Stylization with a Purpose
The Illustrative World of Team Fortress 2

Jason Mitchell

VALVE

OUTLINE

- History of Team Fortress
- Characters
  - Art direction
  - Shading algorithms
- Environments
- Meet the Team
- Post-ship
- Sneak Peek of the next *Meet the Team* short!

TEAM FORTRESS MOD

TEAM FORTRESS 2

INITIAL TEAM FORTRESS 2

INITIAL TEAM FORTRESS 2

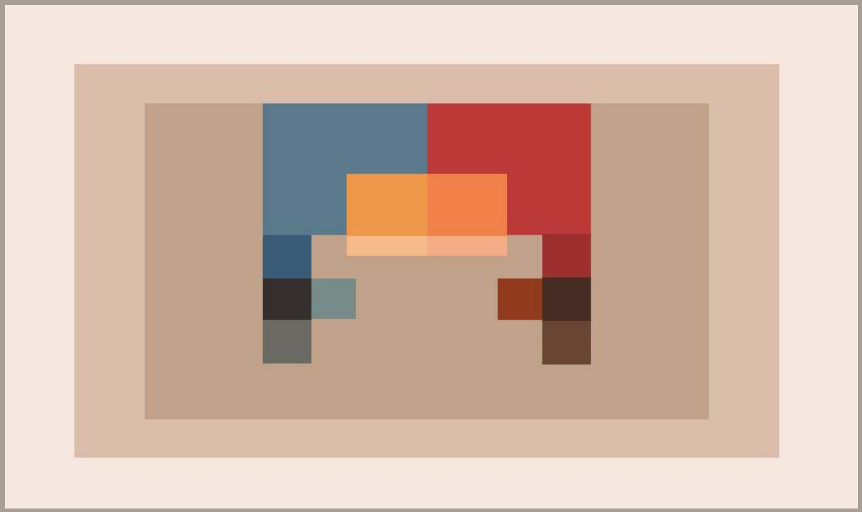
TEAM FORTRESS 2

WHY THE UNIQUE VISUAL STYLE?

- Gameplay
- Readability
- Branding

READ HIERARCHY

- Team – *Friend or Foe?*
  - Color
- Class – *Run or Attack?*
  - Distinctive silhouettes
  - Body proportions
  - Weapons
  - Shoes, hats and clothing folds
- Selected weapon – *What's he packin'?*
  - Highest contrast at chest level, where weapon is held
  - Gradient from dark feet to light chest



