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Erasmus+ Programme  
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جامعة الزيتونة الأردنية  
Al-Zaytoonah University of Jordan



## Geometry Vocational Course Road-map

Traditional Craft Heritage  
Training , Design and Marketing  
in Jordan and Syria  
(HANDS)

ERASMUS+Programme

HANDS Project Number : 610238-EPP-1-2019-1-JOEPKKA2-CBHE-JP



GEOMETRY  
Training Program

# GEOMETRY

Training Program



# Objectives

To delve into the world of geometric ornamentation, understanding its fundamental principles, cultural significance, and practical applications through a blend of theoretical knowledge and hands-on creation.

1

Investigate how base shapes and angles dictate the characteristics of different pattern types.

2

Analyze the role of symmetry in creating order, balance, and visual harmony in geometric patterns.

3

Uncover the mathematical principles underlying geometric patterns, including tessellations, symmetry, and proportions.

4

Explore the cultural history and significance of geometric ornamentation across civilizations.

5

Discover the diverse applications of geometric ornamentation in art, architecture, design, and other fields.

6

Gain hands-on experience in creating geometric ornaments using various techniques and materials.

# Program Details

## Target Audience

School and university students

## Program Duration

Four weeks, two days a week with three hours per day.

## Delivery Method

- Presentations
- Training activities
- Brainstorming
- Discussion and dialogue

# PROGRAM CONTENTS

1

Program Overview  
What is geometric ornamentation?  
**Break**  
Basic geometric shapes and their properties  
**Discussion**

2

Foundations and characteristics of geometric ornamentation  
**Break**  
Patterns and configurations  
**Discussion**

3

Principles and methodologies for creating geometric patterns  
**Break**  
Advanced techniques in geometric ornamentation  
**Discussion**

4

Cultural and Historical Influences  
**Break**  
Versatility and applications of geometric ornamentation  
**Discussion**

5

Designing a pattern using a simple basic shape.  
**Break**  
Combining different base shapes to create more complex patterns.  
**Discussion**

6

Exploring how designs can be transformed through rotations, reflections, and scaling.  
**Break**  
Applying mathematical concepts like symmetry, Golden Ratio, and fractal geometry.  
**Discussion**

7

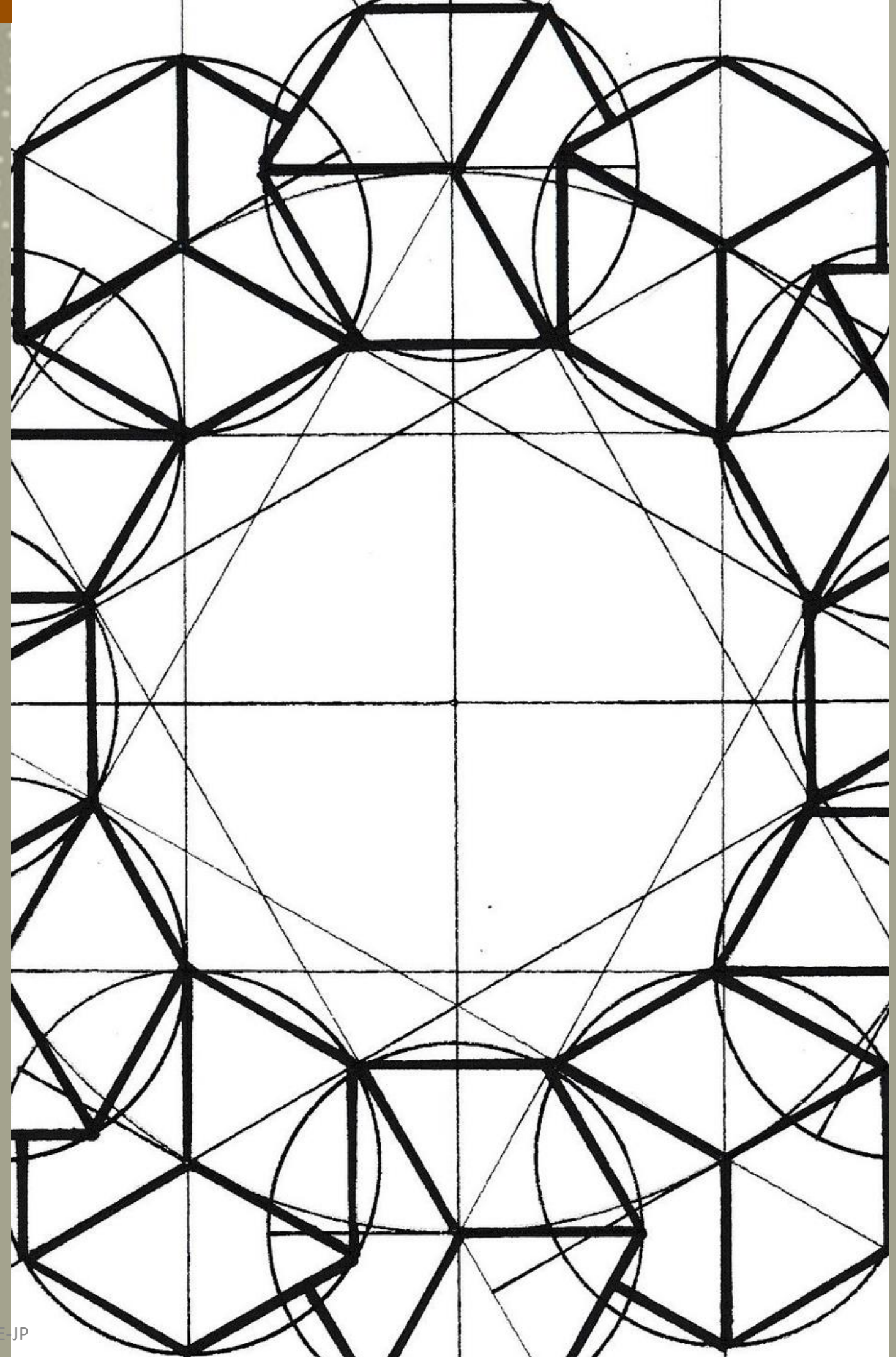
Using negative space to articulate shapes and geometry.  
**Break**  
Experimenting with different materials for creating geometric ornaments.  
**Discussion**

8

Applying the knowledge of cultural styles to design a geometric ornamentation project  
**Break**  
Use software tools to generate and visualize complex tessellation designs.  
**Discussion**

# WHAT IS GEOMETRIC ORNAMENTAION?

Geometric ornamentation is the art of decorating surfaces with patterns and motifs built from basic geometric shapes like squares, circles, triangles, and hexagons. These shapes are then arranged, repeated, and manipulated in various ways to create captivating and intricate designs.



The image shows a highly detailed, ornate ceiling with a repeating octagonal pattern. Each octagon is filled with intricate carvings and contains a smaller, lighter-colored octagonal inset. The ceiling is surrounded by a wide, decorative border with floral and scrollwork motifs. A large, semi-transparent white horizontal band is centered across the image, containing the word "FOUNDATIONS" in a bold, black, sans-serif font. The overall color palette is warm, featuring various shades of brown, tan, and beige.

# FOUNDATIONS



# Introduction to Geometric Shapes

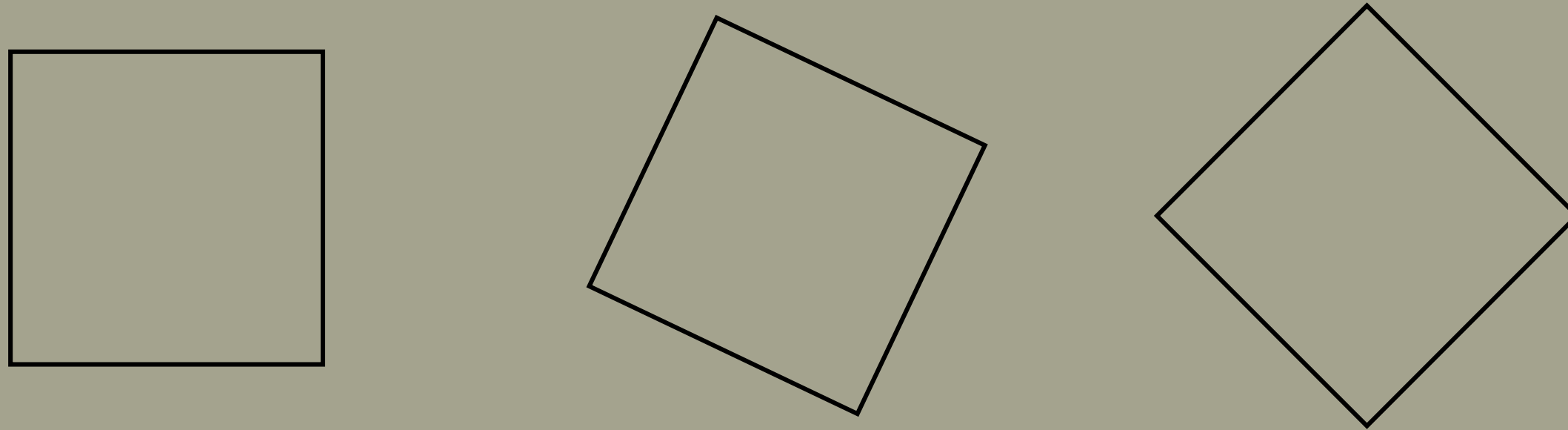
Squares, circles, triangles, pentagons, hexagons, octagons, and more – these seemingly simple shapes are the foundational pillars of geometric ornamentation, each with unique properties and characteristics.



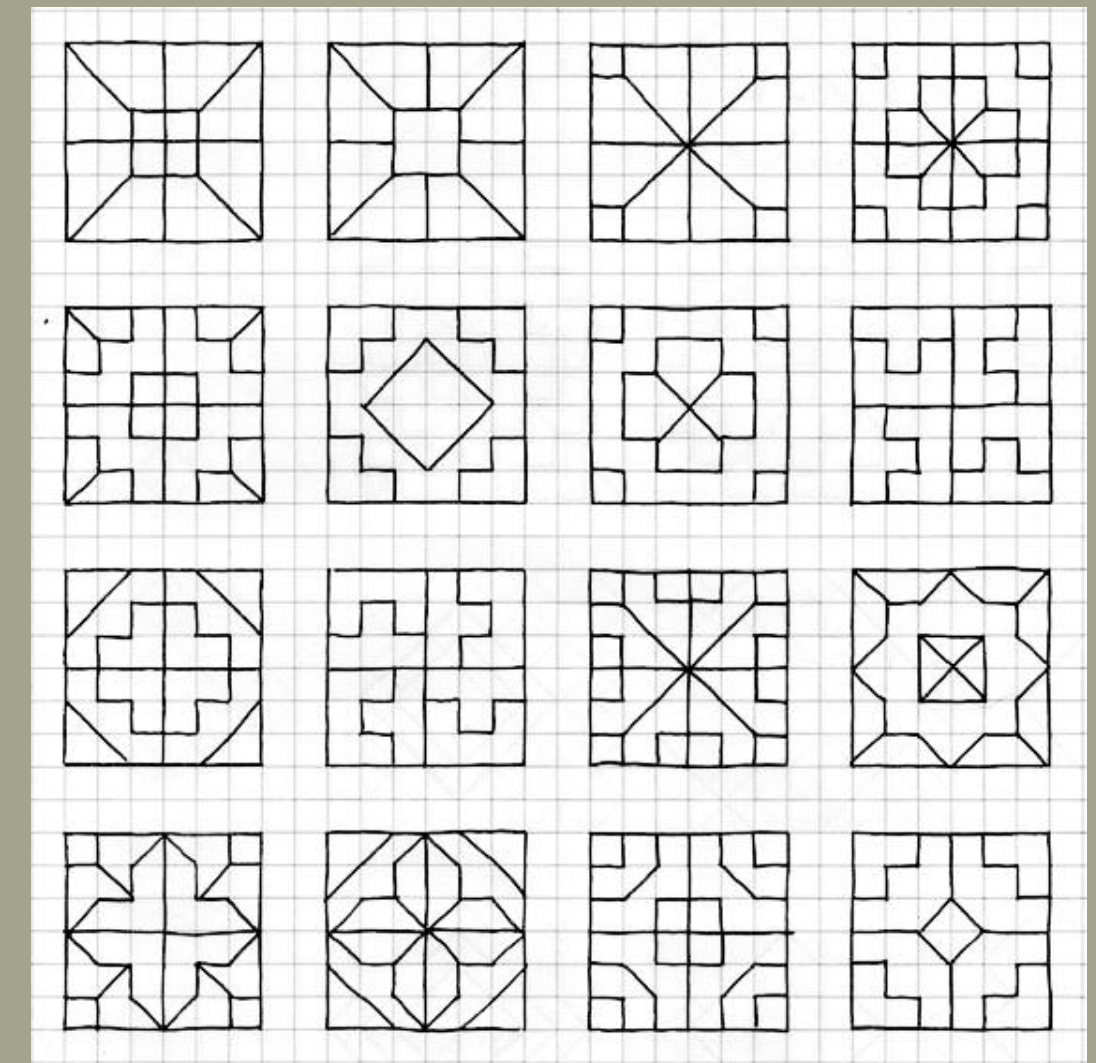
# Introduction to Geometric Shapes

## Square

Defined by four congruent sides and four right angles, the square embodies stability, order, and balance. Its inherent symmetry exudes precision and control, making it a cornerstone of structured, grid-based patterns.



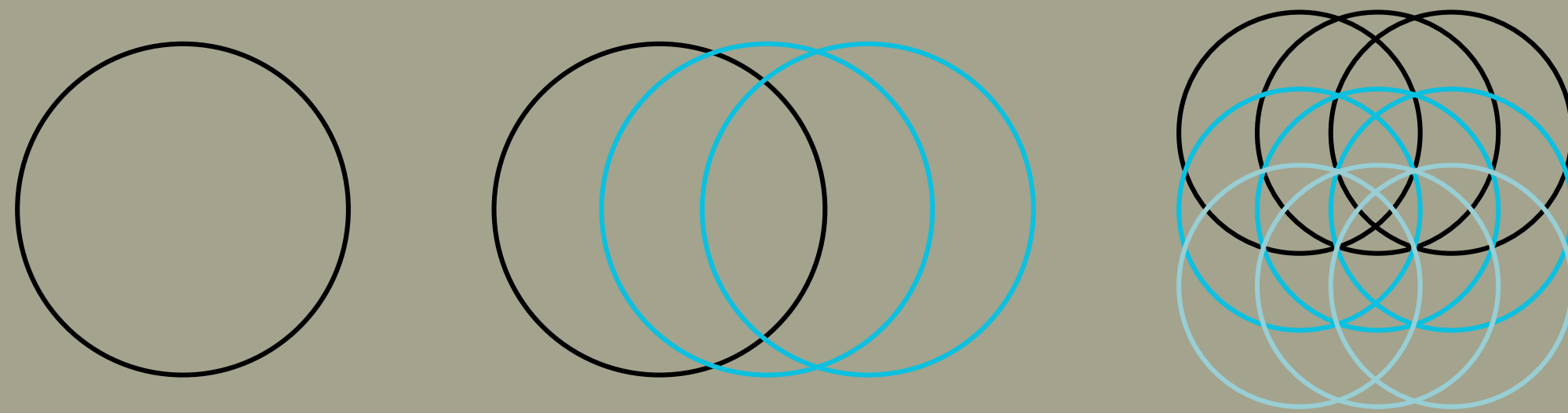
Squares seamlessly fit together, creating mesmerizing checkerboards, grids, and intricate borders. Subdivide them into smaller squares or triangles, and you unlock hidden geometric connections and detailed compositions.



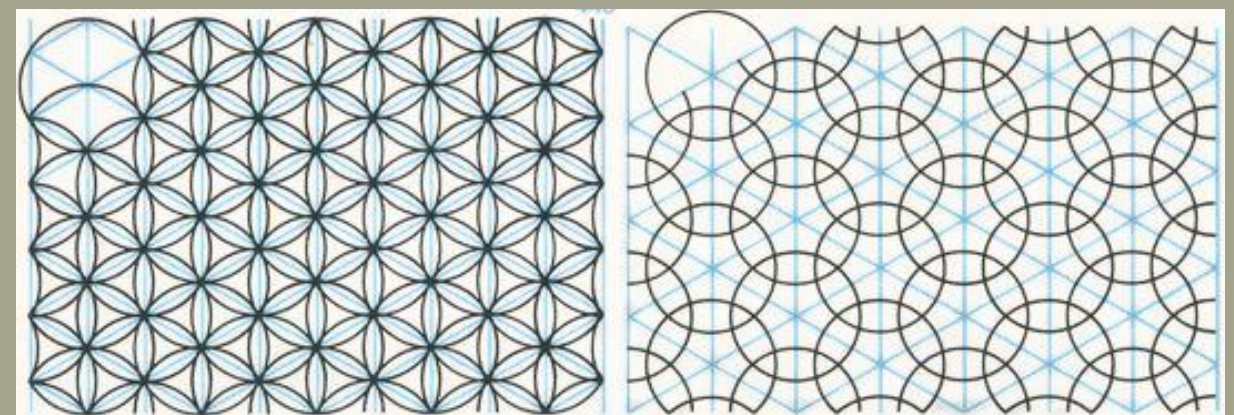
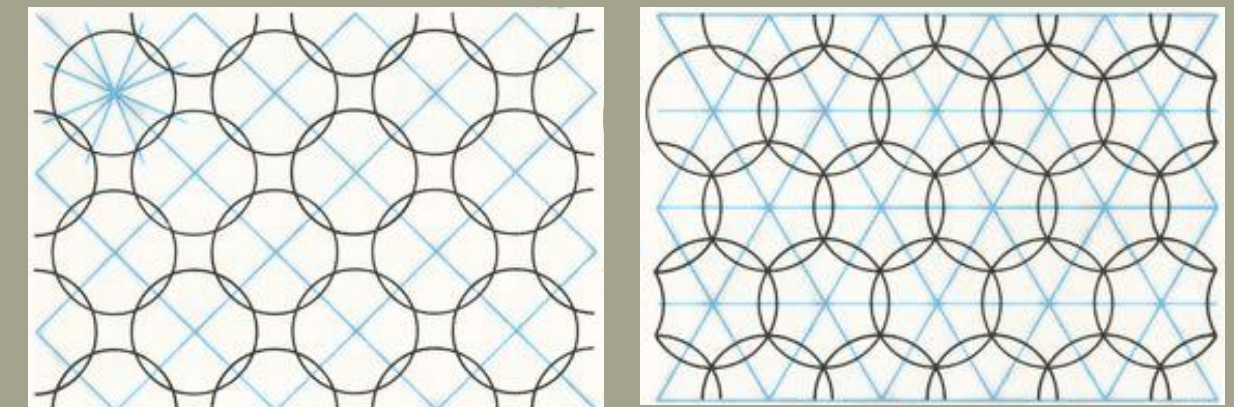
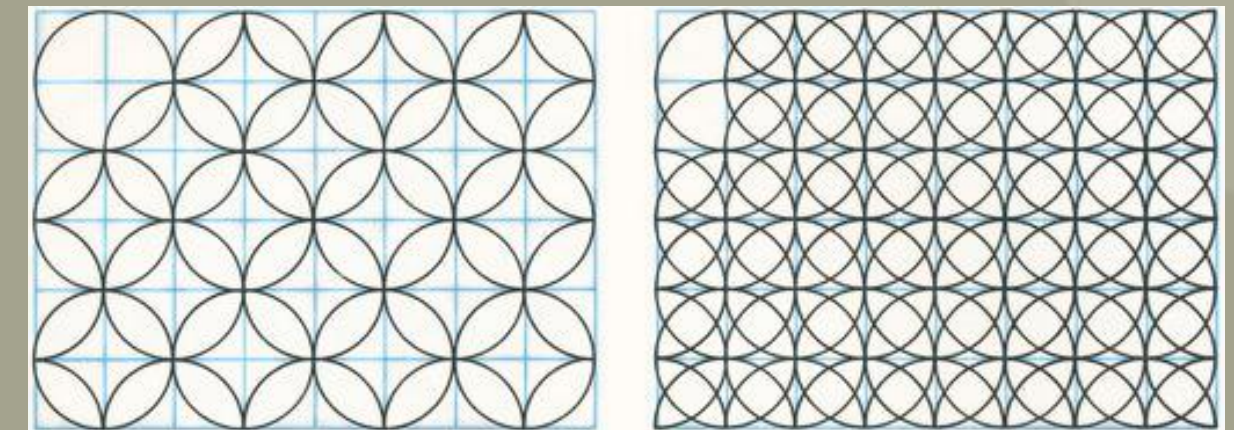
# Introduction to Geometric Shapes

## Circle

The circle embodies infinity and boundless potential. Its smooth, curvilinear form exudes a sense of flow, movement, and dynamic energy, contrasting with the angular rigidity of its counterparts.



