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"The Geometry of Flat and Full: Comparing 2D and 3D Shapes"

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Abstract

This journal, titled "The Geometry of Flat and Full: Comparing 2D and 3D Shapes," *explores the fundamental differences and relationships between two-dimensional (2D) and three-dimensional (3D) shapes. Beginning with the basics, the study introduces 2D shapes, or "flat" shapes, which include polygons like squares, circles, and triangles, each defined by length and width but lacking depth. It then contrasts these with 3D, or "full," shapes, such as cubes, spheres, and pyramids, which possess depth in addition to length and width, giving them volume and creating new structural elements like edges, faces, and vertices. The journal investigates how these shapes are constructed, their distinct properties, and the mathematical concepts associated with each. It discusses calculations for perimeter and area in 2D shapes and expands to surface area and volume for 3D shapes. Visual diagrams and real-life examples demonstrate where each type of shape is commonly found, allowing readers to understand the practical applications of each. By comparing the characteristics of 2D and 3D shapes, this journal aims to provide a foundational understanding of geometry and highlight how moving from flat to full dimensions transforms both visual perspective and mathematical approach. This comparison serves as a basis for more advanced geometry topics and helps cultivate spatial awareness, critical for fields like architecture, engineering, and art.*

Keywords: 2D Shapes, 3D Shapes, Perimeter, Area, Surface Area, Volume, Vertices, Edges, Faces, Comparative Analysis, Real-World Applications, Diagrams and Illustrations.

Introduction

Geometry, the branch of mathematics that studies shapes, sizes, and spatial relationships, is fundamental to our understanding of the physical world. Among the core concepts in geometry is the distinction between two-dimensional (2D) and three-dimensional (3D) shapes, each offering unique characteristics, properties, and applications (Zhu, 2021). This journal, *"The Geometry of Flat and Full: Comparing 2D and 3D Shapes,"* explores these distinctions and seeks to build a solid foundational understanding of both types of shapes, from their structural elements to their real-world significance (Imamura, 2015). 2D shapes, often called "flat" shapes, exist in a plane and are defined by only two dimensions: length and width. Common examples include squares, circles, and triangles, which are bounded by lines and curves. They lack depth or thickness, which makes them appear flat on paper or screens (Lague, 2013). Due to their simplicity, 2D shapes are easy to visualize, draw, and measure in terms of their perimeter (the distance around the shape) and area (the space contained within the shape's boundaries) (Saito, 2019). These shapes are foundational in geometry and are extensively used in fields like art, design, and engineering for creating blueprints, plans, and sketches, as well as analyzing patterns and structures (Cattaneo, 2011). In contrast, 3D shapes, or "full" shapes, incorporate a third dimension depth which gives them volume and transforms them into solid forms. Examples of 3D shapes include cubes, spheres, pyramids, and cylinders, all of which have depth in addition to length and width (Doitrand, 2018). This additional dimension introduces new elements to consider, such as edges (the lines where two faces meet), faces (the flat or curved surfaces), and vertices (the points where edges intersect). Unlike 2D shapes, 3D shapes can be measured in terms of surface area (the total area of all faces) and volume (the amount of space contained within) (Paškevičiūtė, 2017). Understanding 3D shapes is crucial for spatial reasoning, as these shapes appear everywhere in the physical world, from everyday objects like boxes and balls to complex structures like buildings, machinery, and natural formations (Daly, 2016).

This journal will delve into the properties that define 2D and 3D shapes, examining key differences and exploring how these differences influence their uses in various disciplines. By highlighting the transition from 2D to 3D, we can better understand concepts like dimensionality, spatial awareness, and volume, each vital for applications in architecture, physics, and engineering (Soares, 2012). Through diagrams, comparisons, and real-life examples, this journal aims to deepen the reader's grasp of geometry's foundational concepts, demonstrating the importance of both flat and full shapes in modeling and understanding our world (Demantké, 2012).

