

# Computer Graphics

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[original slides by Prof. Steve Marschner]

# Computer Graphics

The study of creating, manipulating  
and viewing digital images.

# Topics in Computer Graphics

- Imaging
  - 2D: image editing, video processing, tone mapping
- Modeling
  - 2D: page descriptions (PDF, SVG), typography
  - 3D: representation of shapes, materials, scenes
- Rendering
  - 2D: drawing shapes, simulating art materials
  - 3D: realistic and non-realistic rendering
- Animation:
  - 2D: rotoscoping, shape interpolation, 2D physics
  - 3D: character animation, 3D physics simulation

# Topics in Computer Graphics

- Systems
  - Hardware: GPUs
  - Software: domain-specific languages and libraries
- Interfaces
  - 2D: shape manipulators, layers, artist-friendly painting
  - 3D: scene editors, digital sculpting, specialized gizmos
- Physical Reproduction
  - 2D: photo printing
  - 3D: additive manufacturing, CAD

# Imaging



[Elisa Zwingenberger]



# The Docks - Palermo, Italy (HDR) - Before and After

<http://www.flickr.com/photos/farbspiel/5147905361/>

© klaus heim



1ev

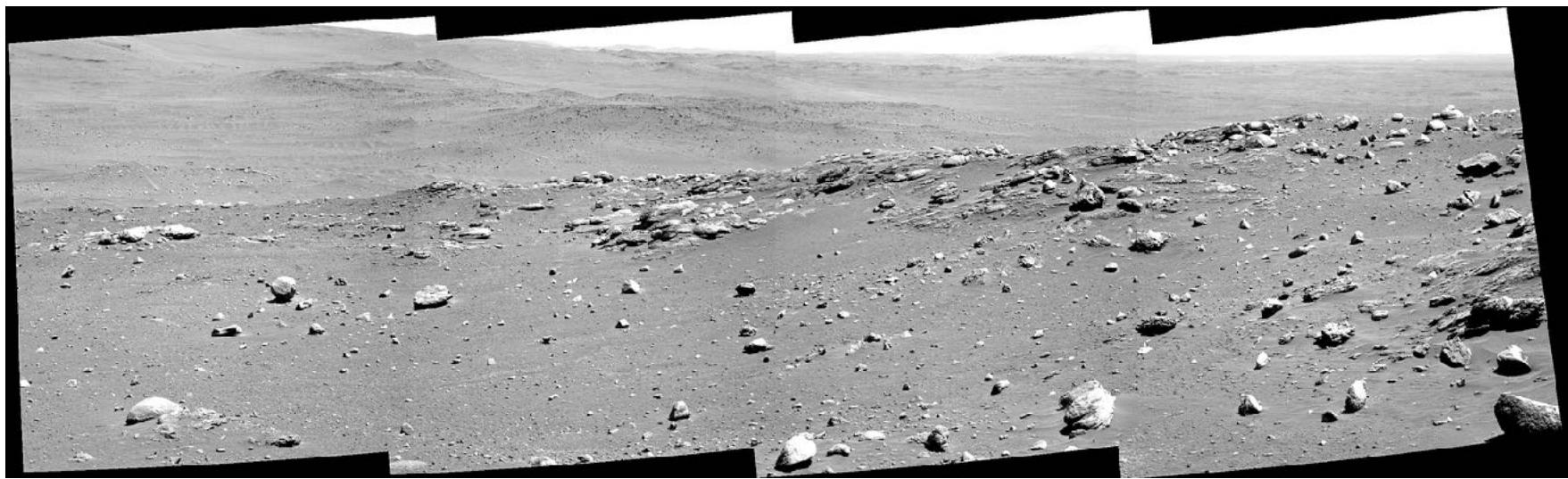
-1ev

-3ev



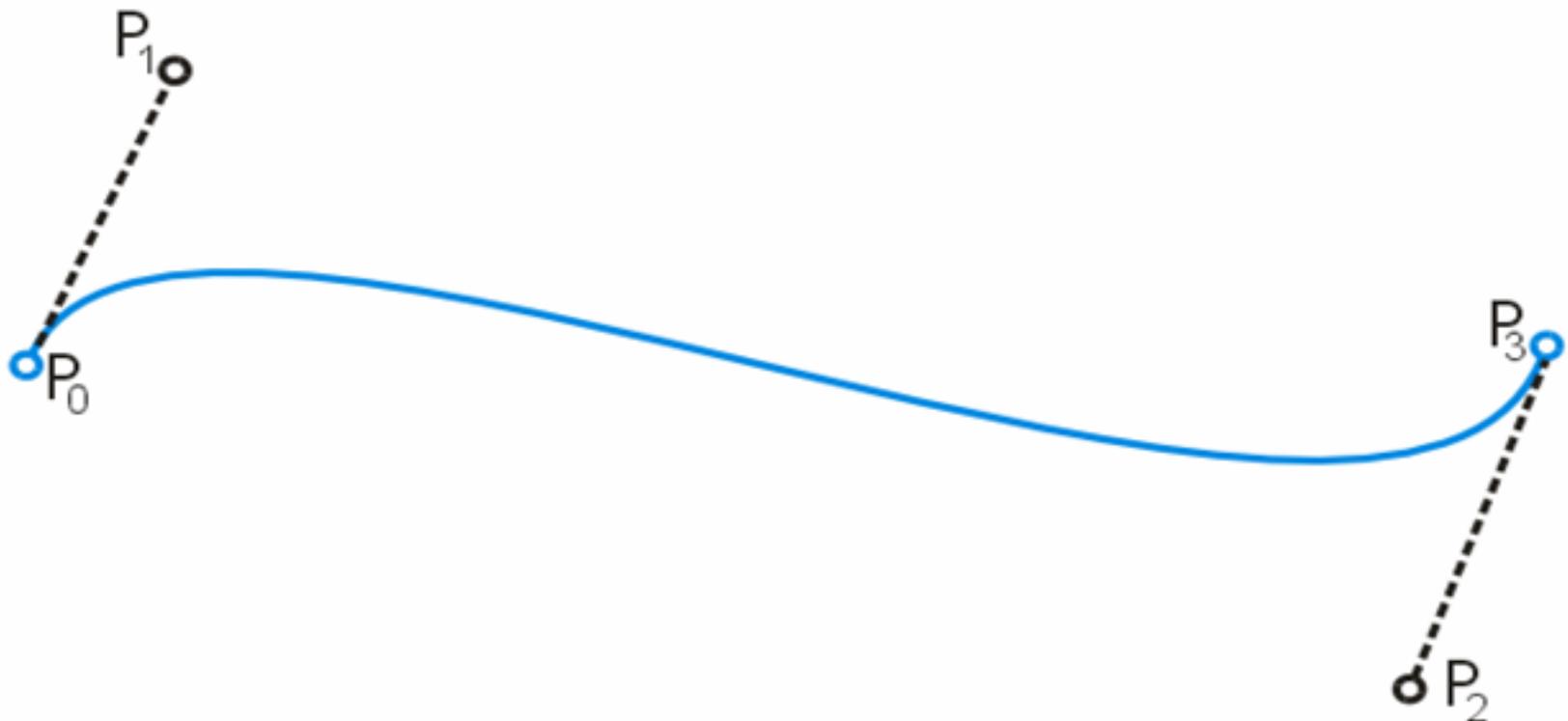
Tone-mapped HDR

Final image after post-processing

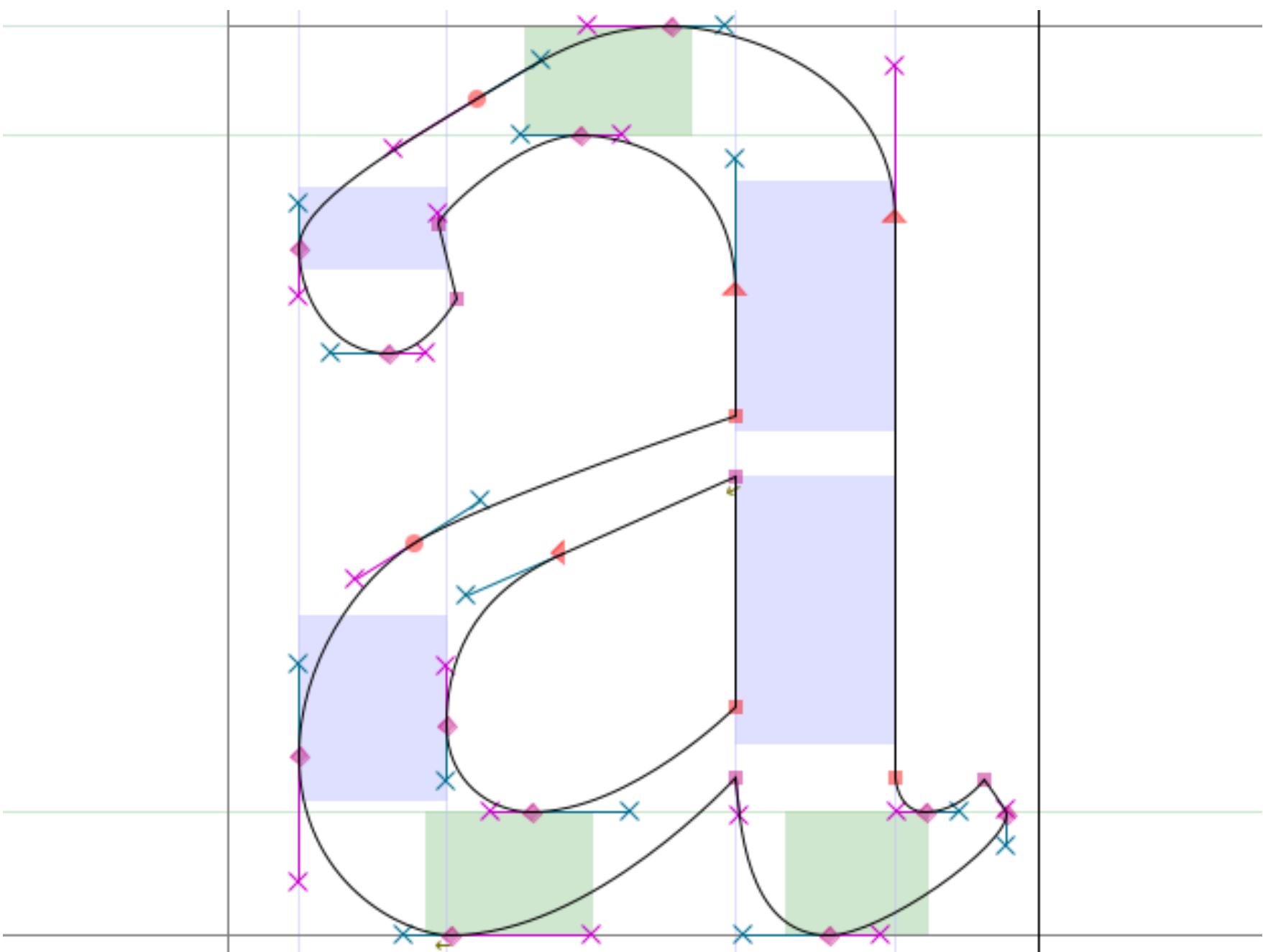


[NASA]

