Lecture 7
Proportion and Scale

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Proportions & Scale

- **Scale** refers to the size of something compared to a reference standard “1:100” or to the size of something else” human scale “

- When the proportions of architectural composition are applied to a particular building, the two-termed relationship of the parts to the whole must be harmonized with a third term—the observer. He not only sees the proportions of a door and their relationship to those of a wall, but he measures them against his own dimensions. This three-termed relationship is called **scale**.
Proportions & Scale

- When an architectural drawing has a scale, meaning that so many units of measure on the drawing represent so many units of measure in the actual building.

- Proportion refers to the proper or harmonious relation of one part to another or to the whole.
why are proportioning systems useful and of particular significance in architectural design?

1. The intent of all theories of proportions is to create a sense of order and harmony among the elements in a visual construction.
2. To establish a consistent set of visual relationships between the parts of a building.
3. The visual order they create can be sensed, accepted, provide an aesthetic rationale for their dimensions.
4. They can visually unify the multiplicity of elements in an architectural design by having all of its parts belong to the same family of proportions.
Proportions

The designer usually has a range of choices when determining the proportions of things, some are given to us by the nature of materials, by how building elements respond to forces “tension or pressure”, its function and by how things are made “manufacturing”. Because these elements are mass-produced in factories, they have standard sizes.

Steel, wood, concrete blocks

Standard Casement Window Units
However, the designer still has the ability to control the proportion of the forms and spaces within and around a building.

A steel column will be thinner than a wood post supporting the same load. In a similar manner, columns become thicker as their loads and unsupported height increase.
Proportions

- **A ratio** refers to the quantitative comparison of two similar things, while proportion refers to the equality of ratios.

- **A proportion** is the equality between two ratio.

- A proportioning system establishes a consistent set of visual relationships between the parts of a building; as well as between the parts and the whole.
Many architectural elements are sized and proportioned according to:

- Their structural properties
- Function
- The process through which they are manufactured. Because these elements are mass-produced in factories.
- Aesthetic and visual judgment.

Aesthetic: Proportioning systems can visually unify the multiplicity of elements in an architectural design by having all of its parts belong to the same family of proportions.
If a space 400 square feet in area were required, what dimensions—what ratios of width-to-length and length-to-height—should it have? The functioning of the space and the nature of the activities to be accommodated will influence its form and proportion. The structural system, or the exterior environment might limit one or more of its dimensions.

- A square space, having four equal faces, is static in nature.
- If its length expands and dominates its width, it becomes more dynamic.
- While square and rectangle spaces define places for activity, linear spaces encourage movement and are capable to subdivision into a number of zones.
Effect of Perspective

- A rectangle can appear to be exactly square, almost a square, or very much unlike a square. It can appear to be long, short, or broad, depending on our point of view.

- Perspective affect the perception of the space’s proportions.

- Colors have another effect: narrow, wide, far…..
Types of Proportion:

Arithmetic: $$\frac{c-b}{b-a} = \frac{c}{c} \quad (\text{e.g., 1, 2, 3})$$

Geometric: $$\frac{c-b}{b-a} = \frac{c}{b} \quad (\text{e.g., 1, 2, 4})$$

Harmonic: $$\frac{c-b}{b-a} = \frac{c}{a} \quad (\text{e.g., 2, 3, 6})$$
Theories of Proportion

A number of theories of desirable proportions have been developed in the course of history.

- Golden Section
- Classical Orders
- Renaissance Theories
- Modulor
- Ken
- Anthropometry
- Scale
The Greeks recognized the dominating role the Golden Section played in the proportions of the human body.

Another progression that closely approximates the Golden Section in whole numbers is the Fibonacci Series: 1, 1, 2, 3, 5, 8, 13, 21. Each term again is the sum of the two preceding ones, and the ratio between two consecutive terms tends to approximate the Golden Section as the series progresses to infinity. \( \frac{21}{13} \approx 1.6 \)
A rectangle whose sides are proportioned according to the Golden Section is known as a Golden Rectangle.
The Parthenon, Athens
Two different analysis
If the diagonals of two rectangles are either parallel or perpendicular to each other, they indicate that the two rectangles have similar proportions. These diagonals, as well as lines that indicate the common alignment of elements are called regulating lines. A regulating line is an assurance against disorder.

