Geometrical Pedagogy of Polygons: Multidimensional Calculation Of Cubic Structures

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Abstract: We will see many things from the start to the end of the day. Large buildings, vehicle mortars, notebooks, and mechanical pumping machines. All these things have some polygons embedded in them. Everything in the world works with geometry; in physics, the inclined plane scenario, and in chemistry, the structural bonds and chemical bonds all require polygons like cubes and cuboids to perform the job to the fullest. So in this research paper, we will discuss the various types of cubical polygons. We will be going deep with their structures and physics properties. This research paper focuses on more than 3-dimensional cubic figures, and it can be a foundation for future inventions.

Keywords: Cubical Structure, Polygon, Dimensions, Solids, Triangles, Figures, Square, Polytope, Geometry

1. Introduction

Polygons are created by simply drawing multiple horizontal lines. The number of sides or angles the polygon has determines its type (isosceles, equilateral, and scalene). Other shapes built with straight lines include triangles (a triangle is a polygon with three sides), rectangles (a rectangle is a polygon with four closed sides), and circles. A special shape called an n-gon is a polygon with n sides; for example, 3-sided polygons are called triangles, and so on [1].

More about 3D cubes: We know about squares, but what is a Cube? The cube is a solid shape made of all squares. The cubic object can be divided into smaller cubes by cutting through any surface point. An example of a Cube is, Polyhedron: A polyhedron is an emergent form of a solid body containing faces, otherwise known as polygons. These shapes are also called solids as they do not have an open or hollow space. Advantages of Cubes: you can use them to make paper crafts, models and toys, table surfaces, etc. Just add color to their surface using liquid paints or dye to make them.

Cubes are more commonly known as blocks. They are geometric shapes that are used in many ways and can be used for storing information. The size and shape can be customized based on user needs and the different types of cubes available in the market. Cubes have played a very important role in our daily life as they have helped us inventory various products easily [2].

Solids, cones, and spheres are the figures you encounter daily. But beyond these common 3D shapes, a plethora of other mathematical structures can be constructed using different combinations of shapes. The science of cubes is an important aspect of mathematics. The cube is a special case of the fourth power, an operation that takes three numbers and produces another number. When a cube is taken from a table, it leaves behind the cube mark. Cubes have their special configuration, called the order of a cube. Here we will be discussing the details of the Square Polynomial Family [3].

2. Types of suqare polynomial

The Square

The Square is a shape with 2 faces; it has four vertices and four edges. The Schlafly symbol is {4}, and the symmetry group is Dihedral (D4) with an order of 2x4. The internal angle of the square is 90 degrees. The properties of our square are cyclic, equilateral, isogonal, and isotopic. It is considered a regular polygon. Speaking in terms of the rectangle, it is a rectangle with two adjacent same-sized sides. Rhombus is a Rhombus with vertex right angled along with equal angles. Parallelogram is a parallelogram with a vertex of one angle and two equal adjacent sides.

Its properties include a central angle of 90 degrees external angle of 90 degrees; the diagonals bisect each other and are equal. They also bisect at an internal angle resulting in angles adjacent to 45 degrees. Basics properties include equal and opposite sides, perimeter = 4s, where s is a length of an edge of a square. Its area is s*s [4].

The Cube – 3-Dimensional Figure

It is shaped with six square faces. It has eight vertices and 12 edges. The cube is the only regular solid made of two different shapes: squares or rectangles. For example, if you cut a rectangular prism into cubes, each piece will have one square face and three rectangles. The cube type is Platonic Solid, and faces by sides can be denoted as 6{4}, and the Conway notation is represented by “C”. The Schlafly symbols include {4,3} : t{2,4} or 4 x {}, tr{2,2}; {}x{}x{} = ({}) ^3. The face configuration is V3.3.3.3, and the Wythoff Symbol is 3|2 4. The symmetry can be displayed in Oh and B3, [4,3], (*432).

The rotation group will be O, [4,3+], (432), and references include U06, C18, and W3. The properties cover regular, convex zonohedron, and Hanner polytope. The dihedral angle is 90 degrees. The vertex configuration is 4.4.4, and the Octahedron is a dual polyhedron. We all know the surface area is 6(a*a) and volume is (a*a*a). The face diagonal is under root 2 x a (Where a is a side). The angles between the faces in terms of radians are pi/2, and the radius of the inscribed sphere is a/2.

