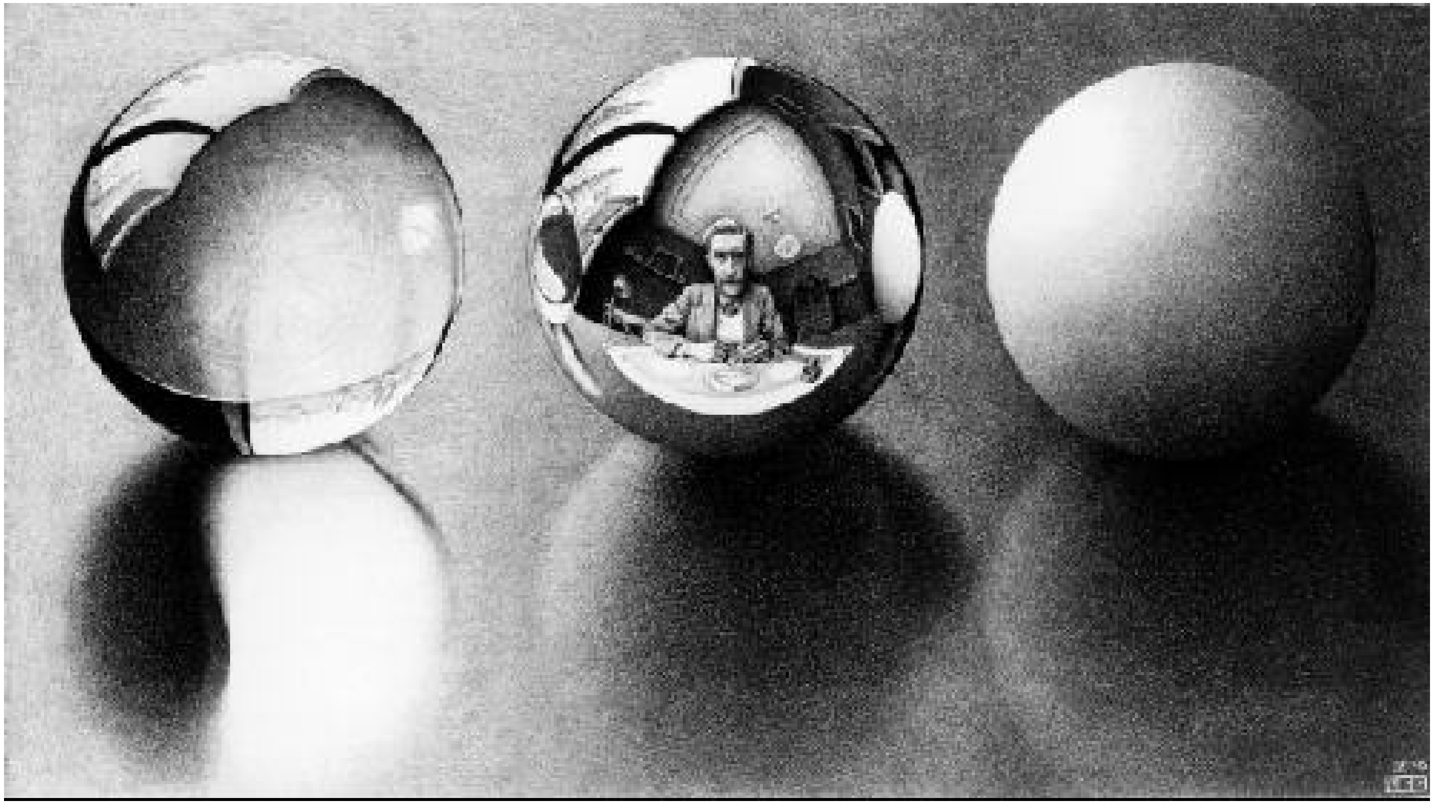
Surface Detail

Foley & Van Dam, Chapter 16

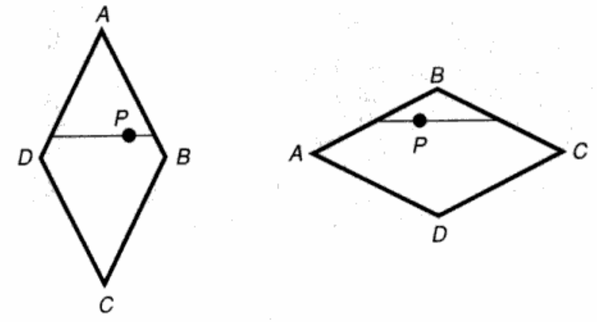


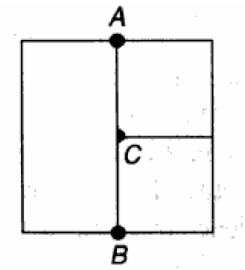
Surface Detail

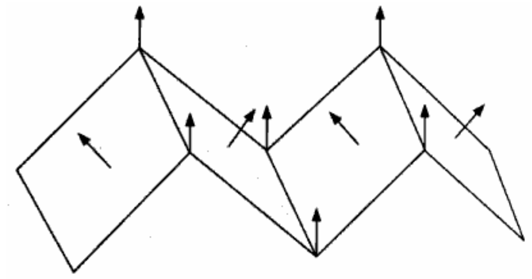
- Problems with Interpolated Shading
- Surface Detail
  - Texture Mapping
  - Texture Synthesis
  - Bump Mapping

Issues with Interpolated Shading

- Polygonal Silhouette
- Perspective Distortion
- Orientation Dependence
- Shared Vertices
- Unrepresentative Normals







