introduction to modeling

modeling

mathematical representation of
virtual objects' geometry

modeling problems

- representation
  - how to represent objects' shape?
- efficiency
  - what algorithms can be use to construct and render?
- manipulation
  - how to edit 3d objects' geometry?

object types by dimensionality

- points (0D)
- curves (1D)
- surfaces (2D)
- volumes (3D)

points

- surface approximation
- scanner output
- complex systems

- trivial representation

curves

- complex systems
- build surfaces

- parametric representation

[© Pixar/Disney]

surfaces

- object surfaces

- many representations
  - polygon meshes
  - subdivision
  - parametric
  - (implicit)

[Cornell PCG]

surfaces

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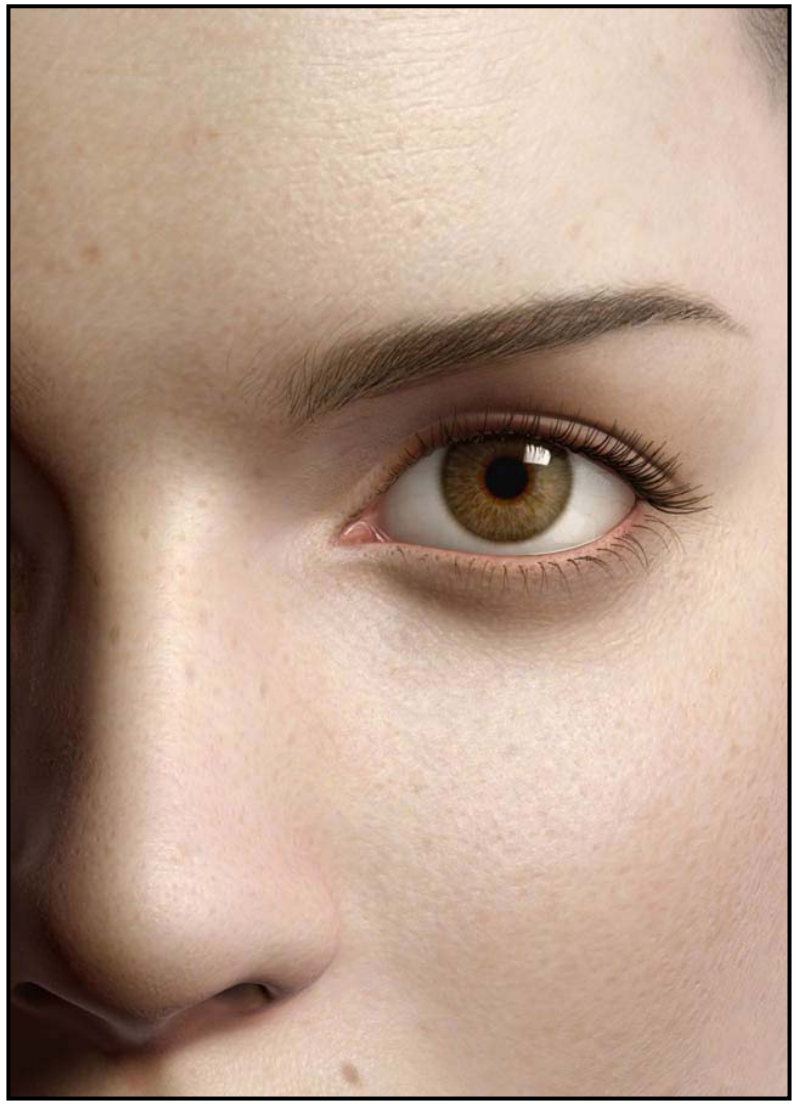

[© Square]

volumes

- liquid/gases
- medical data
- solid modeling

- many representations
  - boundaries
  - CSG
  - voxels

[Nguyen et al., 2002]

