



***n*VIDIA®**

**Cinematic Effects II:
The Revenge**

**Kevin Bjorke, NVIDIA
GDC 2004**

Overview

- **Films and Games:
Differences and Similarities**
 - Visual Qualities
 - Scale of Production
- **Ideas from Cinema, Realized**
 - New Tools, Shaders, Ideas
 - Live Examples
 - Getting it into your engine
 - Getting it into your art pipeline
- **Source Code!**
 - Source code from all examples will be on <http://developer.nvidia.com>



"MRT" visualization
of texture coordinates



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“Revenge”???

- ***The Story So Far...****
 - **Cinematic Effects via Programmable Shading are the Most Powerful Artistic Tool Yet for Games**
 - **But it's an Uphill Battle**
 - **Hard to implement and experiment**
 - **Hard to get into game engines**
 - **Even harder to debug**
- **Payback Time.**

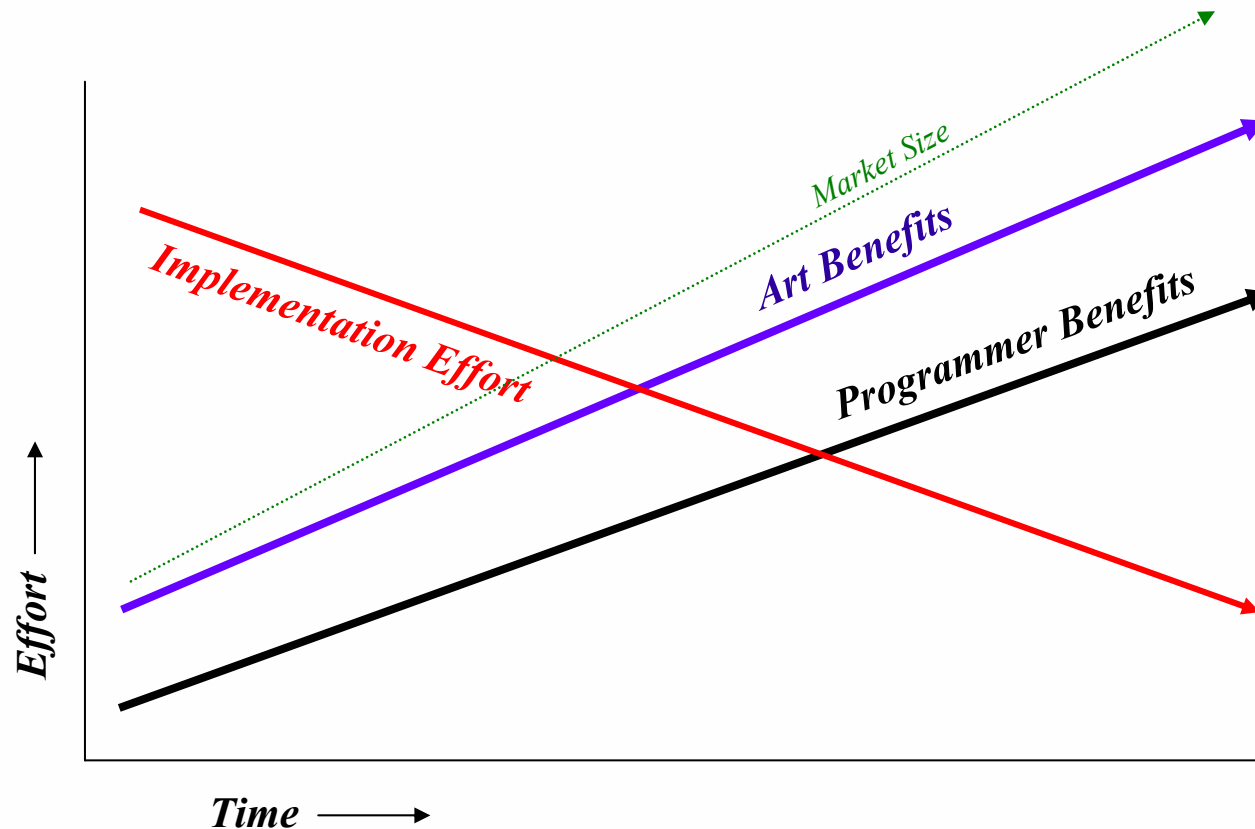


“Thad” from Animatrix – Character © Silver Pictures

*Part I available at <http://developer.nvidia.com/>

When to Add Programmable Shading?

