CS-184: Computer Graphics

Lecture #11: Texture and Other Maps

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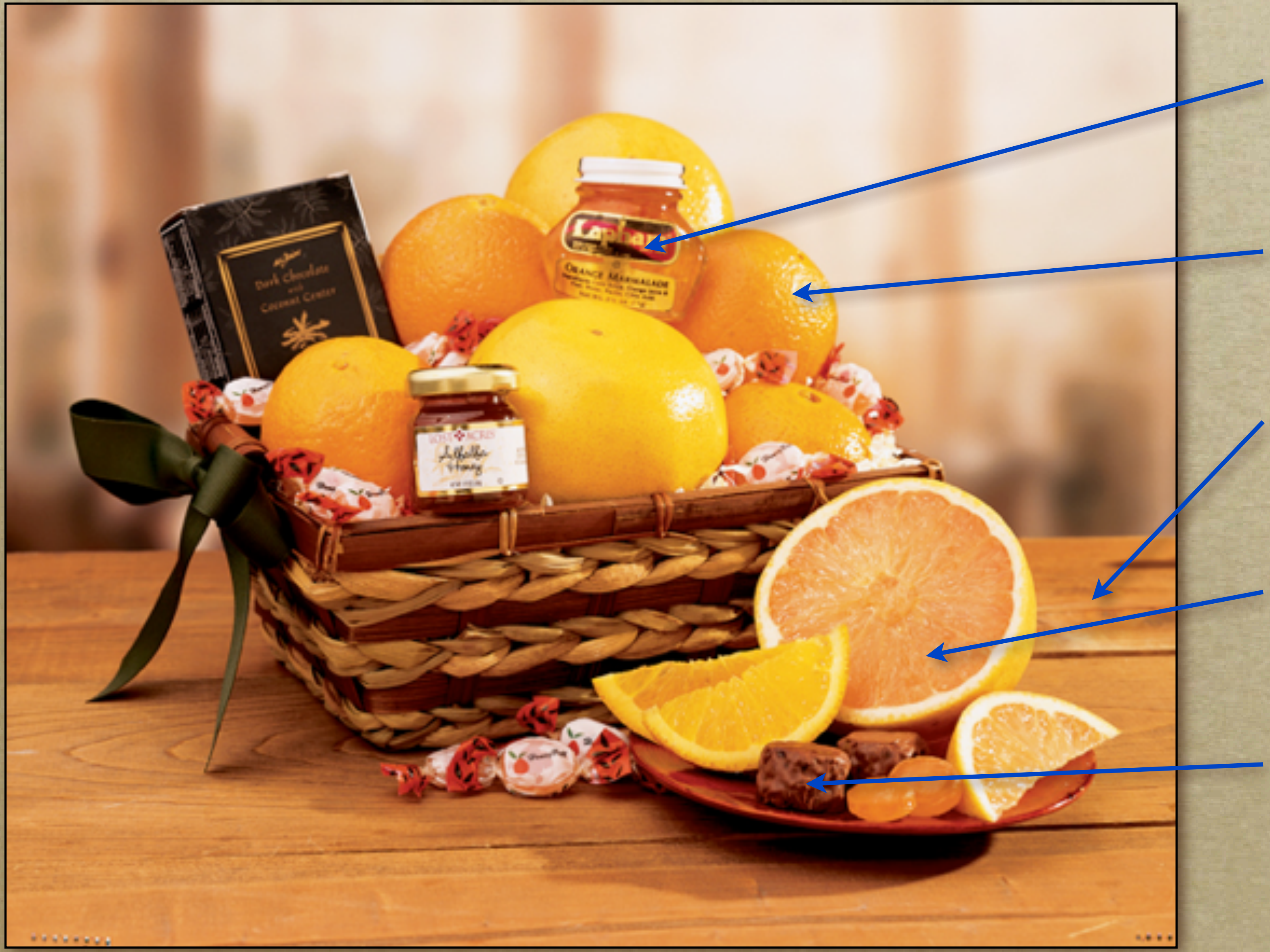
V2008-F-11-1.0

Today

- Texture Mapping
    - 2D
    - 3D
    - Procedural
- Bump and Displacement Maps
- Environment Maps
- Shadow Maps