Color Swatch

EARLY 20TH CENTURY COMMERCIAL ILLUSTRATION

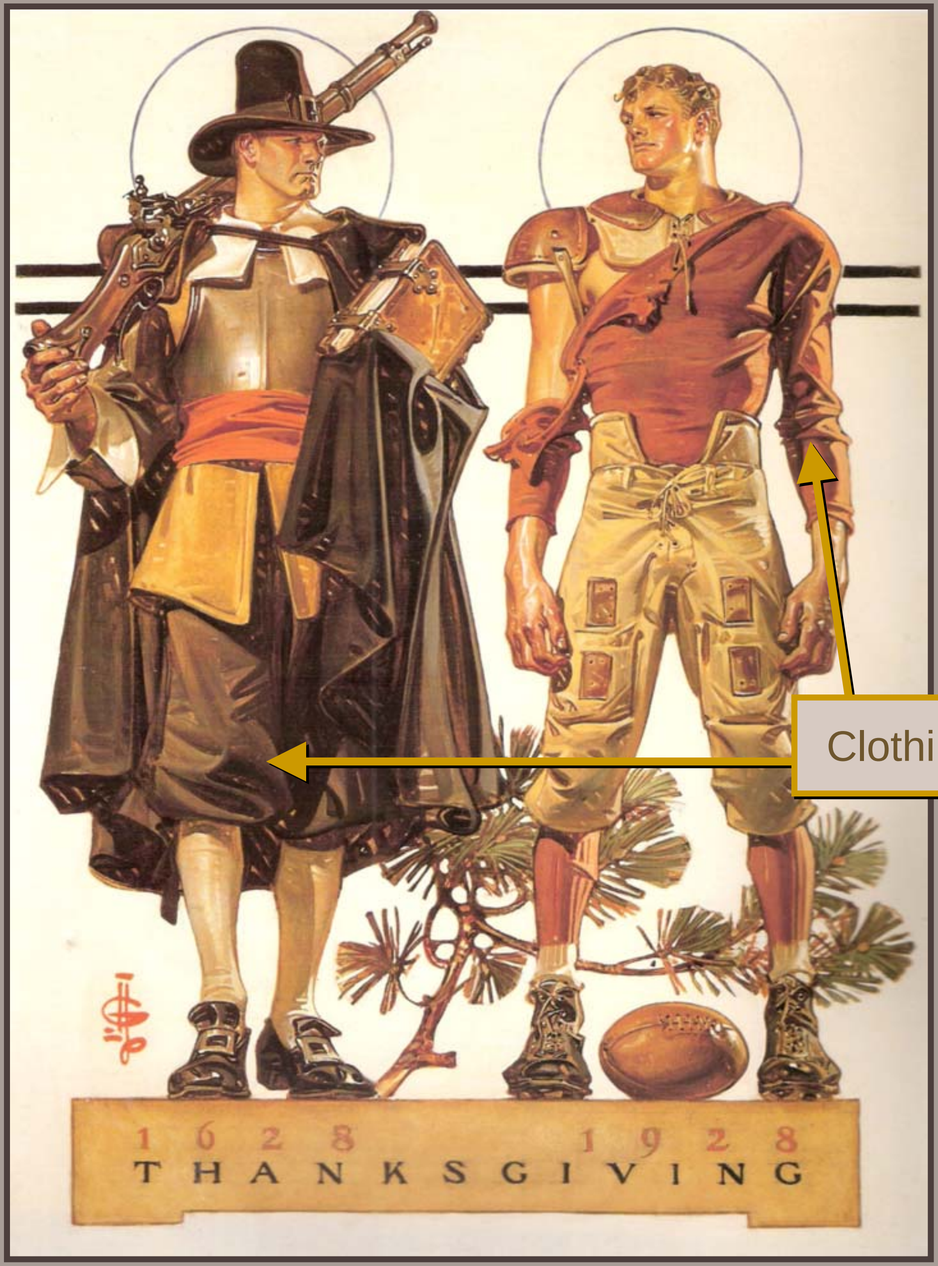
J. C. Leyendecker

Dean Cornwell

Norman Rockwell

EARLY 20TH CENTURY COMMERCIAL ILLUSTRATION

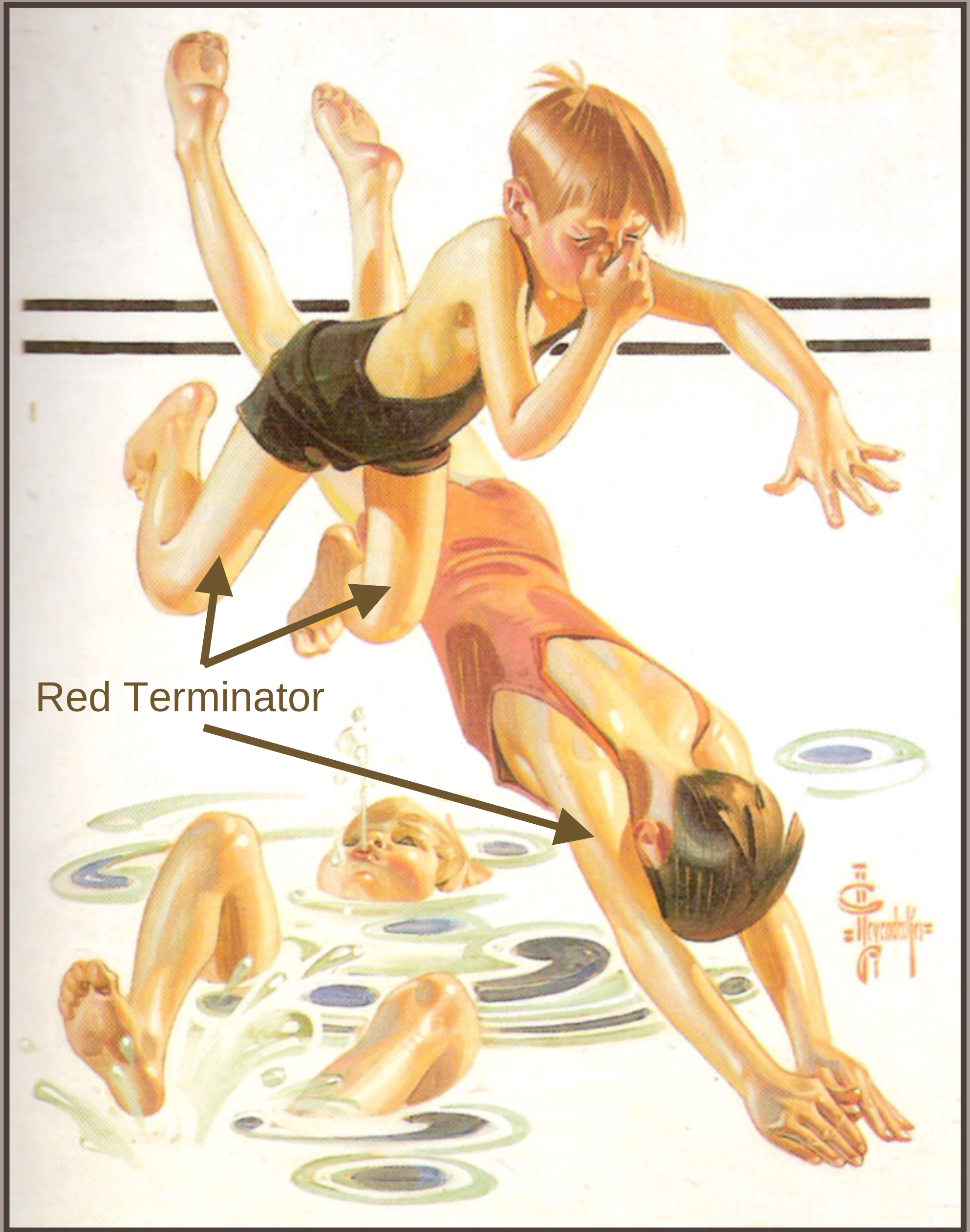
- Chose to adopt specific conventions of the commercial illustrator J. C. Leyendecker:
  - Shading obeys a warm-to-cool hue shift. Shadows go to cool, not black
  - Saturation increases at the terminator with respect to a given light source. The terminator is often reddened.
  - On characters, interior details such as clothing folds are chosen to echo silhouette shapes
  - Silhouettes are often emphasized with rim highlights rather than dark outlines



J.C. Leyendecker
Thanksgiving 1628-1928

J.C. Leyendecker
Tally-Ho, 1930

J.C. Leyendecker
Arrow collar advertisement, 1929



J.C. Leyendecker
Swimmin' Hole, 1935

RIM HIGHLIGHTING

Rim Highlighting

CHARACTER CREATION

1. Character silhouette
2. Interior shapes
3. Model sheet
4. 3D Model
5. Character Skin
6. Final Character in game

CHARACTER SILHOUETTE

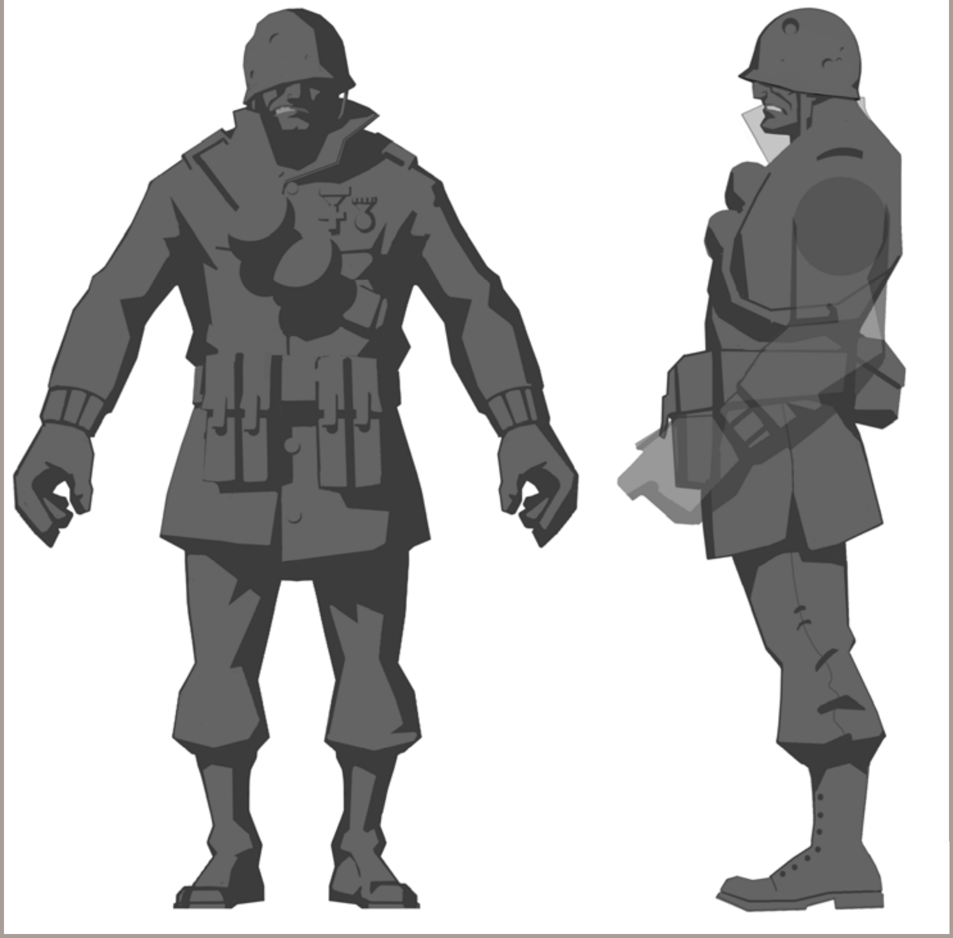
- Building block of character design
- Identifiable at first read

