The Art and Technology Behind Bioshock's Special Effects

Presented by
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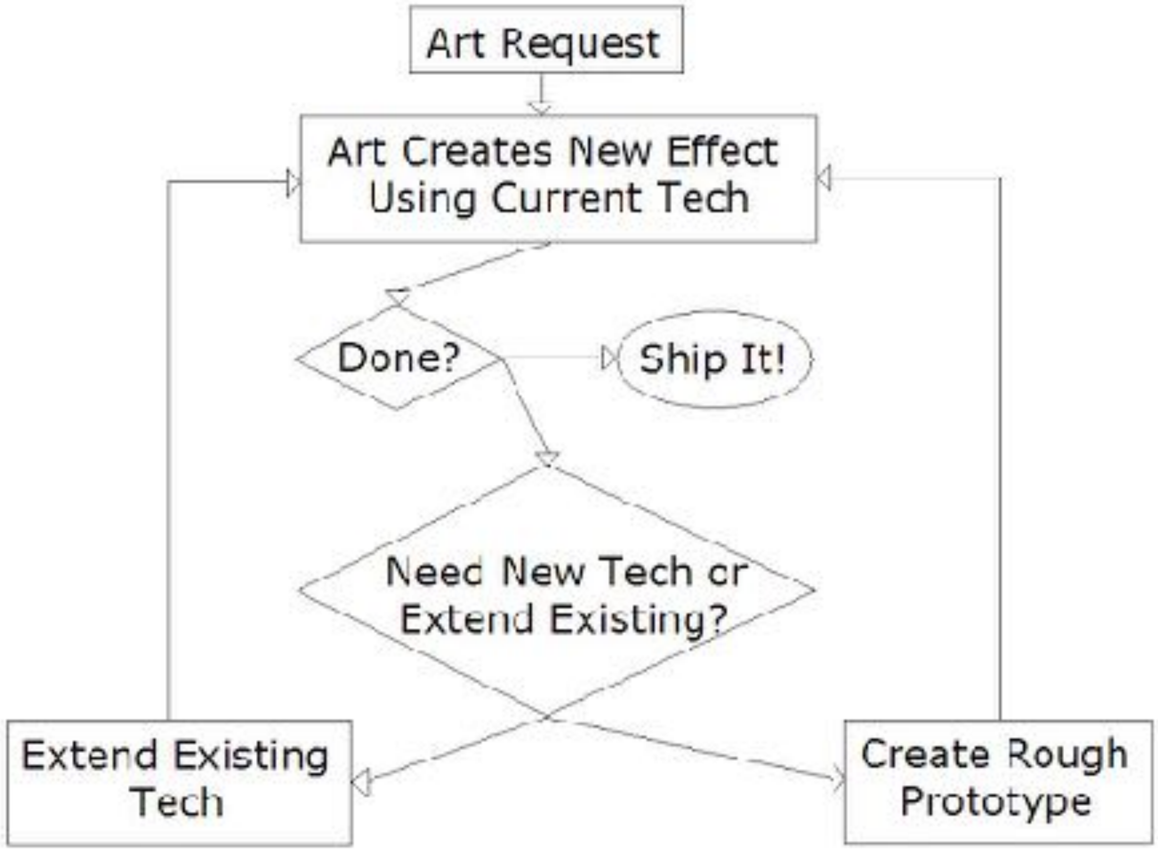
Presentation Overview

- Iterative Workflow Between Art and Tech
- Lit Particles
- Bioshock’s Water: An Artist’s Perspective
- Technology Behind Interactive Waterfalls
- Water Caustics
- Interactive Rippling Water System
- Optimization Case Study: Bioshock’s Fire

