

# Procedural Modeling

## Last Time?

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## Today

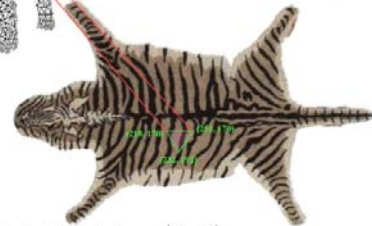
- Texture Mapping
- Common Texture Coordinate Mappings
- Solid Texture
- Procedural Textures
- Perlin Noise
- Procedural Modeling
- L-Systems

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## Texture Mapping



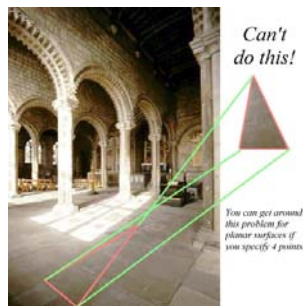
*For each triangle in the model establish a corresponding region in the phototexture*



*During rasterization interpolate the coordinate indices into the texture map*

## Texture Mapping Difficulties

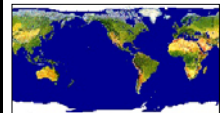
- Tedious to specify texture coordinates
- Acquiring textures is surprisingly difficult
  - Photographs have projective distortions
  - Variations in reflectance and illumination
  - Tiling problems



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## Common Texture Coordinate Mappings

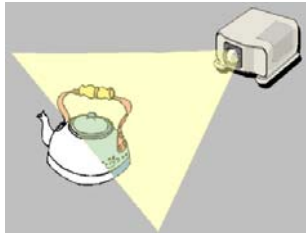
- Orthogonal
- Cylindrical
- Spherical
- Perspective Projection
- Texture Chart



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## Projective Textures

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



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## Projective Texture Example

- Modeling from photographs
- Using input photos as textures

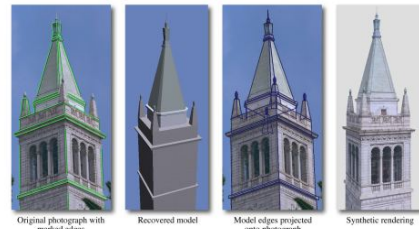
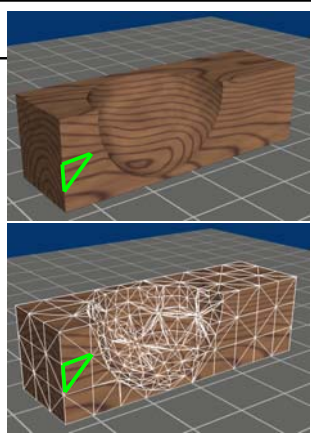


Figure from Debevec, Taylor & Malik  
<http://www.debevec.org/Research>

## Texture Chart

- Pack triangles into a single image



## Questions?

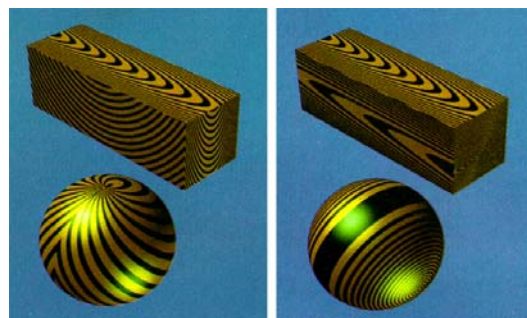
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## Texture Map vs. Solid Texture



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

## Procedural Textures

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

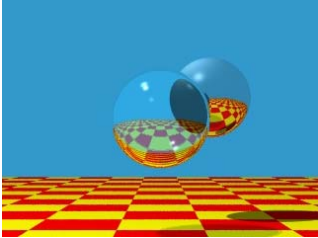
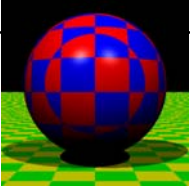
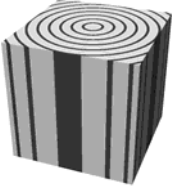


Image by Turner Whitted

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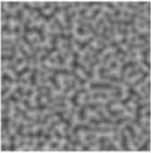

## Procedural Textures

- 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

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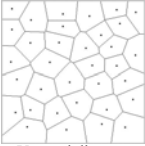
## Perlin Noise


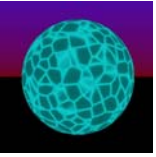
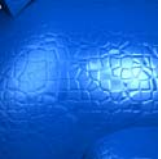
Ken Perlin,  
 "An Image Synthesizer", SIGGRAPH 1985  
 "Improving Noise", SIGGRAPH 2002

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## Cellular Textures



Voronoi diagram

"A Cellular Texture Basis Function", Worley, SIGGRAPH 1996  
[www.worley.com](http://www.worley.com)

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## Questions?

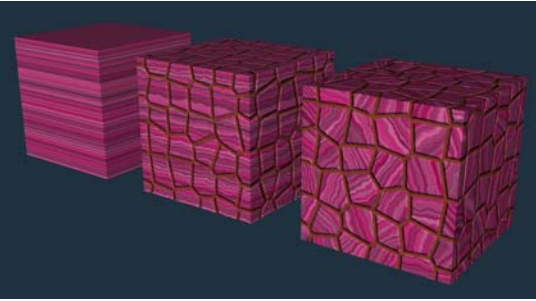


Image by Justin Legakis

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- **L-Systems**

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## Procedural Displacement Mapping

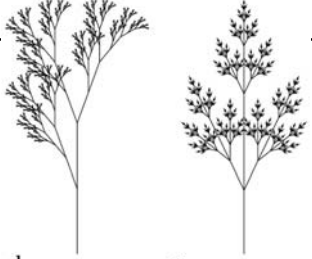


Ken Musgrave  
www.kenmusgrave.com

## L-Systems

alphabet: {a,b}  
 initiator: a  
 production rules:  
 a -> b  
 b -> ba

generations:  
 a  
 b  
 ba  
 bab  
 babba  
 babbabab  
 babbababbabba  
 babbababbababbabab




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

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



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

## L-Systems

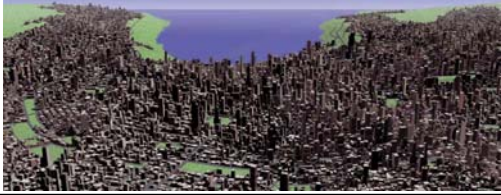


Prusinkiewicz & Lindenmayer,  
*The Algorithmic Beauty of Plants*, 1990  
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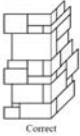
## L-Systems for Cities

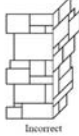
"Procedural Modeling of Cities",  
 Parish & Müller, SIGGRAPH 2001




## Cellular Texturing for Architecture




Correct





Incorrect





"Feature-Based Cellular Texturing for Architectural Models", Legakis, Dorsey, & Gortler, SIGGRAPH 2001

## Questions?

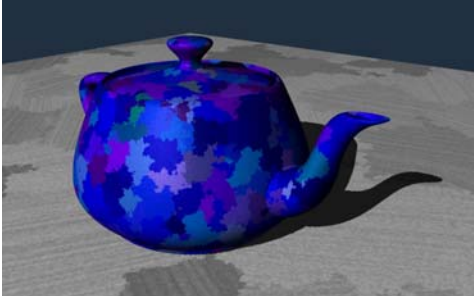


Image by Justin Legakis

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