- Every studio will have its own “break even” point



Games, Films, and Realism

- **Films aren't documentaries**
- **They are vivid stylized illustrations**
 - **Subjective, Not Objective**
 - **"Bigger Than Life"**
- **"Documentary Style" is just that – a *style***
 - **"Reality TV"**
 - **"The Office"**



Sylvia ©2003 Focus Features



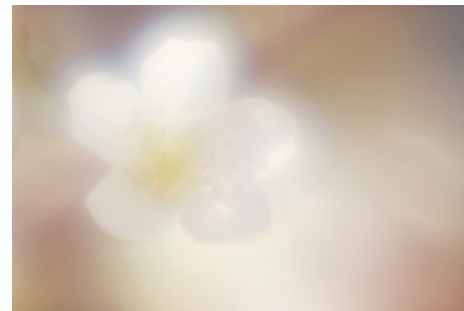
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Computer Graphics and “Photorealism”

- “Photorealism” is just another style
- Photos can be highly abstract!
- Nature is full of more stuff than we can handily write a single set of equations to recreate
- Film borrows many image-making ideas from earlier media



Vogue cover, 1950 - Penn



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Films and Painting

- Film borrows lighting and composition from media like painting
- Lighting leads attention
- Lighting sets emotional tone



Scott's *Blade Runner*



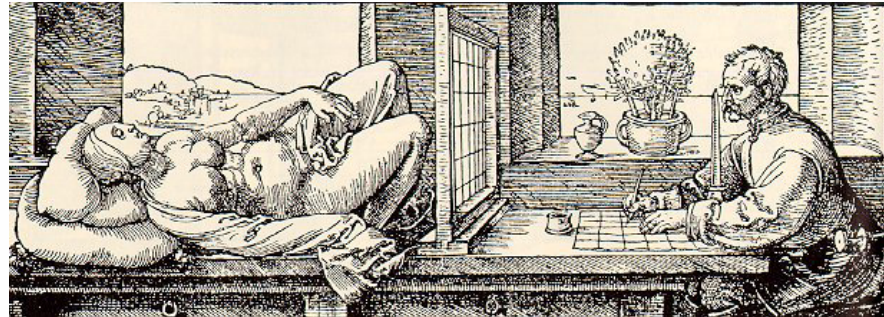
Raphael's *Transfiguration*



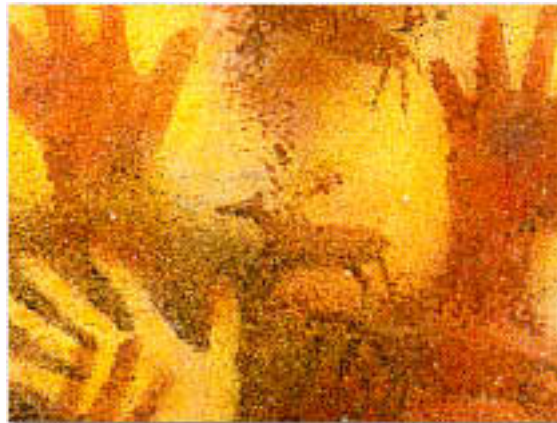
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Geometry and Light

- Computer Graphics
- Cinema & Photo
- Optics and Geometry
- “Measured Seeing”



Drawing Frame



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Visual Art and Gaming?

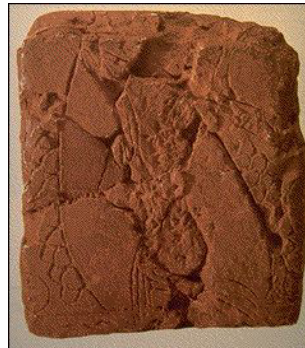
- World's Oldest Art may be “High Score” tags
- (Hand prints are not illustrations – just a trace of something)



Chauvet Cave – maybe 25,000 B.C.

Abstraction Mixed with Precision

- Maps, and then perspective (as well as literature) developed from...
Accounting!
- Accurate depiction was important, but less than abstract issues such as ownership and taxation
- “Artful omission” even then



Mesopotamian Survey Map, ca. 2500 B.C.



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Look Development

- **“Look Development” is when we decide what’s important (and what’s not), and lay down the elements of style for any project (or part of a project)**
- **The earlier in development that a look is determined, the better it is (and the cheaper it is to use)**
- **In gaming, look is often a byproduct of engine design**
- **In films, development is often done initially without particular attention to implementation “details” like budget**



