CS380: Computer Graphics

Applications of Texture Mapping

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Class Objectives (Ch. 9)

- **Various applications of texture mapping**
  - **Add details to scenes**

- **At the last class:**
  - **Texture mapping overview**
  - **Texture filtering for undersampling and oversampling**

Questions

- (I've heard that it can take days to render very close-to-reality CG graphics which uses illumination technology. However, when we look at current 3D games, we can know that games can render relatively close-to-reality graphics within a fraction of second.
- I thought that part of what makes this difference is the use of global and local illumination … How much do we typically have to give up in terms of things like global illumination in order for graphics to continue to render and appear on screen in near real time?)

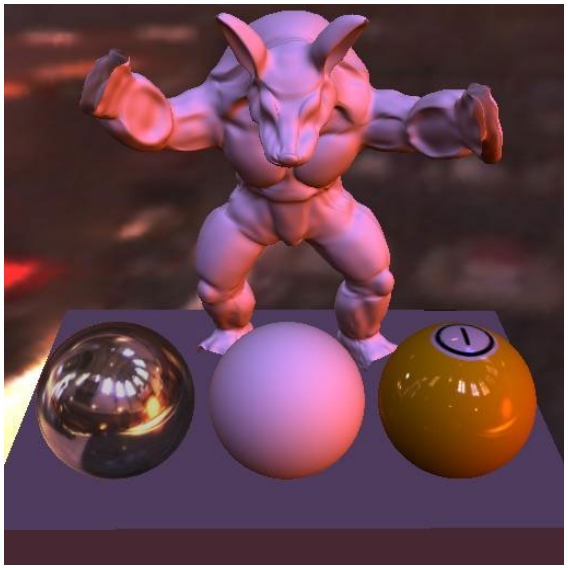
Uses of Texture Maps

- **Texture maps are used to add complexity to a scene**
  - **Easier to paint or capture an image than geometry**
- **Model light**
- **Model geometry, etc**

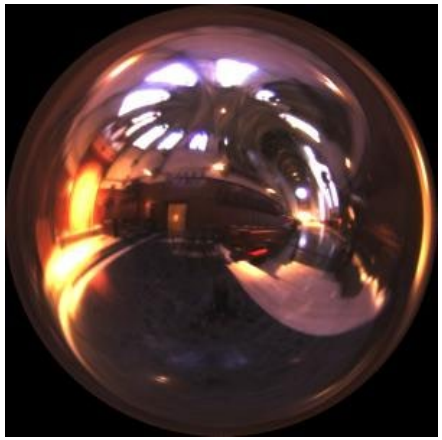
One of key techniques to overcome various problems of rasterization techniques!

Modeling Lighting

- **Light maps**
  - **Supply the lighting directly**
  - **Good for static environments**



- **Environment maps**
  - **A representation of the scene around an object**
  - **Support reflection**



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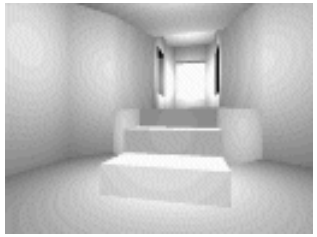
Light Maps in Quake

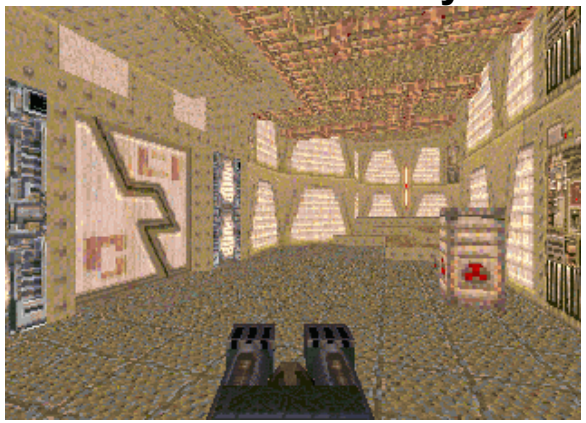
- **Light maps are used to store pre-computed illumination**