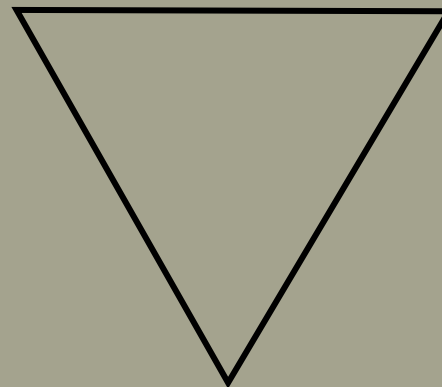
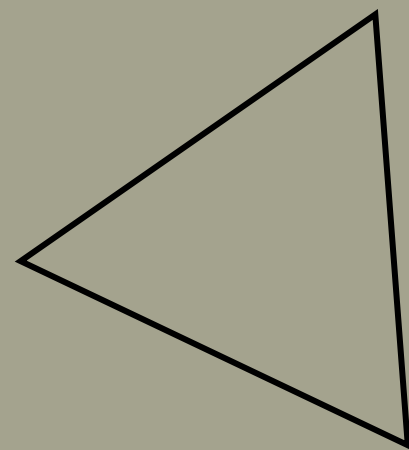
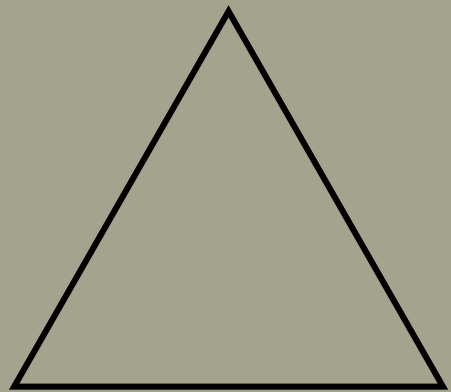
Circles find beauty in juxtaposition. They can be inscribed within squares, creating harmonious compositions of straight and curved elements, or dance tangentially, forming dynamic clusters and patterns that break the mold of rigid symmetry.



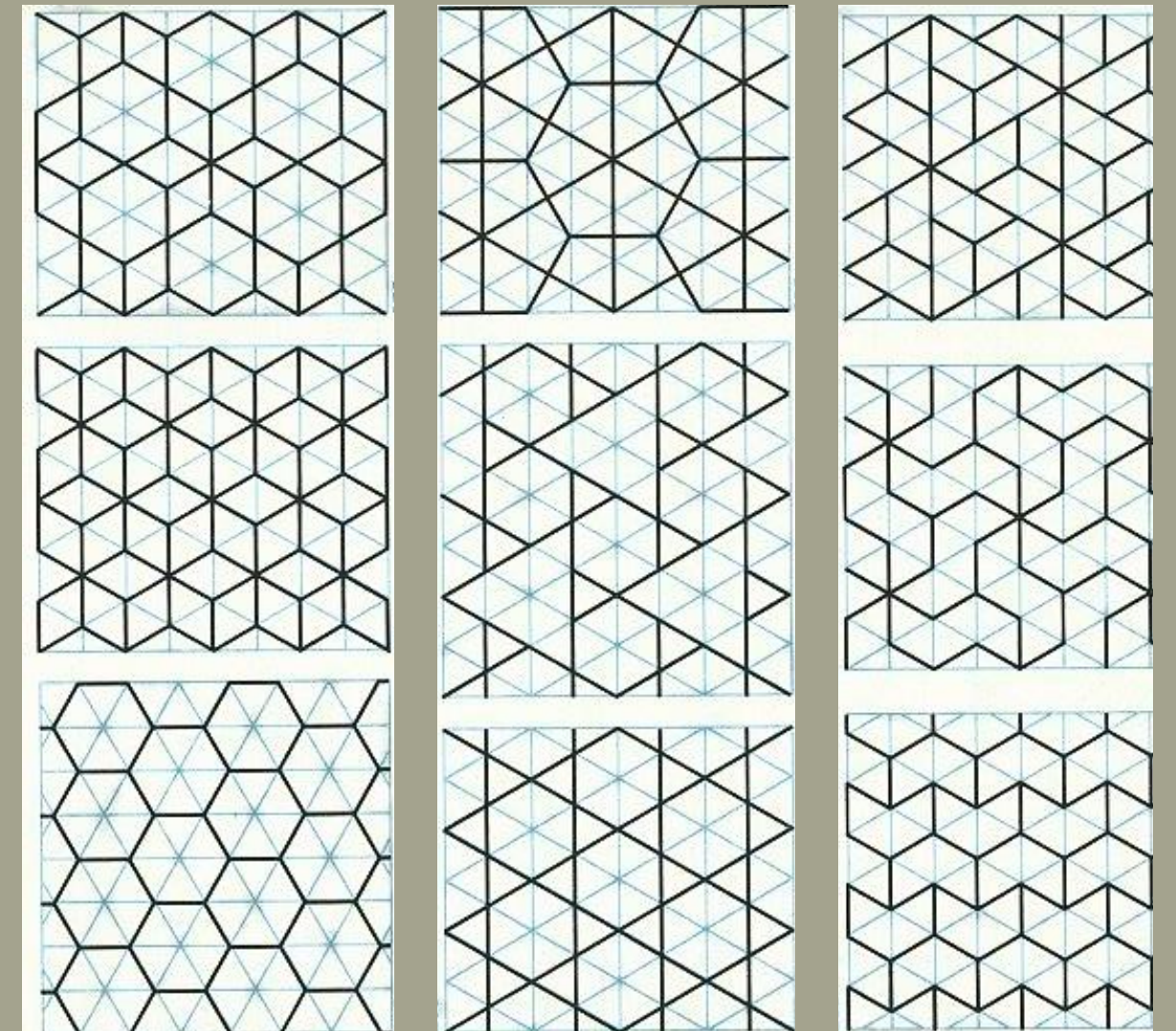
# Introduction to Geometric Shapes

## Triangle

With three sides and three angles, the triangle represents the simplest stable form, yet pulsates with dynamism. Its pointed corners inject a sense of direction and action, imbuing designs with a sense of forward momentum.



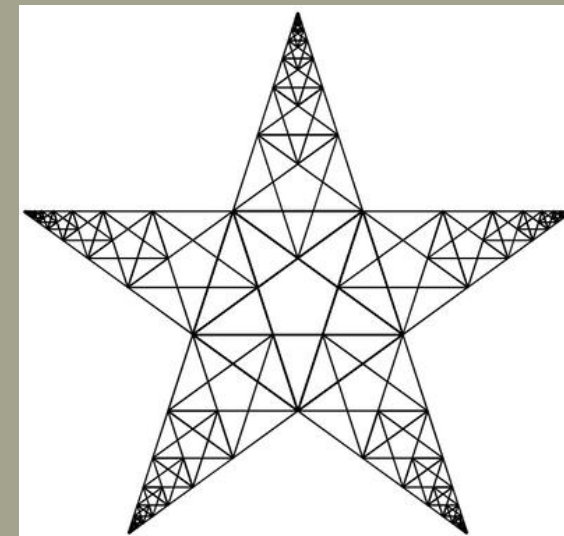
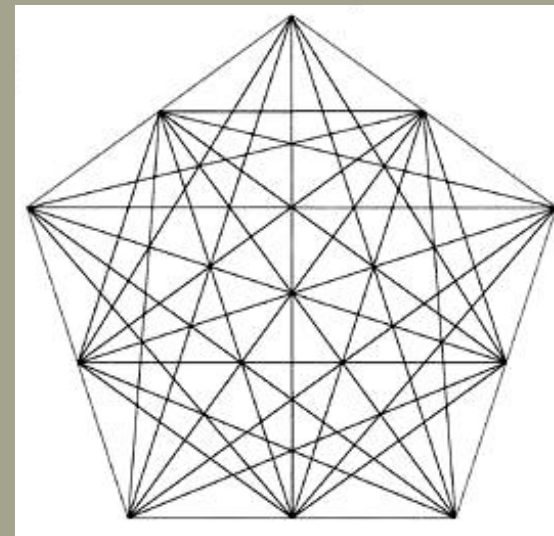
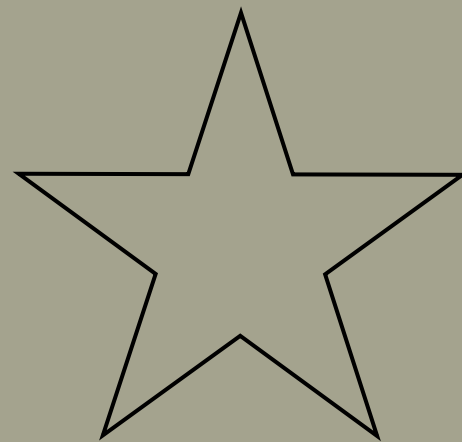
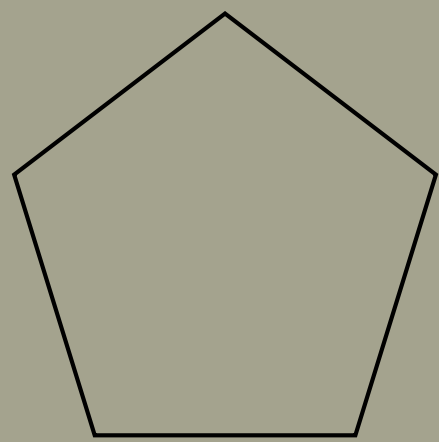
Triangles can form honeycomb patterns, readily observed in nature and architecture. They can also be combined and stacked to create complex stars, polygons, and three-dimensional structures, adding layers of visual complexity and intrigue.



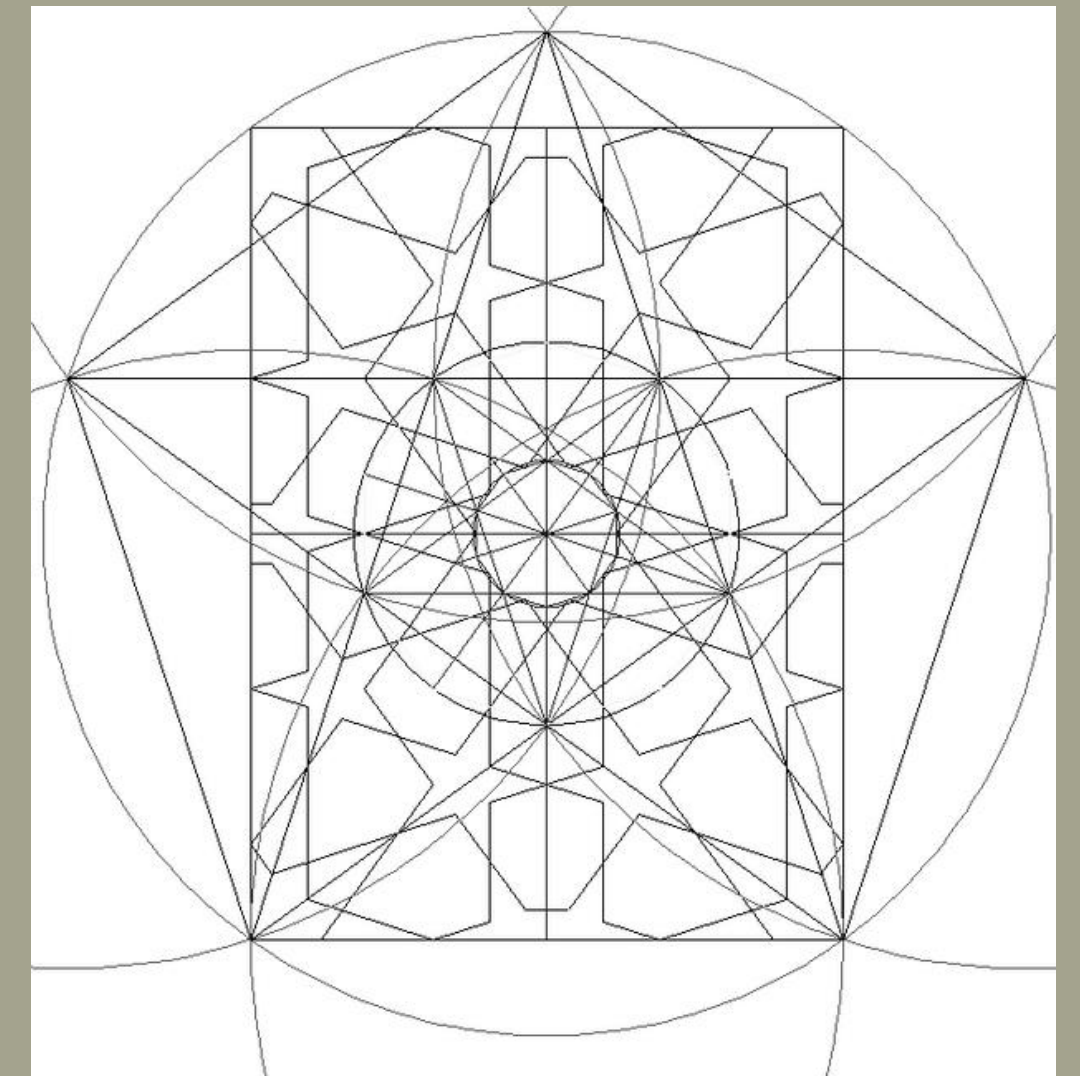
# Introduction to Geometric Shapes

## Pentagon

Defined by five sides and five angles, the pentagon exudes a sense of mystique and power. Its golden ratio proportions lend it an inherent harmony and balance, while its five-pointed star form evokes symbolism in various cultures.



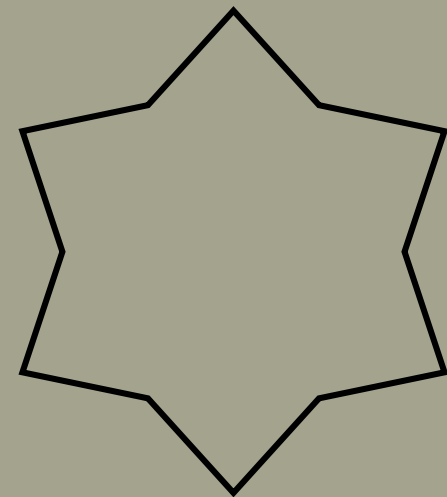
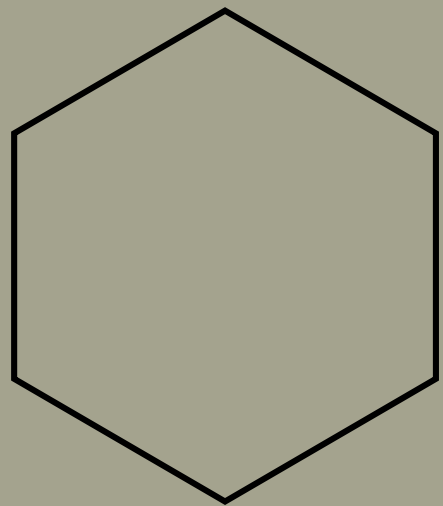
The pentagon forms the basis of the iconic pentagram, a star formed by connecting its vertices. This symbol holds cultural significance in Wicca, geometry, and even art. Pentagrams can also be tessellated in specific arrangements, creating intricate patterns.



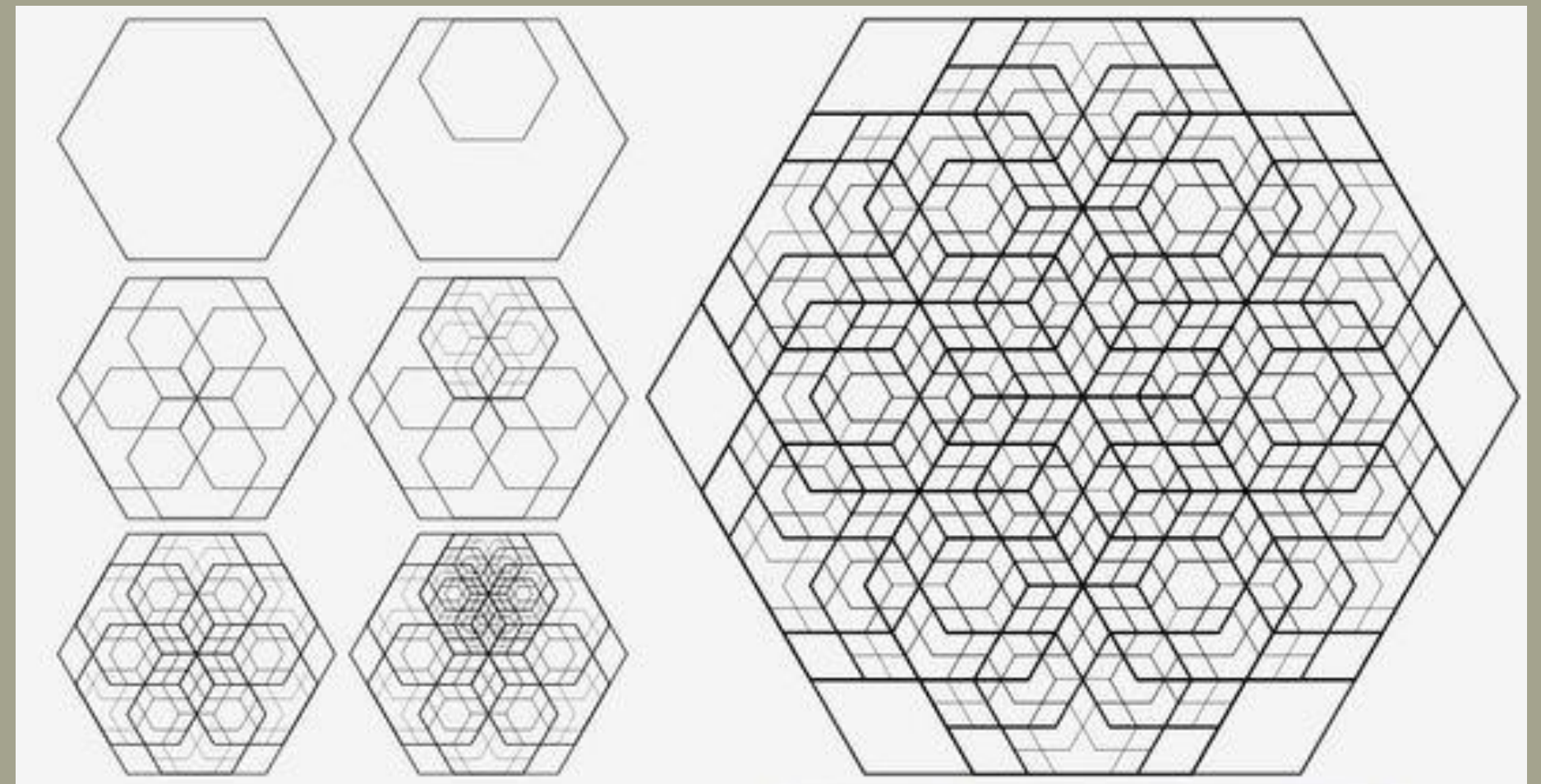
# Introduction to Geometric Shapes

## Hexagon

With six equal sides and six interior angles, the hexagon embodies efficiency and harmonious optimization. Its close-packed structure maximizes space while minimizing gaps, rendering it a champion of functional design.



