

FROM GEOMETRY TO CLASSICAL

HAOYU FU

Thesis submitted to the faculty of the Virginia Polytechnic Institute
and State University in partial fulfillment of the requirements for
the degree of

Master of Architecture

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Durability, Utility and Beauty are the three Vitruvian principles of architecture. They are also my belief of what constitutes architecture. In order to pursue the essence of architecture, I hope to find at least in part an answer through the study of classical buildings that adhere to those principles. Classical architecture is often organized through basic geometric elements such as square, circle and triangle. These geometric elements have endured the history of architecture and suggest being applicable to any contemporary building.

Since ancient time, humans had intimate relationships with animals, including horses. Even today, where the utility of the horse is no longer important, people still love to engage with horses on many levels. From this perspective, a horse is in a way a symbol that syncretize ancient and modern times.

A horse stable offers itself as a great example to study the relationship between man and horse. As a site, Blacksburg, a small town with a significant animal research branch of the university has rich pasture resources. The proposed architecture seeks to recognize the long-standing horse culture in classical terms, a very usable and beautiful ensemble, based on strong principal geometric elements.

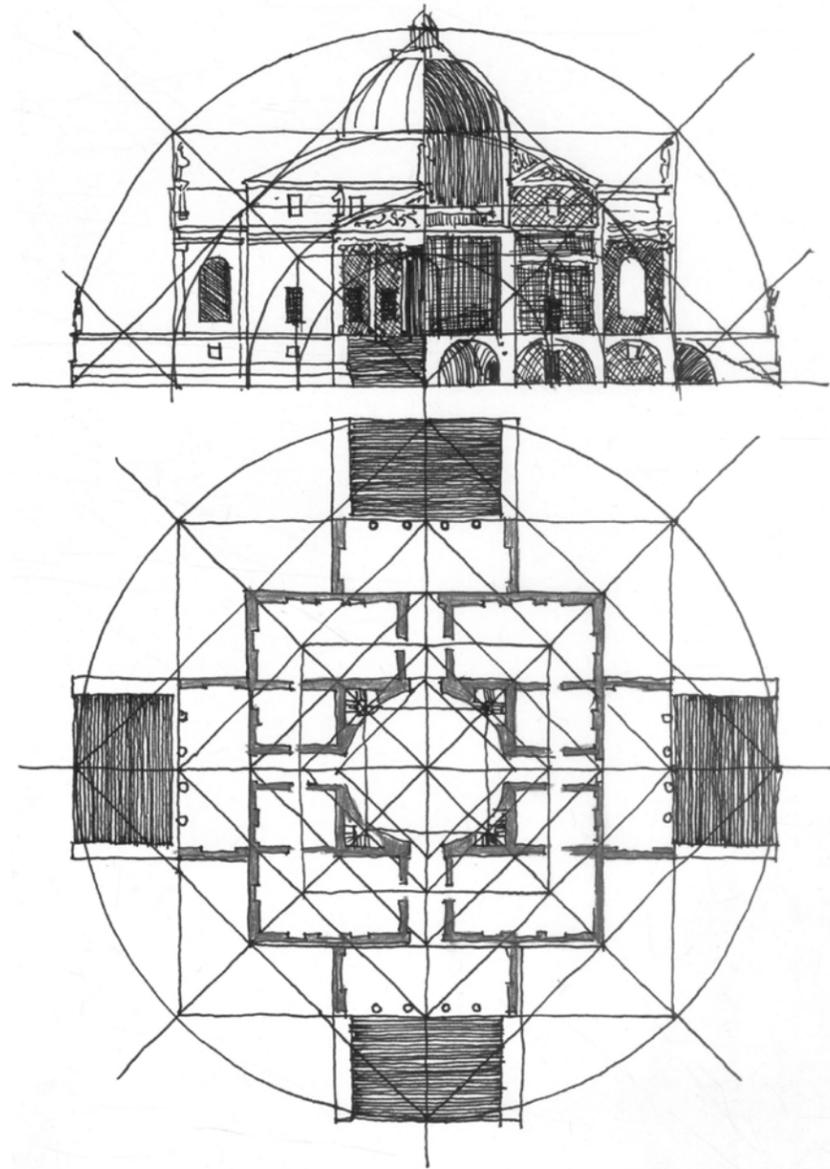
ACKNOWLEDGEMENT

I would like to thank my committee members, Heiner, Kay and Prof. Rodriguez. This could not have been achieved without the advice and support of my committee.

A great debt of gratitude also owed to my parents and friends for their consistent help and reassurance.

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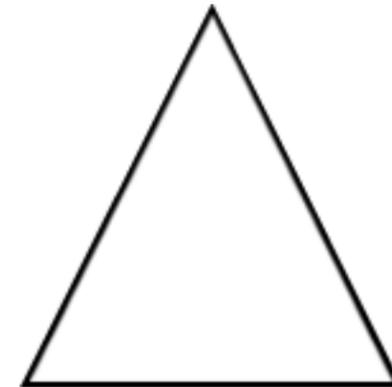
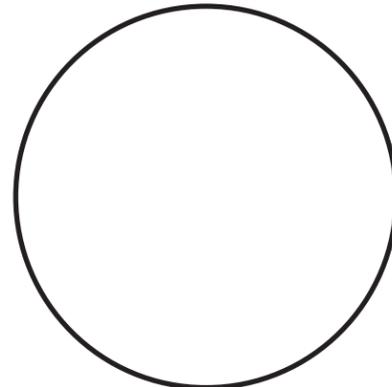
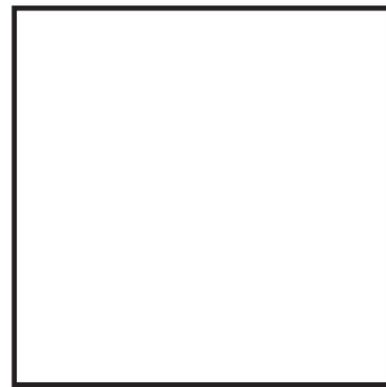
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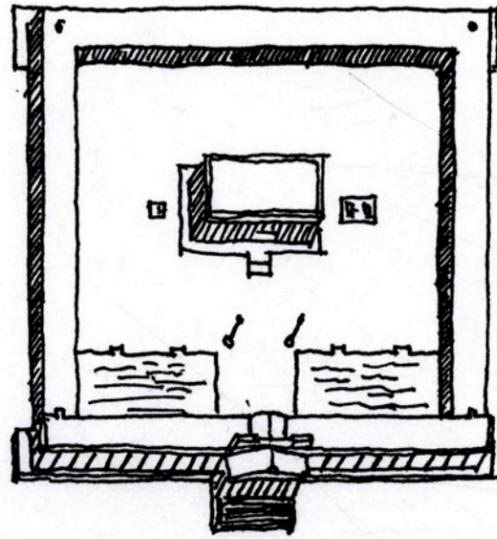
The Roman architect Vitruvius in his book, *De Architectura*, said that there were three principles of good architecture:

1. Firmitas
2. Utilitas
3. Venustas

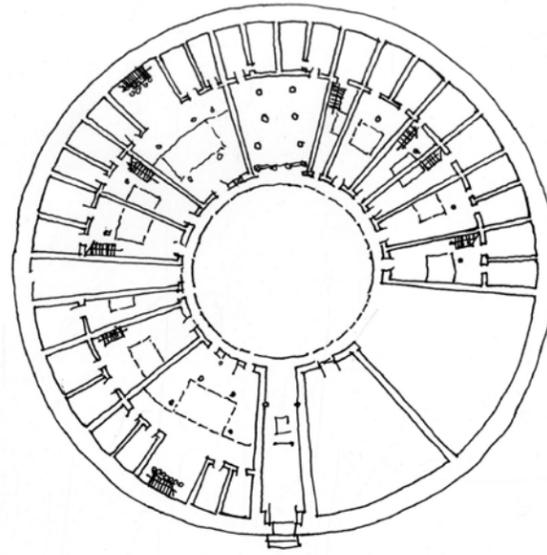
“Architecture depends on order, arrangement, eurythmy, symmetry, propriety, and economy.” (Vitruvius, 14 BC, *The ten books on architecture*. p.13)



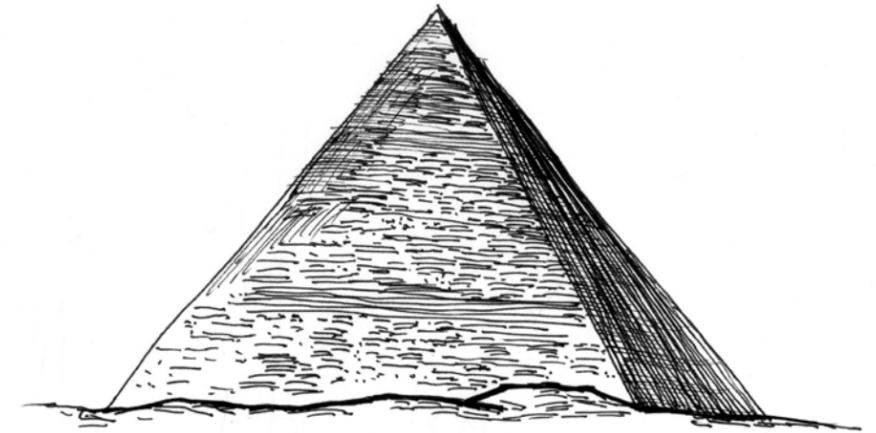
Ancient estheticians thought that simple geometric shapes such as the circle, the square, and the triangle had abstract universal qualities, often symbolic of completeness and unity. Since ancient times, as shown by the examples that follow, great architectures have employed these simple geometric elements.



The Temple of Baal Shamin

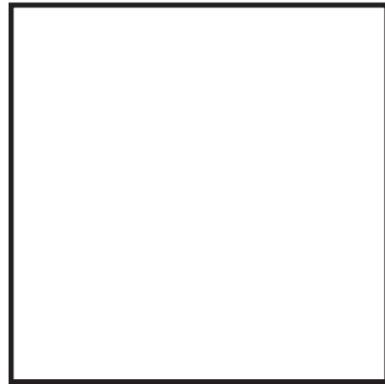


The Tulou in China

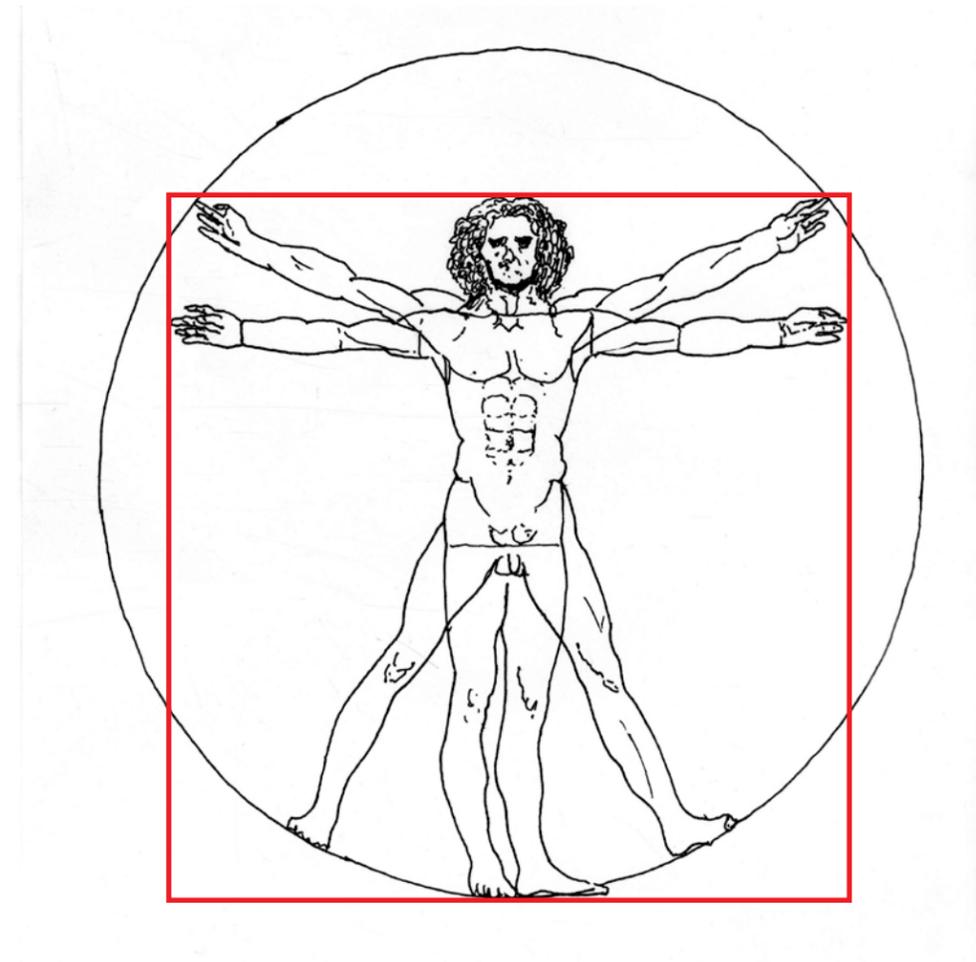


The Great Pyramid of Khufu

THE SQUARE



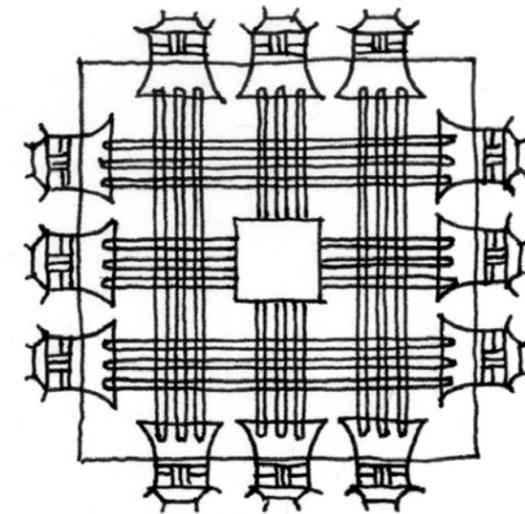
The square is the finest expression of conformity, tranquility, solidity, security and equality. The Square is a familiar and trustworthy shape symbolic of the earth.



With arms outstretched, one's wingspan is equal to one's height. This outstretched human figure, known as "Vitruvian Man," can be encompassed by a square and a circle, as drawn by Leonardo Da Vinci (c.1490). What's more, the square is representative of enclosure.

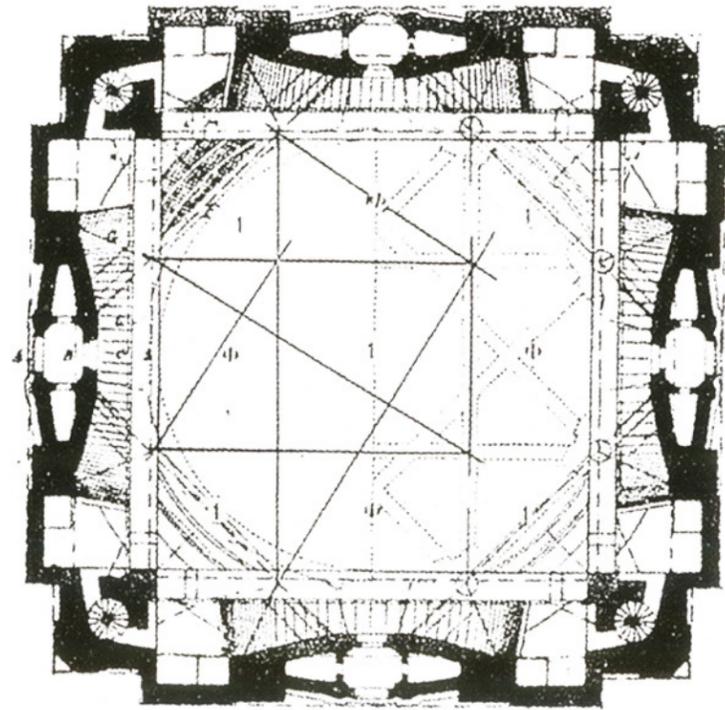


The Chinese word for “country”: an enclosure (meaning ‘city wall’) contains a mouth (meaning ‘people’) and a weapon (meaning ‘army’). The boundary’s shape is a square.

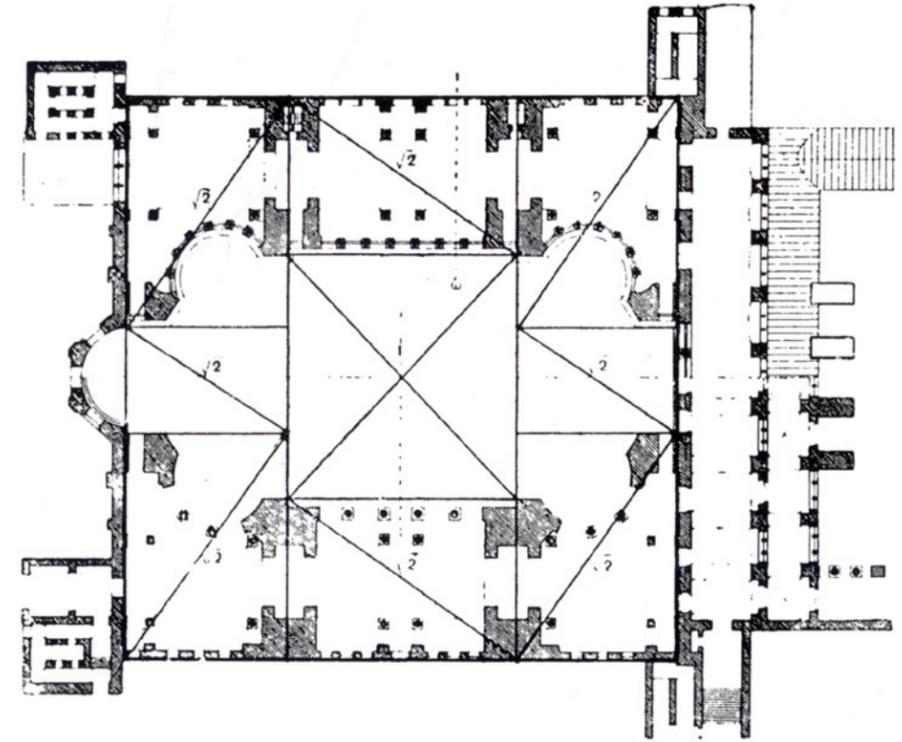


An ancient Chinese diagram of city shows a square as the city’s boundary, with the palace in the center.

THE SQUARE



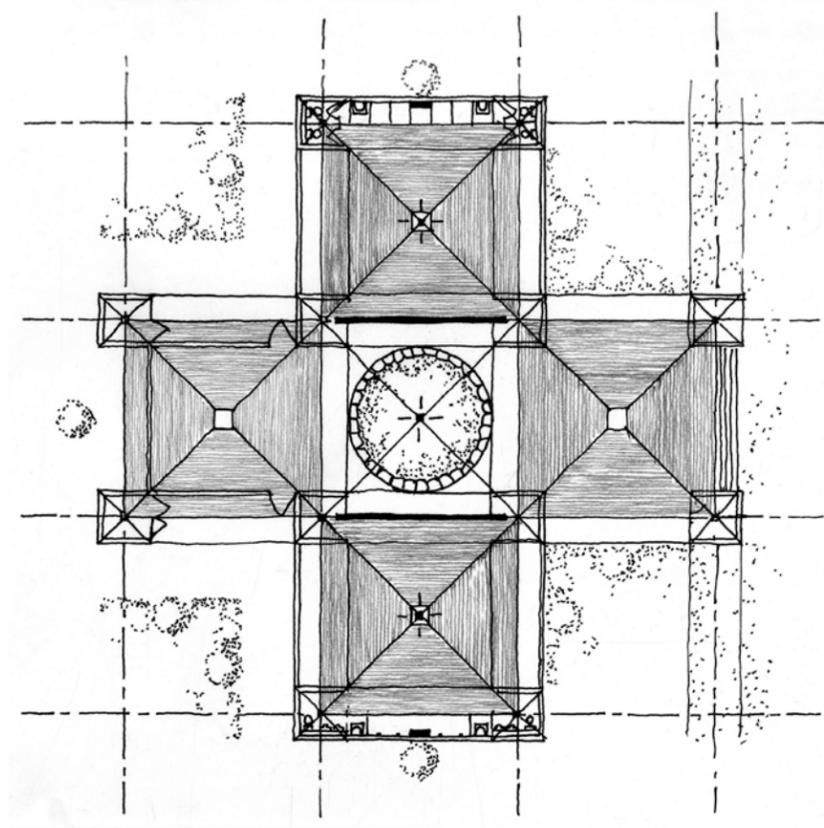
Hagia Sophia, Constantinople. The plan consists of a series of units based on a central square surrounded by rectangles with one side measuring $\sqrt{2}$ times the other.



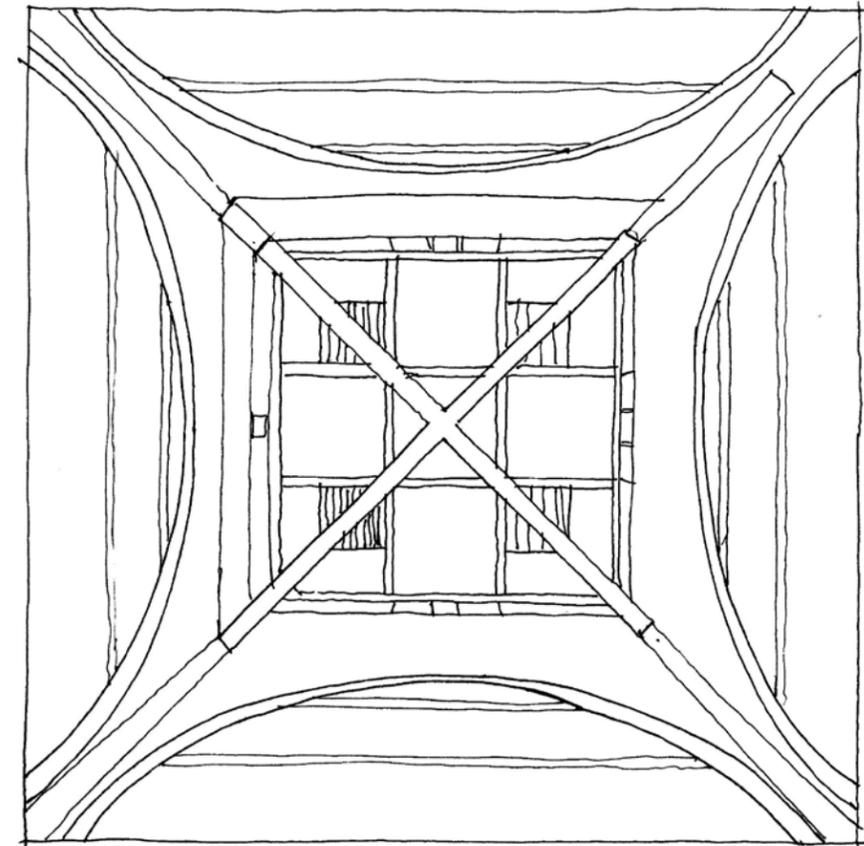
The Church of San Lorenzo, Turin, by Guarino Guarini. The whole composition is based on the square which is in turn divided into squares and golden rectangles.

THE SQUARE

Basic geometry shapes always have a strong appeal because they originated from summing up the abstraction of nature. This is why Louis I. Kahn always used circles, arcs, squares, and triangles to create a supreme space.

