elements are arranged into a pattern, they create a pattern-type and Trilling (2001) categories them into four types: unitary, additive, repeating and hypotactic (figure 4.8.). From my observations and work in Islamic patterns, I can classify them under: repeating and hypotactic.

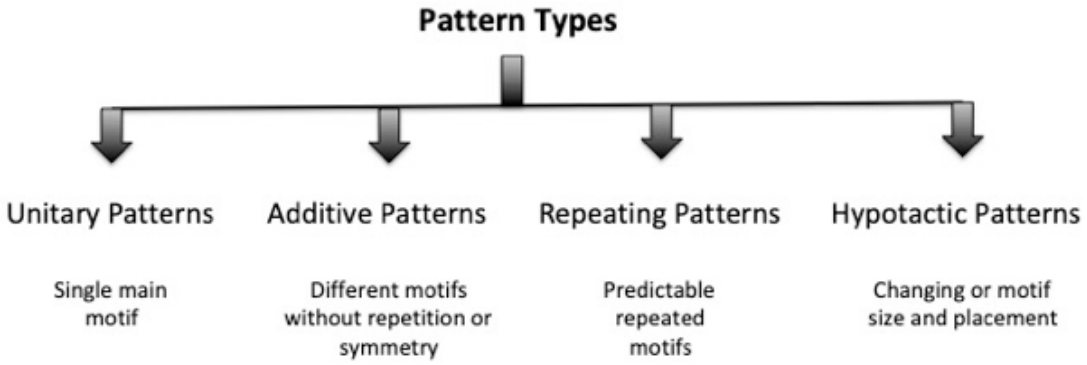


Figure 4.8: Types of Patterns (Trilling, 2001, p. **36).**

However, Trilling (2001) did not study Islamic motifs and patterns in depth. He described them:

> despite an often brilliant color sense and a seemingly boundless inventiveness on the level of detail, the result is conventional strictness that leaves little room for personal exuberance or fantasy" (p. 32).

Trilling position is clear that he did not find Islamic patterns imaginative or fascinating enough, but the categorisation of motifs and patterns he provides is general and can also be applicable to Islamic patterns, which provides a good framework for the study of patterns in this research.

As stated earlier in the literature review, Jones (1865) identified 39 qualities for ornamental arts. From those 39 qualities, I find some relevant to the study of Islamic patterns:

- Proposition 3. As architecture, so all works of decorative arts should possess fitness, proportion, harmony, the result of all which is repose.
- Proposition 6. Beauty of form is produced by lines growing out one from the other in gradual undulations: there are no excrescences; nothing could be removed and leave the design equally good or better.
- Proposition 8. All ornament should be based upon a geometrical construction.
- Proposition 9. Every assemblage of forms should be arranged on certain definite proportions; the whole and each particular member should be a multiple of some simple unit.
- Proposition 11. In surface decoration all likes should flow out of a parent stem. Every ornament, however distant, should be traced to its branch and root.
- Proposition12. All junctions of curved lines with curved or of curved lines with straight should be tangential to each other.
- Proposition 14. Colour is used to assist in the development of form and to distinguish objects or parts of objects one from another (p. xx).

The propositions can be summarised as follows:

1. The elements of the patterns must be proportional to the space and in harmony with each other.
2. Connection lines are gradual and meaningful in connecting the elements.
3. Geometric construction is the cornerstone of design.
4. Numbers of motifs and their multiplications should be consistent.
5. There must be a starting point to all motifs instead of floating in the air without a connection.
6. Following nature's law in organising the motifs and the balance of line is a must.
7. Colour has a purpose in explaining the design visually and it should not be vague. Colour has a function and it should have a purpose in the design.

The remaining 39 qualities can be found in his book *Grammar of Ornaments*, but they are not of a direct relevance to Islamic patterns, in my opinion. As far as I know, these propositions outlined by Jones have not been connected to the study of Islamic patterns before.

Moreover, Trilling (2001) presented seven concepts of ornaments that have been considered by the American Craftsman Association: "movement versus stasis, grace versus strength, determinacy versus indeterminacy, comprehensibility versus complexity, stylisation versus literalism, virtuosity versus truth to materials and application to the object versus integration with the object" (p. 11). These qualities were written about ornaments in general and they are probably discussing patterns occurring in Europe and America, but since Islamic patterns do not have a list of qualities to apply to them, it could be useful to adopt some of these qualities.

Philips (2002) also proposed in his work *The Nature of Ornament: A Summary Treatise* insightful considerations that echo Jones (1865) and Trilling (2001), Some of the qualities are visual, but some are metaphysical, the latter will be mentioned in the following section about the spiritually of Islamic patterns.

One of the most relevant visual qualities that Philips associates ornaments with is scale, which is changeable, in his view. He describes "Ornament knows no absolute of scale. The same devices

and systems may be found simultaneously on a palace and on the earring of a woman passing that palace" (p. 79). This suggests the possibility of transferability of a particular form of ornament from one medium to another.

Additionally, Bonner (2017) states that the two-dimensional Islamic patterns follow 17 plane symmetry groups. He claims that they are the same groups used for wallpaper arrangement and they are called: "plane crystallographic groups". However, these names and these specific categorisations were not used in the literature until the early 20th century and as such, there is no evidenceto support that Muslim artists and mathematicians follow this system. The work of Muslim geometers speaks for itself and these 17 symmetries all have appeared in Alhambra Palace in Granada, Spain.

Studying the 17 symmetries in comparison to biomorphic patterns is beyond the scope of this research.t is important for future studies on this subject to relate the biomorphic pattern arrangement to this modern way of understanding surface design. All of these classifications of Islamic patterns will be further considered in chapter 6: Pattern analysis and compared against the pattern findings.

Islamic biomorphic patterns have their own qualities that make them stand out and be unified under the umbrella term of Islamic arts. Pope (1965) summarises this: "The most intricate compositions of the Islamic period were built upon familiar, traditional themes: the sacred tree, the lotus in myriad forms, the undulating vine that turns back on itself, leaf and flower motifs of infinite variety and subtle geometric interlaces built up from six and eight stars." (p. 134.)

Pope uses five elements:

- The geometric underlying grid, which is mostly based on six- and eight-pointed stars, but can also be based on five- and ten-pointed stars.
- The spiral vine that connects the floral components together, creating a secondary grid.
- The central tree or the central arrangement, from which the whole design stems.

- The lotus, which does not appear as three-dimensional lotus, but as a stylised version.
- Stylised flowers and leaves.

Porter (2000) writes about an important Persian artistic theory known as the Two Qalams and the seven fundamental modes of decorative design. The Qalam theories are concerned with Arabic calligraphy, where the seven modes were concerned with paintings. Those seven modes appeared in letters and in poetry rather than treaties. The earliest reference to these "seven principles" is made by Qutb al-Din Qissakhvan in 1557: "As in calligraphy, which has six styles, in this technique [i.e., painting] seven 'styles' are to be found: islami اسليمي, khatai كتائي, farangj فرانجي, fassali فصالي, abr أبر, daq داغ, girih قيرية" (p.113).

The first two are islimi and khatai and they are defined in section 4.4, the third is frangi meaning Western or French and the last one Girih refers to the dual level geometry used in Persian art and architecture.

Khatei motifs are inspired from nature and they are used in patterns to remind the viewer of the naturae in paradise as described in the Quran (Abd Al-Ameer and Abd Al-Ameer, 2015). Khatei motifs include: leaves, flower buds and full flowers in various styles. The diverse range is part of the motif database in chapter 7.

And He it is who has caused waters to come down from the sky; and by this means have We brought forth all living growth, and out of this have We brought forth verdure. Out of this do We bring forth close-growing grain; and out of the spathe of the palm tree, dates in thick clusters; and gardens of vines, and the olive tree, and the pomegranate: [all] so alike, and yet so different! Behold their fruit when it comes to fruition and ripens! Verily, in all this there are messages indeed for people who will believe. (6:99 Quran, Asad).

4.5 Spirituality of Islamic biomorphic patterns

The spiritual significance of Islamic art was not recorded because most historians were not concerned with art or poetry and the few records that mentioned the art's significance were scattered (Murad, 2009). Cammann (1976) writes in agreement, "Muslim historians and theologians did not concern themselves with such mundane topics as rugs or their patterns"

(p.196). Consequently, researching the spirituality of Islamic art has mostly started in the middle of the twentieth century. Still to some researchers, such as Khunel (1966), Islamic patterns do not carry any spiritual significance. On the other hand, a growing number of researchers believe that Islamic art and patterns have strong spiritual value and deep meanings, such as Burckhardt (1967); Critchlow (1989); Nasr (1987); Necipoğlu (2015); Sutton (2007) and Smeets (1973).

Nasr (1987) considers Islamic art as a form of sacred art that reflects Islamic spirituality. He clarifies:

> Islamic art is based upon knowledge which is itself of a spiritual nature… Since in the Islamic tradition with its gnostic mode of spirituality, intellectuality and spirituality are inseparable being facets of the same reality, the hikmah upon which Islamic art is based is none other than the sapiential aspect of Islamic spirituality itself (p.8).

Sutton (2007) suggests that the circle is the starting point of every pattern and that is directly related to God's wholeness and oneness and all creation is extended from him. In reference to circles, Smeets (1973) clarifies, "the circle is the only geometric figure formed with one line with no beginning or end. It is a sign of infinity, eternity, perfection and God" (p.15). Furthermore, when Islamic patterns are drawn, a large portion of the construction lines are erased or covered by painting for the main pattern to be clear. This act is a representation of how this world is resting on an unseen order. A pattern could be repeated infinitely, but it is usually cropped in a triangular shape. When the cropping happens, the main pieces are placed in the corners and in odd numbers to protect the relationship to the Divine Unity.

On the other hand, some scholars do not acknowledge the spiritual connection of patterns Sutton (2007) refers to; instead they consider the ornaments only as a decor. For instance, Khunel (1966) emphasised:

> It would be a mistake to attribute symbolic or allegorical meaning to these natural motifs when they appear in fantastic stylization, nor should one seek the representational of historical events, however suggestive the scenes" (p.24).

Relating it to spirituality, the underlying meaning of biomorphic language is described by DeLong (2017):

> Biomorphic adornment also alludes to the beauties of paradise and specifically to the Tree of Life… The composition always has an origin or focal point, such as a vase, seed, roots, or cloud from which the rest emanates. All growth moves outward from this point, unfurling and spiralling in a symphony of leaves, buds, and blossoms. This acknowledgement of an origin for a foliate composition is an acknowledgement of the Source, of the Origin, of the Divine (pp. 219, 220).

From a scholar perspective, Necipoğlu (2015) argues explaining the ornaments connection with spirituality:

> Since al-Ghazali regarded the source of all beauty as no other than God, visual beauty could induce in those spiritually or intellectually inclined a contemplation of the wonders of creation, semiotically replete with the signs of divine wisdom. The intuitive passage from aesthetic pleasure and wonder to metaphysical or mystical rapture could thus be virtually instantaneous (p. 33).

In a drawing class I attended for Dr. Shahriar Piroozram, a faculty member at Isfahan University of Art and a renowned persian artist and scholar, he shared his perspective on the ornaments and Islamic patterns. He explained that the presence of biomorphic patterns in sacred spaces leads our souls to absorb the hidden equilibrium and energy those patterns create. Thus, even if we do not understand the language of patterns or their spiritual significance, we are impacted by the energy they produce. According to Philips (2003): "ornament is a universal language that is transmitted by contact, trade and knowledge: its essence is universally understood even when its sources of symbolism have become arcane" (p. 79).

Furthermore, art that is displayed in spaces of worship has two functions. The first is to set the aesthetic of the space of worship, so that the worshippers feel like they are in a new atmosphere

that is different from the other mundane and regular spaces that humans usually work in, visit or occupy. Secondly, it is a visual enforcement of devotion. This is not limited to Islamic spaces and is seen in temples and other religious houses of adulation (Lazaro, 2005).

More specifically, the Safavid period has shifted the practice of Iran from a Sunni branch of Islam into a Shia and the latter views the religion not only as a practical way of life, but it also views it from a spirituality lens and that was reflected in the art produced during the Safavid period. For example, numbers have a lot of regard in the Shia sector and there is an emphasis on specific numbers such as the number 12. This number represents the 12 Imams or religious leaders from the bloodline of Prophet Mohammad (peace be upon him) to carry out the message of Islam and to assure the continuation of the message. Those 12 imams are referred to as the household of the Prophet Ahl Albait أهل البيت. This number has a lot of Islamic associations that are mentioned in the Quran:

And We divided them into twelve tribes, [or] communities. And when his people asked Moses for water, We inspired him, "Strike the rock with thy staff!" -whereupon twelve springs gushed forth from it, so that all the people knew whence to drink… (7:160, Quran, Asad).

There are other natural associations that make number 12 meaningful not only to Shias but humans throughout history, such as the 12 stages of the sun and the moon, the 12 months and the 12 zodiac signs. The records show that number 12 was especially important in the Near East communities (Schimmel, 1993). As a result, twelve pointed stars are used within the geometric patterns.

Numbers can also decode words and phrases within a pattern and it can be done by following a system called “Abjed”, which has been developed by the Shia Imams, according to some resources. This system is presented in the *Masterpiece Razavi* (2001) by Mohammed Al-Reda Al-Razawi, who have documented this system along with more spiritual experiments that are accredited to the Shia Imams. This system is listed in table 4.1. Cammann(1976) emphasises that “patterns were a “mystery system for communicating spiritual ideas”(p.207). According to Ahmadzadh (2015), this numerical system is employed for the remembrance of God. For

example, the dome in Sheikh Lutf Allah's mosque has a very specific number of teardrop shapes that grows from the centre and expand in scale. Counting them reveals the number 298 and it is the numerical value of the word "Rahman رحمن meaning the most merciful referring to God's holy qualities. ر R + Hح +M م + Anن = 200 + 8 + 40 + 50 = 298

A	B	J	D	H	W	Z	Hu	T'	Y
أ	ب	ج	د	ه	و	ز	ح	ط	ي
1	2	3	4	5	6	7	8	9	10
K	L	M	N	S	A'	F	'S	Q	R
ك	ل	م	ن	س	ع	ف	ص	ق	ر
20	30	40	50	60	70	80	90	100	200
Sh	T	Th	Kh	The	'D	'Gh	'Th		
ش	ت	ث	خ	ذ	ض	غ	ظ		
300	400	500	600	700	800	900	1000		

Table 4.1: Abjed system (Al-Razawi, 2001).

Natural elements are usually connected to symbolism the most, because they lend themselves to reflective thinking. One of the oldest natural elements that is the tree of life taking a form in Islamic mosques and spaces as well through the stylised biomorphic patterns. Grabar (1992) describes that:

> The tree of life illustrates a more elusive symbol, whose connotative rather than decorative power is often in the eye of the mind beholding scholars rather than in the understanding of the user or maker (p.40).

However, the new approach of associating Islamic art with spirituality received some criticism linking it to Islamic Sufism. Rabbat (2012) renounced scholars, such the Iranian philosopher Seyyed Hussein Nasr and the Swiss Muslim scholar Titus Burckhardt who "introduced Islamic art and architecture as a symbolic manifestation of a transcendental and rather monolithic and suprahistorical Islam" (p.6). Rabbat identified such scholars as: "mystically inclined Western and Western educated Muslim scholars in the 1960s and 1970s who were searching for an understanding of Islamic art and architecture from within the Islamic Sufi" (p.6). I disagree with this view since spirituality is part of the Islamic faith, and not only Sufism. At the same time, I tend to think researchers should not exaggerate the spiritual dimension and associate it with every minuscule detail in Islamic arts, as well. I actually believe that all the manifestations of art are associated, one way or another, with beliefs and thoughts, either religious or secular.

In conclusion, there are two positions on the matter of spirituality. In my view, ornaments should not be severed from the possible meanings that they might carry because we simply do not understand them. The language of ornaments is not commonly understood, as highlighted in Section 2.3, and a lot of the underlying meanings might have been lost; thus, viewing them as meaningful offers a newfound understanding of the visual language. Most importantly, ornamentation, as a form of art, represents and reflects its socio-cultural context and spirituality is a significant aspect of the Islamic religion and culture.

Chapter 5: Ceramics of the Safavid period

5.1 Introduction

This chapter focuses on the development of ceramics in the Safavid era, especially ceramic tiles and its production techniques. This chapter is divided into three sections: development of ceramics, craft guilds and practical ceramic methods.

In the first section, I track the development of ceramics in Islamic Persia from the 11th century and look at other ruling dynasties in Persia prior to the Safavid such as the Seljuk, Mongol, Ilkhaindi and Timurid. The second section discusses the craft guilds in the Safavid period and the collective work of craftspeople. I end this section with practice-based research, where I test the most popular three methods of ceramics tiles: lustre, faience mosaic and the seven-colour.

5.2 Development of ceramics in the Safavid Period

In the history of Islamic Persia, there are artistically important periods prior to the Safavids, particularly the Seljuks (1040–1157) and the Timurids (1370–1506). Each of those periods have impacted the architecture and artistic abilities in Iran and contributed to the wealth of visual expression that Persian culture still possesses.

5.2.1 Pre-Safavid Period

The Seljuks provided two main contributions that the Safavid used: the advancement in dome constructions and painted decorated ceramics. Pope (1930) indicated that Persian domes deserve a special appreciation since they were hard to achieve. Although domes are now common, that was not always the case, and Pope credits the Persians for dome development because they presented a series of solutions such as filling the cracks between the structure and the dome with arches, vaults and niches. This dome technique is found in the remaining Friday Mosque in Isfahan.

As for the use of tiles, "the earliest evidence of the use of tilework on architectural surfaces (in Persia) is datable from about 1058: it is found on the minaret of the Friday mosque in Damghan" (Carboni and Masuya, 1993, p.2). This was the introduction of the Seljucks to colour ceramic as a mode of embellishing architectural sites. Wulff (1966) indicates: "The period of the Seljuks is named the 'golden age of ceramics'" (p. 132). Wulff explains that new techniques were developed due to the Persians' fascination with Chinese porcelain and their wish to reproduce similar ceramic in superior quality led to a period of trial and error until the Seljuck ceramists established two techniques.

The first technique is the addition of quartz to clay to strengthen the clay body and that composition is referred to as fritware or stonepaste. The fritware was especially used for glazed ceramics for their pure white colour. As a confirmation, Watson (2004) points out "all ceramic made in the Islamic world are (earthen wares). They are made with both earthenware clays (secondary clays with iron content) and with artificiality composed (frit) fabric… the firing temperature that defines them as earthenware. They are fired to 1000 C at which the clay particles have begun to fuse" (p.24).

The second technique developed by the Seljuks is the alkaline glaze that produced vibrant shades of blue such as cobalt and turquoise (figure 5.1) and it had a different use to the type of glazes that was used prior to that, as stated by Watson (2004):

> Glazes in the Islamic tradition divide into two broad families: the first being lead glazes fused with heat oxide, and the second is the so-called alkaline glazes fluxed with soda or potash (p.28).

Figure 5.1: Seljuks -Mina'i production- bowl with prince on horseback 12th–13th century (The Met Museum, 2021).

Lead glazes were local to Iranian cities such as Kirman, Yazd and Rum and their use changes based on the claybody it binds to. However, the alkaline glaze is the best way of applying colour and it is also known as under-glazing. Alkaline glaze was developed from oxides that were mined locally near Kashan, which led to the popular blue cobalt oxide glaze (Pinder-Wilson, 1976). The blue colour in cobalt oxide does not occur naturally, but it is achieved by roasting the mined cobalt ore (Highet,2008). The cobalt oxide is sometimes referred to as lajvard meaning lapis in Persian or Sulumani also in Persian. The latter is used when the Iranian blue colbar is exported to China and both names are used in Abu AlQasim treaty (Watson, 2004).

At the end of the 12th century, a ceramic tile technique was developed that was known as lustre. This technique is the application of metal oxide, such as gold, on the top of a glazed and a fired tile. After the application, the tile or the clay body is fired again, but on a very reduced temperature. Kashan in Iran became the centre of this technique. Lustre tiles were mostly used in prayer niches, mihrab (Wulff, 1966). Pinder-Wilson (1976) indicates that the lustre technique reached Persia most probably via the Egyptians, who were travelling in search of a new patron

after the fall of the Fatimid period. Abul AlQasim called the luster technique as “enamel of the two firings” describing the practical process (Carboni and Masuya, 1993, p.3).

In the second half of the 13th century, the makers of lustre tiles moved from Samura in Iraq to Rayy in Iran, and later to Kashan in Iran (figure 5.2). The shiny quality of lustre was very attractive to people of the time and the demand for it increased.The decorative elements on lustre tiles differed, but the use of geometric patterns had been developed in Kashan and had been used extensively to decorate the prayer niche, mihrab, and sometimes Quranic inscriptions and calligraphic elements were added (Kuhnel, 1963).

Figure 5.2: Luster tiles made by Ali ibn Muhammad ibn Abi Tahir in 1262 in Kashan (V&A, 2020).

The Seljuks fell at the Mongol invasion that started in 1219. The Mongols wanted to eradicate the existence and the legacy of the Seljuks, which led to the loss of literature and architecture. It might seem that the Mongols were not interested in arts because of that destruction, but they spared the artists and the craftspeople to build their monuments, and examples of their patronage to the arts still remain (Pope, 1930). According to Anita Choudrey (2018), artists and makers were a commodity that was fully utilised by the new ruling power, as they are the ones that bring the visual grandeur to reality.

During the Mongol invasion and destruction, all tiles ceased to exist and there are no tiles that date between 1243-1255, but the trade recovered during the ilkhanid period (1256 to 1335) since tiles were in demand to decorate religious and secular spaces (Carboni and Masuya). However, the geometric patterns and biomorphic drawings were replaced with animals and figures in private quarters to accommodate the aesthetic tastes of the Mongols. The last of lustre is known to have been produced in the 17th century, but instead of tiles, it was used to decorate household objects such as bottles and vases. These items were also produced in Kashan, and made in gold lustre with floral touches (Kuhnel, 1963).

The Mongols ruled Iran for various generations and the most remarkable ruler was Timur (1335–1405), from whom the Timurid period inherits its name. Timur brought the best artists to Persia including Chinese artists, who had different artistic skills that merged beautifully with Persian arts to create a very organic and fluid type of biomorphic patterns that had not previously been seen, such as the addition of the lotus, phoenix and cloud motifs. Additionally, Timur popularised the use of faience mosaic in ceramic decorations. With the faience mosaic, different shapes are used and the tiles can be scaled big or small. More crafters were able to produce this type of tile, unlike the lustre that was a specialty of Kashan. The popularity of this technique made it easier for local crafters to replicate without the need of a specialist. The faience mosaic was considered to be "noble in design and robust in execution" (Wulff, 1966, p.120).

Samarkand was the capital of Timur, which is modern-day Uzbekistan. When Timur took control of the city, he destroyed everything and rebuilt the architecture of the city; one of which was the Shah-i-zendah burial ground that housed Timur's deceased family. That construct is a wonder with all the ceramic surfaces that used the faience mosaic techniques (see figure 5.3).

Figure 5.3: Faience mosaic in Shah-i-zendah in Samarkand (Alhamal, 2019).

The faience mosaic method required the pieces to be drawn, glazed and cut to shape before the pieces are placed in the kiln to be fired. Colour in ceramics is called glaze, and because all of the glazes were handmade from natural materials, each glaze required a different firing temperature. Therefore, the faience mosaic method allowed each colour to be fired at its prime result. The coloured ceramics of this method are brilliant in colour and are visually impactful. Regrettably, artistic development has always been impacted by the political situation, and production of ceramic weakened until it was revived again under the Safavid dynasty (Pinder-Wilson, 1976).

5.2.2 Safavid Period

Political unrest ended the Timurid period, and the Safavid dynasty was established in 1501 by Shah Ismail. This period lasted for seven generations until the death of Shah Sultan Husayn in 1722. The specific period that this thesis discusses is the Shah Abbas I period dating from 1587 to 1629 .

The Safavids were considered an Empire and the Golden Age for Persia. The phrase ‘golden age’ indicates secure times, where architecture and culture were able to grow peacefully, which took place during the Safavid period (Dale, 2010). The geographical area that was ruled by the Safavid extended from Iran to Iraq, to parts of Georgia, Armenia and Azerbaijan on the West and parts of Uzbekistan and Pakistan on the East, as seen in Figure 5.1..

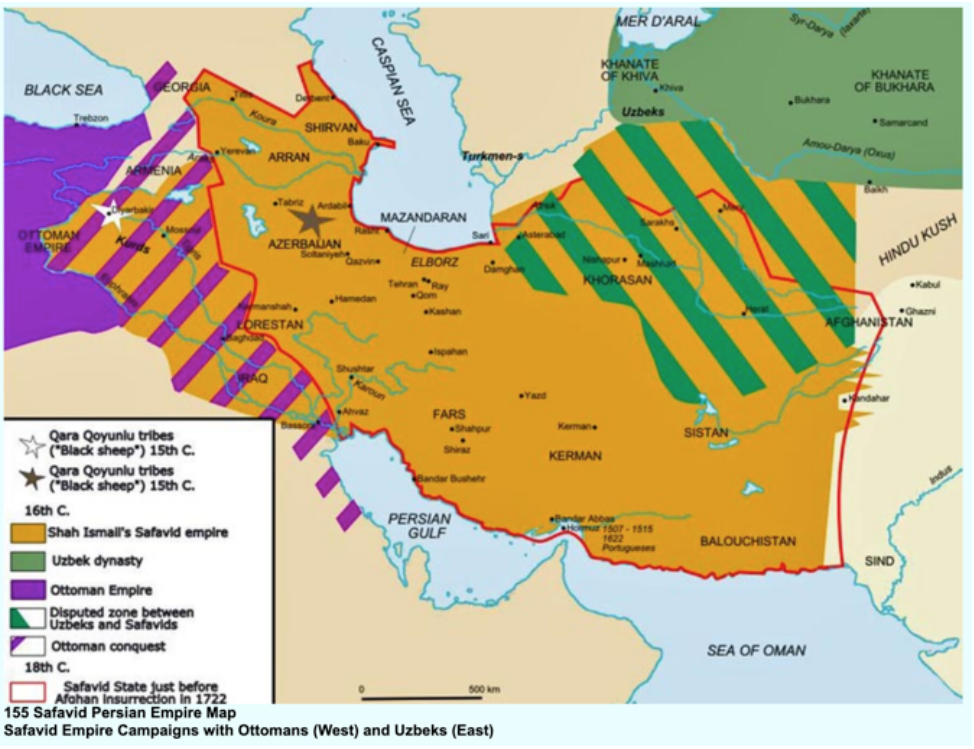


Figure 5.4: The geographical area that was ruled by the Safavid (Iran Politics Club, 2000).

The Safavid period had a role in changing the architectural style of Iran and it was the beginning of the strength and popularity of the Shia branch of Islam, which is still practiced in modern-day Iran now (Brend, 1991). Seherr-Thoss (1968) states: “until the regain of Shah Abbas I, Safavid design was essentially a continuation of Timurid design" (p.173). Thus, true Safavid design started in the period of Shah Abbas I. Moreover, Barry (1995) confirms that fact: “under its 17th century Shah, Isfahan became the ultimate expression of Persian architectural classicism in Eastern Islam” (p. 272). Both statements are a testimony to the glory of Isfahan and the Shah Abbas’s artistic period that is worthy of study.

Shah Abbas I became a leader in 1587 and he started making some large-scale changes in order to secure the stability of his lands, such as the peaceful treaty with the Ottomans in 1590 called “Peace of Istanbul”. Even though he had lost a lot of territories to the Ottomans, he had to agree to the peace treaty between the dynasties to be able to develop the lands he inherited (Canby, 1999). In Shah Abbas I reign Safavid carpets became a principal export commodity (Necipoğlu, 2016, p. 155). and that was the start of Persian carpets becoming famous until now in the international markets

In 1598, the Safavid capital moved from Qazvin to Isfahan. Isfahan already had a town centre and a Friday Mosque, which was one of the very few monuments that remained from the Seljuk period, and which Shah Abbas I intended to modernise . However, he received many protests from the Seljuks living in the area (Dale, 2009).

Figure 5.5: Friday Mosque in Isfahan (Google Maps, 2020).

herefore, he selected a new location 2.5 kilometres away from the Friday Mosque, with the intention to eclipse it with an architectural marvel that was a much larger city square with two new mosques, a palace and a market to drive all the business to this new competitive location (Dale, 2009). The new city square, Maydan-i Naqsh-i Jahan (Square on the Plan of the World) , was 500 metres in length and 146 metres in width, and enclosed two mosques: Sheikh Lutf Allah Mosque, which was built for the royalty; and the Shah mosque (see Figure 5.2), which was built

for the people. The square (see Figure 5.3) also housed the royal palace, the Ali Qapu Palace (High Palace) and the bazaar (shopping market) (Hutt & Harrow, 1978).

Figure 5.6: Isfahan City Square (Hotel One Click, 2020).

The domes of the Friday mosque, Shah Mosque and Sheikh Lutf Allah's Mosque employed the same techniques, but other than that they differed. The main visual difference between the Friday mosque and the two new ones were the patterns. The Friday mosque had a strong geometric language with minimal biomorphic patterns whereas the new mosques were filled with bimorphs. The differences between the patterns were due to the ceramic techniques that were common between the 12th and the 16th centuries.

Figure 5.7: Friday Mosque's Geometric Patterns (Alhamal, 2015).

Figure 5.8: Friday Mosque's preserved historic wall and minbar (Alhamal, 2015).

Figure 5.9: The inside of the Shaikh Lutf Allah Mosque (Alhamal, 2015).

Previous ceramic techniques were laborious, time-consuming and very costly. Therefore, Shah Abbas I pushed his craftspeople to create a better decorative solution that would enable them to more quickly cover the massive surfaces of the Shah mosque. The result was the seven-colour faience, which is called *haft rang* in Persian. The ceramic work was produced locally in Isfahan, which also reduced transportation costs. The rapid aspect of this seven-colour method is the ability to fire all seven colours at the same time in the kiln without them melting on each other and crossing over. The technique that enabled the potters to do that was outlining with manganese. The manganese works as a barrier and border between the colours and it holds each colour in its intended place.

The Safavid covered the interior surfaces of the Shah mosque with seven-colour ceramics (see figure 5.10), which took almost 26 years to complete (Hutt & Harrow, 1978). Sheikh Lutf Allah Mosque also includes ceramic tiles that were made using the seven-colour technique, but the faience mosaic is also used to create a more dramatic effect (Pope, 1930). The seven-colour technique continued to be used as the main ceramic technique until the 18th century (Wulff, 1966).

Figure 5.10: Shah Mosque ceramic tiles (Alhamal, 2015).

The ceramic tiles themselves are referred to as "stone-paste" by the Iranian practitioners. (Other names might be used but they are neither accurate nor used by the makers.) Stone-paste contains three main ingredients: crushed glass, quartz, and white clay. The measurement of each constituent is dependent on the recipe used by the maker. One of the recipes is "eight to ten parts crushed quartz, one part of crushed glass and one part of a fine white clay." Quartz is the main ingredient because of its wide availability in nature and its versatile mineral characteristic. The type of quartz can affect the outcome, so the type of quartz that is used to make the stone-paste can depend on where it is made (Mason & Golombek, 2003).

The glaze is made of opaque frit and mixed with metallic oxides, such as copper for green, cobalt for blue, and so on. The measurements change based on the type of oxide as each one has different requirements. The firing temperature in the kiln also changes based on the oxide glaze (Holakooei, 2013).

The seven colours of the haft-rang begin with white, and then six over-glaze colours: turquoise, violet, blue, yellow, brown and green. The tiles can be painted individually, but common practice is to lay the tiles next to each other as one surface to create the design or the composition on it as

a whole. The process of making the tiles involves three main steps. First the tile is made from clay and fired in the kiln. Second, the white layer of glaze is applied. Third, the remaining six colours are applied to the specified design, hence the name over-glaze, referring to the application stage. Then it gets a third firing and this is when the tiles are ready (Holakooei, 2013).

Ardalan (1974) writes that number seven has a deeper spiritual meaning: “The seven spiritual stages, symbolized by the seven colours which are metaphorically associated to numerous phenomena, such as the seven visible planets, the seven days of the week, the seven metals, the seven climates, the seven levels of traditional education, the seven parts of the body and the seven Prophets (from Abraham to Muhammad)" (p. 169).

Carboni and Masuya (1993) and Watson (2004) disagree with Pope (1930) and Holakooei (2013) about the name of this technique as “seven-colour”. Carboni and Masuya (1993) call it the Spanish name “Cuerda Seca” (p.5) while Watson (2004) refers to it as ‘polychrome underglaze’ and accredits the presence of this technique to the iznik Ottoman tiles. Carboni and Masuya (1993) clarify “the technique of overglaze-enamel painting usually known as “minai” is called by Abu al-Qasim “haft-rangi” (seven-coloured) (p.3) and that was lost in the 13th century. Pope (1930) does not explain the name choice and other journals refer to the use of black outline and a mix of colours as the Safavid haft-rang, seven-colours.

The polychrome underglaze technique is a technique whereby the crafter paints straight into the tile with all the colours at the same time, enabled by the use of a black outline. There are two similar methods to this technique: Cuerda Seca in Spain – possibly started during the Marinid in Moorish Spain (1196–1465) – and Iznik tiles from Turkey during the Ottoman period (1299–1922) (Carboni and Masuya, 1993).

The origin of the Cuerda Seca – Spanish word meaning dry line – technique is debated . Some scholars accredited it to Iran whereas others accredited it to the Spanish when they tried to imitate the Fatimid period (909–1171). The tracked development of this technique also shows a spike from the late 15th century, which coincides with the haft rang in Persia. Regardless of the

origin, the similarity between this style and haft rang cultivated the contemporary practice (Holakooei, 2013).

The Cuerda Seca technique, according to Daudpota (2018), is the application of an outline that consists of olive oil and manganese oxide to work as a barrier between the water-based glaze. The olive oil serves as a painting resistance, but it burns in the kiln and has no further effect. As for the manganese oxide, it is needed to keep the glaze separated in the firing process. Daudpota noted that during his master's degree research, he found it extremely difficult to gather information about the glazing process because the crafters he visited in Spain and Iran were overprotective of their recipes and did not wish to share their chemical formulas. It took him a minimum of three years to test various formulas to be able to produce his own glaze from raw materials and ready mineral stains. His workshop in Pakistan produces its own clay-fired objects such as tiles and pottery, and its own glazes and outline solutions for the various techniques that he uses.

In the study Holakooei (2013), he investigated Cuerda Seca tiles by scanning them in electron microscopy and he provides supportive evidence for Daudpota's work (2018). The scientific analysis explains the technique and it shows that the black line is made of manganese oxide in combination with a traditional binder such as oil or wax and it was intended to outline the design on the tiles before it has been fired. Examining the glaze shows that there was only one firing prior to the outline. In some cases, the tiles were not even fired first before applying the outline and the glaze.

Examples of the Cuerda Seca style have also been found in Turkey. For example, Yesil mosque (1424), also known as the Green Mosque of Bursa (figure 5.11), was tiled by a known artist of the time called Ali Ilyas Ali, who was trained during the Timurid period and later established training programmes for other artists. He was famous and known as the "Master of Tabriz." Another important person that was involved in the Green Mosque was the construction supervisor Haci Ivaz Pasha, who encouraged the invitation of foreign ceramists to the Ottoman court to establish artistic relations. This is when the Cuerda Seca style was transferred across to Turkey. It is thought that similar styles to the haft rang were also developed by the Persian ceramists who moved to Turkey. More ceramists moved from the Timurid court in the 15th

century to the Ottoman court. Evidence of these moves and additions of names can be found in the court treasury. The name describing artisans and craftspeople was *ahl al hiraf*, which is an Arabic phrase that translates to craftspeople (Necipoğlu, 1990).

Necipoğlu (1990) writes: "The large quantities of paper and numbers of scissors listed among the expenses of the royal ceramics workshop confirm the use of stencils drawn by court designers. The stencils were probably transferred to simpler repeating modular tiles by the lower paid painter *nakkash*." نقاش (p. 151.)

Figure 5.11: Green Mosque (Yeşil Camii), Bursa, Turkey (Delgado, 2011).

Cleveland (2004) writes: "Abbas transformed the city, lavishing huge sums on the construction of a carefully planned urban centre laid out along broad thoroughfares and embellished with richly decorated mosques... The material splendour of Isfahan, coupled with Abbas's generous patronage attracted artists and scholars, whose presence contributed to the city's rich intellectual and cultural life." (p.54.) Thanks to the efforts and foresight of Shah Abbas I, Isfahan made its mark on the world and hosted 400,000 residents, which gave it the name "half the world."

The Safavid period started crumbling in the beginning of the 18th century due to the lack of the successors and political strategies, which led to the end of it in 1736. The city of Isfahan started losing its importance as a result because the capital was moved once again to Tehran. In 1860, it was reported by a European scholar who visited Isfahan that the situation was disappointing and unlike the glorious Isfahan that they had heard of, especially on the craft market, where the decline was clear. The infiltration of European goods also had a role in this decline and the prejudice attitude towards local crafts (Philipp, 1984).

When the Islamic world merged with the Western one in the 19th century, the artistic measures changed significantly and the arts and crafts were separated. From that point, the perspective of art and the education of it became based on the European system (Cammann, 1976). Finally, the late 18th and 19th centuries witnessed a serious decline of Islamic art and crafts. However, the ceramicist and potters remained to practice in high standard throughout, which led to fantastic tile restorations in the revival of Islamic arts (Wulff, 1966). The full picture of the context of the ceramic production will not be complete unless the role of the craftsmen is taken into consideration and that will be evident by highlighting craft guilds in the Safavid period.

5.2.3 Craft guilds in the Safavid Period

Philipp (1984) writes that the main focus in studies regarding Middle Eastern guilds is relevant to the Ottomans, but with very little work done regarding iranian guilds.

The term "guild" refers to craftspeople working in a place as a group practicing the same craft or various tasks within that one precise craft, but the specifications of the term have been debated and argued. The word guild in Persian is *senf* صنف, which is also an Arabic word that translates to "type", which is suitable to describe a guild because the latter is dependent on the craft type. The Arabic language has another word to describe guilds as reported from Damascus which *is san'ah* صنعة , which translates to "occupation", and is usually used in the context of handmade work (Philipp, 1984). However, modern Arabic uses the same word to describe any vocation.

The work and the tasks in traditional crafts, such as at the Safavid times, follow a hierarchy of skill from the master, to the managing maker, to the senior crafter, and concluding with the apprentice. The master is in charge of the design task and conducting the most important task of the design or painting or making. The project is completed by the rest of the team, with each having one specific task that completes the project successfully. Each has an input, but their input follows their skill level (Lazaro, 2015).

The workshop or the guild environment was essential in ceramic work because the process of making ceramics requires a large number of tasks. Thus, each individual or group will be specialised in his/their own assignment. Examples of the tasks that were required include: collecting raw materials, processing and formulating the materials, making clay bodies and forms, decorating and glazing, and loading and unloading the kiln. No part was too small and they were all needed for the work to be completed efficiently (Golombek, 2019). Lazaro (2015) explains:

> Each part has a separate identity that is honoured by the collective; it is the process of 'surrendering' to the collective which elevates the 'whole' to a different level of consciousness. As one enters the craft, one enters this ancient process in which the self is slowly absorbed into the collective self (p. 24.).

There were 33 guilds mentioned in various sources in relation to Safavid Isfahan, and potters are part of that number. It is interesting to point out that potters were divided into three categories: the brick makers (kureh-pazam), the earth-ware potters (kureh-garan), and the stone paste potters or tile makers (kashi-pazam) . The encouragement of belonging to a guild comes from two purposes: tax collection, and social and religious unions (Golombek, 2019).

Craft guilds were set up by the royal Safavid and they had control over the choice of colours and motifs within a given design (Kuhnel, 1963). The guild was a collective of working master crafters and apprentices who received artistic training to improve their technical skills and their appreciation of aesthetics. The work was done as a group with supporting roles without individualism and personal styles. The guilds worked with the market police and the later

worked with the court and that established a chain of regulations and commands for artistic practice, choices of materials and trade.

However, there was competitiveness between artists and crafters; hence they usually kept their techniques and practical methods a secret to discourage the competitors from exceeding their efforts. They only shared the knowledge with their apprentices and when they were forced to by a new royal patron that won a battle and took over the political control, which happened several times with each new dynasty (Gray, 1976).

Joining a guild is not as easy as applying for employment. It requires something similar to an initiation, where the new apprentice is joining a working cell, or a collective. Each person within that guild has a specific role that enriches the whole process. Traditional craftspeople are entwined in togetherness to become one, rather than an individualistic practice, and that togetherness relates to the spiritual meaning of life because craft is personification of life. The role, function and position of the craftsperson is:

> Upon entering a traditional craft, the individual craftsman becomes part of a collective whole. His role, function, and ultimately his identity is assumed by his position within the craft in a process that relates 'self' to 'other' and reflects an ordering principle or hierarchy that is universal in origin (Lazaro, 2015, pp. 23-24).

Guilds were a necessity of living, but the competition with machine-made goods was too fierce, which led to a significant decline. Crafters – whether or not they were part of a guild – needed to be paid to work and produce work, but because buyers and royalty stopped the support that sustained a guild, a lot of them ceased. This was part of the decline in crafts after the Safavid period in Iran, as mentioned earlier (Philipp, 1984).

It is also important to acknowledge the role of the craftsperson when we are discussing craft guilds and makers. Necipoglu (2015) discusses the writing of the prominent Muslim philosophers Al-Ghazli, (c.1056–1111) and the passage he wrote reflecting his thinking that objects and architecture are not created in isolation of their makers. In fact, these works are a

reflection of the maker's soul and his relationship with the Divine. According to Bier (1998): "Crafts rely upon human ingenuity and productivity. They encompass both the products and the processes of production that comprise most aspects of material culture" (p. 349). This statement is an invitation to study crafts deeper than just studying the object on its own. It is also important to include the role of the craftsperson that made the object because her/his physical mark and invisible sense is part of the process of making, as well.

In this regard, Crowe (2004) indicated that a lot of the work on Safavid ceramics was done freehand and that depended on the skills of the maker, which required strong hand control. Eeven though the Muslim artists of the 16th and 17th centuries had a strong hand skill that is reflected in their work, they believed that only God was perfect, so they intentionally left an imperfect shape or relied on very slight asymmetry that was barley visible to the untrained eye. Finally, there is still so much to be discussed about the relationship between the craft and its maker, but it is beyond the scope of the research to thoroughly investigate the subject. This overview of the development of ceramic in the pre Safavid and Safavid eras and craft guilds is complemented by the experiments I conducted on ceramic as part of the practice based research, as discussed in the next section.

5.3 Practice-Based research: Experimentation with Ceramic methods

There are three types of ceramics techniques identified by Pope (1930) in Islamic Persia: lustre tiles, mosaic faience, and seven-colours faience. The first two types were mastered during the Seljuk and Timurid times respectively, however they were both labour intensive, which led to the development of the seven-colour.

As outlined in the research methodology, the practice based research enquiry involves experimenting with ceramic methods of tile production. In Section 5.2. I presented the development of ceramics during the Safavid era and a discussion of each method of ceramic tile production while in this section I provide an account of my firsthand experience applying the

methods. I opted to use this practical procedure to closely explore these methods in depth, compare the practicality of each method and to put myself in the craftsperson's shoes, especially that the craftsperson's role is an integral part in the process of producing the ceramic as established in the previous section.

5.4.1 Lustre

To test the lustre technique, I signed up for a weeklong workshop with Boris Aldridge, held at the Prince's School of Traditional Arts, London, in 2018. The lustre technique starts with the shape of the tiles and the most classical combination is the star and the cross as shown in figure 5.11.

After the design is chosen, it is transferred onto the tile using carbon paper and a pen, or it can be directly drawn onto the tile using acrylic paint. Because the transfer method uses contemporary materials that were not used in the 12th century, it will be interesting to know what they used instead. These materials were a useful makeshift and they produced the intended result.

Figure 5.11: Transferring design to tile using black carbon paper and a pen (Alhamal, 2018).

Afterwards, the design is scored into the tile and cleaned using a scribe (a metal pen) (see figure 5.12). The challenging part of this technique was working with the negative space – all the shapes covered in black will become white, and all of the empty spaces will become the lustre.

Only a small amount of lustre is needed for each tile, and needs to be applied in a very thin layer, otherwise it burns. All lustres look like sticky yellow paint and they dry quickly. The lustre application covers everything, the black and the white spaces.The black spaces will burn off in the kiln fire. Lustre also requires a lower temperature than usual of 700°C overnight. Figure 5.13 shows the result of the tile after firing with two types of lustre I applied: gold and blue.

Figure 5.12: Cleaning the design on the tile using a scribe (Alhamal, 2018).

Figure 5.13: The result of the tile after firing with two types of lustre applied: gold and blue (Alhamal, 2018).

The lustre technique has its uses, but it was not used in Safavid monuments. Learning this was a way to understand the reasoning of abandoning this ceramic style in Safavid architecture. The skill required, the cost and the fragility of the outcome might have all contributed to this method's decline.

5.4.2 Faience mosaic

The faience mosaic method that was used by the Timurid and examples of this technique is still present in Uzbekistan and Afghanistan. As previously mentioned, the making of tiles in this way is very time consuming because it has to be done piece by piece. However, the outcome of this method is a brilliantly glazed ceramics that can last for centuries without a change to that colour.

In my study trip to Iran in 2015, I observed ceramic tiles in the interior of Shah Mosque in Isfahan designed following this unique style. It is remarkable that these tiles have been preserved since the construction of the mosque in 1638 until now, for almost 400 years.
Faience mosaic is very similar to another method used in Morocco called *zeilj*. The closeness of the method encouraged me to participate in a zeilj workshop organised by Art of Islamic Pattern in Fez in 2016 under the guidance of Adam Willimson.

In theory, faience mosaic and *zeilj* are not difficult, but they do require attention to detail and accuracy. The pieces fit in their intended places, which is part of the design process to make it easier. Additionally, Moroccan *zeilj* is only applied to geometric shapes, which is much easier than assembling the Persian biomorphic patterns.

In the workshop, we treated the pieces as a puzzle that should seamlessly fit together, and it was not too complicated to configure even though the geometric pattern was not provided (see figure 5.14). It is an intuitive process to the skilled worker.

Figure 5.14: Assembling the pieces for the zeilj tile (Art of Islamic Pattern, 2016).

The pieces are assembled facedown and then the cement is poured on top to connect all the pieces together. According to Pope (1965), the faience mosaic used by the Safavid is also assembled facedown like a puzzle, where all the pieces fit correctly (see figure 5.15).

Figure 5.15: The pieces are facedown (Alhamal, 2016).

Figure 5.16: Completed tiles (Alhamal, 2016).

This method is laborious and assembling the pieces takes a long time (see figure 5.16). The crafter has to work in reverse from how the pieces look at the back rather than their colours. There are methods to make this simpler; for example, by numbering the pieces. Additionally, during the workshop an Iranian architect shared some images of this process that he took during a mosque renovation in Iran.

5.4.3 Seven-colour technique

In an effort to understand this technique, I attended a week-long workshop in 2018, held at the Prince's School of Arts, London, with Ghulam Hyder Daudpota, a Pakistani ceramicist, who follows the Cuerda Seca traditional method. The workshop began with preparing the materials: the black outline and the ceramic glaze. The tiles were made and cut into squares. The tiles had been fired once to turn them into bisque, which is the stage of firing clay.

The black outline mixture was made using manganese oxide, black stain and olive oil in specific percentages tested by Daudpota. The black solution was used to outline the design (figure 5.19), which had already been drawn with pencil onto the bisque tiles. The design I drew to test for this method was adapted from some of the elements that are present on the Shah mosques' tiles. There were options of simple designs provided by Daudpota, but I wanted to try a Safavid design across a few tiles to be as authentic as possible (figure 5.18).

Figure 5.17: Sketching ideas for the tiles (Alhamal, 2018).

Figure 5.19: Outline with Manganese oxide, black stain and olive oil (Alhamal, 2018).

The glaze used for painting was made as a group in the class from raw materials. Making glaze is a chemical process and all the components have to be measured correctly in specific weights and the measuring unit is the weight of water; approximately 1g per cubic centimeter, g/cm3. Calculating using this measuring unit was very challenging, but having this insight to making the glaze was valuable to imagine what the Safavi ceramists had to do. There are three main ingredients that are required in making glaze: glass formers that are usually made from silica and calcium, flux to assist in melting the glaze and a stabiliser that keeps the glaze on the object.

The process can be overwhelming and there are many elements to consider and there are software that can help practitioners in finalising their recipes, but in the hopes of making this process as traditional as possible, we did not use any software and calculated the various elements that will impact the glaze such as the temperature that it needs to be fired at. The colour source is oxide pigments that can either be natural or synthetic.

The brilliance of the glaze was different from the factory-produced glaze. The glaze was carefully applied very close to the line. Any errors in applying the glaze could be corrected by

scratching the extra glaze off with a blade to make the outline appear. Using the class-made glaze gave the produced tiles a softer sheen.

Figure 5.20: Correcting line with blade (Alhamal, 2018).

Figure 5.21: Glaze test on a separate tile (Alhamal, 2018).

Figure 5.22: Outlined design with the black line and painted with water-based glaze (Alhamal, 2018).

Figure 5.23: Result of glazed tiles after firing (Alhamal, 2018).

After testing the seven-colour technique, I recognise the reason for its popularity. It is a speedy method that can provide beautifully decorated tiles and it allows the practitioner to be creative with various designs since it is easy to change ideas and fix mistakes. The flexibility of this method is very appealing.

Chapter 6: Pattern analysis

6.1 Introduction

In this chapter I highlight the process of biomorphic pattern analysis and the steps I follow in the analysis. Further, I include an in-depth analysis of the biomorphic patterns from the two case studies: Sheikh Lutf Allah Mosque and Shah Mosque.

The term 'pattern', according to Wade (1982), is "a formal arrangement of a repeated element, the essential preliminary in pattern construction is to establish a supporting framework" (p. 5). This approach to patterns was my starting point of pattern analysis in order to determine the framework or the underlying grid. The use of the term "analysis" refers to examining all the pattern elements and motifs as separate entities. The outcome of this process was to assemble a database of motifs that I include in Chapter 7. The practitioners can use the database to design their own patterns, particularly practitioners and designers in the West and other places, who are not familiar with the Persian visual language.

Before discussing pattern analysis, I will introduce the steps that I followed to analyse the patterns. These steps I have formulated mostly from my own experience as an artist who has studied and practiced Islamic geometric and biomorphic patterns for more than ten years and also from the limited available literature on the analysis of Islamic patterns, as discussed earlier in Chapter 2. However, none of the resources, as far as I know, has outlined these steps the way I suggested. As such, I consider this as a unique contribution to the field of Islamic art, specifically to analysing Safavid biomorphic patterns.

6.2 Analysis principles

All the biomorphic patterns in this study are reproduced from ceramic tiles; however, the initial designs for tiles and colours would have been first completed on paper in the exact scale that was

needed to execute the tiles (Pope, 1965), then transferred onto the tiles. The decorative language of motifs in Islamic arts has a noteworthy quality, in that a design can be easily modified and repurposed for another medium (Gray, 1976). This is evident through seeing the same motif repeated on ceramic tiles, manuscripts and other crafts. Therefore, using the drawing medium to understand the design on the ceramic tiles is a logical step.

Accordingly, I analysed the patterns on paper to understand them further. As we live in the age of technology, I also drew the patterns using a digital pen and an Ipad using the Procreate software. Then I exported the images to Adobe Photoshop and Illustrator to edit them and finally inserted them in this document. Due to the transfer of images to a different program, this might have participated in decreasing the resolution and quality of some images.

I analysed two sets of designs on the ceramic tiles, in which each design follows a specific symmetry, either rotational or bilateral symmetry. The designs with rotational symmetry usually occur in domes and arches following two main geometric principles: eight-pointed stars and six-pointed stars. The designs with bilateral designs are usually square or rectangular and appear on either exterior panels or interior walls. This section includes the analysis steps followed in both symmetry types and then these steps were also applied in the case studies of Sheikh Lutfallah Mosque in section 6.3 and Shah Mosque in section 6.4.