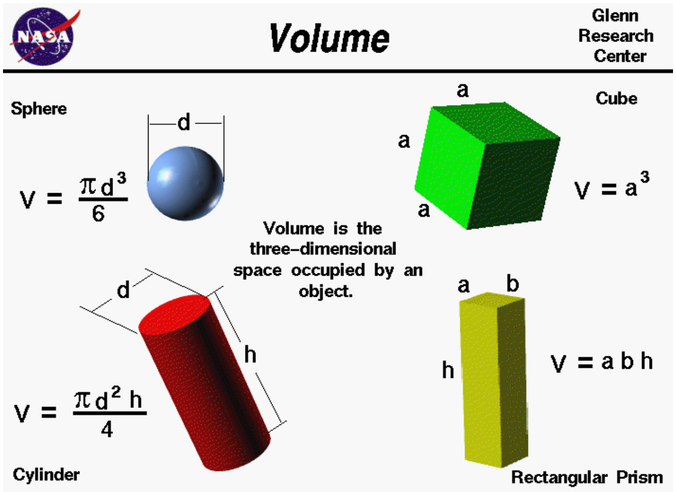

Figure 1.1 – Source: NASA Space Technologies

3. MULTIDIMENSIONAL POLYNOMIALS FROM 4-D TO 7-D

The Tesseract – 4-Dimensional Figure

A four-dimensional square is called a tesseract. It has a unique Schlegel diagram. Its type is convex regular four-polytype. The Schlafly notation is {4,3,3} and the symbol can vary from t0{4,3,2} or {4,3} x {}; t0,{4,2,4} or {4} x {4}, t0,2,3{4,2,2} or {4}x{}x{}; t0,1,2,3{2,2,2} or {}*{}*{}*{}. Its cells include 8{4,3} and faces 24{4}. The edges are 32, and the vertices are 16. The Petrie polygon is an octagon, and the Coxeter group is B4, [3,3,4] and contains a dual structure of 16 cells.

This figure can also be called an Octachoron. Its properties include convex, isogonal, isotaxal, isohedral, and Hanner polytope with a uniform index is 10. This contains 16 zero vertex dimension faces, 32 one-edged dimensional faces, 24 two-faced dimensional edges, and 8 three-faced faces with a 14-faced dimension [5].

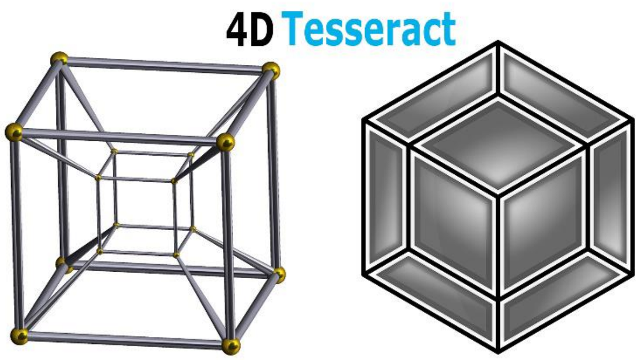

Figure 1.2 – Source: Digitash Web Pics

The Penteract – 5-Dimensional Figure

This is a five-dimensional square; the scientific polygon name is Deca-5-tope. It has a structure ratio of 32,80,80,40,10,1. In short, this has 10 tesseracts, 40 cells, 80 square faces, 80 edges, and 32 vertices. This type is called uniform 5-polytope. The Schlafly symbol is {4,3,3,3}. The Coxeter group B5, [4,33] with an order of 3840. The dual structure has a 5-orthoplex. The basepoint of this penteract is (1,1,1,1,1,1). The average circumradius is 1.118034. The properties include convex, isogonal regular, and Hanner polytope [5].

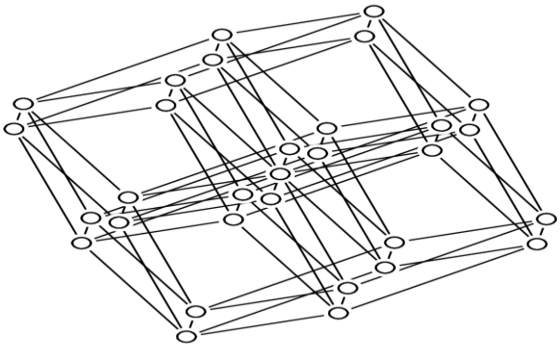

Figure 1.3 – Five Dimension, Source – Research Gate

The Hexeract – 6-Dimensional Figure

This is a six-dimensional square; the scientific polygon name is Dodeca-6-tope. Along with that, it also has a structure ratio of 64,192,240,160,60,12,1. In short it has 12{4,3,3,3} 5 faced edges, 60 {4,3,3} 4 faced edges. These cells include around 160 {4,3}. It consists of faces 240{4}, edges in a total of 192, and vertices of 64. This type is known as Regular 6-polytope. The family comes under the hypercube. The vertex figure is a 5-simplex. The Petrie polygon is a dodecagon. The Coxeter group is B6, [3^4,4]. The dual structure is 6-orthoplex. The properties include convex and Hanner polytope [6]

