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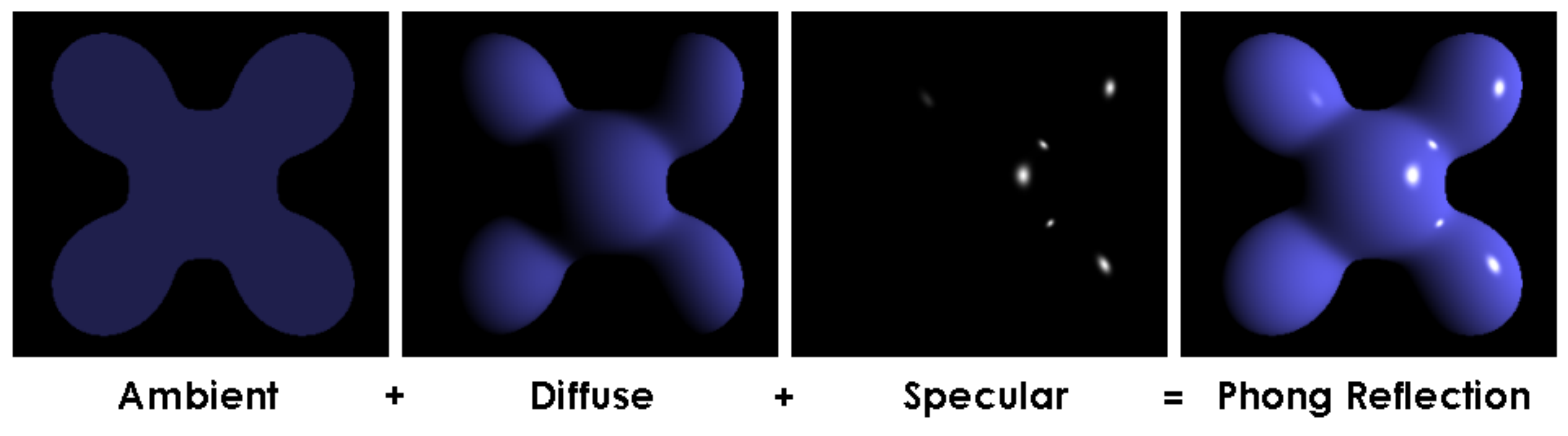
# Materials and Textures

Elements of Graphics
CS324e

# Materials

- Dictates the way light interacts with the surface geometry
- Phong shading is a non-physically-based material model that roughly captures material properties



# Materials in Processing

- Ambient reflects flat light based on color parameters
    - `ambient(r, g, b)`
- Diffuse reflects based on angle to the light
    - Built into the lighting models
- Specular reflects based on the “shininess” of the object relative to the viewer direction
    - `specular(r, g, b) //color of highlights`
    - `shininess(s) //amount of highlight`
    - `lightSpecular(r, g, b) //specular light color`

# Lighting Demo

# Consider…

- What are the material properties of the following?
  - A hotel wall
  - The hood of a car
  - An unglazed clay pot
  - A glazed clay pot

# Advanced Materials

- The Phong shading model can't capture everything!
- Many of the more "interesting" materials involve sub-surface scattering, or light bouncing off of multiple layers within the material…
- Requires a more involved mathematical formula to replicate though…