6.2.1 Designs with Rotational Symmetry

In simple mathematical terms, rotational symmetry means that when a shape is rotated it retains its shape and it does not change. Circular designs have a three-dimensional quality, which has an implication on the design that does not appear in the angular designs. It is the difference between designing a sphere versus a plane. One of the distinctive characters in 3D circular designs is the tapered rosette shape and the changing scale in design elements from small to bigger to fill the spherical space. Necipoğlu (1995) refers to this system as the ‘radial grids’ and she explains it as "the most common composite type is based on the radial grid, that is, the circle divided into equal arcs by radii that generates interlocking star-and-polygon compositions (p. 27).

Furthermore, it is normal practice to treat patterns as two-dimensional on paper when they are analysed even if they are three-dimensional in domes.

The analysis of Safavid patterns with rotational symmetry involved the following steps:

Step 1. Counting the points that originate from the centre of the circular pattern. Usually these points are highlighted in the form of a geometric star. The number will be an indication of the construction. There are three types of stars underlying the Safavid biomorphic pattern: five-, six-, and eight-pointed stars. Due to the rarity of the five-pointed star in biomorphic design and the complexity of its construction, I opted not to cover it in the analysis and I just included the six-pointed (figure 6.1) and eight-pointed-star construction (figure 6.5) with the star variation (figure 6.2) and tessellation (figures: 6.3, 6.4, 6.7 and 6.8).

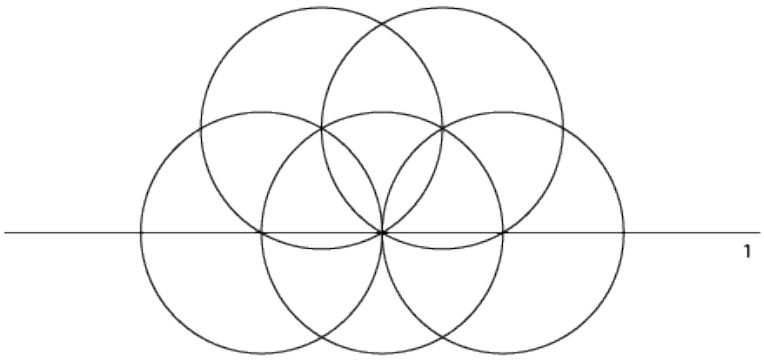
Step 2. Highlighting the repeat unit and analysing it separately if the pattern is circular; understanding one unit leads to deconstructing the whole pattern.

Step 3. Separating each one of the used spirals and categories from the unit. Usually there are two spirals intertwined and each of them was analysed separately since each houses a different set of motifs.

Step 4. Studying the motifs on their own and comparing them to see if there are similarities and differences between them and how they fit in the spaces together.

6.2.1.1 Construction of six-pointed star

The construction of the six-pointed star is very intuitive and has been used since ancient times and as the name suggests, the star is created from six points created by six intersecting circles.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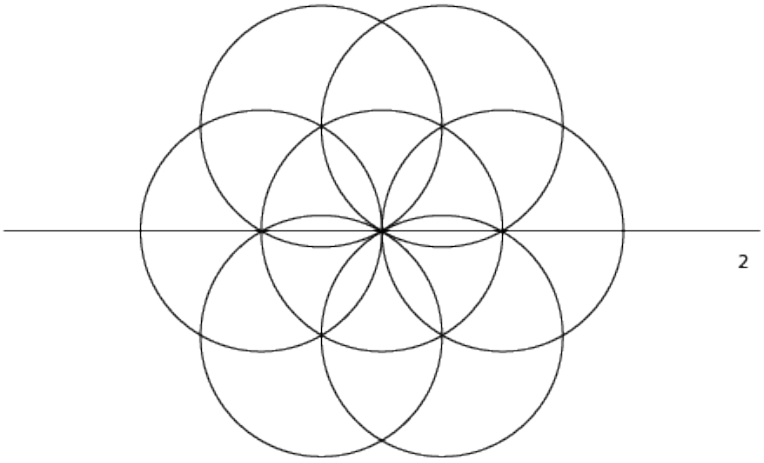
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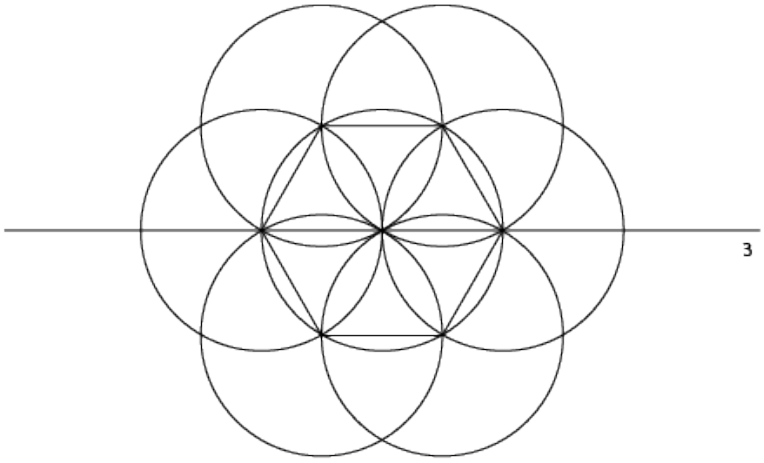
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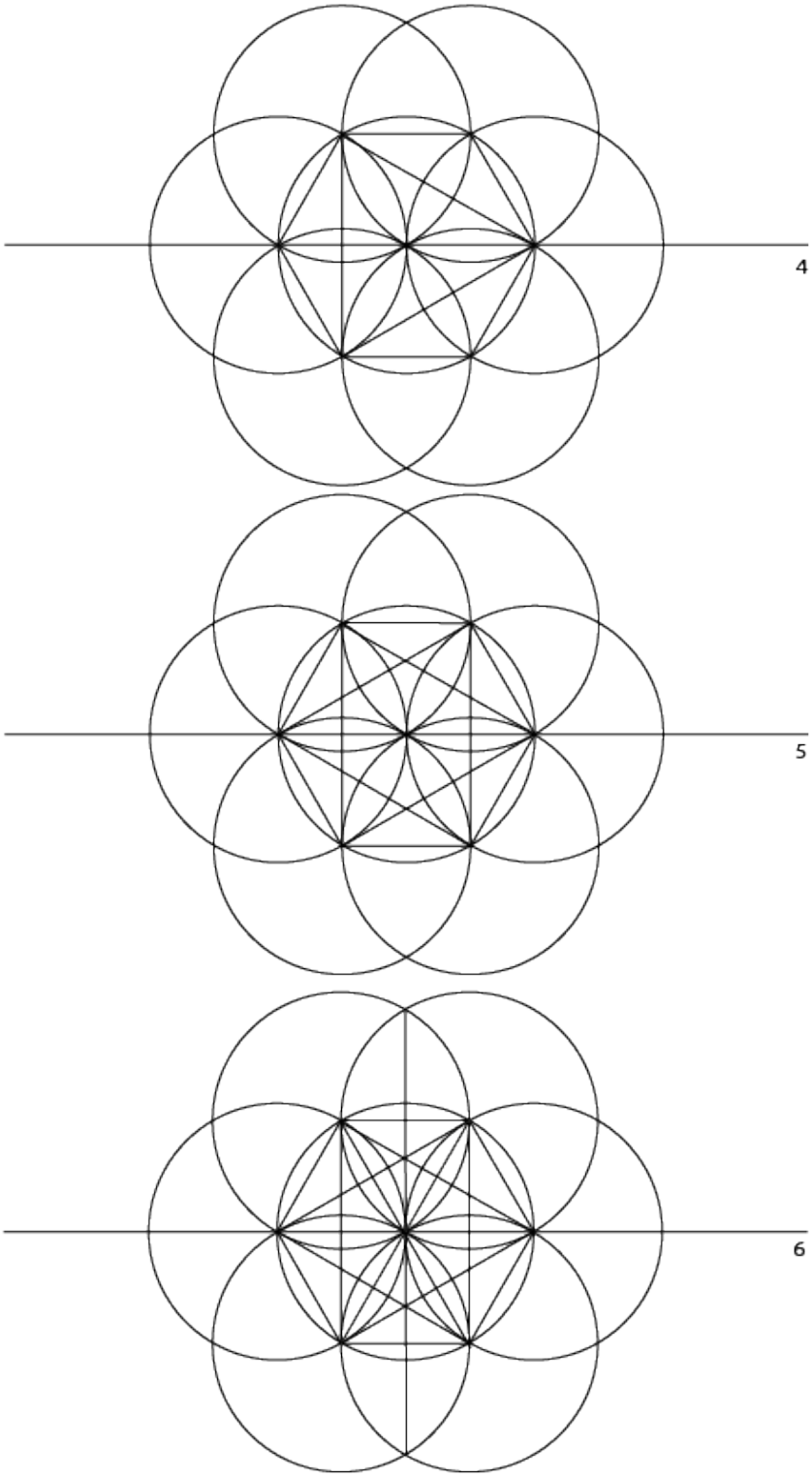


Figure 6.1: Construction of six-pointed star.

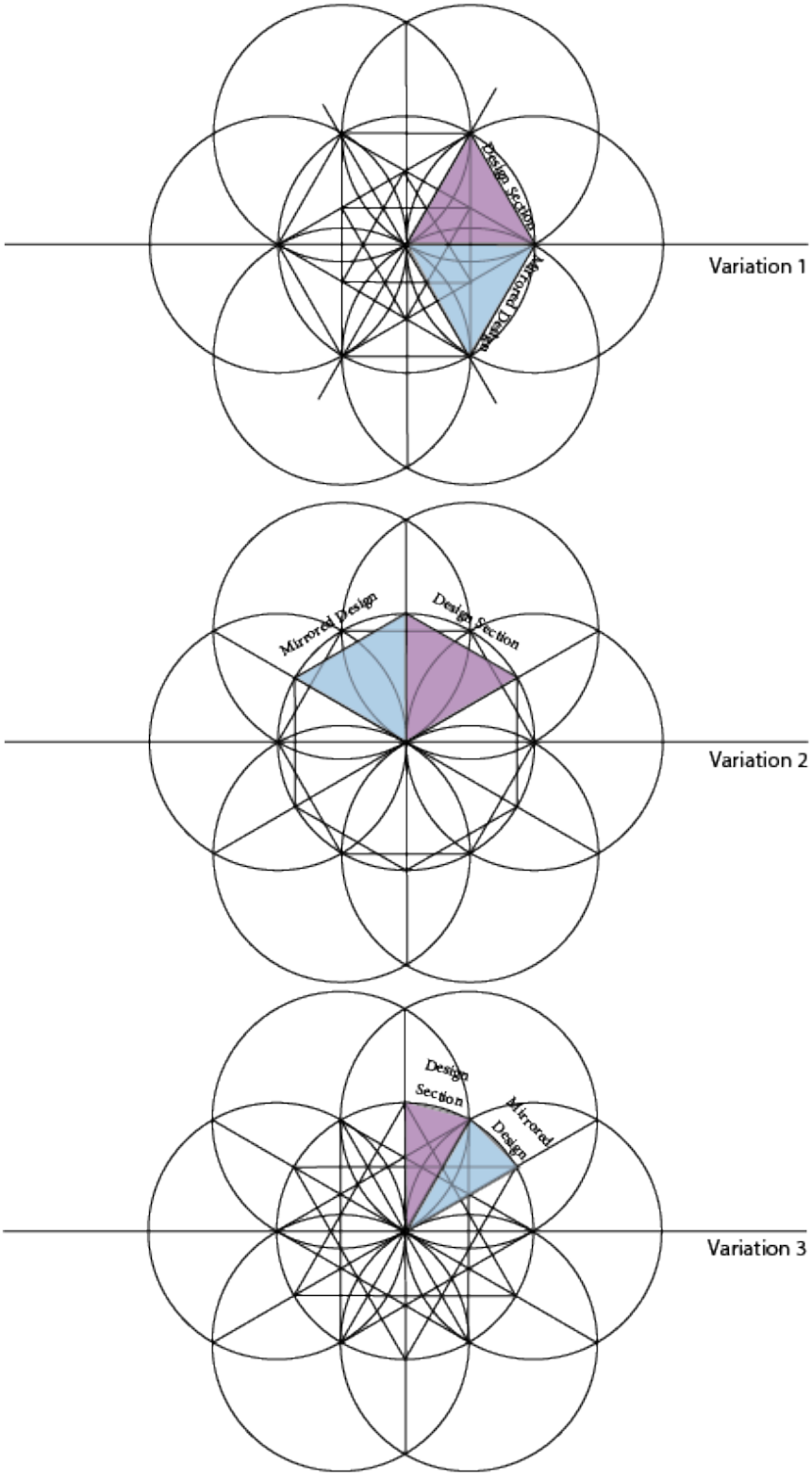


Figure 6.2: Variations of six-pointed-star.

Tessellation of six-pointed star

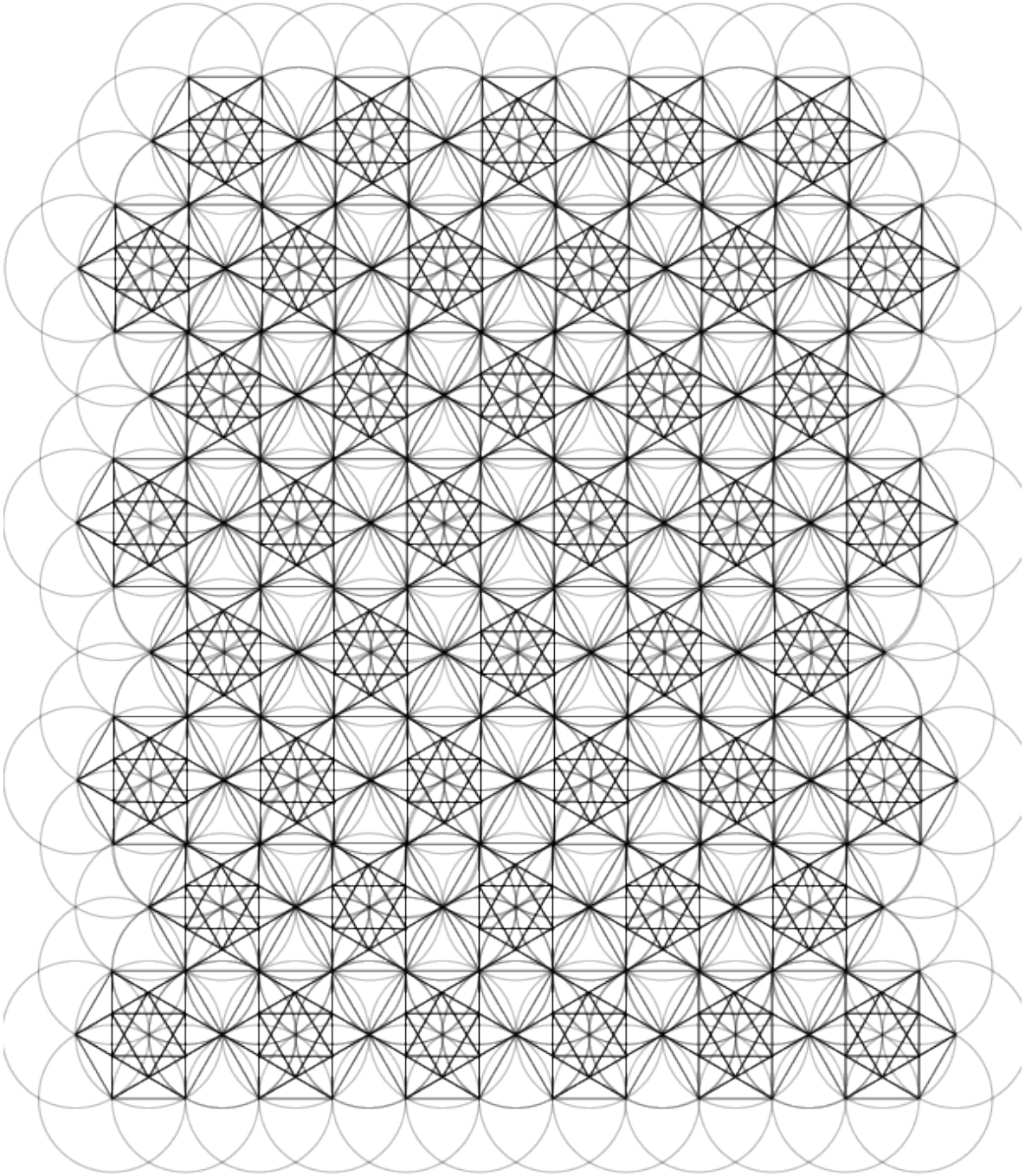


Figure 6.3: Tessellation of six-pointed star.

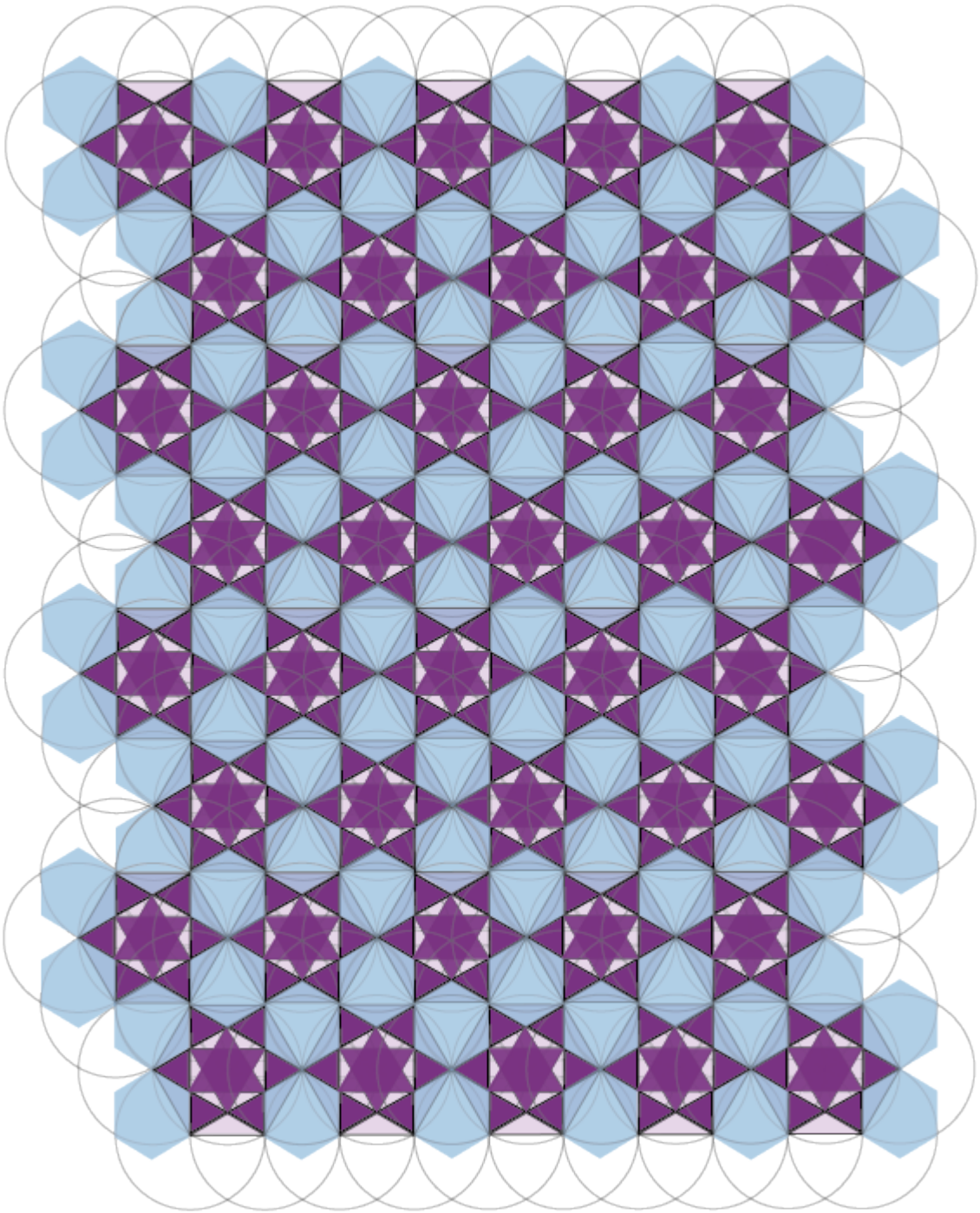
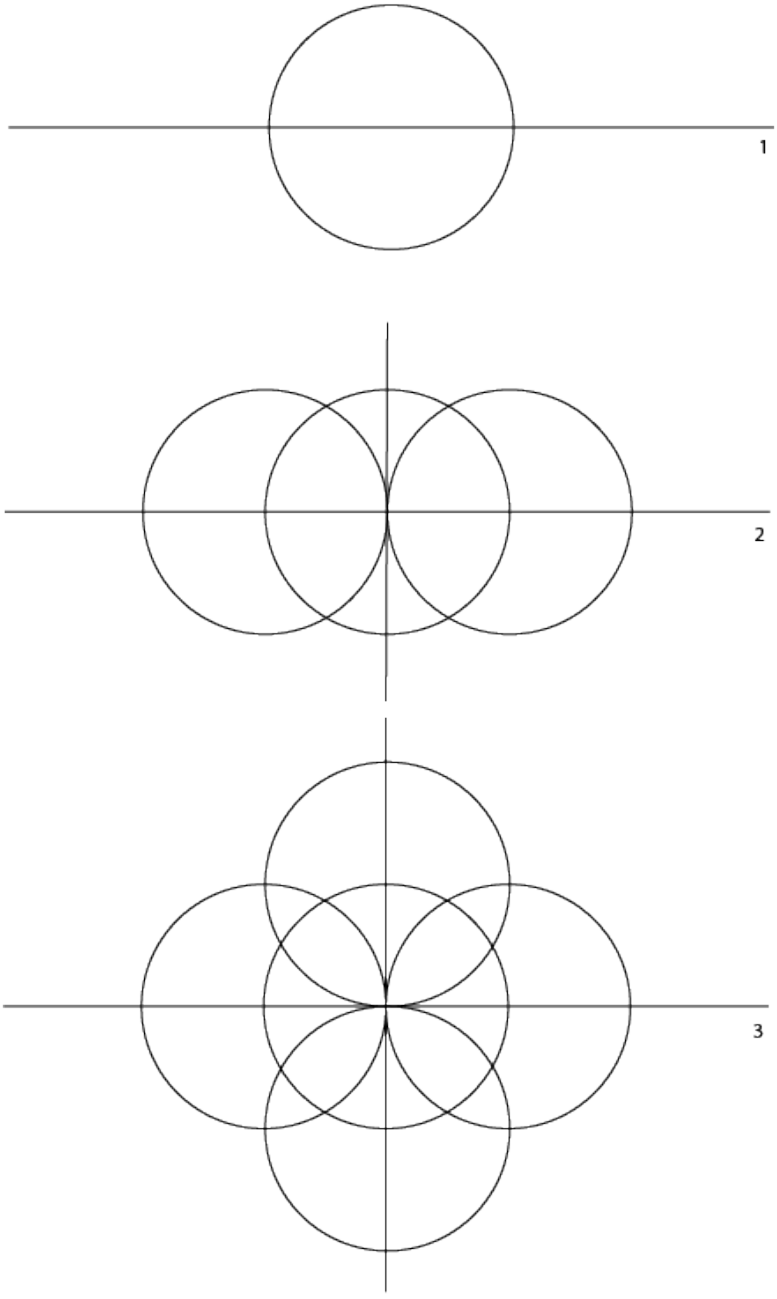
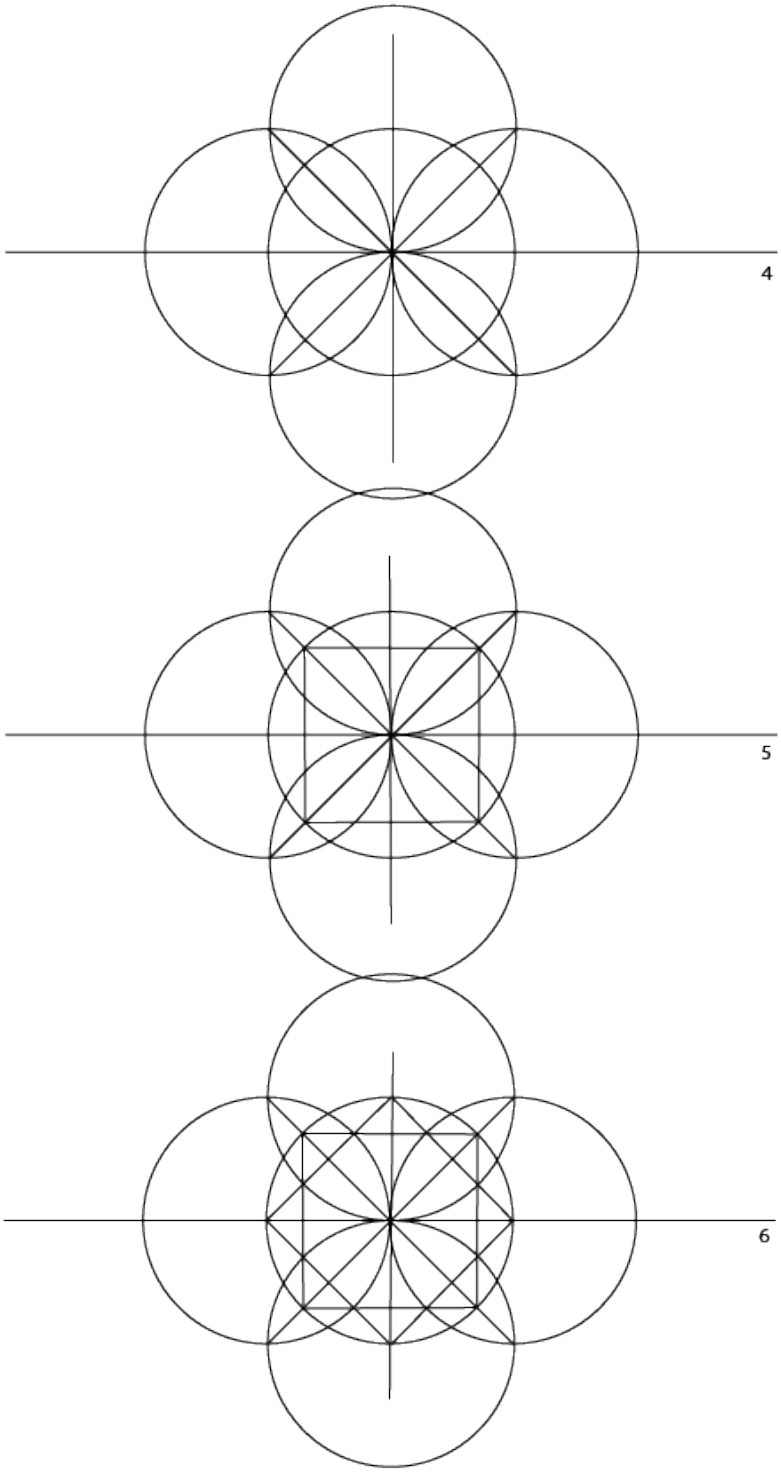


Figure 6.4: Tessellation of six-pointed star in colour.

6.2.1.2 Construction of eight-pointed star

Eight-pointed star construction is based on a four-fold rosette and it is another simple construction that many biomorphic patterns are based on.

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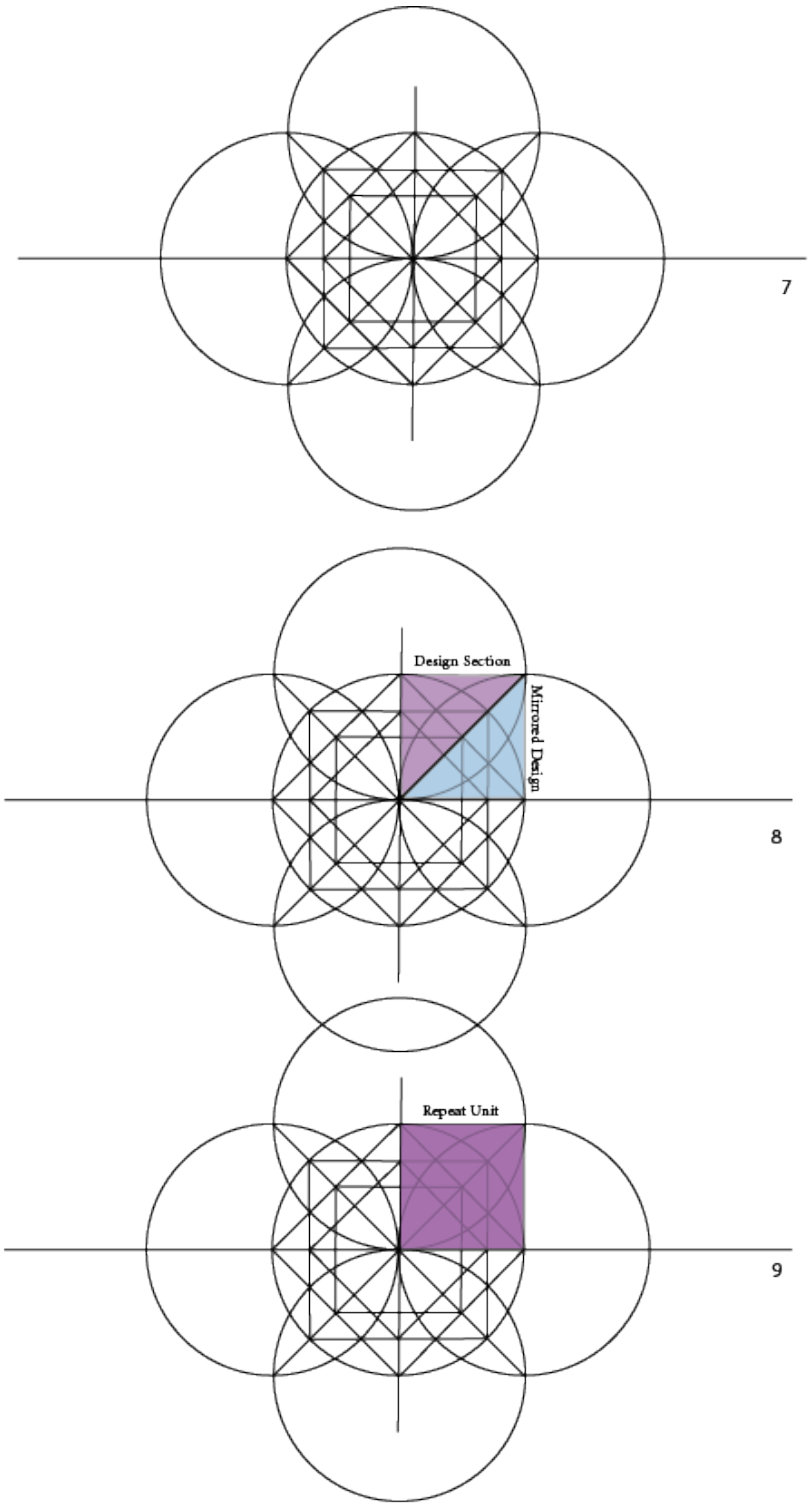


Figure 6.5: Construction of eight-pointed star and the selection of the design section.

Tessellation of eight-pointed star

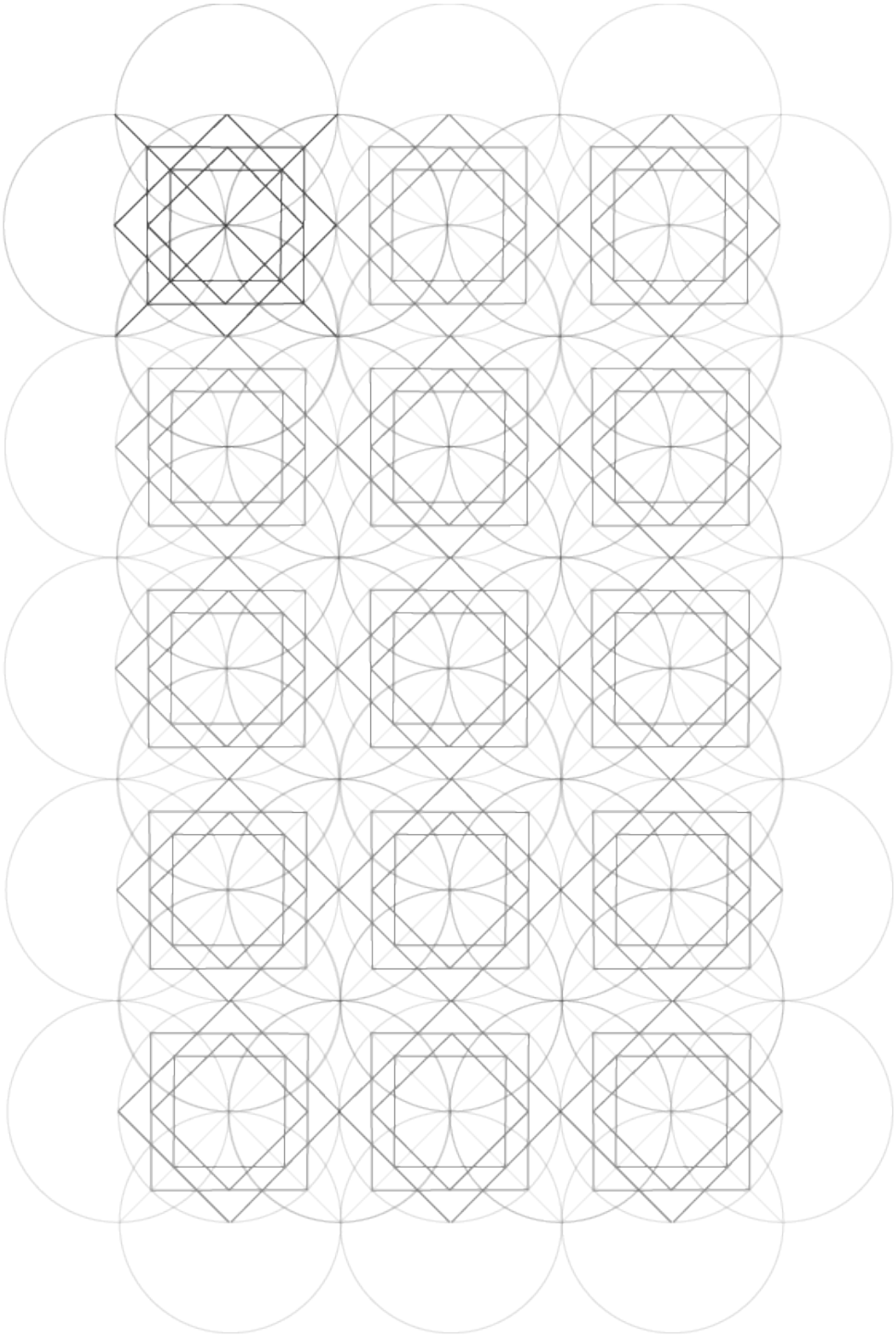


Figure 6.6: Tessellation of eight-pointed-star.

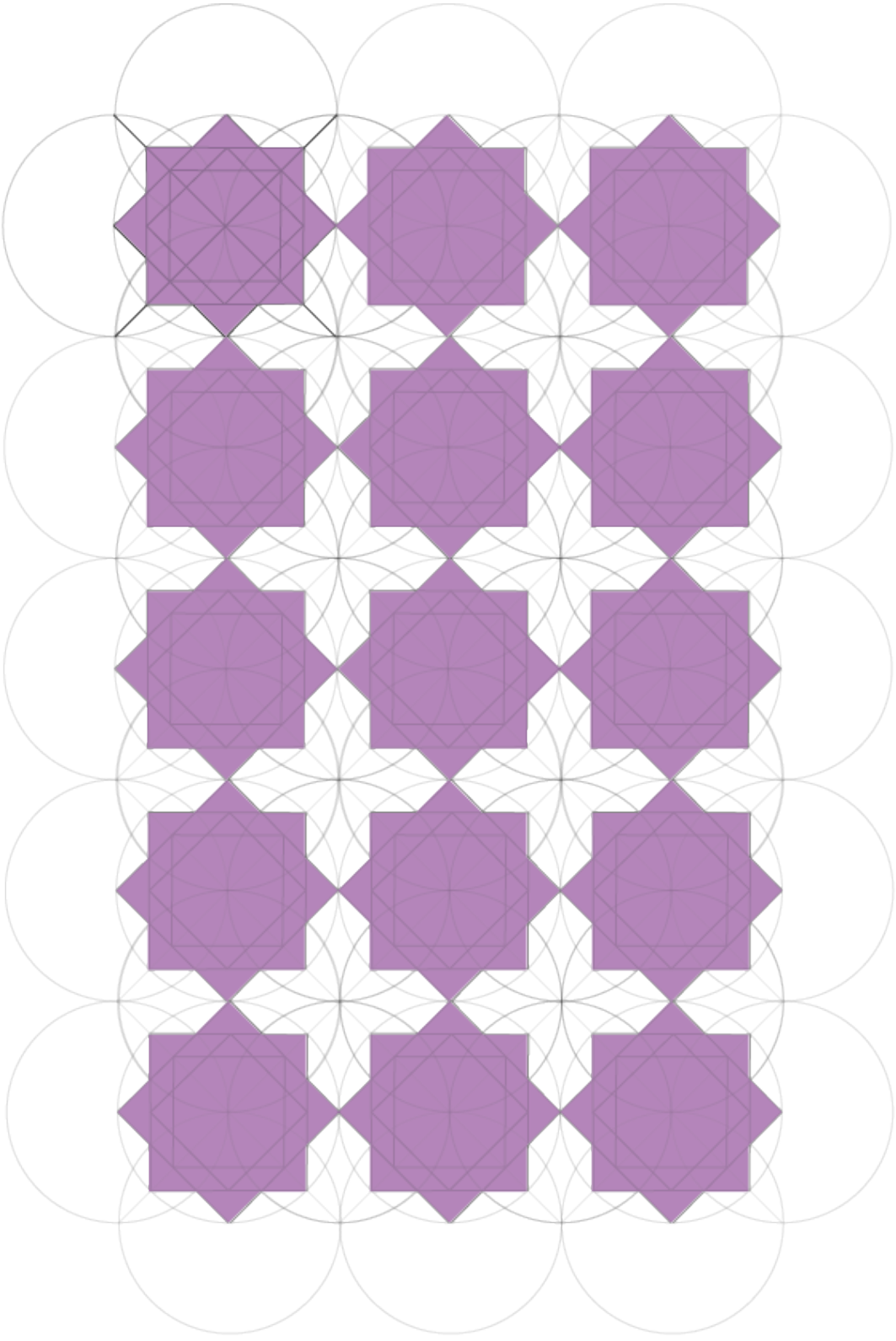


Figure 6.7: Tessellation of eight-pointed star in colour.

6.2.2 Designs with Bilateral Symmetry

In simple mathematical terms, bilateral symmetry means the bisection of an object with a middle line, where the right and left sides mirror each other. In the Safavid patterns examined in this chapter, all the bilateral symmetry is vertical. This type of symmetry can occur by the geometric construction of arch panels and rectangular spaces. These bilateral constructions need an expert geometer and that is beyond the scope of this research; thus the focus was on the symmetry line of those panels.

The analysis of Safavid patterns with bilateral symmetry involved the following steps:

Step 1. Determining the type of symmetry, one symmetry or four symmetries.

Step 2. Studying the symmetry line and the central motifs where everything stems from.

Step 3. Separating the two spiral systems that stem from the centre and studying the motifs on each one. Spirals are prevalent within this type of design. Spirals are categorised to two types: algebraic and pseudo (Polezhaev, 2019). The most popular type of algebraic spirals is the "Archimedean -arithmetic- spiral" named after the 3rd century BC Greek mathematician "Archimedes" (p.94) and the most common of the pseudo is the golden spiral. From the analysis in this chapter, the Archimedean spiral is repeatedly used in panels. It is beyond the thesis scope to discuss spirals and their mathematical qualities and differences further. The focus was on the Archimedean spiral, the only type I identified in my analysis. Constructing this specific spiral geometrically is essential.

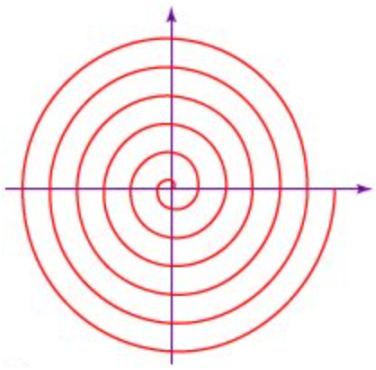


Figure 6.8: Archimedean spiral (Britannica, 2006).

Step 4. Studying the motifs individually and comparing them to see if there are similarities and differences between them and how they fit in the spaces together.

6.3 Case Study 1: Biomorphic patterns of Sheikh Lutf Allah Mosque

6.3.1 Introduction

Mosque of Sheikh Lutf Allah was founded between 1593–94 (Melville, 2016) by the architect: Muhammad Rida Husaynm and it was Shah Abbas's personal mosque (figure 6.8). It is considered as "one of the gems of Safavid architecture" (Canby, 1999,p. 98). The construction was led by Muhibb Ali Kika Lala, who was like the acting chief engineer for many of the Safavid mosques at that time and the construction work was conveyed by Ustad Ali Akbar Al-isfahani. Having a dedicated team to architecture and for each building confirms the importance of the workmanship during the Safavid period (Canby, 1999).

Figure 6.9: Sheikh Lutf Allah Mosque, Isfahan (Alhamal, 2015).

The mosque was named after Sheikh Lutf Allah, the father-in-law of Shah Abbas. One of the main challenges for the architects of this mosque was to change the orientation without affecting the overall look of the square façade because it was not facing the direction of prayer towards Mecca. The facade of the mosque is facing the East side of the square, *maidan*. Therefore, the entry to the mosque had a hallway that bends 45 degrees. The main courtyard, where the dome sits, was also moved to match that change of orientation; hence, the dome appears on the side when walking to the square (Hutt and Harrow, 1978). It is noticeable that the mosque is made of a large domed chamber without a courtyard or a minaret, which does not follow the usual architecture of mosques, but, in fact, it follows the structure of shrines that were built during that period (Brend, 1991).

The architectural plan to build this mosque contained a square shape for the prayer chambers and topped by the dome, but the interior work was remarkable and it changed the square into an octagon, which transformed regular architecture to a masterpiece. Each side of the octagon was

tiled with biomorphic patterns creating three styles and each was repeated twice. The prayer chamber is empty of any furniture, which adds to the impact of the patterns (Pope, 1965).

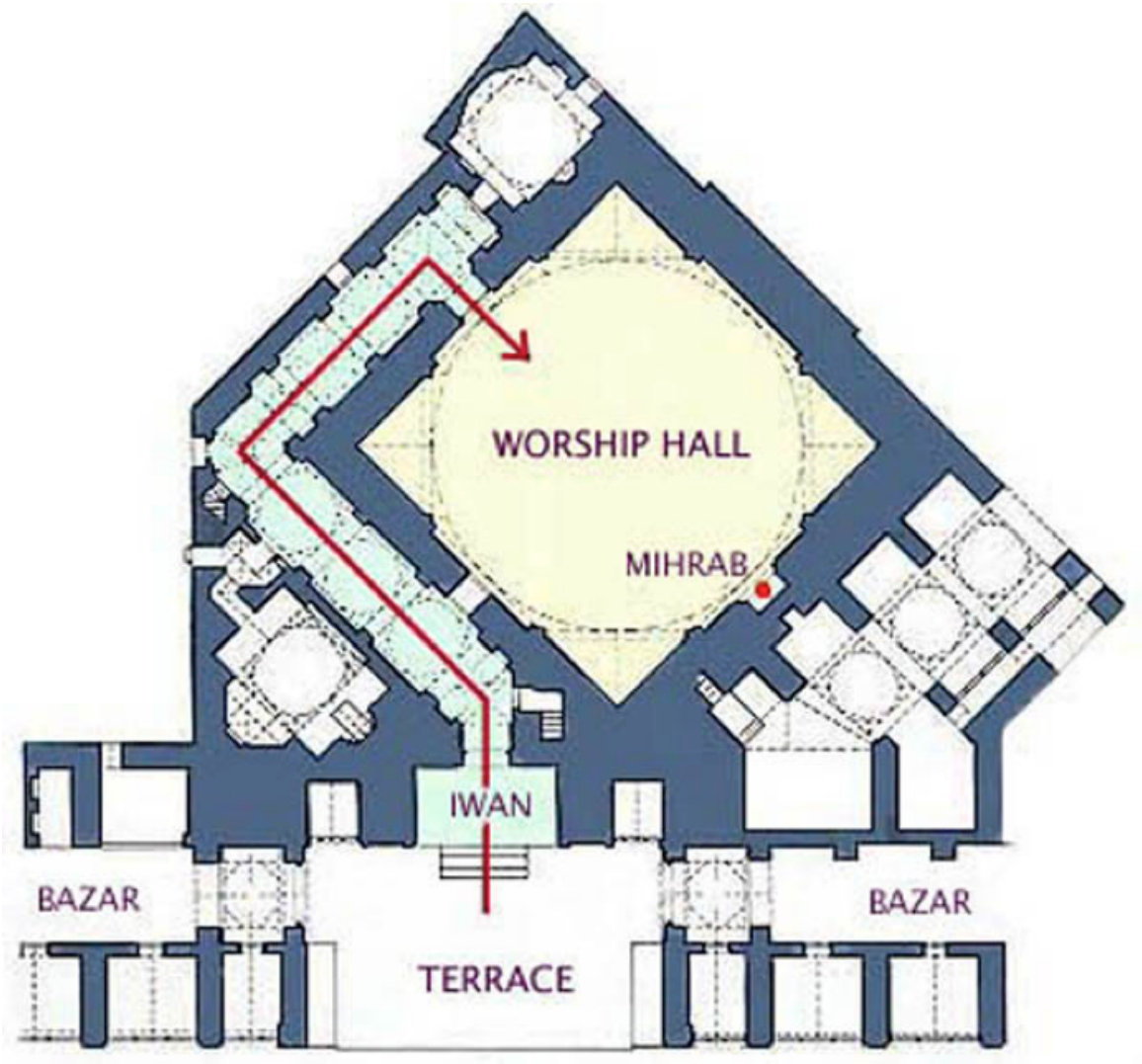


Figure 6.10: Sheikh Lutf Allah Mosque floor plan (young, 2013).

The mosque is divided into three main areas: the iwan; three sided facade and entrance, the portal and the prayer chambers; worship hall (figure 6.10). The facade of the mosque provides an example of the rectangular and arched panels that use bilateral symmetry. However, it has been restored the most, so analysing it will not be fully true to the 17th century Safavid design, so the analysis focus has been the inside of the mosque starting with the portal (figure 6.11) and followed by the prayer chambers (figure 6.12).

The design of the mosque is thoughtful. The designer was aware of the busyness and the chaos that happens in the city square, market area just outside of the mosque. Therefore, he added a portal between the gate and the prayer hall as if to prepare the worshiper mentally and visually before entering the prayer hall (Brend, 1991). The portal has a variety of patterns on the walls, arches and on the small portal domes.

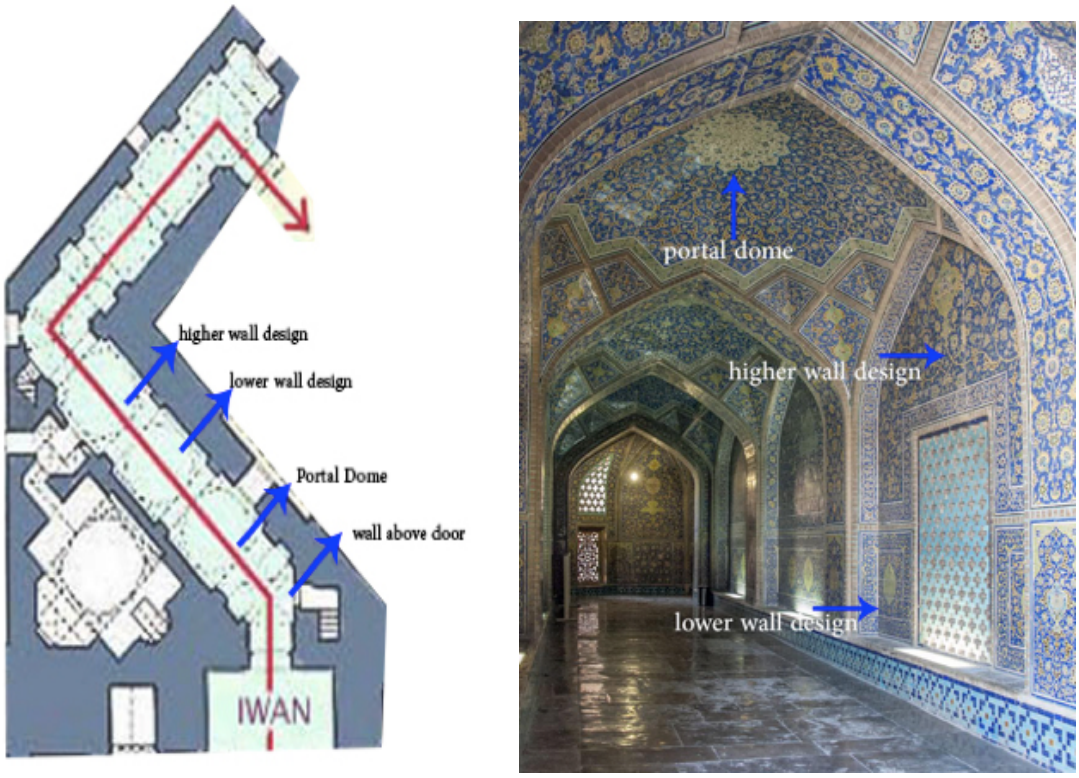


Figure 6.11: The portal between the main entrance and the domed prayer hall (Alhamal, 2015).

The portal is tiled and dimly lit and leads to the main prayer chamber that is much brighter because of the natural light coming from the dome widows and the reflective surfaces of the tiles. It feels like being showered in light upon entry. The portal passage is not a boxed hallway. Instead, it is a domed and arched portal and that provides the opportunity to not only analyse the

wall patterns, but the domed ceilings as well. The dome design is repeated three times with all the exact elements, motifs and colours.

Figure 6.12: Inside the prayer chambers in Sheikh Lutf Allah mosque (Alhamal, 2015).

Moving towards the prayer chambers, the visitor is greeted with an octagonal room filled with an abundance of light and the main dome that is seen from the outside. Even though the dome looks like it is placed low from the outside, it looks quite high inside (Seherr-Thoss, 1968). The dome construction relied on vaults and niches, a skill inherited from the Seljuks, as mentioned in Chapter 5.2.1. The dome is also a single shell, which was common in earlier Persian architecture.

The drum of the dome includes a series of windows with carved biomorphic patterns, so the entry of the light is soft and dispersed and it is not a glaring light, which is an intentional effect especially after the lightly dim hallway that leads up to the chambers (figure 6.12).

Domes in Persian architecture, according to Bonner (2017), follow reflective symmetry and he states: “the number of radial lines of symmetry will invariable be divisible by the number of side walls of the chamber that the dome is covering: e.g., if the plan of the chamber is a square, the reflected symmetry will be a multiple of four” (p. 3). This is the case in the Sheikh Lutf Allah Mosque.

The analysis of the mosque will be divided based on the two types of symmetry that is present within it: bilateral symmetry and rotational symmetry. The bilateral section includes a look at the entrance facade within the iwan, the walls in the portal and the walls in the prayer chambers. The rotational section addresses the domes in the portal, the rotational symmetry on one of the walls in the prayer chambers and the main dome in the prayer chambers. The selected patterns represent a sample from each area of the mosque. Furthermore, the pattern photographic sources are high quality and close-up to enable me to see every detail.

6.3.2 Designs with bilateral symmetry

6.3.2.1 The iwan

The starting point for analysing the patterns of the mosque is to look at the iwan, facade, of Sheikh Lutf Allah’s Mosque (figure 6.13). The first observation is the calculated pattern organisation and distribution. Wall #1 is bisected into side A and side B and then each side is dissected to three portions #1, #2 and #3 and every portion includes smaller panels. In portion #1 of the wall, the division is not only flat, but there is depth where the entrance is placed similar to bisecting a cuboid.

The use of panels in Persian architecture is unique. Pope (1930) explains: “Persian architecture has often been designated as panel architecture, for the wall surfaces are almost universally divided into series of panels, and panels within panels, slightly recessed” (p. 30).

