Programming Planning and Practice Study Notes
By Caroline Joseph

Notes and References based on:
- Kaplan 2012 Study Guide
- Wikipedia – The Free Encyclopedia (online)
- ARE forum – FTP Notes + Jenny C Notes

PLEASE NOTE: (my hold harmless clause)
- These study notes reflect what I thought was important to retain from the references.
- These study notes are not intended to replace or supersede any study aid book available.
- These study notes are to be used as reference only, they do not guarantee a “PASS” grade for the Programming Planning and Practice NCARB exam.
- There may be errors and omissions within the document, so do verify.

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KEY WORDS

- **Architecture** is the process of conceiving and developing physical forms to accommodate human needs and purposes. Its basic purpose is to accommodate and facilitate human activities.

- **Architectural Design:**
  1. It is the process of giving form to an idea by setting objectives, analyzing information, planning spaces and the conception of forms;
  2. It puts together different parts to form a unified, interdependent composition; and
  3. It requires the collaboration and coordination of a team of specialists.
    → Typically architectural design follows this process:
      1. Statement of problem
      2. Collection of data
      3. Analysis of data
      4. Program
      5. Design concept
      6. Design development
      7. Construction documents

- **Site design:** is an exploration of possible solutions to a specific site problem for the conscious rearrangement of the environment for human use, using design characteristics such as space, enclosure, scale, mass, and aesthetics. During this process, the designer must become familiar with the client’s goals, the intended land use, and the parcel of land itself. The various steps may occur in sequence; some may overlap, or occur simultaneously:
  1. Project proposal: scope and cost of services, time (duration)
  2. Research and analysis: collect, organize; analyze date from site, and client. Prepare a program
  3. Design phase: diagrams, schematics, master plan, etc.
  4. Construction phase: contract documents, landscaping plan, grading plan, etc.
  5. Post construction: evaluate and maintain

- **Demography:** statistical study of human populations.

- **Census:** the means for gathering demographic information at a 10 year interval in the U.S., through a numeric enumeration of the number of people, their conditions of living, and their resources.

- **Density:** number of people per unit of area. Density only refers to a ratio, not the total number of people or how they are distributed. Density should not be confused with crowding; high density does not imply crowding. The perception of crowding depends on cultural influences and circumstances.

- **Population Size:** the actual number of people in a given location, without regard to density.

- **Residential Density:** measure of the number of people accommodated in a given area of land. It is important to determine the density for planning public services such as public utility systems, and for calculating traffic volumes. The density may be expressed in net or gross density.
  → **Net Density:** inhabitants ÷ housing land (it does not include streets)
  → **Gross Density:** inhabitants ÷ total land (including streets, local facilities, and open spaces)
- **Primary Social Group**: group of persons with whom one has the most intimate and hence greatest variety of social interactions – e.g. family.

- **Secondary Social Group**: group of person with whom one has less intimate and more specialized interactions – e.g. classmates in the case of school children.

- **Primary Work Group**: this classification deals with the production or collection of resources → miners, farmers, fisherman...

- **Secondary Work Group**: this classification takes the raw materials collected or produced by the primary work group and converts them into usable products → construction workers, factory workers...

- **Third Work Group**: this classification manages and services society and its industries → professionals: architect, teachers...

- **Use Network**: It is a physical pattern of places that are used by individuals for residence, work, recreation, and cultivation, all accessible by systems of convenient transportation, in a city or rural area.

- **Ergonomics**: design based on the mechanics of the human body and its various senses.

- **Time and Motion Studies**: it is the system of studying the factory environment in order to improve productivity of an individual’s physical effort. The result of these studies is to organize individuals into teams, and to alternate tasks among those individuals.

- **Chance encounter**: it is the creation of spontaneous contacts which result in an exchange of information and ideas using basic design principles such as:
  1. Movement and public spaces such as corridors;
  2. Horizontal arrangement of floors vs. multi-floor; fewer floors = more contact;
  3. Horizontal distances exceeding 200 to 300 ft, should be designed with social links between the different increments.

- **Catchment areas / market areas / trade areas / tributary areas**: it is the surrounding base of population within a geographical region, such as the people living at a certain distance from the proposed location of a shopping center, or a school district for a school building. Simple gross population numbers are not enough to determine a catchment area; information must be gathered from census data and local planning agencies.
  
  → **Catchment areas characteristics:**
  1. They may be defined by specific functions or population.
  2. Their boundaries may be determined by geographic features (highway, river), artificial political boundaries (city line, school district), or by nebulous demarcations (division between two ethnic groups). Boundaries are often determined by the availability of transportation.
  3. Catchment areas can overlap
  4. They may increase or decrease in size, or come into existence
  5. They may be a result of population growth in an area
  6. They may be a result of a municipal development
7. Residential catchments are determined by local transportation systems
8. Zoning ordinances help to create and preserve catchment areas by specifying which land use are permitted
9. Existing catchment areas are subject to alteration

- **Neighborhood Unit**: it comprises a group of people with common need and goals for living, education, work, recreation, and other activities.

- **Community**: a group of several neighborhoods with total population between 20,000 and 100,000 people.

- **Housing Types**: it is a fundamental element of urban planning.

<table>
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<td>Single Family House/Detached House</td>
<td>- The dwelling is usually occupied by just one household or family, and consists of just one dwelling unit or suite.</td>
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<td>- Two attached living units, either side by side or one above the other</td>
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<td>Row House</td>
<td>- Three or more attached units with a maximum of eight attached units in most municipalities</td>
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<td>Walk-up apartment</td>
<td>- Normally limited to 3 stories in height, combines efficient land use with a comfortable human scale</td>
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<tr>
<td>High-rise apartment</td>
<td>- Accommodates a large number of people conveniently in relatively small areas of land</td>
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- **Housing Pattern**: it is determined by the layout and configuration of streets, open space, and the apportionment of land into building lots.
• **Street Front Pattern**: Developed in a linear fashion, with houses and apartments lining both sides of the street.

• **End-on Pattern**: Consists of rows of units located at right angles of streets.

• **Court Pattern**: Groups units to face into a common open space.

• **PUD / Planned Unit Development**: It refers to new development. It is an attempt to reinforce diversity and mixture; each large parcel of land can have a mix of uses: residential, commercial, recreational, and open spaces designed with variable lot sizes and densities. It is also the zoning designation used to achieve the cluster concept. PUD may also be applied to industrial types of development. PUD’s have 3 major characteristics and 4 major advantages:
  1. It involves large developments from an entire neighborhood to a new town
  2. It involves a mixture of uses and types
  3. It requires phased development extended over a long period of time
  4. Efficient use of land by grouping compatible uses
  5. The grouping allows for extra land to be given to open space or common use areas
  6. Variety of housing options
  7. Recapture the diversity and variety of urban living

• **Cluster Development**: (housing development pattern) in this type of development dwelling units are grouped and more densely sited than in conventional developments. The remaining land serves as common open space.

• **Urban redevelopment / Urban Renewal**: (housing development pattern) (name for federally funded programs) it is a form of PUD for central city areas. It refers to rebuilding in whole or in part.
- **RPC / Residential Planned Communities**: (housing development pattern) allows the developers to integrate residential, commercial, and industrial uses, and to divide the land into different density areas, based on the village-neighborhood-town concept. Example: Columbia, Maryland.

- **CPTED / Crime Prevention through environmental design**: it takes the idea of defensible space further and includes additional methods to reduce crime, such as electronic surveillance, alarms, and human resources (see Urban Concepts).

- **Tenant Mix**: variety of store types and facilities in a shopping center.

- **Homestead Act, 1862**: this act was passed by the Congress when a large amount of public land was transferred to private ownership. This act allowed for 160 acres of land to be given free to anyone who built a house and lived on the land for 5 years.

- **Water table**: it is the level underground in which the soil is saturated with water. The water generally follows the slope of the grade above, but it may vary slightly. Boring logs will reveal whether groundwater is present and how dip it is. Sites with high water tables – 6 to 8 ft below grade, can cause problems with excavations, foundations, utility placements, and landscaping.

- **Earthwork**: it includes excavating soil for the construction of a building foundation, water and sewer lines, and other buried items as well as modifying the site’s land contours.

- **Wetlands / Jurisdictional wetlands**: areas that are inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support vegetation typically adapted for life in saturated soil conditions.

- **Bioswale / Swale**: shallow and elongated grass-lined ditch or channel that is moist or marshy, designed to detain storm runoff and remove sediments and other contaminants while allowing the water to seep into the ground (increase rainwater infiltration).

- **Swamp**: it is a wetland that features permanent inundation of large areas of land by shallow bodies of water, generally with a substantial number of hammocks, or dry-land protrusions, covered by aquatic vegetation or vegetation that tolerates periodical inundation.

- **Infiltration basin**: closed depression in the earth from which water can only escape into the soil.

- **Catch basin**: A catch basin is a part of a storm drain or sewer system which is designed to trap debris so that it cannot enter the drainage pipes.

- **Excavation**: removal of soil to allow construction of foundations and other permanent features below the finished level of the grade.
  - **Trenching**: A narrow and long excavation done for piping or for narrow footings and foundation walls is called.

- **Grading**: modification of the contours of the site according to the grading plan.
  - **Rough grading** involves the moving of the soil prior to construction to approximate levels of the final grades.
→ *Finish grading* is the final moving of the soil prior to landscaping or paving.

- **Shoring**: temporary support for excavation walls consisting of vertical beams and horizontal timbers.

- **Bracing**: temporary support for excavation walls consisting of vertical sheeting, either wood or steel, supported by diagonal braces.

- **Underpinning**: it is a method to temporarily support existing foundations while they are being repaired or strengthened or when they are being extended to a lower level.

- **Building sewer**: it is the portion of the horizontal piping of the sanitary sewer system outside the building.

- **Invert**: it is the lowest elevations of the existing public sewer line. It should be established during planning because the effluent (out flowing of water) must flow from the lowest point where the sewer lines leaves the building to the main sewer. **Note**: the actual connection of the building sewer to the main line must occur above the invert of the main line at any given point in order to interfere with the free flow.

- **Site analysis map**: on this map information recorded during site analysis is overlaid and superimposed over a base map.

- **Base Map**: it is used as a background map for site analysis. It shows the site’s legal boundaries, contours, roads, buildings, utilities, and other manmade key features.

- **Landform**: refers to the shape of the earth’s surface. The natural shape of land affects how a land is perceived, modified and used. A level landform is flexible, practical, and highly desirable for the majority of human uses.
  → **Landscape**: it is the continuous composition of various earthforms that blend into and reinforce one another.

- **Improvement**: refers to any structure on a parcel of land which has value and improves the parcel’s usefulness. When calculating land value, the improvement must represent the *highest and best use of the land*, that is, the use that is most likely to produce the greatest net return over a given period of time.
  → **Underimprovement** will reduce the value of a property; the property is not producing the maximum income it is capable of producing given its size, zoning and so on.
  → **Overimprovement** means that the cost of improvement exceeds potential revenue or income.

- **Eminent Domain**: it is when an owner is required to relinquish his property to a government entity if the property is needed for a public project (highway, school, road widening ...) or for an overriding public need, such as structure in a way of an aircraft flight path. In the first instance, the government exercises its powers of *eminent domain*, which involves a condemnation proceeding. The owner of the property is entitled to a “just compensation” at the fair market value of the land. Unless it is absolutely necessary, governmental agencies are reluctant to use this power because the legal proceedings are complex and they want to avoid the attendant publicity.
Condemnation: it is the legal process initiated by the public authority wishing to take the property in question to exercise the power of eminent domain to transfer title to the property from its private owner to the government.

- **Air Rights**: it is the right to use the open space above land or above existing structure that can be sold or leased.

- **Subsurface Rights**: refer to rights to oil and minerals under property that can be sold, or leased.

- **Solar Rights**: it refers to the right of a site or building to have access to solar radiation.

- **Riparian Rights**: it is a system of rights and duties that determine the reasonable use, duties, and allocation of water to owners of waterfront property; a person must own land adjacent to a body of water to be considered a riparian owner. Riparian rights also depend upon "reasonable use" as it relates to other riparian owners to ensure that the rights of one riparian owner are weighed fairly and equitably with the rights of adjacent riparian owners. These rights cannot be sold or transferred other than with the adjoining land, and water cannot be transferred out of the watershed. **Note**: the owner does not own the water itself.

- **Development Rights Transfer**: the owner of an historic property may “sell” the development rights to his property to the owner of another nearby property, allowing that owner to develop his property at a higher density.

- **Exaction**: it is a concept where a condition for development is imposed on a parcel of land that requires part of the land to be dedicated to public use.

- **Variance**: it is a deviation from the zoning regulations applicable to a land parcel. It is used when zoning ordinances create an undue hardship on a property owner or a zoning ordinance does not completely cover unusual conditions.

- **Nonconforming uses**: it is a use that is no longer permitted by the zoning ordinance. If a new zoning ordinance is being applied to existing development, there may be properties that contain nonconforming uses. It concerns uses that do not comply with current zoning regulations but that were permitted by the zoning ordinances in effect when the structure was built. Nonconforming uses are allowed to continue unless they are unsafe, or the owner stops using the property in its original fashion or the property is destroyed or demolished by fire. Any new use or rebuilding must be in compliance with existing zoning standards.

- **Conditional Use Permit**: it is granted by a zoning board for a special purpose for the welfare and convenience of the public. It allows a nonconforming use or other use in the zoning ordinance if the property owner meets certain restrictions. This is often done in the public interest. For example, a temporary street fair in a location where it will normally be prohibited.

- **Spot zoning**: [favors a particular owner] the designation of a parcel of land for a use classification different from that of the surrounding area to favor a particular owner.

- **Buildable area**: it is the lot area minus the required setbacks. Structures are only allowed to be built in this area.
- **Fire Zones**: geographic districts generally classified as high, moderate or low hazard based on population density, building height, street access, and congestion that affect fire department response time, and the fire department’s equipment and competence.

- **Life Cycle Cost Analysis / LCC**: used to evaluate the economic performance of a material or building system over the service life of the material or system. It includes all the costs associated with purchasing, installing, maintaining, and disposing of an item from the time the item is installed in a building through the duration of the LCC study period. All costs during the study period are discounted to convert future costs to their equivalent present values and account for the time value of money.

- **Life Cycle Assessment / LCA**: the LCA of a material evaluates the environmental impact from initial raw material extraction to final recycling, reuse, or disposal.

- **Pro forma statement**: 1) a financial projection for the development of a project meant to determine if the project is feasible, given estimates on potential income and the cost of developing the project. 2) It is a mean of determining a project’s construction budget by listing labor and construction costs.

- **Ad Valorum Tax**: taxed based on the value of the property being taxed.

- **Debt service / Cost of Money**: cost to pay off a construction loan for a project. It is considered to be an ongoing cost over many years; it is not part of the original project cost.

- **Value Engineering**: a review process of proposed systems and materials used to explore less expensive options that will achieve a similar result.

- **Overhead**: the general cost of a building that cannot be directly assigned to a project. For example rent, drafting supplies, taxes, professional dues, etc. Salaries and benefits qualify only if the employee or principal is not doing project related work.

- **Agency**: the legal concept is that one person, the agent, acts on behalf of another, the principal, in dealings with another, the third party. In architecture, the agent is the architect, the principal is the owner or client, and the third party is the contractor.

- **Duty**: it is what one person owes another in particular relationships, by applying the term duties to a set of requirements.

- **Liability**: it is the legal responsibility for injury or damage to another person or property.

- **Negligence**: failure to use due care to avoid harming another person or property.

- **Risk management**: tool to limit exposure to liability, e.g. quality control.

- **Privity**: this concept theoretically protects the architect from claims by parties with whom he or she has no direct contractual relationships.
- **Indemnification clause**: attempts to hold harmless both the owner and architect for any damages, claims, or losses resulting from the performance of any work on the project whether by the contractor or others with whom the architect has no contractual relationship.

- **Prescriptive building code**: specifies construction methods, and materials in detail. It is simple to administer but discourages innovation. Most model codes follow this method.

- **Performance building code**: establishes the functional requirements that a structure must satisfy under specific conditions. It promotes innovation in building design, but it may be difficult to administer.

- **Warranty Deed**: a guarantee that the property title will be transferred to a buyer free of liens, claims, or other debt.

- **Off-street requirements**: parking spaces within property lines as required by a city ordinance and often expressed as parking spaces per dwelling unit or per commercial space.

- **Deed**: it is a document signed by the seller (grantor) and delivered to the buyer (grantee), conveying the title of a property from one owner to another, when a property is sold. This document becomes legally recognized when it has been recorded in the office of the recorder in the city or county in which the property is located.

- **Azimuth**: angle north or south from an east-west line.

- **Wind chill factor**: is the felt air temperature on exposed skin due to wind. The wind chill temperature is always lower than the air temperature. This factor has a great effect on building energy consumption for heating.

- **Functional Program**: it is information or data provided by the owner for the analysis and creation of a facilities program.

- **Facilities Program**: it is a program that considers scope, area minimums, area adjacencies, ballpark costs and site analysis based on a functional program.

- **Room Data Sheets**: those sheets list all of the relationships requirements in a given room, including layout, equipment, activity zones, and lighting, temperature, and comfort requirements. For example, several diagnostic imaging departments may have different needs; therefore each will have a room data sheet.

- **Assessment**: a valuation set on taxable property.

- **Amortization**: it refers to spreading payments over multiple periods.

- **Biophilia**: human love of life and living systems; it is the attractions and positive feelings that people have toward certain habitats, activities, and objects in their natural surroundings.
- **Building Commissioning**: it is the process of verifying, in new construction, that all the subsystems achieve the owner’s project requirements as intended by the building owner and as designed by the building architects and engineers; it is a quality-focused process necessary for both non-complex and complex modern construction projects. All forms of building commissioning share the same goals: to produce a building that meets the unique needs of its owner and occupants, operates as efficiently as possible, provides a safe, comfortable work environment, and is operated and maintained by a well-trained staff or service contractor.

- **Retro commissioning**: it is the application of the commissioning process to existing buildings and seeks to improve how building equipment and systems work together.

- **Organic feedstock**: it is an organic matter that mold can eat. Mold cannot eat inorganic materials such as concrete.

- **U-Factor / U-Value**: it describes how well a building element transfers heat. Low U-value = slow heat loss or gain (ex. Brick wall); High U-value = high heat loss or gain (ex: window).

- **R-Value**: it measures the thermal resistance in a building component.

- **Thermal Inertia**: put simply, it is the ability of a material to store heat. For example, concrete walls in an arid climate have a high thermal inertia because they store heat in daytime, and release it slowly at nighttime.

- **Design temperature**: it is the average temperature that a mechanical system is designed for heating (how cold the temperature gets) and cooling (how warm the temperature gets).

- **Primogeniture**: is the right, by law or custom, of the firstborn to inherit the entire estate, to the exclusion of younger siblings; land was passed from father to eldest son.

- **Standpipe**: it is a type of rigid water piping which is built into multi-story buildings in a vertical position, to which fire hoses can be connected, allowing manual application of water to the fire. Within buildings standpipes thus serve the same purpose as fire hydrants. They are required in buildings that are 3+ stories and they should be operational during construction.
  → **Wet standpipe**: it is filled with water from a public supply and is pressurized at all times and they can be used by building occupants.
  → **Dry Standpipe**: it is only used only when needed for fire fighting. It is not filled with water and it is not connected to a constant public water supply; fire engines supply the water to the system.
  → **Combination Standpipe**: it is a combination of both wet and dry.

- **BOMA International**: it stands for Building Owners and Managers Association. It is a professional organization for commercial real estate professionals. These professionals monitor and lobby pertinent legislative, regulatory and codes/standards issues in relation to the commercial real estate industry. It is a primary source of information on building management and operations, development, leasing, building operating costs, energy consumption patterns, local and national building codes, legislation, occupancy statistics, technological developments and other industry...
trends. BOMA International has also set standards for measuring buildings and calculating rentable area.

- **Fair Housing Act**: it is a law that prohibits housing discrimination of the basis of race, color, religion, sex, disability, familial status, and national origin.

- **HUD**: it stands for the US Department of Housing and Urban Development. Its purpose is to develop and execute policies on housing and metropolises.
PROGRAMMING

ARCHITECTURAL PROGRAMMING

→ It is an attempt to analyze and define an architectural problem and establish all the guidelines and needs on which the design process can be based; programming concentrates on seeking the problems, not the solutions. During the programming process, objectives are stated, functional requirements are described, and detailed requirements are noted, in order to help the client understand the real problem in regards to the project and provide a sound basis for making design decisions. The programming method uses a five-step process in relationship to four major considerations described in the book Problem Seeking by William Peña. Architectural programming services can be provided by the architect as part of his basic services, but in most cases, it is considered to be a separate service which should be compensated as an additional service. The programming team consists of the architect, the client, the consultants, and the user’s representative.

Four major considerations of any design problem:

1) **Form**: relates to the site, the physical & psychological environment of the building, and the quality of construction.
2) **Function**: relates to the people and activities of the space or building and their relationships.
3) **Economy**: concerns money; initial cost, operation cost, and life-cycle costs
4) **Time**: the schedule for design, construction and occupancy.

Five-step process of architectural programming: (each of these steps are organized around the four major considerations defined above)

1) **Establish goals / Establish objectives**: goals indicate what the client wants to achieve and why. They establish the direction of programmatic concepts that ultimately suggests the physical means of achieving goals. Ex: increase the daily informal interaction between students and teachers.
2) **Collecting facts / Collect, organize, and analyze data**: the facts describe the existing conditions and requirements of the problem, which should not only be collected, but also organized, using such tools as the program outline format (see definition). Examples of facts to be collected and organized include, but are not limited to, site conditions, space adjacency needs, money available for construction, building code requirements, etc.
3) **Uncovering concepts / Formulate relationships**: develop abstract ideas that are functional solutions to the client’s problems without defining the physical means that should be used to achieve them by using programmatic concepts (see definition). Ex: A programmatic concept to increase the daily informal interaction between students and teachers: provide common spaces for mixed flow in circulation patterns.
4) **Determining needs / Establish priorities**: this step balances the desires of the client against the available budget or establishes a budget based on the defined goals and needs; wants have to be separated from needs. During his step one or more of the four elements of cost (quantity, quality, time, and budget) may have to be adjusted to balance needs against available resources.
5) **Stating the problem**: this step summarizes the essence of the problem in just a minimum of four statements, one for each of the major considerations of form, function, economy, and time. These statements will be the bridge between programming and the design process.
• **Program Outline Format**: the purpose of the program outline format is to organize programmatic data, to summarize basic project needs, and to be used as a guide during the various design phases.

  → The program outline format is broken down into 4 components:

  1. **Total building group**: it refers to all the buildings that constitute a building group. It is like developing a master plan for a group, as well as its shared elements (e.g. circulation, parking ...). Note: A master plan describes the development of a site to be realized over a period of many years.

  2. **Component building**: it refers to the functions any single building in the Total Building Group. This portion should describe the objectives of the building’s activities, the relationship between the major activity centers, the number and type of people to be housed, the amount of space needed to serve the objectives, access, ingress, egress, internal circulation, and possible extension.

  3. **Activity center**: it refers to a space or series of spaces within the component building related to each other by function.

  4. **Space unit**: information about the space itself.

  ![Images of medical campus, acute care, surgery dept., pre-op suite](image1.png)

• **PROGRAMMING CONSIDERATIONS**

• **Design Concepts vs. Programmatic Concepts**

  → **Design Concept**: physical solutions to the client’s problems and which reflect approaches to satisfying programmatic concepts.

  → **Programmatic Concepts**: abstract ideas about how to view and solve the client’s performance problems before attempting to solve them with 3D design ideas. 24 programmatic concepts are identified in the book *Problem Seeking* by William Peña:

  1. Priority
  2. Relationships
  3. Hierarchy
  4. Character
  5. Density
  6. Service groupings
  7. Activity grouping
  8. People grouping
  9. Home base
  10. Communications
  11. Neighbors
  12. Accessibility
  13. Separated flow
  14. Mixed flow
  15. Sequential flow
  16. Orientation
  17. Flexibility
  18. Tolerance
19. Safety
20. Security controls
21. Energy conservation
22. Environmental controls
23. Phasing
24. Cost control

- Psychological and Social Influences

During programming, the architect has to make a clear distinction between the architect’s client and the actual users. They are not always the same. The resulting statement of the programming process must respond to the psychological needs of these users by developing physical guidelines in order to develop a realistic model of the people who will be using the structure, and the nature of their activities. For that reason, the architect needs to get familiar with the following concepts:

1. **Diversity**: humans need a diverse and stimulating environment.
2. **Proxemics**: it is a term created by Edward T. Hall to describe the interrelated observations and theories of humans’ use of space as a specialized elaboration of culture. It deals with the issues of spacing between people, territoriality, organization of space, and positioning of people in space, all relative to the culture of which they are part:
   - **Behavior setting**: studies the effect of the environment on human activity. It can be though as a particular place, with definable boundaries and objects within the place, in which a standing pattern of behavior occurs at a particular time. Example: the activity dictates the behavior; a weekly board of associates meeting in a conference room. The activity of the meeting follows a procedure, it occurs in the same place, and the room is arranged to assist that activity.
   - **Territoriality**: it refers to the need to lay claim to the spaces we occupy and the things we own; people need a place they can call their own. Environments should allow people to claim territory and make choices about where to be and what activities to engage in.
   - **Personalization**: people need to arrange their environment to reflect their presence and uniqueness. Example: moving a chair to make viewing a screen easier.
   - **Status**: the physical environment holds a great deal of symbolism that indicate/communicate status for some human beings. Example: in the US someone with a corner office has more status than someone with only one exterior wall.
   - **Group interaction**: an environment can either facilitate or hinder human interaction. In most behavior settings, groups are disposed to act a certain way. If the setting is not conductive to the activities, people will modify it or modify their behavior. In most cases, providing a variety of spaces for interaction is the best approach:
     1. **Sociopetal**: spaces, buildings, rooms, and even furniture can be considered sociopetal if they bring people together.
     2. **Sociofugal**: it refers to conditions that just do the opposite of sociopetal; they tend to discourage interaction or social contact.
     3. **Personal Space**: there four basic distances that can used to study human behavior:
        - **Intimate distance**: people come within this distance for special conditions - physical contact to a distance of 6” to18”
        - **Personal distance**: general distance maintained between a person and other people - 1 ½ to 2 ½ ft
        - **Social distance**: interaction between strangers - 4ft to 12ft
        - **Public distance**: greatest amount of formality - 12ft outward
### Vocabulary of Form

**Object Structure**

- **Point**: It indicates position. It has no dimension and does not occupy space. It can represent the beginning and ending of a line. It is the place where two lines intersect.
- **Line**: It is the path described when a point moves. It has a position, direction, and length, but no thickness. A line is bounded by two points and forms the border of a plane.
- **Plane**: It is the path described by a line in motion, in a direction other than its own direction. A plane has position, direction, length, and width, but no thickness. It is bounded by lines and defines the external limits of a volume.
- **Volume**: 3D space describe by a plane in motion in a direction other than parallel to itself. It has position in space and his bounded by planes.