	Texture Maps	Light Maps
Data	RGB	Intensity
Resolution	High	Low



Light map image by Nick Chirkov

Textures Only



Textures & Light Maps

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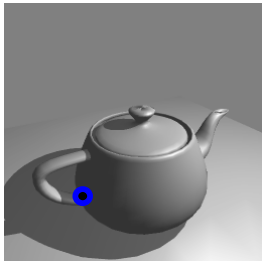
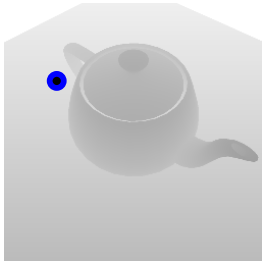
Shadow Maps

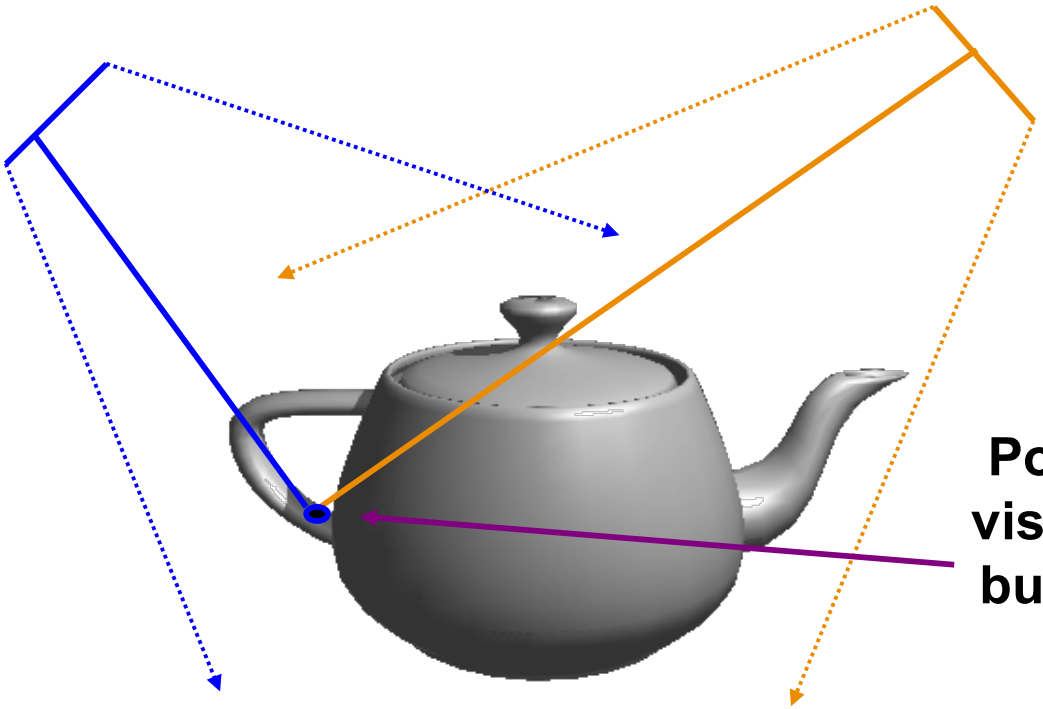


Depth map from eye

Use the depth map in the light view to determine if sample point is visible



Depth map from light



Point in shadow visible to the eye, but not visible to the light

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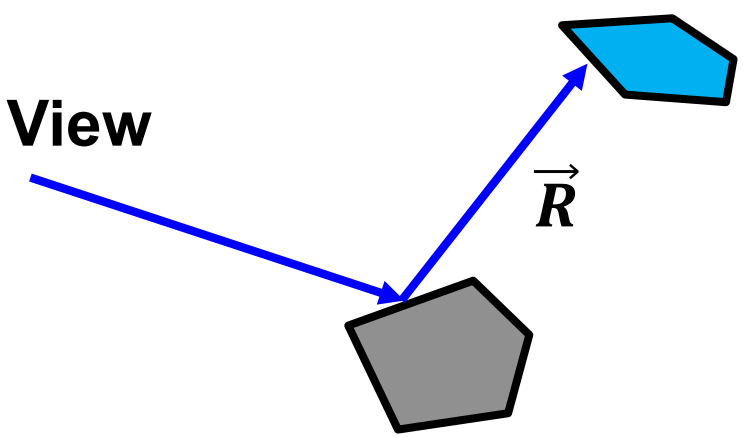
