Planes in architecture define three-dimensional volumes of mass and space. The properties of each plane—size, shape, color, texture—as well as their spatial relationship to one another ultimately determine the visual attributes of the form they define and the qualities of the space they enclose.

In architectural design, we manipulate three generic types of planes:

**Overhead Plane**
The overhead plane can be either the roof plane that spans and shelters the interior spaces of a building from the climatic elements, or the ceiling plane that forms the upper enclosing surface of a room.

**Wall Plane**
The wall plane, because of its vertical orientation, is active in our normal field of vision and vital to the shaping and enclosure of architectural space.

**Base Plane**
The base plane can be either the ground plane that serves as the physical foundation and visual base for building forms, or the floor plane that forms the lower enclosing surface of a room upon which we walk.
Regular forms refer to those whose parts are related to one another in a consistent and orderly manner. They are generally stable in nature and symmetrical about one or more axes. The sphere, cylinder, cone, cube, and pyramid are prime examples of regular forms.

Forms can retain their regularity even when transformed dimensionally or by the addition or subtraction of elements. From our experiences with similar forms, we can construct a mental model of the original whole even when a fragment is missing or another part is added.

Irregular forms are those whose parts are dissimilar in nature and related to one another in an inconsistent manner. They are generally asymmetrical and more dynamic than regular forms. They can be regular forms from which irregular elements have been subtracted or result from an irregular composition of regular forms.

Since we deal with both solid masses and spatial voids in architecture, regular forms can be contained within irregular forms. In a similar manner, irregular forms can be enclosed by regular forms.
TRANSFORMATION OF FORM

All other forms can be understood to be transformations of the primary solids, variations which are generated by the manipulation of one or more dimensions or by the addition or subtraction of elements.

Dimensional Transformation
A form can be transformed by altering one or more of its dimensions and still retain its identity as a member of a family of forms. A cube, for example, can be transformed into similar prismatic forms through discrete changes in height, width, or length. It can be compressed into a planar form or be stretched out into a linear one.

Subtractive Transformation
A form can be transformed by subtracting a portion of its volume. Depending on the extent of the subtractive process, the form can retain its initial identity or be transformed into a form of another family. For example, a cube can retain its identity as a cube even though a portion of it is removed, or be transformed into a series of regular polyhedrons that begin to approximate a sphere.

Additive Transformation
A form can be transformed by the addition of elements to its volume. The nature of the additive process and the number and relative sizes of the elements being attached determine whether the identity of the initial form is altered or retained.
A sphere can be transformed into any number of ovoid or ellipsoidal forms by elongating it along an axis.

A pyramid can be transformed by altering the dimensions of the base, modifying the height of the apex, or tilting the normally vertical axis.

A cube can be transformed into similar prismatic forms by shortening or elongating its height, width, or depth.
We search for regularity and continuity in the forms we see within our field of vision. If any of the primary solids is partially hidden from our view, we tend to complete its form and visualize it as if it were whole because the mind fills in what the eyes do not see. In a similar manner, when regular forms have fragments missing from their volumes, they retain their formal identities if we perceive them as incomplete wholes. We refer to these mutilated forms as subtractive forms.

Because they are easily recognizable, simple geometric forms, such as the primary solids, adapt readily to subtractive treatment. These forms will retain their formal identities if portions of their volumes are removed without deteriorating their edges, corners, and overall profile.

Ambiguity regarding the original identity of a form will result if the portion removed from its volume erodes its edges and drastically alters its profile.

In the series of figures below, at what point does the square shape with a corner portion removed become an L-shaped configuration of two rectangular planes?
While a subtractive form results from the removal of a portion of its original volume, an additive form is produced by relating or physically attaching one or more subordinate forms to its volume.

The basic possibilities for grouping two or more forms are by:

**Spatial Tension**
This type of relationship relies on the close proximity of the forms or their sharing of a common visual trait, such as shape, color, or material.

**Edge-to-edge Contact**
In this type of relationship, the forms share a common edge and can pivot about that edge.

**Face-to-face Contact**
This type of relationship requires that the two forms have corresponding planar surfaces which are parallel to each other.

**Interlocking Volumes**
In this type of relationship, the forms interpenetrate each other’s space. The forms need not share any visual traits.
Additive forms resulting from the accretion of discrete elements can be characterized by their ability to grow and merge with other forms. For us to perceive additive groupings as unified compositions of form—as figures in our visual field—the combining elements must be related to one another in a coherent manner.

These diagrams categorize additive forms according to the nature of the relationships that exist among the component forms as well as their overall configurations. This outline of formal organizations should be compared with a parallel discussion of spatial organizations in Chapter 4.

Centralized Form
A number of secondary forms clustered about a dominant, central parent-form

Linear Form
A series of forms arranged sequentially in a row

Radial Form
A composition of linear forms extending outward from a central form in a radial manner

Clustered Form
A collection of forms grouped together by proximity or the sharing of a common visual trait

Grid Form
A set of modular forms related and regulated by a three-dimensional grid

Lingaraja Temple, Bhubaneshwar, India, c. A.D. 1100
A linear form can result from a proportional change in a form’s dimensions or the arrangement of a series of discrete forms along a line. In the latter case, the series of forms may be either repetitive or dissimilar in nature and organized by a separate and distinct element such as a wall or path.

- A linear form can be segmented or curvilinear to respond to topography, vegetation, views, or other features of a site.

- A linear form can front on or define an edge of an exterior space, or define a plane of entry into the spaces behind it.

- A linear form can be manipulated to enclose a portion of space.

- A linear form can be oriented vertically as a tower element to establish or denote a point in space.

- A linear form can serve as an organizing element to which a variety of secondary forms are attached.
The core is either the symbolic or functional center of the organization. Its central position can be articulated with a visually dominant form, or it can merge with and become subservient to the radiating arms.

The radiating arms, having properties similar to those of linear forms, give a radial form its extroverted nature. They can reach out and relate to or attach themselves to specific features of a site. They can expose their elongated surfaces to desirable conditions of sun, wind, view, or space.

Radial forms can grow into a network of centers linked by linear arms.
While a centralized organization has a strong geometric basis for the ordering of its forms, a clustered organization groups its forms according to functional requirements of size, shape, or proximity. While it lacks the geometric regularity and introverted nature of centralized forms, a clustered organization is flexible enough to incorporate forms of various shapes, sizes, and orientations into its structure.