### Design Characteristics

- **Shape**: outline or configuration of a thing.
- **Size**: is the physical dimension of something. All shapes have size.
- **Color**: the appearance of something caused by the quality of light reflected by it. Shapes are distinguished from their surroundings in part due to color.
- **Texture**: surface characteristics of an object.
- **Space**: it is the interval between points or objects. It is a 3D volume enclosed by building elements where the movement and activities of people take place. Space is perceived by all of our senses. Every space has an effect on people depending on its size, height, scale, color, and details. The shape of spaces can indicate how a person is expected to move. Manipulating space deals with describing the relationship between spatial design and the feeling of people in that space, achieved through design.

### Object Characteristics

- **Form**: the perception of form is based on memory associations developed in childhood, which involve the tactile as well as visual sense (i.e. we know how a jagged rock will feel even before touching it). Form can also imply movement (i.e. church spire appears to go up and up in the sky).
- **Scale**: it is the relative size of a structure or space in reference to the human body. An object is out of scale when something does not conform to its expected size. An extra human scale derives from allowing functions to determine size.
- **Proportion**: it is the relationship between the constituent parts of a structure. It expresses the order of importance of the parts – primary, secondary, or supporting roles, by suggesting the role played by a component part in a structure. (ref. Golden Section)
- **Rhythm**: it is a device for establishing order. It is the regular occurrence of elements, in time or in space. The essence of visual rhythm is spacing, which is conveyed by a recurring design element. A texture can be thought of as a fine-scale rhythm.
- **Balance**: it is the equilibrium among the constituent parts of the structure. It is also a visual quality.
  - → **Static balance**: the parts are equal in size and located equally about a reference axis
  - → **Dynamic balance**: the parts are of unequal size, and arranged about a reference axis so as to compensate for their differences.
- **Symmetry**: it is a balanced arrangement of elements, equally deployed on either side of a central axis
- **Light**: daylight is a design element that a designer is able to control. Light variations must be recognized and considered. A designer can determine how daylight falls on a building, how it enters a building, and how its quality and intensity may be utilized. Light also possesses psychological connotations (e.g. dim light = rest/meditation)
- **Color**: light and color are inseparable. Color is not experienced independently, but rather as one of several characteristics of an object or place. It is useful for articulating and accentuating form and space by establishing physical divisions, direct traffic, and emphasizing architectural elements. Color can also be used as a paint to unify a defect on a surface or discordant elements. Like light it has psychological effects (e.g. red = exciting), it is important for the designer to be aware of colors as they affect behavior.
Space and Volume Needs

→ How to determine space and volume needs:

1. **Client** will have a list of requirements for square footage and special heights based on the client’s experience, what currently exists, or on corporate space standards. These requirements may be subject to review during programming.

2. **People** engaged in a particular activity most commonly define the space required. Ex: an office worker needs from 100 ft² to 250 ft². This information is usually given in a guideline for space requirements. In some instances, space needs can be based on something that is directly related to occupancy. Ex: area per bed for the preliminary planning of a hospital. In both cases, the number of people that must be accommodated is determined and is multiplied by the area per person.

3. **Objects** determine the amount of space required (Ex: washing machine and dryer dimensions determine the necessary clear space for where they will be located in a laundry room).

4. **Specific Activity** governed by certain practices or rules related to the activity itself (Ex: a basketball court has specific dimensions and layout).

5. **Market study research** help determine the space/volume needs for retail sales spaces

6. **Numeric Method**’s main purpose is to present a logical system for the calculation of space requirements to estimate the space needs in living and work spaces. It classifies the different physical facilities (e.g. Educational Facility) into use categories (e.g. Classrooms, Labs, Library ...) which will require a specific amount of space obtained using an index (multiplier).

   → Factors needed to compute an index:
   1) **Ft²/user**: Square feet per user, found using the space standards. (Ex: Classroom 15-20 ft²)
   2) **Hrs/Wk**: Hours per week the space is being used. (Ex: Classroom being used 30h/week)
   3) **% of Time**: Percent of time that space will be occupied while in use (Ex: Classroom student stations will be in use for 60% of the time)

   → Formula using the numeric method

<table>
<thead>
<tr>
<th>Calculate Index</th>
<th>Example:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ft²/user + (Hrs/Wk x % of Time)</td>
<td>15 ÷ (30 x .60) = 15 ÷ 18 = .833</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Calculate NSF</th>
<th>Example:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quantity of users x Index</td>
<td></td>
</tr>
<tr>
<td>(this does not determine the quantity or size of classrooms, it gives a total amount of NSF needed to accommodate those users)</td>
<td></td>
</tr>
<tr>
<td>1st: Calculate the weekly user hours:</td>
<td></td>
</tr>
<tr>
<td>1,000 sociology students - 6hr/week</td>
<td></td>
</tr>
<tr>
<td>1,000 x 6 = 6,000 weekly hours</td>
<td></td>
</tr>
<tr>
<td>2nd: Calculate the Net Square Feet:</td>
<td></td>
</tr>
<tr>
<td>6,000 x .833 = 5,000 NSF</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Calculate Gross Area</th>
<th>Example:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net Area + Efficiency</td>
<td>5,000(NSF) ÷ 60%(Efficiency) = 8,333 sf'(Gross)</td>
</tr>
</tbody>
</table>

→ **Total Building Area**

   → **Space Standards /Net Square Feet per Occupant**: they are specified in building codes, it is the amount of usable floor area required for one person including that person’s share of
floor area required for circulation to be safely housed in a space. For example: a dining table requires 15-17 ft\(^2\) for each person to be safely housed in a space.

→ **NSF-Net Square Feet/Net Area /Net Assignable Area**: sum of all usable (leasable) floor spaces measured to the inside faces of enclosing walls or to the lines of other space separations. It does not include spaces not directly housing the primary activities of the building such as circulation and general service areas (corridors, lobbies, restrooms, custodial rooms, stairways, mechanical spaces...). These secondary spaces are referred to as the unassigned areas.

→ **Gross Building Area**: sum of all building areas (assigned and unassigned) measured to the exterior face of perimeter walls, including interior walls, columns, and shafts.

→ **Efficiency** is the net-to-gross ratio. The ratio maybe dictated by a client or maybe obtained using common efficiency ratios. This ratio ranges from 60-80%; any percentage below 60% is considered inefficient. Efficient means that an area is functioning in the best possible manner with the least waste of space. To increase the efficiency of a building, usually, circulation layout has to be done carefully; the least amount of corridors, the higher the efficiency.

→ **Typical Building efficiencies**:

<table>
<thead>
<tr>
<th>Efficiency</th>
<th>Building Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>55%</td>
<td>Hospital</td>
</tr>
<tr>
<td>60%</td>
<td>College (student union) / court house / retail store</td>
</tr>
<tr>
<td>65%</td>
<td>Apartments / College (Classroom +Admin)</td>
</tr>
<tr>
<td>70%</td>
<td>Auditoriums /Bank / Restaurants</td>
</tr>
<tr>
<td>75%</td>
<td>Prison / Office</td>
</tr>
<tr>
<td>80%</td>
<td>Department Store</td>
</tr>
<tr>
<td>85%</td>
<td>Parking garage / Service areas</td>
</tr>
</tbody>
</table>

→ **Formulas**:

\[
\text{EFFICIENCY} = \frac{\text{NET}}{\text{GROSS}} \times 100
\]

Example:
- Gross Area: 100,000 ft\(^2\)
- Net Square Feet: 60,000 ft\(^2\)
- \[60,000 \text{ ft}^2 \div 100,000 \text{ ft}^2 = .65\]
- \[.65 \times 100 = 65\%\]

\[
\text{GROSS AREA} = \frac{\text{NET}}{\text{EFFICIENCY}}
\]

Example:
- Efficiency Ratio: 65% or .65
- Net Square Feet: 60,000 ft\(^2\)
- \[60,000 \div .65 = 100,000 \text{ ft}^2\]

**Organizational Patterns**

→ The functional needs of a project, the clients’ goal, the site conditions, the desired symbolism, patterns of growth, or other additional factors influence how the physical environment is organized. Each organizational pattern has its own core characteristics which should be measured against several aspects: user behavior and objectives, circulation, health, expansion, and cost. There are 6 fundamental organizational concepts:
<table>
<thead>
<tr>
<th>Organization</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linear</td>
<td>Consist of a series of buildings or spaces (identical or of different sizes and shapes) that always relate to a single line. A linear organization is adaptable, easily expandable, and be built in a modular configuration. <strong>Positive:</strong> major circulation occurs between two points. <strong>Negative:</strong> lack of focus, may be congested, expansion may be limited.</td>
</tr>
<tr>
<td>Axial</td>
<td>It is a variation of the linear system with two or more major linear segments about which buildings or spaces are placed. <strong>Positive:</strong> allows for expansion. <strong>Negative:</strong> may become extended.</td>
</tr>
<tr>
<td>Grid</td>
<td>Consists of two sets of regularly spaced parallel lines, which creates one pattern that is very strong, and one that is quite flexible. <strong>Positive:</strong> allows for expansion in several directions, flexible, compact, and appropriate for very large buildings and building complexes where a great amount of circulation is required. <strong>Negative:</strong> may become monotonous.</td>
</tr>
<tr>
<td>Central</td>
<td>It is based on one space or point about which secondary elements are placed. This organization concept is often used in combination with axial or linear plans. <strong>Positive:</strong> common point of origin, compact, allows for maximum social interaction. <strong>Negative:</strong> somewhat inflexible.</td>
</tr>
<tr>
<td>Radial</td>
<td>More than one linear organization extends from a centralized point. This organization has a central focus and also has the ability to extend outward to connect with other spaces or expand. It can be circular or assume other shapes. <strong>Positive:</strong> common point of origin, compact, allows for maximum social interaction, allows for expansion <strong>Negative:</strong> may become extended</td>
</tr>
<tr>
<td>Cluster</td>
<td>It is a loose composition of spaces or buildings related around a path, axis, or central space, or they are simply grouped together. <strong>Positive:</strong> adaptable to requirements for different sizes of spaces and they are easy to add onto without disrupting the overall composition <strong>Negative:</strong> may become extended</td>
</tr>
</tbody>
</table>

- **Circulation Patterns**
  - They are primary ways of organizing spaces, buildings, and group of buildings. They are vital to the efficient organization of a structure and provide people with their strongest orientation within an environment. Paths of circulation provide the means to move people, cars, products, and services. A circulation pattern is directly related to the organizational pattern of a building but it does not necessarily have to mimic it.
Spaces are laid out along a straight path that connects two major elements at the ends.

**Positive:** simplest, most flexible, double loaded corridor makes it very efficient, spaces are laid out perpendicular to the path and allow for extension along the length of the spaces.

**Negative:** site constraints may restrict the length of the spine.

Making a complete loop of the dumbbell results in a doughnut configuration.

**Positive:** spaces at the perimeter can be expanded outward. It is good for square or nearly square sites and for buildings that must be compact. Spaces that do not need exterior exposure can be placed in the middle. Entries, exits, stairways can be placed wherever needed.

**Positive:** used in large buildings where access must be provided to many internal spaces

**Negative:** not appropriate and inefficient for small buildings.

It is oriented on one major space with paths extending from its central area.

**Positive:** appropriate for large buildings or building complexes

**Negative:** requires a large site. Each corridor must have an exit at the end if it is longer than 20ft.

Consists of a network of paths with no strong direction.

**Negative:** orientation is difficult, may become extended

---

**Service spaces:** service spaces or secondary spaces as well as service access must be planned for during programming. Mechanical rooms should be centrally located to minimize lengths of ducts and runs. Toilet rooms should be located to satisfy adjacency requirements or in an area that has easy access to the entire floor.

**Flexibility:** it involves a variety of concepts which are:

1. **Expansibility:** it is the capacity of a building to be easily enlarged or added onto as needs change or growth occurs.
2. **Convertibility:** it allows an existing building or space to be changed according to a new use.
3. **Versatility:** it is the ability to use the same space for a variety of uses in order to make maximum use of a limited space.
- Determine space relationships

**Matrix Format**

[Matrix Format Image]

How to read a matrix format: follow the outer lines of each tab until it meets with the outer line of another tab on the list. At the point where they meet, provide for the appropriate or required adjacency level.
- **Filled circle/1** = mandatory adjacency
  - Example: entry and living room need to be close to each other in this diagram
- **Empty circle/2** = secondary adjacency / no relationship
  - Example: the bedrooms do not have to be close to each other
- **No circle/3** = no adjacency/separate
  - Example: kitchen and study have to be separated.

**Bubble Diagram**

[Bubble Diagram Image]

How to read an adjacency diagram: follow the lines connecting each circle. The circles indicate required adjacencies, priorities, and relative size of spaces; best for showing relationships.
- **Thick line** = mandatory adjacency
  - Example: entry, study, and living room need to be close to each other
- **Thin line** = secondary adjacency
  - Example: entry, bedroom, and kitchen do not have to be close to each other but should still have a relationship
- **No line** = no adjacency
  - Example: study and bedroom do not need to be next to each other.

**Blocking & Stacking Diagram**

[Blocking & Stacking Diagram Image]

It is a method used to determine the ideal method of introducing program elements in a building envelope. It depicts more regular and accurately sized spaces.
- **Blocking** is the aggregation of area into a block of space, usually at the department level, based on the desired adjacency and support requirements.
- **Stacking** is the placement of the block within a building volume which shows the organization being studied and 3D adjacencies, where each unit is represented by a volume of space as quantified by the program data. (Used in multi-floor facility programming).
Building Prototypes (functional criteria of common building types)

1. **Housing**: the functional problem of housing is that many of the diverse activities it comprises occur simultaneously often in the same space. In analyzing the functional aspects of a dwelling, 1st determine which spaces are required, 2nd how much space is required, 3rd how will people circulate from one space to another. Consider that some functions may require proximity and others separation (Ex: noisy vs. quiet zones). In high-rise apartment buildings, activity spaces are generally quite similar. The livability of individual apartment units must be the basis of the design.

2. **Hotels**: they are divided into 2 major functional components: the public and service areas. The service function is the most critical and its objectives must be control and efficiency, whereas the public function needs to be planned with the convenience of the guest in mind, especially in the bedroom and bathroom layouts.

3. **Shopping Centers**: it is a group or series of shops all oriented to be accessed by the automobile. A primary programming objective is the creation of a convenient and attractive project, which offers maximum merchandising potential for tenant stores. Keep in mind the tenant mix, convenient access to the shopping center and the separation of pedestrian and vehicular areas. There 3 types of shopping centers:
   - **Neighborhood Center**: convenience goods, and personal services. Often built around a supermarket or drugstore. (Ex: Hammocks Center)
   - **Community Center**: in addition to convenience goods and personal services, it provides for the sale of soft goods (clothes), hard goods (hardware). (Ex: Wal-Mart)
   - **Regional Center**: it is built around one or more major department stores and provides general merchandise, furniture, and home furnishings. (Ex: Dadeland Mall)

4. **Schools**: the programming objective for a school is to describe the physical spaces required, the use of these spaces, their functional relationships, and the number of students and equipment needs for each space. Keep in mind the teaching methods likely to be used, life safety, standards, flexibility of spaces, as well as the educational environment (comfort, efficiency, and the needs of the users)

5. **Churches**: church plans are determined by the form of the various rituals which they must accommodate. Space must be provided for support activities (e.g. religious school) in addition to the major area of worship. Keep in mind that most religions require visual and aural (hearing) contact between those who lead the service and the congregation, and also that different religions have different practices which require different architectural expressions.

6. **Theaters**: stage dimension, seating arrangement, and sight lines all vary with the type of performance. All the theater spaces have a functional relationship that must be logically arranged (i.e. back of house, dressing room, front of house...).

7. **Parking Facilities**: parking areas should be designed to minimize traveling time. In Multi-floor parking garages, whether above or below ground, a gradually sloped or ramped floor system is most desirable. 90 degree parking is most often use for efficiency and to permit 2-way traffic flow. Consider ramp approach and departure angles, turning radii, and driveway specifications, sight lines, and control areas (i.e. drop off areas).
8. **Hospitals**: certain facilities and equipment requirements are common to all hospitals and determine the critical organization of space. Hospitals also need to expand in large increments. Consider the provision and arrangement of mechanical services, circulation efficiency, and understand the complex and different functions within a hospital (i.e. therapy rooms, x-ray suites...)

- **Scheduling of Design and Construction**
  - Setting up a timeframe for design & construction is one of the most important parts of programming because it influences cost (the longer it takes, the more it will cost), design decisions, and determines the feasibility of a project. Both schedules for design and construction should be flexible and responsive to changing conditions, and allow for contingencies of at least 2-4 weeks. Several methods are used for scheduling: *bar chart* or *Gantt chart* and the *Critical Path Method* (CPM).
  - **Effects of extending a schedule:**
    1. Original team members may retire or take other positions before completion of the work;
    2. Cost of the project will increase due to inflation that may result in the project being terminated or reducing its scope.
  - **Methods of shortening a schedule:**
    1. Team works overtime;
    2. Hire more people (part-time, freelance, subcontract work);
    3. Reduce the man-hours spent on the project.
  - **Effects of shortening a schedule:**
    1. Higher cost of design;
    2. Higher cost of construction;
    3. Lower quality project.

- **Design scheduling**
  - The architect has control over the scheduling of design and the production of contract documents, but no control over construction. However, the architect must be able to estimate the entire project schedule during programming so that the best course of action can be taken in order to meet the client’s goals, such as suggesting a fast-track schedule to meet a deadline. The time required for these phases is highly variable and depend on several factors.
  - **To organize the design process**, the architect separates the design efforts into phases, each of which must be substantially finished and approved by the client (1wk-1mo) before moving to the next phase:
    1. **Schematic design phase (1-2 mo)**: general layout of the project, preliminary alternates studies for materials and building systems;
    2. **Design development phase (2-4 mo)**: decisions from the previous stage are refined and developed in more details, preliminary specifications, more detailed cost budget;
    3. **Construction documents phase (3-7 mo)**: final working drawings, project manual, bidding documents, contract documents;
    4. **Bidding or Negotiation phase (3-6 wks)**: obtain and analyze bids from several contractors, or negotiate a contract with one contractor;
    5. **Construction administration phase (varies)**: assure that the structure is being built according to the contract documents.
The time required for each phase depends on the following factors:
1. The size and complexity of the project;
2. The number of people working on the project – the design team;
3. The abilities and methodology of the project team – level of experience, skill;
4. The quality and completeness of the program information supplied by the client;
5. The type of client and the decision-making and approval processes of the client;
6. Financing – time to secure financing for the project.

• Construction scheduling
  A construction schedule may be established by the contractor or construction manager, but it is most often estimated by the architect during programming so the client can have an idea of the total time from conception to move-in. Keep in mind that this is just an estimate; the architect can in no way guarantee any estimate of the construction schedule to the client like design scheduling, construction scheduling can be affected by many variables, where most can be controlled, and others not.

The time required for construction scheduling depends on some of the following factors:
1. The size and complexity of the project;
2. The weather;
3. Labor availability & labor disputes;
4. Material delivery time;
5. The quality and completeness of the architect’s drawings and specification;
6. The management ability of the contractor to organize his/her own forces and subcontractors;
7. New construction or remodeling project;
8. Site conditions;
9. The architect-engineer – some or more demanding than others;
10. Lender approvals;
11. Agency and governmental approvals – permit...

• Bar chart: It indicates the starting and finishing dates of major activities of the project. The various activities of the schedule are listed along a vertical axis, and the overlaps of these activities are indicated by bars. However, it does not indicate the relationship between the sequences of activities or the dependency of an activity on the completion of the previous activity. It is superior to CPM as a means of visual communication, and inferior to CPM as a management tool.

• CPM – Critical Path Method: it depicts all the tasks required to complete a project, the sequence in which they occur, their duration, the earliest, or latest possible starting time. It also defines the sequence of critical paths*. The completed CPM diagram is known as the network diagram, which must be continuous, with no gaps or discontinuities. The most effective method to save on construction time is to reduce the critical path time; reducing critical activities on the critical path reduces the whole construction schedule. (Note: At the end of the CPM planning, the project calendar can be determined by converting activity working days into Calendar Days, multiply the working days by 7 and divide by 5.)
Activities: divide the project into concise tasks (numbered circles). No activity can begin until all activities leading into a circle have been completed.

Solid Arrow: beginning and end point of an activity; they have a duration.

Dummies: dashed arrows indicating dependency relationships. Dummies are not activities themselves, therefore they have no duration. They are used to give each activity a unique beginning and ending number, and to allow establishment of dependency relationships without tying in non-dependent activities.

Event: is a moment when a preceding activity has been completed and the following activity may begin.

Milestone events: important points of the construction process.

Interface events: events common to two separate network diagrams.

Path: a diagram has several paths, from start to finish, and each having varying total time duration.

Critical Path (heavier arrows): the total project time established by the path with the longest total required time.

Critical activities: activities along the critical path. Delaying the starting time of any critical activity or increasing their duration will delay the completion of the project.

Float paths: all paths in the network, other than the critical path. It is the difference between the critical path and any other path. It is a measure of the extra time available for an activity or group of activities. This extra time allows for delays to occur in one or more activities along the path. As long as the float time is not exceeded, no delay in project completion time will result.

**Critical Path:**

Event = 1 2 3 4 5 6
Activities = E and F
Critical Activity Time:
14 + 8 = 22 working days

Note: the path with the longest activity time is called the critical path.
In this case, the longest activity time is 22 working days or 21 calendar days (22 / 7 / 3)

**Float Path 1:**

Event = 1 2 3 4 5 6
Activity = A, C, D and E
Activity Time = 1 + 3 + 7 + 8 = 19 working days

Float Time:
(Critical Path) 22 - 19 (Activity Time) = 3 working days

Note: this path can be delayed for 3 working days or 3 calendar days without affecting the timely completion of the project

**Float Path 2:**

Event = 1 2 3 4 5 6
Activity = B, C, D and E
Activity Time = 3 + 3 + 7 + 8 = 21 working days

Float Path 2:
(Critical Path) 22 - 21 (Activity Time) = 1 working day

Note: this path can be delayed for 1 working day or 2 calendar days without affecting the timely completion of the project.
- **Fast-Track Scheduling**: It is a technique to save on overall time in completing an entire project by combining the architect/engineer schedules with the builder’s construction schedule. It requires close coordination, staged bidding, and it is typical to hire a construction manager to supervise the construction process to establish a degree of control over cost and time, and establish responsibility. Oversights and corrections are to be expected; they are an integral part of fast-track scheduling. Note: fast-track scheduling is considered to be an additional service for the architect. Fast-track scheduling makes it possible to construct a high-quality building in 10-30% less time than a conventional construction contract.

- **Project Delivery Methods**

- **Design-Award-Build** (Design-Bid-Build)

**Diagram Legend:**
- Orange: (O) Owner
- Blue: Architect Basic Services: Preliminary Design (PD), Schematic Design (SD), Design Development (DD), Construction Documents (CD), Construction Administration (CA), Bidding Process (BID)
- Red: (GC) General Contractor selected (awarded)
- Red: (Sub) General Contractor suggests to the Owner and Architect a subcontractor for approval
- Yellow: ($) Construction Cost is determined

→ **General Information:**
  1. Standard method of construction
  2. Used when the owner wants to participate in design process
  3. Design decisions are made before getting a GC (general contractor) involved

→ **Steps:**
  1. Owner hires the architect to develop PD to CD phases
  2. Architect prepares bidding process
  3. Owner awards a construction contract to the lowest bidder or other at his own discretion
  4. Subcontractors and suppliers are selected
  5. Cost of construction is determined
  6. Construction Administration begins with the architect as the owner’s agent
  7. Project completed

→ **Advantages:**
  1. Owner participates in the design process
  2. Cost is accurately based on complete sets of documents
  3. Clear separation between design and construction responsibilities
  4. Construction scheduling is simple

→ **Disadvantages:**
  1. Long time to complete CD phase before being able to establish an accurate cost and for construction to begin
  2. General Contractor experience and knowledge of pricing and constructability is not available during the design phases
Construction Management

CM delivery method 1: Construction Manager as advisor CM_A:

DIAGRAM LEGEND:
- Orange: (O) Owner
- Red Letters: (CM_A) (CM_C) Construction Manager as Advisor administers / Constructor
- Blue: Architect Basic Services: Preliminary Design(PD), Schematic Design(SD), Design Development(DD), Construction Documents(CD), Construction Administration (CA)
- Red: (Sub)- CM_C suggests subcontractors for owner approval
- Yellow: Construction Cost is determined ($) 

→ Definition:
- Construction management: activities over and above normal architectural and engineering services conducted during the pre-design, design, and construction phases that contributes to the control of time and cost.
- CM_A: construction manager as agent/advisor - administers design contracts, acts as the owner’s representative to the design team, manages the construction contracts, as well as non-construction activities on the site. He/she has no financial responsibility.
- CM_C: construction manager as constructor – vendor relationship with the owner. He/she has a financial responsibility to the construction project. He/she is brought into the project before the design phases are completed to help with constructability.

→ General Information:
1. Owner can address cost and constructability early during the design process;
2. Fast track scheduling method is used to have a shorter construction time period;
3. Owner hires a CM_A or CM_C to facilitate administrative services, constructability, and address cost throughout the design phases, bidding process, and construction and the CM can establish the cost of construction using one of the following methods:
   3.1. Stipulated Sum / Fixed Price Contract: guaranteed cost for construction before the start of construction and CM_C services. Once the cost is agreed upon, the owner is obligated to pay the amount. However, construction cost may be revised by change order.
      - Construction cost ($7,000) is greater than fixed price ($5,000) = owner does not pay the difference in cost amount ($2,000), CM_C is responsible resulting in financial loss
      - Construction cost ($4,000) is less than fixed price ($5,000) = owner does not receive the savings amount ($1,000), CM_C keeps it resulting in a profit
3.2. **Cost Plus a Fee Contract**: actual cost of construction (materials + equipment + lowest Sub bids + CM<sub>c</sub> own labor) and negotiated fee for CM<sub>c</sub> services. This type of contract is often used when the owner wants to select a specific contractor for his/her capabilities, rather than bidding the project competitively. It usually includes a GMP (see below). An owner will generally select this option if he is not concerned with cost and the contractor will be encouraged to be more efficient in his spending.

