Introduction to Computer Animation

Lecture 7

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Building Models

- ☐ Surface modelling
  - ■ hollow models - most common
- ☐ Solid modelling
  - ■ solid models - used in some engineering applications for modelling objects with mass, inertia, etc...
- ☐ Particle-system modelling
  - ■ Smoke, fog, rocket exhaust, etc...

Polygonal Modelling

- ☐ Computers use numbers
  - ■ (they work best with things that are quantifiable)
- ☐ 3D modelling programs are based on geometry
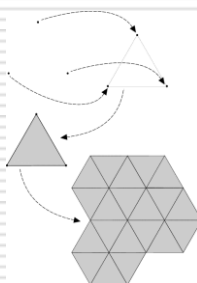 - ■ (the mathematical study of shapes)

Points, Lines, and Planes

- ☐ Point
  - ■ zero-dimensional
- ☐ Line
  - ■ one-dimensional
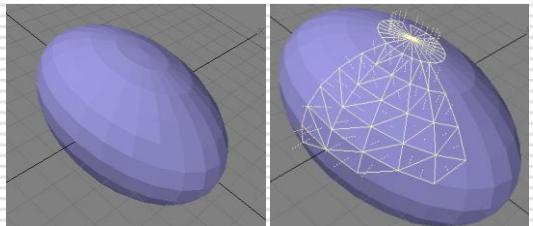- ☐ Plane
  - ■ two-dimensional
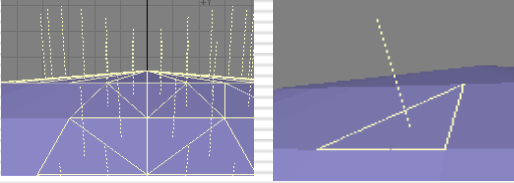

Point

Line
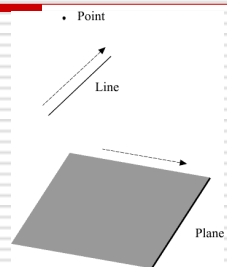
Plane

Vertices

- ☐ Points in space defining a figure such as a triangle are called vertices
  - ■ singular 'vertex'
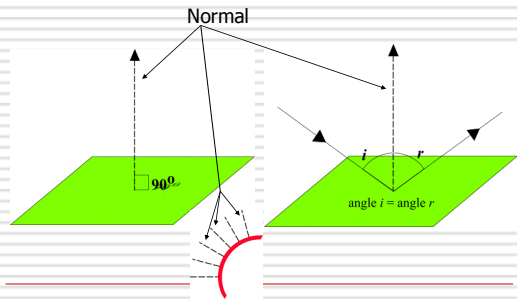- ☐ Build objects from the planes
- ☐ Three points best

Polygonal Modelling
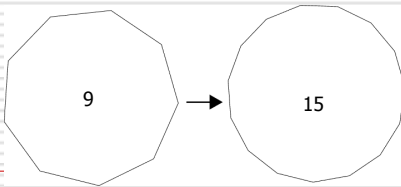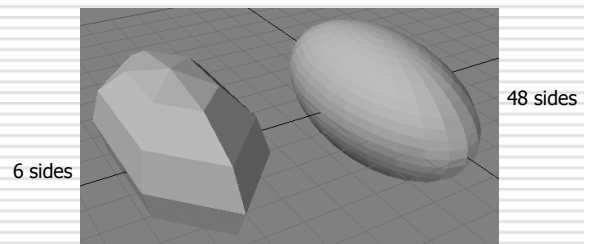
Normals (1)

Normals (2)

Polygonal Approximation (1)

- ☐ Polygons never give a true curve
- ☐ …But, a curve can be approximated by increasing the number of polygons


Polygon Approximation (2)

48 sides

6 sides

Polygonal Approximation (3)

- ☐ Disadvantages
  - ■ Close scrutiny will reveal the polygons!
  - ■ Polygon count
    - ☐ more polygons = more complex model
    - ☐ more polygons = more processing time
  - ■ Makes real-time interaction difficult
- ☐ Solution
  - ■ Polygon reduction

Polygon reduction

- ☐ Specify a maximum polygon count
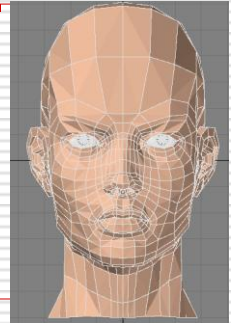- ☐ Specify the minimum angle between polygons
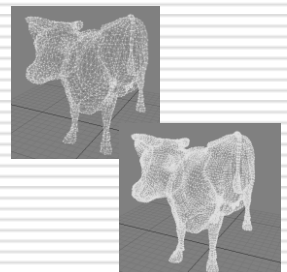
Adding Polygons

- Polygon expansion
  - Opposite of polygon reduction
  - Increases the number of polygons
- Polygon rounding
  - Rounds edges by adding polygons

Local Polygon Operations

- Added detail in key areas
- Removal of polygons from areas of low detail/hidden areas
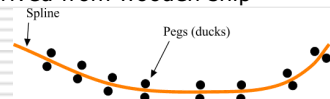- Vertex/Edge insertion
- Vertex/Edge deletion