Surface Detail

- Representing all detail in an image with polygons would be cumbersome



Specific details

Structured noise

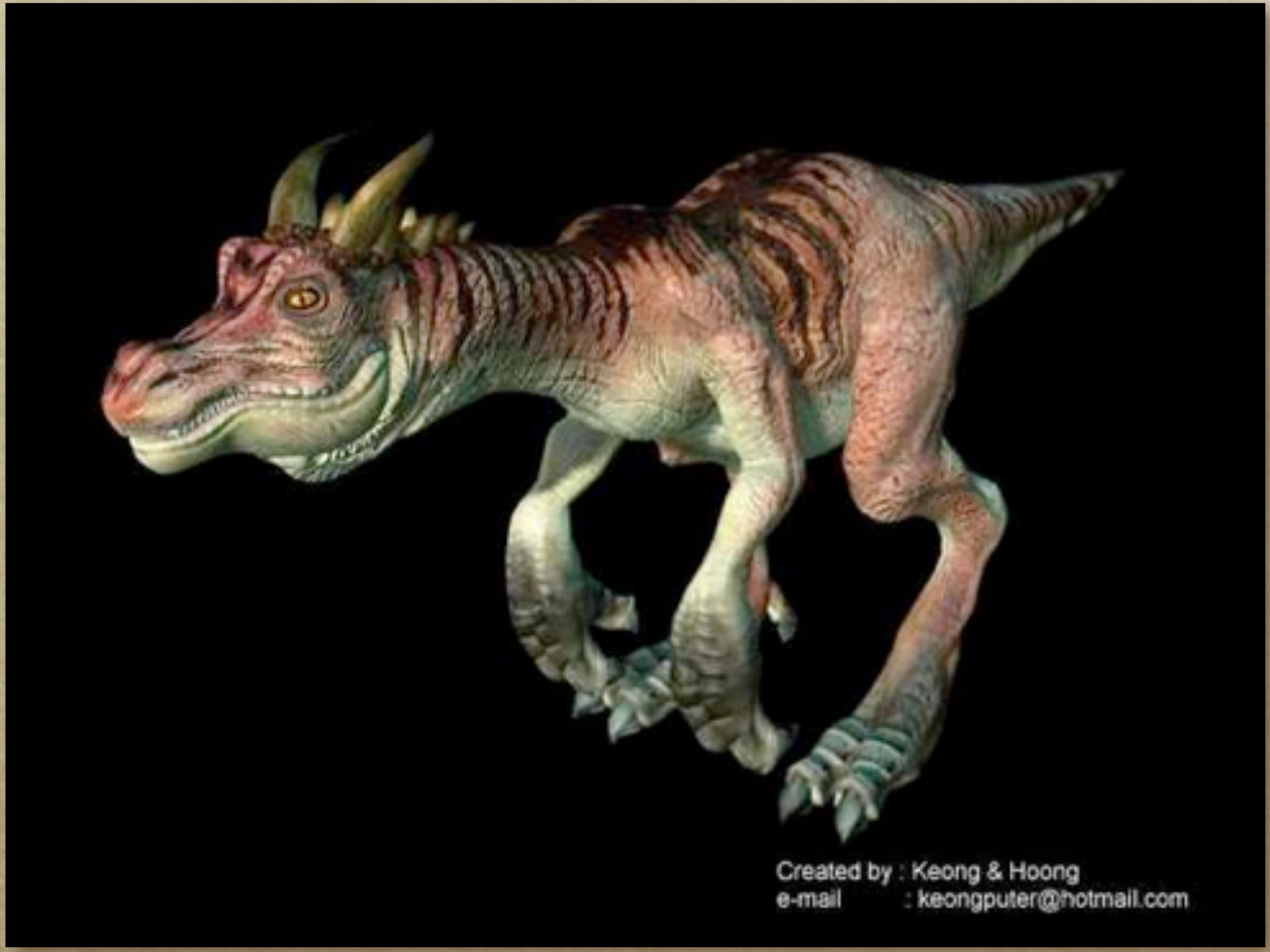
Pattern w/ randomness

Section through volume

Bumps

2D Texture Mapping of Images

- Use a 2D image and map it to the surface of an object



Created by : Keong & Hoong
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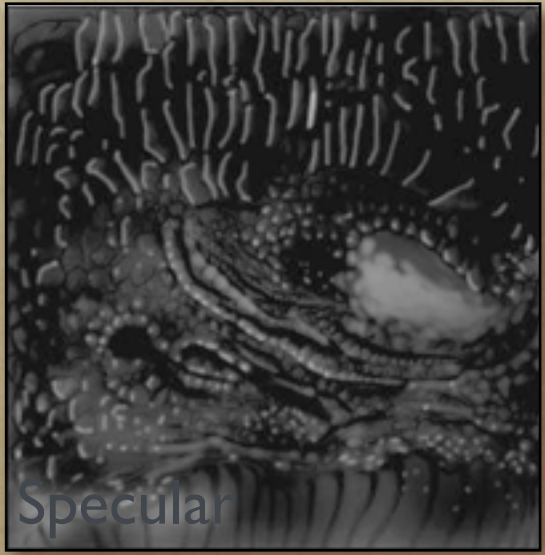
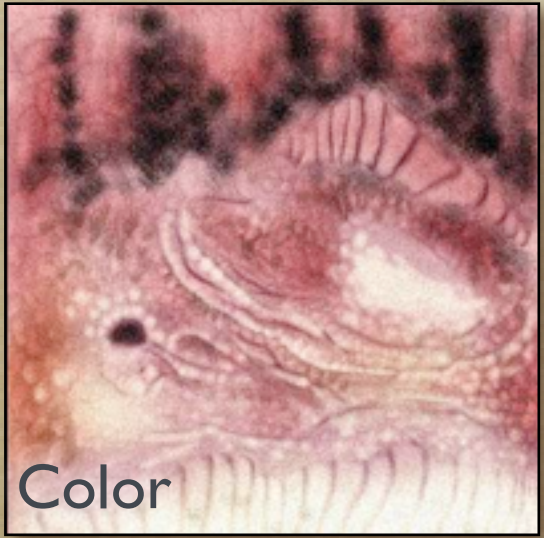
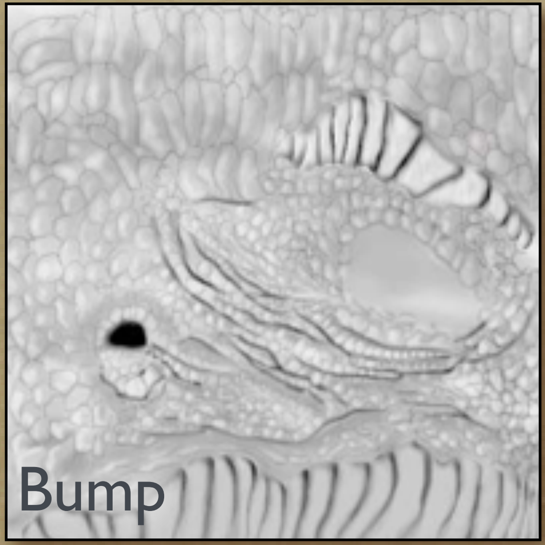
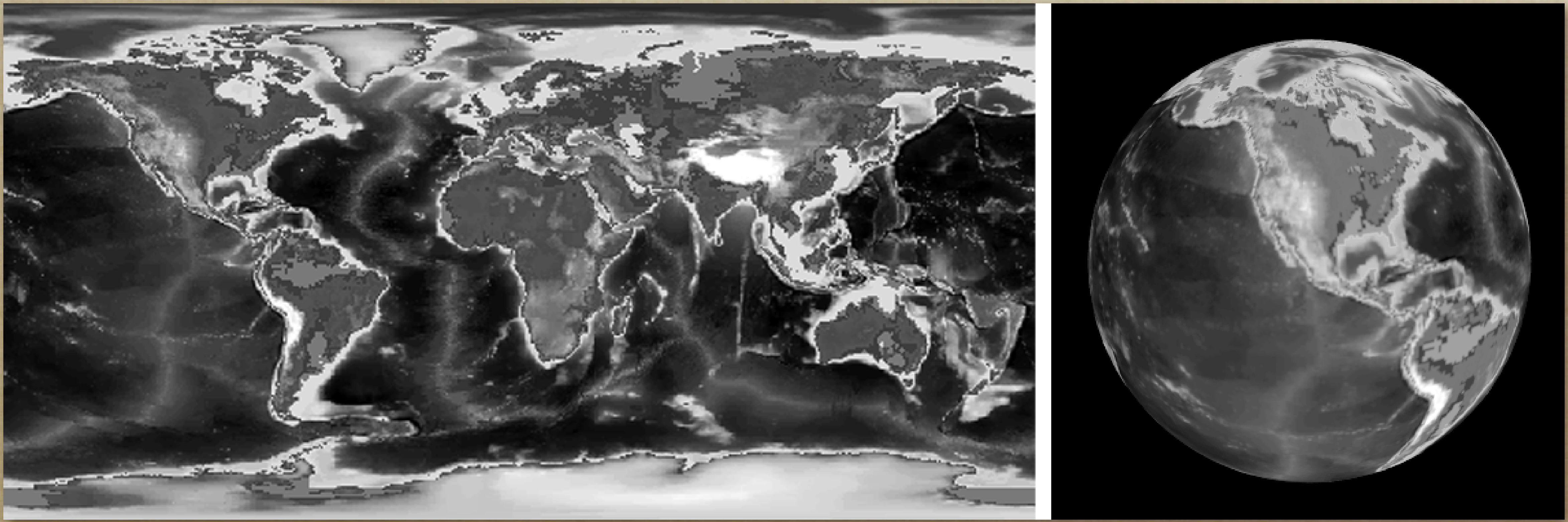