complex systems

- vegetation
- simulation
- crowds

- ad-hoc representation
  - combines multiple types

complex systems

- vegetation
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- ad-hoc representation
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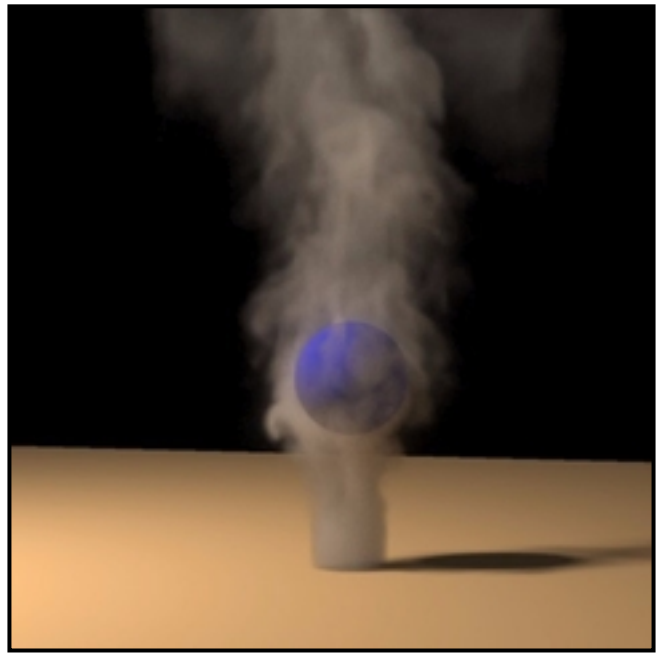

[Stam et al.]

complex systems

- vegetation
- simulation
- crowds

- ad-hoc representation
  - combines multiple types

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choosing surface representations

- each representation has enough expressive power to model the shape of any geometric object
  - geometric operations can run on any representation!
  - but there are tradeoffs

- efficiency
    - complexity, space/time, numerical accuracy
- simplicity
    - acquisition, hardware acceleration, software engineering
- usability
    - user-driven editing operations

topics covered

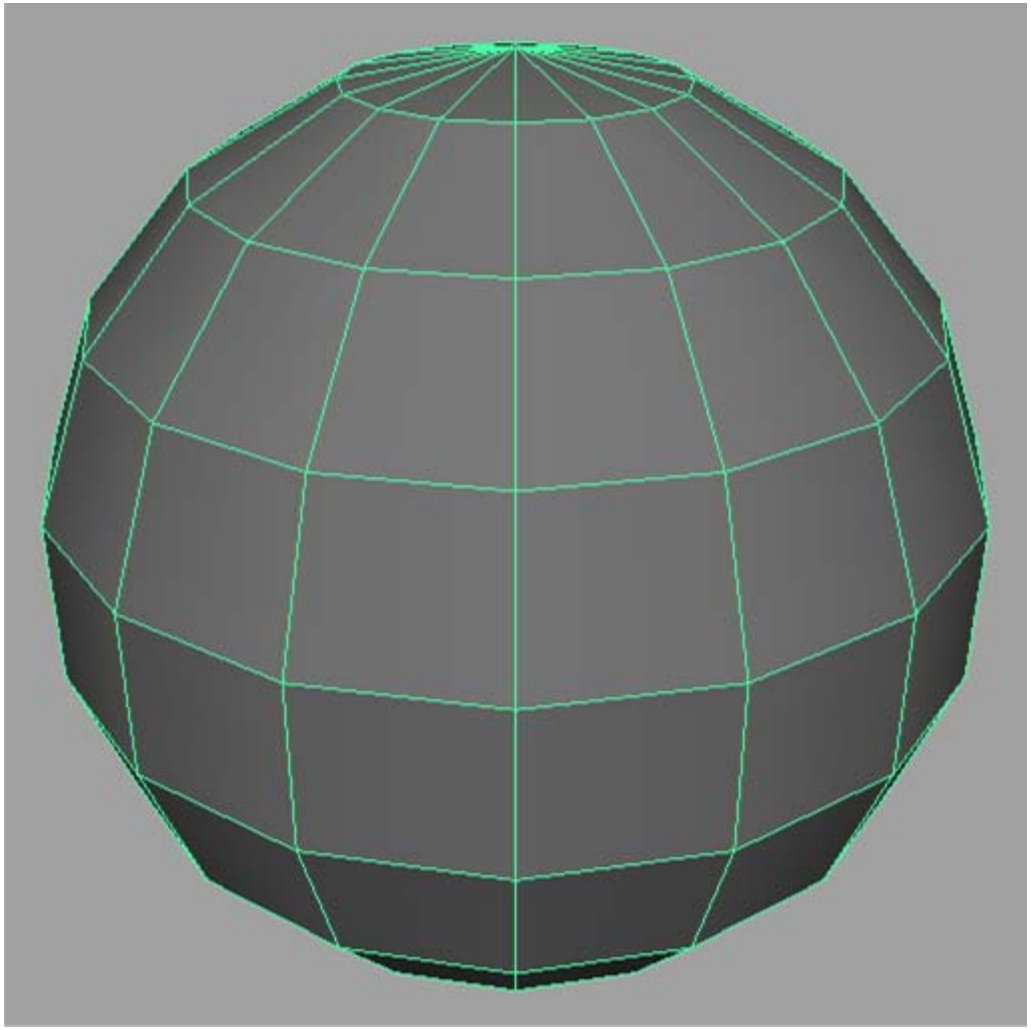
- curves
  - parametric
- surfaces
  - triangle meshes
  - subdivision
  - parametric