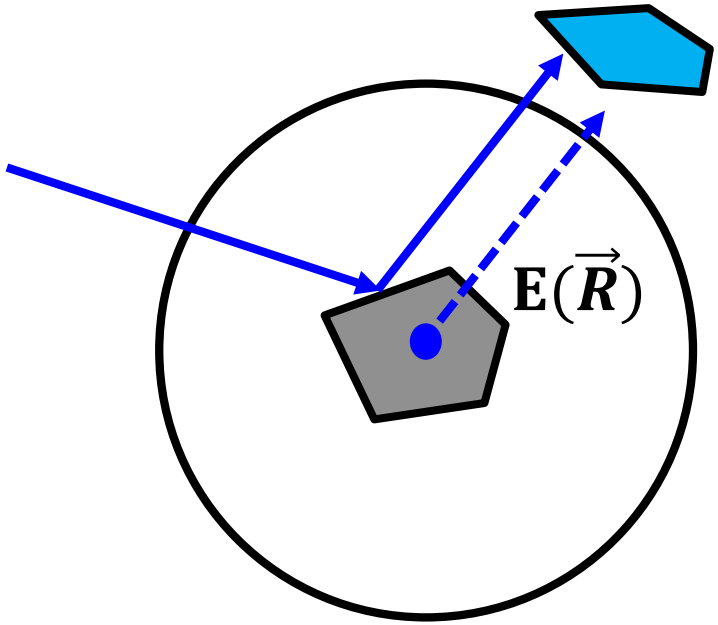
Environment Maps

- **Simulate complex mirror-like objects**
  - **Use textures to capture environment of objects**
  - **Use surface normal to compute texture coordinates**





Spherical env. map

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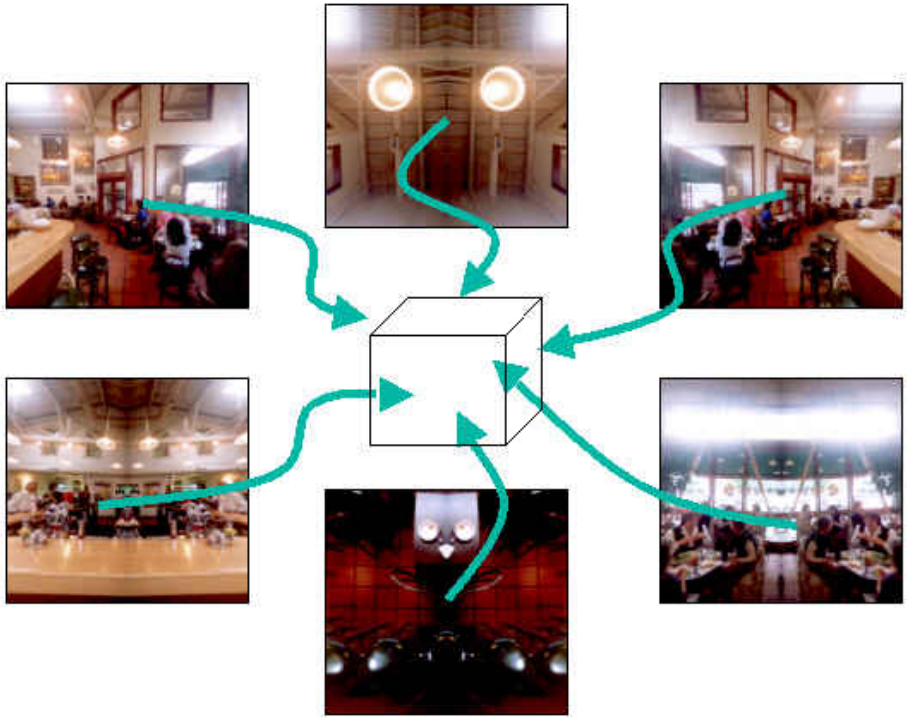
Environment Maps - Example

T1000 in Terminator 2 from Industrial Light and Magic

Cube Maps

- **Maps a viewing direction b and returns an RGB color**
  - **Use stored texture maps**