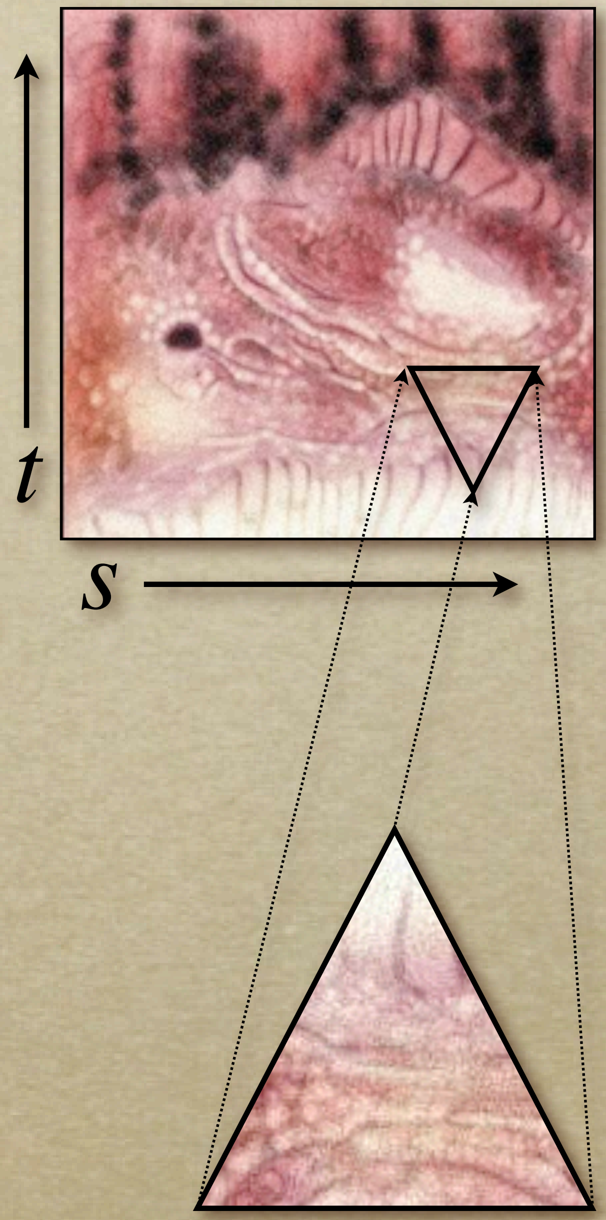
2D Texture Mapping of Images

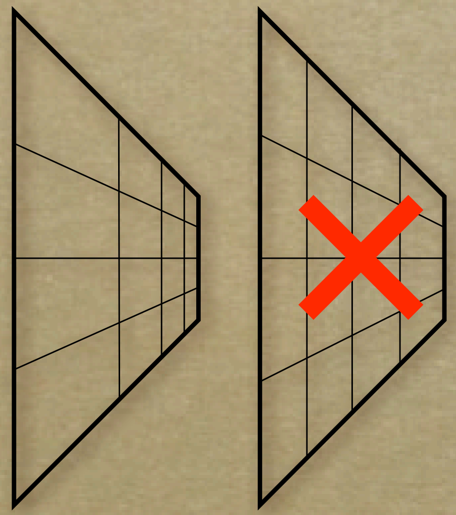
- Example of texture distortion



Texture Coordinates

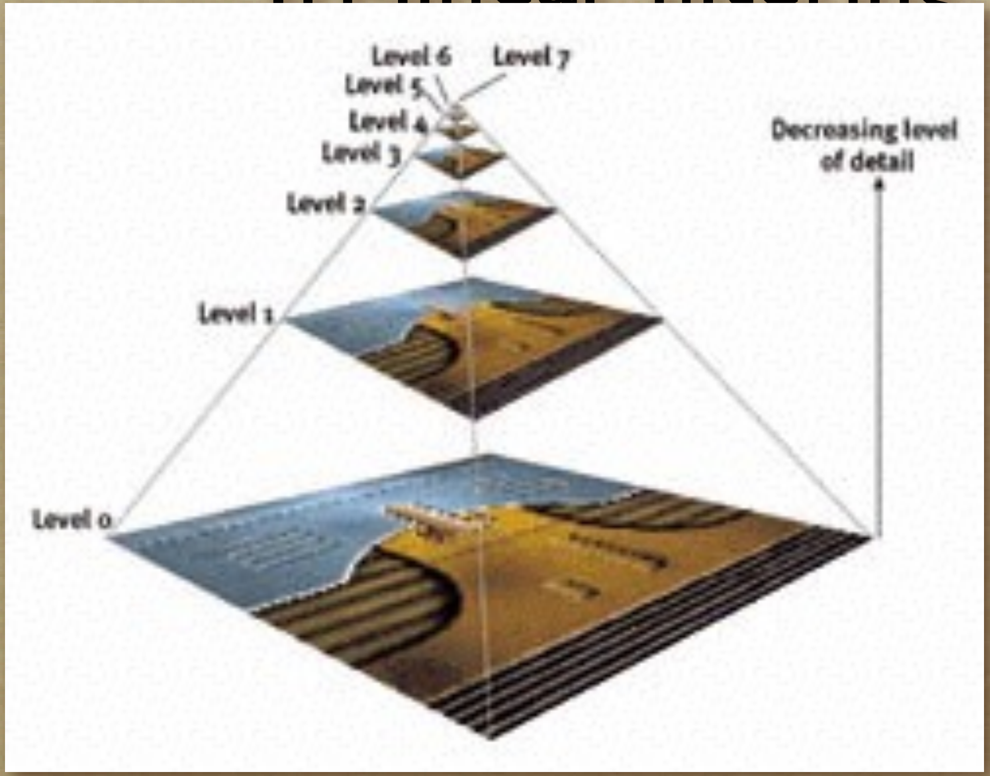
- Assign coordinates to each vertex
- Within each triangle use linear interpolation
- Correct for distortion!

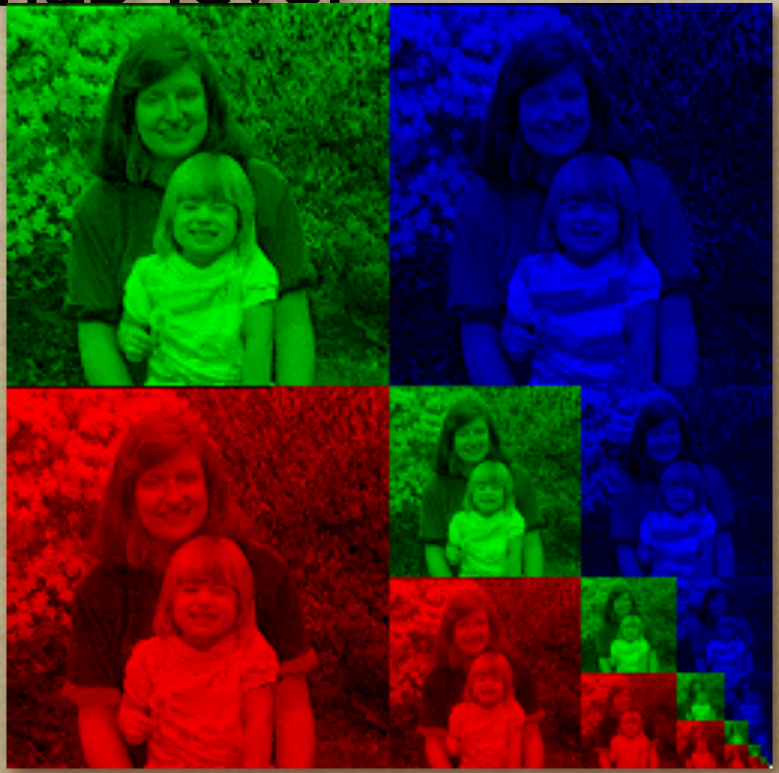




MIP Map

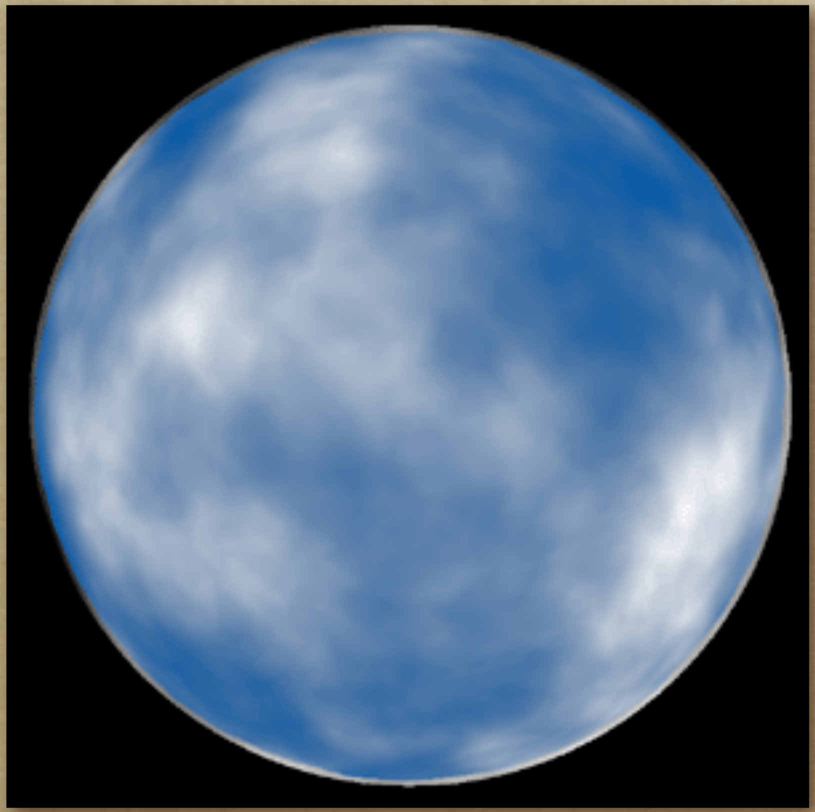
- Pre-compute filtered versions of the texture
  - A given UV rate is some level of the texture
  - Tri-linear filtering UV × map level





Procedural Textures

- Generate texture based on some function
  - Well suited for “random” textures
  - Often modulate some noise function

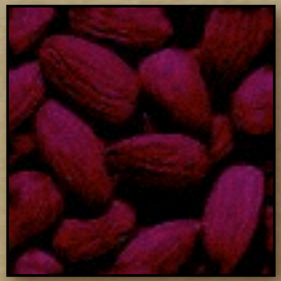


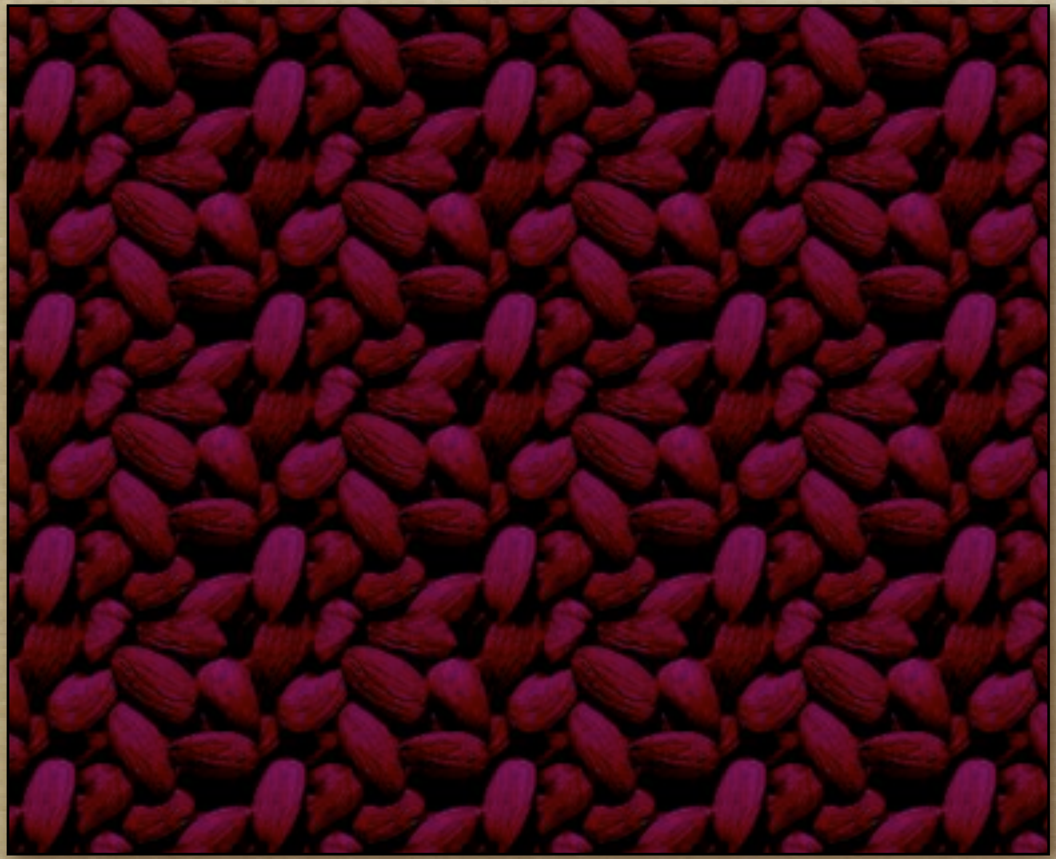
Assigning Texture Coordinates

- Map a simple shape onto object by projection
  - Sphere, cylinder, plane, cube
- Assign by hand
- Use some optimization procedure