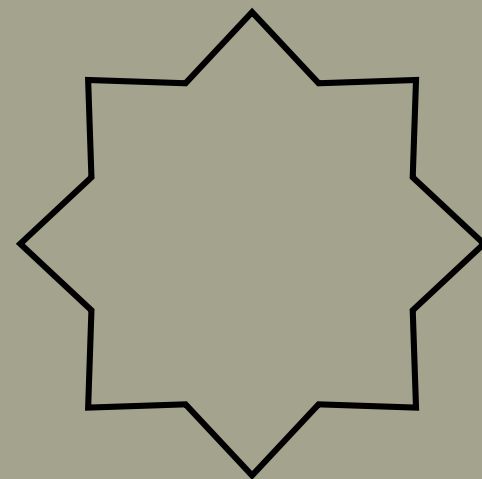
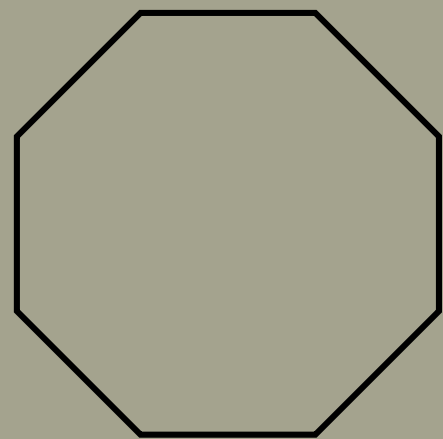
Hexagons form the basic unit of honeycombs, snowflakes, and even basalt columns, their repetitive tessellations creating mesmerizing visual textures and a sense of interconnectedness.



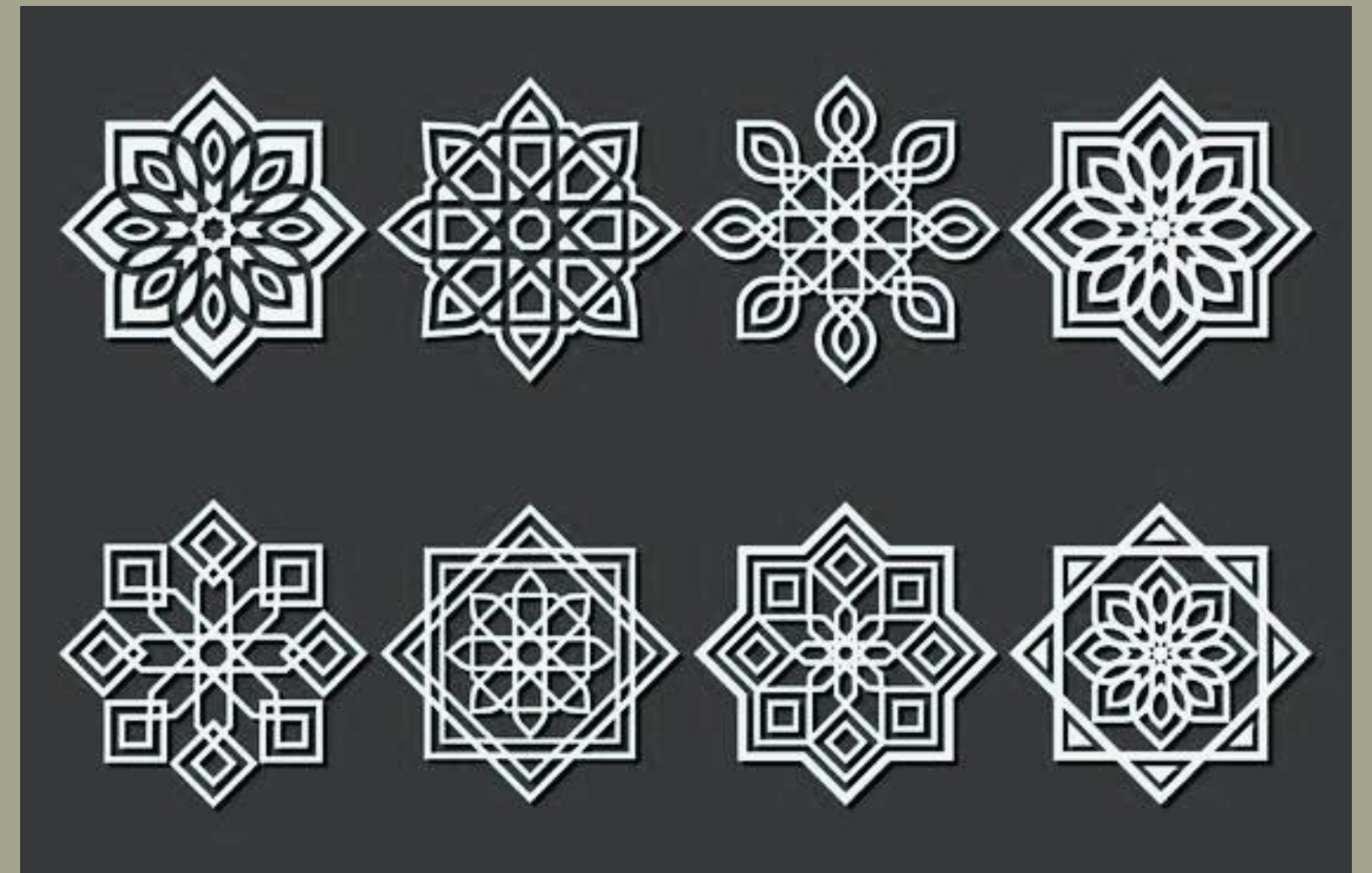
# Introduction to Geometric Shapes

## Octagon

With six equal sides and six interior angles, the hexagon embodies efficiency and harmonious optimization. Its close-packed structure maximizes space while minimizing gaps, rendering it a champion of functional design.



Hexagons form the basic unit of honeycombs, snowflakes, and even basalt columns, their repetitive tessellations creating mesmerizing visual textures and a sense of interconnectedness.



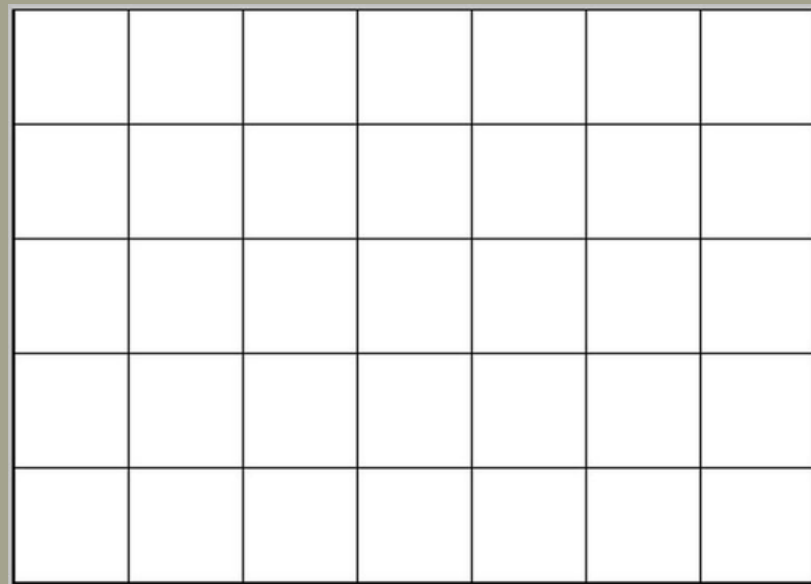


# Repetition and Tessellation

A defining characteristic of geometric ornamentation is the repetition of shapes and patterns. This repetition can be simple, like rows of squares, or more complex, like interlocking stars or tessellations where shapes seamlessly fit together without gaps.

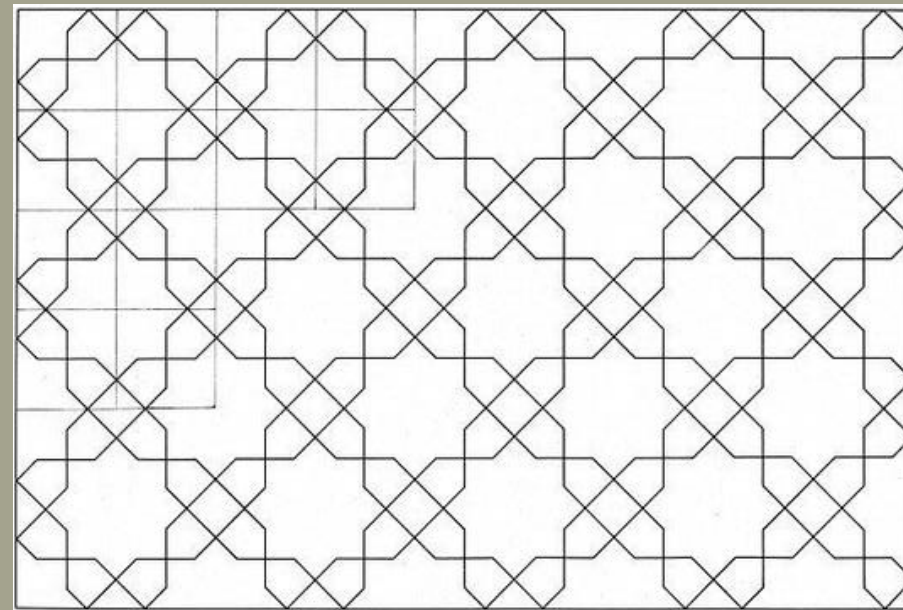
# Repetition and Tessellation

In geometric ornamentation, repetition of shapes, lines, or motifs creates a visual rhythm, guiding the viewer's eye and establishing a sense of unity within the design.



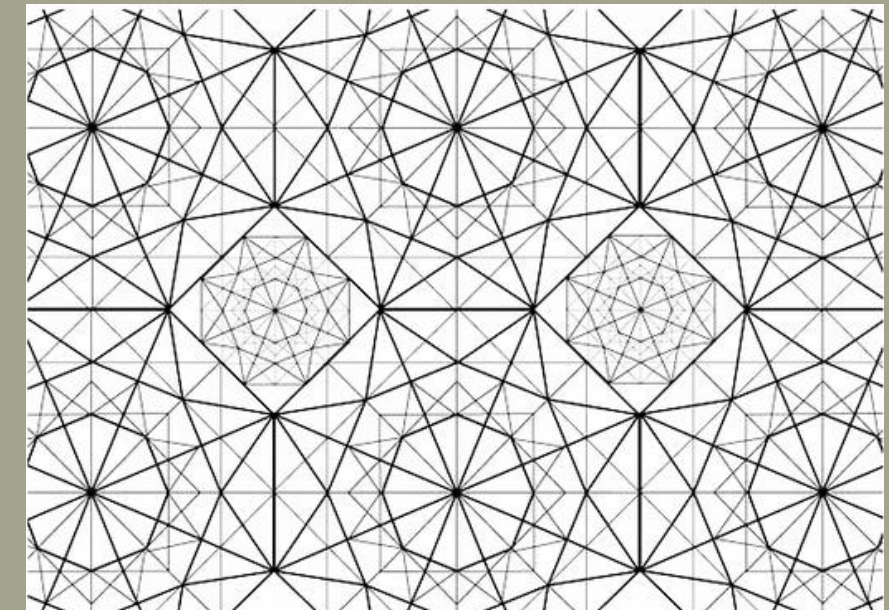
## Simple

Repeating a single shape, like squares in a checkerboard or circles in a polka dot pattern, creates a clear, straightforward rhythm.



## Complex

Repeating a combination of shapes or motifs in a specific sequence fosters a more intricate rhythm, adding layers of visual interest and surprise.



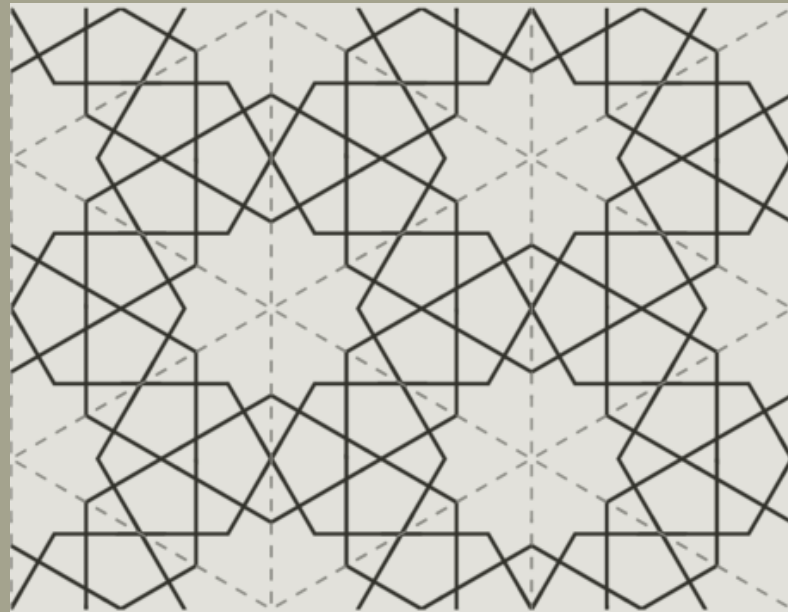
## Modulated

Introducing subtle variations in size, color, or orientation of repeated elements keeps the eye engaged and prevents monotony, adding a dynamic pulse to the pattern.



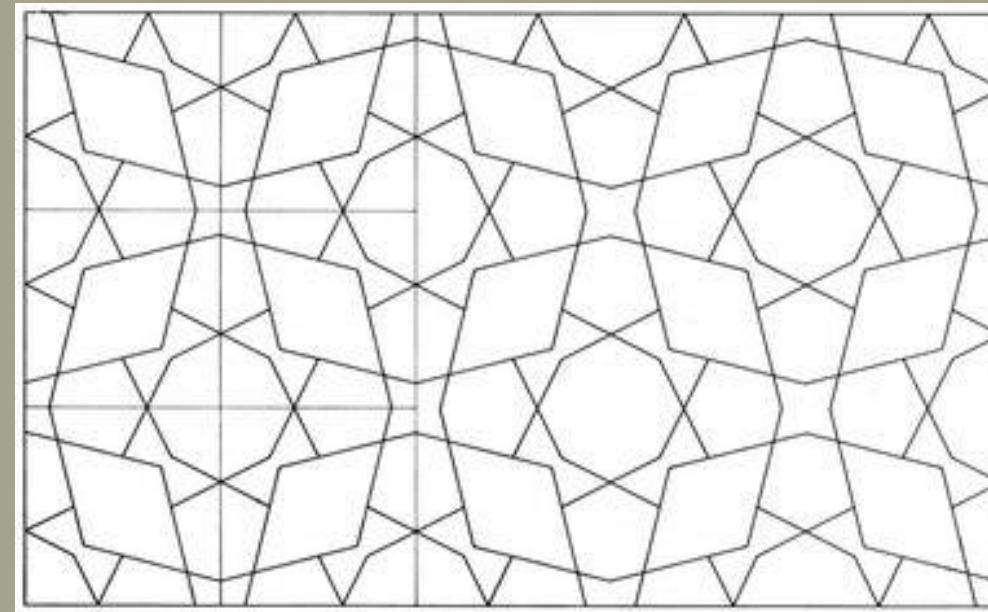
# Repetition and Tessellation

Tessellation is the seamless arrangement of shapes that fit together perfectly, covering a surface without gaps or overlaps.



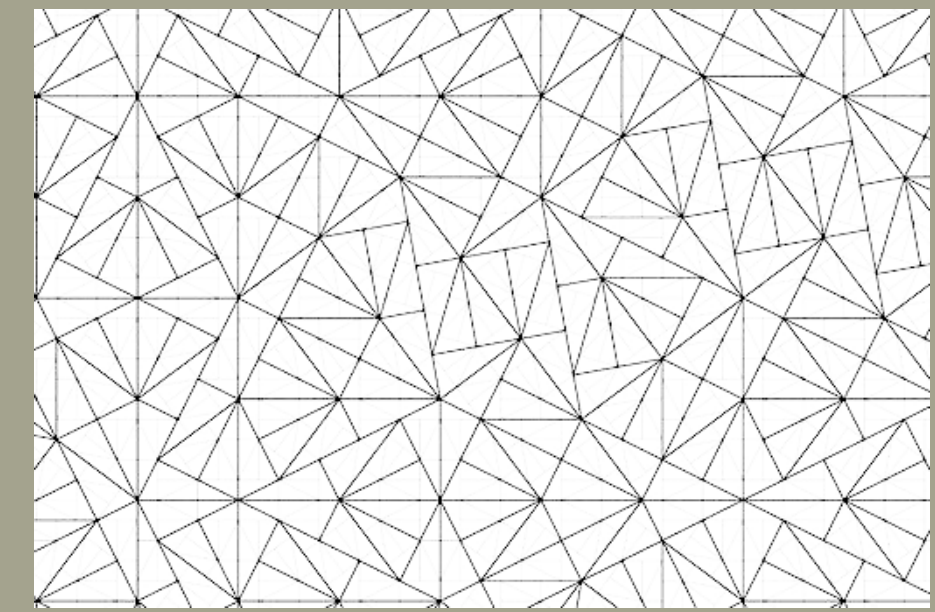
## Regular

These are the most basic tessellations, using shapes like squares, triangles, and hexagons that can be repeated infinitely without changing size or orientation.



## Semi Regular

Involving shapes like trapezoids or rhombi, these tessellations require adjustments in size or orientation to fill the space seamlessly.



## Aperiodic

Breaking the mold of perfect repetition, these tessellations use seemingly random arrangements of shapes to create unexpected and visually intriguing patterns.

