Explicitly Listing Geometry and Topology

Models can consist of thousands of vertices and faces — we need some way to list them efficiently.

This is called a Mesh.

The Cube Can Also Be Defined with Triangles

3D Printing uses a Triangular Mesh Data Format
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Dessert at the House of Someone Obsessed with OSU and Computer Graphics

Another way to Model:
Remember Venn Diagrams (2D Boolean Operators) from High School?
- Two Overlapping Shapes
- Union: $A \cup B$
- Intersection: $A \cap B$
- Difference: $A - B$

Solid Modeling Using 3D Boolean Operators
- Two Overlapping Solids
- Union: $A \cup B$
- Intersection: $A \cap B$
- Difference: $A - B$

This is often called Constructive Solid Geometry, or CSG.

Another way to Model:
Curve Sculpting – Bezier Curve Sculpting

Curve Sculpting – Bezier Curve Sculpting Example

$$P(t) = (1-t)^3 P_0 + 3t(1-t)^2 P_1 + 3t^2(1-t) P_2 + t^3 P_3$$

where $P$ represents \( \begin{bmatrix} x \\ y \\ z \end{bmatrix} \)
Curve Sculpting – Bezier Curve Sculpting Example

Moving a single point moves an entire curve.

Another way to Model: Surface Sculpting

Moving a single point moves an entire surface.

Surface Equations can also be used for Analysis

With Contour Lines

Showing Curvature

Another way to Model: Sculpting with a Wireframe Mesh

This is often called a "Lattice".

Modeling → Simulation (Explosion)

Modeling → Simulation (Smoke)
The object must be a legal solid. It must have a definite inside and a definite outside. It can’t have any missing face pieces.

“Definite inside and outside” is sometimes called “Two-manifold” or “Watertight.”

The Simplified Euler’s Formula* for Legal Solids

\[ F - E + V = 2 \]

For a cube, \( 6 - 12 + 8 = 2 \)

*sometimes called the Euler-Poincaré formula

The full formula is:

\[ F - E + V - L = 2( B - G ) \]

Objects cannot pass through other objects. If you want two shapes together, do a Boolean union on them so that they become one complete object.