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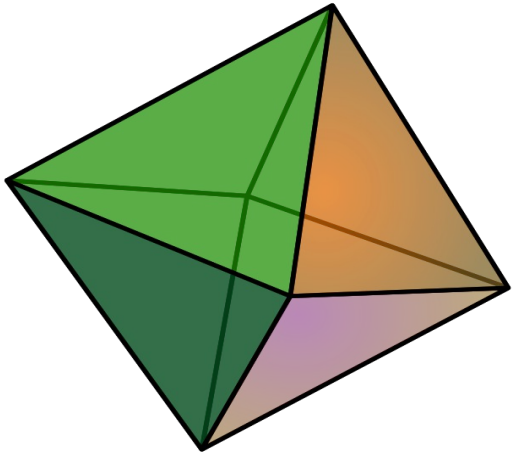
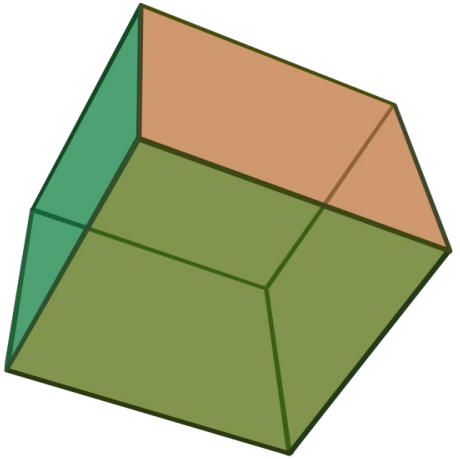
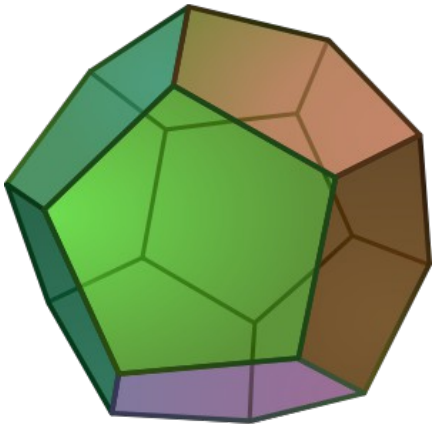
MATH 420.01
02/10/12

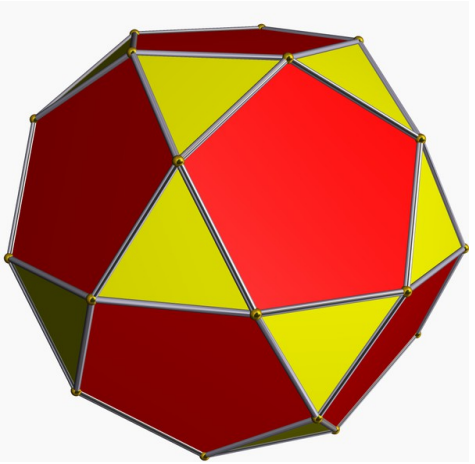
- Geodesic domes are spherical or partial-spherical shell structures based on a network of great circles (geodesics) on the surface of a sphere.

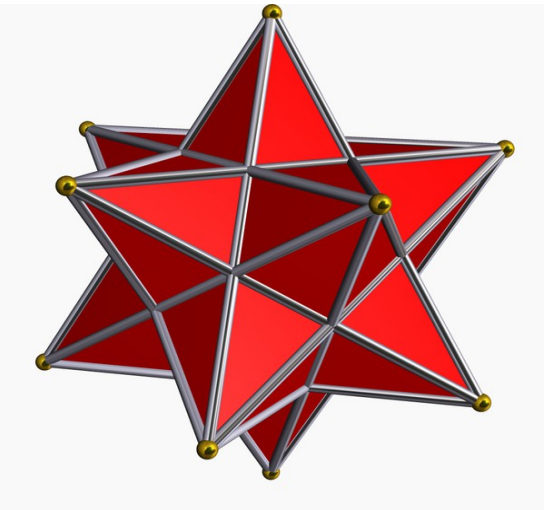
- By using triangulation of a platonic solid or polyhedron, one can produce a close approximation to a sphere.