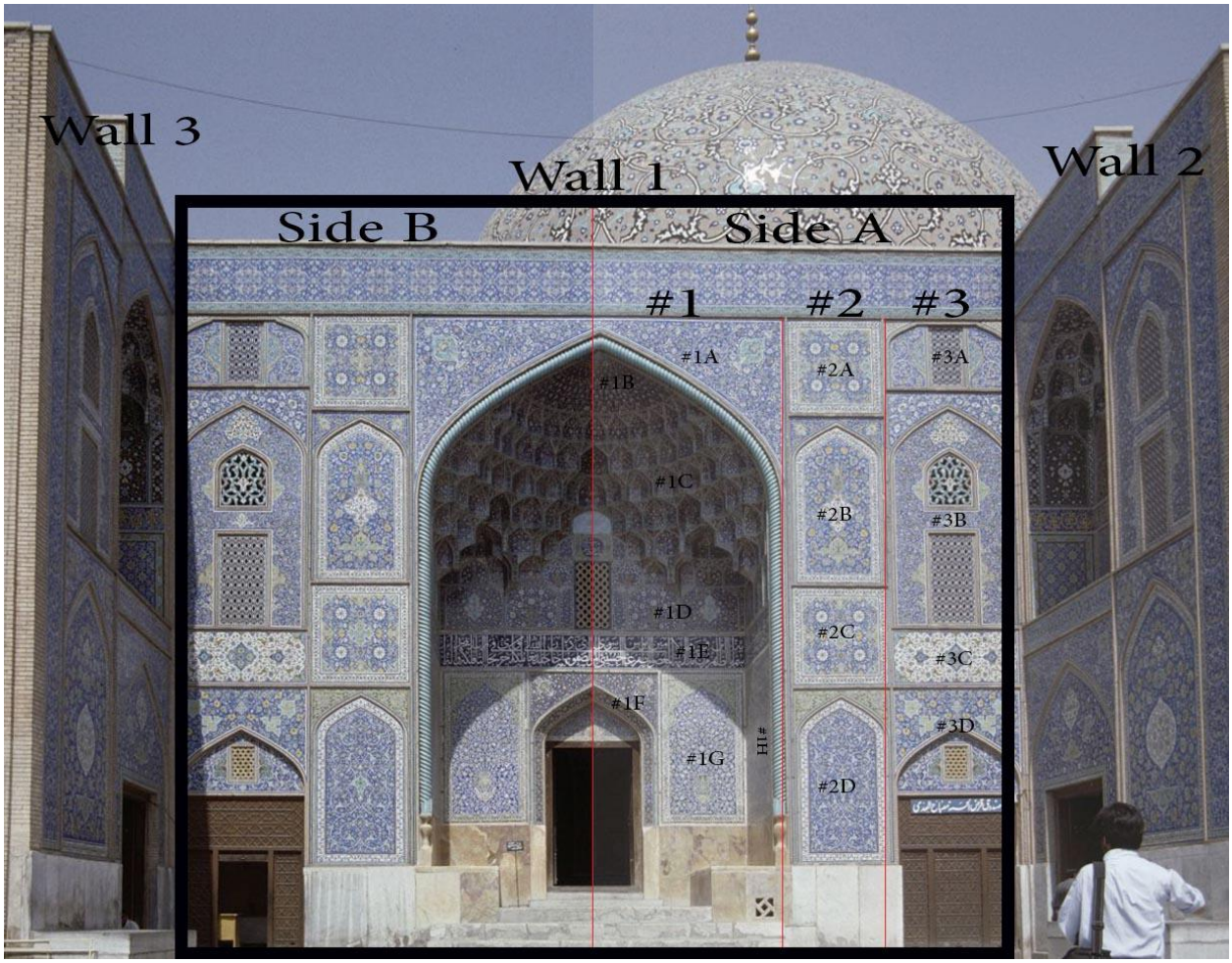


Figure 6.13: Facade of Sheikh Lutf Allah's Mosque (Haq, 1991).

Portion #1 starts with #1A, a pointed arch panel and this is a very popular feature of Persain mosques. The inner quarter dome and muqranse help distribute the weight evenly. This type of arch is drawn with two main points as shown in figure 6.14 and it is also known as equilateral arch due to the equilateral triangle connecting the points. This arch construction is also used in European gothic architecture and the origin of who started using it is debatable. Saoud (2002) writes that this type of arch has been used in Muslim architecture since the end of the 7th century. Regardless of the origin, this arch is used repeatedly on panels that include biomorphic patterns.

The construction of the arch starts with determining the spring line -width- of the arch and that becomes the radius for the first circle (step 1, figure 6.14). The second point on the same line is the starting point for the second circle (step 2, figure 6.14). The space between point 1 and point

2 is the arche's space (step 3, figure 6.14). If the radius is reduced and two circles are drawn, that will double up the arch and give it a frame (step 4, figure 6.14). I rendered the arch area in the figure (step 5, figure 6.14) (Murdock, 2012).

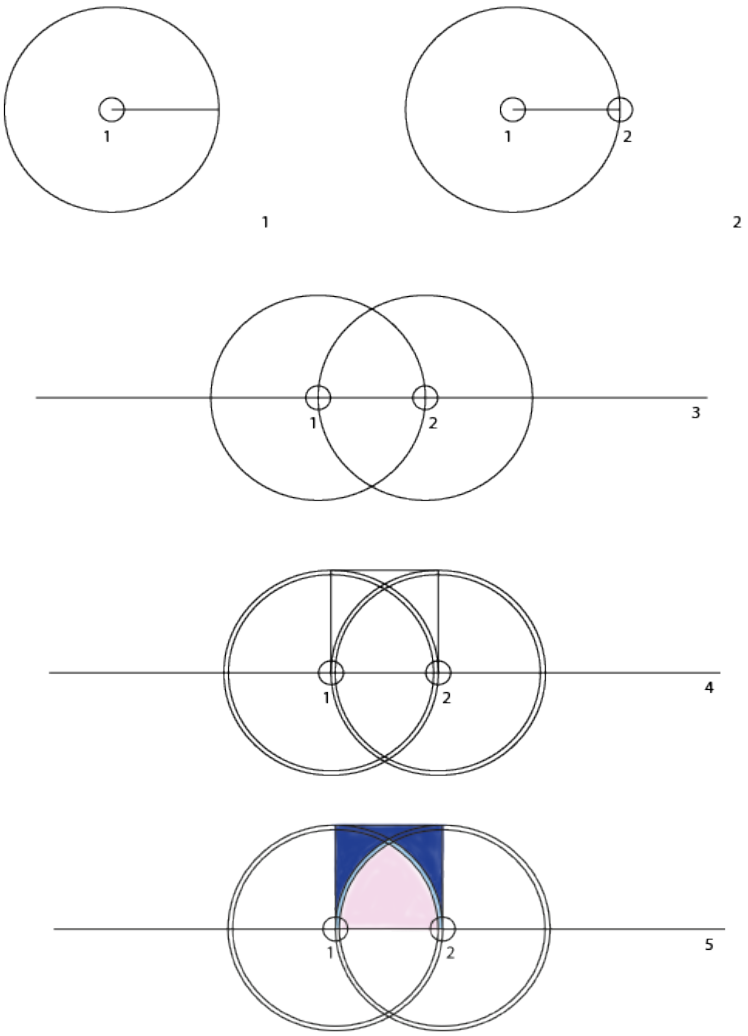


Figure 6.14: Construction of pointed, equilateral arch

The significant thing about portion 1 is the quarter dome #1B and vaulted muqarnas #1C. There are small panels underneath the muqarnas #1D and an arabic calligraphy panel #1E. This is the only panel that is not symmetrical since it is text. The placement of it is directly above the door and that is another traditional element of mosques. The door itself is constructed with a pointed

arch panel #1F. This feature is repeated within this mosque and the Shah mosque as well. On the right side of the door, a pointed arch panel is situated #1G perpendicular to #1H.

The second portion of the wall #2 includes a square #2A, an arched panel #2B, a second square panel #2C and a second arched panel #2D. The division and the proportions are consistent in that portion. The arched panels follow the same construction of the pointed arch highlighted in figure 6.14. The third portion of the wall includes functional elements, it starts with a patterned window #3A followed with an arched panel that includes two pattern windows #3B. These types of windows allow a limited amount of light in. Underneath is a rectangular panel #3C. That wall portion ends with a square arched panel #3D above the door. The third portion of the wall is not as consistent compared to portion #2, but it is symmetrical to side B and that creates harmony in design.

The organisation and the designated spaces were already present, but the tiles - and Isfahan in general- were neglected and the massively deteriorated according to accounts from European travellers from the 18th century, who were very disappointed in the Isfahan that welcomed them after reading travel accounts of the 16th and 17th century that regarded it highly (Philipp, 1984). In figure 6.15, the Sheikh Lutf Allah does not have any exterior panels. The restoration works are unclear and there are no English documents that clearly outlines the process the tiles undertook.

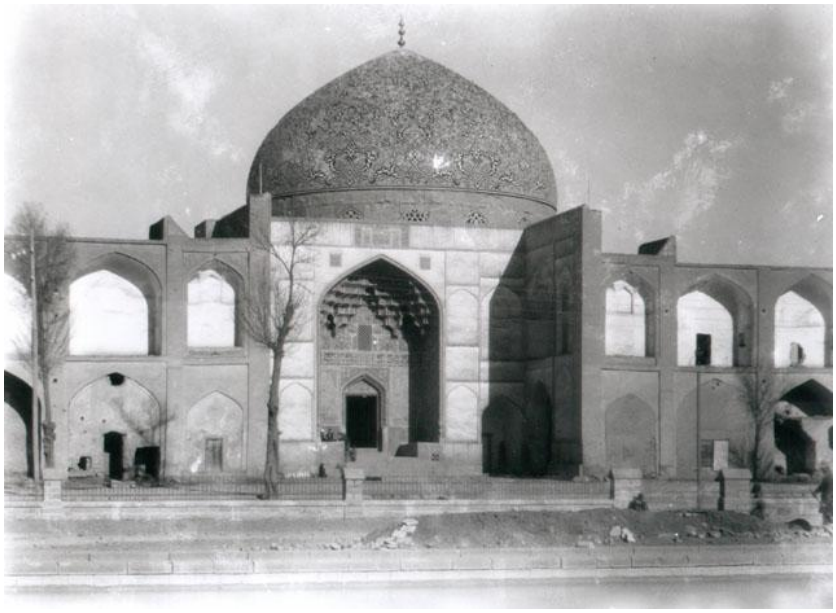


Figure 6.15: Sheikh Lutf Allah's Mosque exterior in early 1930s (Byron, 1933).

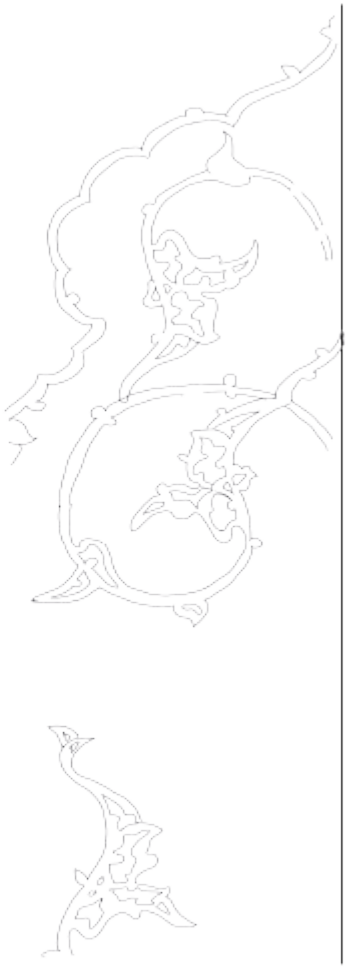
Therefore, the analysis will focus on the interior tiles in the mosque since they are the most authentic part of the mosque that have remained with minimal destruction. The analysis will start with the bilateral symmetry inside the portal of the mosque with three examples and then the prayer chamber walls.

6.3.2.2 First portal wall

Figure 6.16: Step one of wall portal analysis.

Step 2: Highlight the islimi shapes on the line of symmetry (midline).

Step 3: Arrange the primary islimi spiral around the shapes to fill the space



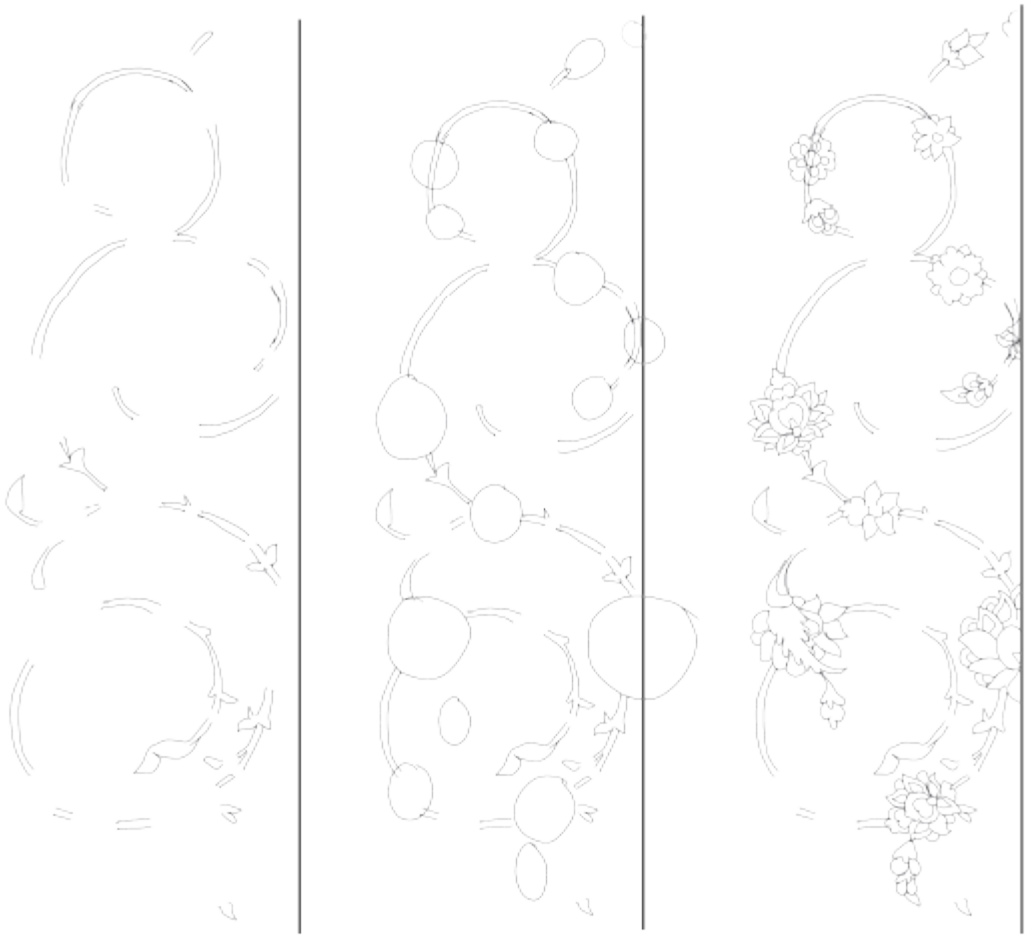
The central islimi shapes in step 2 act like the spine of the design and they are also the starting point of the primary islimi spiral. Sometimes, the islimi spirals extend beyond what is seen on the panel such as the bottom shape in step 3 to symbolise continuity.

Figure 6.17: Steps 2 and 3 of the wall portal analysis.

Step 4: Arrange the secondary floral spiral

Step 5: Choose floral placements on the secondary spiral

Step 6: Place the flowers on the secondary spiral



All the floral elements do not compromise the geometry of the spiral. However, they vary in scale. Note the two main flowers on the midline, where the secondary spirals emerge from, they are positioned and focused in line with the core lines of symmetry. These additional elements work together to accentuate and revolve around the islimi shapes highlighted in step 2.

Figure 6.18: Steps 4-6 of the wall portal analysis..

Step 7: Put all the layers together to create the full pattern, then mirror it.

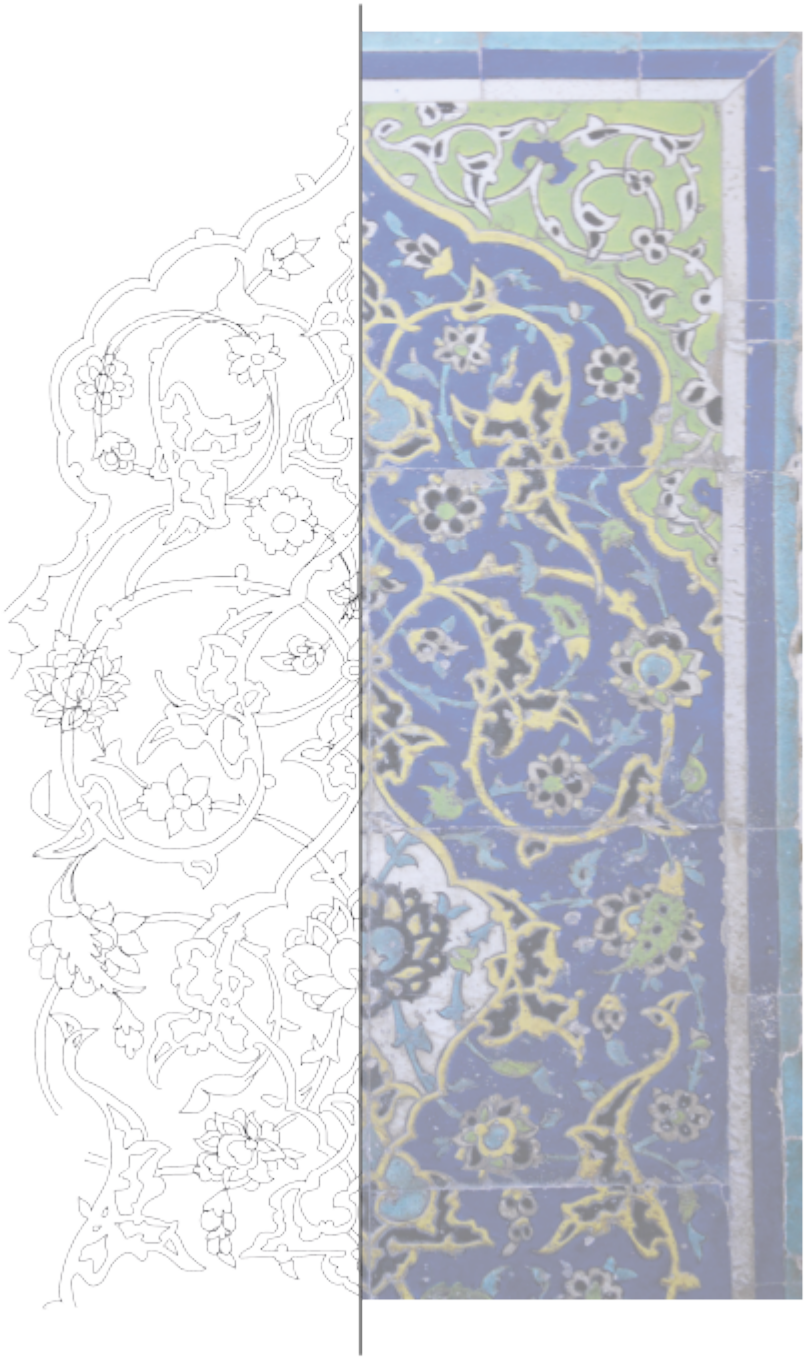


Figure 6.19: Completed portal analysis.

6.3.2.3 Second Portal Wall

The second wall to be analysed is another wall from the portal section of the mosque is one under an arched top. It follows the same bilateral symmetrical approach of the previous pattern, but it also works within a larger pointed arch. The starting point is the same with islimi motif on the central line.

Figure 6.20: Second portal wall in the portal area of Sheikh Lutf Allah's Mosque.

Step 1: This arched panel has a line of symmetry in the middle of the pattern coming from the mid point of the arch and on it there are four elements: flower, crown shape islimi and two cloud collar motifs. The last three are framing shapes.

Step 2: The islimi shapes are filled with another set of smaller islimis on the same line of symmetry such as medallion and crown shapes. Adding more elements allows colour to be implemented in more ways.

Step 3: Simple islimi branches are extended from the central motifs within the islimi frames. There are simple and small islimi spirals as well with the pelmet usually placed at the end.

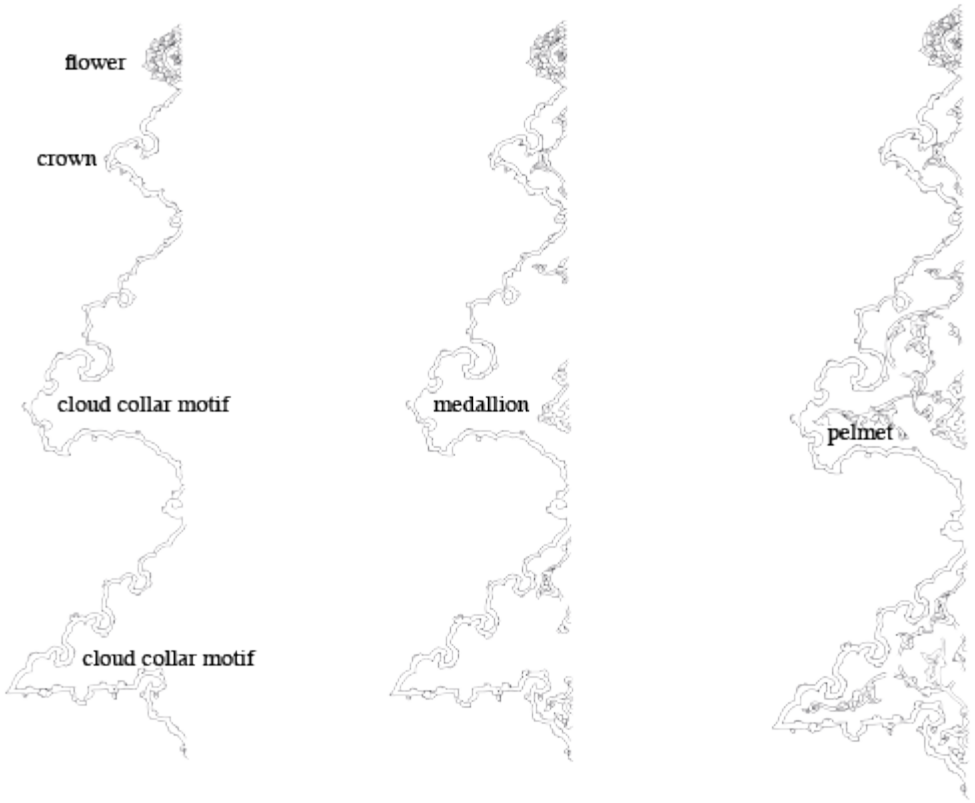


Figure 6.21: Step 1 to 3 in the second portal wall of Sheikh Lutf Allah's Mosque.

Step 4: The islimi spiral starts from one point (highlighted on the drawing) and from there, seven spirals emerge. It is painted in white, a contrasting colour to the dark blue background. Although it is an islimi spiral, the endings are not the regular islimi pelmet. Instead, they are large elaborated leaves. The leaves at the end of spirals are more elaborate and they almost look like feathers with their toothed edges rather than just a botanical leaf. This might be coincidental, but this shift might have been prompted by the changing taste trends that appreciated the Chinese style of the presented birds and clouds, which is especially documented in pottery (Golombek,

2003) and (Watson, 2004). Before each spiral split, a connective islimi is placed. They are highlighted with a circle on the drawing. Every connective element is repeated at least twice. A and D are the same shape, B and F are the same shape with a very small difference within the inner parts of the shape. C, E and G are also the same with minor differences.

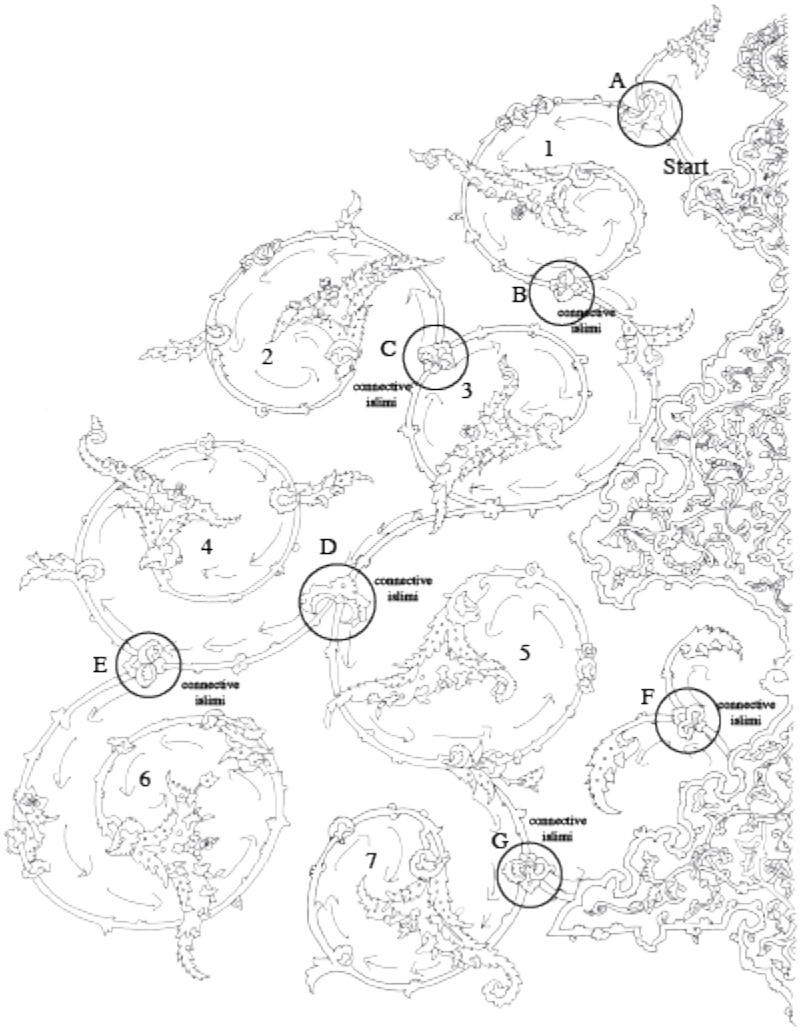


Figure 6.22: Step 4 in the second portal wall of Sheikh Lutf Allah's Mosque.

Step 5: The floral spiral also has one starting point highlighted on the drawing. It starts from the only flower on the midline. The floral spiral is secondary to the islimi and is situated behind it in

a light blue colour that is almost merging into the dark blue background colour of the tile. The direction of it follows the islimi spiral and that provides overall harmony for the design.

Figure 6.23: Step 5 in the second portal wall of Sheikh Lutf Allah's Mosque.

Step 6: The flowers are added into the floral spiral and they differ in size. The biggest ones tend to be placed in between the islimi spirals.

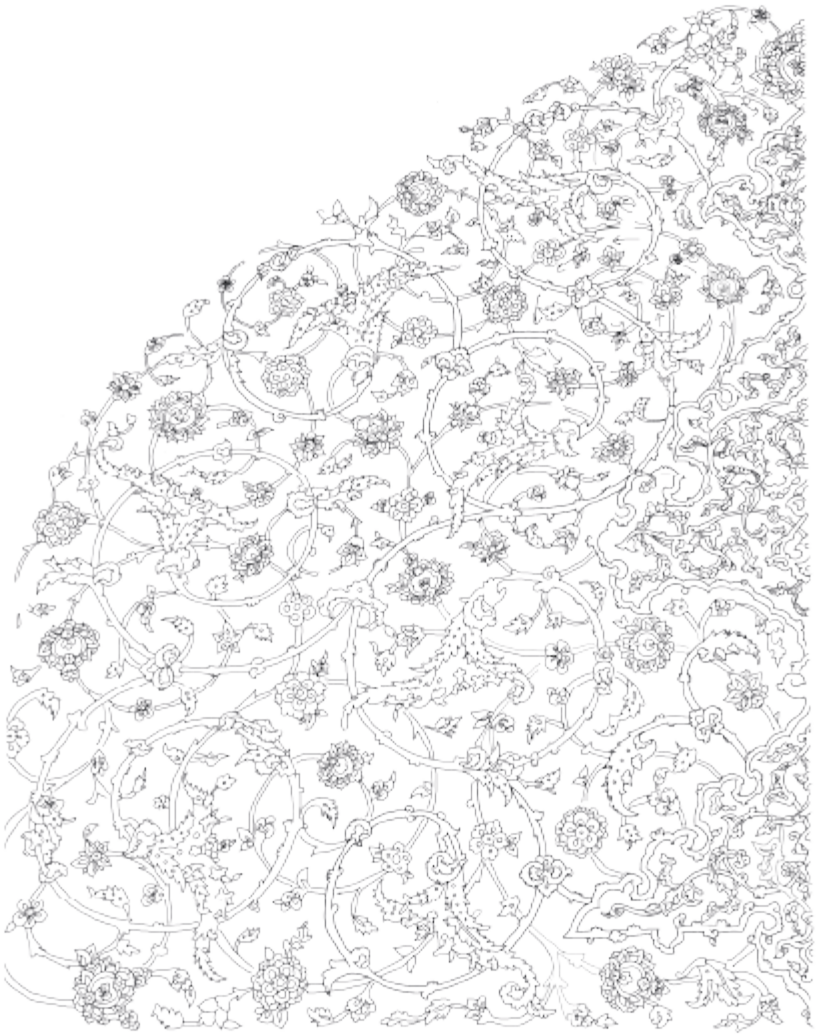


Figure 6.24: Step 6 in the second portal wall of Sheikh Lutf Allah's Mosque.

6.3.2.4 Third portal wall

This third wall inside the portal is the lower band of the wall and it is a rectangular strip that is mirrored horizontally and vertically (figure 6.25). This band extends in the portal on both sides: left and right. Before starting the design analysis, the repeat unit has to be identified and I have highlighted it in figure 6.26. The repeat unit include the design section and the mirrored section and this analysis will focus on the design section.

Figure 6.25: Third portal wall in Sheikh Lutf Allah's Mosque (Alhamal, 2015).

Step 1: The design section is made of a rectangle and all four lines of symmetry are used to generate the design. The vertical lines are the starting point for a quarter of a medallion shape. The inner components and the framing styles make them different from each other. However, the overall shape is the same. The upper horizontal line is a starting point for a horizontal medallion.

Figure 6.26: Step 1of the third portal wall in Sheikh Lutf Allah's Mosque.

Step 2: Additional floral elements are placed on both of the horizontal lines and they are the starting points for other floral elements.

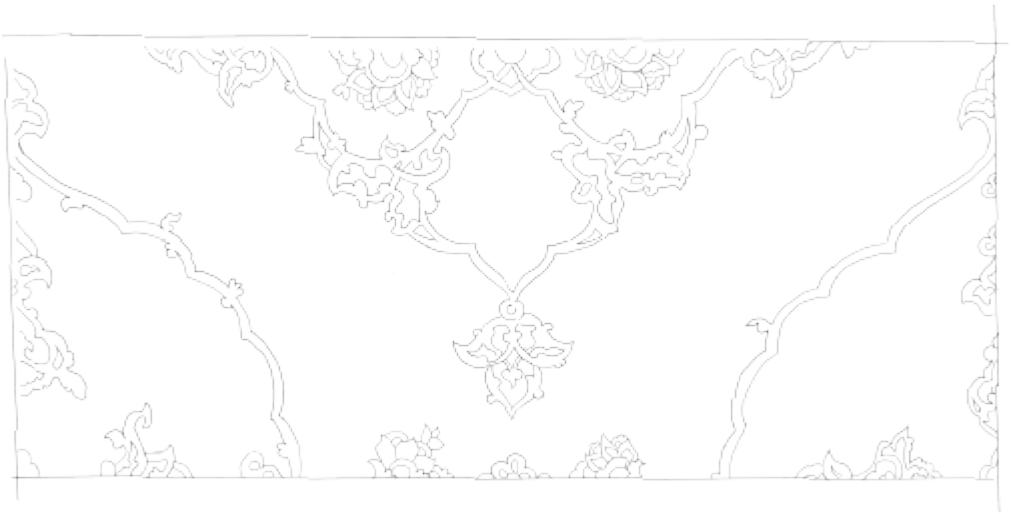


Figure 6.27: Step 2 of the third portal wall in Sheikh Lutf Allah's Mosque.

Step 3: The vertical medallion shapes are filled with simple islimi shapes and curves that connect the shapes that were added to the vertical and horizontal midlines. Shapes within biomorphic patterns are not left to float and they are usually connected to each other.

Figure 6.28: Step 3 of the third portal wall in Sheikh Lutf Allah's Mosque.

Step 4: Floral spirals are added to fill the space between the medallion shapes.

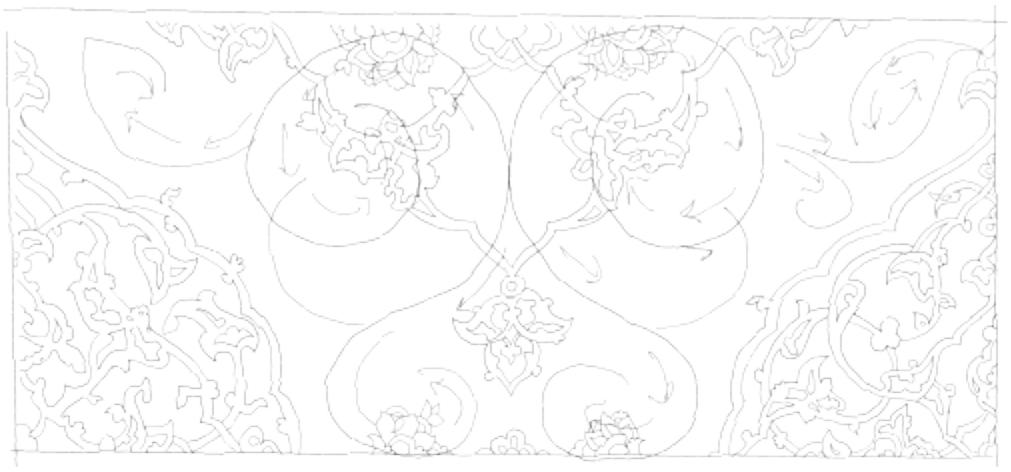


Figure 6.29: Step 4 of the third portal wall in Sheikh Lutf Allah's Mosque.

Step 5: Natural elements such as leaves are added to the spirals, but leaving space for flowers.

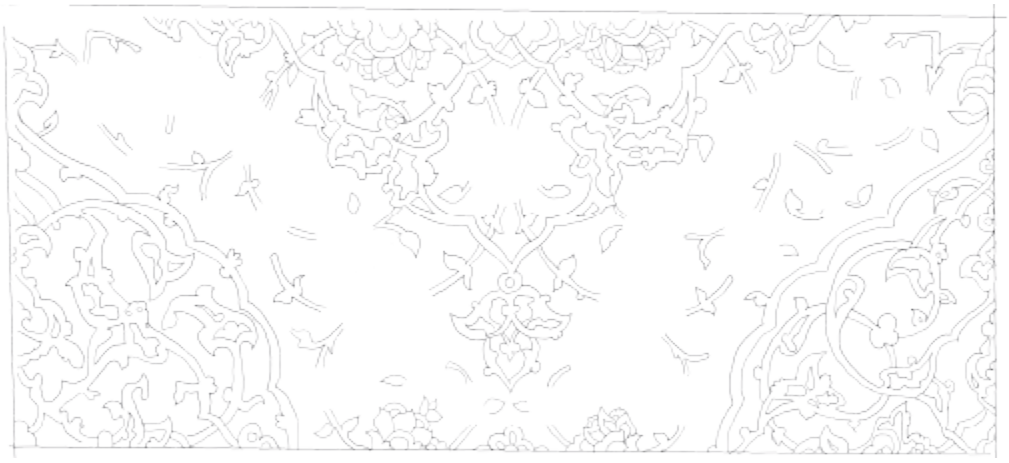


Figure 6.30: Step 5 of the third portal wall in Sheikh Lutf Allah's Mosque.

Step 6: Flowers are added in between the leaves and follow the same direction as the spiral.

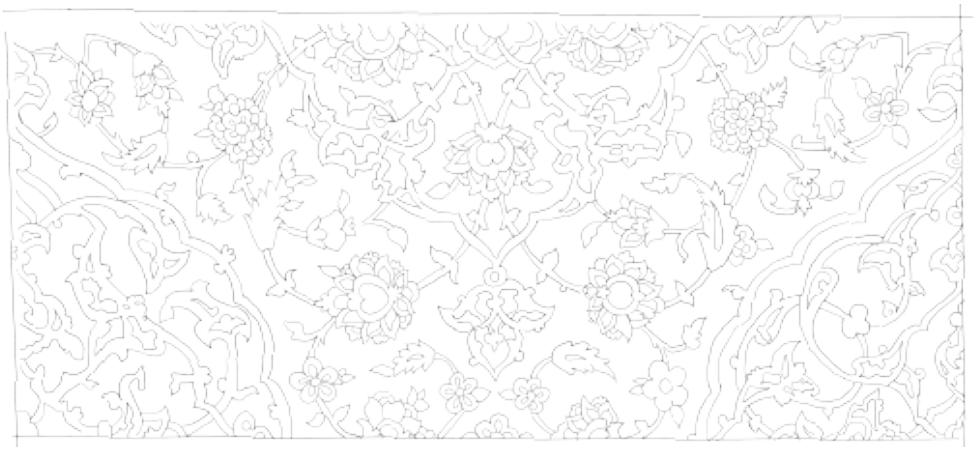


Figure 6.31: Step 6 of the third portal wall in Sheikh Lutf Allah's Mosque.

6.3.2.5 Prayer chamber's lower band

The prayer chamber has four walls with eight divisions creating an octagonal shape in the interior space and figure 6.32 shows the repeating corner and the two additional designs. The corner wall follows rotational symmetry, therefore, it will be analysed in the following section.

Figure 6.32: The wall designs in the prayer chambers (Alhamal, 2015).

However, the prayer chamber also has a lower band that covers the lower part of the wall in most of the space. This band is over a meter high as seen in figure 6.33 and indicated by the person sitting against it and the hat placed on the floor. The following analysis is for the wall band.

Figure 6.33: The lower wall band in the prayer chambers (Alhamal, 2015).

Step 1: Determine the type of symmetry and locate the repeat unit.
The type is bilateral symmetry with one line cutting the whole design creating two mirrored sides

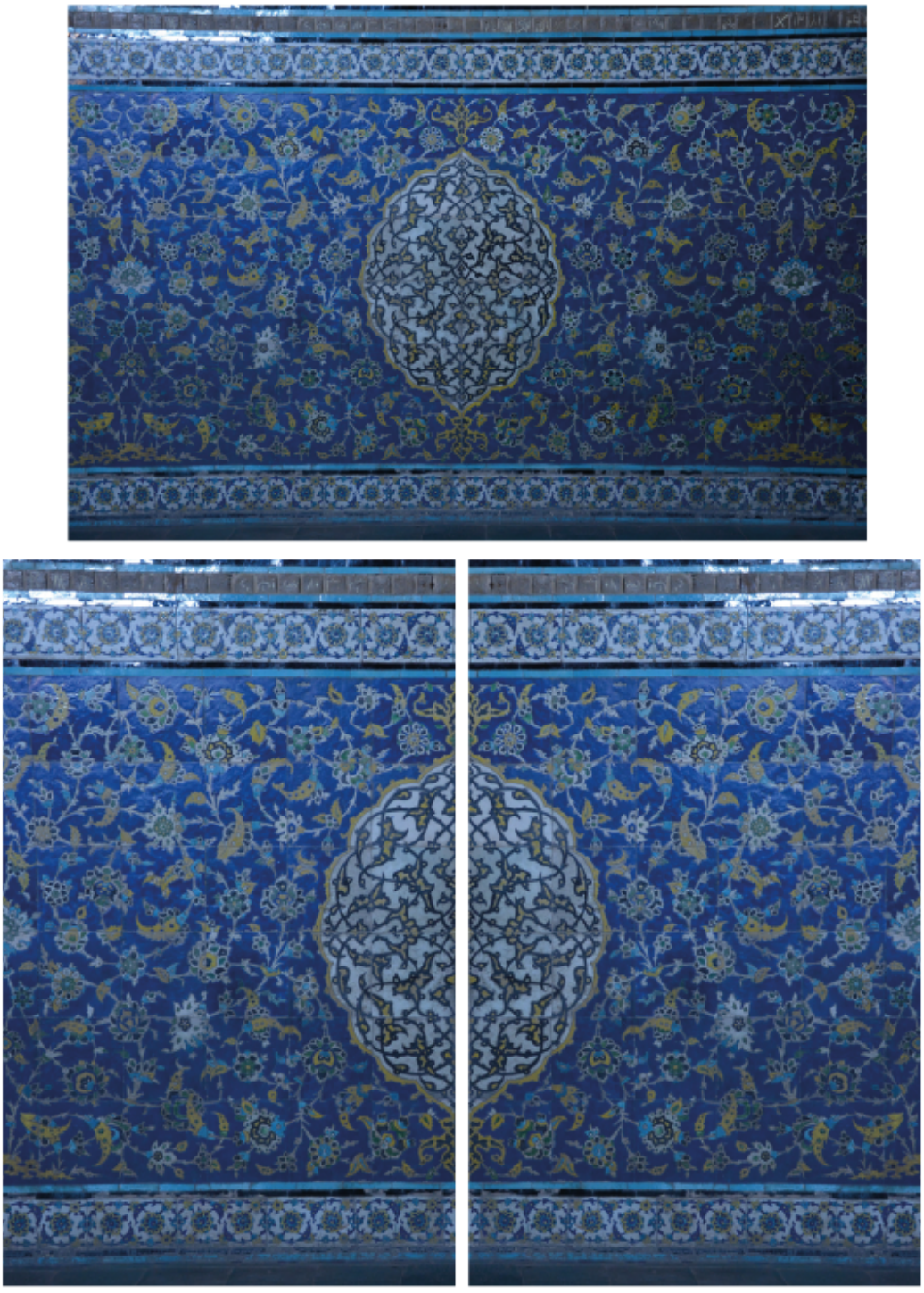


Figure 6.34: Step 1 of analysing the lower wall band in the prayer chambers.

Step 2: Highlight the islimi shapes on the line of symmetry (midline) and there are two lines of symmetry in this design. The line on the right contains the islimi shapes, where the one of the left contains the floral motifs.

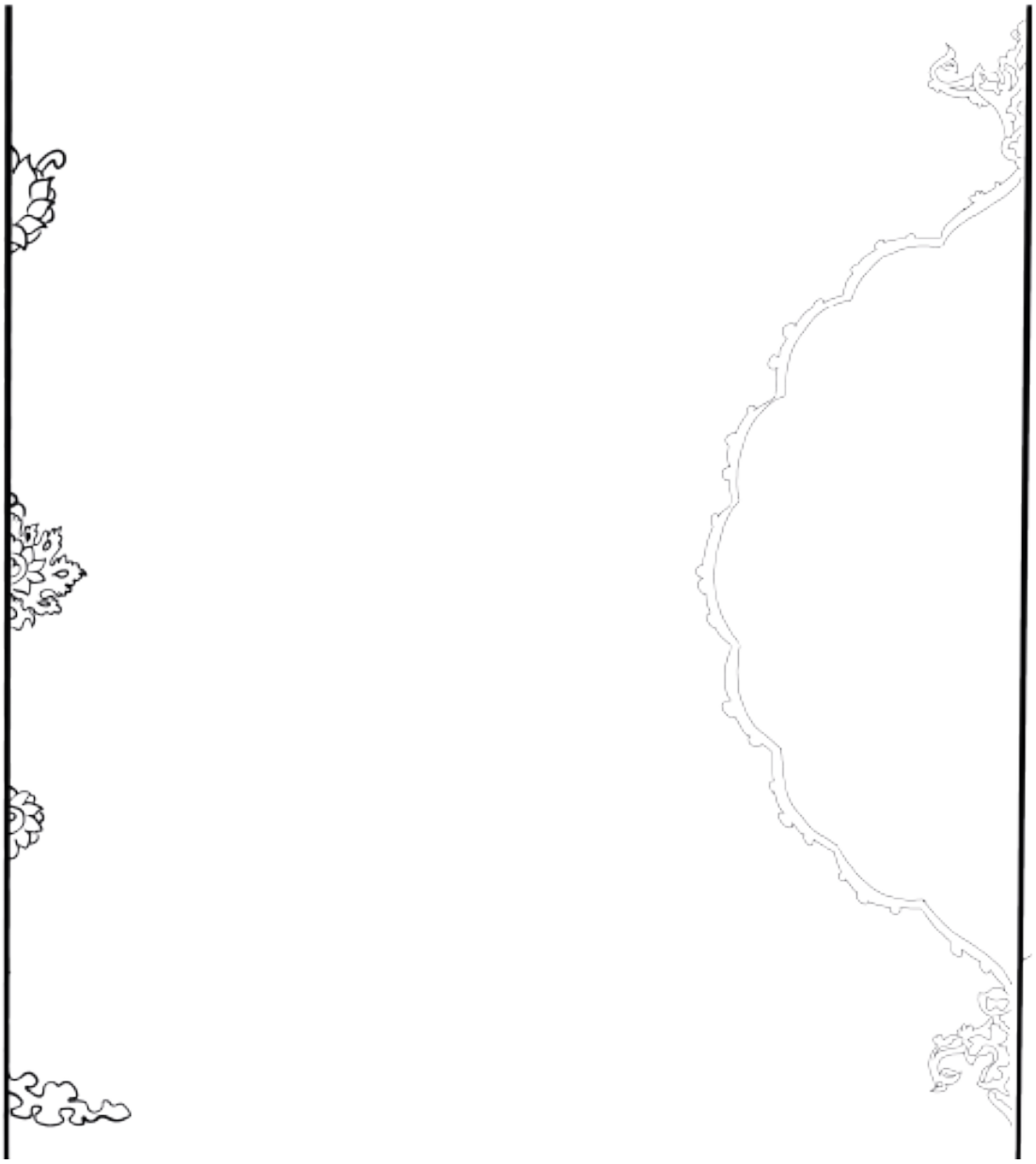


Figure 6.35: Step 2 of analysing the lower wall band in the prayer chambers.

Step 3: The spirals emerge from both symmetry lines on both sides. They also emerge from islimi points and from the flowers places on the symmetry line. There are main geometric spirals, but there are a few drawn free-hand that extend from a flower rather than the spiral origin.

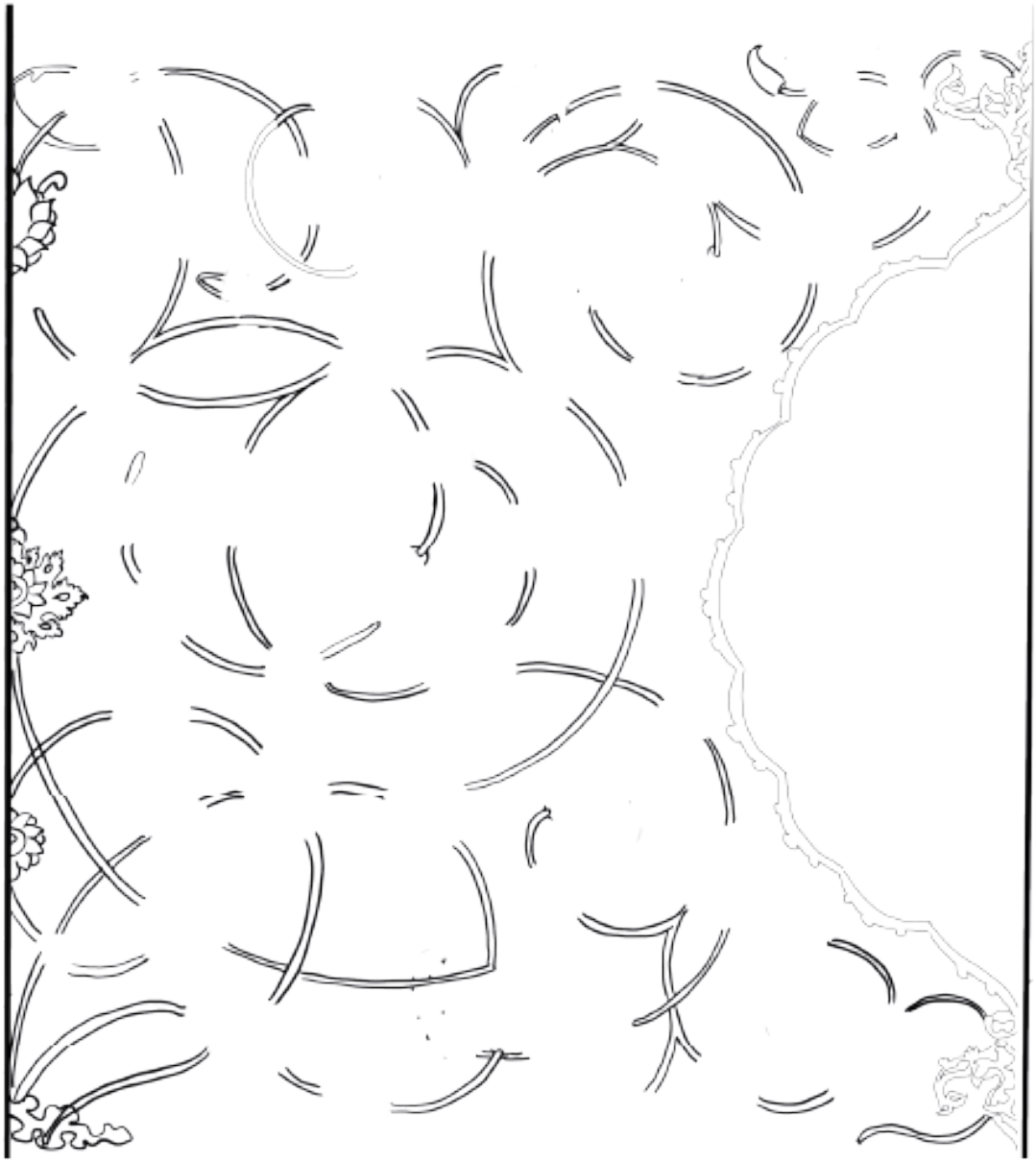


Figure 6.36: Step 3 of analysing the lower wall band in the prayer chambers.

Step 4: Choose floral placements on the spiral. The scale of the flowers change based on the location. There are also very small flowers around the biger ones or smaller ones emerging from the bigger ones to populate the space.

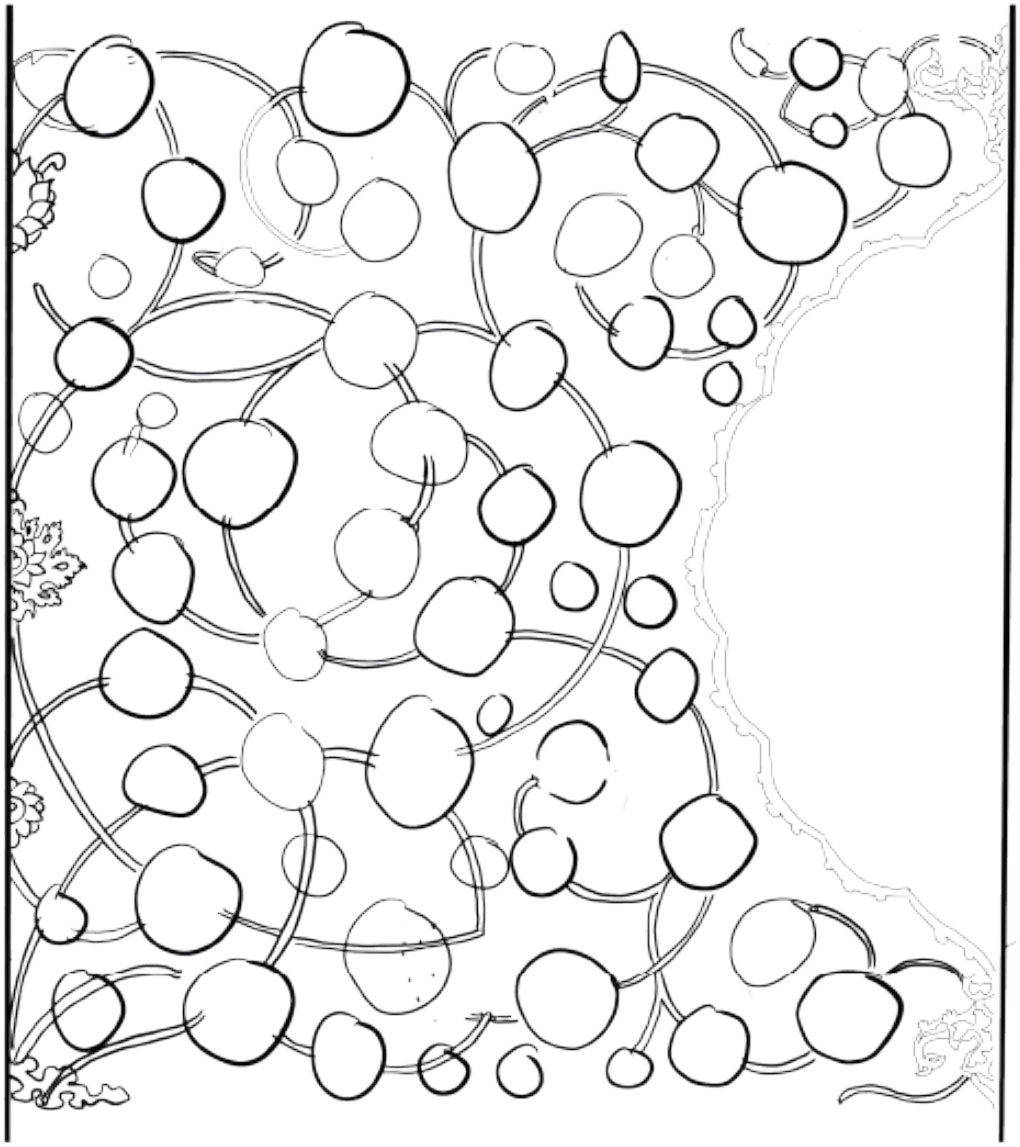


Figure 6.37: Step 4 of analysing the lower wall band in the prayer chambers.