Test from *Animatrix* – © Silver Pictures

Developing Shaders

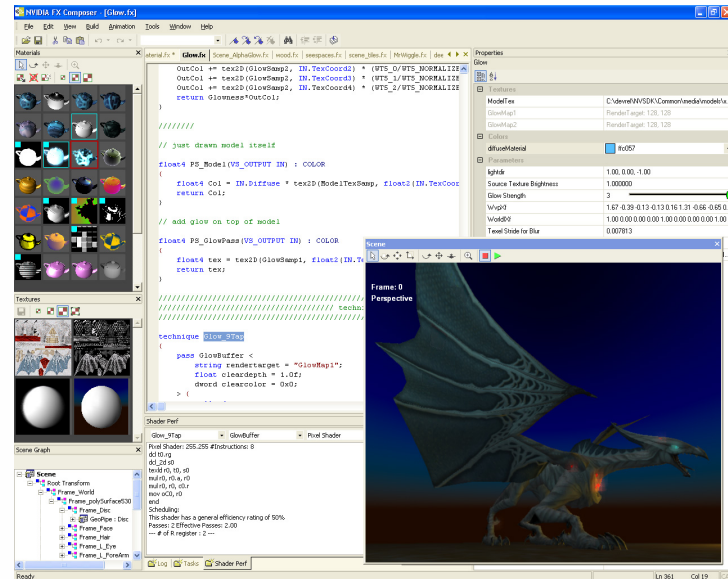
- Tools are important for both Programmers and Designers
- Not just seeing the correct models, but also the correct lighting environment, so that *the shaders developed can really be the ones used in-game.*
- Tools have to support ideas like:
 - Render-To-Texture (RTT)
 - Multiple Render Targets (MRT)
 - Render States like stencil, alpha blend, etc.
 - Custom Texture Maps (e.g. Normalization cubes, noise)
 - Minor management details (what bits connect to which other bits)
- Implementations are typically different in each different DCC application (Maya versus Max versus XSI versus....)
- How to get results in *and out* of your game engine?



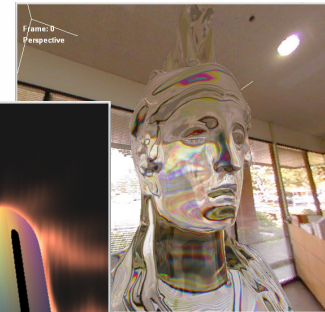
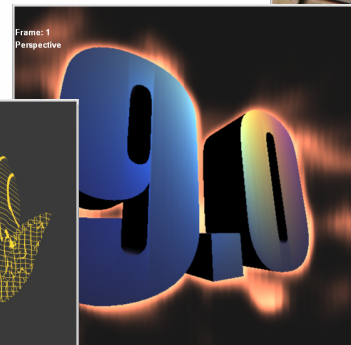
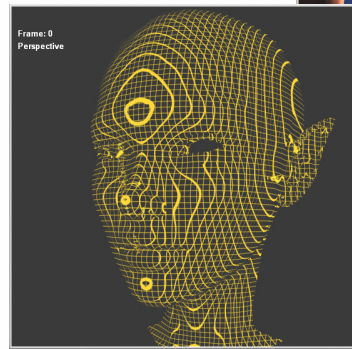
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Using Microsoft FX and FXComposer

- A Tool Built for the Task
- Combine shaders
- Customize shaders
- Move back and forth without rewrites or additional SDKs and runtime layers
- Performance tuning tools
- <http://www.fxcomposer.com/>



Everquest® Content Courtesy
Sony Online Entertainment Inc.

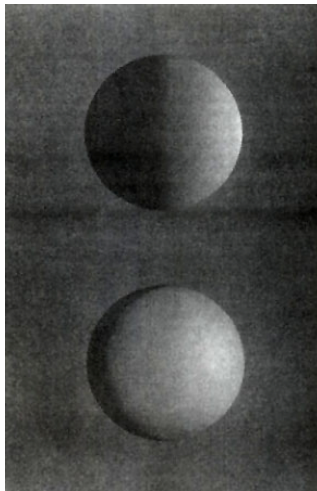


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A Shading Sketchbook

- FX Composer gives us an environment to play with complex ideas, without needing to write a whole C++ game engine to try them out!
- Do experiments, save them and keep them around – you'll use them someday!
- Save, trade, and collect 'em

Ruskin's Shading Exercises, 1877



Bjorke's Dumb Mistake, 2003



Sketches for
Rafael's *Transfiguration*

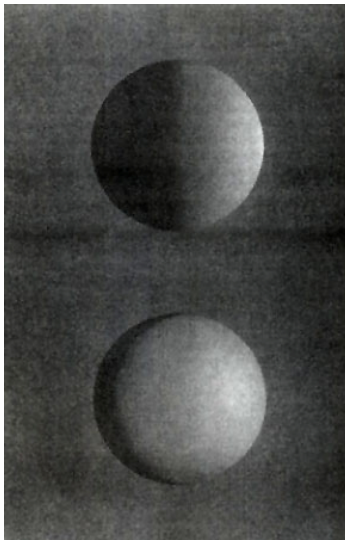


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Turning Pencil Sketches into Shaders