Considering their flexibility, clustered organizations of forms may be organized in the following ways:

- They can be attached as appendages to a larger parent form or space.
- They can be related by proximity alone to articulate and express their volumes as individual entities.
- They can interlock their volumes and merge into a single form having a variety of faces.

A clustered organization can also consist of forms that are generally equivalent in size, shape, and function. These forms are visually ordered into a coherent, nonhierarchical organization not only by their close proximity to one another, but also by the similarity of their visual properties.
A grid is a system of two or more intersecting sets of regularly spaced parallel lines. It generates a geometric pattern of regularly spaced points at the intersections of the grid lines and regularly shaped fields defined by the grid lines themselves.

The most common grid is based on the geometry of the square. Because of the equality of its dimensions and its bilateral symmetry, a square grid is essentially nonhierarchical and bidirectional. It can be used to break the scale of a surface down into measurable units and give it an even texture. It can be used to wrap several surfaces of a form and unify them with its repetitive and pervasive geometry.

The square grid, when projected into the third dimension, generates a spatial network of reference points and lines. Within this modular framework, any number of forms and spaces can be visually organized.

Conceptual Diagram, Gunma Prefectural Museum of Fine Arts, Japan, 1974, Arata Isozaki

Nakagin Capsule Building, Tokyo, 1972, Kisho Kurokawa
Cubic Volumes

Structural Frame

Frame with Adjacent Spaces

Hattenbach Residence. Santa Monica, California, 1971–73, Raymond Kappe
**FORMAL COLLISIONS OF GEOMETRY**

When two forms differing in geometry or orientation collide and interpenetrate each other's boundaries, each will vie for visual supremacy and dominance. In these situations, the following forms can evolve:

- The two forms can subvert their individual identities and merge to create a new composite form.

- One of the two forms can receive the other totally within its volume.

- The two forms can retain their individual identities and share the interlocking portion of their volumes.

- The two forms can separate and be linked by a third element that recalls the geometry of one of the original forms.
Forms differing in geometry or orientation may be incorporated into a single organization for any of the following reasons:

- To accommodate or accentuate the differing requirements of interior space and exterior form
- To express the functional or symbolic importance of a form or space within its context
- To generate a composite form that incorporates the contrasting geometries into its centralized organization

- To inflect a space toward a specific feature of a building site
- To carve a well-defined volume of space from a building form
- To express and articulate the various constructional or mechanical systems that exist within a building form

- To reinforce a local condition of symmetry in a building form
- To respond to contrasting geometries of the topography, vegetation, boundaries, or existing structures of a site
- To acknowledge an already existing path of movement through a building site
Corners define the meeting of two planes. If the two planes simply touch and the corner remains unadorned, the presence of the corner will depend on the visual treatment of the adjoining surfaces. This corner condition emphasizes the volume of a form.

A corner condition can be visually reinforced by introducing a separate and distinct element that is independent of the surfaces it joins. This element articulates the corner as a linear condition, defines the edges of the adjoining planes, and becomes a positive feature of the form.

If an opening is introduced to one side of the corner, one of the planes will appear to bypass the other. The opening diminishes the corner condition, weakens the definition of the volume within the form, and emphasizes the planar qualities of the neighboring surfaces.

If neither plane is extended to define the corner, a volume of space is created to replace the corner. This corner condition deteriorates the volume of the form, allows the interior space to leak outward, and clearly reveals the surfaces as planes in space.

Rounding off the corner emphasizes the continuity of the bounding surfaces of a form, the compactness of its volume, and softness of its contour. The scale of the radius of curvature is important. If too small, it becomes visually insignificant; if too large, it affects the interior space it encloses and the exterior form it describes.
Our perception of the shape, size, scale, proportion, and visual weight of a plane is influenced by its surface properties as well as its visual context.

- A distinct contrast between the surface color of a plane and that of the surrounding field can clarify its shape, while modifying its tonal value can either increase or decrease its visual weight.

- A frontal view reveals the true shape of a plane; oblique views distort it.

- Elements of known size within the visual context of a plane can aid our perception of its size and scale.

- Texture and color together affect the visual weight and scale of a plane and the degree to which it absorbs or reflects light and sound.

- Directional or oversized optical patterns can distort the shape or exaggerate the proportions of a plane.
Base Plane
A horizontal plane laying as a figure on a contrasting background defines a simple field of space. This field can be visually reinforced in the following ways.

Elevated Base Plane
A horizontal plane elevated above the ground plane establishes vertical surfaces along its edges that reinforce the visual separation between its field and the surrounding ground.

Depressed Base Plane
A horizontal plane depressed into the ground plane utilizes the vertical surfaces of the lowered area to define a volume of space.

Overhead Plane
A horizontal plane located overhead defines a volume of space between itself and the ground plane.
The degree to which spatial and visual continuity is maintained between an elevated space and its surroundings depends on the scale of the level change.

1. The edge of the field is well-defined; visual and spatial continuity is maintained; physical access is easily accommodated.

2. Visual continuity is maintained; spatial continuity is interrupted; physical access requires the use of stairs or ramps.

3. Visual and spatial continuity is interrupted; the field of the elevated plane is isolated from the ground or floor plane; the elevated plane is transformed into a sheltering element for the space below.
Lowering a portion of the base plane isolates a field of space from a larger context. The vertical surfaces of the depression establish the boundaries of the field. These boundaries are not implied as in the case of an elevated plane, but visible edges that begin to form the walls of the space.

The field of space can be further articulated by contrasting the surface treatment of the lowered area and that of the surrounding base plane.

A contrast in form, geometry, or orientation can also visually reinforce the identity and independence of the sunken field from its larger spatial context.
The degree of spatial continuity between a depressed field and the raised area surrounding it depends on the scale of the level change.

- The depressed field can be an interruption of the ground or floor plane and remain an integral part of the surrounding space.

- Increasing the depth of the depressed field weakens its visual relationship with the surrounding space and strengthens its definition as a distinct volume of space.

- Once the original base plane is above our eye-level, the depressed field becomes a separate and distinct room in itself.

Creating a stepped, terraced, or ramped transition from one level to the next helps promote continuity between a sunken space and the area that rises around it.