3.3. **Guaranteed Maximum Price** (GMP): highest cost of the construction project guaranteed by the CM<sub>c</sub>

- Construction cost ($6,000) is less than GMP ($10,000) = savings go to the owner ($4,000). Sometimes, the owner shares the savings with the contractor as an incentive to perform the work for less than the GMP.
- Construction cost ($13,000) is greater than GMP ($10,000) = CM<sub>c</sub> is responsible to pay the amount over ($3,000) and absorb the loss

→ **Advantages**:
  1. Cost is determined before CD’s are completed
  2. Ability to use staged bidding which equates to a faster completed project
  3. CM is hired early in the design process to resolve constructability before construction which equates in less cost for construction

→ **Disadvantages**:
  1. Additional cost for hiring a CM - one more person to pay
  2. Complicates relationship between design and construction team
    2.1. Coordination and relationship might not be well designed resulting in conflicts
    2.2. The use of fast-track scheduling which calls for multiple bidding and multiple prime contracts will create a complex situation

- **Design-Build**

 DIAGRAM LEGEND:
- **Orange**: (O) Owner
- **RFP**: owner issues a Request For Proposal to select design-build firms
- **Yellow**: Design-Build firms submit proposals to the owner that provide the design of the project and the cost for design development and construction
- **Red**: Design-Build firm develops and provides construction documents and builds the project

→ **General**:
  1. Single entity responsible for design and construction
  2. Types of design-build firms:
    - Company which has construction and design staff
    - Construction Company hires an architect
    - Development Company hires an architect and construction staff
Joint venture comprised of an architect firm, construction firm, and developer firm

→ **Steps:**
1. Owner issues a request for proposals to selected firms
   - The owner can have an architect do the conceptual design and include it in his/her request for proposals which may reduce cost when hiring a design-build firm
2. Selected firms submit proposals and cost for design, design development, and construction to the owner
3. Owner selects a firm
4. Chosen firm designs, develops documents, and build the project

→ **Advantages:**
1. One firm is responsible for design and construction
2. Cost is determined early in the process
3. Conflicts between designer and constructor are minimized
4. Facilitates fast-track construction

→ **Disadvantages:**
1. Owner’s input is minimized in the design of the project
2. Owner has no representative to protect his/her interest but can hire one outside of the selected firm
3. Any design change would likely require a change order that the owner will have to pay for
4. Dispute may arise regarding the scope of the work
5. Quality issues may arise and be difficult to address if the owner’s decision to select a firm was solely based on the lowest bid

**Financing**

→ **Development loan types**
- **Blanket loan / Blanket Mortgage:** used for the purchase of land that the developer intends to subdivide and resell; generally includes a clause that releases each subdivided plot from the loan as it is purchased and a portion of the debt is repaid;
- **Bond:** it is a kind of debt security issued by a government entity to raise money to finance a construction project;
- **Bridge loan:** short-term loan used to quickly purchase property or to finance a project that must begin immediately while waiting on another lender to approve a long term loan;
- **Construction loan:** used to finance the building of a project for the duration of construction. Once construction is complete, the loan must be converted into a long-term, permanent loan whereby the lender is repaid monthly;
- **Hard money loan:** it is a relatively short-term loan used where there is a distressed financial situation (foreclosure, bankruptcy, or nonpayment of previous loan). The amount of the loan is based on the quick-sale value (usually less than the market value) of an asset (property or real estate).
- **Mezzanine loan:** often used by developers for large projects. It is a large loan with variable interest rate that increases substantially near the time repayment is due. The loan is secured by using stocks in the developer’s company as collateral in case of default; this loan is based on a gamble that property will produce enough revenue to repay the loan when the interest rates escalate.
- **Conventional mortgage:** fixed or adjustable interest rate; secured by the property purchased; when debt is repaid borrower has clear title to the property.
Typical financing procedure for Private projects: all private investments in construction are made with the idea of making a profit. Some owners or developers might have access to capital investment money, own money to invest, or assemble a small partnership, but most, will go to a lender to seek financing. In order to seek that kind of financing and assess the value, cost and feasibility of the project, a financial analysis of a building project, which involves cost and return on investment, must be estimated - pro forma. Along with pro forma, taxes (ongoing operating cost of a development) to which a developer is subject can influence whether a project is undertaken and how the site is developed. Once approved, the financing is made available in the form of a construction loan. The loan funds are paid out to the contractor, subcontractor, and suppliers, which the developer will pay back the debt service or cost of money through rental income.

→ To estimate yearly tax: many taxes are based on a mill levy (rate) on the assessed valuation of a piece of property. The assessed valuation is a percentage of the actual value of the property set by the taxing authority:
  - Example: the assessed valuation of developed property is based on 19% of actual value, and the mill levy is 0.04931. If a developed piece of property is estimated to have an actual valuation of $150,000.00, what will the yearly tax be?
    → Assessed value: (19%)( $150,000.00) = (0.19)( $150,000.00) = $28,500.00
    → Yearly tax: (0.04931) ($28,500.00) = $1405.00

Typical financing procedure for Public projects: when a public agency recognizes the need for a new project, a site is chosen, a project schedule and a budget are developed. This work is done to coordinate with the government’s fiscal process, in which money for projects is requested and divided up. The financing for public projects can be done through several methods:

1. General sales taxes (general tax revenues) and property taxes: the money collected is put in a general fund and used as required by that jurisdiction. They are typically used to fund public works, used to provide ongoing operation and maintenance of existing facilities and normal capital improvements (Ex: replacing curbs, remodeling schools...).
   → General tax: any tax imposed for general governmental purposes
   → Property tax: tax based on the value of property being taxed; it is an ad valorem tax.

2. Special sales taxes: any tax imposed for a specific purpose or by a single-purpose authority. This type of tax requires a majority vote of the people in the district (Ex: fund a major transportation project).

3. General obligation bonds: used to finance the acquisition or construction of specific public facilities and to purchase property that does not collect revenue. The principal and interest on such bonds are paid form general tax revenues (Ex: schools, museums, libraries, parks...). It does not encourage private development.

4. Revenue Bonds / Rate supported bonds: used to finance revenue producing facilities. The bonds are paid back by the revenue from customers using the services that the bond funding paid for (Ex: toll bridges, City water and sewer...)

5. Public enterprise revenue bonds: used to finance facilities for revenue producing public enterprises. The bonds are paid off from revenues generated by the facility through the charges they impose (airports, parking garage, hospitals...)

6. Tax-increment financing: used to purchase land, planning, and public works improvement to encourage private development and it is based on increased taxes due to increased property value. The tax increment acquired from the increased taxes is used to pay the bond issued to originate the development.
7. Development impact fees: costs charged to developers for off-site infrastructure improvements made necessary by new development. (Ex: hookup fees for utility service...)

8. Subdivision exaction: it is not used to fund construction, rather they are requirements that developers either dedicate some land for public use or contribute cash for the purchase of land and facilities made necessary by local governments.

9. Special district assessment / Business improvement districts (BIDs) / Benefit assessments: used to finance public space improvements in order to enhance an area’s appeal and, indirectly, its property values (Ex: park, streetscapes...). Owners within the district’s boundaries are required to contribute through assessed taxes, only if a majority of them has agreed to the improvement.

- **Budgeting and Cost Estimating**

  → Project budget vs. Construction Estimates:

  - **Project budget**: [there is a cap] the purpose of a project budget is to develop cost parameters within which the owner and architect will work. The project budget establishes cost limits, which reflect all anticipated costs.

  - **Construction estimates**: [subject to change] require adjustments during the course of development. (change order or construction change directive)

  → Establishing a project budget or project development budget for construction influences design decisions and determines the feasibility of a project. **Budgets are established following four basic variables: quantity, quality, available funds, and time**, using several methods listed below:

    1. **Pro format statement**, from which an estimated selling price is calculated and balanced against all the various cost – e.g. construction cost – which becomes the budget within which the architect must work.

    2. **Public funding or legislation** – revenue taxes, bonds – where construction budget is often fixed without the architect’s involvement, and the project must be built and designed for the fixed amount.

    3. **Architects** at the request of the owner set a budget and base it on the proposed project. This proposed budget can be further reviewed using value engineering.

  → See the following table for a list of Items included in a Project Budget:
- **Site Acquisition**

1. **Building Costs**
   All work related to the structure and its systems using unit cost figures (ft² x cost per ft²)

2. **Site Development**
   10-20% of Building Costs
   - **Off-site work**: all improvements outside of the property lines of the project, i.e. Utilities and services required to make the development operable.
   - **On-site work**: all improvements within the property lines of the project but excludes the building itself, i.e. landscaping, parking.

3. **Contractor’s overhead and profit**
   5-40% of total construction costs

- **Total Construction Cost (85%)**

- **Movable equipment & Furnishings**
  Movable Equipment: 5-10% of Building Costs

- **Professional Services**
  5-10% or 10-15% of Total Construction Costs

- **Inspection and Testing**
  Varies

- **Miscellaneous Costs**
  Varies

- **Escalation estimate**
  2-10% of Total Construction Costs + Movable equipment & Furnishings per year

- **Contingency**
  5-10% of Total Construction Costs + Movable equipment & Furnishings per year

- **Financing Costs**
  Varies

- **Moving expenses**
  Varies

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site Acquisition</td>
<td>Purchase price, legal fees, title transfer cost...</td>
<td></td>
</tr>
<tr>
<td>Total Construction Cost</td>
<td>Contractor’s overhead and Profit:</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Overhead</strong>: 10-20% of the total cost of labor, materials, equipment:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1. <strong>General overhead</strong>: cost to run a contracting business: office rent, recurring cost, heat, salaries...</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. <strong>Project overhead</strong>: money it takes to complete a particular job, not including labor, materials or equipment: bonds, insurance, permits, sanitary facilities, taxes, trash removal...</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Profit</strong>: 5-20% of the total cost of labor, materials, equipment, and overhead. Most highly variable part of the budget.</td>
<td></td>
</tr>
<tr>
<td>Movable equipment &amp; Furnishings</td>
<td>Movable Equipment: 5-10% of Building Costs</td>
<td>Furniture, accessories, major equipments, etc. necessary to put the facility in operation. These are often listed in separate line items because the funding for them may come out of a separate budget and because they may be supplied under separate contracts (see FF&amp;E)</td>
</tr>
<tr>
<td>Professional Services</td>
<td>5-10% or 10-15% of Total Construction Costs</td>
<td>Topographic survey, consultant fees, architecture fees, engineering fees, soil tests, legal fees...</td>
</tr>
<tr>
<td>Inspection and Testing</td>
<td>Varies</td>
<td>Special on-site full-time inspection, testing for concrete, steel...</td>
</tr>
<tr>
<td>Miscellaneous Costs</td>
<td>Varies</td>
<td>Advertising for bids, fees for sewers and water connection, attorney’s fees, building permit...</td>
</tr>
<tr>
<td>Escalation estimate</td>
<td>2-10% of Total Construction Costs + Movable equipment &amp; Furnishings per year</td>
<td>Include a factor for inflation where the present budget estimate is escalated to a time in the future at the expected midpoint of construction.</td>
</tr>
<tr>
<td>Contingency</td>
<td>5-10% of Total Construction Costs + Movable equipment &amp; Furnishings per year</td>
<td>Account for unforeseen changes prior to and during construction that add to the cost.</td>
</tr>
<tr>
<td>Financing Costs</td>
<td>Varies</td>
<td>Loan origination fees, construction loan interest, administrative costs, permanent mortgages...</td>
</tr>
<tr>
<td>Moving expenses</td>
<td>Varies</td>
<td>Cost to physically relocate: stationary, installing telephones...</td>
</tr>
</tbody>
</table>
Methods of estimating cost

Cost estimating is an ongoing activity for the architect. At each stage of the design process, there should be a revised budget reflecting the decisions made at that time. Listed below are the different types of cost estimating:

1. **Unit Cost System** (Programming) – cost per square foot based on recent experience – it enables estimators to apply cost data accumulated from one building to a different building type, provided the design and performance criteria are similar.

2. **Building Subsystem** (Schematic design) – enables comparison between different conceptual solutions.

3. **Component cost system** (Design development) – enables a more precise selection of components and systems.

4. **Composite Unit Rates** (Construction documents) – these rates are for construction components, assemblies, and systems and are required for pre-bid estimates, final cost checks, the contractor’s cost breakdown, and used as a basis for verifying the contractor’s payment requests.

5. **Parameter method**: (Construction documents) involves an expanded itemization of construction quantities and assignment of unit costs to these quantities. It makes it possible to evaluate the cost implications of each building component and to make decisions concerning both quality and quantity in order to meet the original budget estimate. Instead of using one number for floor finishes, the cost is broken down into carpeting, unfinished concrete...

6. **Matrix costing**: (Design development) it is a way of comparing and evaluating alternative construction components. In this method, a matrix is drawn showing, along one side, the various alternatives, and, along the other side, the individual elements that combine to produce the total cost of the alternatives.

Construction Cost is affected by:

1. Geographical location
2. Availability of labor and materials – shortage, demand & supply
3. Resources to produce or fabricate materials
4. Convenience of available transportation systems
5. Price control / credit control
6. Labor costs largely influenced by building trade unions
7. Inflation – one method to estimate cost escalation based on Cost indexes

Cost estimates are based on 3 factors:

1. Scope – what is included in the building (program)
2. Quality – level of quality achievable
3. Budget – how much money can the owner spend?

Construction cost based on location:

- Suburban areas: lowest cost for development because of its proximity to urban areas.
- Urban areas: highest cost for development mainly because of labor rates.
- Rural areas: variable cost based on accessibility by existing transportation routes.

Cost Indexes: indexes are calculated by averaging costs in a number of major US cities. It is intended to be a construction cost indicator. The indexes can be used to apply costs from one
part of the country to another and to escalate past costs to the expected midpoint of construction of the project being budgeted.

- **Example:** Cost Index in Miami is 950. Cost Index in Fort Lauderdale where you will be building is 1040. If the expected construction cost estimate is $1,400,560 based on prices in Miami, what will be the expected cost in Fort Lauderdale?
  1. Divide Higher index by Lower Index: 1040 ÷ 950 = 1.095
  2. Multiply the result by the base cost: ($1,400,560)(1.095) = $1,533,613.20

- **FF&E – Fixtures, Furniture, Equipment, and Finishes**

  - **Key Terms:**
    - **Freestanding Furniture:** furniture that are not built-ins such as individual tables, chairs, case goods.
    - **Systems Furniture:** components that can be assembled, configured, and reconfigured to create workstations or workspaces.

  - **General:**
    - FF&E services are often listed as a separate line item in a project budget because the funding for them may come out of a separate budget and because they may be supplied under separate contracts;
    - FF&E stands for the procurement of what its name entails and FF&E Services are applicable to project of all sizes;
    - FF&E Services can be offered as an additional service by an architectural or design firm for the selection and acquisition of products;
    - FF&E services can enhance the overall functionality of a project and influence the way that people use and interact with a space;
    - The budget for FF&E is about 3 to 4 times that of Interior design fees;
    - FF&E refers to a wide assortment of products that are prefabricated or custom, such as:
      1. System furniture
      2. Signage
      3. Loose furniture
      4. Planters
      5. Artwork
      6. Window Coverings
      7. Accessories
      8. Custom Furniture
      9. Millwork
      10. Awnings
      11. Specialty Equipment
      12. Audiovisual Equipment
      13. Custom Lighting

  - **Reasons for using FF&E services:**
    1. **To furnish a new space** – it includes reconfiguring an existing space;
    2. **To replace or upgrade an existing FF&E** – replace outdated technologies;
    3. **To refurbish existing furniture** – refinish existing furniture instead of buying new ones;
    4. **To expedite FF&E procurement** – in order to get products in time for a fast track project;
    5. **To simplify FF&E procurement** – assemble multiple FF&E’s in one package for a single point of sale.

  - **Procedure Outline for FF&E services:**
1. **Evaluate Client Needs** (FF&E Programming Process) – identify and document needs for all functional spaces;

2. **Prepare a Cost Estimate** – based on actual cost of comparable items/product (the client must approve the estimate before moving on to the next step)

3. **Select Furniture** based on:
   - Function – needs of the client or program
   - Durability – wear and tear
   - Aesthetics – level of quality
   - Budget – available funds
   - Style – scale, proportion... in relation to space

4. **Prepare Specifications** – requirements for delivery, installation, warranties... using
   - Proprietary (Closed): no product substitution allowed, more control
   - Descriptive (Open): used in competitive bidding, less control
   - Performance: vendors propose products that they think will meet the requirement

5. **Assemble Bid Package and Solicitation Bids**

6. **Administer Contract**

   - The following AIA contract documents are used for FF&E services:
     - AIA B153 - Owner and Architect for FF&E Design Services;
     - AIA B253 - Architect's Services: Furniture, Furnishings and Equipment Design;
     - AIA A151 - Owner and Vendor for FF&E where the Basis of Payment is a Stipulated Sum;
     - AIA A251 - General Conditions of the Contract for FF&E;
     - AIA A751 - Invitation and Instructions for Quotation for FF&E.

   - The overall procedure for administration of these contracts are as follows:
     1. Supplier sends shop drawings and submittals to the architect for review
     2. Purchase orders are sent directly to the owner for payment; the architect is copied on all correspondence and notified of any issues;
     3. The architect helps establish an installation schedule, and punch list

7. **Oversee Ordering Phase** (furniture acquisition process task)

8. **Oversee Tracking/Scheduling Phase** (furniture acquisition process task)

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### Building Codes

- **General:** Buildings are classified in the building code according to:

<table>
<thead>
<tr>
<th>Occupancy group</th>
<th>Construction Type</th>
<th>Test and standards used</th>
<th>Means of Egress design</th>
<th>Fire resistive rating</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>INFLUENCE</td>
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</table>

- Building codes are enacted as laws, generally adopted and enforced by local governments; and affect the design and construction of buildings;
- They are written to protect the health, safety and welfare of the public as they relate to the construction and occupancy of buildings and structures;
- Written on the basis of the "least acceptable risk" – minimum level required for building and occupant safety;
Enforced through the permit process, which requires that specs and drawings be submitted to the AHJ – authority having jurisdiction. The AHJ conducts inspections to verify that the building is proceeding according to the approved plans; the AHJ is responsible for code enforcement;

The architect is responsible for designing a building in conformance with all applicable codes and regulations;

Building codes and fire codes are intended to protect from fire damage;

International Building Code (IBC): it is the primary building model code, published by the International Code Council (ICC). A model building code is one that is written without reference to any particular geographical area. The IBC is a prescriptive code.

Life Safety Code: it is used in conjunction with the building codes by some jurisdiction but it is not a legal code. It addresses construction, protection, and occupancy features necessary to minimize danger to life from fire including smoke, fumes, or panic. It does not address general fire damage prevention or building construction features that are normally part of the fire or building codes. The life safety codes also address egress – number and location of exits in a building.

National Fire Protection Agency (NFPA) wrote its own building code – NFPA 5000

In addition to building codes, there are companion codes that govern other aspects of construction. Ex: National Electric Code, International Fire Code...

Building codes indicate what tests or standards a particular type of material must satisfy in order to be considered acceptable for use. For that reason, model codes make extensive use of industry standards developed by trade associations, standard writing organizations, standard approving groups, and government agencies (see testing and material standards below).

Building codes recognize that there is no such thing as a fireproof building; there are only degrees of fire resistance (see types of tests and standards + fire resistive standards below).

- **Testing & Material Standards**

All approved materials and construction assemblies referenced in the building codes are required to be manufactured to accepted methods or tested approved by agencies according to standardized testing, or both. The following are the principal standard agencies and testing laboratories:

1. **ASTM** – American Society for Testing and Materials: publishes standards and test procedures; it does not actually perform tests, but its procedures and standards are used by testing agencies.
3. **Industry trade groups**: standard writing organizations that have an interest in a particular material, product, or filed of expertise, such as ASHRAE (American Society for Heating, Refrigeration and Air-Conditioning Engineers)
4. **ANSI** – American National Standard Institute: does not develop or write standards; it approves standards developed by other organizations and works to avoid duplications between different standards.
5. **NRTL** – Nationally Recognized Testing Laboratory: when a standard describes a test procedure or requires tests in its description of a material or product, a testing laboratory
must perform the test. Underwriters Laboratories (UL) is one of the most well known NRTL’s.

→ Note: UL: When a product successfully passes the prescribed test, it is given a UL label.

There are 2 types of UL labels:
- Listed label: passed safety test and is manufactured under the UL follow-up services program.
- Classified label: samples of the product were tested for certain types of uses only.

- Types of tests and standards
→ The most important types of tests for building components are those that rate the ability of a construction assembly to prevent the passage of fire and smoke from one space to another, and tests that rate the degree of flammability of a finish material

- Types of Construction assembly tests:
  1. ASTM E119 – building construction and material: evaluates an assembly’s ability to prevent the passage of fire, heat, and hot gasses for a given amount of time; these assemblies are given a rating according to time: 1-4-hr rating, and for doors and other assemblies 20/30/45 minute rating.
  2. NFPA 252 – door assemblies: evaluates the ability of a door assembly to resist the passage of flame, heat, and gases
  3. NFPA 257 – window and glass block assembly: prescribes specific fire and hose stream test procedures to establish a degree of fire protection in units of time

- Types of Finish materials in building construction tests:
  1. ASTM E84 / Steiner Tunnel Test – surface burning characteristics of building materials: test samples in a narrow chamber that has a controlled flame at one hand. The result is a materials flame spread rating. Class A (I), B (II), C (III)
     → Class A (I) is the most fire resistant.
  2. NFPA 265 / Room Corner Test: sometimes required in addition to the ASTM E84 test for textile interior finishes or instead of it. It determines the contribution of interior textile and ceiling covering to fire growth.
  3. NFPA 286 – evaluating contribution of wall and ceiling interior finish to room fire growth: it evaluates materials other than textiles and addresses displacement during the ASTM E84 test.

- Fire resistive standards
→ The building codes specify requirements for two broad classifications of fire resistance: resistance of materials and assemblies, and surface burning characteristics of finish materials
→ For finish materials, building codes regulate the flame spread rate along the surface of a material and limit the amount of combustible material in a building.
→ When a fire-resistive barrier is built, any penetrations in the fire-resistive barrier must also be fire rated. Duct penetrations are protected by fire dampers placed in line with the wall
→ Many materials by themselves do not create a fire-rated barrier; it is the construction assembly of which they are part that is fire resistant.
→ One of the most common types of construction assemblies is the partition. Below find the different types of partitions:
  1. Fire partition: In most cases, a fire partition provides a continuous barrier from the floor to the underside of the floor or ceiling above, or to the ceiling of a fire-resistance rated
floor/ceiling or roof/ceiling assembly. Example: corridor walls, walls separating dwelling units...

<table>
<thead>
<tr>
<th>Minimum Partition Rating</th>
<th>Minimum Opening rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 hr</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Corridors: 20 min.</td>
</tr>
<tr>
<td></td>
<td>• Others: 45 min or ¾ hour</td>
</tr>
</tbody>
</table>

2. **Fire Barrier**: It offers more protection than a fire partition. It is a vertical or horizontal assembly that is fire-resistance rated and is designed to restrict the spread of fire, confine it to limited areas, and/or afford safe passage for protected egress. Example: stairways, separate mixed-use occupancy...

<table>
<thead>
<tr>
<th>Minimum Partition Rating</th>
<th>Minimum Opening rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 hr or more</td>
<td>• 20 min. to 3hrs depending on the fire barrier’s rating</td>
</tr>
<tr>
<td></td>
<td>• maximum aggregate width of 25%</td>
</tr>
<tr>
<td></td>
<td>• single opening cannot exceed 120ft² in area</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Minimum Partition Rating</th>
<th>Minimum Opening rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 hr to 4hrs</td>
<td>• No openings</td>
</tr>
</tbody>
</table>

3. **Fire Wall**: it is a fire-resistance rated wall that is used to separate a single structure into separate construction types or to provide for allowable area increases by creating what amounts to separate buildings even though they are attached. They must extend continuously form the foundation to or through the roof. Example: wall separating row house units.

<table>
<thead>
<tr>
<th>Minimum Partition Rating</th>
<th>Minimum Opening rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 hr to 4hrs</td>
<td>• No openings</td>
</tr>
</tbody>
</table>

4. **Smoke Barrier**: continuous vertical or horizontal membrane that is designed and constructed to restrict movement of smoke. It is a passive form of smoke control. Openings in smoke barriers must have a 20-minute rating.

<table>
<thead>
<tr>
<th>Minimum Partition Rating</th>
<th>Minimum Opening rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 hr</td>
<td>• 20 min</td>
</tr>
</tbody>
</table>

**Occupancy**

→ Occupancy refers to the type of use of a building or interior space. Every building or portion of a building is classified according to its use and is assigned an occupancy group based on similar life-safety characteristics, fire hazards, and combustible contents; different uses in a building require different responses to maintain fire and life safety. Knowing the occupancy classification is important in determining several aspects of building requirements: egress design, ventilation requirements, maximum area, number of floors, etc. If in doubt for a category selection, consult with the local building official.

→ Occupancy group table

<table>
<thead>
<tr>
<th>Group</th>
<th>Occupancy</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>ASSEMBLY</td>
</tr>
<tr>
<td>B</td>
<td>BUISINESS</td>
</tr>
</tbody>
</table>
### Types of occupancies:

1. **Mixed occupancy & Occupancy separation**: it happens when a building or area of a building containing two or more occupancies; each occupancy must be separated from other occupancies with a fire barrier. The idea is to increase the fire protection between occupancies as the relative hazard increases.

2. **Accessory use occupancy**: a space or room that is an accessory to a main occupancy but that does not exceed 10% of the floor area of the main occupancy. It does not need to be separated from the main occupancy with a fire barrier. Ex: a small gift shop in a hospital.

3. **Incidental use occupancy**: a space or room, not exceeding 10% of the floor area of the story where it is located, which is incidental to a main occupancy and has the same qualification has the nearest main occupancy, but must be separated from the main occupancy by a fire barrier. Ex: linen collection room on the same floor as hotel rooms.