# 2D modeling

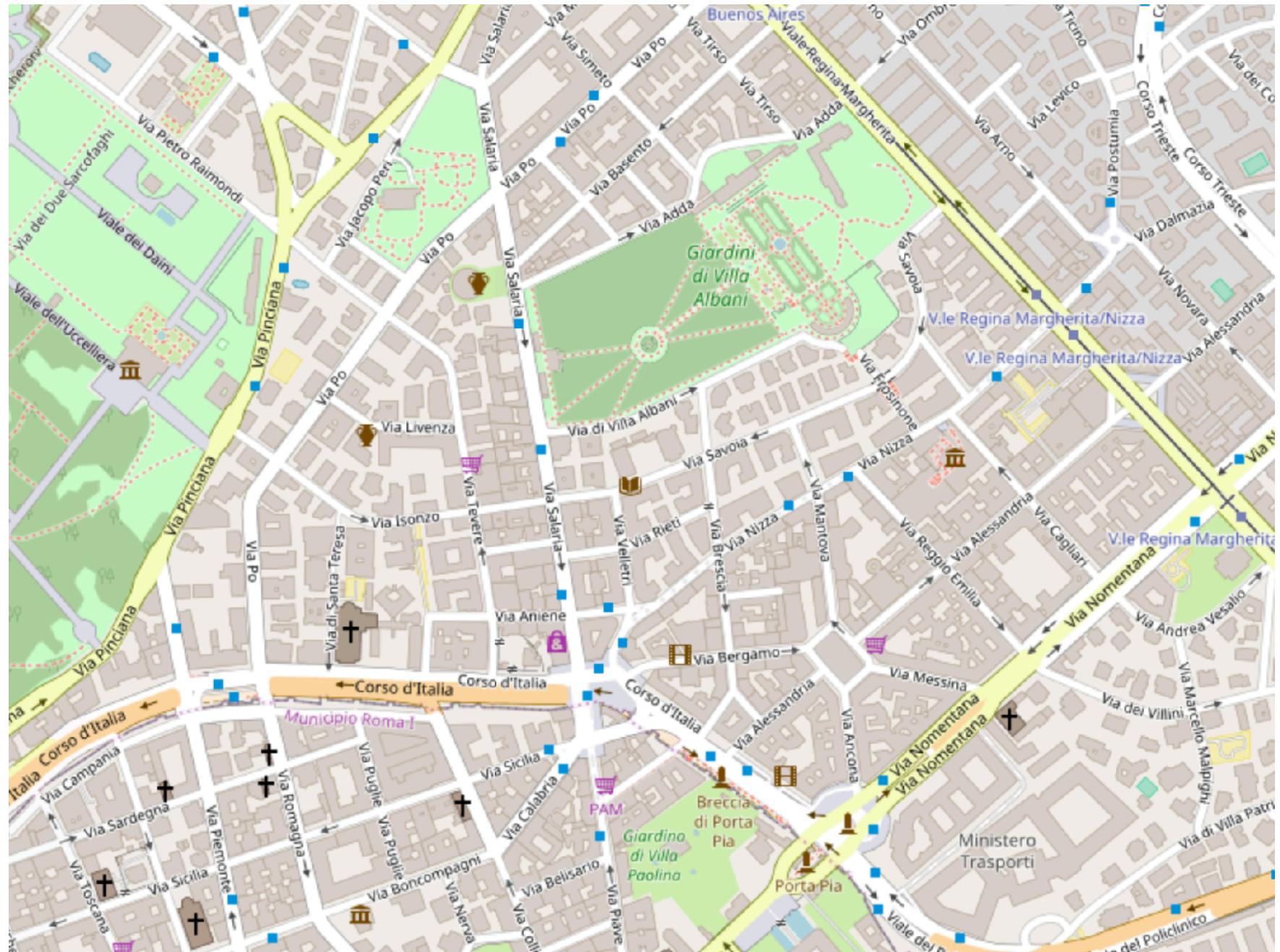