INTERIOR SHAPES

- Solving interior character design with shadow shapes
- Keep it iconic
- Work out design in three quarter pose

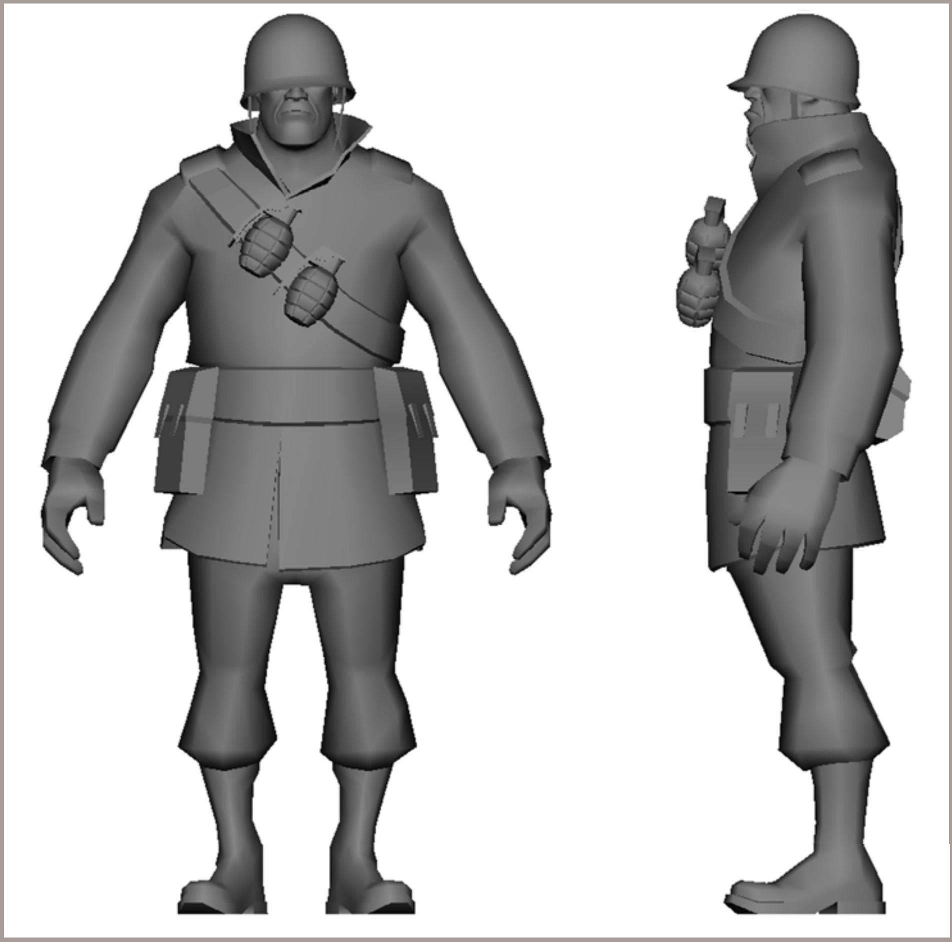
MODEL SHEET

- Use concept painting as guide
- Solve design problems using silhouette only
- Solve interior design with shadow shapes

