REVIVING ROOTS:
RECONSTRUCTING PATTERNS SEEN IN THE ISLAMIC WORLD

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Completing this thesis would not have been possible without the incredible support system of people around me.
I could not have done this alone.

I want to begin by expressing my deepest gratitude **to Allah (SWT)**, the Most Merciful and Compassionate. Reaching this milestone would not have been possible without His blessings. By His will, I plan to continue to pursue knowledge and seek His grace in all aspects of my life.

To my thesis advisor, Wladek Fuchs. Your guidance throughout this process has been invaluable. In my moments of doubt, you were always there with words of encouragement that motivated me to cross the finish line. Thank you for believing in me.

To my family, who I don't thank enough. Your constant encouragement and confidence in my ability have inspired me, pushing me to do my best in everything I do. Your trust in my capabilities has meant the world to me, and your faith in my potential humbles me beyond acknowledgment. Thank you for everything that you have done for me. I could not have achieved this, or any, milestone without you all by my side.

To my friends, who have been a source of support and joy throughout this entire journey. We've been through it all together, and the past five years would not have been the same without our shared memories. I cannot wait to see where we go from here.

ABSTRACT

Islamic art has a rich history dating back to the 7th century, and its influence can be seen in architecture, calligraphy, textiles, and other forms of creative non-figural expression. One of the defining characteristics of Islamic art is the use of geometric patterns, which have been an integral part of its design aesthetic for centuries. These patterns decorate surfaces, often as intricate tessellations (repetitions) that create mesmerizing visual effects. Over time, these patterns have become a symbol of Islamic art and architecture and continue to inspire contemporary artists and designers today.

This thesis investigates the potential of Islamic geometric patterns to extend beyond their typical use in architecture. Through an exploration of relevant literature, primarily through the work of Knippenberg, Habraken, and Teuffel, as well as Melancon, Gorissen, Garcia-Mora, Hoberman, and Bertoldi, characteristics of the unique qualities of the shapes found within tessellations present in Islamic art are identified. Additionally, model-making and pattern-deconstruction exercises are conducted to deepen understanding of the pattern-construction process.

Using these methods, the thesis focuses on one particular pattern located in Masjid-i-Sayyed in Isfahan, Iran, and several other locations. This pattern is then utilized to create a new modular form inspired by the original tilings, which suggests infinite tessellation and many manipulation possibilities. By creating these new modules, the researcher challenges the original orientation that traditional Islamic tilings were created and instead proposes a more expansive view of their potential.

This thesis holds significance as it contributes to the ongoing discourse surrounding Islamic art and geometry. It provides new insights into the possibilities of manipulating Islamic geometric patterns, which artists, designers, and architects can apply in their respective fields. Furthermore, it emphasizes the unique qualities of these patterns and how they can be utilized to create new aesthetically pleasing and structurally sound forms. Ultimately, this thesis expands our comprehension of Islamic art and geometry and provides a foundation for further research.

THESIS STATEMENT

This investigation studies Islamic Geometric Patterns (IGP) as they appear in art and architecture and presents new approaches to pattern manipulation through pattern deconstruction and folding methods. Most IGPs are rarely transformed from their presented state as decorative elements and are only used as such. In this investigation, the researcher identifies one IGP repeated across artworks in the Middle Eastern Region and transforms the selected pattern through the previous methods mentioned (pattern deconstruction and folding). Due to using a pattern with origins in geometry, the new transformed module can be tessellated in multiple directions in a similar fashion to the original pattern.
A brief investigation of non-figural artwork was conducted to gather a better understanding of IGPs and their current uses. Non-figural artwork is an art form that does not contain or suggest any living creature within it. This art gained popularity in Islam among artisans who wanted to express themselves and show praise to God without misrepresenting God's creations. The three types of non-figural art that quickly grew in popularity were calligraphy, botanical imagery, and geometric patterns. It is common to see all three of these in one piece of art to create thought-provoking work with a deeper meaning.

Most would agree that the calligraphy within the artwork allows an individual to see a greater connection to God within a piece as, in most cases, the calligraphy is direct quotes from the Quran. However, there is disagreement around this. Although calligraphy provides a more direct connection to God, Keith Critchlow, British artist and professor of architecture, believes that the geometry within art is what holds a connection to a higher being and that patterns are intended to aid those who look to have a higher understanding of the world around them. Critchlow believes these patterns exist not simply as ornamentation but to help viewers see the spiritual realm. In contrast to Critchlow's beliefs, Doris Behrens-Abouseif, previous Nasser D Khalili Chair of Islamic Art and Archeology at SOAS University of London, believes the ideas of 'morality' and 'beauty' are not interchangeable terms. Abouseif argues that beauty does not exist with a relationship of religious or moral standing but on its own. Shapes belong to no religion or culture. This research, as it deals with the deconstruction of geometry rather than its potential religious significance, sides with the thoughts of Abouseif.

After reviewing different positions within the literature, a general pattern study was conducted. Due to the nature of non-figural art, many IGPs were paired with the organic shapes of flowers and the curving lines of calligraphy; the general pattern study presents the IGP as it is seen as well as the underlying pattern that is implied, to provide a better visualization of the geometry that is present in the artwork as a semi-broad introduction to all of the shapes that are commonly seen in these compositions. It is also seen in this study that patterns are capable of spanning across surfaces of different planes. To look at this further, the general pattern study is then conducted on domes, identifying the individual shapes that appear on the domes and how the process of tessellation occurs across the surface

See Apendix A for Methodology Diagram

of a dome. The general pattern studies were followed by a more in-depth shape analysis, finding that two categories of shape within IGPs are typically separated into Star and Girih shapes.

Star shapes are precisely what they are named to be, stars. The complexity of a star is categorized by the number of points it is given. Most stars seen in IGPs have points divisible by 4,5, or 6; these stars make up 95% of all star shapes in Islamic art. The other category of shapes seen are called Girih shapes. 5 shapes fall into this category: the decagon, pentagon, irregular hexagon, rhombus, and bowtie. The sides of all of these shapes share a similar length. This allows any of them to match with one another in any orientation while still being able to repeat infinitely and seamlessly.

Once a general understanding of IGP's was gathered, the study transitioned to the manipulation of tile patterns to discover their potential as 3-dimensional forms. Before allowing the researcher to explore self-driven investigations, there was a brief study of other investigations that had similar goals in mind. The first precedent shown was a research project conducted by Harvard graduates, investigating the manipulation of folded patterns through origami and inflatable structures The engineers developed a way of designing structures based on origami folding that shape expands and contracts from inflation. This allows the structures to fold up flat for storage and transport while being constructed of solid and rigid materials. This investigation aims to implement these structures as deployable units in disaster zones to be emergency shelters (Melancon, Gorissen, García-Mora, Hoberman, Bertoldi; Knippenberg, Habraken, Teuffel.).

The second study analyzed deployable structures conducted by Ruud van Knippenberg, Arjan Habraken, and Patrick Teuffel. The study recognizes that multiple folding typologies can generate various forms. This study investigates non-singular, rigid folding arrangements and classifies them as having a high potential for translation into an actual structure.

By learning from the previously mentioned studies, the researcher can deconstruct an existing IGP and later reconstruct the pattern in different orientations to create new, modular shapes, showing how they can be created with the potential for tessellation and can be applied to design. The hundreds of patterns that currently exist have the possibility of generating their modules at different complexities and scales.

Contents

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BACKGROUND

CHAPTER ONE

For centuries geometry has been associated with the existence of a higher being, a divine creator, God. The shapes and patterns used in designing and constructing religious architecture, such as mosques, temples, and churches, have often been called sacred geometry. The study of sacred geometry originates in nature and the basic principle of mathematics. These patterns can be found across the world's religions; a few examples can be seen in Buddhism within Mandalas, Christianity within cathedrals, and Islam within Mosques and calligraphy.

Within Islamic art, geometric patterns are one of the three primary art forms that artisans of the time perfected. The focus on geometry as an art form stemmed from the prohibition of art that held any human or animal representation within it. This was enforced so that artists would not misrepresent God's creations and prevent the artwork from becoming objects for people to worship. Thus, geometry grew in popularity among local craftsmen, along with calligraphy and botanical imagery. These art forms became known as non-figural art that quickly evolved from variations of simpler forms seen in past civilizations of the Greek, Roman, and Sasanian peoples. Many works of art and architecture within the Islamic region combine all three forms of non-figural art within them. In the Alhambra (14th C.), Spain, floral patterns are seamlessly used alongside calligraphy and geometric patterns, complementing each other to create more significant works of art covering the entire building in beautiful arrangments.

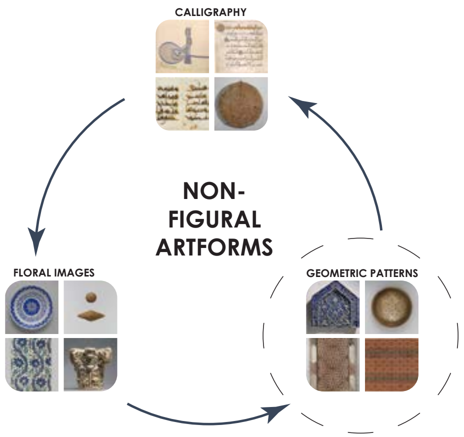


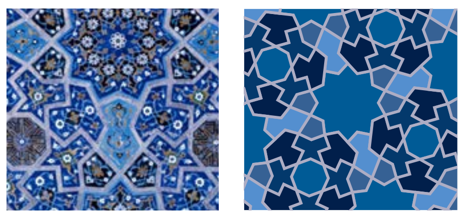
Figure 1.1

Figure 1.2

In the current literature, there is disagreement about whether or not there is a deeper meaning behind geometric patterns within the culture of Islam. In her book Beauty in Arabic Culture, Doris Behrens-Abouseif states that the characteristic that separates the philosophical beliefs of the Islamic world from that of Medieval Europe is the idea that 'beautiful' and 'good' are not interchangeable terms. Abouseif believes that beauty does not directly relate to morality and religious teachings. Others, like Keith Critchlow, disagree and think these patterns are intended to aid those looking at them to better understand the world around them. Critchlow believes these patterns exist not simply as ornamentation but to help viewers see the spiritual realm. This research's methods align with Abouseif, as there is a detailed focus on removing pattern compositions from their original context.

