

# Shape Illustration and Visualization

Baoquan Chen

JPEG slides are from Pat Hanrahan

# Lines

# Reflection Lines

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From Farin and Harnsford

# Feature Detectors!

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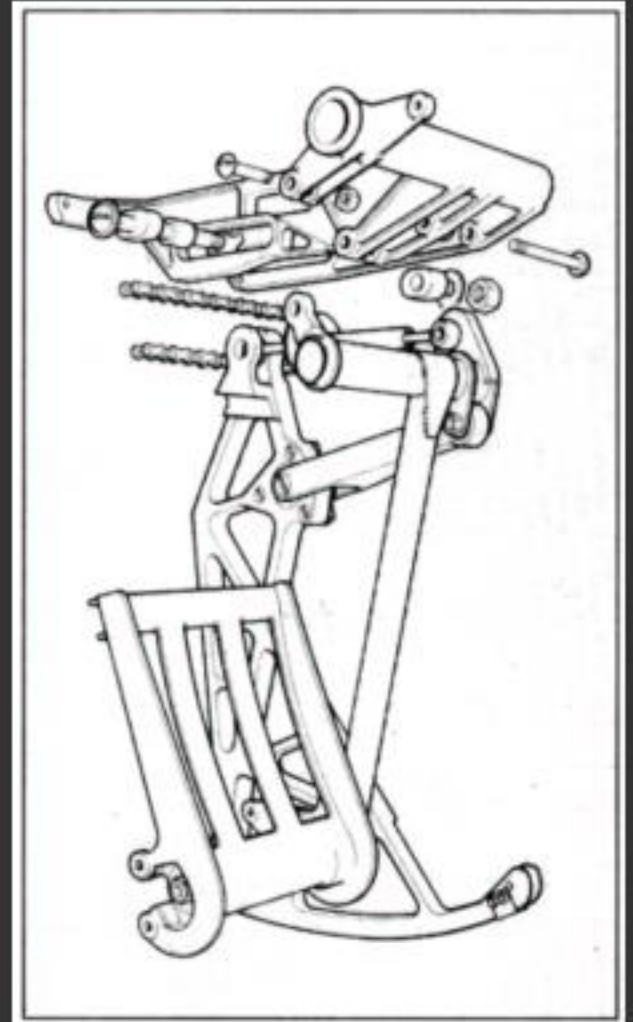
**Picasso, Portrait of Igor Stravinsky, 1920.**

**Graphite and charcoal, Musée Picasso, Paris, France**

# Conveying Shape

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## Shading Lines



From Gooch<sup>2</sup>

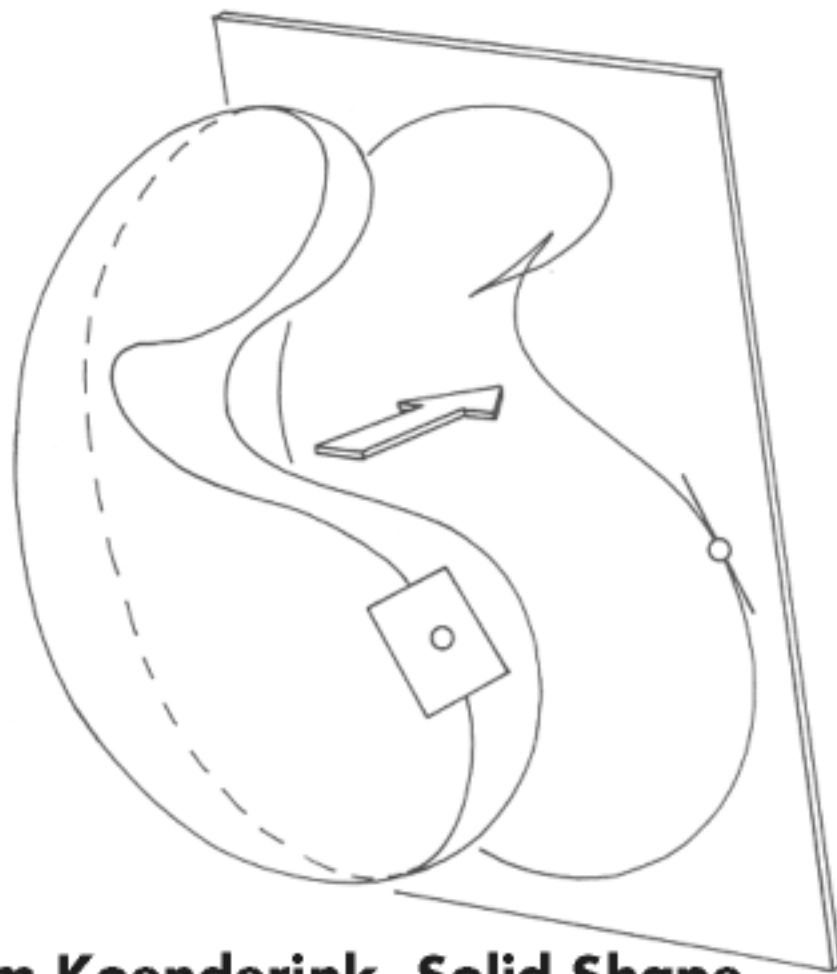
# Types of Lines

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- **Discontinuities: creases and self-intersections**
- **Boundaries between surface patches**
- **Silhouettes and contours and cusps**
- **Parabolic lines**
- **Isoparametric lines**
- **Lines of curvature**
- **Attached and unattached shadows**
- **Isoluminance and luminance extrema**
- **Highlights**

# Occluding Contour

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**From Koenderink, Solid Shape**