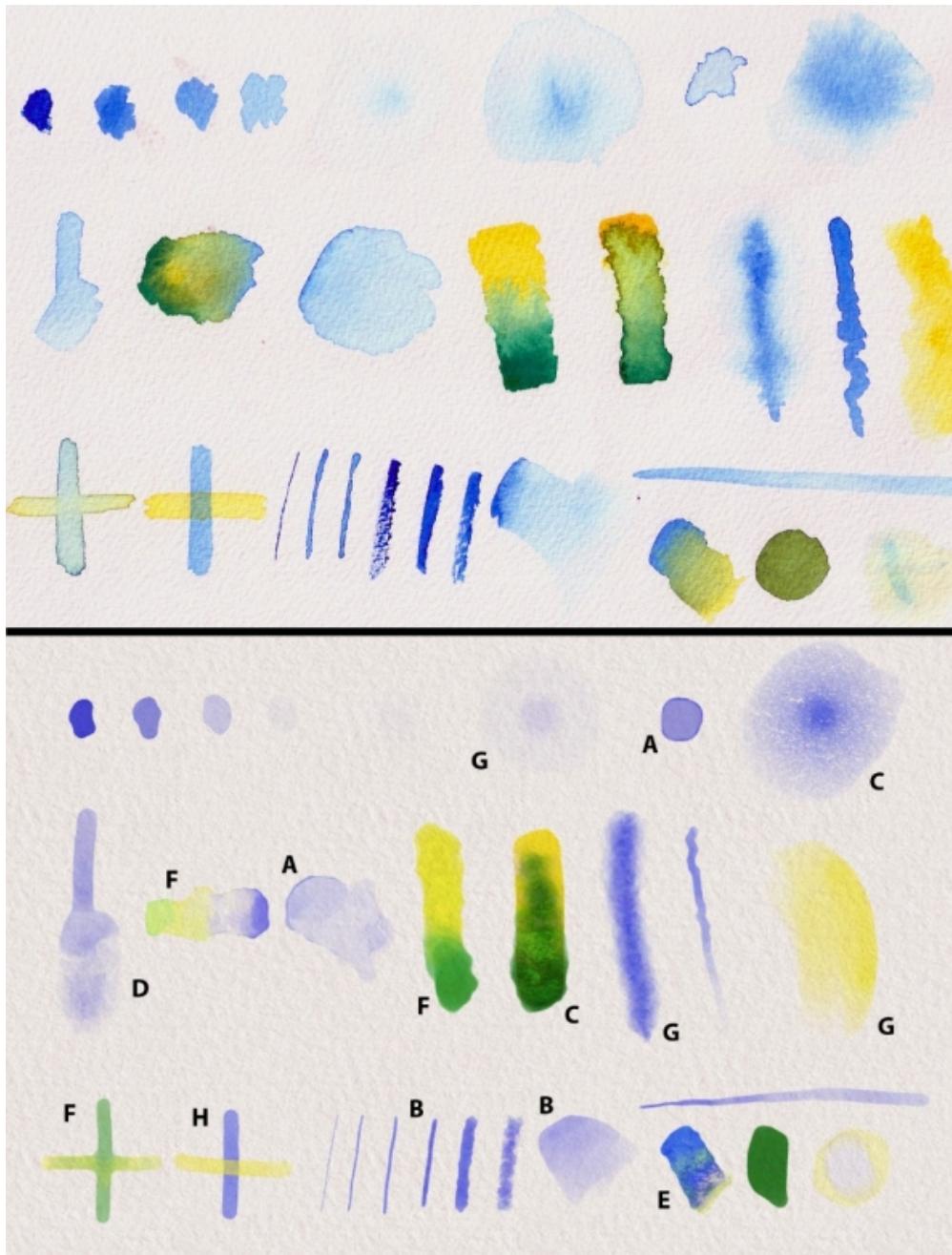






# 2D