In exploring the properties and structural elements of 2D and 3D shapes, this journal will address key differences, examine how they interact, and investigate their applications in various disciplines (Lin, 2013). The transition from 2D to 3D is not just a mathematical concept but a fundamental shift that influences how we approach visual and spatial problems, from designing architecture to programming computer graphics and simulating scientific phenomena (Low, 2016). Through diagrams, comparisons, and practical examples, this journal aims to deepen the reader's grasp of geometry's foundational concepts, demonstrating the importance of both flat and full shapes in modeling and understanding our world. The exploration of "flat" versus "full" geometry reveals the essential role that dimensionality plays in how we visualize and work with shapes, particularly when representing real-world objects in fields like engineering, robotics, and physics (Kapałczyńska, 2016). The study of 2D and 3D shapes offers a versatile toolset that not only enriches our mathematical understanding but also develops critical spatial awareness for problem-solving, creative design, and physical modeling, bridging the gap between abstract theory and real-life application (Morimoto, 2020).

Statement of the problem

The inability of many students to distinguish between the characteristics of 2D and 3D forms such as area versus volume and edges versus vertices reduces their capacity to properly envision and manipulate these structures. By elucidating the differences between 2D and 3D forms, the research "The Geometry of Flat and Full: Comparing 2D and 3D Shapes" hopes to improve spatial understanding and useful applications. It offers fundamental resources for improved geometry understanding and application across a range of domains.

Objectives of the Study

To identify and describe the primary distinctions between 2D and 3D forms in terms of measurement, structure, and dimensions.

To contrast the mathematical characteristics of 2D and 3D forms, emphasizing the differences between these measures across dimensions, such as area and perimeter for 2D shapes and surface area and volume for 3D shapes.

To assist readers comprehend how the change from flat (2D) to full (3D) forms impacts their sense of space in order to hone their spatial awareness and visualization skills.

To illustrate how 2D and 3D geometry are utilized in domains such as engineering, design, architecture, and commonplace things in order to investigate practical uses of these shapes.
To improve problem-solving abilities by giving readers real-world examples through activities and pictures that allow them to apply 2D and 3D geometric ideas.
The aim is to provide readers with a greater comprehension of dimensionality, laying the groundwork for more intricate studies in geometry and spatial analysis.

Methodology

It might be confusing to understand the distinctions between 2D (two-dimensional) and 3D (three-dimensional) forms, especially when it comes to dimensionality and shape attributes. When comparing 2D and 3D geometry, students or learners may encounter difficulties in the following typical areas

The Concept of Dimensionality:

i. Dimensions in 2D and 3D: objects in 2D are on a plane and only have length and width (like a square or circle), but objects in 3D include depth, width, and length (like a cube or sphere). It can be difficult to visualize the change from two to three dimensions, particularly when transferring 3D forms onto two-dimensional surfaces like paper.

ii. Adding Depth in 3D: It might be challenging for students to understand that adding depth produces volume, a feature of 3D forms, as opposed to merely increasing size or surface area.

Comprehending Shape Properties

iii. Vertices, Faces, and Edges: 3D forms add faces, whereas 2D shapes just contain vertices and edges. It frequently takes detailed explanation to distinguish between edges (lines), vertices (points), and faces (surfaces) in 2D and 3D forms. A cube, for instance, has eight vertices, twelve edges, and six faces, whereas a square has four vertices and four edges.

iv. Surface Area against Perimeter versus Volume: In two-dimensional forms, the area denotes the space the shape occupies, while the perimeter denotes the distance around the shape. However, surface area in 3D represents the entire area of all external surfaces, whereas volume measures the space inside a form. Because students occasionally attempt to apply 2D measurements to 3D forms or confuse area with volume, this can be perplexing.

Changes in shape across dimensions:

i. Projection and Cross-Sections: Spatial thinking is needed to understand how a 2D form may depict a cross-section or projection of a 3D shape (for example, a circle is a cross-section of a sphere). It can be challenging to visualize this, particularly in the absence of tangible models or visual assistance.

ii. Comparing 2D and 3D counterparts: A lot of forms have both 2D and 3D counterparts, such as a circle and a sphere or a square and a cube. It might be challenging to understand how they relate to one another since, although having comparable qualities, they seem different (for example, a square extruded into a third dimension becomes a cube).

Viewpoint and Representation:

Orthographic versus Isometric Views: It can be difficult for students to depict 3D things in 2D space using drawings (such as orthographic or isometric projections) as it necessitates an understanding of perspectives. Complexity is increased when a 3D item is flattened into a 2D plane, such as a technical design or blueprint, while acknowledging how it appears from various perspectives.