# Examples of Line Types

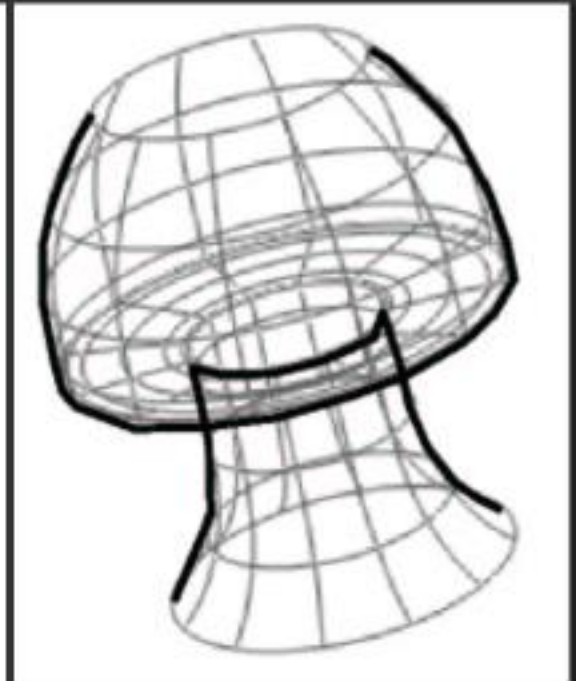
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**Discontinuities**



**Boundaries**



**Silhouettes**



# Line Drawing Conventions

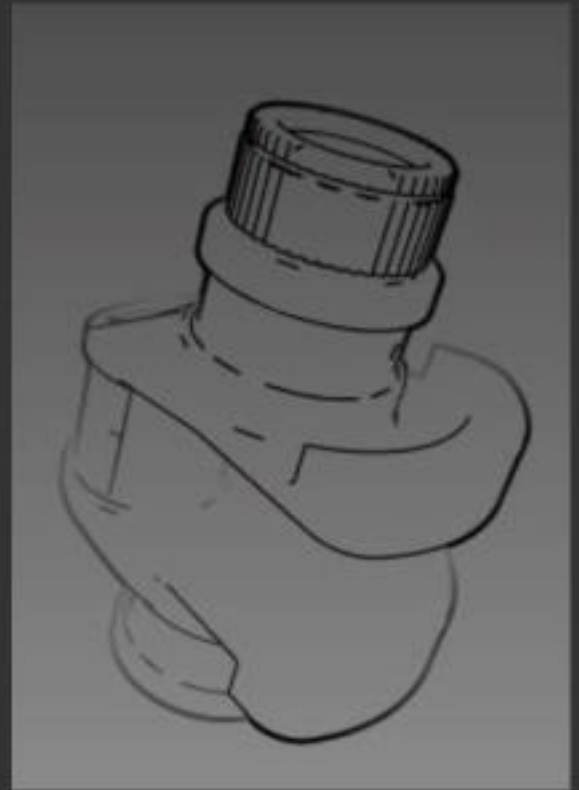
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**Single weight**



