

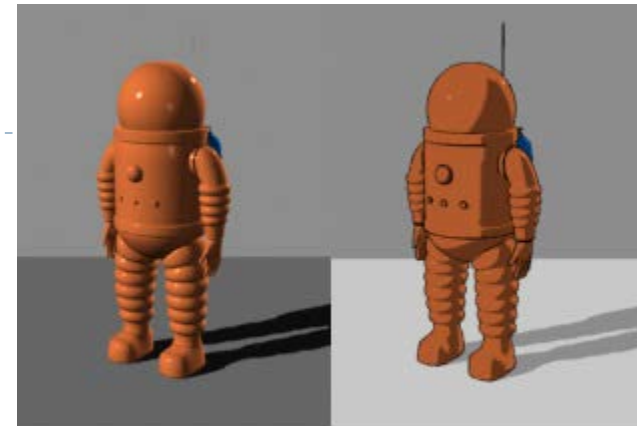
CSE 167:
Introduction to Computer Graphics
Lecture #16: Toon Shading

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Announcements

Toon Shading

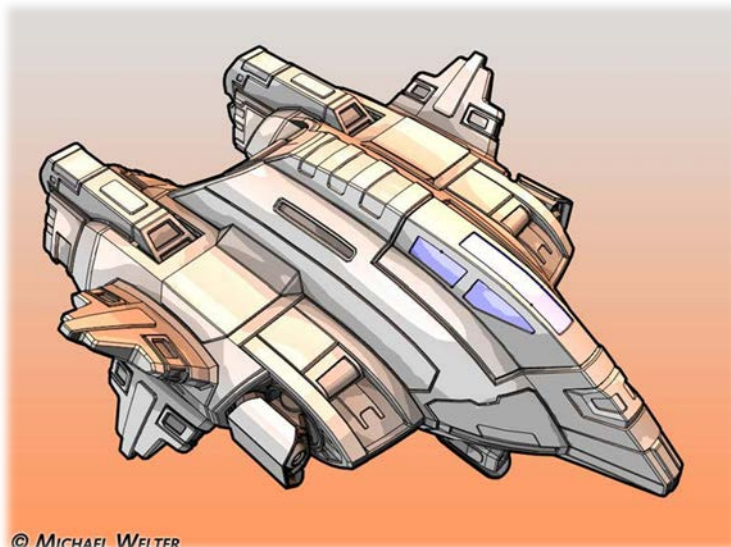
- ▶ A.k.a. Cel Shading (“Cel” is short for “celluloid” sheets, on which animation was hand-drawn)
- ▶ Gives any 3D model a cartoon-style look
- ▶ Emphasizes silhouettes
- ▶ Discrete steps for diffuse shading, highlights
- ▶ Non-photorealistic rendering method (NPR)
- ▶ Programmable shaders allow real-time performance



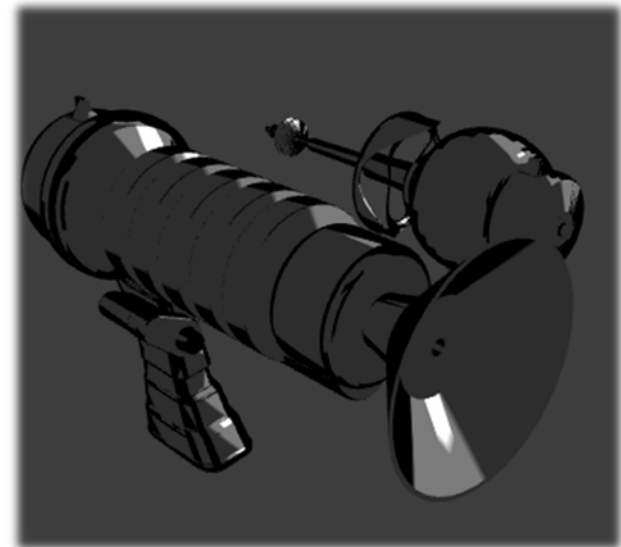
plastic shader

toon shader

Source: Wikipedia



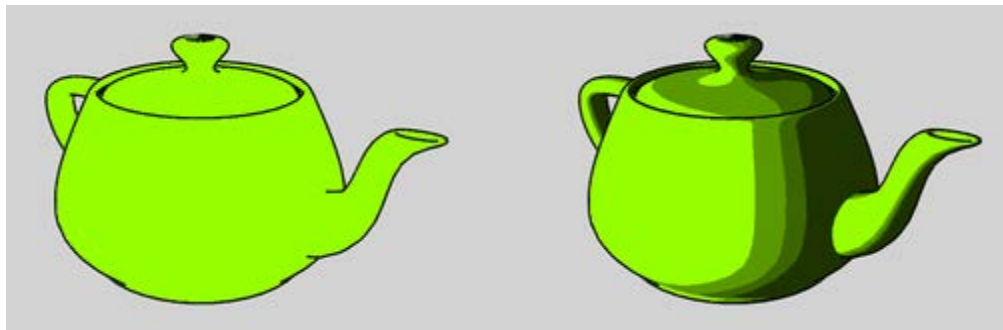
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GLSL toon shader

