

Andrew  
Kaufman

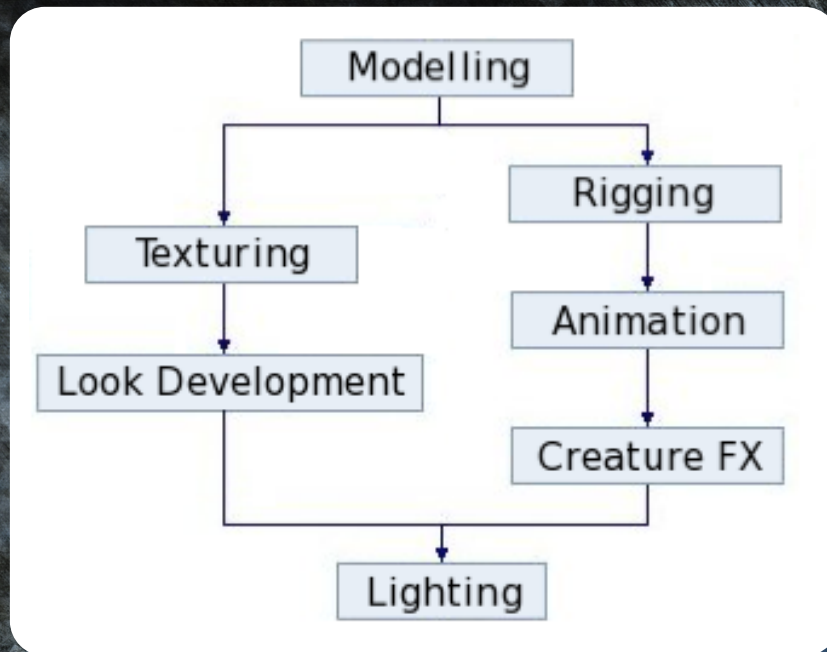
R & D

The VFX Pipeline

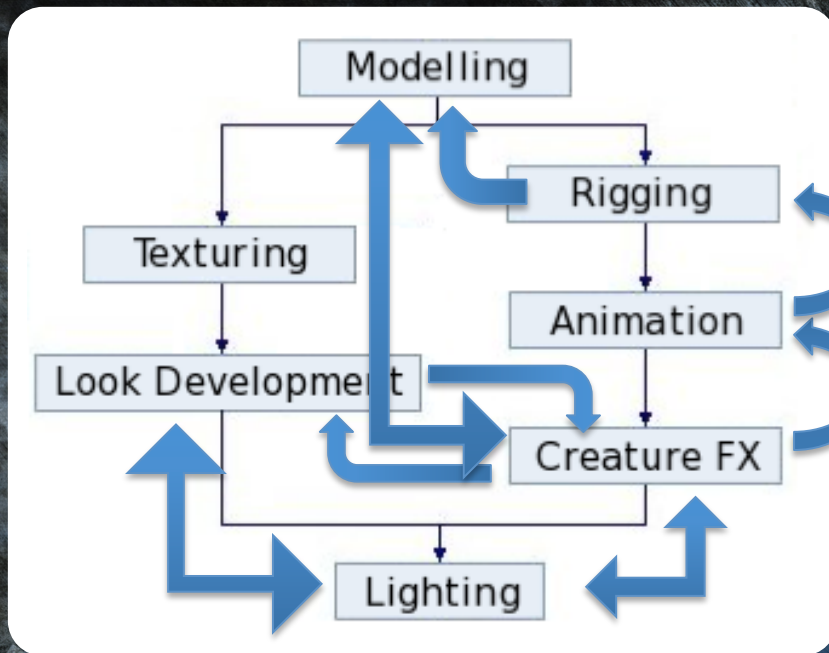
# Focus of the Talk

- 1) Pipeline Overview
- 2) Department Breakdowns
- 3) Software Development
- 4) Demo Reels
- 5) Q & A

Pipeline | how a shot is made  
Overview



Simplified VFX Pipeline



Simplified VFX Pipeline

# VFX vs Animation

- Animation Studio
  - Fully digital films
  - Pixar, Dreamworks, etc
- Visual Effects Studio
  - Add digital elements to live action
  - ILM, Weta, MPC, etc

# Shows, Sequences, Shots

- Typical Show consists of 500-1000 VFX shots
  - May be spread across multiple VFX Studios
- Sequences are a collection of related Shots
  - Usually corresponding to on-set filming
- Shots are generally 100-400 frames (24fps)
  - Some shots are finalized in few days
  - Hardest shots take up to a year to finish

# A single VFX Shot

- Bring it online
- Track the camera
- Prep the plate for VFX
- Animate the CG assets
  - Add simulation passes
- Generate interaction FX
- Light and Render all CG
- Composite with original film
- Deliver to Clients (daily, weekly)