**Two weights**

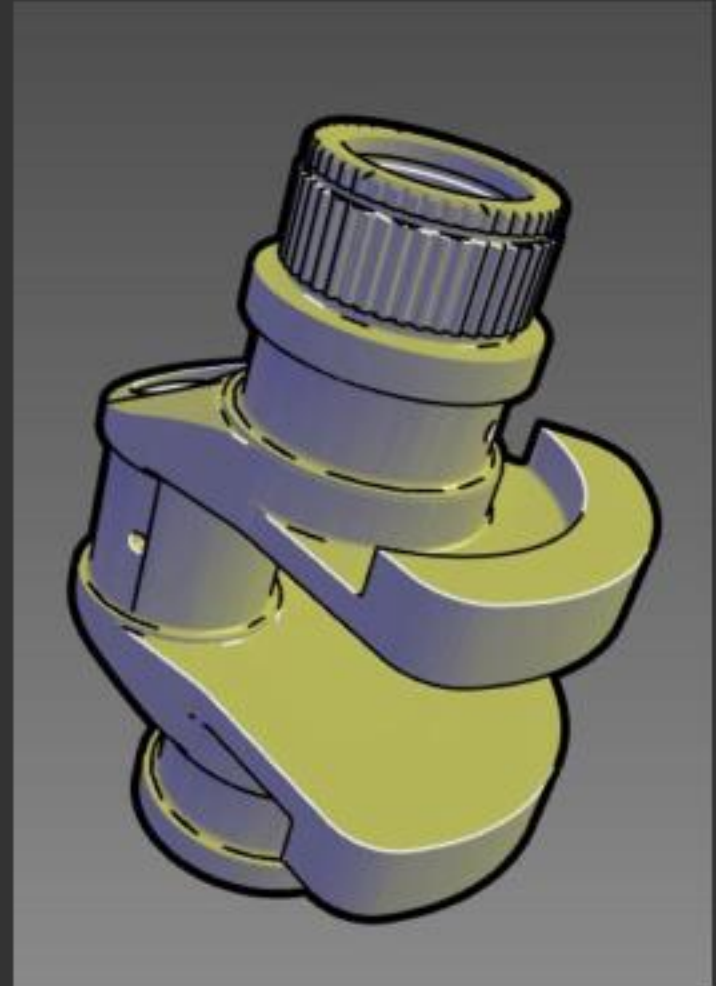


**Distance weighting**

**From Martin (reproduced in Gooch and Gooch)**

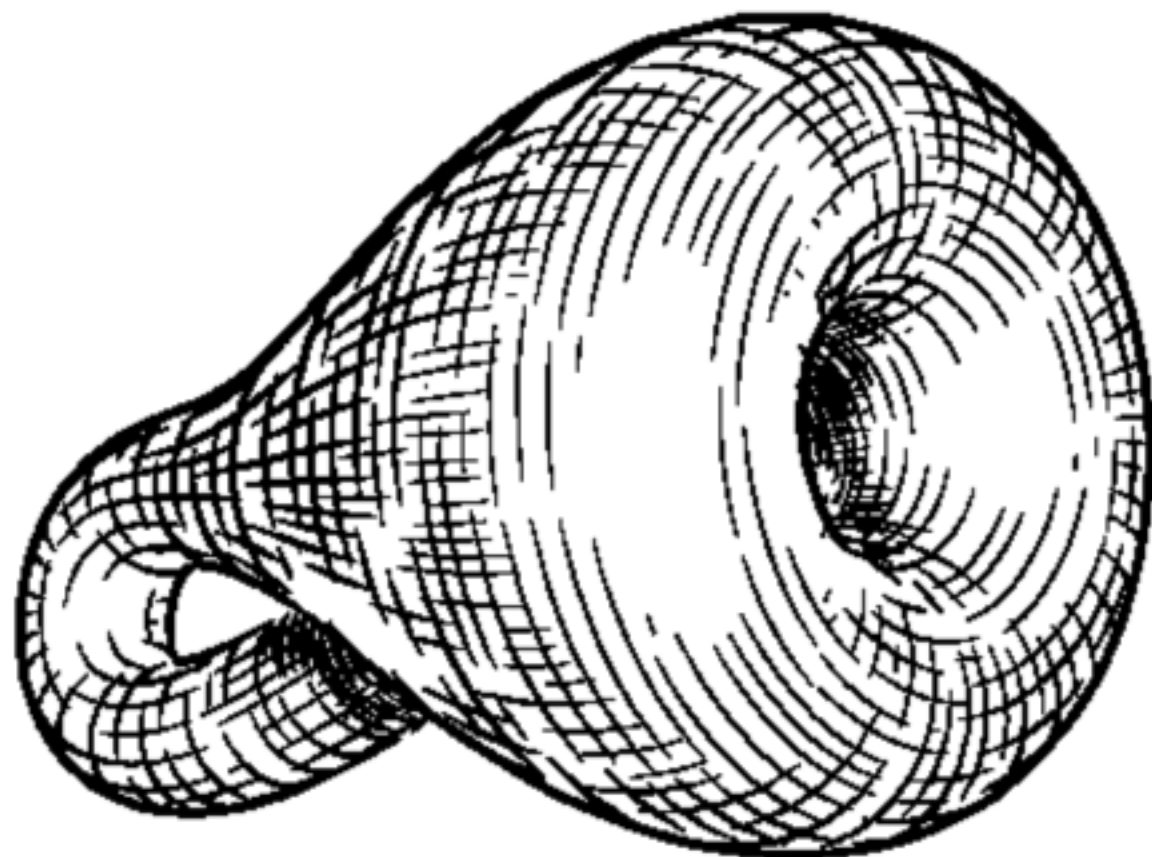
# Highlighting

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# Curvature Directions

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Klein bottle

From Hertzmann and Zorin

# Photorealism vs. Non-Photorealism

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Mississippi River Bank, Saint Paul  
From Hui Xu and Baoquan Chen



# Photograph to Illustration

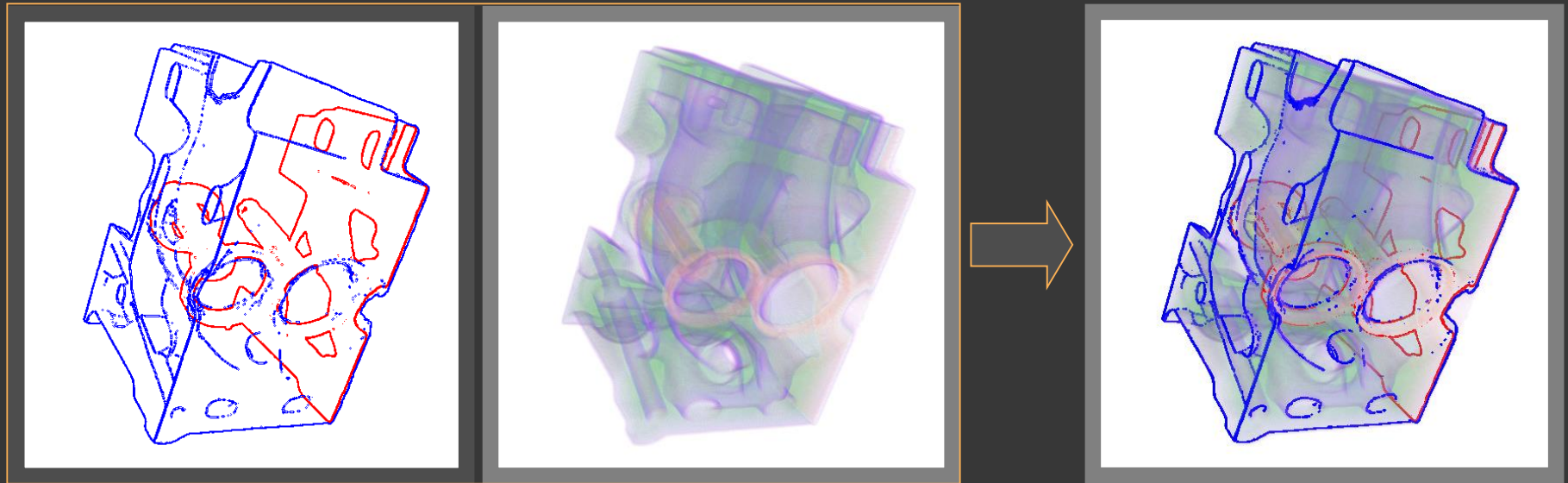
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**Raskar, et al. Non-photorealistic Camera ..., SIGGRAPH'04**

