Content guide for *The Geometrical Ball*

The Geometric Ball is an ode to the classical 32-panel (20 hexagons and 12 pentagons) pattern recognized by young and old across the world as a soccer ball. The pattern is referred to as the *truncated icosahedron,* the best known of the 13 geometric structures (Archimedean solids) defined and documented over 2000 years ago by Archimedes, the Greek mathematician, physicist, engineer, inventor, and astronomer. The picture also celebrates Eigil Nielsen, the Danish national team goalkeeper and founder of the SELECT ball company, who first introduced the truncated icosahedron to the world of soccer, and it acknowledges the discovery on Earth and in interstellar space of the “soccer ball molecule” (Carbon-60) at a scale 275 millions times smaller than a size 5 soccer ball. The artwork is mixed-media on canvas and measures 127cm x 127cm (50” x 50”).

The geometry

Diagram showing the different paths to the formation of a stable Carbon-60 molecule (“The Football Molecule”) in interstellar space.

Microscopic image of a truncated icosahedron artificially constructed from DNA material at a scale of 400nm.

The 13 Archimedian solids composed of regular polygons (equiangular and equilateral) and defined and documented over 2000 years ago by Archimedes, the Greek mathematician, physicist, engineer, inventor, and astronomer. The drawing continues down and to the right.

Drawing of the truncated icosahedron in the orthogonal projection centered on the face.

Drawing (in the background behind the ball) of the molecular structure of the Carbon-60 molecule with the structure of the truncated icosahedron

The truncated icosahedron (12 pentagons and 20 hexagons), one of the 13 Archimedian solids and known globally as the symbol of the game of soccer (football).

Schematic illustration of the conversion of sheets of graphene (hexagonal / honeycomb lattice) into Carbon-60 molecules in space (the interstellar medium). The hexagonal carbon rings loose carbon atoms when exposed to UV irradiation from nearby hot stars, giving rise to “pentagonal defects” at the edges of the sheet. These defects induce curvature of the sheet and eventually the formation of Carbon-60 molecules in the truncated icosahedron pattern.

Drawings of the icosahedron from different viewing angles (orthogonal projections) centered on the vertex and face, respectively.

The pentagons and hexagons that constitutes the truncated icosahedron are both regular polygons and tangential polygons — i.e. an inscribed circle can be drawn that is tangent to each side at the midpoint.

Drawing of an unfolded truncated icosahedron (football) with the 20 hexagons and 12 pentagons in the same 2-dimensional plane.

Drawing of the first 16 cyclic polygons.

Drawing of an icosahedron (a polyhedron with 20 equilateral and equiangular triangular faces). Additional lines mark where the icosahedron can be truncated turning the 20 triangles into 20 hexagons and 12 pentagons.

The definitions of an Archimedian solid, the regular polygon, and equiangular and equilateral.

The pentagons and hexagons that constitutes the truncated icosahedron are both regular polygons and cyclic polygons — i.e. a circle can be drawn that passes trough all vertices.

The mathematics

Definition of a Platonic solid. Note — a Platonic solid is a convex figure constructed from one type of regular polygon. An Archimedean solid is convex figure that is constructed from two or more types of regular polygons.

Definition of the icosahedron (one of the 5 Platonic solids).

Definition of the truncated icosahedron (one of the 13 Archimedian solids)

Definition of the Goldberg polyhedron. Goldberg polyhedra always have exactly 12 pentagonal faces, but can have more than 20 hexagonal faces. The truncated icosahedron is a Goldberg polyhedron.

The formula for the radius of the sphere circumscribing a truncated icosahedron (radius of a classical football based on that design) with an edge length of *a*. The letter ϕ represents the Golden Ratio of 1.618.

The formula for the surface area of the truncated icosahedron with a side length *a*.

The formula for the surface area of the truncated icosahedron with a side length *a*.

The mathematical definition of a convex polytope.

Euler's polyhedron formula stating that the Euler characteristic χ defined as the number of vertices (V) minus the number of edges (E) plus the number of faces (F) for a convex 3-dimensional polyhedron, is always equal to 2:

$$\chi = V - E + F = 2$$

The mathematical derivation, using the Euler polyhedron formula, of the number of pentagons needed to construct the truncated icosahedron (the classical football pattern).

Eigil Nielsen and SELECT

Drawing of the SELECT ball company's logo

Brief text about Eigil Nielsen and the SELECT ball company

Manipulated image displaying the process of hand sewing a 32 panel SELECT soccer (football) ball. The process requires ~630 double stitches and 60 corner stitches over a distance of ~3.8 meters. The ball is closed with a double knot.

Manipulated image of goalkeeper Eigil Nielsen in action for the Danish national team.

Manipulated image of Eigil Nielsen holding a new SELECT Super Brilliant in his hands.

Drawing of the SELECT name as it appears on all their balls.

Drawing of the SELECT name above the Danish flag as it often appears on SELECT balls as a reference to the company's founder and country of origin.

Manipulated image displaying Eigil Nielsen in a team photo for Kjøbenhavns Boldklub (KB), a Danish soccer club based in Copenhagen for which he played from 1939-1952.

Drawing of a solid white classical SELECT Brilliant Super football (soccer ball) constructed in the pattern of the truncated icosahedron from 20 hexagons and 12 pentagons.