Surface Detail

- Applying the shading models we have described, generates smooth, uniform surfaces
- To increase realism, we want to model surface details (changes in color and grain, for example)
- Common Techniques:
  - Surface-Detail Polygons
  - Texture Mapping
  - Bump Mapping

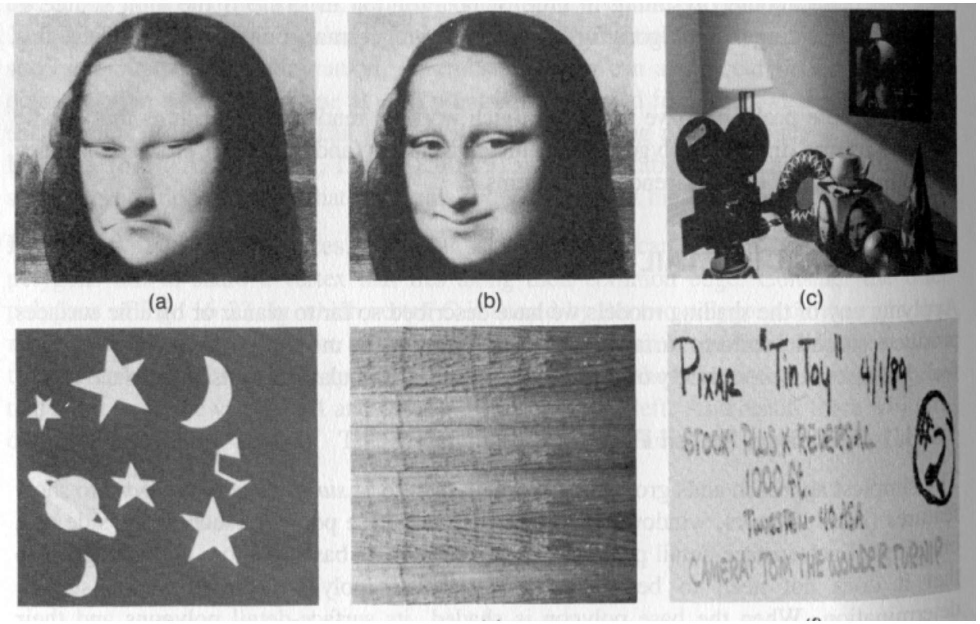
Texture Mapping

- Maps an image or a random pattern to a polygonal or free-form surface
- Generates a smooth surface that changes in color

