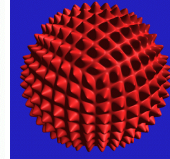
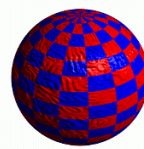
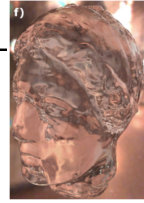


Procedural Modeling

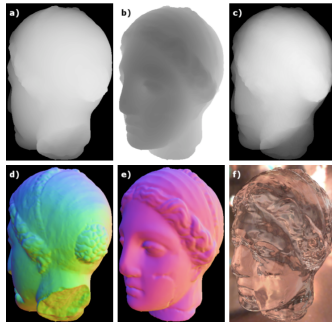
Last Time?

- Modern Graphics Hardware
- Cg Programming Language
- Gouraud Shading vs. Phong Normal Interpolation
- Bump, Displacement, & Environment Mapping



Reading for Last Time:

- Chris Wyman, "An Approximate Image-Space Approach for Interactive Refraction", SIGGRAPH 2005



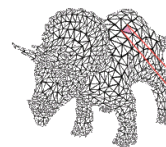
Final Project Progress Reports

- What do you plan to show for your progress report in 2 weeks?
- Each teammate should make a post outlining their contributions thus far
- Post image(s), e.g., bloopers
- Post revised task list

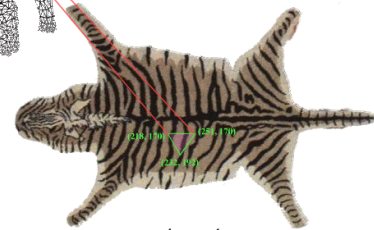
Today

- **Texture Mapping**
- **Common Texture Coordinate Mappings**
- Solid Texture
- Procedural Textures
- Perlin Noise
- Procedural Modeling
- L-Systems

Texture Mapping



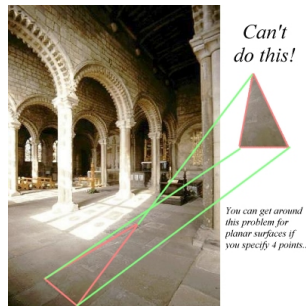
For each triangle in the model establish a corresponding region in the phototexture



During rasterization interpolate the coordinate indices into the texture map

Texture Mapping Difficulties

- Tedious to specify texture coordinates
- Acquiring textures is surprisingly difficult
 - Photographs have projective distortions
 - Variations in reflectance and illumination
 - Tiling problems



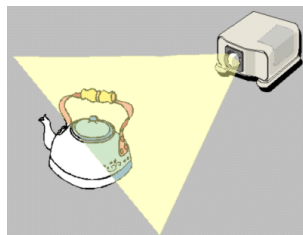
Common Texture Coordinate Mappings

- Orthogonal
- Cylindrical
- Spherical
- Perspective Projection
- Texture Chart



Projective Textures

- Use the texture like a slide projector
- No need to specify texture coordinates explicitly



Projective Texture Example

- Modeling from photographs
- Using input photos as textures

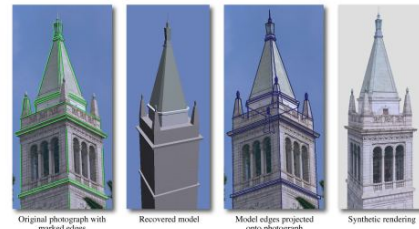
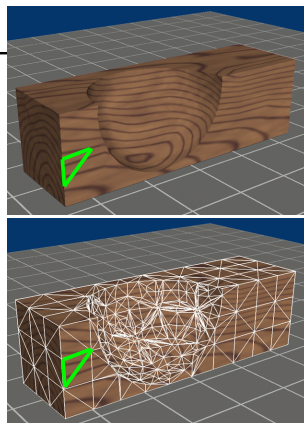


Figure from Debevec, Taylor & Malik
<http://www.debevec.org/Research>

Texture Chart

- Pack triangles into a single image

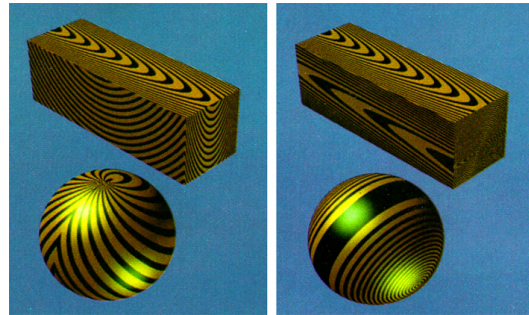


Questions?