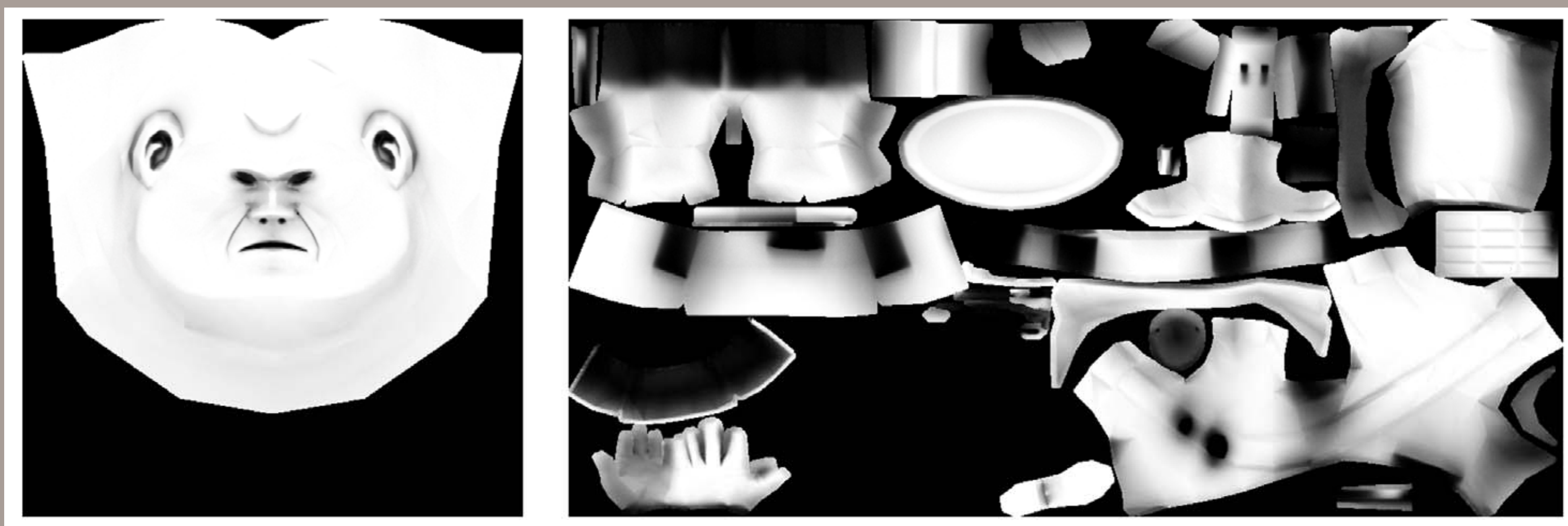


3D Model

- Match silhouette to model sheet
- Solve 3 quarter design with screenshots / paintovers
- Model with character in mind



BASE AMBIENT OCCLUSION MAP

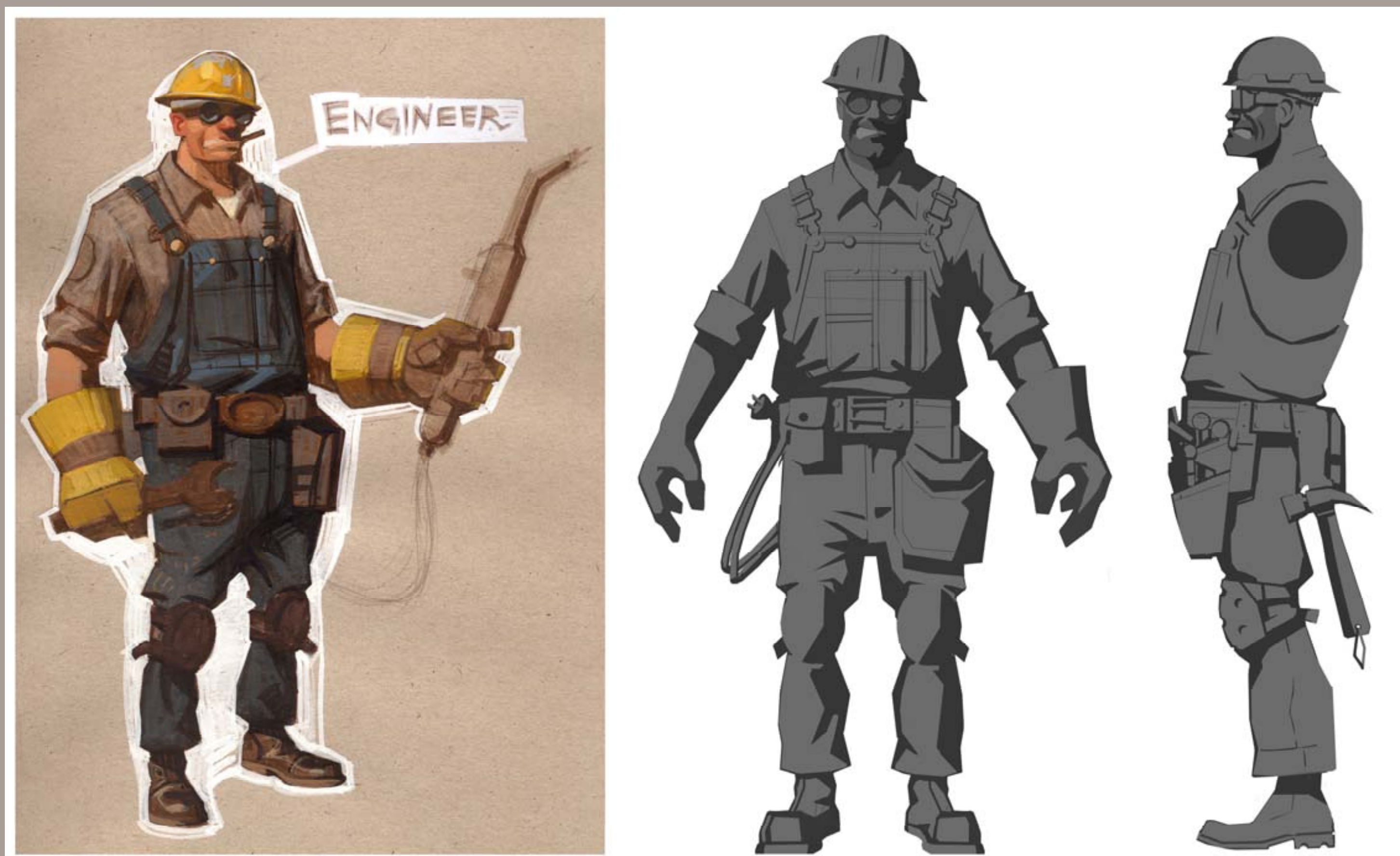


CHARACTER SKIN

FINAL CHARACTER

- 3D model with texture and basic shading

ENGINEER CONCEPT



ENGINEER MODEL

PYRO CONCEPT

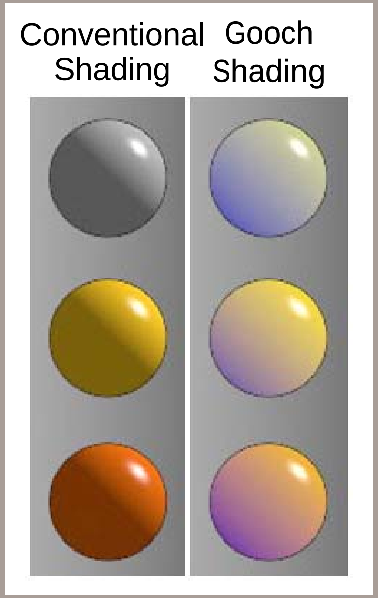
PYRO MODEL

Character Shading Algorithm

- Previous work in Non-Photorealistic Rendering
- Character lighting equation in *Team Fortress 2*