A general pattern analysis study was conducted to gather a greater understanding of the diversity within patterns in Islamic art. Specifically, imagery photographed by designer and writer David Wade was analyzed. This analysis separates the geometry from the compositions seen in the images. This study was necessary due to the nature of most compositions containing a combination of different non-figural art forms.

> "Much of the art of Islam, whether in architecture, ceramics, textiles or books, is the art of decoration – which is to say, of transformation."
> -David Wade



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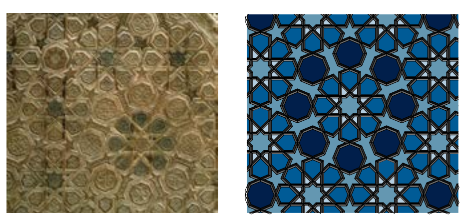

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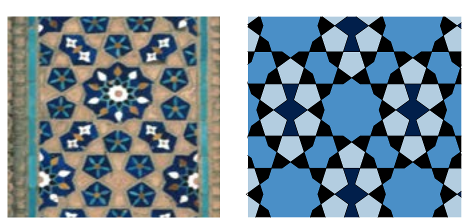

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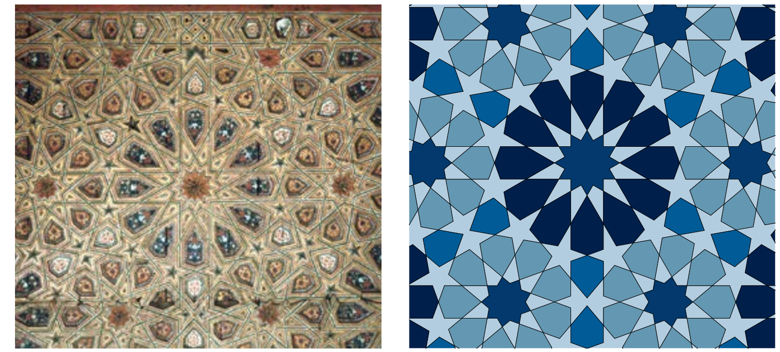

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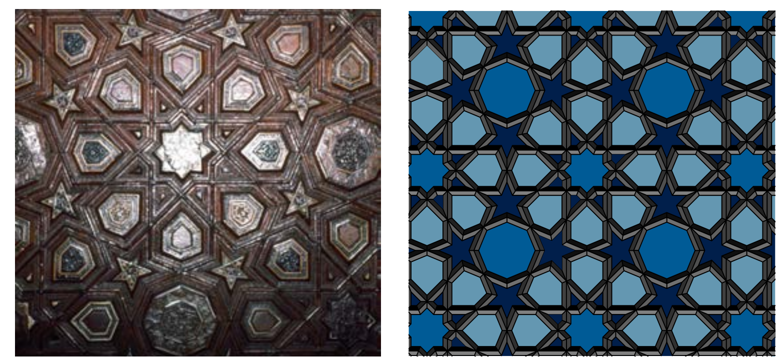

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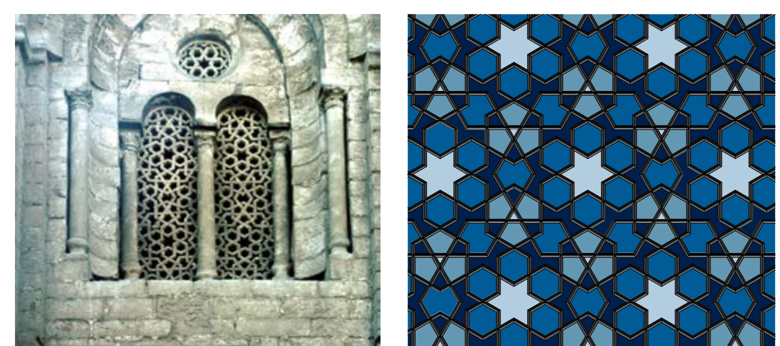


Figure 1.8:


Figure 1.9


Figure 1.10


Figure 1.11

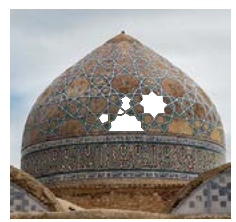


Figure 1.12

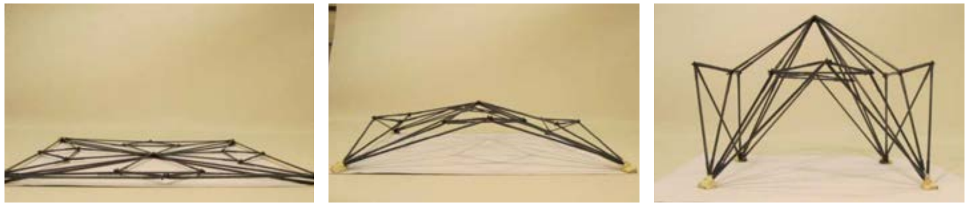
A set of domes was incorporated into the pattern analysis study to delve deeper into the array of patterns present in Islamic tilings. Four domes situated in Iran, namely the Shah Nematollah Vali Shrine, the Shahzeyd Holy Shrine, the Imamzade Abollah Shrine, and the Saveh Jame' Mosque, were included in this study.

Analysis of the domes revealed that larger shapes with more significant surface areas were employed where the dome had its widest span, while smaller shapes were utilized as the dome approached its narrower peak.


Figure 1.13

This study was significantly influenced by two important precedent studies, which greatly impacted the direction of the research. The first of these studies was conducted by a group of engineers at Harvard University, who designed a series of inflatable structures with underlying bases of origami folding techniques.

These structures can be assembled in minutes through inflation, allowing for easy construction and transportation. The ultimate objective of this study is to deploy these structures in disaster zones, where they can serve as emergency shelters (Melancon, Gorissen, García-Mora, Hoberman, Bertoldi).



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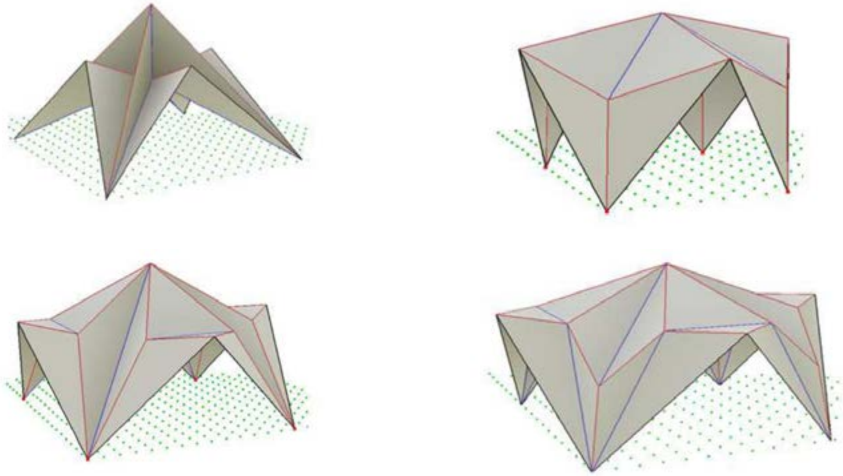


Figure 1.15

The second study that was reviewed explored the use of folded patterns in creating deployable structures. Through an analysis of multiple folding typologies, the researcher concluded that a wide variety of forms could be generated, which have the potential to be translated into reliable structures (Knippenberg, Habraken, Teuffel).

Based on the analysis of previous studies, it was deduced that the folding of geometries, irrespective of whether it pertains to origami or other applications, was most successful when it involved simplifying intricate geometric compositions into smaller, more manageable shapes. Researchers often employed a simplified shape, predominantly variations of the triangular shape, to aid in this endeavor.

To implement this valuable insight into the ongoing research, a deeper understanding of the specific shapes that manifest within compositions of Islamic geometry was deemed necessary. Gaining a more comprehensive view of these shapes would facilitate identifying the most appropriate simplified shape to utilize when folding Islamic geometries.

STAR VS GIRIH

CHAPTER TWO

Islamic art tiles are renowned for their intricate and complex arrangements achieved through tessellation. This non-figural art form has gained immense popularity across regions due to its captivating beauty. It is worth noting that despite originating from different times and places, the same shapes are repeatedly used in various compositions. The most commonly observed shapes in Islamic geometry are star shapes and girih tiles.

GIRIH TILES

Girih shapes are strapwork patterns of interlacing lines that create rhombic units. These shapes are combined in various ways to create complex, visually stunning designs found in everything from mosques to pottery. The precise rules and techniques used to create these patterns have been passed down through generations of Islamic craftsmen and remain an essential part of Islamic artistic heritage today. Inspired by 2nd-century Syrian Roman knotwork patterns, artists mimicked the interlacing lines they saw. These patterns contained different types of shapes, often referred to as polygons in contact by Western scholars. The tile shapes are used are the decagon, pentagon, irregular hexagon, bowtie, and rhombus. When touching one another, these polygons created new shapes called Girih patterns. Each side of these shapes shares an identical length, and all shapes, except for the pentagon, have at least two axes of symmetry. These qualities allow the tiles to tesselate infinitely only by repeating those five polygons. Besides infinite repetition, these shapes can also be used to create drawings replicating the region's architecture. When the shapes are laid in a specific fashion, it is possible to draw the elevations of common architectural building typologies of structures seen built at the time. These elevations are drawn simply by connecting intersecting lines within the Girih tiles to one another. These patterns can be seen alongside the second type of pattern that artists, the star pattern, developed. Girih patterns are often found in Islamic architecture in the form of intricate tilework, and they are widespread in Iran and Central Asia. One of the most famous examples of girih patterns in the mausoleum features a stunning array of girih patterns created by arranging the shapes in various ways.