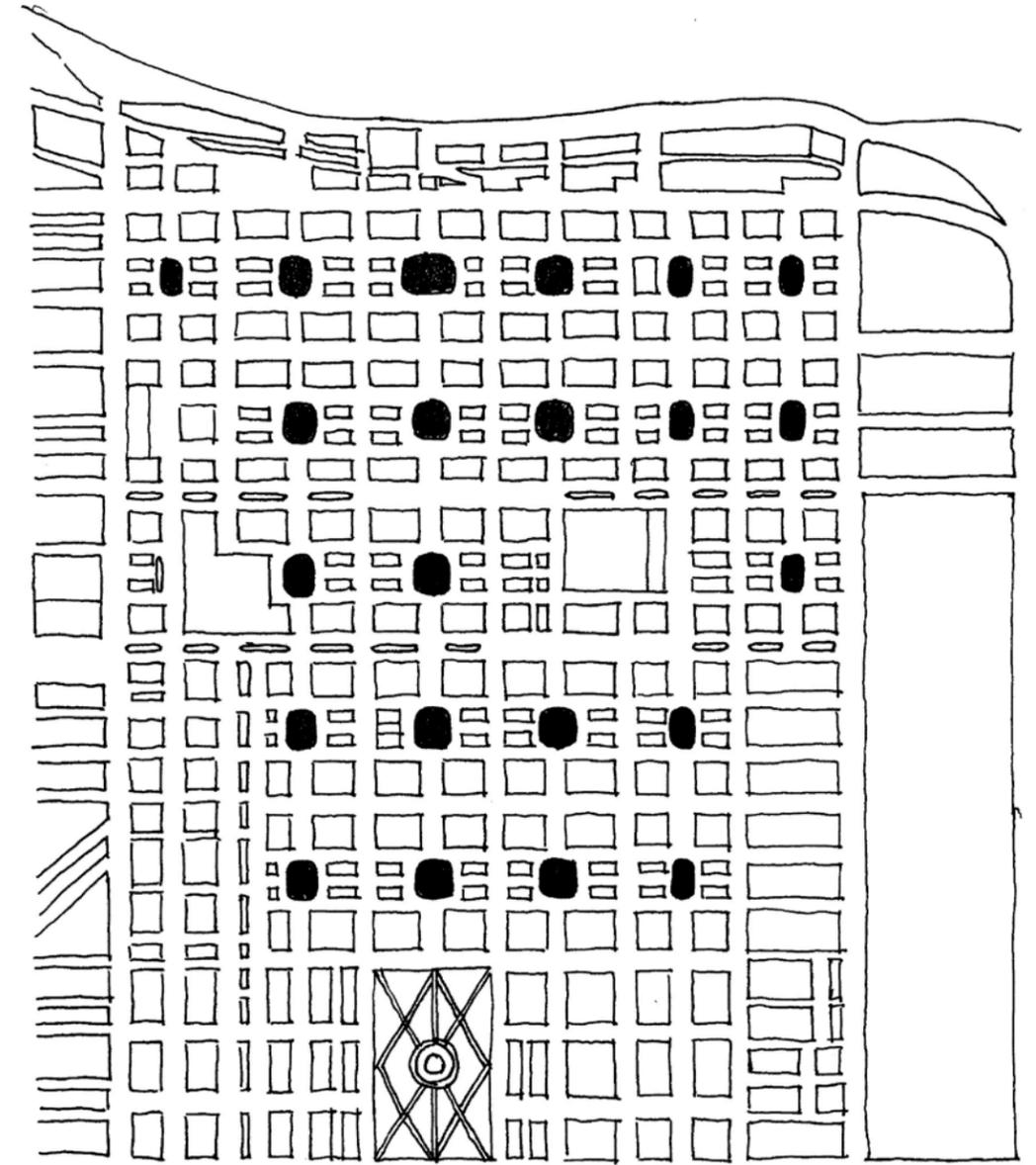
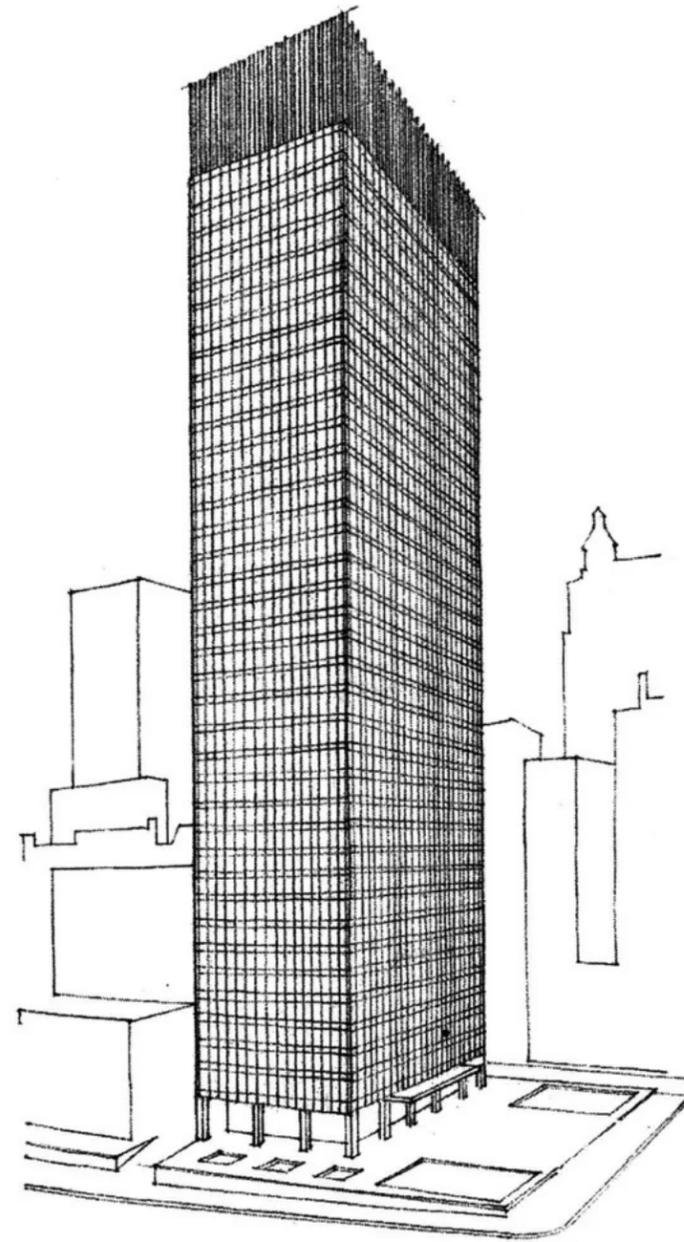


Trenton Bath House
Louis I. Kahn



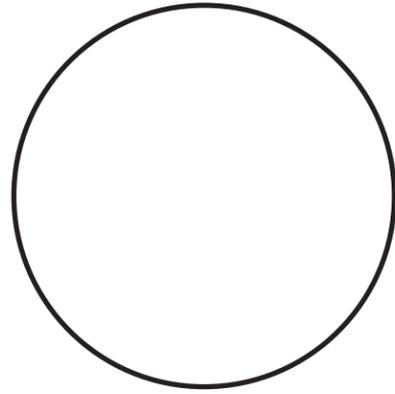
Phillips Exeter Academy Library
Louis I. Kahn

THE SQUARE

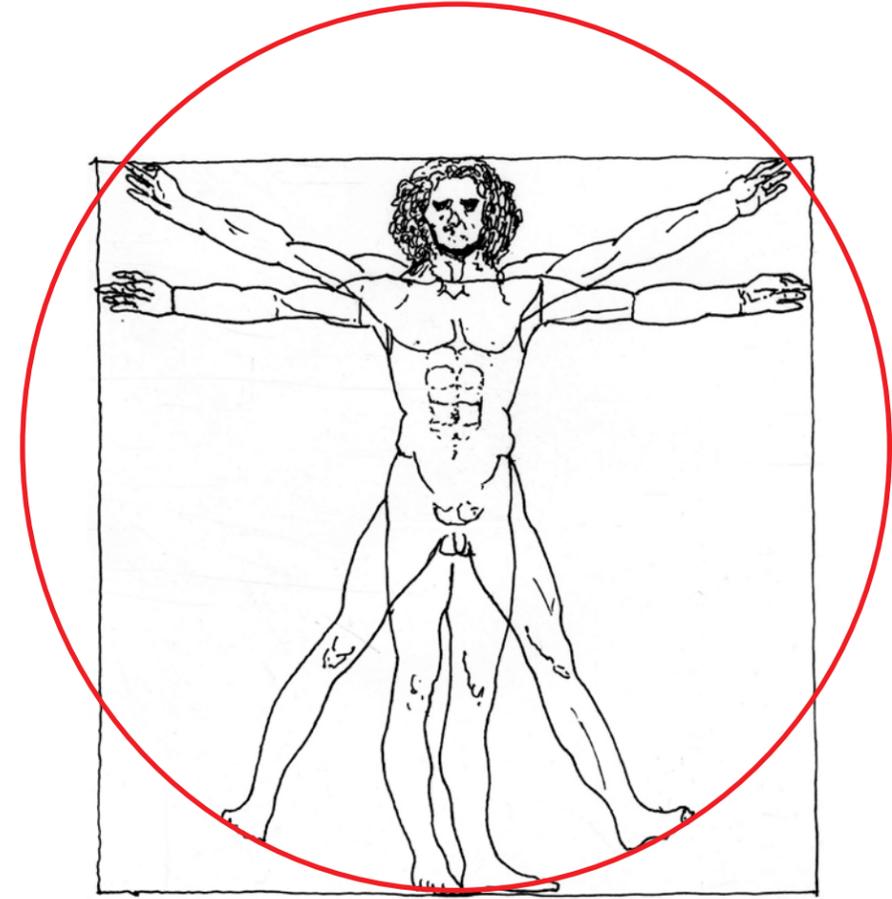


Squares are also widely used in modern architecture and modern urban planning. The famous Seagram Building In NYC designed by Mies van der Rohe, or the Savannah, GA urban layout are prime examples.

THE CIRCLE



The Circle represents for protection or infinity, it limit what's inside while not allowing outside things to come in. It means integrity, communication, perfection, and completeness and symbolizes heaven.

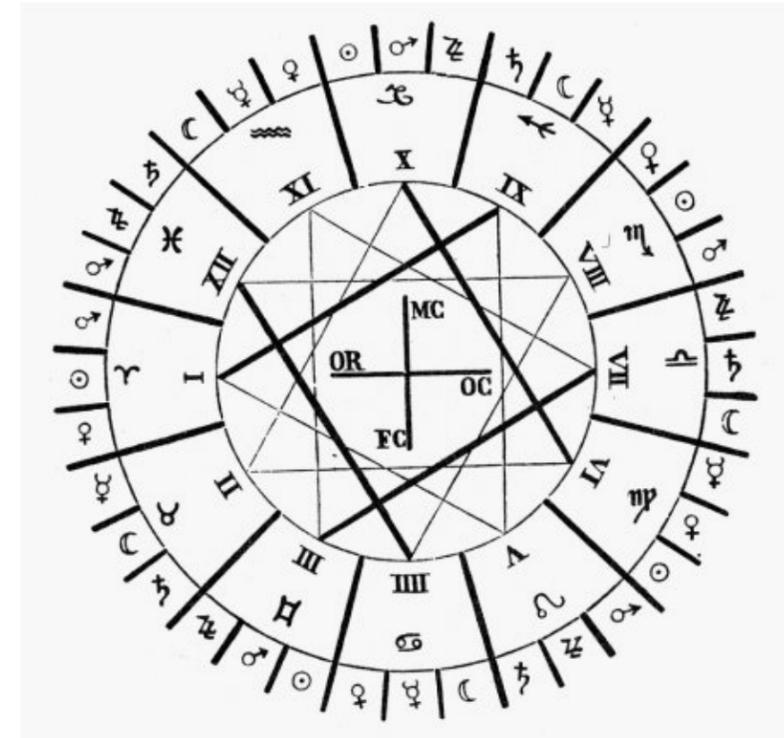


The Circle seems to be free to move and this sense of movement embodies energy and motivation. The completeness of the circle implies infinity, unity and harmony.

THE CIRCLE

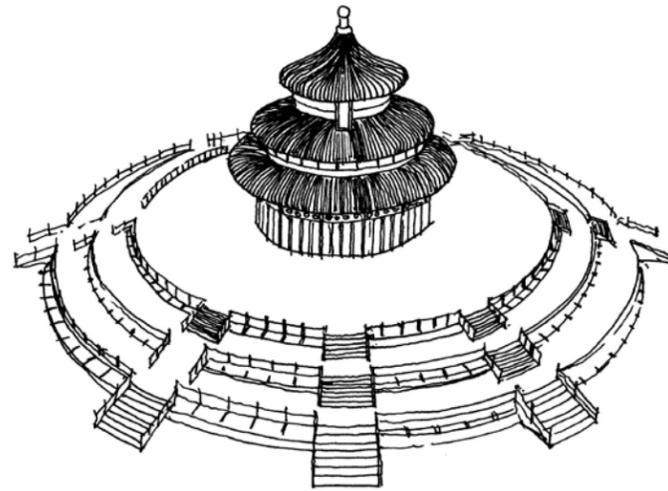


Around 1000 BC, Chinese sages claimed that everything in nature results from the union of two opposing forces called Yin and Yang. The shape made by Yin and Yang is a circle.

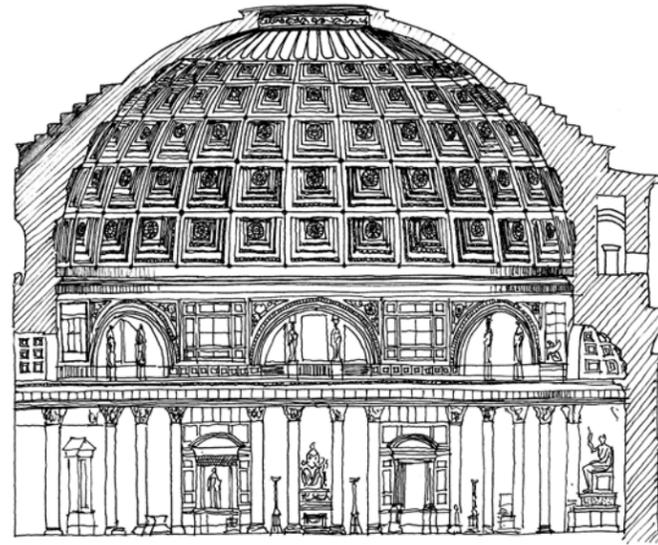


The planisphere is used in astronomy to help people learn how to recognize stars. The planisphere consists of a circle.

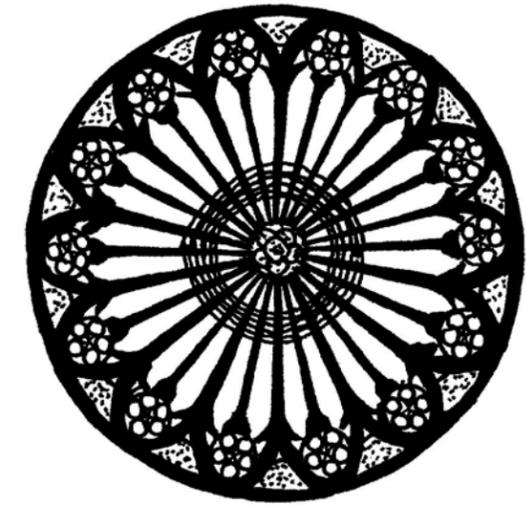
THE CIRCLE



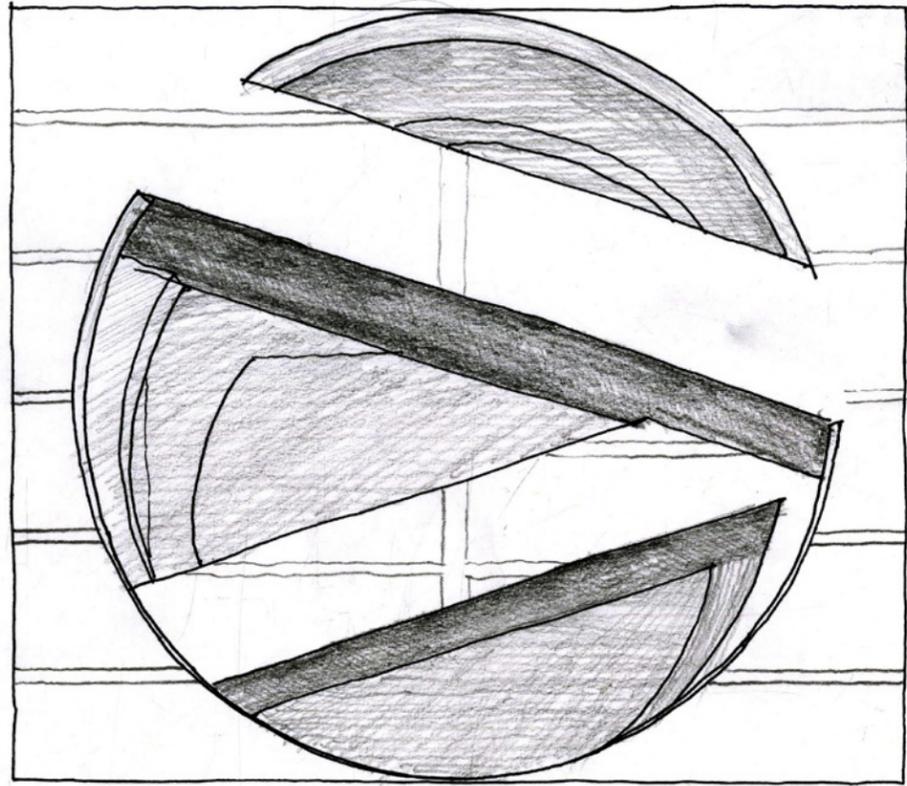
Temple of Heaven



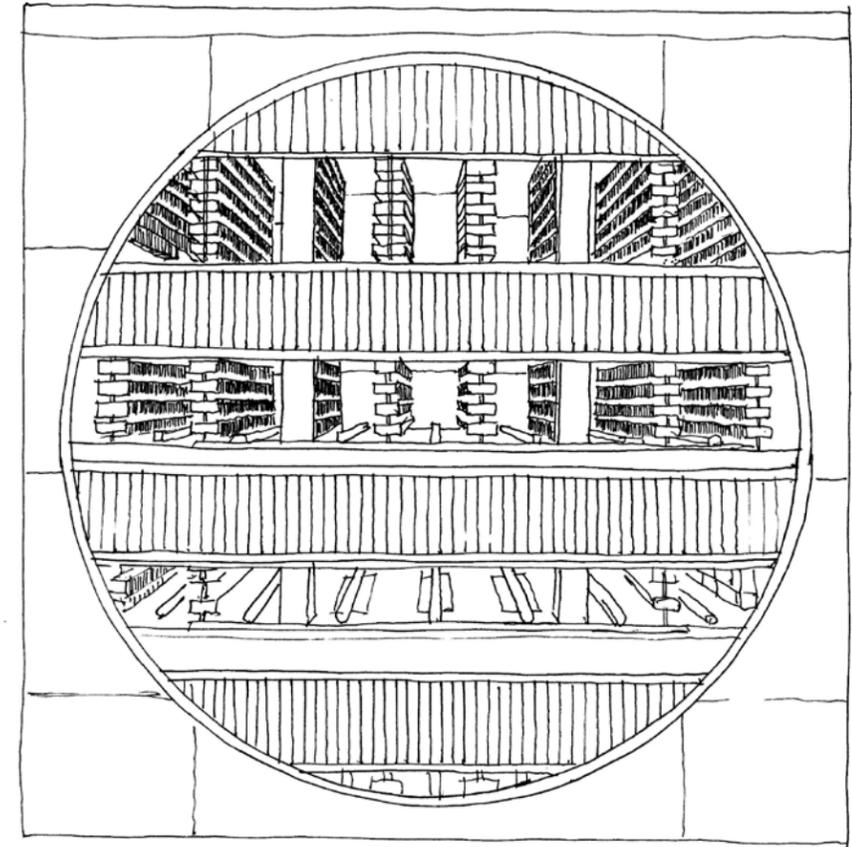
The Pantheon



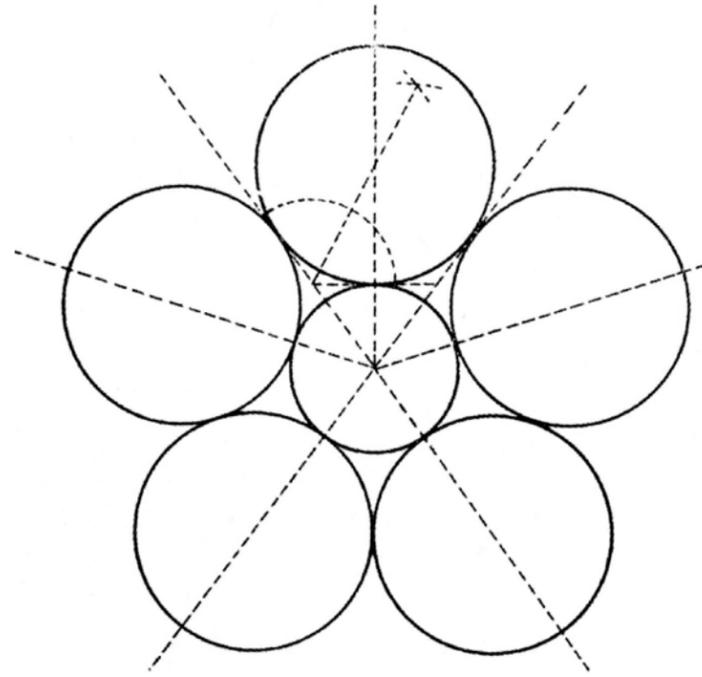
Gothic Rose Window



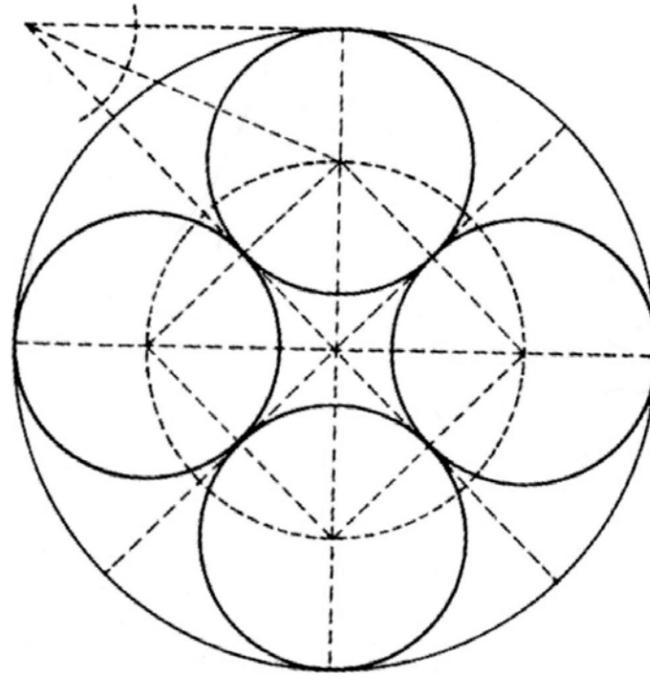
National Assembly Building in Dhaka
Louis I. Kahn



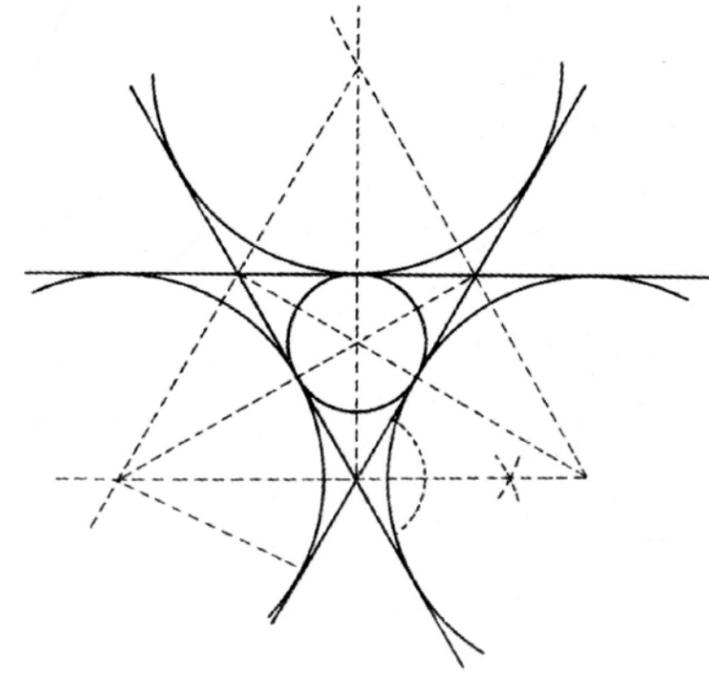
Phillips Exeter Academy Library
Louis I. Kahn



Several circles tangent to each other and to the outside of a given circle.

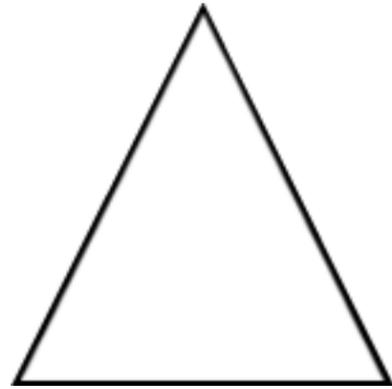


Several circles tangent to each other and to the inside of a given circle.

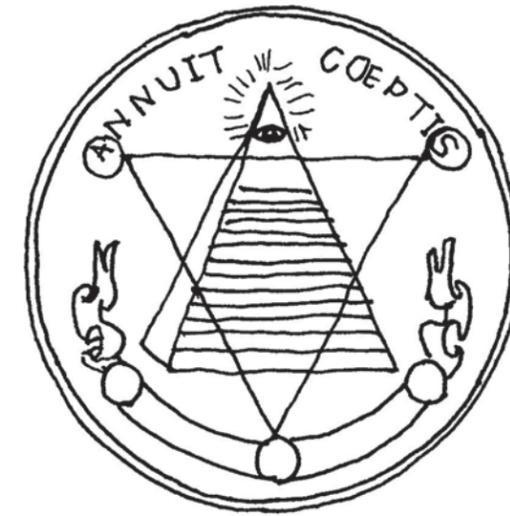


Four circles tangent to three straight lines that are symmetrically crossed.

THE TRIANGLE



The equilateral triangle is one of the three basic forms, along with the circle and square. The triangle represents stability and equilibrium. When it rotates, it represents tension, conflict, movement and aggressiveness. It has also symbolized the union of earth and sky.

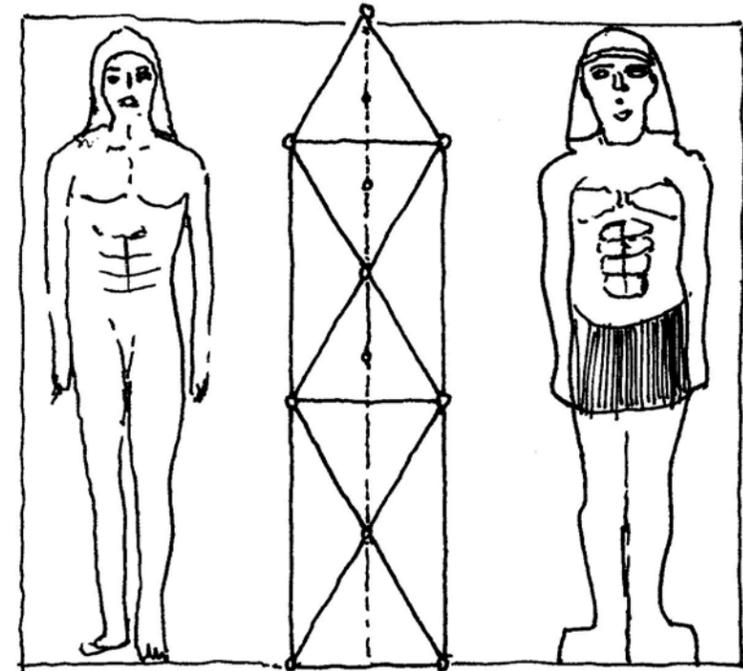


The equilateral triangle is the most stable form. As a result, a large number of complex structures and architectures use equilateral triangle as structure.