# Mixing Surfaces with Volumes

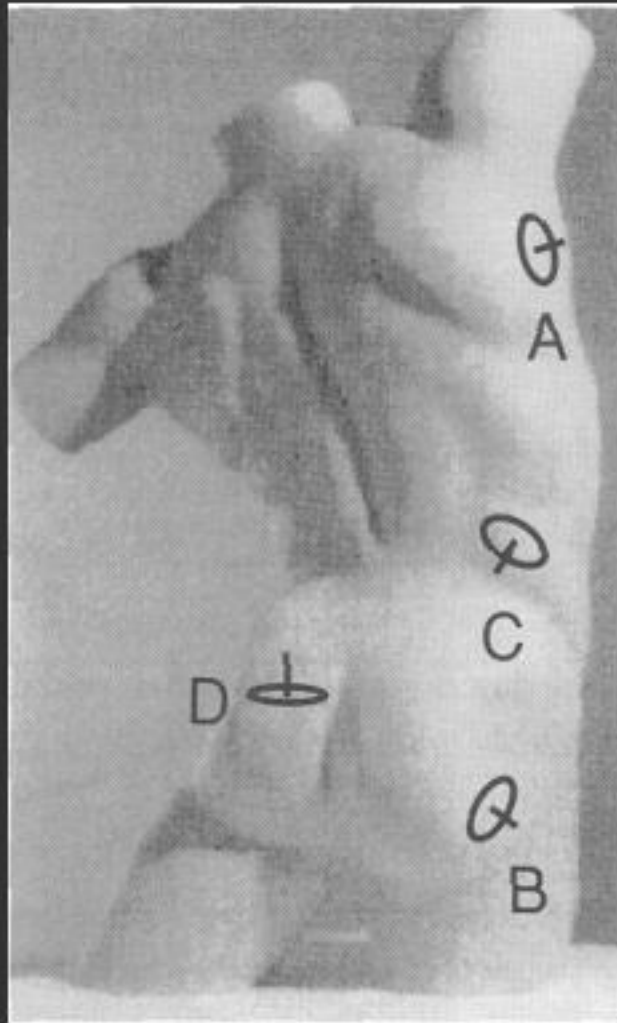
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shading

# Estimating Orientation

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From Koenderink, van Doorn, Kappers



# Goals

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- Show form and orientation of surface
- Maintain contrast with background
- Reveal textural details
- Emphasize important features

Shading model developed by Gooch et al.

# Learning from Technical Illustration

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The non-photorealistic cool (blue) to warm (tan) transition on the skin of the garlic. Colored pencil drawing by Susan Ashurst.

# Learning from Technical Illustration

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Characteristics in many technical illustrations:

- edge lines, the set containing surface boundaries, silhouettes, and discontinuities, are drawn with black curves
- matte objects are shaded with intensities far from black or white with warmth or coolness of color indicative of surface normal; a single light source provides white highlights
- shadowing is not shown
- metal objects are shaded as if very anisotropic

# Learning from Technical Illustration

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Edward Tufte. *Visual Explanations*. Graphics Press, 1997:

Tufte advocates improving a computer graphics animation by lowering the contrast of the shading and adding black lines to indicate direction. He states that this is an example of the strategy of *the smallest effective difference* :

*Make all visual distinctions as subtle as possible, but still clear and effective.*

The principle provides a possible explanation of why cross-hatching is common in black and white drawings and rare in colored drawings: colored shading provides a more subtle, but adequately effective difference to communicate surface orientation.

# Traditional Shading of Matte Objects

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$$I = k_d k_a + k_d \max(0, \hat{\mathbf{i}} \cdot \hat{\mathbf{n}})$$

# Tone-based Shading of Matte Objects

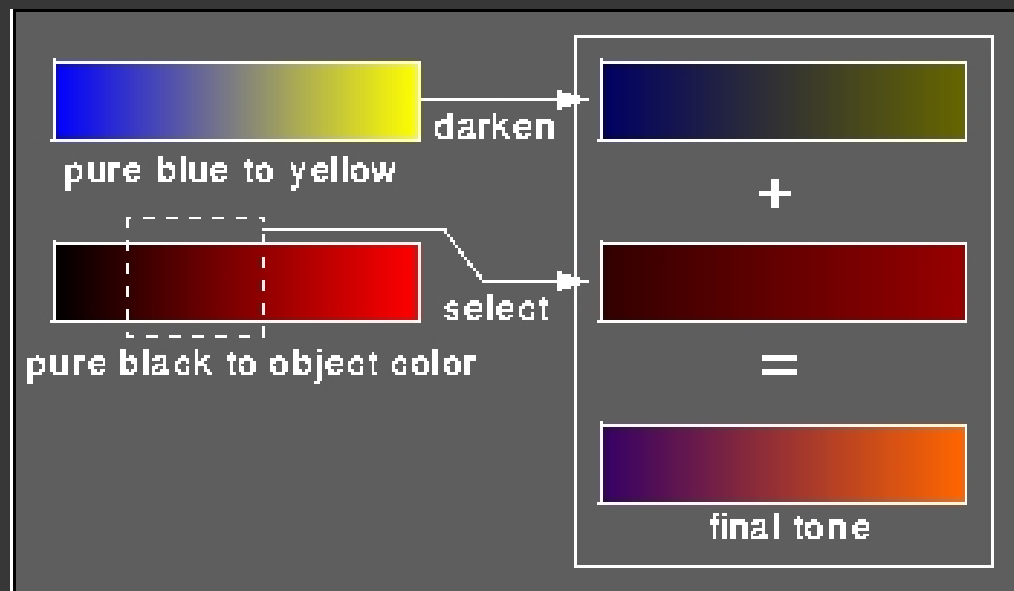
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Adding blacks and whites to a given color results in what artists call *shades* in the case of black, and *tints* in the case of white. When color scales are created by adding grey to a certain color they are called *tones*.