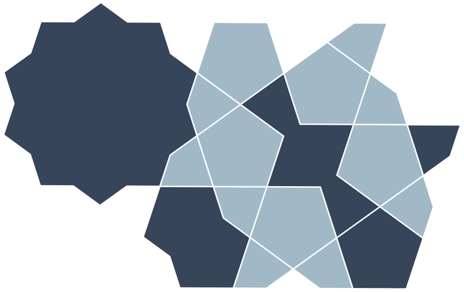


Figure 2.1

STAR SHAPES

One of the most recognizable shapes in Islamic tilings is the star shape, which comprises overlapping polygons. Using only the tools of a compass and a ruler, artisans connected intersections to create shapes with distinct points that went outward, similar to that of a star. These patterns can be painted on tiles carved into wood, among other places.

The first step to successfully drawing a star pattern is to divide a circle into x amount of equal sections. After the sections have been created, the segment lines are connected to create a collection of construction lines utilized to create a star that consists of the number of points that equals the amount of division the original circle was divided into. All star patterns fall within one of the four categories in what Eric Broug calls the Islamic Geometric Design Family Tree. The first three categories make up 95% of all known star patterns. The last category of grouped stars comprises 5% of stars seen within geometric compositions. Due to the last sections having such a wide variety, the study only focuses on the first three-star groups.

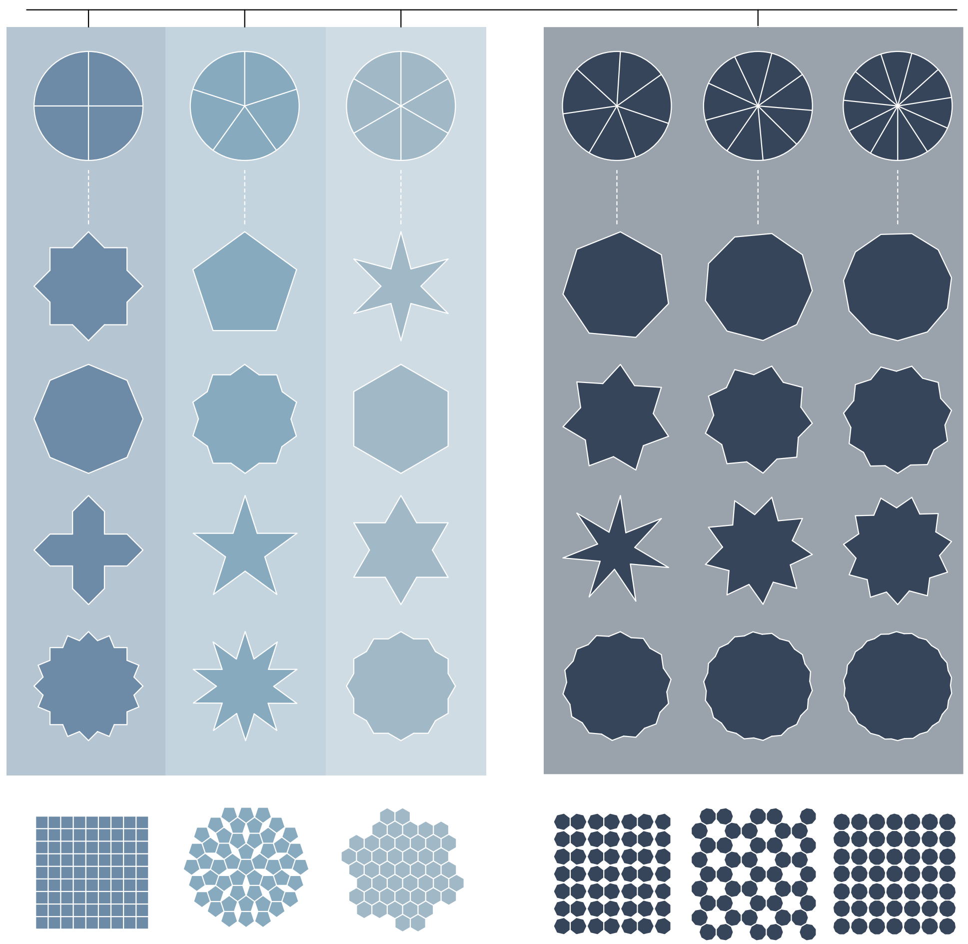


Figure 2.2

LINXIA GRAND THEATRE

Star and girih patterns are not limited to traditional Islamic architecture but can also be found in modern buildings. One example is the Linxia Grand Theatre in Linzia City, Gansu Province, China. The Linxia Grand Theatre is a performing arts center completed in 2019 and designed by the China Northwest Architecture Design and Research Institute.

The building's facade features a large 10-point star as its main element, created by an intricate interlocking of triangles to create a ribbed visual effect across the span of the building.

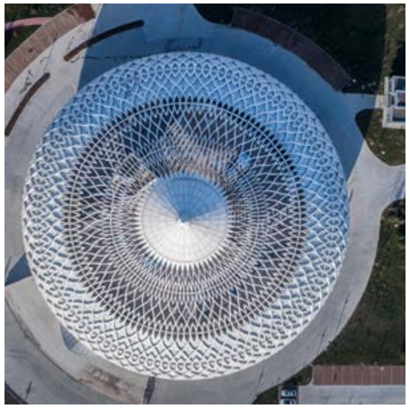


Figure 2.3, 2.4, 2.5 (Top to bottom)

LOUVRE MUSEUM (ABU DHABI)

Another example of Islamic geometry used in modern architecture is in the Louvre Museum in Abu Dhabi. The art museum features a unique layered dome facade comprising eight sheets of stainless steel aluminum. Every layer has a complex geometric pattern perforated onto its surface, allowing light to pass through to the inside of the building for a stunning visual effect, casting intricate shadows on the museum's interior walls and floors.

Besides its aesthetic appeal, the dome also has a practical function. The perforations help regulate the museum's temperature, allowing hot air to escape through the holes in the layers. The dome also provides shading and protection from the sun's harsh heat.

Figure 2.6, 2.7, 2.8 (Top to bottom

AL BAHR TOWERS

Located in Abu Dhabi, the Al Bahr Towers are another example of incorporating Islamic geometry into modern architecture. The most distinct feature of the towers is the shading system that surrounds the exterior of the building. The complex arrangement of the panels is inspired by muqarnas typically seen in Islamic architecture.

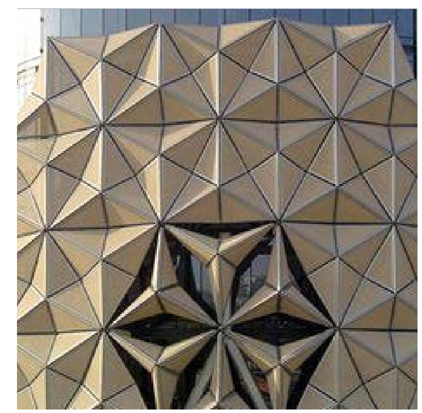


Figure 2.9, 2.10, 2.11 Top to bottom

INSTITUT DU MONDE ARABE

The Institut du Monde Arabe (IMA) in Paris, France, is a cultural institution prioritizing public access and education to Arab and Islamic cultures. Similar to the Al Bahr Towers, this piece of architecture also incorporates elements of Islamic design into the function of the building.

The most prominent feature of the building is the facade, with hundreds of small movable pieces on the surface of the building; it can open and close. This feature allows for the control of light and airflow. These kinetic parts are arranged in patterns resembling geometric designs in Islamic art.

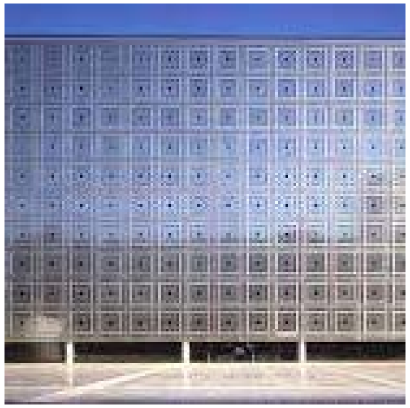


Figure 2.12, 2.13, 2.14 (Top to bottom)

RESEARCH MAKING

CHAPTER THREE

After acquiring a fundamental comprehension of the assorted shapes frequently replicated in Islamic compositions, the research can progress toward pattern manipulation. In this stage, the researcher aims to remove the identified shapes from their larger patterns and treat them as discrete entities. The researcher can manipulate these shapes in various ways to test the study's potential for creating new patterns.

These shapes are subjected to various material tests to assess how they interact with different media, such as paper or fabric, and how they respond to various treatments, such as scaling, rotation, and distortion. The researcher analyzes the results of these tests to identify which shapes and manipulations are the most promising for producing new patterns.

YARN STUDIES

The present study aims to examine the spatial quality of star patterns through a simple manipulation tactic of extrusion. This approach involves the elevation of the stars through the weaving of yarn in their general path. To achieve this, three different stars were selected for examination, including an 8-point, 10-point, and 12-point star.

The process of elevating the stars was executed by constructing them along nailed boards that served to define their direction. As the yarn was woven, each star gradually rose in elevation, producing a three-dimensional structure that revealed the spatial quality of its pattern. This approach provided a unique opportunity to investigate the spatial characteristics of the stars, as their elevation and shape were manipulated through the extrusion process.

This study's findings revealed the stars' intricate spatial qualities as each point was raised and stretched in a defined direction. Using the extrusion technique, the stars demonstrated a unique depth and form often overlooked in two-dimensional representations. This research sheds light on the importance of exploring new techniques to understand spatial qualities in visual arts and provides a foundation for further research.