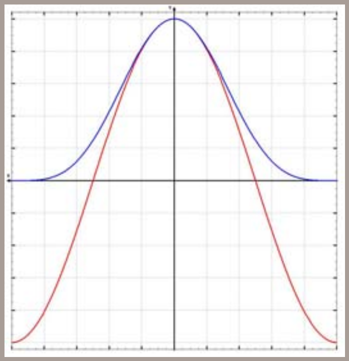
Gooch, 1998

- Hue and luminance shifts indicate surface orientation relative to light
- Blend between warm and cool based upon unclamped Lambertian term, underlying albedo and some free parameters
- Extreme lights and darks are reserved for edge lines and highlights



$$\left(\frac{1}{2}\left(\hat{n}\cdot\hat{l}\right)+\frac{1}{2}\right)\left(k_{blue}+\alpha k_d\right)+\left(1-\left(\frac{1}{2}\left(\hat{n}\cdot\hat{l}\right)+\frac{1}{2}\right)\right)\left(k_{yellow}+\beta k_d\right)$$

HALF LAMBERT



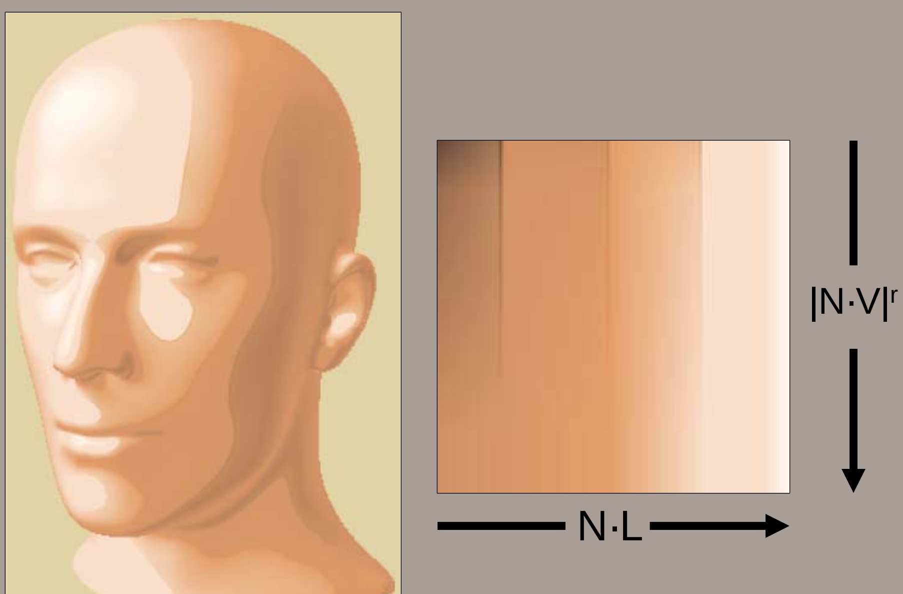
- Typically clamp N·L to zero at the terminator
- Half Lambert scales the -1 to 1 cosine term (red curve) by ½, biases by ½ and squares to pull the light all the way around (blue curve)
- We have been applying this curve since *Half-Life* in 1998
- Similar to *Exaggerated Shading* [Rusinkiewicz06]

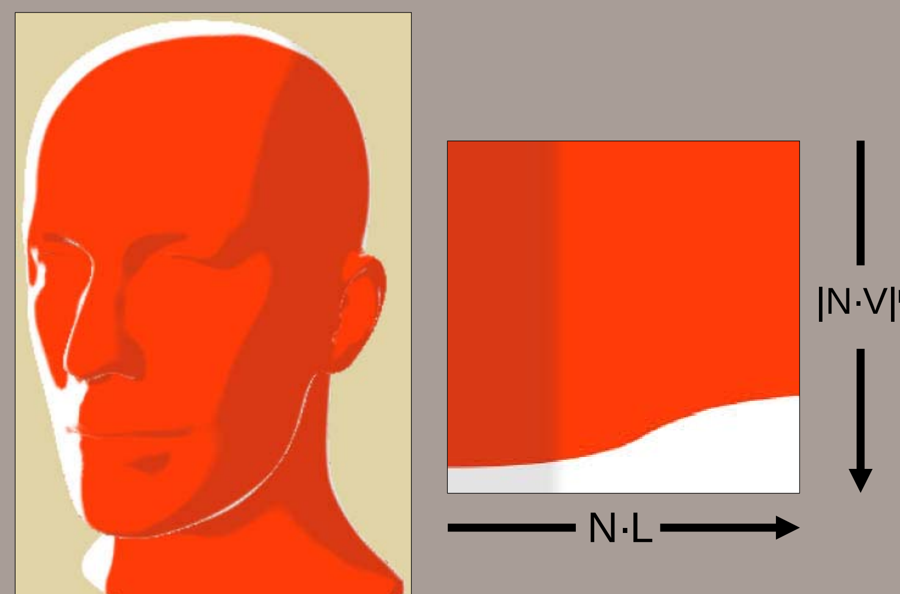
Lake, 2000

- Lake used a 1D texture lookup based upon the Lambertian term to simulate the limited color palette cartoonists use for painting cels
- Also allows for the inclusion of a view-independent pseudo specular highlight by including a small number of bright texels at the “lit” end of the 1D texture map

BARLA, 2006

- Barla has extended this technique by using a 2D texture lookup to incorporate view-dependent and level-of-detail effects.
- Fresnel-like creates a hard “virtual backlight” which is essentially a rim-lighting term, though this term is not designed to correspond to any particular lighting environment.





CHARACTER LIGHTING EQUATION

VIEW INDEPENDENT

$$k_d\left[a(\hat{n})+\sum_{i=1}^{L}c_i w\left(\left(\frac{1}{2}\left(\hat{n}\cdot\hat{l}_i\right)+\frac{1}{2}\right)\right)\right]+$$

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

VIEW-DEPENDENT

View Independent Terms

$$k_d\left[\boxed{a\left(\hat{n}\right)}+\sum_{i=1}^{L}c_i w\left(\left(\frac{1}{2}\left(\hat{n}\cdot\hat{l}_i\right)+\frac{1}{2}\right)\right)\right]$$

- Spatially-varying directional ambient

View Independent Terms

$$k_d\left[a(\hat{n}) + \boxed{\sum_{i=1}^{L} c_i w\left(\left(\frac{1}{2}\left(\hat{n}\cdot\hat{l}_i\right)+\frac{1}{2}\right)\right)}\right]$$

- Spatially-varying directional ambient
- Modified Lambertian terms

VIEW INDEPENDENT TERMS

$$k_d\left[a(\hat{n})+\sum_{i=1}^{L}c_i w\left(\left(\frac{1}{2}\boxed{\left(\hat{n}\cdot\hat{l}_i\right)}+\frac{1}{2}\right)\right)\right]$$