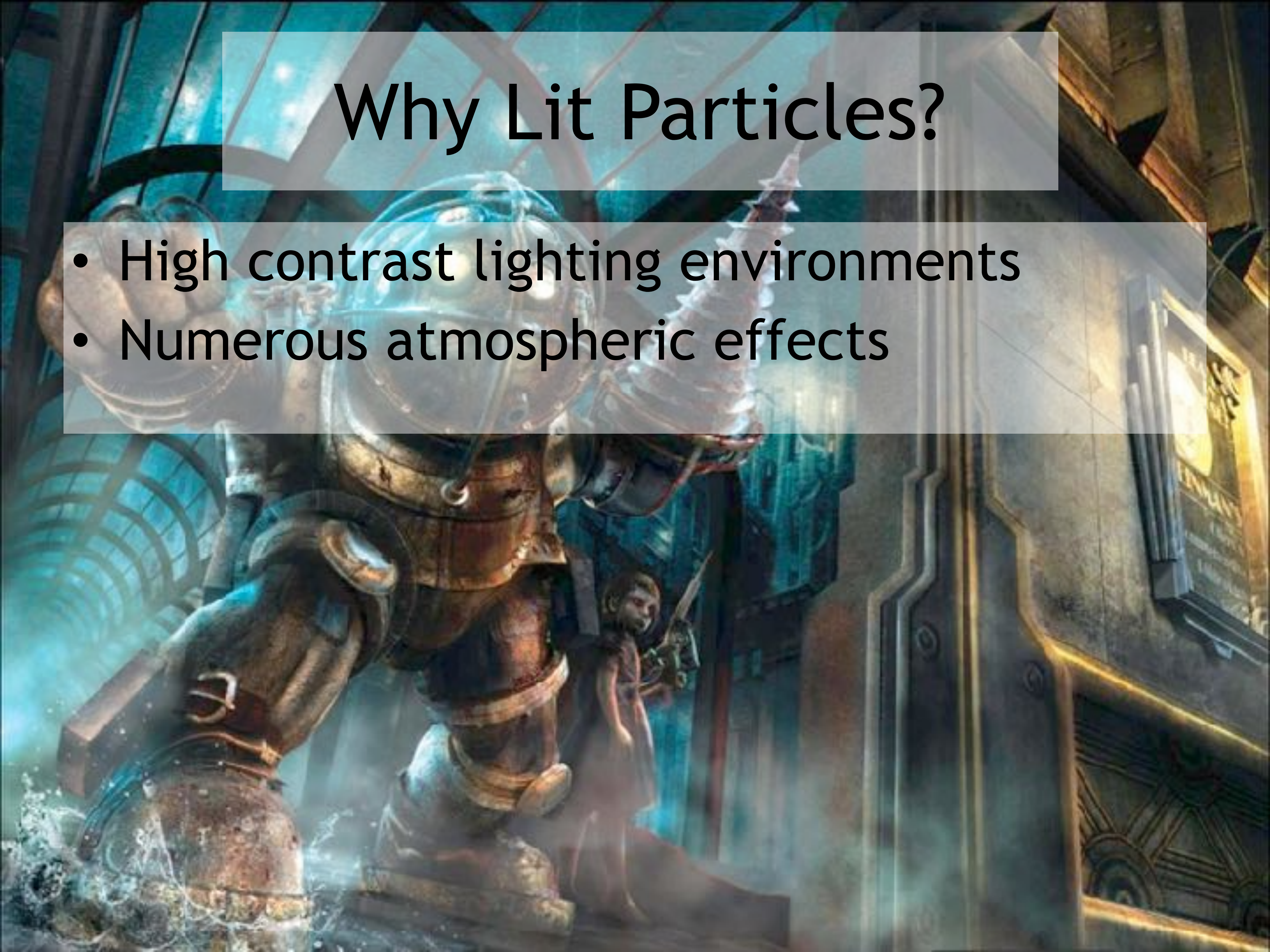
Art and Tech Iterative Workflow



The FX Closet

Why Lit Particles?

- High contrast lighting environments
- Numerous atmospheric effects

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Technical Challenges With Lit Particles

- Must be rendered in a single pass
- Need to satisfy very high performance requirements
- Potential for shader permutation issues

Lit Particles: Iteration 1

- Light attenuation done per vertex
- Static branching used to accumulate multiple lights in vertex shader
- Attenuated color interpolated via single float3
- Per vertex approximation typically good for highly tessellated geometry

Lit Particles: Iteration 2

- Problems with iteration 1:
  - Particles too dark in total darkness
  - Particles too bight in bright environments
- Solutions
  - Used maximum of new ambient term, vertex lighting
    - Not ambient + lighting
  - Scale RGB down if any component over 1.0
    - newRGB = oldRGB / (1.0 + max(0.0, maxRGBChannelValue -1.0));


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Lit Particles: Iteration 2

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Lit Particles: Iteration 3

- Big need for per pixel lighting
  - Specular highlights
  - Avoid painting highlights into textures
- First prototype: 1 per pixel light
  - Remaining lights used per vertex lighting
  - Two new interpolators: per pixel direction and per pixel color


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SMASH the DEBRIS blocking the door.


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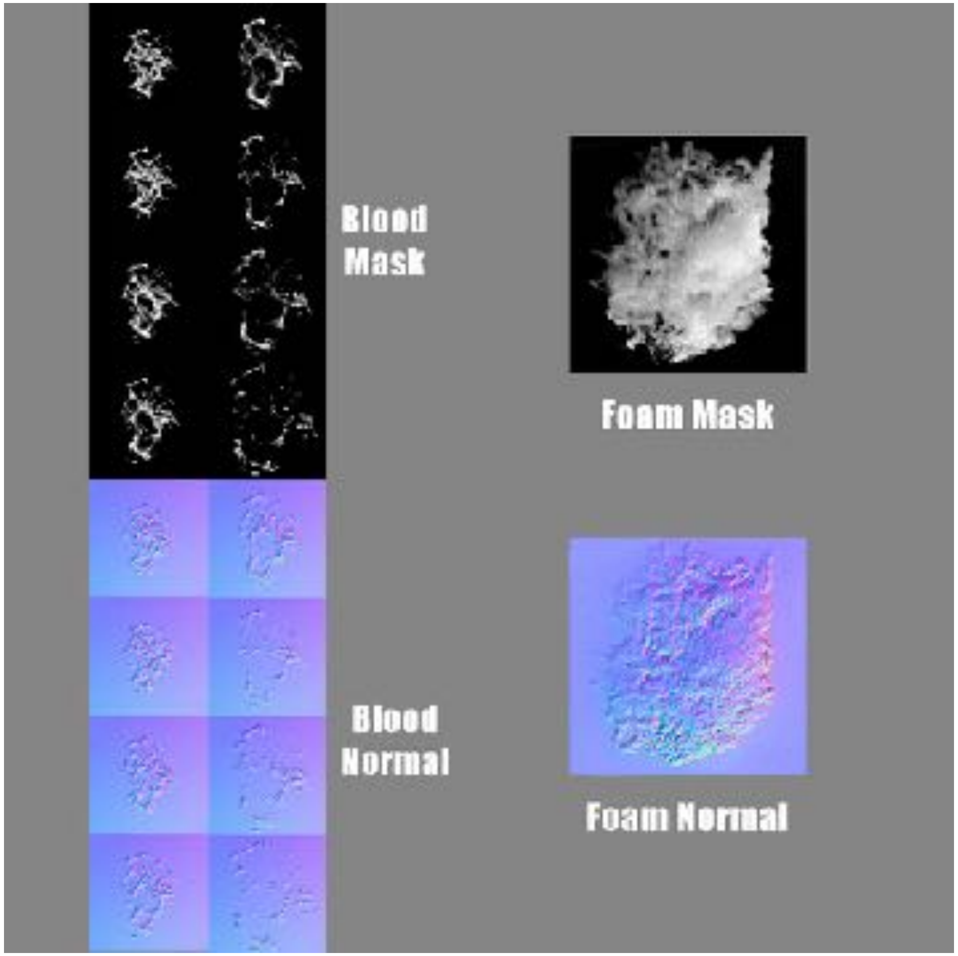
Lit Particles: Iteration 4

- Numerous issues with iteration 3
  - Popping
  - Washed out lighting
  - Heavily interpolator limited
- New solution: Averaged per pixel lighting
  - Attenuated color same as before
  - Light direction for all sources accumulated per vertex
  - Weighted by:
    - Incident angle for each light
    - Magnitude of light's color and attenuation

Per-Pixel Blood And Foam

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Lit Particles: Iteration 5

- Particles would be dark depending on lighting direction
- Implemented fake light


