B. Begin Planning Your Final Project

Part 1: Cook-Torrance and Gooch shading
The topic I am (hopefully) exploring in my final project is bidirectional reflectance distribution functions, or more specifically the Cook-Torrance reflectance model, as detailed in their 1982 paper available here. If it looks nice, I will also combine it with the Gooch shading model (detailed in their 1998 paper here).

The Cook-Torrance model is an alternative to the Blinn-Phong model of specular lighting that can render objects based on the relative brightness of different lights and materials.

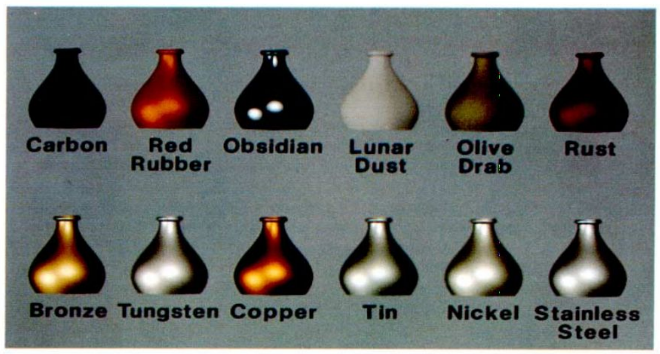

Fig. 7. A variety of vases.

The Cook-Torrance model is based on the following spectral calculation:

$$k_{\text{spec}} = \frac{DFG}{4(V \cdot N)(N \cdot L)}$$

Where

- k_{spec} is the spectral light
- D is the result of a facet slope distribution function (there are a few to choose one, but Cook and Torrance use a function developed by Blinn in their examples)
- F is the result of a Fresnel term calculation (I will most likely implement Schlik's approximation of this)
- G is the result of the following equation representing microsurface self-shadows:
  - $G = \min\left(1, \frac{2(H \cdot N)(V \cdot N)}{V \cdot H}, \frac{2(H \cdot N)(L \cdot N)}{V \cdot H}\right)$
  - H here is the half-angle between the normal and viewing vectors, as used in the Blinn-Phong spectral model
- V is the view (camera) vector, L is the light vector, and N is the normal vector

Implementing this function in HLSL is a matter of translation more than anything. Additionally, I will have to optimize wherever possible by researching possibly more efficient approximations of D, F, and G.

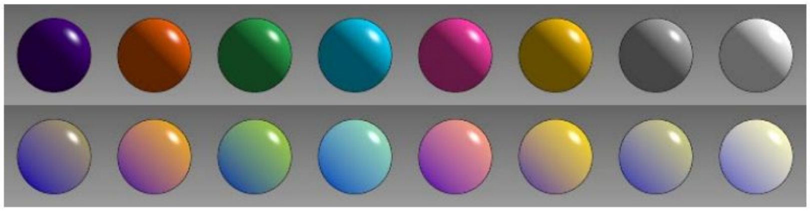

Figure 9: Top: Colored Phong-shaded spheres with edge lines and highlights. Bottom: Colored spheres shaded with hue and luminance shift, including edge lines and highlights. Note: In the first Phong shaded sphere (violet), the edge lines disappear, but are visible in the corresponding hue and luminance shaded violet sphere. In the last Phong shaded sphere (white), the highlight vanishes, but is noticed in the corresponding hue and luminance shaded white sphere below it. The spheres in the second row also retain their "color name".

Gooch shading will involve either a separate pass or an additional set of calculations that color the object based on each pixel's distance from the light source, not dissimilar to the Lambertian model diffuse lighting. This is its equation:

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

Where:

- I is the final Gooch color
- k_{cool} and k_{warm} are the cool and warm colors of the object
- lˆ and nˆ are the normalized light and normal vectors

Implementing this simple function in HLSL is trivial.

Part 2:
My group partners for the final project are Hana Cho and Valentino Abate.