See Apendix B for full documentation

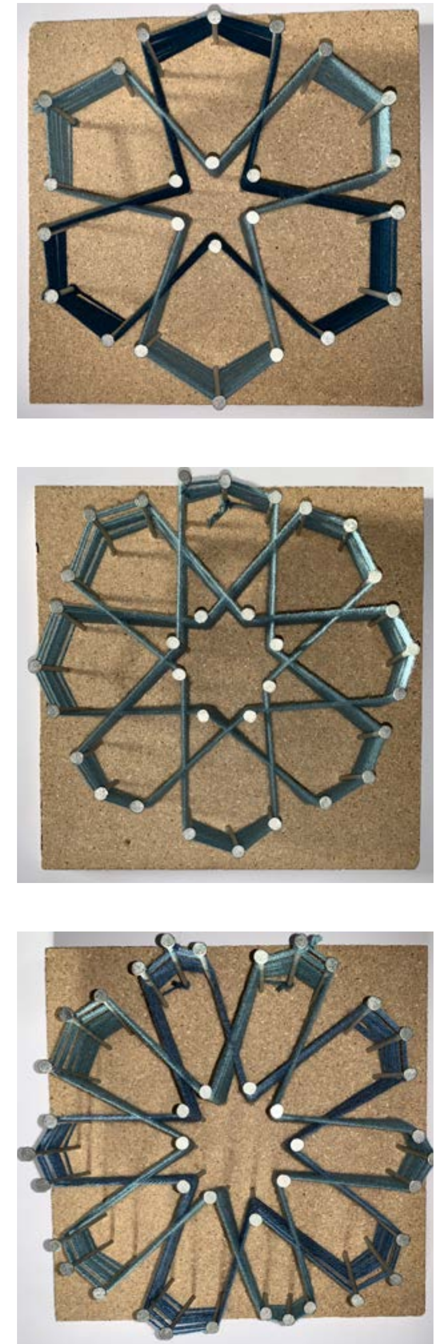


Figure 3.1, 3.2, 3.3 (Top to bottom)

CONCRETE YARN STUDIES

A second series of iterative of models were created as a result from the preliminary investigations of yarn. These models were formed by submerging yarn in concrete paste and arranging the yarn into various star configurations. The plaster-saturated yarn was then positioned on bowls in order to dry in the shape of a dome. This exploration revealed that the shapes had the ability to sustain their own weight when specific points of the star were extruded while others remained on the ground plane.

The experimentation involved utilizing yarn as a flexible and easily manipulated material that could be shaped into various forms. Concrete paste was then applied to the yarn in order to give it structure and rigidity. The star shapes were chosen due to their geometric properties, which made them ideal for studying the structural capabilities of the models. By laying out the plaster-drenched yarn on bowls, the yarn was allowed to set in a curved form, simulating a dome structure.

The results of the study indicated that the models could support themselves when certain points of the star shape were extruded and others were left on the ground plane. This suggested that the star shapes had the potential to be utilized in the design of architectural structures.

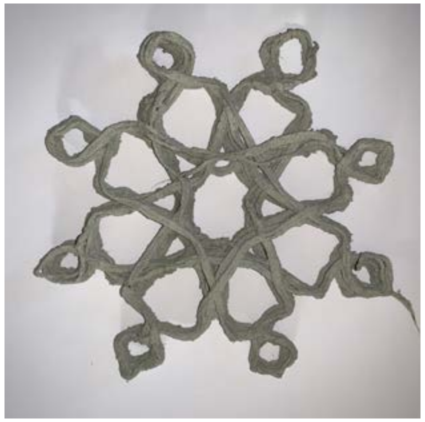


Figure 3.4, 3.5, 3.6 (Top to bottom)

TENSION STUDY

A model was constructed using wooden dowels and elastic bands to observe the behavior of a ten-pointed star under conditions of tension and compression. The construction process involved careful attention to detail, as the precise placement and stress of the elastic bands played an important role in accurately simulating the structural properties of the star shape.

Through the process of model creation and examination, our team has gained significant insights regarding the structural features of the ten-pointed star shape, particularly with respect to its stability even in the absence of additional support structures. This knowledge has important implications for the field of architecture.

See Apendix C for full documentation

Figure 3.7, 3.8, 3.9 (Top to bottom)

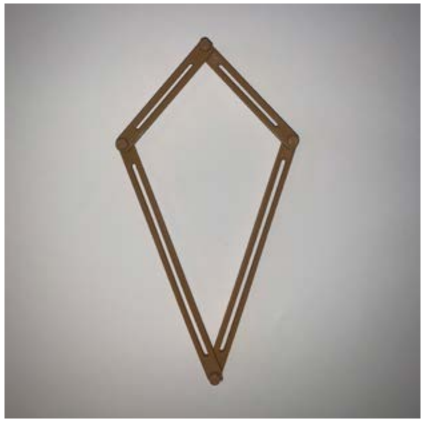
KINETIC STUDIES

The study then undertook a thorough analysis of two prominent buildings, namely the Al Bahar Towers in Abu Dhabi and the Institut Du Monde Arabe in Paris. By constructing a series of models based on these buildings' dynamic and responsive facades, we have further enhanced our understanding of geometric principles and their potential applications in architecture. These facades include various kinetic features that respond to external factors, such as sunlight and temperature.

The primary aim of this model series was to explore the mechanics of Girih tiles and their corresponding kinetics. Each intersection of the lines in the tiles was used as an axis of rotation to simulate dynamic, movement-based elements in the model. The drawings were then 3D printed to create accurate physical representations.

The results of the kinetic model studies have led to a better understanding of the mechanics of Girih tiles and how they can be utilized in the design. Additionally, the 3D-printed models allowed for a more tangible and interactive representation of the kinetic elements

See Apendix D for full documentation



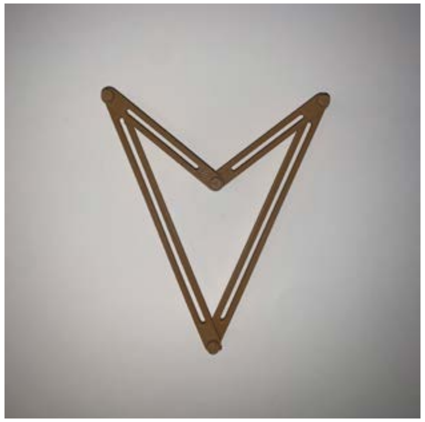


Figure 3.10, 3.11, 3.12 (Top to bottom)

DECONSTRUCTION

CHAPTER FOUR

As the study of shape manipulation progressed, the research revisited findings gathered from precedent studies previously analyzed in the first phase of the investigation (Melancon, Gorissen, García-Mora, Hoberman, Bertoldi; Knippenberg, Habraken, Teuffel.) Through the review of these works, the assumption that simplifying the complex compositions of Islamic patterns into simpler shapes was supported. The next and final method of pattern manipulation is titled “Deconstruction’.’ where this method was chosen to progress the investigation into the final stages

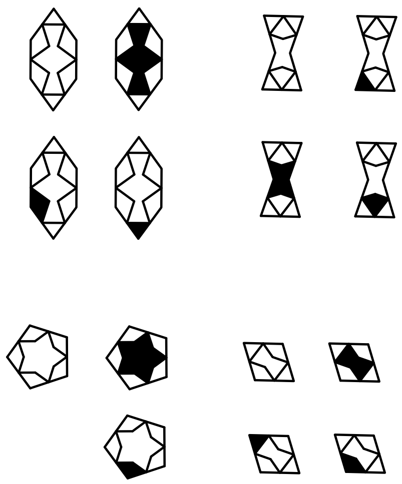


Figure 4.1

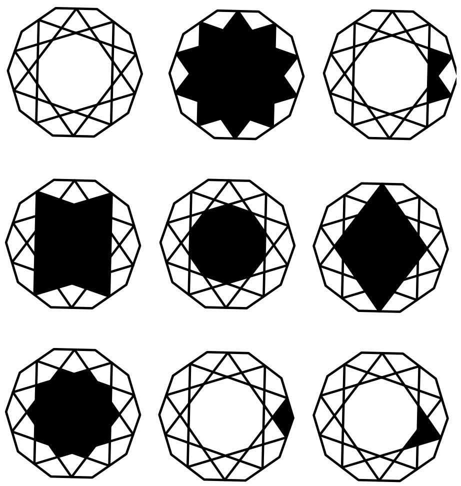


Figure 4.2

To establish a framework for deconstructing complex compositions, it was necessary to analyze the Girih and star shapes. This preliminary examination provided a foundation for understanding how the deconstruction method could be structured.

As a fundamental principle, it was determined that all deconstruction would occur only along the construction lines of a shape. This limitation was necessary to prevent infinite deconstruction, rendering the method impractical. Construction lines, as defined in this context, refer to the lines essential for drawing a specific shape.

By adopting this approach, the deconstruction method can be more effectively applied to further the study, allowing for a more systematic and controlled approach to pattern manipulation, in contrast to other methods investigated earlier in the thesis.

This process began with the deconstruction of Girih shapes, it was revealed that each form has a specific number of secondary shapes that are revealed through simplifying them on their lines of construction. Further analysis discovered that most Girih shapes contain one or multiple unique secondary shapes not present in other figures.