Step 5: The flowers on the spiral follow the direction of the spiral and the directions is moving through out the pattern, but it can be traced with the arrows.

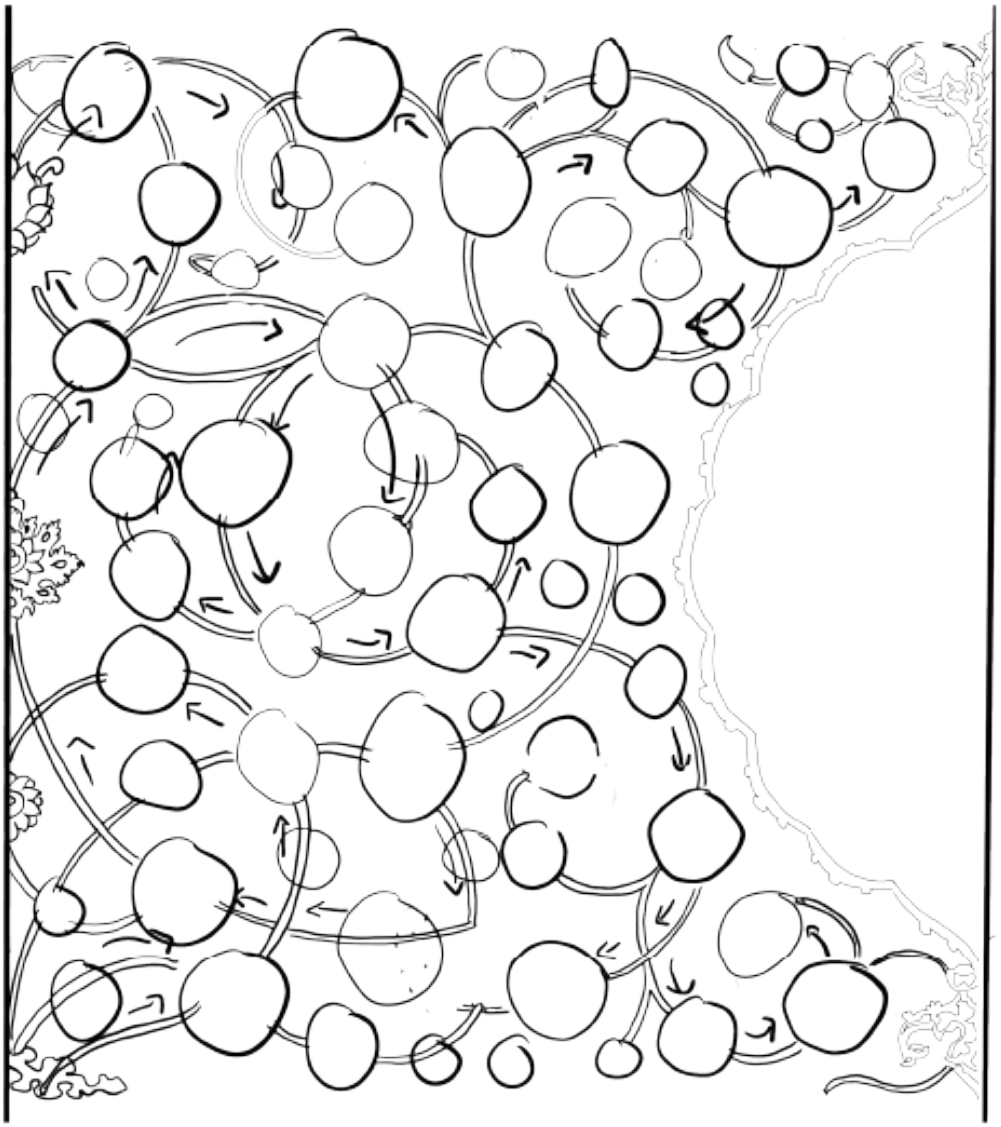
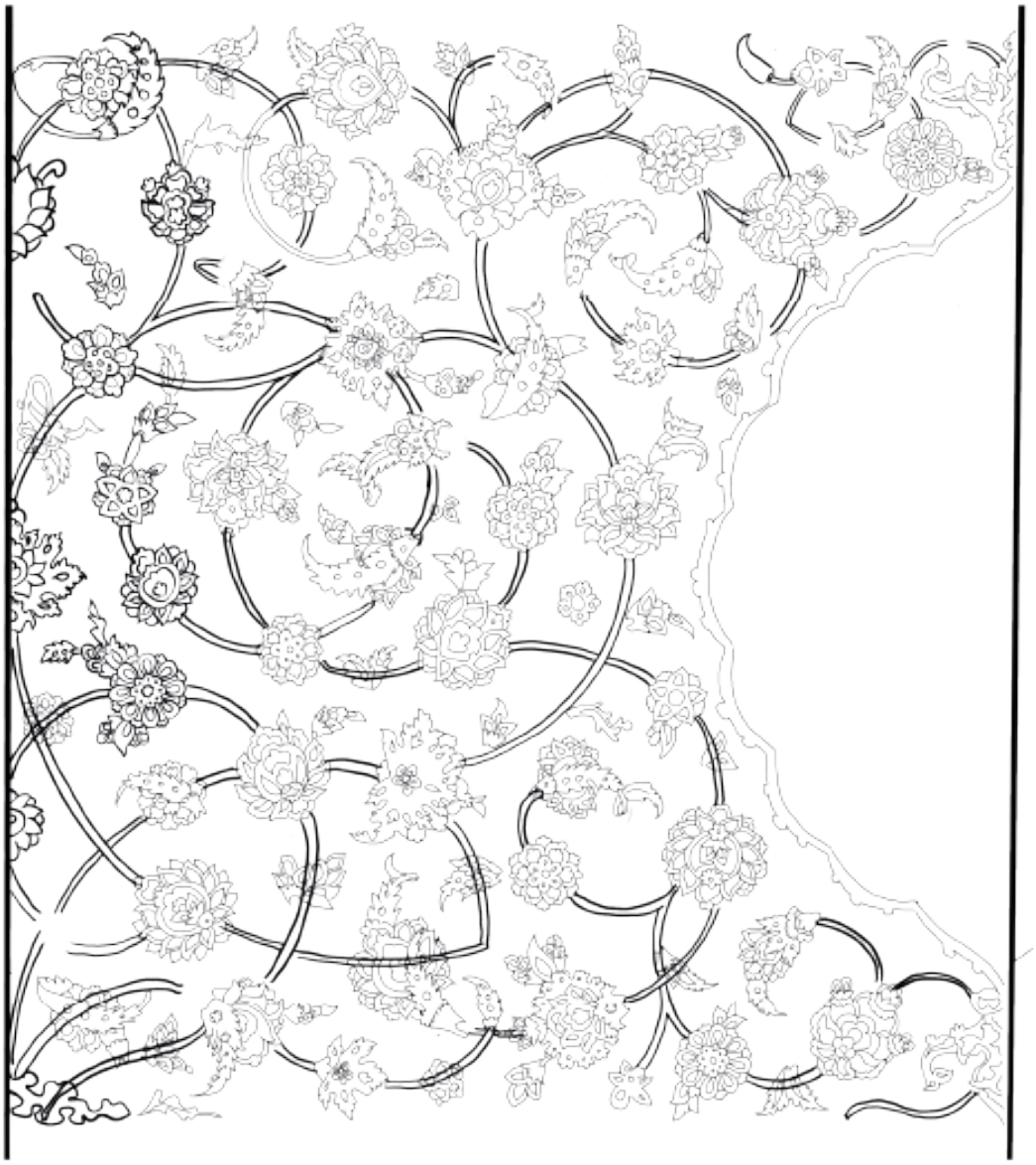


Figure 6.38: Step 5 of analysing the lower wall band in the prayer chambers.

Step 6: When the flowers are placed on the spiral, the biggest ones, are usually in the middle of the spiral rather than the ending. There is a gradual decrease in size when the spiral comes to an end. The spiral is usually finished with smaller buds and elaborate leaves.



The flowers will be individually listed in the motif database, but this unit includes about 65 flowers, which a few designs repeated.

Figure 6.39: Step 6 of analysing the lower wall band in the prayer chambers.

Step 7: The direction of the flowers is important to note as mentioned in step 5, so re-checking the direction with the arrows is important.

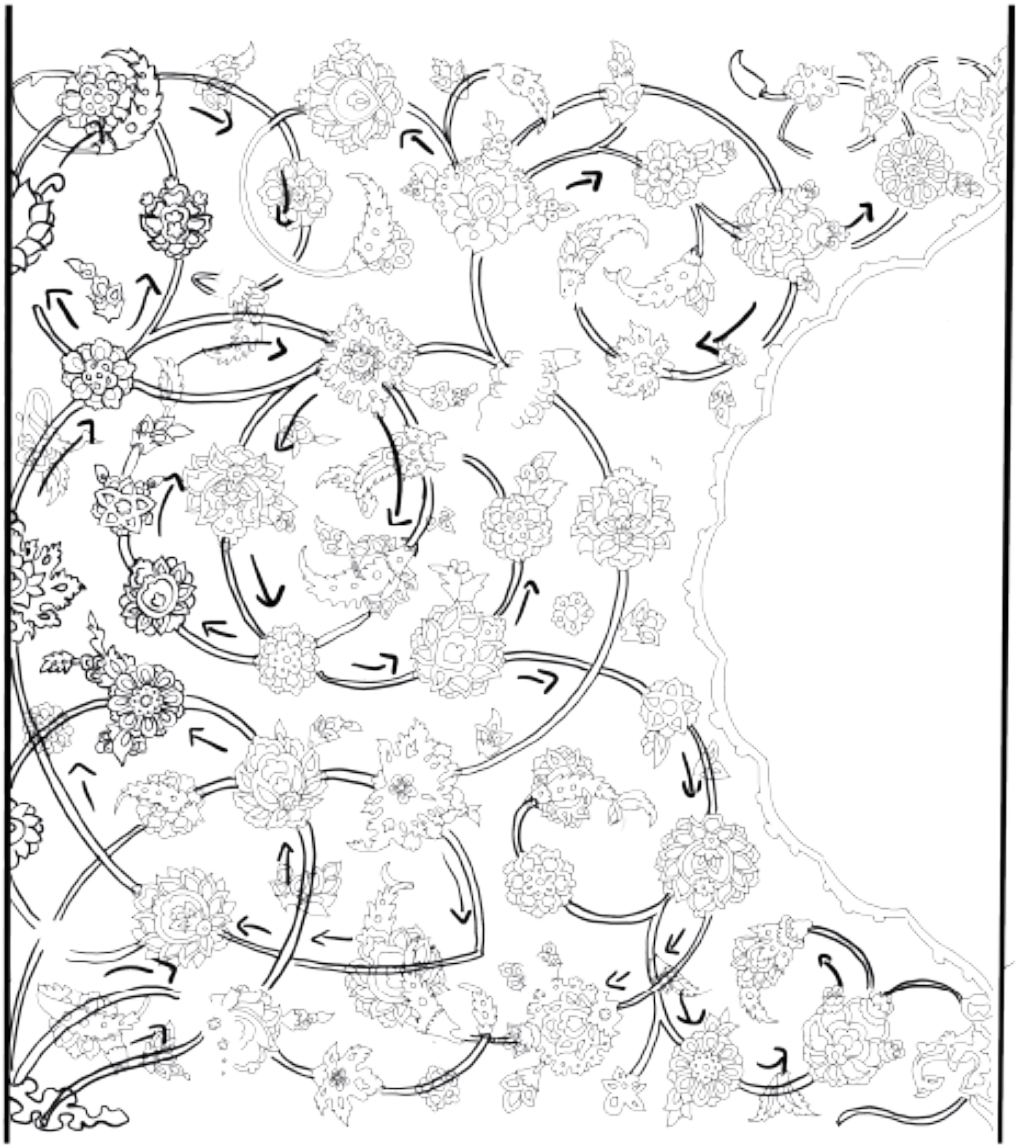


Figure 6.40: Step 7 of analysing the lower wall band in the prayer chambers.

Step 8: Complete the inner islimi motifs inside the islimi shape on the right central line. The inside of the Islimi shape also has its own two lines of symmetry on the X and Y axis.

Step 9: The islimi motifs on the axis line are starting point for the islimi spirals and end of the spiral is a split pelmet.

Step 10: The direction of this islimi spiral is also important and the spiral loop is going inwards.

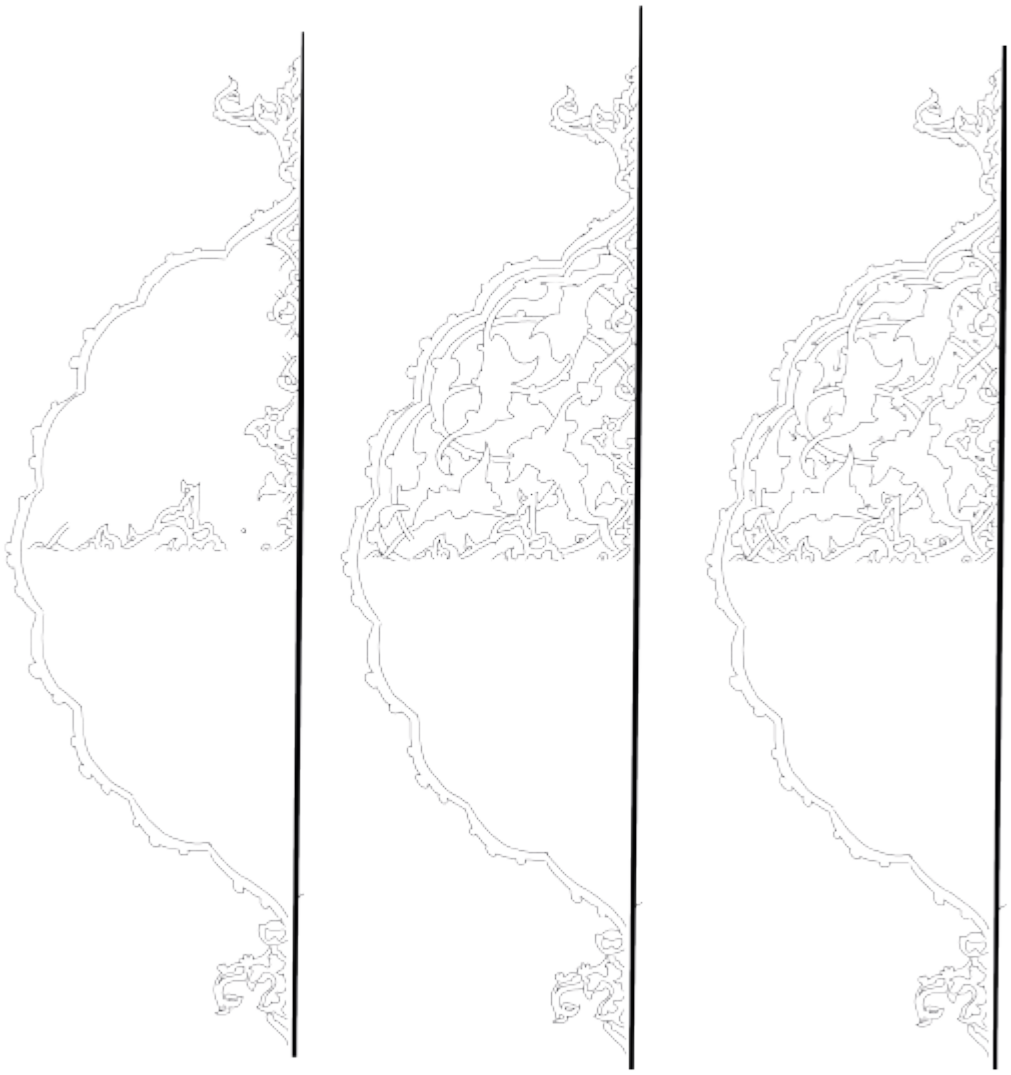


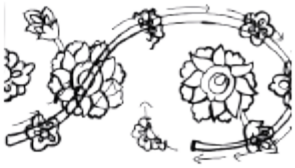
Figure 6.41: Step 8-10 of analysing the lower wall band in the prayer chambers.

Step 11: The islimi motifs are usually not solid and they have empty spaces within to encourage the introduction of other colours.

Step 12: Mirror the designed section to complete the unit.

Step 13: Create the border band above this design and it starts with two interlacing spirals.

Step 14: The placement of flowers follows a specific direction in both and they are opposite from each other, which is a nice motion.



Step 15: Add the big leaves at the end of the spirals and the smaller leaves around the rest of the elements.

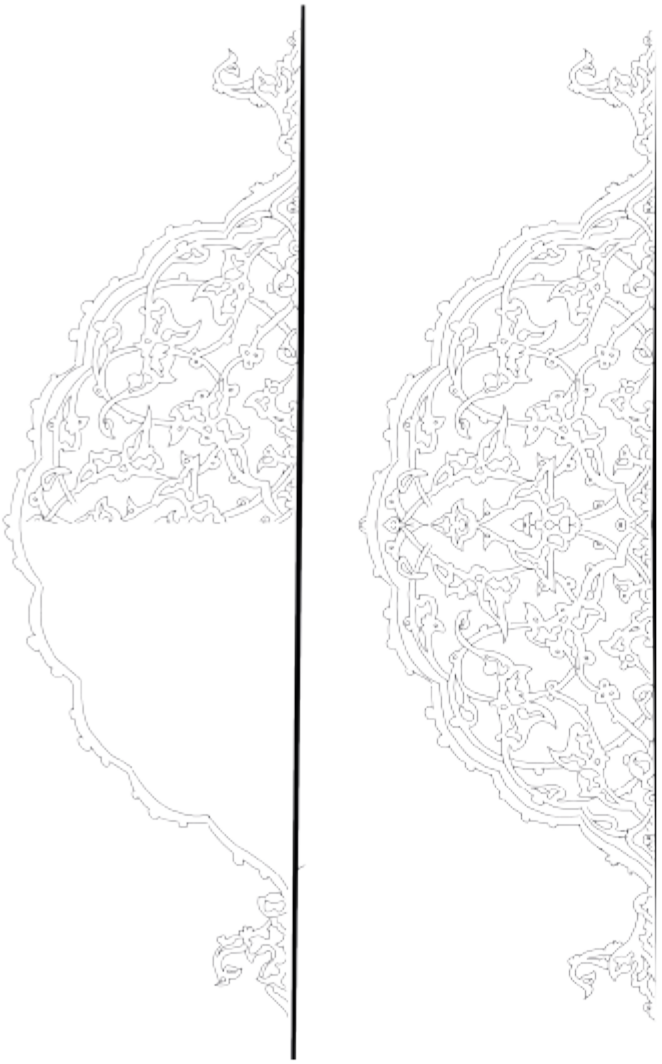


Figure 6.42: Step 11-15 of analysing the lower wall band in the prayer chambers.

Step 16: Put all the elements together to complete the design.

This band wraps around all the walls in the prayer chamber. The ceramic technique used in this band is the seven-colours, which have sped up the process, but everything was painted by hand hence the number of years that took to completing this.

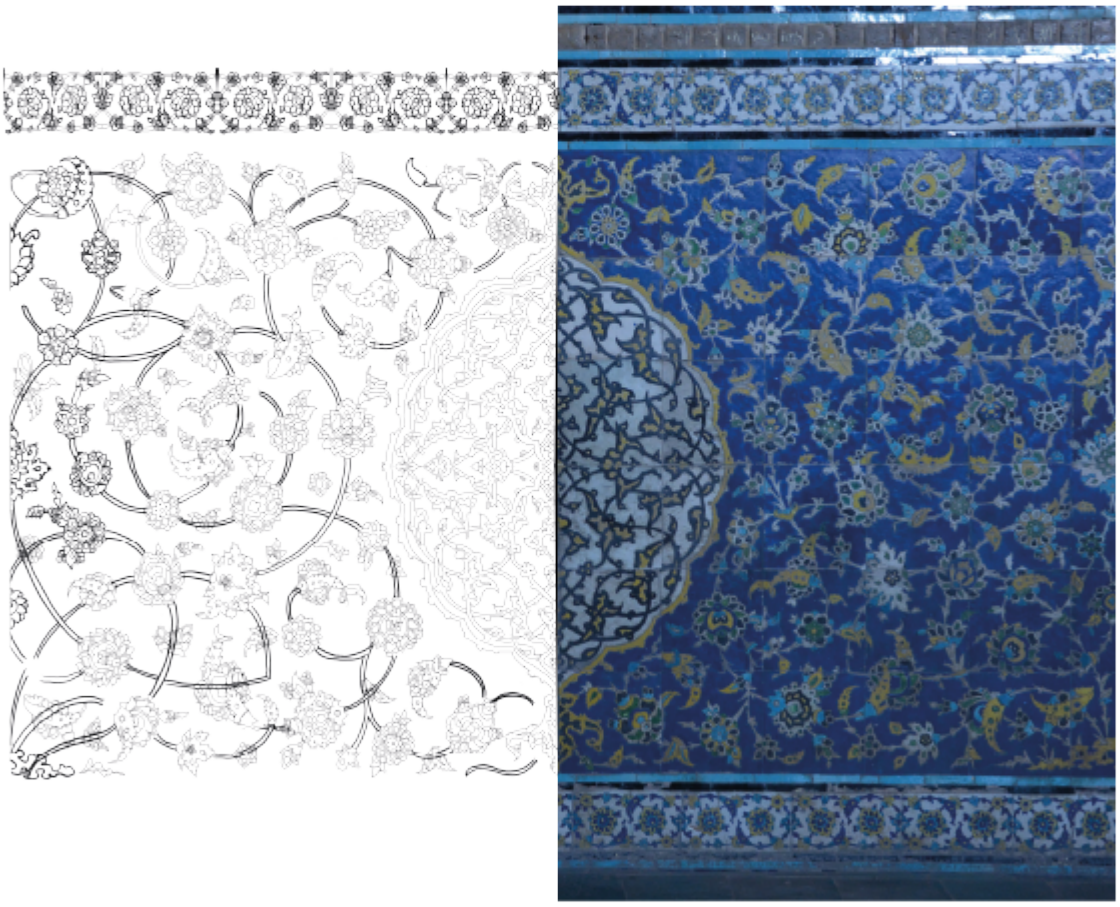


Figure 6.43: Step 13 of analysing the lower wall band in the prayer chambers.

6.3.3 Designs with rotational symmetry

There are four rotational symmetry designs in Sheikh LufAllah Mosque that will be analysed in this section. Two designs appear in the two portal domes, one on the prayer chamber's wall and the large dome topping the prayer chambers. The portal has a total of six domes, but only two designs are repeated and Figure 6.44 illustrates these two designs. The composition of the centre

in a circular design is known as *shamsah* شمسة meaning small sun making the rest of the elements in the design as the sunrays.

Figure 6.44: Inside the portal in Sheikh Lutf Allah Mosque (Alhamal, 2015)

At first glance, the domes look alike because they are executed in the same colour. However, at a closer inspection, there are two designs and both include a central star with a smaller islimi design and surrounded by a bigger mixed design. The first portal dome is made of a twelve-pointed star, which is a variation of the six-pointed star whereas the second portal dome is made of a sixteen-pointed star and that is a variation of the eight-pointed star. It is interesting to point out that the first portal dome is very floral unlike the second portal dome, where the islimi shapes are more prominent.

6.3.3.1 First portal dome

The first portal dome follows the six-pointed star construction and provides six design units that are divided into 12 sections. Since the geometric construction has been explained in 6.2.1.1, the analysis will discuss the design section.

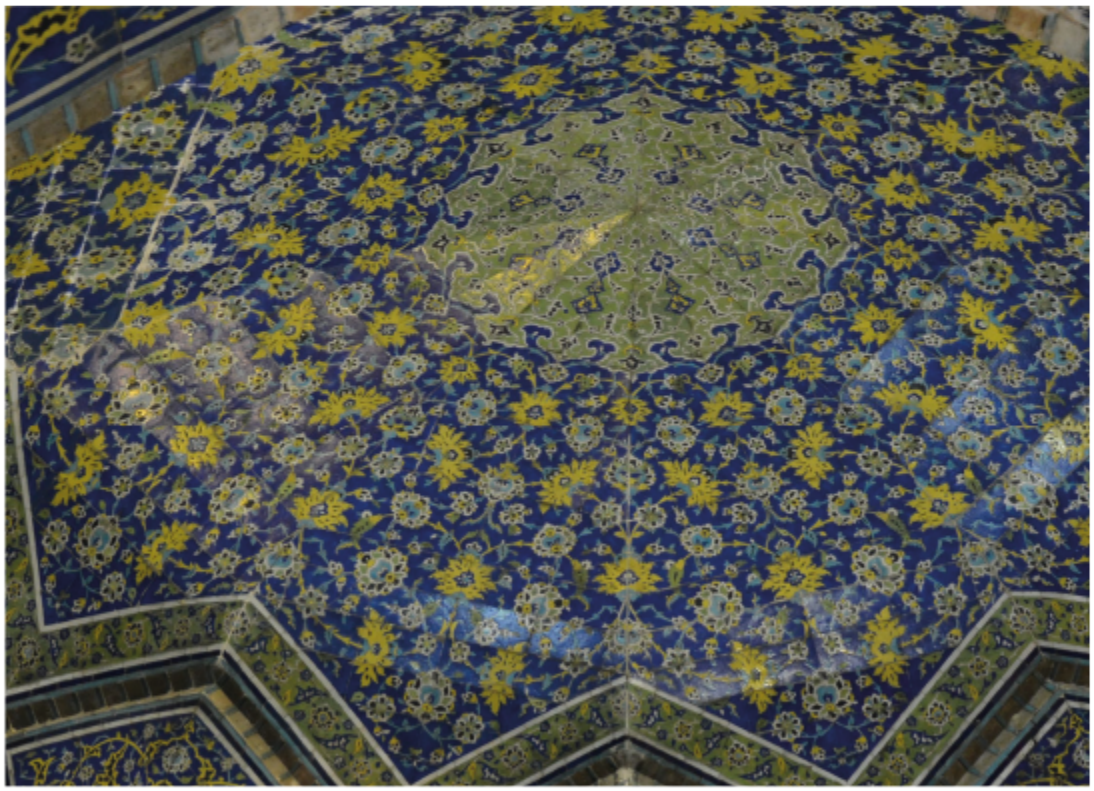
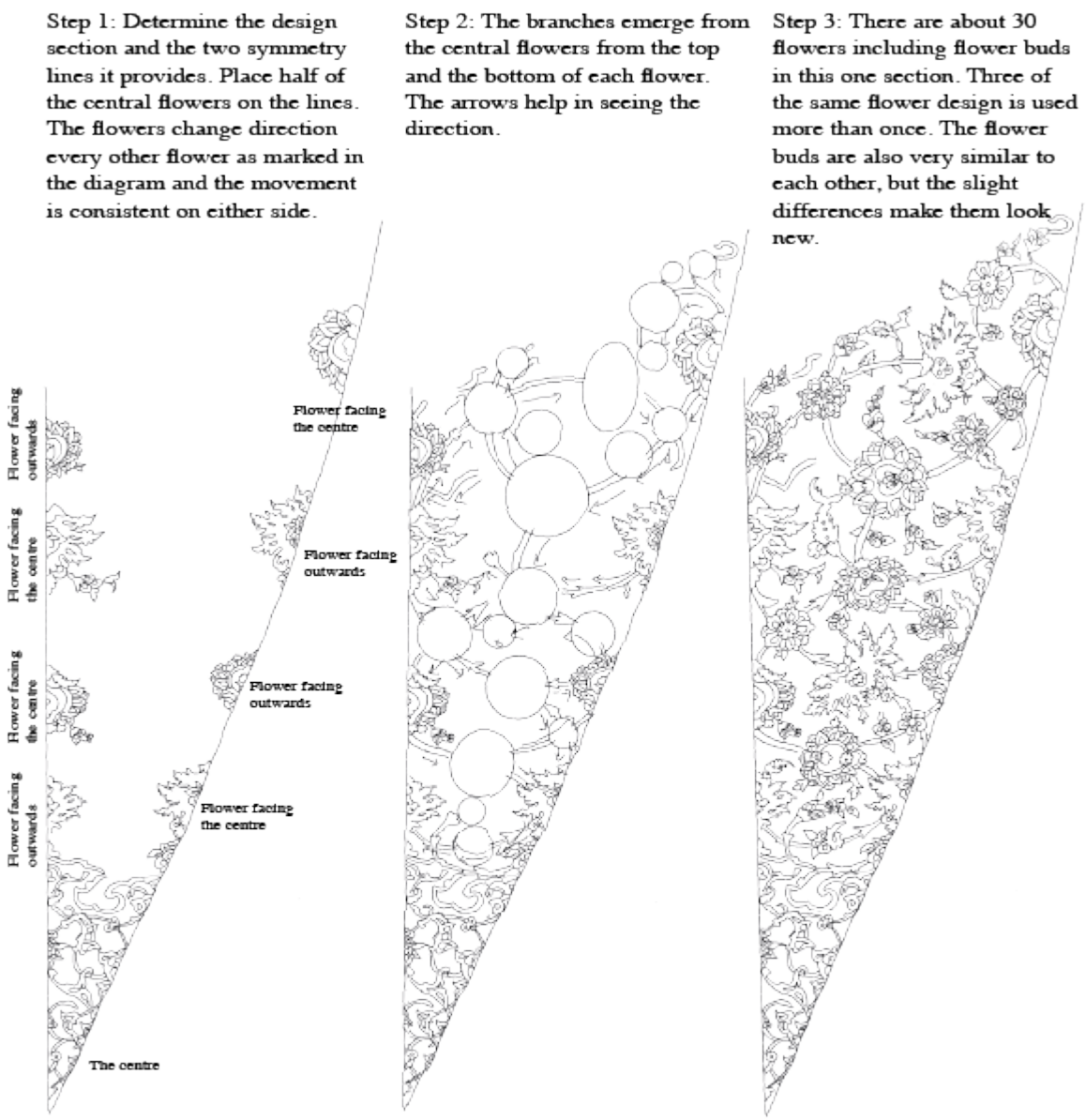


Figure 6.45: Closeup of the first portal dome pattern (Alhamal, 2015)



The border of this pattern is drawn differently since it is place on a three-dimensional place hence the shape. The repeat unit begins with two flowers on the symmetry line (A & C) and one in the centre of the space (B). There is one spiral that starts from A, passes by B and end after passing C. The spiral passes in the centre of each flower. There is a branch the comes out of B with a reflected S shape and that adds to the complexity of a very simple design.

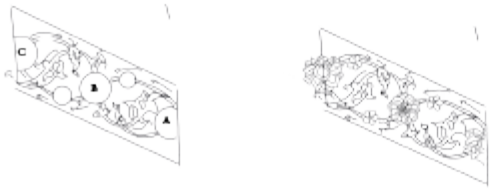


Figure 6.46: First dome portal analysis.

6.3.3.2 Second portal dome

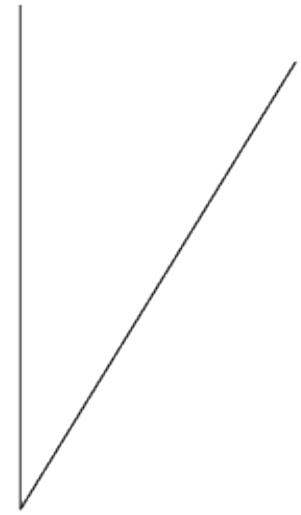
Step 1: Determine the type of symmetry.
This dome's pattern follows rotational symmetry and it is based on an twelve-pointed star, which can be a variation from the six-pointed star construction.

However, it is executed differently from two dimensional twelve-pointed stars since this is a three dimensional space

The pattern will be analysed in two stages. First, the smaller central star pattern will be analysed and then the larger one around it.

Figure 6.47: Step 1 of the second portal dome pattern.

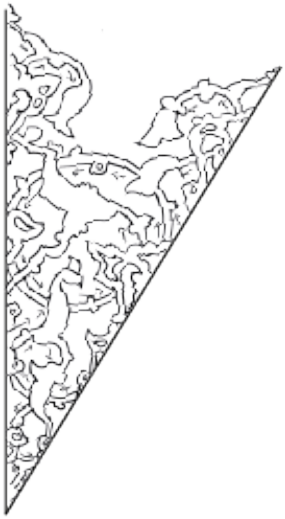
Twelve-pointed star patterns give us twelve sections by default and only one of which is designed. Then it is mirrored to create a full design unit and that unit is repeated six times to give us the full 12 sections. It is interesting to highlight, that rotational patterns provide two lines of symmetry instead of the one that bilateral patterns provide.



Step 2: Highlight the design section and place Islimi motifs on both central lines.

Step 3: Connect the central islmi shapes to each other and these connections can be done with a spiral and other islimi shapes.

Step 4: Note the direction of the connection. The direction is usually outward and then inward.



Step 5: Islimi shapes are not usually solid and they have spaces within them for colours.

Step 6: Add a frame around the islimi shapes. The frame usually changes from one pattern to the other. In this one, the frame has a dip downwards in the middle space.

Figure 6.48: Step 2-6 of the second portal dome pattern.

Step 7: Highlight the same previous section and start in the same way with adding the central elements on both midlines of the section.

Step 8: Connect the motifs from either sections and these connections are similar to the central star previously analysed with one spiral.

Step 9: Add the appropriate inner spaces within the islimi shapes and do not leave them solid.

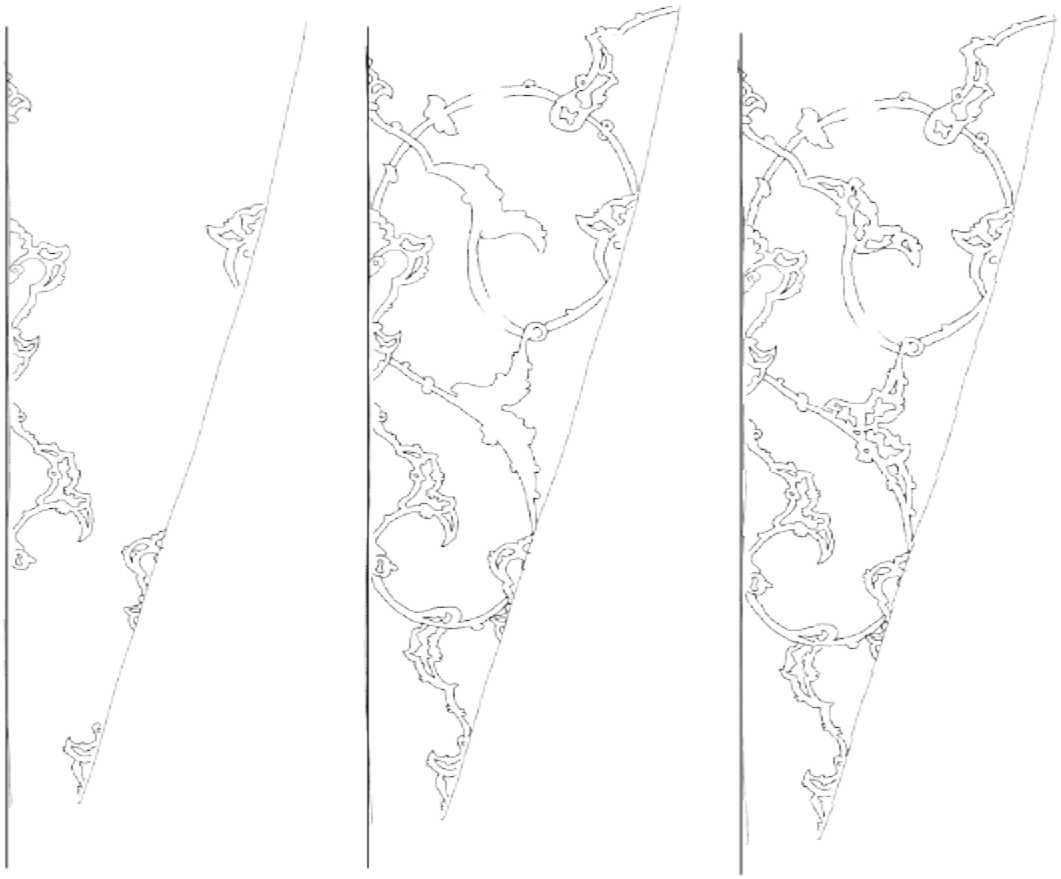


Figure 6.49: Step 7-9 of the second portal dome analysis.

Step 10: The direction of the connection is important and in this case there are two directions, where other islimi shapes emerge from and that from the top upwards and from the bottom downwards.

Step 11: Add the central floral motifs in between the islimi and they will be the starting points for the next step.

Step 12: The secondary floral spiral will emerge from the central flowers on either side of the section. Keep in mind the direction of the flowers and the placement of them as well.

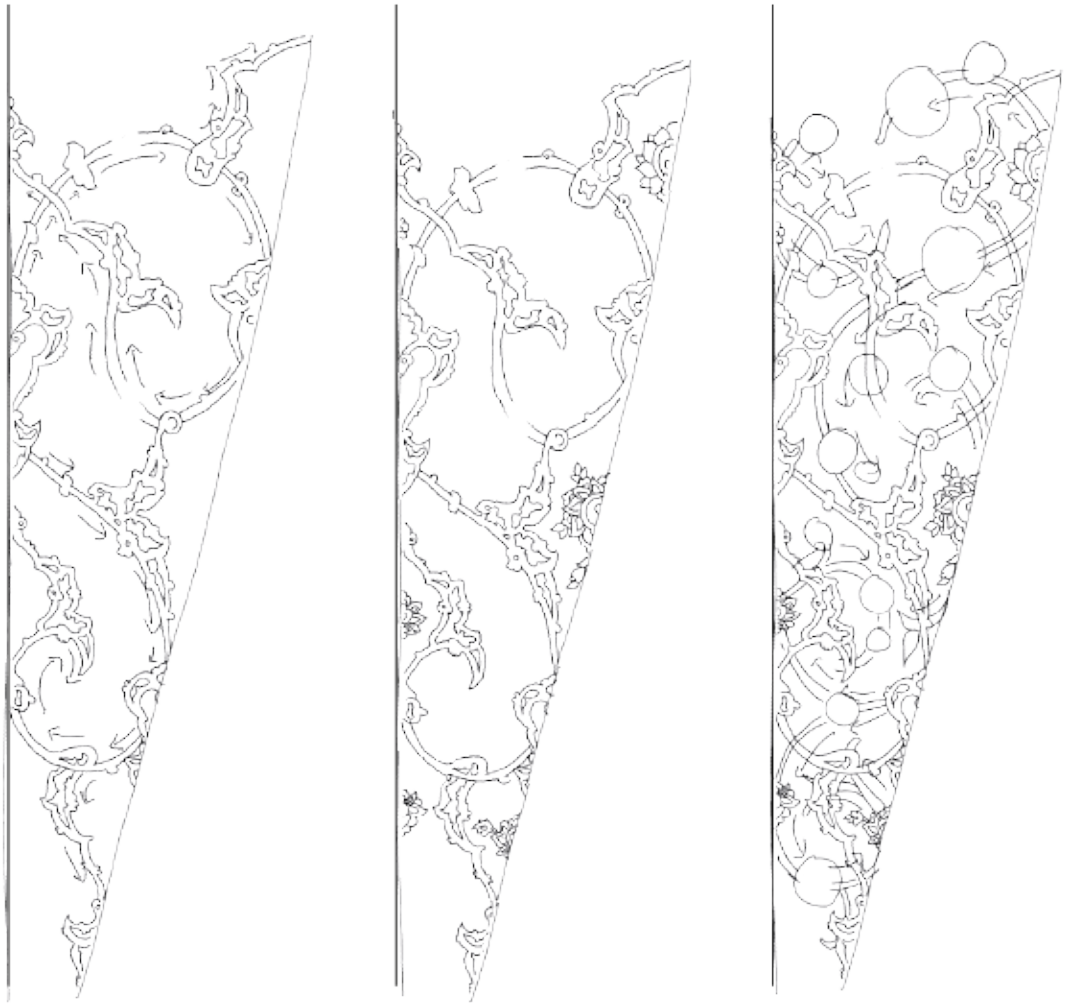


Figure 6.50: Steps 10-12 of the second portal dome analysis.

Step 13: Add the flowers according to the direction and the scale is different based on the available space.

Step 14: Add extra leaves to populate the remaining space.

Figure 6.51: Step 13-14 of the second portal dome analysis.

Step 15: Mirror the section to get the full repeat unit and join it with the central star and compare it against the ceramic design. The discrepancies are there because applying the pattern on ceramic in three dimensions differ from a line drawing, but the drawing concept to achieve the pattern is the same.

Figure 6.52: Completion of second portal dome analysis.

6.3.3.3 Prayer chamber's wall

The following analysis is of the upper part of the wall in the prayer chamber. The lower part of this wall was covered in the previous section in 6.3.2.5.

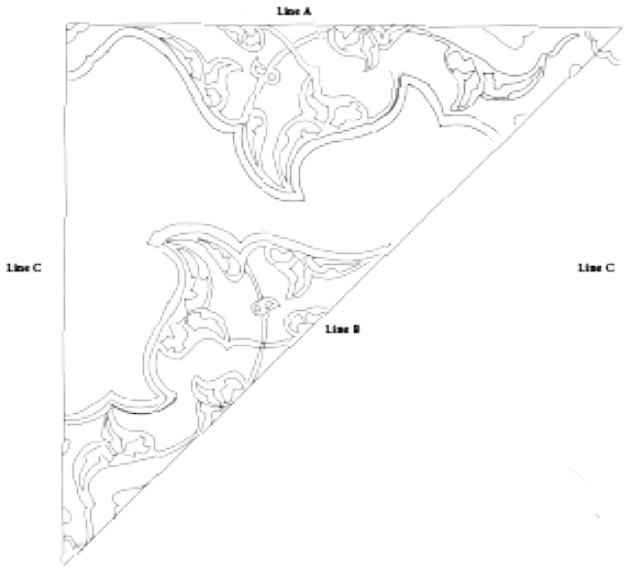
Figure 6.53: Inside the prayer chambers (Alhamal, 2015).

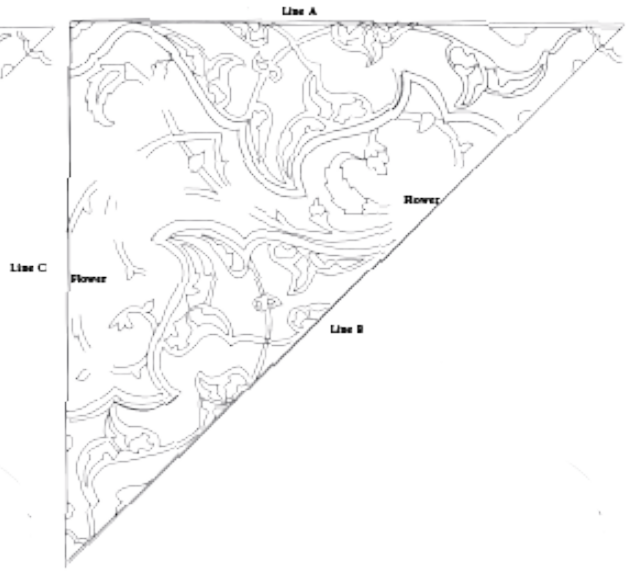
The upper part of the wall is a flat wall, but it follows a rotational symmetry of an eight-pointed star. This is an example that shows rotational symmetry applied on two-dimensional spaces as well. The design section is an eighth that is mirrored, which makes the design unit that it repeated is that square. The interesting thing about the pattern is that it ignores the cross formed by the eight pointed star and it follows the square instead.

Figure 6.54: Geometric analysis of the prayer chamber wall.

Step 1: Place the islimi shapes on two lines of symmetry. The lines in this one are not facing each other like previous constructions in the rotational symmetry in dome designs and the used line are A & B. When these shapes are mirrored, it will create a full closed shape.

Step 2: This design has two areas, the islimi shapes on A&B and the khatei in between and it begins with two flowers, that are placed on line C &B. Thus, all three sides of the triangle have been used for the design.





Step 3: The floral motifs are very simple, but their impact -even though they are in the background rather than the foreground- is strong and they are seemingly floating without an end.

Step 4: Mirror the design to see the complete repeat unit.

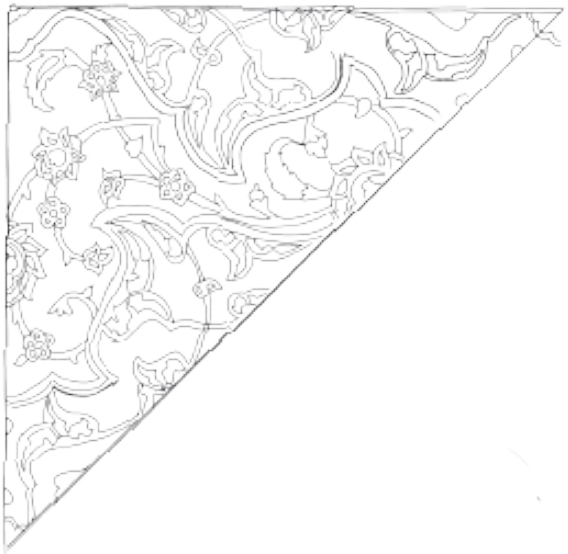


Figure: 6.55: Step 1-4 of the analysis of the prayer chamber wall.

6.3.3.4 Prayer chamber's dome

The last rotational symmetry is the main dome of the mosque and it is truly impressive in terms of geometry, biomorphs and construction. There are two parts to analysing the dome: the central star and the surrounding motifs. The central star is based on an eight-pointed star construction and then divided further to 16 divisions doubling the original eight figure 6.x). The section has been mirrored, which results in eight design units that are repeated across in rotation. There is reliance on the underpinning geometric grid in designing the biomorphic elements since they correspond well.

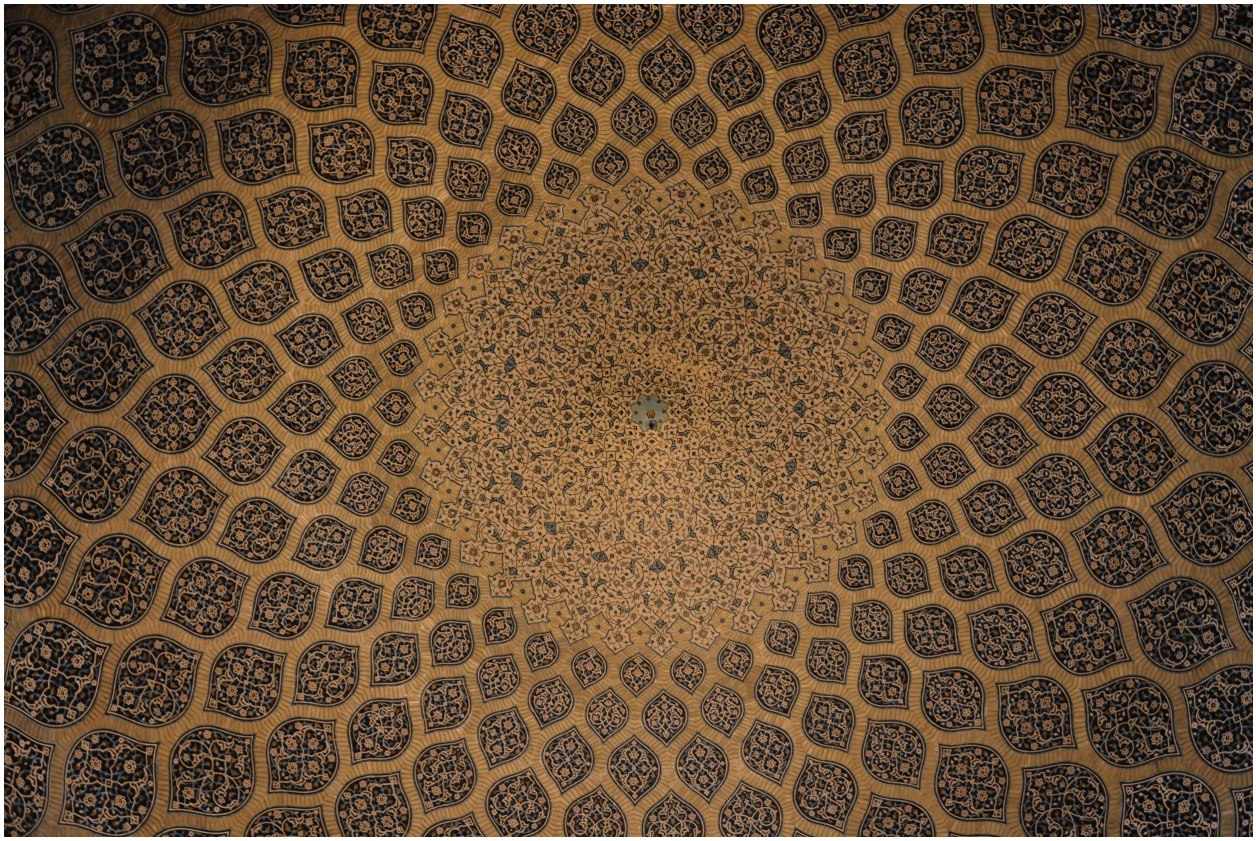


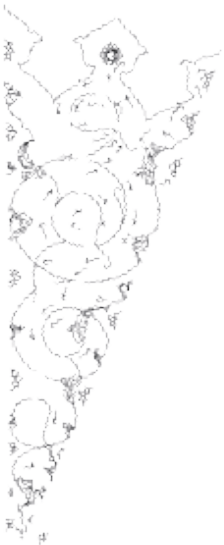
Figure 6.56: Central star of the main dome (Alhamal, 2015).

The analysis is divided into two parts: the central star analysis in figure 6.57 and the analysis I learnt from Adam Williamson (2017) for the surrounding star and the geometric system of the dome. Williamson's analysis for this specific dome is the first of its kind and it is recognised in the geometry community.

Step 1: The geometry of the central star provides the design section and that has two symmetry lines, where the islimi will be placed on. Since the centre is separated visually then the rest, this section has a frame to close it.

Step 2: Floral motifs are placed within the islimi and outside of it on the same lines of symmetry.

Step 3: There are two spirals. The first is the islimi spiral that emerges from the islimi motifs. The arrows show the directions and it is downwards and inwards.



Step 4: The secondary floral spiral follows the same movements of the first creating more depth to the design since they will visually look intertwined.

Step 5: The islimi spiral is completed by the islimi shapes on it. Placed at the end of the spiral and in the middle between two spirals.

Step 6: The flowers are placed and since the sale is small considering the full dome. The designs of them are very basic and most of them are with five petals.

Figure 6.57: step 1-6 of central star inside the Sheikh Lutf Allah's mosque.

The geometric system for the rest of the dome pattern follows the geometry. Diving the central star to 32 requires a great level of accuracy and the lack of geometric accuracy in drawing could damage the overall design. Drawing the pattern using a computer program makes the process a little easier, but it still needs a careful examination of all the elements. The design starts with four divisions exactly like the construction of an eight-pointed star in section 6.2.1.2.