Whereas the act of stepping up to an elevated space might express the extroverted nature or significance of the space, the lowering of a space below its surroundings might allude to its introverted nature or to its sheltering and protective qualities.
Similar to the manner in which a shade tree offers a sense of enclosure beneath its umbrella structure, an overhead plane defines a field of space between itself and the ground plane. Since the edges of the overhead plane establish the boundaries of this field, its shape, size, and height above the ground plane determines the formal qualities of the space.

While the previous manipulations of the ground or floor plane defined fields of space whose upper limits were established by their context, an overhead plane has the ability to define a discrete volume of space virtually by itself.

If vertical linear elements such as columns or posts are used to support the overhead plane, they will aid in visually establishing the limits of the defined space without disrupting the flow of space through the field.

Similarly, if the edges of the overhead plane are turned downward, or if the base plane beneath it is articulated by a change in level, the boundaries of the defined volume of space will be visually reinforced.
Vertical Linear Elements
Vertical linear elements define the perpendicular edges of a volume of space.

Single Vertical Plane
A single vertical plane articulates the space on which it fronts.

L-shaped Plane
An L-shaped configuration of vertical planes generates a field of space from its corner outward along a diagonal axis.

Parallel Planes
Two parallel vertical planes define a volume of space between them that is oriented axially toward both open ends of the configuration.

U-shaped Plane
A U-shaped configuration of vertical planes defines a volume of space that is oriented primarily toward the open end of the configuration.

Four Planes: Closure
Four vertical planes establish the boundaries of an introverted space and influence the field of space around the enclosure.
A vertical linear element, such as a column, obelisk, or tower, establishes a point on the ground plane and makes it visible in space. Standing upright and alone, a slender linear element is nondirectional except for the path that would lead us to its position in space. Any number of horizontal axes can be made to pass through it.

When located within a defined volume of space, a column will generate a spatial field about itself and interact with the spatial enclosure. A column attached to a wall buttresses the plane and articulates its surface. At the corner of a space, a column punctuates the meeting of two wall planes. Standing free within a space, a column defines zones of space within the enclosure.

When centered in a space, a column will assert itself as the center of the field and define equivalent zones of space between itself and the surrounding wall planes. When offset, the column will define hierarchical zones of space differentiated by size, form, and location.
No volume of space can be established without the definition of its edges and corners. Linear elements serve this purpose in marking the limits of spaces that require visual and spatial continuity with their surroundings.

Two columns establish a transparent spatial membrane by the visual tension between their shafts. Three or more columns can be arranged to define the corners of a volume of space. This space does not require a larger spatial context for its definition, but relates freely to it.

The edges of the volume of space can be visually reinforced by articulating its base plane and establishing its upper limits with beams spanning between the columns or with an overhead plane. A repetitive series of column elements along its perimeter would further strengthen the definition of the volume.
A single vertical plane, standing alone in space, has visual qualities uniquely different from those of a freestanding column. A round column has no preferred direction except for its vertical axis. A square column has two equivalent sets of faces and therefore two identical axes. A rectangular column also has two axes, but they differ in their effect. As the rectangular column becomes more like a wall, it can appear to be merely a fragment of an infinitely larger or longer plane, slicing through and dividing a volume of space.

A vertical plane has frontal qualities. Its two surfaces or faces front on and establish the edges of two separate and distinct spatial fields.

These two faces of a plane can be equivalent and front similar spaces. Or they can be differentiated in form, color, or texture, in order to respond to or articulate different spatial conditions. A vertical plane can therefore have either two fronts or a front and a back.

The field of space on which a single vertical plane fronts is not well-defined. The plane by itself can establish only a single edge of the field. To define a three-dimensional volume of space, the plane must interact with other elements of form.
The height of a vertical plane relative to our body height and eye level is the critical factor that affects the ability of the plane to visually describe space. When two-feet high, a plane defines the edge of a spatial field but provides little or no sense of enclosure. When waist-high, it begins to provide a sense of enclosure while allowing for visual continuity with the adjoining space. When it approaches our eye level in height, it begins to separate one space from another. Above our height, a plane interrupts the visual and spatial continuity between two fields and provides a strong sense of enclosure.

The surface color, texture, and pattern of a plane affect our perception of its visual weight, scale, and proportion.

When related to a defined volume of space, a vertical plane can be the primary face of the space and give it a specific orientation. It can front the space and define a plane of entry into it. It can be a freestanding element within a space and divide the volume into two separate but related areas.
An L-shaped configuration of vertical planes defines a field of space along a diagonal from its corner outward. While this field is strongly defined and enclosed at the corner of the configuration, it dissipates rapidly as it moves away from the corner. The introverted field at the interior corner becomes extroverted along its outer edges.

While two edges of the field are clearly defined by the two planes of the configuration, its other edges remain ambiguous unless further articulated by additional vertical elements, manipulations of the base plane, or an overhead plane.

If a void is introduced to one side of the corner of the configuration, the definition of the field will be weakened. The two planes will be isolated from each other and one will appear to slide by and visually dominate the other.

If neither plane extends to the corner, the field will become more dynamic and organize itself along the diagonal of the configuration.
A building form can have an L-shaped configuration and be subject to the following readings. One of the arms of the configuration can be a linear form that incorporates the corner within its boundaries while the other arm is seen as an appendage to it. Or the corner can be articulated as an independent element that joins two linear forms together.

A building can have an L-shaped configuration to establish a corner of its site, enclose a field of outdoor space to which its interior spaces relate, or shelter a portion of outdoor space from undesirable conditions around it.

L-shaped configurations of planes are stable and self-supporting and can stand alone in space. Because they are open-ended, they are flexible space-defining elements. They can be used in combination with one another or with other elements of form to define a rich variety of spaces.
A pair of parallel vertical planes defines a field of space between them. The open ends of the field, established by the vertical edges of the planes, give the space a strong directional quality. Its primary orientation is along the axis about which the planes are symmetrical. Since the parallel planes do not meet to form corners and fully enclose the field, the space is extroverted in nature.

The definition of the spatial field along the open ends of the configuration can be visually reinforced by manipulating the base plane or adding overhead elements to the composition.

The spatial field can be expanded by extending the base plane beyond the open ends of the configuration. This expanded field can, in turn, be terminated by a vertical plane whose width and height is equal to that of the field.