Repeating Textures

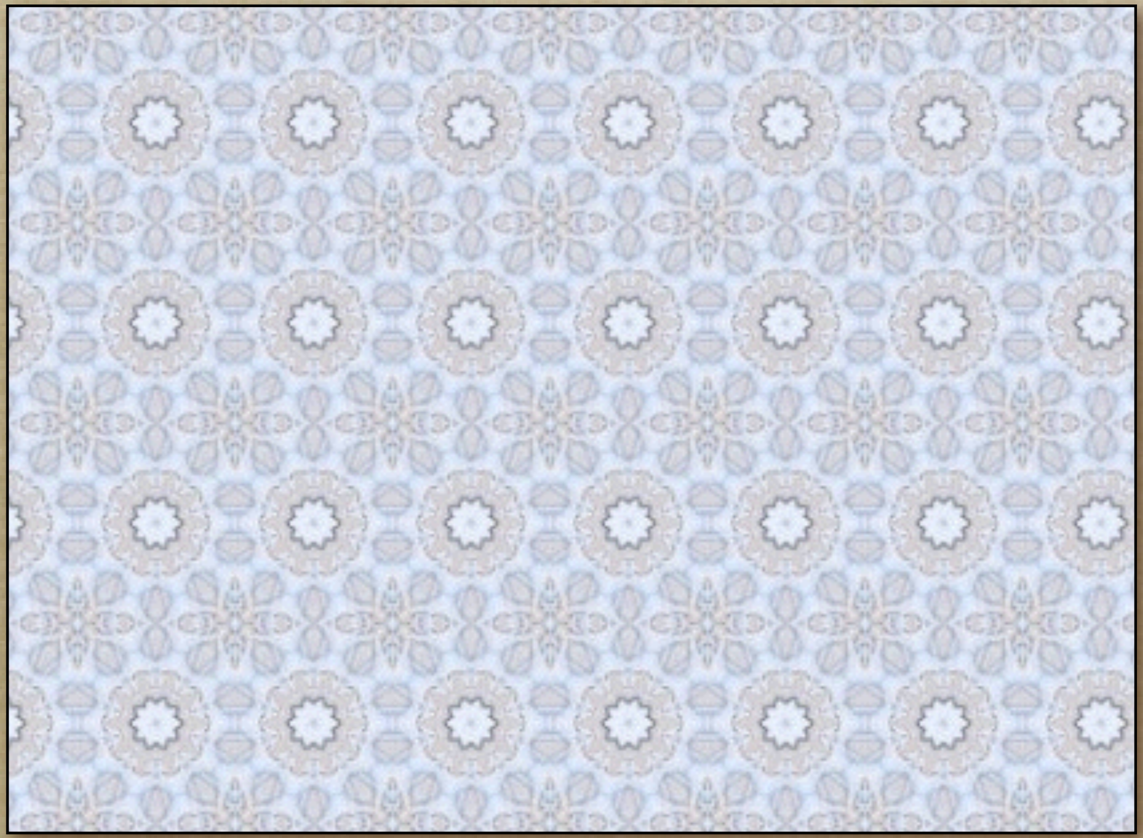
- Image Tiles allow repeating textures
  - Images must be manipulated to allow tilling
  - Often result in visible artifacts
    - There are methods to get around artifacts....



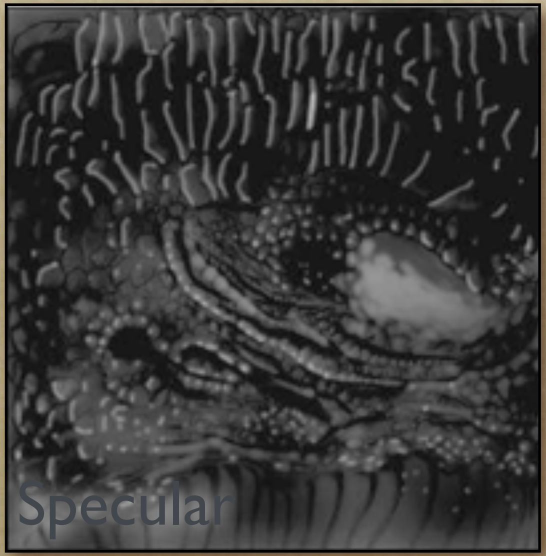


Repeating Textures

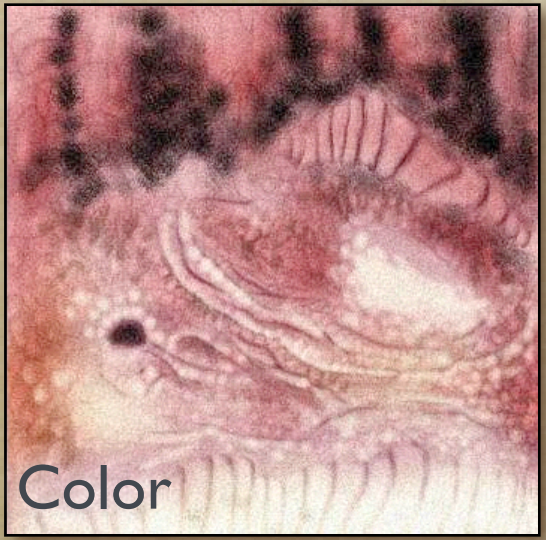
- Image Tiles allow repeating textures
  - Images must be manipulated to allow tilling
  - Often result in visible artifacts
    - Artifacts not an issue for artificial textures