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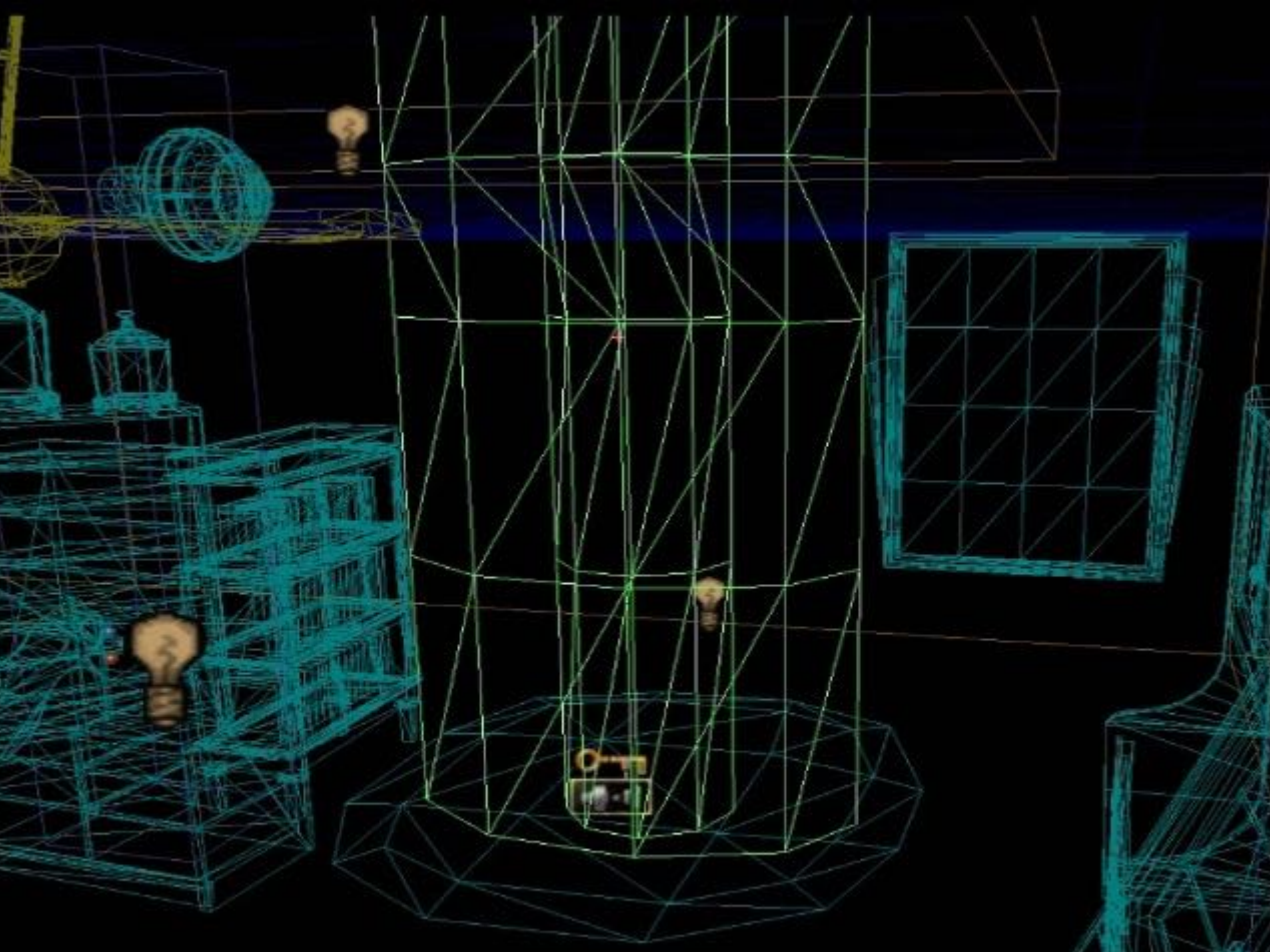
Lit Particles: Final Thoughts

- Performance limitations
- Performance benefits

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Water: An Artist's Perspective

- Underwater game? Probably need to make water look ok.
- Began using existing tech
- Limitations spawned a variety of art requests


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EVERY NIGHT


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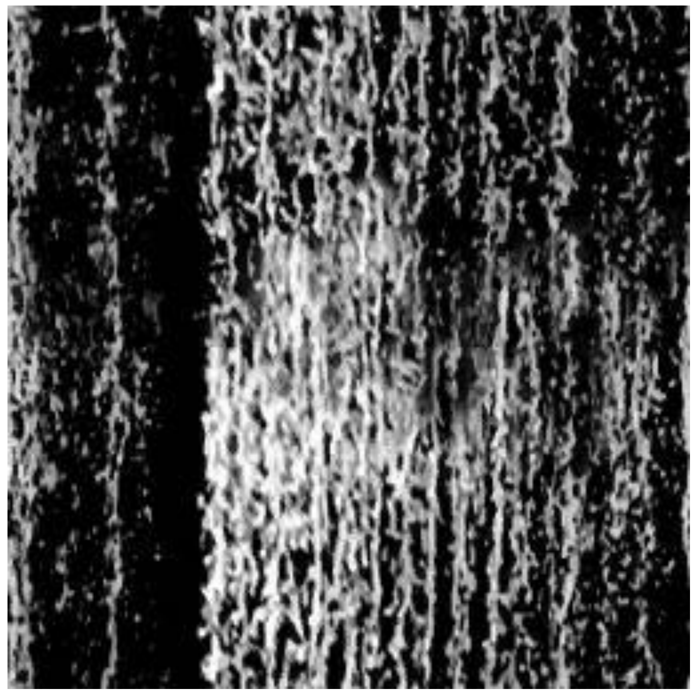
Iteration 1 Texture

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Final Implementation Textures