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Environment Maps - Problems

- **Expensive to update dynamically**
- **Not completely accurate**
  - **One of main reason that Cars (Pixar movie of 2006) used ray tracing**

images from NVIDIA

Reflection of swimming pool is wrong

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Environment Maps - Problems

- **Expensive to update dynamically**
- **Not completely accurate**
  - **One of main reason that Cars (Pixar movie of 2006) used ray tracing**

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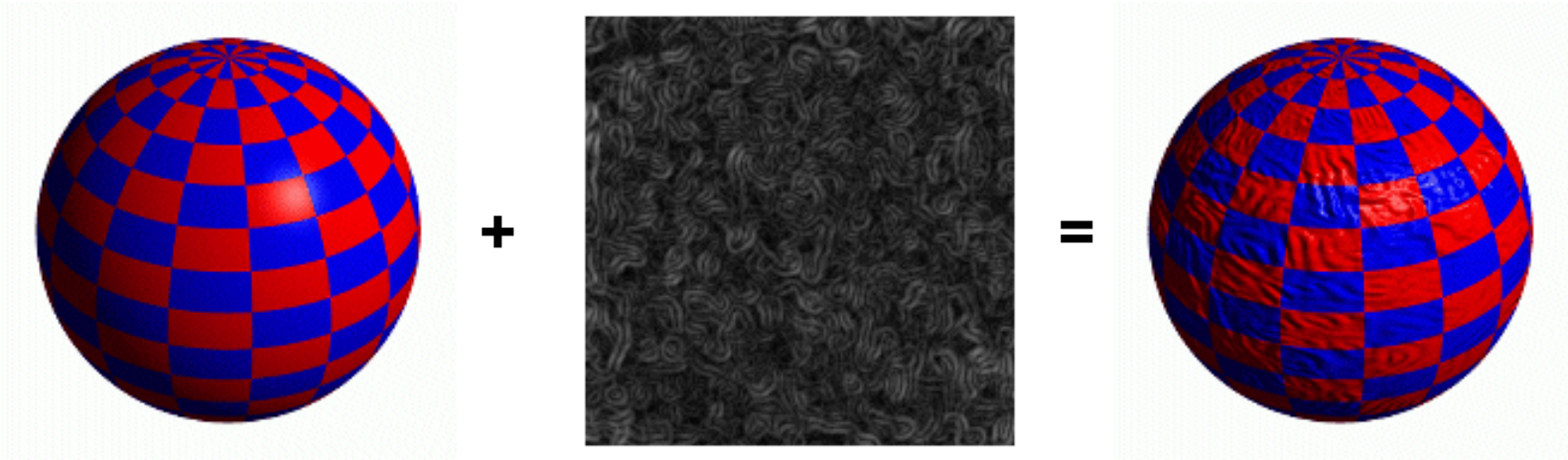
Modeling Geometry

- Store complex surface details in a texture rather than modeling them explicitly
- Bump maps
  - Modify the existing normal
- Normal maps
  - Replace the existing normal
- Displacement maps
  - Modify the geometry
- Opacity maps and billboards
  - Knock-out portions of a polygon using the alpha channel

Bump Mapping

- **Modifies the normal not the actual geometry**
  - **Texture treated as a heightfield**
  - **Partial derivatives used to change the normal**
  - **Causes surface to appear deformed by the heightfield**