### Construction type

- Every building is classified into one of five major types of construction based on fire-resistance rating of its major construction components. The purpose of this is to protect the structural elements of a building from fire and collapse, and to divide the building into compartments so that a fire in one area will be contained long enough to allow people to evacuate the building and firefighters to arrive.

- The five types of construction are: **Type I, II, III, IV, and V**.
  - **Type I** buildings are most fire resistive, while type V is the least fire resistive.
  - **Type I and II** are noncombustible. Types III, IV, V are considered combustible.

- In combination with occupancy groups, construction type limits the area and height of buildings.

- **How to use the Allowable Floor Area and Height table**: The concept is the more hazardous the building, the smaller it should be. The table can be used to find solutions to several situations:
  - Situation 1: If the occupancy group and construction type are known, simply find the intersection of the row “occupancy” and the column “type”, read the permitted area or height, and then increase the areas according to the percentages allowed for sprinklers and perimeter space.
  - Situation 2: required floor area and occupancy are known, the architect must determine the construction type to meet the client size needs. This process is usually done during the pre-design part of a project.
  - Situation 3: an architect may be asked to design for occupancy different than the original occupancy as part of a remodeling project. If the existing building is too large, the project will be unfeasible, unless significant steps are taken such as including a sprinkler system or adding a fire wall.
- **Situation 4**: required floor space of a project exceeds that allowed by the code and for the construction type the architect wants to use. In this case, the architect can subdivide the building into smaller portions with fire walls; those portions are then considered as separate buildings.

  - **Construction type is influenced by fire zones.** A municipality may divide a city into fire zones representing the degree of fire hazard based on density, access for fire fighting equipment, existing building height, etc. The building code may then restrict the types of construction that are allowed in the various fire zones.

  - **Construction type influences the location of a building on a property** – 2 choices:
    1. Follow the code for setback requirements from the property line, which includes provisions for the exterior bearing wall required fire-protection rating and limitations on openings;
    2. Allow for a greater setback than required from the code to diminish the limitations on openings and fire-protection rating for lower cost or other reasons.

- **Means of Egress**
  - It is a continuous and unobstructed path of vertical and horizontal egress (exit) travel from any point in a building or structure to a public way.
  - The Egress system is composed of 3 parts:
    1. **Exit Access**: portion of the means of egress that leads to the entrance of an exit. The exit access does not provide a protected path of travel but travel distance is measured and regulated. Example: aisles, rooms, spaces, corridors, doorways, hallways, intervening rooms, and ramps.
    2. **Exit**: portion of the means of egress that provides a protected (1 or 2hr rating) and fully enclosed path of egress, from all interior spaces, between the exit access and exit discharge. Travel distance is not an issue once the exit has been reached. Example: door, exit stair enclosure, exit passage ways, and horizontal exits.
    3. **Exit Discharge**: portion of the means of egress between the termination of an exit and a public way. Example: exit balconies, exit courts, and exterior exit stairway.
      - **Note**: A public way is any street, alley, or similar parcel of land essentially unobstructed from the ground to the sky that is permanently appropriated to the public for public use and has a clear width of no less than 10 feet.

- **Occupant Load**: It is the number of people that a building code assumes will occupy a given building or portion of a building. The IBC requires that occupant load be established by taking the largest number determined by one of the three methods:
  1. **Actual number of people** the space or building is designated to accommodate, typically used where fixed seating exist.
     - **Ex**: auditorium has 150 seats = occupant load 150
  2. **Determine the occupant load factor** as given in the code by dividing the area in ft$^2$ by the occupant load factor.
     - **Ex**: restaurant is 2500 ft$^2$ and the occupant load factor is 15 ft$^2$, divide 2500 by 15, equals 166.67 or 167 persons.
→ **Occupant Load Factor**: the amount of floor area, net or gross, presumed to be occupied by one person.
  - Net area: space actually used
  - Gross area: space used including stairs, corridors, toilet rooms, mechanical rooms, closets, and interior partition thickness.

3. **Determine the cumulative occupant load** where occupants exit through intervening spaces to an ultimate exit
   - Ex: office is 3700 ft² with a load factor of 100 ft², 2 classrooms each 1200 ft² with a load factor of 20 ft². First the office, divide 3700 by 100 = 37 persons. Second Classrooms, 2 classrooms, 1200 + 1200 = 2400 ft², divide 2400 by 20 ft²= 120 persons. Total occupants is 120 + 37 = 157 persons

→ **Exits**
  - **Number of exits**: the number of exits depends on the occupant load, the occupancy type, the limitations of the common path of egress travel, and specific requirements for large occupancy loads.

<table>
<thead>
<tr>
<th>Up to maximum occupancy load</th>
<th>1 exit</th>
</tr>
</thead>
<tbody>
<tr>
<td>More than maximum occupancy load</td>
<td>2 exits</td>
</tr>
<tr>
<td>Common path of egress travel more than the limit of travel in code</td>
<td>2 exits</td>
</tr>
<tr>
<td>Occupancy load between 501-1000</td>
<td>3 exits</td>
</tr>
<tr>
<td>Occupancy load 1001 or more</td>
<td>4 exits</td>
</tr>
</tbody>
</table>

→ **Common Path of Egress Travel**: portion of an exit access that the occupants are required to traverse before two separate and distinct paths of egress travel to two exits are available. If the common path of egress travel is greater than 75 feet provide 2 exits, except in H occupancy group. Sometimes, the common path of egress travel can be extended to 100 feet, if certain conditions are met, such as a fully sprinklered building.

→ **Exit access travel distance**: it is the distance that an occupant must travel from the most remote point in the occupied portion of the exit access to the entrance to the nearest exit. Because exit access areas are not protected, the code limits how far someone must travel to safety. Travel distances are based on the occupancy and whether or not the building is sprinklered.

→ **Separation of Exits**: use the diagonal distance rule.
  - 2 exits are required in a non-sprinklered building, the distance between the doors must be equal or greater than 1/2 of the maximum overall diagonal dimension of the building or area to be served
  - 2 exits are required in a sprinklered building, the distance between the doors must be equal or greater than 1/3 of the maximum overall diagonal dimension of the building or area to be served
  - 3 or more exits are required, 2 must conform to the diagonal distance rule, and the third and additional exits must be at a reasonable distance apart, so that if one is blocked, the others will be available
→ **Width of Exits**: the minimum width in inches of exits is determined by multiplying the occupant load served by a .03 factor for stairways or a .02 factor for egress components other than stairways. If the minimum width is less than the minimum width given in the code, use the larger of the two. If a greater width is specified in the code, the larger number must be used

   ▪ Example: an office has an occupant load of 157; the minimum width of the corridor will be determined by \(157 \times 0.02 = 31.4\)” or 32” clear width. But elsewhere in the code, it says that when the occupant load is greater than 50, provide a 44” corridor. Therefore, 44” should be used for the corridor clear width.

→ **Exit through intervening spaces**: egress can pass through an adjoining room provided that the room is accessory to the area served and if the adjoining room is not an H occupancy.

→ **Exits cannot pass through**:

   1. Kitchens
   2. Storage rooms
   3. Closets
   4. Any other spaces of similar purposes

→ **Corridors**: they must be fire- resistance rated and extend from the floor to the underside of the structural slab above or to the underside of a fire-resistive ceiling, except if:

   1. Half of the required egress in group E lead to the exterior at ground level
   2. Corridors in a dwelling unit or a guestroom in group R
   3. Corridors in open parking garages
   4. Group B occupancies that require 1 exit by other provisions in the code

   ▪ If a corridor is fully sprinklered, in group A, B, E, F, M, S, and U occupancies, it does not need to have a fire rating, this principle extends to the doors along the corridor;

   ▪ A corridor must be continuous to an exit and must not pass through intervening rooms;

   ▪ Dead end corridors are limited to 20 feet but there are 3 exceptions: two of those exceptions allow for a 50 feet long corridor depending on the occupancy group, and the third exception, allows for a corridor longer than 20 feet, if the length is less than 2.5 times its width at the narrowest point;

   ▪ Opening requirements in a 1 hour corridor fire rated corridor are as follows:

<table>
<thead>
<tr>
<th>Doors</th>
<th>20 minutes fire rating / smoke and draft control seals/ self-closing/automatic closing by actuation of a smoke detector</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glass</td>
<td>UL Listed / ¾ hour fire protection rating / cover a maximum of 25% of the wall except if the glass is fire-resistance rated</td>
</tr>
<tr>
<td>Duct</td>
<td>Provide a fire damper with a 20 minutes fire rating</td>
</tr>
</tbody>
</table>
Exit Corridor minimum width: 44” or 3’-8"
→ Doors and handrails cannot project in a corridor more than 7” into the required width when fully up;
→ Project horizontally from either side of the corridor a max. of 1 ½” for trims and other decorations, and 3 ½” for handrails.

Egress Doors should be (1) readily distinguishable, (2) readily recognizable, (3) cannot be covered with mirrors or other reflective materials, and (4) cannot be concealed fabrics, decorations, or similar materials
- Egress Door size: 36” wide with a clear width of 32” min., and 80” high min. The maximum width of swinging doors is 48”;
- Egress doors must be pivoted or side-hinged;
- Egress doors must swing in the direction of travel when the area served has an occupant load of 50 or more or is a group H occupancy;
- Egress doors must not swing into a required travel path, they can be recessed to avoid this problem;
- Egress doors must not swing into a required travel path more than 7”

Egress stairways: they must be completely enclosed because vertical shafts provide the most readily path for fire and smoke spreading upward from to floor. Note: stories include basement, not mezzanine.

Requirements for Fire Rating in exit stairways:

<table>
<thead>
<tr>
<th>STORIES</th>
<th>Wall Rating</th>
<th>Door Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>4’</td>
<td>2 hr</td>
<td>1 ½ hr or 90min</td>
</tr>
<tr>
<td>1-4</td>
<td>1 hr</td>
<td>1 hr</td>
</tr>
</tbody>
</table>

Requirements for all exit/egress stairways:

<table>
<thead>
<tr>
<th>Occupant load &gt; 50</th>
<th>44” wide or as wide as determined the .03 factor, whichever is greater</th>
</tr>
</thead>
<tbody>
<tr>
<td>Occupant Load &lt; 50</td>
<td>36” wide</td>
</tr>
<tr>
<td>Handrail Projection into required width</td>
<td>4 ½”</td>
</tr>
<tr>
<td>If accessible by ADA</td>
<td>48” between handrails – see ADA table</td>
</tr>
<tr>
<td>Stair risers</td>
<td>4” to 7”</td>
</tr>
<tr>
<td>Stair tread</td>
<td>No less than 11”</td>
</tr>
<tr>
<td>Nosing Radius</td>
<td>½” radius max.</td>
</tr>
<tr>
<td>Nosing Space</td>
<td>1 ¼” max.</td>
</tr>
<tr>
<td>Landing</td>
<td>No less than the minimum width of the stair in the direction of travel but no more than 48” if it is a straight run</td>
</tr>
<tr>
<td>Distance between landings</td>
<td>12’ measured vertically</td>
</tr>
<tr>
<td>Intermediate handrails</td>
<td>Stair is wider than 60” or 5’-0”</td>
</tr>
</tbody>
</table>

Provide handrails on both sides except if
1. Aisle stairs have a center handrail
2. Stairs inside dwelling units
3. Spiral stairways
4. Aisle stairs serving seating only on 1 side
5. Single change in elevation where the landing depth on each side is greater than what is required for landings, in decks, patios, and walkways
6. Single risers in group R-3 occupancy at an entrance or
7. Single risers within dwelling units of R-2 and R-3 occupancy

<table>
<thead>
<tr>
<th>Top of Handrail</th>
<th>34” to 38” above the nosing of the treads</th>
</tr>
</thead>
<tbody>
<tr>
<td>Handrail Extension beyond top riser</td>
<td>12”</td>
</tr>
<tr>
<td>Handrail Extension beyond the bottom riser</td>
<td>Depth of one tread Ex: if tread is 11”, the handrail will extend 12” beyond the 11” tread</td>
</tr>
<tr>
<td>Handrail Configurations</td>
<td>Perimeter Dimension: 4” min and 6 ¼” max. It may be greater than 6 ¼” if it has a graspable finger recess on both sides</td>
</tr>
<tr>
<td>Guards</td>
<td>Should be provided for any walking surface 30” above the ground and must be 42” high min. and designed such that a 4” diameter cannot pass through any opening up to a height of 43”</td>
</tr>
</tbody>
</table>

- **High-Rise Buildings**: for the purpose of the means of egress, they are required to be provided with:
  1. Automatic sprinkler system
  2. Smoke detectors and alarms
  3. Communication systems
  4. Central control stations for fire department use
  5. Smoke control for exit stair enclosures
  6. Standby power systems

- **Americans with Disabilities Act – ADA**
  - It is a civil rights legislation; became a law in 1992;
  - It is not a national building code and it does not depend on inspection for its enforcement, building owners must comply with its requirements or be liable for civil suits;
  - **Note**: the ADA states that alterations to qualified historic buildings or facilities shall comply with the requirements of the applicable ADA sections – including elevators and accessible routes- unless it is determined that compliance with the requirements would threaten or destroy the historic significance of the building.
  - **Note**: Permanent rooms and spaces must be identified with uppercase lettering signs. If pictograms are used, they should be accompanied with the equivalent verbal description placed below the pictogram. Signage in both cases must be mounted on the wall adjacent to the latch side of the door.

- **Key words**:
  - **Accessible Route**: continuous unobstructed path connecting all accessible elements and spaces in a building or facility. The standards for accessible routes are designed to accommodate a person with a severe disability who uses a wheelchair, and are also intended to provide ease of use for people with other disabilities. The accessible route includes: Corridors, floors, ramps, elevators, lifts, and clear floor space at fixtures.
  - **Barrier-Free Provisions**: regulations which provide accessibility to buildings and sites for persons with disabilities.
  - **Area of refuge**: an area where people unable to use stairways can remain temporarily while waiting for assistance.
A portion of a stairway landing within a smoke proof enclosure

A portion of an exterior exit balcony located immediately adjacent to an exit stairway when the balcony complies with local requirements for exterior exit balconies

A portion of a one-hour fire resistive corridor located immediately adjacent to an exit enclosure

A vestibule located immediately adjacent to an exit enclosure and constructed to the same fire resistive standards as required for corridors and openings

A portion of a stairway landing within an exit enclosure which is vented to the exterior and is separated from the interior of the building with no less than 1-hr fire-resistive doors

When approved by the appropriate local authority, an area or room which is separated from other portions of the building by a smoke barrier

An elevator lobby when elevator shafts and adjacent lobbies are pressurized as required for smoke proof enclosures
→ **Clear Floor Space**: the minimum unobstructed floor or ground space required to accommodate a single stationary wheelchair – 30” x 48” (2'-6” x 4'-0”)
  - **Note**: In toilet rooms; clear floor space, turning space, and accessible route may be overlapped to accommodate requirements.

→ **ADA Dimensional Standards**:

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum clear width for 1 wheelchair + 1 ambulatory person in an accessible route</td>
<td>48” (4'-0&quot;)</td>
</tr>
<tr>
<td>Minimum clear width for 2 wheelchairs in an accessible route</td>
<td>60” (5'-0&quot;)</td>
</tr>
<tr>
<td>Clear floor space for 1 wheelchair</td>
<td>30” x 48” (2'-6” x 4'-0&quot;)</td>
</tr>
<tr>
<td>Minimum 180° Turning Space for 1 wheelchair</td>
<td>60” (5'-0&quot;)</td>
</tr>
<tr>
<td>T-shaped space</td>
<td>All sides of the “T”: 36” (3'-0”) wide</td>
</tr>
<tr>
<td>Minimum continuous clear width for an accessible route</td>
<td>36” (3'-0&quot;)</td>
</tr>
<tr>
<td>Minimum clear width at doorway passage point / door clear opening width @ 90°</td>
<td>32” (2'-8&quot;) with a maximum doorway depth of 24” (2'-0&quot;)</td>
</tr>
</tbody>
</table>
  - **Note1**: if the doorway depth is greater than 24” provide a 36” clear door opening
  - **Note2**: Exception: doors not requiring full user passage may have a clear opening of 20”.
  - **Note3**: clear width is measured from the face of the door and the opposite stop.
| Accessibility route is less than 60” (5'-0”) wide for 2 wheelchairs         | Provide passing spaces of 60”x 60” (5'-0"x 5'-0") at intervals not exceeding 200’ |
| Clear width for making turns in corridors and around obstructions:         | • If obstruction is 48” or greater treat as a continuous accessible route 36” (3'-0") wide; |
  - **Note1**: if obstruction is less than 48":
    1. 42” – 48” – 42”
    2. 36” – 60” – 36”
| Accessible route slope maximum                                             | 5% or 1:20 slope (1” rise for every 20” of distance) |
  - **Note**: any slope greater than 1:20 is considered a ramp.
| Accessible route cross slope                                               | 1:50 maximum               |
| Accessible route headroom minimum clearance                                | 80” (6'-8")               |
  - **Note**: if vertical clearance is less than 80” provide a guardrail or other barrier, for example under a stair
| Minimum Clearance at doors in series                                       | 48” (4'-0")               |
  - **Note**: if 48” clearance is not possible, doors must be automatic
| Changes in level less than ¼”                                              | May be vertical without edge treatment |
| Change in level between ¼” and ½”                                          | Must be beveled with a slope no greater than 1:2 |
| Change in level greater than ½”                                            | Must be a ramp              |
| Maneuvering Clearance at doors @ Front Approach                             | Pull Side: 60”(5'-0") minimum |
  - **Note**: if 1:12 slope is not possible:
  - Openings in floor or ground surfaces shall not allow passage of a sphere more than ½ inches.
  - Elongated openings shall be placed so that the long dimension is perpendicular to the dominant direction of travel.
| Opening in floor clearance                                                 | 1:12                       |
| Maximum ramp slope                                                         | 1:12                       |

[Page 47 of 112]
Use 1:10 slope ➔ 6” rise max.
Use 1:8 slope ➔ 3” rise max.

<table>
<thead>
<tr>
<th>Maximum ramp rise</th>
<th>30” (2'-6&quot;)</th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ Note: any rise greater than 30” requires a level landing before the next ramp starts</td>
<td></td>
</tr>
<tr>
<td>Minimum ramp clear width</td>
<td>36”(3'-0&quot;)</td>
</tr>
<tr>
<td>Maximum ramp length</td>
<td>30’-0”</td>
</tr>
<tr>
<td>Minimum landing length</td>
<td>60”(5'-0&quot;)</td>
</tr>
<tr>
<td>Landing @ Ramp change direction</td>
<td>60” square minimum</td>
</tr>
<tr>
<td>Provide handrails on both sides of a ramp if</td>
<td>Rise 6” or Run 72”(6’-0&quot;)</td>
</tr>
<tr>
<td>Ramp surface to Top of Handrails</td>
<td>34”(2'-10&quot;)min - 38”(3'-2&quot;) max</td>
</tr>
<tr>
<td>Handrail Extension</td>
<td>12”(1'-0&quot;) past top riser</td>
</tr>
<tr>
<td></td>
<td>12”(1'-0&quot;) + 1 thread (11&quot;) = 23”</td>
</tr>
<tr>
<td>Space between handrail and wall</td>
<td>1 ½” minimum</td>
</tr>
<tr>
<td>Maximum Riser height and tread depth</td>
<td>Riser: 4” min. to 7” max</td>
</tr>
<tr>
<td></td>
<td>Tread: 11”min. measured from riser to riser</td>
</tr>
<tr>
<td>▪ Note: open risers are not permitted</td>
<td></td>
</tr>
<tr>
<td>Stairway part of accessible route in an unsprinklered building</td>
<td>48” (4'-0&quot;) clear between handrails</td>
</tr>
<tr>
<td>Protruding objects from 27” or below, above the floor</td>
<td>Protrude any amount</td>
</tr>
<tr>
<td>Protruding objects from 27” or higher, above the floor</td>
<td>Protrude 4” maximum</td>
</tr>
<tr>
<td>Standard car stall dimensions</td>
<td>9'-0” wide x 19'-0” long</td>
</tr>
<tr>
<td>Long compact cars</td>
<td>7'-6” wide x 15'-0”</td>
</tr>
<tr>
<td>Accessible Car parking space width</td>
<td>96” (8'-0&quot;) min. with 60”(5'-0&quot;) wide access aisle</td>
</tr>
<tr>
<td>Note: Curb cut ramp 1:12 max / 1:10 flare sides</td>
<td></td>
</tr>
<tr>
<td>Accessible Van parking space width</td>
<td>▪ 132” (11'-0&quot;) min. with 60”(5'-0&quot;) wide access aisle</td>
</tr>
<tr>
<td></td>
<td>▪ 96” (8'-0”)min. with 96” (8’-0”)wide access aisle</td>
</tr>
<tr>
<td>▪ Note: curb cut ramps are not allowed from van accessible spaces</td>
<td></td>
</tr>
<tr>
<td>Accessible parking space location from building entrance</td>
<td>200’ maximum</td>
</tr>
<tr>
<td>Quantity of accessible parking spaces to be provided given total cars in a lot</td>
<td>7-50 ➔ 2 accessible spaces</td>
</tr>
<tr>
<td></td>
<td>51-100 ➔ 3 accessible spaces</td>
</tr>
<tr>
<td></td>
<td>101 -150 ➔ 5 accessible spaces</td>
</tr>
</tbody>
</table>

**Historic Preservation**

→ Information and regulations pertaining to national historic landmarks and historic preservation in general is developed by the Historic Preservation Service of the National Park Service.

→ **Key Terms:**
  - **Preservation:** the act or process of applying measures necessary to sustain the existing form, integrity and materials of an historic property.
  - **Mothballing:** term used in historic preservation when you designate certain areas to be repaired or restored at a later date, under a later contract.
  - **Adaptive-reuse:** process of adapting old structures for purposes other than those initially intended while retaining their historic features. Example: An old factory may become an apartment building - loft.
4 treatments are applied to historic structures from most historically accurate to least:

2. **Rehabilitation**: [keep historic character but makes it look better] emphasizes the retention and repair of historic materials but gives more latitude to replacement because it assumes the property is more deteriorated prior to work.
3. **Restoration**: [only keep material from on period, removes others] focuses on the retention of materials from the most significant time in a property’s history, while permitted the removal of materials of other periods.
4. **Reconstruction**: [re-creation of history] least historically accurate and allows the opportunity to re-create a non-surviving site, landscape, structure, or object in new materials.

**Secretary of Interior’s Standards for Rehabilitation**

- It is a guide to historic rehabilitation developed by the Historic Preservation Service of the National Park Service;
- They are applied to specific rehabilitation projects taking into consideration economic and technical feasibility;
- Those standards must be met if Federal Tax Investment Credits are to be involved;
- Those standards take precedence over local requirements;
- New additions, exterior alterations, or related new construction shall not destroy historic materials that characterize the property. The new work shall be differentiated from the old while still being compatible in massing, size, scale and architectural features.

*Note:* The U.S National Park service established guidelines for preservation, restoration, and reconstruction similar to those of rehabilitation.

**Masonry in historic building**

The Historic Preservation Service of the National Park Service provides several recommendations for the treatment of historic masonry in several categories:

1. **Identify, Retain and Preserve**
   - Unique masonry from the restoration period should be identified and should not be altered or covered.
2. **Protect and Maintain**
   - Provide proper drainage
   - After testing surfaces, the surfaces should be cleaned only when necessary using the gentlest method
   - Do not use sandblasting and chemical products for cleaning
   - Paint only if damaged or deteriorated
3. **Repair**
   - For mortar should be repointed by hand-raking the joints and duplicating the mortar in strength, composition, color, texture, and joint profile. Never use electric saws, hammers, and high Portland cement content.
   - For masonry, repair by patching, piecing in, or reinforcing using recognized preservation methods
4. **Replace**
If feature is too deteriorated for repair, it may be replaced with a reproduction.
If the same kind of material is not possible, a compatible substitute material may be considered

5. **Remove existing features from other historic periods**
   - If the structure has features from both the original construction and construction from other periods, the items from the other periods should be removed, and if possible stored to facilitate research.

6. **Recreate missing features**
   - Consider this method only if none of the previous recommendations is feasible.

**Other considerations:**
- Environment affects site development + building design, building design affects the community of which it is part.

- Accessibility to transportation is critical to the selection and development of a building site. (Highway access, traffic counts, servicing access, pedestrian access...)

- There are 3 major types of site circulation: automobile, pedestrian, and service. Note: service and automobile circulation should be kept separate.

- Site security can be accomplished by viewing the site at four different levels: perimeter protection (1st line of defense on a site, e.g. fences), access and parking (e.g. limiting access points), on-site security (e.g. nighttime lighting), and building envelope protection (final layer of security, e.g. camera surveillance).
PLANNING CONCEPTS

- **URBAN DEVELOPMENT**
  - **General:** Cities begun near a major geographic feature such as the junction of two rivers tended to develop along the water and ultimately away from it. When begun in less confining circumstances, cities have grown more or less equally in all directions, usually in a uniform grid pattern. The constant challenge of urban design is to set down forms which aid and allow future expansion.

  - The form of urban development can be viewed at two scales:
    1. Large scale: the metropolitan region (city);
    2. Smaller scale: the community and neighborhood.

  - At the city scale, in the 20th century, the pattern of development has been generally determined by:
    1. geographic features
    2. The layout of transportation, most notably the highway
    3. Land use plans.

- **Typical Town Patterns**
  - Typical town patterns of development have been used as planning tools throughout history:
    1. **Rectilinear pattern:** originated in agricultural societies. Derived from the logic of parallel furrow plowing (parallel lines that the machine does when moving earth). It also suited the logic of ordered planning, property ownership, and building construction. Used often but not always for agricultural settlements.
    2. **Circular pattern:** derived from practices of herding societies: the necessity of enclosing the maximum amount of land with the minimum amount of fence. It is also suited for the logic of economical fortification. Used often but not always for military installations.
    3. **Radiocentric:** it is a consequence of incremental urban growth, radiating from a center and expanding outward to an urban periphery.

