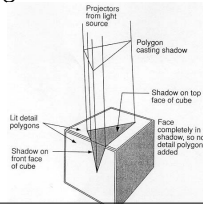# Surface Detail

- extra polygons associate with a "base" polygon
  - doors, window details, etc
  - different color, surface properties
- not compared during visible surface determination
- they have precedence over base polygon
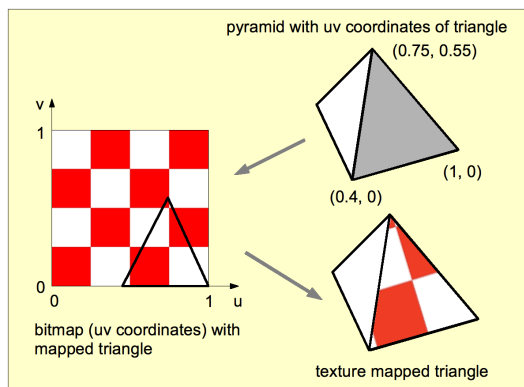

Texture Mapping

- a way of increasing visual complexity without increasing geometric complexity

- add fine detail to object

- map image, called a *texture map*, onto surface (like wallpaper)
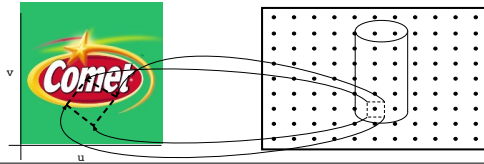
- scanned in, synthesized

Catmull, 1974

Texture Mapping

Texture Mapping

- assign a texture coordinate at each vertex
- texture coordinates do not get transformed
- interpolated during rasterization
- fragment shader has texture coords
- uses texture coordinates to look up into texture map, and assign surface color
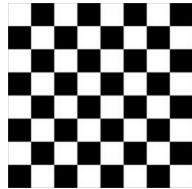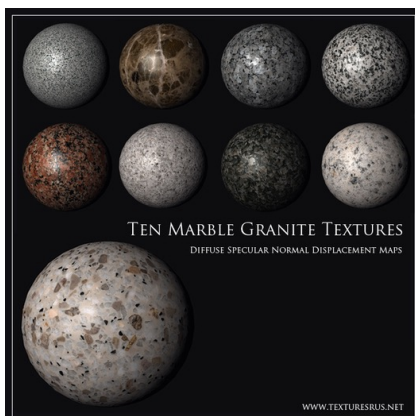
Texture Map Sources

- scanned in

- synthesized
  - painted
  - rendered

You can buy textures!

Ten Marble Granite Textures
Diffuse Specular Normal Displacement Maps

WWW.TEXTURESRUS.NET

Texture Mapping

- if object bigger than texture map, texture can repeat

© 1983 COOK, R.—LUCASFILM LTD.

Texture Mapping

- Texture maps can modify more than just colour

- transparency (alpha)

- specularity

- any lighting property

- all of the above
  (multiple textures)

CROW, F.—C.G.R.G. O.S.U.

Bump Mapping

- texture maps can perturb surface normal
- illusion of bumps

Blinn, 1978

COLLERY, M.—CRANSTON—CSURI PROD.

Texture Mapping Examples

© 1985 J. BLOOMENTHAL — XEROX CORP.

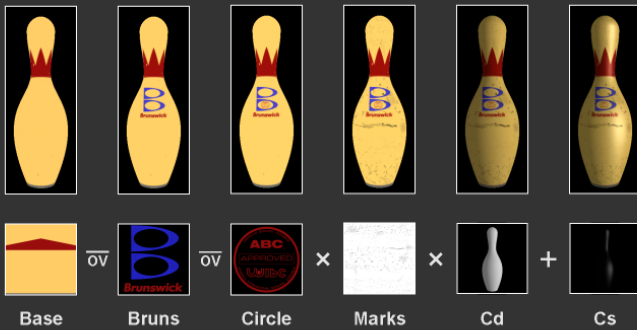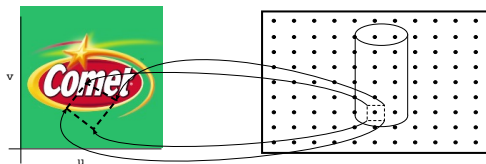## Multipass Rendering

```
// bowling pin, based on RenderMan example
(CIRCLE over (BRUNS over BASE)) * MARKS * Cd + Cs
```


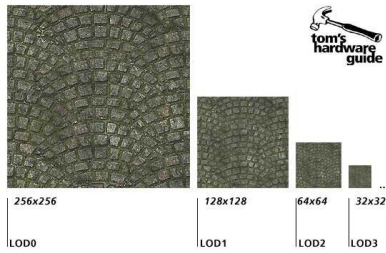| Base | Bruns | Circle | Marks | Cd | Cs |

Problems with Texture

- small objects ->
  integrate over large number of texels

MIP Maps
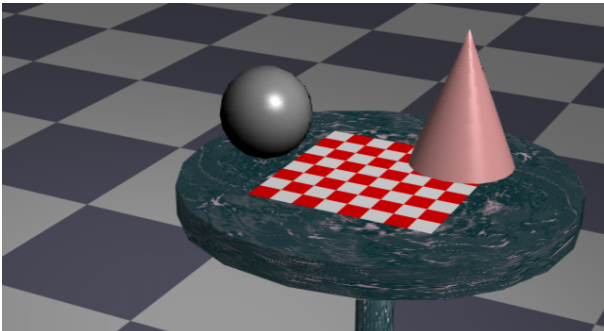
256x256
LOD0

128x128
LOD1

64x64
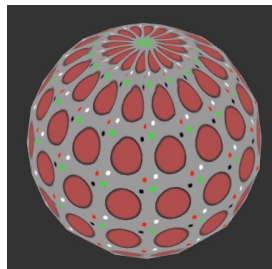LOD2

32x32
LOD3

...