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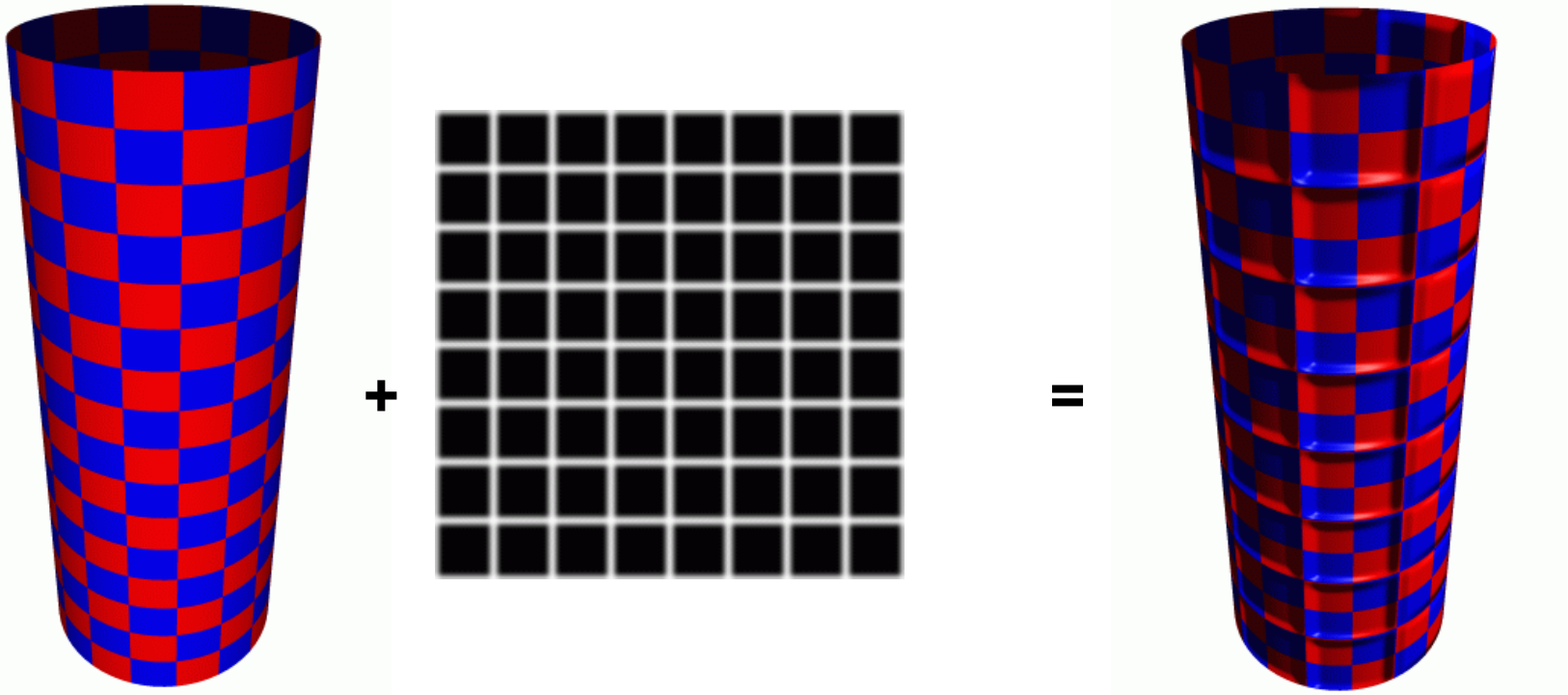
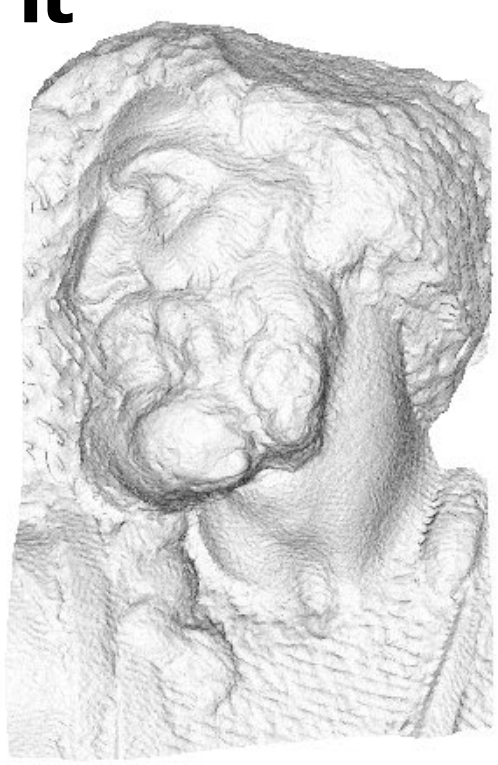
More Bump Map Examples