- **Historical Influences of Development**

  | First Human Settlements | Layout: Living quarters surrounded the granary, the temple, and the palace  
  | Security: Walled in or situated in a tactical position for protection |
  | Greek Cities | Layout: laid out like the first human settlements but more developed. More activities required more and separate spaces. A rectilinear pattern of blocks was used to form a town.  
  | Security: Enclosure wall was irregular and determined by the topography |
Roman Cities

| Location: Town’s location depended on the productivity of the surrounding regions & territorial control for strategic land areas. |
| Layout: Used the rectilinear form of blocks to form a town. |
| Security: Enclosure wall were regular |
| General: Had 2 main intersecting streets: *cardo* and *decumanus*. 2 types of Roman towns: Commercial town/oppidum, Military camp/castrum |

Earlier Medieval Cities

| Location: Often built on the foundations of pre-existing Roman outpost towns |
| Layout: started at the crossroads of 2 main streets. The town adjusted to the site conditions ⇒ irregular shape that seemed to lack geometrical order. Towns were founded and planned with the use of orderly geometry (rectilinear, circular and radiocentric). Medieval cities were organized around the church and the market. |
| Security: Towns are walled for defense and depended on hygienic practices (i.e. waste removal) |

Later Medieval Cities

| Security: the invention of gunpowder required more protection |
| Star-shaped City: regularly spaced bastions at points around the wall so that the entire enclosure and all approaches to the city could be defended. Streets radiated from out from the center allowing the defense to be controlled from one point and easy movement of materials and troops. |
Renaissance Cities

General: Planners paid more attention to aesthetics of urban design. Recalled the principle and forms of the classical world in architecture & town planning.

Layout: city plans combined symmetrical order and radial layout of streets focused on points of interest. The primary organization was overlaid on a grid of secondary streets or over existing road systems. Used the town square/classical forum/plazas that served as a gathering place as well as a setting for principal public buildings.

Baroque

General: The concept was applied first for forest landscapes and later applied to towns.

Connector: Boulevards were used to unite the various parts of a larger, often expanding city.

Focus: Plazas were used as a convening public forum in a compact town.

Example: Vista avenues in Versailles used in French landscape architecture to make large expanses of terrain visible.

Industrial Revolution

Factory System: work force had to be close to the factory, source of power, and transportation = population increase in factory town → overcrowding, filthy, devoid of open space, and recreational activities.

Garden City Concept

General: result of the reform movement and published by Ebenezer Howard in 1898.

Concept: combine the best of the city and country-living in his town-country idea.
Cité Industrielle Concept

General: result of the reform movement and published by Tony Garnier in 1917. 1st concept to emphasize the idea of zoning

Concept: it is a model industrial city. It suggests the separation of work from housing; separate zones for residential, public, industrial, and agricultural use, linked by separate circulation paths for vehicles and pedestrians. Buildings would be placed on long narrow lots with ample open space between them.

Gridiron Street system

General: encouraged by the Ordinance of 1785 which established the rectangular survey system / ubiquitous system of the USA. The system divided the country into a grid of Checks - 24 miles square, each subdivided into 16 townships (6 miles on a side), each further divided into 36 sections (1 mile square)

Concept: regularly planned public open spaces and uniform spacing and setbacks of buildings.

NOTE: See further description under “Survey” section

New Town Concept

Concept: it is an extension of the idea that entirely new communities can be built away from the crowding and ugliness of existing cities. These new towns were suppose to be autonomous centers surrounded by a greenbelt, but they never became truly independent because they lacked significant employment centers; they still depended on nearby cities for jobs
New Urbanism

Concept: attempt to counter the many undesirable aspects of city development (urban sprawl, automobile dependence, environmental deterioration, housing segregation, loss of farmland, single use development. One of the primary design features is the development of neighborhoods intended for mix use. It promotes the connection of neighborhoods and towns to regional patterns of bicycle and public transportation, and pedestrian systems. It encourages buildings to be integrated with their surroundings, and supports the preservation and reuse of historic structures.

- **Urban Planners**

<table>
<thead>
<tr>
<th>Name</th>
<th>Known For</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sir Christopher Wren</strong></td>
<td>Master plan for rebuilding the city of London after the Great Fire of 1666 (not used)</td>
</tr>
<tr>
<td>Astronomer, Geometer, Mathematician-physicist, Architect</td>
<td>Designed 51 churches in the city of London</td>
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<tr>
<td></td>
<td>Work: St. Paul’s Cathedral (1710)</td>
</tr>
<tr>
<td><strong>Kevin Lynch</strong></td>
<td>Coined the words “imageability” and “wayfinding”</td>
</tr>
<tr>
<td>Urban Planner / Author</td>
<td>Wrote <em>The Image of the City</em> which influenced urban planning and environmental psychology</td>
</tr>
<tr>
<td><strong>Christopher Wolfgang Alexander</strong></td>
<td>Wrote <em>A Pattern Language</em> which describes a practical architectural system called a “generative form”. The reasoning is that users know more about the buildings they need than any architect could; the &quot;pattern language&quot; is designed to empower anyone to design and build at any scale.</td>
</tr>
<tr>
<td>Architect</td>
<td></td>
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<tr>
<td><strong>Jane Jacobs</strong></td>
<td>Wrote <em>The Death and Life of Great American Cities</em> which is a critique of urban renewal policy of the 1950s and how they destroyed communities and created isolated, unnatural urban spaces.</td>
</tr>
<tr>
<td>Writer/Activist/Urban Theorist</td>
<td>Jacobs advocated the abolition of zoning laws and restoration of free markets in land, which would result in vibrant, dense, and mixed-use neighborhoods and communities</td>
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<tr>
<td></td>
<td>Frequently cited <em>Greenwich Village</em> as an example of a vibrant urban community</td>
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<td></td>
<td>Coined phrase “eyes on the street” a reference to natural surveillance by people in their neighborhood</td>
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<tr>
<td><strong>Camillo Sitte</strong></td>
<td>Authority on urban construction planning and regulation in Europe</td>
</tr>
<tr>
<td>Architect / City Planning Theorist/ Painter/Art Historian</td>
<td>Wrote <em>City Planning According to Artistic Principles</em> which suggested that the quality of urban space is more important than architectural form (the whole is much more than sum of its parts)</td>
</tr>
<tr>
<td></td>
<td>Planning cannot be done in 2D, but IN 3D.</td>
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</tbody>
</table>
Believed Greek spaces like the agora (gathering place) or forum (marketplace) were good urban spaces.
Said a public square should be seen as a room and should form an enclosed space.
Churches and monuments shouldn’t be isolated, but integrated into the squares.
Thought that the experience of an irregular urban structure with big plazas and monuments was more appropriate than the hygienic planning procedures in practice at the time.

<table>
<thead>
<tr>
<th>Georges-Eugène Haussmann</th>
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<tbody>
<tr>
<td>(a.k.a. Baron Haussmann)</td>
</tr>
<tr>
<td>Civic Planner</td>
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<tr>
<td>Responsible for the plan to rebuild and “modernize” Paris under Napoléon III.</td>
</tr>
<tr>
<td>Rebuilding of Paris plan inspired some of the most important architectural movements including the City Beautiful Movement in the United States.</td>
</tr>
<tr>
<td>Encompassed all aspects of urban planning, both in the city center and in the surrounding districts.</td>
</tr>
<tr>
<td>Cut down the Luxembourg Garden and destroyed much of the old city with twisting streets and rundown apartments.</td>
</tr>
<tr>
<td>Built new wide tree lined boulevards. Placed regulations on facades/heights of buildings, public parks, sewers/waterworks, facilities and monuments.</td>
</tr>
<tr>
<td>Influenced by the frequency of street revolutions, now streets were too broad for rebels to build barricades and military could assemble and get through.</td>
</tr>
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<table>
<thead>
<tr>
<th>Tony Garnier</th>
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</thead>
<tbody>
<tr>
<td>Architect/City Planner</td>
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<tr>
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<tr>
<td>Wrote Une Cité Industrielle which suggested that functions of a city could be separated by zoning into four categories: leisure, industry, work, and transportation.</td>
</tr>
<tr>
<td>Was developed in response to the industrial revolution.</td>
</tr>
<tr>
<td>Schools and vocational schools are placed near the industries they’re related to, and there are no churches or government/police buildings so man can rule himself.</td>
</tr>
<tr>
<td>Pioneered the use of reinforced concrete.</td>
</tr>
<tr>
<td>Designed innovative building block with free standing houses.</td>
</tr>
<tr>
<td>Enormous open spaces. There are few squares or parks.</td>
</tr>
<tr>
<td>Trees are incorporated into important streets.</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Sir Ebenezer Howard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Writer/Parliament Record keeper</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Wrote Garden Cities of To-morrow which describe a utopian city where people live harmoniously with nature, the basis for the Garden City Movement.</td>
</tr>
<tr>
<td>The book offered a vision of towns free of slums and enjoying the benefits of both town (such as opportunity, amusement and good wages) and country (such as beauty, fresh air and low rents). He illustrated the idea with his famous Three Magnets diagram (pictured), which addressed the question 'Where will the people go?', the choices being 'Town', 'Country' or 'Town-Country.</td>
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<table>
<thead>
<tr>
<th>Pierre Charles L’Enfant</th>
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<tbody>
<tr>
<td>Architect/Civil Engineer</td>
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<tr>
<td>Designed the layout of the streets in Washington DC.</td>
</tr>
<tr>
<td>Submitted plans for the federal city in Washington DC that followed Baroque planning elements including grand radial avenues, sight lines, ceremonial spaces, and respect of natural contours of the land. The two most important buildings on the avenues were to be the houses of Congress and the White.</td>
</tr>
<tr>
<td>Name</td>
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<tr>
<td>-------------------------------------------</td>
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<tr>
<td>Daniel Hudson Burnham</td>
</tr>
</tbody>
</table>
| Director of works and designed the general plan of the World's Columbian Exposition in Chicago  
| Designed one of the first skyscrapers: the Masonic Temple Building, which was 21 stories tall, and a skeleton frame  
| Designed the Flatiron Building in New York and Union Station in Washington DC, as well as the Monadnock, Reliance Building, and Rookery offices  
| Prepared the Plan of Chicago which laid out plans for the future of the city to controlled growth and suggested that every citizen should be within walking distance of a park  
| Helped with the McMillan Plan which led to the overall design of the national mall in Washington DC |

| Clarence Samuel Stein                     | Architect /Urban Planner/Writer                                                                                                                                                                                                                                                                                                                                 |
| Major proponent of the Garden City Movement in the USA  
| Collaborated with Henry Wright to design Rayburn, New Jersey a garden suburb noted for its superblock layout and for the total separation between the automobile and the pedestrian. |

| Henry Wright                             | Landscape Architect                                                                                                                                                                                                                                                                                                                                 |
| Major proponent of the garden city, an idea characterized by green belts and created by Sir Ebenezer Howard  
| Wright became one of the core members of the Regional Planning Association of America, along with Clarence Stein, Lewis Mumford, and Benton MacKaye, and it was this association that led to Wright's most well-known work. |

| Lewis Mumford                            | Historian/Author                                                                                                                                                                                                                                                                                                                                     |
| Believed that what sets humans apart from animals is not our use of tools, but our use of language/symbols.  
| Critical of urban sprawl and argued that the structure of modern cities is partially responsible for social problems seen in western society. Argues that urban planning should emphasize organic relationships between people and their living spaces  
| Said the medieval city should be the basis of the ideal city.  
| Modern cities are too much like Roman cities (a sprawling megalopolis) which ended in collapse. |

| Frederick Law Olmstead                    | Journalist/Landscape Architect                                                                                                                                                                                                                                                                                                                       |
| “The father of Landscape Architecture”  
| Famous for designing Central Park and Prospect Park as well as many parks throughout the country |

| Clarence Arthur Perry                    | Planner/Writer                                                                                                                                                                                                                                                                                                                                       |
| A strong advocate of the Neighborhood Unit – neighborhood community and recreation center  
| Wrote The Neighborhood Theory which served as a framework to design functional, self-contained neighborhoods in industrial cities. |

| Patrick Geddes                           | Biologist / Town Planner                                                                                                                                                                                                                                                                                                                             |
| Responsible for introducing the concept of region to architecture  
| Believed that by changing spatial form, it would be possible to |
change the social structure as well
- Emphasized the preservation of human life and energy rather than superficial beautification. The happiness, health, and comfort of all residents are more important than the roads and park for the rich.
- He coined the word “conurbation”: a region comprising a number of cities, large towns, and other urban areas that, through population growth and physical expansion, have merged to form one continuous urban and industrially developed area.

<table>
<thead>
<tr>
<th>Ludwig Hilbersimer</th>
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<tbody>
<tr>
<td>Architect/Urban Planner</td>
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</tbody>
</table>

Taught at the Bauhaus
- Wrote *City Plan* which emphasized street hierarchy including safety for children to walk to walk to school while increasing the speed of vehicular circulation
- Developed studies for the new town center which was a dissolution of major cities and a complete penetration of landscape and settlement
- In order to create a sustainable relationship between human’s industry, and nature, human habitation should be built in a way to secure people against disaster and crisis

### Urban Concepts

#### Kevin Lynch Concepts

1. **Urban Legibility**: refers to the ease with which parts of the city can be recognized and organized into a coherent pattern. It is the basis of orientation - e.g. maps, streets signs...
2. **Imageability**: it links the urban scale with the community scale. It is the quality of environment that gives it a high probability of evoking a strong image in the mind of a given observer. Example: Paris can be considered to be an imageable city, the hills of San Francisco are part of the image of the city in the minds of most people who visit or live there. It is a vital tool for orientation, way-finding, and general well-being.
3. **Image of the City**: Each individual constructs a mental picture of his or her environment that may be stable in overall form, but is forever changing in detail. Thus they form a collective image.

   → Kevin Lynch discerned 5 elements for structuring mental images of the environment that exist as mixtures and overlaps:
   1. **Paths**: it is a way of circulation along which people customarily, occasionally, or potentially move. Paths are the predominant elements of most of our environmental images since other elements are arranged along, or related to paths. (Pedestrian walkway, highway when travelling on it, a river...).
   2. **Edges**: they are linear elements other than paths that form boundaries, terminations, or separations between two districts or that break continuity. (Shoreline, a wall, a highway when seen from a far...). Edges may be either solid or penetrable. Note: when 2 districts are joined at an edge, it forms a seam.
   3. **Districts**: they are 2D areas that people perceive as having some common, identifying character and that they can enter. (A college campus, a residential neighborhood, an industrial area...).
4. **Landmarks:** they are prominent visual features that act as points of references and people cannot enter them - they are viewed from the exterior. Landmarks help identify an area, and so serve to orient people (A tower, a monument, a natural feature, a central plaza...).

5. **Nodes:** they are strategic centers of interest that people can enter. Nodes are types of landmarks, distinguished by their functions. (A plaza, financial district...).

- **Oscar Newman Concepts**
  - **Defensible Space & Creating Defensible Space**, encompasses ideas about crime prevention and neighborhood safety. The theory also argues that an area is safer when people feel a sense of ownership and responsibility for that piece of a community. Newman’s describes a range of environmental design elements that use the basic concepts of surveillance, territoriality, and real and symbolic barriers to reduce crime.
  
  - His concept revolves around 4 factors that make a defensible space:
    1. **Territoriality:** the idea that one’s home is sacred – it is mine therefore I will protect it;
    2. **Natural Surveillance:** the link between an area's physical characteristics and the residents' ability to see what is happening;
    3. **Image:** the capacity of the physical design to impart a sense of security;
    4. **Milieu:** other features that may affect security, such as proximity to a police substation or busy commercial area.

- **Clarence A. Perry Concept**
  - **Neighborhood Unit Concept:** a neighborhood is a relatively small area in which a number of people live in close proximity and share similar needs and desires in housing, social activities, and other aspects of day-to-day living. The original concept of a neighborhood as part of city planning was developed by Clarence A. Perry. His concept primarily proposed as a way of bringing people together to discuss common problems and to become involved in the planning process. Perry formulated this concept through 6 principles:
    1. No major traffic arterials or through routes should pass through residential neighborhoods
    2. Use cul-de-sac, curvilinear layouts, and low volume roadways to preserve a quiet and safe residential atmosphere
    3. The population of a typical neighborhood should be around 5,000
    4. The neighborhood focal point will be the elementary school, centrally situated on a common green space, which would serve as a community center of neighborhood activity. This principle would facilitate the main proposal of the concept.
    5. The neighborhood should be designed for a density roughly 10 families per acre and occupy 160 acres of land
    6. There should be shopping facilities, churches, library, and a community center in conjunction with the school. 10% of the area should be allocated to recreation.

- **Superblock Concept**
  - It is an outgrowth of the **New Town Concept** stating that new communities can be built away from the crowding and ugliness of existing cities. It minimizes the impact of the car on
housing and allows the development of pedestrian circulation and park space within the block. A variation of the superblock concept is the Planned Unit Development or PUD.

- **Examples:**
  1. **Radburn, New Jersey**, by Henry Wright: large piece of land that limited the intrusion of the automobile. The superblock was surrounded by a continuous street and vehicular access was provided with cul-de-sacs.
  2. **Chandigarh, India** by le Corbusier
  3. **Brasilia** by Lucio Costa & Oscar Niemeyer.

### City Beautiful Movement Concept
- Its goal was to improve urban habitability and appearance, as well as social betterment for all. Another part of this concept revolved around using environmental design concepts geared to industrial technology. Importance was given to the management and conservation of natural resources, as well as the development of techniques for metropolitan planning.

### World Columbian Exposition
- It was held in Chicago and was designed by architects Daniel Burnham and John Root, and by landscape architect Frederick Law Olmsted. The expo grouped classical buildings symmetrically around formal courts of honor – White City, reflecting pools, and large promenades. It started the City Beautiful movement in the United States and revived interest in urban planning. The expo resulted in having civic center’s organized around formal parks, a proliferation of classical public buildings, and broad tree-lined parkways and streets.
  - Held in Chicago in 1893 to celebrate the 400th anniversary of Christopher Columbus's arrival in the New World in 1492.
  - The prototype of what they thought a city should be
  - Showed desirable results could be achieved through organized efforts
  - Designed to follow Beaux Arts principles and French neoclassical architecture based on symmetry, balance, and splendor.

### Environmental Design Concepts geared towards technology:
- The city of **Radburn in New Jersey**, based on the Garden City and Superblock Concept, is also an example of the maturation of environmental design concepts in the 1920’s. Designed by
Henry Wright and Clarence Stein, *Radburn* further develops the idea of adjusting to the growing use of the automobile. Radburn is a satellite commuter of Manhattan, but with its own work places, commercial center, schools, parks... it introduced a circulation network that included a separate pedestrian system and a street pattern that prevented through automobile traffic.

**Historical timeline of urban patterns of development**

- **Natural resource conservation and management, 1920’s consisted of:**
  1. Re-planning of NY state by Wright & Stein to utilize land resources rationally & distributing urban and rural population workably = conserving natural resources, restoring damaged landscapes, rebuilding obsolete cities or towns, accommodating future growth
  2. Developments of technique of metropolitan planning in NY through the Regional Planning Association of NY

- **Radburn, NJ, Henry Wright & Clarence Stein**
  - Environmental design concept geared towards technology, it introduced a circulation network that included a separate pedestrian system and a street pattern that prevented through automobile traffic. (see Urban Concepts)

- **Le Corbusier, Contemporary City, 1922**
  - Cities with vast open spaces → office & housing towers surrounded by large green spaces

- **Frank Lloyd Wright, Broadacre City, 1932**
  - Cities with vast open spaces = every home situated on at least 1 Acre of land

- **City of Reston, Virginia by Robert Simon, 1964**
  - It was influenced by the Radburn city plan. It was the first modern post-war planned community, and features a series of underpasses that promote travel on foot
- **Development Growth Pattern**
  → Cities have grown more or less equally in all directions, usually in a uniform grid pattern. With the proliferation of the automobile, cities have expanded in a number of typical patterns.

  - **Finger Plan**
    - Development occurs along corridors of public transit and automobile expressway routes.

  - **Cluster Form**
    - It does not have a dominant center. Consists of varying centers of activity. Each center is served by an interconnected system of expressways and other arterial roads providing multi-directional travel through the region connecting the cluster centers with each other and with the urban core.

  - **Satellite Pattern**
    - Variant of the cluster form. It has a dominant center. Each satellite is a regional civic, cultural and commercial center. Expressways and rapid transit systems connect the satellites to each other and to the central urban core.

  - **Linear Pattern**
    - A city or several cities strong out in a continuous line and connected by a transportation spine.
    - Example: eastern seaboard in the USA.

  - **Megalopolis**
    - 1) Two or more major urban centers near each other grow together as the space between them is developed.
    - 2) It is an extensive linear arrangement of cities. Those cities function separately; physically however they have continuity.
<table>
<thead>
<tr>
<th>Pattern</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expanding Grid / Rectilinear Pattern</td>
<td>City is formed at the junction of 2 roads and laid out in the prevalent pattern. Growth simply follows the grid pattern until some natural feature, limiting population stops it. Usually found in smaller cities.</td>
<td>Philadelphia</td>
</tr>
<tr>
<td>Field Pattern</td>
<td>It has no central focus or apparent overall organization scheme. Development takes place in an amorphous network of highways and natural features</td>
<td>Los Angeles</td>
</tr>
<tr>
<td>Radiocentric Pattern</td>
<td>Large circular urban form with a series of radial bands of intense development emanating from the central core</td>
<td>Washington DC</td>
</tr>
<tr>
<td>Star Pattern</td>
<td>Revolves around the urban core, and development follows radiating spokes of main highways or mass transit routes</td>
<td>Baltimore, Chicago</td>
</tr>
<tr>
<td>Ring Shaped</td>
<td>Linear form encircling an open undeveloped area, such as a body of water or a reserve</td>
<td>Cities of Holland</td>
</tr>
<tr>
<td>Sheet</td>
<td>Shape of an extensive urban area without specific focal points, well defined routes, or articulated form. It describes low density development</td>
<td>St Petersburg, Tampa</td>
</tr>
</tbody>
</table>
Satellite

- Constellation of urban developments, each with its own central core located around a major urban center. Often, the outer cores are connected with a road system called a beltway.
- Example: Houston

Constellation

- Series of urban development's of approximately equal size and population located fairly close to each other but without a dominating center.
- Example: US Midwestern cities

Patterns of Land Use

- As a general rule older cities follow the sector pattern and more recent cities follow the concentric zone pattern.

Concentric Zone Pattern

- It is a series of concentric rings around an original central business district or original center. The rings are the results of progressive phases of growth. The pattern within each ring is determined by the type of urban transportation in predominant use during the zones development. The rings do not have precise boundaries; they blend one into the other.
- It was the first model to give the explanation of distribution of social groups within urban areas/explain urban structures.
- Transition Zone: commercial + residential mixed zone
 Sector Pattern

- The sector pattern suggested that zones expand outward from the city center along railroads, highways, and other transportation arteries. Land uses are portrayed by pie-shaped wedges radiating from the center of the city. This model however varies from city to city. Land values & housing costs are related to the pattern of the sectors.

 Multiple Nuclei Pattern

- While a city may have started with a central business district, similar industries with common land-use and financial requirements are established near each other. These groupings influence their immediate neighborhood. Example: Hotels and restaurants spring up around airports, for example. The number and kinds of nuclei mark a city's growth.
- It is a city composed of several distinct nuclei reflected by all or some of these factors:
  1. Nuclei are similar in purpose as well as form – shopping center
  2. Similar activities tend to group together for mutual benefit – offices + shipping + manufacturing
  3. Activities have similar long distance transportation access (airport + highway)
  4. Activities and land values influence one another

**PLANNING CONSIDERATIONS**

- **Human Factor**
  - It is important to allow, not prescribe, an optimum environment for the widest range of human activity by understanding the relationship between people and their environments, (although no single environment can satisfy all people) by taking into account different considerations:
1. **Biological**: man’s genetic endowments – mental, biological- are constants while man’s choices in creating his environment change constantly – cultural system, i.e. lifestyle.

2. **Perceptual**: it concerns the variety of images that men perceive; men need the diversity of sensory and perceptual experiences. All people try to avoid monotonous environments. People need and seek simulation which encourages healthy perceptual development and growth. When designing, it is helpful to be aware of the permanent features in an environment, as well as the transitory.

3. **Demographic**: it concerns demography, population density and size.

4. **Sociological**: understanding human society through their **social groupings** – primary and secondary social group; which are interdependent, and their **3-part grouping** based on one’s work and profession - primary, secondary and tertiary work group.

### Land Ownership

→ **Ownership**: it is the legal possession of property (land or buildings). Ownership of property carries with it the right to use the property as one sees fit, subject to certain restrictions imposed by society using regulations*. Laws and regulations governing property rights of ownership are both, permissive and prohibitive.

*Note: regulation of property uses has several forms: the regulation of ownership of both, land and buildings, the regulation of land itself, and the regulation of the building of structures.

→ **Types of Owners**:

1. **Joint tenancy**: [shared ownership / 1 dies = survivor becomes sole owner] 2 or more owners. Each owner has a share in the ownership of the whole. The interest of each joint owner automatically passes on to the survivor upon one an owner’s death. Any of the joint owners may sell their share independently of the other owners; the purchaser will then assume the place of the seller. If the property is to be sold, all owners must sign the necessary papers.

2. **Partnership**: [shared ownership / 1 dies = dissolved + assets split among the survivors] A group of owners. Each owner has a share in the ownership of the whole. Upon the death of one of the partners, the partnership may be dissolved and the assets distributed among the surviving partners and the estate of the deceased partner, according to the original agreement among the partners.

3. **Corporation**: [shared ownership / 1 dies = next of kin takes place, it goes on] it is a legal entity with rights and liabilities independent of those of the shareholders. If a shareholder dies, the share of the ownership of the corporation passes to the shareholder’s heirs, and the corporation continues unchanged. A corporation may own, or lease a property, or enter into any arrangement that is available to an individual. In the eyes of the law, a corporation is treated as an individual.
4. **Trustee**: [trustee acts on owner’s behalf] it is an owner who holds property in his own name for the benefit of another person, or group for whom he acts. Typically, this happens when a property is passed to someone who is unable to act in his own interest. The trustee is charged by law to act on behalf of this person or group and protect the interests of this person or group.

→ **Types of Ownership:**

1. **Fee simple/Fee absolute**: [owns land + structure] the owner has absolute title of ownership, which he can transfer by sale or bequest (will).

2. **Condominium**: [owns a portion of the structure] a buyer obtains a fee simple ownership of a portion of a structure, and usually a part of the shared service areas, land, and site improvements. Ownership of the land and public service areas are not shared. The owner of a condominium has a marketable title to the property, which may be sold to another person, mortgage, lease, or bequeathed to an heir. Each owner of a condominium pays her own property taxes and also a periodic fee for the maintenance of the service areas owned jointly. Decisions relating to assessment for operating cost or repairs are made by an owner’s association.