Thinking abstractly and mentally rotating:

Mental Visualization: It can be challenging to mentally see and rotate shapes, especially when they are complicated or irregular 3D shapes. Visualization exercises can be beneficial, but they need to be practiced and often scaffold with visual assistance.

Applications in Real-Life Scenarios:

Using your understanding of 2D and 3D geometry in practical settings, such as comprehending why packing a box requires volume calculations rather than area or why wrapping paper is related to surface area, can help you better understand these ideas. However, doing so frequently calls for specific examples to connect theory to real-world applications.

Identification and Classification of Shapes

Examining both typical 2D forms which are flat and lie on a plane and 3D shapes which have depth and occupy space is necessary to comprehend how shapes are recognized and categorized.

2D Shapes: Definitions, Categories, and Properties

1. Square

Definition: A quadrilateral with four equal sides and four right angles.

Table 1: Table showing the properties and description of a Square

Property	**Description**
Edges:	4 equal-length edges
Vertices	4 vertices (corners)
Perimeter	The sum of all side lengths, P = 4 × side length
Area	A = side length^2

2. Rectangle

Definition: A quadrilateral with opposite sides equal and four right angles.

Table 2: Table showing the properties and description of a Rectangle

Property	**Description**
Edges:	4 edges (two pairs of equal-length sides)
Vertices:	4 vertices
Perimeter:	P = 2 × (length + width)
Area:	A = length × width

3. Circle

Definition: A shape with all points equidistant from a central point.

Table 3: Table showing the properties and description of a Circle

Property	**Description**
Edges	No edges
Vertices	No vertices
ii. Circumference (Perimeter):	$C = 2\pi r$, where r is the radius
iii. Area:	$A = \pi r^2$

4. Triangle

Definition: A polygon with three sides and three angles.

Types:

i. Equilateral Triangle: All sides and angles are equal.

ii. Isosceles Triangle: Two sides and two angles are equal.

iii. Scalene Triangle: All sides and angles are different.

Table 4: Table showing the properties and description of a Triangle

Property	Description
Edges	3 edges
Vertices	3 vertices
Perimeter	The sum of all side lengths
Area	$A = \frac{1}{2} \times \text{base} \times \text{height}$

5. Polygon (General)

Definition: A closed shape with straight sides.

Examples:

i. Pentagon: 5 sides

ii. Hexagon: 6 sides

iii. Octagon: 8 sides

Table 5: Table showing the properties and description of a Polygon

Property	Description
Edges	Equal to the number of sides
Vertices	Equal to the number of corners
Perimeter	The sum of all side lengths
Area	Calculated differently based on the type of polygon

3D Shapes: Definitions, Categories, and Properties

1. Cube

Definition: A 3D shape with six equal square faces.

Table 6: Table showing the properties and description of a Cube

Property	Description
Faces	6 square faces
Edges	12 equal-length edges
Vertices	8 vertices
Surface Area	$SA = 6 \times \text{side length}^2$
Volume	$V = \text{side length}^3$

2. Rectangular Prism (Cuboid)

Definition: A 3D shape with six rectangular faces.

Table 7: Table showing the properties and description of a Rectangular prism (Cuboid)

Property	Description
Faces	6 rectangular faces
Edges	12 edges
Vertices	8 vertices
Surface Area	$SA = 2\,(lw + lh + wh)$, where l, w, and h are the length, width, and height
Volume	$V = l \times w \times h$

3. Sphere

Definition: A 3D shape where all points on the surface are equidistant from the center.

Table 8: Table showing the properties and description of a Sphere

Property	Description
Faces	No faces
Edges	No edges
Vertices	No vertices
Surface Area:	$SA = 4\pi r^2$
Volume:	$V = \frac{4}{3}\pi r^3$

4. Cylinder

Definition: A 3D shape with two parallel circular bases connected by a curved surface.

Table 9: Table showing the properties and description of a Cylinder

Property	Description
Faces	2 circular bases and 1 curved surface (total: 3 faces)
Edges:	2 edges (where the curved surface meets the circular bases)
Vertices	No vertices
Surface Area	$SA = 2\pi r\,(r + h)$, where r is the radius and h is the height
Volume	$V = \pi r^2 h$

5. Pyramid

Definition: A 3D shape with a polygonal base and triangular faces that converge at a common point (apex).