Today

- Texture Mapping
- Common Texture Coordinate Mappings
- Solid Texture
- Procedural Textures
- Perlin Noise
- Procedural Modeling
- L-Systems

Texture Map vs. Solid Texture



“Solid Texturing of Complex Surfaces”,
Peachey, SIGGRAPH 1985

Procedural Textures

$f(x,y,z) \rightarrow \text{color}$

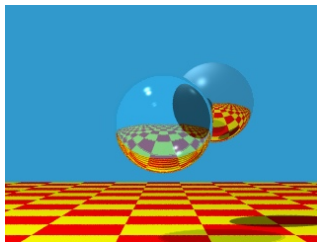
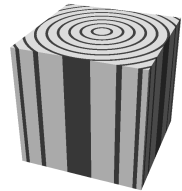
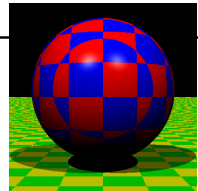


Image by Turner Whitted

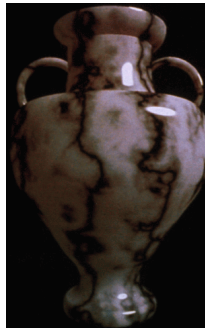
Procedural Textures

- Advantages:
 - easy to implement in ray tracer
 - more compact than texture maps (especially for solid textures)
 - infinite resolution
- Disadvantages
 - non-intuitive
 - difficult to match existing texture



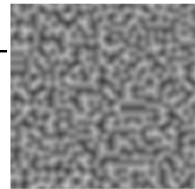
Readings for Today:

- Ken Perlin, “An Image Synthesizer”, SIGGRAPH 1985 & “Improving Noise”, SIGGRAPH 2002

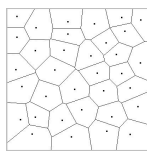


Perlin Noise

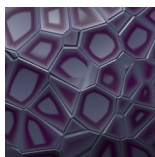
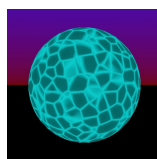
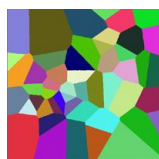
- Properties:
 - Looks “random”, but is deterministic (always returns the same answer for a specific coordinate)
 - Small memory footprint & fast to compute
 - Known amplitude & frequency
 - Smooth interpolation when zoomed in
- Can be combined/layered:
 - Add multiple noise functions w/ different frequencies and amplitudes
 - Simple arithmetic operations (thresholding, sine waves, etc.)



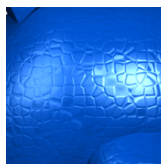
Cellular Textures



Voronoi diagram



"A Cellular Texture Basis Function", Worley, SIGGRAPH 1996
www.worley.com



Questions?

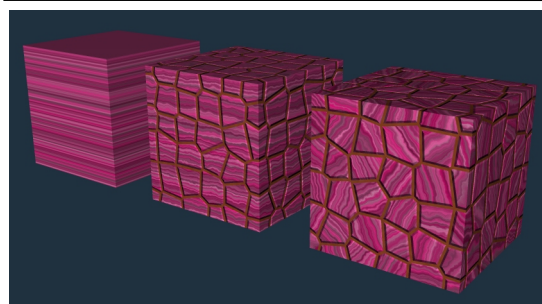


Image by Justin Legakis

Today

- Texture Mapping
- Common Texture Coordinate Mappings
- Solid Texture
- Procedural Textures
- Perlin Noise
- **Procedural Modeling**
- **L-Systems**