It is a means of verification order or rhythm.

Villa Foscari, Malcontenta, Italy, 1558, Andrea Palladio
Classical Orders
Classical Orders

a: base
b: column diameter
c: body
d: capital
e: shaft
f: cornice
g: cornice
h: frieze
k: architrave.
To the Greeks and Romans of classical antiquity, the Orders represented in their proportioning of elements the perfect expression of beauty and harmony.

1. The basic unit of dimension was the diameter of the column.

2. From this module were derived the dimensions of the shaft, the capital, as well as the pedestal “base of column” below and the entablature above “upper parts”, down to the smallest detail.

3. The system of spacing between columns was also based on the diameter of the column.

4. The sizes of columns varied according to the extent of a building.

5. The Orders were not based on a fixed unit of measurement, but were proportionate and in harmony with one another (next figure).
Classical Orders

The Classical Orders according to Vignola
Renaissance theories: is a proportion which depends on mathematical system generated from the Greek mathematical system of proportions.

Palladio was probably the most influential architect of the Italian Renaissance. In The Four Books on Architecture, he proposed seven "most beautiful and proportionable manners of rooms as below.

![Diagrams of Renaissance Theories](image-url)
Renaissance Theories/ Palladio

Palazzo Chiericati, Vicenza, Italy, 1550, Andrea Palladio
54 x 16 (18), 18 x 30, 18 x 18, 18 x 12
Renaissance Theories

Palladio also determined the proper height of a room as follow:

1- Height of rooms with flat ceilings would be equal to their floor width. \( \text{Width} = \text{height} \)

2- Height of vaulted square rooms would be one-third greater than its floor length. \( 1:1:1.3 \)

3- For other rooms, height can be measured according to the equations of the types of proportions mentioned above “Geometric, Arithmetic, Harmonic.”

In last case, the height of a room is equal to the mean (b) between the two extremes of the width (a) and length (c) of the room. \( a < b < c \)
Le Corbusier developed his proportioning system, the Modular, to order the dimensions.

He saw the measuring tools of the Greeks, Egyptians, and other high civilizations as being "infinitely rich and accurate because they formed part of the mathematics of the human body, the source of that harmony which moves us to beauty.

He therefore based his measuring tool, the Modular, on both mathematics (the aesthetic dimensions of the Golden Section and the Fibonacci Series), and the proportions of the human body (functional dimensions).
The basic grid consists of three measures, 113, 70, and 43 cm, proportioned according to the Golden Section.

\[ 43 + 70 = 113 \]
\[ 113 + 70 = 183 \]
\[ 113 + 70 + 43 = 226 \text{ (2} \times 113 \text{)} \]
113, 183, and 226 define the space occupied by the human figure. From 113 and 226, Le Corbusier developed the Red and Blue series, diminishing scales of dimensions that were related to the stature of the human figure.

**Red:** 4, 6, 10, 16, 27, 43, 70, 113, 183, 296, 226 (113*2)

**Blue:** 13, 20, 33, 53, 86, 140, 226, 366
The Modular
The Modular
Human body

The Traditional Japanese Ken

- The traditional Japanese unit of measure, the shaku, was originally imported from China. 1 ken = 6 shaku
- The shaku is almost equivalent to the English foot. 1 ken = 6 * 30 = 180 cm
- The ken was soon standardized unit for residential architecture.
- The ken evolved into an aesthetic module that ordered the structure, materials, and space of Japanese architecture.
- Two methods of designing with the ken modular grid developed that affected its dimension. The ken grid of 6 shaku determined the center-to-center spacing of columns.
- The standard floor mat (3x6 shaku or 0.5x1 ken or 90x180 cm)
- The traditional floor mat was originally proportioned to accommodate two persons sitting or one person sleeping.

floor mat = two persons sitting = one person sleeping
1 mat = bed area
Anthropometry

- **Anthropometry**: refers to the measurement of the size and proportions of the human body.