*The **temperature** of a color is defined as being warm (red, orange, and yellow), cool (blue, violet, and green), or temperate (red-violets and yellow-greens). The depth cue comes from the perception that cool colors recede while warm colors advance.*

# Tone-based Shading of Matte Objects

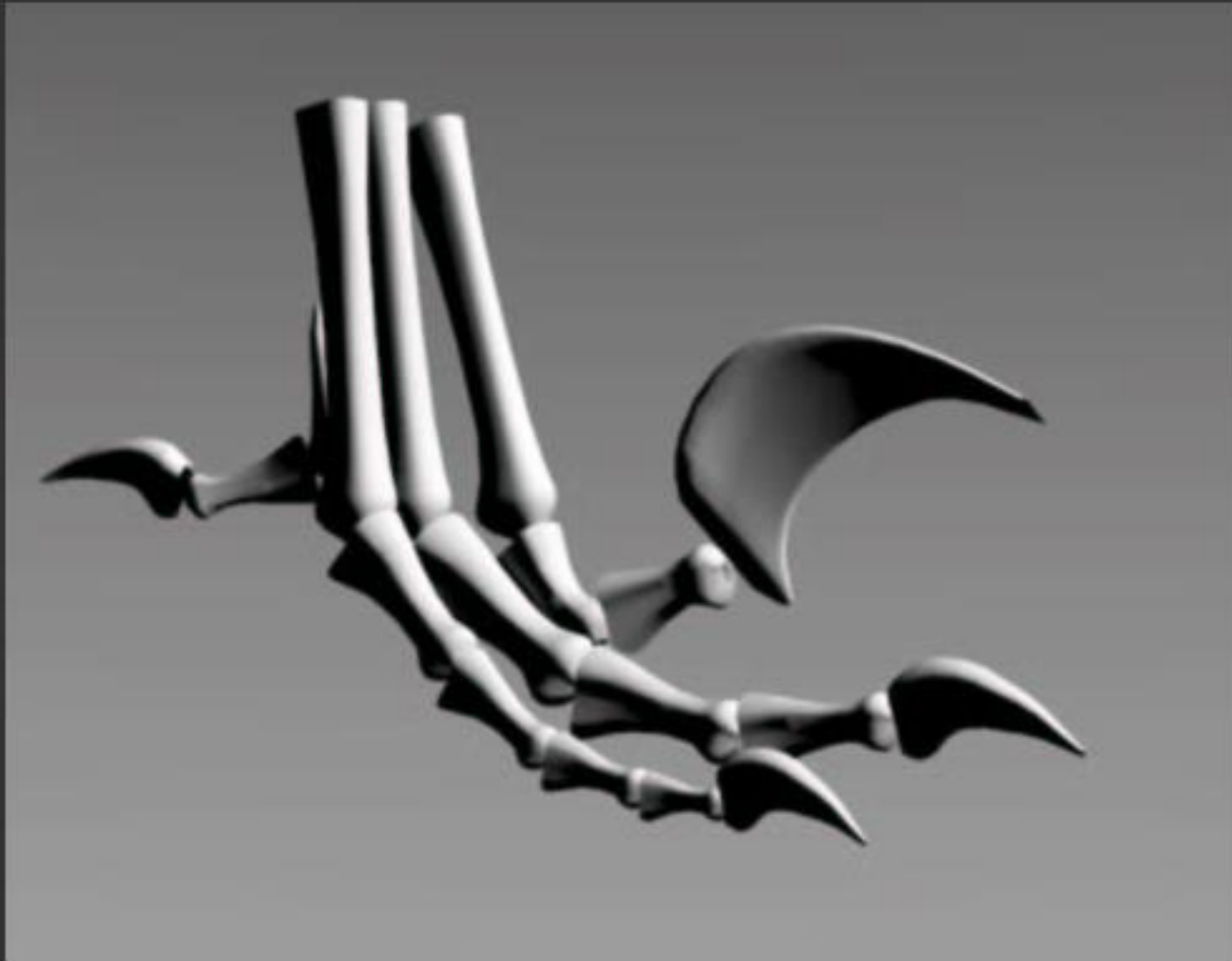
How the tone is created for a pure red object by summing a blue-to-yellow and a dark-red-to-red tone.



$$I = \left( \frac{1 + \hat{\mathbf{l}} \cdot \hat{\mathbf{n}}}{2} \right) k_{cool} + \left( 1 - \frac{1 + \hat{\mathbf{l}} \cdot \hat{\mathbf{n}}}{2} \right) k_{warm}$$