Types:

i. Square Pyramid: A pyramid with a square base.

ii. Triangular Pyramid (Tetrahedron): A pyramid with a triangular base.

Table 10: Table showing the properties and description of a Pyramid

Property	Description
Faces	Number of triangular faces depends on the base shape
Edges:	Varies with the base (e.g., a square pyramid has 8 edges)
Vertices	Number of base vertices plus one apex
Surface Area	Sum of the areas of the base and the triangular faces
Volume	$V = \frac{1}{3} \times$ base area $\times$ height

6. Cone

Definition: A 3D shape with a circular base and a curved surface that narrows to a point (apex).

Table 11: Table showing the properties and description of a Cone

Property	Description
Faces	1 circular base and 1 curved surface
Edges	1 edge (where the base meets the curved surface)
Vertices	1 apex
Surface Area	$SA = \pi r (r + l)$, where l is the slant height
Volume	$V = \frac{1}{3} \pi r^2 h$

Table 12: Table showing the elementary structural summary of 2D shapes

Property	Description
Edges	Straight lines that form the boundary of the shape.
Vertices	Points where two edges meet.
Perimeter	The total length of the boundary.
Area	The amount of space enclosed by the shape.

Table 13: Table showing the elementary structural summary of 3D shapes

Property	Description
Edges	Lines where two faces meet.
Vertices	Points where edges meet.
Surface Area	The total area of all faces.
Volume	The amount of space occupied by the shape.

Knowing these components makes it easier to evaluate the characteristics of 2D and 3D forms and tell them apart.

Comparative Analysis

We may compare 2D and 3D forms in terms of their measurements, dimensional characteristics, and mathematical formulae for computations in order to fully comprehend their differences. This is a thorough analysis:

1. Dimensional Properties

2D Shapes: Two-dimensional (2D) shapes are flat and only have length and width. They exist on a plane and are often described in terms of area and perimeter.

3D Shapes: Three-dimensional (3D) shapes have length, width, and depth (or height). They occupy space and are described in terms of volume and surface area.

2. Types of Measurements

2D Shapes: Perimeter and Area

Perimeter: The total distance around the boundary of a 2D shape.

Table 14: Table showing 2D shapes and their Formula for Perimeter

Shape	Formula for Perimeter
Square	$P = 4 \times$ side length
Rectangle	$P = 2 \times$ (length + width)
Circle	$P = 2\pi r$ (circumference)
Triangle	$P = side_1 + side_2 + side_3$
Area	The amount of space enclosed within a 2D shape.

Table 15: Table showing 2D shapes and their Formula for Area

Shape	Formula for Area
Square	A = side length^2
Rectangle	A = length × width
Circle	A = πr^2
Triangle	A = $\frac{1}{2}$ × base × height

3D Shapes: Surface Area and Volume

Surface Area: The total area of all the external faces or surfaces of a 3D shape.

Table 16: Table showing 3D shapes and their Formula for Surface Area

Shape	Formula for Surface Area
Cube	$SA = 6 \times$ side length^2
Rectangular Prism	$SA = 2\ (lw + lh + wh)$, where l, w, and h are the length, width, and height
Sphere	$SA = 4\pi r^2$
Cylinder	$SA = 2\pi r\ (r + h)$
Cone	$SA = \pi r\ (r + l)$, where l is the slant height
Volume	The amount of space enclosed within a 3D shape.

Table 17: Table showing 3D shapes and their Formula for Volume

Shape	Formula for Volume
Cube	V = side length^3
Rectangular Prism	$V = l \times w \times h$
Sphere	$V = \frac{4}{3}\pi r^3$
Cylinder	$V = \pi r^2 h$
Cone:	$V = \frac{1}{3}\pi r^2 h$
Pyramid	$V = \frac{1}{3}$ × base area × height

3. Detailed Analysis of Mathematical Formulas

Perimeter (2D) against Surface Area (3D)

Perimeter (2D):

i. Calculates the length of the whole form.

ii. Applied to real-world scenarios like framing a photo or enclosing a garden.