- **Side Note:**

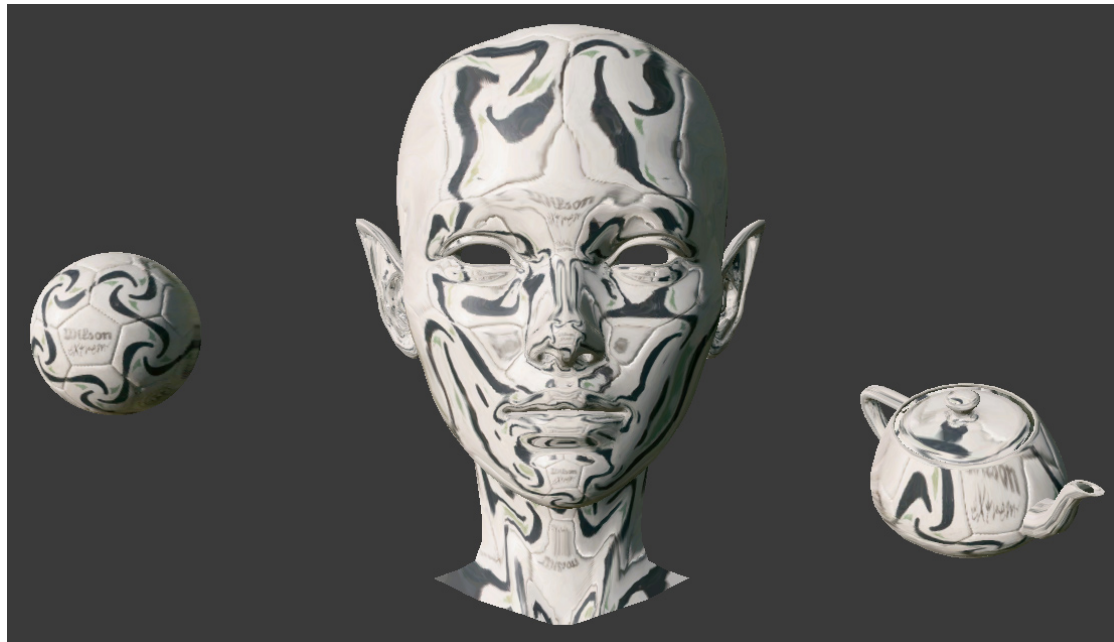
- A shaded sphere is trivial to turn into a shader
- Useful as color reference
- Beware tiny details (like JPEG noise), they smear



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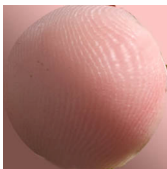
Fanciful examples

- Photos will distort
- This is probably rarely useful, but *cheap* – only ONE cycle
- Can we do something generically useful with this?



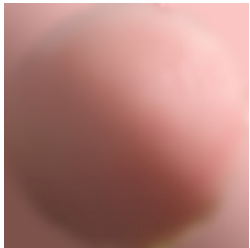
Does the shape have to be a sphere?

- Not if we're willing to do some work with Photoshop
 - I like "Liquify" and the Smudge/Stamp Tools



Refining the Color

- Gaussian Blur in the texture to isolate the color
- Great to mix with other shading models



Sketching In FX Composer

- While we're on the subject of sketching:
- FX Composer lets us intercept mouse events
- We can use this to build mini-apps entirely from FX shaders



Scale

- **Films have Massive Scale**
- **Lots of Models**
- **Lots of Polygons**
- ***Lots of Shaders***
 - *Toy Story*: 1300
 - *Bugs*: Double
 - *Monsters Inc*: “thousands”
- **Lots of Compositing Layers (sometimes hundreds)**
- **Long Schedules**
 - Instant Rendering shaves off *some* schedule...



Long Schedules

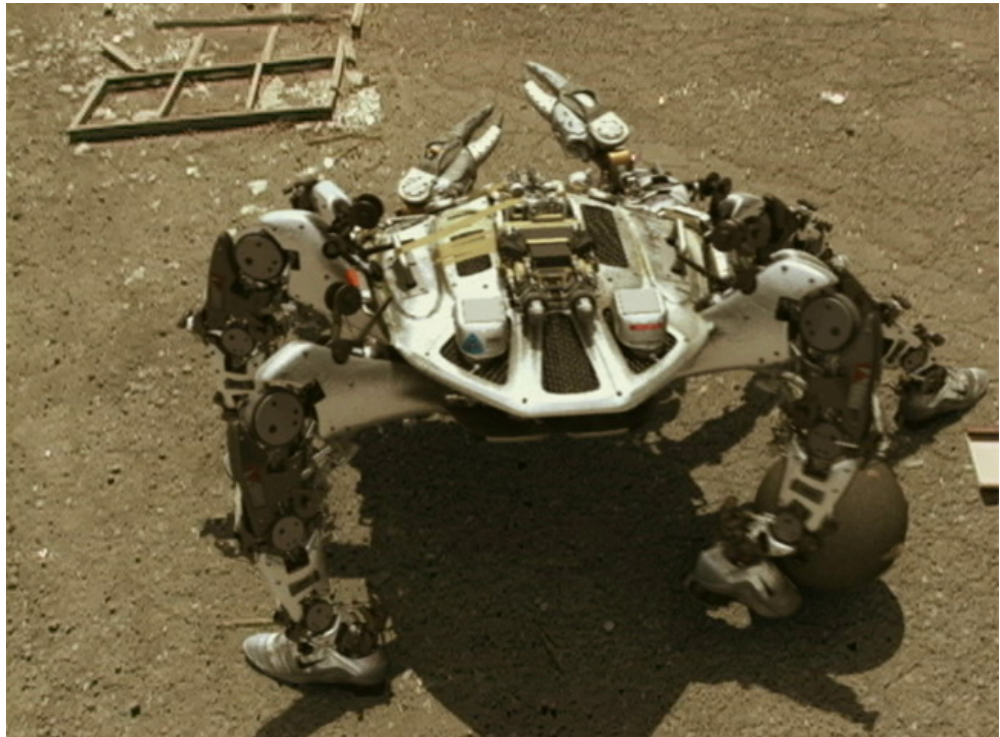
- **Movies have lots of money and time, so they have the potential to develop cool technologies**
- **Those technologies need to be locked down early enough so that shots on the last day of production look like they belong with shots from the first day of production**
- **Fastest turnaround in innovation: TV Commercials**