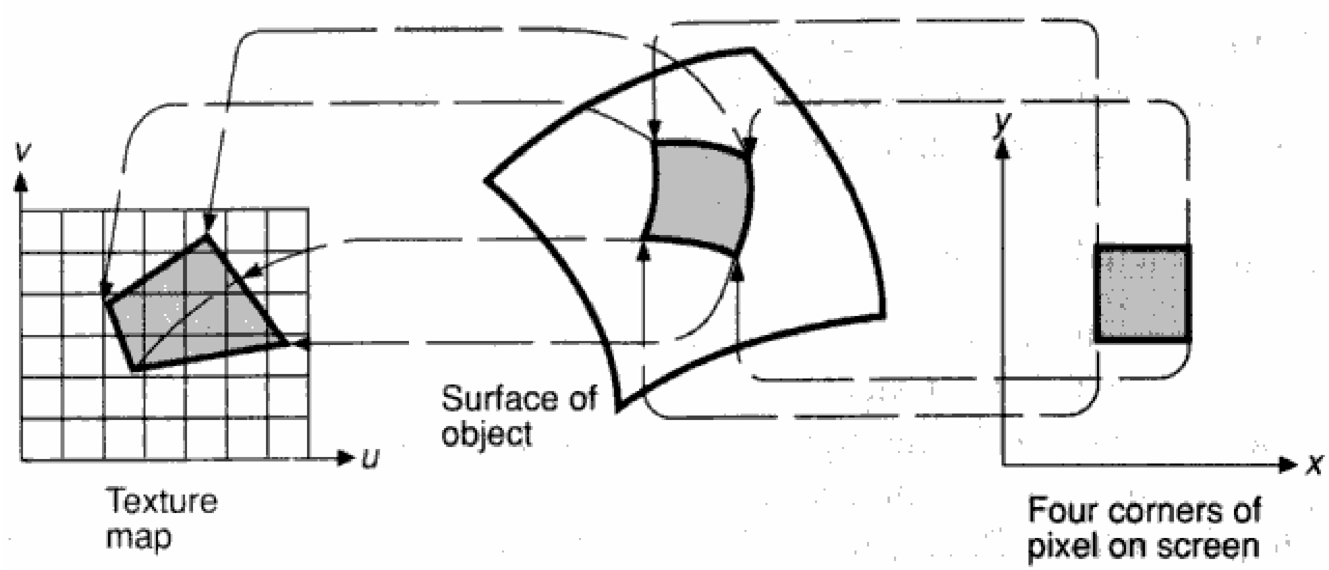
Texture Mapping

- Textures used in the image



Texture Mapping

- Elements of the texture are called **texels**
- Two-step texture mapping:
  1. Mapping the pixel area on the surface
  2. Mapping the surface area to the texture map



Texture Mapping

- **Problem:** Texture map may be smaller than the surface, if replicate the texture, the image will not look natural

