CSE 167:
Introduction to Computer Graphics
Lecture #15b: Toon Shading

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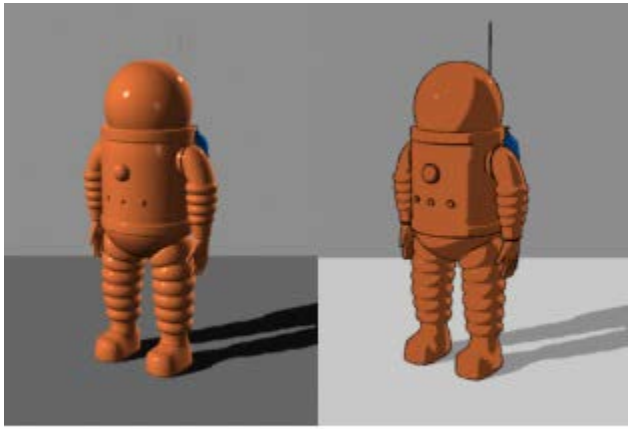
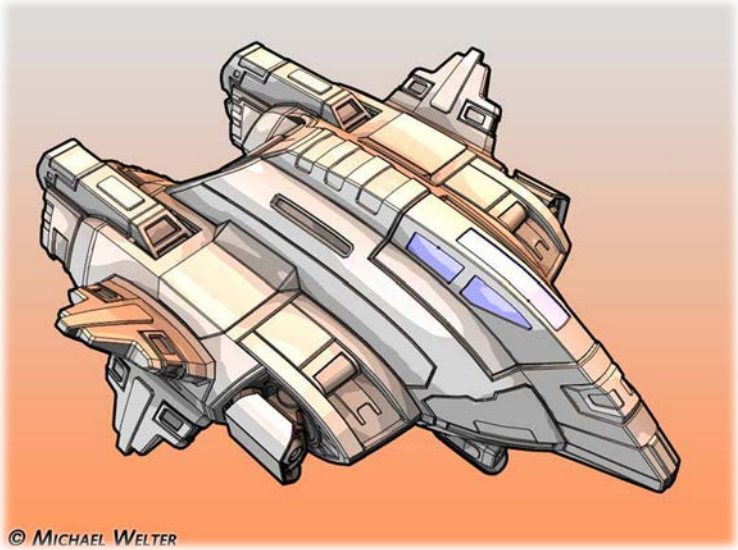
Toon Shading

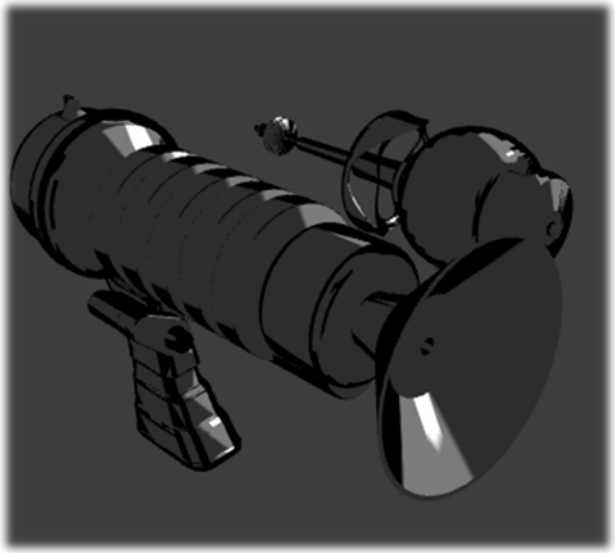
- A.k.a. Cel Shading ("Cel" is short for "celluloid" sheets, on which animation was hand-drawn)
- Gives any 3D model a cartoon-style look
- Emphasizes silhouettes
- Discrete steps for diffuse shading, highlights
- Non-photorealistic rendering method (NPR)
- Programmable shaders allow real-time performance