Nike.Com campaign, Weiden + Kennedy, Dir Neill Blomkamp <http://www.theembassyvfx.com/>

NikeLab.COM

- The Embassy Visual Effects
- Four Weeks!
- Using Lightwave, Shake, and NVIDIA Quadro graphics



Nike campaign, Weiden + Kennedy, Dir Neill Blomkamp <http://www.theembassyvfx.com/>

Shadows

- Shadows are often more important than illumination
- Once shadows appear, it's hard to go back!

1998



2004



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Art Lesson: Shadows in FX Composer

- Simple shadows
- Render to Texture
- Where's the light?
- Sharing Lights
- Working with light maps



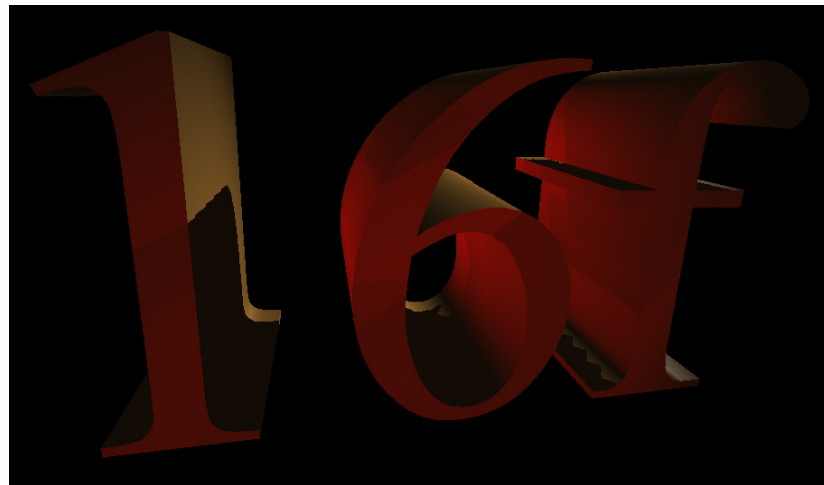
The Art Lesson



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Complex Shadows -- Translucence

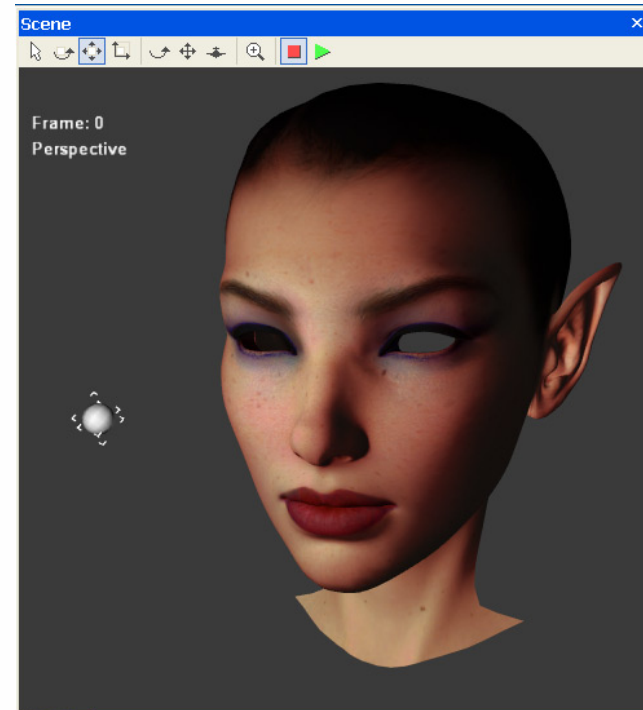
- Depth values can be used behind objects, too
- Simon Green & Greg James will talk more about this technique and more, on Friday at 2:30