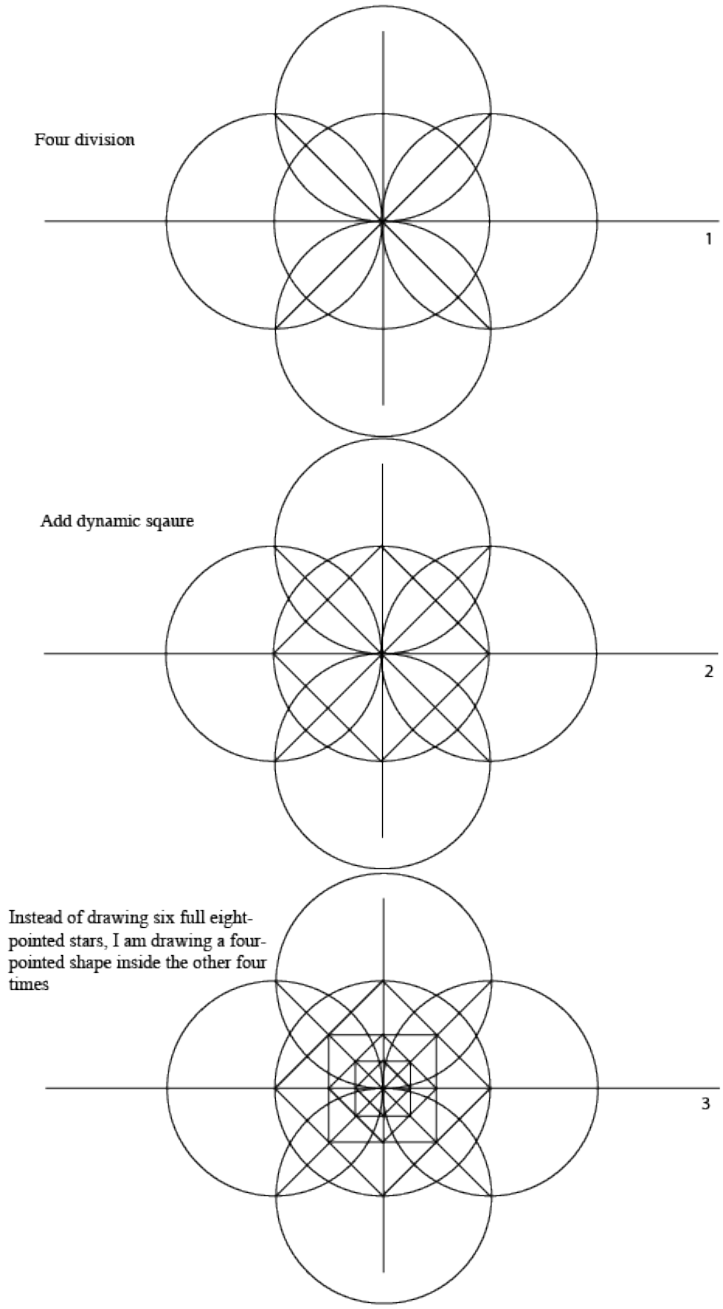


Figure 6.58: Step 1-3 in dividing the central star to 32.

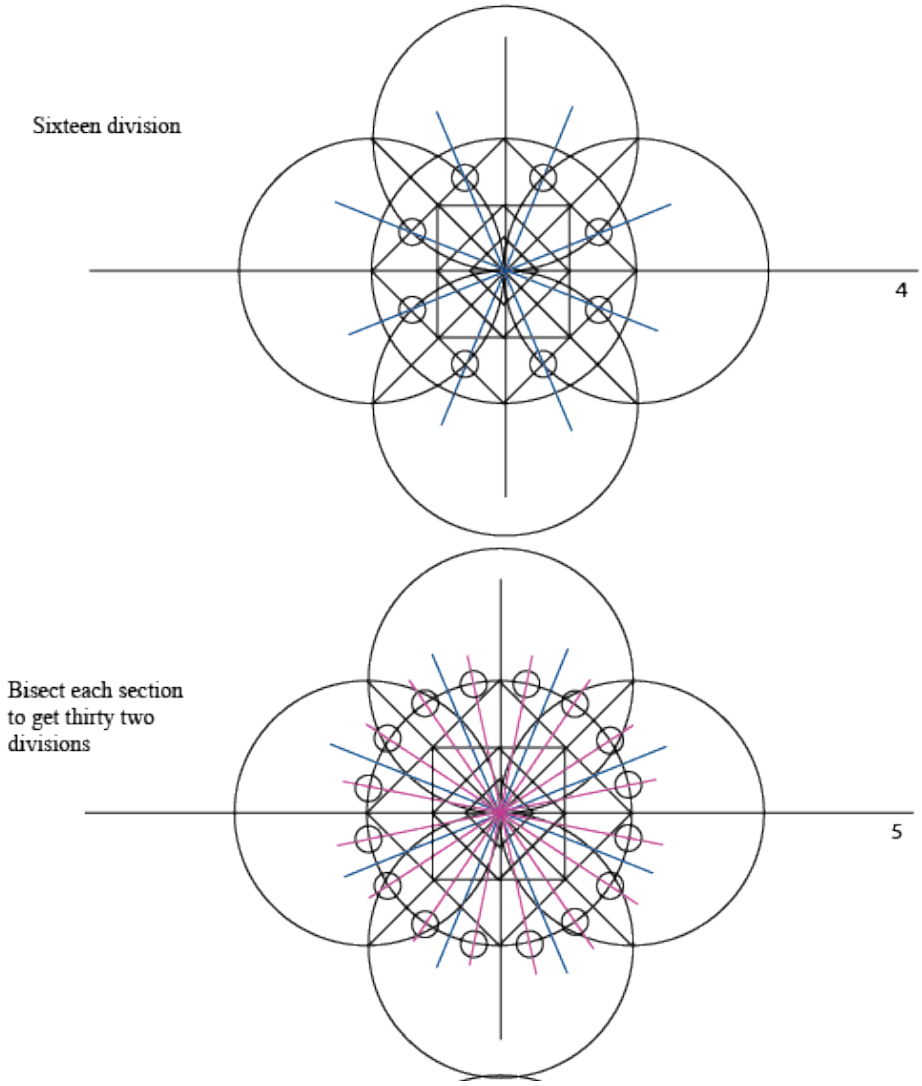


Figure 6.59: Step 4-5 in dividing the central star to 32.

After the division in step 5 in figure 6.59, the aim is to create nine rings around the central star for the drop shape patterns to sit within them. The size of the drops increases from the centre and gets bigger as it goes outwards. Circles are placed on the rings and they are connected with a free-hand drawing to create the drop shapes (figure 6.60). This could have been one of the ways this pattern could have been constructed. There are bricks around the drop shapes and their muted colour is a nice contrast to the dark blue colour of the drops.

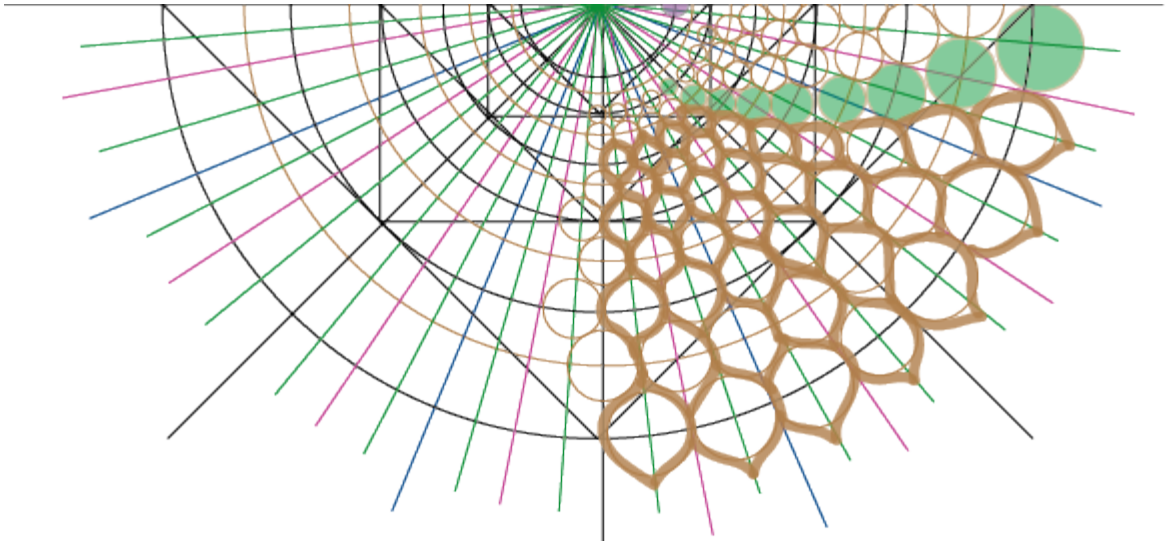


Figure 6.60: Creating the drop shape from the nine rings.

The design inside the drops changes in the first three drops that are closest to the centre, but then it remains consistent from the third drop and it increases in scale to match the drop size.

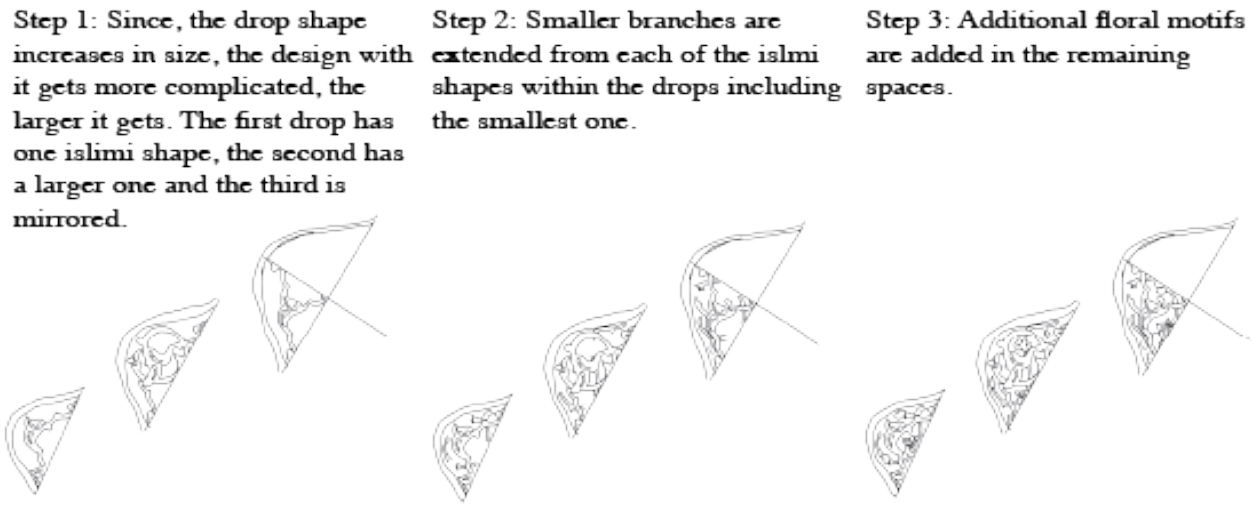


Figure 6.61: Step 1-3 of drop design

6.4 Case Study 2: Biomorphic patterns of Shah Mosque

6.4.1 Introduction

Shah Mosque, also known as Imami mosque and Masjid-i-Shah in Persian, was commissioned in 1611 (Melville, 2016) and built under the guidance of architect Abu'l Qasim (figure 6.62). The entrance structure was completed in 1616 and it was a little over 27 meters in height with two minarets (Seherr-Thoss, 1968). It was fully completed with all the interior ceramic tiles in 1638 (Pope, 1965). It is also called the Royal Mosque, as an attribute to Shah Abbas, the commissioner of the mosque.

Figure 6.62: Shah Mosque from the outside (Alhamal, 2015).

Similar to the Shaikh Lutf Allah mosque, Shah Mosque faced the same challenge of changing its orientation. Given the monumental size of the mosque, the solution was easier. Upon entry, the whole mosque is turned 45 degrees. The monumental scale of the mosque was intentional and it was a display of the empire's wealth and power. It is fully covered in tiles apart from the Arabic calligraphy inscriptions. Shah Abbas rushed the completion of the mosque. The seven-colour ceramic tile technique known as haft-rangi in Persain helped speed up the process (Hutt and Harrow, 1978).

The architecture of Persian mosques has a narrative in the path that leads the person from the exterior door to the prayer area. The multi-level vaults and half domes create a change in the light, which creates a dimly lit atmosphere; this then leads to a space filled with light, and that is exactly what is seen in the Shah Mosque.

The architectural plan of the mosque is based on an old Persian plan that usually appears in a Sasanian Palace, but the rest of the plan is based on the 11th century Seljuk architecture with four iwans surrounding the courtyard that has a central pool that is used for ablution before prayer (figure 6.63). This central pool is the centre of the whole design and Clevenot (2000) writes: "the proportion of this rectangular courtyard corresponds to those of Pythagoras in right-angle triangle, short side = 3, long side =4, diagonal side = 5" and the rest of the mosque follows this proportion (p. 44).

Figure 6.63: Cross section illustration of Shah Mosque (Getty Images, 2016).

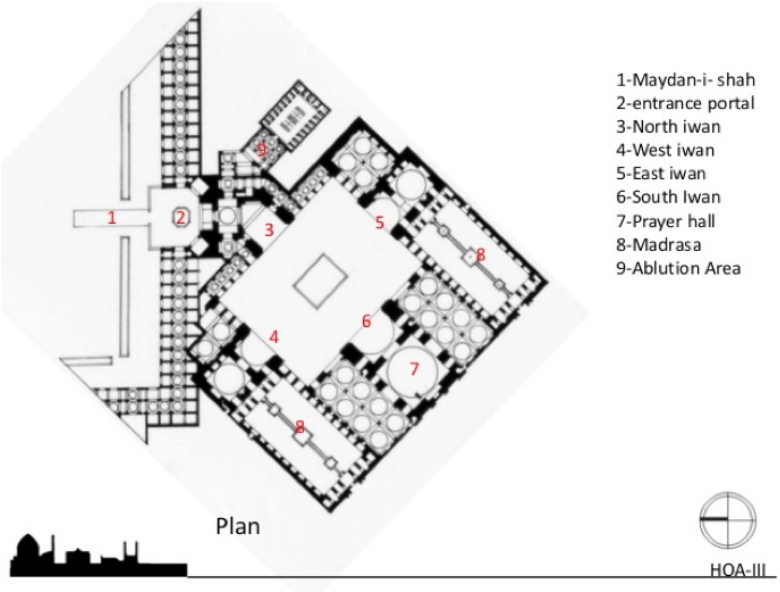


Figure 6.64: The floor plan of Shah's Mosque (Harlalka, 2016).

The floorplan in figure 6.64 illustrates the various spaces within the mosque. It starts with a facade that is made of an exterior iwan #2 leading into the inside of the mosque via a portal. The portal leads to the courtyard and that includes the four iwans: North #3, which is the entry point too, West #4, East #5 and South #6. Each iwan has its own domed space that is filled with biomorphic patterns. The mosque also included a religious school within it in space #8.

The mosque also includes a series of arches and smaller domed areas around (figures 6.63 and figure 6.64) Pope (1930) writes in admiration:

"The most impressive arrangement of these arches is in the Masjid-i-Shah in Isfahan... there is a succession of half a dozen arches each enclosing the next, repetitions in a diminishing vista of the same form but each different in weight and colour and all varying in planes of light, like the recurrence of a basic musical figure which sustains a bewildering elaboration." (p. 23.)

Figure 6.65: Inside the court of Shah Mosque (Alhamal, 2015).

Additionally, the impact of the arches that Pope (1930) mentions is due to the selection of patterns that are covering them, which are placed over a certain length of plain brick and that placement gives the patterns an impressive and powerful quality.

Following the same style of analysis as the first case study, the patterns of the Shah mosque will also be divided into bilateral symmetry and rotational symmetry. The amount of the patterns within the mosque is very vast. Therefore, a small sample of patterns is selected to demonstrate visual styles that are different from the Sheikh Lutf Allah's Mosque.

6.4.2 Designs with bilateral symmetry

The bilateral designs are usually found on the panels covering the facade, on the closed arches (figure 6.66) and within the interior walls (figure 6.67) covering every two dimensional surface. Due to the vast amount of these types of patterns and their close similarity to the previous mosque, only a few will be selected from each area to give us a well-rounded understanding of the styles.

Figure 6.66: panels on the closed arches of Shah Mosque (Alhamal,2015).

Figure 6.67: various bilateral symmetrical patterns on the interior walls of Shah Mosque (Alhamal, 2015).

There is a stylistic shift in some of the biomorphic patterns in the Shah mosque such as the addition of a third floral spiral that is placed within the islimi primary spiral and that was not shown in Sheikh Lutf Allah's Mosque. This third spiral or in most cases second floral spiral is delicate with small simple flowers and little leaves. It is not elaborate like the secondary floral spiral, but it acts as an extra visual layer when looking at the overall design. The direction of this spiral is very obvious from the leaves that are pointing to the direction of the movement.

6.4.2.1 Wall from courtyard arches

There are many patterns in the courtyard around the arches, but this pattern in particular is slightly different from the others because of its vase shape at the base where all the floral motifs come from. The concept of the pattern is a realistic representation of a vase filled with flowers.

However, all the other elements are stylised and produced in the Safavid motif language that is seen in the previous mosque.

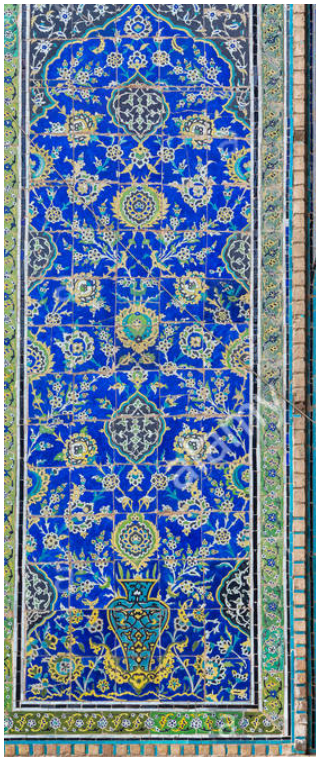


Figure 6.68: Wall from courtyard arches

Step 1: There are two midlines in this design: A & B. Both lines have half central motifs. Each line has two framed islimi shapes and the rest of the motifs are floral.

Step 2: The design starts from the base with a vase and the branches emerge from there in an upwards direction. The space is narrow and does not include any spirals, only simple branches that connect the motif from A to B and B to A.

Step 3: The floral motifs are added and they vary in shape and style, but the follow the direction established in the previous step. The tiles of the islimi shapes were worn-down and hard to see, so only one is included.

Figure 6.69: Step 1-3 analysis of wall from courtyard arches

6.4.2.2 Wall from inside iwan

There are four iwans within the mosque and it has been extremely difficult assigning the right images to the right iwan, my plan to visit the mosque again was delayed by political issues and then Covid-19. From the different iwan patterns, figure 6.70 looked different from any of the patterns in the previous mosque and the main different feature is the thick spirals.

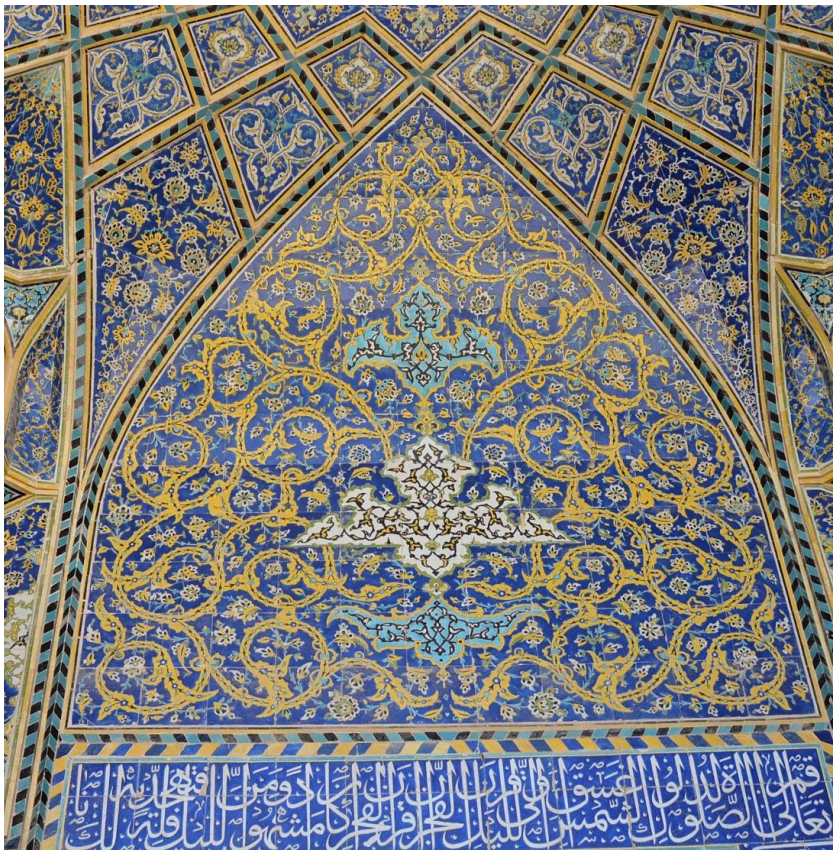


Figure 6.70: Wall from inside the iwan

Step 1: This arched panel starts with a midline and the central shapes are placed on it. The central shapes are both islimi and floral, which is an indication, that there will be two spirals coming along.

Step 2: The islimi spiral starts from one starting point and unlike the usual spirals, this one is very thick. However, it still follows the usual islimi spiral style of drawing.

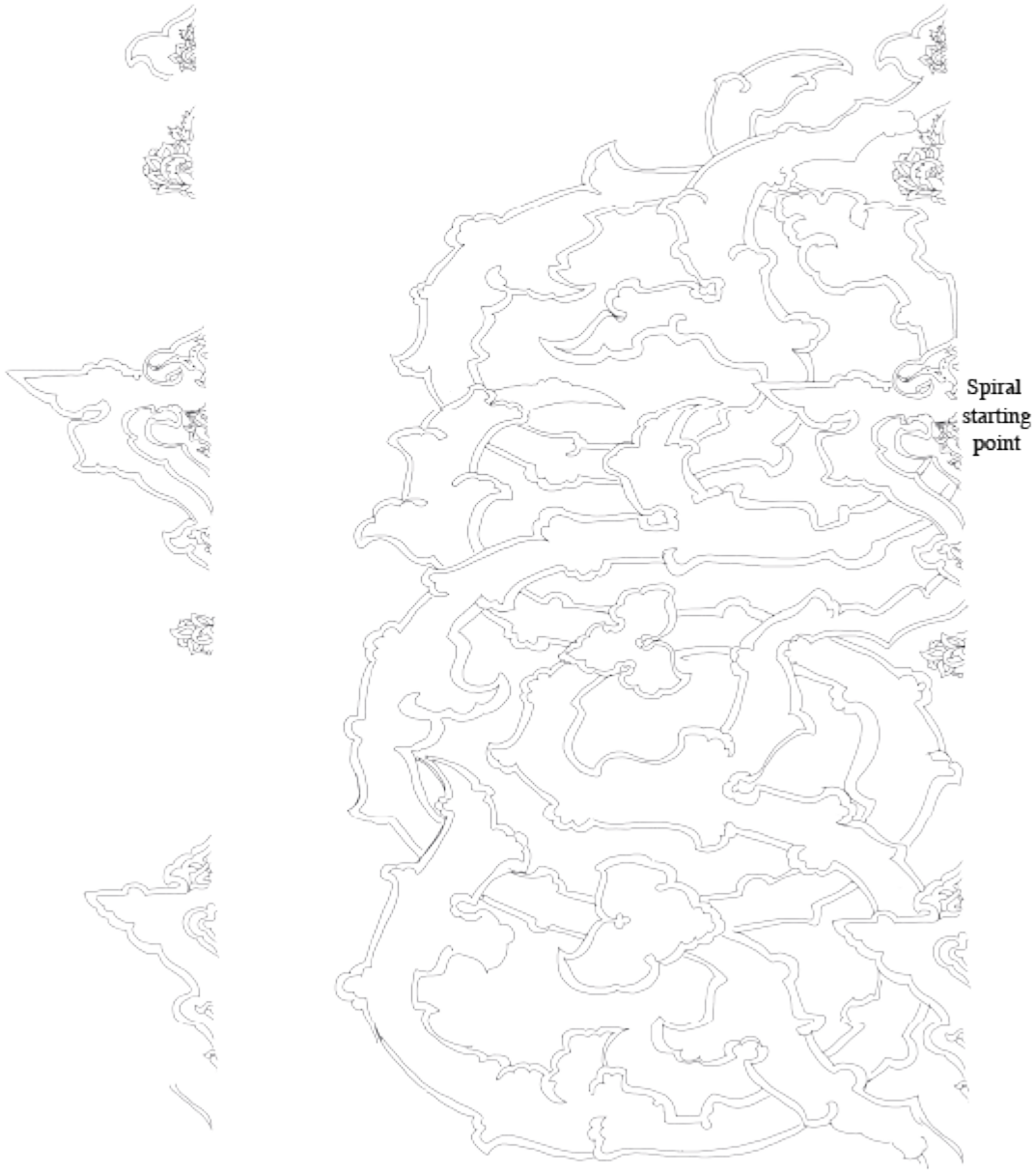


Figure 6.71: Step 1-2 analysis of wall from inside the iwan

Step 3: The islimi shapes on the midline and the connective islimi shapes are filled with more islimi shapes.

Step 4: The direction of the islmi spirals is divided to two main sections: upwards and downwards, so there is constant movement in the design.

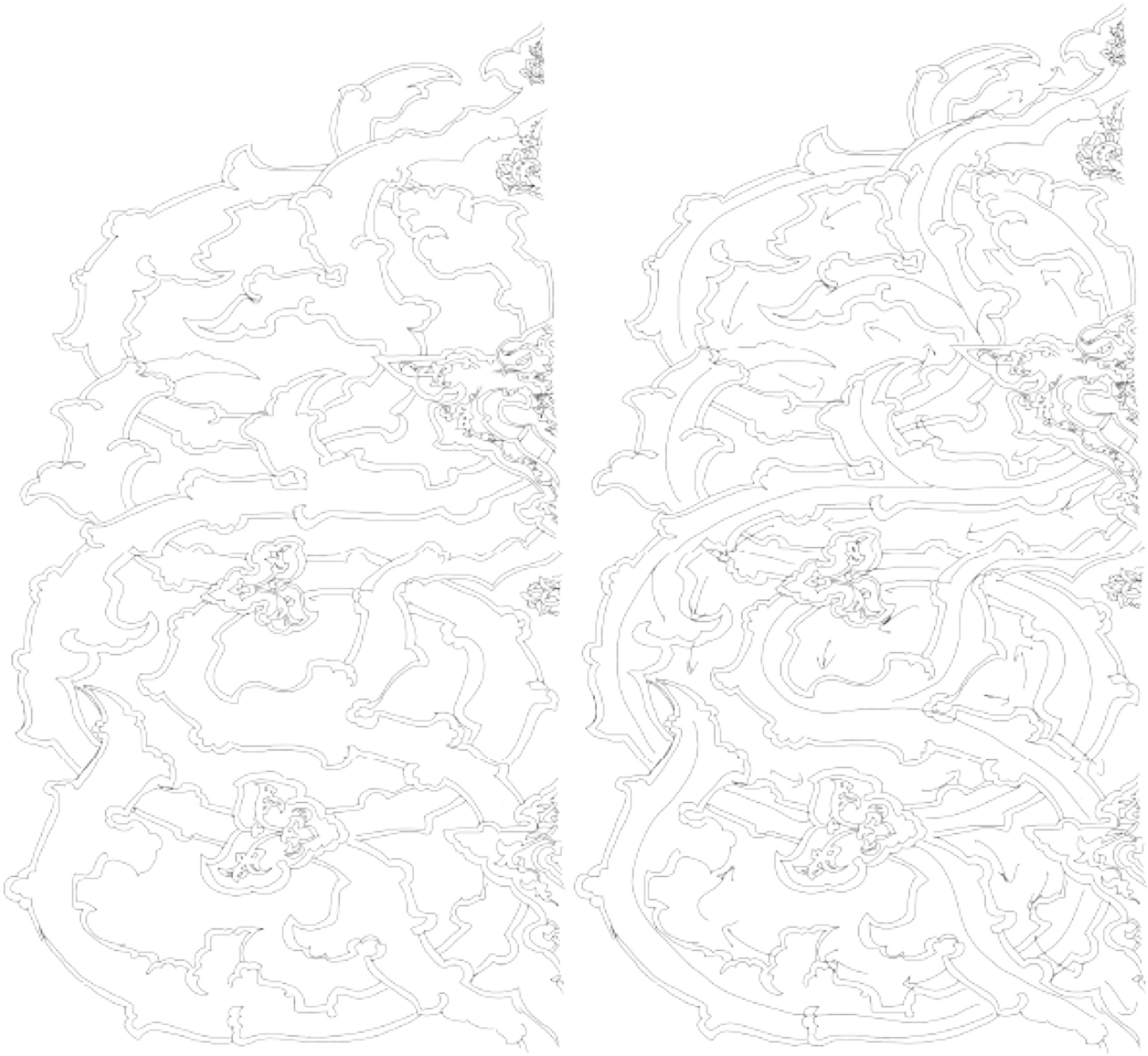


Figure 6.72: Step 3-4 analysis of wall from inside the iwan

Step 5: One of the reasons that the islimi spiral is thick, is that it contains a smaller floral spiral within it. There is also another floral spiral that is placed behind the islimi spiral. Both floral spirals have an abundance of different flowers on them.

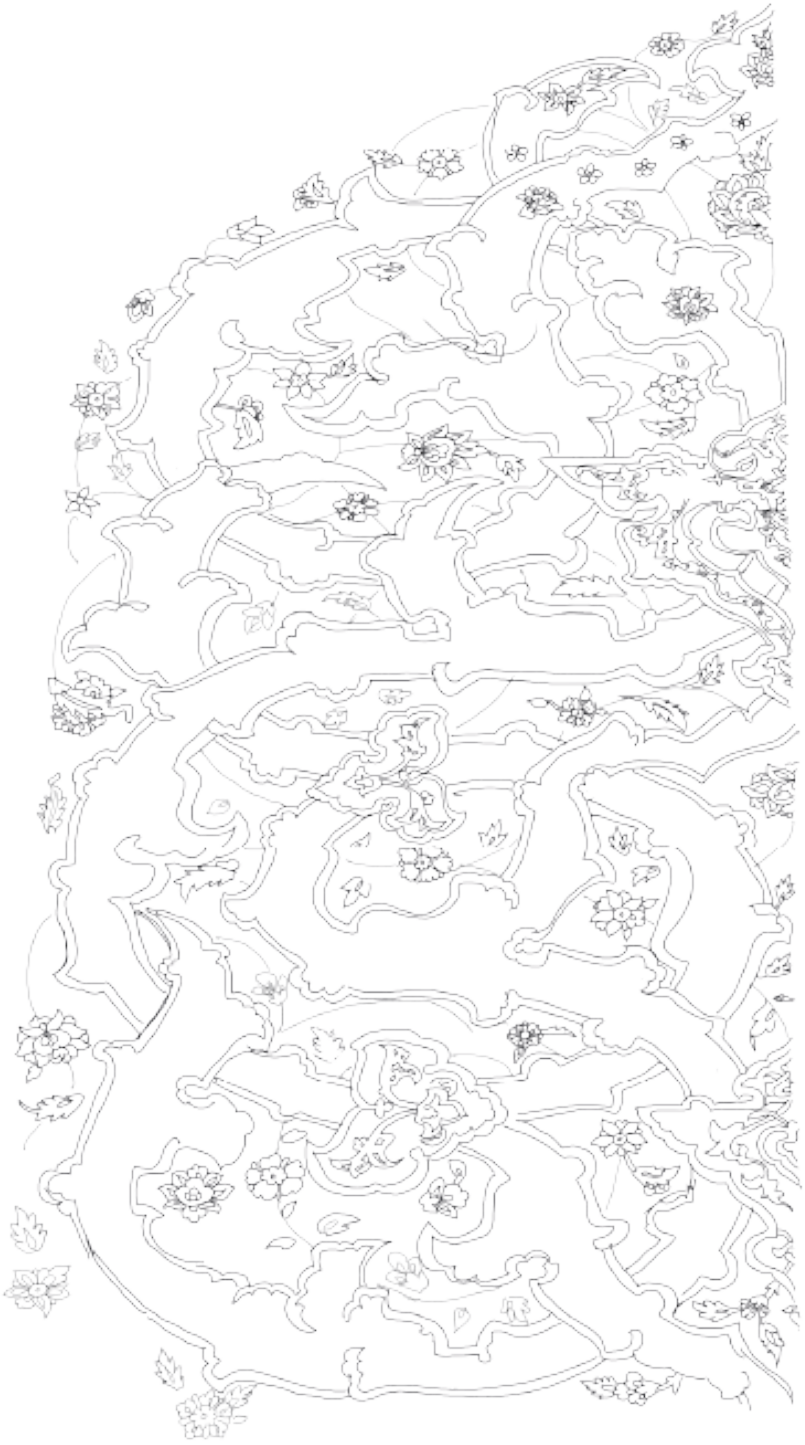


Figure 6.73: Step 5 analysis of wall from inside the iwan

6.4.3 Designs with rotational symmetry

There are three types of rotational designs in the Shah mosque: the smaller domes in the walkway around the main court in between the four iwans (figure 6.63), on top of the vaulted wall where it connects to the dome (figure 6.74) and the domes inside the iwans (figure 6.x).

6.4.3.1 Half dome from vaulted wall

Vaulted walls are a constant feature within the shah mosque and figure 6.74 is an example of the pattern organisation in this type of wall. It usually starts with a half dome design and smaller triangles surrounding it that look like beaming sun rays. The analysis is for the half dome since it follows rotational symmetry.

Figure 6.74: Half dome on top of a vaulted wall in Shah Mosque(Alhamal, 2015).

There are two ways of looking at the construction of this design either as a curve generated from the centre (A) or two crossing lines that grow in size as they move away from the centre (B). I use B in my analysis.

A

B

Figure 6.75: The start of the Half dome from vaulted wall analysis.

This half rotational design is based on a five-pointed star, which is identifiable by the five-point star formed at the start of the design and it grows into ten sections and since this is only half, it

means that it has 20 sections. This type of dual type design is known as Ghiri design and it is a special Persian construction documented in Topkapi Scroll (Necipoglu, 1995). Since this is a complex geometric pattern, the biomorphic design is very simple.

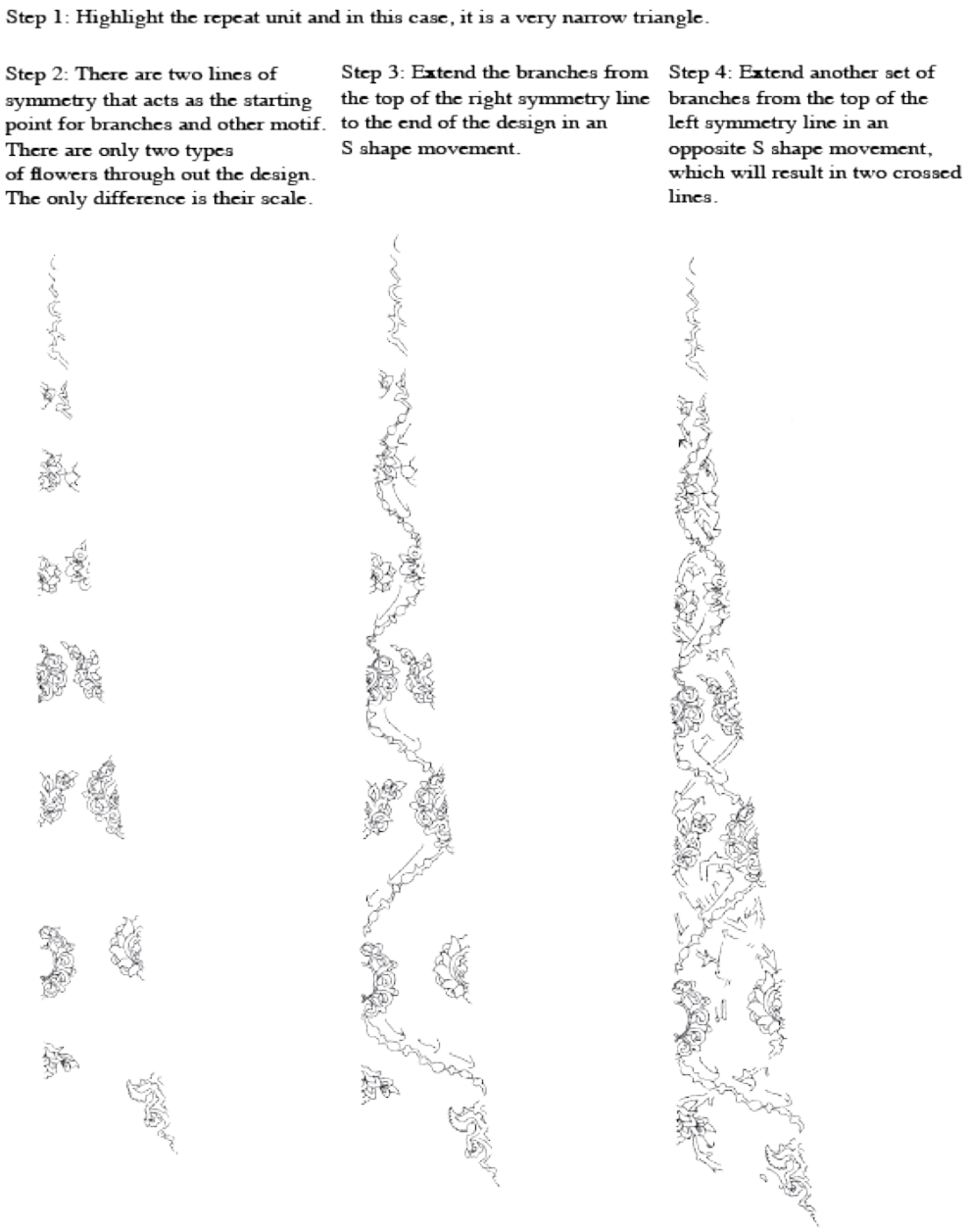


Figure 6.76: Steps 1-4 of Half dome from vaulted wall

6.4.3.2 Dome between arches

There are many domes within the shah mosque and it is interesting to showcase some of the domes are located in different spaces, such as the dome between the arches in figure 6.78. This dome is based on an eight-pointed star and it is identified as such from the eight angles framing the design. The islimi motifs are also repeated eight times. The central star with the yellow background is doubled to 16 points instead of eight.

The analysis for the pattern will be divided into two parts, the first part will analyse the triangle within the dome itself and the second will analysis one of the surrounding triangles.

Figure 6.78: Dome between arches (Bajurin, 2015).

Step 1: The design section is triangular with three lines: A, B & C and they all include design elements. However, only A & B are symmetrical and contribute to the repeat unit. They both have two islimi medallion shapes.

Step 2: The floral spiral starts from a hidden point behind the islimi shape placed on line A. It is unusual for a floral spiral not to have a flower as its starting point. The spiral has two directions: upwards and downwards.

Step 3: The floral motifs are placed on the spiral following the direction of the spiral. Around the design section, there is a frame with a repeating design unit. The design is a simple S shape spiral with two leaves and three flowers that is repeated across framing the central design.

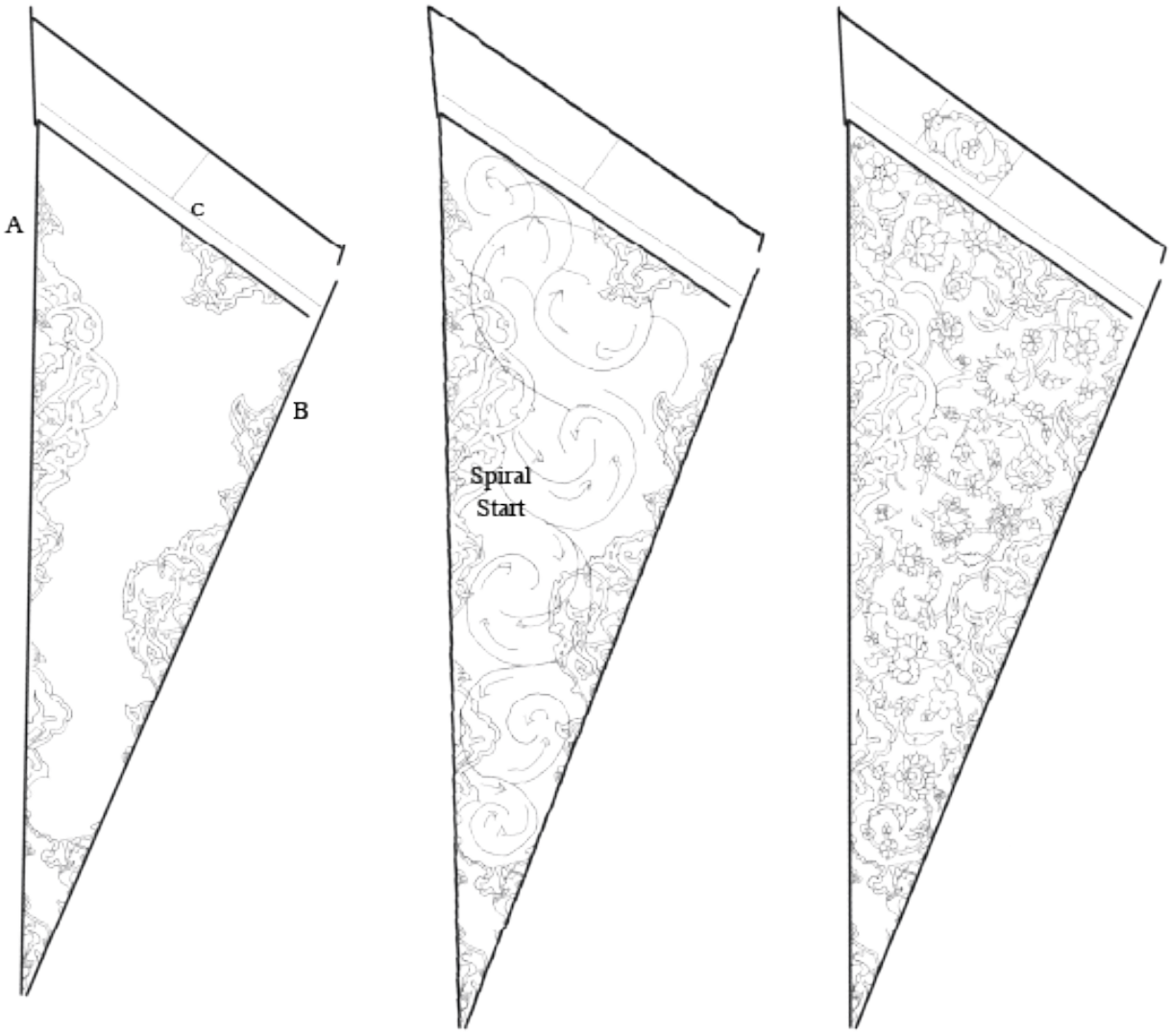


Figure 6.79: Part 1 analysis for dome between arches

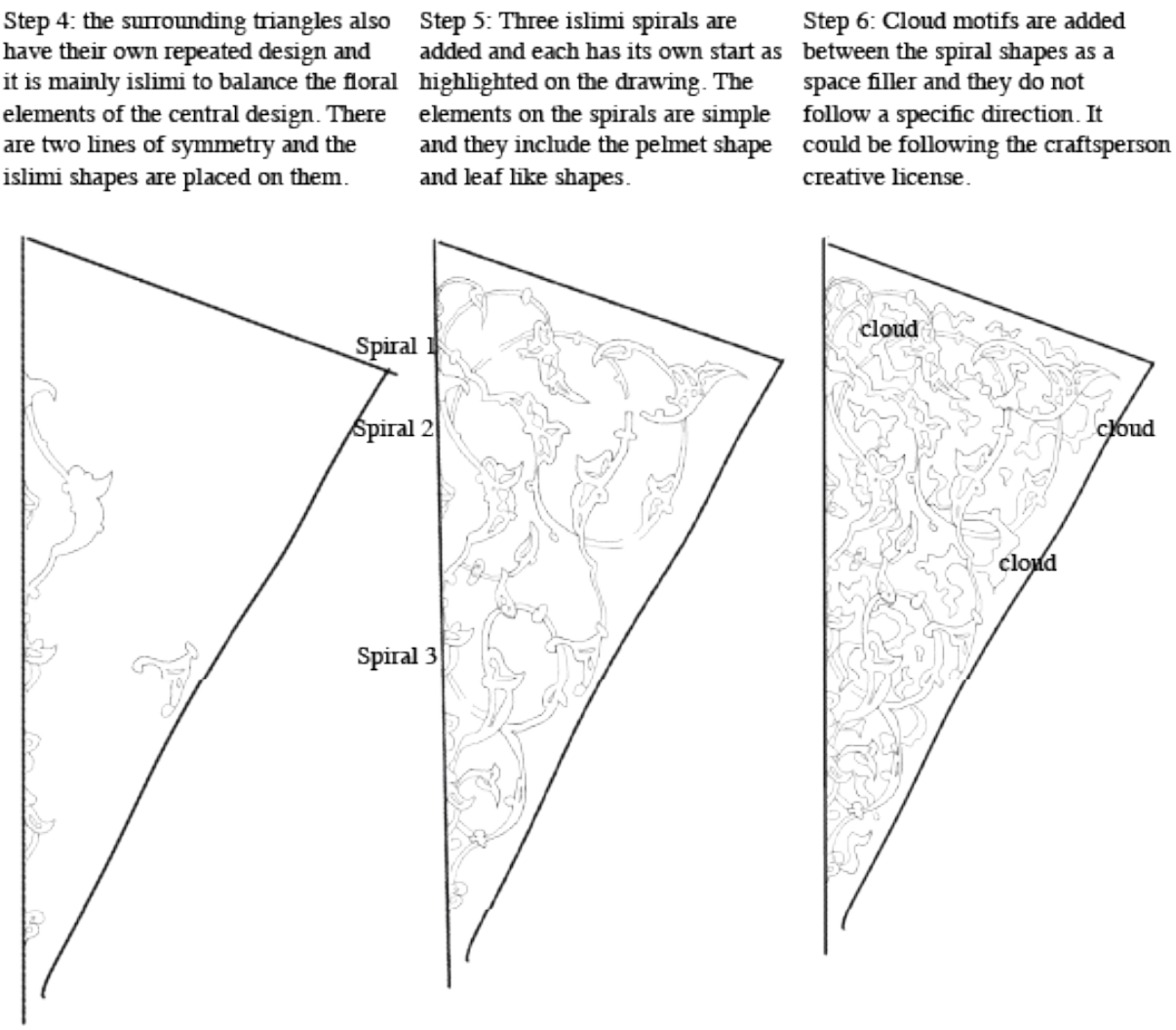


Figure 6.80: Part 2 analysis for dome between arches

6.4.3.3 South iwan dome

The dome topping the South iwan is the large beige and blue dome that is seen from the outside. It is the biggest of the domes and it has the most elaborated design and it is very floral (figure 6.81). I divided the analyses to two: the central star of the dome (figure 6.82) and the surrounding design -the blue circle-. The dome also includes four windows, but they do not interrupt or change the design of the sections.

The dome's central star in the Shah Mosque bears a great resemblance to the one in Sheikh Lutf Allah Mosque. It is made of 32 points and based on a 16-pointed star construction. Unlike the dome in Sheikh Lutf Allah's Mosque, the surroundings of the star are very floral.

Figure 6.81: The dome inside the South iwan in Shah Mosque (Alhamal, 2015).

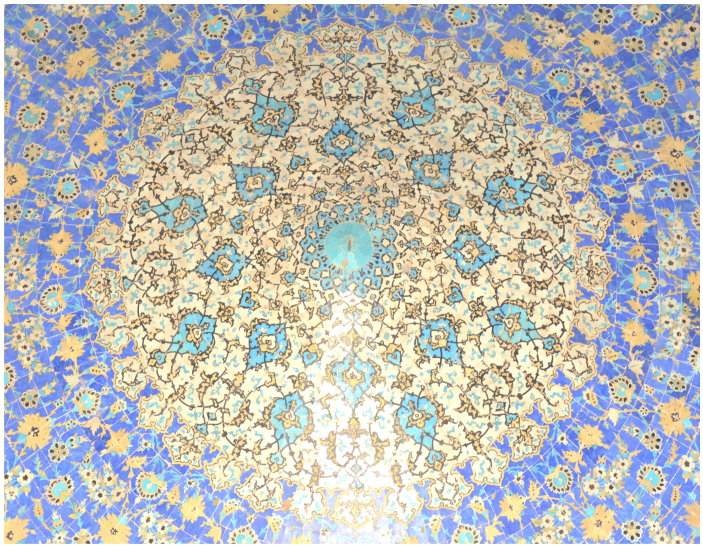


Figure 6.82: close-up of the central dome inside the South iwan in Shah Mosque (Alhamal, 2015).

Step 1: This section has its own frame to separate the central star from the bigger surrounding elements. It is separated by colour and by a frame. The frame takes the shape of islimi motifs. The design of the section is within two midlines: A and B, both of which are used as starting points for the design.

Step 2: There is one starting point for the islimi spiral from a shape placed on line A. This point is highlighted on the drawing and two main spirals come out of it. One going upwards and another going downwards. Each spiral has a smaller spiral coming out of it via the connective islimis.

Step 3: Additional cloud motifs are added in between the islimi shapes. The clouds are slightly different from each section to the other and that can be an indication of the craftsperson's own creative license.

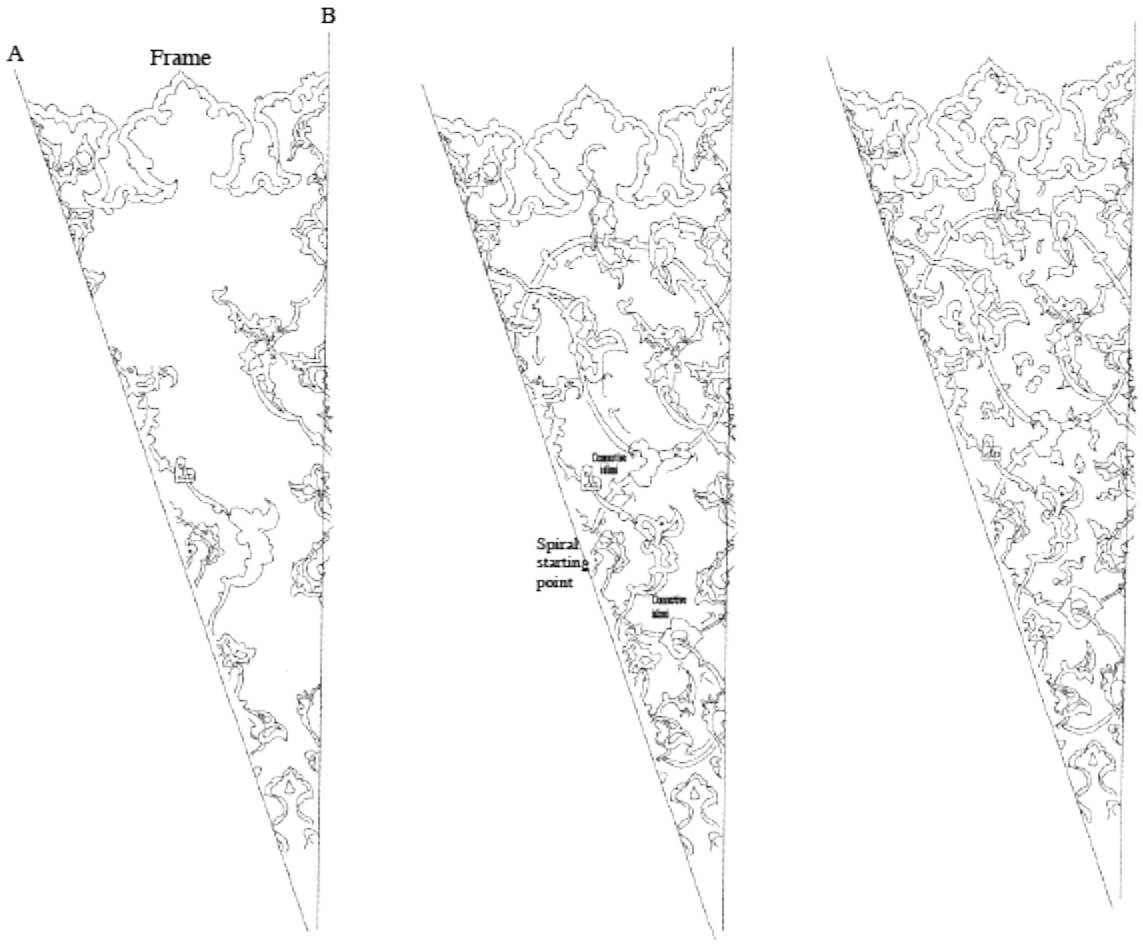


Figure 6.83: Step 1-3 of central dome analysis of the South iwan in Shah Mosque

Step 4: There are four spiral that are added into the design with one starting point. The spirals change in size and they reduce in size the closer they get to the centre. The direction of the spirals is also important to notice. In spiral 1, the directions is inwards clockwise. In spiral 2, it is inwards, but anticlockwise, then it goes back to clockwise in spiral 3 and ends with anticlockwise. Even when the direction changes, it stays consistent.