If one of the parallel planes is differentiated from the other by a change in form, color, or texture, a secondary axis, perpendicular to the flow of the space, will be established within the field. Openings in one or both of the planes can also introduce secondary axes to the field and modulate the directional quality of the space.
Various elements in architecture can be seen as parallel planes that define a field of space:

- a pair of parallel interior walls within a building
- a street-space formed by the facades of two facing buildings
- a colonnaded arbor or pergola
- a promenade or allée bordered by rows of trees or hedges
- a natural topographical form in the landscape

The image of parallel vertical planes is often associated with the bearing-wall structural system, wherein a floor or roof structure spans the spaces between two or more parallel load-bearing walls.

Sets of parallel vertical planes can be transformed into a wide variety of configurations. Their spatial fields can be related to one another either through the open ends of their configurations or through openings in the planes themselves.
A U-shaped configuration of vertical planes defines a field of space that has an inward focus as well as an outward orientation. At the closed end of the configuration, the field is well defined. Toward the open end of the configuration, the field becomes extroverted in nature.

The open end is the primary aspect of the configuration by virtue of its uniqueness relative to the other three planes. It allows the field to have visual and spatial continuity with the adjoining space. The extension of the spatial field into the adjoining space can be visually reinforced by continuing the base plane beyond the open end of the configuration.

If the plane of the opening is further defined with columns or overhead elements, the definition of the original field will be reinforced and continuity with the adjoining space will be interrupted.

If the configuration of planes is rectangular and oblong in form, the open end can be along its narrow or wide side. In either case, the open end will remain the primary face of the spatial field, and the plane opposite the open end will be the principal element among the three planes of the configuration.
If openings are introduced at the corners of the configuration, secondary zones will be created within a multidirectional and dynamic field.

If the field is entered through the open end of the configuration, the rear plane, or a form placed in front of it, will terminate our view of the space. If the field is entered through an opening in one of the planes, the view of what lies beyond the open end will draw our attention and terminate the sequence.

If the end of a long, narrow field is open, the space will encourage movement and induce a progression or sequence of events. If the field is square, or nearly square, the space will be static and have the character of a place to be in, rather than a space to move through. If the side of a long, narrow field is open, the space will be susceptible to a subdivision into a number of zones.

U-shaped configurations of building forms and organizations have the inherent ability to capture and define outdoor space. Their composition can be seen to consist essentially of linear forms. The corners of the configuration can be articulated as independent elements or can be incorporated into the body of the linear forms.
SUMMARY TYPOLOGY: SPACE-DEFINING ELEMENTS

[Diagrams of space-defining elements]
SUMMARY TYPOLOGY: SPACE-DEFINING ELEMENTS
No spatial or visual continuity is possible with adjacent spaces without openings in the enclosing planes of a spatial field. Doors offer entry into a room and influence the patterns of movement and use within it. Windows allow light to penetrate the space and illuminate the surfaces of a room, offer views from the room to the exterior, establish visual relationships between the room and adjacent spaces, and provide for the natural ventilation of the space. While these openings provide continuity with adjacent spaces, they can, depending on their size, number, and location, also begin to weaken the enclosure of the space.

The following section of this chapter focuses on enclosed spaces at the scale of a room, where the nature of the openings within the room’s enclosure is a major factor in determining the quality of its space.
Within Planes
An opening can be located wholly within a wall or ceiling plane and be surrounded on all sides by the surface of the plane.

Centered  Off-Center  Grouped  Deep-set  Skylight

Along one edge  Along two edges  Turning a corner  Grouped  Skylight

At Corners
An opening can be located along one edge or at a corner of a wall or ceiling plane. In either case, the opening will be at a corner of a space.

Vertical  Horizontal  3/4 Opening  Window-wall  Skylight

Between Planes
An opening can extend vertically between the floor and ceiling planes or horizontally between two wall planes. It can grow in size to occupy an entire wall of a space.
An opening located wholly within a wall or ceiling plane often appears as a bright figure on a contrasting field or background. If centered within the plane, the opening will appear stable and visually organize the surface around it. Moving the opening off-center will create a degree of visual tension between the opening and the edges of the plane toward which it is moved.

The shape of the opening, if similar to the shape of the plane in which it is located, will create a redundant compositional pattern. The shape or orientation of the opening may contrast with the enclosing plane to emphasize its individuality as a figure. The singularity of the opening may be visually reinforced with a heavy frame or articulated trimwork.

Multiple openings may be clustered to form a unified composition within a plane, or be staggered or dispersed to create visual movement along the surface of the plane.

As an opening within a plane increases in size, it will at some point cease to be a figure within an enclosing field and become instead a positive element in itself, a transparent plane bounded by a heavy frame.

Openings within planes naturally appear brighter than their adjacent surfaces. If the contrast in brightness along the edges of the openings becomes excessive, the surfaces can be illuminated by a second light source from within the space, or a deep-set opening can be formed to create illuminated surfaces between the opening and the surrounding plane.
Openings that are located at corners give a space and the planes in which they are located a diagonal orientation. This directional effect may be desirable for compositional reasons, or the corner opening may be established to capture a desirable view or brighten a dark corner of a space.

A corner opening visually erodes the edges of the plane in which it is located and articulates the edge of the plane adjacent and perpendicular to it. The larger the opening, the weaker will be the definition of the corner. If the opening were to turn the corner, the angle of the space would be implied rather than real and the spatial field would extend beyond its enclosing planes.

If openings are introduced between the enclosing planes at all four corners of a space, the individual identity of the planes will be reinforced and diagonal or pinwheel patterns of space, use, and movement will be encouraged.

The light that enters a space through a corner opening washes the surface of the plane adjacent and perpendicular to the opening. This illuminated surface itself becomes a source of light and enhances the brightness of the space. The level of illumination can be enhanced further by turning the corner with the opening or adding a skylight above the opening.
A vertical opening that extends from the floor to the ceiling plane of a space visually separates and articulates the edges of the adjacent wall planes.

If located at a corner, the vertical opening will erode the definition of the space and allow it to extend beyond the corner to the adjacent space. It will also allow incoming light to wash the surface of the wall plane perpendicular to it and articulate the primacy of that plane in the space. If allowed to turn the corner, the vertical opening will further erode the definition of the space, allow it to interlock with adjacent spaces, and emphasize the individuality of the enclosing planes.