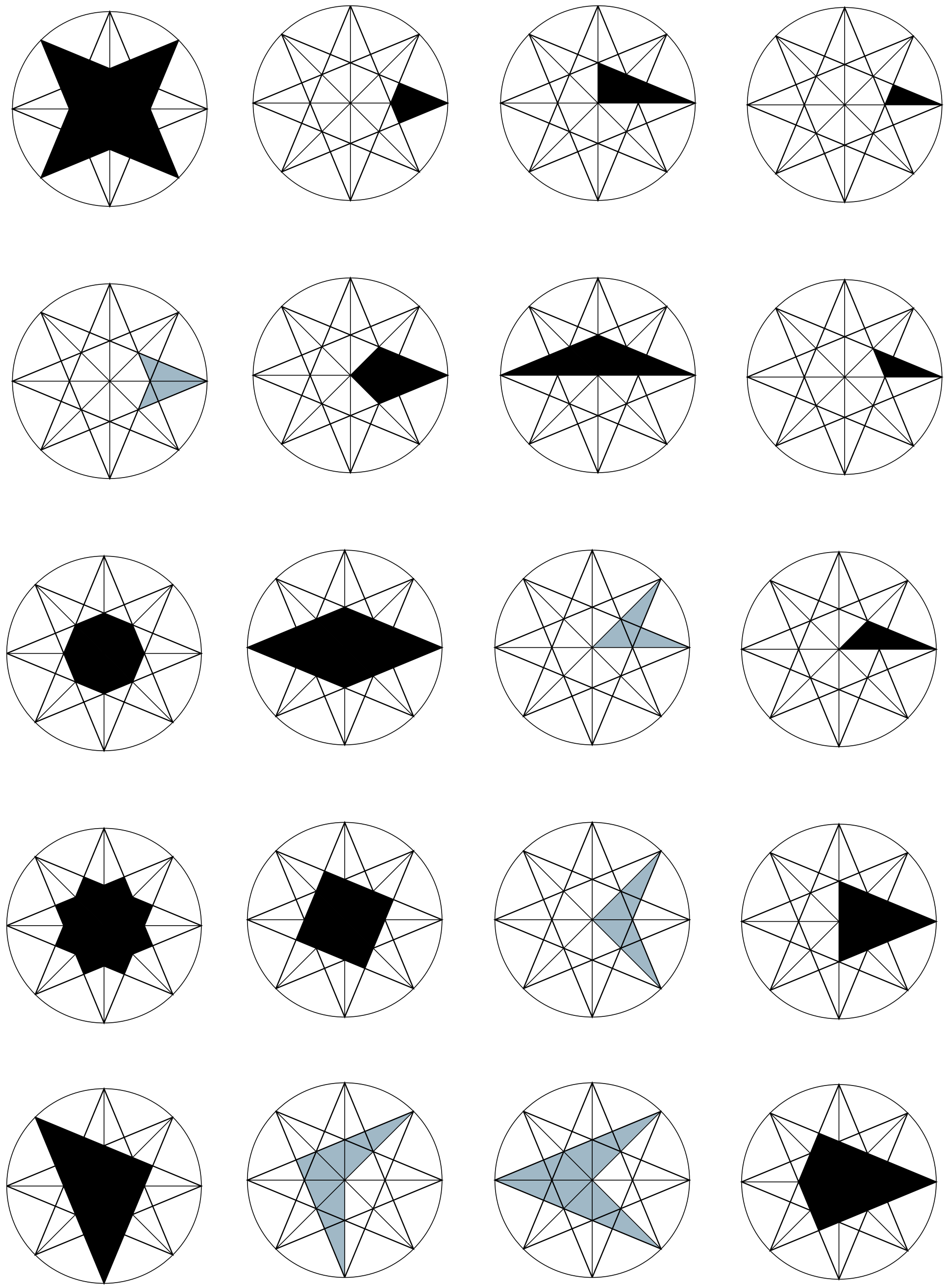


Figure 4.3

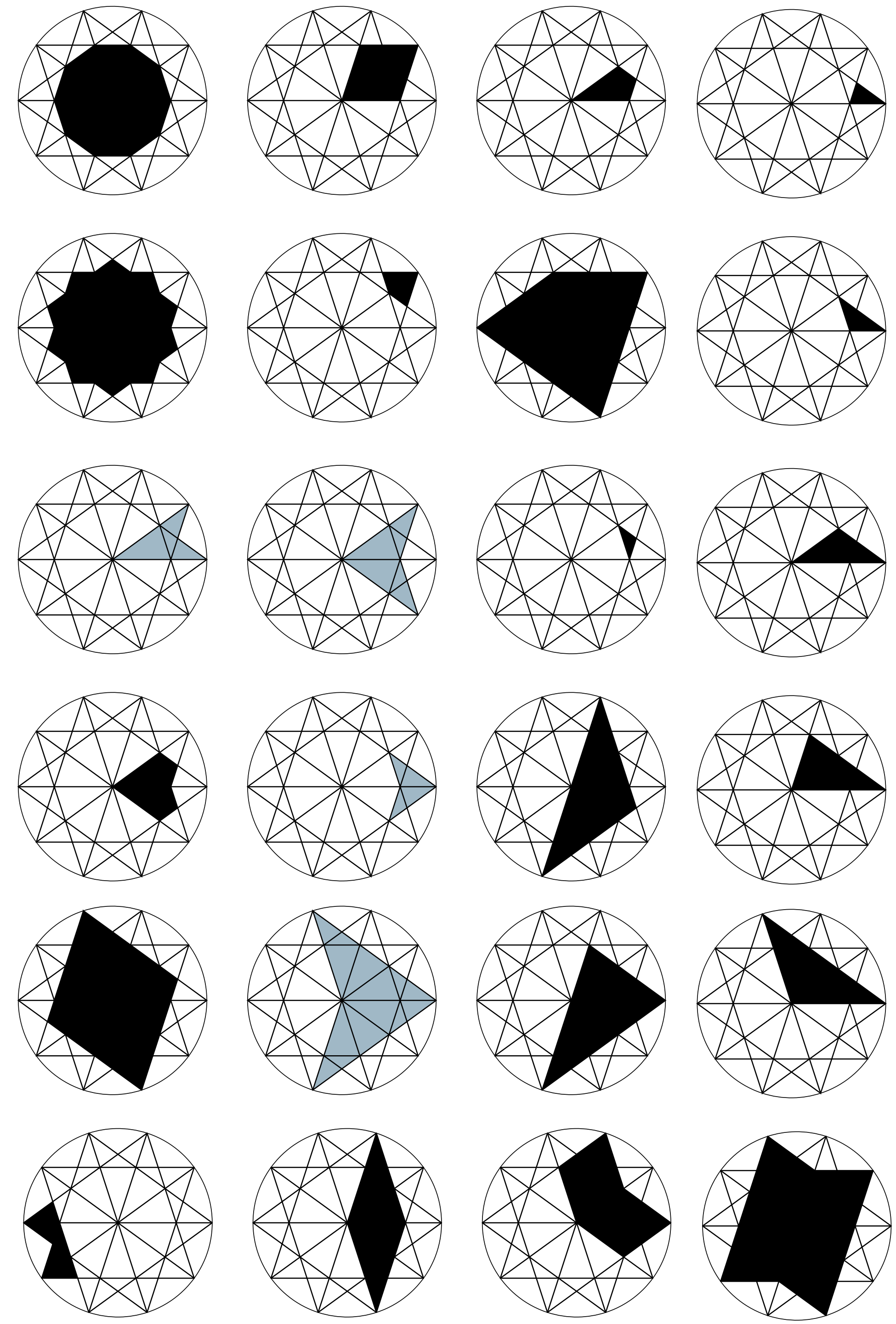


Figure 4.4

AMOUNT OF SECONDARY SHAPES INCREASE AS THE POINTS OF A STAR INCREASE

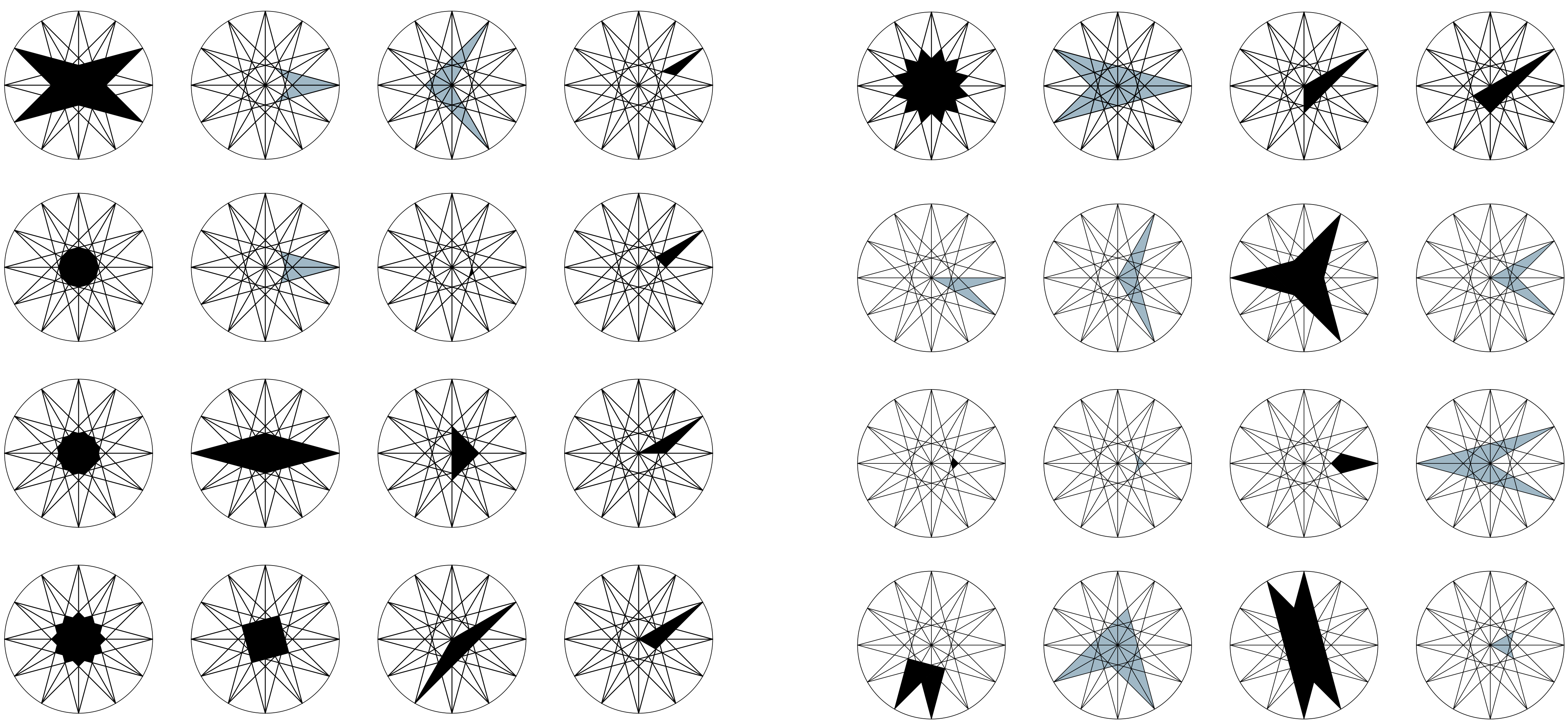
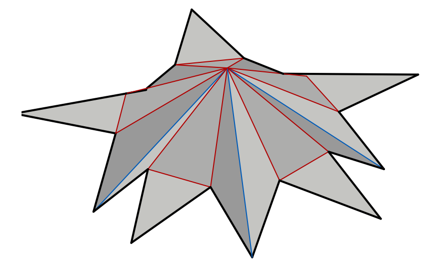
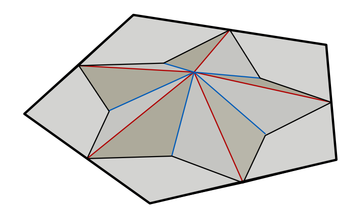


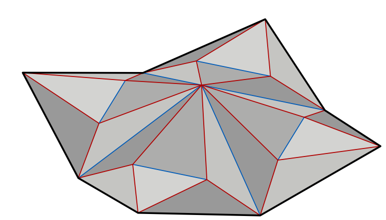
Figure 4.5

FOLDING STUDIES

A series of folding studies were conducted to test the manipulation of deconstructed shapes into three-dimensional forms. These folds were inspired by a precedent study seen earlier in the investigation (Knippenberg, Habraken, Teuffel). To better learn from previously conducted research, these folding models were constructed in the same style as the precedent and used a combination of star and girih shapes as a basis for each form.