Step 5: There are two lines of symmetry that have been determined from the section: line A and B. The floral elements are placed on each line. Line A has 12 flowers on it, where line B has 14.

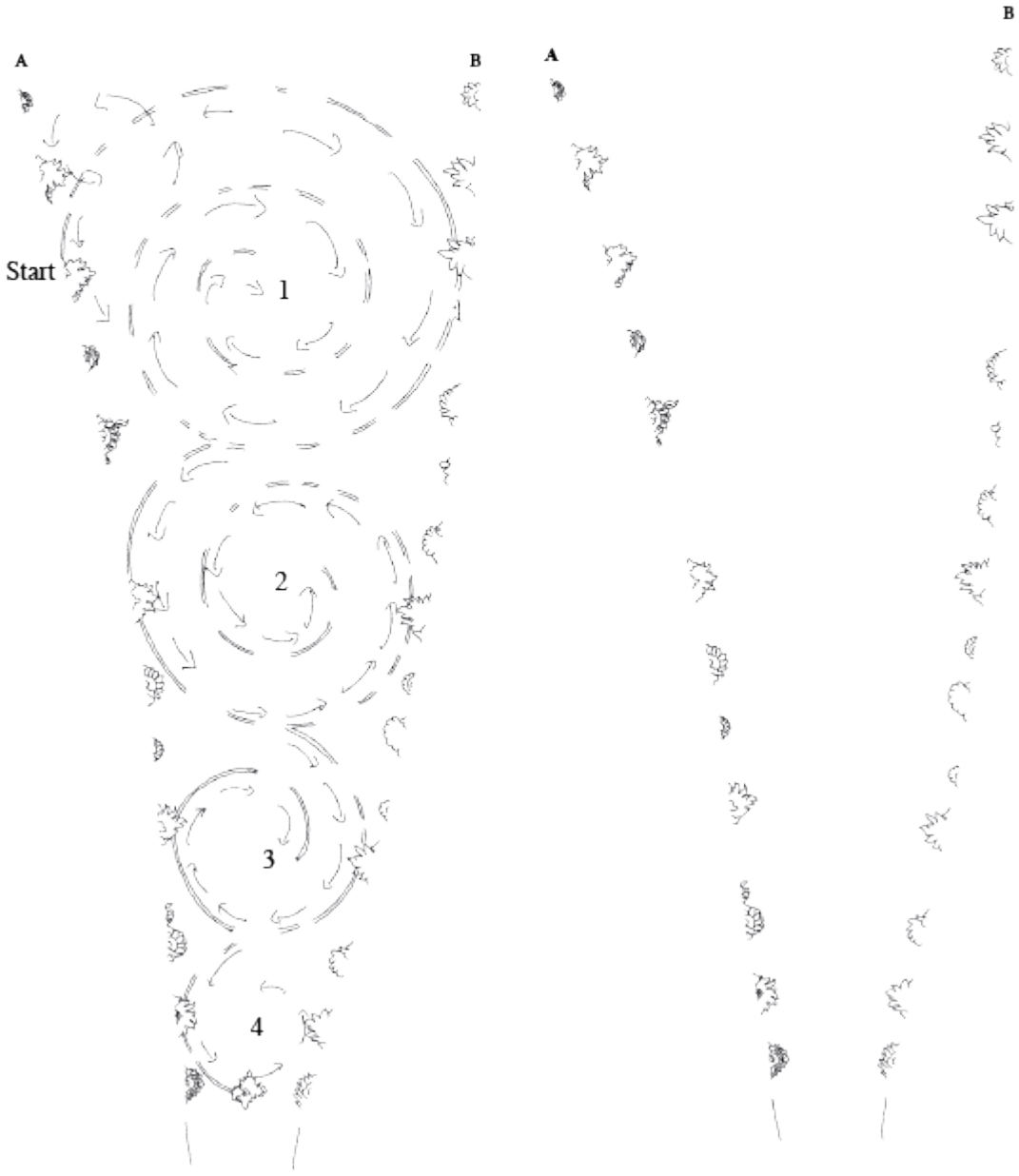


Figure 6.84: Step 1-3 of dome analysis of the South iwan in Shah Mosque.

Step 6: The floral elemnets are added onto the spirals and there are nearly 75 flowers and 25 flower cluster. The direction and the size of the flowers follows the spirals.

Figure 6.85: Step 6 of dome analysis of the South iwan in Shah Mosque.

Chapter 7: Results of the analysis of biomorphic patterns

7.1 Introduction

This chapter will highlight three aspects of my research: the results of the Safavid biomorphic pattern analysis, the motif database generated from the biomorphs, and the qualities of biomorphic patterns. All three aspects can be used by practitioners, historians and other art and design specialists in the field of Islamic ornaments, Islamic patterns and Islamic motifs to reproduce biomorphic patterns and utilise them in art and design.

7.2 Findings

In chapter 5, I tested various ceramic techniques to understand how biomorphic patterns can be applied on ceramic surfaces and I have analysed 13 biomorphic patterns in chapter 6 , eight from Sheikh Lutf Allah Mosque and five from Shah Mosque. Both ceramic tiled production techniques and patterns analysis have resulted in a number of findings which are listed and discussed further below.

Pattern medium. Patterns usually exist on a medium and there is a variety of media that host patterns such as paper, leather, brass, ceramics, etc. One of the fundamental components in determining the choice of the medium is its relative impact on the final pattern's scale and visual language. In chapter 6, I found that patterns applied into ceramic require a slightly larger scale, which can restrict the amount of details that can be included and it is dependent on the type of the technique used. Additionally, the modest colour palette resulted in a limited number of glazes available, seven to be exact, which was another limiting factor. However, in chapter 7 when I used paper and computer assisted software for my analysis, I had with these media more freedom to work on a smaller scale and to be flexible with the outcome. Advances in technologies and software particularly can permit adjustment of scale, colour palette and brush sizes freely which

does not always transition onto a traditional medium. Therefore, the medium needs to be considered before the design is drawn.

*Pattern organisation***.** Another prerequisite of design is the pattern organisation and the planning of the surface. In the case of a mosque, the surface is made of walls and ceilings. Thus, an interior wall is considered as one big canvas and it is usually bisected into one symmetrical unit and then divided further to smaller portions and panels and later can be designed in a number of shapes, sometimes they are rectangular, arched or domed. Generally, the wall itself is symmetrical and it matches the ceiling's symmetry which is usually domed. This general bilateral symmetry of the whole creates balance, as discussed in chapter 6 (figure 6.13).

Underpinning geometric grid. Biomorphic patterns are based on a larger geometric grid that guides the overall shapes and motifs of the whole pattern. The type of geometry used is dependent on the intended space. As highlighted in Chapter 6, there are two main types of symmetries within Safavid biomorphic patterns: rotational symmetry and bilateral symmetry. Rotational symmetry is based on a six-pointed star and its twelve-pointed star variation or on eight-pointed stars and its sixteen-pointed star variation. Occasionally, there is a use of a five-pointed star and its ten and twenty variations. This type of symmetry is more likely used in domes, but it can also be used on some walls although this is uncommon. The bilateral symmetry is mostly applicable on angular spaces like walls and panels.

According to my analysis, there seems to be a rule: if the geometry is simple, the biomorphic patterns tend to be complex, but if the geometry is complex, the biomorphic patterns tend to be much simpler as fewer variations become available due to a more complex medium. The geometric grid results in a design section and its mirrored section where the two create a recurrent section that is repeated across systematically to create the whole pattern.

Symmetry. Symmetry is a default character of geometry and it is an outcome of geometric design. Biomorphic patterns work on reflective symmetry, which can be rotational or bilateral. Any type of symmetry provides a line of symmetry that the motifs emerge and are constructed from. The type of symmetry used is dependent on the underpinning geometric grid. Furthermore,

the symmetry is not only used in the geometric grid, but also used within the design section. The motifs are most likely symmetrical in case of the islimi shapes and most of the floral elements. There are few asymmetrical floral elements, but they are not as common.

Spiral systems. The method of drawing a spiral geometrically is highlighted in the previous chapter and the way of drawing it is not a new finding. Nevertheless, identifying two spiral systems within a biomorphic design is a new finding of this study. The spiral can be drawn mathematically following the Archimedean spiral or it can be drawn free-hand with very skilled hands. Most of the patterns that I analysed and photographed from the mosques included two types of spirals and I refer to them as the islmi spiral and the khatei floral spiral (figure 7.1). The islimi spiral is usually the primary one and it is present in the foreground and appears bolder and more prevalent. Additionally, Islimi motifs are placed on the islimi spiral (figure 7.6).

On the other hand, the khatei floral spiral tends to be the secondary spiral and it is usually glazed in a lighter colour and located in the background. Floral motifs are placed on it with the full flowers being in the middle of it and the floral buds and larger leaves are placed at the tail of the spiral. In most cases, each spiral starts from a matching element. For example, islimi spirals usually emerge from islimi elements where khatei spirals start from a floral element. Moreover, these two systems appear together; however, this is not a must and there are panels that have one or the other.

Figure 7.1: Spiral System in Shah Mosque (Alhamal, 2015).

In some cases, the primary islimi spiral, can include a one string floral spiral inside of it, which increases the complexity of the visual language (figure 7.2). The direction of the elements that are placed on the spirals follows the direction of the spiral to create a harmonious motion.

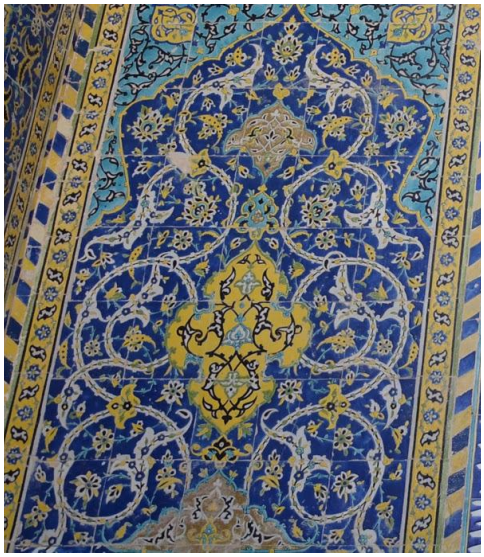


Figure 7.2: Minor floral spiral within the islimi spiral in Shah Mosque (Alhamal, 2015).

Spirals are also present and contained within borders (figure 7.3). However, the spiral is usually an S shape and it is not very elaborate. In most cases, the two spiral systems also appear together, but in a very simplified way. The islimi spiral mostly includes one pelmet and the floral one has up to four flowers. These borders have a repeat unit, as well, like the rest of the biomorphic design and that makes it easier to multiply around panels.

Figure 7.3: Different border spirals in Sheikh Lutf Allah's Mosque (Alhamal, 2015).

Direction and movement. A vital factor in biomorphic patterns is the direction of the motifs whether they are placed on spirals, branches or symmetry lines. There is usually a system for that motion to keep it consistent and that system follows the spiral. For example, if the spiral is going upwards and inwards, the motifs on it will match that motion; this directionality we discussed and highlighted in chapter 6 as part of pattern analysis. As we saw, it is normal to have different directions in one pattern, as well. There does not seem to be a fixed rule on the direction itself because sometimes it is heading upwards following the sun's direction, but other times it is shying away from the sun. The rule is that motifs should follow the established direction, whichever it might be.

Pattern Qualities. In chapter 4, I discussed some of the pattern qualities that were presented by Jones (1865), Trilling (2001) and Philips (2002). Unlike European motifs, Islamic motifs do not have a list of pattern qualities that practitioners can refer to and use as a guide. There are general concepts like geometry, symmetry and harmony, but not an iteration to be followed. Therefore, I will list suggested pattern qualities that evolved from reading the literature and from analysing

the patterns first hand. This list can be expanded by future researchers, but it is intended as an established starting point to lead on from.

- The construction of patterns is not haphazard or random.
- Patterns should have a general geometric grid guiding the design and the placement of the motifs.
- The geometric grid provides construction lines that can assist the biomorphic design. For example, rotational symmetry such as a 6 or an 8-pointed star usually provides two main lines of symmetries and they are usually the starting point for the biomorphic design.
- There is a free-hand drawing element to biomorphic patterns and it requires skilled eye, and hand and mind correlation.
- Symmetry should be applied and followed to create a harmonious and visually pleasing pattern.
- Spirals appear in patterns to emphasise the constant motion within the pattern. The number of spirals can go from one to three spirals. Different spirals tend to have different purposes, as explained in the spiral system in the findings.
- The direction of the spiral and the motifs placed on it should be consistent. The pattern includes two spiral directions: clockwise and anticlockwise.
- The same biomorphic pattern can be applied on various media such as ceramic, paper, wood, brass and so on.
- The level of details within the biomorphic patterns is limited to the type of the medium that is used. For example, ceramic tiles have their limitations compared to painting a pattern on paper. Therefore, the affordances of a certain medium can affect the richness of biomorphic patterns in detail and their complexity.

*Role of the craftsperson***.** During the analysis, it became apparent that craftspeople, who added the detailed motifs and glazes, have used their own creative licence in completing the biomorphs on the ceramic tiles and that is clear from the placement of the motifs and the small discrepancies within the flowers. The geometry indicates the area for each motif, but the craftsperson chooses the type of motif either from their own motif library or the guild's collective motif library. The most pronounced example is that not every single petal is exact, which is an indication that free-

hand skills have been used (figure 7.4). These little imperfections and minimal differences are natural on a big canvas and they do not threaten the required skill level to complete a panel. As mentioned in section 4.5 on the spirituality of biomorphic patterns, this imperfection might not be coincidental. It may indicate that only Allah, the creator of the universe, is perfect and this imply the humbleness of the Muslim craftsperson and subordination to Allah's great power.

Figure 7.4: Close up example of the craftsperson's work in Shah mosque (Alhamal, 2015).

7.3 Motif Database

The motif database is an important outcome of this research because it serves as a comprehensive list of elements that can be adopted when creating biomorphic patterns. It is especially useful for artists living in countries that do not have access to such highly decorated buildings like the Safavid mosques. It is difficult to know which motifs can be used in a biomorphic pattern particularly when an artist wants to draw their own pattern and not trace it from an existent pattern.

There are multiple possibilities to presenting this database. To preserve the authenticity and exclusivity of each mosque separately, I divided the motif database into two divisions, one for

each mosque. Additionally, each mosque is split into two types of motifs: Islimi and Khatei; therefore, each type is also presented separately (see figure 7.5).

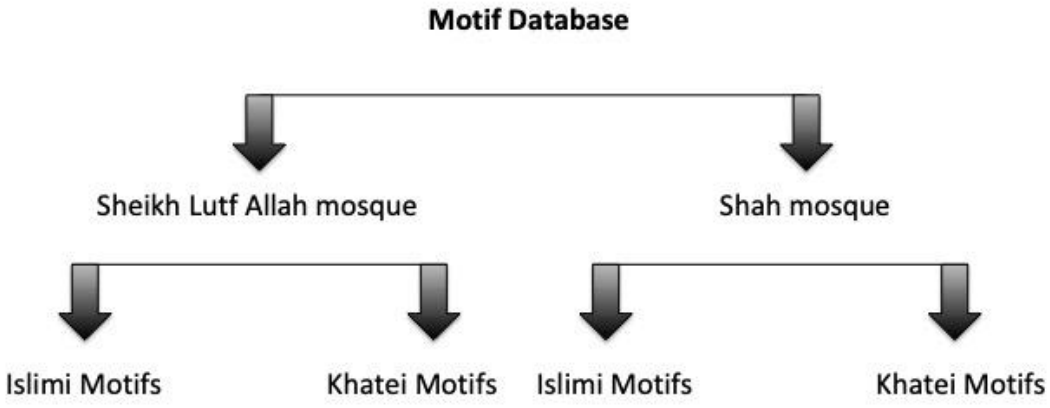


Figure 7.5: Motif Database (Alhamal, 2020).

The term khatei, as previously discussed, including all of its relative floral motifs, but I have identified four main elements within the khatei: flower buds, leaves, symmetrical flowers (with mostly bilateral symmetry and some rotational symmetry) and asymmetrical flowers. The placement of each of the floral elements is also different. Flower buds are usually placed at the end of the spiral and they can vary from being very simple to elaborate with a leaf covering some of the floral buds. Leaves are either placed on spirals or they come out of the sides of the flowers. These flowers can vary in scale depending on the available space. Moreover, even if the floral elements are different they all follow the direction of the spiral, as clarified in the analysis in Chapter 6. Separating these elements is useful to understand all the possibilities in the flower language. There are further observations that are written in some of the coming sections that are specifically relevant to each.

7.3.1 Sheikh Lutf Allah Mosque

7.3.1.1 Islimi Motifs

The islimi motifs are usually found on the line of symmetry, where the islimi spirals stem and smaller islimi shapes are placed on those islimi spirals, especially the pelmet shape that is repeated countless times in varying scales and directions (figure 7.6).

Figure 7.6: Elements of islimi motifs from Shah Mosque (Alhamal, 2015).

Connective Islimi shapes are usually found on the primary Islimi spiral and it usually is placed before the split of a spiral and acts like the starting point of two additional spirals. These connective Islimi shapes are sometimes similar to each other and sometimes they are different. These connective shapes also follow the direction of their spiral (figure 7.6).

Some of the other elements within islimi look like crowns and medallions and the so-called cloud-collar shape (figure 7.7), in particular, with the latter being very similar to a Chinese example (figure 7.8). According to Anita Chowdry (2018), artist and Islamic manuscript researcher, the Islimi motif that usually appears on the symmetry line is known as the collar motif and it is attributed to the Timurid period and their outfits that have a collar shape placed on the shoulder (figure 7.9) and it is inherited from Chinese clothing, as well (figure 7.10). In the Chinese culture, the cloud-collar motif is very highly spiritual and it is a symbol for the gate to the heavens, but there is no evidence if the Persian artists used it for that specific symbolism.

Figure 7.7: Islimi motif from Sheikh Lutf Allah that looks like the cloud-collar shape (Alhamal, 2015).

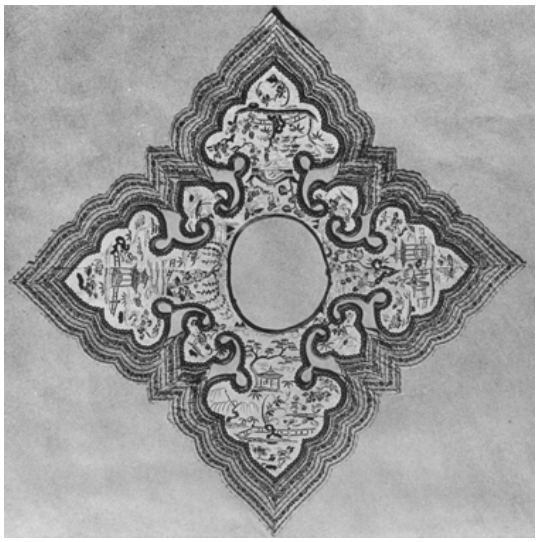


Figure 7.8: Chinese cloud collar (the Johns Hopkins University Museum in Cammann, 1951).

Figure 7.9: Timurid miniature dating to 1430 (The Met Museum, 2021).

Figure 7.10: Ch'ing portrait (detail) showing Chinese lady wearing a late form of cloud collar, Doolittle collection, New Haven (Cammann, 1951).

The following islimi motifs database, as illustrated in figure 7.11, includes various pelmets, connective islimis, medallions and cloud-shape motifs. The first two are drawn fully, where the last two are drawn as a half shape that can be mirrored and repeated. The motifs can be placed as a frame on the line of symmetry, within a shape or placed on the islimi spiral. They can also appear in a very simple format or they can be detailed and more pronounced.

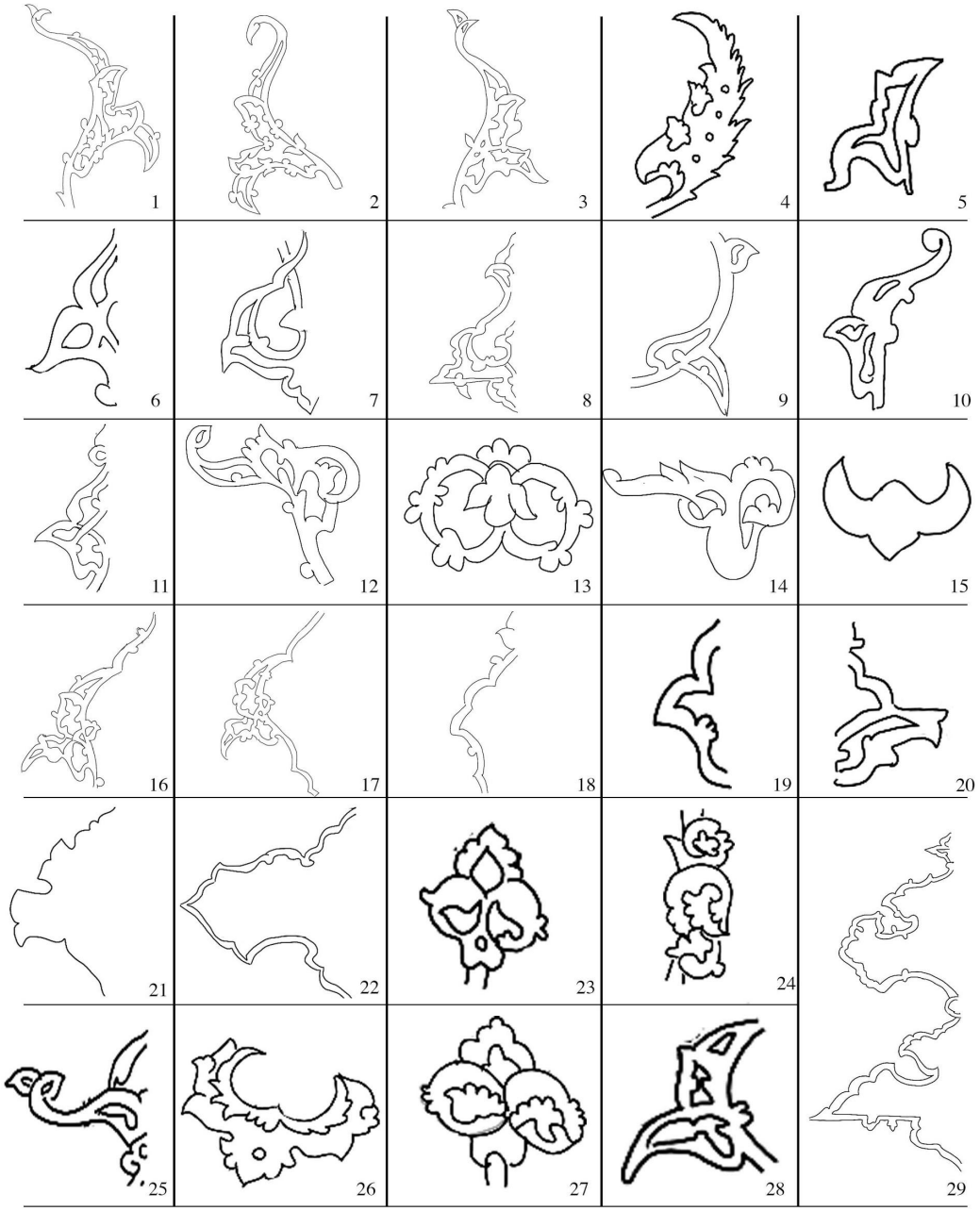


Figure 7.11: Islimi motifs from Sheikh Lutf Allah Mosque.

7.3.1.2 Khatei Motifs

In this section, I will cover leaves, flower buds, symmetrical flowers and asymmetrical flowers.

7.3.1.2.1 Leaves

Leaves are usually scattered within the pattern and they are important to the balance of the pattern while also being inherently part of the biomorphic pattern elements. Using them, they usually work as a filler for smaller places and as previously mentioned, as well as found rotationally emerging from a node point along the line of symmetry, on flower buds or floral spirals. They stem from flowers and are arranged evenly and in keeping with directionality rules applied to the pattern. Just like in nature, there are many types of leaves that appear within khatei motifs. Botanical books have diagrams and lists for leaves morphology based on three criteria: shape, margin referring to the edges of the leaf and venation referring to the surface of the leaf (Bell & Bryan, 1991). Although these are scientific classifications, I find, from my experience as an artist, that they also work well in classifying stylised leaves found in biomorphic patterns.

There are three components for leaves and their structure: "petiole (leaf stalk), lamina (leaf blade) and stipules" (Hodge and Maughan, 2013, p.68). The most important part I am interested in is the lamina and that is the drawn part and most visible. The lamina has two types: simple and compound. The simple is made of one body whereas the compound is made of more than one body within the same leaf.

The simple lamina I observed in the biomorphic patterns are: elliptic (oval shaped), falcate (hooked shape), lanceolate (pointed shape) and rhombic (diamond shape) Figure 7.12. The compound laminae I observed are: palmate (not to be confused with the pelmet islimi shape) and trifoliate (with three leaflets) Figure 7.13. The lamina can have either smooth or toothed edges and these are called entire (smooth), crenate (round teeth), serrate (forward pointing teeth). Safavid artists did not use these names, but they must have had their own reference language which is not recorded or reported. In my view, it can be valuable to make use of the scientific advancements in botany and use some of the references to enhance the motif language.

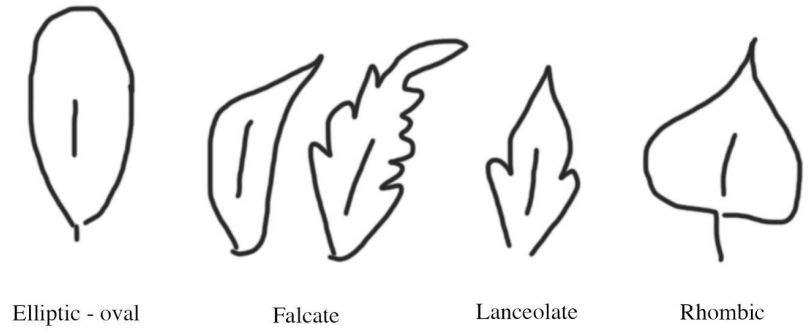


Figure 7.12: Simple Lamina (Leaf body).

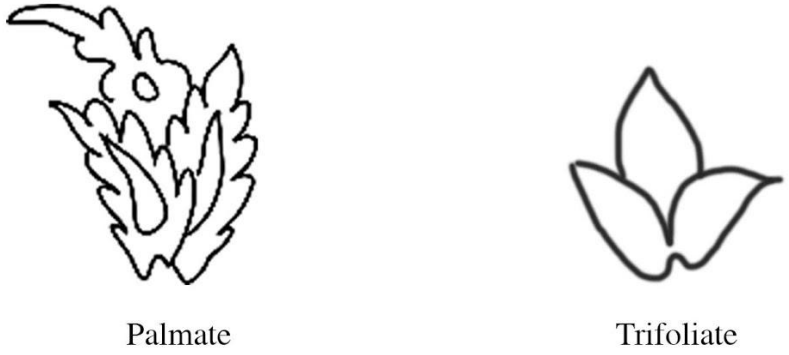


Figure 7.13: Compound Lamina (Leaf body).

Another classification to leaves from an artistic point of view is proposed by Birol and Derman (1991:2007) and reads as follows: “small plain leaves, large toothed leaves, leaves with large segments, folded leaves and curled leaves” (p.21). These descriptive names are more specific to the leaves in Ottoman biomorphs, but they are very similar to the Safavid ones. This classification can also be employed, but I prefer the botanical connection as it is more accurate to descriptions and classifications we find in biomorphic patterns.

As illustrated in figure 7.14, there are many different leaves in the database and they can be drawn either in a simple style or overly stylised and detailed.

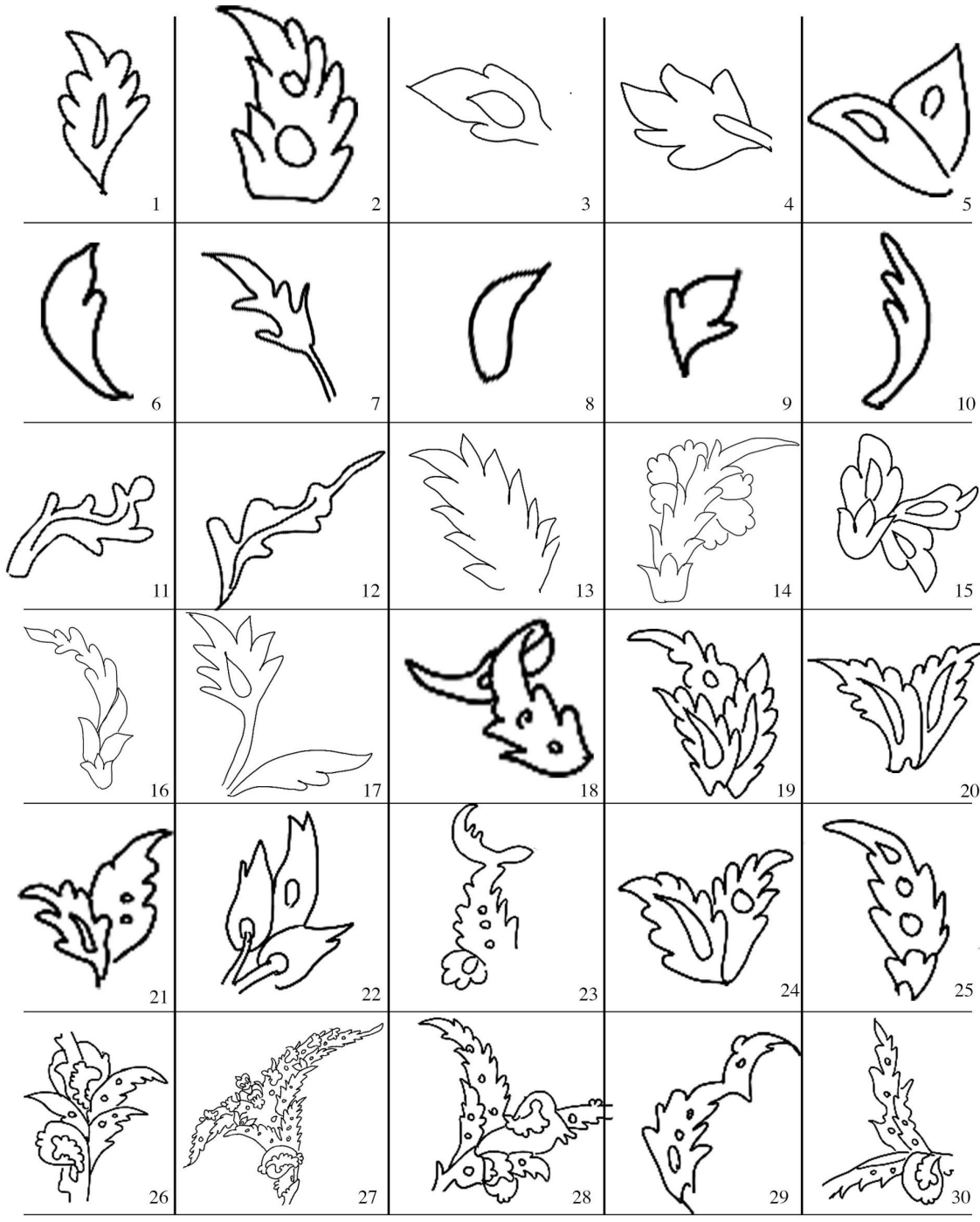


Figure 7.14: Leaves in Sheikh Lutf Allah Mosque.

7.3.1.2.2 Flower buds

The flower buds have three placements within a pattern: at the middle point of the spiral, at the end of the floral spiral, or out of a larger flower. It is a stylised 2Dimensional version of a real flower bud and it is even drawn closely to the real flower parts (figure 7.15). It starts with a stem and grows into receptacle, ovary and sepal and the flower comes out of it (Hodge and Maughan, 2013).

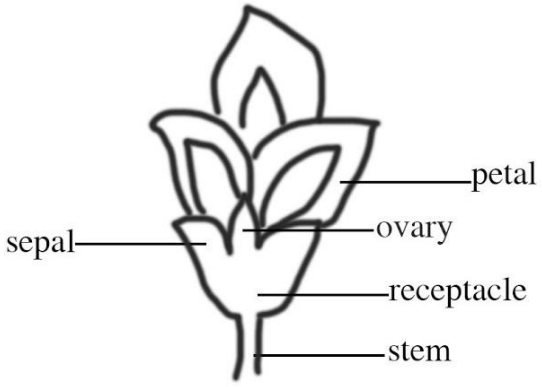


Figure 7.15: Botanical components of a flower bud.

Flower buds follow a simple construction concept and they are usually very small on a ceramic tile (around 5cm), there is a huge variety of them. They differ by changing the style of the petal from pointy to round and toothed. They can also be a complicated flower with a stylised leaf (figure 7.16). It is great to observe a variety of them on a panel, which makes it more alive since they are an indication of birth and a new flower life.

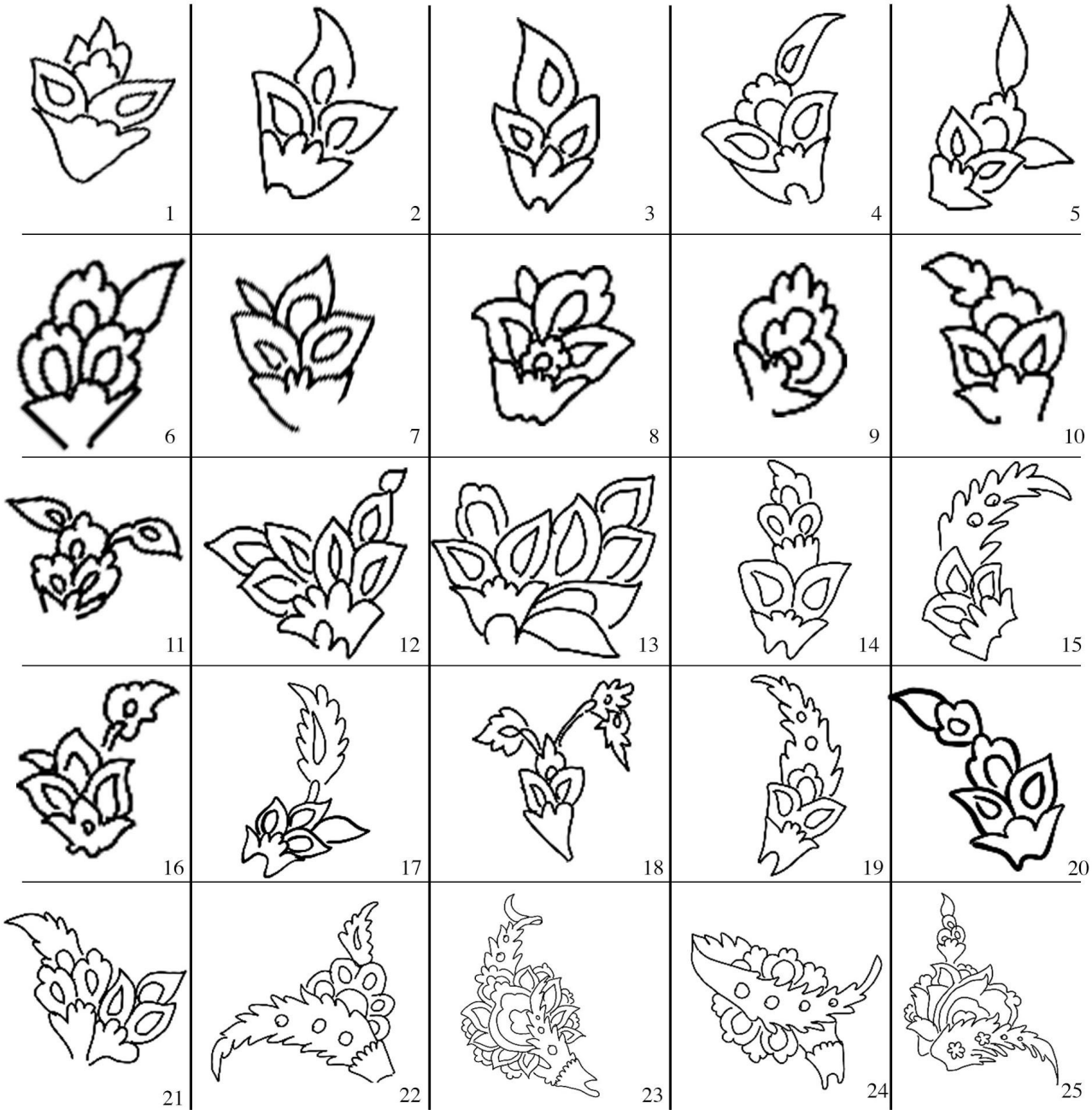


Figure 7.16: Flower buds in Sheikh Lutf Allah Mosque.

7.3.1.2.3 Symmetrical flowers

Symmetry is very important in biomorphic patterns and not only for the overall pattern, but also for the motifs themselves as well as being found present in most of the floral forms.
The components of a symmetrical flower are usually similar to the ones in flower buds as highlighted in figure 7.17; however, these petals are much larger and fuller. There are sometimes a combination of petal types like a round petal, a toothed petal and a pointed petal (figure 7.17). Even though the combinations can be the same in flowers, the arrangement of it makes the flowers different from each other. Sometimes the pointed petals are at the foreground while the round ones are in the background as one example. These variations represent in a stylistic way the 2D profile of the different petals and as found in nature, will have a single central line of symmetry that runs parallel to the direction of the peal. .

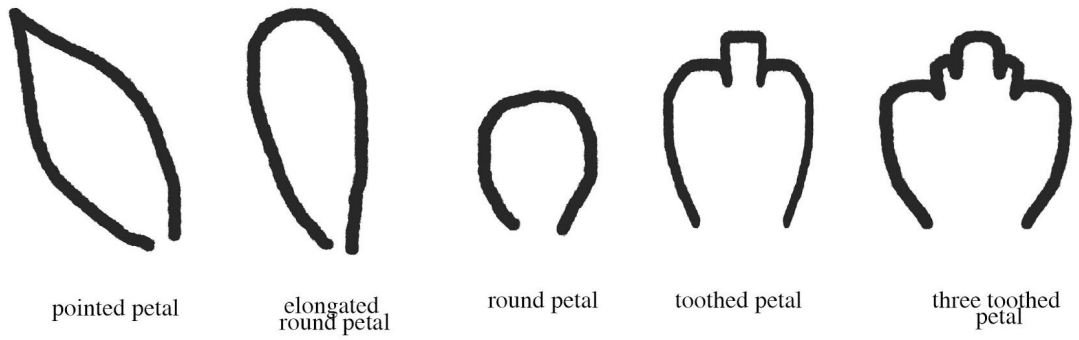


Figure 7.17: Types of flower petals.

The type of symmetry that is presented in this motif database from Sheikh Lutf Allah Mosque is bilateral symmetry that vertically bisects the flower and this type is referred to as *hatayi* by Turkish artists (See figures 7.18 and 7.19). Rotational symmetry also exists in floral motifs, but is more unconventional to be constructed in this way.

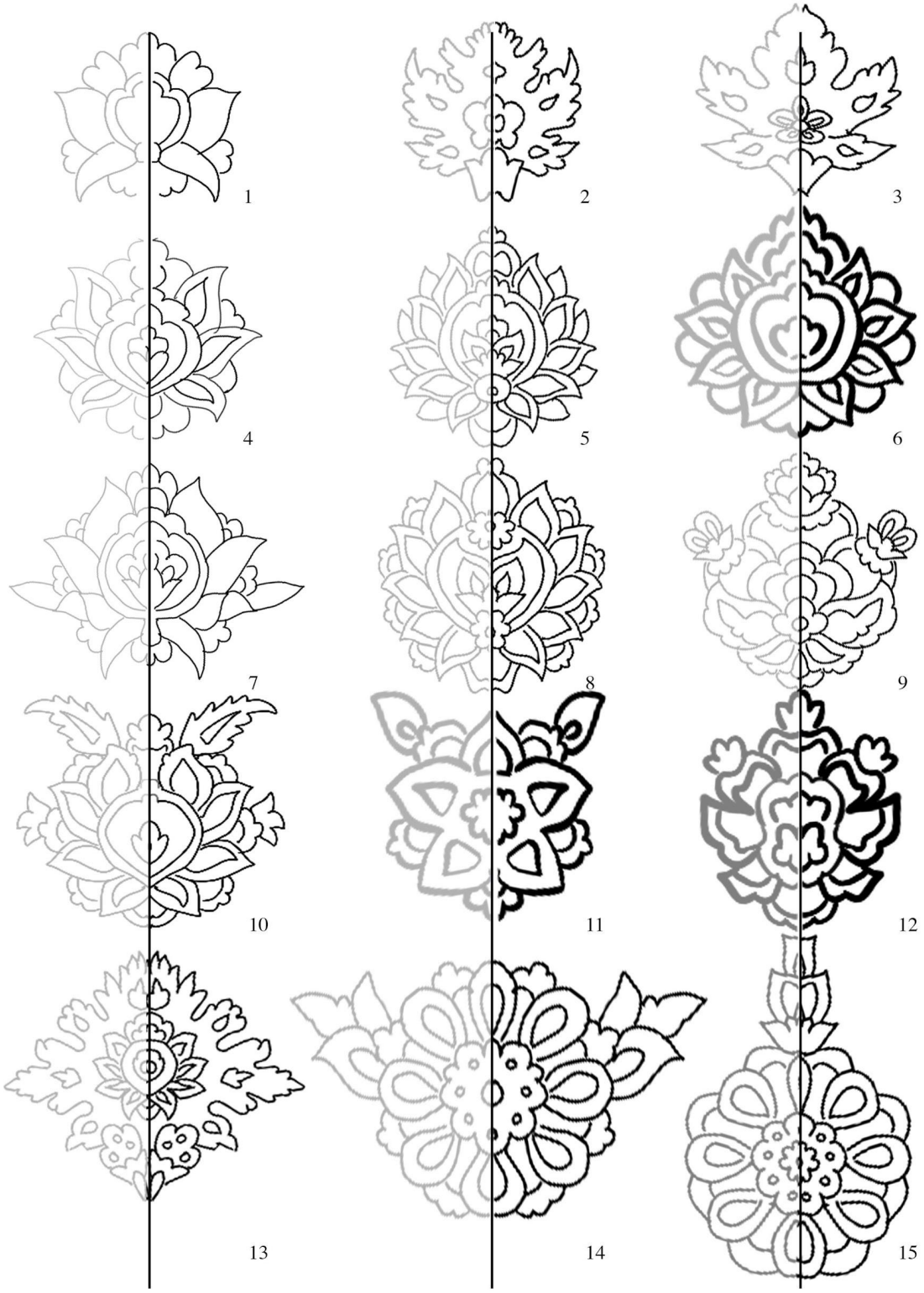


Figure 7.18: Flowers 1-15 with bilateral symmetry in Sheikh Lutf Allah Mosque.

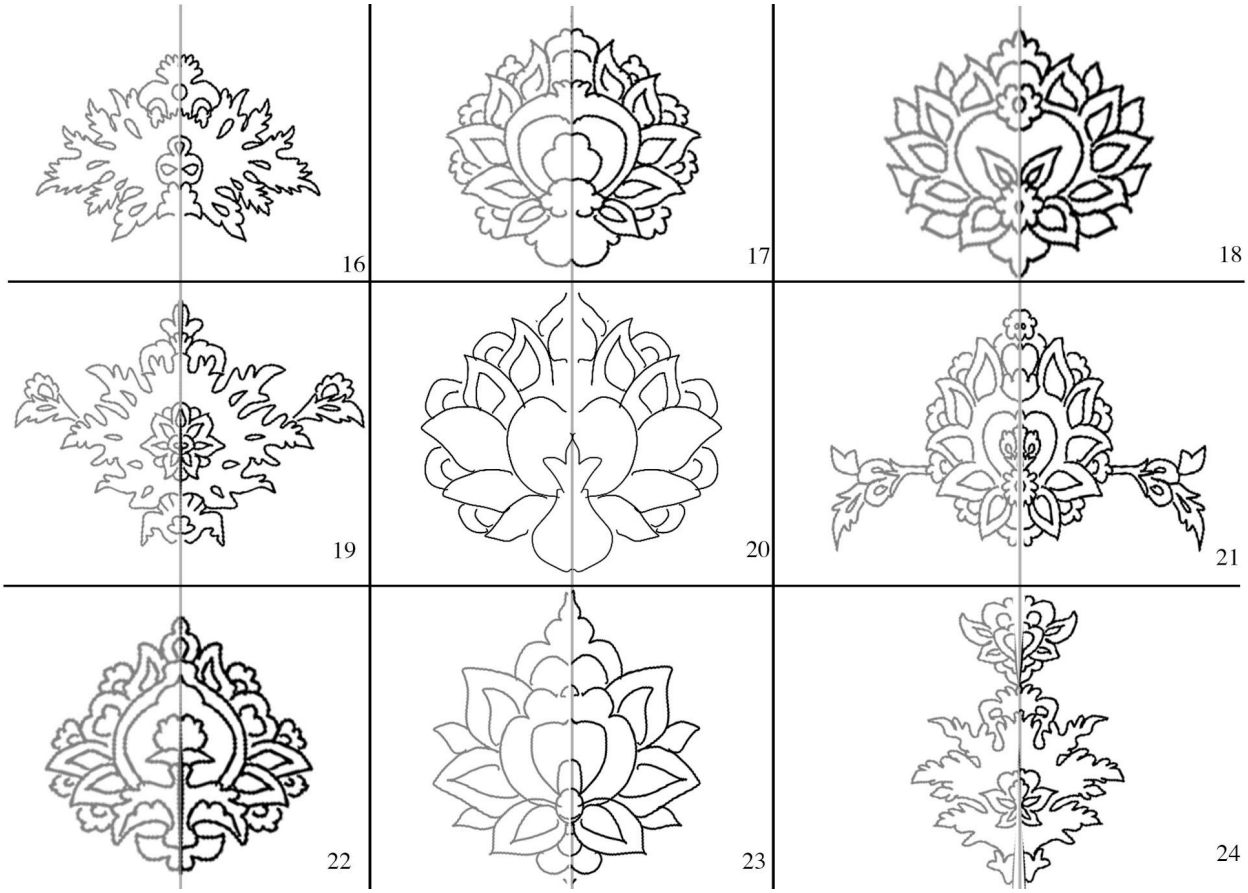


Figure 7.19: Flowers 16-24 with bilateral symmetry in Sheikh Lutf Allah Mosque.

7.3.1.2.4 Asymmetrical flowers

Asymmetrical flowers in Sheikh Lutf Allah Mosque contain some sort of symmetry in the middle, but then the main change that causes the asymmetry is the addition of flower buds and side leaves as shown in figure 7.20. This can transform a regular symmetrical flower into a new motif and it also adds further detail and complexity.

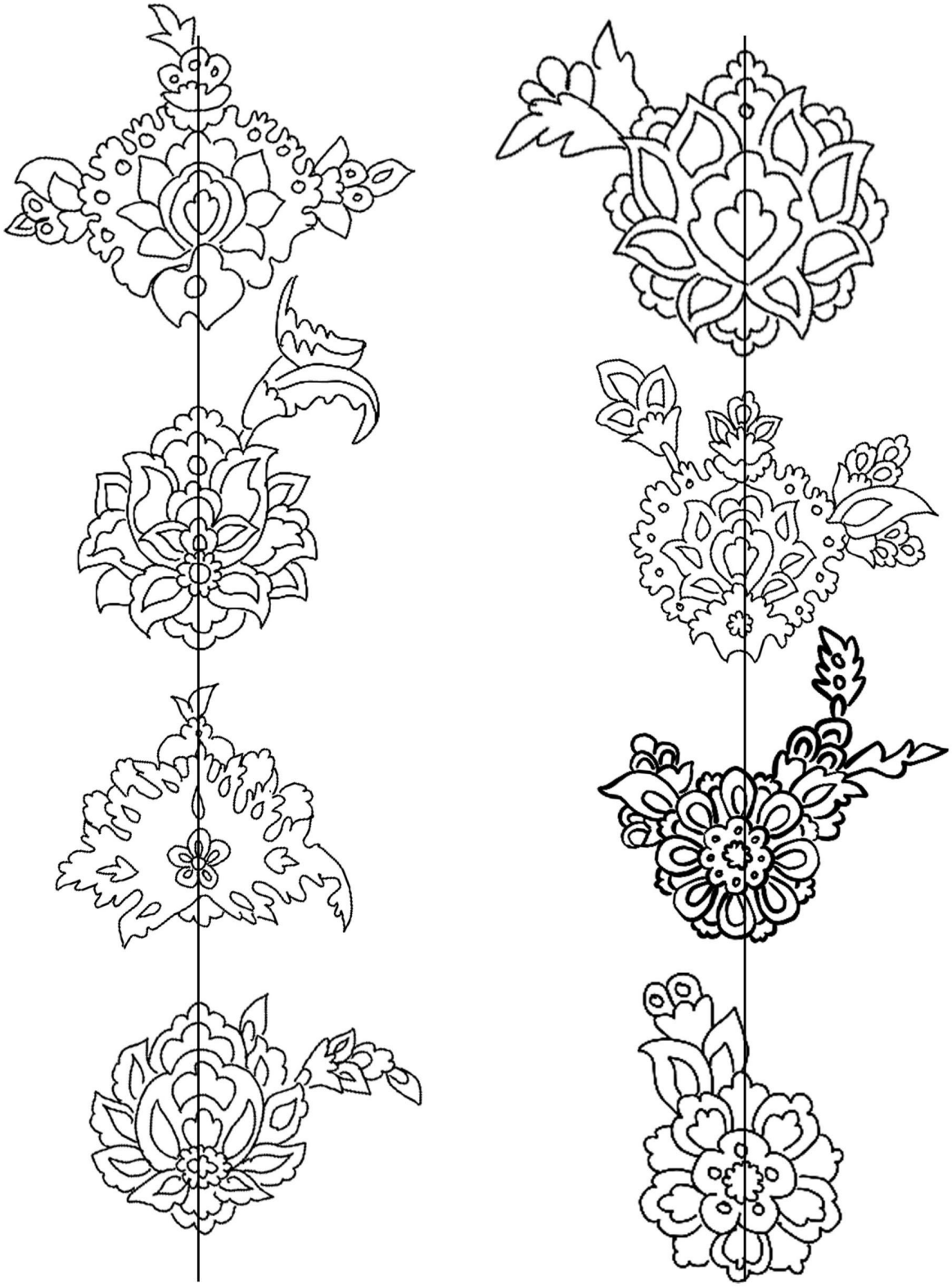


Figure 7.20: Asymmetrical flowers in Sheikh Lutf Allah Mosque.

7.3.2 Shah Mosque

The motifs in the Shah mosque are very similar to the previous mosque, Sheikh Lutf Allah Mosque, since they have been designed in the same period and by the same Safavid ruler. Hence, there are minor differences between them. However, I preferred to assemble the motifs of each mosque separately to create its own database. This will enable future researchers, artists or designers who might be interested in studying or reproducing the biomorphs of one of these mosques separately. Following are Shah Mosque Islimi motifs (figure: 7.21), khatei motifs of flower buds (figure: 7.22), leaves (figure: 7.23) and symmetrical flowers (figure 7.24) that are very similar to Sheikh Lutf Allah's motifs.