- Spatially-varying directional ambient
- Modified Lambertian terms
  - Unclamped Lambertian term

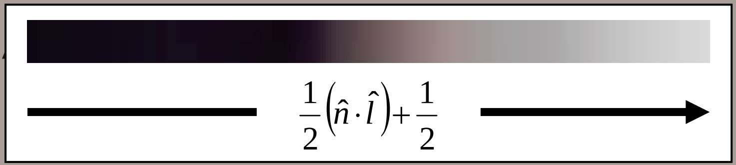
VIEW INDEPENDENT TERMS

$$k_d\left[a(\hat{n})+\sum_{i=1}^{L}c_i w\left(\boxed{\left(\frac{1}{2}\left(\hat{n}\cdot\hat{l}_i\right)+\frac{1}{2}\right)}\right)\right]$$

- Spatially-varying directional ambient
- Modified Lambertian terms
  - Unclamped Lambertian term
  - Scale, bias and exponent

VIEW INDEPENDENT TERMS

$$k_d \left[a(\hat{n}) + \sum_{i=1}^{L} c_i \boxed{w\left(\left(\frac{1}{2}\left(\hat{n}\cdot\hat{l}_i\right)+\frac{1}{2}\right)\right)} \right]$$

- Spatially-varying directional ambient
- Modified Lambertian terms
  - Unclamped Lambertian term
  - Scale, bias and exponent
  - Warping function
- 

VIEW INDEPENDENT TERMS

$$k_d \left[a(\hat{n}) + \sum_{i=1}^{L} c_i \, w\left(\left(\frac{1}{2} \left(\hat{n} \cdot \hat{l}_i \right) + \frac{1}{2} \right) \right) \right]$$

- Spatially-varying directional ambient
- Modified Lambertian terms
  - Unclamped Lambertian term
  - Scale, bias and exponent
  - Warping function

VIEW INDEPENDENT TERMS

$$\boxed{k_d}\left[a(\hat{n})+\sum_{i=1}^{L}c_i w\left(\left(\frac{1}{2}\left(\hat{n}\cdot\hat{l}_i\right)+\frac{1}{2}\right)\right)\right]$$

- Spatially-varying directional ambient
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  - Warping function
- Albedo

VIEW INDEPENDENT TERMS

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  - Unclamped Lambertian term
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- Albedo

VIEW-DEPENDENT TERMS

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

View-Dependent Terms

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

- Multiple Phong terms per light

VIEW-DEPENDENT TERMS

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

- Multiple Phong terms per light
  - k_{rim} broad, constant exponent

VIEW-DEPENDENT TERMS

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

- Multiple Phong terms per light
  - k_{rim} broad, constant exponent
  - k_{spec} exponent (constant or texture)

VIEW-DEPENDENT TERMS

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- Multiple Phong terms per light
  - k_{rim} broad, constant exponent
  - k_{spec} exponent (constant or texture)
  - f_s artist tuned Fresnel term

VIEW-DEPENDENT TERMS

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

- Multiple Phong terms per light
  - k_{rim} broad, constant exponent
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  - f_s artist tuned Fresnel term
  - f_r rim Fresnel term, $(1-(n\cdot v))^4$

VIEW-DEPENDENT TERMS

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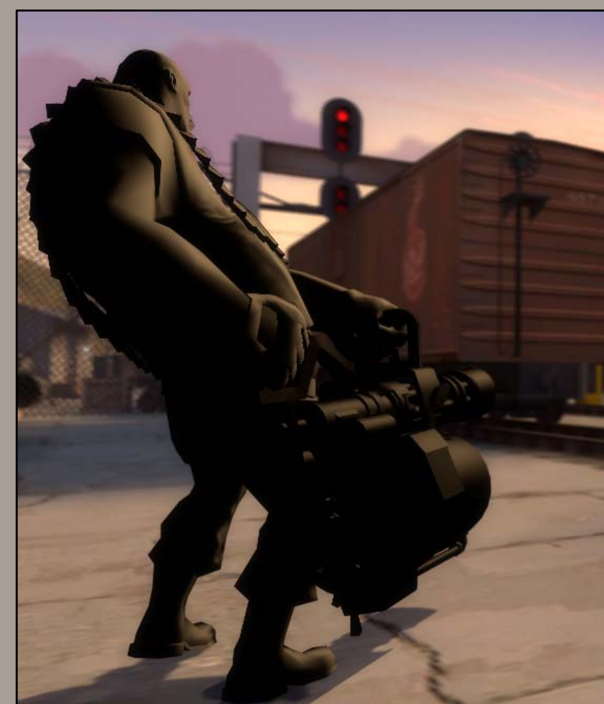

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  - f_r rim Fresnel term, $(1-(n\cdot v))^4$
  - k_r rim mask texture
  - k_s specular mask texture
- Dedicated rim lighting
  - $a(v)$ Directional ambient evaluated with v

VIEW-DEPENDENT TERMS

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

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  - k_s specular mask texture
- Dedicated rim lighting
  - $a(v)$ Directional ambient evaluated with v
  - k_r same rim mask

VIEW-DEPENDENT TERMS

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

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  - f_r same rim Fresnel

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  - $a(v)$ Directional ambient evaluated with v
  - k_r same rim mask
  - f_r same rim Fresnel
  - $n\cdot u$ term that makes rim highlights tend to come from above (u is up vector)