- **Solution:** Texture Synthesis

- Only works for random looking textures

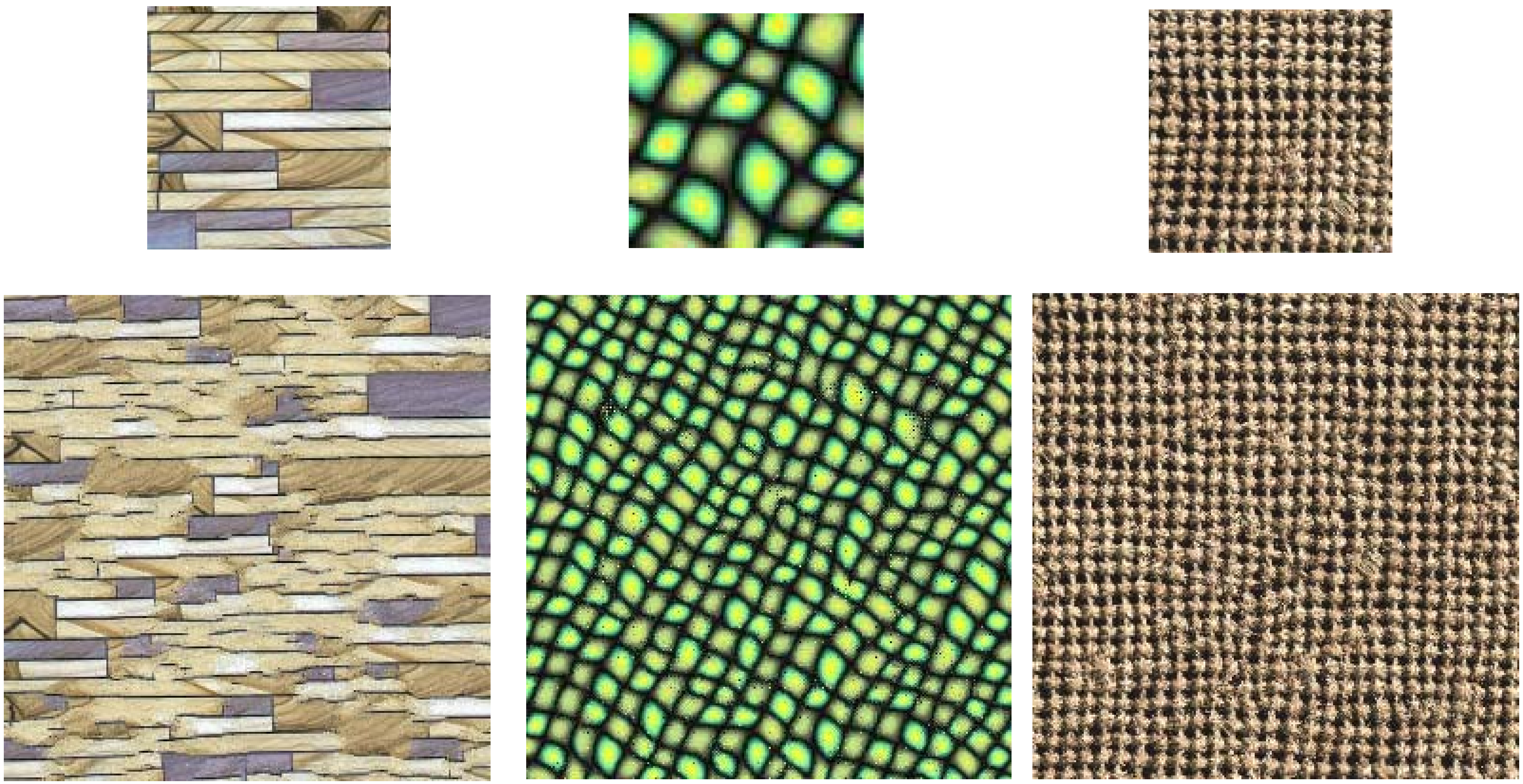
Texture Synthesis

- **Input:** a small texture map
- Find a “description” of the random process that generates the texture sample
- Use the description to generate synthetic textures of arbitrary size

Texture Synthesis

- **Examples:** from **www.vision.ee.ethz.ch/~rpaget**

  Samples (top) vs. synthetic (bottom)