- Spaces in architecture are determined by its dimensions.

- Average dimensions must always be treated with caution since variations exists between men and women, among various age and racial groups.

- The different situation of human body affects the design.
Anthropometry

Human scale in architecture is based on the dimensions and proportions of the human body.
Ordering Principles

- Order without diversity can result in monotony or boredom;
- diversity without order can produce confusion.
- A sense of unity with variety is the ideal.

Ordering principles:

1. Axis
2. Symmetry
3. Hierarchy
4. Rhythm
5. Datum
6. Transformation
Axis

- A line established by two points in space, about which forms and spaces can be arranged in a symmetrical or balanced manner.

- Dominating & regulating device: Although imaginary the axis is perhaps the most elementary means of organizing forms and spaces in architecture.

- It implies symmetry or balance.
The terminating elements of an axis serve to both send and receive its visual thrust. It can be: a linear elements or well-defined spaces “centralized building” forms, vertical planes “a facade”, or gateways.
**Symmetry**

- The balanced distribution and arrangement of equivalent forms and spaces on opposite sides of a dividing line or plane, or about a center or axis.
- A symmetrical condition can not exist without implying the existence of an axis or center about which it is structured.
- There are two fundamental types of symmetry: bilateral symmetry and Radial symmetry.
- A symmetrical condition can occur in only a portion of the building to respond to exceptional conditions of its site or program.
bilateral symmetry and Radial symmetry.

a portion of the building has symmetry
Hierarchy التميز والسيطرة

- The articulation of the importance or significance of a form or space by its **size, shape, or placement** relative to the other forms and spaces of the organization.

- It can be: 1. exceptional size, 2. a unique shape, 3. a strategic location.

- In an architectural composition, there can be more than a single dominant element; primary and secondary.

- Many dominant elements may cause confusion.

- When everything is emphasized, nothing is emphasized.
Hierarchy “in size, shape, or placement”
Hierarchically important locations for a form or space include:

1. the termination of a linear sequence or axial organization
2. the center piece of a symmetrical organization
Hierarchy

3. the focus of a centralized or radial organization

4. being offset “counterbalance“ above, below, or in the foreground of a composition
Datum

- A line, plane, or volume of reference to which other elements in a composition can relate.
- It organizes a random pattern of elements through its regularity, continuity and constant presence.
- To be an effective ordering device, a linear datum must have sufficient visual continuity to cut through or bypass all of the elements being organized.
Datum

- A datum must have sufficient **size**, **closure**, and **regularity**
- It can gather elements above, below in front of or behind it.

Datum can be:
1. **A line** can cut through or form a common edge for the pattern, while a grid of lines can form a neutral, unifying field for the pattern.
Datum as a plane or a volume

A **plane** can gather the pattern of elements beneath it or serve as an encompassing background.

A **volume** can collect the pattern of elements within its boundaries or around it.
Datum

Overhead plane
Datum

renovated 17th century
Rhythm & Repetition

- A unifying movement characterized by a patterned repetition or alternation of formal elements or motifs in the same or a modified form.
- The movement may be of our eyes as we follow recurring elements in a composition, or of our bodies as we advance through a sequence of spaces.
- Examples: beams and columns, windows and doors
Rhythm & Repetition

Jami Masjid, Golbarga, India, 1367
Rhythm & Repetition
Repetition Organization

Graded rhythm: at irregular intervals

1. A linear fashion

2. A radial manner

3. randomly but related by proximity
Transformation

- The principle that an architectural concept, structure, or organization can be altered through a series of disconnected manipulations and rearrangement in response to a specific context or set of conditions without a loss of identity or concept.

- The original design concept can, through a series of finite permutations, be clarified, strengthened, and built upon, rather than destroyed.

- The process of developing a design concept is a series of transformation.
Transformation
Reference:

Thank you