A horizontal opening that extends across a wall plane will separate it into a number of horizontal layers. If the opening is not very deep, it will not erode the integrity of the wall plane. If, however, its depth increases to the point where it is greater than the bands above and below it, then the opening will become a positive element bounded at its top and bottom by heavy frames.

Turning a corner with a horizontal opening reinforces the horizontal layering of a space and broadens the panoramic view from within the space. If the opening continues around the space, it will visually lift the ceiling plane from the wall planes, isolate it, and give it a feeling of lightness.

Locating a linear skylight along the edge where a wall and ceiling plane meet allows incoming light to wash the surface of the wall, illuminate it, and enhance the brightness of the space. The form of the skylight can be manipulated to capture direct sunlight, indirect daylight, or a combination of both.
The basic patterns of linear and planar elements that define discrete volumes of space, and the varieties of openings that serve to connect these spatial volumes to one another and their context are presented on pages 158–59 and 161. The qualities of an architectural space, however, are much richer than what the diagrams are able to portray. The spatial qualities of form, proportion, scale, texture, light, and sound ultimately depend on the properties of the enclosure of a space. Our perception of these qualities is often a response to the combined effects of the properties encountered and is conditioned by culture, prior experiences, and personal interest or inclination.

### Qualities of Architectural Space

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<th>Properties of Enclosure</th>
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The degree of enclosure of a space, as determined by the configuration of its defining elements and the pattern of its openings, has a significant impact on our perception of its form and orientation. From within a space, we see only the surface of a wall. It is this thin layer of material that forms the vertical boundary of the space. The actual thickness of a wall plane can be revealed only along the edges of door and window openings.

Openings lying wholly within the enclosing planes of a space do not weaken the edge definition nor the sense of closure of the space. The form of the space remains intact and perceptible.

Openings located along the edges of the enclosing planes of a space visually weaken the corner boundaries of the volume. While these openings erode the overall form of a space, they also promote its visual continuity and interaction with adjacent spaces.

Openings between the enclosing planes of a space visually isolate the planes and articulate their individuality. As these openings increase in number and size, the space loses its sense of enclosure, becomes more diffuse, and begins to merge with adjacent spaces. The visual emphasis is on the enclosing planes rather than the volume of space defined by the planes.
House, Berlin Building Exposition, 1931, Mies van der Rohe

Palazzo Garzadore (Project), Vincenza, Italy, 1570, Andrea Palladio

Color Construction (Project for a Private House), 1922, Theo van Doesburg and Cornelis van Eesteren
The size of a window or skylight controls the amount of daylight a room receives. The size of an opening in a wall or roof plane, however, is also regulated by factors other than light, such as the materials and construction of the wall or roof plane; requirements for views, visual privacy, and ventilation; the desired degree of enclosure for the space; and the effect of openings on the exterior form of a building. The location and orientation of a window or skylight, therefore, can be more important than its size in determining the quality of daylight a room receives.

An opening can be oriented to receive direct sunlight during certain portions of the day. Direct sunlight provides a high degree of illumination that is especially intense during midday hours. It creates sharp patterns of light and dark on the surfaces of a room and crisply articulates the forms within the space. Possible detrimental effects of direct sunlight, such as glare and excessive heat gain, can be controlled by shading devices built into the form of the opening or provided by the foliage of nearby trees or adjacent structures.

An opening can also be oriented away from direct sunlight and receive instead the diffuse, ambient light from the sky vault overhead. The sky vault is a beneficial source of daylight since it remains fairly constant, even on cloudy days, and can help to soften the harshness of direct sunlight and balance the light level within a space.
The location of an opening affects the manner in which natural light enters a room and illuminates its forms and surfaces. When located entirely within a wall plane, an opening can appear as a bright spot of light on a darker surface. This condition can induce glare if an excessive degree of contrast exists between the brightness of the opening and the darker surface surrounding it. The uncomfortable or debilitating glare caused by excessive brightness ratios between adjacent surfaces or areas in a room can be ameliorated by allowing daylight to enter the space from at least two directions.

When an opening is located along the edge of a wall or at the corner of a room, the daylight entering through it will wash the surface of the wall adjacent and perpendicular to the plane of the opening. This illuminated surface itself becomes a source of light and enhances the light level within the space.

Additional factors influence the quality of light within a room. The shape and articulation of an opening is reflected in the shadow pattern cast by sunlight on the forms and surfaces of the room. The color and texture of these forms and surfaces, in turn, affect their reflectivity and the ambient light level within the space.
Two spaces may be related to each other in several fundamental ways.

**Space within a Space**
A space may be contained within the volume of a larger space.

**Interlocking Spaces**
The field of a space may overlap the volume of another space.

**Adjacent Spaces**
Two spaces may abut each other or share a common border.

**Spaces Linked by a Common Space**
Two spaces may rely on an intermediary space for their relationship.
A large space can envelop and contain a smaller space within its volume. Visual and spatial continuity between the two spaces can be easily accommodated, but the smaller, contained space depends on the larger, enveloping space for its relationship to the exterior environment.

In this type of spatial relationship, the larger, enveloping space serves as a three-dimensional field for the smaller space contained within it. For this concept to be perceived, a clear differentiation in size is necessary between the two spaces. If the contained space were to increase in size, the larger space would begin to lose its impact as an enveloping form. If the contained space continued to grow, the residual space around it would become too compressed to serve as an enveloping space. It would become instead merely a thin layer or skin around the contained space. The original notion would be destroyed.

To endow itself with a higher attention-value, the contained space may share the form of the enveloping shape, but be oriented in a different manner. This would create a secondary grid and a set of dynamic, residual spaces within the larger space.

The contained space may also differ in form from the enveloping space in order to strengthen its image as a freestanding volume. This contrast in form may indicate a functional difference between the two spaces or the symbolic importance of the contained space.
An interlocking spatial relationship results from the overlapping of two spatial fields and the emergence of a zone of shared space. When two spaces interlock their volumes in this manner, each retains its identity and definition as a space. But the resulting configuration of the two interlocking spaces is subject to a number of interpretations.

The interlocking portion of the two volumes can be shared equally by each space.

The interlocking portion can merge with one of the spaces and become an integral part of its volume.