rendering

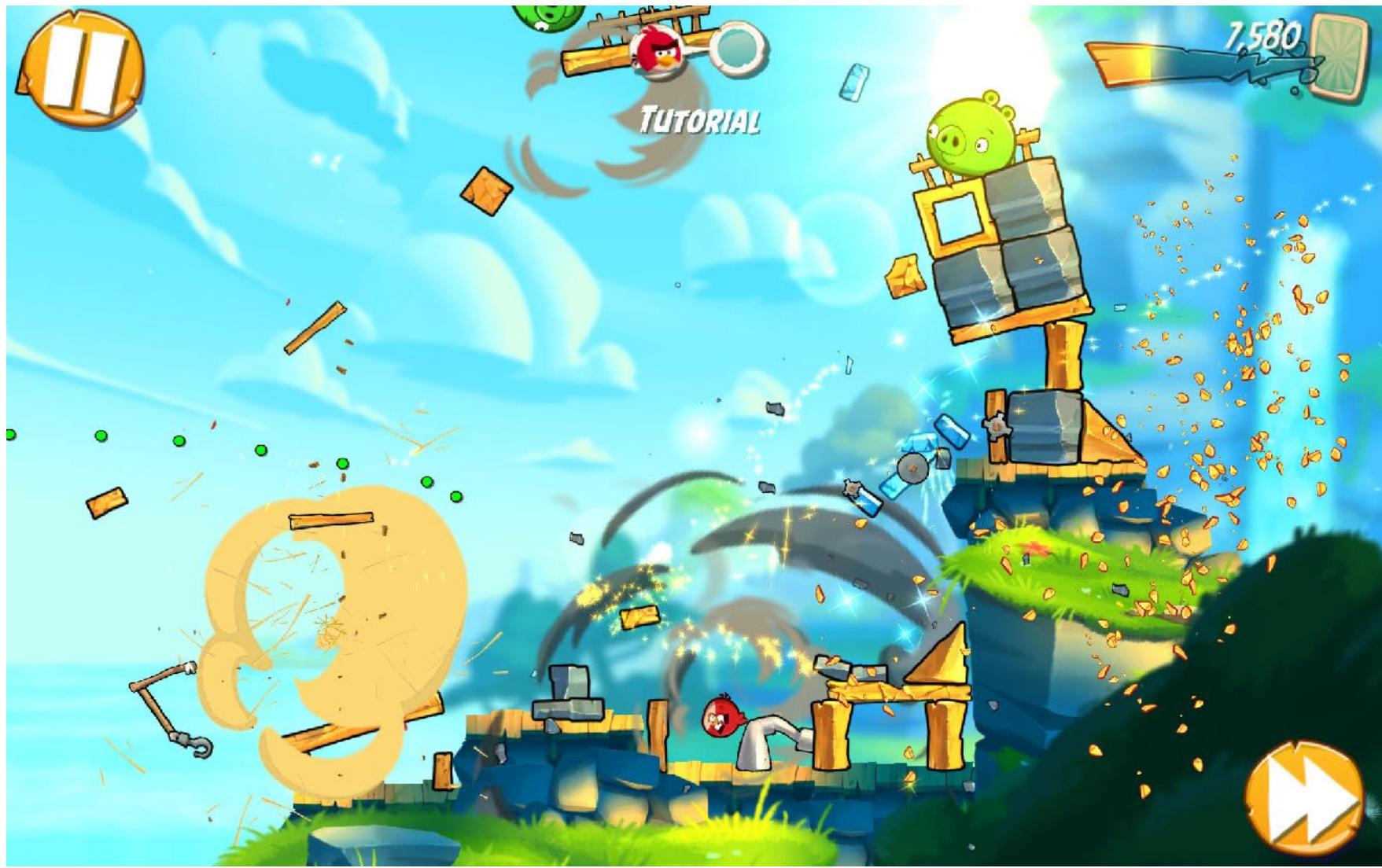