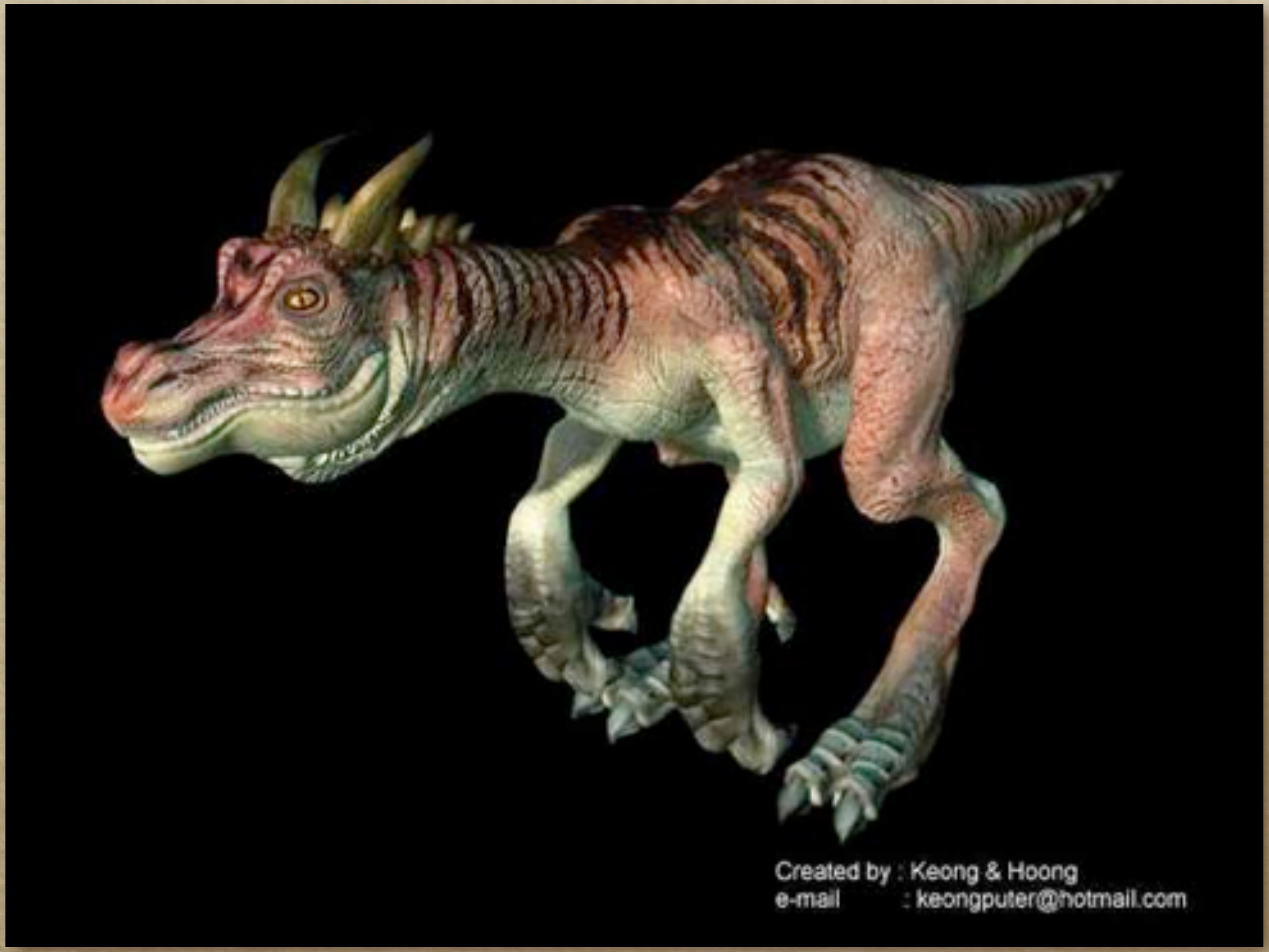
Non-Color Textures

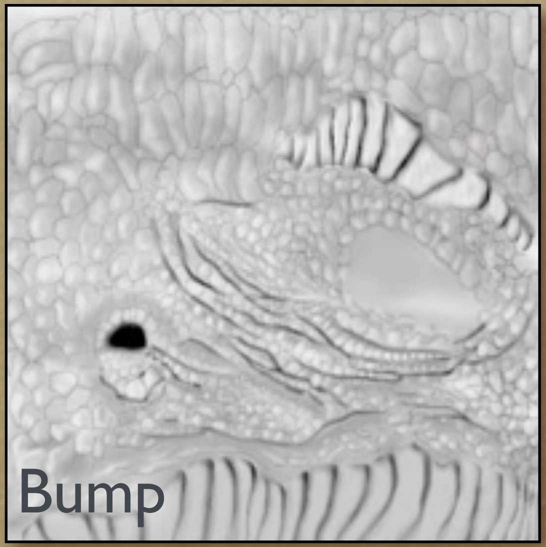


Specular



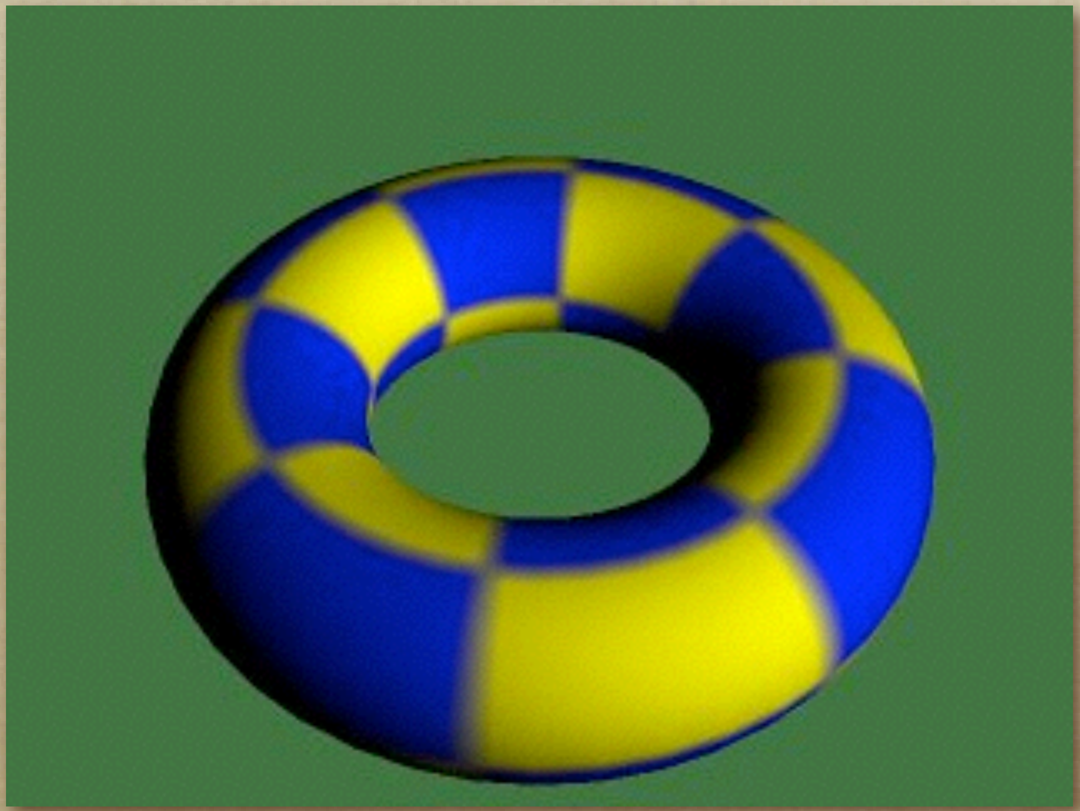
Color



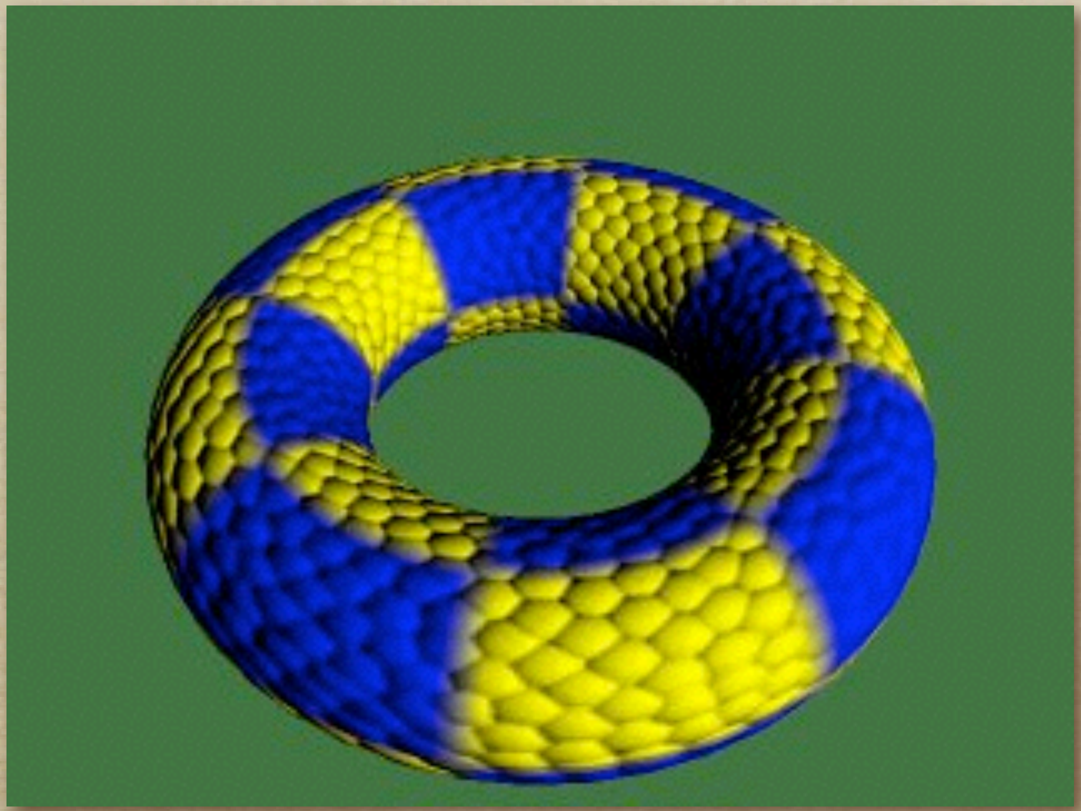


Bump

Bump Mapping



No bump mapping



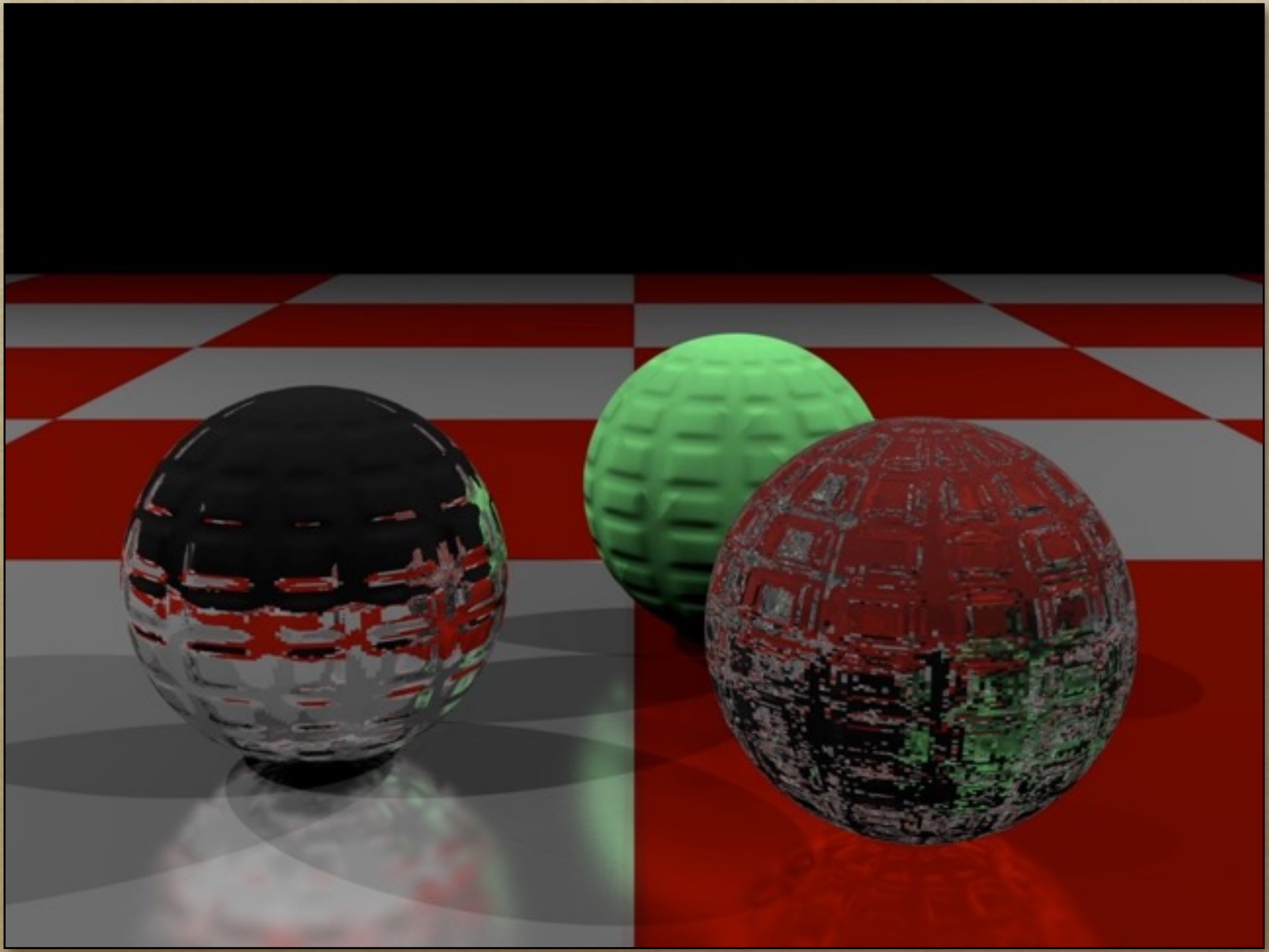
With bump mapping

Images by Paul Baker
www.paulsprojects.net

Bump Mapping

- Add offset to normal
  - Offset is in texture coordinates S,T,N
  - Store normal offsets in RGB image components
  - Should use correctly orthonormal coordinate system