Surface Area (3D):

i. Measures the overall area of all the outside surfaces of a 3D object.

ii. Important for applications like wrapping a present, painting a wall, or determining the material needed for a project.

Example Comparison:

A square with side length s has a perimeter of $4s$ and an area of s^2.

A cube with side length s has a surface area of $6s^2$, since it has six equal square faces.

Area (2D) against Volume (3D)

Area (2D):

i. The volume within a flat form is measured.

ii Useful for figuring out the dimensions of a poster, flooring, or quilt fabric.

Volume (3D):

i. Calculates the volume of a three-dimensional object.

ii Used to calculate a box's capacity, the amount of air that fills a space, or the amount of liquid that a container can store.

Example Comparison:

A circle with radius r has an area of πr^2.

A spher**e** with radius r has a volume of $\frac{4}{3}\pi r^3$.

4. Key Differences and Insights

Dimensionality:

2D: Shapes have just two dimensions, length and width and are limited to a single plane. 3D: Shapes have three dimensions: height (or depth), breadth, and length. They extend into space.

Mathematical Relationships:

i. Linear to Quadratic: The measurements must be squared in order to get from 1D (length) to 2D (area). For instance, a square's area grows quadratically as its side length rises.

ii. Quadratic to Cubic: The measurements must be cubed in order to get from 2D (area) to 3D (volume). For instance, a cube's volume grows cubically with its side length.

Practical Applications:

In design, layout planning, and any situation involving flat surfaces, 2D calculations are frequently utilized. Engineering, architecture, and real-world items that take up space all require 3D calculations.

Table 18: Table showing summary of formula differences between 2D and 3D shapes

Measurement	2D Shapes	3D Shapes
Perimeter	Total boundary length	-
Area	Space within the shape	-
Surface Area	-	Total area of all outer surfaces
Volume	-	Space enclosed within the shape

Some comparison examples are given below:

Square against Cube:

Square: Perimeter = $4s$, Area = s^2

Cube: Surface Area = $6s^2$, Volume = s^3

Circle against Sphere:

Circle: Circumference = $2\pi r$

Sphere: Surface Area = $4\pi r^2$, Volume = $\frac{4}{3}\pi r^3$

This systematic comparison draws attention to the key distinctions between the measurement and computation of 2D and 3D form attributes, highlighting the complexity introduced by the third dimension.