Williams, 1983

Problems with Texture

- texture at edges may not match

Problems with Texture
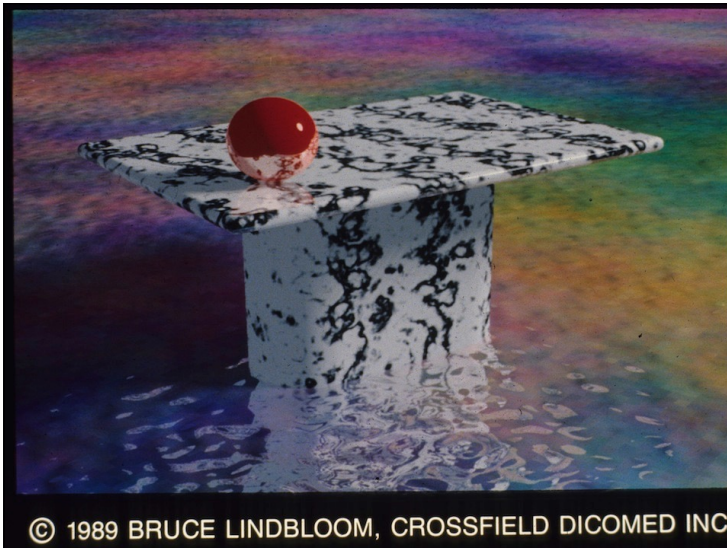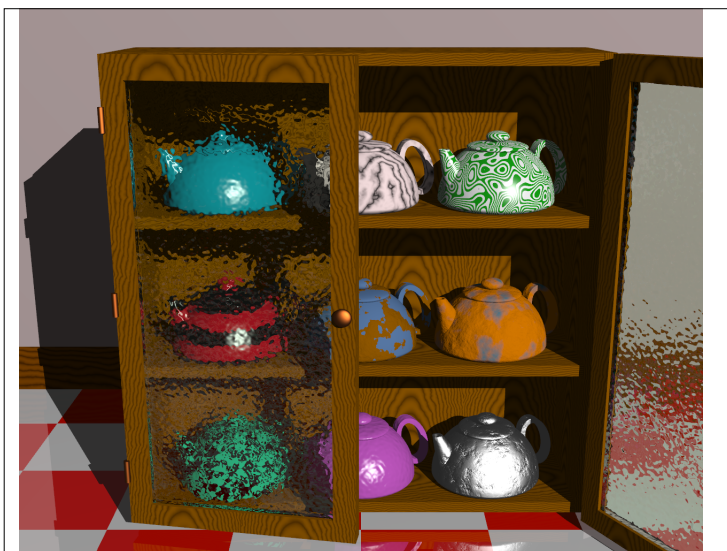
- textures can distort

Solid Textures

- with complicated, curved 3D objects want a 3D texture to make sure textures match

- it needs lots of memory

- solution: procedural texture

- $f(x, y, z)$ evaluated by fragment shader

- as if you "carve" object out of solid texture

Perlin, 1985

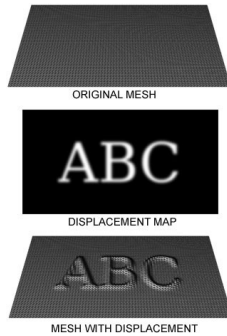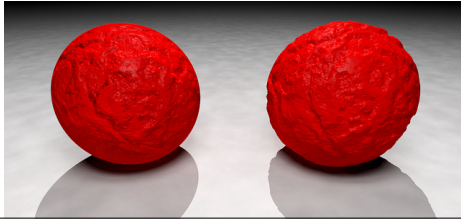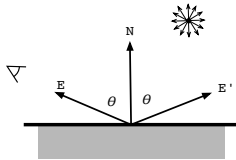© 1989 BRUCE LINDBLOOM, CROSSFIELD DICOMED INC.

Displacement Maps

- use 2-D texture value and surface normal to displace surface
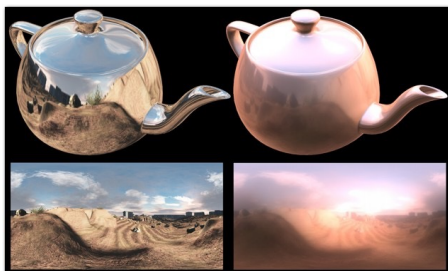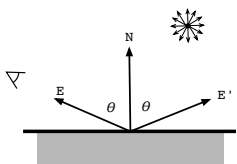- must be done before surface is broken down into polygons

ORIGINAL MESH

ABC

DISPLACEMENT MAP

ABC

MESH WITH DISPLACEMENT

Environment Maps
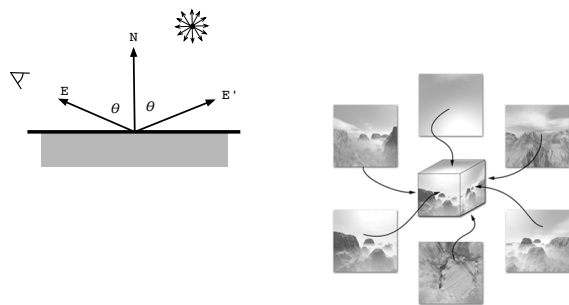
- a cheap way to do reflections

Blinn, Newell 1976

Environment Maps

Environment Maps

Environment Maps