# Diffuse + No Ambient

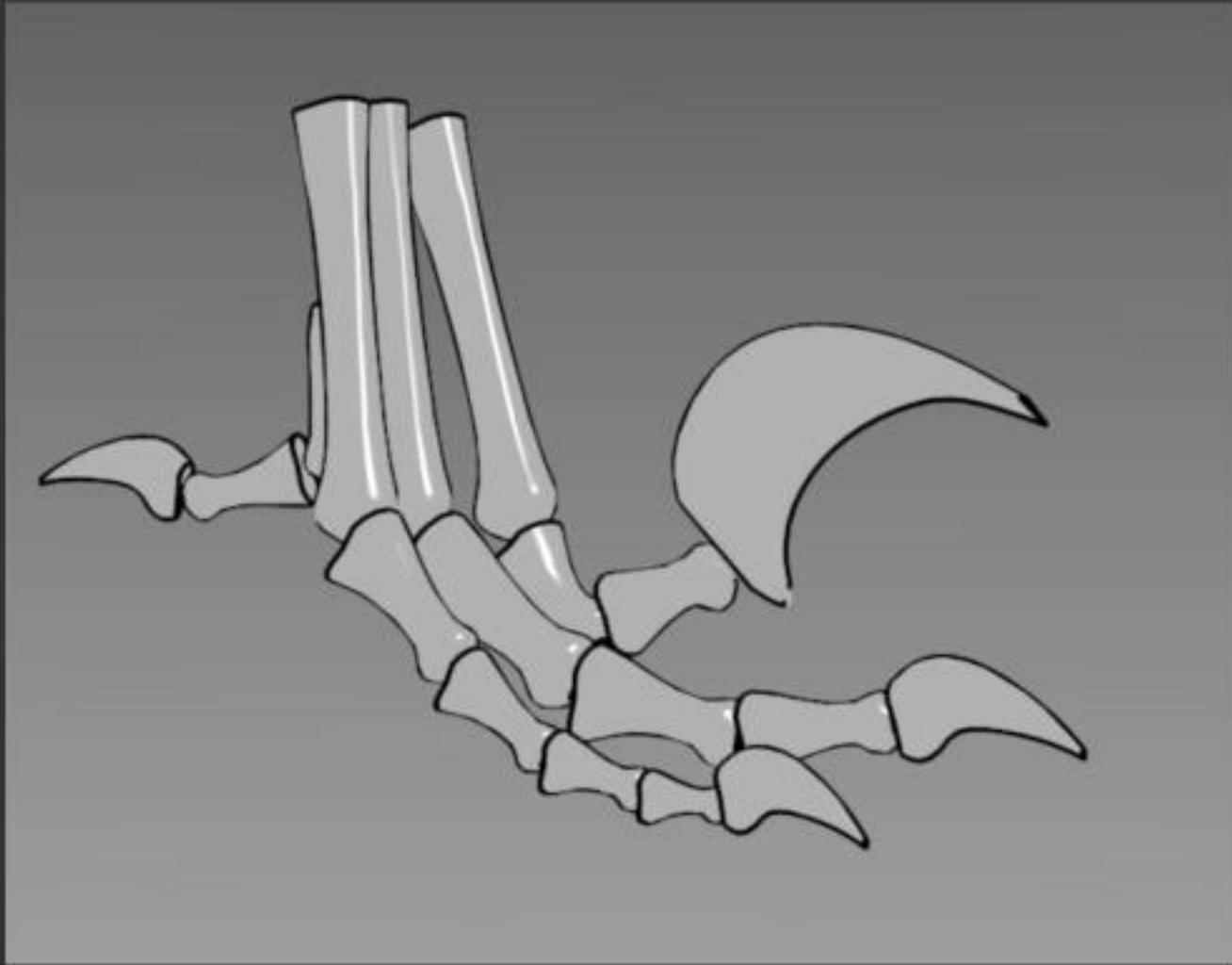
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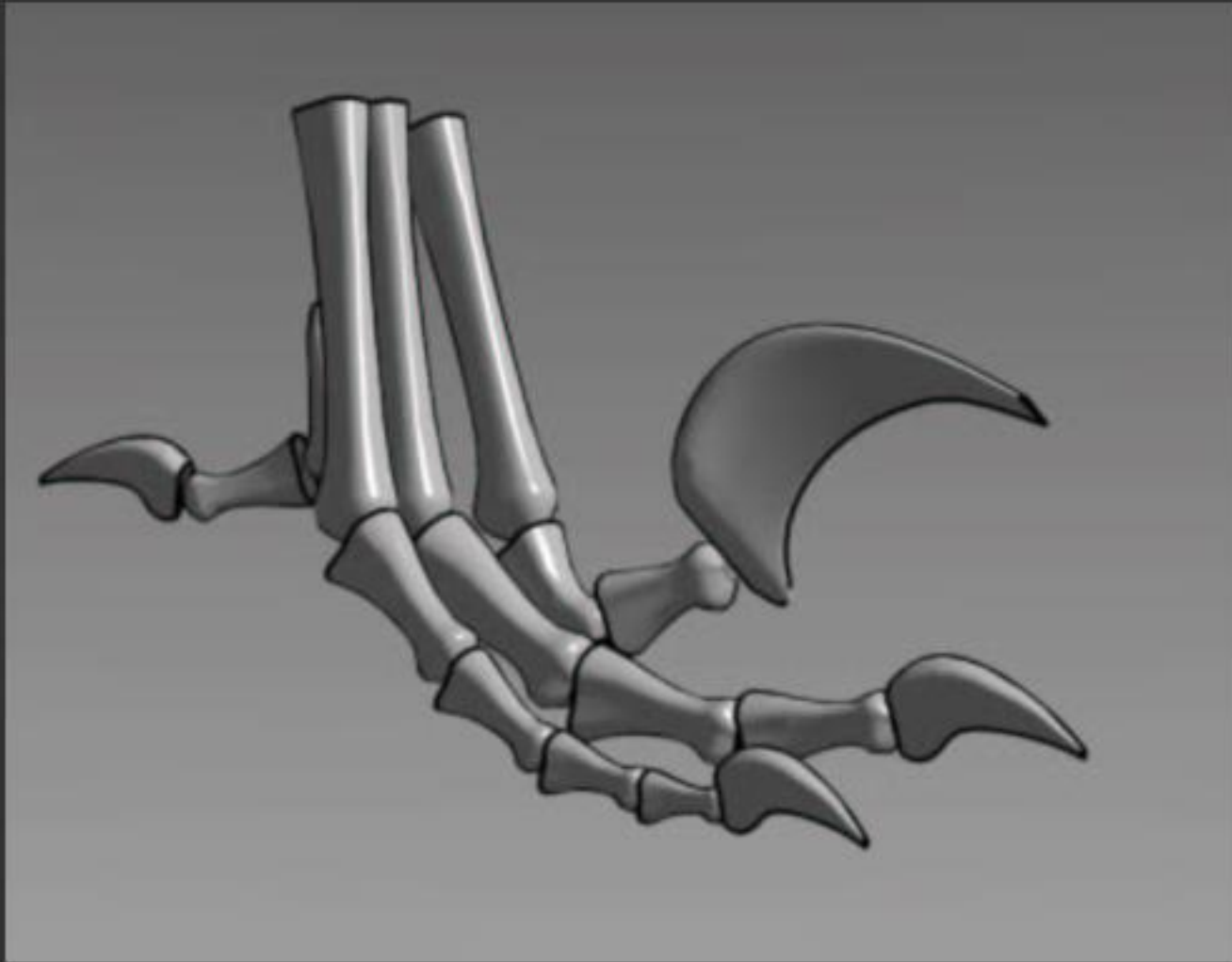
# Edges + Highlights