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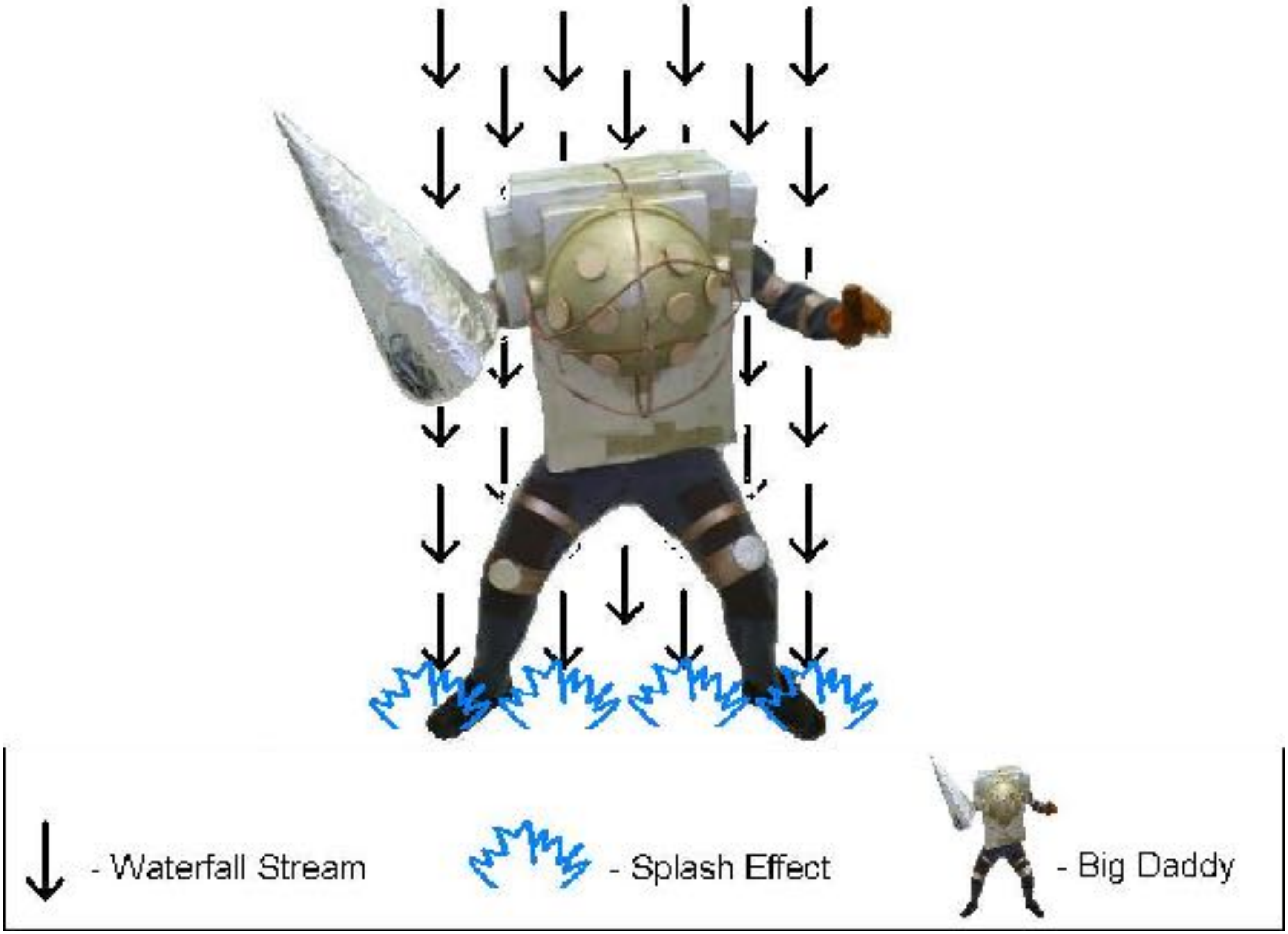
