Geometric Form and its Variants in Architecture based on Function

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Abstract - *Geometrical forms play an important role in architecture as satisfying both aesthetic and functional aspects. This research analyzes how architectural forms resemble the three fundamental geometric shapes: squares, triangles, and circles. It also goes into detail discussing a specific geometric form, its derivatives, and how it relates to various types of buildings. The sphere was chosen from these geometrical forms because, symbolically, spherical space represents each person's first "place of residence," which is the human womb. Humans initially concentrated on the circular form, and afterwards all cultures started focusing on the rectangle or square form. In various architect's work, geometry is manifested in form & shape. As this analysis is to determine how the geometric form varies depending on the space typology, it is important to understand this relationship.*

***Key Words*: Sphere, Aesthetical, Functional, Visual, Emotional.**

1. INTRODUCTION

The volumetric (3 dimensional) forms generated from the primary shapes of circles, triangles, and squares are the most significant primary forms such as sphere, cylinder, cone, pyramid and cube. Figure 1 shows the forms from primary shapes.

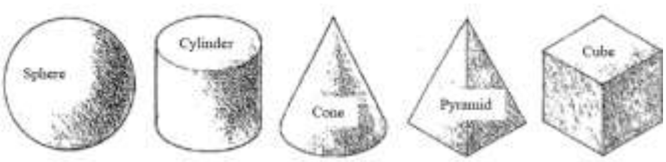

Fig -1: Form from primary shapes

Among these basic forms, the sphere is selected because it has a single surface devoid of lines, corners, and edges. It is a form that lacks a clear vertical or horizontal focus and is closed within itself. Purely convex form on the outside and concave inside.

1.1 Derivatives from Sphere

Derivatives from sphere with five categories such as Hemisphere, Inverted hemisphere, Hemisphere with openings, Hemisphere with Curvature variants, sections of the hemisphere.

1.2 Sphere

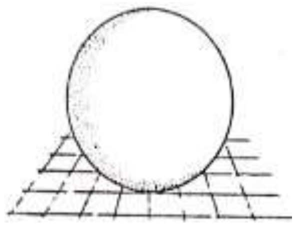

Fig -2: Sphere

Visual Effect: Internally, the form is concave and externally, pure convex.

Emotional Effect: Diffuseness and lack of concentration.

Example:

Fig -3: **Sphere:** The Las Vegas Sphere

The shiny, new Las Vegas Sphere is more than just a 17,600-seat amphitheater-style. The world's largest spherical structure at 516 feet wide and 366 feet tall.

The spherical form was selected to produce headphone-style sound, because the curved surfaces have the ability to automatically reflect sound from all directions produced this effect. Spherical form offers an amphitheater-style sitting space with the center of attention. It was possible to create an LED ball on Earth's using a continuous surface devoid of edges and corners, which is why this spherical form chosen. Therefore, the spherical form was selected for this type of building to satisfy both functional and aesthetic requirements. To wrap people inside a new experience. The Sphere is a

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technological marvel that is sure to provide visitors with an immersive and unforgettable experience.

1.3 Hemisphere

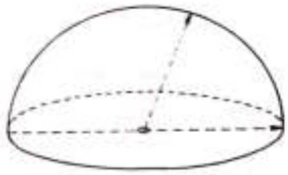

Fig -4: Hemisphere

Visual Effect: Diffuse quality throughout the sphere, however the rim indicates the end of continuity.

Emotional Effect: A sense of circular movement set up by the rim.

Example:

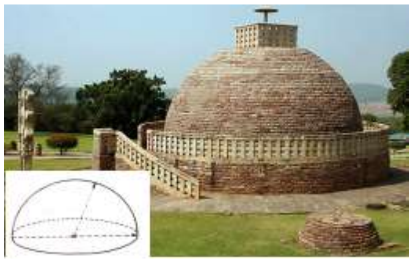

Fig -5: **Hemisphere:** Sanchi Stupa

In 1989, Sanchi Stupa received the designation as a UNESCO World Heritage Site. The Stupas of Sanchi display the Buddhist style of architecture.

Stupa has a central structure consists of a hemispherical dome (anda) on a base, with a relic chamber is the main highlight of this site. The pedestal has a diameter of 120 feet and a height of 54 feet, making it unique nationally. The dome represents the earth's enclosure by the dome of heaven. As a result, the stupa's domed shape evolved to symbolize a person sitting in meditation. The circular design of the plan symbolized the Buddhist concept of the wheel of life and death. Therefore, it is evident that the hemispherical form was chosen for this kind of structure in order to meet both aesthetic and functional needs.

1.4 Inverted Hemisphere

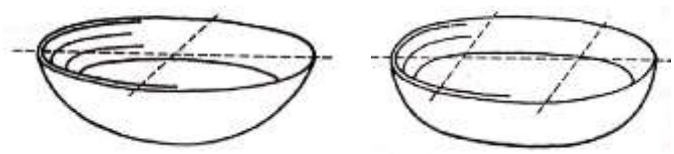

Fig -6: Inverted Hemisphere

Visual Effect: The base is flattened, and the bowl is overturned, facing the sky.

Emotional Effect: The flattened base creates a feeling of circular movement.

Example:

Fig -7: **Inverted Hemisphere:** Stadium

View:
A vital feature of an arena design is to make all seats offer an outstanding view of the whole field.

Gap:
Reducing the gap between the spectators and the field of play should be the primary objective.

Number of Seating's:
Accurate numerical measurements are necessary for the bowl's construction as the maximum number of spectators that an arena can accommodate increases.

In order to provide the perfect shape and views, architects aim to achieve a balance between the playing surface and the bowl viewing plan. Therefore, it is evident that the Inverted hemispherical form with flat base was chosen for this kind of structure in order to meet both aesthetic and functional needs.