Source: Wikipedia



Off-line toon shader



GLSL toon shader

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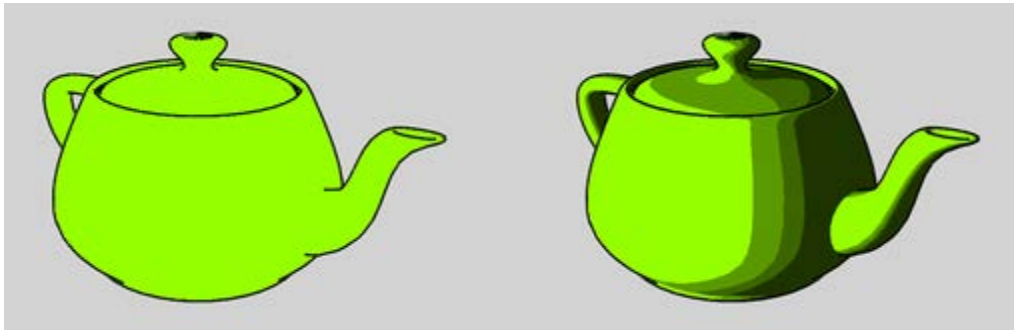
Approach

- 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.

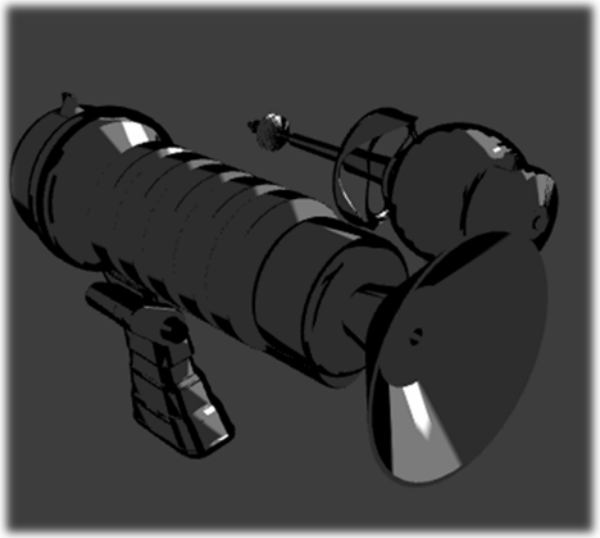


Source: Wikipedia

Silhouette Edges

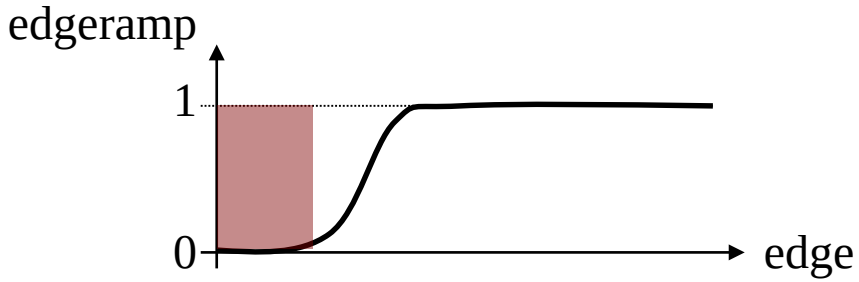
- Silhouette edge detection
  - Compute dot product of viewing direction $\mathbf{v}$ and normal $\mathbf{n}$

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



  - Use cutoff value for edge:
    - if edge<0.01 draw black, else don't change pixel color
  - Use 1D texture to define edge ramp for smoother transition

```
uniform sample1D edgeramp;
e = texture1D(edgeramp,edge);
```



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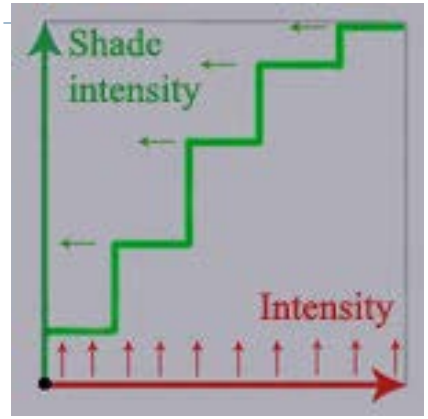
Discretized Shading

- 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

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