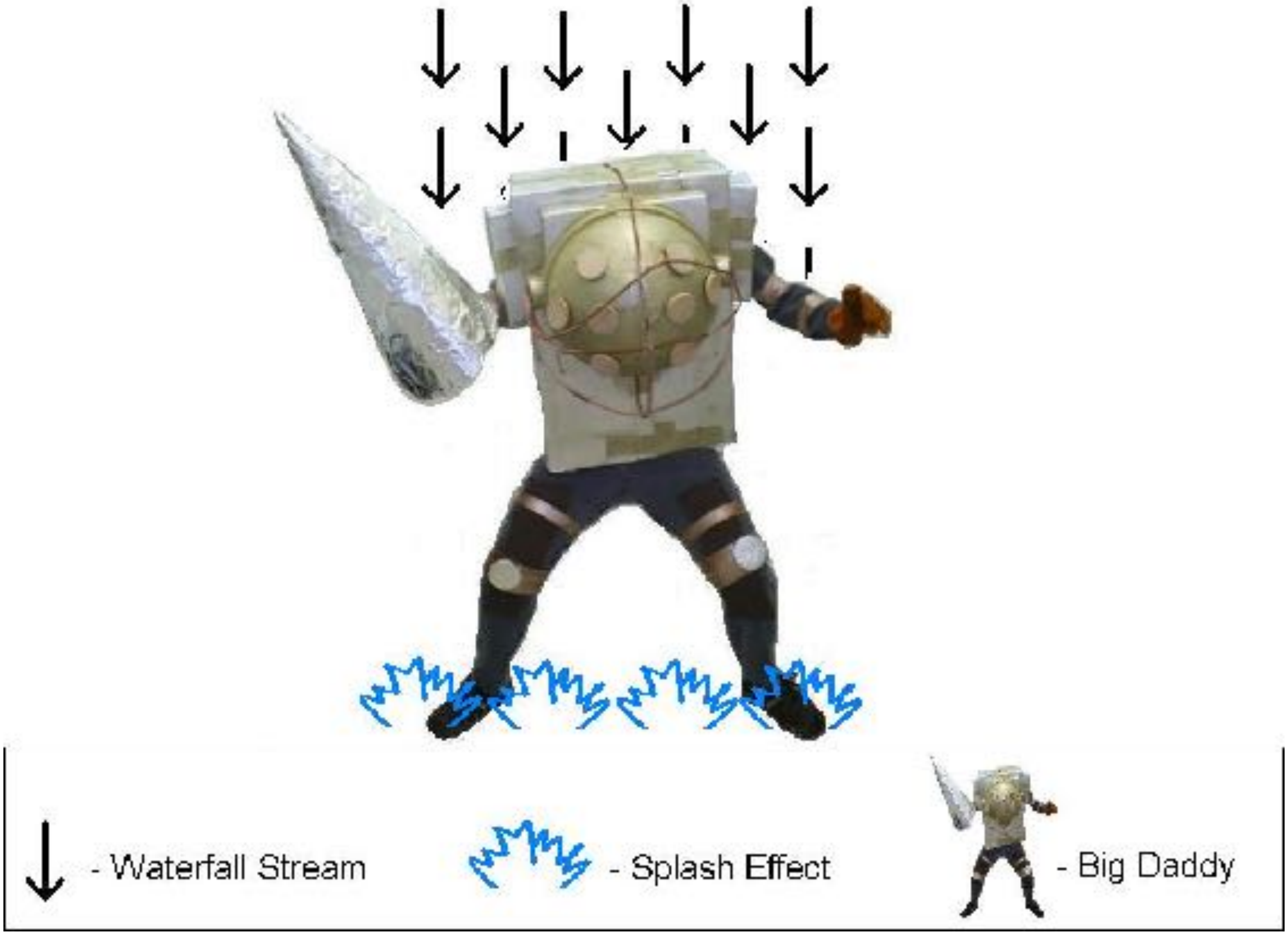
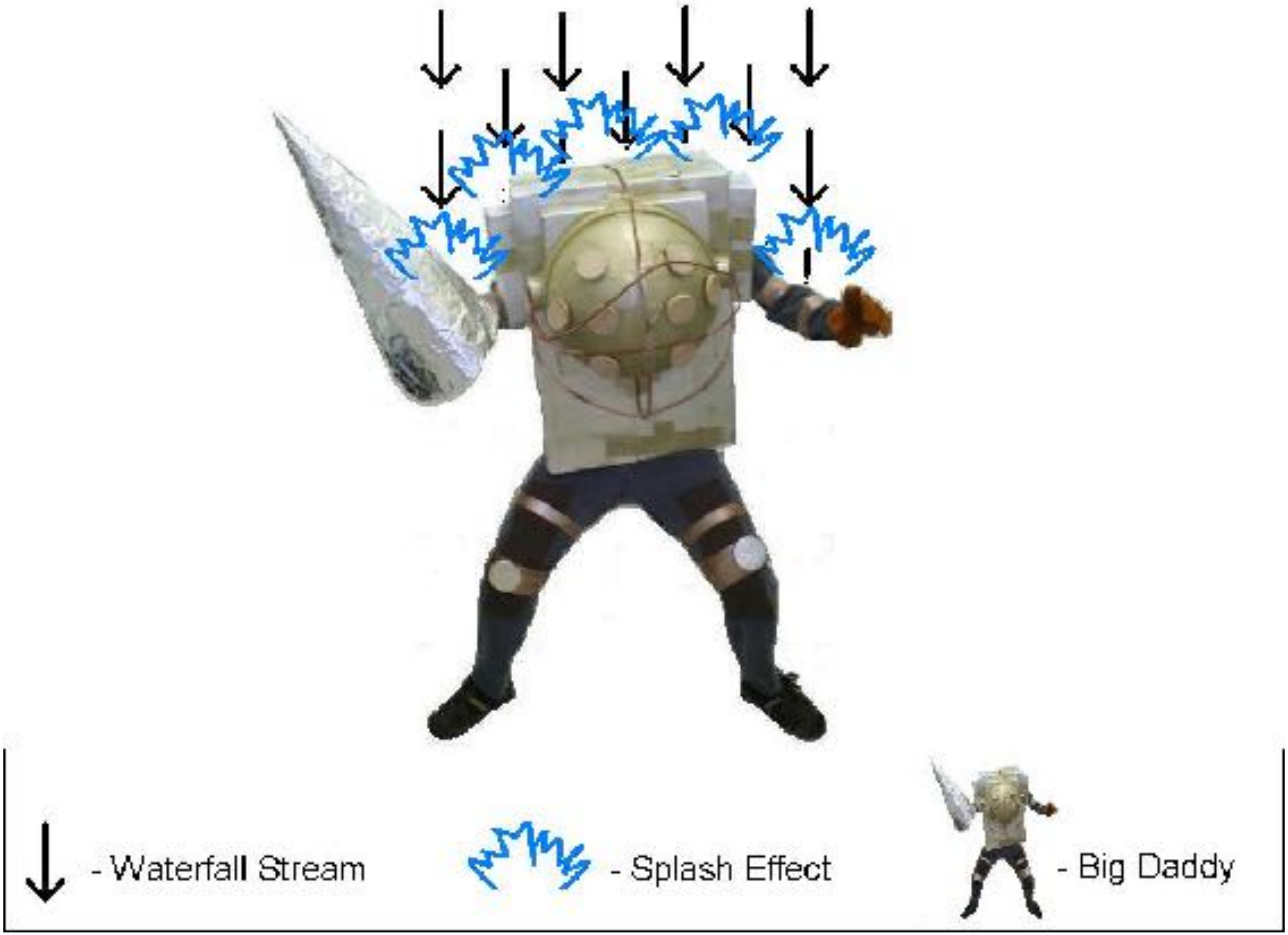
(Non) Interactive Waterfalls