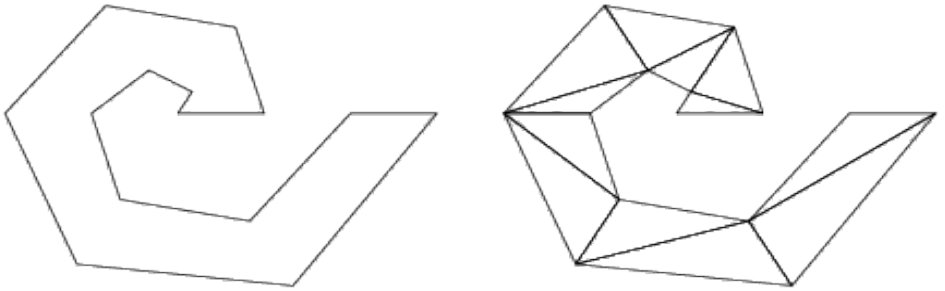






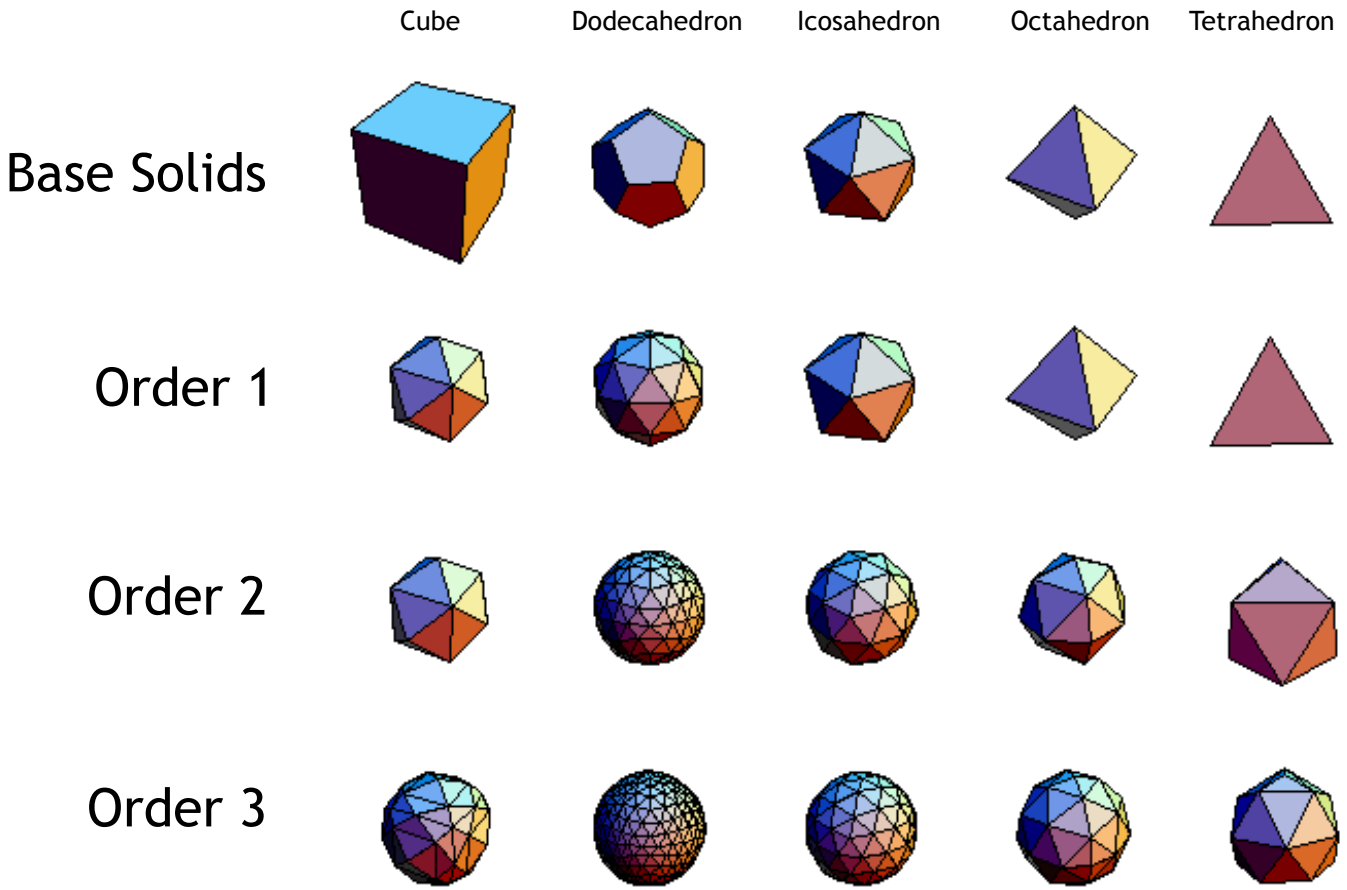




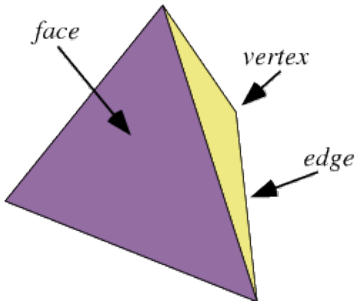


- Triangulation is the division of a surface or plane polygon into a set of triangles.
- Usually each triangle side is entirely shared by two adjacent triangles.