# Department Breakdowns | for a typical VFX Studio

# Technology Departments

- Research & Development
- Pipeline
  - Show TDs
  - Department TDs
- IT

# Production

- Producers, Coordinators
- Bidding
  - Concept Art
  - Script Assessment
- Staffing

# Previsualization (Pre Vis)

- Very basic Animatics
  - Before the actors are filmed
  - Fast and loose
  - Often done off-site
- Rough Modeling
- Blocking Animation
- Basic Rendering

# Post Vis

- Medium Quality Animation & Rendering
  - After the actors are filmed
  - To help with editing
- Final (or near final) Modeling
- First Pass Animation / Rotomation
- Simplified Final Rendering

# Assets

- Modeling
- Texturing
- Look Development
- Rigging

# Modeling

- Sculpt original characters
- Rebuild captured geometry
- Organize UV sets, material tags, proxy geo, etc.
- Software: Maya & ZBrush

# Texturing

- Paint textures
- Defines the initial look
- Data Management is becoming important
  - Latest character has 1 TB of textures
- Software: Mari & Photoshop



# Look Development

- Assembles the shaders
- Defines the final look
- Needs to be as interactive as possible
- Software: Proprietary
  - Embedded in Maya & 3delight

# Rigging

- Builds the deformation armature
- Intuitive controllers for complex solvers
- Manages data output for Animators
  - Troubleshooting
- Software: Maya & Proprietary

# Shot Setup

- Plate Turnover (I/O)
  - Shotgun Database
- Matchmove
  - Camera & Set tracking
  - Lens Distortion
- Roto / BG Prep (paint outs)

# Animation

- Defines the performance
  - Characters, vehicles, props
  - Start from mocap, reference footage, or more abstract concept work
- Tech Anim
  - Deformation fixups (automated and manual)
- Software: Maya & Proprietary

# Creature FX

- Layered simulation on top of animation
  - Muscles, fat, hair, cloth
- Software: Maya, Houdini, Proprietary

# FX

- Simulated physical phenomena
- Rigid Body Dynamics
- Destruction
- Dust / Debris
- Volumetrics
  - smoke, fire, fluids
- Software: Houdini

# Lighting

- Final application of Look Dev
- Mimic on-set lighting
  - Blend CG lighting effects
- Rendering from 3D to 2D
  - Rayes vs Ray Traced, AOVs
- Software: Proprietary
  - Embedded in Maya & 3delight

# Compositing

- Integration of all images
  - Plates
  - 3D Renders
  - Pre-filmed elements
- Lens Distortion
- Color Correction
- Final department before delivery

Software: Nuke



# Software | in the IE Pipeline Development

# Cortex

- Framework for computation and rendering
- C++ libs with Python bindings
- Cross-application capable
- Stable API; Production proven; 3000+ unit tests



# Renderers

- OpenGL
- RenderMan (3delight)
- Arnold
- Mantra (limited functionality)

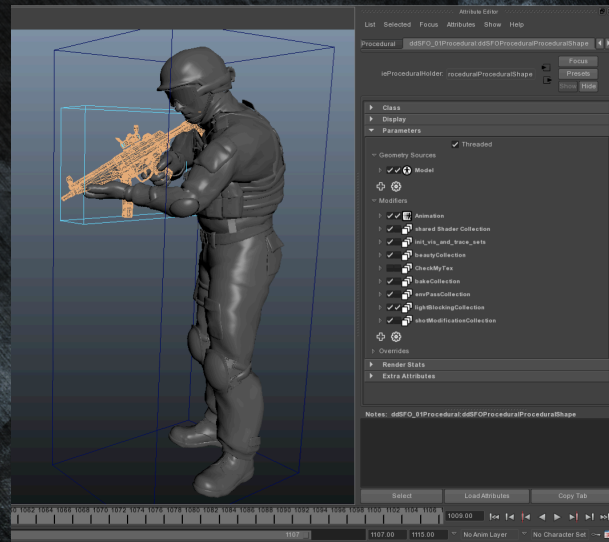


# Procedurals

- Generate geometry at render time
- One definition for GL preview and final render
- Automated multithreading (with TBB)
  - Spawn sub-procedurals (reentrant)

# Interaction

- Hosted in Maya or Houdini
- Specialized manipulation
- Parameters exposed natively
- Can convert to Live Geometry



# Gaffer

- Application Framework for node graphs
- Multithreaded computation, Qt based UI framework
- Leverages: Cortex, OpenEXR, OIIO, OCIO, TBB, Alembic
- Ships with Apps:
  - procedural scene generation for rendering (early days);  
image manipulation; file browser / previewer;  
Cortex Op dialog; command line interface

Shader Palette (modularProcedural/modularProceduralShape)