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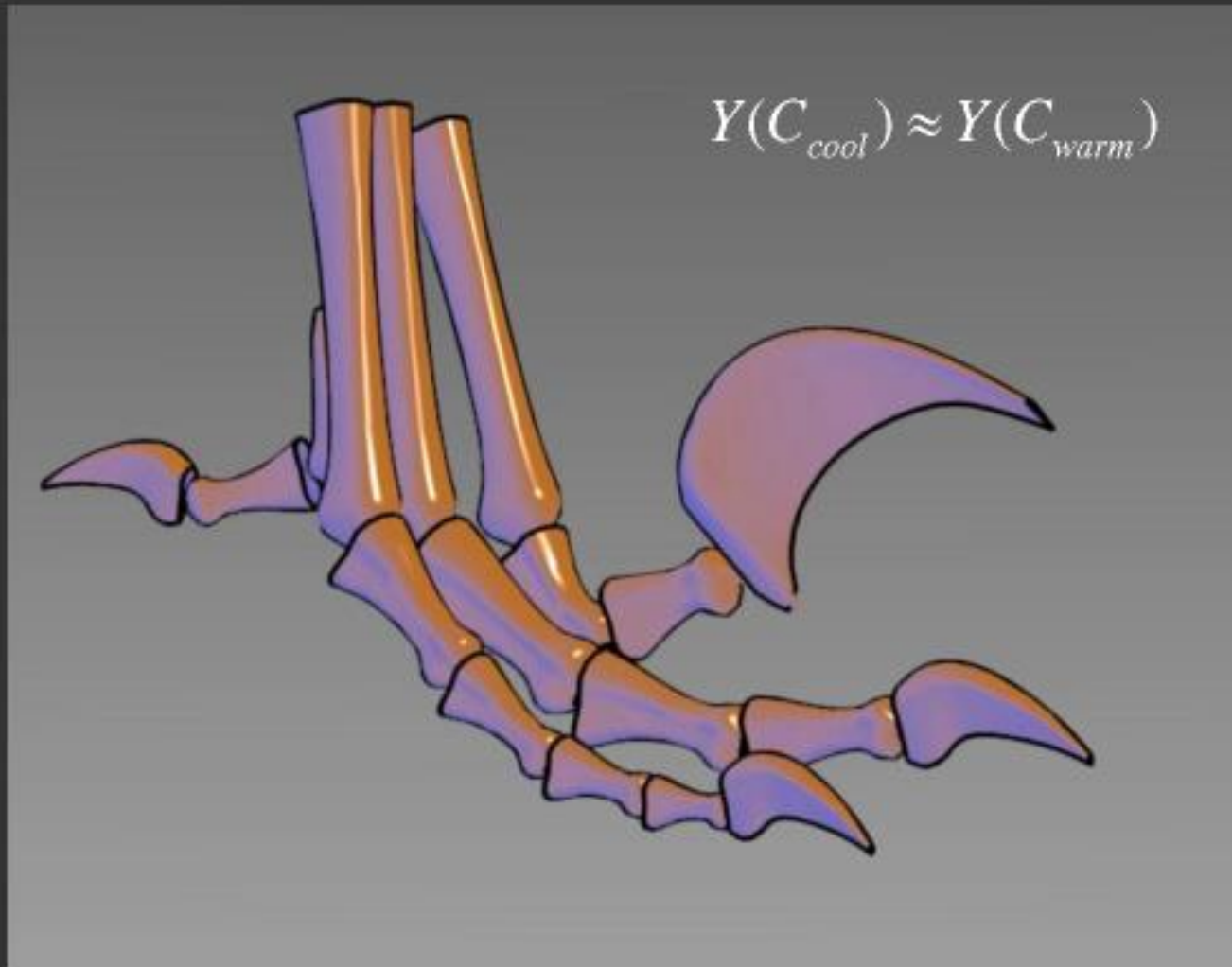
# Lower Diffuse; Add Ambient

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# Tone-based Shading

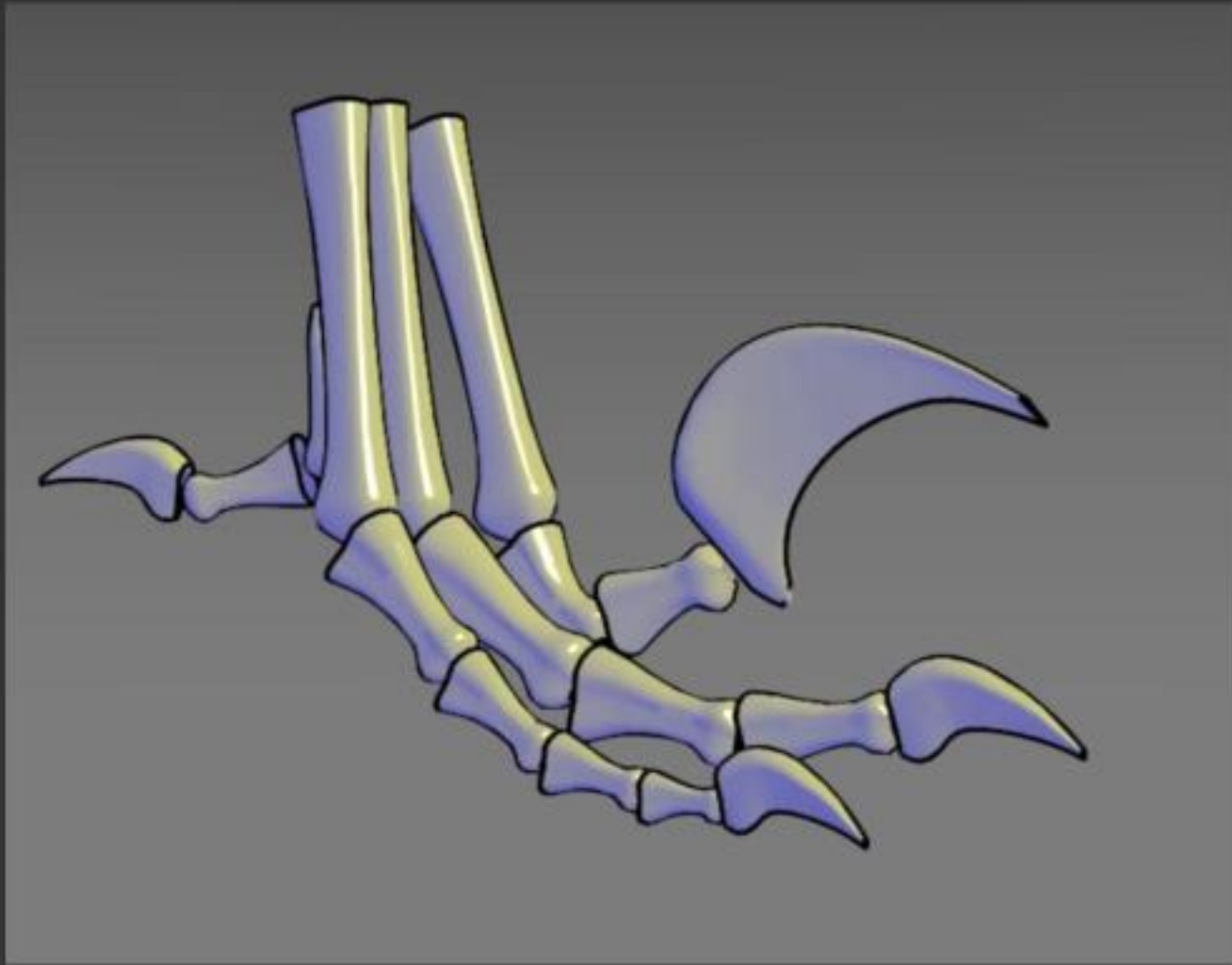
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$$L = \text{lerp}\left(\frac{1 + \hat{\mathbf{N}} \cdot \hat{\mathbf{L}}}{2}, C_{cool}, C_{warm}\right)$$