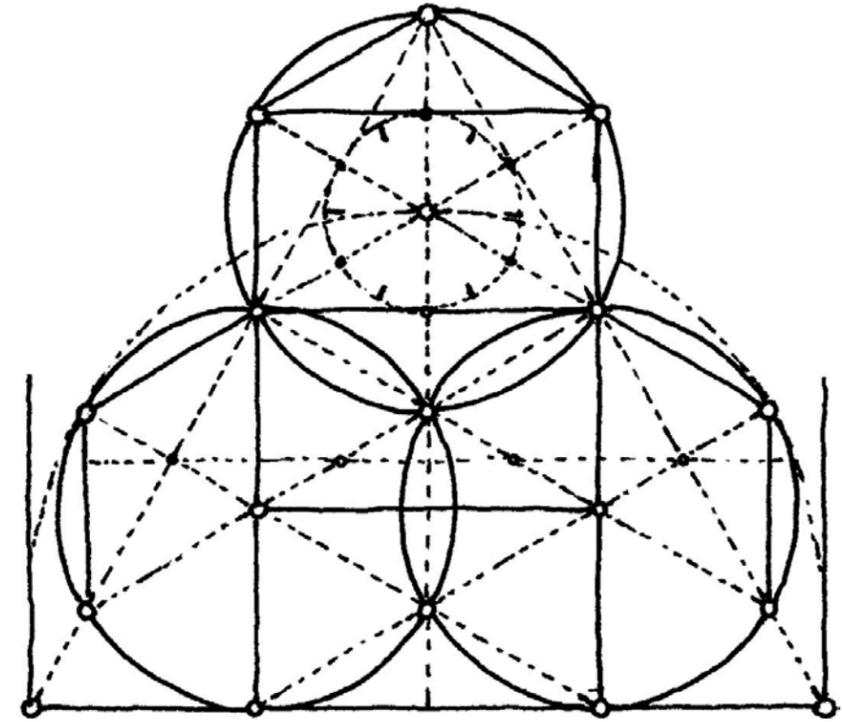
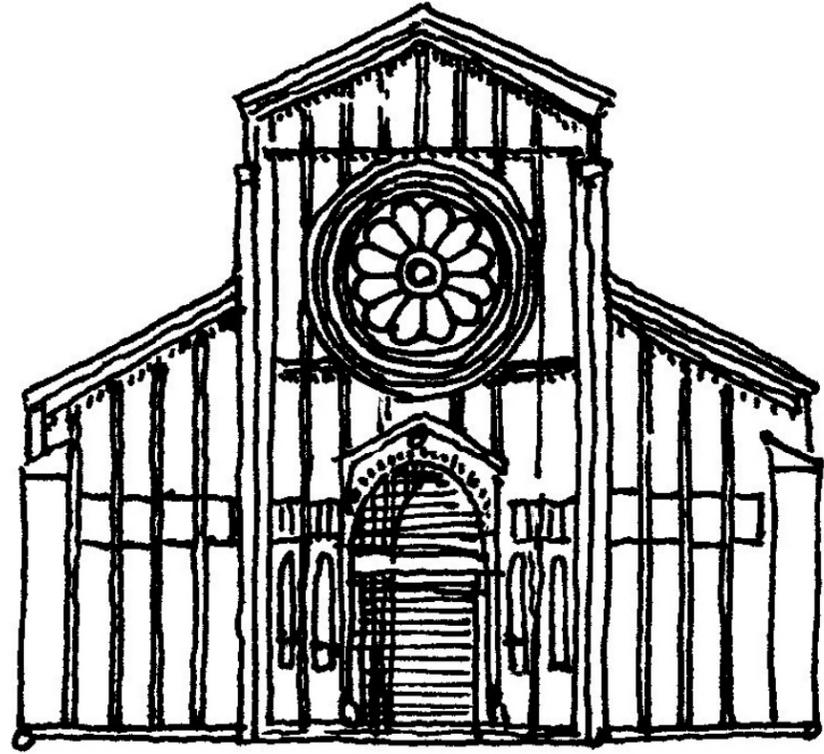
THE TRIANGLE



Old Chinese ideogram for mountain: Triangles represent stability; hence, in ancient Chinese, mountain is signified by three triangles.

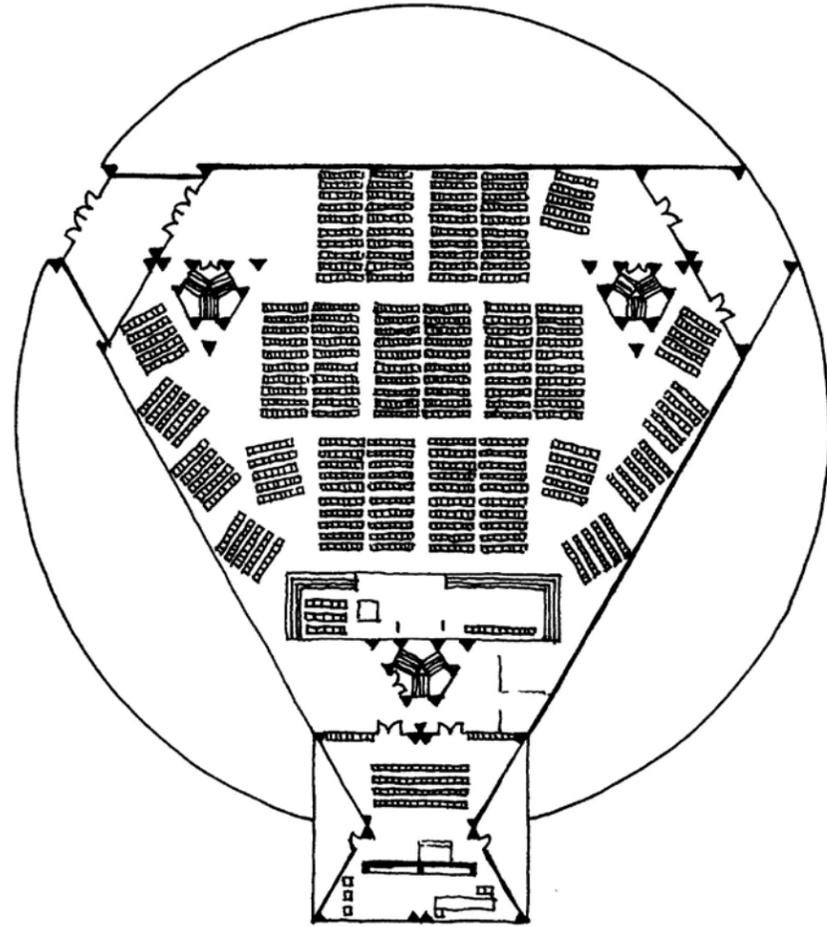


The Statue of Apollo of Tenea is an example of a harmonious structural scheme, which shows that triangles appear many times in human body composition.

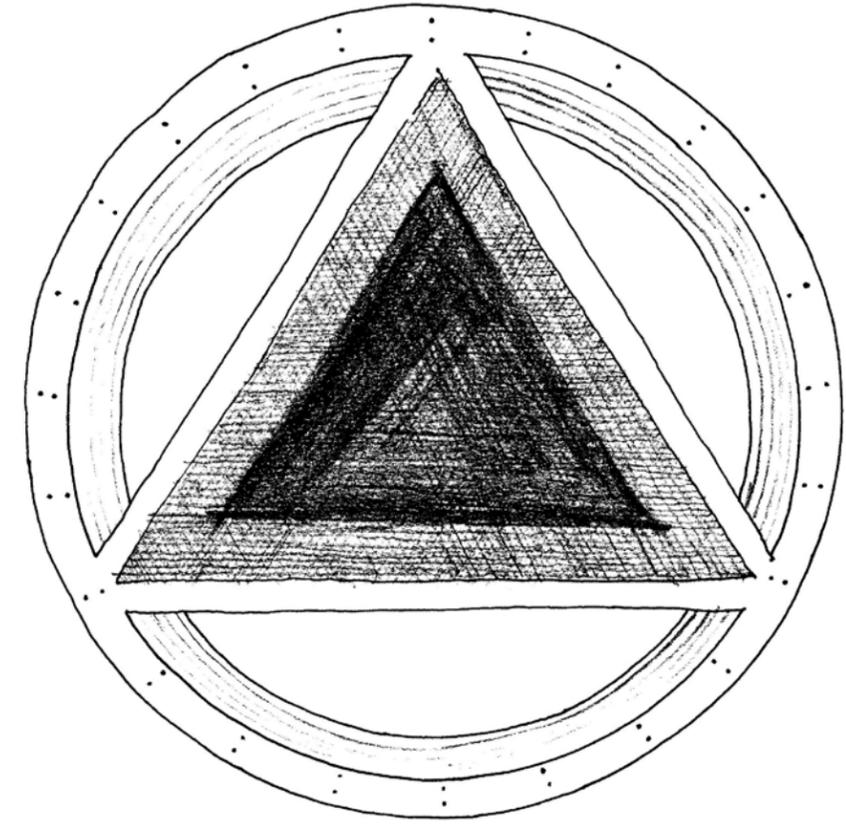


Drawing of the facade of San Zeno Church in Verona and a diagram of its harmonious structural layout.

THE TRIANGLE

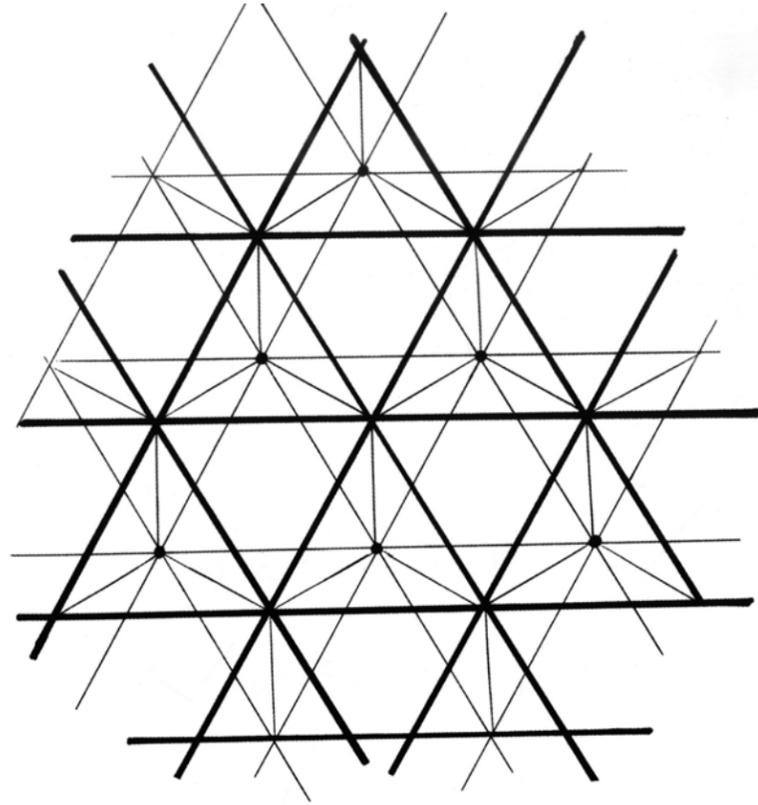


Mikveh Israel Synagogue
Louis I. Kahn

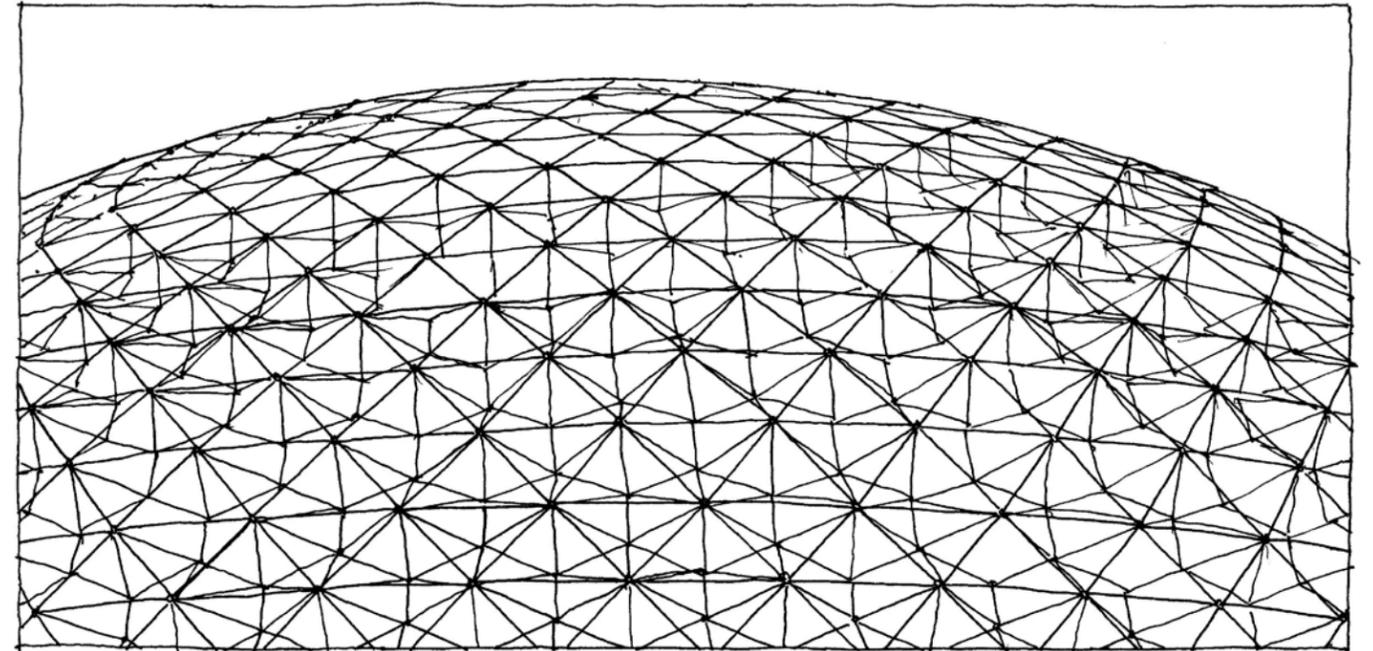


Yale Art Gallery
Louis I. Kahn

THE TRIANGLE

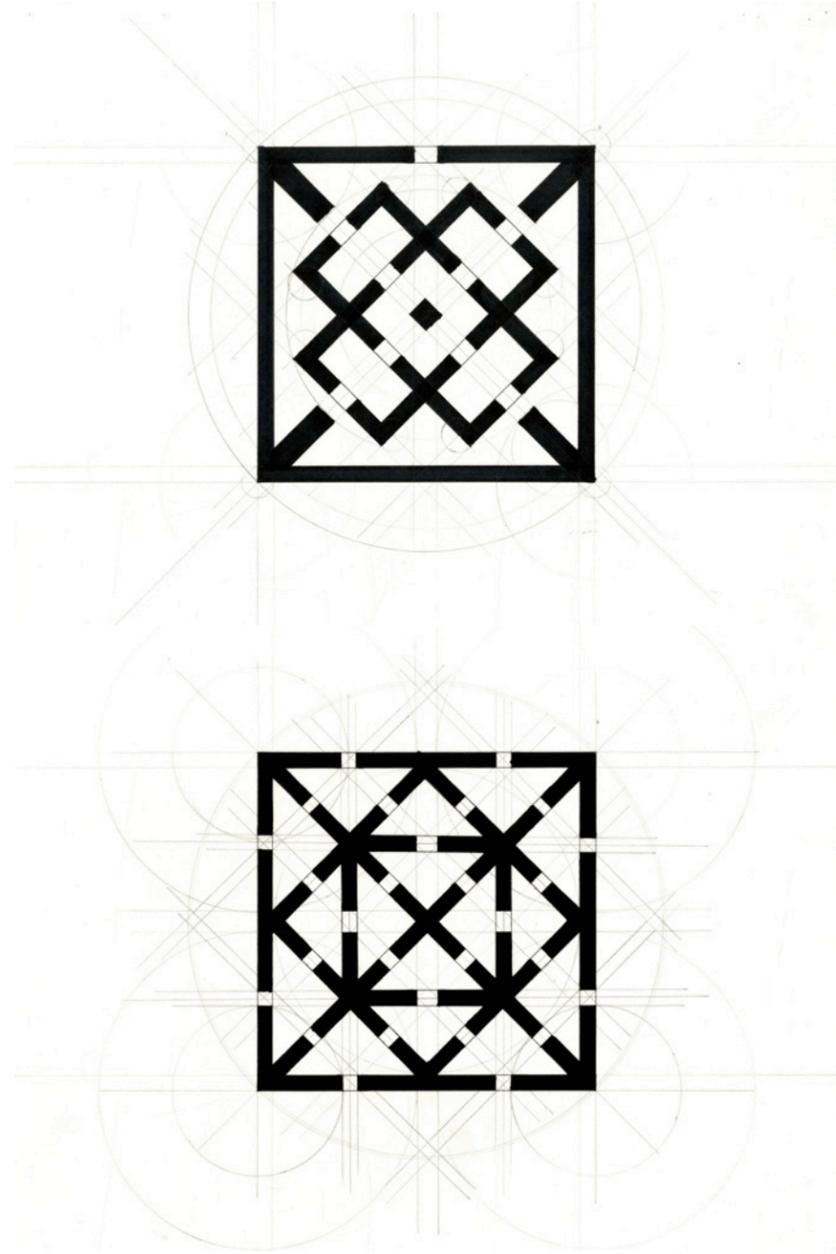


Three-dimensional grid
The grid is composed of two overlapping planes of equilateral triangular structures. This is the most solid three-dimensional grid that can be constructed to form a bearing plane.

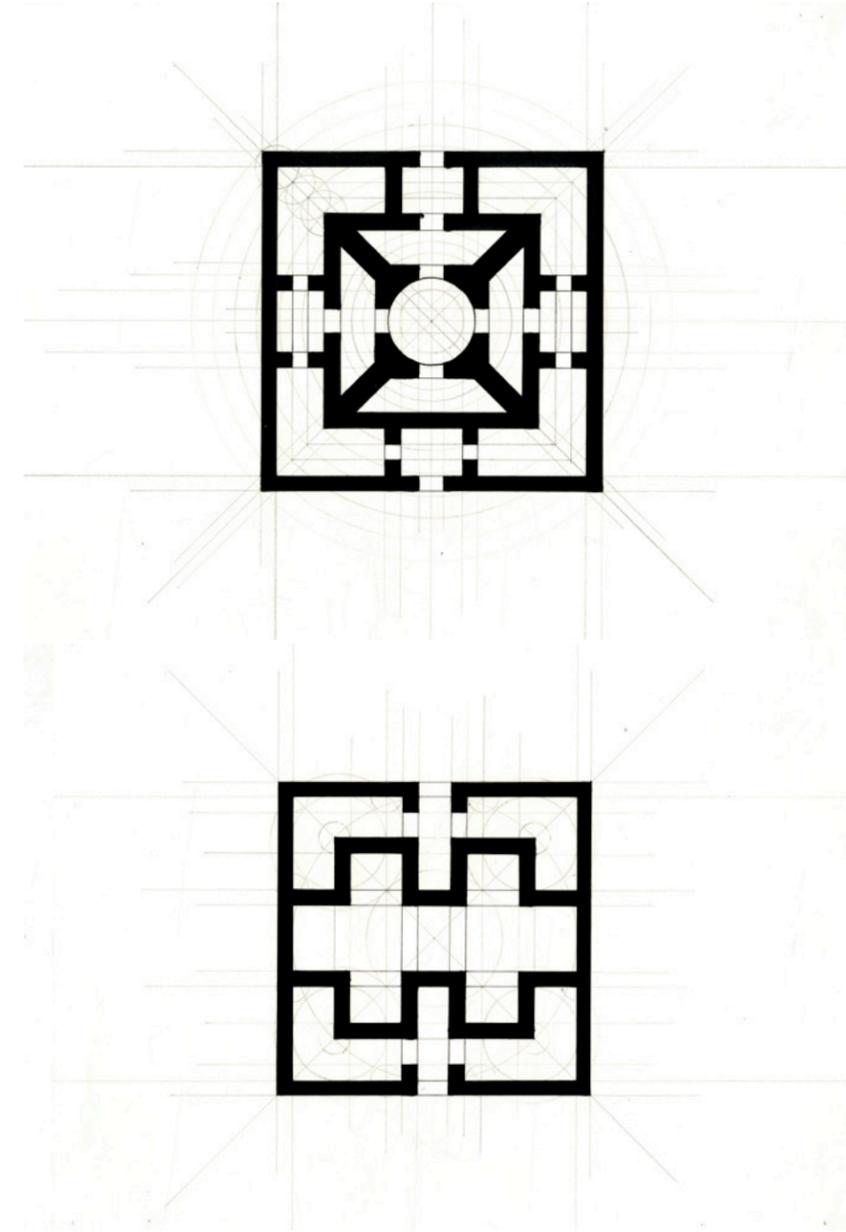


Giant dome for the Montreal Expo. The entire structure is composed of a double triangular grid. Buckminster Fuller, 1967.

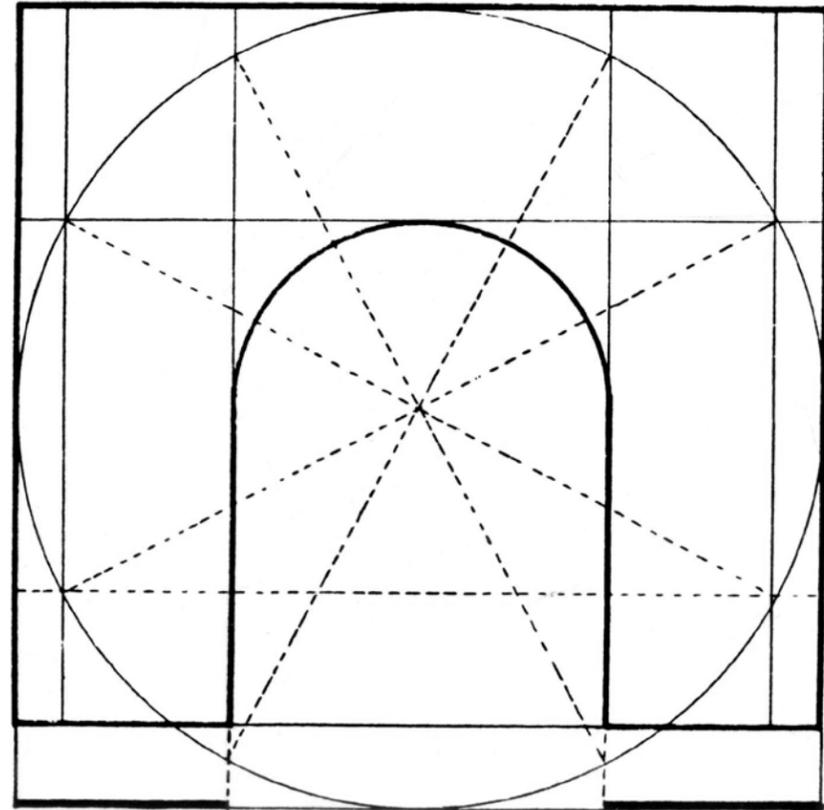
CASE STUDY : GEOMETRY PATTERN



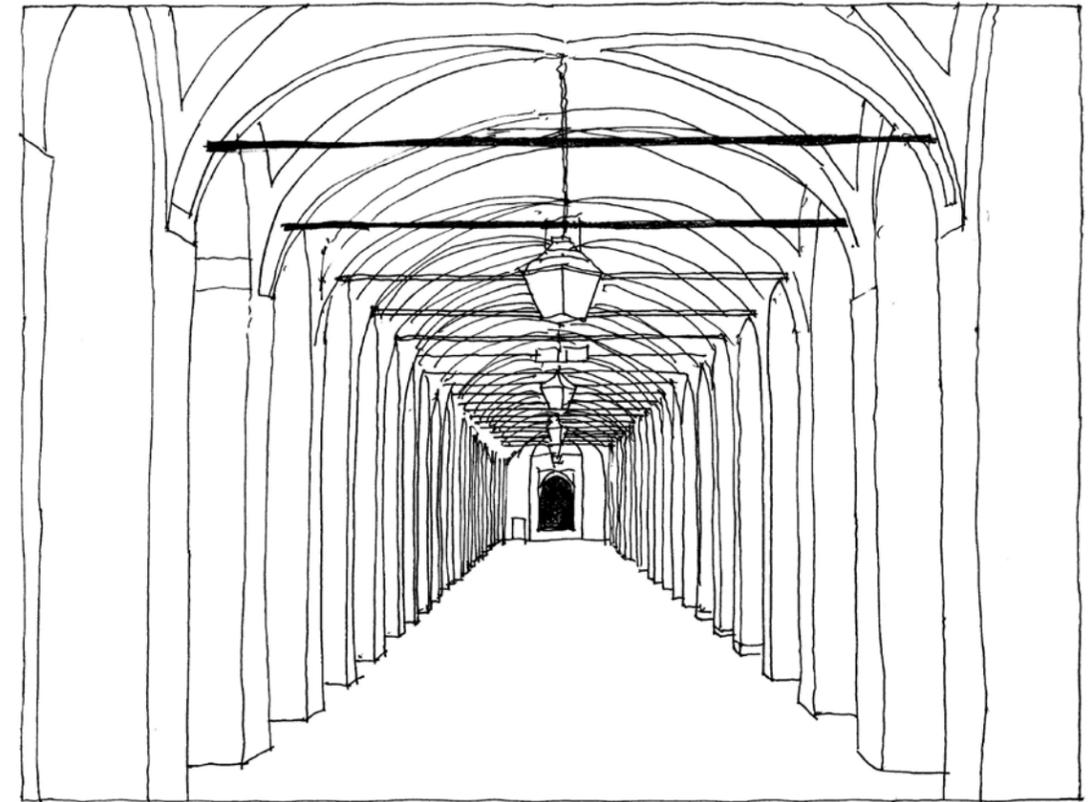
In classical architecture, a large number of classical geometric shapes are applied in plans, elevations and spatial sequences of architectures.



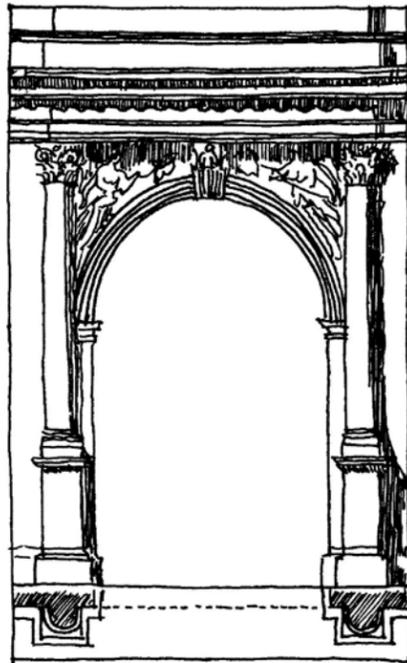
Geometry plays an important role in classical architectures. As a result, I drew these four drawings based on circles, squares and triangles.



