

1.0 Structures are found in natural and human-made environments

1.1 Classifying Structural Forms

Natural

- not made by people
- occur naturally in the environment



Manufactured

- built by people
- many are modeled after natural structures



Structures can also be classified by their Design

Solid Structures

Can be made by, piling up or forming similar materials into a particular shape or design.

- Mountains, coral reefs are natural mass structures
- Sand castles, dams and brick walls are manufactured mass structures)

Advantages: held in place by its own weight, losing small parts often has little effect on the overall strength of the structure

- solid structures are not always completely solid, but are layered and have hollowed out areas for specific functions (a power dam and the Great pyramids of Egypt are a good examples)

Frame Structures

Have a skeleton of strong materials, which is then filled and covered with other materials, supporting the overall structure. Most of the inside part of the structure is empty space.

- **Load-Bearing Walls:** these are the walls that support the load of the the building.
- **Partition Walls:** these are the walls that divide up the space inside the building.
- because they are relatively easy to design and build, and inexpensive to manufacture, the frame structure is the most common construction choice.

All frames, whether simple or complex must overcome similar problems.

To solve these problems joints, type of material, bracing, anchoring and design all must be considered in the overall structural frame construction.

Shell Structures

Structures, which keep their shape and support loads, even without a frame, or solid mass material inside, are called shell structures. These structures use a thin, carefully shaped, outer layer of material, to provide their strength and rigidity. The shape of a shell structure spreads forces throughout the whole structure, which means every part of the structure supports only a small part of the load, giving it its strength.

Examples include: igloos, egg cartons, turtle shell, food or pop cans, or, even bubbles in foam and cream puffs. **Flexible structures**, like parachutes, balloons and different types of clothing are a different type of shell.

Shell structures have two very useful features:

- they are completely empty, so they make great containers
- their thin outside layer means they use very little material

Problems in building shell structures include:

- A tiny weakness or imperfection on the covering can cause the whole structure to fail.
- When the shell is formed from hot or moist materials, uneven cooling can cause some parts to weaken other parts by pushing or pulling on nearby sections.
- Flat materials are difficult to form into the rounded shell shape.
- Assembly of flexible materials is very precise, so that seams are strong where the pieces are joined.

1.2 The Function of Structures

Structures are things that have a definite size and shape, which serve a definite purpose or **function**. To perform its function, every part of the structure must resist forces (stresses such as pushes or pulls) that could damage its shape or size.

Multiple Functions

Most structures have several functions, which may include:

· supporting (its own weight)	· transporting	· lifting	· separating
· containing (substances)	· sheltering	· fastening	· communicating
· breaking	· holding		

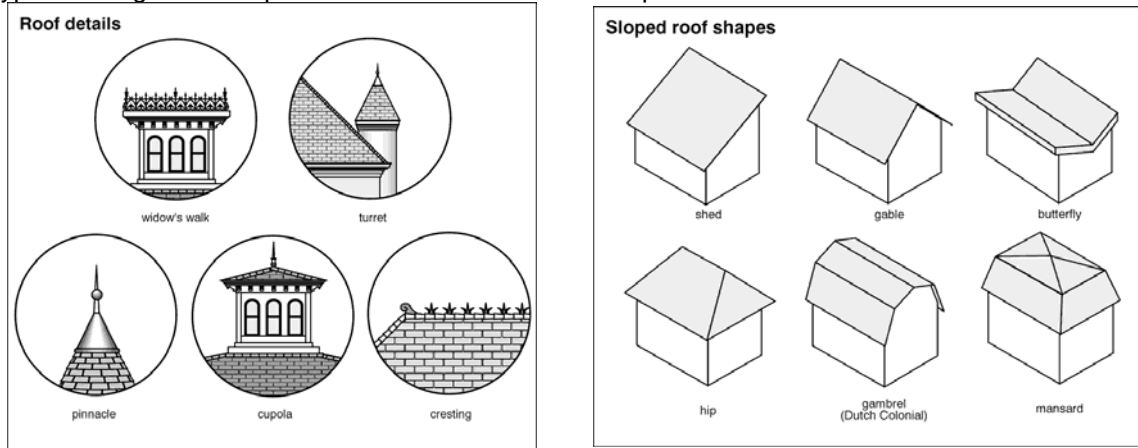
Precise, measurable standards normally are indicated in the specifications the structure must comply with in order to perform its function/s.

Function and Effective Design

Function - What is the structure supposed to do? What was it designed for?

Common Function, Different Design

Some structures may appear very different from each other, but share a common function. Roof types are a good example of this and are illustrated on p. 272.