Lines and Curves

- Curves
  - Appear more natural
  - Regarded as a basic geometric building block
  - 2 or 3 dimensional
- Linear approximation (polyline)

Splines

- Splines
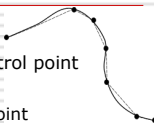 - Term derived from wooden ship building

  - Control points control line curvature.
 - Cubic

Types of Spline (1)

- Interpolating splines
  - Spline passes through each control point
  - Cardinal spline
    - Passes through each control point except last one and first one
  - Advantages:
    - high degree of control over line placement
  - Disadvantages
    - can result in irregularities in the line

Types of Spline (2)

- Approximating splines
  - Curve goes near but not through control points
  - B-spline
    - similar to the cardinal spline - line passes all control points except first and last.
  - Bézier spline
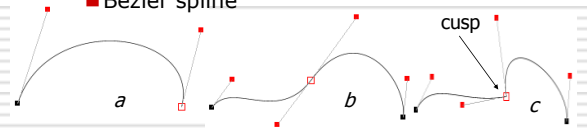
NURBS

- Non-Uniform Rational B-Splines
  - Control points (off the line)
  - Edit points - also called 'knots' (on the line)
- Very flexible
  - Use control points for a smoother curve
  - Use edit points for greater accuracy
 - Combines the best features of Interpolating and Approximating splines

Last Word About Splines

- Splines are 'Parameterised'
  - Splines have a mathematical definition
  - Splines have a specific direction
    - directions can be reversed
    - allows points to be placed accurately on the line
  - Spline curves are also known as parameterised curves

Spline Patches

U

- Curves are easy to create
- Curves can be used to quickly generate a curved surface
- Original curve = 'U curve'
- second curve = 'V curve'

V

- U curve is moved along the V curve to produce a patch
- Control of the patch depends on the type of spline used to create it
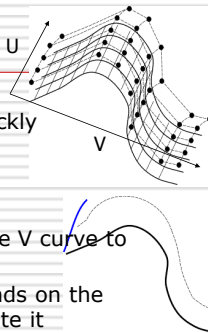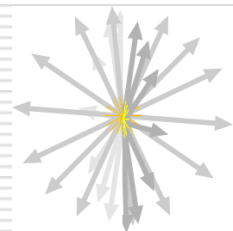
Lights

- Location & direction
  - XYZ & HPB
- Intensity
  - Brightness
- Colour
  - RGB triplet

Types of light

- Point light
- Spot light
- Ambient light
- Infinite or directional light
  - also called distant, global or parallel light
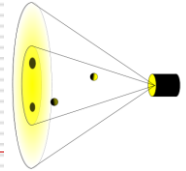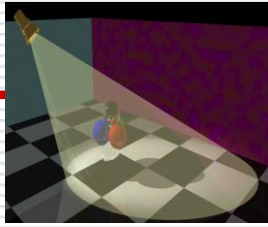- Volume light
- Projector light

Point Light

- Similar to a bare light bulb
  - Omni-directional
- parameters
  - Decay (or falloff)
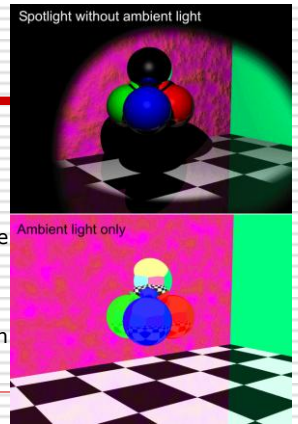- Only apparent through it's illumination of objects in the scene

Spotlight

- Direction
- Spread
  - cone of light
- Dropoff

Ambient Light

Spotlight without ambient light

- Simulates daylight
- Only has intensity and colour parameters
- Directionless nature has some unusual properties
- Used to simulate lighting effects such as twilight.

Ambient light only

Directional or Infinite Light

- Has direction
  - but same direction no matter what position is in the scene.
- Radiates equal amount of light irrespective of distance
- Simulates sunlight
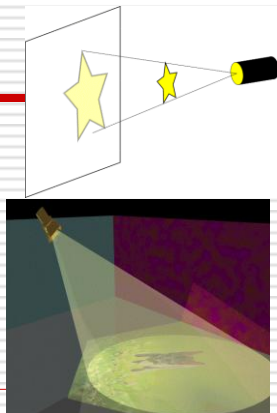 - Called a 'Sun' light in some applications

Here...   ...or here
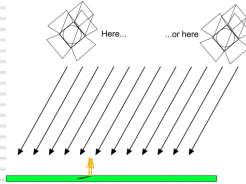
Volume Light

- Specialised form of lighting
- Illuminates a specific volume
  - Sphere, cone, cube, etc…
- Normally radiates from the centre of the volume in all directions
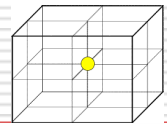
Projector Light

- Projects light through a specified flat image onto a screen like a magic lantern

Other types of light

- Linear
- Area
- Photometric
- Dome
- Various others depending on the application

Today

- Introduction to animation in 3D
  - Lights, Cameras, Rendering
- More modelling