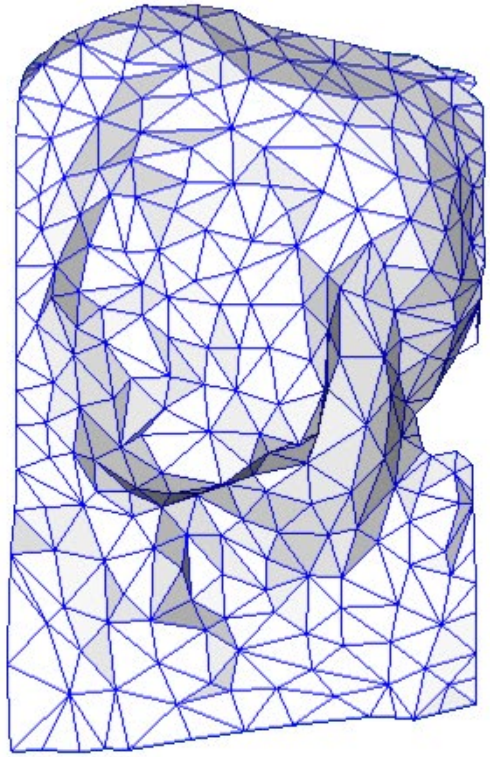
Note that silhouette edge of the object not affected!

Normal Mapping

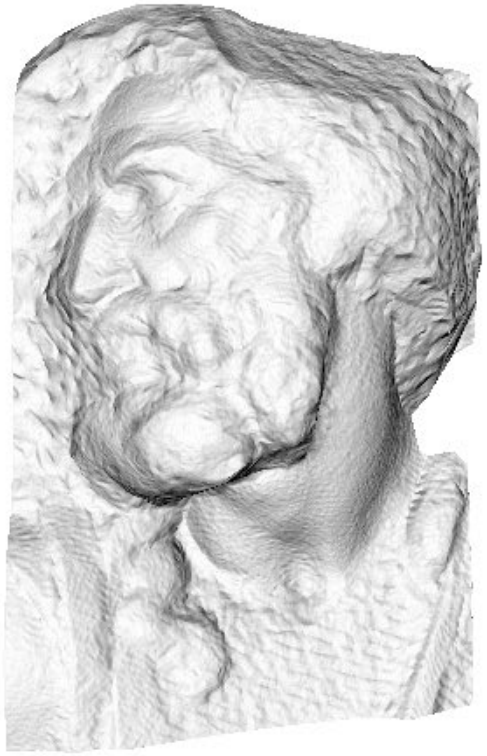
- **Replaces the normal rather than tweaking it**