Visualization of some 2D and 3D shapes

2D Shapes

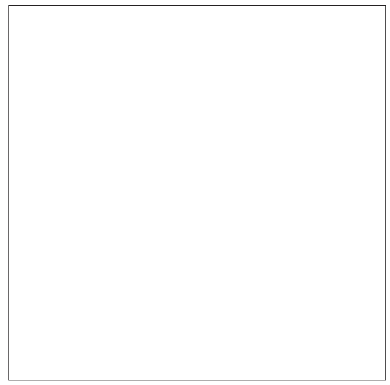

Figure 1: Diagram of a Square

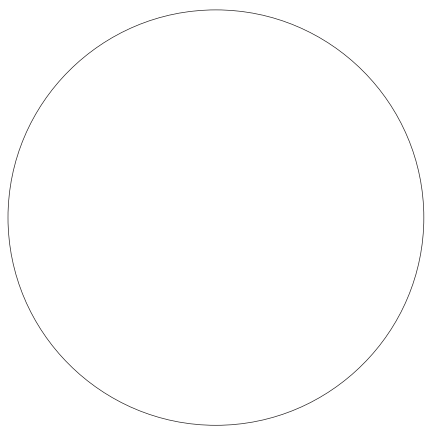

Figure 2: Diagram of a Circle

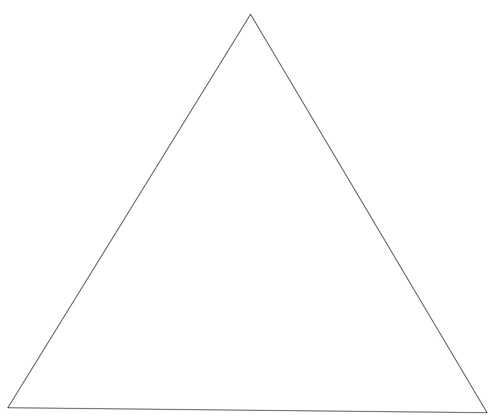

Figure 3: Diagram of a Triangle

3D Shapes

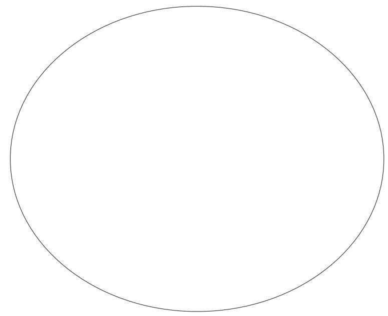

Figure 4: Diagram of a Sphere

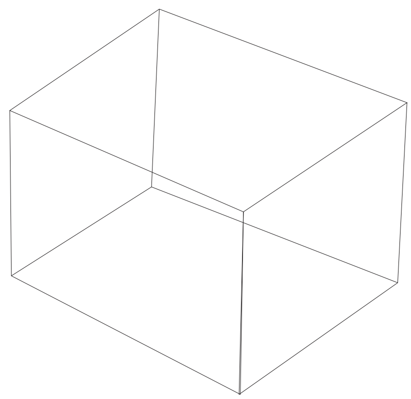

Figure 5: Diagram of a Cube

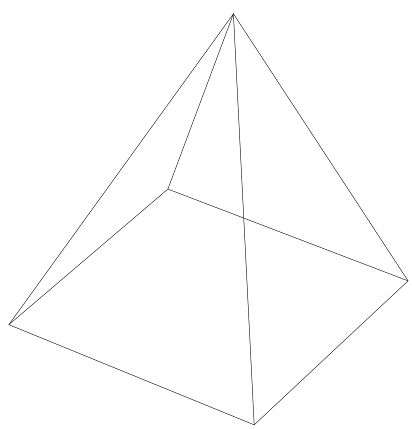

Figure 6: Diagram of a Pyramid

The diagrams above illustrate the differences between 2D and 3D shapes.

Step-by-Step Calculation Examples

1. Calculating the Perimeter and Area of a Square

Given: Side length $s = 4$ units

Perimeter Calculation: Perimeter = $4s = 4 \times 4 = 16$ units

Area Calculation: Area = $s^2 = 4^2 = 16$ square units

2. Calculating the Surface Area and Volume of a Cube

Given: Side length $s = 4$ units

Surface Area Calculation: Surface Area = $6s^2 = 6 \times 4^2 = 6 \times 16 = 96$ square units

Volume Calculation: Volume = $s^3 = 4^3 = 64$ cubic units

These instances demonstrate the differences between the formulae for 2D and 3D measurements as well as the extra complexity that arises when a shape expands into three dimensions.

Application-Based Examples

Architecture

Building Layout and Floor Plans (2D Shapes)

Application: Architects use 2D shapes like rectangles, squares, and circles to design and plan the layout of buildings. Floor plans represent a bird's-eye view of the structure, showing room dimensions, walls, and furniture placement.

Importance: Calculating the area of rooms ensures optimal space utilization and meets building codes. The perimeter helps determine materials needed for walls, fences, or partitions.

Structural Design and 3D Modeling (3D Shapes)

Application: 3D shapes like cylinders, cubes, and prisms are used in creating detailed models of buildings. These models help architects visualize how a structure will look in reality.

Importance: Calculating surface area is critical for determining the amount of material required for construction, such as bricks, tiles, or paint. Volume calculations are used for determining the space within a building, which is important for HVAC (heating, ventilation, and air conditioning) systems.

Engineering

Bridge Construction (2D and 3D Shapes)

Application: Engineers use both 2D and 3D shapes to design bridges. Triangles are commonly used in bridge trusses because they distribute weight efficiently and maintain structural stability.

Importance: Understanding the properties of triangles helps ensure the bridge can support heavy loads without collapsing. For suspension bridges, engineers use cylindrical cables, requiring volume and surface area calculations to determine the material needed and the weight of the cables.

Car Design (Aerodynamics and Volume)

Application: In automotive engineering, the exterior of a car is modeled using smooth, curved 3D surfaces like ellipsoids and cylinders to enhance aerodynamics.

Importance: Understanding these shapes and their properties helps reduce air resistance, improving fuel efficiency. Engineers also calculate the volume of the trunk and cabin to optimize space for passengers and cargo.