The interlocking portion can develop its own integrity as a space that serves to link the two original spaces.
Adjacency is the most common type of spatial relationship. It allows each space to be clearly defined and to respond, each in its own way, to specific functional or symbolic requirements. The degree of visual and spatial continuity that occurs between two adjacent spaces depends on the nature of the plane that both separates and binds them together.

The separating plane may:

- limit visual and physical access between two adjacent spaces, reinforce the individuality of each space, and accommodate their differences.

- appear as a freestanding plane in a single volume of space.

- be defined with a row of columns that allows a high degree of visual and spatial continuity between the two spaces.

- be merely implied with a change in level or a contrast in surface material or texture between the two spaces. This and the preceding two cases can also be read as single volumes of space which are divided into two related zones.
Two spaces that are separated by distance can be linked or related to each other by a third, intermediate, space. The visual and spatial relationship between the two spaces depends on the nature of the third space with which they share a common bond.

The intermediate space can differ in form and orientation from the two spaces to express its linking function.

The two spaces, as well as the intermediate space, can be equivalent in size and shape and form a linear sequence of spaces.

The intermediate space can itself become linear in form to link two spaces that are distant from each other, or join a whole series of spaces that have no direct relationship to one another.

The intermediate space can, if large enough, become the dominant space in the relationship, and be capable of organizing a number of spaces about itself.

The form of the intermediate space can be residual in nature and be determined solely by the forms and orientations of the two spaces being linked.
The following section lays out the basic ways we can arrange and organize the spaces of a building. In a typical building program, there are usually requirements for various kinds of spaces. There may be requirements for spaces that:

- have specific functions or require specific forms
- are flexible in use and can be freely manipulated
- are singular and unique in their function or significance to the building organization
- have similar functions and can be grouped into a functional cluster or repeated in a linear sequence
- require exterior exposure for light, ventilation, outlook, or access to outdoor spaces
- must be segregated for privacy
- must be easily accessible

The manner in which these spaces are arranged can clarify their relative importance and functional or symbolic role in the organization of a building. The decision as to what type of organization to use in a specific situation will depend on:

- demands of the building program, such as functional proximities, dimensional requirements, hierarchical classification of spaces, and requirements for access, light, or view
- exterior conditions of the site that might limit the organization's form or growth, or that might encourage the organization to address certain features of its site and turn away from others

SPATIAL ORGANIZATIONS

Compositions of Nine Squares: A Bauhaus Study
Each type of spatial organization is introduced by a section that discusses the formal characteristics, spatial relationships, and contextual responses of the category. A range of examples then illustrates the basic points made in the introduction. Each of the examples should be studied in terms of:

- What kinds of spaces are accommodated and where? How are they defined?
- What kinds of relationships are established among the spaces, one to another, and to the exterior environment?
- Where can the organization be entered and what configuration does the path of circulation have?
- What is the exterior form of the organization and how might it respond to its context?

**SPATIAL ORGANIZATIONS**

- **Centralized Organization**
  A central, dominant space about which a number of secondary spaces are grouped

- **Linear Organization**
  A linear sequence of repetitive spaces

- **Radial Organization**
  A central space from which linear organizations of space extend in a radial manner

- **Clustered Organization**
  Spaces grouped by proximity or the sharing of a common visual trait or relationship

- **Grid Organization**
  Spaces organized within the field of a structural grid or other three-dimensional framework
A linear organization consists essentially of a series of spaces. These spaces can either be directly related to one another or be linked through a separate and distinct linear space.

A linear organization usually consists of repetitive spaces which are alike in size, form, and function. It may also consist of a single linear space that organizes along its length a series of spaces that differ in size, form, or function. In both cases, each space along the sequence has an exterior exposure.

Spaces that are functionally or symbolically important to the organization can occur anywhere along the linear sequence and have their importance articulated by their size and form. Their significance can also be emphasized by their location:

- at the end of the linear sequence
- offset from the linear organization
- at pivotal points of a segmented linear form

Because of their characteristic length, linear organizations express a direction and signify movement, extension, and growth. To limit their growth, linear organizations can be terminated by a dominant space or form, by an elaborate or articulated entrance, or by merging with another building form or the topography of its site.
The form of a linear organization is inherently flexible and can respond readily to various conditions of its site. It can adapt to changes in topography, maneuver around a body of water or a stand of trees, or turn to orient spaces to capture sunlight and views. It can be straight, segmented, or curvilinear. It can run horizontally across its site, diagonally up a slope, or stand vertically as a tower.

The form of a linear organization can relate to other forms in its context by:

- linking and organizing them along its length
- serving as a wall or barrier to separate them into different fields
- surrounding and enclosing them within a field of space

Curved and segmented forms of linear organizations enclose a field of exterior space on their concave sides and orient their spaces toward the center of the field. On their concave sides, these forms appear to front space and exclude it from their fields.
A clustered organization relies on physical proximity to relate its spaces to one another. It often consists of repetitive, cellular spaces that have similar functions and share a common visual trait such as shape or orientation. A clustered organization can also accept within its composition spaces that are dissimilar in size, form, and function, but related to one another by proximity or a visual ordering device such as symmetry or an axis. Because its pattern does not originate from a rigid geometrical concept, the form of a clustered organization is flexible and can accept growth and change readily without affecting its character.

Clustered spaces can be organized about a point of entry into a building or along the path of movement through it. The spaces can also be clustered about a large defined field or volume of space. This pattern is similar to that of a centralized organization, but it lacks the latter’s compactness and geometrical regularity. The spaces of a clustered organization can also be contained within a defined field or volume of space.

Since there is no inherent place of importance within the pattern of a clustered organization, the significance of a space must be articulated by its size, form, or orientation within the pattern.

Symmetry or an axial condition can be used to strengthen and unify portions of a clustered organization and help articulate the importance of a space or group of spaces within the organization.
A grid is established in architecture most often by a skeletal structural system of columns and beams. Within the field of this grid, spaces can occur as isolated events or as repetitions of the grid module. Regardless of their disposition within the field, these spaces, if seen as positive forms, will create a second set of negative spaces.

Since a three-dimensional grid consists of repetitive, modular units of space, it can be subtracted from, added to, or layered, and still maintain its identity as a grid with the ability to organize spaces. These formal manipulations can be used to adapt a grid form to its site, to define an entrance or outdoor space, or to allow for its growth and expansion.