- Normal offsets from gradient of a grayscale image
  - $\mathbf{b}(u,v) = [s,t,n](u,v) = \nabla i(u,v)$
  - $\nabla = \left[\frac{\partial}{\partial u}, \frac{\partial}{\partial v}\right]^{\mathsf{T}}$

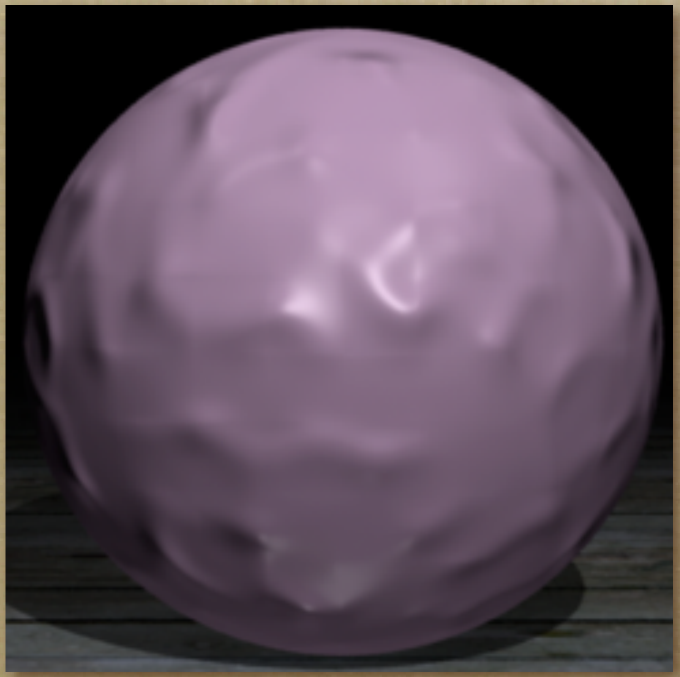
Bump Map Example



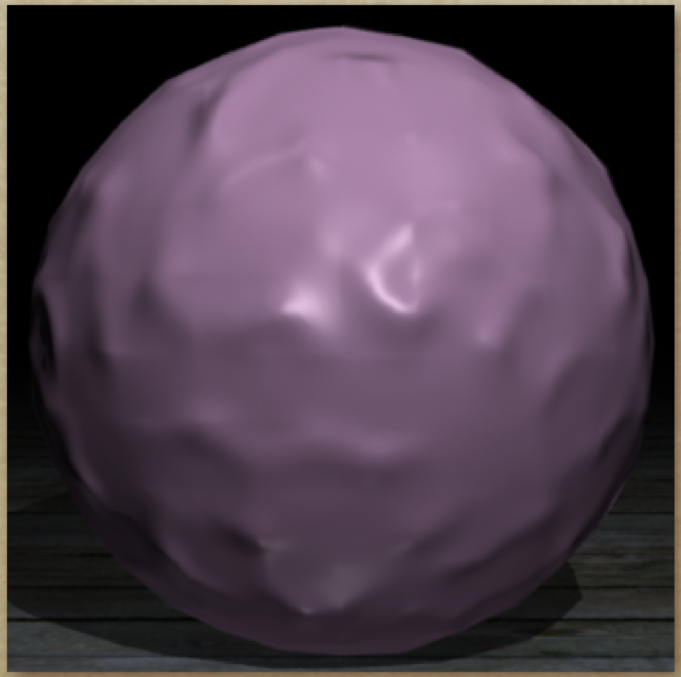
Catherine Bendebury and Jonathan Michaels
CS 184 Spring 2005

Displacement Maps

- Actually move geometry based on texture map
  - Expensive and difficult to implement in many rendering systems
  - Note silhouette



