

Solid Modeling

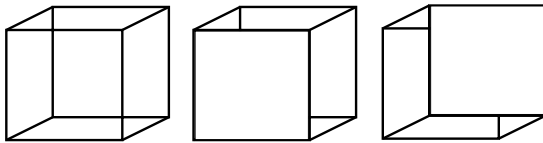
Solid Modeling

- Definition
- Historical review
- Constructive Solid Geometry
- Boundary representations
- Cell decompositions

What is a "Solid Model"?

"an unambiguous computer representation of a physical solid object"

- Requicha and Rossignac ('92)



Historical Review

- "Bézier" curves and surfaces: Bézier ('66, '67) and de Casteljaou ('59, '63)
- Non-rational curves and surfaces:
Coons ('63, '65) and Ferguson ('64)
- B-splines: Cox ('72), de Boor ('72),
Gordon and Riesenfeld ('74, '74)
- β-splines: Barsky ('81)
- NURBS: Versprille ('75), Tiller ('83)
- Surveys: Requicha and Voelcker ('82),
Requicha and Rossignac ('92)

Historical Review

Movement in 1980s from application-oriented research to theoretical issues

- algebraic geometry
- collision/interference detection
- inhomogeneous objects
- robust geometric and topological operations

Implicit Functions

Functions of the form

$$f(x,y,z) \leq 0$$

can be used to describe solid.

Two types of implicit solid:

- constructive solid geometry (CSG)
- blobby models

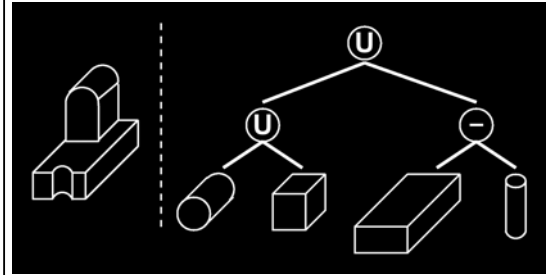
Constructive Solid Geometry

- CSG builds solid models by combining primitive (implicit) objects with Boolean operators
- Objects: spheres, cubes, cylinders, etc.
- Operators: addition, intersection, union, etc.
- Assembled into CSG tree:
 - internal nodes = operators
 - leaves = objects

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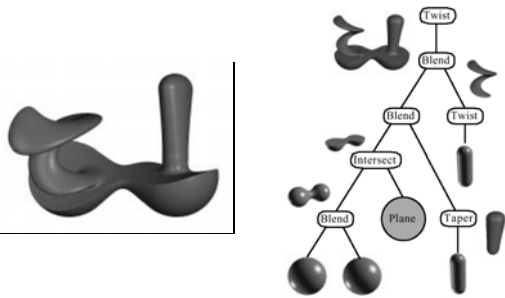
Constructive Solid Geometry



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Example BlobTree



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Boundary Representations

- Represent only the boundary
- Polygonal, analytic and subdivision surfaces the most popular
- Polygon-based surfaces require special data structures, such as
 - winged-edge: Baumgart ('75)
 - quad-edge: Guibas and Stolfi ('85)

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Cell Decompositions

- Objects expressed as cells or polyhedra attached to each other
- Voxel-based models very popular
 - data arranged on a grid
 - simple yet powerful and general
 - intuitive and natural representation
 - can represent details easily
 - mature rendering algorithms

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Cell Decompositions

Voxel-based modeling systems:

- wax-like objects: Galyean and Hughes ('91)
- detailed objects: Wang and Kaufman ('95)
- deformable objects: Gibson ('95, '97, '99)



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