surface representation

surface representation types

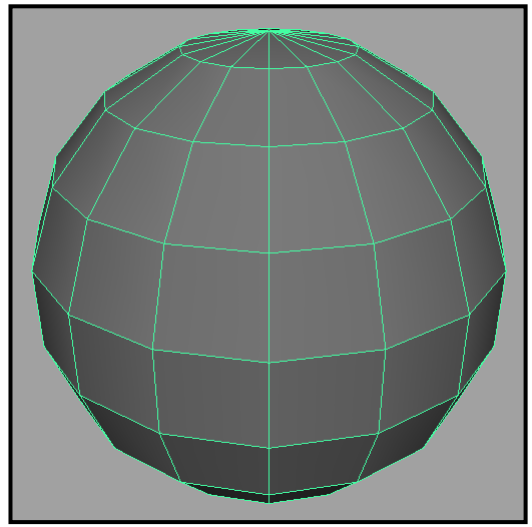
- non-smooth models
  - polygon meshes
- smooth models
  - parametric surfaces
  - subdivision surfaces

polygon meshes



polygon meshes

- collection of polygons



- not smooth,
- easy to model any shape

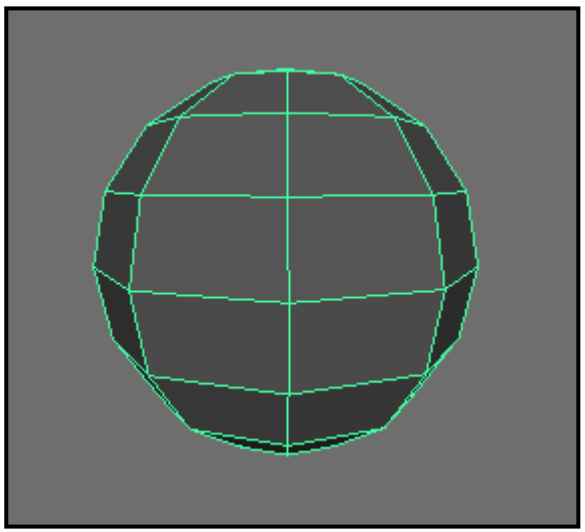
- used by most low-level algorithms
  - convert other rep. to this one
- used in interactive graphics
  - very efficient