Bump

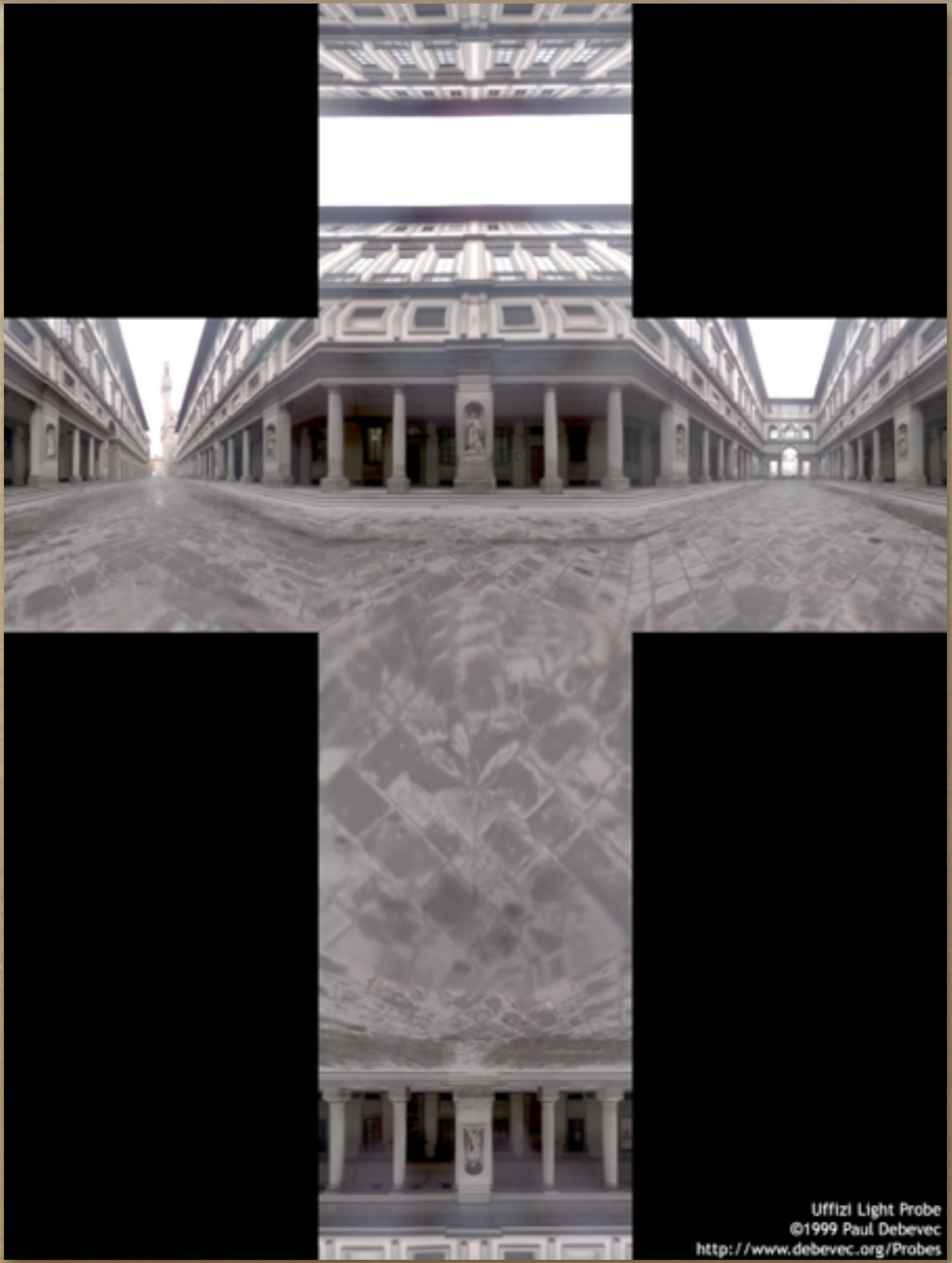


Displacement

Environment Maps

- Environment maps allow crude reflections
- Treat object as infinitesimal
  - Reflection only based on surface normal
- Errors hard to notice for non-flat objects

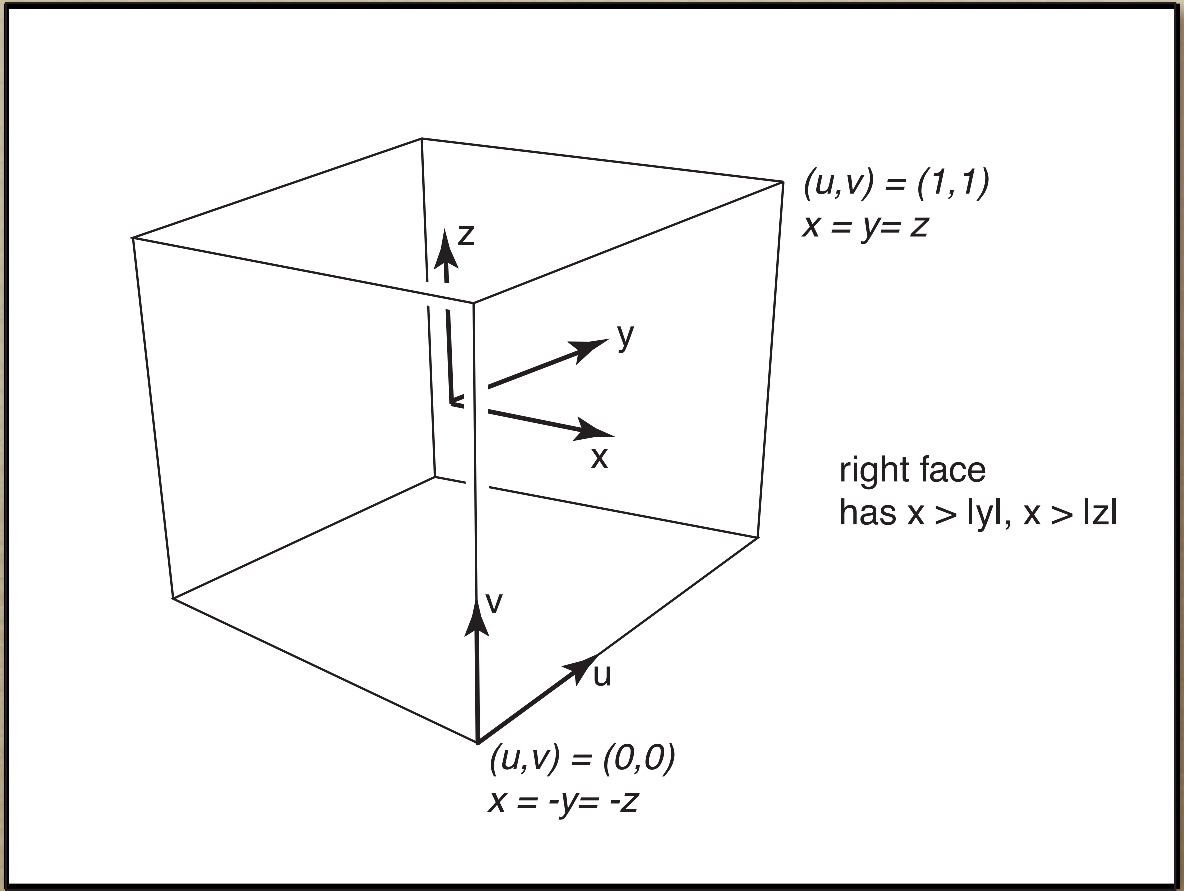
Environment Maps



Environment Maps

$$u = \frac{y + x}{2x}$$

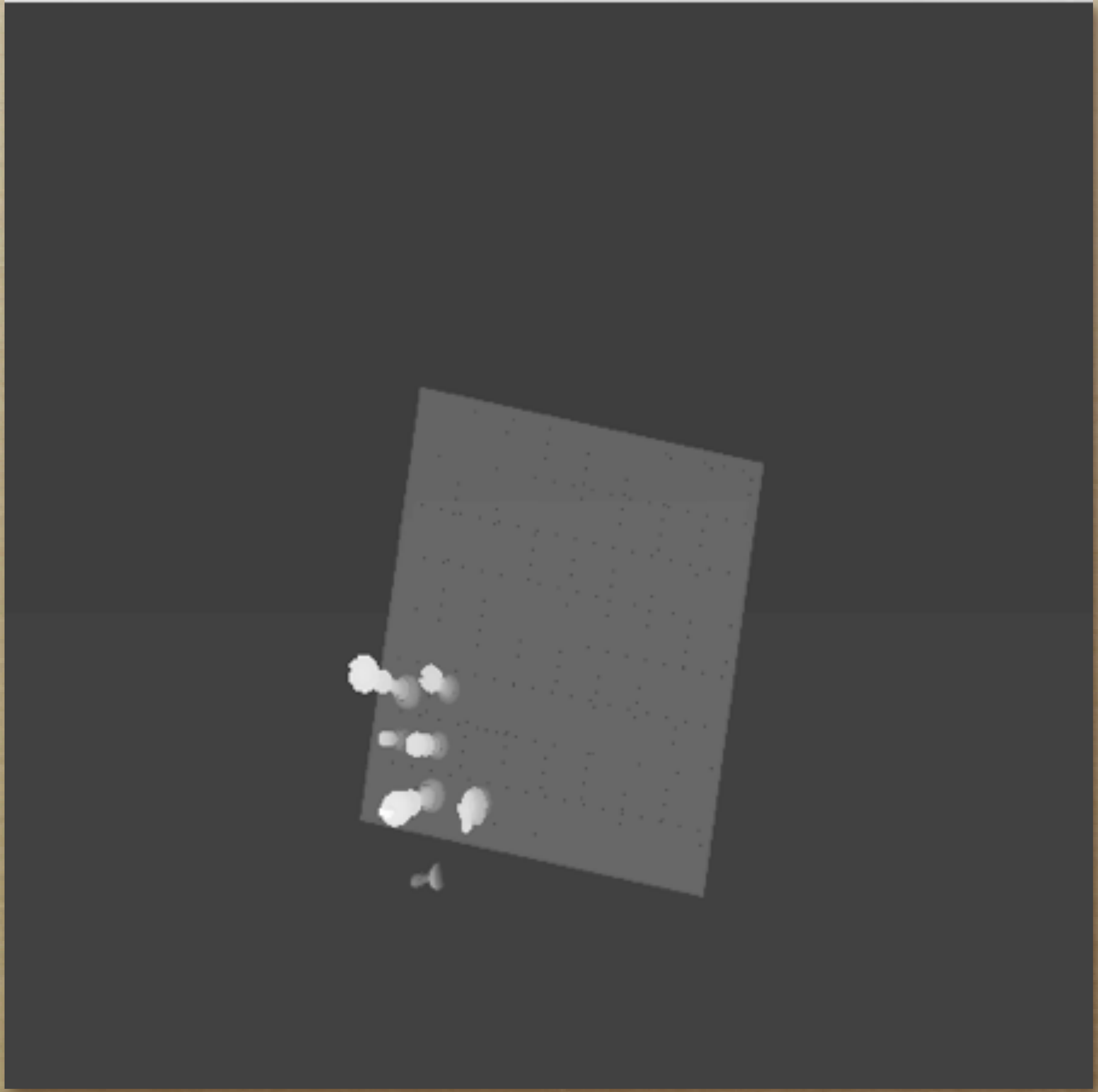
$$v = \frac{z + x}{2x}$$



Shadow Maps

- Pre-render scene from perspective of light source
  - Only render Z-Buffer (the shadow buffer)
- Render scene from camera perspective
  - Compare with shadow buffer
  - If nearer light, if further shadow