To accommodate the specific dimensional requirements of its spaces or to articulate zones of space for circulation or service, a grid can be made irregular in one or two directions. This dimensional transformation would create a hierarchical set of modules differentiated by size, proportion, and location.

A grid can also undergo other transformations. Portions of the grid can slide to alter the visual and spatial continuity across its field. A grid pattern can be interrupted to define a major space or accommodate a natural feature of its site. A portion of the grid can be dislocated and rotated about a point in the basic pattern. Across its field, a grid can transform its image from a pattern of points to lines, to planes, and finally, to volumes.
Entering a building, a room within a building, or a defined field of exterior space, involves the act of penetrating a vertical plane that distinguishes one space from another and separates “here” from “there.”

The act of entering can be signified in more subtle ways than punching a hole in a wall. It may be a passage through an implied plane established by two pillars or an overhead beam. In situations where greater visual and spatial continuity between two spaces is desired, even a change in level can establish a threshold and mark the passage from one place to another.

In the normal situation where a wall is used to define and enclose a space or series of spaces, an entrance is accommodated by an opening in the plane of the wall. The form of the opening, however, can range from a simple hole in the wall to an elaborate, articulated gateway.

Regardless of the form of the space being entered or the form of its enclosure, the entrance into the space is best signified by establishing a real or implied plane perpendicular to the path of the approach.
Entrances may be grouped formally into the following categories: flush, projected, and recessed. A flush entrance maintains the continuity of the surface of a wall and can be, if desired, deliberately obscured. A projected entrance forms a transitional space, announces its function to the approach, and provides overhead shelter. A recessed entrance also provides shelter and receives a portion of exterior space into the realm of the building.

In each of the above categories, the form of the entrance can be similar to, and serve as a preview of, the form of the space being entered. Or it can contrast with the form of the space to reinforce its boundaries and emphasize its character as a place.

In terms of location, an entrance can be centered within the frontal plane of a building or be placed off-center to create a condition of local symmetry about its opening. The location of an entrance relative to the form of the space being entered will determine the configuration of the path and the pattern of the activities within the space.

The notion of an entrance can be visually reinforced by:

- making the opening lower, wider, or narrower than anticipated
- making the entrance deep or circuitous
- articulating the opening with ornamentation or decorative embellishment

Palazzo Zuccari, Rome, c. 1592, Federico Zuccari
All paths of movement, whether of people, cars, goods, or services, are linear in nature. And all paths have a starting point, from which we are taken through a sequence of spaces to our destination. The contour of a path depends on our mode of transportation. While we as pedestrians can turn, pause, stop, and rest at will, a bicycle has less freedom, and a car even less, in changing its pace and direction abruptly. Interestingly though, while a wheeled vehicle may require a path with smooth contours that reflect its turning radius, the width of the path can be tailored tightly to its dimensions. Pedestrians, on the other hand, although able to tolerate abrupt changes in direction, require a greater volume of space than their bodily dimensions and greater freedom of choice along a path.

The intersection or crossing of paths is always a point of decision-making for the person approaching it. The continuity and scale of each path at an intersection can help us distinguish between major routes leading to major spaces and secondary paths leading to lesser spaces. When the paths at a crossing are equivalent to each another, sufficient space should be provided to allow people to pause and orient themselves. The form and scale of entrances and paths should also convey the functional and symbolic distinction between public promenades, private halls, and service corridors.

The nature of the configuration of a path both influences and is influenced by the organizational pattern of the spaces it links. The configuration of a path may reinforce a spatial organization by paralleling its pattern. Or the configuration may contrast with the form of the spatial organization and serve as a visual counterpoint to it. Once we are able to map out in our minds the overall configuration of the paths in a building, our orientation within the building and our understanding of its spatial layout will be made clear.
1. **Linear**
   All paths are linear. A straight path, however, can be the primary organizing element for a series of spaces. In addition, it can be curvilinear or segmented, intersect other paths, have branches, or form a loop.

2. **Radial**
   A radial configuration has linear paths extending from or terminating at a central, common point.

3. **Spiral**
   A spiral configuration is a single, continuous path that originates from a central point, revolves around it, and becomes increasingly distant from it.

4. **Grid**
   A grid configuration consists of two sets of parallel paths that intersect at regular intervals and create square or rectangular fields of space.

5. **Network**
   A network configuration consists of paths that connect established points in space.

6. **Composite**
   In reality, a building normally employs a combination of the preceding patterns. Important points in any pattern are centers of activity, entrances to rooms and halls, and places for vertical circulation provided by stairways, ramps, and elevators. These nodes punctuate the paths of movement through a building and provide opportunities for pause, rest, and reorientation. To avoid the creation of a disorienting maze, a hierarchical order among the paths and nodes of a building should be established by differentiating their scale, form, length, and placement.
A circulation space may be:

Enclosed
forming a public galleria or private corridor that relates to the spaces it links through entrances in a wall plane;

Open on One Side
forming a balcony or gallery that provides visual and spatial continuity with the spaces it links;

Open on Both Sides
forming a colonnaded passageway that becomes a physical extension of the space it passes through.

The width and height of a circulation space should be proportionate with the type and amount of movement it must handle. A distinction in scale should be established between a public promenade, a more private hall, and a service corridor.

A narrow, enclosed path naturally encourages forward motion. To accommodate more traffic as well as to create spaces for pausing, resting, or viewing, sections of a path can be widened. The path can also be enlarged by merging with the spaces it passes through.

Within a large space, a path can be random, without form or definition, and be determined by the activities and arrangement of furnishings within the space.
This chapter discusses the interrelated issues of proportion and scale. While scale alludes to the size of something compared to a reference standard or to the size of something else, proportion refers to the proper or harmonious relation of one part to another or to the whole. This relationship may not only be one of magnitude, but also of quantity or degree. While 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, and by how things are made.
In truth, our perception of the physical dimensions of architecture, of proportion and scale, is imprecise. It is distorted by the foreshortening of perspective and distance, and by cultural biases, and is thus difficult to control and predict in an objective and precise manner.

Small or slight differences in the dimensions of a form are especially difficult to discern. While a square, by definition, has four equal sides and four right angles, a rectangle can appear to be exactly square, almost a square, or very much unlike a square. It can appear to be long, short, stubby, or squat, depending on our point of view. We use these terms to give a form or figure a visual quality that is largely a result of how we perceive its proportions. It is not, however, an exact science.