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Skin and Shading

- **Diffuse Subsurface Scattering on the Cheap:**
 - By remapping “ $(N \cdot L)$ ” in our diffuse-shading calculations to “ $((N \cdot L) + w) / (1 + w)$ ” we can “wrap” light around the contours of an object
 - (Don’t worry about the math details – an example awaits!)
 - Since this is all in the diffuse lighting, it’s sometimes okay to do the job in the vertex shader



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Skin and Direct Reflectance

- The younger you are, the less dead skin
- Live skin cells reflect like little cat's eye reflectors
- Therefore, a flat skin tone = youthful appearance
- Oren-Nayar Shading (expensive) and “grisaille” shading (cheap!)
- Combining ideas



Traditional Grisaille Relief



One Modern Variation



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Lighting

- Light what's lit – not what's not lit
- Use PS_3_0 early outs
 - Bonus: Using “if” can also benefit batch sizes
- For deferred shading, only shade lit pixels
- “Gloominance” is perfectly safe in all cases for floating-point pixels



Spotlight



Smart Light Placement

- Magy Seif El-Nasr's "ELE":
The Expressive Lighting Engine
- <http://ist.psu.edu/SeifElNasr/>
- Uses robotics load-balancing equations to maximize visibility and "mood" for a limited set of lights



Mirage, El-Nasr et al, CIRA

Reflections

- Can replace all specular in some circumstances
- Can use VM to generate CUBE maps
- Can have finite radius (see talk later)
- Can have distance with quadratic falloff (see talk later)



Environment-mapped background, reflected card-shaped light source, 16-bit blending with overbright bloom

Volume Texture Lights

- Use for constraining light
- Use for creating fake volumes of shadow
- *Cheap!*
- Show example...

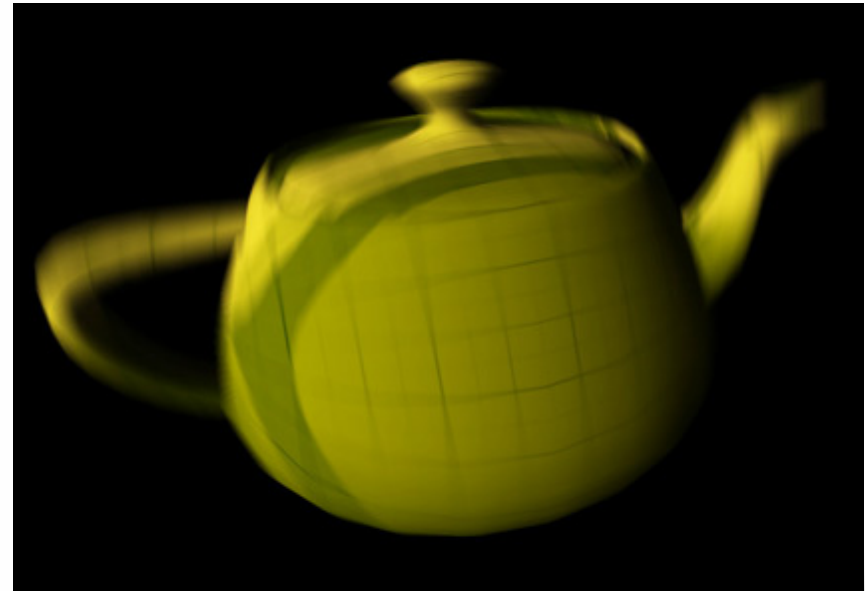
**FX Composer
Sample**



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New Territory: Camera Effects

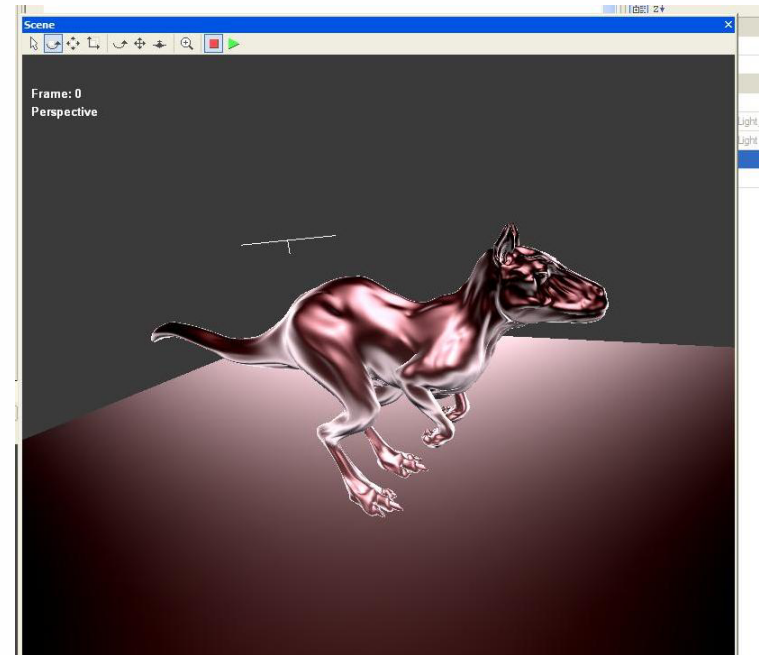
- Accumulation Buffer (ref) gives us:
- Motion Blur
- Depth of Field
- Soft Shadows
- More...
- No special shading, but shaders must go *fast*