original mesh
4M triangles



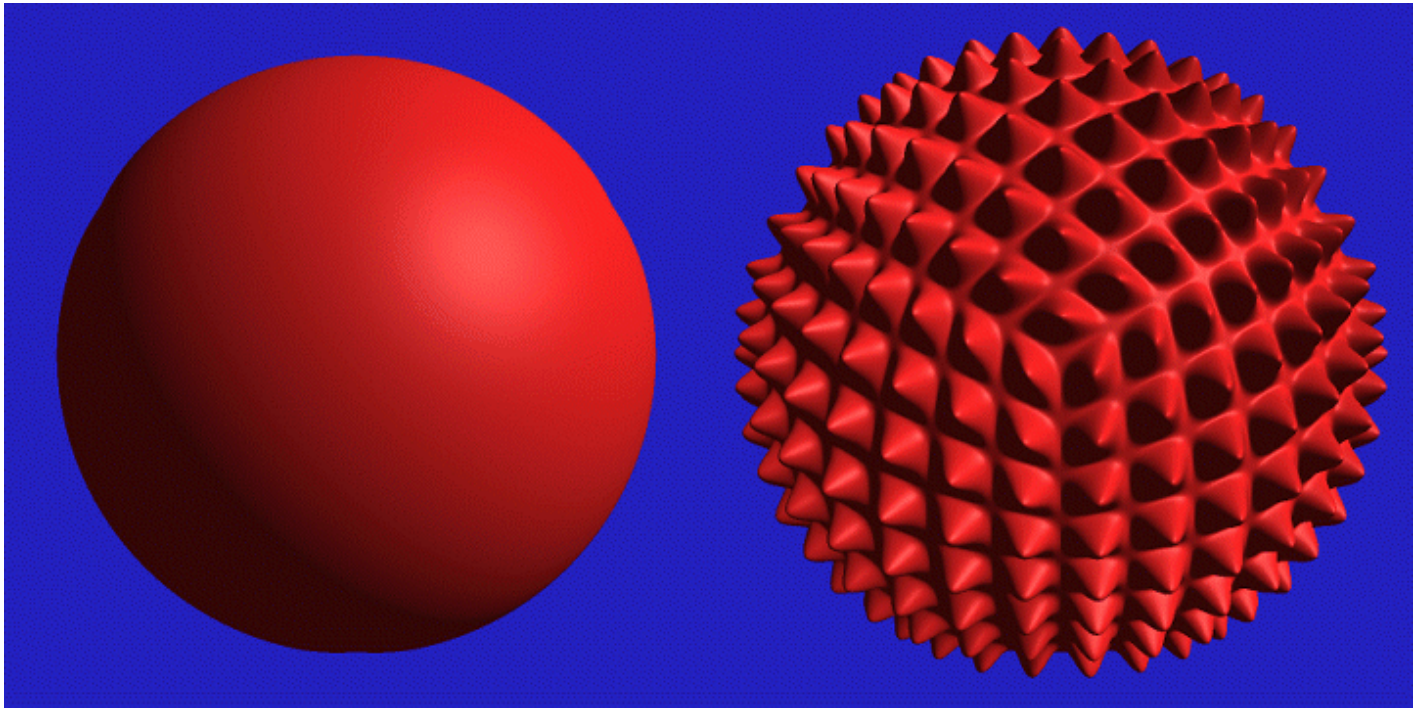
simplified mesh
500 triangles



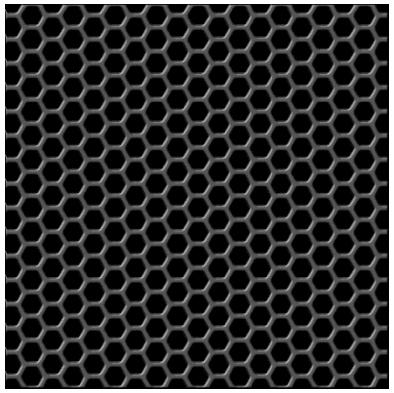
simplified mesh
and normal mapping
500 triangles

Displacement Mapping

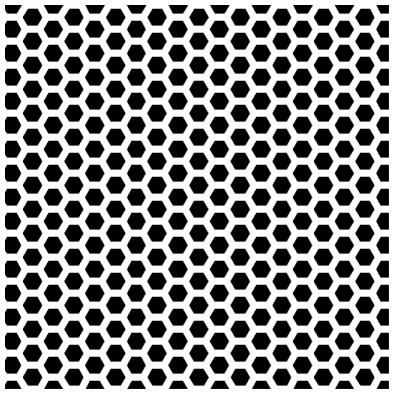
- **Texture maps can be used to actually move surface points**