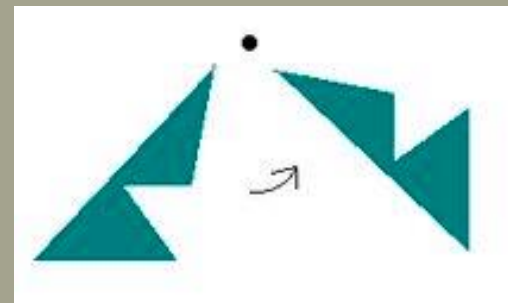
# Symmetry and Order

Symmetry plays a crucial role in creating balance and harmony in geometric ornamentation. Patterns can be symmetrical along an axis, around a central point, or even have multiple layers of symmetry. This adds a sense of order and visual interest to the design.



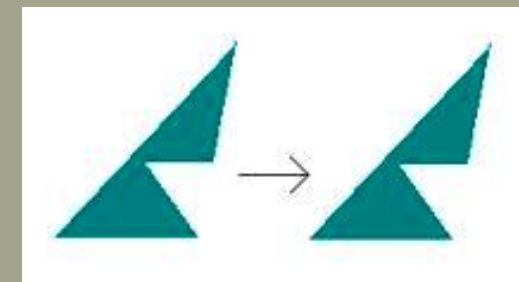
## Reflective symmetry

A pattern mirrors itself across a line. Islamic mosaic patterns are a popular example.



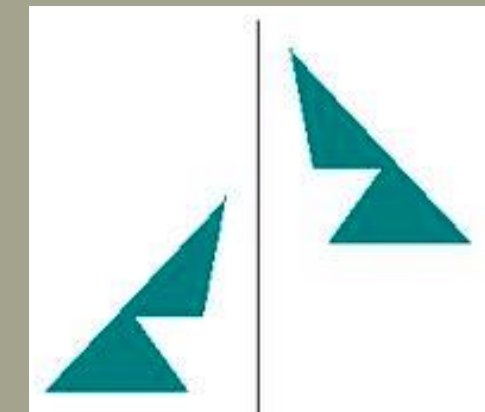
## Rotational symmetry

A pattern appears identical after being rotated by a specific angle. Think of a mandala or snowflake.



## Translational symmetry

In translational symmetry, patterns replicate perfectly through shifts without rotation or reflection.

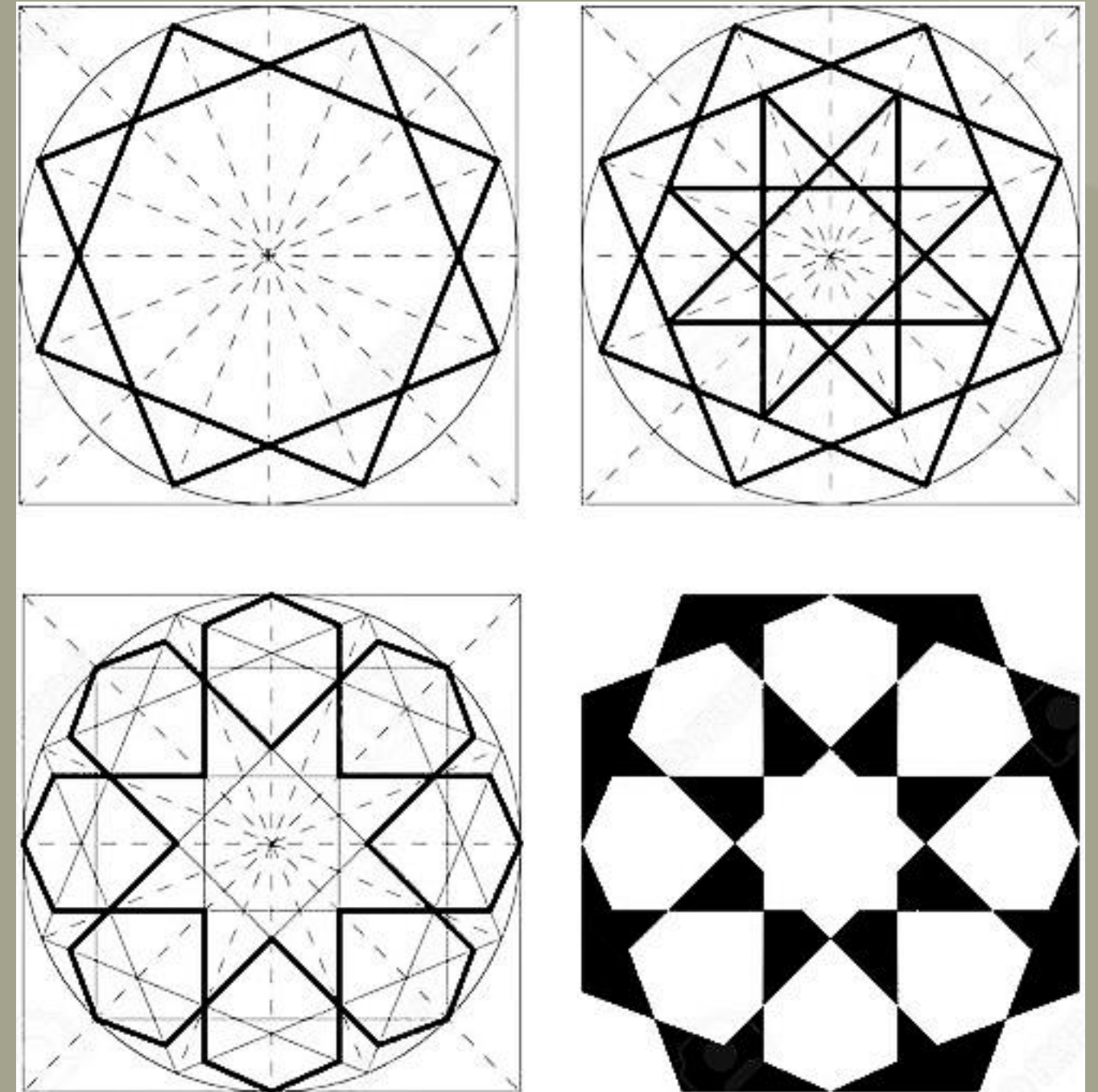


## Glide symmetry

A combination of reflection and translation, creating mesmerizing repeating patterns with slight shifts.

# Use of Negative Space

Negative space refers to the areas surrounding the shapes in a pattern. In geometric ornamentation, negative space is often just as important as the shapes themselves. It can be used to emphasize the positive shapes, create optical illusions, or even introduce hidden meanings within the design.

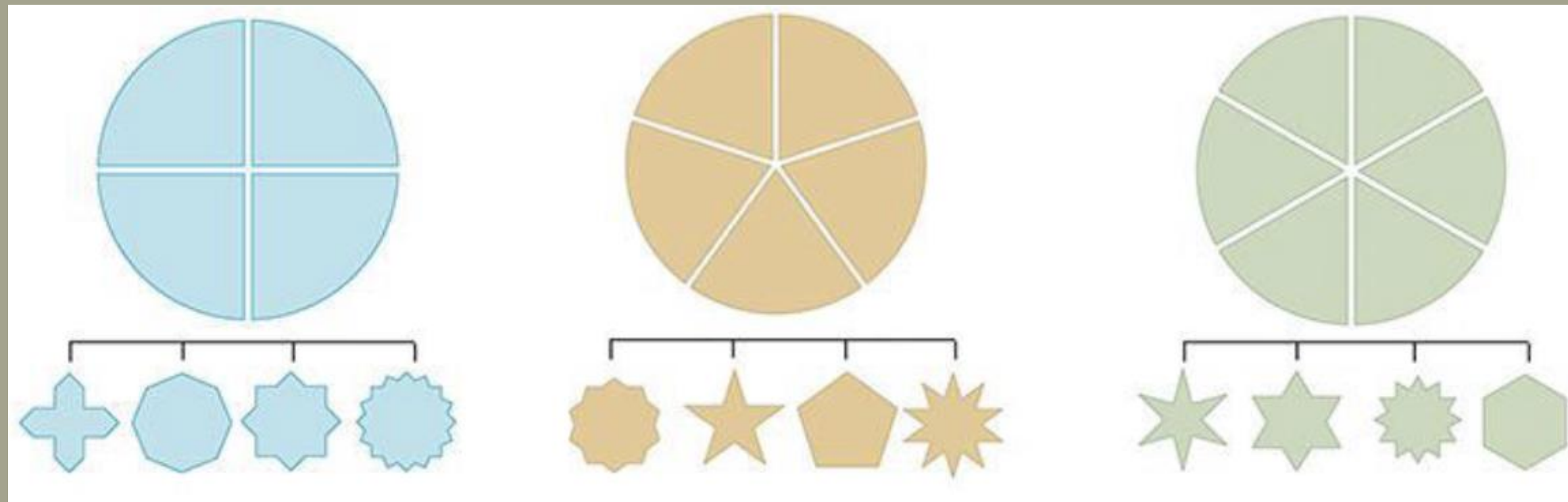




# PRINCIPLES AND TECHNIQUES

# Patterns and Configurations

Despite their complexity, geometric patterns typically fall under one of three primary categories: Fourfold, fivefold or sixfold patterns. These pattern types are based on the internal lines of symmetry found within them. When starting a pattern, a circle is drawn. This circle is then split into equal parts and depending on the number of these parts, either four, five or six, different distinctive characteristics appear.



Four/Eight-Fold  
Configuration

Five/Ten-Fold  
Configuration

Six/Twelve-Fold  
Configuration

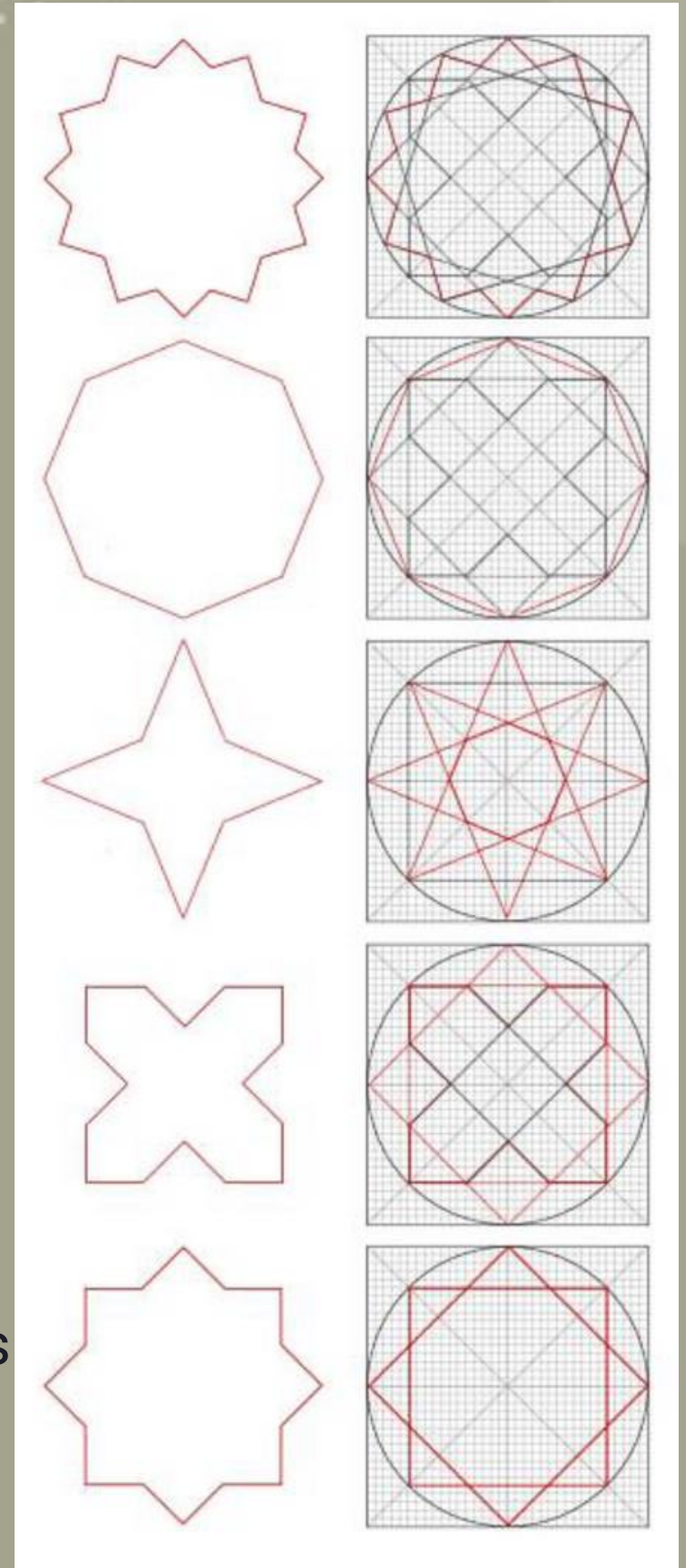
# Patterns and Configurations

## Four/Eight-Fold Configurations

These configurations exhibit bilateral symmetry across a single axis, often creating square-based or diamond-shaped motifs. Examples include Islamic tilework, Celtic knots, and Greek fret patterns.

### Characteristics:

- **Balance and Order:** Fourfold patterns often convey a sense of stability, balance, and structure due to their clear horizontal and vertical lines.
- **Dynamic Movement:** Eightfold patterns often suggest movement, fluidity, and energy due to their rotational symmetry.
- **Tessellation:** Both fourfold and eightfold patterns can tile seamlessly, meaning they can be repeated without gaps or overlaps to cover a surface.
- **Symbolism:** In various cultures, fourfold patterns can represent the four cardinal directions or elements (earth, air, fire, water), while eightfold patterns can symbolize spiritual concepts like enlightenment or infinity.



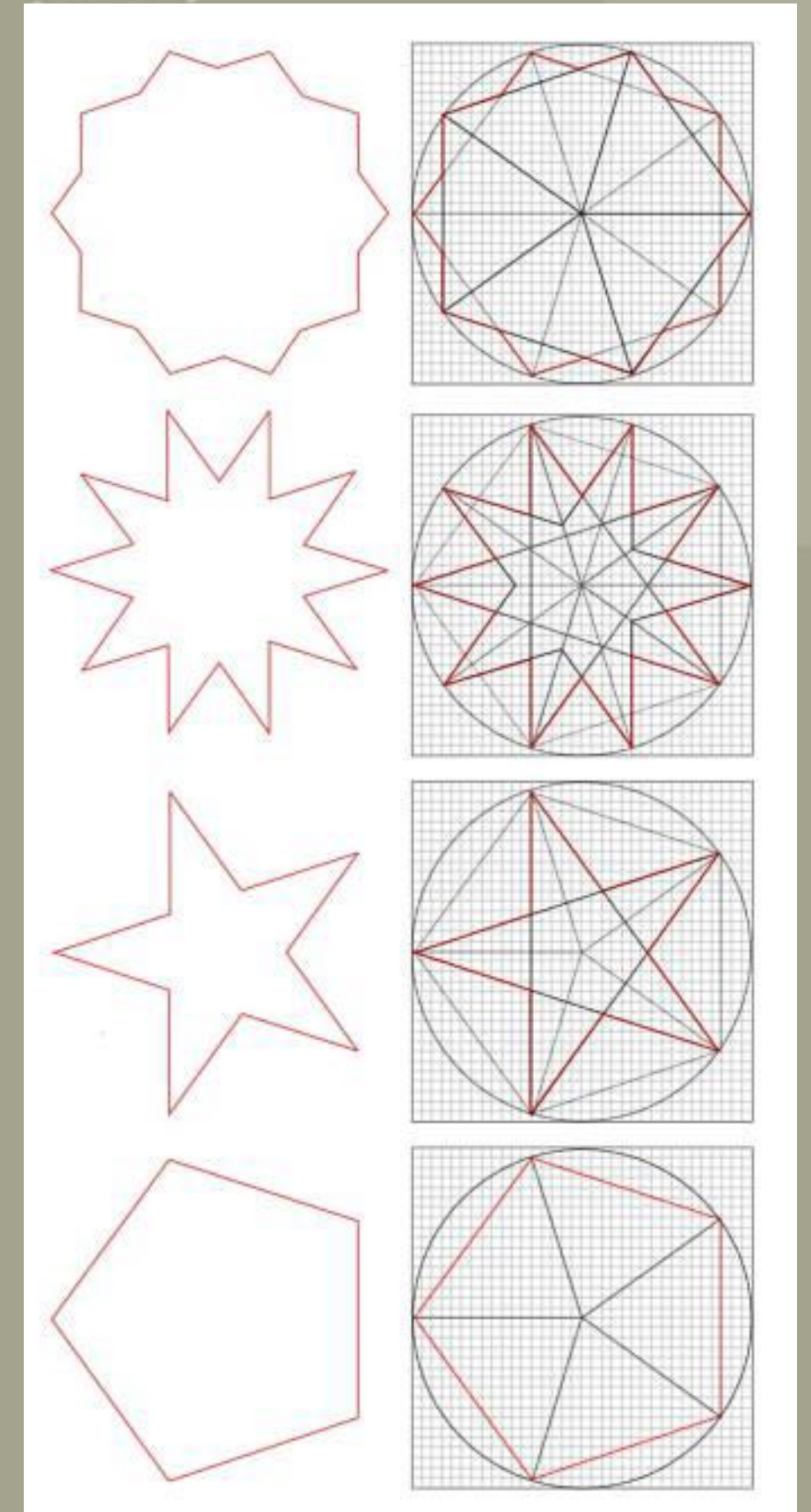
# Patterns and Configurations

## Five/Ten-Fold Configurations

More complex and less common, these exhibit rotational symmetry around a central point at angles of 72 degrees. Examples include starfish, some Islamic star patterns, and certain types of origami flowers.

### Characteristics:

- **Dynamic and Fluid:** Fivefold patterns possess a sense of rotational movement and fluidity due to their 72-degree symmetry.
- **Complex and Intricate:** Tenfold patterns offer a higher degree of complexity and visual richness due to their 36-degree symmetry, often appearing star-like or multifaceted.
- **Tessellation:** Both fivefold and tenfold patterns can tessellate seamlessly, covering a surface without gaps or overlaps.
- **Symbolism:** In various cultures, fivefold patterns can represent the five elements (earth, air, fire, water, spirit) or the five senses, while tenfold patterns can symbolize completeness or perfection.