Edit Shader Scene

Shader Graph

```

    graph LR
      ieCheckerBoard --> ieRemap
      ieNotes --> ieCombine
      ieRemap --> ieCombine
      ieCombine --> ieStandardSurface
      ieStandardSurface --> ShaderOutput
  
```

Node Editor: ieRemap

Node Name: ieRemap **RenderManShader**

Shader: shadingNodes/utilities/ieRemap **Reload**

Settings: Clear

Remap

Min In	0	0	0	
Max In	1	1	1	
Min Out	0	0	0	
Max Out	0.4	1	1	

Grade

Invert:

Multiply	1	1	1	
Offset	0	0	0	
Gamma	1	1	1	

Viewer: ieStandardSurface

XY: 0, 0 **RGBA: 0.0000, 0.0000, 0.0000, 0.0000**

Attribute Editor

modularProcedural modularProceduralShape imA1 ieGeometryCombine inits

ieProceduralHolder: modularProceduralShape

Class

Display

Parameters

- Threaded

Geometry Sources

Shader Palettes

- Shader Palette **Edit Network**

Modifiers

- Shader Palette Assignment

Filter

Replacement Node: 0.0000

Replacement Node Name: vln001

Shader: Shader Palette:ShaderOutput

Overrides

Frame: 5.0000

Frame Rate: 24.0000

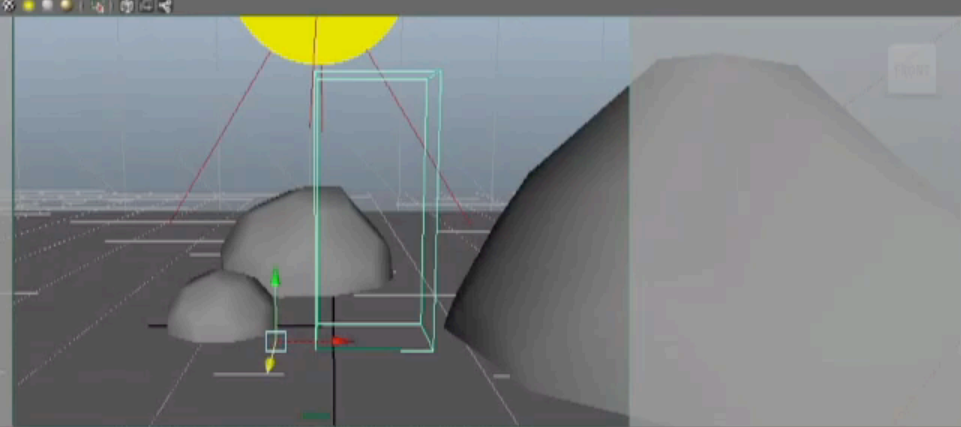
Render State

Extra Attributes

Notes: modularProceduralShape

Subst Load Attributes Copy Tab

Verts:	184	0	0
Edges:	274	0	0
Faces:	97	0	0
Inst:	300	0	0
UVs:	300	0	0

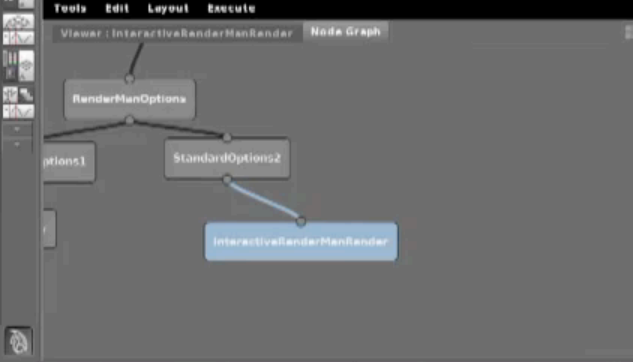


Attributes panel for 'blokewthgun' showing 'inst1' and 'instShadingGroup' with 'Parent' and 'Break' buttons.

Inputs section showing 'File' and 'Host' fields, and a 'Time' field set to '1.000'.

Preview section with checkboxes for 'Draw Geometry', 'Draw Root Parent', and 'Draw Child Bounding'.

Queries section with 'All Dynamic Attributes'.



Node Editor for 'InteractiveRenderManRender' showing settings for 'User' and 'State' (Running), with checkboxes for 'Update Light' and 'Update Shaders'.



Notes section for 'blokewthgunSceneShape'.

Buttons for 'Select', 'Load Attributes', and 'Copy Tab'.





# GitHub

- Public Issue tracking and Milestones
- Documented design decisions
- Official code reviews (both internal and external)
  - All internal developers have their own Fork
- Linux and OSX Binaries

Q & A | what interests you?

We're Recruiting!

Pipeline TDs wanted

[jobs@image-engine.com](mailto:jobs@image-engine.com)