Motion blur

Making the Most of the Direct X VM

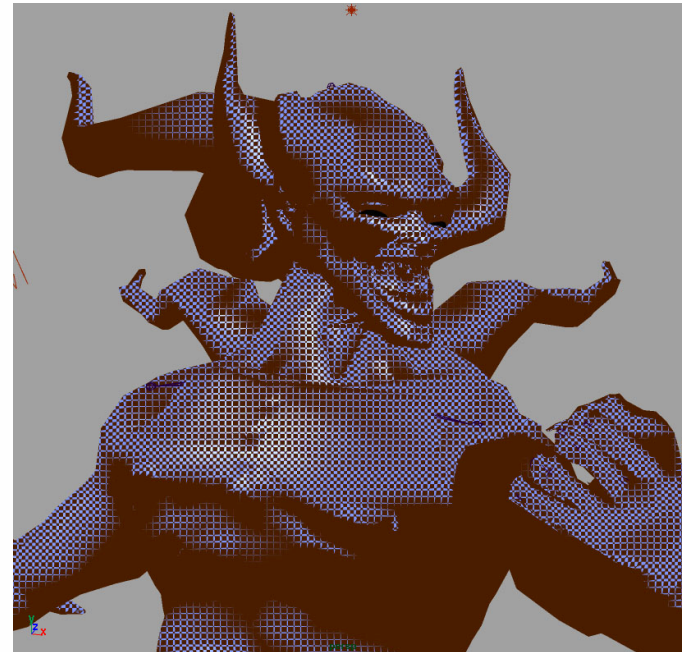
- Texture Generation
- “Texture Shaders” on the CPU can generate images, or create textures containing predictable functions
- Matrix Manipulation using HLSL intrinsics make complex shadowing a functional reality



Dinosaur with Physically-based car paint BRDF

Compositing & 2D Effects

- FP buffers make things more powerful than ever
- Lots of fun...
- Color controls
- Final “sweetening”
- Blend modes
- Mix 2D/3D sprites



Halftoning Patterns



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That's a Wrap!

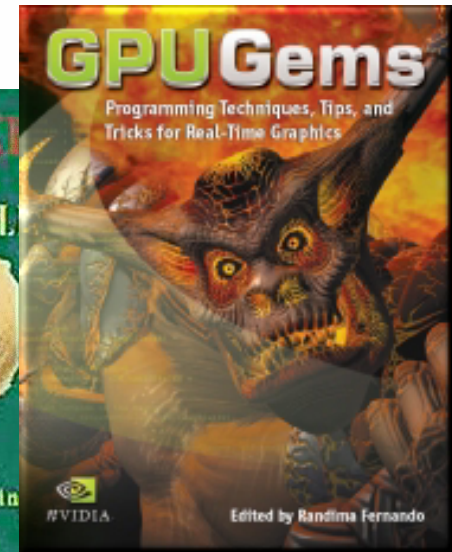
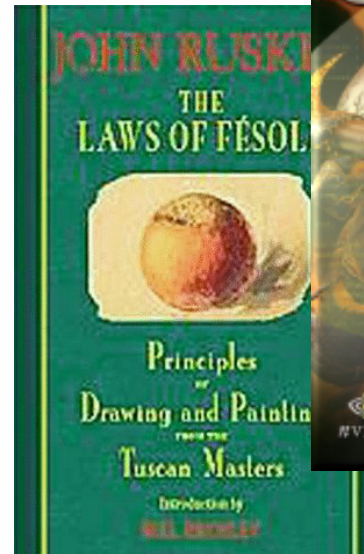
- Games now have the capacity to match film shading, in character if not pixel-to-pixel
 - Get used to *lots* of shaders
 - Get tools that let you play
 - <http://www.fxcomposer.com/>
 - Play with shaders, try everything, keep a “sketchbook” of useful ideas



The End

Some Recommended Books

- Jon Ruskin: *The Laws of Fésole, Principles of Drawing and Painting from the Tuscan Masters*
- John Alton: *Painting with Light*
- Randima Fernando: *GPU Gems*



