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

Jürgen P. Schulze, Ph.D.
University of California, San Diego
Fall Quarter 2020

Cel Animation

DEFINITION: The process of first drawing each frame of animation onto paper, then transferring these to transparent acetate sheets (cels, short for celluloid). Colour is then added on the reverse of the cel. Layers are built up to create dimension.


The cels are individually photographed onto film by a rostrum camera.

ink line

paint on underside

acetate

background plate

UCSD
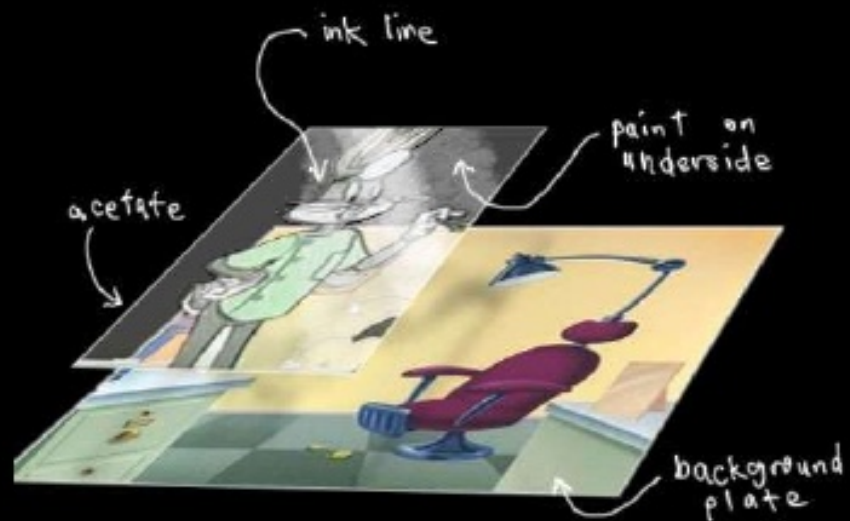
Toon Shading

- A.k.a. Cel Shading ("Cel" is short for "celluloid" sheets)
- Gives any 3D model a cartoon-style look
- Main features:
    - Emphasizes silhouettes
    - Discrete steps for diffuse shading, highlights
- Non-photorealistic rendering method (NPR)
- Programmable shaders allow real-time performance
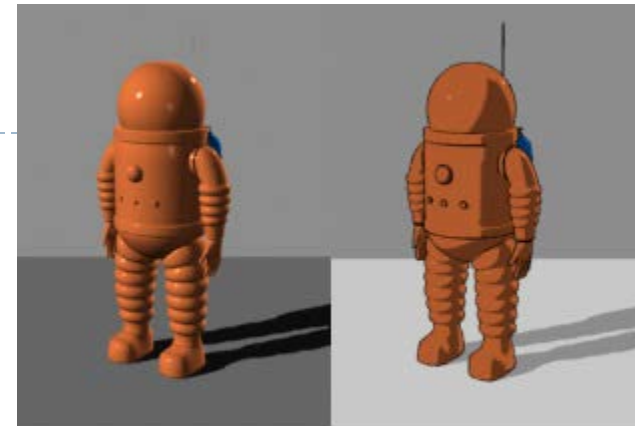
plastic shader   toon shader

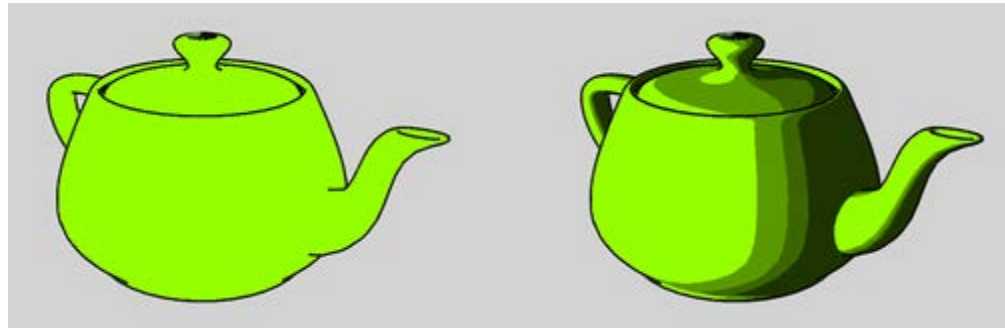*Source: Wikipedia*

© MICHAEL WELTER

UCSD
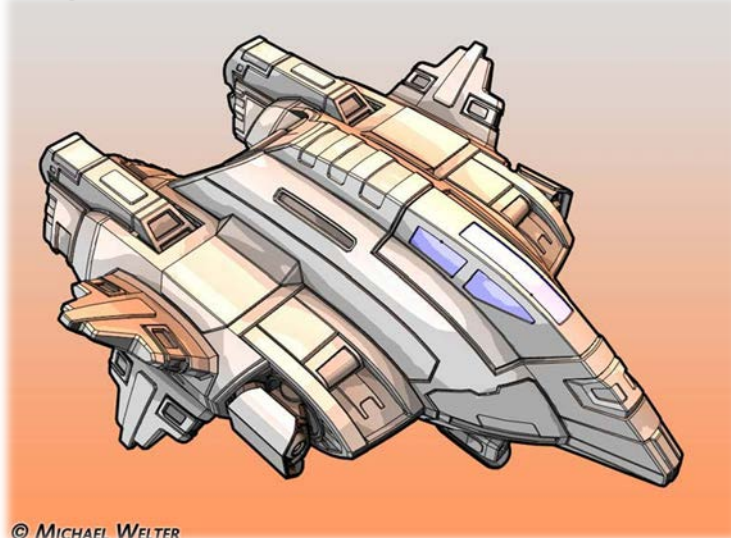
Approach

- ## 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 **v** and normal **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
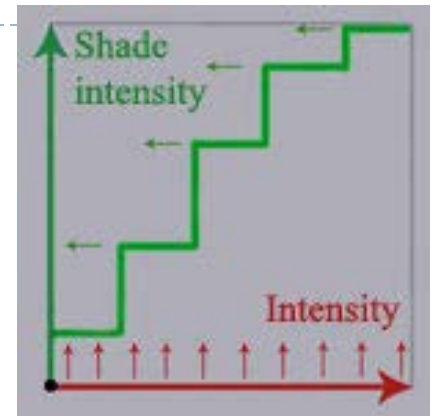
UCSD

Discretized Shading

▸ **Compute diffuse and specular shading**

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

▸ **Discretize shading:**

▸ If..then..else tree comparing values against thresholds

```
if (intensity > 0.95)
    color = float4(1.0,1,1,1.0) * color;
else if (intensity > 0.5)
    color = float4(0.7,0.7,0.7,1.0) * color;
else if (intensity > 0.05)
    color = float4(0.35,0.35,0.35,1.0) * color;
else
    color = float4(0.1,0.1,0.1,1.0) * color;
```

UCSD

Toon Shading Demo

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

UCSD