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1.5 Hemisphere with Opening

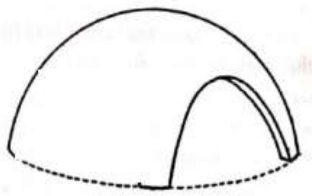


Fig -8: Hemisphere with Opening

Visual Effect: The centre is invisible from outside.

Emotional Effect: Each opening represents an interruption in the continuity of the domical surface.

Example:

Fig -9: **Hemisphere with Opening:** Igloo

Figure 9 shows that the Igloo as example for Hemisphere with opening. One well-known example of a hemispherical object used in everyday life is an igloo.

The hemisphere's curved face was formed in the top and flat face was formed in the base of Igloo. The strength of the snow and ice is insufficient to sustain a horizontal roof. Long snow slabs would need to reach from side to side in order to cover the cube. If they weren't reinforced these would be quite heavy and easily break. Because of the dome's ability to distribute force uniformly, the roof is able to support itself. To create access to the interior and to regulate temperature, a single, small entrance was placed within the hemisphere. To satisfy the need hemispherical form with small opening was chosen.

1.6 Hemisphere with curvature variants

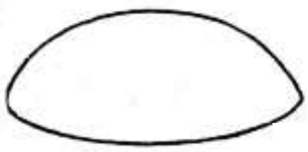


Fig -10: Hemisphere with curvature variants

Visual Effect: In comparison, the edge is greatest and the surface is least.

Emotional Effect: The circular movement gains strength over the surface quality due to a relative increase in edge.

Example:

Fig -11: **Hemisphere with curvature variants:** Pavilion Copenhagen, Denmark

The building is a self-supporting dome that can be used as a recreational area, garden pavilion, greenhouse, or mobile display pavilion.

The pavilion's remarkable strength comes from its facade's curvature, which eliminates the need for steel frames or internal load-bearing walls to support the facade's. The droplet is a fully transparent pavilion resembling a resting water droplet and made out of sheets of 6 mm clear polycarbonate. The structure is kept wind and waterproof without the use of caulk or sealants because to the polycarbonate sheets fish-scale overlap pattern. The design increases standing height around the inside rim of the facade and maximizes available floor space with an oval shape and circular layout. Therefore, it is evident that the hemispherical form with curvature variants was chosen for this kind of structure in order to avoid internal support and maximize the area.

1.6 Section of the Hemisphere

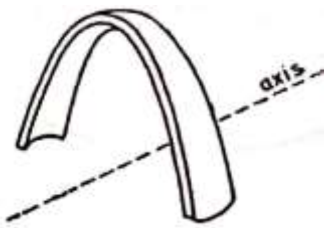


Fig -12: Section of the Hemisphere

Visual Effect: A narrow mass increases the edge's but minimizing the surface.

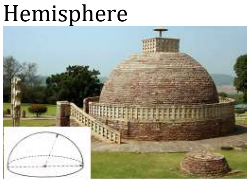
Emotional Effect: Lacks volume and encloses no space. But one can cross to go from one visual region to another.

Fig -13: **Section of the Hemisphere:** Gateway Arch

It's the nation's tallest monument, soaring 630 feet above the Mississippi River. It is made of 886 tons of stainless steel that has been seamlessly curved. The most famous landmark in the Midwest, the Gateway Arch, has been commended for its ability to connect "the rich heritage of yesterday with the richer future of tomorrow." The popularity of the arch as a massive attraction for the large number of Americans taking road trips. To satisfy the need a narrow strip from hemisphere was chosen.

2. COMPARATIVE ANALYSIS

Table -1: Comparative analysis of Sphere & its variants

Sphere and its Derivatives	
Sphere  **Example:** The Las Vegas Sphere	**Based on Function:** The world's largest spherical structure at 516 feet wide and 366 feet tall. Sphere was chosen to create better sound effect in the interior and Continuous LED surface for the exterior.
Hemisphere  **Example:** The Sanchi Stupa	**Based on Function:** In Buddhism, a stupa is a hemispherical structure containing relics that is used as a place of meditation and specifically associated with religious importance.
Inverted Hemisphere  **Example:** Stadium	**Based on Function:** Inverted hemispherical form with flat base was chosen to meet the essential requirements of arena design such as uninterrupted view, to reduce the distance between spectators and field and to increase the number of seating's.
Hemisphere with opening  **Example:** Igloo	**Based on Function:** Hemispherical dome was used as a default structure based on the strength of the material (snow and ice) and also it distributes the load evenly. A small opening was created in hemisphere to maintain temperature and provide access to the interior space.
Hemisphere with curvature variants  **Example:** Pavilion	**Based on Function:** Curvature, which eliminates the need for internal support and the structure is made out of sheets of 6 mm clear polycarbonate which act as wind and waterproof. With an oval profile and circular footprint, the design maximizes available floor space and gains standing height along the inside rim of the facade.
Section of the Hemisphere  **Example:** The Gateway Arch	**Based on Function:** Seamlessly curved arch act as a most famous landmark in the Midwest. The Gateway Arch, has been commended for its ability to connect "the rich heritage of yesterday with the richer future of tomorrow."
Inference: The sphere & its variants were chosen majorly based on the functional need of the space rather than the aesthetical aspect.	

3. CONCLUSIONS

After thoroughly researching the sphere and its variants with the help of case studies shown that the form was selected with consideration for space typology.

Each form, and its variants, has a unique character that meets the various requirements of the user while also being visually pleasing in all aspects.

Therefore, rather than focusing only on aesthetics, we need to design the space with both function and aesthetics in mind. The sphere and its variants were created mainly based on the functional aspects. So, the functional aspect plays a major role in design. Finally it was concluded that the geometric form and its variants was identified based on the building typology.

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