(Semi) Interactive Waterfalls



Interactive Waterfalls



Interactive Waterfalls: Iteration 1

- Analogous to 1D shadow mapping
  - Camera is placed on top of waterfall, pointed down
  - Waterfall treated like 2D plane, depth values rendered into 1D row of 2D texture
- Use vertex texture fetch or ATI's R2VB to displace particle splash effects

E3 Footage

E3 Footage

Interactive Waterfalls: Iteration 2

- Added a second 1D shadow map, as seen from the bottom of the waterfall upward
  - Allowed outlines to be scissored into the waterfall
- Added a simulation step
  - Gravity!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Water Caustics

- Light that bounces off of water surfaces
- Important in creating water atmospherics

Caustics: Iteration 1

- Texture sequence
- Projectors/Decals used to place effect


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RAPTURE

Caustics: Iteration 2

- 1 Diffuse texture, sampled twice
  - .uv sample + swizzled .vu sample
- Diffuse texture UV’s offset by separate normal map


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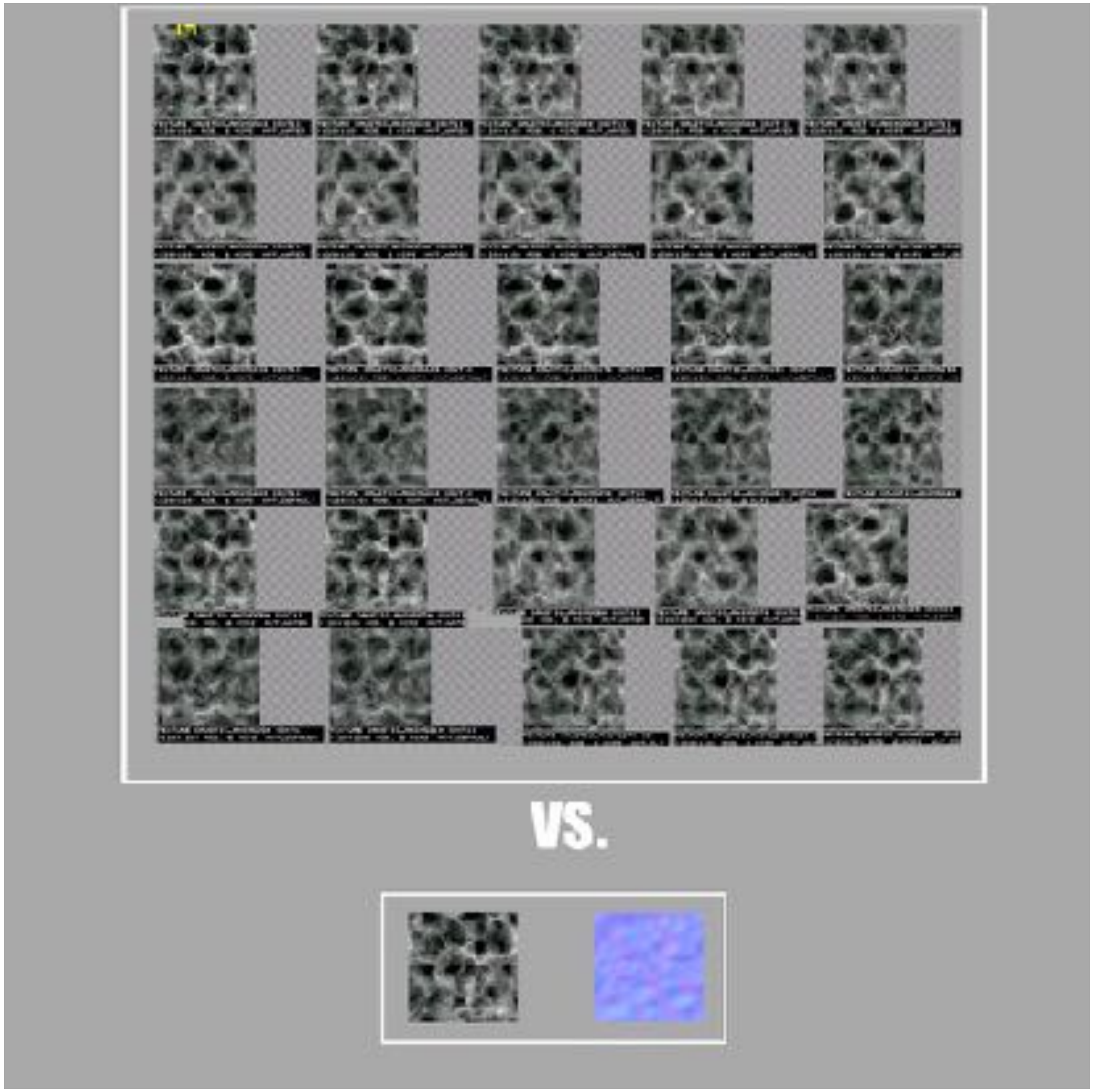
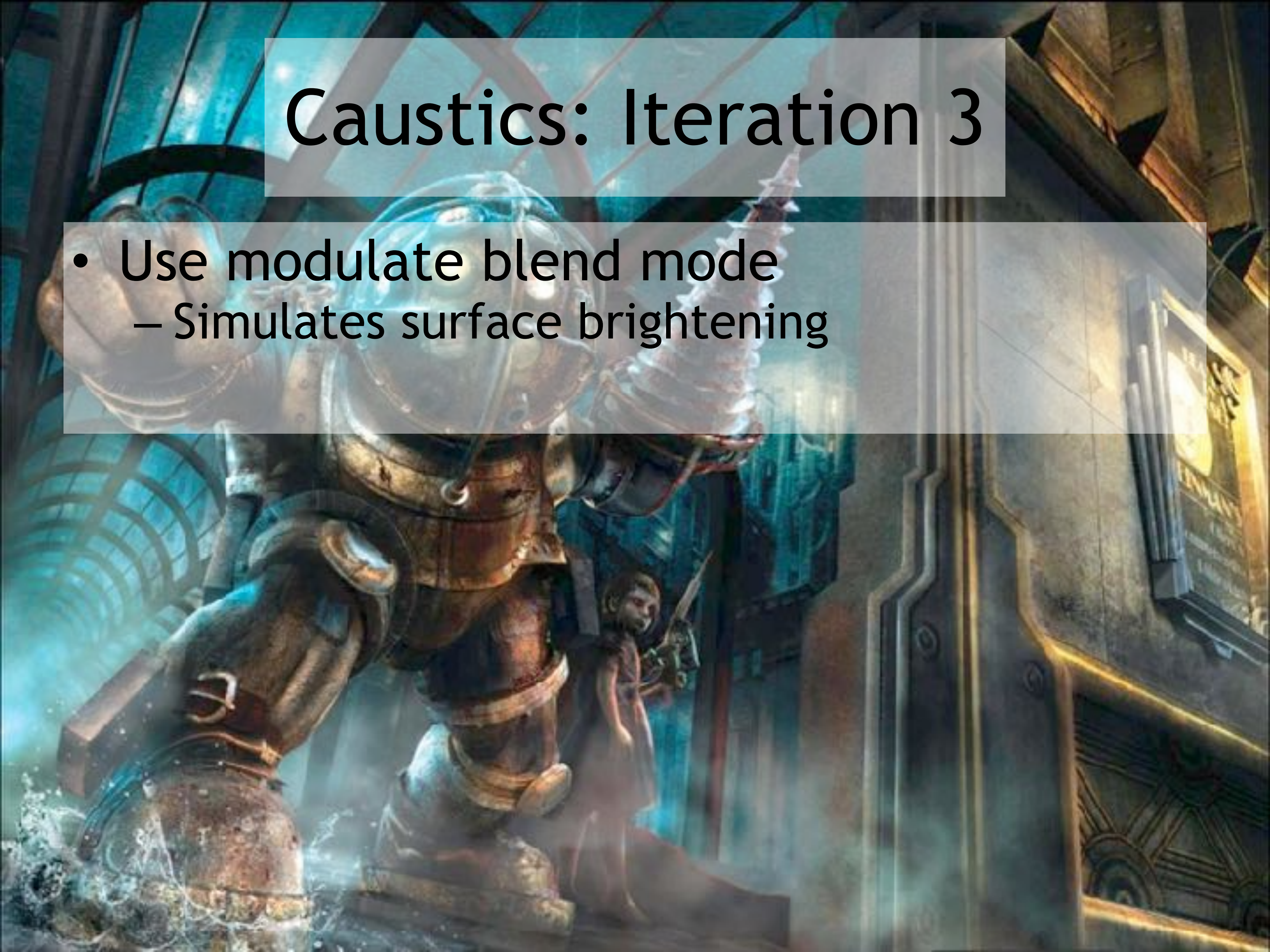
Memory Savings



Caustics: Iteration 3

- Use modulate blend mode
  - Simulates surface brightening

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Water = Lighting

- Controlling how light hits water surfaces is very important
- Special lighting system extension gave artists precise control over light contributions