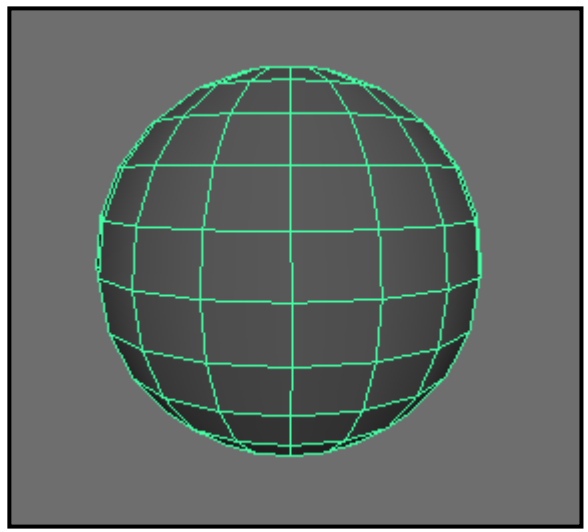
polygon meshes

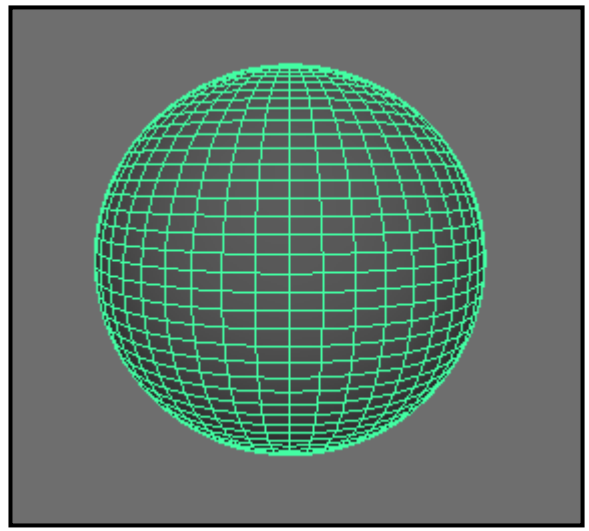
[© id Software]