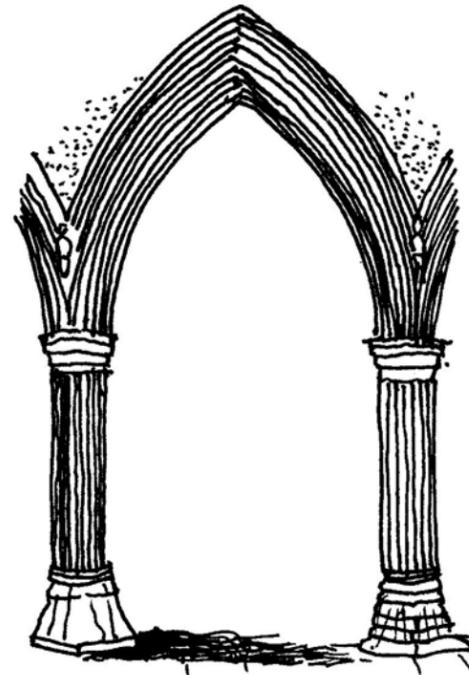
Proportions of Septimius Severus Arch in Rome.



The arch is one of the Romans' greatest achievements. In addition to good load-bearing characteristics, its appearance is often considered beautiful.



Semicircular arches are an important feature of Roman architecture.

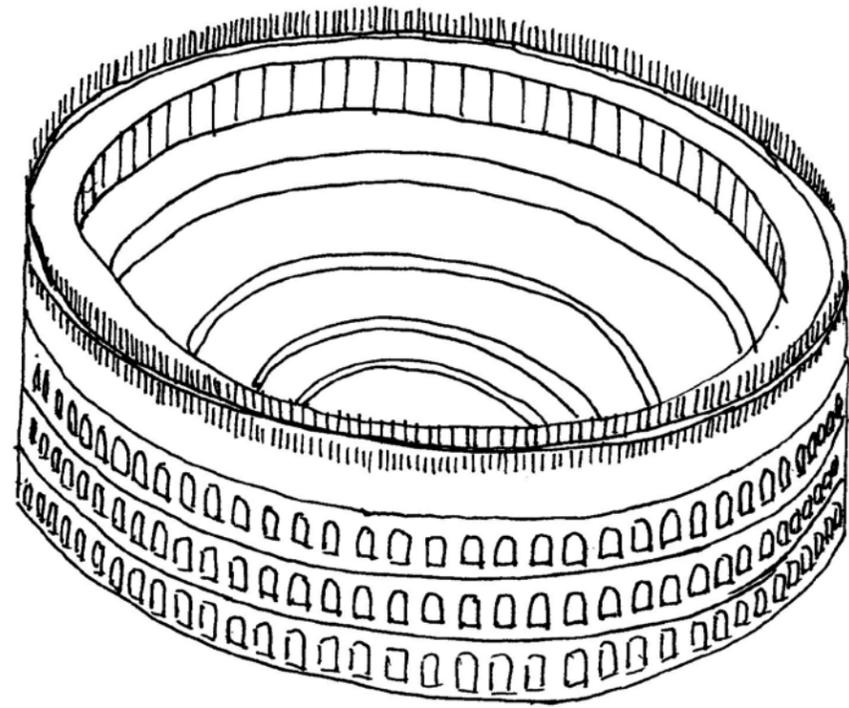


Ogive arch is a obvious sign of Gothic architecture.

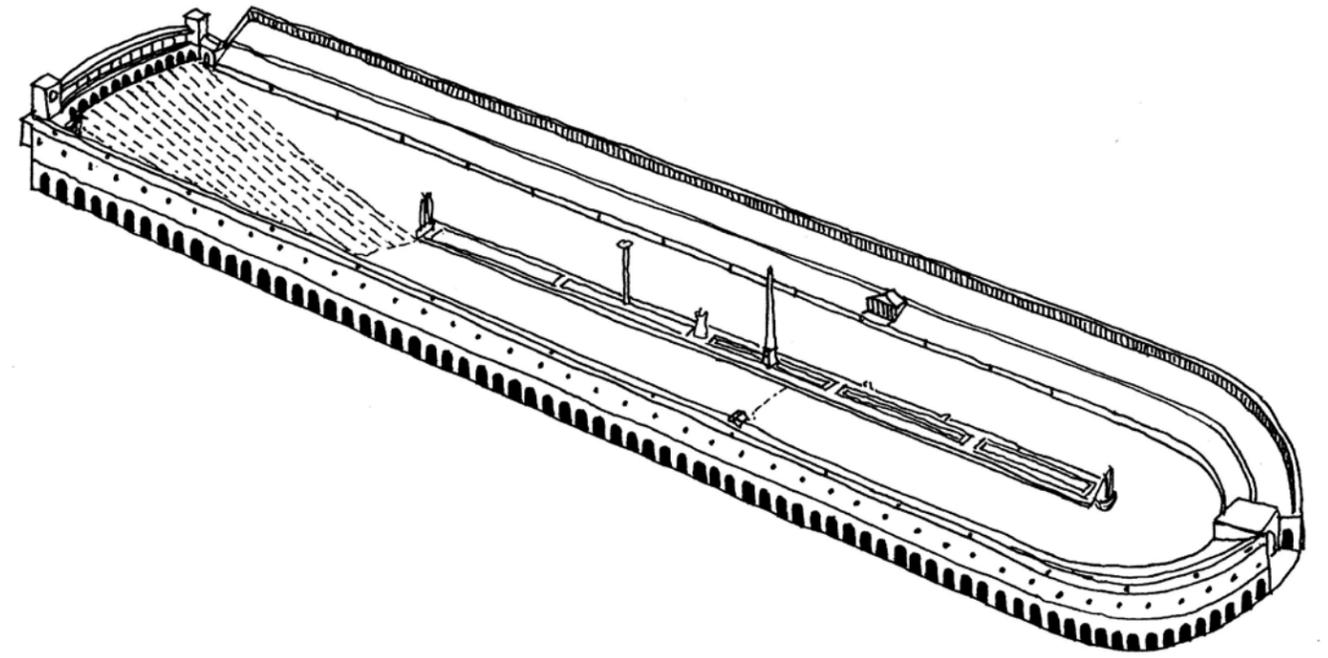


Arches for Islamic architecture are pointed, horseshoe, trilobal and so on.

THE COLOSSEUM



The Colosseum is a representative of the architecture of ancient Rome, and a symbol of ancient Roman civilization. Arches are widely used in the Colosseum.



The Hippodrome of Constantinople is a Roman arena, it was the social and sports center of Byzantine Empire. In 330 AD, the emperor built it for chariot races. The horse race was U-shaped and emperor's grandstand was at its eastern end.



The horse was tamed 4000 years ago. In ancient times, horses made outstanding contributions to agricultural production, transportation and military activities. In order to be precise in battlefield, horses were often trained in various techniques and coordination, later this training was developed into equestrian events.

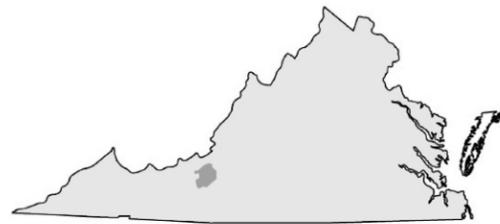


Nowadays, many people still love riding horse. Therefore, I chose the horse as the pragmatic and programmatic starting point for my thesis. The building program merely serves as the vehicle for searching for the essence of classical architecture and classical geometric relationships. As a result, the three principles of good architecture---Durability, Utility and Beauty served as the basic structure for the design of this facility.

THE SITE



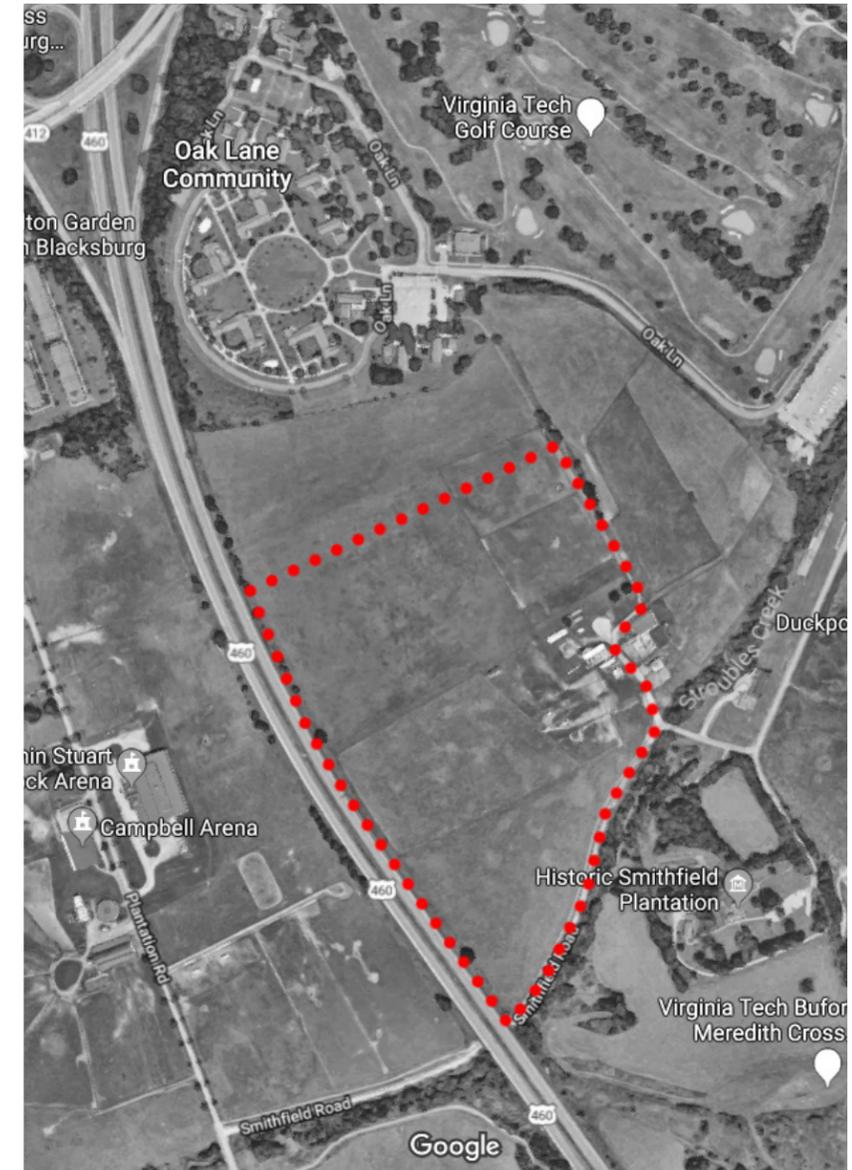
America



Virginia



Blacksburg



The site is in Blacksburg, adjacent to road 460, which was originally a ranch with fertile pastures. The site is close to Virginia Tech which has more than 30,000 students and faculty members with a large branch of agricultural and farming related research including animals such as cows and horses. A well-designed horse facility with a proper horse stable could attract many people to ride horses and learn about horse culture.

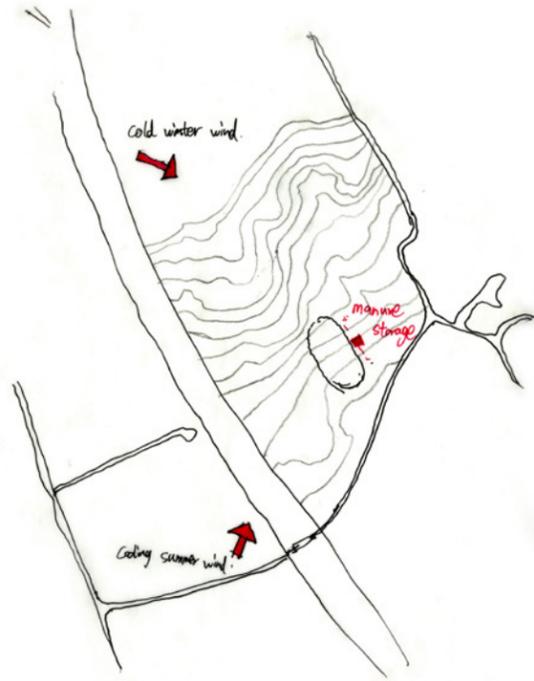
THE SITE



SITE PLAN



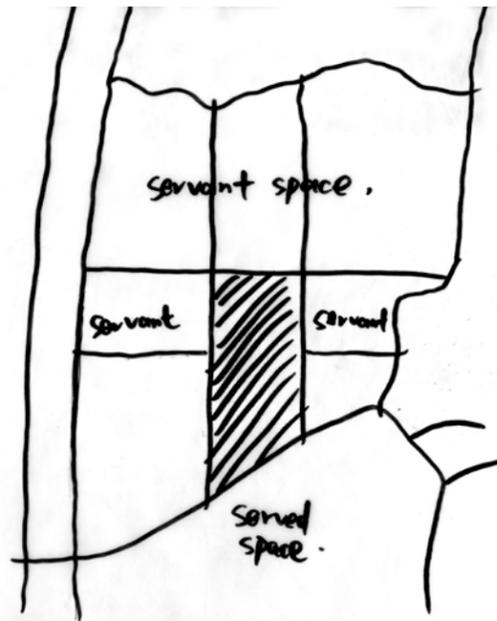
Route Analysis



Wind Analysis



Zoning plan

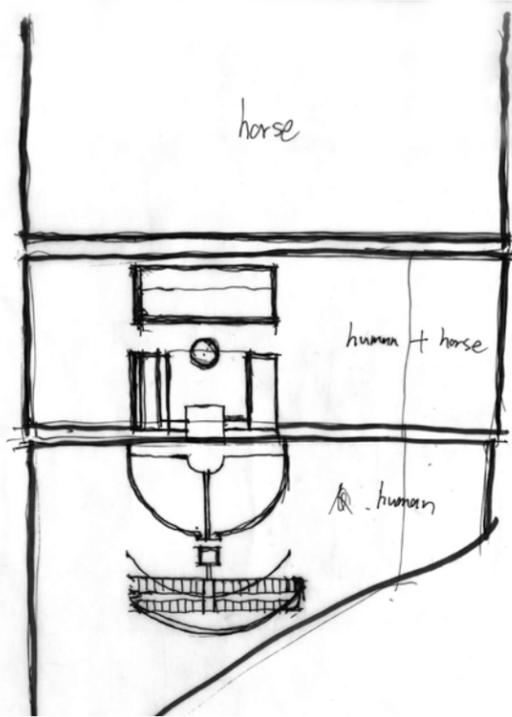


Servant and served space

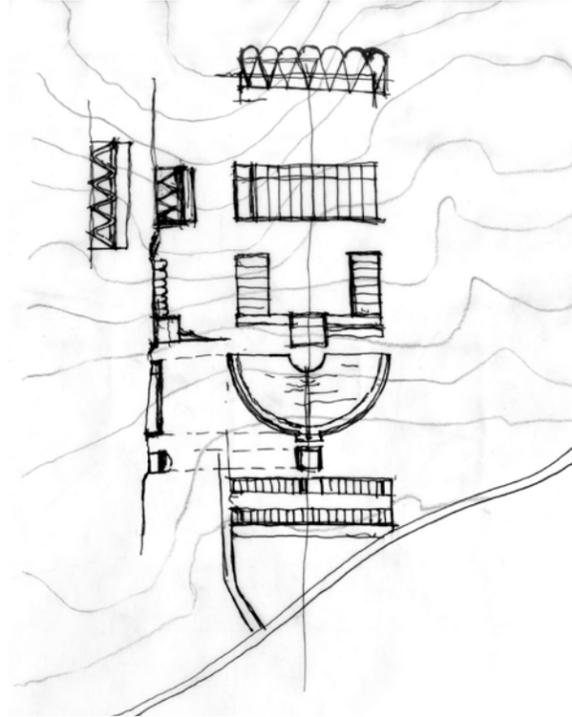


Based on different functions, the site was divided into three parts: southern part is for people, mainly used as parking place. Middle part is for horse and people, which include horse stable, indoor arena and outdoor training space. Northern part is for horse, where is mainly consist of pasture.

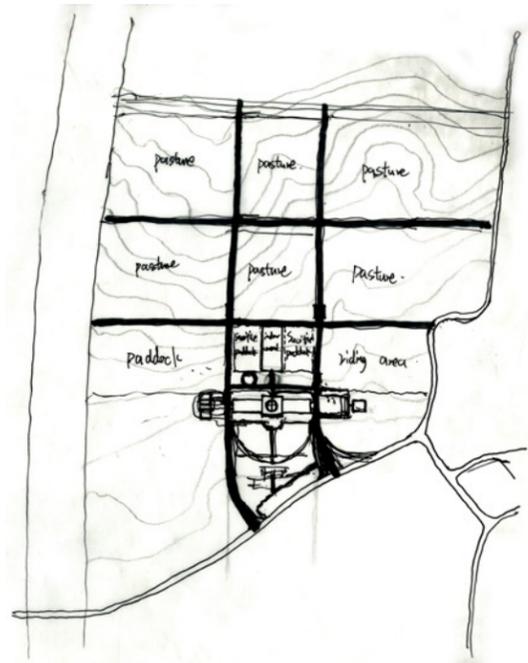
SITE PLAN



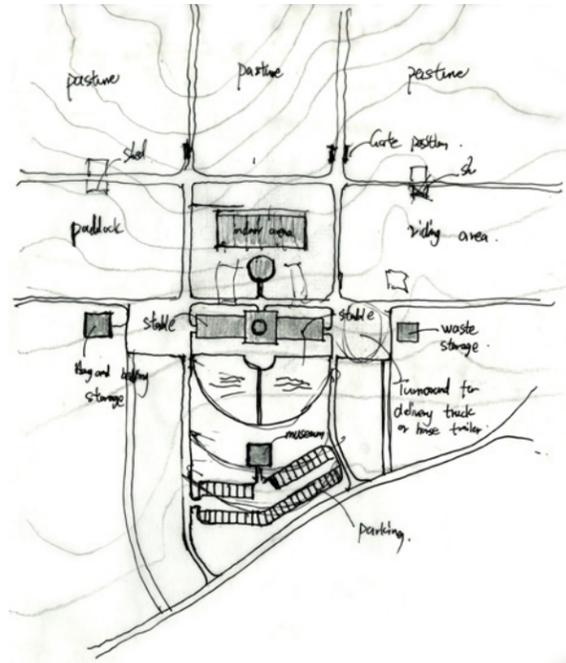
Buildings layout



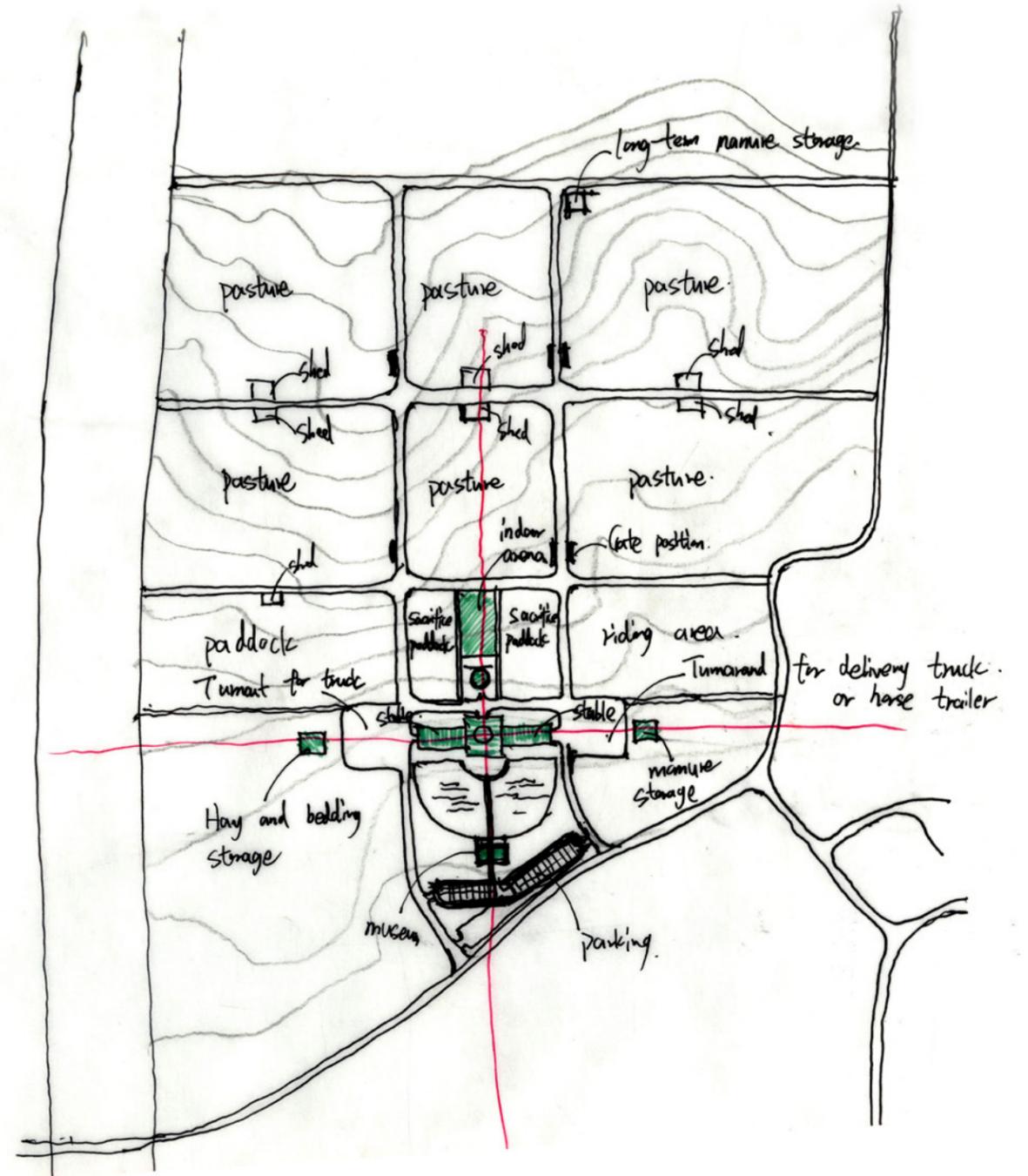
Buildings layout



Classification of site

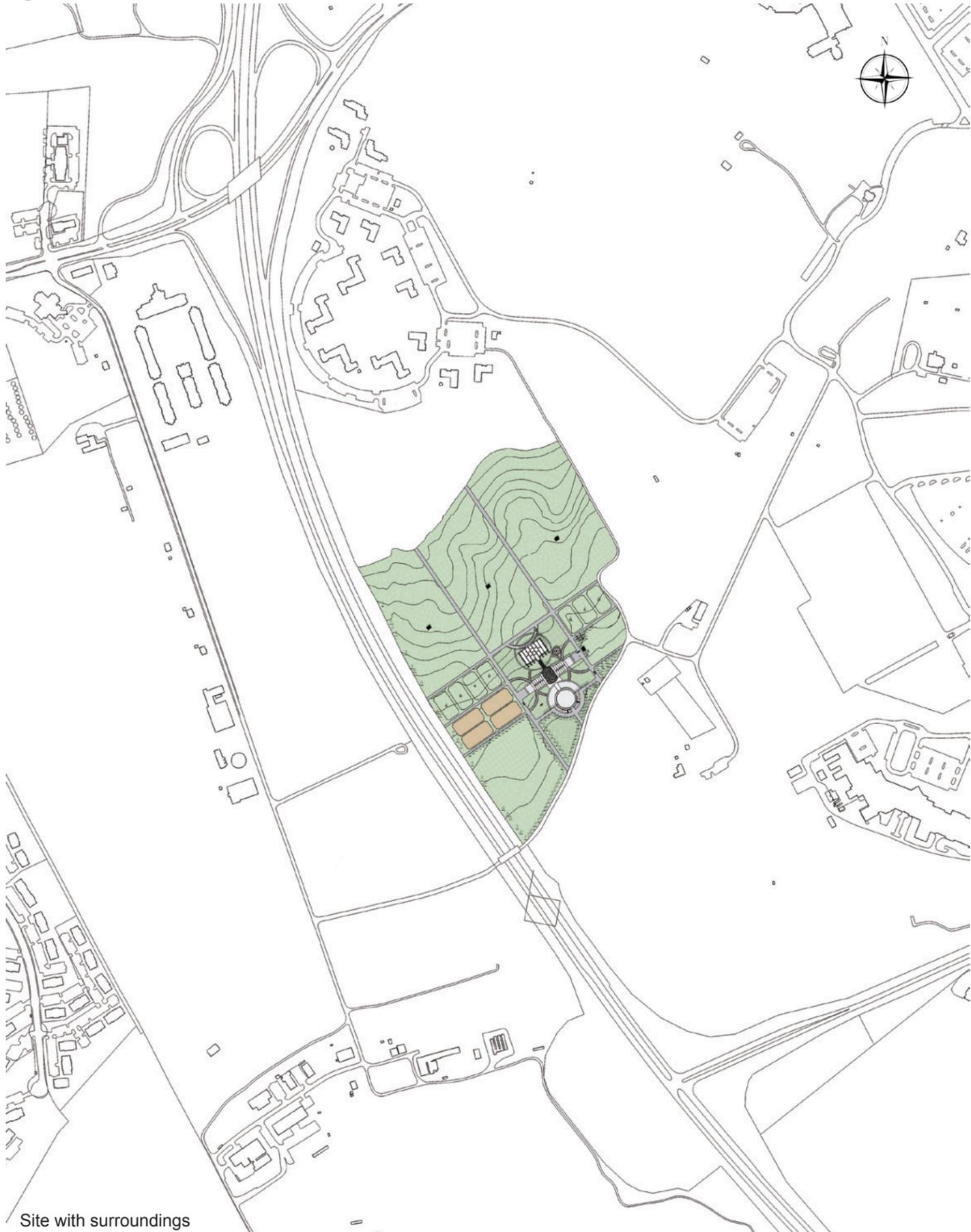


Classification of site

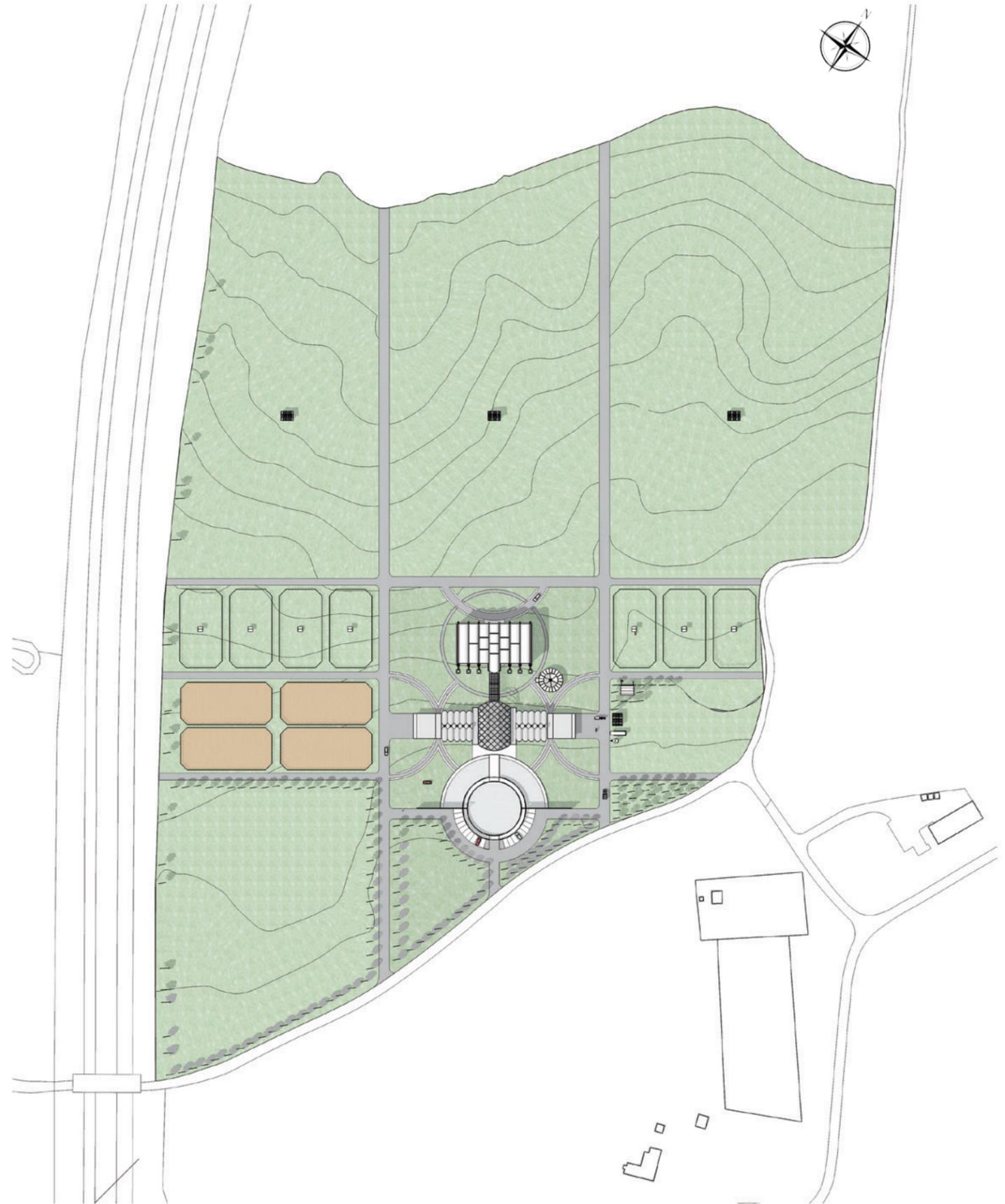


Subdivision of the site according to different functions, serves as the prototype of site plan.