Shadow Maps



Shadow Buffer

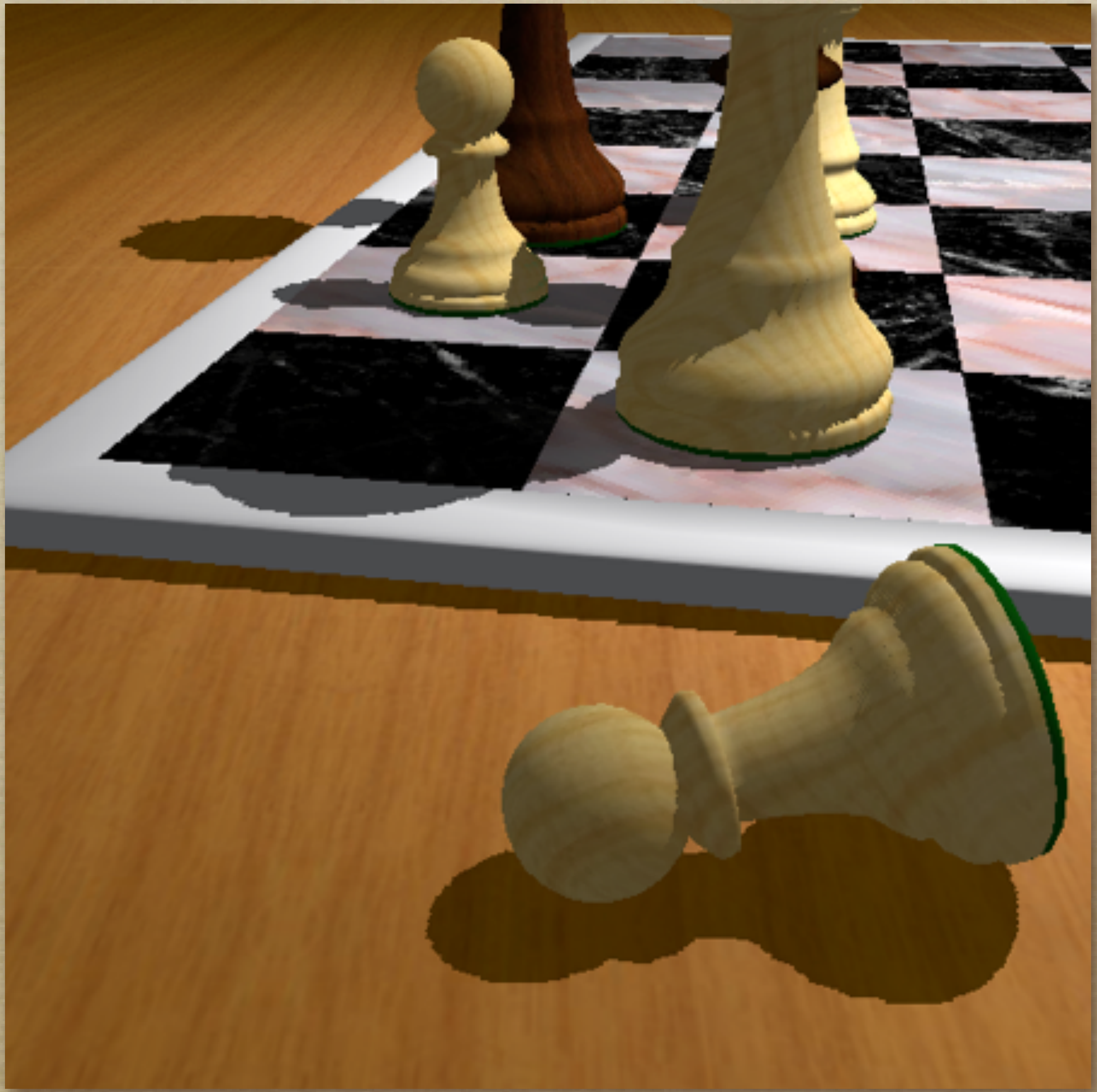


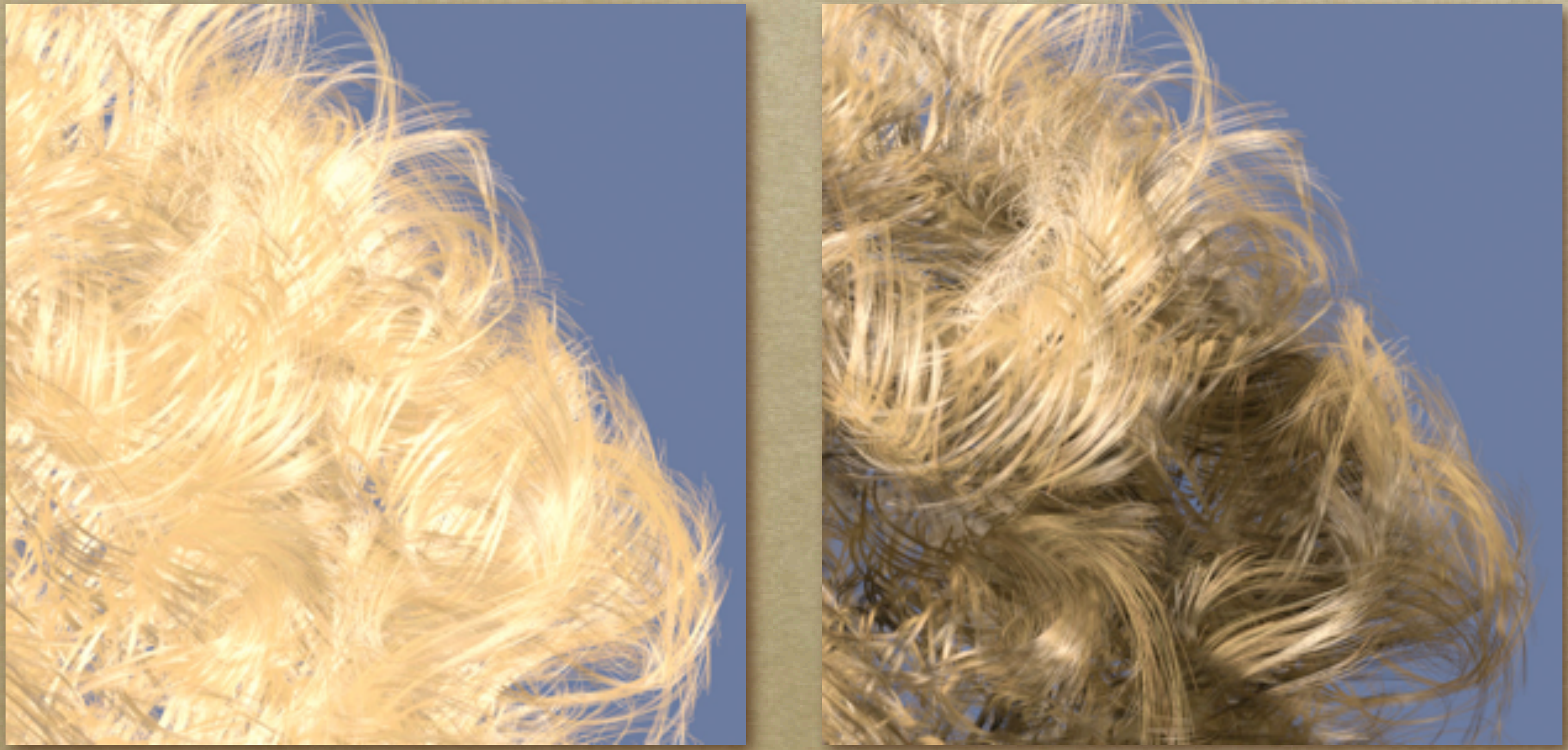
Image w/ Shadows

From Stamminger and Drettakis
SIGGRAPH 2002

Note: These images don't really go together, see the paper...

Deep Shadow Maps

- Some objects only partially occlude light
  - A single shadow value will not work
  - Similar to transparency in Z-Buffer



From
Lokovic and Veach
SIGGRAPH 2000