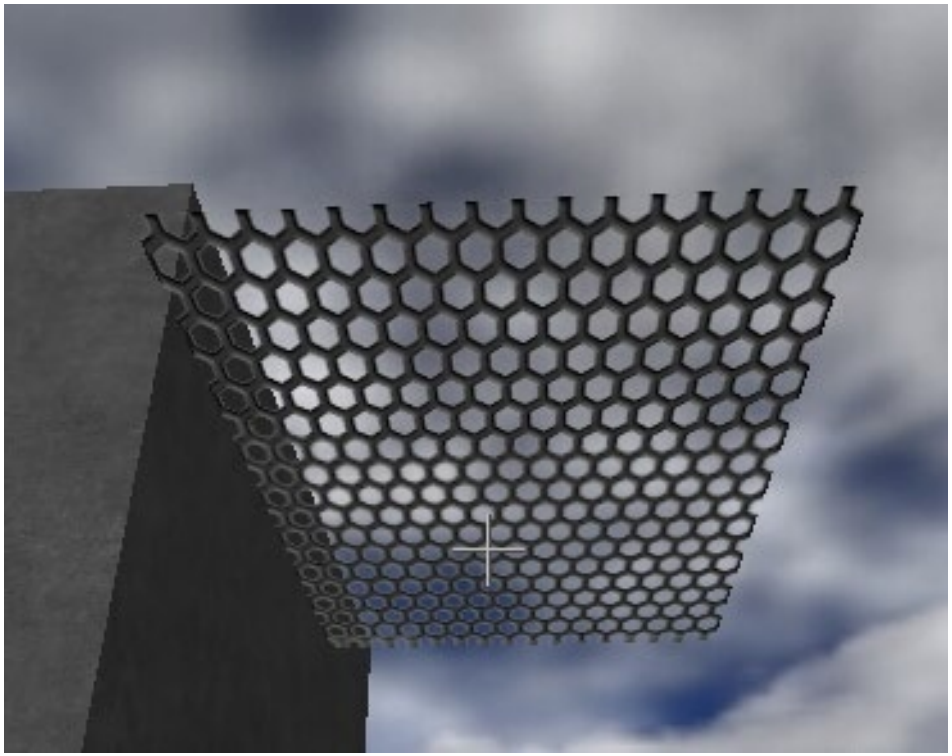
Opacity Maps



RGB channels



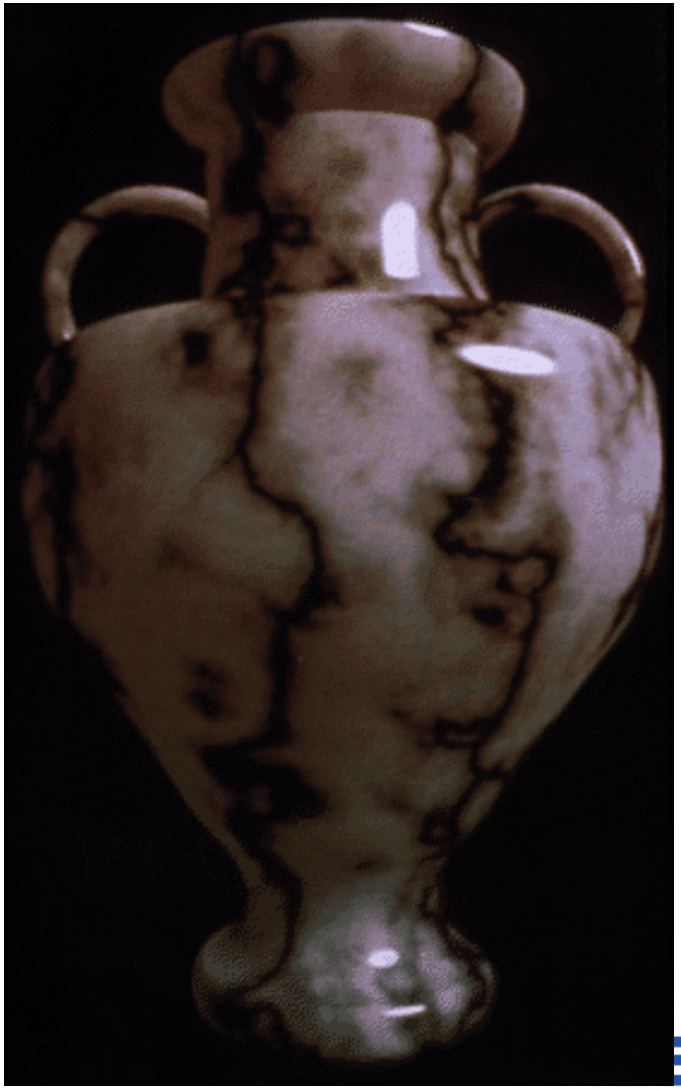
alpha channel



Use the alpha channel to make portions of the texture transparent

3D or Solid Textures

- Solid textures are three dimensional assigning values to points in 3 space
  - Very effective at representing some types of materials such as marble and wood
- Generally, solid textures are defined procedural functions rather than tabularized functions as used in 2D



Class Objectives were:

- Texture mapping overview
- Texture filtering
- Various applications of texture mapping

Next Time

- **Visibility and ray tracing**

Homework

- **Go over the next lecture slides before the class**
- **No more video summary submission**
- **Submit questions two times during the whole semester**