SITE PLAN

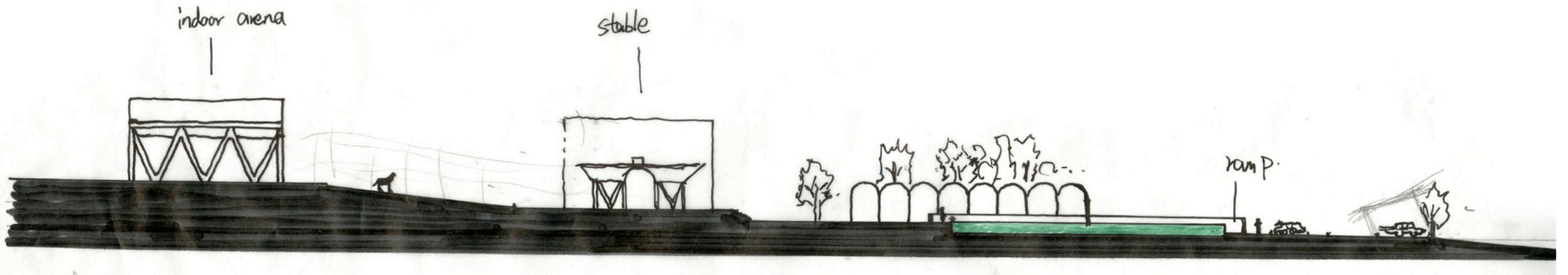


Site with surroundings



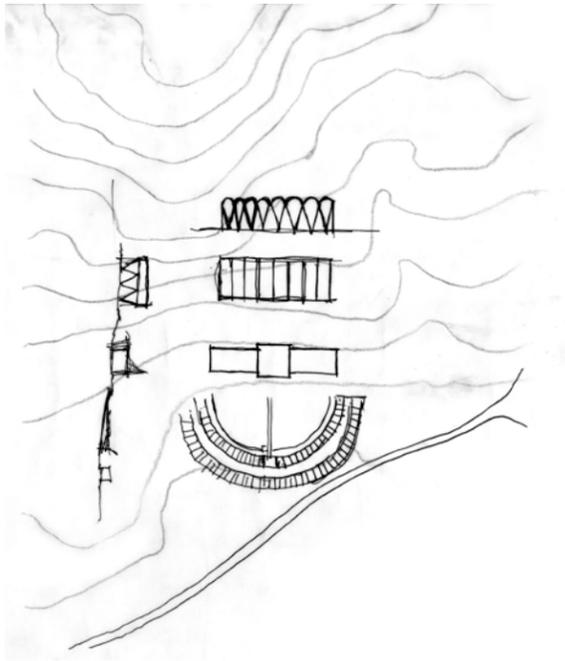
Final site plan

SITE PLAN

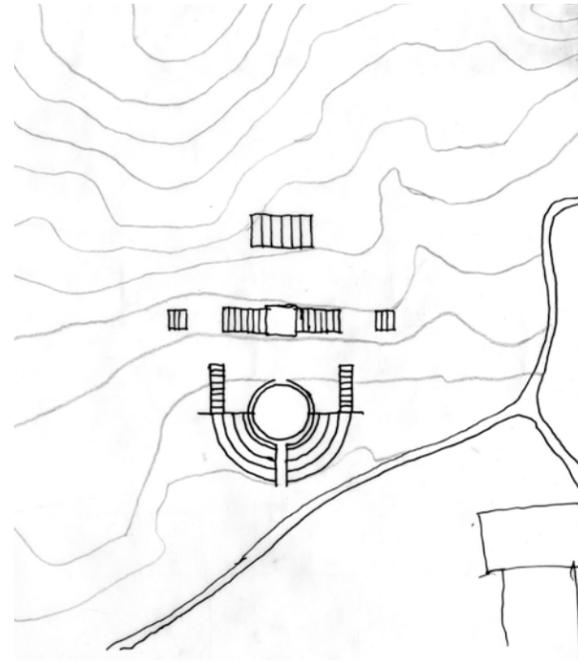


Architectural Layout

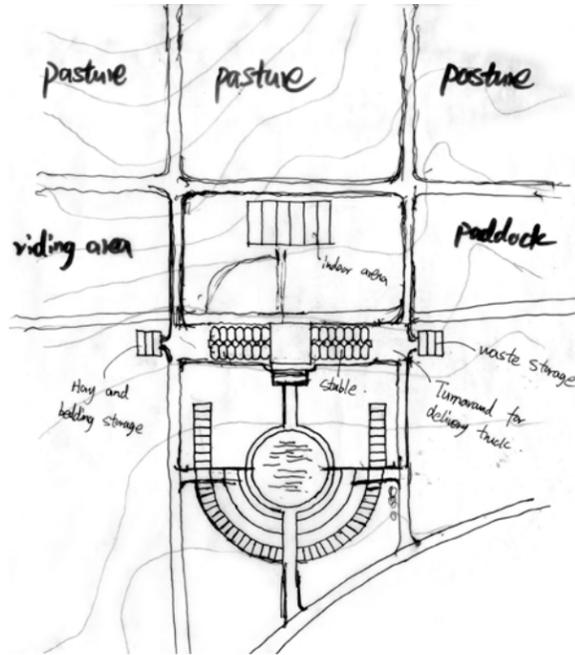
SITE PLAN



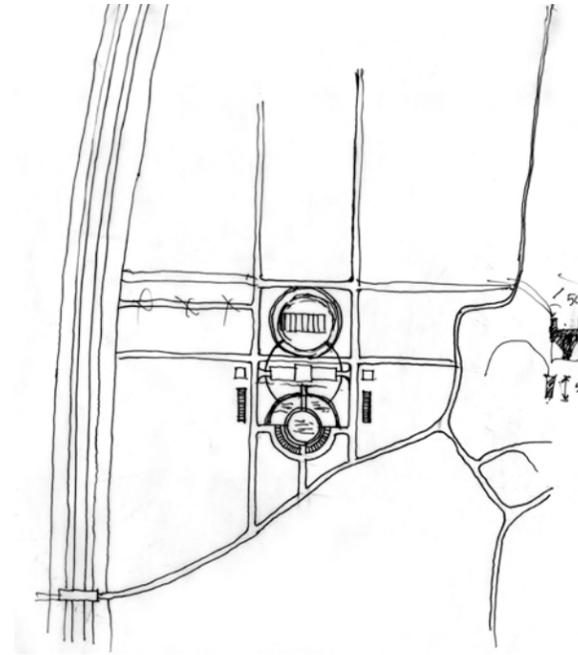
Layout of parking lot, stable of arena



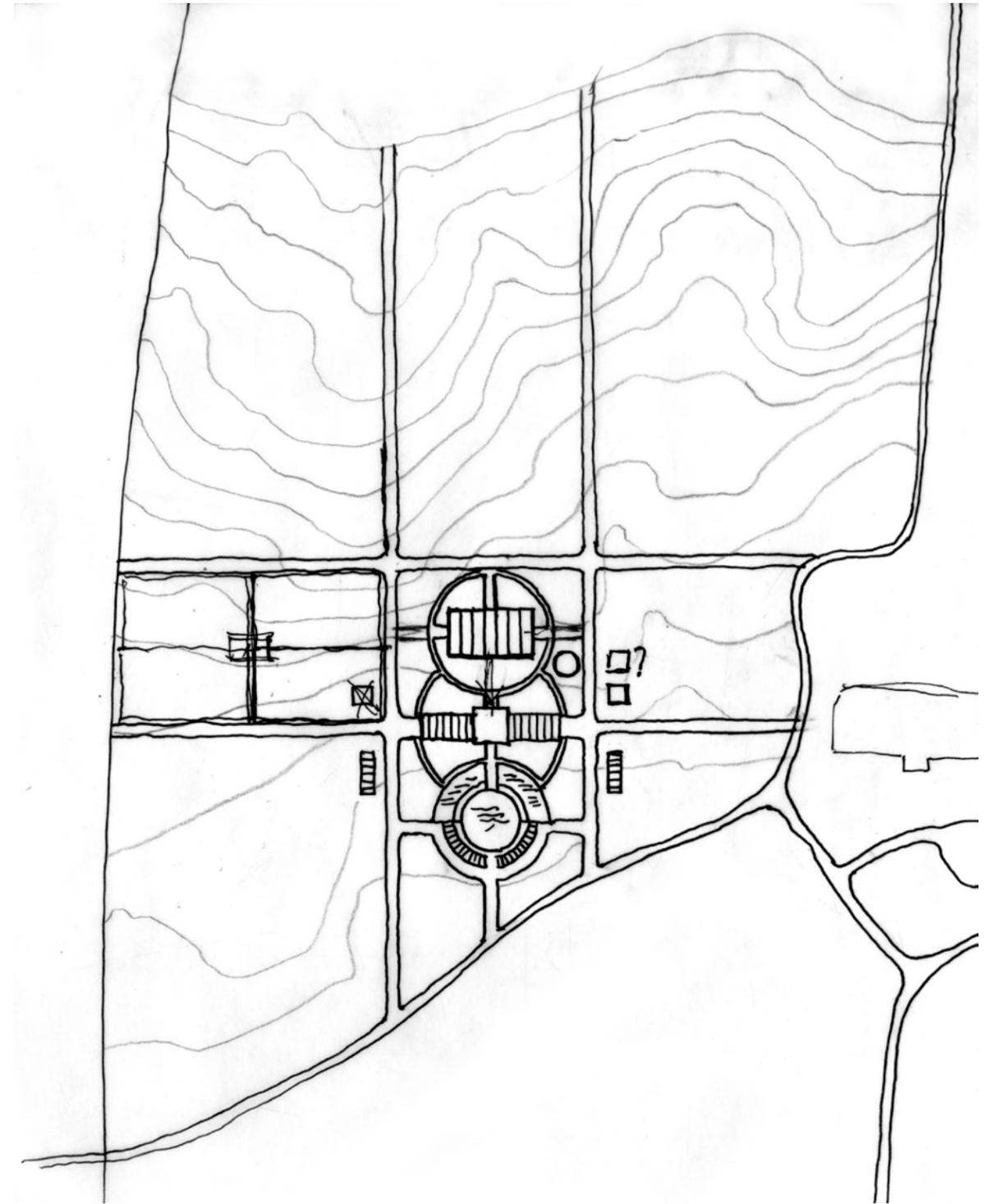
Layout optimization



Road planning

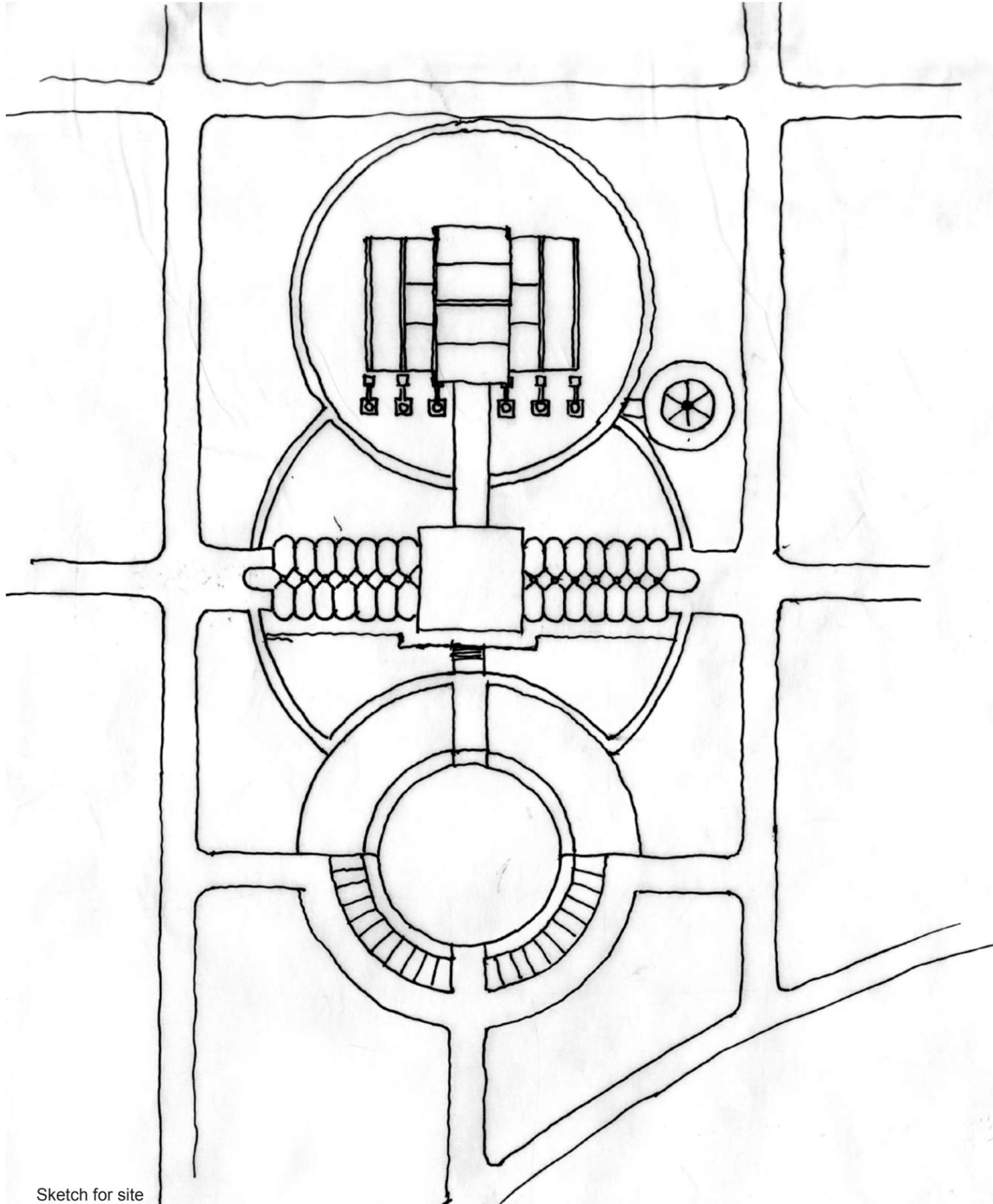


Circle elements

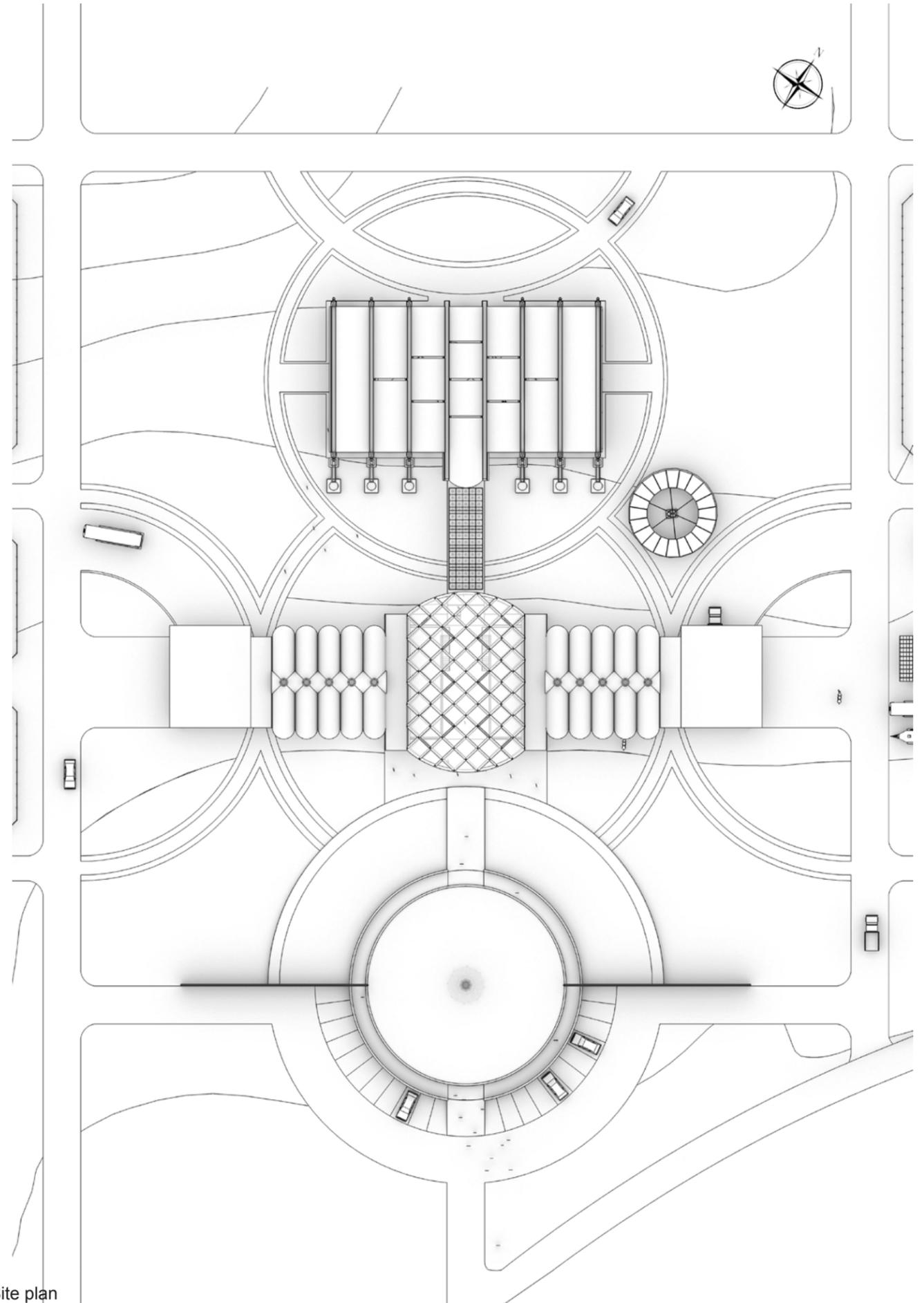


The master plan is consist of circles and rectangles: the shape of stable and arena is rectangle and they are surrounded by round paths.