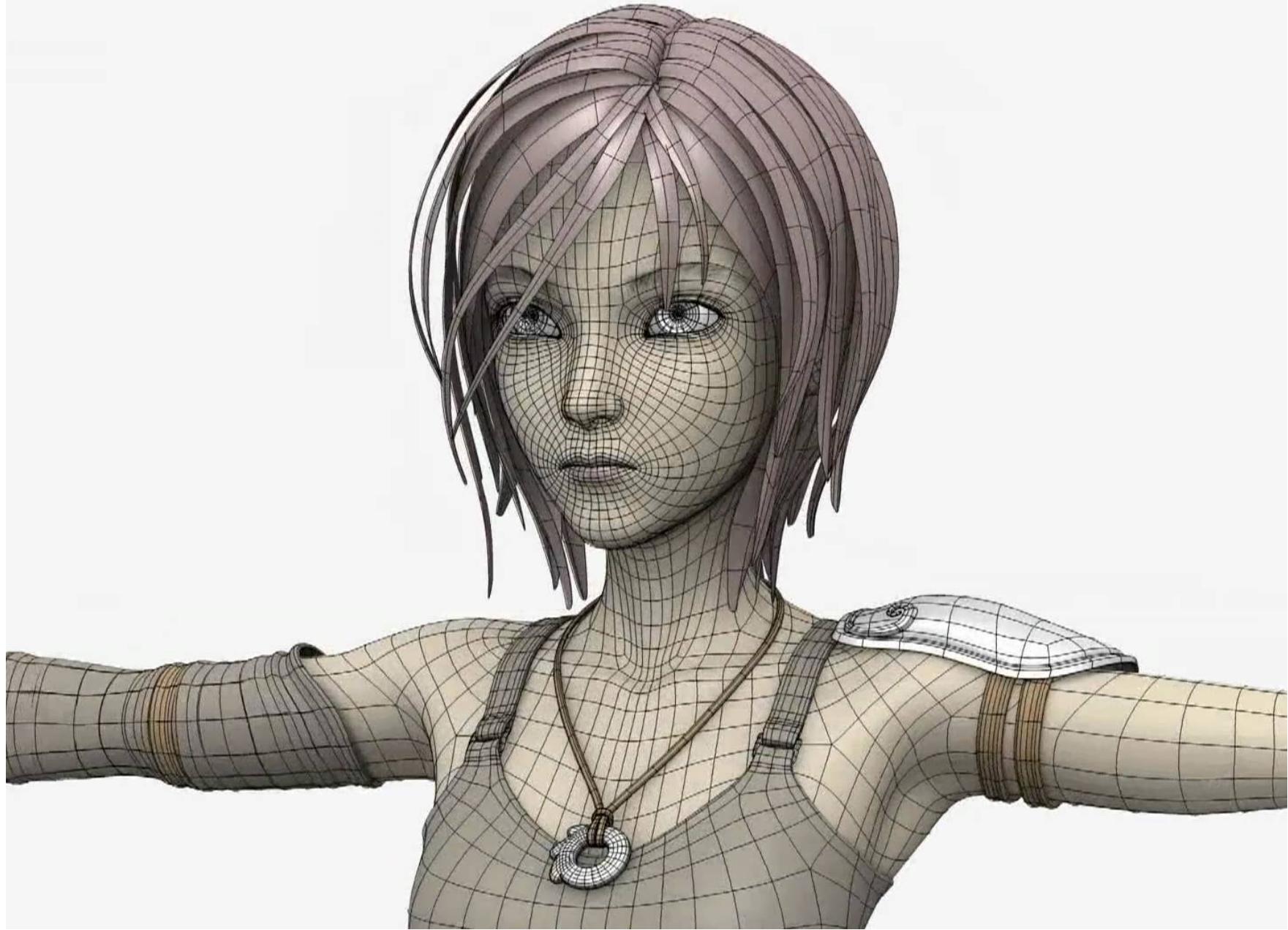
# 2D Animation