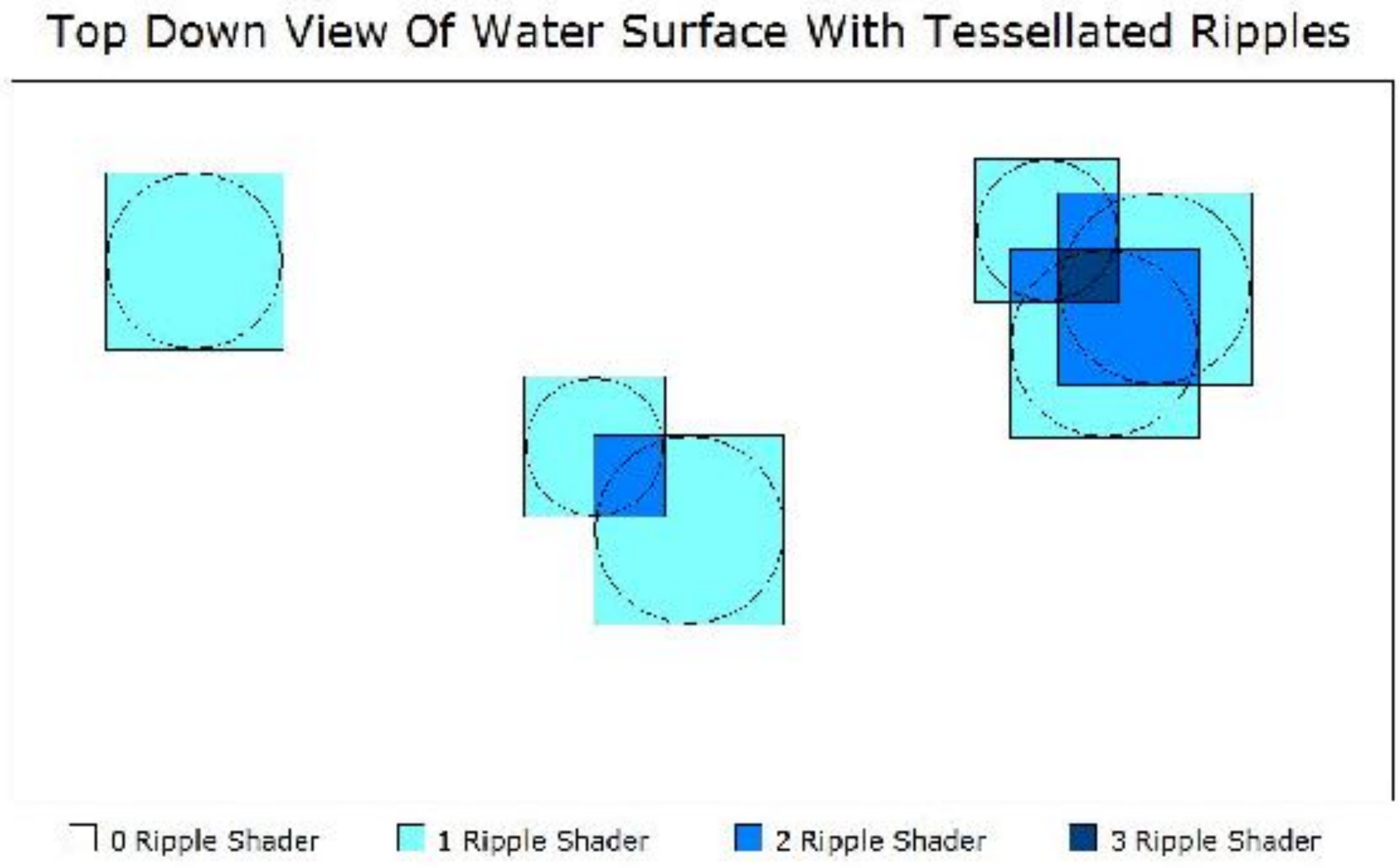
Interactive Rippling Water

- Considered four basic approaches
  - Exposing ripple locations to entire fluid surface shader
  - Dynamically tessellating fluid surfaces around ripple areas using Delaunay Triangulations
  - Dynamically tessellating fluid surfaces around ripple areas using real time 2D BSP trees
  - Deferred rendering approach

First Approach

- Bind an array of ripple locations to pixel shader
- For each pixel
  - For each ripple
    - Calculate UV's, sample ripple normal map
- Performance of every pixel bound by number of ripples on entire surface