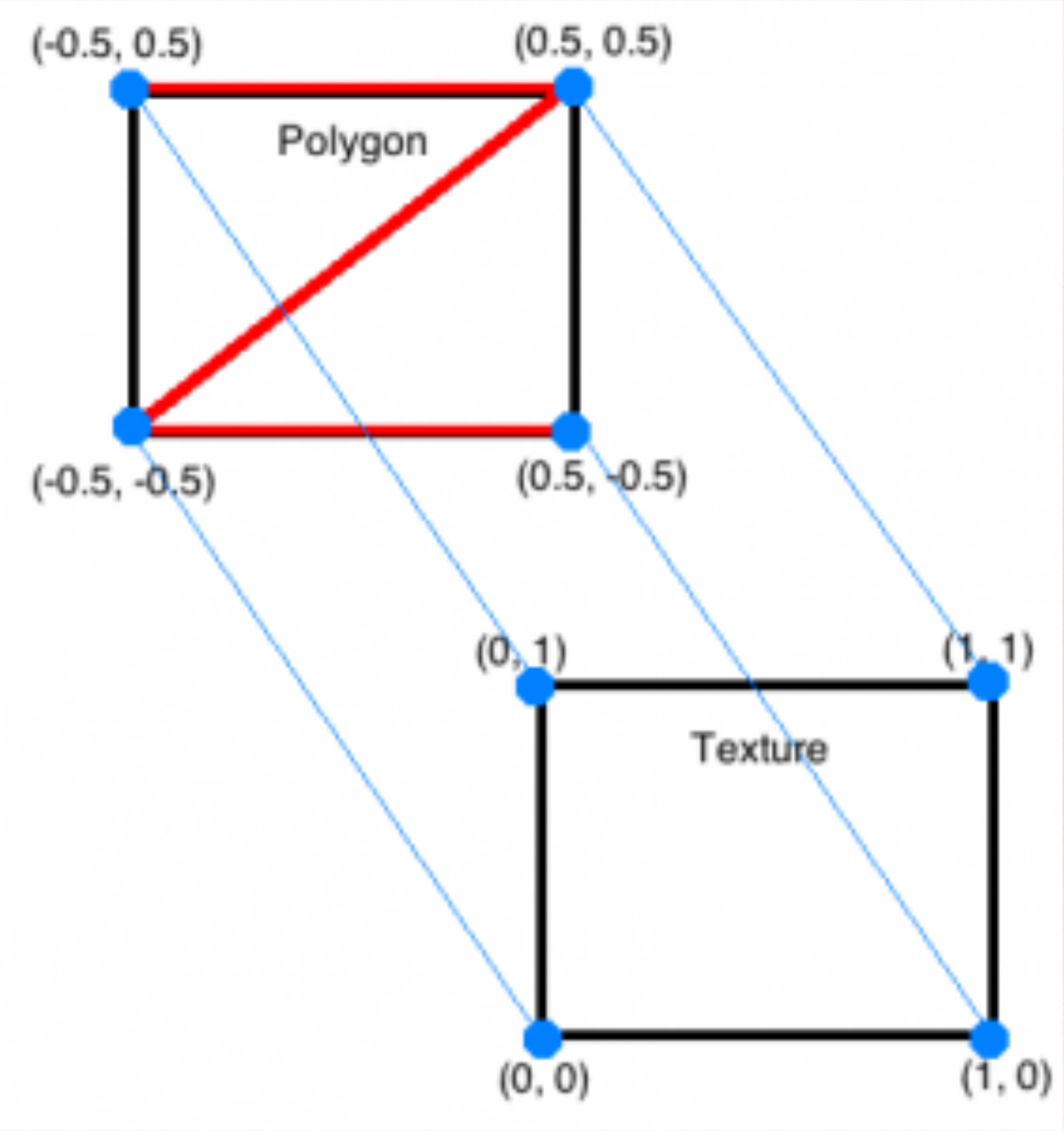
WAX
JADE
MARBLE

# Adding Detail

- Materials convey the underlying composition of the object, but how can we efficiently convey the surface color and patterns?

# Textures

- Provides more detail across geometry
- Deforms with the geometry
- Mapping between geometry vertices (x, y) and texture coordinates (u, v)



```
PImage tex = loadImage(“texture_file”);
…
beginShape();
texture(tex);
vertex(x1, y1, z1, u1, v1);
vertex(x2, y2, z2, u2, v2);
vertex(x3, y3, z3, u3, v3);
vertex(x4, y4, z4, u4, v4);
endShape();
```

# Texture Demo

# Consider

- Consider the previous in-class example.  How do these modifications change the texture?

```
vertex(0, 0, 0, 0, 0);

vertex(350, 0, 0, .5, 0);

vertex(350, 200, 0, .5, 1);

vertex(0, 200, 0, 0, 1);
```

# textureMode and textureWrap

- `textureMode(IMAGE)` sets mapping to number of pixels in texture image coordinates
- `textureMode(NORMAL)` sets mapping to normalized (0.0 - 1.0) texture image coordinates
- `textureWrap(CLAMP)` locks the texture into place
- `textureWrap(REPEAT)` repeats the texture along the surface

# Exercise

- Consider the previous in-class example.  How many times will the texture image be drawn if textureWrap is set to REPEAT and the vertices are modified as follows:

```
vertex(0, 0, 0, 0, 0);

vertex(350, 0, 0, 3, 0);

vertex(350, 200, 0, 3, 4);

vertex(0, 200, 0, 0, 4);
```

# Applying Textures to Meshes

- Possible to apply textures to meshes within Processing
  - Map all texture coordinates to vertices
  - Store in a GLModel (Java class for storing 3D model information in vertex buffers)
- But much easier to use 3D modeling programs like Blender or Maya!

# OBJs and MTLs

- Create objects in .obj format and material properties in .mtl format then import into Processing
- How-to:
    - Processing -> File -> Examples -> Basics -> Shape -> LoadDisplayObj

# Hands-on: Using Textures

- Today’s activities:

  1. Recreate the scene you built for the last hands-on activities
  2. Change the material properties of the 3D objects (modifying their shininess, ambience, and specularity)
  3. Create a simple square or rectangle using Shape and apply a texture to it
  4. Experiment with texture mode and texture wrapping options