3. **Cooperative**: [owns a share (not the land or structure) and his allowed to occupy a portion of a structure] the owner of a cooperative does not legally own a specific piece of physical property. He owns a share of stock in a corporation. The corporation owns the land and the structure. The owner of the share of stock is allowed to occupy some stated portion of the structure built upon the property. The share can be bequeathed, but for selling, usually, he must get prior approval from the other stockholders. Decisions relating to assessment for operating cost or repairs are made by an owner’s association.

4. **Leasehold**: [owns nothing / right to use a property for a period of time with conditions] a lessee (person to whom the lease is granted) has the right to use a piece of property under certain conditions that are described in the lease, paid in rent – lease payments. A lessee can sublease - sell the right of use of the property to another - only if it is not prohibited in the terms of the lease. A lease exists for a specific period of time either with or without an option to renew. (Note: anything a lessee builds on the property reverts to the lessor upon expiration of the lease).

5. **Sale-and-leaseback**: [owner becomes a lessee by selling his property to the buyer and leasing it back from the same buyer, now the new owner → the original owner can still use the property + substantial tax benefits + avoid long term capital investment/ the new owner = investment + profit from rent] it is a form of leasehold. The owner of a piece of commercial or industrial property recovers the capital invested in the property, but at the same time retains the use of the property for the specified life of the lease. In other words, the seller sells an asset and leases it back from the buyer for the long-term; therefore, the seller continues to be able to use the asset but no longer owns it.

→ **Finance the purchase of a property**
1. **Mortgage**: it is a contract by which a buyer of a property (*mortgagor*) borrows money from a bank or other lender (*mortgagee*) with which to purchase the property, and pledges the property as security for the loan.

   → **Procedure:**
   1. Mortgagee transfers money to the Seller (principal: 80-90% of total price);
   2. Mortgagor makes a down payment to Seller (10-20% of total price);
   3. Seller gives a deed to the property to the Mortgagor;
   4. Mortgagor makes loan payments to the Mortgagee - principal (80-90%) + interest - over an extended period of time (usually 10-40 years);
   5. Mortgagor makes payments until the loan is paid off, at which time, the Mortgagee cancels the mortgage.
   6. The mortgagor gives the Mortgagor a clear title to the property.

   → **Diagram:**

   → **Payment Default**: If the buyer defaults in payments, the mortgagee has the right to foreclose the property (take possession of property) and sell it to recover its investment. If the mortgagee sells the property and the amount of money from the sale is in excess of the amount owed by the mortgagor, the difference goes to the mortgagor.

2. **Trust Deed / Deed of Trust**: it is also a contract by which a buyer borrows money from a lender, like in a mortgage, the difference lies in the procedure.

   → **Procedure:**
   1. Mortgagee transfers money to the Seller (principal: 80-90% of total price)
   2. Mortgagor makes a down payment to Seller (10-20% of total price)
   3. Seller gives a deed to the property to the Mortgagor
4. The Mortgagor transfers the title to the property to a fourth party, which is called the trustee by means of a trust deed.

5. Mortgagor makes loan payments to the Mortgagee - principal (80-90%) + interest - over an extended period of time (usually 10-40 years)

6. Mortgagor makes payments until the loan is paid off, at which time, the Mortgagee cancels the mortgage

7. The trustee, not the Mortgagee, transfers the title back to the Mortgagor, and the Mortgagor has clear title to the property.

→ Diagram:

→ Payment Default: If the buyer defaults in payments, the trustee has the right to foreclose the property (take possession of property) and sell it using the power-of-sale clause.

→ Why a trustee? (simple explanation – Google it for more details) Under a mortgage, when a mortgagor defaults, the case has to go before a judge. When a trustee is involved, the case does not have to go to court. When the borrower defaults, the trustee is able to take title to the property and have it auctioned off to pay back the lender. No judge is involved, the mortgagor is satisfied.

3. 2nd Mortgage or Trust Deed: A property may have more than one debt against it; in addition to a 1st mortgage or trust deed, it may carry a 2nd one. The procedure for the 2nd is the same as the 1st, except that:
   - It is subordinate to the 1st mortgage or trust deed;
   - It has a higher interest rate because the lender will have a greater difficulty in getting repayment should the mortgagor default on one or both debts.
Usually it has a “default in prior mortgage clause” – if mortgagor defaults in payment on a prior mortgage, the second mortgagee may pay the amount, add it to the loan, and immediately institute foreclosure.

→ **Deed Restrictions**: Any clause in a deed which restricts the future use of a parcel of land by the buyer of the land. This type of agreement is enforceable between buyer and seller, and sometimes third parties. Most deed restrictions are generally established for a certain period of years such as 10, 15, 20, or 30 years.

→ **Types of deed restrictions**

1. **Restrictive Covenants**: it is a legal agreement used to protect or uphold a condition of use on a parcel of land. Its purpose is to maintain a desired uniformity of appearance, site development, and quality of construction, and prevent unfavorable land uses or structures, thus maintaining and even increasing the value of the development. They can be more effective than zoning in achieving and maintain aesthetics harmony and overall quality. Covenants are more difficult to alter than zoning. Deeds may contain covenants to limit the height, size, or appearance of a building. Covenants are legal and enforceable if they are reasonable and in the public interest.

2. **Affirmative covenant**: those covenants legally commit a buyer to perform certain duties in the future. Such covenants run with the land so that future owners of record will always be responsible to perform the same duties. Affirmative covenants are also used to require buyers of PUD’s and condominiums to make payments for the maintenance of common areas, association fee. Example: maintaining a fence, or roadway.

3. **Conditional covenant / Condition**: it is a clause that imposes a restriction on a buyer and specifies that if the restriction is violated, the title to the land will revert to the original grantor or his heirs.

4. **Easement**: it is the right of one party to use a portion of the land of another party in a particular way, usually without compensation. An easement for a stated purpose may not be unilaterally modified for another purpose at a later date; if the original purpose was an easement of ingress, the person can only use it for that purpose and may not use it for any other. There are many types of easements:

   4.1. **Utility easement**: it allows a utility company to install and maintain lines above and below ground within the boundaries of the easement. No permanent structures can be erected within the easement without getting permission from the party holding the easement, although the land belongs to the property owner.

   4.2. **Access easement /Easement for ingress**: if one parcel of land is not served by a public road and another parcel separates the first parcel from the street, an access easement may be granted, which allows the public and the owner of the inaccessible land to cross. An access easement creates a public or private right-of-way (see right-of-way).
4.3. **Support easement / Party Wall Agreement**: it is for the construction of common party walls between properties. It is used in row housing, where a common wall is shared by two adjacent owners. Each owner owns half of the wall, but each has an easement of support in the other half of the wall. The arrangement cannot be revoked unilaterally.

4.4. **Joint use easement**: two private owners share the joint use of a strip of land between two houses, which has a property line running through it such as a driveway.

4.5. **Scenic easement**: protects views and prevents the development of land that is of scenic value to the public. Used by public agencies to control land use without the need to purchase large tracts of property.

4.6. **Conservation easement**: limit land use in large areas. Used by public agencies to control land use without the need to purchase large tracts of property.

4.7. **Right-of-way**: it is the legal right of one party or the public to traverse land belonging to another. A right-of-way, in its most common form refers to the public land used for streets and sidewalks. The boundary of a right of way usually corresponds to the property line of adjacent property owners.
   - **Private right-of-way**: allows one person to traverse the land of another in order to reach his own property. This type of easement is the result of negotiations between private parties.
   - **Public right-of-way**: may come into existence simply by the long-established use of a pathway or roadway over private land whose owner fails to discourage such use.

4.8. **Historical façade easement**: can be established by a municipality to protect a historically valuable architectural façade in an area where redevelopment is occurring and where the existence of the façade is threatened. The municipality does not compensate the owner to preserve the façade.

- **Land Analysis** (Land Use & Land Value)

  - Land use depends on its potential roles in a:
    1. Catchment area
    2. Location
    3. Topography
    4. Cost
  - There are 8 basic categories of potential land use:
    1. Natural resources (mining, forestry...)
    2. Agricultural
    3. Residential
    4. Commercial
    5. Industrial
    6. Governmental
    7. Institutional
8. Open space/conservation

→ Land values are generally based on:
  1. a value per square foot or per acre
  2. the concept of “highest and best use”
  3. Location (market area, population density, special site features…)
  4. Local market conditions (incl. demand for the land)
  5. Potential profit-making use
  6. Zoning
  7. Access – vehicular access, proximity to transportation
  8. Utilities – proximity to utilities
  9. Topography

→ Land value may be determined for 5 of the categories of land use (natural resources, agricultural, residential, commercial, and industrial land use) using 4 methods:

1. **Market Approach / Comparison method / Market Data Approach**: it is the most common technique for determining land value. This method reflects the market value most closely and is applicable to all land use, only if one of its requirements is met: sufficient data has to be available on comparable land being offered for sale at the same time of valuation. This approaches procedure requires that the surrounding region be investigated to find properties that have recently sold or are on the market that are similar to the property being valued; the property is then assumed to have the same value as that of the similar properties. Since no two properties are alike, adjustments will have to be made to reflect the unique nature of the property.

2. **Income Approach / Residual method**: it is used in highly developed areas with no vacant land where data of comparable parcels is not available. The basis is the potential the property has to yield a profit or income; value must be estimated on the potential income from site improvements. The potential income is estimated and then various expenses (taxes, insurance, maintenance…) are deducted. The resulting amount must be capitalized to estimate the current, total value of the property because potential income is usually figured on a yearly basis.

3. **Cost Approach / Allocation method**: It is used to determine the value of improved properties; the value of the land is estimated at its highest and best use. The cost to replace the building or add improvements is calculated by figuring out the estimated accrued depreciation and deducting it from the replacement cost or cost of the improvements. This adjusted amount is then added to the land value to get the total value of the property.

4. **Development method**: it is used to value land that has a potential use for residential or industrial subdivision. This method depends on evaluating development cost. How? 1. Determine the selling price of individual lots, 2. Determine the cost to develop the subdivision, 3. Determine the period of time necessary to sell the developed lots, and 4. Determine the possible discounts of the net sale price.
Zoning

→ **Zoning ordinance in history:** it is the most common form of legal constraint on land development. It was originally an attempt to improve the problems of the rapidly expanding cities - crowding, factories built to close to housing and tall buildings blocking air and light - and a way to regulate land use. **The first zoning ordinance was passed in New York City in 1916;** it was the first attempt by a municipal government to control the use and location of buildings throughout a city.

→ **Euclid v. Ambler. 1925:** initiated and validated the concept of zoning in suburbs with the rationale of public health, welfare, and safety.

→ **Berman v. Parker, 1954:** zoning became concerned with social and environmental issues, i.e. aesthetics.

→ **Zoning today:** it is the division of a city or other governmental unit into districts, and the regulation of the use of the land, and the location and bulk of buildings on property within those districts. Legally it is founded on the right of the state to protect the health, safety, and welfare of the public. Special types of zoning exist such as floodplain zoning, rural zoning... Sometimes zoning ordinances will also place maximum limits on the number of stories of a building or the height in feet above grade level.

→ **Zoning primarily regulates:**

1. The **uses** allowed on a parcel of land depending on the zoning district – residential, commercial, and industrial occupancies with subdivisions within each of these;
2. The **area** of the land that may be **covered** with building – FAR;
3. The **bulk/mass of the structures** – FAR, setbacks, bulk pane restriction;
4. The **distances** the buildings must be set back from the property lines – Setbacks;
5. Parking and loading space requirements.

→ **Note:** If a zoning ordinance and a building code give different information for maximum heights and areas, the lower of the two take precedence.

→ **Zoning regulations result in:**

1. Segregation of permitted uses
2. Control of population density
3. Provision for parking and loading spaces
4. Influence on building form
5. Stabilization of property values
6. Prevents the proliferation of poorly planned developments

→ **Key Terms:**

- **Uses:** they are established for the zoning districts and are based on residential, commercial, and industrial occupancies with subdivisions within each of these. For example, a residential zone may include single-family, low-density multifamily and high-density family dwellings. Each zoning district specifies a list of permissible uses. Each zone may be used for the purposes listed for that zone and for any use listed in a more...
restrictive zone - Single-family uses are the most restrictive; a piece of land in a particular zoning district may be used for the uses designated for that zone and usually for any use ranked above it, but not for use below it.

- **FAR / Floor Area Ratio**: the amount of land that can be covered is determined by setting the maximum square footage allowed expressed as a ratio (1:1, 2:1...) or decimal fraction (0.1, 2.0...). FAR of 1:1 or 1.0 means that for every 1 square foot of land, an owner may build up to 1 square foot of building. FAR expresses the relationship between the amount of useable floor area permitted in a building (or buildings) and the area of the lot on which the building stands. It is obtained by dividing the gross floor area of a building by the total area of the lot. The diagram below illustrates 3 simple ways that a 1.0 FAR might be reached.

  → **Diagram Legend**: 1) 1 story covering the entire lot, 2) 2 stories covering half the lot, 3) 4 stories covering a quarter of the lot

→ **Formulas**:

\[
FAR = \frac{\text{Total covered area on all floors of all buildings on a certain plot}}{\text{Area of the lot}}
\]

- Example: 100,000 square foot site with a 3.0 FAR, how many stories will a maximum-sized building be if half the site is set aside for parking?
  - FAR = total allowable floor area \div area of site
  - 3.0 = total allowable floor area \div 100,000

  total allowable floor area = area of site \times FAR
  total allowable floor area = 100,000 \times 3.0 = 300,000

  half the site = area of site \div 2
  half of the site = 100,000 \div 2 = 50,000

  Stories quantity = total allowable floor area \div half of the site
  Stories quantity = 300,000 \div 50,000 = 6

  Result: a maximum-sized building on a site of 100,000 ft\(^2\) with a 3.0 FAR can have a maximum of six stories when half of the site is dedicated to parking.

→ **Note**: FAR does not take into account setbacks just the buildable area.
- **Setbacks**: the amount of land that can be covered is also determined by setbacks. Setbacks are the minimum distance a building must be placed from a property line. The front setback, usually the greatest setback, is the distance from the property line facing the street or the primary front of the property. The rear setback is the distance from the back of the lot, while the side setbacks are the distance from the side property lines.

- **Bulk Plane Restriction**: it sets up an imaginary inclined plane beginning at the lot line or the center of the street and sloping at a prescribed angle toward and over the lot. A building cannot extend into this plane. The purpose of the restriction is to ensure adequate light and air to neighboring properties and to the open space and streets around the land.

- **Road**
  - Roads should have a **maximum of 10% grade for drainage**.
  - Roads provide primary means of access to a site. Their availability and capacity maybe prime determinants in whether or how a parcel is developed. **There are four basic road categories**:
    1. **Local streets**: lowest capacity + provide direct access to building sites.
    2. **Collector streets**: higher capacity than local streets + connect local streets and arterial streets + not usually intended for through traffic.
    3. **Arterial streets**: major continuous circulation routes that carry large amounts of traffic on two or three lanes + usually connect expressways + parking is usually not allowed + avoid direct access to building sites from arterial streets.
    4. **Expressways**: limited access roads designed to move large traffic between, through, and around population centers.

  - **Note**: Entrance location to a site is most desirable to be located on a collector street rather than an arterial street.

  - **Access entrance to site location in relation to intersections**:
    1. at a minimum of 150ft to an intersection
    2. a minimum of 80° angle to an intersection
    3. avoid slight offsets to an intersection
    4. avoid two-way intersections

- **Parking**
  - For parking and circulation, there should be 400ft² of space per car
  - Drainage slope in parking lots: 1 ½ % minimum to 5% maximum (2% and 3% are preferred)
  - **Most efficient parking**:
    - Double loaded configuration
    - Utilize a drive as a back up space
  - **Dead end parking**:
    - Require a back-up space
    - Appropriate for parking with few cars
  - **90° parking**:
- Most efficient in terms of land use – 11 cars per 100 lineal feet of curb;
- Most difficult for a driver to maneuver within;
- Only configuration that allows for 2-way traffic.

→ **60° parking:**
  - Relatively economical
  - Less total width for either a single or double loaded layout
  - Allows easy access to and from parking spaces
  - One-way circulation pattern
  - 9 cars per 100 lineal feet of curb

→ **45° parking:**
  - Relatively economical
  - Less total width for either a single or double loaded layout
  - Allows easy access to and from parking spaces
  - One-way circulation pattern
  - 8 cars per 100 lineal feet of curb

→ **30° parking:**
  - Least efficient
  - Uneconomical
  - One-way circulation pattern
  - 5 cars per 100 lineal feet of curb

### Survey

→ It describes the location, form, and boundaries of land. Surveys also describe all the special features of a site that are pertinent to site development and building design.

→ A land survey provides the following information:
  1. Survey title / property location / certification / date
  2. Scale & compass orientation
  3. Tract boundary lines, courses & distances
  4. Adjacent property owners names
  5. Bench mark with reference elevation
  6. Location, type, size, flow of all that is existing on the property: structures, building, foundation, roads, meter box, hydrant, water & gas mains, sewers, utility poles, bodies of water, paved areas (surfacing type), flood plain max., right of way, trees with trunk over 8’ in diameter and 3’ above ground, road elevation of all improved roads...
  7. Elevations (vertical dimensions) through the site sufficient to develop a complete and thorough contour map or topographic contour lines of the site.

→ Surveying for building construction is done at three levels of details:
  1. **Preliminary survey:** basic information for the preparation of building plans.
  2. **Construction survey:** describes the precise condition of the site and adjacent structures, and established base lines, benchmarks, and offsets.
  3. **Possession survey:** it is made after the completion of construction to record the completed development, including site improvement, and structures.

→ **Types of surveys:**
1. **Geodetic**: it is used for very large land areas. This survey takes into consideration the spherical shape of the earth, and describes large land areas with great precision.

2. **Plane**: it is used for most site development work and assumes that the earth is a flat plane. There are various types of plane surveying:
   - **Land survey**: land parcels or sites general measurement and description.
   - **Topographic Survey**: contour lines – natural and manmade features and elevation.
   - **Route survey**: layout road and utility lines – used by civil engineers.
   - **Hydrographic survey**: describes and maps bodies of water for purposes of navigation, water supply, or water-related construction.
   - **City survey**: used for city planning.
   - **Aerial survey**: prepared using aerial photography – see photogrammetry.
   - **Construction survey**: provides a system of markers to determine the precise location of a building on its site.
   - **Plat map**: a land plan. A component of a survey, typically furnished by a civil engineer, and drawn to scale, it indicates the bearings and dimensions of property lines.

→ **United States Survey System / Public Land Survey System / Rectangular Survey System**: the Land ordinance of 1785 was the beginning of this survey system. It is the most common land description for site boundaries in the US. It was used to survey and spatially identify land parcels before designation of eventual ownership, particularly for rural, wild or undeveloped land. The US Survey System divided land that was not already surveyed into a grid system of meridians and parallels 24 miles apart. Find below a list of the key terms associated with this type of boundary description, and a representative diagram of this system.

   - **Meridian**: north-south lines. Some meridians serve as the basis of the grid layout they are called principal meridians. Other meridians are called guide meridians, which are east or west of the principal meridians.
   - **Parallels**: east-west lines that follow the lines of the latitudes of the earth. Some parallels serve as the basis of the grid layout they are called base line. Other parallels are called standard parallels, which are north or south of the baseline.
   - **Range (R)**: it is the row of townships running north and south.
   - **Township (T)**: it is the row of townships running east or west.
   - **Check**: 24 mi. square bounded by parallels and meridians, divided into 16 townships
   - **Township**: 6 mi. on one side divided into 36 sections
   - **Sections**: 1 mi. square parcel of land containing 640 acres further divided into quarter sections. (Note: 1 acre = 43,560 ft)
   - **Quarter Section**: .5 mi square further divided into four more parcels

→ Diagram for land description **SE 3/4 of the SW 4/4 of Section 31, T.2N R.8W**
→ **Metes and Bounds Survey System:** it is a method for describing a property in the form of a narrative. The property is described by beginning at a specific point on the property boundary and then describing the length and direction of the boundaries of the property, until the entire property is encompassed.

  - **Example:** "beginning with a corner at the intersection of two stone walls near an apple tree on the north side of Muddy Creek road one mile above the junction of Muddy and Indian Creeks, north for 150 rods (rod is a unit of measurement) to the end of the stone wall bordering the road, then northwest along a line to a large standing rock on the corner of John Smith’s place, thence west 150 rods to the corner of a barn near a large oak tree, thence south to Muddy Creek road, thence down the side of the creek road to the starting point."

→ **Lot and Block survey System:** it is a method used in the United States and Canada to locate and identify land, particularly for lots in densely populated metropolitan areas, suburban areas. The description must identify

  1. The individual lot,
  2. The block in which the lot is located, if applicable,
  3. A reference to a platted subdivision or a phase thereof,
  4. A reference to find the cited plat map (i.e., a page and/or volume number), and
  5. A description of the map’s place of official recording (e.g., recorded in the files of the County Engineer)

  - **Example:** The legal description of a 2.5 acres (10,000 m²) property under the Lot and Block system may be something like:
    1. Lot 5 of Block 2 of the South Subdivision plat as recorded in Map Book 21, Page 33 at the Recorder of Deeds.
    2. Some simple maps may only contain a lot and map number, such as Lot C of the Riverside Subdivision map as recorded in Map Book 12, Page 8 in the office of the City Engineer.

→ **Methods of field measuring & recording to create an Existing building survey:**

  1. **Field measurement:** hand measuring, tape measure, traditional surveying equipment, EDM (electronic distance measurement), REDM (reflectorless electromagnetic distance measurement) – EDM & REDM are both laser based instruments.

  2. **Rectified photography:** large format, film based view cameras to photograph facades. It produces a flat image with no perspective distortion from which dimensions can be scaled.

  3. **Orthophotography:** it is similar to rectified photography except that it relies on digital photography and correction of optical distortion through computer software.

    - **Photogrammetry:** it is the surveying of objects or spaces through the use of photography and associated software. There are 2 methods:
      → **Stereophotogrammetry:** uses 2 overlapping photographs in a computer program to produce a digital stereo image to produce 3D drawings
      → **Convergent photogrammetry:** uses multiple, oblique photographic images of an object taken at different angles in order to derive 3D models and measurements. This method requires surveyed reference points.
- Laser scanning: it uses laser beams which symmetrically sweep over an object or space to obtain 3D coordinates of points on the surface of the object or space being scanned. No surveyed reference points are needed.

- Site Analysis
  → Site analysis is the prequel to site design. It is the process of investigating basic data that relates to a particular site (survey information, topographic data, geological information, zoning ordinances, existing character, microclimate...). The purpose of site analysis is to determine whether a parcel of land is suitable for a specific proposed use, and it begins when all the basic site data are collected. Once site data is collected, a base map is prepared and the resulting site analysis information is recorded on a site analysis map overlaid on the base map. The following is a list of some basic data that must be gathered and analyzed for a complete site analysis:

1. **Climate**: every site is affected by macroclimate & microclimate (temperature, wind intensity, humidity patterns, etc.)
2. **Topography**: land development is strongly influenced by the form of a site’s surface features (slope, elevation, landforms, etc.)
3. **Soils**: determine the soils capacity to support buildings, roads, and plant materials (soil type, moisture content, depth of bedrock, etc.)
4. **Hydrology**: refers to the occurrence, movement, and quality of water on a site (runoff rates, aquifer zones, drainage patterns, etc.)
5. **Vegetation**: plant types and patterns represent a major site resource and often determine the form of development.
6. **Existing land use**: consider manmade features on and around the site, such as structures, circulation systems, and activity patterns.
7. **Sensory qualities**: they are those intangible elements that affect people through the senses of sight, smell, touch, and hearing (scenic vistas, quality of light, characteristics of sounds, etc.)
8. **Natural hazards**: there are several natural elements that are potentially hazardous to a site and must be identified (earthquake fault zones, flood plains, poisonous plants, etc.)

- Environmental Factors
  → Climate analysis and its impact on site development are examined at two levels to help determine the orientation of buildings, their protection (or exposure to) from sun & wind, fenestration, building materials, heating & cooling systems, the location and selection of plant materials, as well as aesthetics & appearance: macroclimate and microclimate. Other climatic considerations include the human comfort zone, air pollution, noise, and glare.

1. **Macroclimate**: it refers to the overall climate of the region and is reflected in the weather data available from the National Weather Service statistics. From this information, a region can be classified as cool, temperate, hot-arid, or hot-humid. The macroclimate of an area:
   - Depends on
     1. **Site Latitude**: the amount of solar energy that is received in a particular location in relation to latitude (the angular distance north or south from the equator of a point on the Earth's surface).
     2. **Site Elevation**: as elevation increases, temperature decreases
3. **Proximity to bodies of water**: bodies of water reduce temperature extremes both daily and seasonal, on nearby land areas. The bodies of water act as a moderator. Big body of water = increase moderating influence on the climate.

- **Influenced by**
  4. **Prevailing winds**: winds can alter a climate whether it carries warm air, cold air, moisture...
  5. **Ocean currents**: currents can be warm or cool
  6. **Mountain barriers**: force prevailing winds to rise.
  7. **Clear/Cloudy Sky**: clouds are like a blanket thus they can slightly alter the range of daily and seasonal temperatures.

2. **Microclimate** – it refers to the site specific modification of the macroclimate; it is a local atmospheric zone where the climate differs from the surrounding area. Microclimates exist, for example, near bodies of water which may cool the local atmosphere, or in heavily urban areas where brick, concrete, and asphalt absorb the sun's energy, heat up, and reradiate that heat to the ambient air: the resulting *urban heat island* is a kind of microclimate. Microclimate information can be obtained from the National Oceanic and Atmospheric Administration (NOAA), by walking the site, or by studying the climate-influenced details of indigenous architecture. The microclimate of an area depends on:

1. **Solar radiation on the site influenced by the**:
   a. **Amount of solar radiation**: it is a function of *altitude*, the angle between the sun and the horizon. The amount of solar radiation received on the ground surface depends on the angle of the sun’s rays to the surface
   b. **Duration of sunlight exposure**: (northern hemisphere)
     - **Summer Solstice**: day that has the maximum hours of sunlight exposure – June 21 or 22 – lowest angle – depending on the site’s location, the sun rises and sets north of an azimuth through the site.
     - **Winter Solstice**: day that has the minimum hours of sunlight exposure – December 21 or 22 – highest angle - depending on the site’s location, the sun rises and sets south of an azimuth through the site.
     - **Equinox**: day when the hours of sunlight equals the hours of darkness – March 21 -vernal equinox, September 21 - autumnal equinox – the sun rises and sets directly above the equator.
   c. **Site slope**: it affects the amount of solar energy that a site receives. South-facing slopes receive more solar energy than level or north-facing slopes.