Design

Graphic Design (2D Shapes)

Application: Graphic designers use 2D shapes to create logos, posters, and layouts. Understanding how shapes interact and the space they occupy is crucial for effective visual communication.

Importance: Calculating the area helps ensure that text and images are proportionally sized and positioned. Designers use the perimeter to create borders and frames.

Product Design (3D Shapes)

Application: Product designers use 3D modeling to create everyday objects, from smartphones to furniture. Understanding the surface area helps in selecting materials, and volume calculations are crucial for packaging and functionality.

Understanding 2D and 3D shapes and their properties is essential for creating functional, safe, and aesthetically pleasing designs in these fields. Calculations involving perimeter, area, surface area, and volume play a vital role in these real-world applications.

Results and Discussion

In domains such as architecture, engineering, and design, it is essential to comprehend the distinctions and uses of 2D and 3D forms. The methodical examination of these forms, with an emphasis on their characteristics like volume, surface area, area, and perimeter, lays the groundwork for useful, real-world problem-solving. While 3D modeling enables architects to envision and build whole projects, taking into consideration spatial volume and material needs, 2D forms are essential in architecture for producing precise floor plans that facilitate effective space management and material estimation.

Both 2D and 3D forms are widely used in engineering, from aerodynamic designs in automobile design that increase fuel economy by lowering drag to triangular trusses in bridge design that guarantee structural stability. While product designers use 3D modeling to create items that are both practical and material-efficient, graphic designers utilize 2D forms to create layouts that are both aesthetically pleasing and useful. Examining example studies, such the construction of bridges or water bottles, demonstrates how crucial calculations pertaining to these forms guarantee efficiency, safety, and functioning. All things considered, the application of geometric knowledge to real-world situations emphasizes how important form qualities are to design and engineering results.

For sustainability, effectiveness, and accuracy in architecture, engineering, and design, it is essential to comprehend the geometric qualities of forms. Accurate measurement, effective material usage, and the promotion of innovation in consumer goods, transportation, and construction are all dependent on it. The ability of geometry to convert theoretical knowledge into useful applications in a variety of fields shows how linked it is with practical advancements.

Conclusion and Recommendations

In conclusion, design, engineering, architecture, and other fields all depend on a grasp of the geometric characteristics of 2D and 3D forms. An essential framework for real-world applications, ranging from building and bridge design to the creation of aerodynamic automobiles and consumer goods, is provided by the distinctions between perimeter, area, surface area, and volume. In a variety of projects, the analysis of these forms contributes to cost-effectiveness, efficiency, and safety. Examples from everyday life, such floor plans in architecture and truss structures in engineering, highlight how essential accuracy is in mathematical computations. Further illustrating the usefulness of these ideas is the fact that product designers use 3D modeling to produce visually appealing and useful products.

The following recommendation are therefore made to be followed in order to better understand the differences between 2D and 3D shapes and furthermore aid solving real life problems more easily;

i. We advocate that educational establishments give more attention to the real-world uses of 2D and 3D geometry. To close the gap between academic understanding and real-world problem-solving skills, courses must to include real-world case studies.

ii. Advanced 3D modeling software should be used by engineers and architects to better envision and simulate projects. This can lower the chance of mistakes and increase design efficiency.

iii. More creative and effective applications of geometric principles can result from fostering cooperation among architects, engineers, and designers. Design optimization for both form and function is ensured by information sharing across disciplines.

iv. The use of 2D and 3D forms may be further improved by funding research to investigate novel materials and geometric arrangements, particularly in industries like product design and sustainable building.