- The *n*th order operation replaces each polygon of the polyhedron by the projection onto the circumsphere.



- Given a polyhedron vertex, the sum of the angles is chosen to be constant.

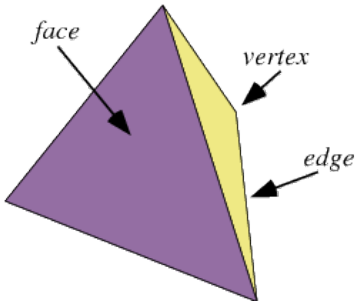


- Using a convex polyhedron, to find the number of edges meeting at the vertex, e'

$$e' = \frac{2e}{v}$$

where e is the number of edges and v is the number of vertices.

- Given a polyhedron vertex, the sum of the angles is chosen to be constant.



- *n* is the number of edges, A is the angle of the original vertex, F is the angle of the new vertex

$$A = B$$

$$2e'A = nF$$

$$2\mathrm{A} + F = 180$$

Solving for A gives

$$2\mathrm{A} + \frac{2e'}{n}A = 2\mathrm{A}\left(1 + \frac{e'}{n}\right) = 180$$

$$A = 90\frac{n}{e' + n}$$

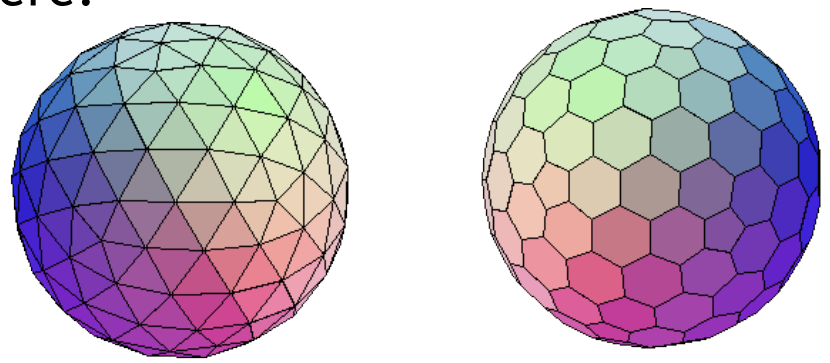
$$F = \frac{2e'}{n}A = 180\frac{e'}{e' + n}$$

- The polyhedron vertex sum is

$$\Sigma = nF = 180\frac{e'n}{e'+n}$$

solid	e	v	e'	n	A	F	Σ
tetrahedron	6	4	3	3	45	90	270
octahedron	12	6	4	3	~38	~102	~308
cube	12	8	3	4	~51	~77	~308
dodecahedron	30	20	3	5	~56	~67	~337
icosahedron	30	12	5	3	~33	~112	~337

- On a geodesic dome, the chords correspond to the “strut”.
- Usually, curves on a geodesic dome follow the surface of a sphere circumscribing a regular polyhedron with triangular faces.
- By connecting like points along the subdivided sides, a natural triangular grid is formed on each face of the polyhedron.
- Each segment of the grid is then projected as a "chord" onto the surface of the circumscribing sphere.
- The chord factor is the ratio of chord length to the radius of the circumscribing sphere.

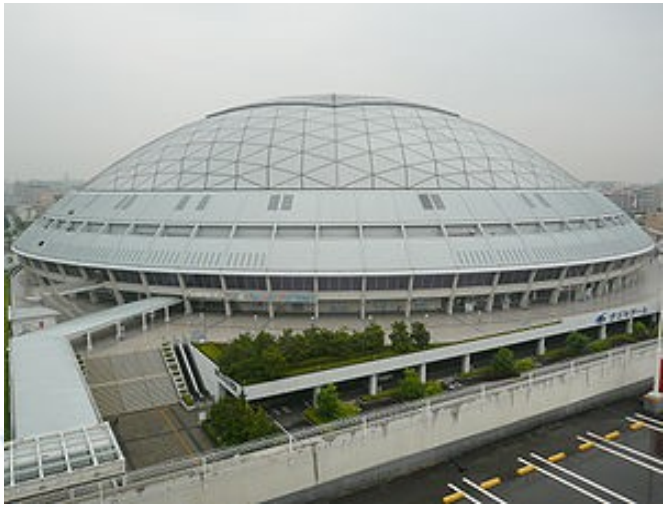


A geodesic dome and its dual (vertices of one correspond to faces of the other)

- The triangular elements found in geodesics intersection have a local triangular rigidity that distributes the stress across the structure.

Montreal Biosphere
Canada

Spaceship Earth
Walt Disney World



Nagoya Dome
Japan