2. **Topography of the site affected by**:
   a. **Wind velocity on the surface of a hill** is influenced by the steepness of the slope and the prevailing wind direction.
     - **@ Crest/Top of Hill**: cold & windy – wind can be about 20%+ than wind on flat ground
     - **@ mid-slope of Hill**: warm
     - **@ valley**: cold air flows down hill and settles in low-lying regions & less air circulation
- **@ windward side of hill** (the side in the direction of the wind): great wind speeds & turbulent winds at crest
- **@ leeward side of hill** (the side away from the wind direction): less turbulent winds & wind velocity is minimal known as the *wind shadow*.

→ Note: In general in temperate climate the best microclimate for winds are on south or southeast facing slopes; in the middle of the slope or toward the top of the hill rather than at the very top or bottom of the slope.

3. **Proximity to bodies of water**: the effect of a body of water on the land adjacent to it is to moderate the microclimate. The difference in temperature between the two causes an almost constant breeze. Warm air rises over warmer land during the day and causes a breeze from the water. At night the pattern may be reversed; cold air flows down a hill and settles in low-lying regions, causing pockets that remain colder than higher elevations during the first part of the day this results in an inversion (see inversion phenomenon diagram in the following page).

4. **Ground surface materials**: ground surfaces having low *albedo* and high *conductivity* moderate and stabilize the microclimate considerably such as grass, whereas high albedo and low conductivity such as pavement, are much hotter than what the macroclimate will produce.
   a. **Albedo**: (reflectivity) fraction of radiant energy received on a surface that is reflected. It is expressed as a number from 0 to 1.0.
      - **LOW – 0 (grab, no reflection)**: flat black surface that absorbs all the heat and reflects none, ex: grass, vegetation.
      - **HIGH - 1.0 (no grad, reflection)**: reflecting surface that absorbs no heat and reflects all the energy, ex: pavement, snow.
   b. **Conductivity**: it is the time rate of flow of heat passes through a material.
      - **LOW conductivity (keep energy)**: retard the passage of heat, ex: sand, natural materials
      - **HIGH conductivity (release energy)**: lets heat pass through them quickly, ex: metals, concrete, masonry

5. **Trees**
   a. **Modify air flow**: level rows of trees are effective wind breakers which can also reduce the wind chill factor
   b. **Obstruction of solar radiation**: block the direct radiation of the sun, as well as light and glare – Ex: deciduous trees (trees lose their leaves seasonally) & evergreens (trees have leaves year round)
   c. **Filtration of air-born pollutants**: filter the air by absorbing dust, dirt, and other pollutants
   d. **Photosynthesis** – absorb carbon dioxide $\text{CO}_2$ and release oxygen $\text{O}_2$
   e. **Water evaporation**: Evaporate water vapor into the air through perspiration which cools & humidifies the air

6. **Structures or manmade structures**
   a. **Alter air movement** – block, divert, and channel winds, sometimes in unpredictable ways
b. Reflect solar radiation & elevate temperatures – urban areas are generally warmer than comparable rural areas both, day or night, winter or summer.

7. **Other Climatic considerations:**

a. **Human Comfort Zone:** It is the range of temperature and relative humidity in which the average person is comfortable wearing light clothing. Factors influencing human comfort are:

   - **Temperature range:** 63° and 71° in winter / 66° and 75° in summer
   - **Humidity range:** 30% to 60% - 75% is uncomfortable regardless of the temperature
   - **Air Movement:** it causes a cooling sensation because of heat loss from the body by convection and evaporation
     - Air movement of 50 feet per minute - not noticed.
     - Air movement of 50 – 100 feet per minute – pleasant.
     - Air movement of 100 – 200 feet per minute – pleasant and noticeable.
     - Air movement of 200 -300 feet per minute – drafty.
     - Air movement of 300 and more – uncomfortable.
   - **Solar Radiation affect comfort zone**
   - **Microclimate variables affect comfort zone**

b. **Air pollution:** it is caused by both Man, and acts of Nature, but Man’s actions and practices are of a greater concern. The effects of manmade pollution can be magnified by natural weather actions such as the *inversion phenomenon*. (See diagram below).

c. **Noise:** it is unwanted sound. Sound levels are measured in decibels with a scale value of 1(threshold of hearing) to 140 (threshold of pain). One decibel is the smallest difference between two sounds that the human ear can detect. **Noise may be controlled by either locating activities at some distance from the noise source or by placing physical barriers between the noise source and the planned activity using noise barriers.**

   - 50 to 60 decibels is the comfortable noise level for the average person
   - 30 decibels is recommended for sleep/study areas
   - 85 decibels is the safety threshold
   - Higher than 85 decibels over a prolong period ≈ hearing impairment
d. **Glare**: it occurs when there are two sources of illumination of extremely different intensities. *Glare is not a result of too much light, but rather too much contrast.* Glare may be alleviated by certain wall treatments, sun control devices, and natural landscape elements.

e. **Ecosystem or Ecological System and Ecology**:
   - **Ecosystem**: it is formed by a community of organisms (living animals and plants in a given area) and its environment. It may be a forest, a pond … Ecosystems are constantly changing.
     - **Simple ecosystem**: if a particular species is destroyed, the simple/unstable system is likely to collapse
     - **Complex ecosystem**: if a particular species is destroyed, the complex/stable system itself will form new relationships. Example: a forest.

   - **Ecology** is the study of living organisms in relation to their environment. Ecology applied to site development means:
     1) The need to understand the impact of construction on the surrounding natural environment – see EIS below
     2) The need to be aware of the impact of smaller scale buildings on the surroundings, whether the environment is rural (impact on natural landforms, water runoff, wildlife, and existing vegetation) or urban (minimize noise, pollution, pay attention to building placement in relation to wind patterns, sunlight, glare, transportation system…)

   - **EIS / Environmental Impact Statement**: The Environmental Policy Act of 1969 requires that for every major federal action that may significantly affect the quality of the human environment, the responsible official must prepare a detailed statement discussing the environmental impact of the proposed action, describe any adverse effects that cannot be avoided, and any irreversible and irretrievable commitments of resources that would be involved. The topics required in the impact statement depend on the type of site, the building or development program, and the requirements of a particular agency:
     - A complete resource inventory of the existing conditions of the region and the project site
     - A complete description of the proposed project, with an emphasis on its environmental impact
     - The environmental impact assessment
     - Alternatives to the proposed project
     - Alternative process or methods
     - Alternative configurations
     - The no-action alternative
     - Environmental and socioeconomic impacts of the proposed project that cannot be avoided
f. **Ahwahnee Principles**: In 1991, the Local Government Commission, a private nonprofit group in Sacramento, California, invited architects Peter Calthorpe, Michael Corbett, Andrés Duany, Elizabeth Moule, Elizabeth Plater-Zyberk, Stefanos Polyzoides, and Daniel Solomon to develop a set of community principles that express new, sustainable land use planning ideas as a possible resolution to the existing pattern of urban and suburban development impairing the quality of life (air pollution, loss of open spaces, etc.).

- **Community principles** include having complete and integrated communities, a diversity of housing types, an ample supply of open spaces, encourage pedestrian and bicycle use, efficient use of water, and much more.
- **Regional principles** include having a continuous system of greenbelt corridor, regional institutions and services located in the urban core, and much more
- **Implementation principles** include having the local governments take charge of the planning process, plans should be developed through an open process...

g. **Sustainable design / Green Building Design**: it addresses a wide range of concerns to achieve a balance between the consumption of environmental resources and the renewal of those resources. The concerns include the environmental impact of a building, the use of materials, energy conservation, the use of alternative energy sources, adaptive reuse, indoor air quality, reuse, site disturbance, site development, building location, building size, shape, and design, and so on.

h. **Solar orientation**: it influences 3 aspects of site planning: the orientation of the building to control solar heat gain or heat loss, the location of outdoor spaces and activities, and the location of building entries.

- **Building orientation**: it is the direction the length of the building faces. For most northern hemisphere locations, the best overall orientation is to have its principal façade facing south or slightly east or west of south. East of south (5° to 25°, depending on the climatic region) is considered ideal to balance the desired heat gains in the winter and to minimize heat gains in the summer. To control or allow the sun rays into the structure, louvers, overhangs, or deciduous trees can be used. On the east and west facades, however use vertical sun baffles because of the sun’s lower angles at these points in the morning and late afternoon in the summer.
Design strategies for building orientation based on climatic regions

Cool climates
- Optimum orientation angle: 12°
- Compact form with smallest surface area possible relative to the volume
- South: large windows
- East & West: small windows
- North: minimal or no windows
- Interior materials: high thermal mass
- Summer shading for glazed areas
- Use dark or medium-dark colors for the building’s exterior

Temperate climate
- Optimum orientation angle: 17.5°
- Rectangular building with the long direction oriented generally along the east-west axis and facing slightly the east
- South facing openings to capture winter light
- Use the cooling effect of the wind in the summer, block it in the winter
- Shade glazing in the summer, allow the sun to fall on glazing and the building in the summer
- Use medium colors for the building’s exterior

Hot-humid climates
- Optimum orientation angle: 25°
- Provide shade for all openings
- Maximize natural ventilation using large openings, high ceilings, and cross ventilation
- Construct buildings using light materials; minimize thermal mass
- Use light colors for the building exterior
Hot-arid climates

- Optimum orientation angle: 5°
- Compact form with smallest surface area possible relative to the volume
- Minimize opening sizes
- Provide shade for openings
- Maximize thermal mass
- Use light colors for the building exterior

- Topography

  - Topography describes the surface features of land.
  
  - A topographic map shows:
    - The slope and contour of the land;
    - Natural and artificial features, such as trees, vegetation, outcroppings;
    - Natural features, such as view analysis, significant natural features should be identified (rock outcroppings, caves...), and subsurface conditions of groundwater and rock (water table, removal of rocks near the surface) must also be studied during site analysis.
    - Manufactured structures, such as roads, existing buildings, utility poles;
    - Property boundaries.

  - Topography affects:
    1. Location of major site features (building, parking, drives...)
    2. Quantity of soil to be moved to maintain desired slope and drainage patterns.

  - Any modifications to the land should be kept to a minimum because:
    1. Moving or removing earth is expensive;
    2. Excavating and building on steep slopes is more expensive than on gentle slopes;
    3. Excessive modifications affect drainage patterns;
    4. Large changes in elevation can require a retaining wall, which add cost to the project;
    5. Damage tree roots

  - If the natural contours and slope have to be changed → the amount of earth cut away in grading operation should equal the amount of earth required to fill in other portions of the site.

  - It is better to orient the length of a building parallel to the direction of the contours to minimize excavation costs.

  - Key words:
    - Contour Lines: graphic way to show the elevations of the land in a plan view. Contour lines are also used to make a slope analysis to determine the suitability of the land for various
uses. Each contour line represents a continuous line of equal elevation above some reference benchmark. Existing contour lines are dashed and new contour lines are solid. At the property lines, the contour lines must match up with the existing contours at adjacent properties or retaining walls must be built. Modifications should not be done within the drip line of trees.

→ **Common contour line representations:**

- **Ridge / Crown**: point in the direction of the downslope – toward low elevation
- **Valley / Swale**: point in the direction of the upslope – toward higher elevation
- **Concave slope**: closely spaced contour lines near the top of the slope
- **Convex slope**: closely spaced contour lines at the bottom of the slope
- **Uniform slope**: equally spaced contour lines
- **Hills**: concentric circles with elevations getting higher towards the center
- **Depression**: concentric circles with the elevations getting lower towards the center

![Contour Line Diagram](image)

- **Contour Interval**: it is the vertical distance between adjacent contour lines. A contour interval will vary depending on the steepness of the slope, the scale of the map, and the amount of detail required.

- **Slope of land**: the slope of the land can be determined using the contour interval and the horizontal distance between any two contour lines. The resulting slope is represented as a percentage.

→ **Formula**: $G = \left( \frac{d}{L} \right) \times 100\%$

→ **Example**: find the slope between point A (85ft) and point B (100ft), if the horizontal distance between them is 80ft.
The vertical distance → \( d = 100 - 85 = 15 \text{ft} \)

The slope → \( G = \left( \frac{d}{L} \right) \times 100\% = \left( \frac{15\text{ft}}{80\text{ft}} \right) \times 100\% = (0.19) \times 100\% = 19\% \)

→ **Note:** slope categories for different types of uses:
- 0%-4%= usable for all types of intense activity + easy to build on;
- 4%-10%= suitable for informal movement + outdoor activity + can be built on without much difficulty
- 10%-25% = difficult to climb + use for outdoor activity + more expensive + more difficult to build on
- 25% or more = very steep slope + subject to erosion + very expensive to build on

**Soil**

→ It is the pulverized layer of the earth, formed by the erosion of rocks and plant remains and modified by living plants and organisms.

→ **Soil cutout:**

<table>
<thead>
<tr>
<th>LEVEL 1</th>
<th>TOPSOIL (organic + minerals)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEVEL 2</td>
<td>MINERALS</td>
</tr>
<tr>
<td>LEVEL 3</td>
<td>ROCK (partially weathered &amp; fractured)</td>
</tr>
<tr>
<td>LEVEL 4</td>
<td>BEDROCK</td>
</tr>
</tbody>
</table>

→ All soils are a combination of the following types and any site analysis must include a subsurface investigation to determine the types of soil as well as the water content. Soils are classified according to grain size and as either organic or inorganic:

- **Gravel:** rock particles low in plasticity. Excellent for construction loads, very good bases for building foundations, drainage, and for sewage drain fields. It is unsuitable for landscaping.

- **Sand:** same abilities as gravel, just that it has smaller granular particles.

- **Silt:** fine grained sedimentary soil composed of material smaller than sand but larger than clay. It is stable when dry or damp but unstable when wet. When frozen it swells, heaves and compresses under load. It can provide an adequate base for foundations if soil investigations show they are stable; building foundations and road bases must extend below it or they must be elastic enough to avoid damage. Silt makes better foundations if they are mixed with other types of soils.

- **Clay:** composed of smaller particles than silts. It expands when wet, and shrinks when it dries. It is also subject to slippage. It is poor for foundations unless it can be kept dry or they are mixed with other types of soils. It is also poor for landscaping and unsuitable for sewage drain fields or other types of drainage.

- **Organic:** organic materials such as Peat consist of vegetable or other organic matter excellent for landscaping but unsuitable for building foundation and roads. Usually, these
soils must be removed from the site and replaced with sands and gravels for foundations and roads.

→ **Key terms:**
  - **Hardpan:** unbroken mixture of sand, clay, and gravel
  - **Shale and Slate:** soft rocks with a fine texture. They have the second highest bearing capacity.
  - **Boulders:** rocks that have broken off of bedrock
  - **Bedrock:** solid rock that forms the earth’s crust. It has the highest bearing capacity of all soil types.

→ **General:**
Soil tests are usually requested by the architect but paid for by the owner. They are typically referred to in the specifications for information only. However, soil tests are not part of the contract documents.

→ **Soil tests are used to determine the exact nature of the soil** – bearing capacity, water table level, and porosity – using borings or test pits.
  - **Boring log:** removal of undisturbed samples of the soil at regular intervals, usually a minimum of 4 borings is taken.
  - **Test Pit:** 10ft trenches dug at the job site that allow visual inspection of the soil strata and direct collection of undisturbed samples; soil below 10ft cannot be directly examined.

→ **Water present in soil can cause several problems for foundations** as well as other parts of the site, such as reduce the load carrying capacity of the soil, cause differential settlements, and foundations can be subject to hydrostatic pressure.

→ **Possible solutions to other potential land problems:**
1. Water within 6ft of land surface → pump out excavation, waterproof slab/basement, and resist hydrostatic pressure by, for example, using a continuous drain pipe around the foundation.
2. Rock found near the surface of the land → use explosives which will reduce manual labor
3. Soil is composed of soft clay, water bearing sand or silt → construct deeper foundations, use drive piles, or remove poor soil
4. Underground streams → building over this location should be avoided and apply caution when siting the structure
5. Cut and Fill: it has to be balanced; amount taken out (cut) should be equal to amount putted in (fill)

→ **To increase bearing capacity, decrease settlement or both, several soil treatments are used:**
1. **Drainage:** increase the strength of the soil and prevent hydrostatic pressure
2. **Fill:** if existing soil is unsuitable for building, the undesirable material is removed and new engineered fill is brought in, which should be compacted before building commences.
3. **Compaction:** compact existing soil
4. **Densification:** on-site compaction using vibration, dropping heavy weights, or pounding piles into the ground and filling the voids with sand.
5. **Surcharging**: preloading of ground with fill material to cause consolidation and settlement of the underlying soil before building. Once the required settlement has taken place, the fill is removed and construction begins.

6. **Mixing**: a layer of sand or gravel can be placed on less stable soil and mixed in.

→ **Proctor test / Proctor compaction test**: it is named after the engineer Ralph R. Proctor (1933). The test is used frequently by geotechnical engineers to determine the optimum moisture content at which a given soil type will become most dense and achieve its maximum dry density.

→ **Procedure**: these laboratory tests generally consist of compacting soil at known moisture content into a cylindrical mould of standard dimensions using a compactive effort of controlled magnitude. The soil is usually compacted into the mould to a certain amount of equal layers, each receiving a number blows from a standard weighted hammer at a specified height. This process is then repeated for various moisture contents and the dry densities are determined for each. The graphical relationship of the dry density to moisture content is then plotted to establish the compaction curve. The maximum dry density is finally obtained from the peak point of the compaction curve and its corresponding moisture content, also known as the optimal moisture content.

→ **Soil bearing capacity - Maximum amount of pressure or load by soil type**:

<table>
<thead>
<tr>
<th>Soil Type</th>
<th>Maximum Load (psf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bedrock</td>
<td>10,000</td>
</tr>
<tr>
<td>Graded Gravel &amp; Sand</td>
<td>3,000 to 12,000</td>
</tr>
<tr>
<td>Compacted Sand / Compacted Fill</td>
<td>2,000 to 3,000</td>
</tr>
<tr>
<td>Silt / Clay</td>
<td>1,000 to 4,000</td>
</tr>
</tbody>
</table>

→ **Foundation types**

<table>
<thead>
<tr>
<th>Deep Foundations</th>
<th>Used for very large design loads, or in the presence of poor soil at shallow depth, or because of site constraints.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pier Foundations</td>
<td></td>
</tr>
</tbody>
</table>
| Caisson Foundations | Belled Caissons  
 | Socketed Caissons |                                                  |
| Pile Foundations | End Bearing Piles  
 | Friction Pile |                                                  |

<table>
<thead>
<tr>
<th>Shallow Foundations</th>
<th>Transfers building loads to the earth near the surface</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spread Footing</td>
<td></td>
</tr>
<tr>
<td>Mat-Slab Foundation</td>
<td></td>
</tr>
<tr>
<td>Pad Foundation</td>
<td></td>
</tr>
<tr>
<td>Slab on grade Foundation</td>
<td></td>
</tr>
<tr>
<td>Rubble trench Foundation</td>
<td></td>
</tr>
<tr>
<td>Earthbag Foundations</td>
<td></td>
</tr>
</tbody>
</table>
Drainage

Key Terms:
- Runoff: additional storm water that does not steep into the ground.
- Runoff coefficient: the fraction of total precipitation that is not absorbed into the ground.

Buildings need to be built away from major drainage paths or must bridge them so that water flow is not restricted and potential damage is avoided.

If the runoff coefficient is greater than the capacity of the natural or artificial drainage from the site, holding ponds must be constructed.

Retention pond vs. Detention pond:
- Retention pond: it is used to manage storm water runoff to prevent flooding and downstream erosion, and improve water quality in an adjacent river, stream, lake, or bay. It is an artificial lake with vegetation at the perimeter, and includes a permanent pool of water in its design; it is designed to hold a specific amount of water indefinitely. Usually the pond is designed to have drainage leading to another location when the water level gets above the pond capacity.
- Detention pond / holding pond: it is a storm water management facility installed on, or adjacent to rivers, streams, lakes, or bays. It is designed to protect against flooding by storing water for a limited period of time while slowly draining the water out at a controlled rate to a downstream water body.

Subsurface drainage methods to minimize subsurface water:
1. Slope the land (1/4”/ft minimum) around the building to drain surface water before it soaks into the ground near the structure;
2. **Use gutters and drain pipes** to collect water from the roof and decks to drain away water from the building;

3. **French Drain / Subdrain**: perforated drain tile set in a gravel setting bed laid around the footings 6” below the floor slab to collect water and carry it away to a storm sewer system for example;

4. **Layer of gravel and waterproofing membrane** against a wall or slab to relieve hydrostatic pressure.

5. **Enclosed storm sewers** that carry the runoff from the site to a municipal storm sewer system or to a natural drainage outlet such as a river.
   
   → **Note**: large sewer systems require manholes for service access, located wherever the sewer changes direction, or a maximum of 500ft apart. Storm sewers are completely separate from sanitary sewers.
   
   → **Important**: Sanitary sewers and storm sewers usually take precedence in planning because they depend on gravity flow.

→ **Surface water drainage methods to minimize surface water**:

   1. **Sloping the land away from the building**: areas for surface drainage require minimum slopes to provide for positive drainage
   2. **Modify the finish contours** to divert water into natural drainage patterns or artificial drains
   3. **Use a Drain inlet**: allows storm water to run directly into the storm sewer
   4. **Use a Catch basin**: allows debris to settle instead of flowing down the sewer
   5. **Sheet flow**: water that drains across a sloping surface, whether paved, grassy, or landscaped.
   6. **Gutters**: built into roadways and parking areas
   7. **Ground swales**: part of landscaping and channels

**Energy Efficiency and Natural Resources**

→ When planning a project, it is important to look at passive design methods for energy efficiency as well as the use of alternative energy sources. Both can greatly reduce operating costs, improve human comfort, reduce reliance on mechanical systems, and reduce the use of fossil fuels. Below find a list of ways it can be achieved.

→ **Energy Efficiency can be achieved through**:

   1. **Building orientation** (rectangular building with the long direction facing east-west);
   2. **Building shape** (any building which maximizes the total area, e.g. a cube has the least surface for the volume contained);
   3. **Landscaping** (use of deciduous trees or evergreens);
   4. **Building shading** (horizontal or vertical shading);
   5. **Earth sheltering** (burying a portion of a building underground);
   6. **Green roofs** (*extensive green roof* – use soil less than 6” deep, *intensive green roof* – use ticker soil and support complex landscapes);
   7. **Air locks** (vestibule entry system to prevent cold drafts from entering a building);
   8. **Insulation & weather sealing** (air barriers, vapor barrier, cementitious foam...);
   9. **Glazing** (use appropriate type of glazing system);
   10. **Double envelope** (dynamic buffer zone - two glazed layers as the outer skin of a building);
11. **Daylighting** (knowing the daylight variables, take more advantage of day lighting with building design, window design, light shelves, and glazing selections).

→ **Alternative energy sources to improve a building’s sustainability while decreasing life-cycle costs:**
  1. **Solar design** (use the sun’s energy for passive solar design- solar energy is collected, stored, and distributed without the use of mechanical equipment- or active solar design – use mechanical equipment)
  2. **Wind** (wind power to generate electricity)
  3. **Geothermal** (use of ground surface heat pumps using the temperature of the earth)
  4. **Photovoltaic** (direct conversion of sunlight into electricity)

### Asbestos and Lead Exposure- Hazardous Conditions

→ **Key Terms:**
  ➔ **EPA:** Environmental Protection Agency
  ➔ **OSHA:** Occupational Safety and Health Administration - it is designed to protect workers who handle ACM and other hazardous materials
  ➔ **Asbestos Containing Materials (ACM):** regulated by EPA/OSHA/State/Local Agencies
  ➔ **Permissible Exposure Limit (PEL):** it is a standard that sets the number of asbestos fibers a worker can be exposed to.
  ➔ **National Emission Standards for Hazardous Air Pollutants (NESHAP):** an EPA regulation that dictates requirement of ACM removal before remodel/demo in order to prevent significant asbestos release into the air.
  ➔ **Asbestos Hazards Emergency Response Act (AHERA):** an EPA regulation that handles asbestos found in K-12 schools, and requires that all facilities be inspected to determine the presence and amount of asbestos.

→ **Asbestos:** it is a natural mineral used commercially for their desirable physical properties. Asbestos became increasingly popular among manufacturers and builders in the late 19th century because of its sound absorption, average tensile strength, its resistance to fire, heat, electrical and chemical damage, and affordability. It was used in such applications as electrical insulation for hotplate wiring and in building insulation. The inhalation of asbestos fibers can cause serious illnesses and long exposure to high concentrations of asbestos fibers is more likely to cause health problems.

→ **The three most common types of asbestos found in buildings are:**
  1. **Chrysotile:** white asbestos, accounts for about 95% of asbestos found
  2. **Amosite:** brown asbestos
  3. **Crocidolite:** blue asbestos

→ **Asbestos Facts:**
  ➔ Asbestos were originally used for spray fireproofing, sound proofing, pipe insulation, floor/ceiling tiles, mastic, etc.;
  ➔ EPA banned spray application of asbestos containing fireproofing materials in 1973;
  ➔ Laboratory analysis is the only way to positively identify asbestos;
  ➔ Owner is responsible for cost to identify and remove asbestos;
  ➔ Removal of asbestos is less of a concern if no children will be living in the building.
→ Health Hazards known to exist from asbestos exposure:
   1. **Asbestosis**: non cancerous chronic respiratory disease caused by accumulation of asbestos fibers in the lungs
   2. **Cancer of Lung, Stomach, and/or Colon**
   3. **Mesothelioma**: rare cancer in the thin membrane lining the chest and abdomen

→ Methods to minimize/contain asbestos fibers during removal:
   → Wet methods
   → HEPA vacuuming
   → Area isolation
   → Use of Personal Protective Equipment
   → Avoid sawing, sanding and drilling

→ **Lead**: toxic material once used in paint and other household products, found in contaminated air, water, soil, food, and consumer products.