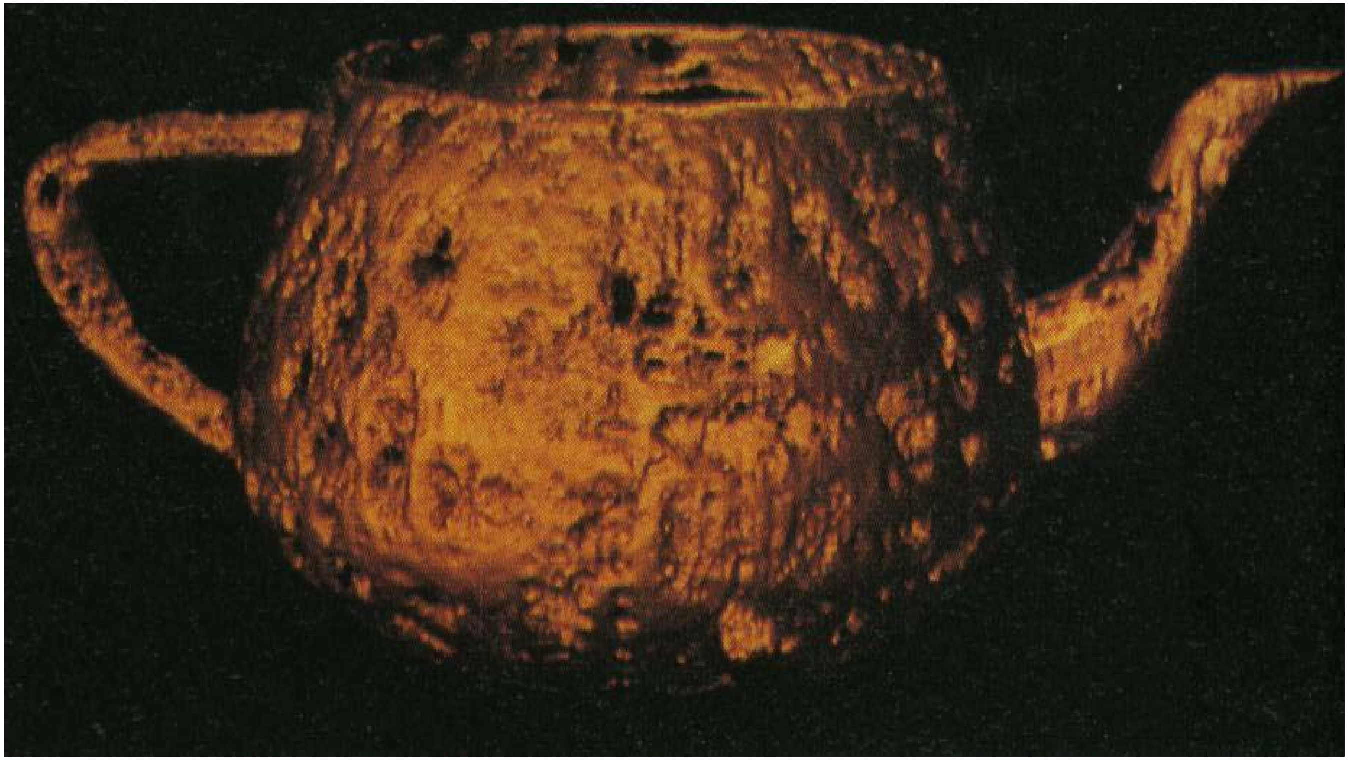


Texture Synthesis

- **Examples:** from **www.vision.ee.ethz.ch/~rpaget**
  Samples (top) vs. synthetic (bottom)

Bump Mapping

- Used when we want to generate rough surfaces without increasing the polygons
- Bump maps affect lighting



Bump Mapping

- The surface is represented by points P(s,t):

$$P(s,t) = \left[x(s,t), y(s,t), z(s,t)\right]$$

- The bump map is an array of displacements:

$$B(u,v)$$

- The normal N(s,t) to the point P(s,t) is given by the cross product of the partial derivatives (each tangent to the surface in the direction s and t):

$$N(s,t) = \frac{\partial P(s,t)}{\partial s} \times \frac{\partial P(s,t)}{\partial t}$$

Bump Mapping

- We can displace P(s,t) in the direction of the normal by a quantity B(u,v):