7.3.2.1 Islimi Motifs

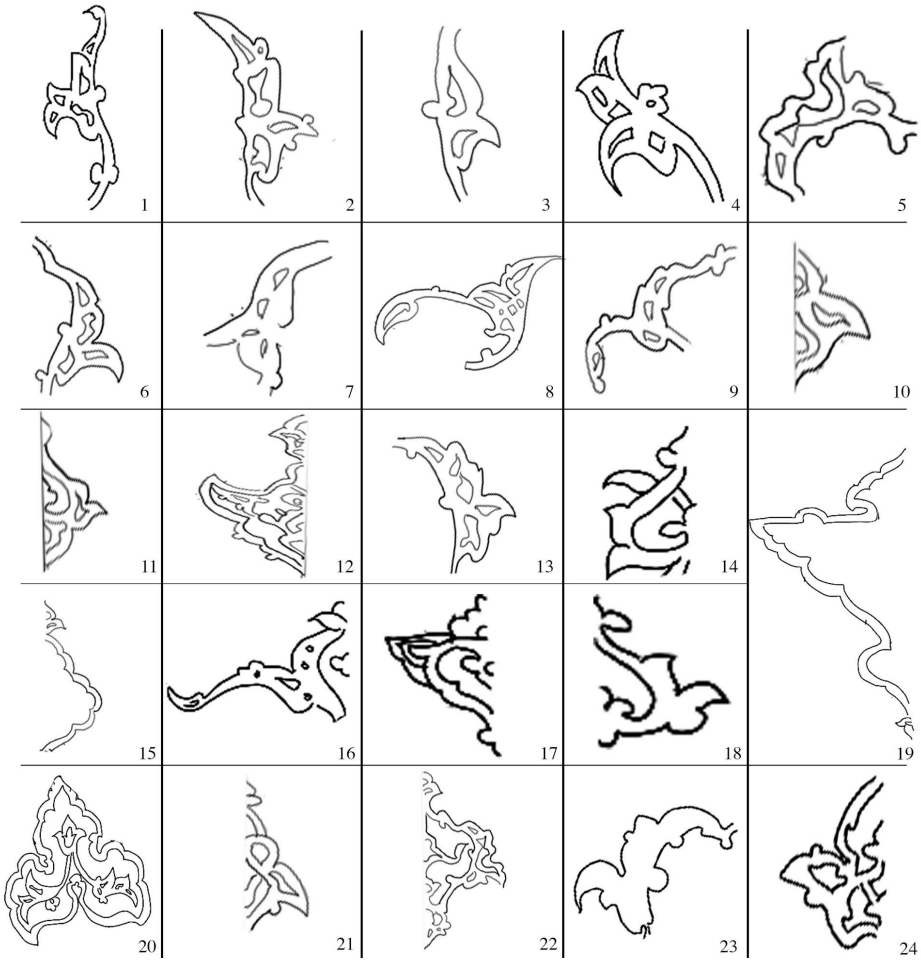


Figure 7.21: Islimi motifs in Shah Mosque.

7.3.2.2 Khatei Motifs

7.3.2.2.1 Flower buds

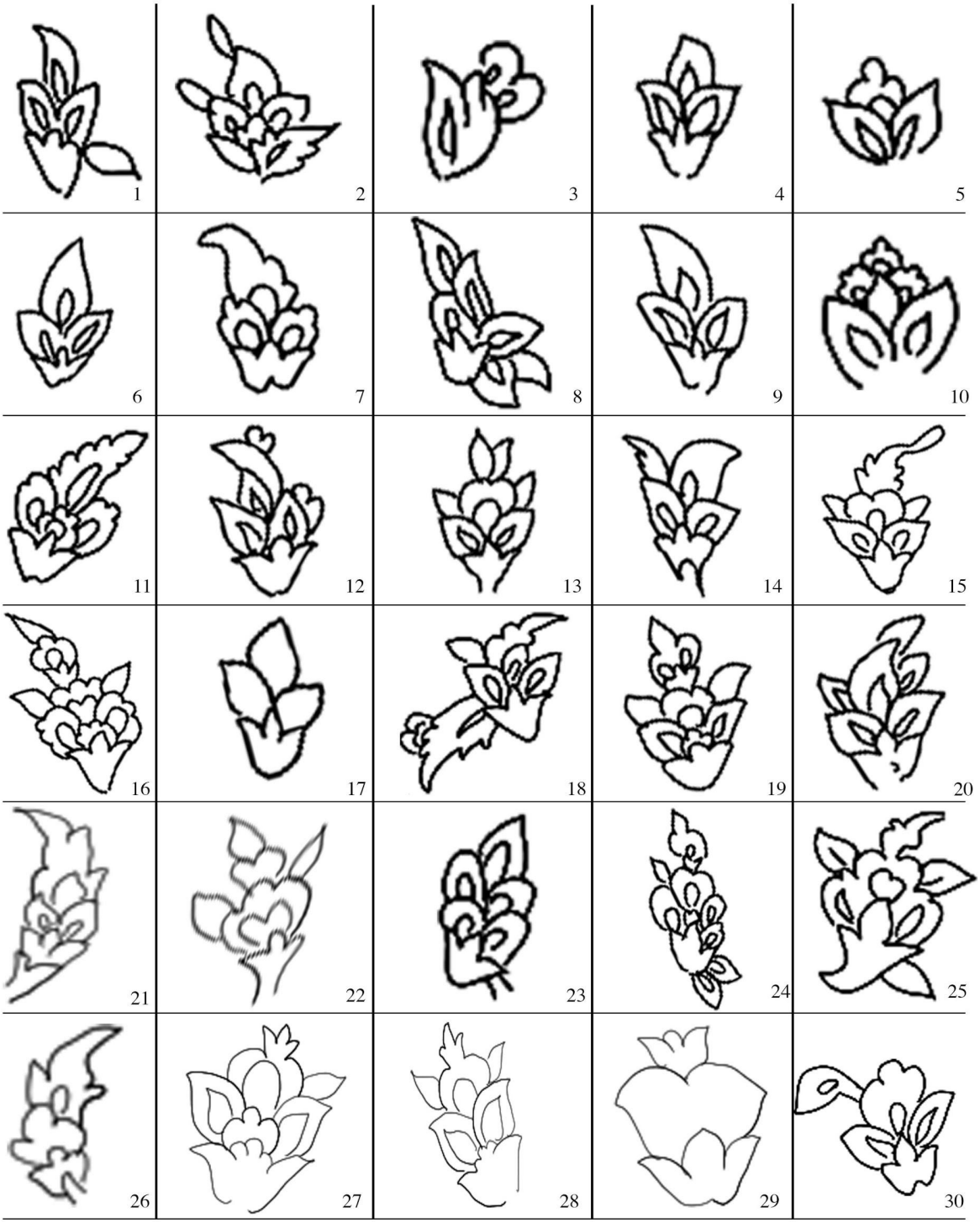


Figure 7.22: Flower buds in Shah Mosque.

7.3.2.2.2 Leaves

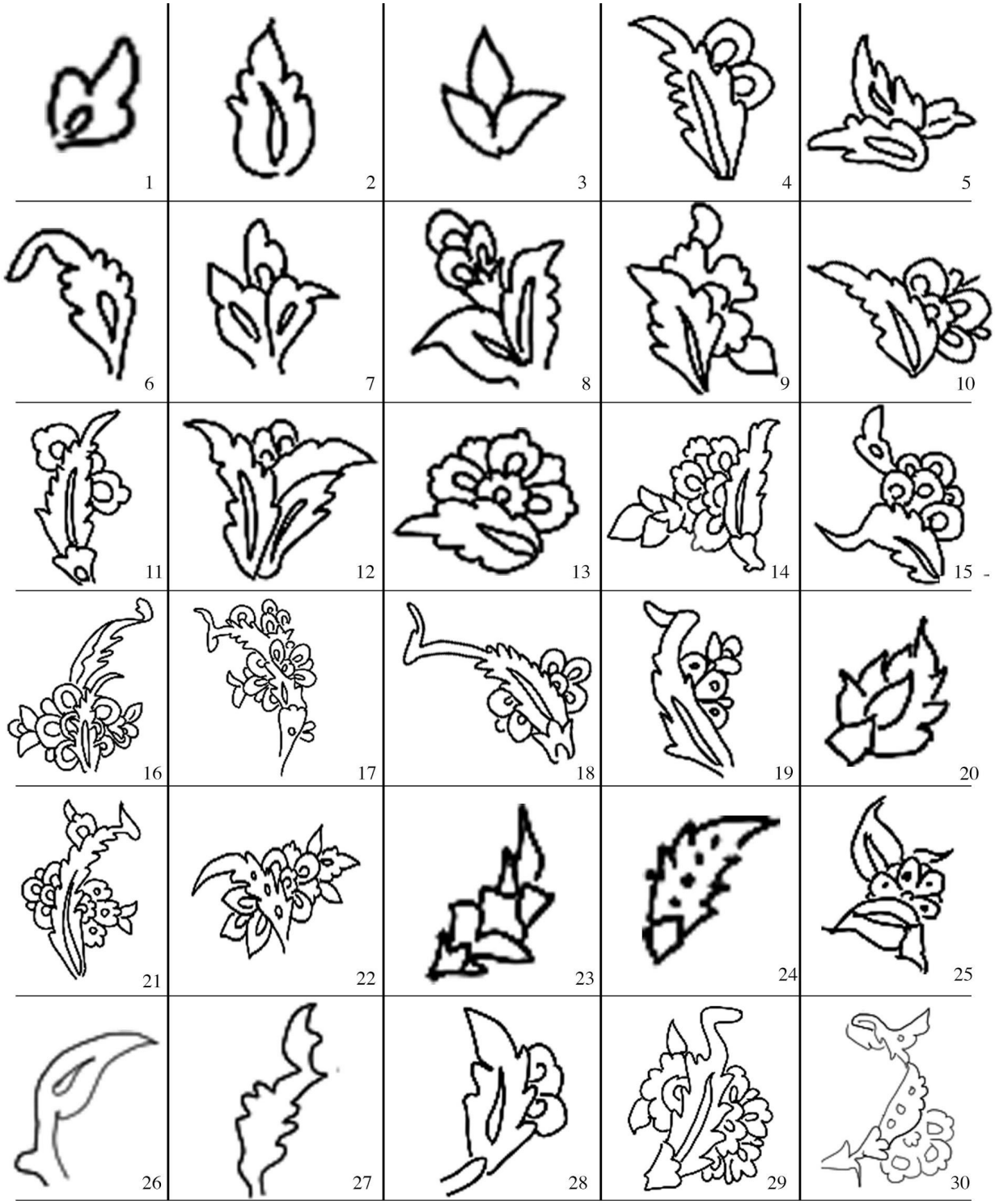


Figure 7.23: Leaves in Shah Mosque.

7.3.2.2.3 Symmetrical flowers

Similar to the symmetrical flowers of the previous mosque, the focus is on flowers with vertical bilateral symmetry, *hatayi*, (See figure 7.24).

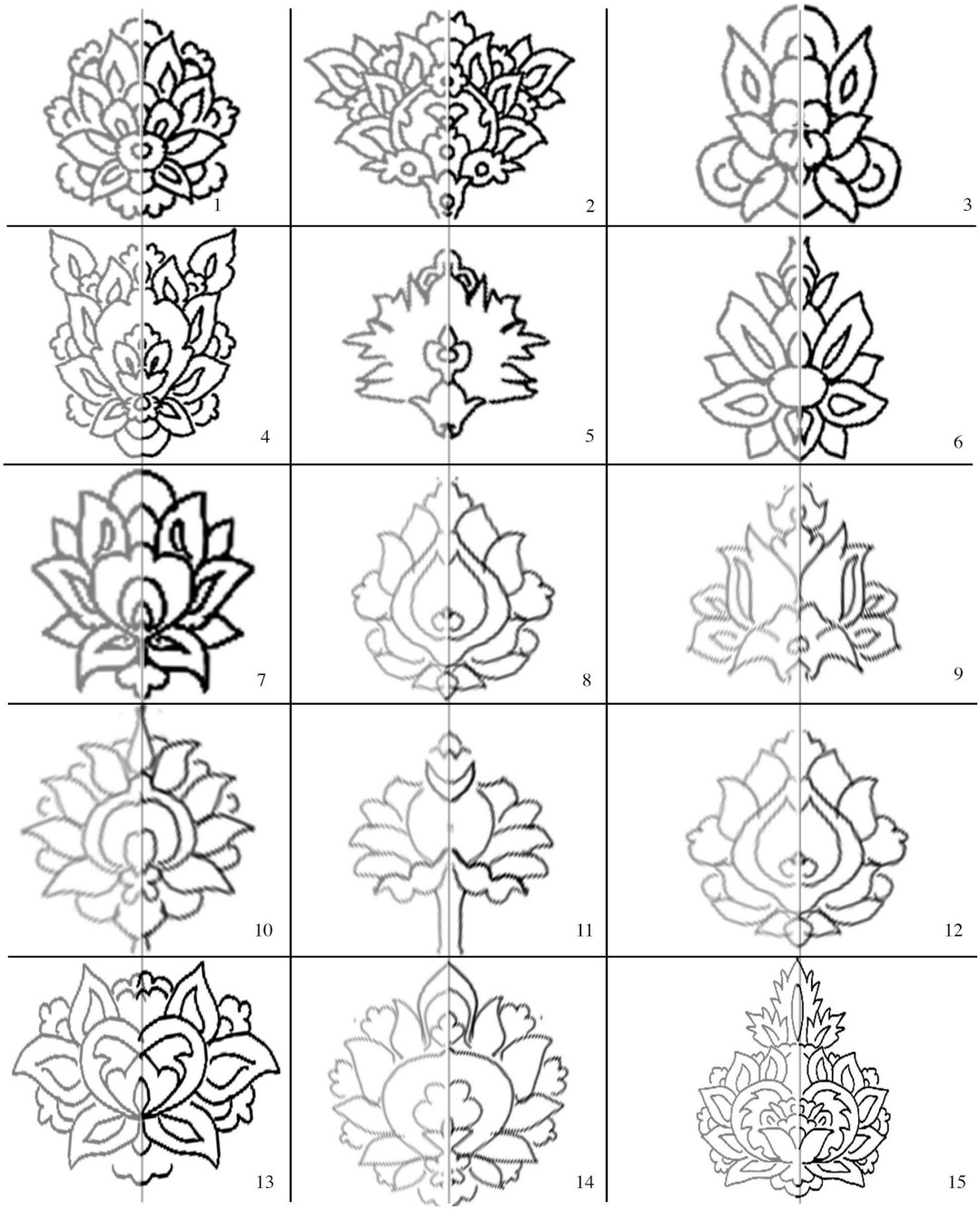


Figure 7.24: Symmetrical flowers in Shah Mosque.

7.3.2.2.4 Asymmetrical flowers

A type of asymmetrical flower that I did not observe in the Sheikh Lutf Allah's mosque is the flower clusters and most of them come from the inner dome tiles. These flower clusters occur in the natural botanical world and they are referred to as flower-heads or more scientifically as inflorescence, but both are general terms and the cluster name can be more specific depending on the type of floral cluster that it describes. For example, corymb "flat-topped flowerhead, where the individual flowers arise from different points on the stem, as in common hawthorn" (Hodge and Maughan, 2013, p.71). Examining the common hawthorn flower cluster in figure 7.25 shows the similarity between them and some of the floral clusters in the database in figure 7.26. Coincidentally, hawthorn grows in Iran and it is known as *zalzalk* and it is eaten as a fruit (Acta Horticulturae, 2021). This might be one of the inspiring plants for flower clusters due to its prominence in fruit production and relative approximation with the area at the time, and it is interesting to connect the floral motifs to the botanical world and the environment of the region where the mosque was built.

Figure 7.25: Common hawthorn (Zelenko, 2005).

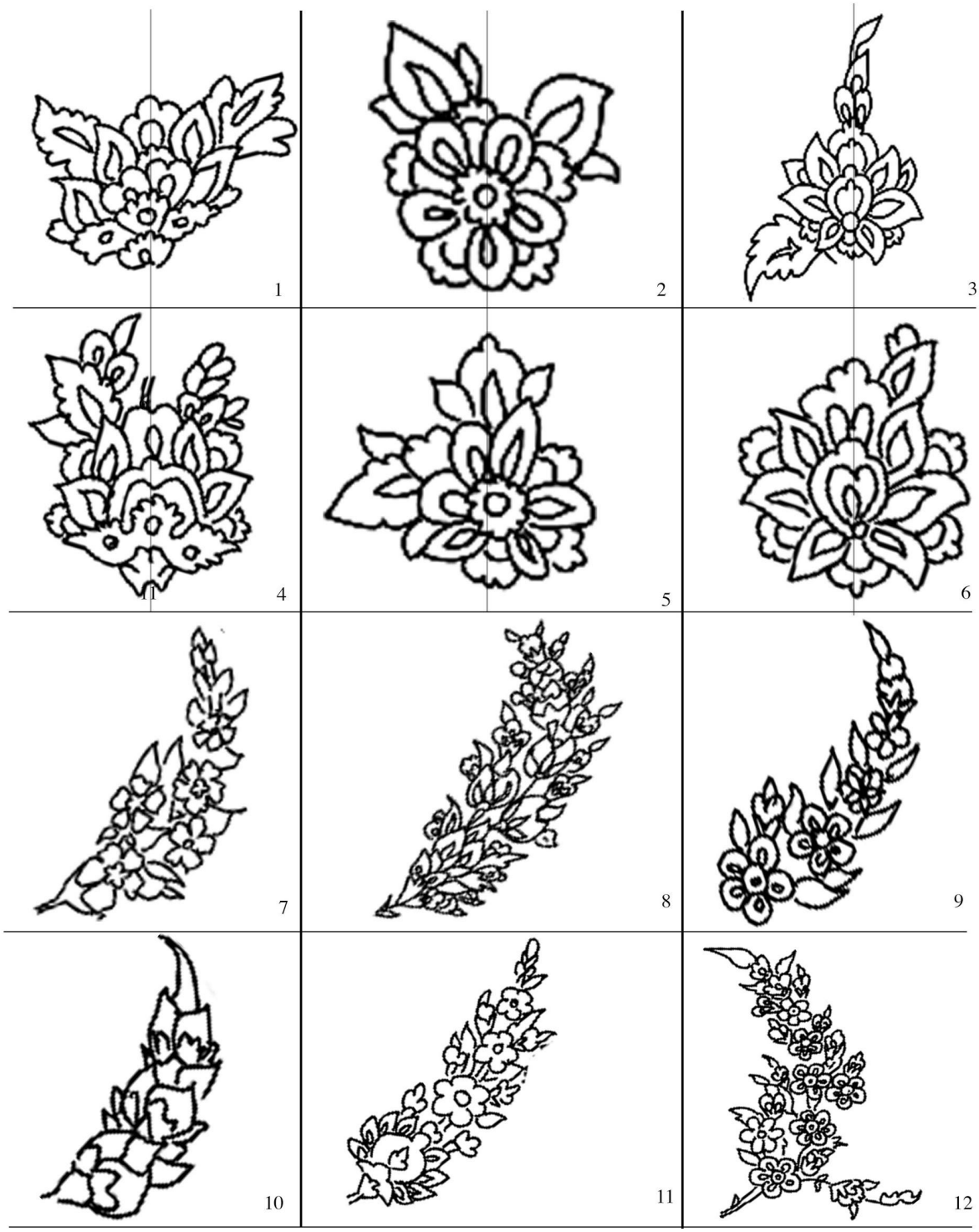


Figure 7.26: Asymmetrical flowers in Shah Mosque.

7.4 Creating patterns from the database

The purpose of the motif database in the previous sections are to help designers and practitioners use the Safavid visual language of the biomorphic patterns to create their own work with the following section investigating and identifying how the database can be used and utilised further with the following two cases. Note that these cases follow the same order of pattern making used in the pattern analysis chapter.

The first step is to choose a type of symmetry whether it is rotational or bilateral. If it is rotational, then a geometric system of five-, six- or eight-pointed star needs to be determined. The second step is to find the repeat unit in the pattern to begin the design process. Further below I have two cases presented as a practical example, the first following the eight-pointed star rotational symmetry and the second adopting bilateral symmetry.

7.4.1 Case one: Rotational symmetry using an eight-pointed star

For this example, the rotational system that will be used is the eight-pointed star. The process starts with the geometrical construction of an eight-pointed star that was listed in chapter 6. Following that is the addition of central islimi motifs on the two midlines of the section, where the primary islimi spiral emerges. Afterwards, central floral motifs are also placed on the central lines of the section in between the islimi shapes. The floral spiral springs from the central floral motifs. The placement of additional flowers on the secondary spiral is chosen based on the available space and the direction of the spiral.

Step 1: Construct the underpinning geometry that you want for your biomorphic pattern. In this case, I am using the simple eight-pointed star system. I divided each 8^{th} into two, which results in 16 divisions meaning that each quarter of the geometry will have 4 sections with two repeat units. Every repeat unit includes a design section and a mirrored section. The lines within the section can assist me further and you can increase the construction line by adding additional eight-pointed stars within.

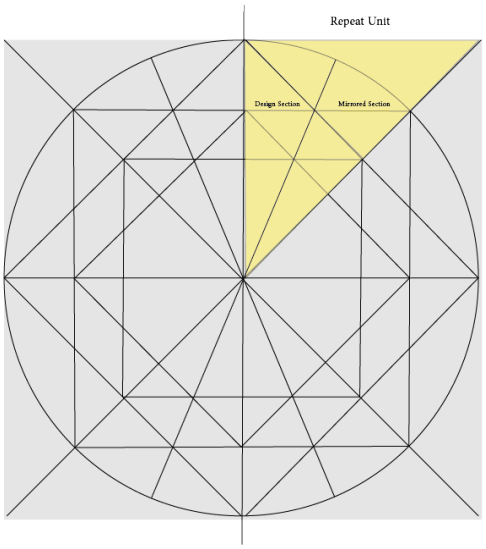


Figure 7.27: Step 1 of case 1.

Step 2: This section provides two symmetry lines:
A & B and I will choose islimi shapes from the motif database to go on there. I am also employing different direction on each line. Elements on A are facing outward, where elements on B are facing inward.

Step 3: I intentionally left space between the islimi, so I can place the bi-symmetrical central flowers. They follow the same direction as the islimi shapes.

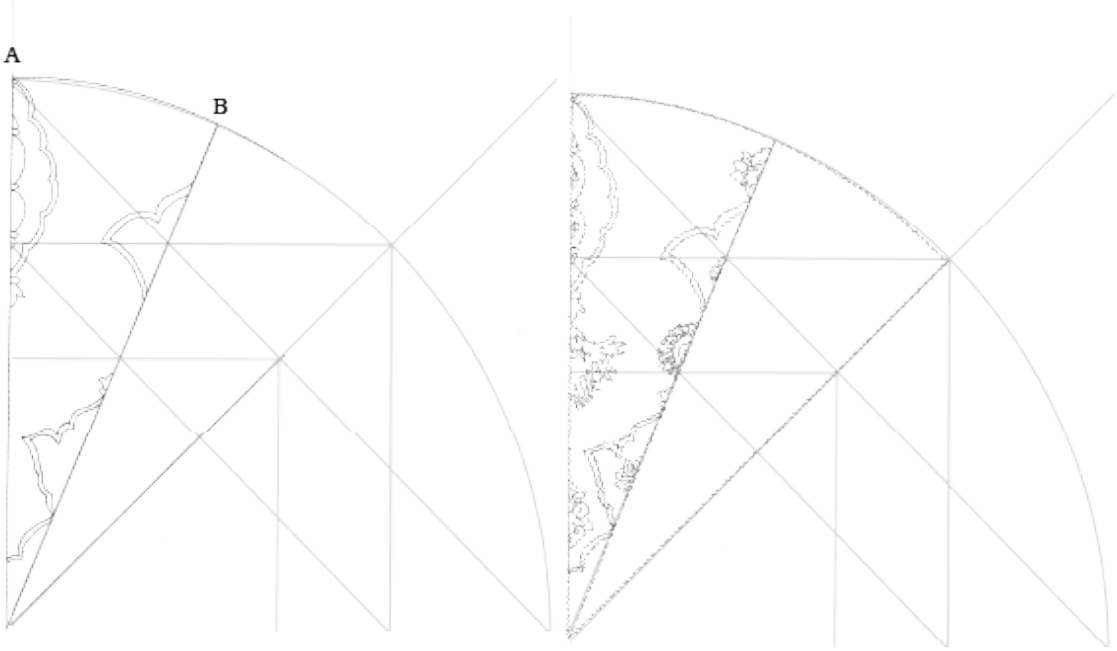


Figure 7.28: Step 2-3 of case 1.

Step 4: The islmi shapes are the starting point for the islimi spiral and I chose two points of emergence: C & D. The C spiral comes out from outwards and then inwards into itself with two branches on the right and left. Spiral D also comes outwards and inwards and it has a smaller spiral coming out of it. These spirals were drawn by hand but follow the style of the Archimedean spirals. They could have been also done geometrically.

Step 5: Flowers can also provide a starting point of spirals or branches. I added branches that emerge from the top and the bottom of the flowers. Even this simple addition can give another level of complexity to the pattern.

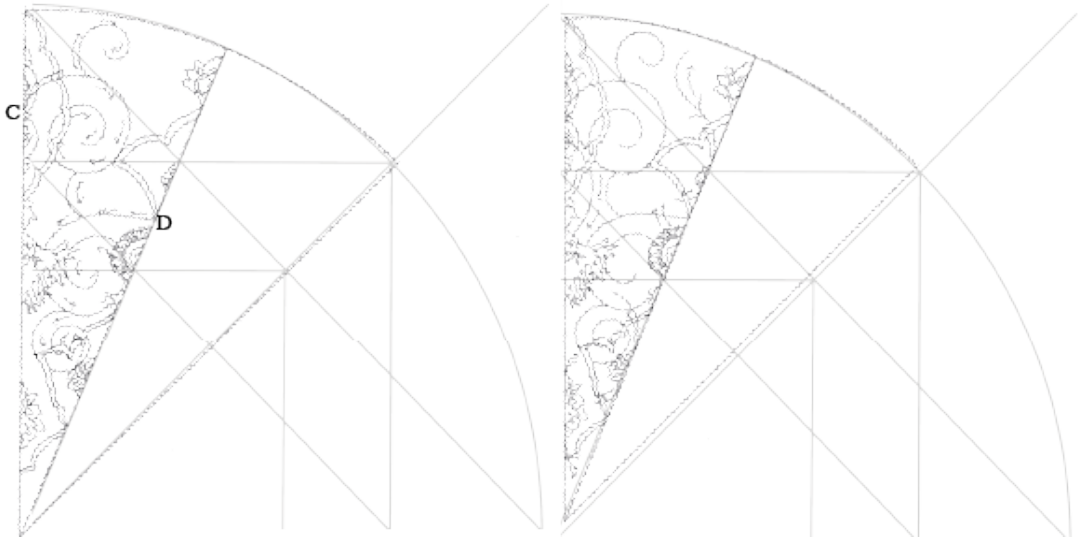


Figure 7.29: Steps 4-5 of case 1.

Step 6: Islimi spirals have additional elements and I added pelmets at the end of the spirals and the sides and connective islimi before the spiral split into two. These elements give thickness and detail to the spiral and the design overall.

Step 7: I added khatei elements to the floral branches and the follow the same direction of the branches. The top branches have flowers pointing upwards and bottom branches have flowers and leaves pointing downwards. Full flowers are in the middle of the branch and flower buds are at the end.

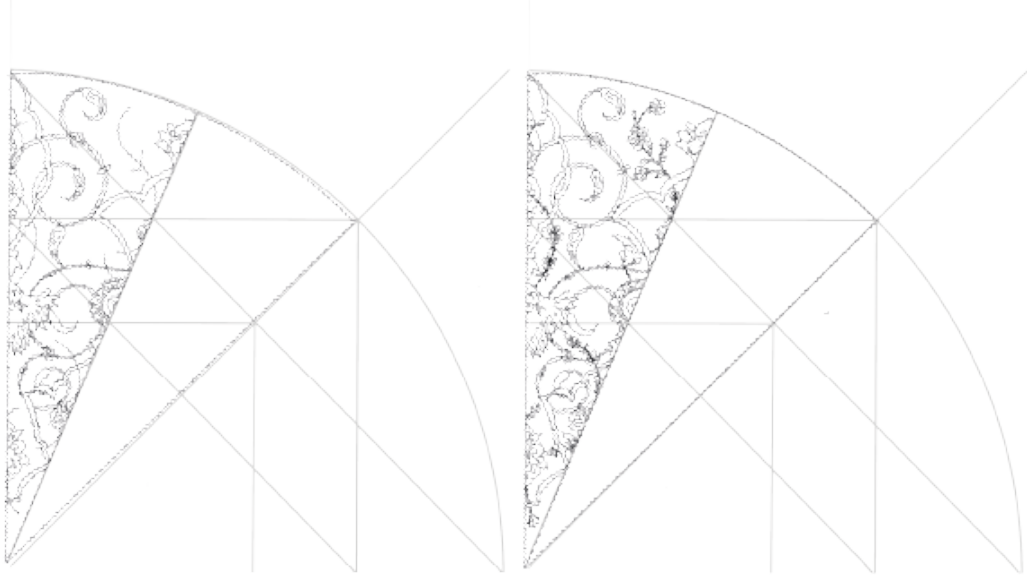


Figure 7.30: Steps 6-7 of case 1.

Step 8: Mirroring the section can reveal more elements of the design that can be corrected if needed. The half islimi shapes become closed. The mirroring stage helps us see how the spirals and the floral branches work together when they reflected.

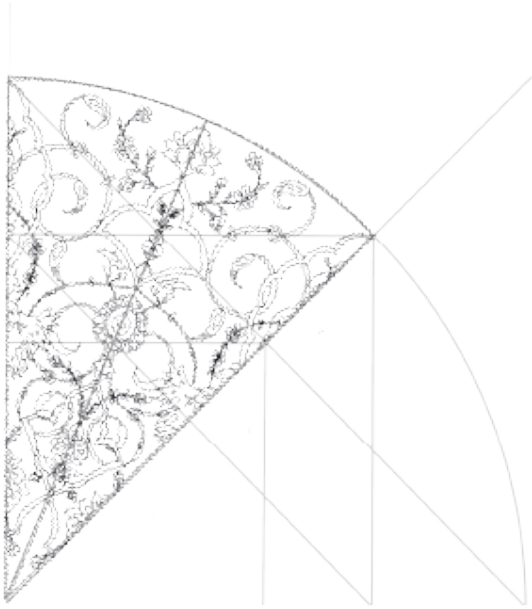


Figure 7.31: Step 8 of case 1.

Step 9: Filling the whole space with the pattern gives us a better idea of how it will look and then colouring is further utilised to fill and emphasise certain areas and certain relationships of smaller spaces. The design does not stop until the colours are determined and added.

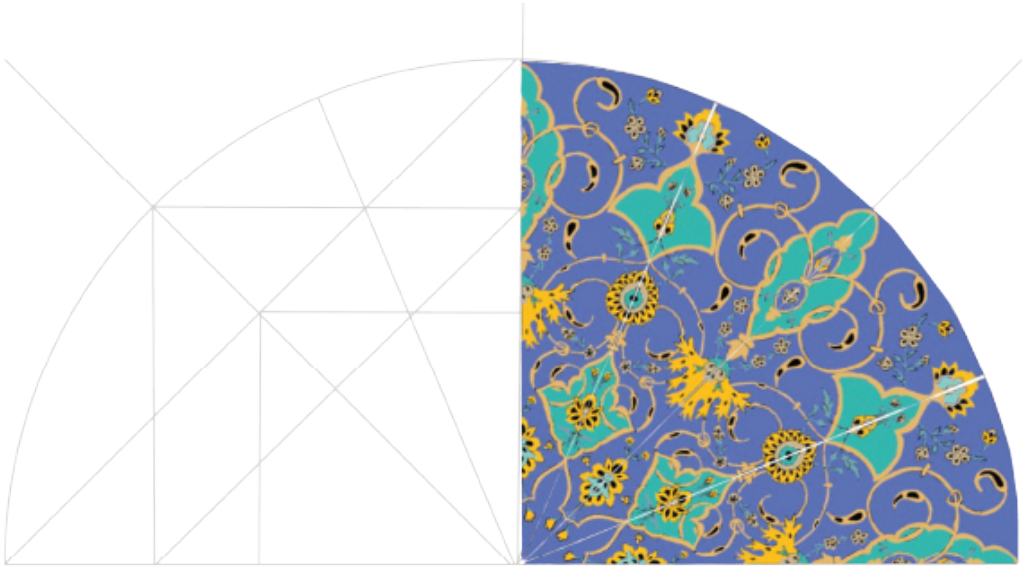


Figure 7.32: Step 9 of case 1.

7.4.2 Case two: bilateral symmetry

Panels with pointed arches are a very popular feature of the Shah mosque, thus, using that type of panel as the case will be a logical and useful example of application.

Step 1: The pointed arch construction provides a midline that can be the starting point of the design. I placed three islimi elements on there and one khatei element. The elements are drawn as a half unit rather than a full shape to assure a symmetrical shape when it is mirrored at the end of the steps.

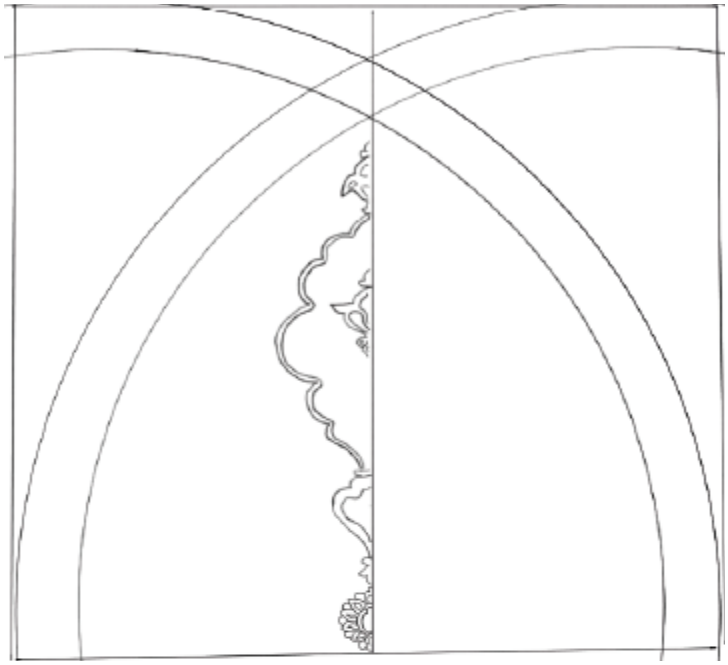


Figure 7.33: Step 1 of case 2.

Step 2: An isimi shape is the beginning point for islimi spirals and I chose the second shape to be that point. The first archimedean spiral emerges in an upward clockwise direction and the second spiral comes from the side of the first in a downward anticlockwise direction. A connective islimi shape is placed at the starting point of the second spiral. Islimi spirals are primary and in the foreground. The floral spiral works in a similar way, where it emerges from the flower

placed on the midline. Five floral spirals emerge from that point and they become secondary spirals since they are placed behind the islimi ones.

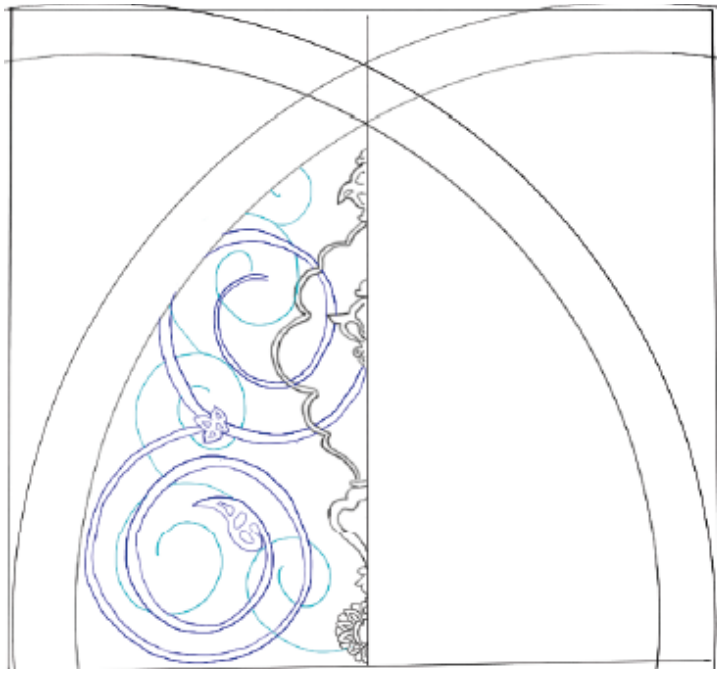


Figure 7.34: Step 2 of case 2.

Step 3: With both spirals placed in the drawing, circles are drawn on the islimi spiral to mark spaces that need more islimi shapes. Additional circles are drawn on the floral spiral to indicate the placement of flowers. The choice of placement is the contribution of the artist or the craftsperson. The two general rules are to fill the empty space and connect elements to each other, so nothing is floating in the space and to follow the direction of the spirals.

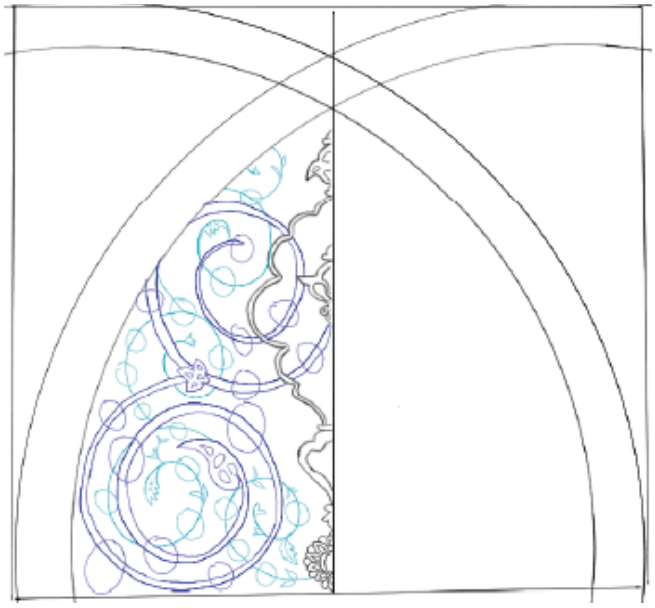


Figure 7.35: Step 3 of case 2.

Step 4: The floral motifs are added first and they come from the motif database. There are many elements that came from the database such as leaves, flower buds, symmetrical flowers.

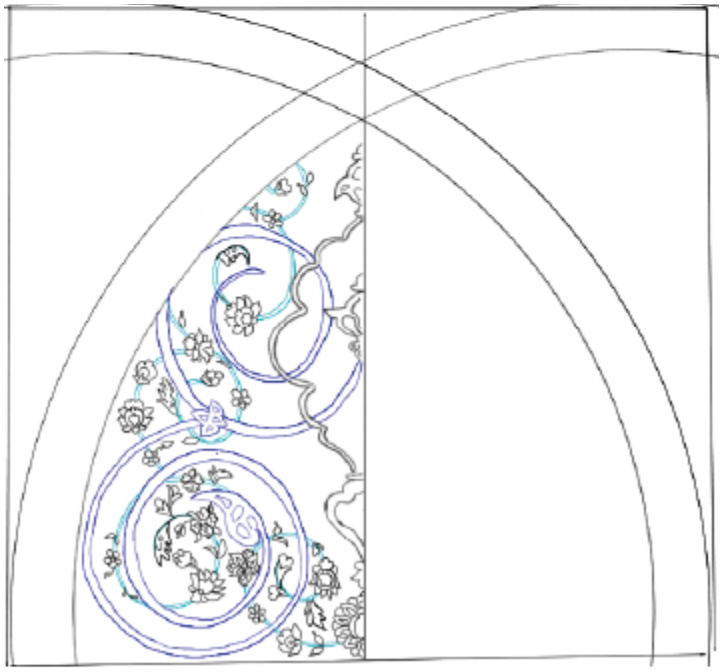


Figure 7.36: Step 4 of case 2.

Step 5: Islimi pelmets are added to the islimi spiral and I have added some cloud shape motifs into the background. The cloud motifs are mentioned in the analysis and a lot of the cloud shapes

have very simple forms. The addition of clouds is another element that is attributed to the artist or the craftsperson creative license.

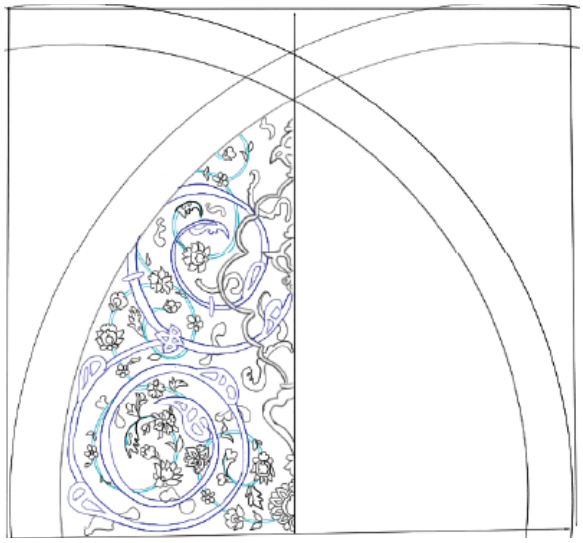


Figure 7.37: Step 5 of case 2.

Step 6: I added a simple S shape spiral unit to frame the pattern following the arch line.

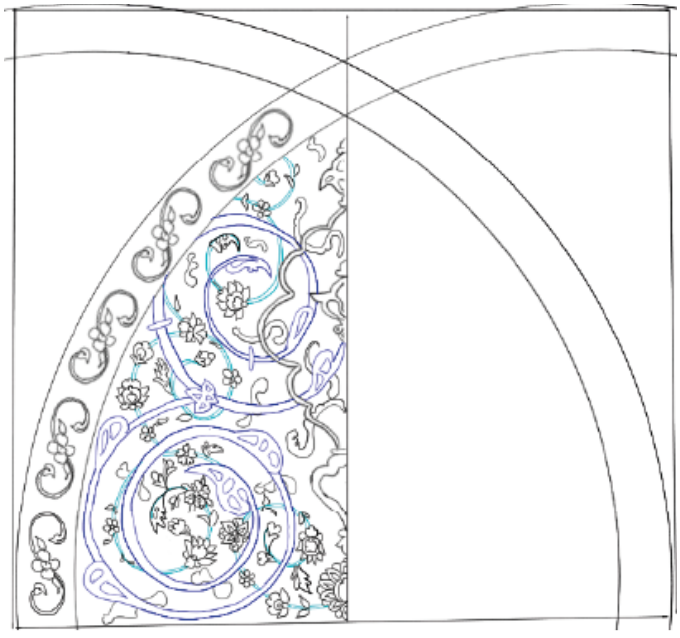


Figure 7.38: Step 6 of case 2.

Step 7: The design is mirrored to have a complete panel. Moreover, the design needs to be coloured because colouring can provide additional visual information and distinction between pattern elements. I used colours that appear in Sheikh Lutf Allah's and Shah's mosque. I

coloured the islimi spiral and the islimi elements in yellow, the floral spiral in light blue, the flowers in yellow, white and blue, the clouds in white and some of the backgrounds in light green.

Figure 7.39: Step 6 of case 2.

7.4.3 Further consideration

In this thesis, the biomorphic patterns were studied as two-dimensional entities on paper and ceramics, but there are further considerations that future practitioners need to be mindful of if they intend on applying these patterns in three-dimensional spheres. We are lucky that we have architectural software like 3Ds Max and Revit that will help in generating solutions for designs in three-dimensional spaces, however, practitioners need to be aware of the suggested pattern qualities listed in chapter 7 in order to replicate effectively within any of these software solutions.

Moreover, practitioners need to be aware of the medium they are using and its limitations. In my ceramic experiments in Chapter 5, I was limited in drawing a certain scale because I needed to leave space for the manganese black outline and applying glaze had a different feel in comparison to applying paint. With designs made on paper, motifs can be close to each other with a great amount of details and in a very small scale (figure 7.40). However, a full comparison between media is beyond the scope of this research.

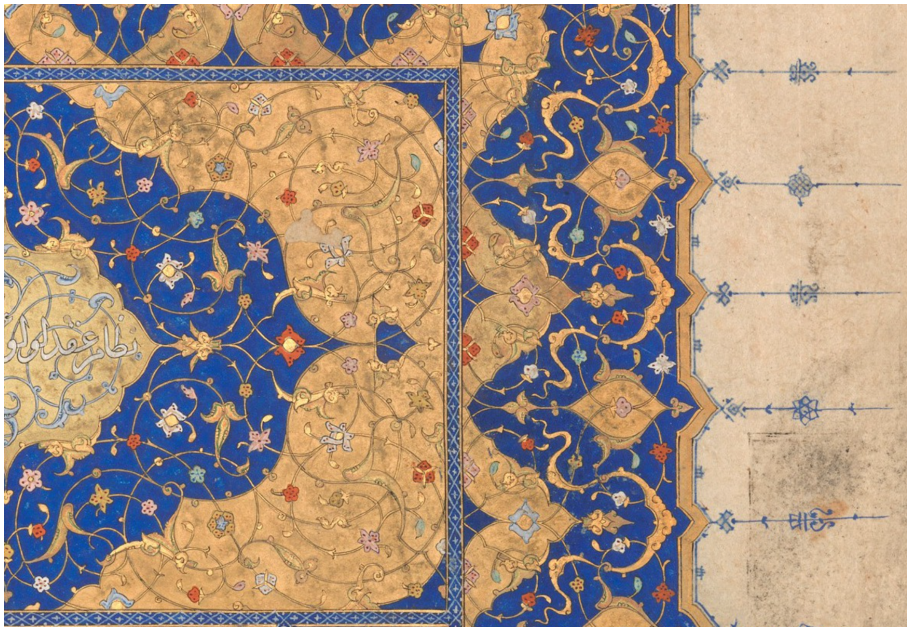


Figure 7.40: Details of Khamsa of Nizami 1509–10 (The Met Museum, 2021).

Chapter 8: Conclusion

8.1 Introduction

This thesis was motivated by my professional experience as an Islamic art and patterns practitioner, tutor and researcher. This has led me further in order to specialise on Islamic ornaments, more specifically the biomorphic patterns and motifs that use nature as the main inspiration. Since the Islamic period is vast, extending from the 7th century until the 19th century and geographically expanded from Spain to India, I had to select a specific time period and a geographical location to focus the research on a manageable amount and to conduct a fair and

equal analysis. I did not want to repeat the same approach I have highlighted in the literature review of the broad and generic studies of Islamic art that attempt to discuss the entirety of Islamic art and architecture and then fall short in giving attention to details such as ornaments and patterns, which is where we find the least amount of previously documented study available.

Thus, I chose the Safavid period (1502-1722) since it is known for its unique ceramic industry (Mason, 2003) and the designs exhibited a high standard of biomorphic patterns. Additionally, Necipoğlu (2015) specified that after the 15th century there was a change in the taste of the patronage and a special interest in floral motifs had developed. Moreover, my experience as an artist, my exposure to Safavid art during my visits to Iran and the minimal availability of information on Safavid biomorphs in the literature were also motivating factors in this topic choice, so as to fill the gaps we currently see in the literature within this field of knowledge.

8.2 Discussion

Biomorphic patterns, as the name suggests, come from the natural and organic world. The Islamic biomorphs are highly stylised vegetal motifs and are not a literal representation of nature. This type of pattern includes two types of motifs known in Persian as islimi and khatei. The islimi type includes organic patterns that do not have a direct natural source whereas the khatei one is inclusive of all plant, fruit and floral forms. The style of biomorphic patterns in the Islamic world retains a unifying quality where a lot of shapes are repeatedly used on all media from architectural surfaces to objects and textiles. From the various applications of biomorphic patterns, I am interested in their application on the ceramic architectural surfaces of walls and ceilings of mosques.

Several concerns were raised in the literature review such as the vagueness of the term “Islamic art”, the European gaze on arts from the Islamic lands, and the minimisation of the role of biomorphic ornaments. These concerns were first raised in the 20th century and they are still concerns now in the 21st century. Although there are more publications in the field of Islamic arts especially in recent years, the majority remain general without addressing these concerns.

Two recent publications (Blair and Bloom, 2019; Shaw, 2019) question the term "Islamic art", but the outcome of such discussions led to more uncertainty and the term remains unclear, which does not really resolve the issue. Pope (1965) suggested categorising Islamic art by referring to the ruling period and the geographical location and that is the approach I have adopted in this research, by choosing the Safavids ruling period. It is not a perfect solution, but it does resolve those uncertainties and allows for a focused analysis of the patterns and motifs to be conducted when relating them to a specific period and region. Renaming the Islamic art field and redefining it will be an interesting subject of research for future scholars.

In terms of the European gaze on arts from the Islamic lands, that type of conditioning and views on Muslims and their art cannot be undone with a single research project. This is a recurring topic that is beyond the scope of this thesis, but part of the solution can be in the encouragement of Muslim scholars to contribute to the discussion since they are familiar with their own culture and its visual language. Additionally, Non-Muslim researchers can still enrich the field if they take the sociocultural context of Islamic art into consideration rather than studying art, and architecture, as separate entities from their intended culture and religion. There is socio-psychological discussion to be had there on the best approach and I believe the more interpretations and discussions can only be a positive one, but again this conversation is beyond the scope of this thesis.

The third concern discussed in the literature review was the minimised importance of biomorphic patterns since most scholars only mention it in passing without insightful and in-depth examination and evaluation, so I am hopeful that this research might change some misconceptions and showcase biomorphic patterns as a meaningful and recognised visual language from the past that can be utilised further in future design.

It is interesting to highlight that the work that has already been done in the field of Islamic biomorphic patterns, in general has been limited and newcomers to this art find it confusing to learn independently without a teacher. The tradition of the apprentice in arts to learn is still practiced in Iran and Turkey, among other Islamic countries, and the accomplished students of the masters usually focus on producing art rather than teaching it. In this research, I provide

pattern principles for analysing and reproducing biomorphic patterns that can assist emerging artists, craftspeople and practitioners.

As a result, there are two ways to employ the thesis, either by using the analysis as outlined in Chapter 6, which could potentially be applied to other biomorphs from other Islamic periods or by using the motif database provided in Chapter 7 in pattern creation which is in itself a stand-out asset as this level of study has not yet been done by previous scholars. Developing a database allows for thorough analysis to be conducted and developed upon in future, in order for others to gain a more detailed understanding of the subject.

Analysing patterns is a way of observing and decoding the visual language of a motif starting with understanding the pattern grid structure, such as the type of symmetry, geometry and repeating unit. Then focusing on the motif itself one by one, which can be an informative and intricate process. Tracing and redrawing motifs gives an insight to the craftspeople's hand-skills and how they added their own creative licence while painting and drawing the same stylised flower.

The analysis method I used can be applied to Ottoman, Mughal and Qajar biomorphic patterns to generate more motif databases which are needed to enrich our understanding of the visual language used during the various Islamic periods. Having these databases will allow scholars to do comparative studies of the different biomorphic styles as well.

Examining the patterns has enabled me to collect the motifs that appeared in them in a database that can be used as a reference for artists who want to use the Safavid visual language. At the end of chapter 7, I tested the database and the pattern principles by creating two example patterns to investigate the process further. The produced patterns were created easily by following the rules and there are endless possibilities in how the findings can be employed in future patterns. This process can be generalised and further adapted to much greater extents. However, the practitioner has to have skill, creativity and a good understanding of proportionality to be able to generate patterns effectively.

The application of these patterns is not only limited to ceramic tiles and architectural spaces, the same motifs are used abundantly within other media and other artistic forms such as manuscripts, pottery, weaponry, textiles and more. In figure 8.1 a biomorphic pattern appears on a Vase carpet that dates to the 17th century, a brass jar from the 16th century, a leather manuscript cover from the 16th century and a ceramic tile panel from the Shah mosque I studied earlier. All of these applications were during the Safavid period and it shows how versatile a biomorphic pattern can be.

Vase Carpet, 17th cent | Brass Jug with Inscription, 16th cent | Leather cover of Mantiq al-tair, 16th cent | Tile from Shah Mosque, 17th cent

Figure 8.1: Biomorphic patterns applied on a range of media in the Safavid era showing (from the left to the right): vase carpet, 17th century; Brass Jug with Inscription, 16th century; leather cover of Mantiq al-tair manuscript, 16th century and a ceramic tile from Shah Mosque, 17th century (The Met Museum, 2021).