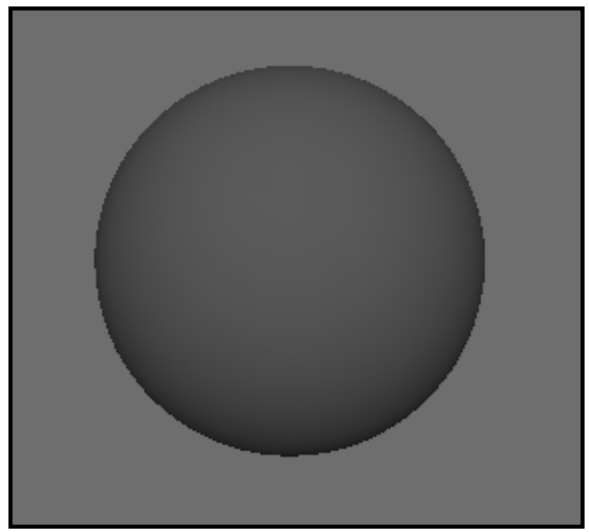
polygon meshes – tesselation

- use more polygons to approximate smoothness
  - silhouettes, lighting

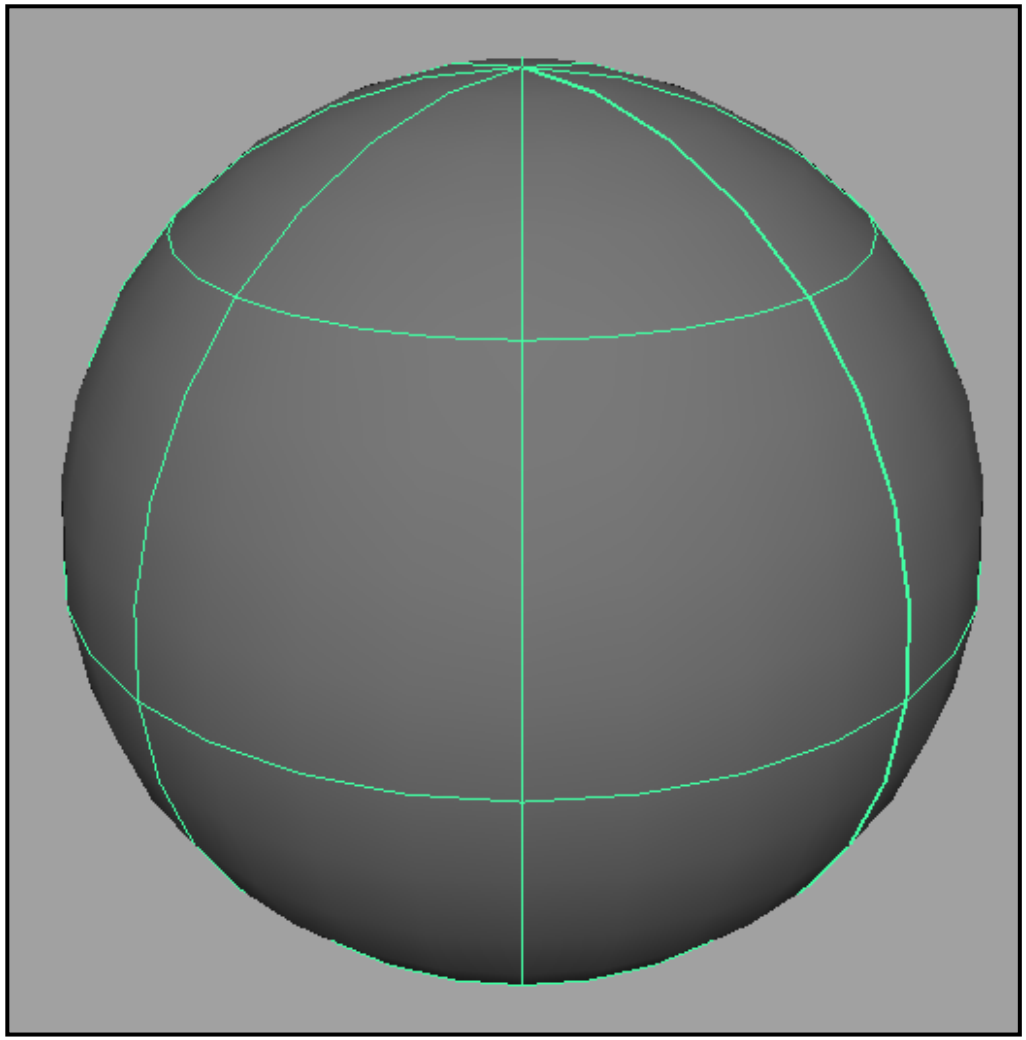






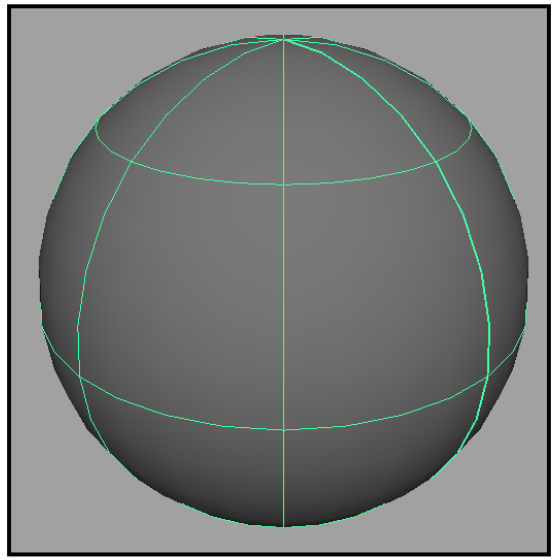


parametric surfaces



parametric surfaces

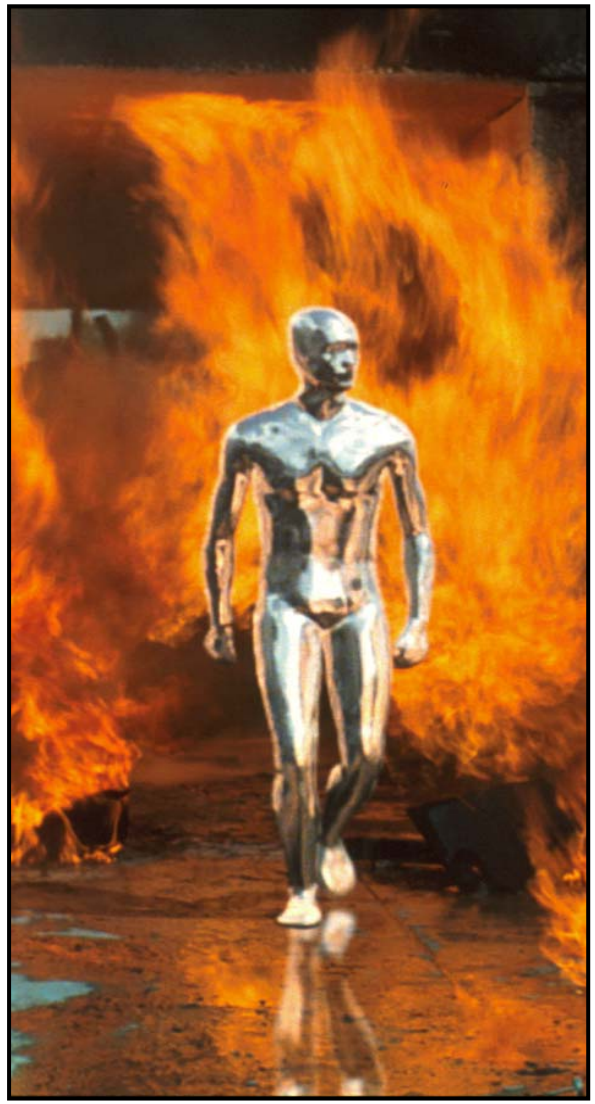
- smooth surfaces generated by simple control points