VIEW-DEPENDENT TERMS

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

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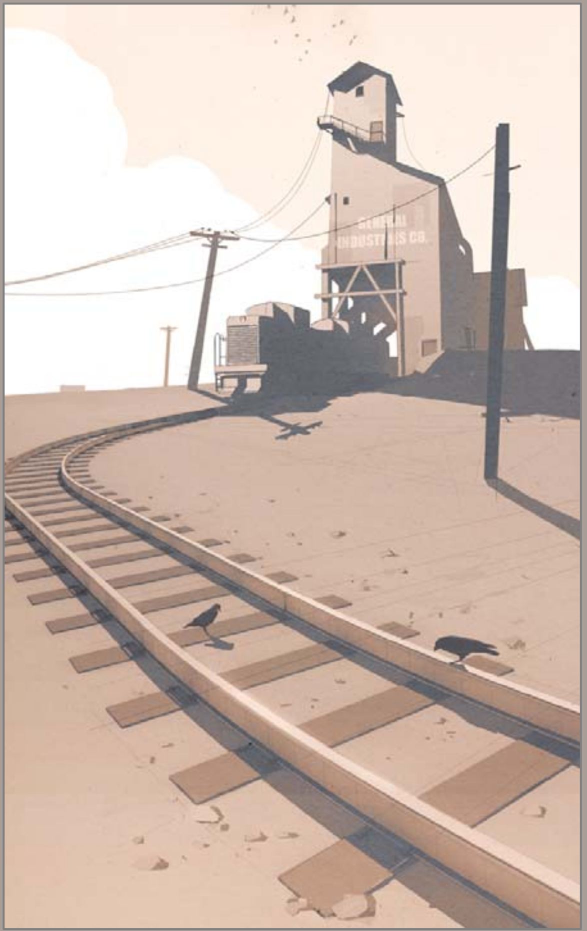
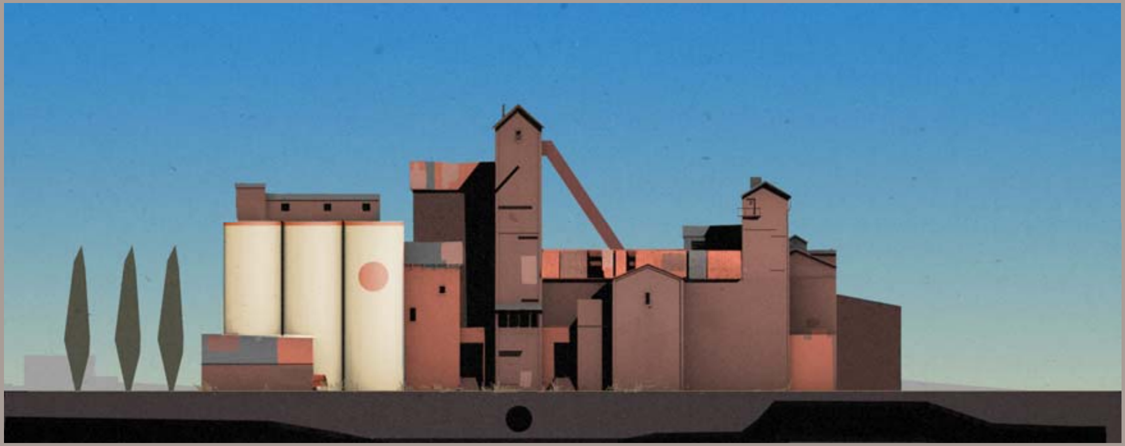
Environment Design

- Creating a compelling, immersive world
- Team distinction through material hue/value/saturation.
- Impressionistic painterly look



CONTRASTING TEAM PROPERTIES

- Red
  - Warm colors
  - Natural materials
  - Angular geometry
- Blue
  - Cool colors
  - Industrial materials
  - Orthogonal forms