# Tone-based Shading

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Blue to yellow + object color

# Anisotropic Metallic Objects

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# Shading of Metal Objects

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In practice illustrators represent a metallic surface by alternating dark and light bands, what is known as “*anisotropic reflection*” on milled metal parts. Lines are streaked in the direction of the axis of minimum curvature,

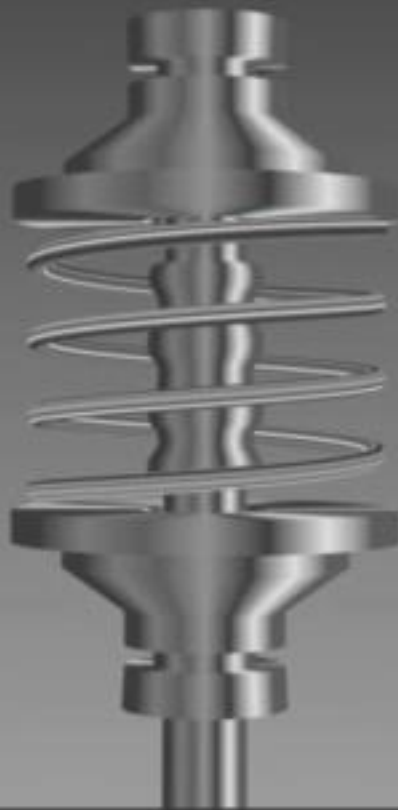
To simulate a milled object, we map a set of 20 stripes of varying intensity along the parametric axis of maximum curvature. The stripes are random intensities between 0.0 and 0.5 with the stripe closest to the light source direction overwritten with white. Between the stripe centers the colors are linearly interpolated.

# Metallic Shading

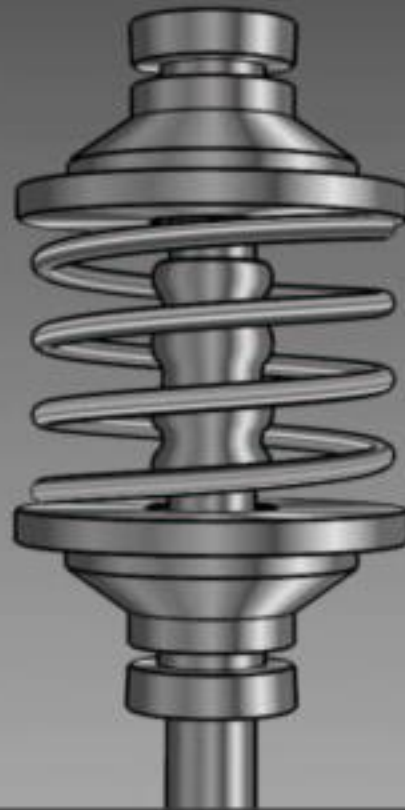
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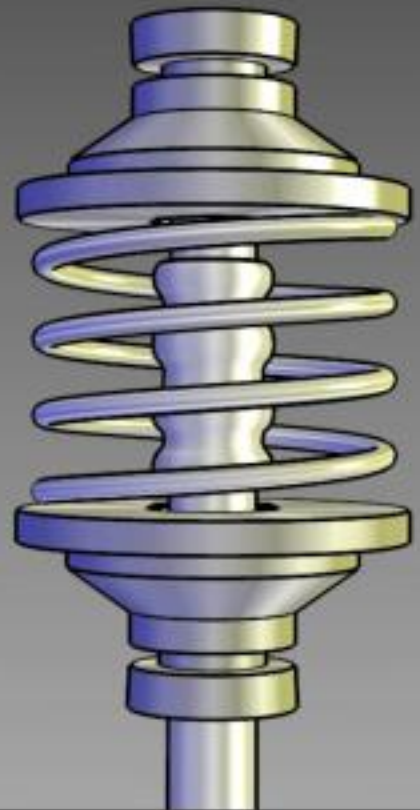
**Phong**



**Metal**



**Metal+Edges**



**Metal+Tone**

# Summary

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- Illustrations better than photographs!
- Illustration techniques
- Enhance important features
- Deemphasize unimportant detail
- Depending on task, lines may be better than shaded pictures
- Cartoon shading may be better than realistic shading
- Static views may be better than animation
- Interested related topics: best views, shadows