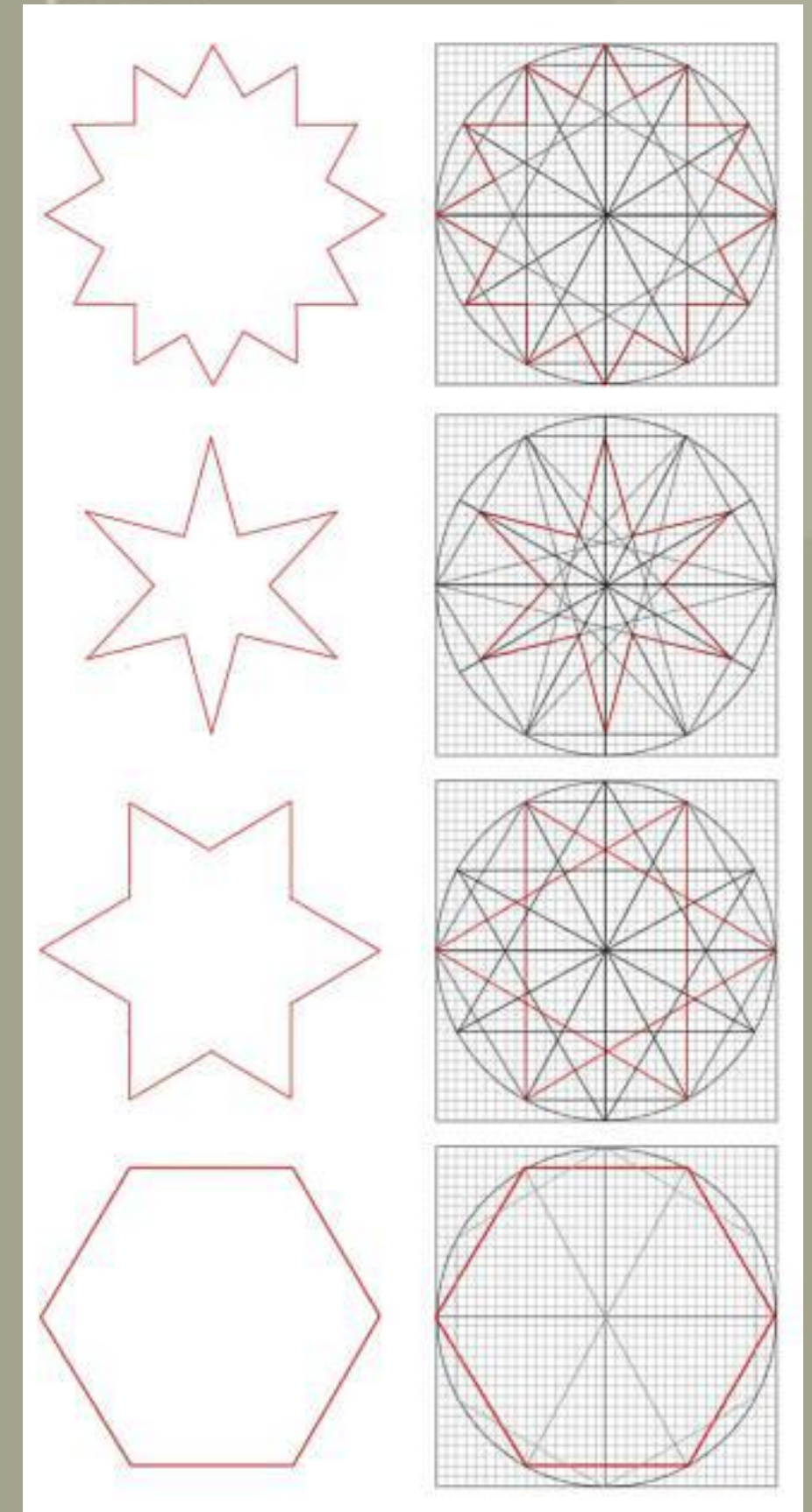
# Patterns and Configurations

## Six/Twelve-Fold Configurations

These configurations also exhibit rotational symmetry around a central point but with angles of 60 degrees. Examples include snowflakes, honeycombs, and some Islamic geometric designs.

### Characteristics:

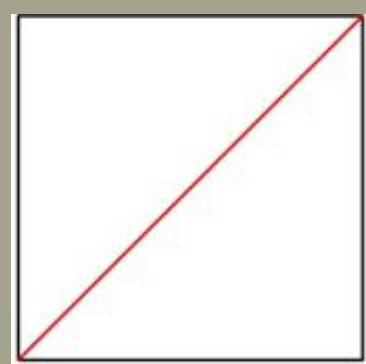
- **Stability and Order:** Sixfold patterns convey a sense of balance and structural integrity due to their hexagonal symmetry and prominent 120-degree angles.
- **Complexity and Intricacy:** Twelfold patterns offer a high degree of visual richness and complexity due to their 30-degree symmetry, often appearing maze-like or multifaceted.
- **Tessellation:** Both sixfold and twelfold patterns can tessellate seamlessly, covering a surface without gaps or overlaps.
- **Symbolism:** In various cultures, sixfold patterns can represent the six directions, six elements, or even the six points of a snowflake, while twelfold patterns can symbolize completeness, cyclical renewal, or even the twelve months of the year.



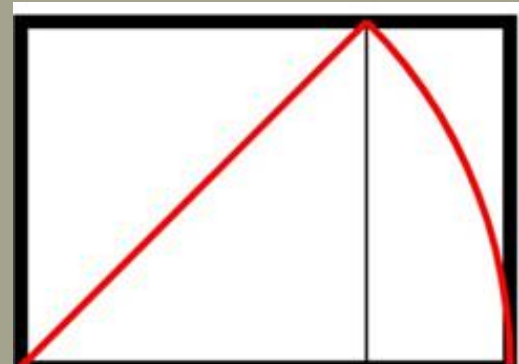


# Proportions

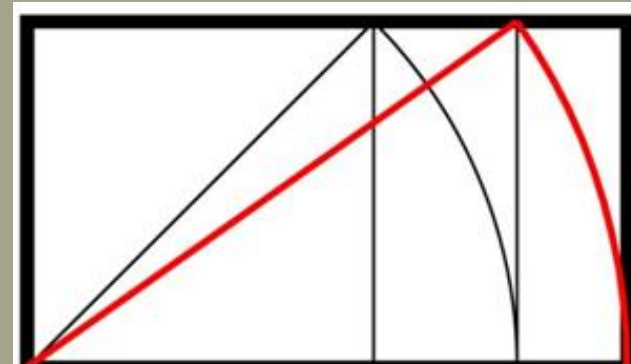
In essence, proportions describe the relationships between the sizes of different elements within a composition. These relationships can be expressed numerically (e.g., the Golden Ratio 1:1.618) or visually through perceived balance and pleasing relationships between shapes.



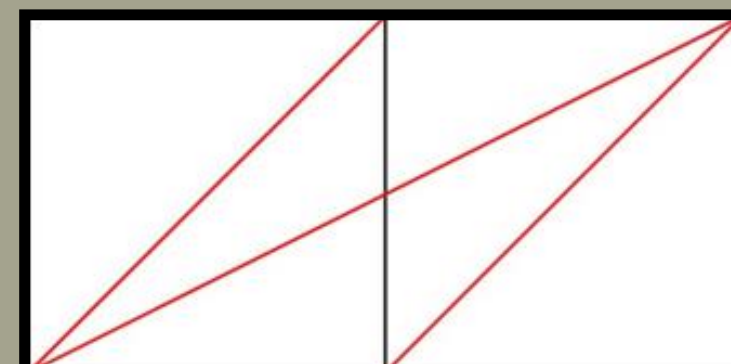
Square



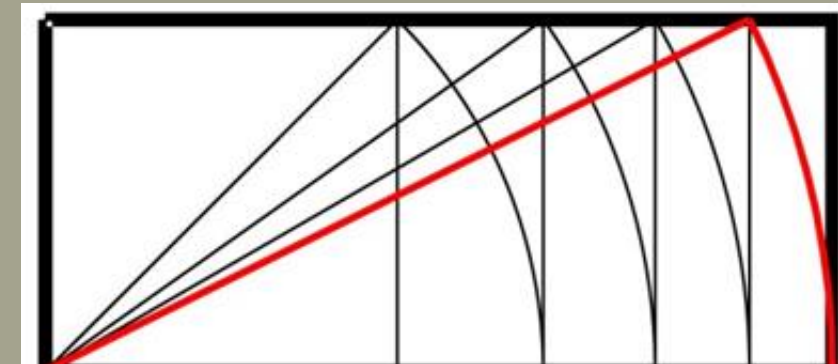
$\sqrt{2}$



$\sqrt{3}$



$\sqrt{4}$

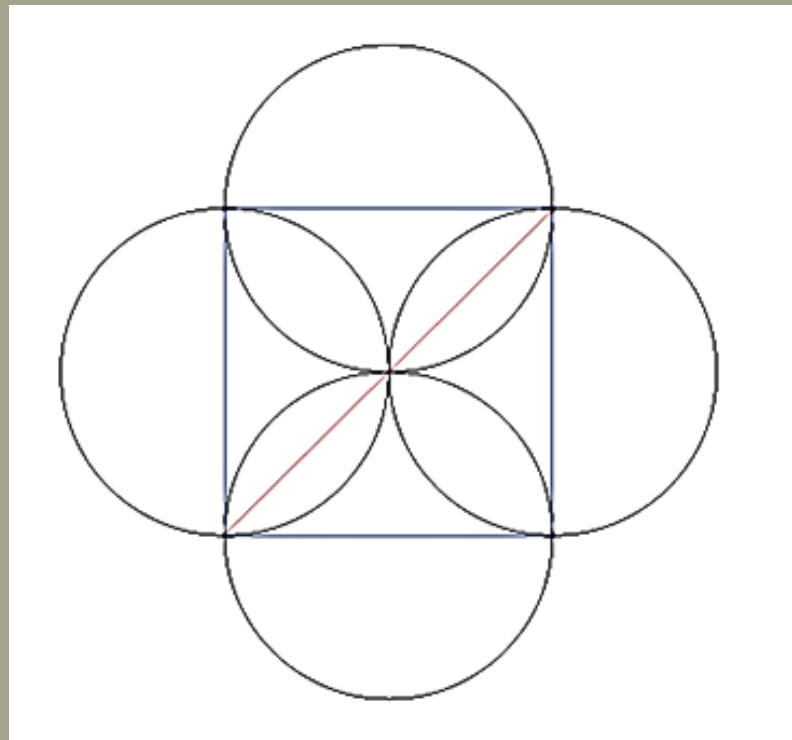


$\sqrt{5}$

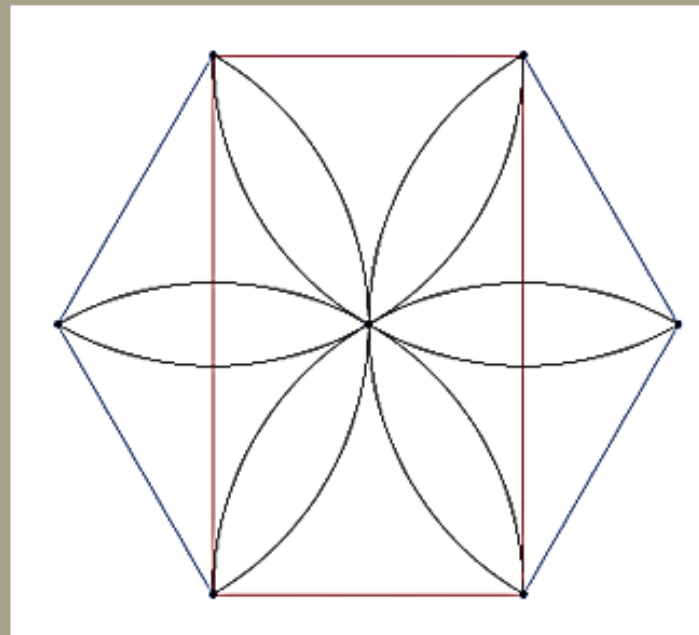
# Proportions

## Why are Proportions Important?

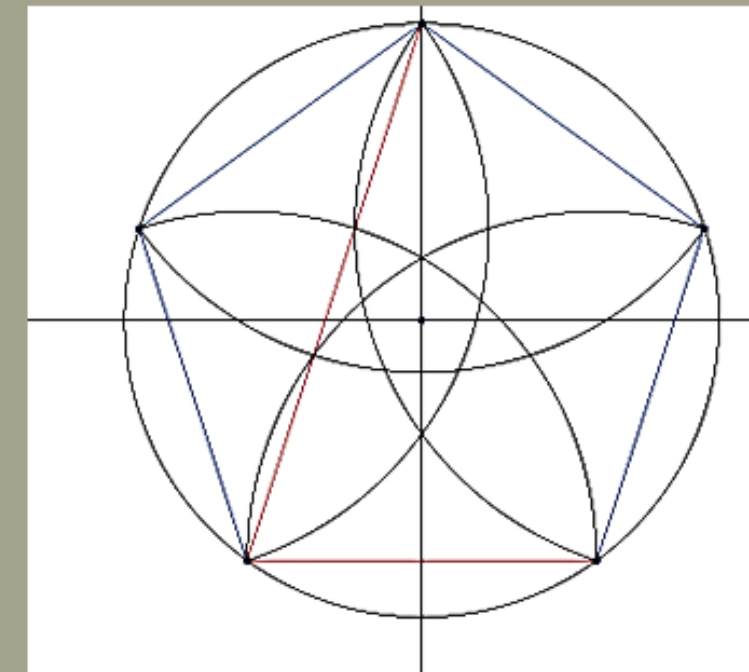
- Visual Harmony: Carefully chosen proportions create a sense of balance and order, preventing elements from appearing too large or too small, jarring the eye.
- Structural Stability: In architecture and tilework, specific proportions can contribute to the structural integrity and stability of the design.
- Symbolic and Cultural Significance: In some cultures, specific proportions and ratios hold symbolic meanings, connecting the art form to spiritual beliefs or cosmological concepts.