Other Characteristics of Structures

Besides form and function, structures can be interpreted and classified by the materials and components they are made of. Natural and man-made structures share some common features. Safety - all structures are designed and built within an acceptable margin of safety (but usually, structures are designed with a built-in large margin of safety).

Cost - adding extra strength to a structure costs money, as well as using more highly skilled workers and better materials does. Norman Breakey designed the pain roller to make painting a large wall less time consuming and more economical.

· Designers plan their structures to withstand conditions they hypothesize will occur. Good design is a compromise between a reasonable margin of safety and reasonable cost.

· Usually, totally unexpected events will cause even the best (well-designed) structures to fail (example: the World Trade Centre Towers).

Aesthetics

Aesthetics is the study of beauty in nature.

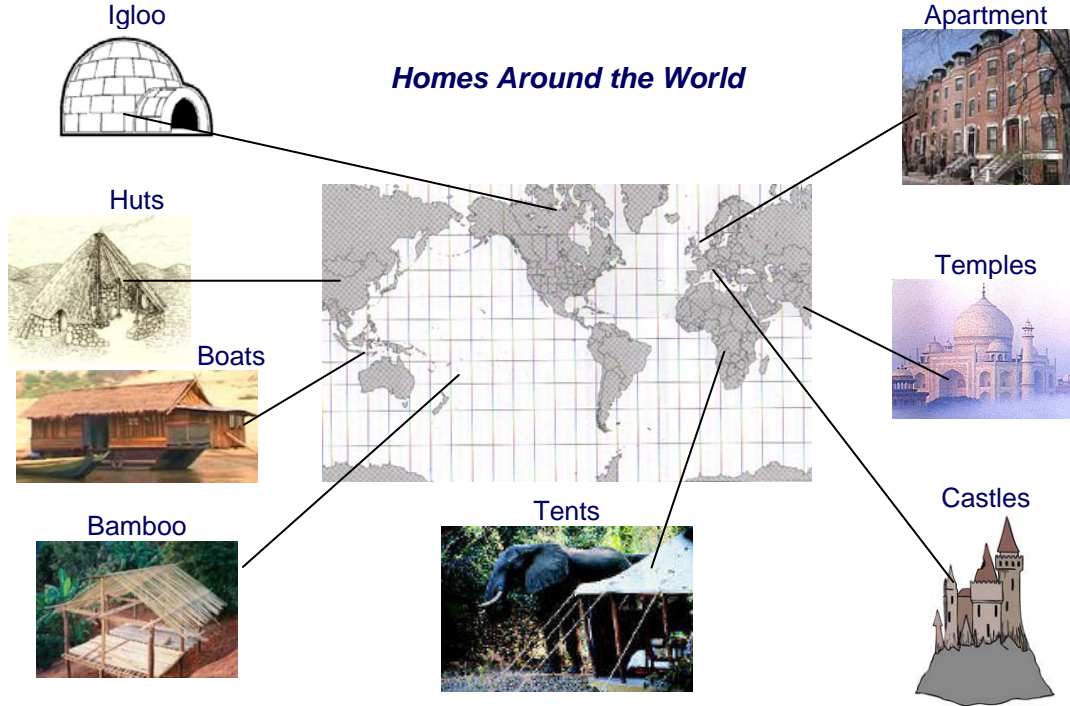
· The best designs usually 'look good' - 'aesthetically pleasing'

· The aesthetics are usually accomplished by the shape, texture, color, type of material, symmetry and simplicity of the repeated pattern used in the design.

1.3 Human Built Structures around the World

The Human Home

Homes from many different cultures reflect the adaptations these cultures have made to provide a suitable shelter. The varied structures result from climate, culture, tradition, technology and economics. Availability of materials, portability and traditional practices are considerations for different cultures when they build their homes.



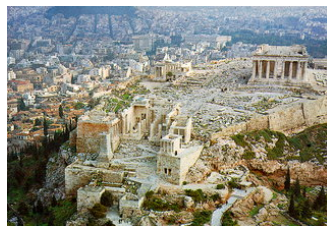
Some structures are combinations of different types of structures:

- **Football helmets** are shell structures - to protect the head, with a frame structure attached in front - to protect the face.
- **Hydro-electric dams** are mass structures, with frame structures inside to house the generators
- **Airplanes** are frame structures, with a 'skin' that acts like a shell - giving it the added strength to resist stresses and making it lightweight and flexible.
- **Domed buildings** combine shell and frame construction
- **Warehouses** are often built with columns to support the roof (frame) and concrete blocks, (mass structures) which stay in place because of their weight.

Current or Classical – Advantages and Disadvantages of Different Designs.



Stonehenge



Acropolis



Great Wall of China

Can you think of some other **Famous Structures**?