8.3 Revisiting the research questions

The primary question that this research attempts to answer is:

How to reproduce biomorphic patterns that appear on ceramic tiles of Safavid mosques and use them in design?

Specifically:

1. What are the production techniques of ceramic tiles in the Safavid period?

2. What are the rules and principles of the biomorphic patterns that appear on ceramic tiles of Safavid mosques?

3. How a database of motifs of Safavid biomorphic patterns is used in design?

To answer the questions, I had to rely on the practice-based method since it allowed me to use my artistic practice to support the research enquiry. I also wanted a pragmatic outcome to immerse myself in the practical aspect of the experience of producing ceramic tiles to enrich the research and probe into the process of making ceramics. Moreover, it is important to explore the position of the craftsperson and how their skills impacted biomorphic patterns. When Islamic arts and crafts have been previously discussed in literature, scholars barely mentioned biomorphs and makers apart from Wulff (1966) who investigated the process and visited the craftspeople of Iran in order to specifically document and try to understand the process.

My practice based research required two methods: ceramic technique testing and pattern analysis. The first method is testing the traditional ceramic techniques used during the Safavid period and there are three that were used specifically on ceramic tiles; lustre, mosaic and the seven-colours. The latter is an invention of the Safavid period and it changed the course of ceramic tiles and became the mostly used method.

The scholarly work on Islamic Persian ceramics is limited and it is mostly focused on pottery rather than tiles and although they are similar, there are differences in technique and outcome. In addition, reading about crafts and ceramic methods in comparison to practicing them are two very different things. Practice provides an experience that showcases the limitations and variables that need to be considered, where reading is a literature study with a finite way to gain knowledge for the craft.

From the three ceramic methods I tested, the one that is applied on Safavid ceramic tiles the most is the seven-colour technique. It is a quicker method of creating complex biomorphic patterns, but scale can be a limitation. Moreover, the seven-colour tiles do not have the same colour brilliance that previous ceramic techniques had due to the firing temperature used in the process.

Therefore, seven-colour tiles will not have the same longevity and aging process as previous tiles from earlier eras.

After learning those practical techniques, I transitioned my work from the ceramic surface to the patterns themselves. Thus, the second methodology is pattern analysis of the biomorphic patterns that are present on the ceramic tiles of the two Safavid monuments: Sheikh Lutf Allah Mosque and Shah Mosque. This method included de-constructing the existing patterns to understand and reverse engineer how they are constructed, starting with symmetry, geometric grid and placement of motifs. The chosen patterns were photographed during my study trip to Iran, taking photos and observations of these two mosques subsequently became an additional part of the methodology.

The analysis process included finding the underpinning geometric grids and how they relate to the biomorphic elements, which resulted in an insightful discovery that the craftspeople and their hand skills have a huge amount of contribution in making the pattern. The geometry exists as a framework and as a general rule and guideline, but the choice of motifs, their placement and how the space is populated is usually in the hand of the craftsperson. This could have been a personal effort from the practitioner or most likely, the collective effort of the guild, where the practitioners are taught the same type of motifs. There are personal touches as well in the application of the pattern and in the brush stroke of the artists that made them. In conclusion, biomorphic patterns are based on two aspects: an orderly geometric system and on the creative skill and artistic interpretation of the craftsperson.

Examining the patterns has enabled me to collect the motifs that appeared in them and develop them into a database that can be used as a reference for artists who want to use the Safavid visual language. At the end of chapter 7, I tested the database and the pattern principles by creating two example patterns to investigate the process further. The produced patterns were created successfully and easily by following the rules and there are endless possibilities and variations in how the findings can be employed in future patterns. This process can be generalised and used vastly; however, the practitioner has to have skill and creativity to be able to generate patterns.

And as with any craft dependent on manual abilities and precision the skill is developed over time through a combination of practice and study.

8.4 Further research

This research has answered the research questions regarding Safavid biomorphic patterns, but it has generated a lot of opportunities for further research. My focus was only on the biomorphic patterns of ceramic tiles under Shah Abbas I, but these patterns are also applied to manuscripts, textile and more. It will be interesting to do further comparative studies to test how the patterns change and adapt to the different media. Furthermore, there are so many periods within Islamic history with their own biomorphic contributions and it will be valuable to continue the work of assembling additional motif databases from each period to examine the growth and the development in the biomorphic visual language.

In the analysis, my objective was to examine the geometric grid and the biomorphic motifs and elements. However, there are many subjects that can be investigated within this area such as the reasoning behind choosing a specific geometric grid, the relationship between the pattern and the space it occupies and the placement and distribution of motifs. The analysis of patterns I provided in Chapter 6 presented the biomorphs as line drawings with a brief mention of colour; thus, a study of the drawings in colour could be beneficial to the field and it might yield different results. Moreover, my analysis was two-dimensional, thus, a comparative study with three-dimensional sphere design and how the design can be moved and adapted between the two and three dimensional spaces will be interesting.

In Chapter 7, I observed the strong connection between the khatei motif and the botanical world. Therefore, deeper research in the area of the botany that inspired the Safavid flora and other Islamic period will provide a lot of valuable insight on how certain flowers were stylised. Additionally, comparing biomorphic patterns on ceramic with the ones in manuscripts will provide a fascinating avenue of investigation.

Lastly, The issue that we face as researchers when reading about Islamic art is that the majority of the references and scholarly work studies consider Islamic art as a thing of the past. However, this is problematic as it has severed Islamic art from its sociocultural context. Islamic art should be perceiveded as a continuous tradition that is still practised in many Muslim communities in the Islamic World.

Finally, during the pursuit of my research enquiry and searching for references on Islamic art and patterns in the Arabic language, as an Arabic speaker, I found a limited number of resources in the Arabic language, mostly on Islamic architecture, which calls for establishing and funding more research in the area of Islamic patterns in the Arab countries. This will contribute to reviving the Islamic artistic heritage and strengthening the cultural identity.

Bibliography

Abd Al-Ameer, A. and Abd Al-Ameer, W., 2015. Aesthetic values of the decorations heterogeneities in Islamic architecture. *al-academy*, (73), pp.237-262.

Abd Al-Ameer, W., 2016. Semantic analogy of Quran text Content found in ornamental figures in Islamic Aachitecture. *al-academy*, (76), pp.237-258.

Abdah Mohammed, A., 2003. *Decoration on art objects in Islamic Egypt until the end of the fourth century AH - 10th century AD*. Ph. D. Cairo University.

Abdellahi, S. and Goris, T., 2015. *The geometry of paradise flowers*. Isfahan Mathematics House (IMH), Utrecht University.

Abdullah, I., 2009. Arabesque: The world of a Muslim recited. *Al Mothaqaf Journal*, (1087).

Abdullahi, Y. and Embi, M., 2015. Evolution of abstract vegetal ornaments in Islamic architecture. *International Journal of Architectural Research:* ArchNet-IJAR, 9(1), p.31.

Abisaab, R., 2004. *Converting Persia, religion and power in the Safavid Empire*. New York: I.B.Tauris & Co Ltd.

Aboras, R., 2008. *Islamic decoration as a source for the design of contemporary furniture units*. Masters. King Saud University.

Abumalih, A. and Rabbat, N., 2019. *Islamic Civilisation: Architecture, identity and art*. Cup.

Acta Horticulturae, 2021. *FLAVONOID CONTENT OF HAWTHORN (CRATAEGUUS MONOGYNA) IN IRAN*. [online] Actahort.org. Available at: <https://www.actahort.org/books/765/765_37.htm> [Accessed 22 January 2021].

Adamson, G., 2007. Craft and the romance of the studio. *American Art*, 21(1), pp.14-18.

Adolfloosplzen, 2019. *Adolf Loos Plzen*. [image] Available at: https://www.adolfloosplzen.cz/projects-and-investors-in-pilsen/10-bendova-street/ [Accessed 11 Sep. 2019].

Aghaie, K., 2005. The Origins of the Sunnite-Shi'ite divide and the emergence of the taziyeh tradition. *TDR/The Drama Review*, 49(4), pp.42-47.

Aghamiri, A., 2015. *Sharefah: Spiritual light in Illumination*. Tehran: Honar Saraye Gouya.

Ahmed, A., 2006. *Islamic arts until the end of the Fatimid era*. 2nd ed. Cairo: Ain Shams University.

Akhavi, S., 1996. Contending discourses in Shi'i law on the doctrine of wilayat Al-faqih. *Iranian Studies*, 29(3-4), pp.229-268.

Al-Farabi, A., Mustafa, M. And Al-Nisani, b., 1907. *The total collection from the second teacher, the philosopher of Islam Abi Nasr Mohammed bin Mohammed bin Tarqan bin Ozlgh al Farabi*. Alexandria Library.

Al Ajlouni, R.A., 2005. *Development and evaluation of digital tool for virtual reconstruction of historic Islamic geometric patterns*. Ph. D. Texas A&M University.

Albarn, K., Smith, J., Steele, S. and Walker, D., 1974. *Language of pattern*. London: Thames & Hudson.

Alhamal, E., 2015. Iran. [Online]. Available at: < https://arabianwanderess.com/middle-east > [Accessed 29 January 2021].

Alhamal, E., 2018. *Lustre Tiles: Kashan Tiles*. [Online]. [Accessed 22 June 2020]. Available at: https://www.islamicillumination.com/blog/lustre-tiles-kashan-tiles

Alhamal, E., 2018. Traditional Islamic Ceramic Tiles. [Online]. [Accessed 22 June 2020]. Available at: https://www.islamicillumination.com/blog/making-ceramic-islamic-tiles-inspired-from-islamic-art

Alkandari, F., 2011. *Islamic ceramic ornamentation and process: proposals for a new aesthetic vocabulary in contemporary architectural embellishment within Kuwait*. Ph. D. University of Central Lancashire.

Allen, J., 2007. *Drawing geometry: A primer of basic forms for artists, designers and architects* . Floris.

AlNahas, U., 2006. *Units of Islamic patterns*. 17th ed. Cairo: T. DN.

AlQuraishi, N., 2017. The structural foundations of the plant decorative units in the holy Kadhimiya threshold. *Funon Al-Basrah,* (14), pp.159-175.

AlTamimi, H., 2011. Calculation of Sentences in the books of interpretation. *Journal of Sharia and Islamic Studies*, (87), pp.261-271.

Alwakeel, N., 2012. Islamic techniques' impact on Safavid plant ornaments to create fabric designs suitable for ladies' printed evening clothes. *Jordanian Arts*, (1), pp.23-55.

Alwan, M. and Mohamed, J., 2016. The structural characteristics of the form in the Turkish ceramics. *Journal of Nabo*ʻ (13), pp.87-113.

Aqamiri, A., 2008. Arayaha va nuqush-i islimi. Tehran: Yasawuli.

Architectural Digest. 2012. *Moroccan Motifs*. [online] Available at: http://www.architecturaldigest.com/blogs/the-aesthete/2012/04/geometric-patterns-islamic-art [Accessed 11 May. 2014].

Archnet. 2019. *Islamic Periods Timeline*. [image] Available at: http://archnet.org/timelines/48 [Accessed 2 Jul. 2019].

Ardalan, N. and Bakhtiar, L., 1973. *The sense of unity*. Chicago: University of Chicago Press.

Ardalan, N., 1974. Color in Safavid architecture: the poetic diffusion of light. *Iranian Studies*, 7(1-2), pp.164-178.

Ariffin, A., 2005. *Architectural conservation in Islam*. Skudai, Johor Darul Ta'zim, Malaysia: Penerbit Universiti Teknologi Malaysia.

Azzam, K., 2013. *Arts & crafts of the Islamic lands*. London: Thames & Hudson Ltd.

Babaie, S., 1994. Shah Abbas II, the Conquest of Qandahar, the Chihil Sutun, and Its Wall Paintings. *Muqarnas*, 11, pp.125-142.

Babayan, K., 1994. The Safavid synthesis: From Qizilbash Islam to imamite Shi'ism. *Iranian Studies*, 27(1-4), pp.135-161.

Baer, E., 1989. Jewelled ceramics from Medieval Islam: A note on the ambiguity of Islamic ornament. *Muqarnas*, 6, p.83.

Bakhtiar, L., 1976. *Sufi*. London: Thames and Hudson.

Barakat, H., Waley, M., Nurul Iman Rusli, Amira Salleh, Islamic Arts Museum Malaysia, issuing body, & British Museum, host institution., 2018. *The arabesque: An introduction*. Kuala Lumpur: Islamic Arts Museum Malaysia.

Barone, T. and Eisner, E., 2012. *Arts based research*. London: Sage.

Beaton, C., 1956. Marilyn Monroe. [photograph] (Marilyn Monroe's own private collection).

Behiery, V., 2015. LIGHT OF THE SUFIS: THE MYSTICAL ARTS OF ISLAM. *Islamic Art Magazine*, (5th).

Bell, A. and Bryan, A., 1991. *Plant Form: An Illustrated Guide To Flowering Plant Morphology*. Oxford: Oxford University Press.

Bier, C., 1998. Art: crafts, technology, and material culture. *Iranian Studies*, 31(3-4), pp.349-359.

Bier, C., 2016. Geometry made manifest: reorienting the historiography of ornament on the Iranian Plateau and beyond. In: *The Historiography of Persian Architecture*. London and New York: Routledge Tylor and Francis Group, pp.41-79.

Bier, C., 2016. *Symmetry and Pattern in Islamic Art*. [video] Available at: https://vimeo.com/167488190 [Accessed 23 Oct. 2017].

Birol, I. and Derman, C., 1991. Motifs in Turkish decorative arts [*Türk Tezyini San'atlarında Motifler]* İstanbul: Kubbealtı Akademisi Kültur ve San'at Vakfı.

Birol, I. and Derman, C., 2007. *Motifs in Turkish decorative arts* [Türk Tezyînî San'atlarında Motifler]. 7th edition. İstanbul: Kubbealtı neşriyâtı.

Birol, I. and Derman, C., 2011. *Motifs in Turkish decorative arts* [Türk Tezyînî San'atlarında Motifler]. 8th edition. İstanbul: Kubbealtı neşriyâtı.

Birol, I., 2014. Pattern Design in Turkish Decorative Arts: Drawing Technique and Its Types [Türk Tezyini Sanatlarinda Desen Tasarimi: Cizim Teknigi ve Cesitleri]. Istanbul: Kubbealtı Neşriyatı Yayıncılık.

Blair, S., 1983. The octagonal pavilion at Natanz: a reexamination of early Islamic architecture in Iran. *Muqarnas*, 1, p.69.

Blair, S., Bloom, J. and Ettinghausen, R., 1994. *The art and architecture of Islam 1250-1800*. New Haven [Conn.]: Yale University Press.

Blair, S., Bloom, J. 2003. The Mirage of Islamic Art: Reflections on the Study of an Unwieldy Field. *The Art Bulletin, 85*(1), 152-184. doi:10.2307/3177331

Blair and Bloom, 2019. *Islamic art: past, present, future*. New Haven, Yale University Press in association with Qatar Foundation, Virginia Commonwealth University and Virginia Commonwealth University School of the Arts in Qatar.

Blake, S., 2016. *Astronomy and astrology in the Islamic world*. Edinburgh: Edinburgh University Press.

Bolt, B., 2007. The Magic is in the handling. In: B. Bolt and E. Barrett, ed., *Practice as research approaches to creative arts enquiry*. London: I. B. Tauris, pp.27-34.

Bond, A., 1883. Ornamentation. *The Decorator and Furnisher*, 2(3).

Bonner, J., 2016. The Historical Significance of the Geometric Designs in the Northeast Dome Chamber of the Friday Mosque at Isfahan. *Nexus Network Journal,* 18, pp.55–103. https://doi.org/10.1007/s00004-015-0275-3

Bonner, J., 2017. *Islamic Geometric Patterns*. New York: Springer.

Bora, M. and Khudair, T., 2006. The unseen world in the Islamic faith. *Journal of The Iraqi University*, 1(17), pp.49-77.

Brend, B., 1992. *Islamic art*. London: British Museum Press.

Biggs, M. and Buchler, D. 2008. Architectural Practice and Academic Research. *Nordic Journal of Architectural Research*. 2o:1, pp. 83-94.

Biggs, M., and Buchler, D., 2008. Eight criteria for practice-based research in the creative and cultural industries. *Art, Design and Communication in Higher Education, 7*, 5-18.

Britannica, 2006. Spiral Of Archimedes. [image] Available at: <https://www.britannica.com/science/Spiral-of-Archimedes> [Accessed 10 January 2021].

British Standards Institution et al., 1998. *British standards online [electronic resource]*., London]: BSI.

Broug, E., 2008. *Islamic geometric patterns*. London: Thames & Hudson.

Bucklow, S., 2009. *The alchemy of paint: art, science and secrets from the Middle Ages: colour and meaning from the Middle Ages*. Marion Boyars Publishers Ltd.

Burckhardt, T. and Michaud, R., 1976. *Art of Islam*. London: World of Islam Festival Pub. Co.

Burckhardt, T., 1967. *Sacred art in East and West: Its principles and methods*. London: Perennial Books.

Burckhardt, T., 1992. *Fez, city of Islam*. Cambridge, UK: Islamic Texts Society.

Burckhardt, T., 2009. *Art of Islam: Language and meaning*. London: World Wisdom.

Cammann, S., 1951. The Symbolism of the cloud collar motif. *The Art Bulletin*, 33(1), pp.1-9.

Cammann, S., 1976. Religious symbolism in Persian art. *History of Religions*, 15(3), pp. 193-208.

Cammann, S., 1978. The interplay of art, literature, and religion in Ṣafavid symbolism. *Journal of the Royal Asiatic Society of Great Britain & Ireland*, 110(02), pp.124-136.

Campbell, F., 1918. The home beautiful. *Fine Arts Journal,*36(11), pp.3-11

Canby, S., 1999. *The golden age of Persian art*. London: British Museum.

Candy, L. and Edmonds, E., 2018. Practice-Based Research in the Creative Arts: Foundations and Futures from the Front Line. *Leonardo*, 51(1), pp.63-69.

Cappellari, F., 2017. *The spiritual in Islamic calligraphy: a phenomenological approach to the contemporary Turkish calligraphic tradition*. Ph.D. University of Edinburgh.

Carboni, S. and Masuya, T., 1993. *Persian Tiles*. New York: The Metropolitan Museum of Art.

Carmines, E. and Zeller, R., 2008. *Reliability and Validity assessment*. London: Sage.

Cenani, S. and Cagdas, G., 2006. Shape grammar of geometric Islamic ornaments. *eCAADe*, pp.290-297.

Chester Beatty Library. 2014. *Chester Beatty's A to Z: from Amulet to Zodiac*. [image] Available at: https://wsimag.com/art/9550-chester-beattys-a-to-z-from-amulet-to-zodiac [Accessed 29 Aug. 2019].

Chipping Campden History. 2019. *C R Ashbee and the guild of handicraft*. [online] Available at: https://www.chippingcampdenhistory.org.uk/content/history/people-2/arts_artists_and_craftspeople/c_r_ashbee [Accessed 11 Sep. 2019].Chipping Campden

Chowdry, A., *Patronage under Timurid princes*, lecture notes, City Lit, delivered 5 March 2018.

Ciccone, T., 2019. *Nadir Divan-Begi Madrasah In Bukhara, Uzbekistan*. [image] Available at: <https://www.orientalarchitecture.com/sid/1351/uzbekistan/bukhara/nadir-divan-begi-madrasa> [Accessed 26 December 2020].

Clarke, N., 2018. *Arab conquest - Oxford Reference*. [online] Oxfordreference.com. Available at: https://www.oxfordreference.com/view/10.1093/acref/9780198662778.001.0001/acref-9780198662778-e-361 [Accessed 3 Jul. 2019].

Cleveland, W., 2004. *A History of the modern Middle East*. Oxford: Westview Press, pp.37-56.

Clévenot, D., 2017. *Ornament and decoration in Islamic architecture*. London: Thames and Hudson.

Creswell, J. W., 2003. *Research design: Quantitative, qualitative, and mixed methods approaches*. (2nd ed.). Thousand Oaks, CA: Sage.

Critchlow, K., 1989. *Islamic patterns*. London: Thames and Hudson.

Critchlow, K., 2011. *The Hidden geometry of flowers*. Edinburgh: Floris.

Crowe, Y., 2004. A late Safavid dish: a cluster of exotic trees and foliage. *Muqarnas*, 21(1), pp.121-128.

D'Avennes, P., 1978. *Arabic art in color*. New York: Dover Publications.

Dabbour, L., 2012. Geometric proportions: the underlying structure of design process for Islamic geometric patterns. *Frontiers of Architectural Research*, 1(4), pp.380-391.

Dale, S., 2009. Empires and emporia: palace, mosque, market, and tomb in Istanbul, Isfahan, Agra, and Delhi. *Journal of the Economic and Social History of the Orient*, 53(1), pp.212-229.

Dale, S., 2010. *The Muslim empires of the Ottomans, Safavids, and Mughals*. Cambridge: Cambridge University Press.

Daudpota, G. H., 2018. *Ceramics of Pakistan*. The Prince's Foundation School of Traditional Arts.

Delgado, C., 2011. *Mausoleum of the fifth Ottoman Sultan, Mehmed I, in Bursa, Turkey*. [image] Available at: https://commons.wikimedia.org/wiki/User:Kadellar/T%C3%BCrkiye#/media/File:Ye%C5%9Fil_T%C3%BCrbe_-_01.jpg [Accessed 25 Jul. 2019].

DeLong, L., 2013. *Curves*. London: Wooden Books.

DeLong, L., 2017. Islamic Art and the LDS Faith. *Dialogue: A Journal of Mormon Thought,* 50(2), 218-222. doi:10.5406/dialjmormthou.50.2.0218

Dennis, J. and Wenneker, L., 1965. Ornamentation and the organic architecture of Frank Lloyd Wright. *Art Journal*, 25(1), pp.2-14.

Denny, B., 2004. *Iznik: the artistics of Ottomans ceramics*. London, Thames & Hudson.

Denzin, N. K., & Lincoln, Y. S., 2005. *The SAGE handbook of qualitative research* (3rd ed.): Thousand Oaks, CA: Sage.

Dowlatshahi, A., 1979. *Persian designs and motifs for artists and craftsmen*. New York: Dover Publications.

Ekasha, R. ed., 1981. *Art in Islamic thought: a knowledge and methodology*. 2nd ed. International Institute of Islamic Thought.

El-Said, I. and Parman, A., 1976. *Geometric concepts in Islamic art*. London: World of Islam Festival Publishing Company.

El-Shorbagy, A., 2020. Women in Islamic architecture: towards acknowledging their role in the development of Islamic civilization, *Cogent Arts & Humanities*, 7:1, 1741984.

Elias, J., 1998. Sufism. *Iranian Studies, 31*(3/4), pp.595-613.

Elliot, J., 2006. *Mirrors of the unseen*. New York: St. Martin's Press.

Encyclopaedia Britannica. 2015. *Architecture*. [online] Available at: http://www.britannica.com/topic/architecture#ref405496 [Accessed 10 Sep. 2015].

Encyclopaedia Britannica. 2019. *Byzantine art*. [online] Available at: https://www.britannica.com/art/Byzantine-art [Accessed 24 Sep. 2019].

Erzen, J., 2007. Islamic Aesthetics: an alternative way to knowledge. *The Journal of Aesthetics and Art Criticism*, 65(1), pp.69-75.

Erzen, J., 2011. Reading Mosques: meaning and architecture in Islam. *The Journal of Aesthetics and Art Criticism*, 69(1), pp.125-131.

Ettinghausen, R., 1975. Islamic Art. *The Metropolitan Museum of Art Bulletin*, 33(1), pp.2-52.

Falke, J., 1871. The naturalistic element in ornamentation. *The Workshop, 4*(2), pp.17-20.

Fischbach, F., 1873. The elementary forms of ornamentation. *The Workshop, 6*(6), pp.81-85.

Fletcher, R., 2004. Musings on the Vesica Piscis. *Nexus Network Journal*, 6(2), pp.95-110.

Fragner, B. ed., 2012. The Safavid Empire and the sixteenth and seventeenth century political and strategic balance of power their the world system. In: *Iran and the World in the Safavid Age*. I.B.Tauris.

Gerring, J., 2007. *Case study research*. Cambridge: Cambridge University Press.

Gocer, A., 1999. A hypothesis concerning the character of Islamic art. *Journal of the History of Ideas*, 60(4), pp.683-692.

Golombek, L., Mason, R., Proctor, P. and Reilly, E., 2019. *Persian Pottery in the First Golden Age: The Sixteenth and Seventeenth Centuries*. Brill.

GPF. 2017. *The Unconquerable Persian Legacy*. [image] Available at: https://geopoliticalfutures.com/unconquerable-persian-legacy/ [Accessed 23 Jul. 2019].

Grabar, O., 1964. Islamic art and Byzantium. *Dumbarton Oaks Papers, 18*, pp.67-88.

Grabar, O., 1973. *The formation of Islamic art*. Westford: Yale University.

Grabar, O., 1992. *The mediation of ornament*. Princeton, N.J.: Princeton University Press.

Graves, M., 2010. *Worlds writ small: Four studies on miniature architectural forms in The Medieval Middle East*. Ph. D. University of Edinburgh.

Gray, David E., 2014. *Doing Research in the Real World*. Thousand Oaks, CA:

Sage.

Gray, C. and Malins, J., 2004. *Visualizing research: A guide to the research process in art and design*. London: Ashgate.

Groat, L. and Wang, D., 2013. *Architectural Research Methods*. Hoboken: Wiley.

Griffel, Frank, "al-Ghazali", *The Stanford Encyclopedia of Philosophy* (Summer 2020 Edition), Edward N. Zalta (ed.), URL = <https://plato.stanford.edu/archives/sum2020/entries/al-ghazali/>.

Grube, E. and Michell, G., 1995. *Architecture of the Islamic world*. London: Thames and Hudson.

Grünbaum, B., Shephard, G. and Grunbaum, B., 1992. Interlace patterns in Islamic and Moorish Art. *Leonardo*, 25(3/4), pp.331-339.

Guilherme, A., Manso, M., Pessanha, S., Zegzouti, A., Elaatmani, M., Bendaoud, R., Coroado, J., dos Santos, J.M.F. and Carvalho, M.L., 2013. Micro-XRF for characterization of Moroccan glazed ceramics and Portuguese tiles. *Journal of Instrumentation*, 8(02), p.C02055.

Harrow, L., 1978. *Iran: V. 2*. London: Scorpion Cavendish LTD.

Hasanabadi, A. and Mahbub, E., 2009. Introducing the Safavid documents of the Directorate of Documents and Publications of the Central Library of the Holy Shrine at Mashhad (Iran). *Iranian Studies*, 42(2), pp.311-327.

Hedgecoe, J. and Damlūjī, S., 1992. *Zillij*. Reading: Garnet.

Henry, R., 2014. *Introduction to geometry | Art of Islamic Pattern*. [online] Artofislamicpattern.com. Available at: http://artofislamicpattern.com/resources/educational-posters/ [Accessed 24 May. 2014].

Highet, J., 2018. The Blue Road. [online] Asian Art. Available at: <https://asianartnewspaper.com/the-blue-road/> [Accessed 19 January 2021].

History. 2019. *C R Ashbee and the guild of handicraft*. [online] Available at: https://www.chippingcampdenhistory.org.uk/content/history/people-2/arts_artists_and_craftspeople/c_r_ashbee [Accessed 11 Sep. 2019].

Hoag, J., 1975. *Islamic architecture*. Milan: Electa Editrice.

Hodge, G. and Maughan, S., 2013. *RHS botany for gardeners*. London: Mitchell Beazley.

Holakooei, P., Tisato, F., Vaccaro, C. and Petrucci, F.C., 2014. Haft rang or cuerda seca? Spectroscopic approaches to the study of overglaze polychrome tiles from seventeenth century Persia. *Journal of Archaeological Science*, 41, pp.447-460.

Holy Quran.

Honarvar, M., 2015. *Golden twist* [Pichish-i zarrin]. Tehran: Yassavoli.

Honarvar, M., 2013. *Symbols of Iranian illumination and carpet design*. 2nd ed. Tehran: Bazaarcheh Ketab.

Honarvar, M. and Khonyāgar, R., 2009. *Designs and ornaments of Eslimi and Khatei pattern in the carpet designing and illumination* [Naqsh Va Nigār-I Islīmī, Khatāyī Dar Ṭarrāḥī-I Farsh Va Hunar-I Taz_hīb]. Tehran: Yassavoli.

Honarvar, M. and Khonyagar, R., 2013. *Designs and ornaments of Eslimi and Khatei pattern in the carpet designing and illumination* [Naqsh Va Nigār-I Islīmī, Khatāyī Dar Ṭarrāḥī-I Farsh Va Hunar-I Taz_hīb]. Tehran: Yassavoli.

Hopper, V., 2000. *Medieval number symbolism*. Mineola (New York): Dover.

Hukmat, S. and Uzunahmet, H., 2020. The Decorative orientations in the Mediterranean Architecture and its influence on the development of cultural sustainability. *European Journal of Sustainable Development*, 9(1), p.109.

Huković, A., 2015. Morocco the keeper of the Gibraltar door. *Islamic Art Magazine*, (7th).

Iris. 2017. *IRIS: 1962 Qazvin (Iran) Earthquake Archive*. [online] Available at: https://ds.iris.edu/seismo-archives/quakes/1962qazvin/ [Accessed 25 Aug. 2019].

Jones, D., 2018. The elements of decoration: surface, pattern and light. In: *Architecture of the Islamic World*. London: Thames and Hudson, pp.144-175.

Jones, D., & Michell, G., (1976). *The arts of Islam*: Hayward Gallery, 8 April-4 July 1976. [London], Arts Council of Great Britain.

Jones, O., 1856. *The grammar of ornament*. London: Day and Son.

Khazâie, M., 2021. The Source and Religious Symbolism of the Arabesque in Medieval Islamic Art of Persia. *Central Asiatic Journal*, 49(1), pp.27-50.

Korn, P., 2015. *Why we make things and why it matters*. London: Vintage.

Kuban, D., 1987. The style of Sinan's domed structures. *Muqarnas,* 4, pp.72-97.

Kühnel, E., 1962. *The minor arts of Islam*. Translated by K. Watson. New York: Cornell University Press.

Kühnel, E., 1963. *Islamic art & architecture*. Translated by K. Watson. New York: Cornell University Press.

Kühnel, E., 1971. *The minor arts of Islam*. Ithaca, N.Y.: Cornell University Press, pp.1-240.

Hennink, M., Hutter, I., & Bailey, A., 2011. *Qualitative research methods*. London: Sage.

Labrusse, R., 2016. Grammar of ornament: dematerialisation and embodiment from Owen Jones to Paul Klee. In: G. Necipoglu and A. Payne, ed., *Histories of Ornament*. Princeton: Princeton University Press.

LACMA. 2018. *Tile section of a mihrab*. [image] Available at: https://collections.lacma.org/node/239878 [Accessed 21 May 2018].

Lamprey, B., 1890. Persian tiles. *The Decorator and Furnisher*, 15(4), pp.127-128.

Lassikova, G., 2010. Hushang the dragon-slayer: fire and firearms in Safavid Art and diplomacy. *Iranian Studies,* 43(1), pp.29-51.

Lawlor, R., 1982. *Sacred geometry*. New York: Crossroad.

Lazaro, D., 2005. *The Materials, methods & symbolism in Pichhvai painting tradition of Rajasthan*. Grantha Corporation.

Lee, A., 1987. Islamic star patterns. *Muqarnas,* 4, p.182-197.

Leoni, C., 2014. Art, production and market conditions Gottfried Semper's historical perspective on commodities and the role of museums. *Journal of Art Historiography*, 11.

Lings, M., 2005. *Splendours of Qur'an calligraphy and illumination*. Liechtenstein: Thesaurus Islamicus Foundation.

Lings, M., 2009. Forward. In: R. Guénon and J. Herlihy, ed., *The essential René Guénon: metaphysical principles, traditional doctrines, and the crisis of modernity* (The Perennial Philosophy Series). World Wisdom Books.

Loos, A., 1971. Ornaments and crime. In: U. Conrads, ed., *Programs and manifestoes on 20th-century architecture*.

Lopes, P. and Salovey, P., 2004. Toward a Broader Education: Social, Emotional and Practical Skills. In: J. Zins, R. Weissberg, M. Wang and H. Walberg, ed., *Building Academic Success on Social and Emotional Learning*. Danvers: Columbia University.

Lundy, M., 2001. *Sacred geometry*. New York: Walker & Co.

Mahmood, S., 2015. *The establishment of the simulation of decorative elements in the contemporary interior design of the Abbasid architecture: a study on the Abbasid palace and the Mustansiriya school*. Ph.D. Sudan University of Science and Technology, Fine and Applied Arts.

Mahmoudi Farahani, L., Motamed, B. and Jamei, E., 2016. Persian gardens: meanings, symbolism, and design. *Landscape Online*, pp.1-19.

Majidi, F., 2014. Observation of image and color of Isfahan mosques in perspective of Islamic art's indices. *Research Journal of Recent Sciences*, 4(10), pp.113-121.

Martineau, J., 2002. *A little book of coincidence*. New York: Walker & Co.

Mason, R., 2003. Petrography of pottery from Kirman. *Iran*, vol. 41, 2003, pp.271–278.

Mason, R. and Golombek, L., 2003. The Petrography of Iranian Safavid ceramics. *Journal of Archaeological Science,* 30(2), pp.251-261.

Mason, R., Tite, M., Paynter, S. and Salter, C., 2002. Advances in Polychrome Ceramics in the Islamic World of the 12th Century AD. *Archaeometry,* Volume 43, Issue 2, pp. Pages 191-209. https://doi.org/10.1111/1475-4754.00014

Massey, J., 2013. Ornament and decoration. In: *The Handbook of Interior Architecture and Design*, London: Bloomsbury, pp.497-636.

Melville, C., 2016. New light on Shah Abbas and the construction of Isfahan. In: Necipoğlu, Gülru and Karen Leal ed. *Muqarnas Volume XXXIII: An Annual on the Visual Cultures of the Islamic World*. Leiden: E. J. Brill, pp. 155-176.

Michon, J., 2008. *Introduction to traditional Islam, illustrated*. Foundations, Art and Spirituality. Bloomington, Ind.: World Wisdom.

Millner, A., 2015. *Damascus tiles: Mamluk and Ottoman architectural ceramics from Syria*.

Minar, C. and Crown, P., 2001. Learning and craft production: An Introduction. *Journal of Anthropological Research*, 57(4), pp.369-380.

Mohammad, H., 2016. Engineering and rhythmic systems of securitisation for a selection of plant elements in Islamic art and benefit from them in teaching decorative painting in art education. *Journal of Architecture, Arts and Humanities*, (2), pp.266-282.

Mordgani, Z., 2012. *Art at Farabi*. Damascus: Safhat.

Muḥammad, B., 2012. *Interpretation of spaces in Islamic arts*. Amman: Dar Majdalawi.

Munro, T., 1946. Style in the arts: A method of stylistic analysis. *The Journal of Aesthetics and Art Criticism,* 5(2), pp.128-158.

Murad, b., 2009. *Philosophical vision of Islamic art*. Cairo: Madbouli.

Murdock, W., 2012. *Circular-Based Arches – Part 1: One-Centered And Two-Centered Arches | Thisiscarpentry*. [online] Thisiscarpentry.com. Available at: <https://www.thisiscarpentry.com/2012/01/06/circular-based-arches-part-1/> [Accessed 23 January 2021].

Muslim Museum. 2019. *Expansion of the Islamic World to 1500*. [image] Available at: http://muslimmuseum.org.uk/wp-content/uploads/0622/01/Islamic-Expansion.jpg [Accessed 2 Jul. 2019].

Mutawe, H., 2010. *Islamic arts of Iran and Turkey*. Alexandria: Dar El Wafaa.

Nader. A. ed., 1968. *Abu Nasr Al - Farabi book the people of the city virtuous*. 2nd ed. Beirut: Dar Almashreq.

Nasr, S., 1987. *Islamic art and spirituality*. Albany: State University of New York Press.

Nasr, S., 1993. *A young Muslim's guide to the modern world*. Cambridge: The Islamic Texts Society.

Nasr, S., 1993. *The need for a sacred science*. Richmond: Curzon.

Nasr, S., 2008. *Islamic spirituality: Foundations*. London, Routledge.

Necipoğlu, G., 1990. From international Timurid to Ottoman: A change of taste in sixteenth-century ceramic tiles. *Muqarnas*, 7, p.136-170.

Necipoğlu, G., 2015. *The Scrutinising gaze in the aesthetics of Islamic visual cultures: Sight, insight and desire*. *Muqarnas*, 32, pp.23-61.

Necipoğlu, G., 2016. Early modern floral: The agency of ornament in Ottoman and Safavid visual cultures. In: G. Necipoglu and A. Payne, ed., *Histories of Ornament*. Princeton: Princeton University Press.

Necipoğlu, G., 2017. *The arts of ornamental geometry. A Persian compendium on similar and complementary interlocking figures*. Leiden: BRILL.

Necipoğlu, G., 1995. *The Topkapı scroll: Geometry and ornament in Islamic architecture: Topkapı Palace Museum Library MS H. 1956*. Santa Monica, CA, Getty Center for the History of Art and the Humanities.

Necipoğlu, G. and Payne, A., 2016. *Histories of ornament*. Princeton University Press.

Netton, I., 1999. *Al-Farabi and his school*. 2nd ed. Richmond: Curzon.

Nikbin, H. and Zula, T., 2004. Anaṣir-i taz'ini-i islimi wa ḫatayi dar ṭarraḥi-i fars wa tad_hib. Tehran: Yasawuli.

Niman, J. and Norman, J., 1978. Mathematics and Islamic art. *The American Mathematical Monthly*, 85(6), pp.489-490.

Northedge, A., 2019. Reviewed work: Islamic art by Barbara Brend. Cambridge: *Cambridge University Press on behalf of School of Oriental and African Studies*, pp.374-375.

Othman, R. and Zainal-Abidin, Z., 2011. The importance of Islamic art in mosque interior. *Procedia Engineering,* 20, pp.105-109.

Oweis, F., 2002. Islamic art as an educational tool about the teaching of Islam. *Art Education*, 55(2), pp.18-24.

Palma, V., 2016. *A Natural history of ornament. In: Histories of Ornament: From Global to Local*. New Jersey: Princeton University Press.

Patton, M. (1990). *Qualitative evaluation and research methods (pp. 169-186)*. Beverly Hills, CA: Sage

Paulus, E., 1872. Plant ornamentation in Gothic architecture. *The Workshop,* 5(8), pp.113-115.

Pérez-Arantegui, J., Soto, M. and Castillo, J., 1999. Examination of the 'cuerda seca' decoration technique on Islamic ceramics from al-Andalus (Spain). *Journal of Archaeological Science*, 26(8), pp.935-941.

Petsopoulos, Y., 1982. *Tulips, arabesques and turbans*. London: Alexandria Press.

Philipp, T., 1984. Isfahan 1881–1891: A close-up view of guilds and production. *Iranian Studies*, 17(4), pp.391-411.

Philips, T., 2003. The nature of ornament: A summary treatise. *The Architectural Review*, pp.79-81.

Picon, A., 2016. Ornament and its users: From the Vitruvian tradition to the digital age. In: G. Necipoglu and A. Payne, ed., *Histories of Ornament*. Princeton: Princeton University Press.

Pigments through the Ages. 2019. *Pigments through the Ages - Choose a time period*. [online] Available at: http://www.webexhibits.org/pigments/intro/history.html [Accessed 7 Aug. 2019].

Pile, J., 2000. *A history of interior design*. New York: Wiley.

Pinder-Wilson, R., 1976. *Paintings from the Muslim Courts of India*. London: World of Islam Festival Pub.

Pishva'i, M., 2007. *History of Islam*. Qum: Ahl al-Bayt World Assembly.

Polezhaev, A., 2019. Spirals, their types and peculiarities. In: S. Müller and K. Tsuji, ed., *Spirals and Vortices in Culture, Nature, and Science*. Springer, pp.91-112.

Pope, A., 1930. *An introduction to Persian art since the seventh century* A.D. New York: C. Scribner's Sons.

Pope, A., 1965. *Persian architecture: The triumph of form and color*. New York: G. Braziller.

Pope, A., 1965. *Persian architecture*. London: Thames and Hudson.

Porter, V., 1995. *Islamic tiles*. London, The British Museum Press.

Porter, Y., 2000. From the "Theory of the Two Qalams" to the "seven principles of painting": theory, terminology, and practice in Persian classical painting. *Muqarnas*, 17, pp.109-118.

Prince's School of Traditional Arts, 2014. *The geometry of structure and space*. [online] Available at: http://www.psta.org.uk/postgraduateprogramme/traditionalartscourses/thegeometryofstructureandspace/ [Accessed 6 May. 2014].

Pye, D., 1968. *The nature and art of workmanship*. Cambridge University Press.

Rabbat, N., 2012. What is Islamic architecture anyway? *Journal of Art Historiography*, pp. 1-15.

Rashq, Tawshe'h and Tawriq. 2019. In: *Arabic Arabic Dictionary*. *Dictionary of meanings*.

Refaie, A., 2010. *Aesthetic and philosophical origins of Islamic art*. Hernand, Virginia: World Institute of Islamic Thought.

Renard, J., 2016. *Historical dictionary of Sufism*. 2nd ed. London: Rowman & Littlefield.

Reznikoff, I., 2008. Sound resonance in prehistoric times: A study of Paleolithic painted caves and rocks. *The Journal of the Acoustical Society of America*, 123(5), pp.3603-3603.

Rodemann, P., 1999. *Patterns in interior environments*. New York: J. Wiley & Sons.

Saoud, R., 2002. The Arch That Never Sleeps. *Foundation for science, technology and civilisation*, pp.1-9.

Samamara.com. 2015. *sama mara*. [online] Available at: http://www.samamara.com/ [Accessed 10 Sep. 2015].

Saniei, M. and Delavar, A., 2012. Communicational role of mosques architecture. *Asian Social Science*, 8(3).

Schattschneider, D., 2010. The Mathematical side of M. C. Escher. *Notices of AMS*, 57(6), pp.706-718.

Schimmel, A., 1993. *The mystery of numbers*. Oxford: Oxford University Press.

Scrase, T., 2003. Precarious production: Globalisation and artisan labour in the Third World. *Third World Quarterly*, 24(3), pp.449-461.

Seherr-Thoss, S., 1968. *Design and color in Islamic architecture*. Smithsonian Institution Press, pp.171-195.

Sennett, R., 2008. *The craftsman*. New Haven: Yale University Press.

Shabbar, S., 2015. London: Muhammadi Trust of Great Britain.

Shani, R. and Chen, D., 2001. On the Umayyad Dating of the Double Gate in Jerusalem.

Shnaoua, h. And Wadi, p., 2014. The intuitive system in Islamic art between imaginary and logical. *Journal of the Babylon Center for Humanitarian Studies,* 4 (2), pp. 305-318.

Silverman, D., 2014. *Interpreting qualitative data* (5th ed.): Los Angeles, CA: Sage.

Simakov, N., 1993. *Islamic designs in color*. New York, Dover.

Singh, A., 2017. Existence of Arabesque in Islamic Architecture. *International Journal of Scientific and Research Publications,* 7(6), pp.292-295.

Skains, R., 2020. Creative practice as research: discourse on methodology. *Media Practice and Education*, 19(1), pp.82-86.

Smeets, R., 1973. *Signs, symbols & ornaments*. New York: Van Nostrand Reinhold.

Smith, H. and Dean, R., 2009. *Practice-led research, research-led practice in the creative arts*. Edinburgh: Edinburgh University Press.

Sönmez, S., 2020. *The geometric language of Anatolian Seljuk art* [Anadolu Selc¸uklu Sanatının Geometrik Dili]. Ketebe Yayınevi.

Sotheby. 2011. *15th Century Timurid mosaic tile*. [image] Available at: http://islamicartsmagazine.com/magazine/view/sothebys_arts_of_the_islamic_world_evening_sale/ [Accessed 21 May 2018].

Spradley, J., 1980. *Participant observation*. Long Grove: Waveland Press.

Stockbauer, 1874. On style in ornamentation. *The Workshop*, 7(5), p.65-69.

Subhani, J., 2014. *The message: The life of the Prophet of Islam*. Pakistan: Islamic Seminary Publications.

Sullivan, G., 2005. *Art practice as research: Inquiry in the visual arts*. London: Sage.

Šurković, K., 2015. Contemporary tradition: A new approach to mosque decoration. *Islamic Art Magazine,* (7th).

Sutton, D., 2007. *Islamic design*. New York: Walker & Co.

Sykes, E., 1901. Persian folklore. *Folklore*, 12(3), pp.261-280.

Tabbaa, Y., 1987. Bronze Shapes in Iranian Ceramics of the Twelfth and Thirteenth Centuries. In *Muqarnas IV: An Annual on Islamic Art and Architecture*, edited by Oleg Grabar. Leiden: E.J. Brill,

The British Museum. 2019. *Medina the illuminated*. [online] Available at: https://www.britishmuseum.org/explore/themes/hajj/medina_the_illuminated.aspx [Accessed 3 Jul. 2019].

The Met Museum, 2021. *Bowl With Prince On Horseback*. [image] Available at: <https://www.metmuseum.org/art/collection/search/451041> [Accessed 16 January 2021].

The Met Museum, 2019. *Tile with Image of Phoenix*. [image] Available at: https://www.metmuseum.org/art/collection/search/446207 [Accessed 29 Aug. 2019].

The Met Museum, 2021. *Dragon-Handled Jug With Inscription*. [image] Available at: <https://www.metmuseum.org/art/collection/search/444607> [Accessed 11 January 2021].

The Met Museum, 2021. *Khamsa Of Nizami*. [image] Available at: <https://www.metmuseum.org/art/collection/search/446543> [Accessed 11 January 2021].

The Met Museum, 2021. *Mantiq Al-Tair*. [image] Available at: <https://www.metmuseum.org/art/collection/search/454362> [Accessed 11 January 2021].

The Met Museum, 2021. *Vase Carpet*. [image] Available at: <https://www.metmuseum.org/art/collection/search/452187> [Accessed 11 January 2021].

The Met Museum, 2021. *Wine Drinking in A Spring Garden*. [image] Available at: <https://www.metmuseum.org/art/collection/search/451403> [Accessed 10 January 2021].

Travel Notes. 2019. *CHEHEL SOTUN, IRAN*. [image] Available at: http://ttnotes.com/chehel-sotun.html# [Accessed 25 Aug. 2019].

Trilling, J., 2001. *The language of ornaments*. London: Thames and Hudson.

Trilling, J., 2003. *Ornament*. Seattle: University of Washington Press.

Troelenberg, E., 2015. Arabesques, unicorns, and invisible masters: The art historian's gaze as symptomatic action? *Muqarnas*, 32, pp.213-232.

Unit for Housing and Urbanization, Graduate School of Design, Harvard University; Agence pour la Dedensification et la Rehabilitation de la Medina de Fes(ADER-Fes). 1999. Case study: Fez, Morocco - Rehabilitation of the Fez Medina. Culture in sustainable development. Washington, DC: World Bank. [online] Available at: http://documents.worldbank.org/curated/en/1999/05/440861/case-study-fez-morocco-rehabilitation-fez-medina

University of Cambridge. 2015. *We ask the experts: why do we put things into museums?* [online] Available at: http://www.cam.ac.uk/research/discussion/we-ask-the-experts-why-do-we-put-things-into-museums [Accessed 10 Sep. 2015].

Utaberta, N., Mamamni, H., Surat, M., Che-Ani, A. and Abdullah, N., 2012. The study on the development of ornamentation in the architecture of Safavid Dynasty. *International Journal of Civil, Environmental, Structural, Construction and Architectural Engineering*, 6(7), pp.465-469.

Vernoit,, S. (2000). *Discovering Islamic art: Scholars, collectors and collections, 1850-1950*. London, Tauris.

Wade, D., 1982. *Geometric patterns & borders*. New York: Van Nostrand Reinhold.

Wade, D., 2006. *The Historical Setting | Pattern in Islamic Art*. [online]

Patterninislamicart.com. Available at: http://patterninislamicart.com/background-notes/the-historical-setting [Accessed 16 Sep. 2014].

Wallace, E. and West, S., 2015. *Roads to geometry*. 3rd ed. Long Grove: Waveland Press.

Watson, O., 2004. *Ceramics from Islamic Lands*. London: Thames & Hudson.

Weingarden, L., 1985. Aesthetics politicized: William Morris to the Bauhaus. *Journal of Architectural Education*, 38(3), pp.8-13.

Williamson, A., 2013. Introduction to Islimi. In: *Arts & crafts of the Islamic lands*. London: Thames & Hudson.

Wilson, E., 1988. *Islamic designs for artists and craftspeople*. New York, N.Y., Dover.

Worsley, G., 2005. *The uncomfortable truth about the Arts and Crafts dream*. Telegraph. [online] Available at: https://www.telegraph.co.uk/culture/art/3638825/The-uncomfortable-truth-about-the-Arts-and-Crafts-dream.html [Accessed 8 Jul. 2019].

Wright, F., 1901. The art and craft of the machine. *Brush and Pencil*, 8(2), pp.77-81, 83-85, 87-90.

Wulff, H., 1966. *The traditional crafts of Persia*. Cambridge: The M.I.T. Press.

Yin, R., 2003. *Case study Research: Design and methods*. 3rd ed. London: Sage.

Young, O., 2013. *Sheikh Lotfollah Mosque plan - completed 1618*. [image] Available at: https://www.flickr.com/photos/owenyoung/11147743213 [Accessed 29 Aug. 2019].

Zelenko, E., 2005. Common Hawthorn Flowers. [image] Available at: <https://commons.wikimedia.org/wiki/File:Common_hawthorn_flowers.jpg> [Accessed 22 January 2021].

Zereshk, 2005. *Gawhar Shad Mosque*. [image] Available at: <https://en.wikipedia.org/wiki/Gawhar_Shad#/media/File:Goharshad2.jpg> [Accessed 26 December 2020].

Glossary

Arabesque is a French term that literally means Arabic style that is used to describe organic shapes present in all Islamic biomorphic patterns even if it is not an Arab style. It is sometimes used interchangeably with the term “islimi”.

Bilateral symmetry
Mathematical term used to describe a pattern bisected in the middle to create two sides that are the mirror image of each other.

Biomorphic patterns
Stylised natural forms that are used to decorate architectural surfaces and objects. Biomorphic patterns are referred to sometimes as vegetal or arabesque.

Bisque
When a ceramic tile is fired in the kiln without any glaze to transform the clay-body into ceramic.

Faience mosaic
This term refers to a ceramic technique where small pieces of ceramics are arranged like mosaic to create a pattern and it works on geometric and biomorphic patterns

Islamic art
Arts and crafts produced from the 7th to the 19th century in the Islamic lands from Spain to India.

Islimi
Persian word describing organic motifs found in biomorphic patterns.

Iwan

Arabic word to describe the three-walled facade of mosques and the centre of it that usually includes the vaulted entrance.

Khatei
Persian word describing floral motifs found in biomorphic patterns.

Kiln
Special oven with a very high temperature that reaches to over 1000 degrees for the use of ceramics that transforms the clay-body into a ceramic piece.

Lustre
Shiny glaze usually in gold or copper that is applied to ceramic tiles. The name is used to refer to a Persian ceramic technique.

Masjed
Arabic word for mosque which is a place of worship for Muslims.

Mihrab
Arabic word for the prayer niche, where the prayer leader stands to lead the prayer.

Motif
A decorative element and a group of arranged motifs make the pattern. These motifs can be organic or botanical shapes.

Ornamentation
Decorative elements on architectural surfaces and objects that include geometry, bimorphs, calligraphy and figures.

Rotational symmetry
Mathematical term used to describe a pattern that retains its design when rotated.

Seven-colours

This is a Persian ceramic technique developed in the 16th century under Shah Abbas I and it refers to the outline and underglaze treatment of ceramic tiles.

Underglaze

When paint is applied to bisque ceramics before it is fired in the kiln again.

Appendix A

This appendix includes further pattern analysis and pattern exploration that I have done during my PhD for a number of patterns beyond the Safavid biomorphic patterns.