- smooth
- hard to model complex shapes

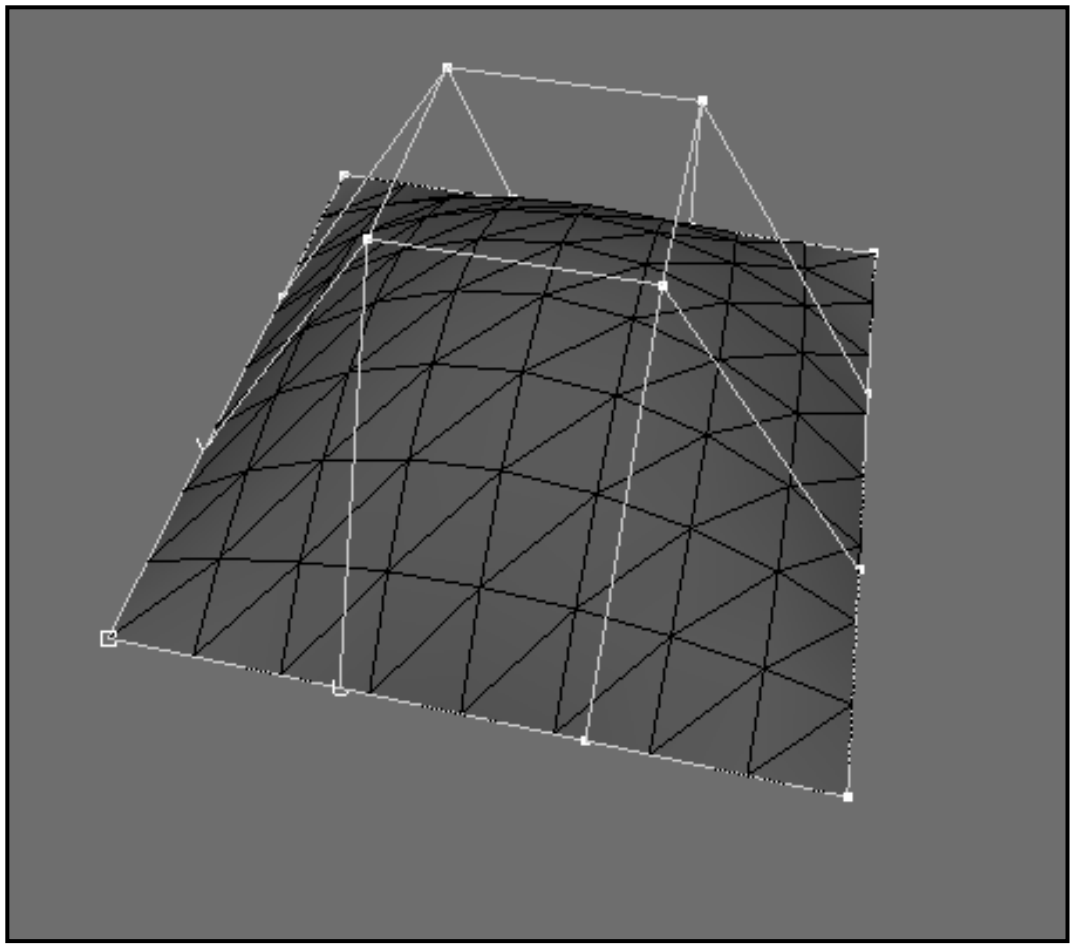
parametric surfaces

[Cornell PCG]