The Hepteract – 7-Dimensional Figure

This is a seven-dimensional square; the scientific polygon name is Tetradeca-7-tope. It has a structure ratio of 128, 448, 672, 560, 280, 84, 14, 1. This type comes under Regular 7-polytope. Its family is a hypercube. The Schlafly symbol is {4,35}. The structure displays 540{4,3} cells, 672{4} faces, 448 edges, and 128 vertices. The vertex figure is 6-simplex, and the Petrie polygon is tetradecagon. The Coxeter group is C7, [35,4]. The dual structure is 7-orthoplex. Its properties include convex and Hanner polytope.

Figure: 1.4 7-Dimensional Figure- Source: ResearchGate

4. MULTIDIMENSIONAL POLYNOMIALS FROM 8-D TO 10-D

The Octeract – 8-Dimensional Figure

This is an eight-dimensional square; the scientific name is Hexadeca-8-tope. It has a structure ratio of 256, 1024,1792, 1792, 1120, 448, 112, 16, 1. This type is a Regular 8-polytope. This comes under a family of hypercubes. The Schlafly symbol is {4,36}. It has 1792{4} faces, 1024 edges, 256 edges, 1792{4,3} cells, and 448 {4,33} 5-faced sides. Its vertex figure is a 7-simplex. The Petrie polygon is C8, [36,4]. The dual structure is an 8-orthoplex. The properties are convex and Hanner polytope [6].

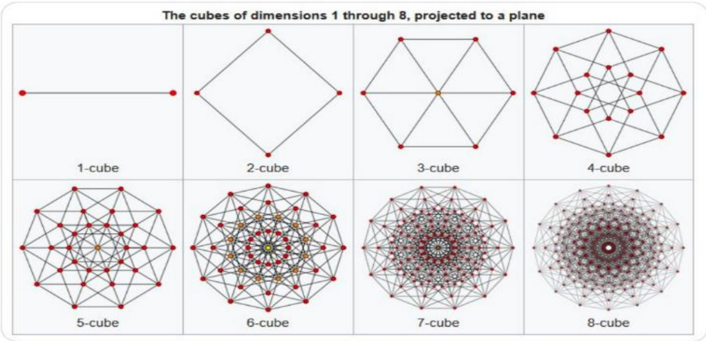

Fig. 1.5 8-Dimensional Figure. Source: Mike's Math Page.

The Enneract – 9-Dimensional Figure

This is a 9-dimensional square; the scientific name is Octadeca-9-tope. It has a structure ratio of 512, 2304, 4608, 5376, 4032, 2016, 672, 144, 18,1. This type is a Regular 9-polytope. It comes under the hypercube family. The Schlafli symbol is {4,37}. In short, it has 512 vertices, 2304 edges, 4608{4} faces, 5376{4,3} cells, 4032 {4,3,3} four faces, and 672 six faces. Its vertex figure is 8-simplex, and the Petrie polygon is an octadecagon. The Coxeter group is C9, [37,4] and the dual structure is 9-orthoplex. Its properties include convex and Hanner polytope.

The Dekeract – 10-Dimensional Figure

This is a 10-dimensional square; the scientific name is Icosa-10-tope. It has a structure ratio of 1024, 5120, 11520, 15360, 13440, 8064, 3360, 960, 180, 20, 1. This type is a Regular 10-polytope. This comes under hypercube's family. The Schlafly symbol is {4,38}. It has 1024 points, 5120 segment edges, 11520 square faces, 15360 {4,3} cells, 8064 five-faces, 180{4,36} six faces. Its vertex figure is 9-simplex, and the Petrie polygon is icosagon. Its Coxeter group is C10 [38,4]. The dual structure is 10-orthoplex. Its properties include convex and Hanner polytope [7].

5. Conclusion

Therefore, we have observed and analysed up to ten dimensional figures. There are more dimensions, but scientists and researchers till now have declared about these confidently along with specifications including designs. There can be some technology that finds the surface areas including the volume in future. To find all such technologies and possibilities this paper will be a base.

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