See Apendix E for full documentation

Figure 4.6, 4.7, 4.8 (Top to bottom)

(RE)CONSTRUCTION

CHAPTER FIVE

After establishing an understanding of the deconstruction method and gathering sufficient knowledge about individual shapes through the Research Making process, a strong enough foundation was present for applying shape manipulation to a selected pattern.

This step transitions the research into the final phase of the investigation as it applies the learnings of deconstruction into a larger composition and allows the method to reveal new designs from existing patterns.

THE CHOSEN PATTERN

In choosing an existing composition to apply the deconstruction process, it was also essential to select a pattern that was already familiar to the researcher. In revisiting the six compositions that were looked at in the first phase of the research, the one located within the Gur Amir Mausoleum in Transoxiana, Samarkand was selected.

Not only has the pattern already been seen in this investigation, but it has also been repeated across a spread of other buildings. The repeatability and familiarity with this composition were the main reasons behind moving forward with this tiling rather than others that have been seen in the research process.

Figure 5.1

Figure 5.2

Figure 5.3

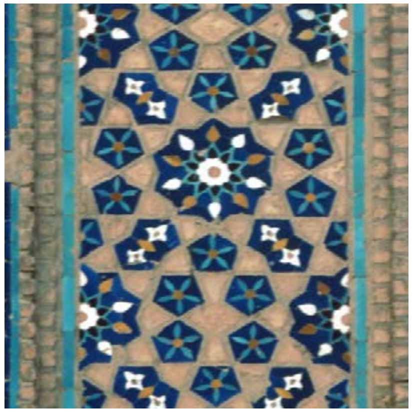


Figure 5.4

Figure 5.5

Figure 5.6

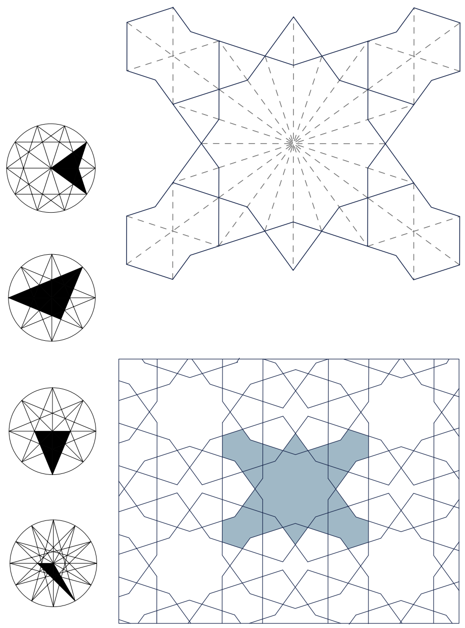


Figure 5.7

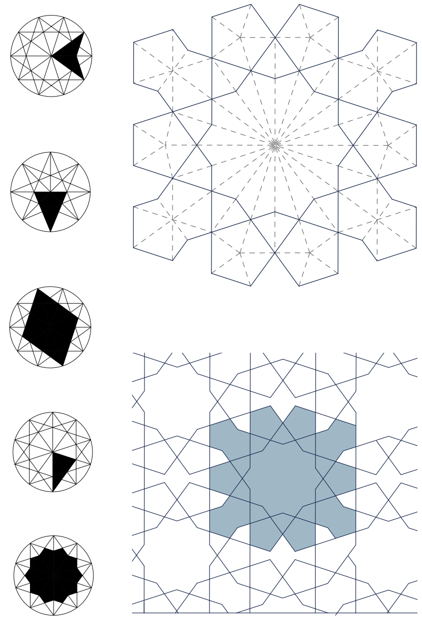


Figure 5.8

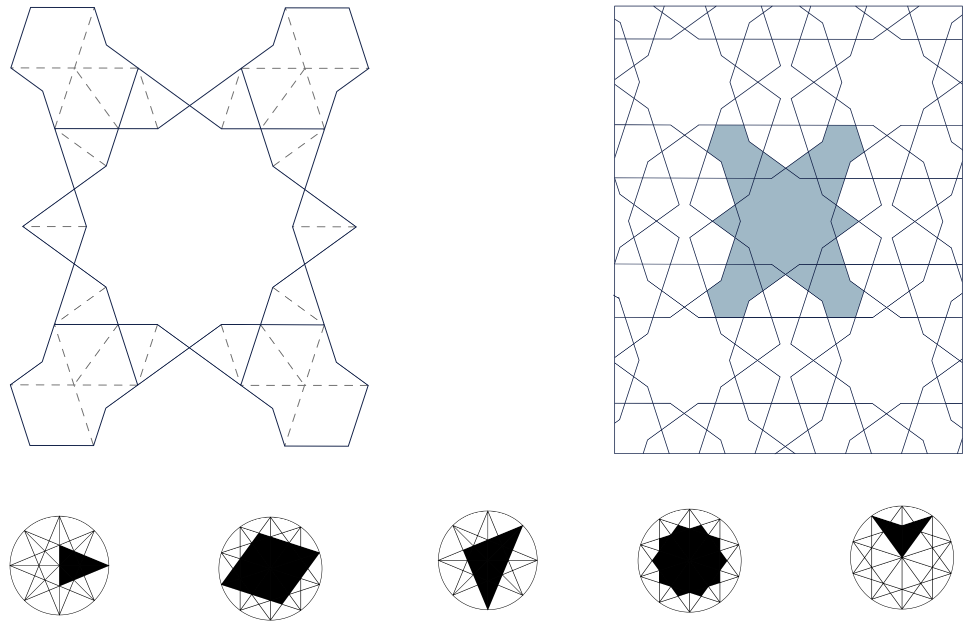


Figure 5.9

A couple of essential steps followed the choosing of the pattern. The pattern was first deconstructed in the same manner initially done with the star and girih shapes earlier in the study. The construction lines of the entire composition were identified and drawn to reveal the secondary shapes present within the pattern.

To simplify the composition further, specific points of the pattern were highlighted as a basis for identifying the overall shape of the final module. Three different iterations were explored, each one containing different combinations of secondary shapes that were revealed in the deconstruction study.

The first two iterations utilized as many deconstructed shaps as the researcher could identify, maximizing the number of variables that needed to be considered when constructing the final model. This large number resulted in complex results that could not be explored due to the limitation of time. In order to continue the exploration of deconstructing this composition, different secondary shapes were selected in the third iteration of the design. This iteration is used in generating the final module in the thesis study.

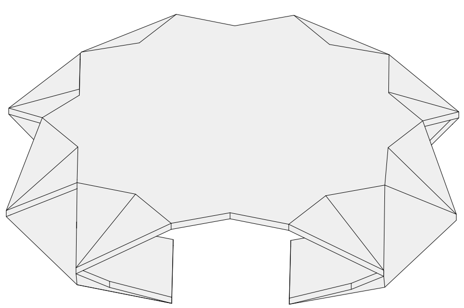


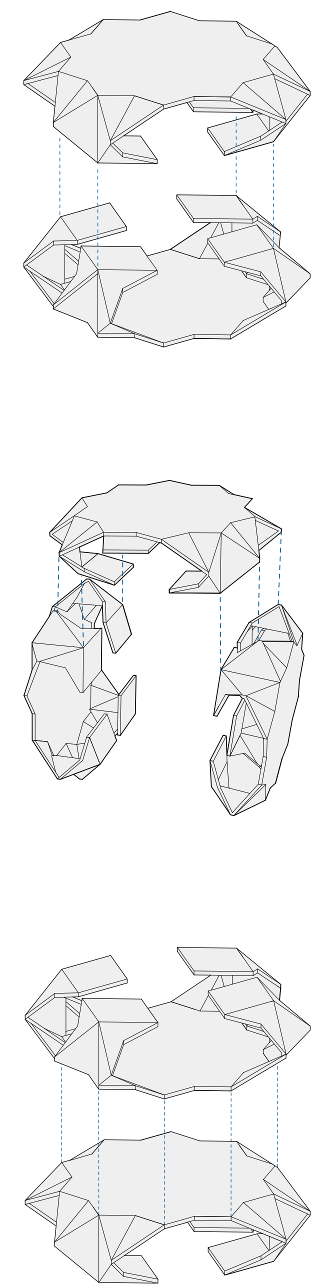
Figure 5.10

THE FINAL FORM

In applying the folding experimentation done in the last chapter toward Iteration 3, the final form of this study could be created. This form, in a similar fashion to the tiling that it was inspired by, can infinitely tesselate in several different directions that are revealed in the series of images throughout the chapter. There are three main points of connection on this form that show potential for exciting design opportunities.

Rather than focus on one connection point and generate a design based on that, the research instead investigates many different ways that the designed module can connect to itself to generate unique forms.

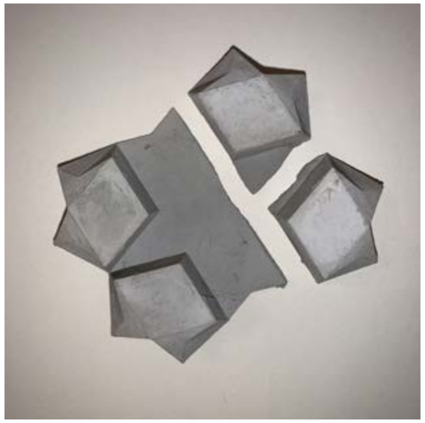
Figure 5.11 (Right)

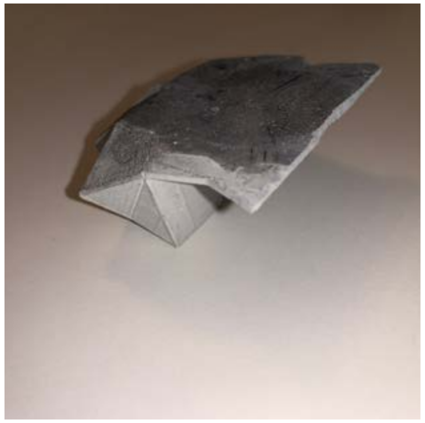


MATERIAL STUDY

Once the final form has been identified it was important to reproduce as many exact replicas of the original form as possible. Doing this will allow for experimentation with the tessellation of the designed shape. Ensuring that each replicated module is exact will preserve the scale of the form and allow for seamless repetition.

