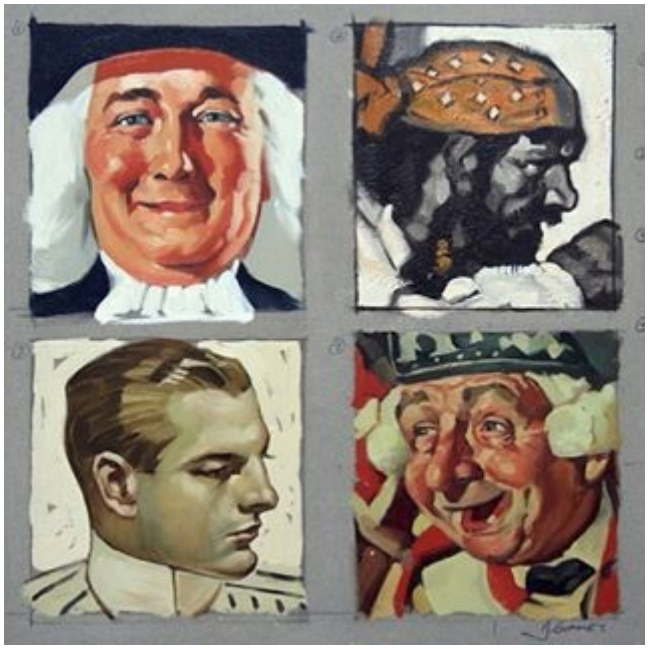
Mitchell at al., the engineers at Valve, present the shading technique used in the popular multi-player shooter, *Team Fortress 2*. Both the technique and their artistic influences yield an original stylistic NPR. The authors claim the technique can quickly convey geometric information, so that players can consistently identify other players under various lighting conditions.

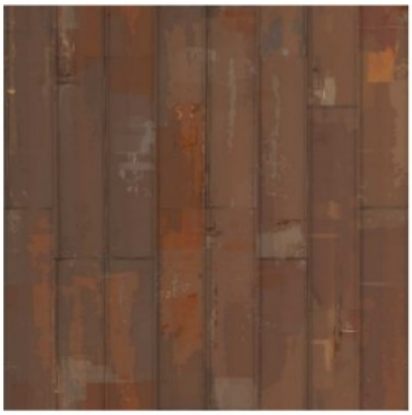
The paper provides information on how to implement shading techniques yielding the style of illustrations of artists such as Leyendecker, Cornwell and Rockwell



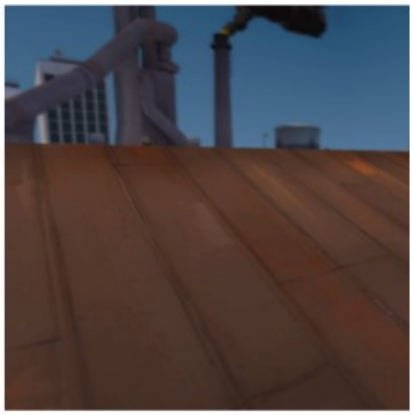
Source

The information specifically include details on *diffuse light warping function* (for illustrative rendering), *rim lighting* and other conventional shading techniques.

Among the miscellaneous prerequisites to achieve the effect discussed in the paper are rather simple yet distinct geometry of various characters and the environment, the use of textures with visible brush strokes and recognizable color scheme (red and blue).



2D Texture



Texture applied in 3D

The technique involves the combination of various view independent and view dependent lighting terms. The former kind includes spatially-varying directional ambient term and modified Lambertian lighting terms.

$$k_d \left[a(\hat{n}) + \sum_{i=1}^{L} c_i w\left(\left(\alpha \left(\hat{n} \cdot \hat{l}_i \right) + \beta \right)^{\gamma} \right) \right]$$

The above expression also includes *a()*, a directional ambient term (irradiance environment map by Ramamoorthi and Hanrahan, 2001) and *w()*, diffuse warping function (1D texture lookup function, typical texture below).

The view dependent terms include Phong specular term and custom rim lighting term.

$$\sum_{i=1}^{L} \left[c_i k_s max\left(f_s \left(\hat{v} \cdot \hat{r}_i \right)^{k_{spec}}, f_r k_r \left(\hat{v} \cdot \hat{r}_i \right)^{k_{rim}} \right) \right] + \left(\hat{n} \cdot \hat{u} \right) f_r k_r a(\hat{v})$$

The result of applying aforementioned terms on a character model is illustrated below.


(a) Albedo


(b) Warped diffuse


(c) Ambient cube

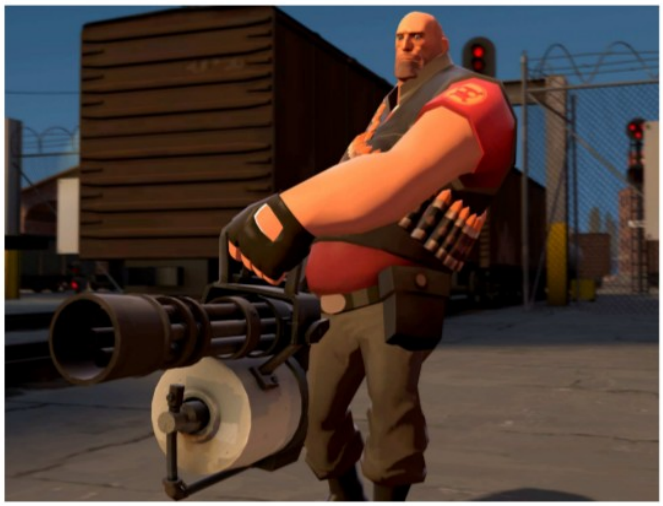

(d) (b) + (c)


(e) (a) * (d)


(f) Specular


(g) Rim lighting


(h) Specular + Rim Lighting


(j) Final result

The techniques discussed in the paper are real-time rendering techniques, appropriate for video-games. They can be implemented using gpu shaders. There are several items the authors left out due to performance reasons. The diffuse term could benefit from a 2D texture (light warp with varying hue) instead of the 1D diffuse light warp. Other improvement, as suggested by the authors, is finding a way for consistent rim highlights, which is currently impossible due to varying mesh density.

The lighting model discussed in this work includes a wealth of tweakable parameters. It would be interesting to implement it and play with different configurations of these parameters and see what effects are possible. Also, the aforementioned issue with rim highlights may be turned into an advantage in certain styles of NPR. It would be interesting to over exaggerate this artifact for unique effects.

References

Jason L. Mitchell, Moby Francke, and Dhabih Eng. 2007. Illustrative rendering in Team Fortress 2. In *ACM SIGGRAPH 2007 courses* (SIGGRAPH '07). ACM, New York, NY, USA, 19-32. DOI=10.1145/1281500.1281666 http://doi.acm.org/10.1145/1281500.1281666

http://in2gpu.com/2014/07/02/rim-lighting/