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. If it's in nice neat rows like this, it is called a Regular Mesh. If it's not, it is called an Irregular Mesh, or oftentimes called a Triangular Irregular Network, or TIN.

The Cube Can Also Be Defined with Triangles

3D Printing uses a Triangular Mesh Data Format
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Go Beavs! 🐻

Another way to Model:
Remember Venn Diagrams (2D Boolean Operators) from High School?

Two Overlapping Shapes
Union: A ∪ B
Intersection: A ∩ B
Difference: A - B

Solid Modeling Using 3D Boolean Operators

This is often called Constructive Solid Geometry, or CSG.

Another way to Model:
Curve Sculpting – Bezier Curve Sculpting

Curve Sculpting – Bezier Curve Sculpting Example
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Moving a single point moves an entire curve

A Small Amount of Input Change Results in a Large Amount of Output Change

Another way to Model: Surface Sculpting

Moving a single point moves an entire surface

A Small Amount of Input Change Results in a Large Amount of Output Change

Surface Equations can also be used for Analysis

With Contour Lines

Showing Curvature

Another Way to Model: Volume Sculpting

This is often called a “Lattice” or a “Cage”.

A Small Amount of Input Change Results in a Large Amount of Output Change

Modeling → Simulation (Explosion)

Modeling → Simulation (Smoke)
Object Modeling Rules for 3D Printing

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

\[ F - E + V = 2 \]

*sometimes called the Euler-Poincaré formula

The full formula is:

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

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

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.