TEAM FORTRESS 2

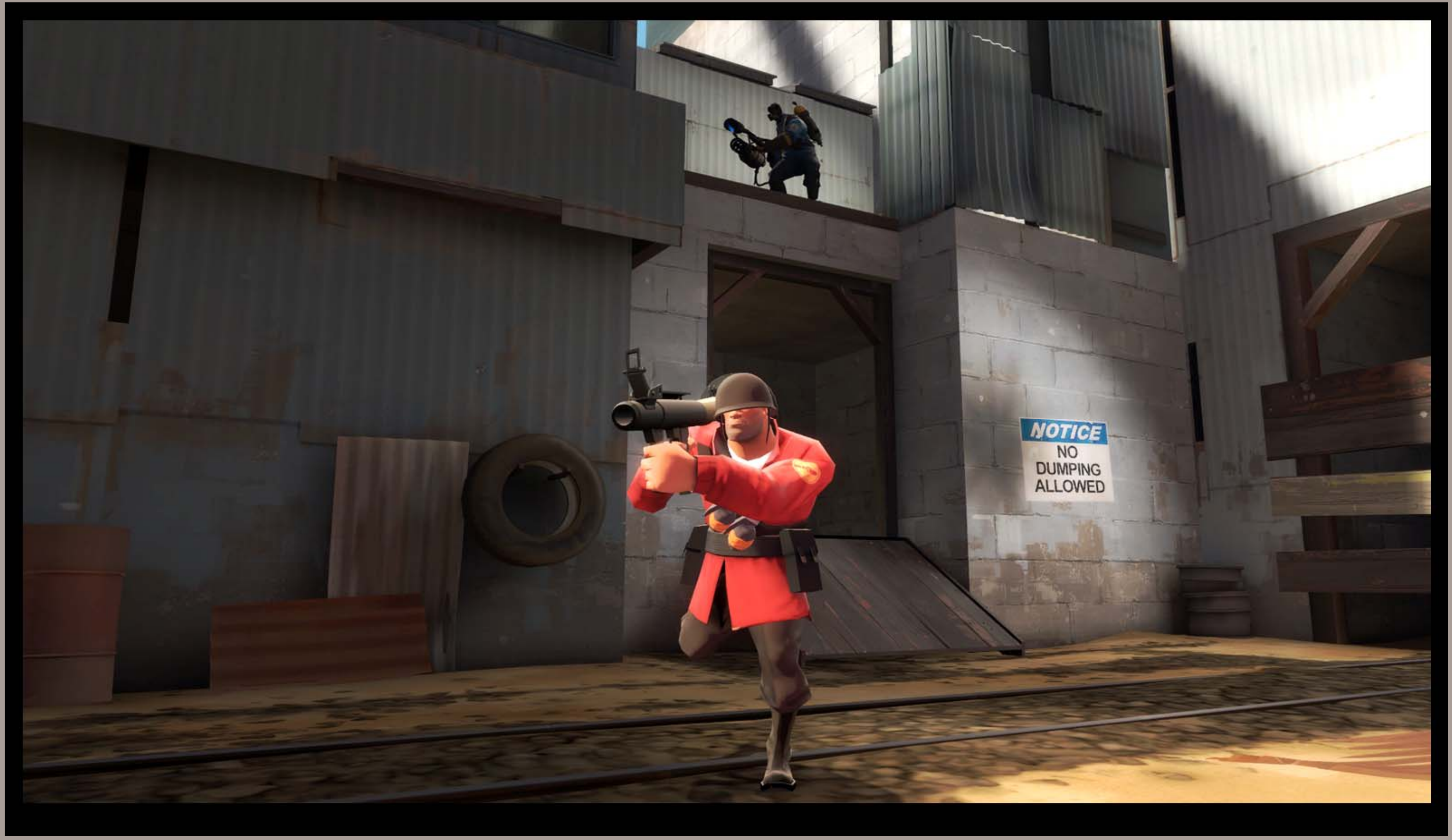
RED BASE IN 2FORT MAP


TEAM FORTRESS 2


2
CLOSED
KEEP THIS

BLUE BASE IN 2 FORT MAP


TEAM FORTRESS 2


NOTICE
NO
DUMPING
ALLOWED

ROUGH SHELL

Early game screenshot

CONCEPT

2D Paintover

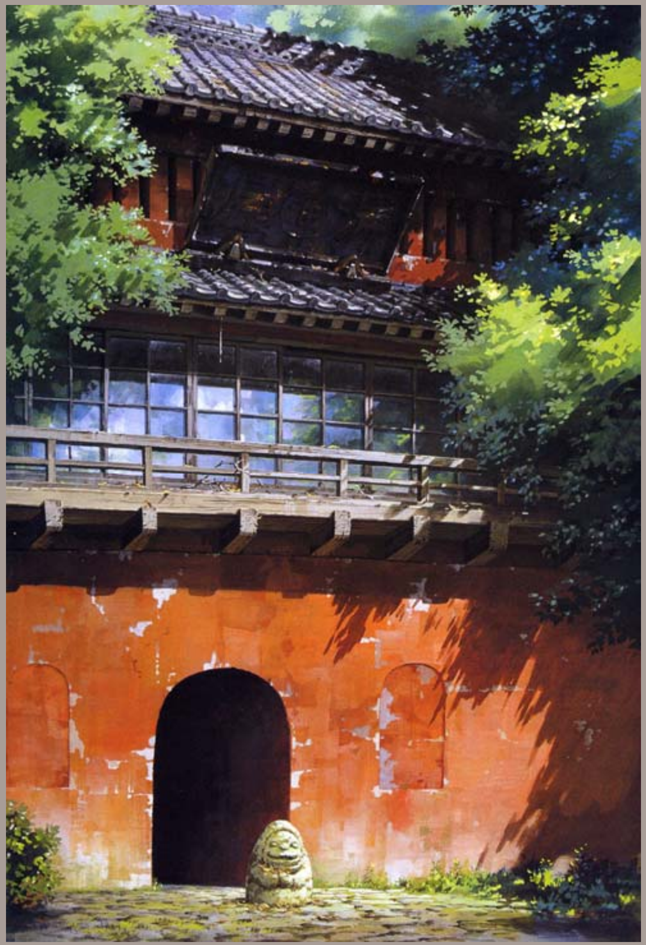
ART PASS

Final in-game screenshot

IMPRESSIONISTIC TEXTURES

Shot from *Spirited Away*

MIYAZAKI – BRUSH WIDTH FORESHORTENED



- Can easily imagine a 3D camera move between these 2D views of the same space

BACKGROUND PLATES FROM *SPIRITED AWAY*

WORLD TEXTURING


Texture map


In-game Screenshot

WORLD TEXTURING

Texture map

In-game Screenshot

WORLD TEXTURING

Texture map

In-game Screenshot

WORLD TEXTURING

Texture map

In-game Screenshot

MODEL TEXTURING

Texture map

In-game Screenshot

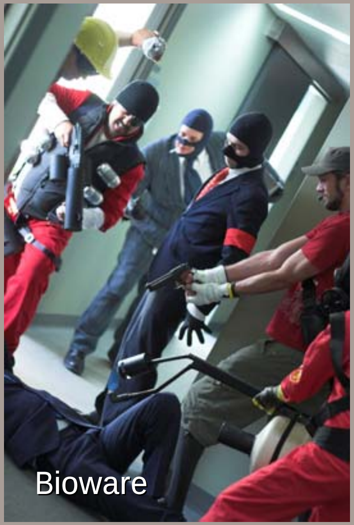
CLASS = CHARACTER

- Defined personalities and archetypes up front
- Consistent voice casting
- In-game taunt animations and context-sensitive emotes
  - “So much blood…”
- Meet the Team shorts
  - Character vignette movies rendered with game engine
  - Game assets except:
    - Up-rezzed hands
    - More facial morph targets
    - More facial wrinkle maps
- We find ourselves mixing the terms “Class” and “Character”

HOW DID FANS REACT?


NC Soft


Volition


Bioware


Blizzard


Nihilistic


EA LA

WHERE DO WE GO FROM HERE?

- Successful multiplayer games live for a long time
- Regular updates via Steam
    - Shipped 28 times since the Beta in September
    - New features, code optimizations and exploit fixes
    - This is why we built Steam & Steamworks in the first place
        - Steam is not just a digital distribution system
        - Can ship updates extremely quickly and fully engage the community
- Extend experience for dedicated players
    - Maps
    - Game modes
    - Achievements
- Unlockable weapons in *Team Fortress 2*
    - Can ship more quickly than new maps and game modes

NEW MEDIGUN CONCEPT

MEET THE SCOUT

- Things to look for…
  - Distinct character classes
    - Shape and Shading
  - Analogous color palette
  - Painterly world texturing

CONCLUSION

- History
- Characters
  - Art direction
  - Shading algorithms
- Environments
- Meet the Team
- Post-ship
- *Meet the Scout*

REFERENCES

- Barla, P., Thollot, J., & Markosian, L. 2006. “X-Toon: An Extended Toon Shader,” *NPAR 2006*
- Gooch, A. A., Gooch, B., Shirley, P., and Cohen, E. “A Non-Photorealistic Lighting Model for Automatic Technical Illustration,” SIGGRAPH98.
- Lake, A., Marshall, C., Harris, M., and Blackstein, M. 2000. “Stylized Rendering Techniques for Scalable Real-Time 3D Animation,” ACM Press, New York, J.-D. Fekete and D. Salesin, Eds., 13–20.
- Jason Mitchell, Moby Francke and Dhabih Eng, “Illustrative Rendering in *Team Fortress 2*,” ACM Symposium on Non-Photorealistic Animation and Rendering, 2007

READING LIST

- Art History, Cinematography & Graphic Design
  - *Painting with Light* by John Alton
  - *The Science of Art: Optical Themes in Western Art from Brunelleschi to Seurat* by Martin Kemp
  - *Secret knowledge: Rediscovering the Lost Techniques of the Old Masters* by David Hockney
  - *On Reflection* by Jonathan Miller
  - Anything by Edward Tufte or Marcel Minnaert

QUESTIONS?