Procedural Displacement Mapping



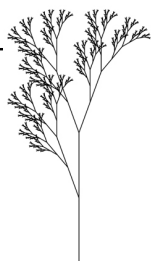
Ken Musgrave
www.kenmusgrave.com

L-Systems

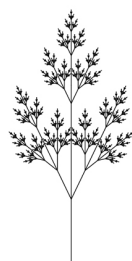
alphabet: {a,b}
initiator: a
production rules:
a → b
b → ba

generations:

a
b
ba
bab
babba
bababab
babbababbabba
babbababbababbabab



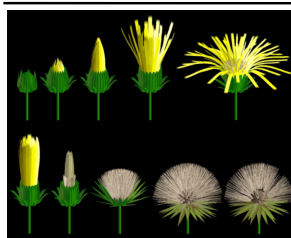
d
n=7, $\delta=20^\circ$
X
X → F[+X]F[-X]+X
F → FF



e
n=7, $\delta=25.7^\circ$
X
X → F[+X]F[-X]FX
F → FF

Prusinkiewicz & Lindenmayer,
The Algorithmic Beauty of Plants, 1990
<http://algorithmicbotany.org/>

L-Systems

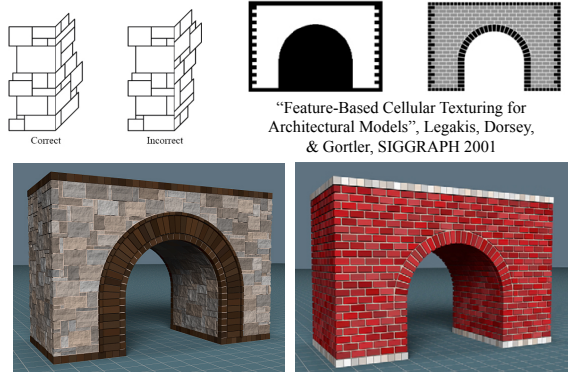


Animation of Plant Development
Prusinkiewicz et al.,
SIGGRAPH 1993

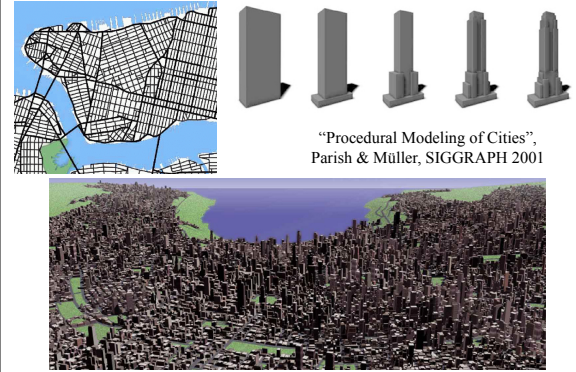
Prusinkiewicz & Lindenmayer,
The Algorithmic Beauty of Plants, 1990
<http://algorithmicbotany.org/>



Cellular Texturing for Architecture



L-Systems for Cities



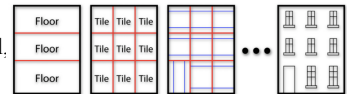
Procedural Modeling of Buildings



- "Procedural Modeling of Buildings", Mueller, Wonka, Haegler, Ulmer & Van Gool, SIGGRAPH 2006

Image-based Procedural Modeling of Facades

- Mueller, Zeng, Wonka, & Van Gool, SIGGRAPH 2007



Input Photograph



Reconstructed 3D Geometry

Questions?

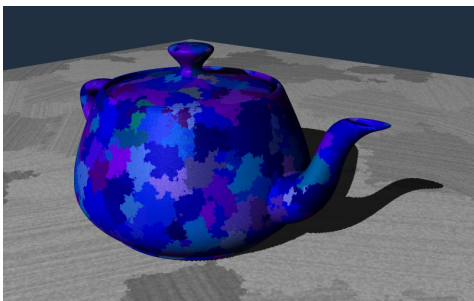


Image by Justin Legakis

Reading for Tuesday:

- "WYSIWYG NPR: Drawing Strokes Directly on 3D Models", Kalnins, Markosian, Meier, Kowalski, Lee, Davidson, Webb, Hughes, & Finkelstein, SIGGRAPH 2002