SITE PLAN

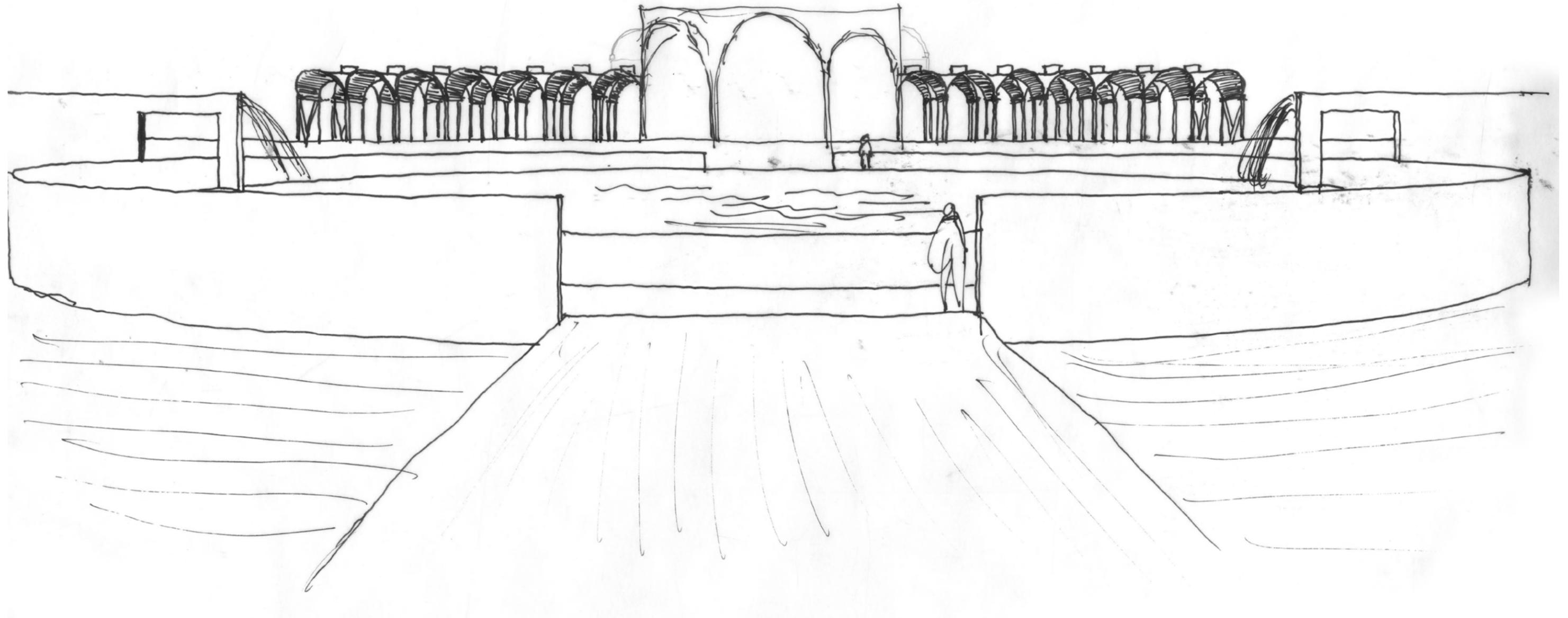


Sketch for site



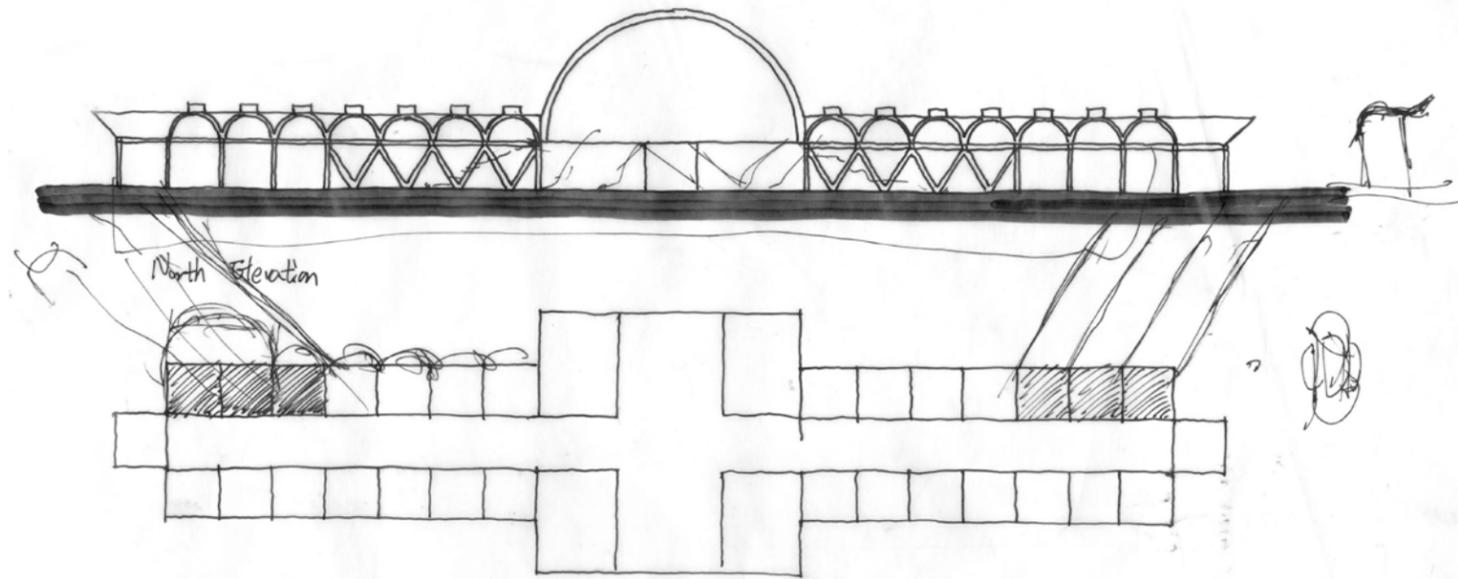
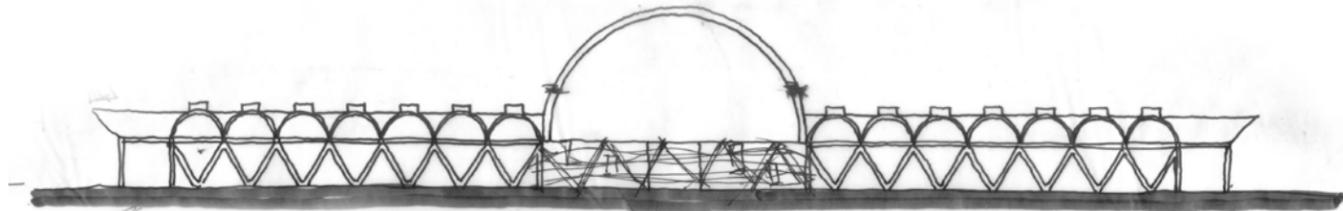
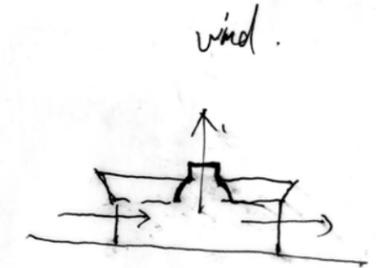
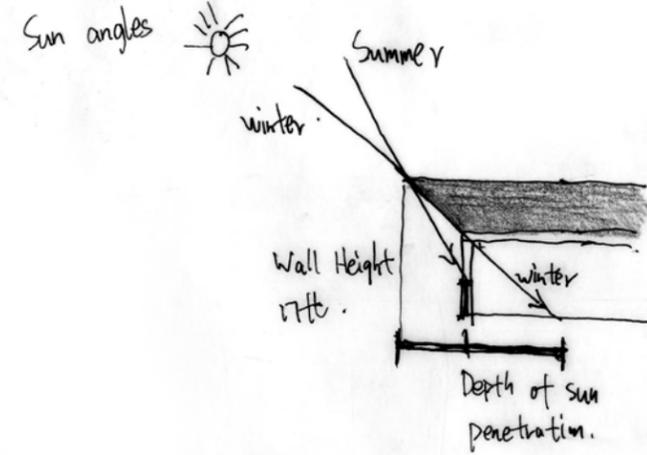
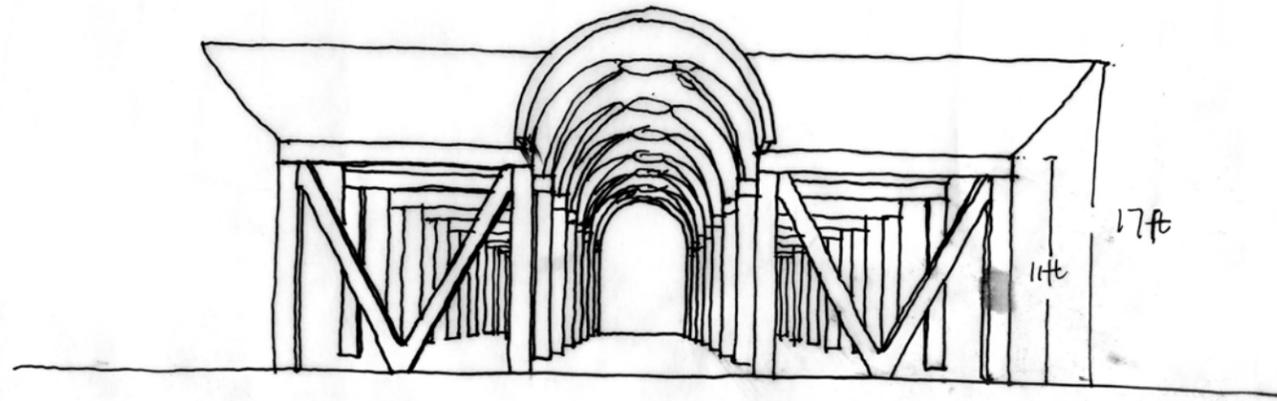
Site plan

THE STABLE



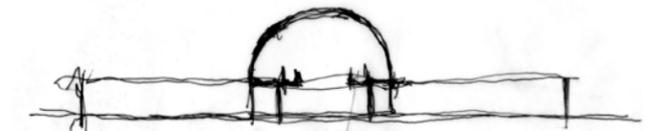
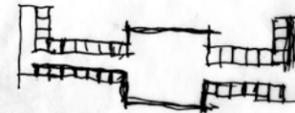
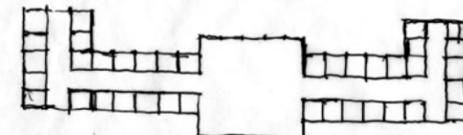
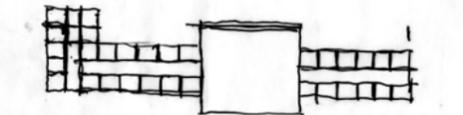
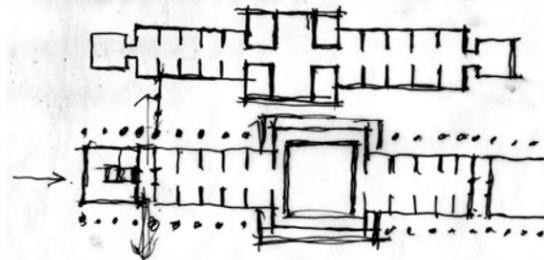
Conceptual sketch for stable

THE STABLE

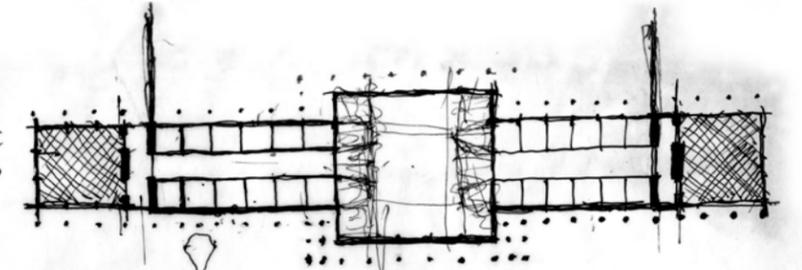


05/05/2018

Servant and served space for stable



stud
pen



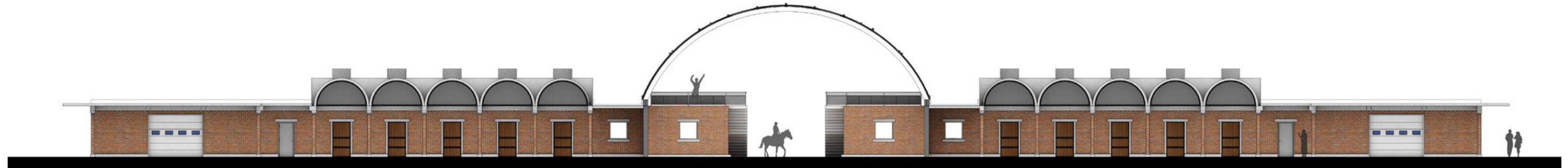
THE STABLE



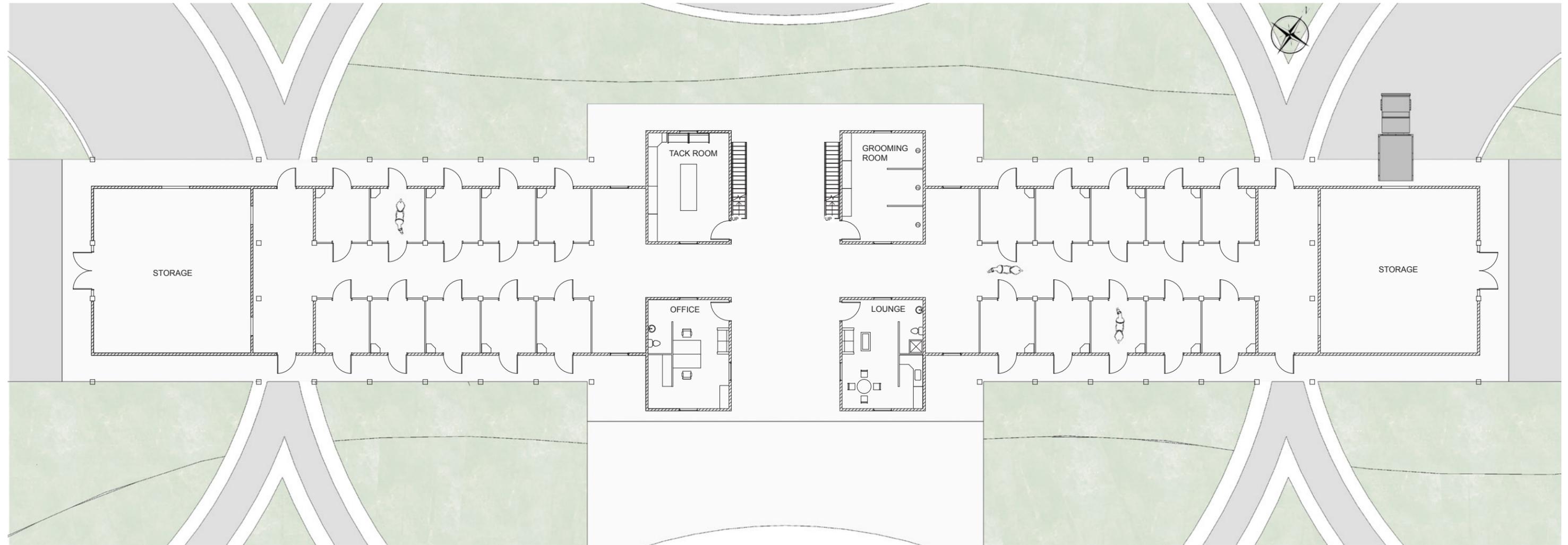
View from parking place



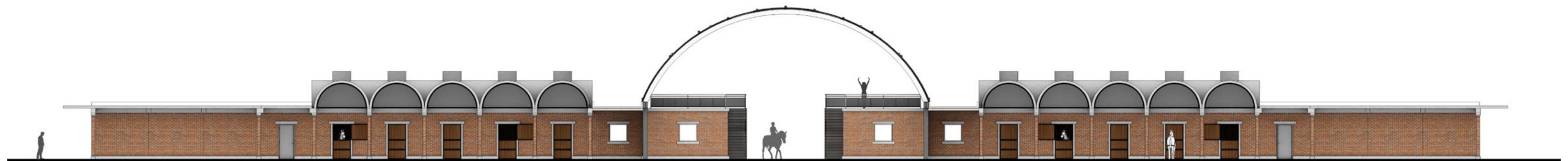
THE STABLE



North Elevation



Ground Floor Plan



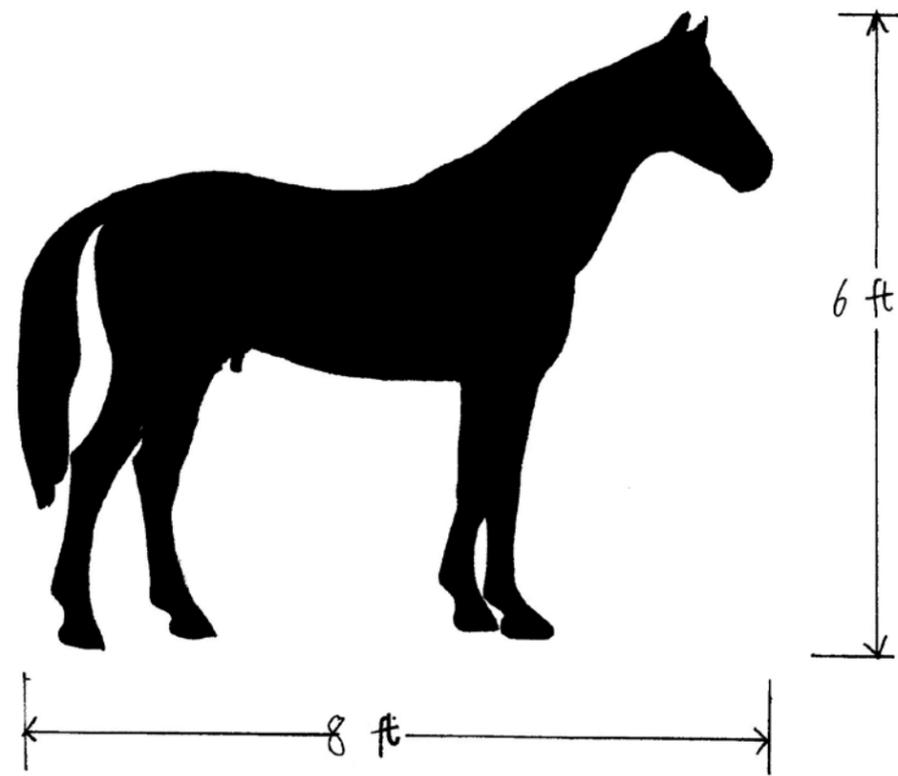
South Elevation

THE STABLE

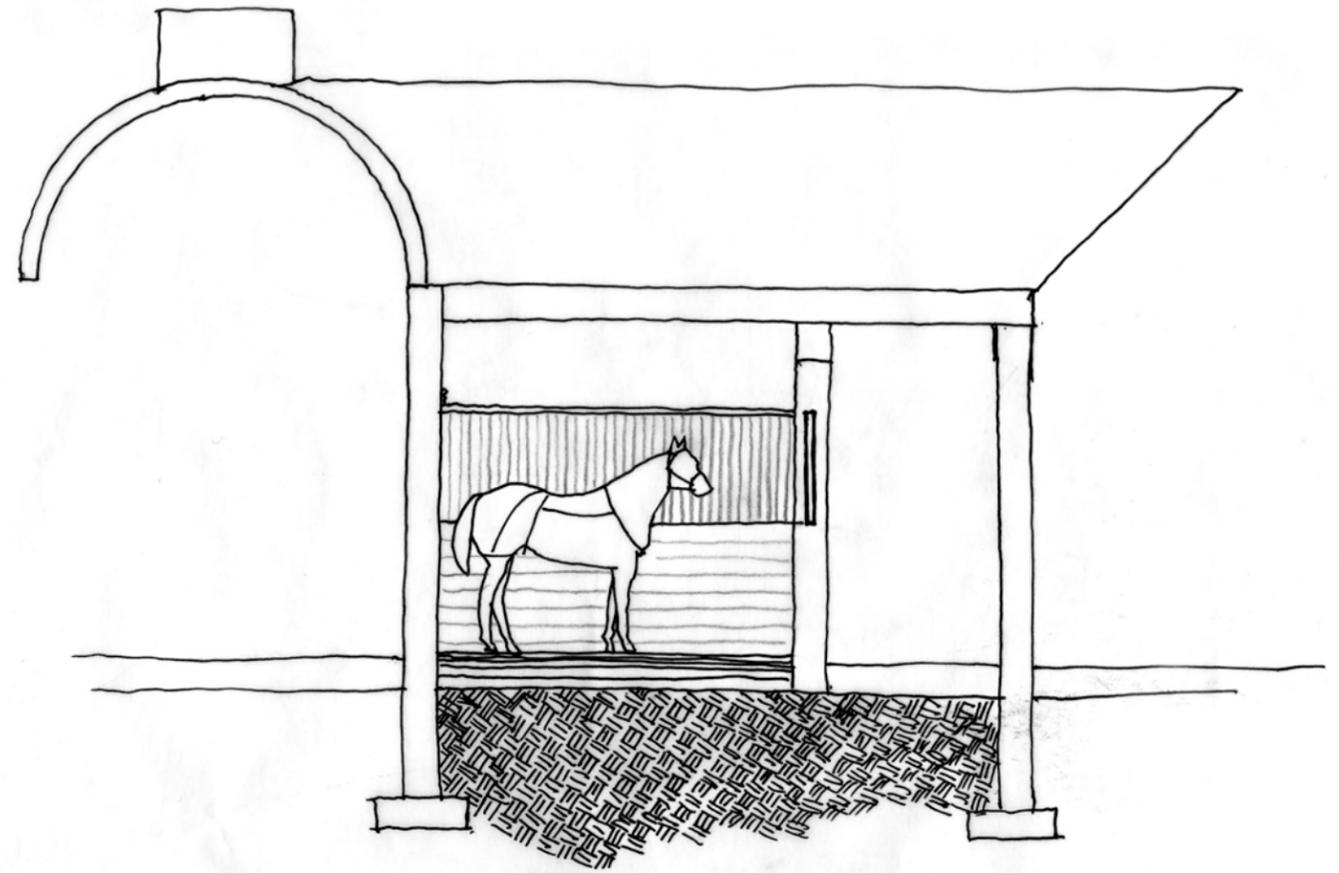


Stable Indoor Rendering

THE STABLE

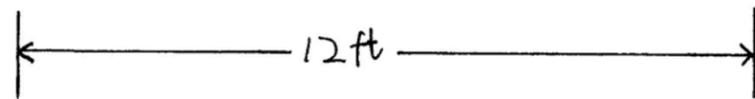
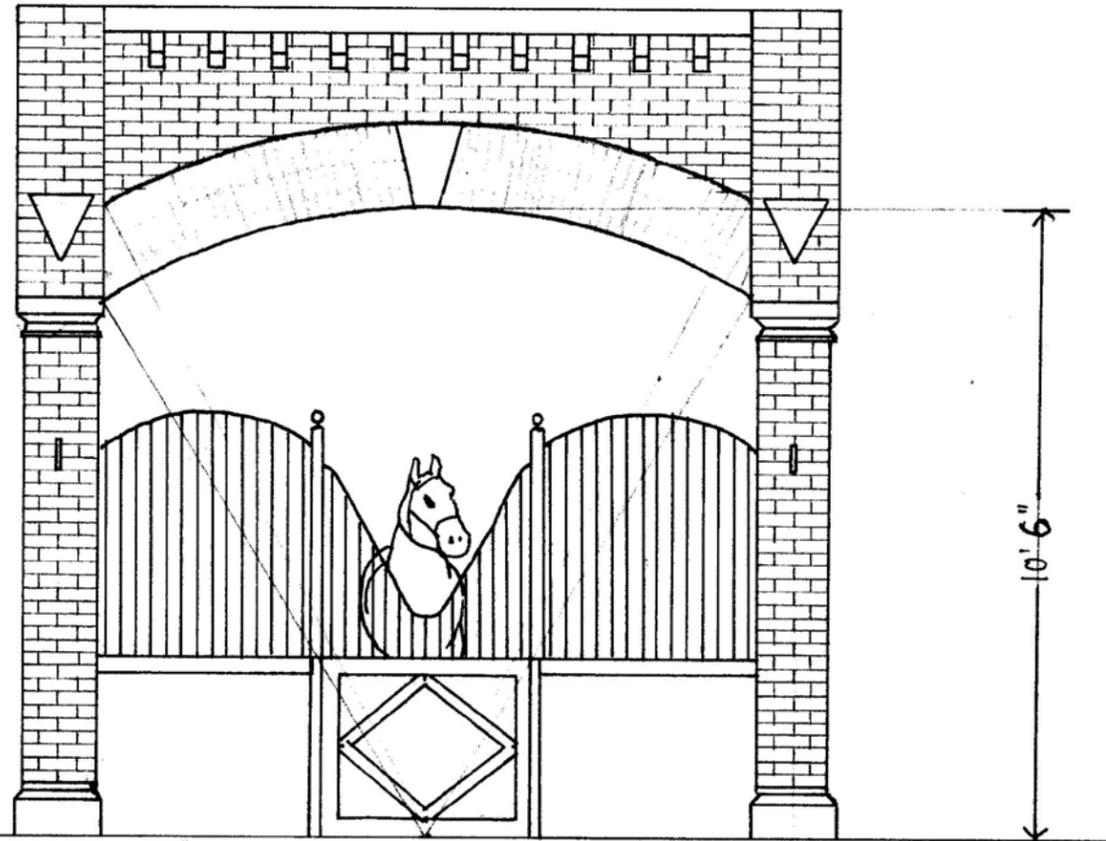


The Size of Horse

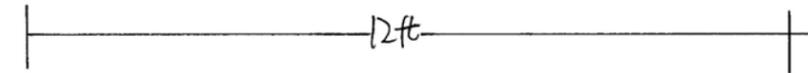
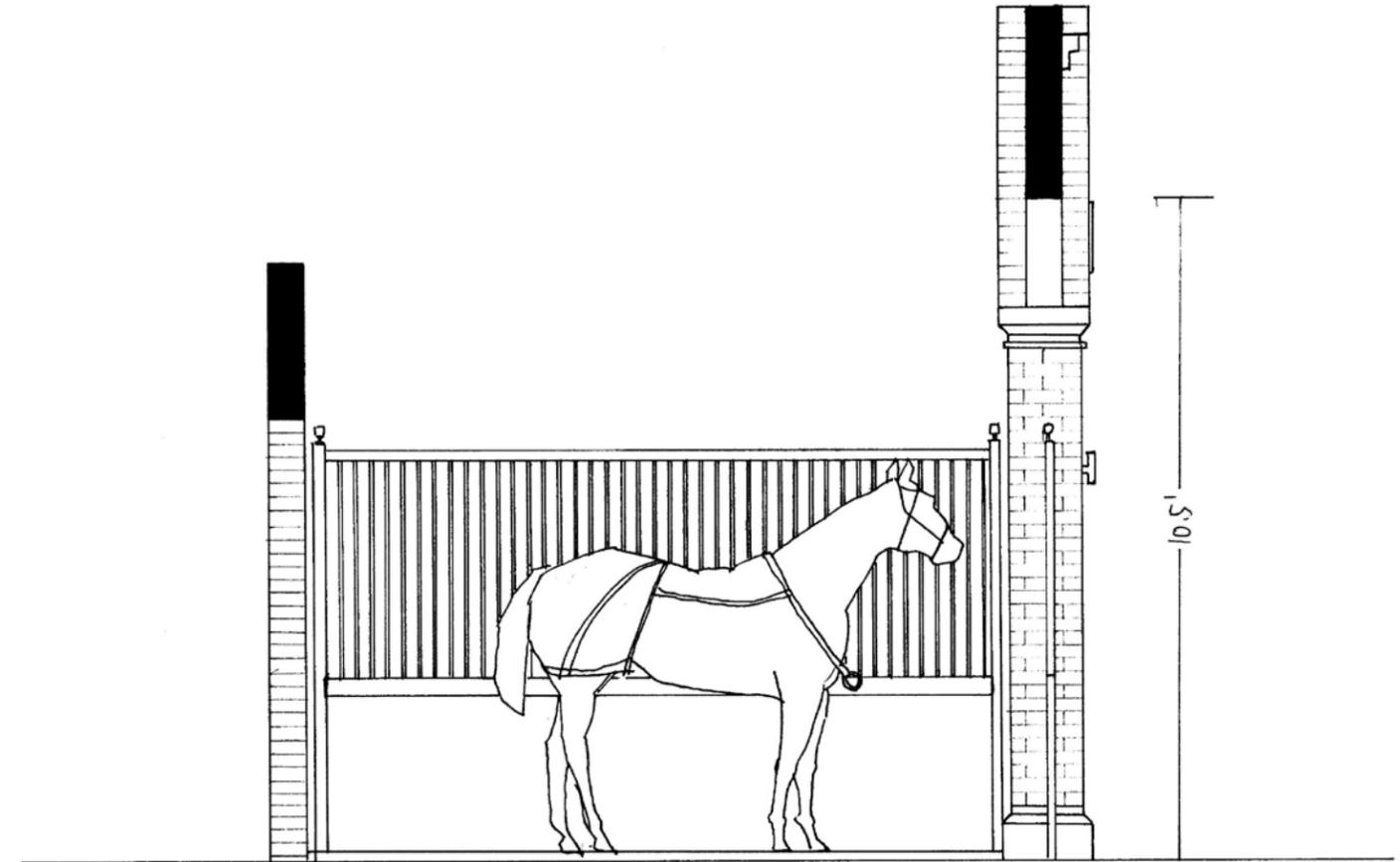