Recommended Talks @ GDC

● Today:

- *Next-Gen Visual Effects Showcase* 12:30
- *Tools to Squeeze the Maximum Performance from Your GPU* 2:30
- *Practical Performance Analysis and Tuning* 4:00
- *GPU Gems Showcase* 5:30

● Thursday:

- *Realtime Shader Creation* 3:00

● Friday:

- *Real-Time Translucent Animated Objects* 2:30

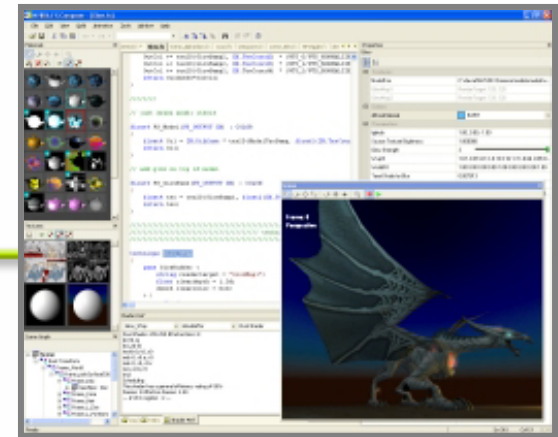


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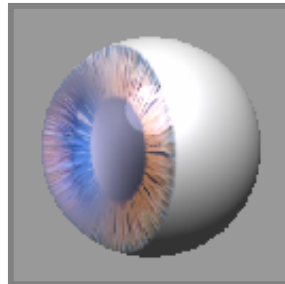
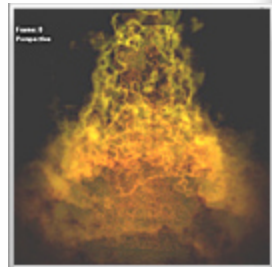
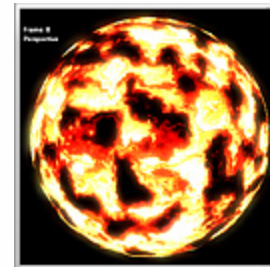
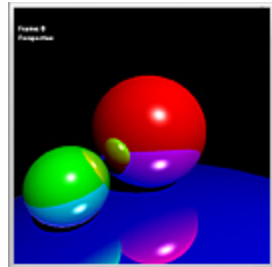
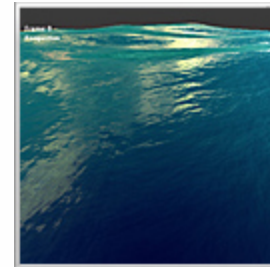
developer.nvidia.com

The Source for GPU Programming

- Latest documentation
- SDKs
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GPU Gems: Programming Techniques, Tips, and Tricks for Real-Time Graphics

- Practical real-time graphics techniques from experts at leading corporations and universities
- Great value:
 - Contributions from industry experts
 - Full color (300+ diagrams and screenshots)
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 - 816 pages
 - Available at GDC 2004

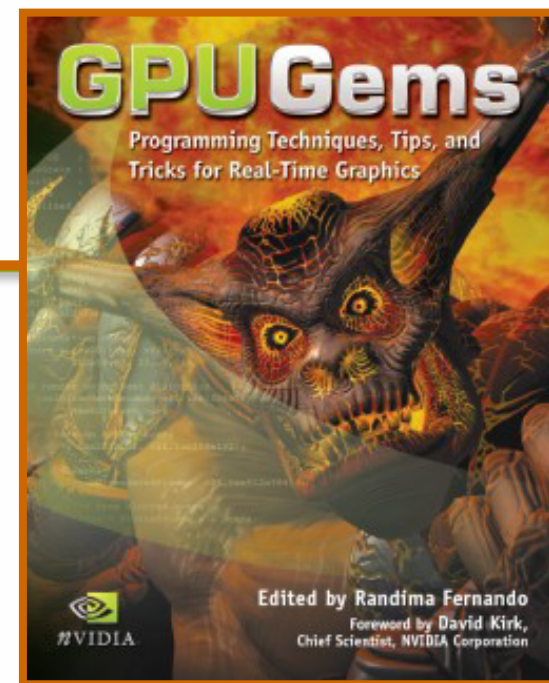
For more, visit:

<http://developer.nvidia.com/GPUGems>

“GPU Gems is a cool toolbox of advanced graphics techniques. Novice programmers and graphics gurus alike will find the gems practical, intriguing, and useful.”

Tim Sweeney

Lead programmer of *Unreal* at Epic Games



“This collection of articles is particularly impressive for its depth and breadth. The book includes product-oriented case studies, previously unpublished state-of-the-art research, comprehensive tutorials, and extensive code samples and demos throughout.”

Eric Haines

Author of *Real-Time Rendering*