References

Cattaneo, C., Cantatore, A., Ciaffi, R., Gibelli, D., Cigada, A., De Angelis, D., & Sala, R. (2011). Personal Identification by the Comparison of Facial Profiles: Testing the Reliability of a High-Resolution 3D–2D Comparison Model. *Journal of Forensic Sciences, 57*(1), 182–187. https://doi.org/10.1111/j.1556-4029.2011.01944.x

Daly, A. C., Critchley, S. E., Rencsok, E. M., & Kelly, D. J. (2016). A comparison of different bioinks for 3D bioprinting of fibrocartilage and hyaline cartilage. *Biofabrication, 8*(4), 045002. https://doi.org/10.1088/1758-5090/8/4/045002

Demantké, J., Mallet, C., David, N., & Vallet, B. (2012). DIMENSIONALITY BASED SCALE SELECTION IN 3D LIDAR POINT CLOUDS. ˜ *the œ International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences/International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, *XXXVIII-5/W12*, 97–102. https://doi.org/10.5194/isprsarchives-xxxviii-5-w12-97-2011

Doitrand, A., & Leguillon, D. (2018). Comparison between 2D and 3D applications of the coupled criterion to crack initiation prediction in scarf adhesive joints. *International Journal of Adhesion and Adhesives, 85*, 69–76. https://doi.org/10.1016/j.ijadhadh.2018.05.022

Imamura, Y., Mukohara, T., Shimono, Y., Funakoshi, Y., Chayahara, N., Toyoda, M., Kiyota, N., Takao, S., Kono, S., Nakatsura, T., & Minami, H. (2015). Comparison of 2D- and 3D-culture models as drug-testing platforms in breast cancer. *Oncology Reports, 33*(4), 1837–1843. https://doi.org/10.3892/or.2015.3767

Kapałczyńska, M., Kolenda, T., Przybyła, W., Zajączkowska, M., Teresiak, A., Filas, V., Ibbs, M., Bliźniak, R., Łuczewski, Ł., & Lamperska, K. (2016). 2D and 3D cell cultures – a comparison of different types of cancer cell cultures. *Archives of Medical Science*. https://doi.org/10.5114/aoms.2016.63743

Lague, D., Brodu, N., & Leroux, J. (2013). Accurate 3D comparison of complex topography with terrestrial laser scanner: Application to the Rangitikei canyon (N-Z). *ISPRS Journal of Photogrammetry and Remote Sensing*, *82*, 10–26. https://doi.org/10.1016/j.isprsjprs.2013.04.009

Lin, P., & Chen, S. (2013). The effects of gender differences on the usability of automotive on-board navigation systems – A comparison of 2D and 3D display. *Transportation Research Part F Traffic Psychology and Behaviour*, *19*, 40–51. https://doi.org/10.1016/j.trf.2013.03.001

Low, Z., Chua, Y. T., Ray, B. M., Mattia, D., Metcalfe, I. S., & Patterson, D. A. (2016). Perspective on 3D printing of separation membranes and comparison to related unconventional fabrication techniques. *Journal of Membrane Science*, *523*, 596–613. https://doi.org/10.1016/j.memsci.2016.10.006

Morimoto, K., Ardelean, A., Wu, M., Ulku, A. C., Antolovic, I. M., Bruschini, C., & Charbon, E. (2020). Megapixel time-gated SPAD image sensor for 2D and 3D imaging applications. *Optica*, *7*(4), 346. https://doi.org/10.1364/optica.386574

Paškevičiūtė, M., & Petrikaitė, V. (2017). Differences of statin activity in 2D and 3D pancreatic cancer cell cultures. *Drug Design Development and Therapy*, *Volume 11*, 3273–3280. https://doi.org/10.2147/dddt.s149411

Saito, S., Huang, Z., Natsume, R., Morishima, S., Li, H., & Kanazawa, A. (2019). PIFu: Pixel-Aligned Implicit Function for High-Resolution Clothed Human Digitization. *2D*. https://doi.org/10.1109/iccv.2019.00239

Soares, C. P., Midlej, V., De Oliveira, M. E. W., Benchimol, M., Costa, M. L., & Mermelstein, C. (2012). 2D and 3D-Organized Cardiac Cells Shows Differences in Cellular Morphology, Adhesion Junctions, Presence of Myofibrils and Protein Expression. *PLoS ONE*, *7*(5), e38147. https://doi.org/10.1371/journal.pone.0038147

Zhu, D., Zaffalon, M. L., Zito, J., Cova, F., Meinardi, F., De Trizio, L., Infante, I., Brovelli, S., & Manna, L. (2021). Sb-Doped Metal Halide Nanocrystals: A 0D versus 3D Comparison. *ACS Energy Letters*, *6*(6), 2283–2292. https://doi.org/10.1021/acsenergylett.1c00789