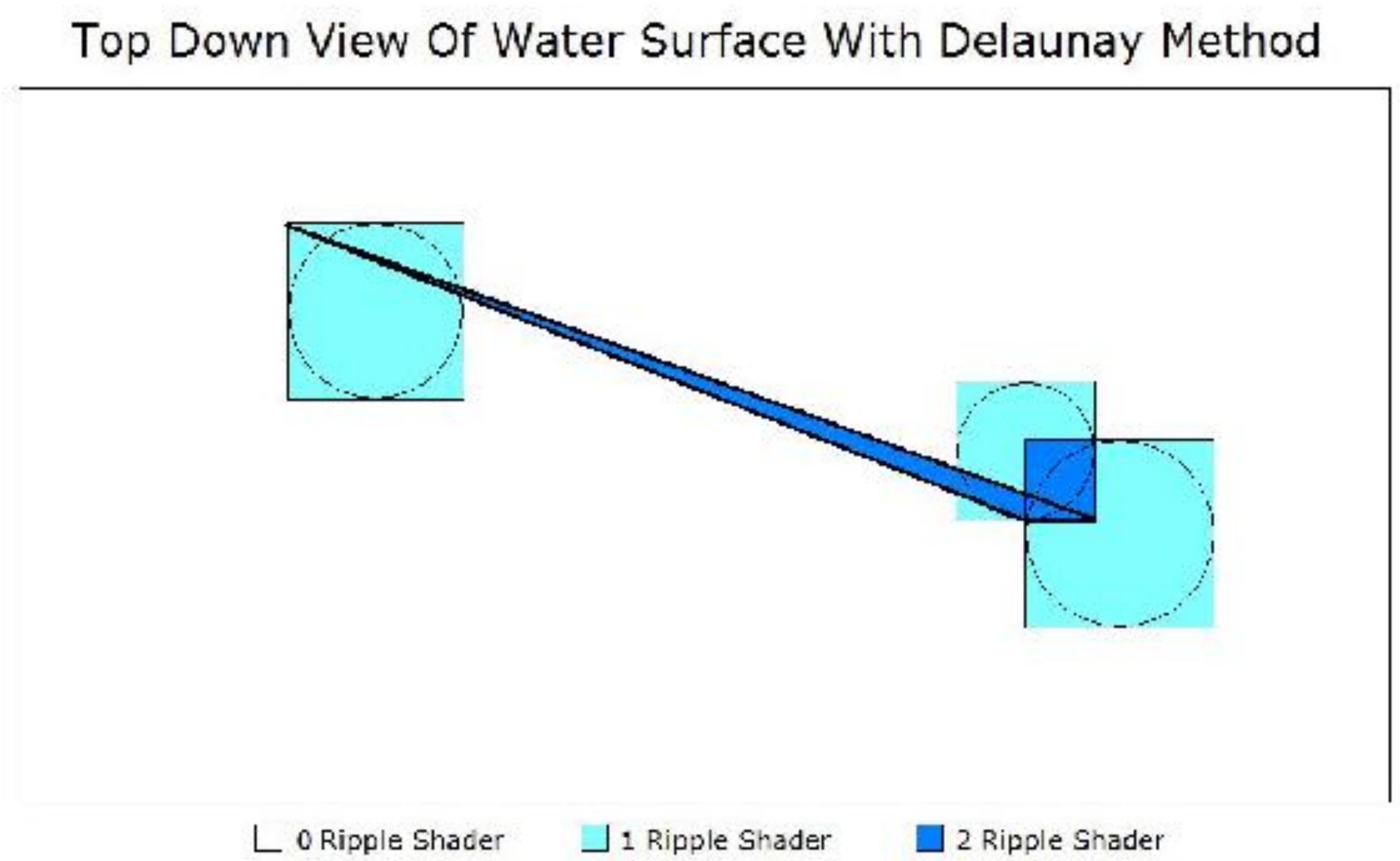
Tessellation Approach



Delaunay Triangulation Method

- Run Delaunay Triangulation using all ripple quad corners
- For each triangle generated
  - Generate UV's for all ripples the triangle intersects
- Batch triangles according to how many ripples they were affected by

Issues with Delaunay Method



BSP Method

- Build 2D BSP tree using edges of each ripple quad
- Last edge added from ripple quad is flagged to indicate child leafs are affected by that ripple
- Post build, tree could be traversed, adding new geometry for each BSP leaf.

Deferred Rendering Approach

- Render all ripple info into a ‘Ripple Buffer’
  - Same resolution as main color/depth buffers
  - Signed FLOAT16 buffer allows normal and diffuse to be stored without MRT
- Store normals in local space to the water surface
- Sample ripple buffer from fluid shaders in screen space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Fire Optimization

- Having art and tech on the same page during optimizations is priceless!!
- Fire optimizations:
  - Merged multiple particle emitters and lights into single emitters and lights
  - Scaled particle size, spawn rates depending on parent object size
  - Reduced particle spawn rates where possible


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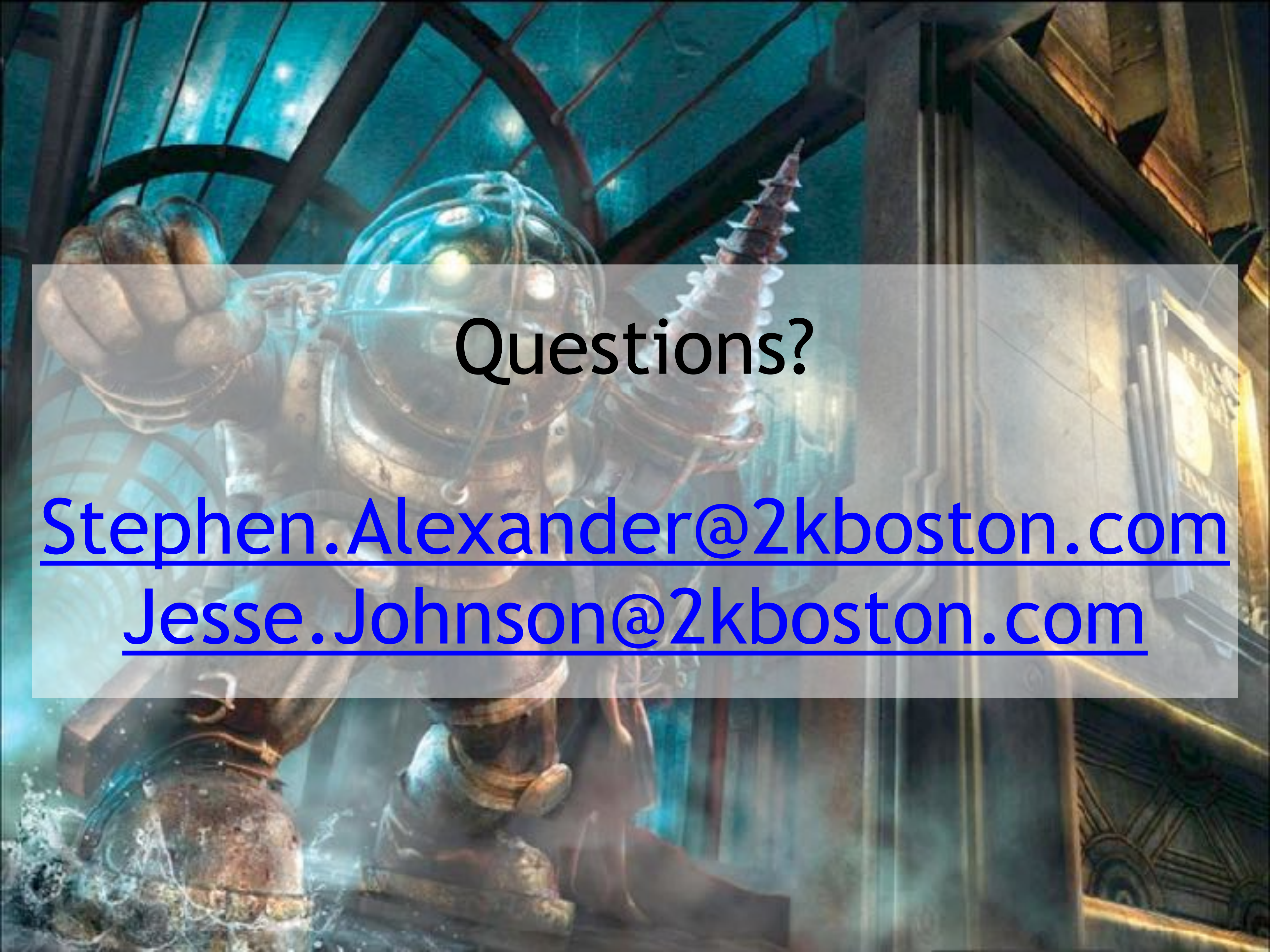

Questions?

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