If the precise dimensions and relationships of a design that is regulated by a proportioning system cannot be objectively perceived in a similar manner by everyone, why are proportioning systems useful and of particular significance in architectural design?

The intent of all theories of proportions is to create a sense of order and harmony among the elements in a visual construction. According to Euclid, a ratio refers to the quantitative comparison of two similar things, while proportion refers to the equality of ratios. Underlying any proportioning system, therefore, is a characteristic ratio, a permanent quality that is transmitted from one ratio to another. Thus, 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. Although these relationships may not be immediately perceived by the casual observer, the visual order they create can be sensed, accepted, or even recognized through a series of repetitive experiences. Over a period of time, we might begin to see the whole in the part, and the part in the whole.
Proportioning systems go beyond the functional and technical determinants of architectural form and space to provide an aesthetic rationale for their dimensions. 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. They can provide a sense of order in, and heighten the continuity of, a sequence of spaces. They can establish relationships between the exterior and interior elements of a building.

A number of theories of “desirable” proportions have been developed in the course of history. The notion of devising a system for design and communicating its means is common to all periods. Although the actual system varies from time to time, the principles involved and their value to the designer remain the same.

Theories of Proportion:
- Golden Section
- Classical Orders
- Renaissance Theories
- Modular
- Ken
- Anthropometry
- Scale  A fixed proportion used in determining measurements and dimensions

Types of Proportion:
- Arithmetic  \( \frac{c-b}{b-a} = \frac{c}{a} \)  (e.g., 1, 2, 3)
- Geometric  \( \frac{c-b}{b-a} = \frac{c}{b} \)  (e.g., 1, 2, 4)
- Harmonic  \( \frac{c-b}{b-a} = \frac{c}{a} \)  (e.g., 2, 3, 6)
Mathematical systems of proportion originate from the Pythagorean concept of ‘all is number’ and the belief that certain numerical relationships manifest the harmonic structure of the universe. One of these relationships that has been in use ever since the days of antiquity is the proportion known as the Golden Section. The Greeks recognized the dominating role the Golden Section played in the proportions of the human body. Believing that both humanity and the shrines housing their deities should belong to a higher universal order, they utilized these same proportions in their temple structures. Renaissance architects also explored the Golden Section in their work. In more recent times, Le Corbusier based his Modulor system on the Golden Section. Its use in architecture endures even today.

The Golden Section can be defined as the ratio between two sections of a line, or the two dimensions of a plane figure, in which the lesser of the two is to the greater as the greater is to the sum of both. It can be expressed algebraically by the equation of two ratios:

\[
\frac{a}{b} = \frac{b}{a+b} = 0.618
\]

The Golden Section has some remarkable algebraic and geometric properties that account for its existence in architecture as well as in the structures of many living organisms. Any progression based on the Golden Section is at once additive and geometrical.

Another progression that closely approximates the Golden Section in whole numbers is the Fibonacci Series: 1, 1, 2, 3, 5, 8, 13, ... 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.

In the numerical progression: 1, Ø, Ø², Ø³, Ø⁴, ... Øⁿ, each term is the sum of the two preceding ones.
A rectangle whose sides are proportioned according to the Golden Section is known as a Golden Rectangle. If a square is constructed on its smaller side, the remaining portion of the original rectangle would be a smaller but similar Golden Rectangle. This operation can be repeated indefinitely to create a gradation of squares and Golden Rectangles. During this transformation, each part remains similar to all of the other parts, as well as to the whole. The diagrams on this page illustrate this additive and geometrical growth pattern of progressions based on the Golden Section.
These two graphic analyses illustrate the use of the Golden Section in the proportioning of the facade of the Parthenon. It is interesting to note that while both analyses begin by fitting the facade into a Golden Rectangle, each analysis then varies from the other in its approach to proving the existence of the Golden Section and its effect on the dimensions and distribution of elements across the facade.
Le Corbusier saw the Modulor not merely as a series of numbers with an inherent harmony, but as a system of measurements that could govern lengths, surfaces, and volumes, and "maintain the human scale everywhere." It could "lend itself to an infinity of combinations; it ensures unity with diversity... the miracle of numbers."
Anthropometry refers to the measurement of the size and proportions of the human body. While the architects of the Renaissance saw the proportions of the human figure as a reaffirmation that certain mathematical ratios reflected the harmony of their universe, anthropometric proportioning methods seek not abstract or symbolic ratios, but functional ones. They are predicated on the theory that forms and spaces in architecture are either containers or extensions of the human body and should therefore be determined by its dimensions.

The difficulty with anthropometric proportioning is the nature of the data required for its use. For example, the dimensions given here in millimeters are average measurements and are merely guidelines that should be modified to satisfy specific user needs. Average dimensions must always be treated with caution since variations from the norm will always exist due to the difference between men and women, among various age and racial groups, even from one individual to the next.
Of a room’s three dimensions, its height has a greater effect on its scale than either its width or length. While the walls of the room provide enclosure, the height of the ceiling plane overhead determines its qualities of shelter and intimacy.

Raising the ceiling height of a 12 X 16-foot room from 8 to 9 feet will be more noticeable and affect its scale more than if its width were increased to 13 feet or its length to 17 feet. While the 12 X 16-foot room with a 9-foot ceiling might feel comfortable to most people, a 50 X 50-foot space with the same ceiling height would begin to feel oppressive.

In addition to the vertical dimension of a space, other factors that affect its scale are:
- the shape, color, and pattern of its bounding surfaces
- the shape and disposition of its openings
- the nature and scale of the elements placed within it
Given a random organization of dissimilar elements, a datum can organize the elements in the following ways:

**Line**

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.

**Plane**

A plane can gather the pattern of elements beneath it or serve as an encompassing background for the elements and frame them in its field.

**Volume**

A volume can collect the pattern of elements within its boundaries or organize them along its perimeter.
The simplest form of repetition is a linear pattern of redundant elements. Elements need not be perfectly identical, however, to be grouped in a repetitive fashion. They may merely share a common trait or a common denominator, allowing each element to be individually unique, yet belong to the same family.

We tend to group elements in a random composition according to:

- their closeness or proximity to one another
- the visual characteristics they share in common

The principle of repetition utilizes both of these concepts of visual perception to order recurring elements in a composition.