→ **Lead Facts**:
   → Typically lead based paint that is in good condition is not a hazard
   → Children under 6 are at the greatest risk for lead poisoning
   → Most common sources for lead poisoning are by breathing or swallowing the following:
     ▪ Deteriorating lead based paint
     ▪ Lead contaminated dust
     ▪ Lead contaminated residential soil

→ Health Hazards known to exist from lead exposure:
   ▪ **Children**:
     – Damage to brain and nervous system
     – Behavioral and learning problems (e.g. Hyperactivity)
     – Slowed growth
     – Hearing Problems
     – Headaches
   ▪ **Adults**:
     – Reproductive Problems
     – High blood pressure
     – Nerve disorders
     – Memory/concentration problems
     – Muscle/joint pain

→ Methods to minimize/contain lead during removal:
   → If disturbing more than 6ft² of lead paint in homes, in child care facilities, or a in school built before 1978, the work must be done by contractors certified by the EPA to follow procedures for safe removal;
   → Contain work area;
   → Minimize dust;
   → Clean up thoroughly.
### PRACTICE CONCEPTS

- **Practice Management**
  - Refers to all the activities related to running a professional services business, from business organization to project management.

- **Business organization types**

<table>
<thead>
<tr>
<th>Type</th>
<th># People</th>
<th>Advantage</th>
<th>Disadvantage</th>
</tr>
</thead>
</table>
| **Sole proprietorship** | 1        | • Easy to set up;  
  • Total management control by the owner;  
  • Tax advantages to the owner-expense +lost may be deducted from the gross income of the business. | • Owner is personally liable for all debts + losses of the company;  
  • More difficult to raise capital and establish credit as a sole owner;  
  • May be difficult to sell the business because of owner reputation;  
  • Usually, Owner quits or die = no more company. |
| **General Partnership**     | 2*       | • Easy to form;  
  • All partners share management, profit, & risk of the business;  
  • Skills and talents of several people rather than one;  
  • Business is taxed as ordinary income on personal tax forms | • All partners are responsible and liable for the actions of the others;  
  • Income is taxed at individual rates  
  • Disagreements between partners may arise;  
  • 1 partner withdraws = partnership dissolved. |
| **Limited Partnership**     | 1’ general partners + 1’ limited partners | • General partners invest, manage and are financially responsible(like in general partnership);  
  • Limited partners are investors and receive portions of the profits;  
  • Limited partners are liable only to the extent of their investment. | • General partners are responsible and liable for the actions of the others. |
| **Corporation / C Corporation** | Unlimited stockholders | • Corporation is financially independent from the stockholders;  
  • Stockholders are only liable for the amount of money invested in the corporation;  
  • If sued, the personal assets of stockholders are not at risk;  
  • Taxed at a lower rate than are individuals;  
  • Changes in shareholders does not affect the corporation = continuity;  
  • Easy to raise capital by selling stocks in the corporation. | • Corporations are taxed at 2 levels: corporations are taxed on their profits, and then shareholders are taxed on their dividends;  
  • Initial cost, continuing paperwork and formal requirements necessary to maintain the business are the primary disadvantages. |
| **S Corporation**          | 100 max. Stockholders | • Corporation is financially independent from the stockholders;  
  • Stockholders are only liable for the amount of money invested in the corporation;  
  • If sued, the personal assets of stockholders are not at risk;  
  • Taxed at a lower rate than are individuals; | • Eligibility requirements;  
  • Initial cost, continuing paperwork and formal requirements necessary to maintain the business are the primary disadvantages. |
- Changes in shareholders does not affect the corporation = continuity;
- Easy to raise capital by selling stocks in the corporation
- Liability for malpractice is generally limited to the person responsible;
- Avoid double taxation: S corporations do not pay any federal income tax; rather, stockholders must report profits or losses on their personal income taxes in proportion to the share of stock they hold.

<table>
<thead>
<tr>
<th>LLC – Limited Liability Company / LLP – Limited Liability Partnership</th>
<th>Members + Managers</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Easier to set up and operate than a corporation</td>
<td></td>
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<tr>
<td>• Formed like a partnership = investors are members, those who manage are managers ; the difference is that non members can be managers;</td>
<td></td>
</tr>
<tr>
<td>• Liability is limited to a member’s investment</td>
<td></td>
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<tr>
<td>• A member has no personal liability</td>
<td></td>
</tr>
<tr>
<td>• Tax choice: Taxed as a partnership or a corporation – if corporation is chosen , members are only taxed at one level</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Joint venture</th>
<th>2+ persons or firms</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Temporary association for the purpose of completing a project;</td>
<td></td>
</tr>
<tr>
<td>• Treated as a partnership;</td>
<td></td>
</tr>
<tr>
<td>• Cannot be sued like a corporation can;</td>
<td></td>
</tr>
<tr>
<td>• Profits may be taxed as a partnership or the individual members of the joint venture may be taxed separately.</td>
<td></td>
</tr>
</tbody>
</table>

→ Office organization
1. **Departmental organization**: project moves through the office from one department to another
   - **Advantage**: efficient, take advantage of many types of specialists
   - **Disadvantage**: communication can be a challenge, discourages anyone from gaining a breadth of experience or share their knowledge in other aspects of project planning and completion.
2. **Studio organization**: each studio is responsible for completing an entire project.
   - **Advantage**: close and immediate communication among members of the team, creating of synergy that comes from sharing ideas and group problem solving, works even better with a strong project manager system. Sometimes the studio organization can be combined with one or more departments that provide very specialized work – e.g. spec writing.

→ The architect’s responsibility and familiarity with legal issues and terms is an important part of practice management. Below find a list of fundamental principles and issues that the architect must understand in any practice (refer to party responsibilities in CDs Notes and read AIA Contracts A201 – A101 – B101 – C401, for more information and review)
1. **Agency**: the architect must be careful to act on the owner’s behalf by clearly defining the different parties’ duties and responsibilities as outlined in the AIA contracts.

2. **Duty**: for the architect, duty can be established 3 ways:
   - **Terms of a contract** – AIA: outline services and responsibilities of the architect which may not be exceeded without the consent of the owner.
   - **Legislative enactment** – building codes + architectural licensing laws
   - **Architect’s conduct** – implied duties: in the case of implied duties, duties not outlined by the contracts or general conditions, the architect is not free to act unilaterally without consultation with the client. The architect may be held liable for the consequences of either action or inaction.

3. **Liability, negligence, and risk management**: architects are constantly exposed to liability from third party claims, actions, inactions, and negligence. **An architect may be find negligent, only if three conditions are met** (listed below). An architect cannot avoid total liability, but he can limit exposure through risk management, by, for example, maintaining a quality control program, or by having well-written contracts and follow them thoroughly.
   - A legal duty is established between the parties;
   - The architect breached that duty;
   - The breach of that duty was the cause of the damage or injury suffered by the other party.

4. **Third-party claims**: through the concept of privity, and the indemnification clause, provided in the contracts, the architect should be protected from third party claims. However, the architect can still minimize those claims but doing the following:
   - Contract language should not imply responsibility for management, supervision, coordination, or planning of construction, unless specifically provided
   - Do not give directions concerning methods of construction
   - Point out obvious construction safety problems to the contractor

5. **Copyright**: copyright protection can be done 1) for drawings, specifications, pictorial, or graphic representations of the architect’s work, and 2) for the building itself. Registering the work is advisable but not required. Generally, **the architect owns the copyright unless the architect is an employee of the owner or the architect specifically assigns the copyright to the owner**. The architect can transfer copyright to the owner, if desired, or can grant a license to reproduce the building or derivative work one or more times.

6. **Insurance**: when doing business and completing a project, insurance is a key component. Each of the primary parties to a project must have certain kind of insurance to protect against liability, property loss, and personal loss (for the types and definitions of insurances, see CDs notes). The architect should have the following insurances:
   - Professional liability
   - General liability
   - Property insurance
   - Personal injury protection
   - Automobile insurance
   - Worker’s compensation
Architect Fees

Key Term:

Utilization Rate: it is used by architectural firms to determine the amount of time spent on billable work as a percentage of the total time an employee is compensated; it is an important number for firms that charge their time to clients. It shows the billing efficiency of an individual or a firm. There are two methods to calculate utilization rate:

- UR = BILLABLE HOURS / TOTAL HOURS over a particular time period
- UR = BILLABLE HOURS / FIXED HOURS per WEEK

Methods for calculating architectural fees:

- Note: Whichever method is chosen, add a fixed percentage of contingency (5-10%) for complex or remodel jobs to address any unforeseen problems or issues that come up during design and/or construction.
1. Multiple of Direct Salary Expense (DSE): employee’s direct salary or wages are multiplied by a factor to cover employee benefits, overhead, and profit.
2. Multiple of Direct Personnel Expense (DPE): employee benefits are included in the direct salary or wages of all employees. That expense is in turn multiplied by a factor to cover overhead and profit.
3. Professional Fee plus Expenses: professional services are separated from services with identified costs such as costs for reimbursable, paying consultants, etc.
4. Hourly Billing Rate: the project is billed using standard rates for every hour worked. Often it has a “not to exceed” value without consent of the owner clause.
5. Stipulated/Lump Sum: a specific amount is agreed upon for the total payment of architectural services.
6. Percentage of the cost of work: based on a percentage of construction cost
7. Unit price contract: based on acceptance and incorporation of unit price quotes for the various portions of the project

Project Management

It is the coordination of the entire process of completing a job in the architect’s office. In most cases project management is the responsibility of one person –project manager, but sometime, a partnering system is used. The partnering method allows various stakeholders of a project, i.e. owner, architect, client...- to be brought together into the decision making process.

Project manager’s tasks based on the requirements of three critical areas: time, fees, and quality

Planning:

- Time: CPM, or / and Gantt Chart
- Fee Projection: it takes the total fee the designer (minus profit, overhead, and other expenses) will receive for the project and allocates it to the schedule and staff members who will work on the project. A fee projection should be the basis for setting the final fee agreement with the client. A simple method for estimating and allocating fees is using a fee projection chart that combines time scheduling with fee projections based on experience, and common rules of thumb the design office may use.
- Quality planning: it involves determining with the client what the expectations are concerning design, cost, and other aspects of the project – obtained during programming.
9. **Scheduling**: a useful technique for developing a schedule while at the same time involving all members of the design team, construction team, and sometimes the client, is the *full wall schedule.*

3. **Monitoring** the progress of the project to see if the planned aspects of time, fee, and quality are being accomplished using a project monitoring chart. If the actual line begins to vary too much above the budgeted line, the project manager must find the problem and correct it.

4. **Coordinating** the various people involved on a weekly or even daily basis to make sure the schedule is being maintained and the necessary work is getting done, using checklist, holding weekly project meetings...

5. **Documenting** everything done on a project to provide a record in case legal problems develop and serve as a project history for future projects.

### Pre-Design

→ **In 5 broad steps:**
1. An architect must decide whether or not to accept a project offered by a potential client based on several factors such as current workload, the client’s reliability, etc.;
2. An architect must first negotiate an agreement with the owner that determines the scope of the work, the fees required, and other aspects of the contract;
3. Once the architect has accepted to take over the project, he must also coordinate with regulatory agencies, in case of unusual design challenges, zoning variances requirements, development of preliminary designs, etc. to get a better grasp at the project and compute any additional fees these procedures might require;
4. The architect must assemble and coordinate the various consultants on the project with the approval of the client;
5. Contractual arrangements must be made between the consultant, owner, and architect. (see party responsibilities in CDs notes)

→ One of the most important parts of pre-design concerns the coordination of the consultants. Below find key aspects of the contractual obligations between the owner, architect, and consultant:

- **Owner / Consultant contract** → architect not responsible for paying the consultant.

- **Architect / Consultant contract** → architect responsible for paying the consultant.

- **Architect’s responsibility towards the Owner, in regards to the Consultant:**
  1. The architect is responsible to the owner for ensuring that the drawings and specifications conform to the applicable codes.
  2. The architect is the prime consultant and is liable to the owner for the consultant’s work.

- **Architect’s responsibility towards the Consultants:**
  1. Inform the consultants of the applicable code requirements
  2. Inform the consultants of any design decisions that may have code implication

- **Consultant’s responsibility towards the Architect:**
  1. Consultant is responsible for code compliance regarding their area of work
  2. Responsible for the accurate production of the consultant’s own drawings and specifications
  3. Responsible for checking their own various documents for consistency
Architect’s design decisions are affected by:

1. Cost
2. Function
3. Aesthetics
4. Time
5. Sustainability – LEED certification is considered an additional service for the architect
   a. Level and quality of Sustainability is rated by the LEED system. LEED’s goal is to introduce new sustainable approaches and technologies to the construction industry. It is comprised of 6 categories: (1) sustainable sites, (2) water efficiency, (3) Energy and atmosphere, (4) materials and resources, (5) indoor air quality, (6) innovation and design practice. In order for a project to be LEED certified, the design decisions have to improve the building’s performance against an established standard in percentages.

   b. It is important to educate and explain to the client, the project team, and bidders, the benefits, requirements and characteristics of sustainable design, in order to avoid misunderstandings, and unnecessary additional fees from bidder, contractor, and consultants.

   c. Sustainability affects:
      - **Cost** → life-cycle costing considerations (initial cost, operating cost, maintenance cost, residual value, replacement cost) and matrix costing considerations (balancing aesthetics, budget and function)
      - **Function** → environmental impact and energy efficiency
      - **Aesthetics** → balance function + cost + aesthetics = better reputation for sustainability
      - **Time** → may result in longer construction process and construction
### Prominent Architects

<table>
<thead>
<tr>
<th><strong>Prominent Architects</strong></th>
<th><strong>Known For</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>William LeBaron Jenney</td>
<td>“The Father of the American Skyscraper”&lt;br&gt;Noteable Project: the <strong>Home Insurance Building</strong>, in Chicago the first 8 story fully metal framed building, considered to be the first skyscraper. He used masonry, iron, and terra cotta flooring and partitions for fireproof construction</td>
</tr>
<tr>
<td>Le Corbusier</td>
<td>One of the pioneers of Modern Architecture&lt;br&gt;Distanced himself from the past, and based designs on functionality without ornamentation&lt;br&gt;Developed the <strong>Five Points of Architecture</strong> which included:&lt;br&gt;- <strong>pilotis</strong> (reinforced concrete stilts),&lt;br&gt;- a <strong>free facade</strong> (non supporting walls designed however),&lt;br&gt;- an <strong>open plan</strong> (no structure in the way),&lt;br&gt;- <strong>ribbon windows</strong> (for unencumbered views), and <strong>roof garden</strong> (green area consumed by the building on the ground was relocated to the roof)&lt;br&gt;Developed <strong>The Modulor Man</strong> a continuation of architectural scale and proportion based off the human body, the golden ratio, Fibonacci numbers, and the double unit.&lt;br&gt;Noteable Project: <strong>Villa Savoye, Notre Dame du Haut</strong></td>
</tr>
<tr>
<td>Ludwig Mies van der Rohe</td>
<td>Pioneer of modern architecture,&lt;br&gt;“<strong>Less is more</strong>” and “<strong>God is in the details</strong>”&lt;br&gt;He strived towards an architecture with a minimal framework of structural order balanced against the implied freedom of free-flowing open space. He called his buildings “skin and bones” architecture. He sought a rational approach that would guide architecture through a creative process&lt;br&gt;Noteable Project: <strong>Barcelona Pavilion, Farnsworth House</strong></td>
</tr>
<tr>
<td>Louis Henri Sullivan</td>
<td>Father of the modern skyscraper, father of modernism&lt;br&gt;Inspiration to the Chicago group of architects who have come to be known as the Prairie School&lt;br&gt;Used steel frames with terra cotta to create tall buildings that emphasized verticality&lt;br&gt;“<strong>Form follows Function</strong>” - Believed that the exterior of a building should reflect its inner structure and function. Ornamentation must be derived from nature rather than classical architecture of the past&lt;br&gt;Noteable Project: <strong>Guarantee Building (Prudential Building)</strong></td>
</tr>
<tr>
<td>Frank Lloyd Wright</td>
<td>Leader of the <strong>Prairie School</strong>&lt;br&gt;Emphasized structures built in harmony with humanity and its environment, which he called organic architecture.&lt;br&gt;Noteable Project: <strong>Falling water, Robie House, Johnson Wax Headquarters building</strong></td>
</tr>
<tr>
<td>Buckminster Fuller</td>
<td>Developed the <strong>geodesic dome</strong>, and futuristic prototype housing</td>
</tr>
<tr>
<td>Walter Gropius</td>
<td>Founder of the <strong>Bauhaus School</strong>, pioneer of modern architecture, and the <strong>International Style</strong>.&lt;br&gt;Emphasized the <strong>gesamtkunstwerk</strong> or total work of art&lt;br&gt;Noteable Project: <strong>Fagus Factory, Bahaus school</strong></td>
</tr>
<tr>
<td>Charles McKim</td>
<td>Member of McKim, Mead, and White, a prominent architectural firm&lt;br&gt;Brought Beaux-Arts architecture to America.&lt;br&gt;<strong>Beaux-Arts</strong>: Beaux-Arts architecture depended on sculptural decoration along conservative modern lines, employing French and Italian Baroque and Rocco formulas combined with an impressionistic finish and realism. Slightly overscaled details, bold sculptural supporting consoles, rich deep cornices, swags and sculptural enrichments in the most brilliant finish the client could afford gave employment to several generations of architectural...</td>
</tr>
<tr>
<td>Modelers and Carvers</td>
<td>Architectural Styles</td>
</tr>
<tr>
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</tr>
</tbody>
</table>
| Modelers and Carvers | Romanesque           | • Walls of massive thickness with few and comparatively small openings  
|                      |                      | • Buttresses are not a highly significant feature, as they are in Gothic architecture. Romanesque buttresses are generally of flat square profile and do not project a great deal beyond the wall.  
|                      |                      | • The arches used in Romanesque architecture are nearly always semicircular, for openings such as doors and windows, for vaults and for arcades.  
|                      |                      | • Arcades are also used: an arcade is a row of arches, supported on piers or columns.  
|                      |                      | • Piers were often employed to support arches  
|                      |                      | • Columns and vaults are an important structural feature of Romanesque architecture. | ![Romanesque.jpg] |
| Modelers and Carvers | Gothic               | • Emphasizes verticality (height) and light (expansive area of windows) achieved by the development of certain architectural features: clustered columns, pointed ribbed vaults, and flying buttresses = thinner walls  
|                      |                      | • Religious structures were often surmounted by one or more towers and pinnacles and perhaps tall spires.  
|                      |                      | • Gothic cathedrals were intended to convey a theological message: the great glory of God. Symbolically and through ornamentation.  
|                      |                      | • Most Gothic churches, unless they are entitled chapels, are of the Latin cross (or "cruciform") plan, with a long nave making the body of the church, a transverse arm called the transept and, beyond it, an extension which may be called the choir, chancel or presbytery. | ![Gothic.jpg] |
### Renaissance

- San Augustino (shown)/St Peters Basilica / Santa Maria Novella / Palazzo Medici / St Peters Piazza

- The plans of Renaissance buildings have a square, symmetrical appearance in which proportions are usually based on a module.
- Façades are symmetrical around their vertical axis.
- Arches are semi-circular or (in the Mannerist style) segmental.
- Vaults do not have ribs. They are semi-circular or segmental and on a square plan, unlike the Gothic vault which is frequently rectangular.
- The dome is used frequently, both as a very large structural feature that is visible from the exterior, and also as a means of roofing smaller spaces where they are only visible internally.

### American Georgian

- A 1–2 story box, 2 rooms deep, using strict symmetry arrangements.
- Panel front door centered, topped with rectangular windows (in door or as a transom) and capped with an elaborate crown/entablature supported by decorative pilasters.
- Cornice embellished with decorative moldings, usually dentil work.
- Multi-pane windows are never paired, and fenestrations are arranged symmetrically (whether vertical or horizontal), usually 5 across.
- Roof: Side-gabled; Gambrel; Hipped.
- Chimneys on both sides of the home.
- A portico in the middle of the roof with a window in the middle is more common with post-Georgian styles.
- Larger windows with 9 or 12 panes on the main floors.

### Federal/Adamesque

- Differs from preceding Georgian colonial interpretations in its use of plainer surfaces with attenuated detail, usually isolated in panels, tablets and friezes.
- Flatter smoother facade and rarely used pilasters.
- Applied to the balanced and symmetrical version of Georgian architecture.
<table>
<thead>
<tr>
<th>Greek Revival</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thomas Jefferson was to prove instrumental in introducing Greek revival architecture to the United States.</td>
</tr>
<tr>
<td>A rebirth of classical Greek architectural elements</td>
</tr>
<tr>
<td>Some larger or commercial buildings in this style are loosely based on the Greek temple, with a low triangular roofline and a facade of columns. Usually includes rectangular balanced compositions with sash windows, elaborate entrances with transoms, projecting porticos, and large ornaments.</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>Gothic Revival</th>
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</thead>
<tbody>
<tr>
<td>a.k.a Victorian Gothic</td>
</tr>
<tr>
<td>The Gothic Revival style was based on the churches and homes of Europe in the Middles Ages and is considered the first true Victorian style. They have irregular pitched gable roofs, fanciful eave treatments, pointed arch windows, and sometimes elaborate Gothic ornamentation and details</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>Italianate</th>
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<tbody>
<tr>
<td>Borrowed Italian Renaissance motifs synthesized with picturesque aesthetics.</td>
</tr>
<tr>
<td>They are rectangular in shape, with two to three stories, tall and narrow, a balanced composition with bracketed cornices, parapets and false fronts, elongated, arched, wooden sash windows, large paneled doors, and facades decorated with molded panels, friezes, pilasters or quoins.</td>
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<table>
<thead>
<tr>
<th>Second Empire</th>
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<tbody>
<tr>
<td>In the United States, the Second Empire style usually combined a rectangular tower, or similar element, with a steep, but short, mansard roof; the roof being the most noteworthy link to the style's French roots.</td>
</tr>
<tr>
<td>This tower element could be of equal height as the highest floor, or could exceed the height of the rest of the structure by a story or two.</td>
</tr>
<tr>
<td>The mansard roof crest was often topped with an iron trim, sometimes referred to as &quot;cresting&quot;.</td>
</tr>
<tr>
<td>Floor plans for Second Empire residences could either be symmetrical, with the tower (or tower-like element) in the center, or asymmetrical, with the tower or tower-like element to one side.</td>
</tr>
<tr>
<td><strong>Shingle Style</strong></td>
</tr>
<tr>
<td>-------------------</td>
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<tr>
<td>McKim, Mead and White and Peabody and Stearns were two of the notable firms of the era that helped to popularize the Shingle style.</td>
</tr>
<tr>
<td>Style</td>
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<tr>
<td>Colonial Revival</td>
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<tr>
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<tr>
<td>Prairie School</td>
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<tr>
<td>American Craftsman</td>
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<tr>
<td>Roof Features</td>
</tr>
<tr>
<td>---------------</td>
</tr>
<tr>
<td>- Deeply overhanging eaves,</td>
</tr>
<tr>
<td>- Exposed rafters or decorative brackets under eaves</td>
</tr>
<tr>
<td>- Front porch beneath extension of main roof</td>
</tr>
<tr>
<td>- Tapered, square columns supporting roof</td>
</tr>
<tr>
<td>- 4-over-1 or 6-over-1 double-hung windows</td>
</tr>
<tr>
<td>- Frank Lloyd Wright design motifs</td>
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<tr>
<td>- Hand-crafted stone or woodwork</td>
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<tr>
<td>- Mixed materials throughout structure</td>
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**International Style**

- The term *International Style* came from the 1932 exhibition at the Museum of Modern Art, organized by Philip Johnson, and from the title of the exhibition catalog for that exhibit, written by Johnson and Henry Russell Hitchcock
- Three principles: the expression of volume rather than mass, the emphasis on balance rather than preconceived symmetry, and the expulsion of applied ornament.
## Classical Orders

Each style is distinctive by their capital (topmost feature of a column) and entablature (upper part of a Greek or Roman order).

<table>
<thead>
<tr>
<th>Greek Orders</th>
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### Doric

Doric columns are the simplest. The *shaft* (the tall part of the column) is plain and is channeled with 20 flutes (lines carved into them from top to bottom). There is no base in the Doric order; they instead are placed directly on the stylobate. The *capital* (topmost part of the column) is made of a circle (*Echinus*) topped by a square (*Abacus*). In the *entablature* (area above the column), composed of the *architrave*, *frieze* and *cornice*; the architrave is smooth or is divided by horizontal lines, the *frieze* is divided into *metopes* and *triglyphs*. The *metope* is a plain or carved section between triglyphs- a unit consisting of three vertical bands.

![Doric Column Diagram](image)

### Ionic

The Ionic style is a little more decorative than the Doric. Ionic *shafts* are taller than the Doric ones which make the columns look slender. They also have *flutes*; 24. The shafts have a special characteristic: *entasis*, a curved tapering of the column shaft that make the columns look straight; even at a distance the shafts would appear to get narrower as they rise, so this bulge makes up for that. The *frieze* is plain, but sometimes comes with a continuous ornament such as carved figures.. The *bases* were large and looked like a set of stacked rings. Ionic *capitals* consist of two opposed *volute* or scrolls in the *echinus* of the capital. The architrave of the entablature commonly consists of three stepped bands, *fasciae*.

![Ionic Column Diagram](image)
The Corinthian order is the most ornate of the Greek orders, characterized by a slender fluted column having an ornate capital decorated with two rows of acanthus leaves and four volutes. Corinthian also uses entasis to make the shafts look straight. The shaft of the Corinthian order, like that of the Ionic order has 24 flutes. Unlike the Doric and Ionic orders cornices, which are at a slant, the Corinthian roofs are flat.

The Romans adapted all the Greek orders and also developed two orders of their own, basically modification of Greek orders. The Romans also invented the superposed order. A superposed order is when successive stories of a building have different orders. The heaviest orders were at the bottom, whilst the lightest came at the top. This means that the Doric order was the order of the ground floor; the Ionic order was used for the middle story, while the Corinthian or the Composite order was used for the top story. The Colossal order was invented by architects in the Renaissance. The Colossal order is characterized by columns that extend the height of two or more stories.

The Tuscan order has a very plain design, with a plain shaft, and a simple capital, base, and frieze. It is a simplified adaptation of the Doric order by the Romans. The Tuscan order is characterized by an unfluted shaft and a capital that only consist of an echinus and an abacus. In proportions it is similar to the Doric order, but overall it is significantly plainer. The column is normally seven diameters high. Compared to the other orders, the Tuscan order looks the most solid.

The Composite order is a mixed order, combining the volutes of the Ionic with the leaves of the Corinthian order. Until the Renaissance it was not ranked as a separate order. Instead it was considered as a late Roman form of the Corinthian order.