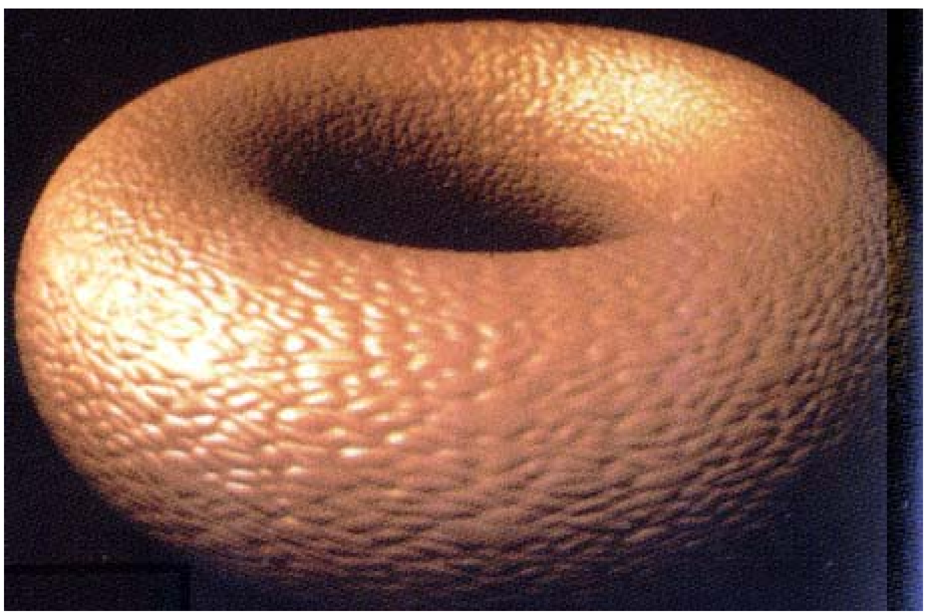
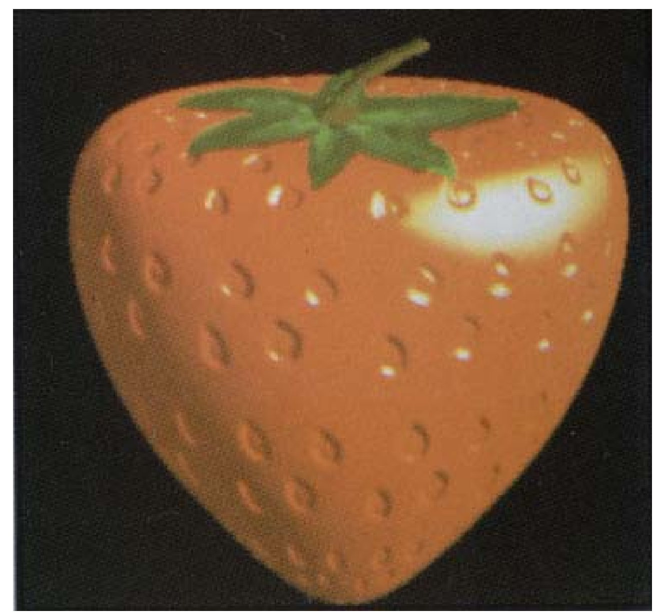
$$P'(s,t) = P(s,t) + \frac{B(u,v)N(s,t)}{\left|N(s,t)\right|}$$

- It can be proved that a good approximation of the new (unnormalized) normal N'(s,t) is:

$$N'(s,t) = N(s,t) + \frac{\frac{\partial B(u,v)}{\partial u}\left(N(s,t) \times \frac{\partial P(s,t)}{\partial t}\right) - \frac{\partial B(u,v)}{\partial v}\left(N(s,t) \times \frac{\partial P(s,t)}{\partial s}\right)}{\left|N(s,t)\right|}$$

Bump Mapping

- The new normals N'(s,t) are used in the illumination model
- **Question:** how can you spot an image obtained via bump mapping ?

Bump Mapping

- **Example:** texture vs. bump mapping
  - Texture mapping: color that varies across a surface
  - Bump mapping: normals that varies across a surface