

Geometric Modelling



Lecture 14

Geometric Modelling

- Most computer modelling/animation packages are based on some form of geometric modelling.
- Their purpose is to create and animate 2D and 3D shapes (generally surfaces).
- The often complex surfaces generated using such packages are typically constructed from simpler geometric primitives.

Geometric Modelling

- Geometric Modelling can be useful in scientific visualisation:
 - Concept Modelling
 - Sophisticated Data Visualisation

Concept Modelling

- Construction of a visualisation based on an “artist’s impression”.
- This is a valid form of visualisation when
 - abstract concepts need to be explained
 - subject material cannot be sampled/digitized
 - subject material needs to be simplified
- For example, a visualisation of how antibodies attack antigens.

Sophisticated Data Visualisation

- The animation and rendering facilities provided in modelling packages are generally far superior to those in pure scientific visualisation packages.
- If scientific data can be imported into a modelling package then broadcast quality animations can be more easily produced.

Modelling Primitives

- Most modelling packages provide a set of primitive object types to use in constructing more complex surfaces.
- Primitives include:

point
lines
polylines
polygons
splines / nurbs

rectangular prisms
ellipsoids
meshes
surface patches

Mathematical Surfaces

- Some modelling systems support exact mathematical surface models and can output them accurate to device resolution.
- In these cases circles, ellipsoids and surfaces may be defined exactly by equations, rather than approximated by polygons and meshes.

Constructing Surfaces

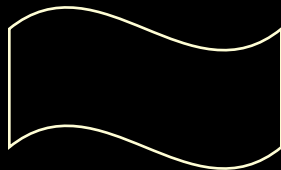
- 3D primitives may be joined together using various techniques to produce more complex surfaces.
- If these simple compound objects are not sophisticated enough, surface patches (polynomial surfaces) may be fitted to the simpler skeleton producing a smoother surface.

Extrusion / Skinning

- A common and powerful technique is extrusion. This takes two objects, a shape and a path and replicates the shape along the path.

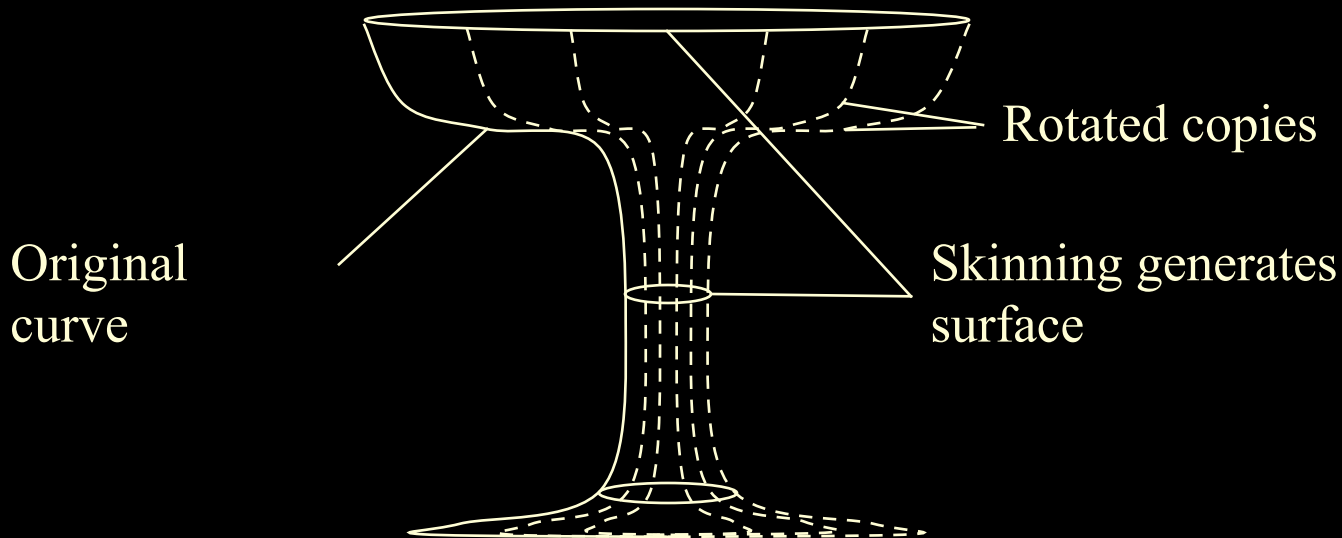
A line extruded along a curved path => surface

A rectangle extruded in Z => box



Rotate / Skinning

Copy/rotate/skin are simple but powerful techniques.
Here a glass is generated by rotating a profile



Particle Systems

- High-end geometric modelling / animation products may also include particle systems.
- These modules perform particle dynamics calculations.
- Points may be assigned masses and forces (wind, gravity, turbulence) affect the particles.

Particle Systems...

- Particle systems can be used to calculate the points on a mesh to simulate a flag waving in a breeze.
- They can calculate the trajectories of objects in force fields.
- Note that although the simulations are quite sophisticated they may have approximations which make them unsuitable for use as a scientific analysis

A Comparison of Packages

- Commercial geometric modelling packages tend to be very expensive. Suites which include inverse kinematics and particles systems can cost in excess of \$100,000
- Some of the main packages are:
 - Alias / Wavefront
 - Softimage
 - Houdini (Prisms)

A Comparison of Packages...

- No single package has the best of everything. Most animation houses have more than one suite. One package may have a better modelling environment whilst another has a better animation toolset.
- Vislab standardized on Houdini for several reasons.
 - Data flow / paradigm
 - Data import / export abilities

Most Modelling Packages...

- are set up like an image editor in that one performs a series of operations to produce a final image
- have an undo buffer to permit undoing tasks, but it is generally not possible to undo just one operation at some point in the history buffer
- have limited data import / export abilities
- are artist friendly and scientist unfriendly

Houdini

- Houdini constructs surfaces by building a network of operations (much like AVS 5)
- It is therefore simple to remove/alter an earlier step
- Houdini has extensive data import / export options making it easy to handle scientific data.
- Houdini is logical user friendly (artist unfriendly ?)

Houdini...

- Houdini provides a comprehensive set of rendering techniques including ray tracing.
- A set of image compositing operations
- A texture mapping subsystem
- A particle animation system
- more...