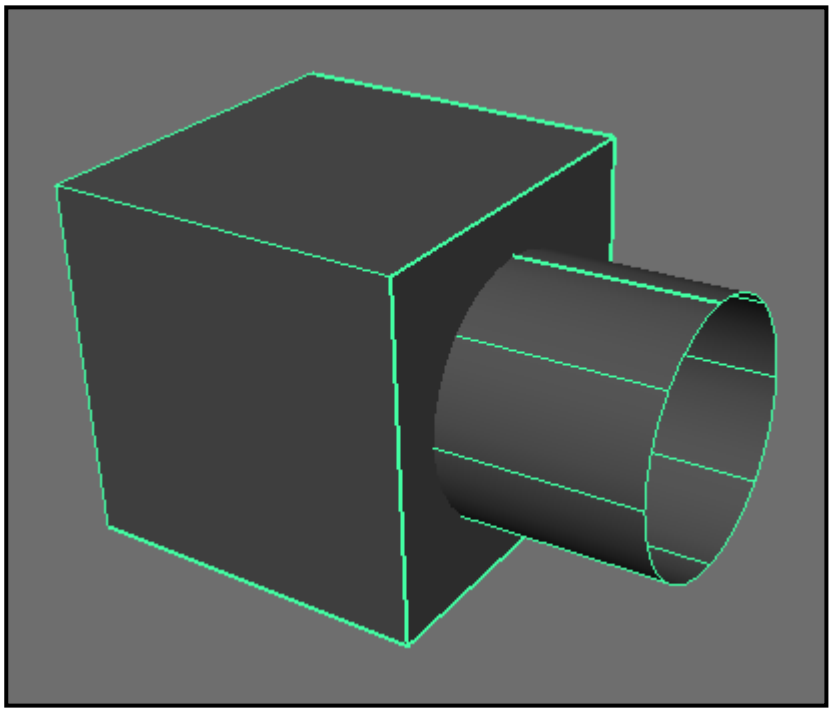
[© ILM]