Two different methods were explored in finding an optimal way to reproduce the final form. The first called for casting the module in silicone so that concrete replicas could be poured and created. This method did not show to be a successful approach, the concrete was brittle and continuously broke when removing it from the silicone mold. The second method explored was that of 3D printing. This proved to be a faster process when compared to waiting for the concrete pour to dry. The ability to print four modules simultaneously proved the most significant benefit and one of the main reasons for committing to this method.





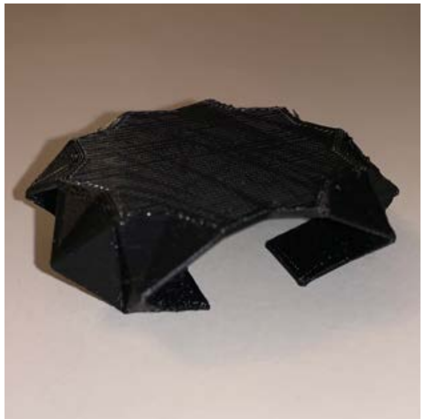


Figure 5.12, 5.13, 5.14 (Top to bottom)

TESSELLATION TESTING

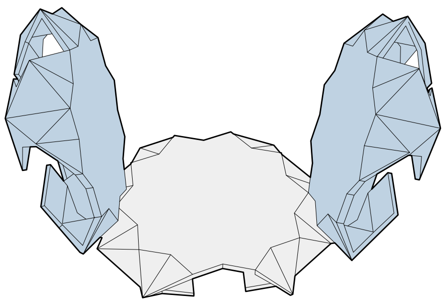


Figure 5.15

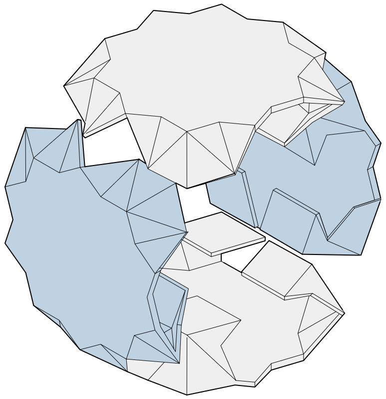


Figure 5.16

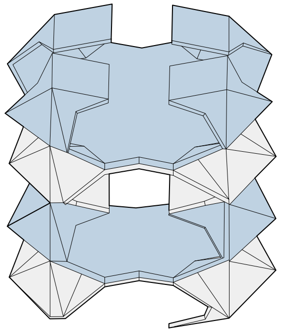


Figure 5.17

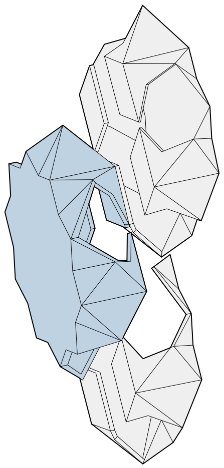


Figure 5.18

LIMITATIONS

CHAPTER SIX

As with any research project, there are limitations to the present study that must be acknowledged. These limitations should be taken into consideration when interpreting the results and implications of the research.

A significant limitation of this thesis study was time. With the scope and complexity of the research, the investigation would have benefited from additional time to conduct a more in-depth analysis and gather more data. However, the study had to prioritize certain aspects due to time constraints. The limitations resulting from the time also had implications for the study's potential direction. Despite these limitations, the research findings contributed value to the existing literature in the field.

Furthermore, the availability of materials and resources presented another limitation of this study. Access to specific resources and materials was crucial to the success of the research. However, due to budget constraints, the researcher could not purchase all the desired resources. The researcher had to work within the available resources and materials to mitigate any potential impact on the study's validity. This limitation highlights the need for future studies to consider resource availability and the impact that it can have on the direction and validity of their research.

Figure 6.1

Constructing models was an arduous process in this thesis study, hampered by time and resource limitations. Each model creation required a significant amount of time, causing delays in the research process. The research came to a halt until the model was finished and each iteration's learning was recorded. This process reduced the time available for data collection and analysis.

Several instances occurred when the models created were unsuccessful or had to be reconstructed due to undesirable outcomes or physical damage. These setbacks resulted in further delays and required additional time and resources. Despite these challenges, the researcher persisted in creating models, documenting their findings, and producing significant contributions to the existing literature.

In summary, this thesis study faced limitations such as time and resource constraints, as well as the time-consuming process of model creation.

CONCLUSION

SEVEN

This research illuminates the vast potential of geometric patterns extracted from Islamic art and architecture, offering invaluable insights. It presents novel opportunities for designers to integrate Islamic art into their creations, paying homage to its rich heritage while venturing beyond the confines of contemporary design. The capacity to manipulate these patterns endows designers with boundless possibilities, empowering their creative endeavors.

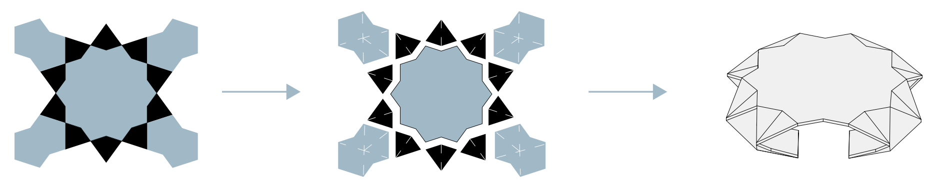


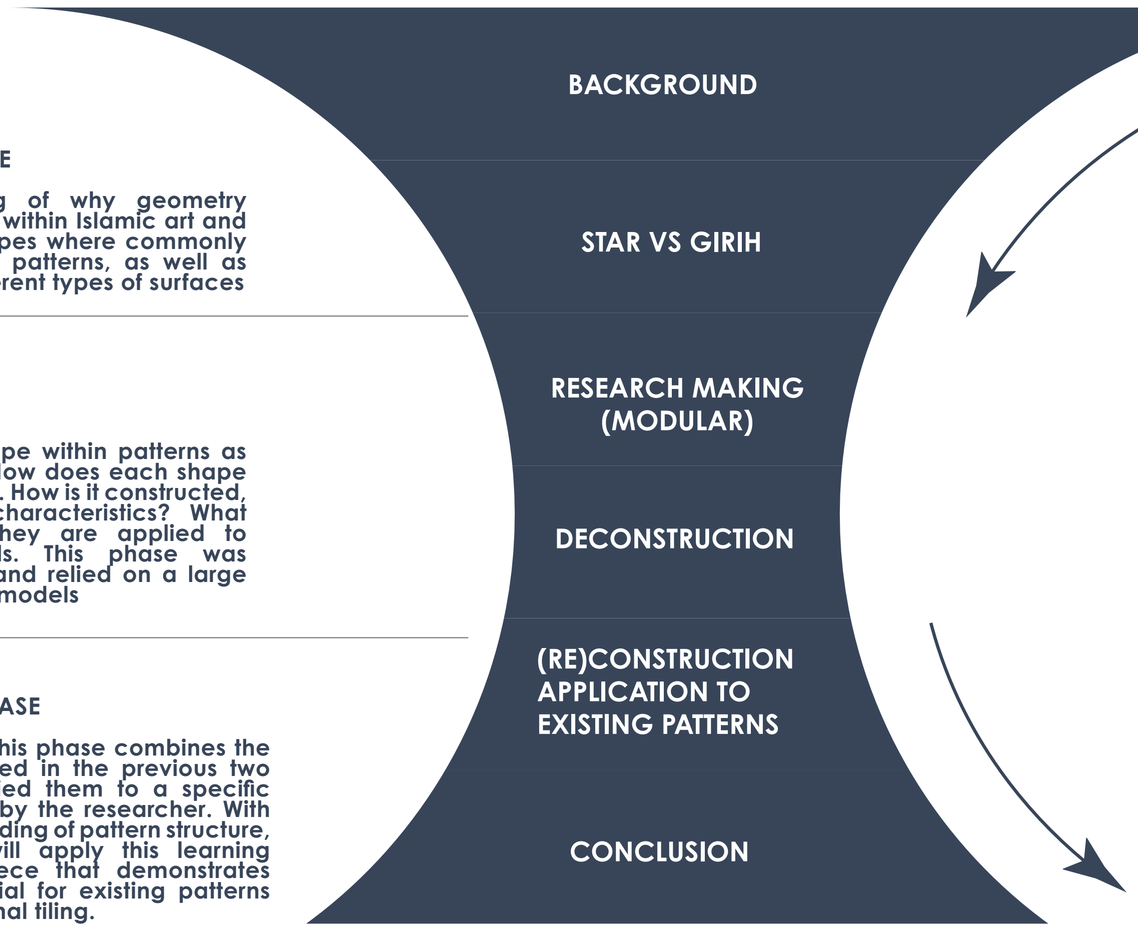
Figure 7.1

Throughout the research, several important insights were gathered. One key finding was that the process of deconstruction is highly effective for producing new modular forms from 2-dimensional patterns. This suggests that many other forms could emerge by applying the process to other patterns beyond those studied in this research. However, it is important to note that the investigation of patterns is an expansive and complex endeavor, and no single researcher can explore all possible variations or outcomes. Therefore, while the final module constructed as a result of this research represents an important advancement, it is not the only or most optimal for that could be produced from the identified pattern.

There is significant potential for further investigation into creating new forms using the deconstruction process applied to patterns seen within Islamic geometry. The final result of this research represents just one of many possible outcomes.

