



This is a still from the game *The Legend of Zelda The Wind Waker*. The image here shows a technique known as cel-shading. This is an effect where 3d models have a shader that limits many features of standard shaders to produce an image where 3d models appear to lack depth and appear more cartoony as a result. Like standard shaders, this approach's appearance is still dictated by factors such as camera placement and this one in particular does not change geometry but there are different means of calculating the effects of lighting. Generally, a lighting system uses every shade in a gradient to make a lighting effect where objects appear slowly less lit up as they move out of range of a light source to emulate real life lighting. Cel-shading simplifies lighting by reducing the range of possible light reflection on an object from a gradient to a series of blocks. These blocks are usually few in number and feature different shades of light reflection. If you look at the image above, on the characters face there are two areas with different shades of light: the left and the right. The left side is well lit while the right has a shadow effect. There is no area where the two shades blend. This helps create the illusion that the model on screen is not a 3d model but more like a sketch as the image appears flatter and less like reality. There are generally more aspects to this style such as heavier outlines around objects, but the way lighting is handled is consistent among users of the style.

I enjoy this effect because it is effective in conveying a more cartoonish style. It is very easy on the eyes. Recreating this effect is actually really tricky but I believe I have found some means to attempt it. For one, I found out about this function known as smoothstep which can be used when calculating light intensity on an object. Basically, this function can be used by declaring an upper and lower bound for how much light an object can have (usually we would put the lower bound at pure darkness and the upper at pure light) and the function will then declare whether the amount of light a point on an object is closer to the lower or the upper bound. If it is closer to the lower bound, I assign a low level of light reflection and if it is closer to the higher bound, I assign a higher amount of reflection. This would produce results similar to the image shown above where there are distinct areas with solid blocks of light that do not blend together. This function can be used for other means of helping the style such as using it to produce the right shading for an outline or specular reflection.