$\sqrt{2}$

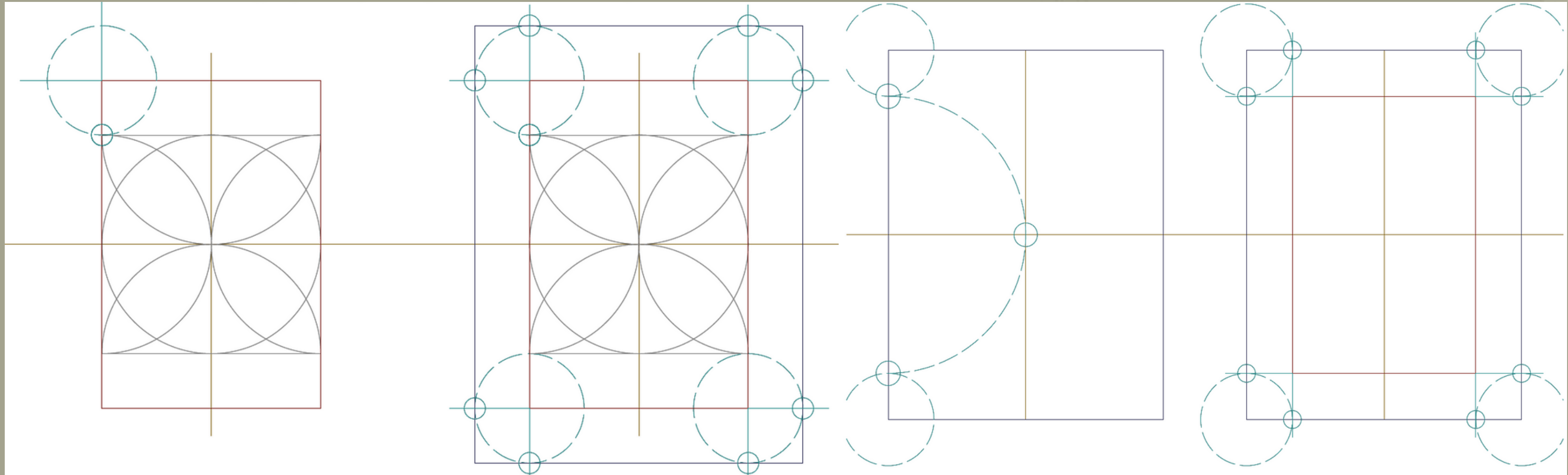


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Golden Ratio

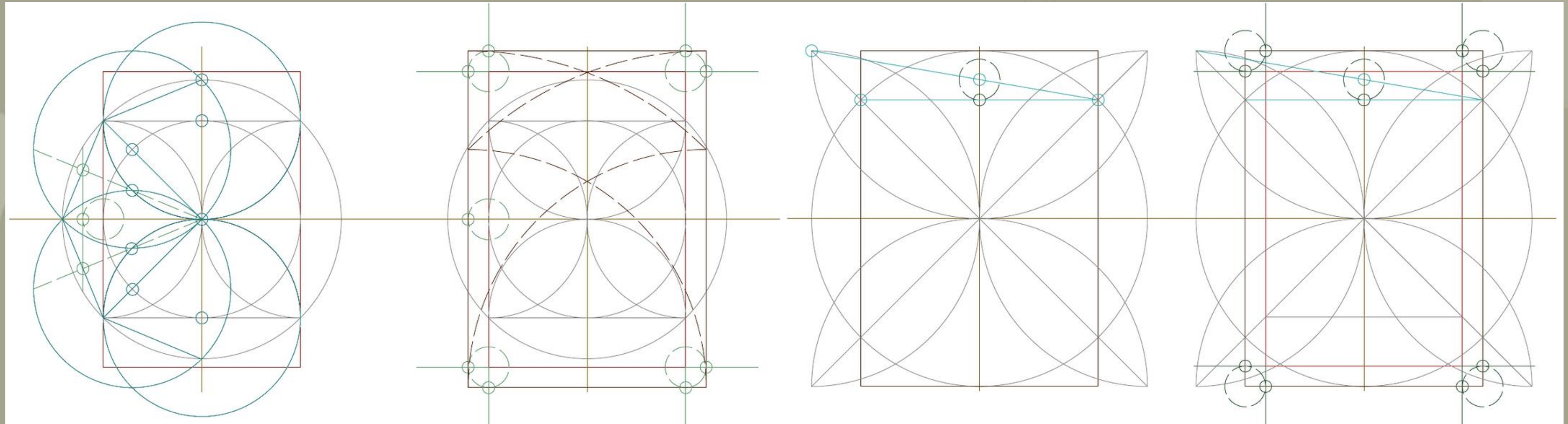
# Methodologies



Methodology to go from Square to Square and half to 3x4 Rectangle

Methodology to go from 3x4 Rectangle to Square and half rectangle

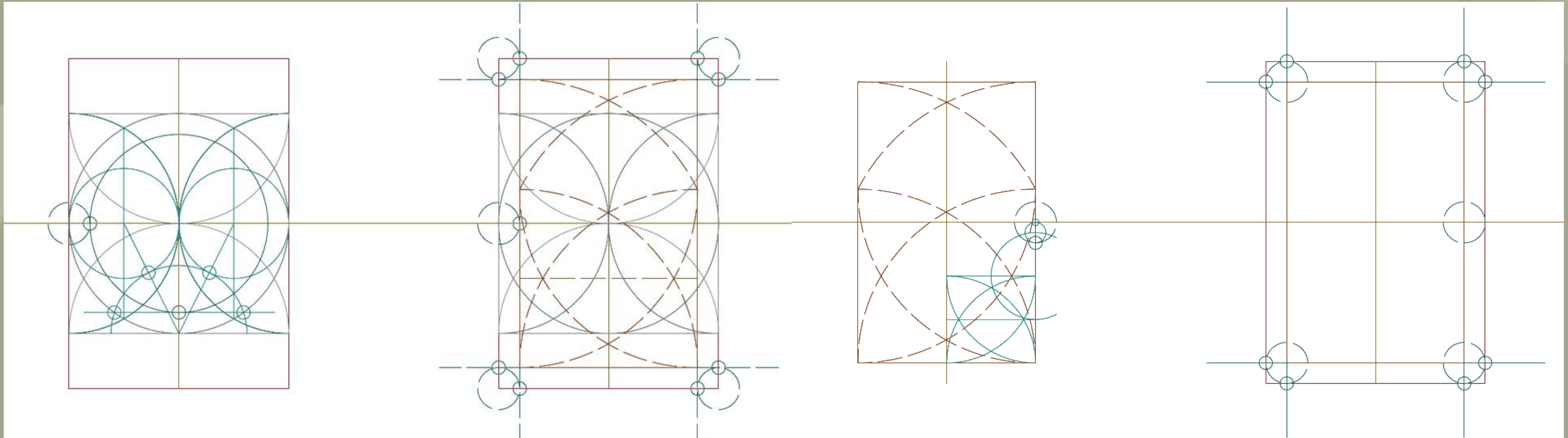
# Methodologies



Methodology to go from Square and half  
rectangle to Root 2 rectangle

Methodology to go from Root 2 rectangle to  
Square and half rectangle

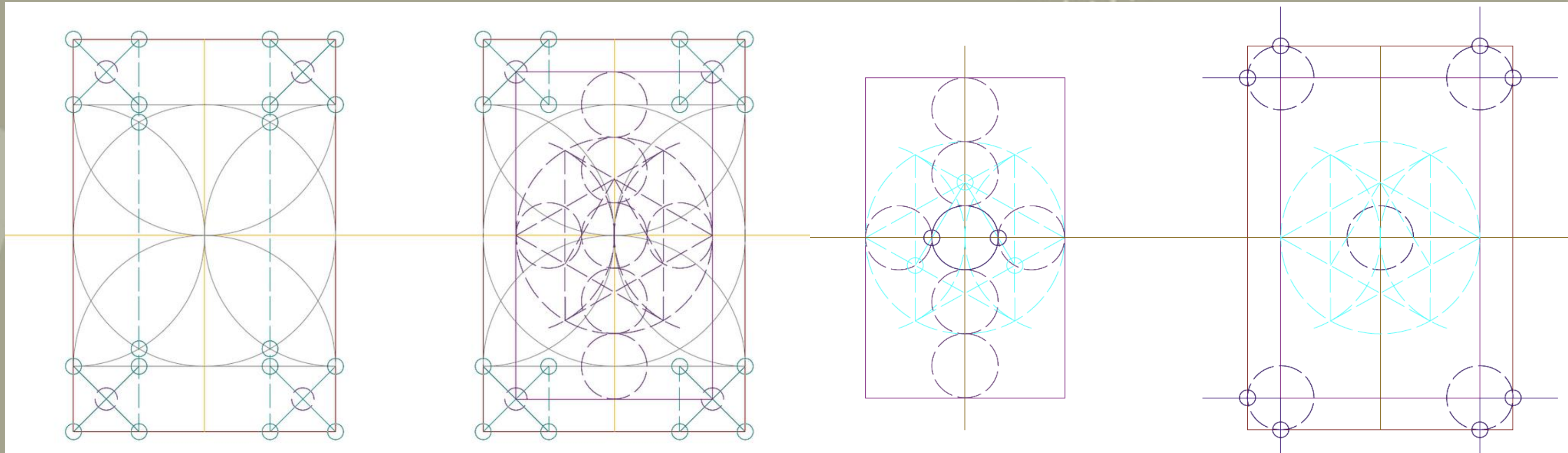
# Methodologies



Methodology to go from Square and half rectangle to Golden rectangle

Methodology to go from Golden rectangle to Square and half rectangle

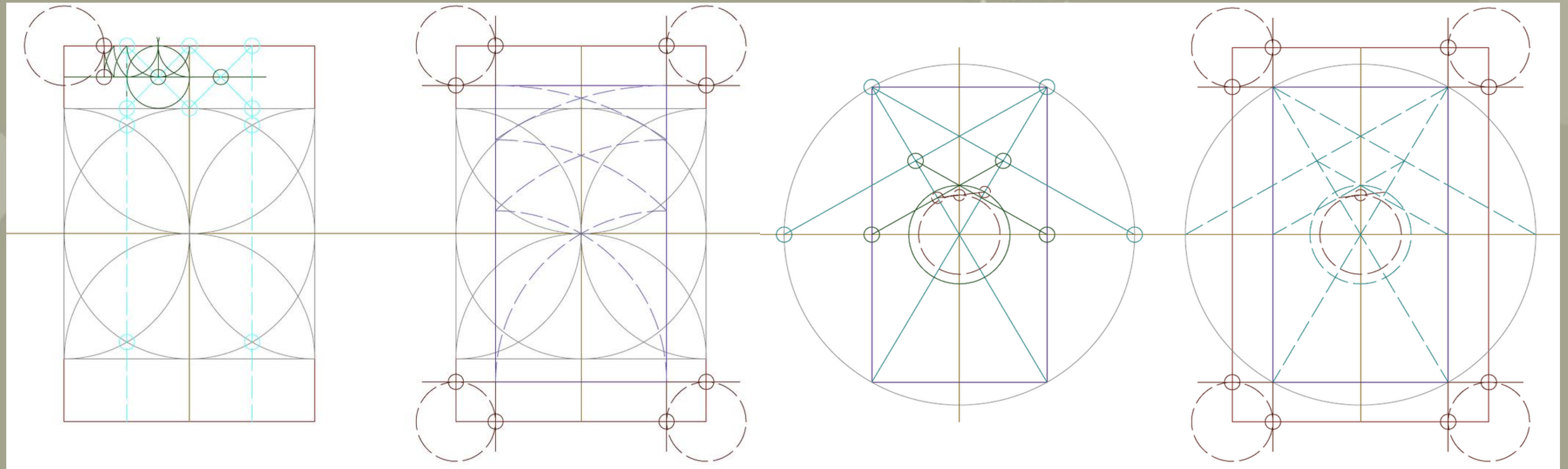
# Methodologies



Methodology to go from Square and half rectangle to 3x5 Rectangle

Methodology to go from 3x5 Rectangle to Square and half rectangle

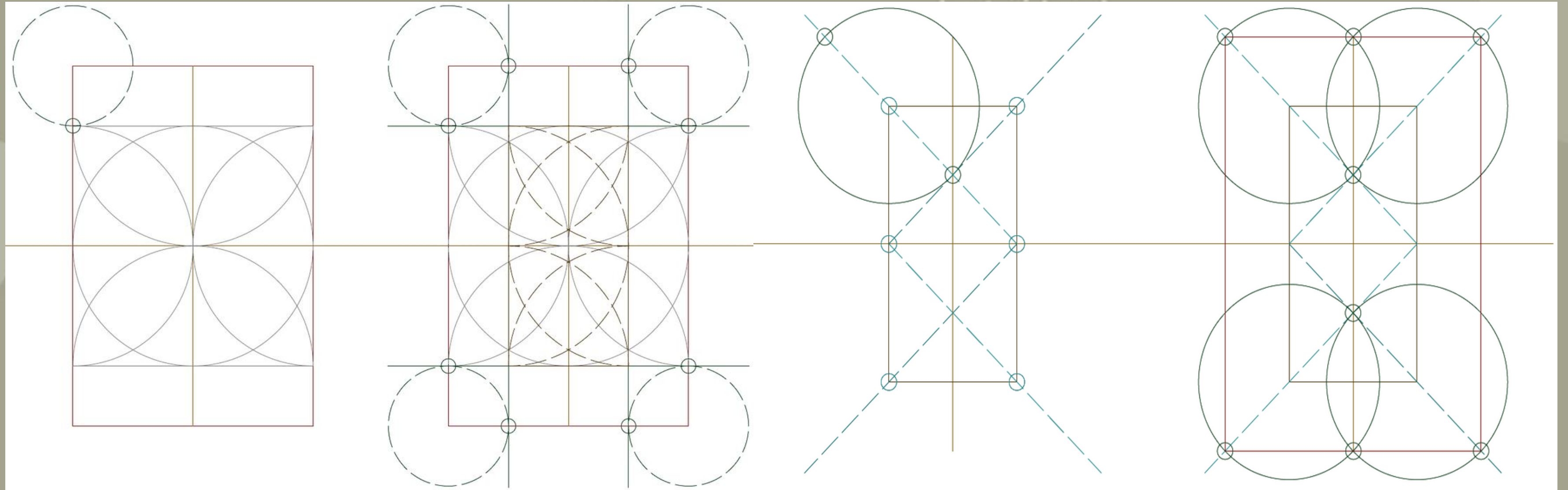
# Methodologies



Methodology to go from Square and half rectangle to Root 3 rectangle

Methodology to go from Root 3 rectangle to Square and half rectangle

# Methodologies

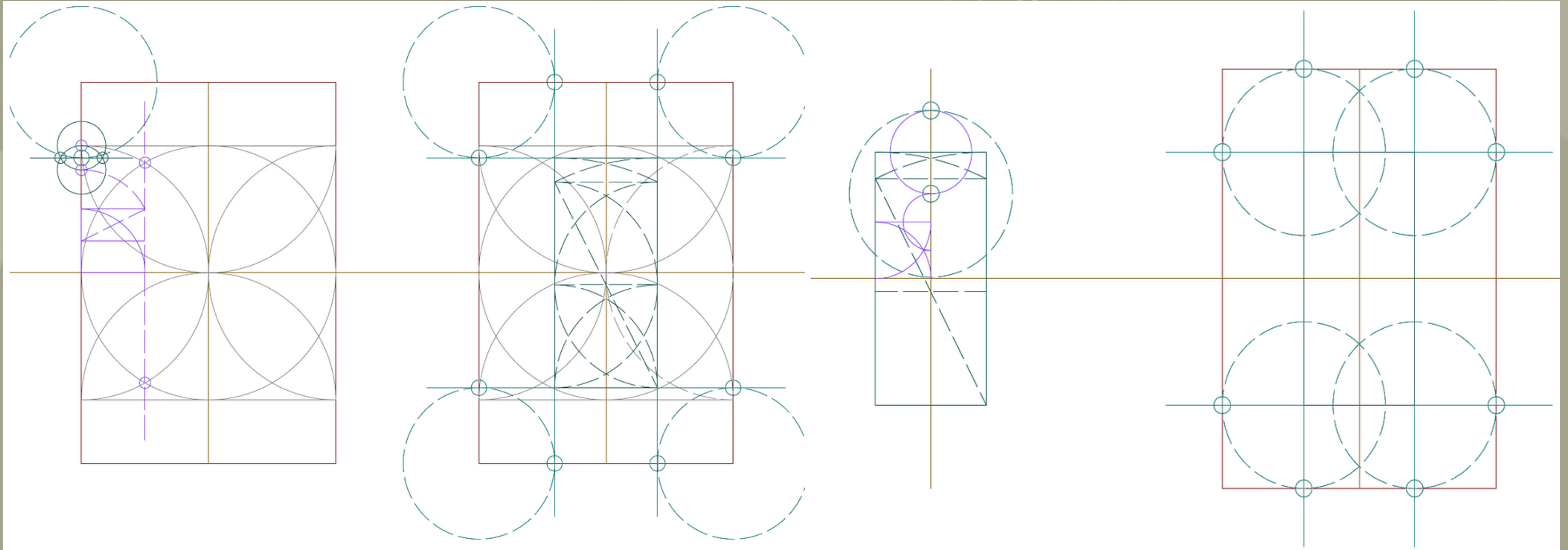


Methodology to go from Square and half rectangle to Double square

Methodology to go from Double square to Square and half rectangle



# Methodologies



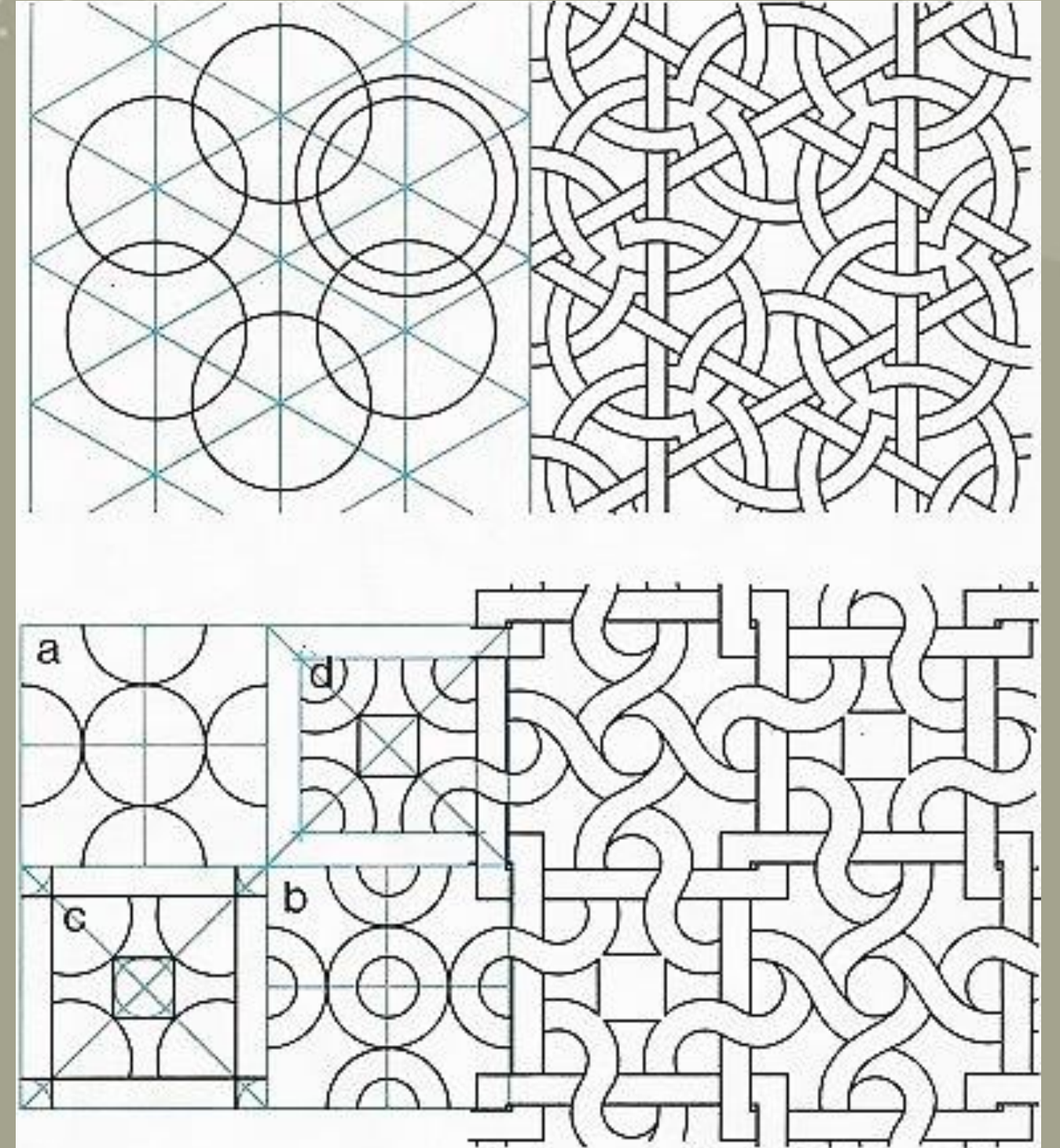
Methodology to go from Square and half rectangle to Root 5 rectangle

Methodology to go from Root 5 rectangle to Square and half rectangle

# Advanced Techniques

## Interlacing

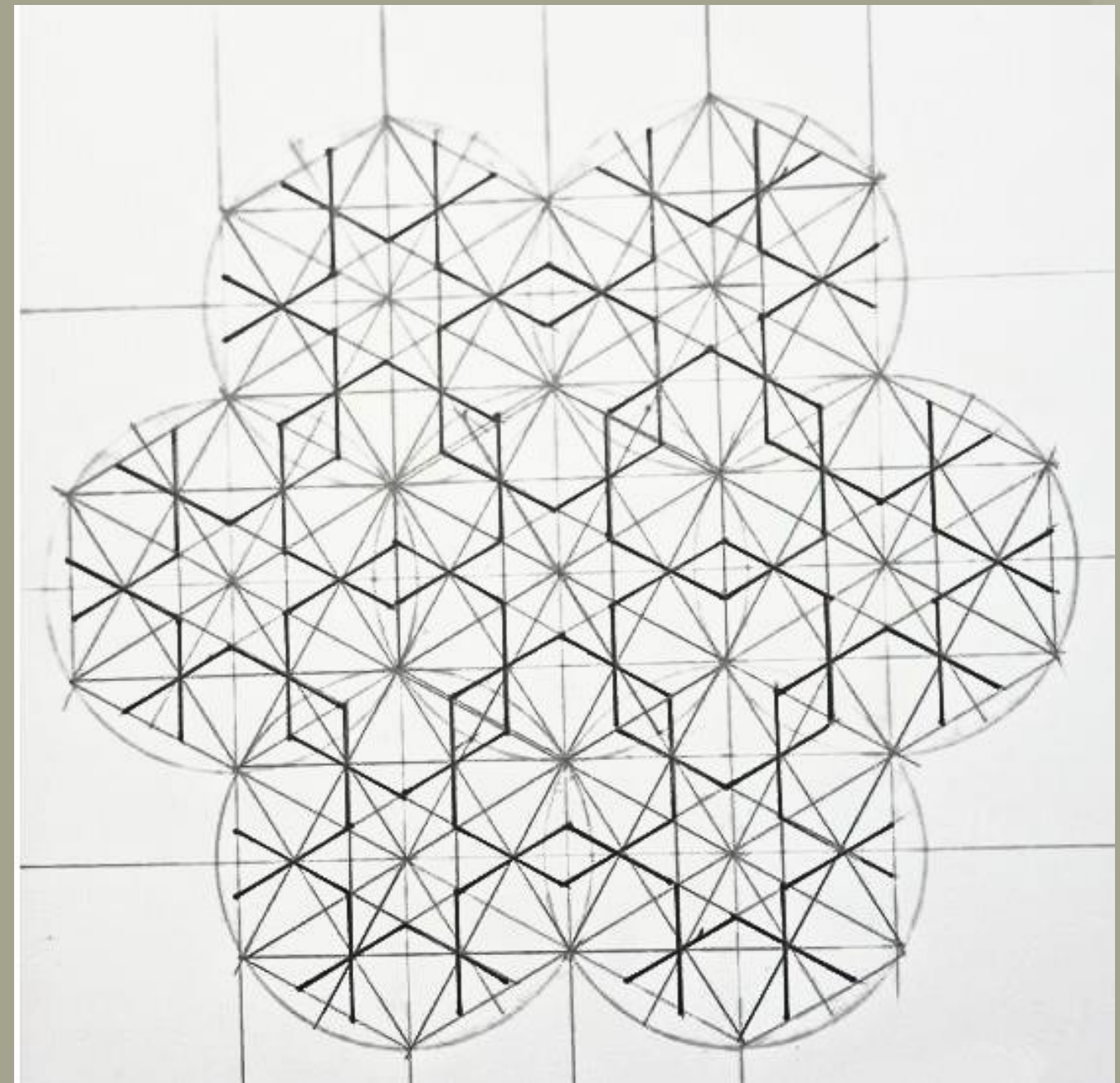
This method fosters a captivating interplay of foreground and background by weaving geometric shapes, like squares or triangles, in an overlapping fashion. The resultant knots and interwoven passages create a sense of depth and dynamism, drawing the eye on a captivating journey through the pattern.