The Size of Horse

THE STABLE

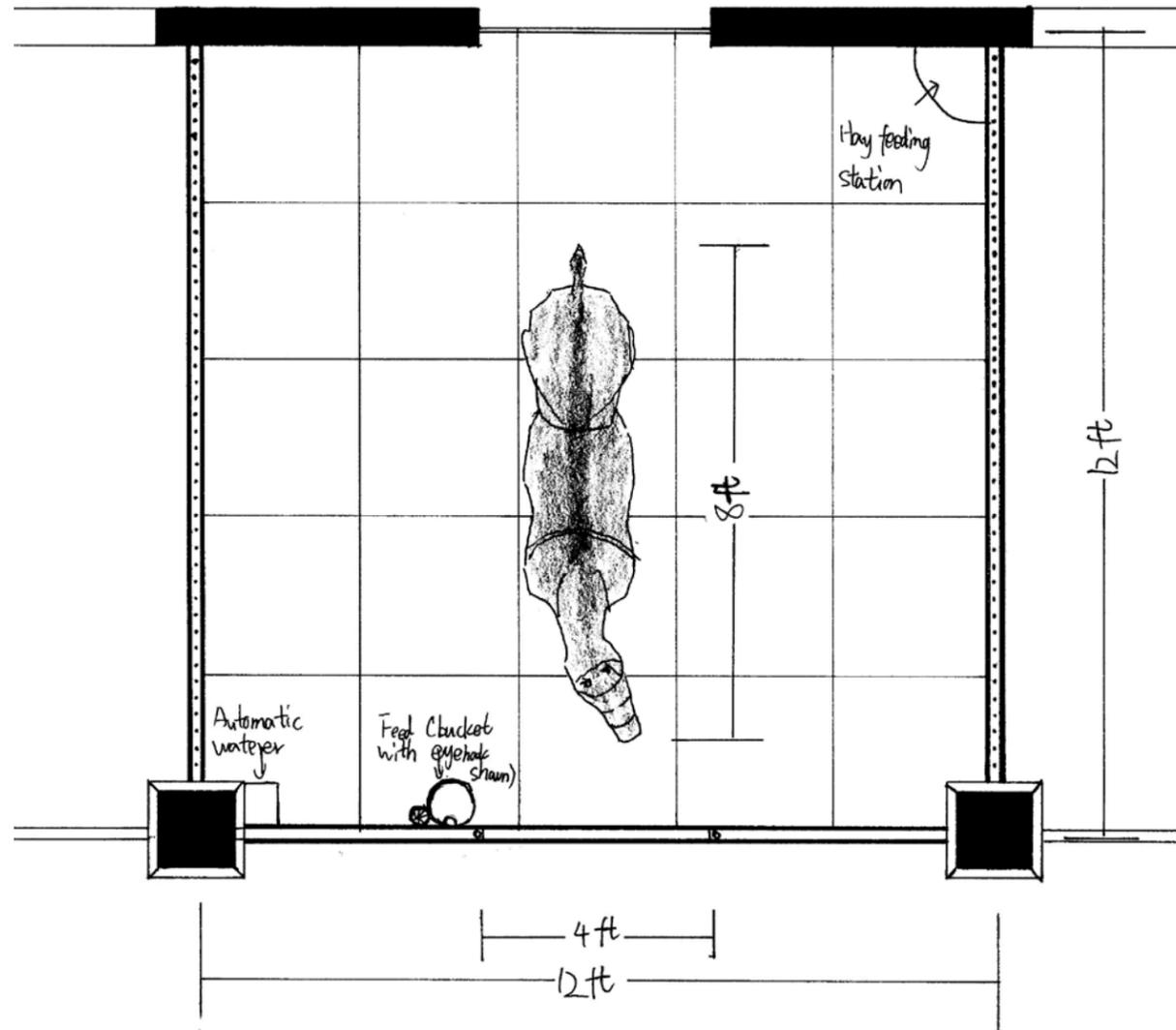


The Size of Stall

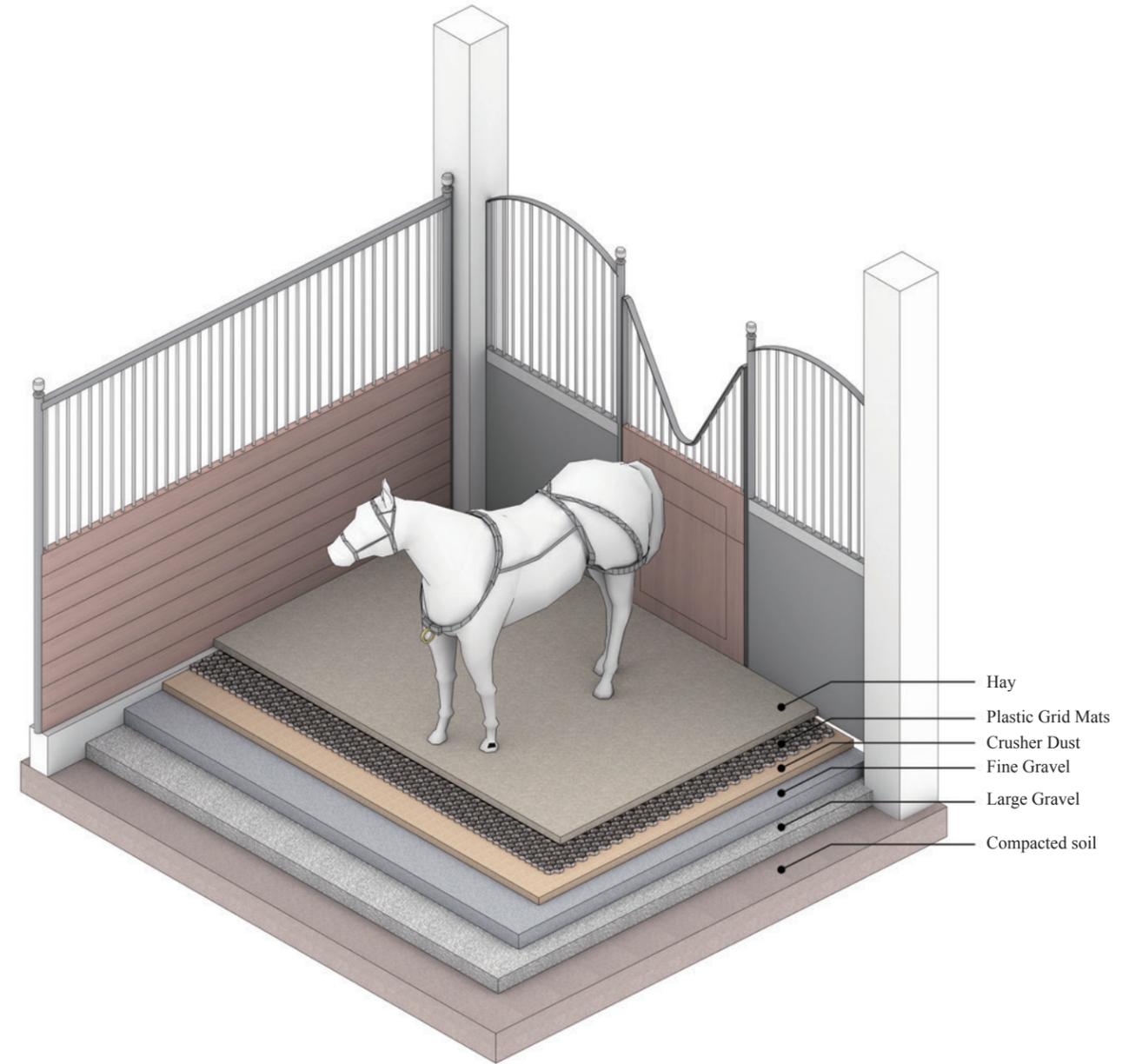


The Size of Stall

THE STABLE

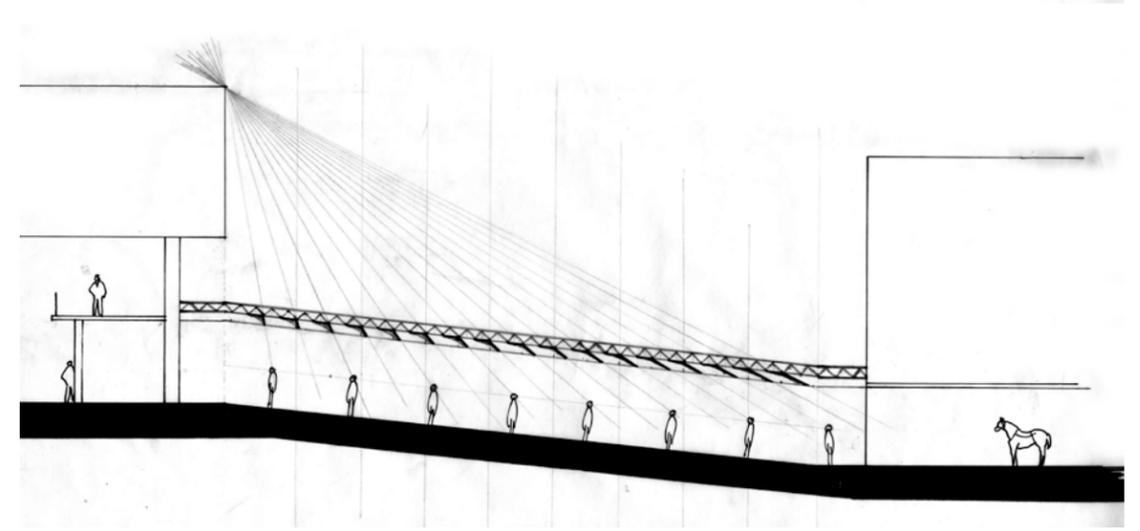
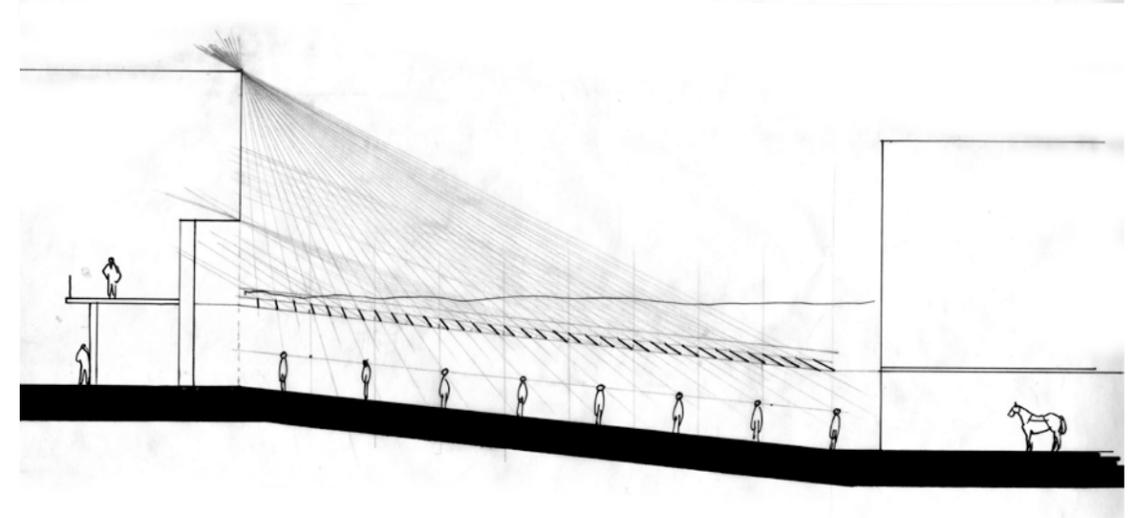
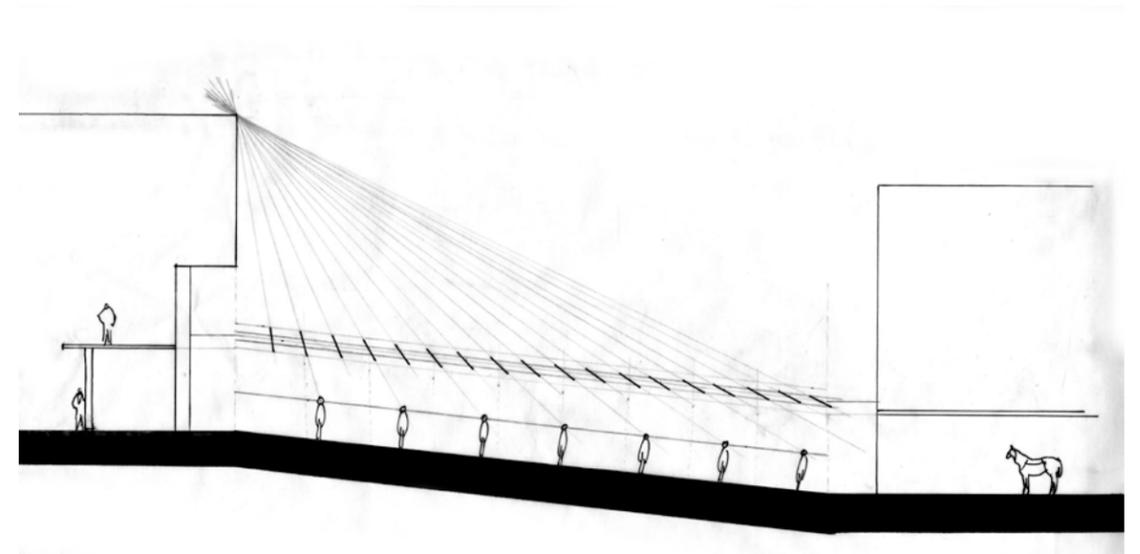
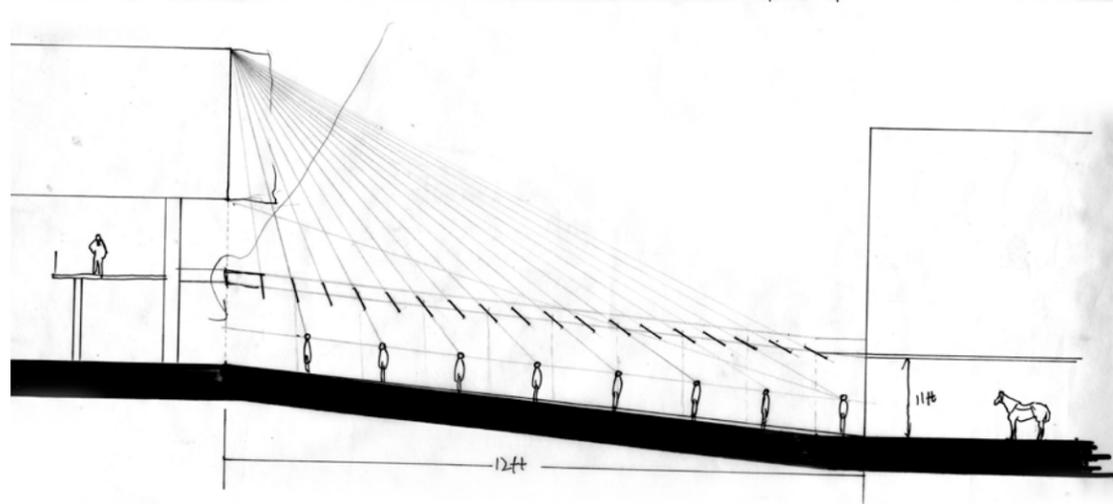
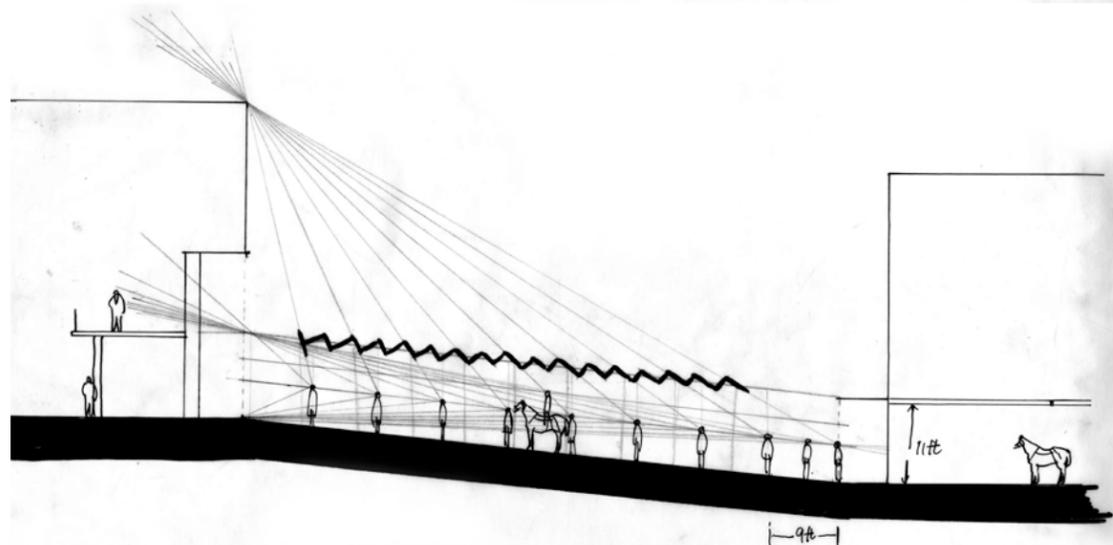
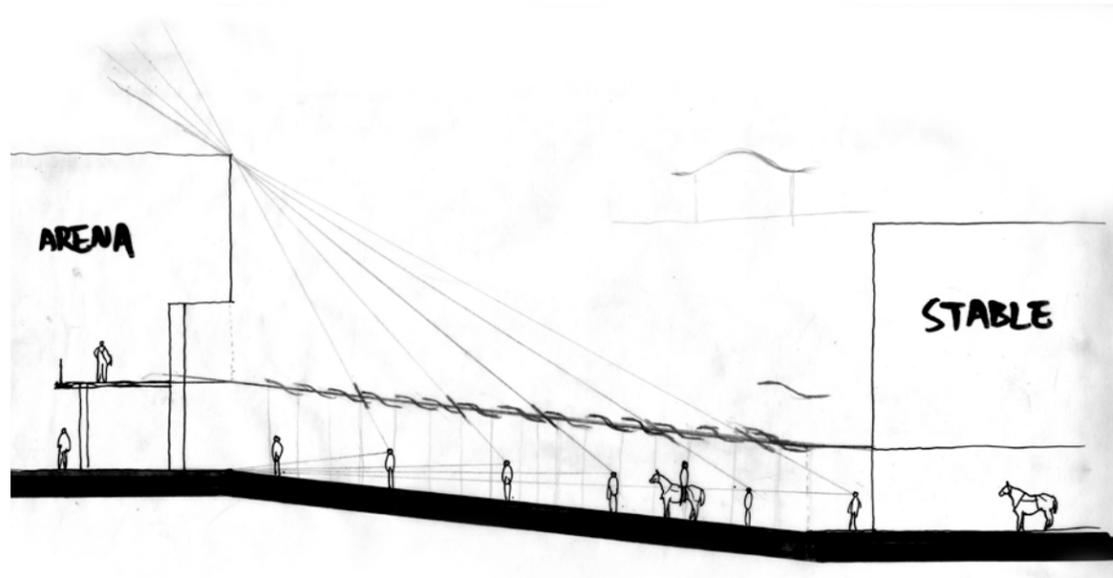


Layout of Stall



Flooring Materials

THE CORRIDOR



The corridor is the connection between horse stable and indoor arena. Unlike traditional closed corridors, the top of the corridor is transparent. In this way, the corridor not only serves as a shelter, but also serves as a viewing skylight.

Concept Sketch of Corridor

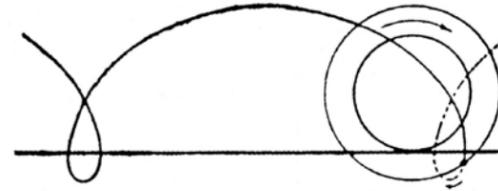


Rendering of the corridor



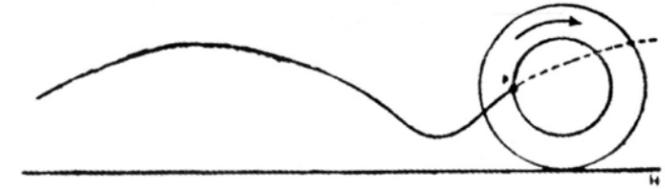
CYCLOID

The cycloid is the path traced by a fixed point on the circumference of a circle that rolls along a given straight line.



CURTATE CYCLOID

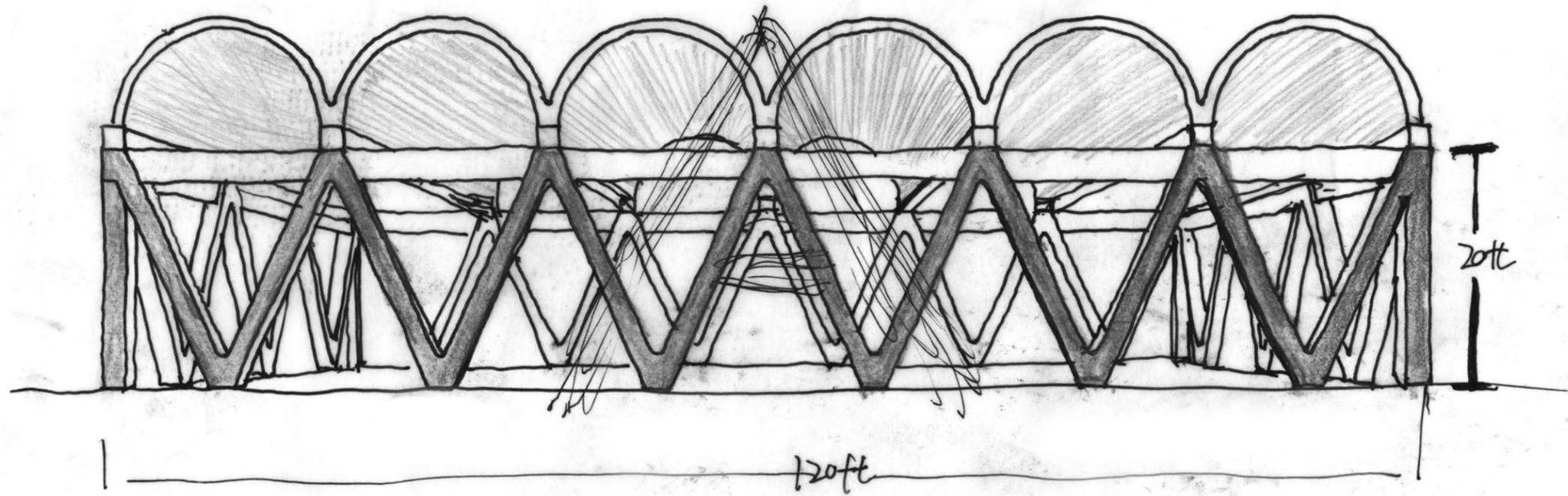
A point traced out on the inside of a circle rolling along a straight line generates a curtate cycloid.



PROLATE CYCLOID

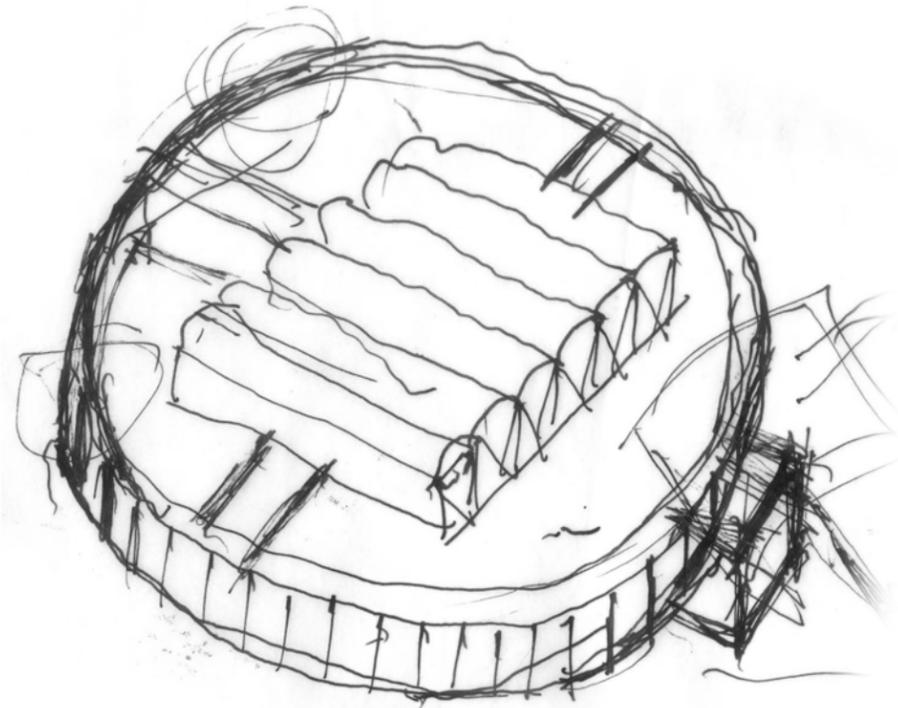
A point on the outside of a circle rolling along a straight line describes a prolate cycloid.