APPENDIX A: METHODOLOGY DIAGRAM

RESEARCH METHODOLOGY DIAGRAM



BEGINNING PHASE

An understanding of why geometry gained popularity within Islamic art and what types of shapes where commonly used within these patterns, as well as observing the different types of surfaces

MIDDLE PHASE

Treating each shape within patterns as modular pieces. How does each shape act as a single unit. How is it constructed, what are their characteristics? What happens when they are applied to different materials. This phase was very exploratory and relied on a large number of sketch models

CONCLUDING PHASE

(re)Construction, this phase combines the research conducted in the previous two phases and applied them to a specific pattern identified by the researcher. With this new understanding of pattern structure, the researcher will apply this learning to a modular piece that demonstrates the further potential for existing patterns beyond their original tiling.

Understanding of non-figural art, current conflicts within the literature, and existing patterns (analyzing how they appear on flat surfaces and curved surfaces). This section also introduced two precedent studies that are relevant to findings later in the research.

Identifing unique shapes that appear within geometric patterns; categorizing them by name and characteristics that group them. This section also provides an indepth analysis of two domes and how these shapes appear on those domes.

The shapes previously identified are now removed from larger patterns that they are commonly found in. These shapes are treated as singular entities that the researcher manipulates in a variety of material tests to test the potential of the study.

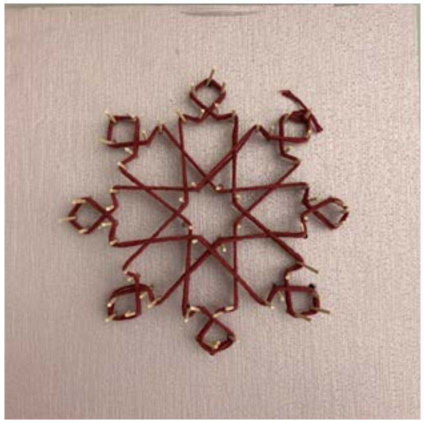
The single shapes are broken down further through the construction lines that are needed to create them. Secondary shapes are identified within the construction lines in order to create a larger pool of shapes to continue the study.

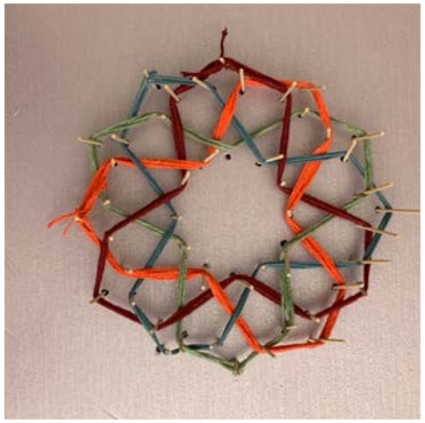
A single pattern is identified by the researcher and the process of deconstruction is applied to the chosen pattern. Once the present secondary shapes have been found, the lines are folded to create new forms inspired by the original design.

The potential for the application of deconstruction goes beyond one pattern. It is impossible for the researcher to conduct this testing with all patterns seen. Additional limitations include time, alternate testing opportunity, and resources.

Figure 8.1

APPENDIX B: YARN STUDIES





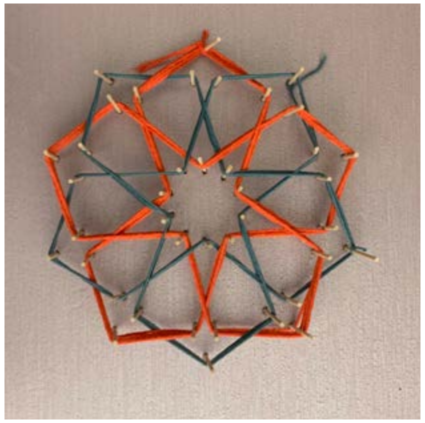


Figure 8.2, 8.3, 8.4 (Top to bottom):

Reviving Roots

APPENDIX C: TENSION STUDIES

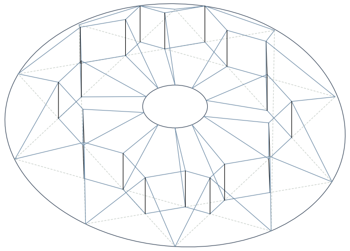


Figure 8.5, 8.6, 8.7 (Top to bottom):

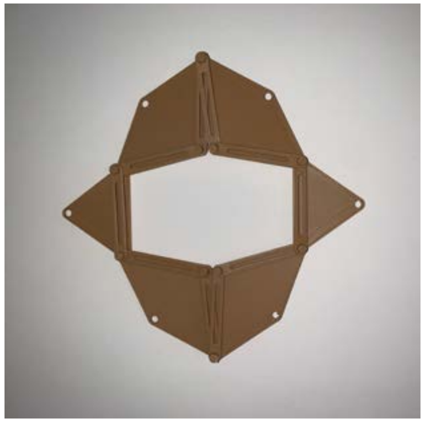
Reviving Roots

APPENDIX D: KINETIC STUDIES

Reviving Roots

Figure 8.8, 8.9, 8.10 (Top to bottom):

APPENDIX D: KINETIC STUDIES



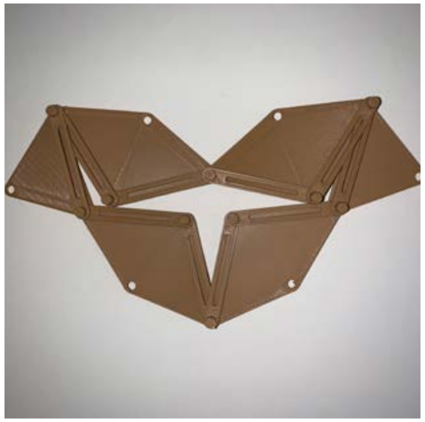
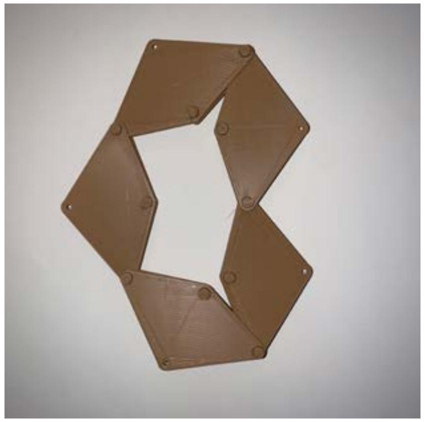


Figure 8.11, 8.12, 8.13 (Top to bottom):

Reviving Roots

APPENDIX D: KINETIC STUDIES



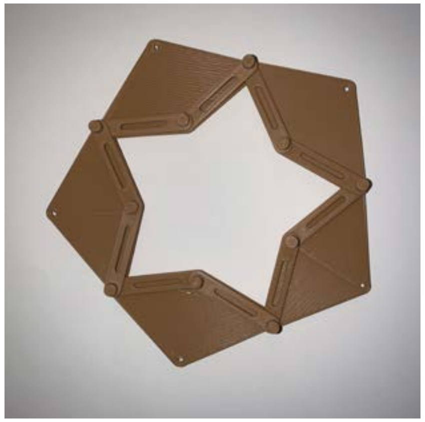
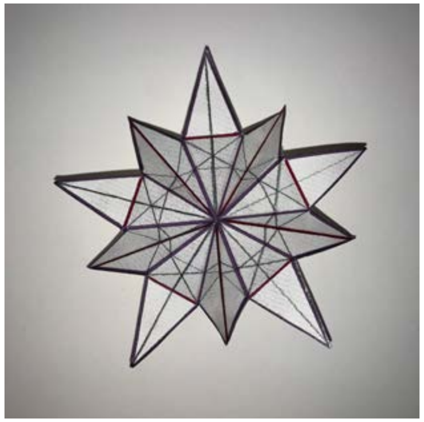
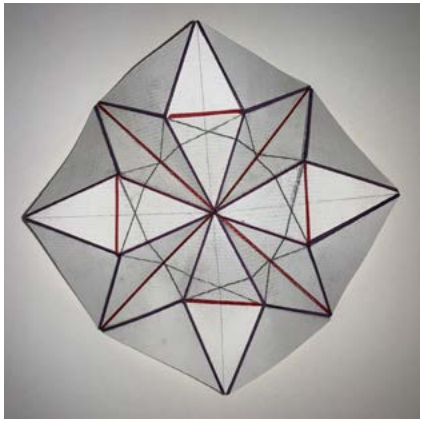
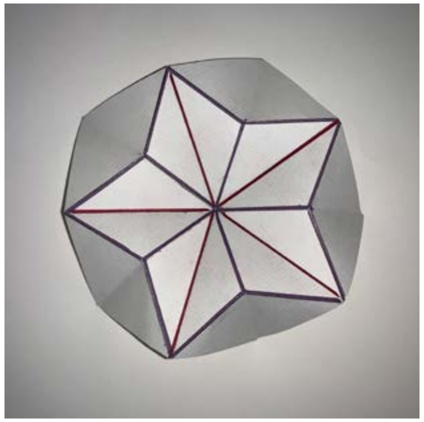


Figure 8.14, 8.15, 8.16 (Top to bottom):

Reviving Roots

APPENDIX E: FOLDING STUDIES




First Row (Left to right): Figure 8.17, 8.18:
Second Row (Left to right): Figure 8.19, 8.20
Third Row (Left to right): Figure 8.21, 8.22

CLOSING REMARKS

As I come to the end of my thesis year and my time at the University of Detroit Mercy, I am filled with accomplishment. The past five years have been filled with challenges and growth. Through it all, I have developed a deep passion for architecture and a commitment to excellence in all aspects of my work.

My thesis year has given me the opportunity to explore my own ideas and creative vision in a way that has challenged and inspired me. Through the process of developing my research project, I have gained a deeper understanding of the complexities of architectural design and the importance of careful consideration of every detail.

Looking back on my time at the School of Architecture and Community Development, I am grateful for the incredible faculty, staff, and fellow students who have supported and encouraged me through this thesis and the past five years. I am proud of the work that I have accomplished and the friends that I have made along the way.

As I move forward in my career, I carry with me the lessons and experiences I have gained while studying in Detroit. I am excited for the opportunities that lie ahead and look forward to continuing to grow and develop as a designer.

LIST OF FIGURES

CITATION

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