# Advanced Techniques

## Overlapping

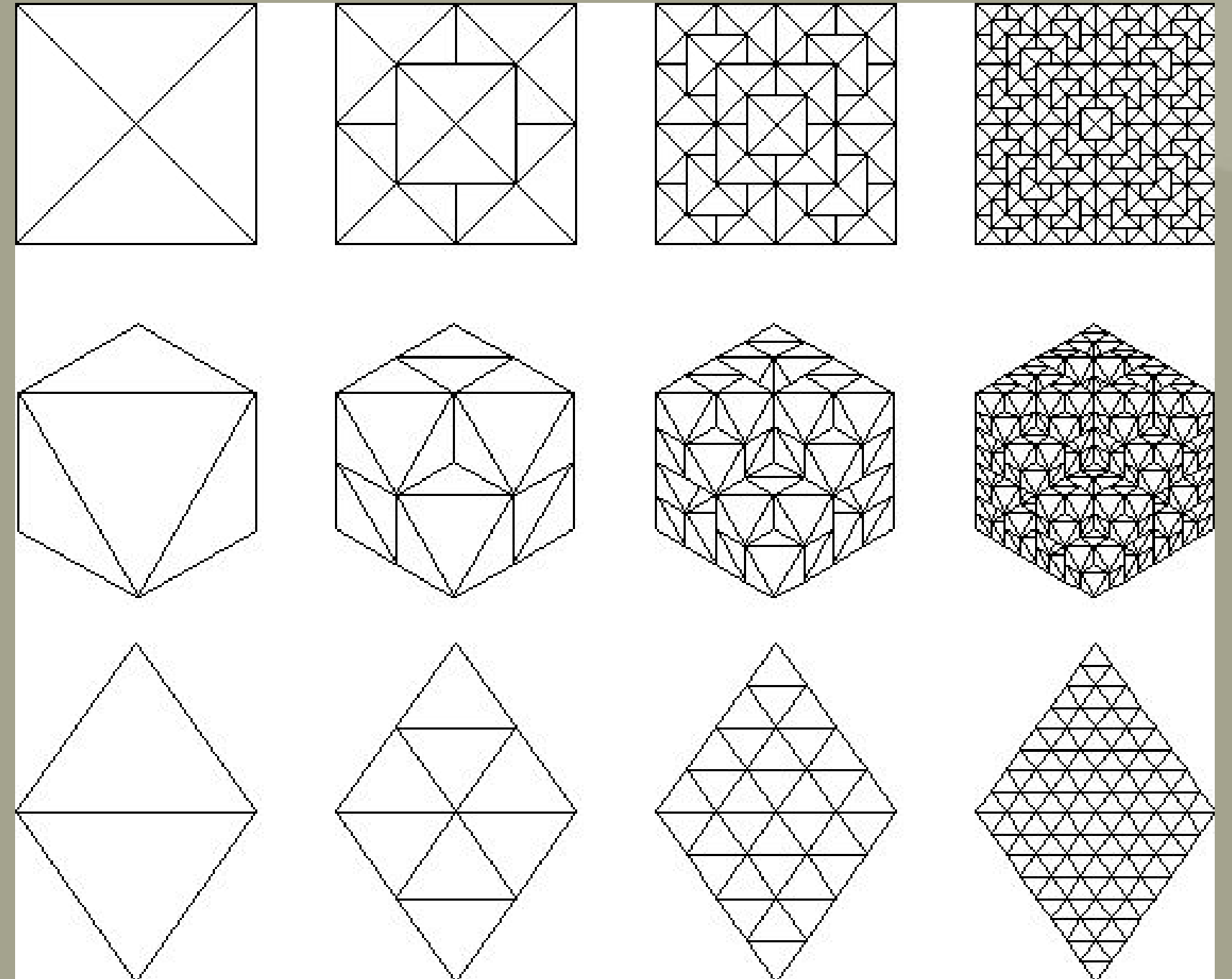
By layering geometric shapes, such as circles or hexagons, upon one another, a multi-faceted design emerges. Each layer unveils fragments of the underlying structure, while simultaneously casting captivating shadows and highlighting unexpected intersections. This technique introduces a sense of textural richness and creates an aura of mystery, inviting the viewer to decipher the interplay of forms.



# Advanced Techniques

## Fractals

Harnessing the inherent complexity of fractal geometry, this technique introduces an element of infinite detail and unpredictability into the design. By employing self-repeating iterations, intricate and mesmerizing patterns emerge, reminiscent of natural marvels like snowflakes or fern fronds.





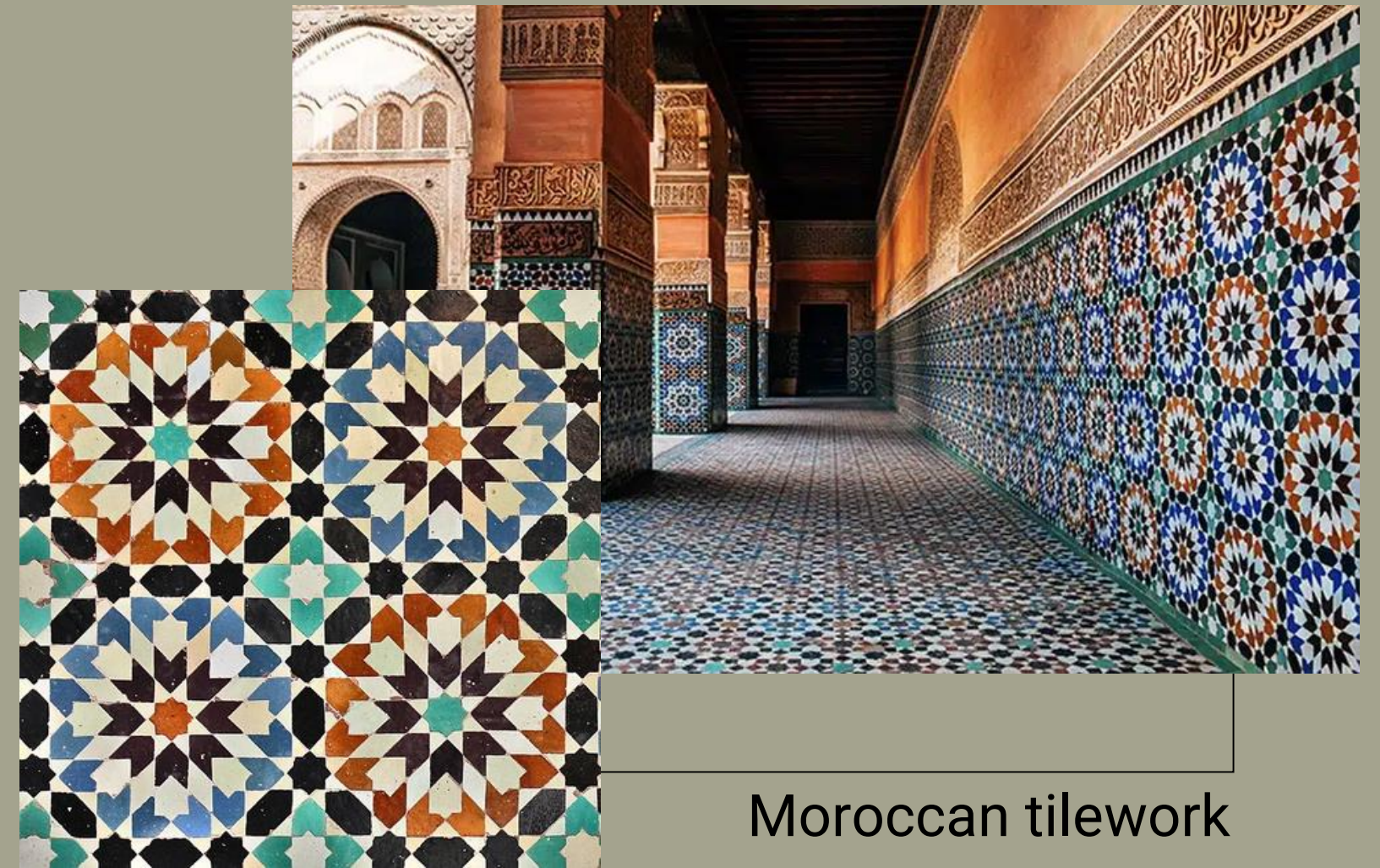
# CULTURAL AND HISTORICAL INFLUENCES

# Traditional Islamic Patterns

Within the realm of Islamic art, geometric ornamentation transcends mere decoration, transforming into a meticulously crafted dialogue between faith, philosophy, and mathematics.

## Star Patterns

- Geometric Foundations: Built upon fundamental shapes like squares, triangles, and pentagons, these patterns employ tessellation principles to create mesmerizing compositions that seamlessly cover surfaces.
- Interlocking: Stars often interlock and overlap. They embody unity and infinity, symbolizing a harmonious connection between earthly and divine realms.



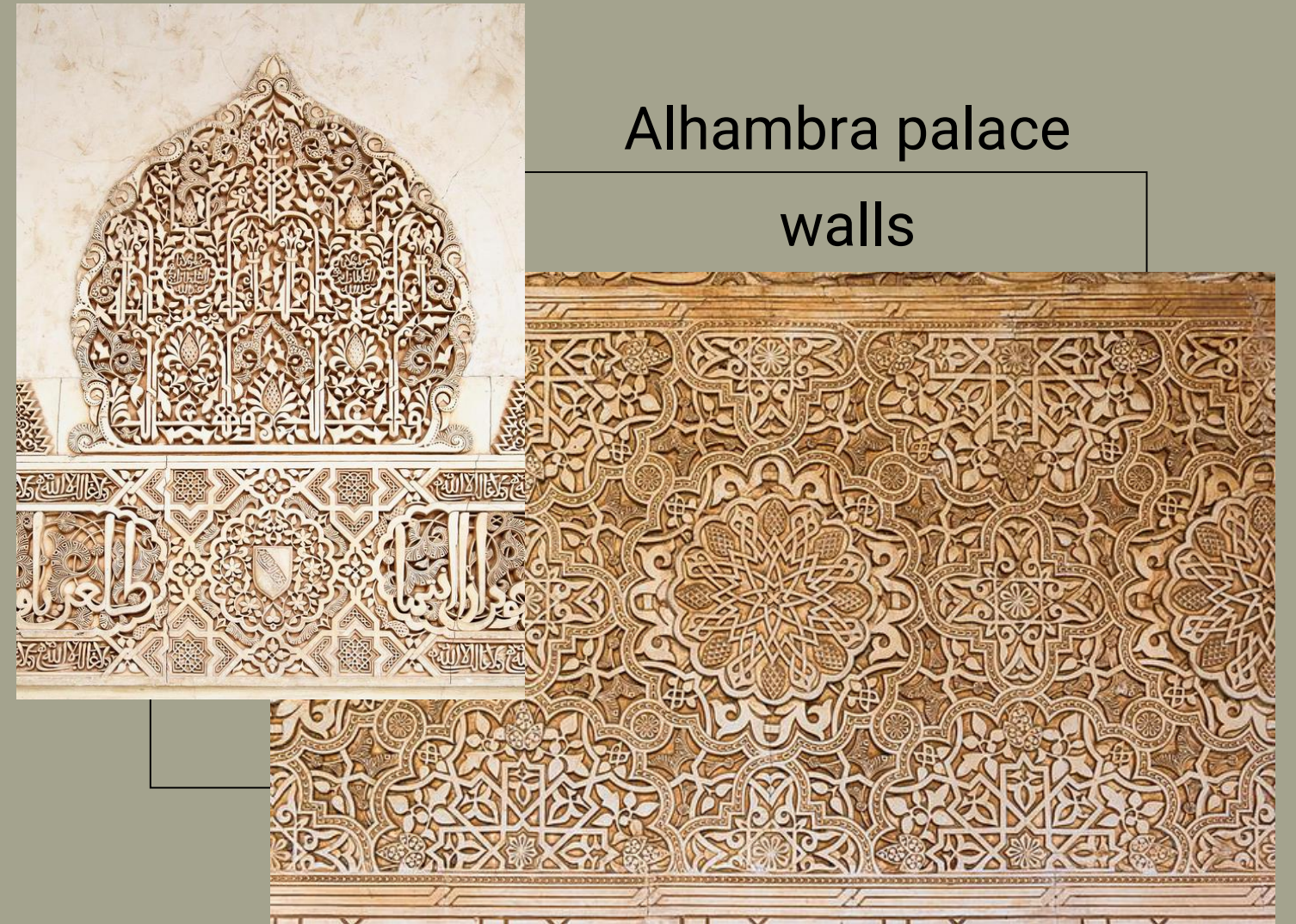
Moroccan tilework

# Traditional Islamic Patterns

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## Arabesques

- Infinite Rhythm: Arabesques weave continuous, interwoven lines, often incorporating floral and geometric motifs. They symbolize the boundless nature of divine creativity and the interconnectedness of all things.
- Symbolic Elements: Flowers represent earthly beauty and spiritual growth, while geometric shapes allude to cosmic order and divine perfection. Their harmonious interplay creates a sense of balance and tranquility.