INDOOR ARENA

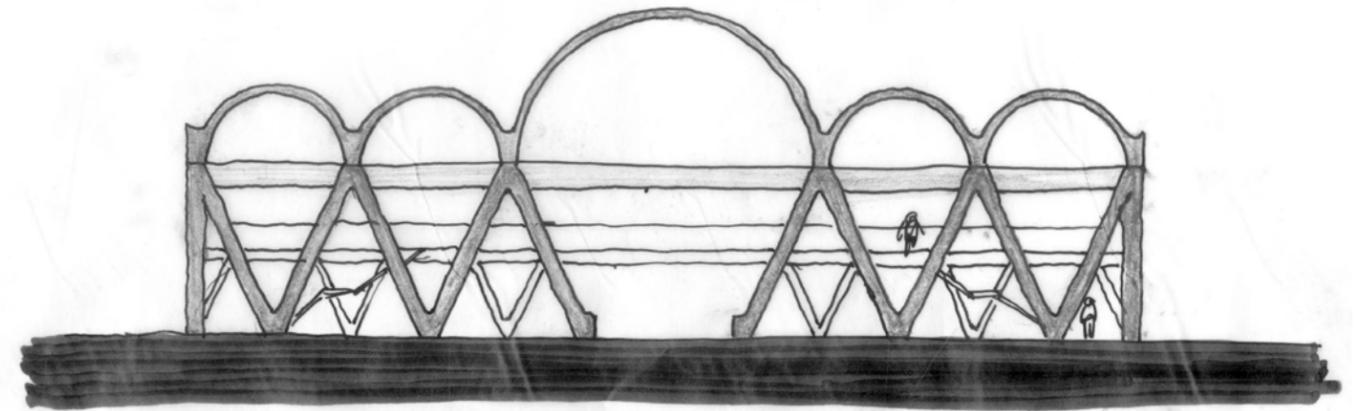
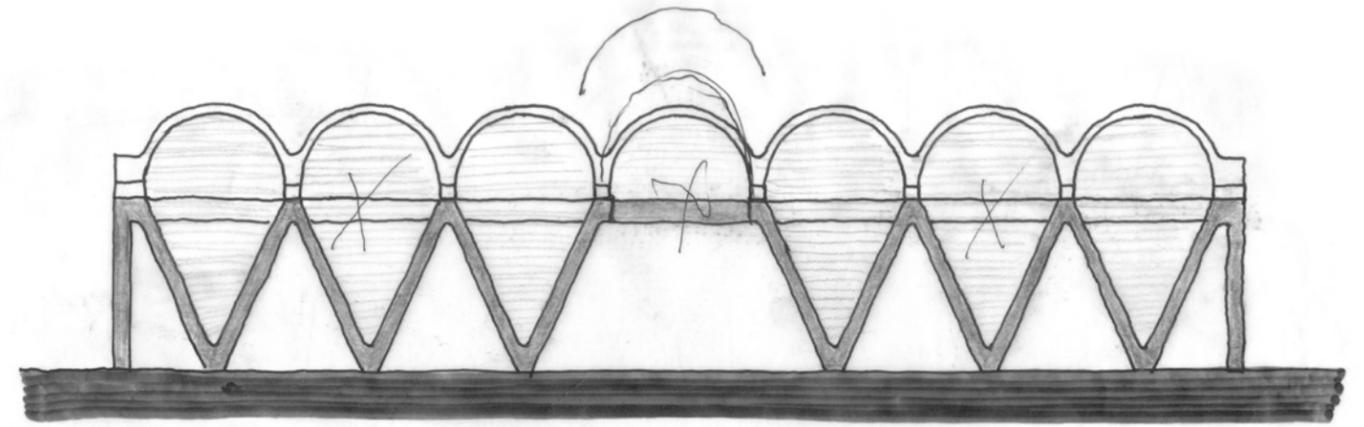


Conceptual sketch for indoor arena

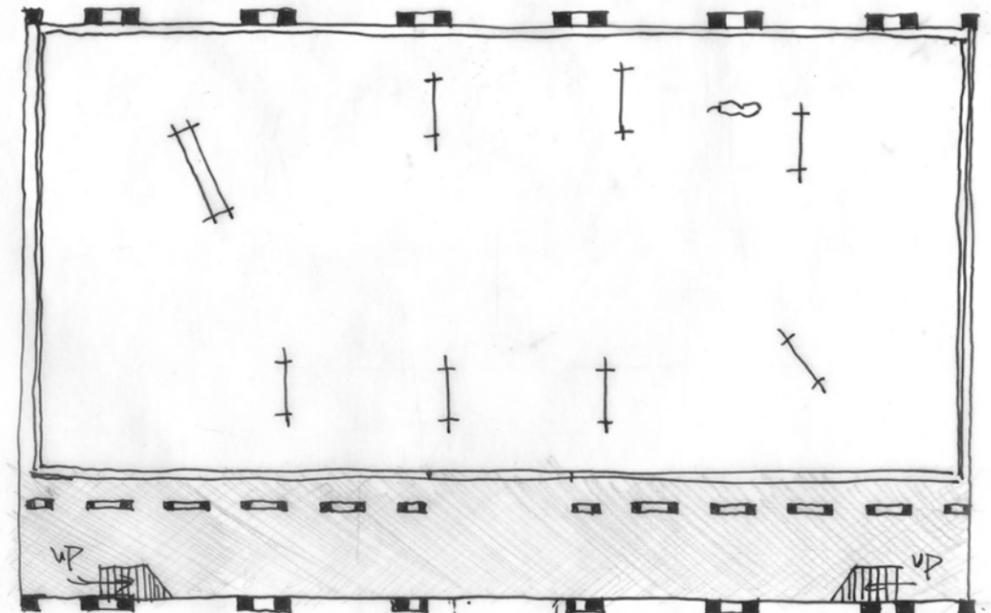
INDOOR ARENA



Conceptual sketch for indoor arena

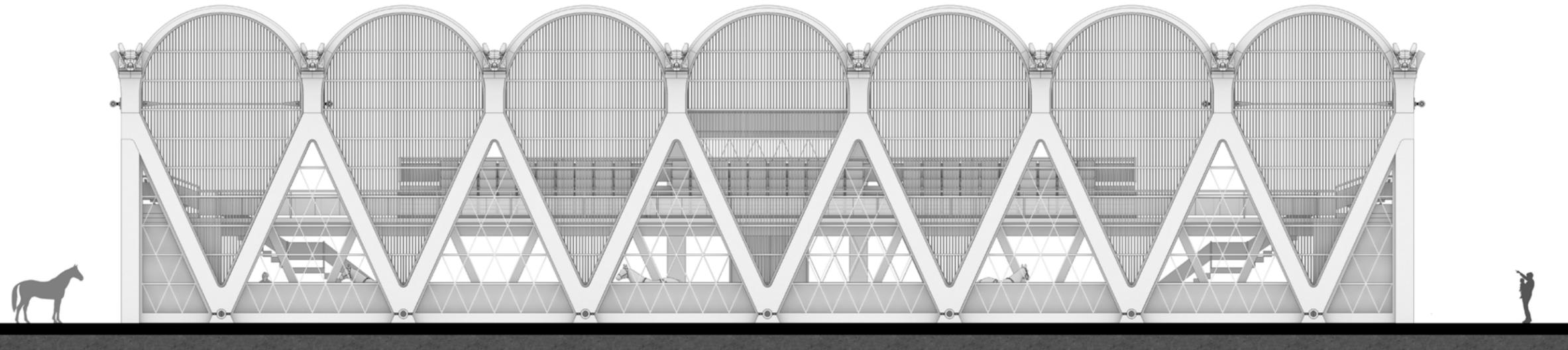


South Elevation.

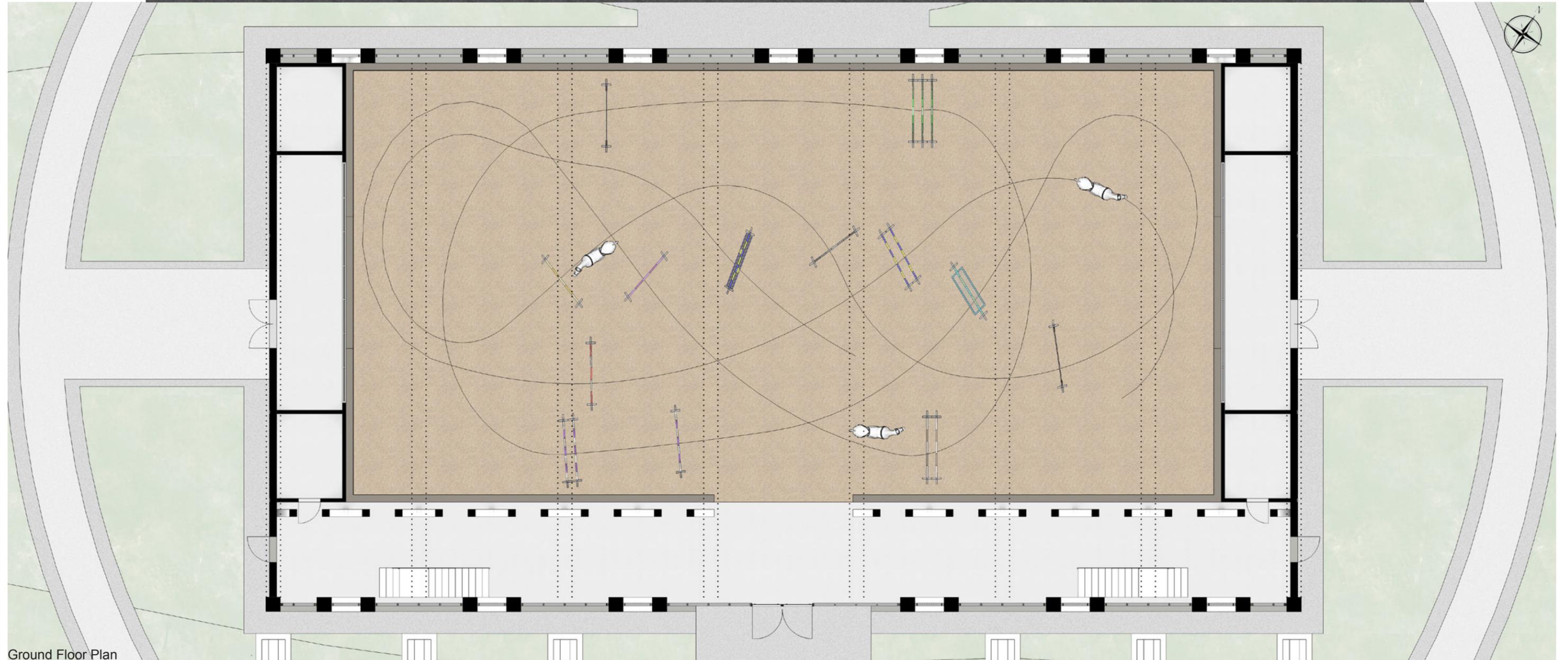


Design Process

INDOOR ARENA

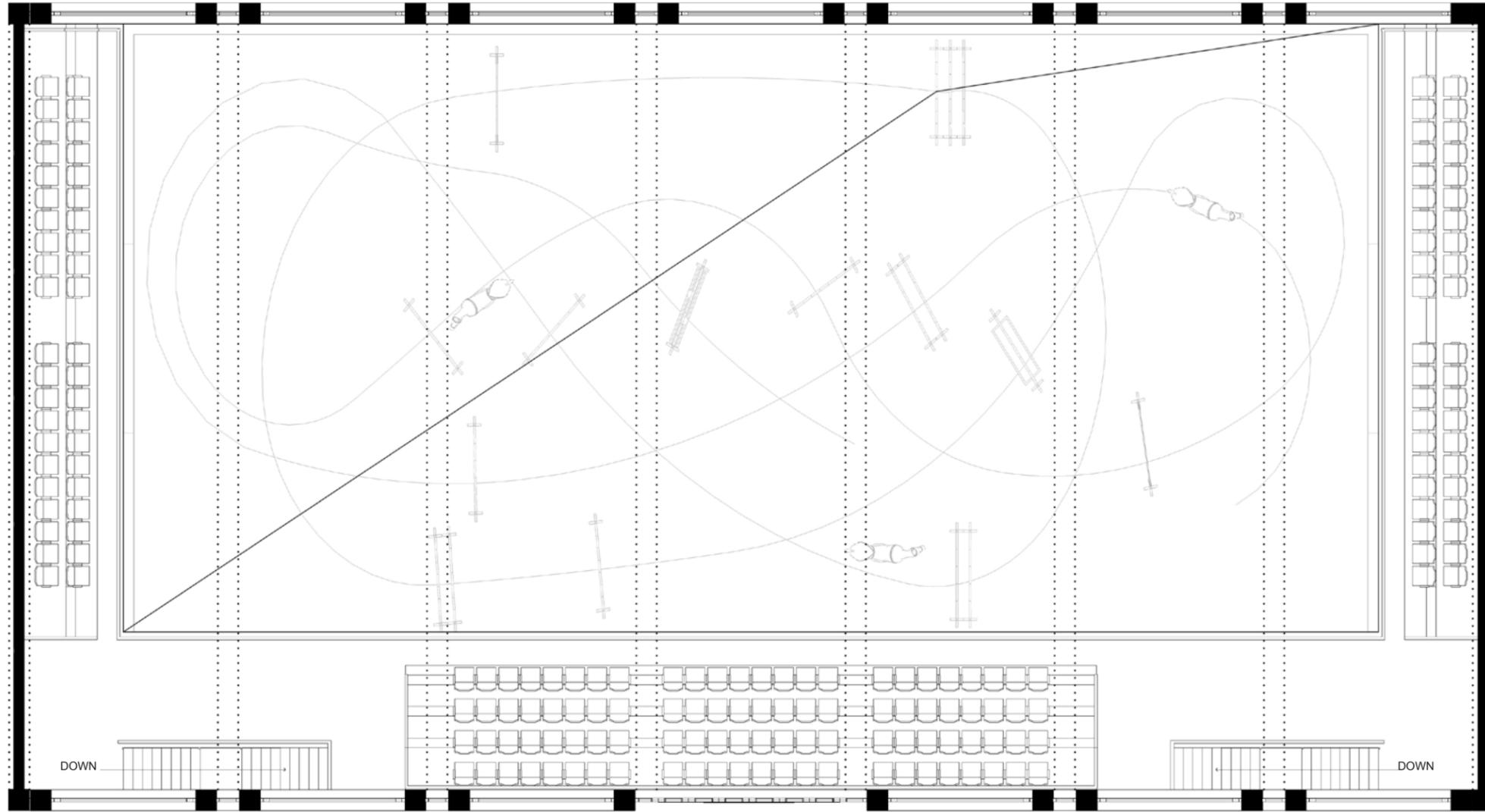


North Elevation

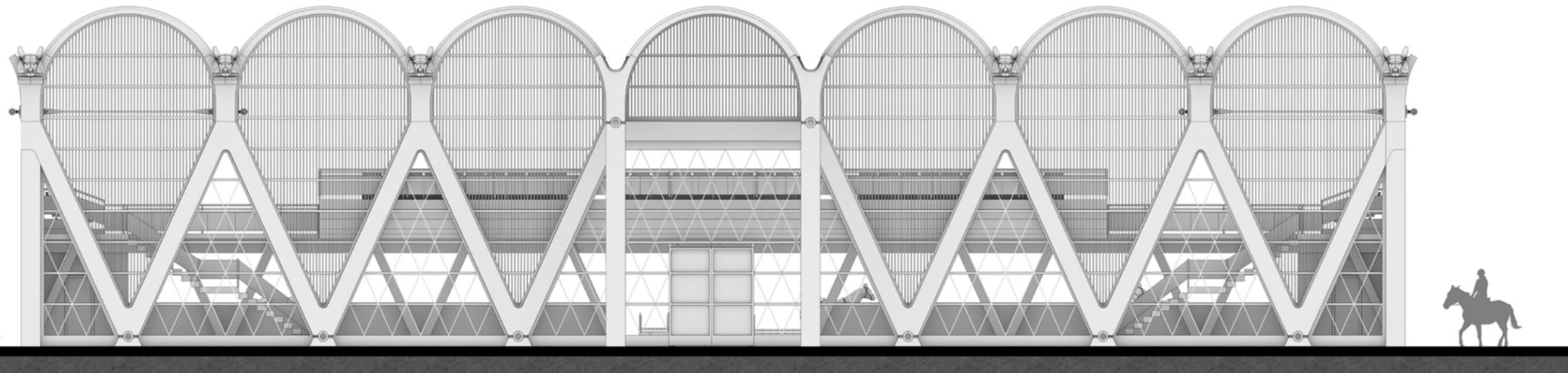


Ground Floor Plan

INDOOR ARENA



Second Floor Plan



South Elevation

INDOOR ARENA



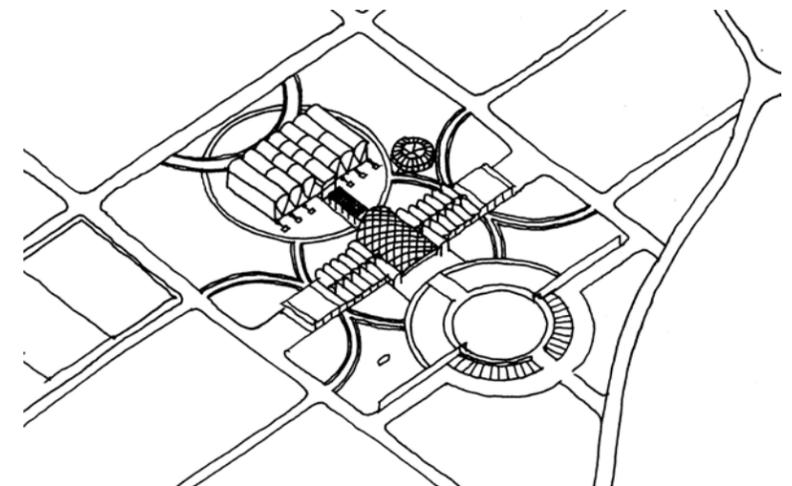
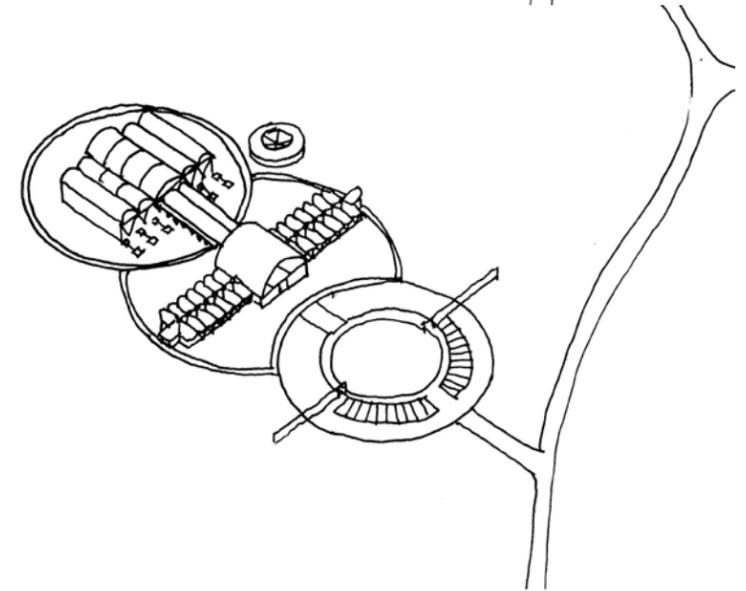
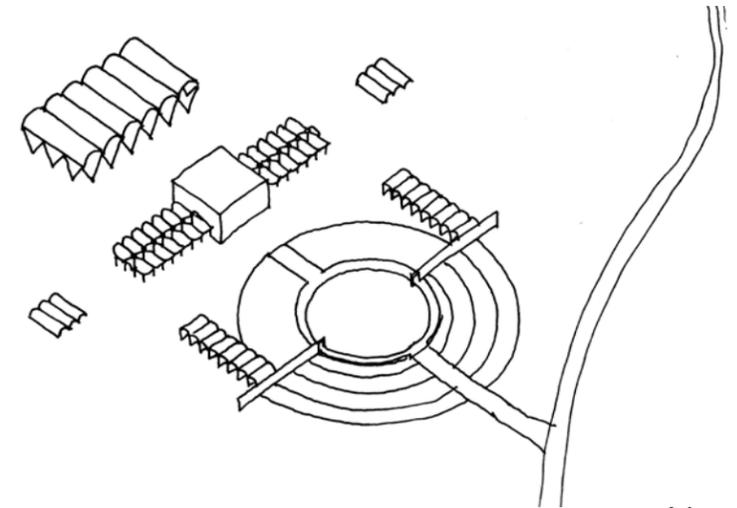
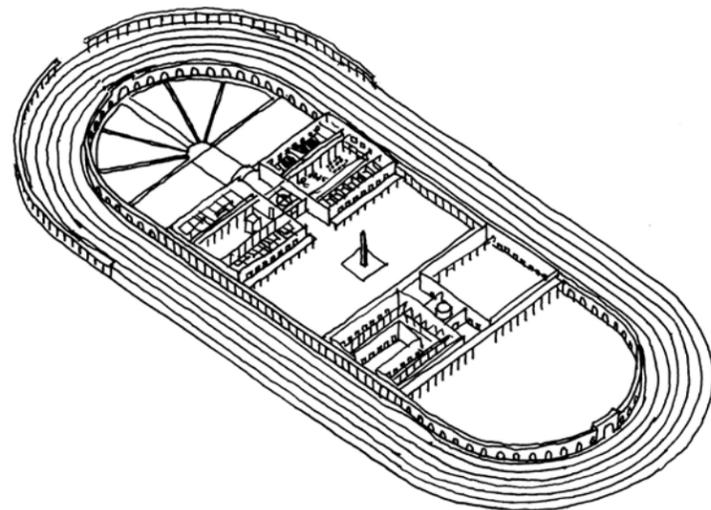
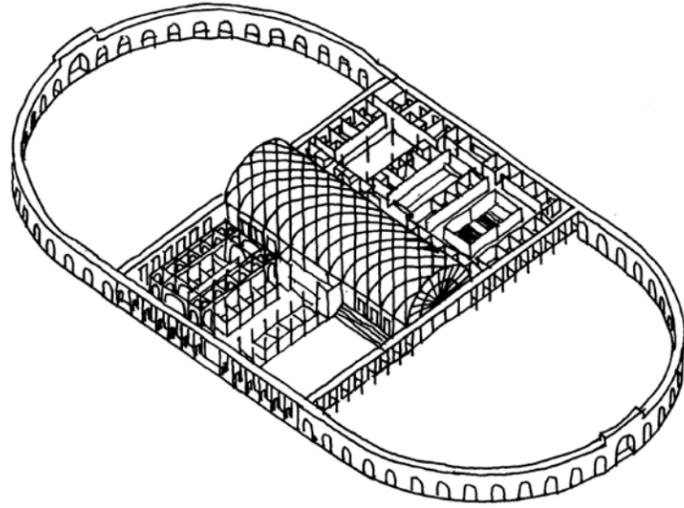
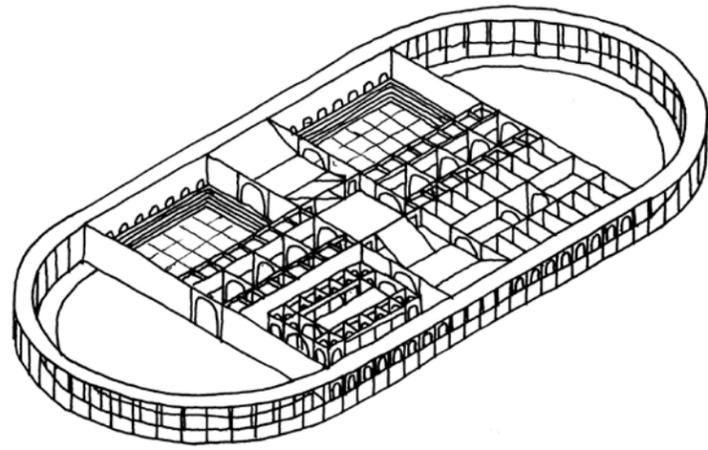
Perspective of Indoor Arena

INDOOR ARENA

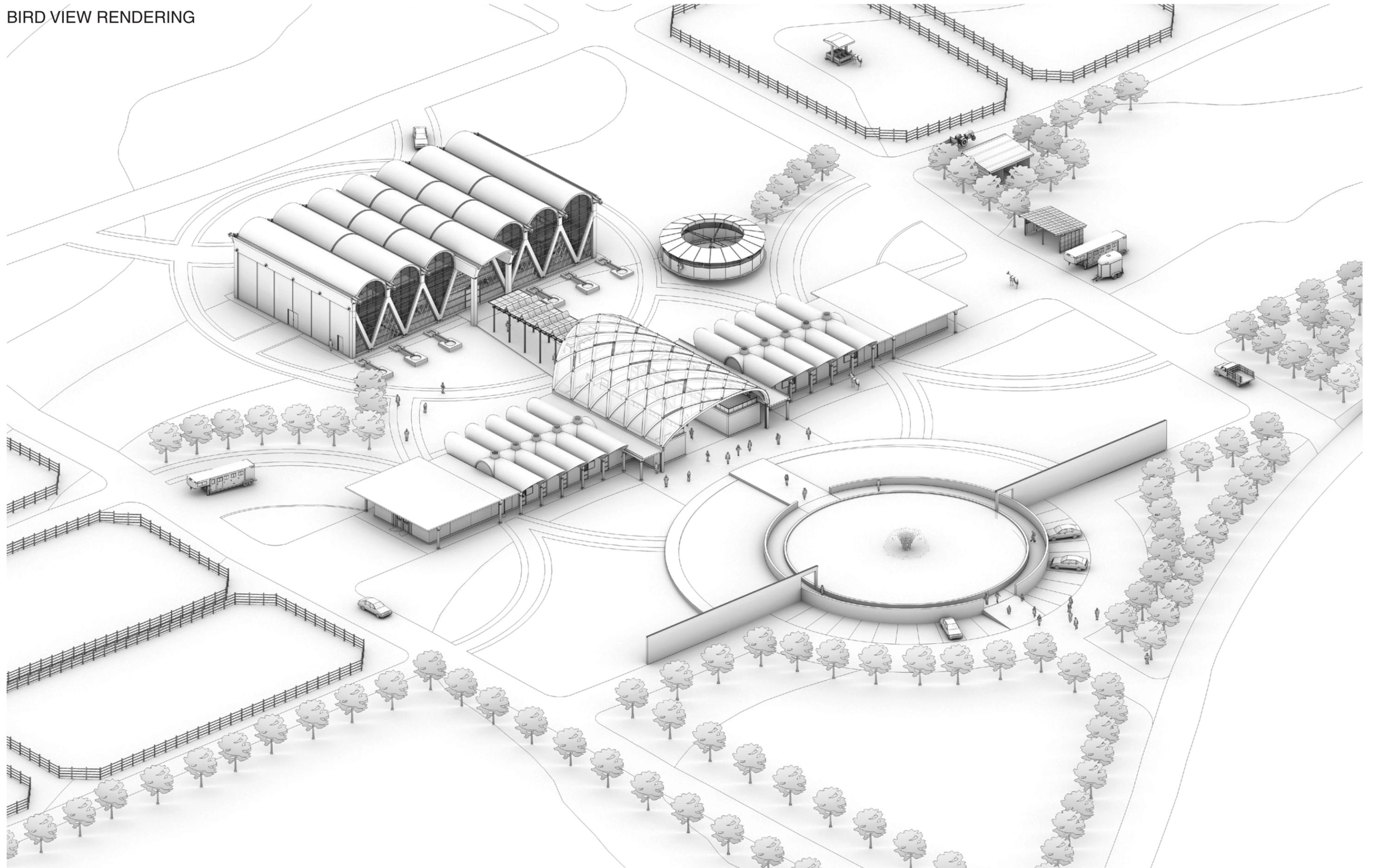




BIRD'S EYE VIEW OF PREVIOUS VERSIONS



BIRD VIEW RENDERING



CONCLUSION

What we generally admire in Classical Architecture is the well-balanced rhythm, symmetry, proportion, and the overall arrangement. While geometry is only a small regulating part of classical architecture, to me, it is the most interesting aspect.

This thesis explores some aspects of the harmony of geometry with respect to generating architectural form. For me, it is just a starting point to pursue the making of components that are responsible for what makes Classical Architecture beautiful.