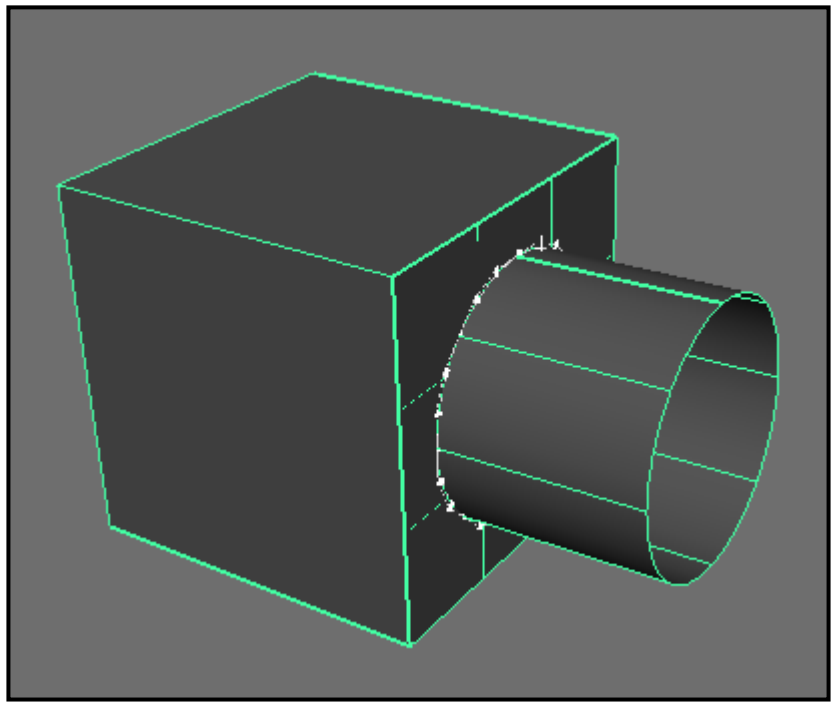
parametric surfaces – control points



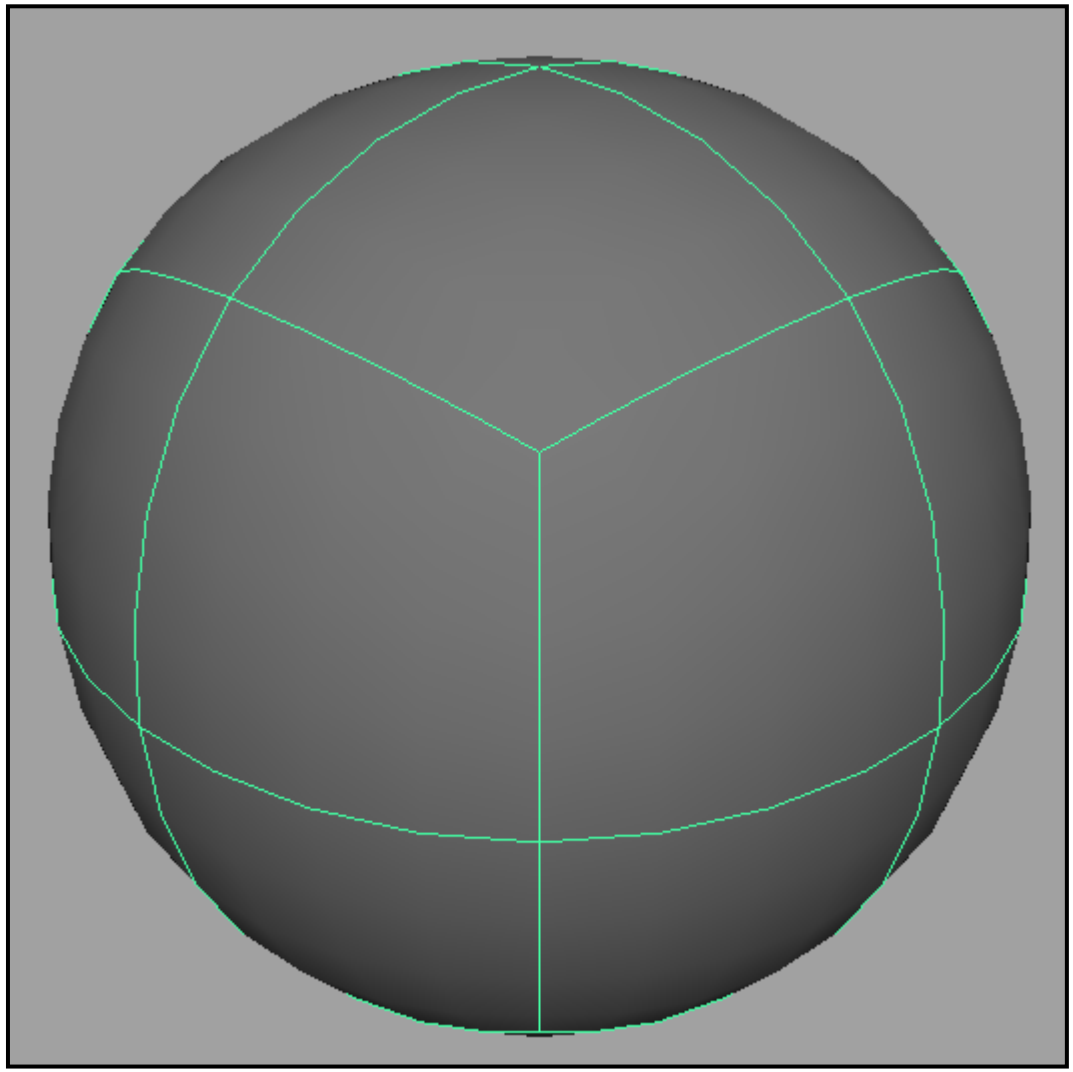
parametric surfaces - joining

- not easy to model arbitrary shapes
  - need to join patches





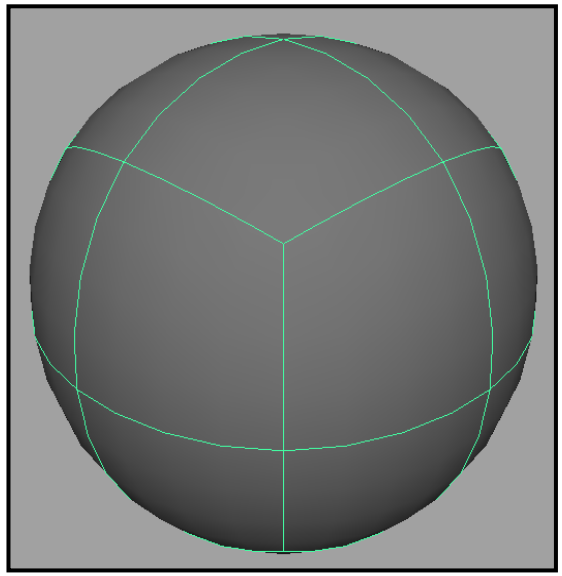
subdivision surfaces



subdivision surfaces

- "smooth polygon meshes"
  - rules for subdividing surface

- smooth
- easier to model complex shapes



subdivision surfaces

[© Pixar/Disney]

subdivision surfaces

- start with a polygon mesh
- apply subdivision rule
  - different types exists
- converge to continuo limit surface