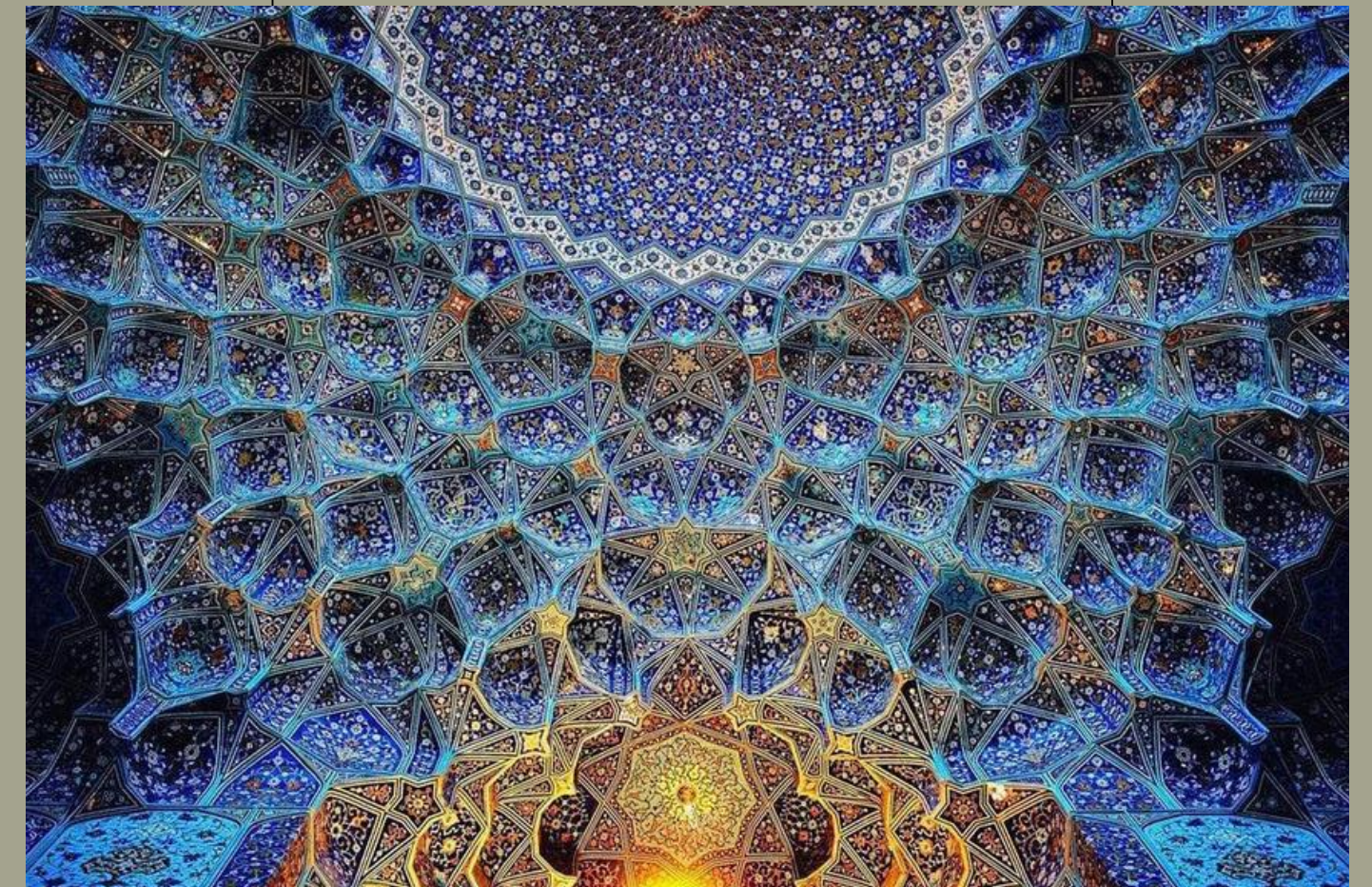
Alhambra palace  
walls

# Traditional Islamic Patterns

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## Geometric Grids

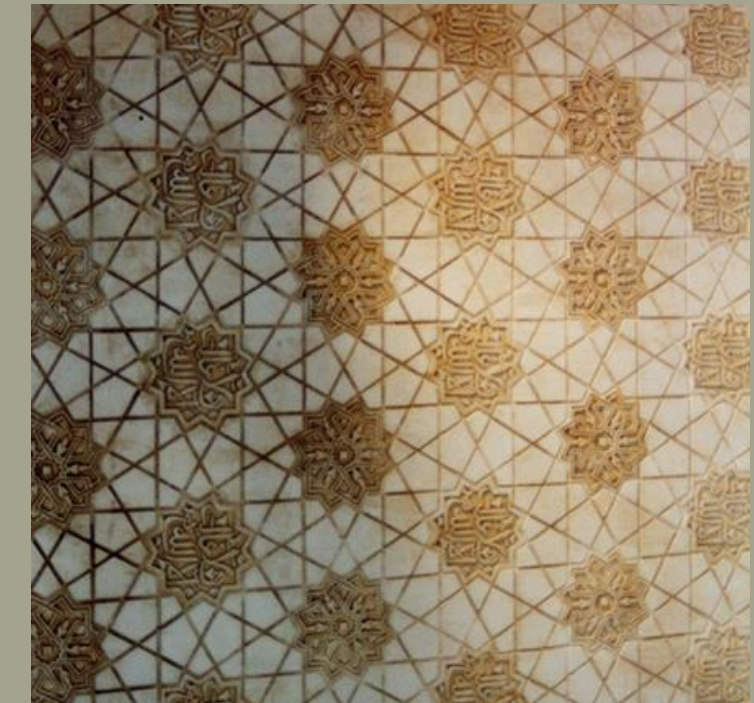
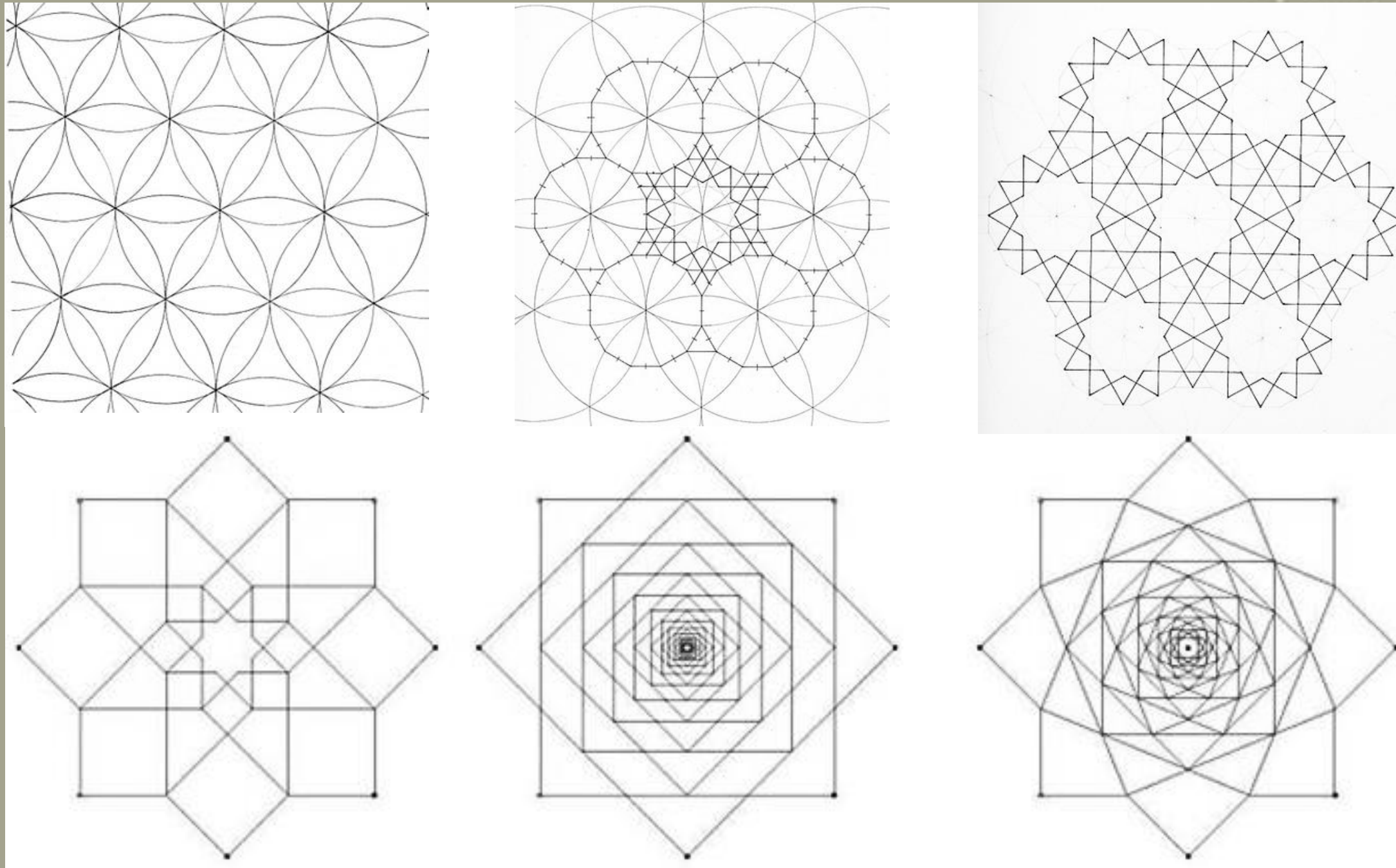
- **Mathematical Harmony:** These grids utilize principles of tessellation, symmetry, and proportions like the Golden Ratio to create visually stunning and mathematically precise patterns.
- **Symbolic Connections:** The geometric order reflects the divine perfection and cosmic harmony believed to govern the universe. Each element, from the smallest line to the intricate arrangement, carries symbolic significance.



Muqarnas ceilings

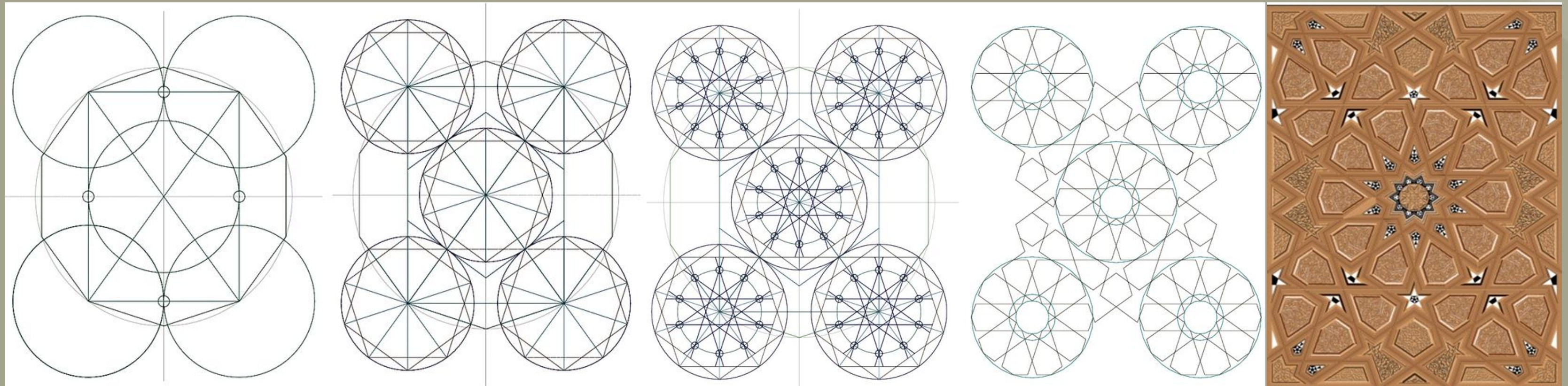


# Traditional Islamic Patterns



Analysis stages: step by step examples of unfolding pattern

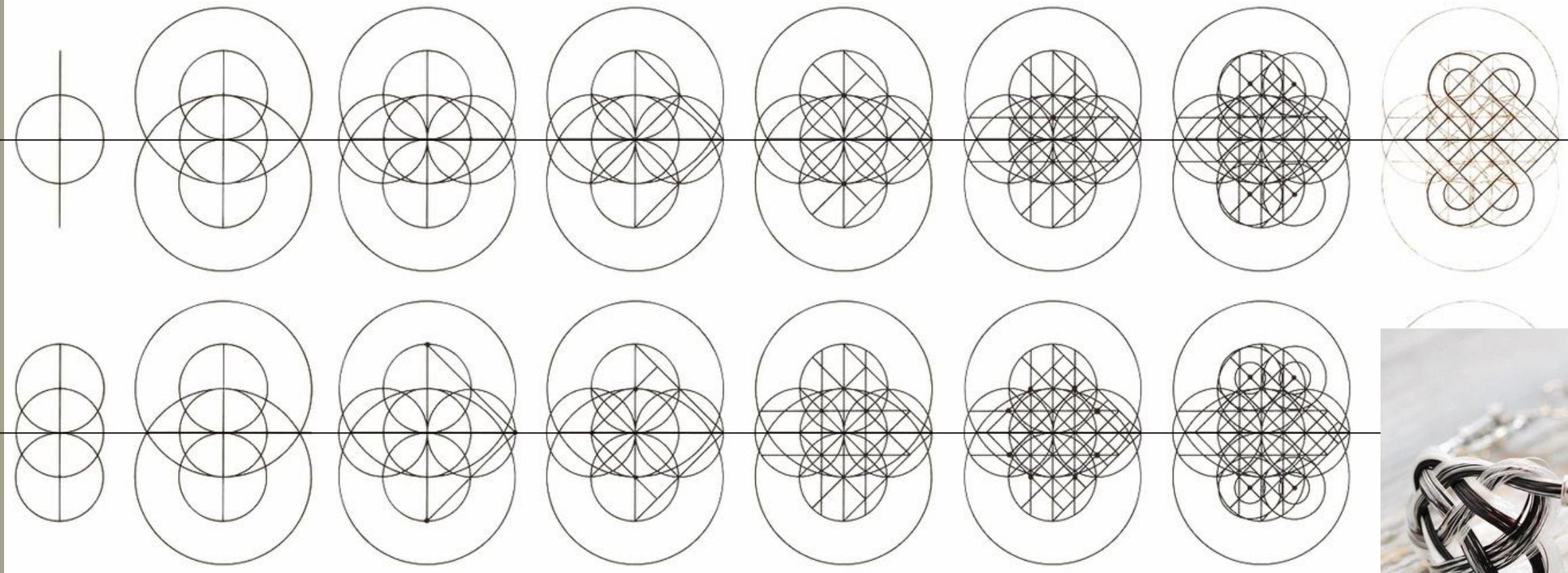
# Traditional Islamic Patterns



Stages for creating tenfold pattern order layout

# Celtic Knotwork and Interlacing

The world of Celtic art is woven with intricate knots and interwoven patterns, known as "knotwork" and "interlacing." These captivating designs are not mere decoration; they are windows into a rich cultural heritage, brimming with symbolism and fascinating artistic techniques.



These intricate patterns were carved into stone, woven into fabrics, and adorned metalwork.

# African Beadwork and Textiles

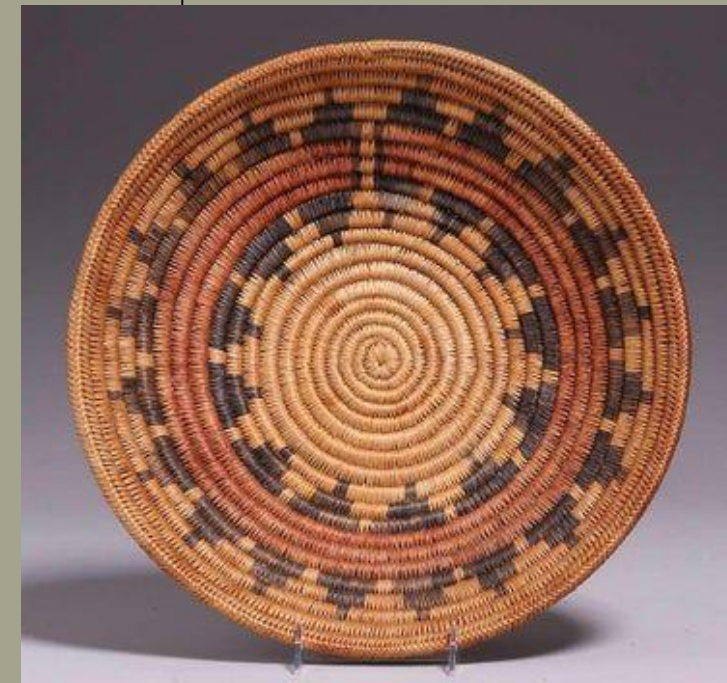
Far from mere ornamentation, geometric patterns and motifs in African beadwork and textiles transcend aesthetics, becoming powerful expressions of cultural identity, social status, and spiritual beliefs. Geometric shapes are not random; they constitute a visual language, each form carrying significant meaning. Circles symbolize the sun, spirals represent life's journey, and intersecting lines depict pathways or connections within communities.



# Native American Basket Weaving

Native American traditions are woven not just into stories and songs, but also into the intricate patterns and symbols adorning their baskets. These functional vessels transcend mere utility, transforming into canvases for narratives whispered through geometric designs and natural materials.

- Spiral motifs: Representing the seasons and the cosmos.
- Star patterns: Symbolizing celestial guidance, hope, and protection.
- Checkerboard patterns: Representing earth and sky, balance, and duality.
- Zigzag and wave patterns: Mimicking flowing water, the journey of life, and the movement of animals.

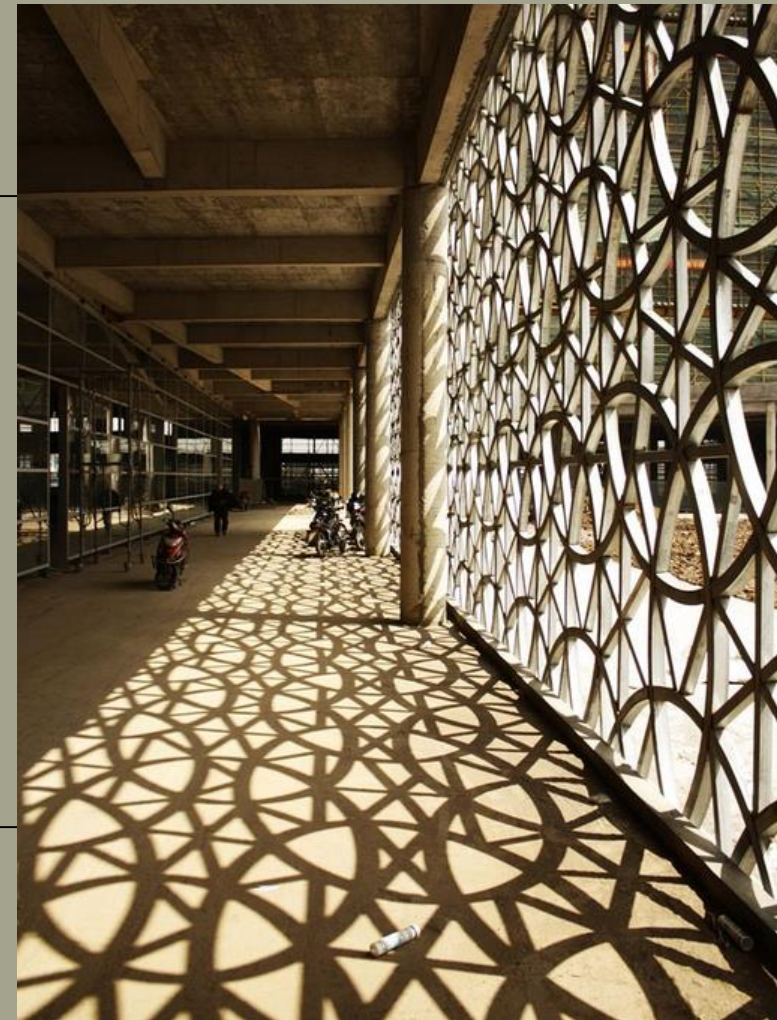


# VERSATILITY AND APPLICATION



# Geometric Ornamentation in Architecture

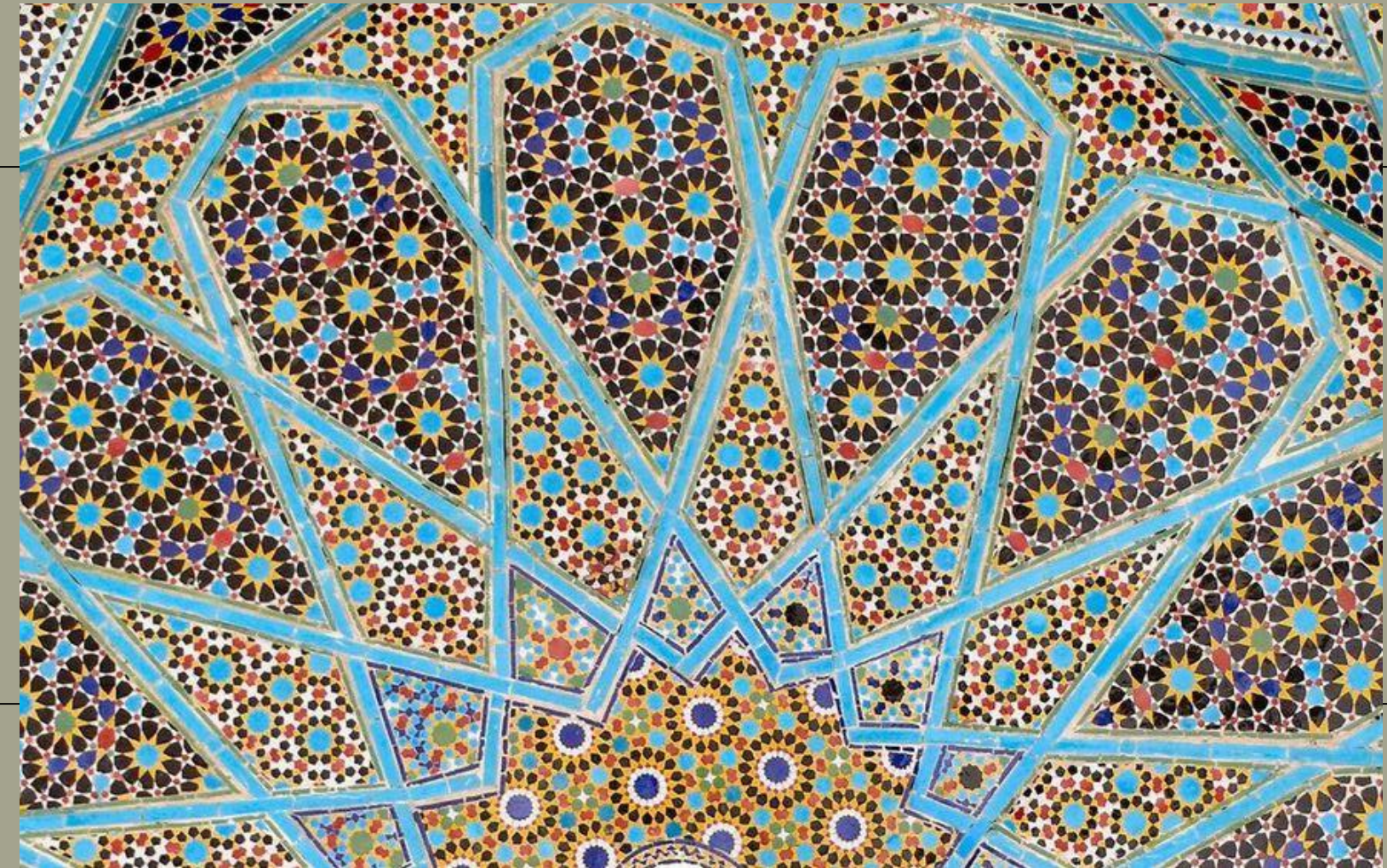
Across history, geometry has transcended its mathematical roots to become a vibrant language expressed in the very fabric of buildings. From monumental facades to shimmering mosaics and stained glass windows, geometric designs have been employed to enhance architectural beauty, symbolism, and structural integrity.



**Facades**

# Geometric Ornamentation in Architecture

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**Mosaics**



# Geometric Ornamentation in Architecture

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**Stained Glass**

# Geometric Patterns in Textile Design

Across continents and throughout history, geometric motifs have woven themselves into the very fabric of human cultures, adorning clothing, tapestries, and carpets with captivating patterns and profound meanings.

## Techniques

- Loom Weaving: The process of interlacing vertical (warp) and horizontal (weft) threads on a loom to create fabrics with varied textures, patterns, and geometric designs.
- Embroidery: The art of decorating fabric with needle and thread to create detailed geometric motifs, borders, and embellishments.
- Stenciling: A technique where pre-cut shapes act as guides to apply dye or paint to fabric with accuracy and repetition, creating geometric patterns like stripes, checkerboards, and intricate motifs.



# Graphic and Product Design

In both graphic and product design, geometric ornamentation reigns supreme, weaving a captivating tapestry of functionality and visual delight. Its clean lines and inherent order create a sense of timeless elegance, while offering endless possibilities for dynamic interplay between shapes, scales, and colors. From logos and packaging to furniture and textiles, geometric patterns not only guide the eye but also evoke emotions





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Al-Zaytoonah University of Jordan



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(HANDS)

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