Approach

- ▶ Start with regular 3D model
- ▶ Apply two rendering tricks:
 - ▶ Silhouette edges
 - ▶ Emphasize pixels with normals perpendicular to viewing direction.
 - ▶ Discretized shading
 - ▶ Conventional (smooth) lighting values calculated for each pixel, then mapped to a small number of discrete shades.



Source: Wikipedia

Silhouette Edges

- ▶ Silhouette edge detection

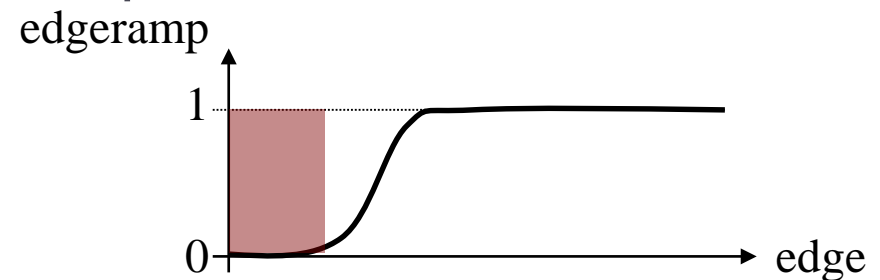
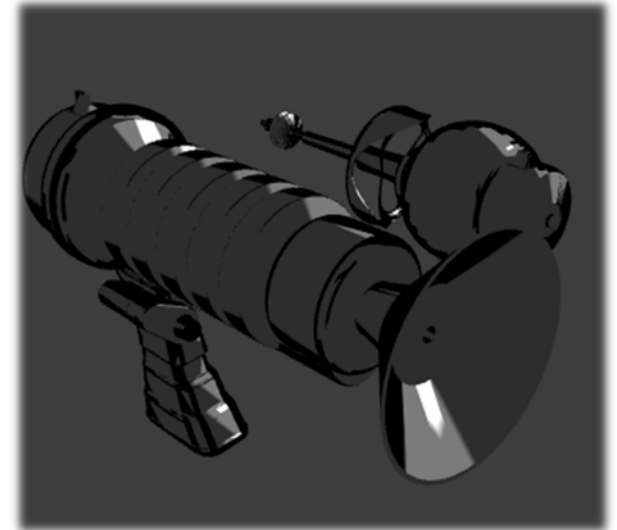
- ▶ Compute dot product of viewing direction \mathbf{v} and normal \mathbf{n}

$$\text{edge} = \max(0, \mathbf{n} \cdot \mathbf{v})$$

- ▶ Use cutoff value for edge:

- ▶ if $\text{edge} < 0.01$ draw black, else don't change pixel color

- ▶ Use 1D texture to define edge ramp for smoother transition
- ```
uniform sampler1D edgeramp;
e = texture1D(edgeramp, edge);
```



# Discretized Shading

- ▶ Compute diffuse and specular shading

$$\text{diffuse} = \mathbf{n} \cdot \mathbf{L} \quad \text{specular} = (\mathbf{n} \cdot \mathbf{h})^s$$

- ▶ Discretize shading

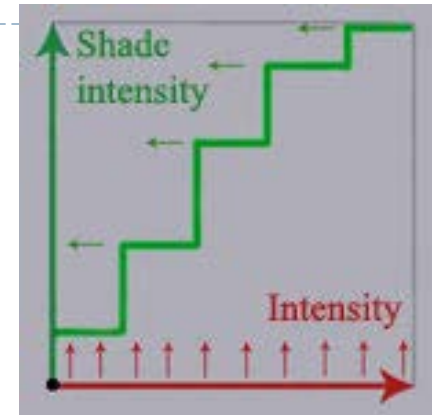
- ▶ Approaches:

- ▶ If..then..else tree comparing values against thresholds

```
if (diffuse < A) diffuse = 0.0;
else if (diffuse < B) diffuse = B;
else if (diffuse < C) diffuse = C;
else diffuse = D;
```

- ▶ 1D textures to map diffuse and specular shading to colors

```
uniform sampler1D diffuseramp;
uniform sampler1D specularramp;
color = e * (texture1D(diffuse,diffuseramp) +
texture1D(specular,specularramp));
```



# Toon Shading Demo

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<http://www.bonzaisoftware.com/npr.html>