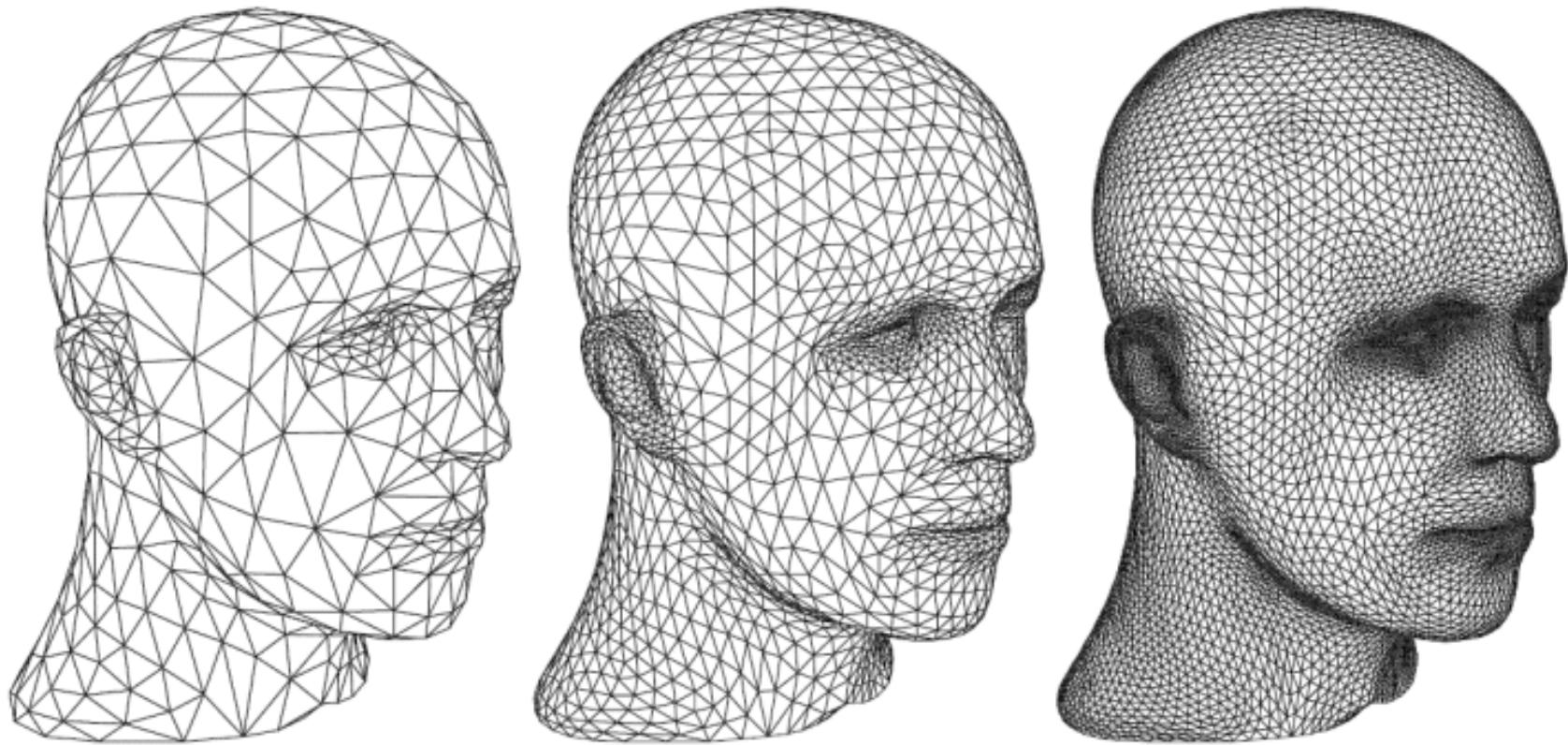


[A Scanner Darkley]

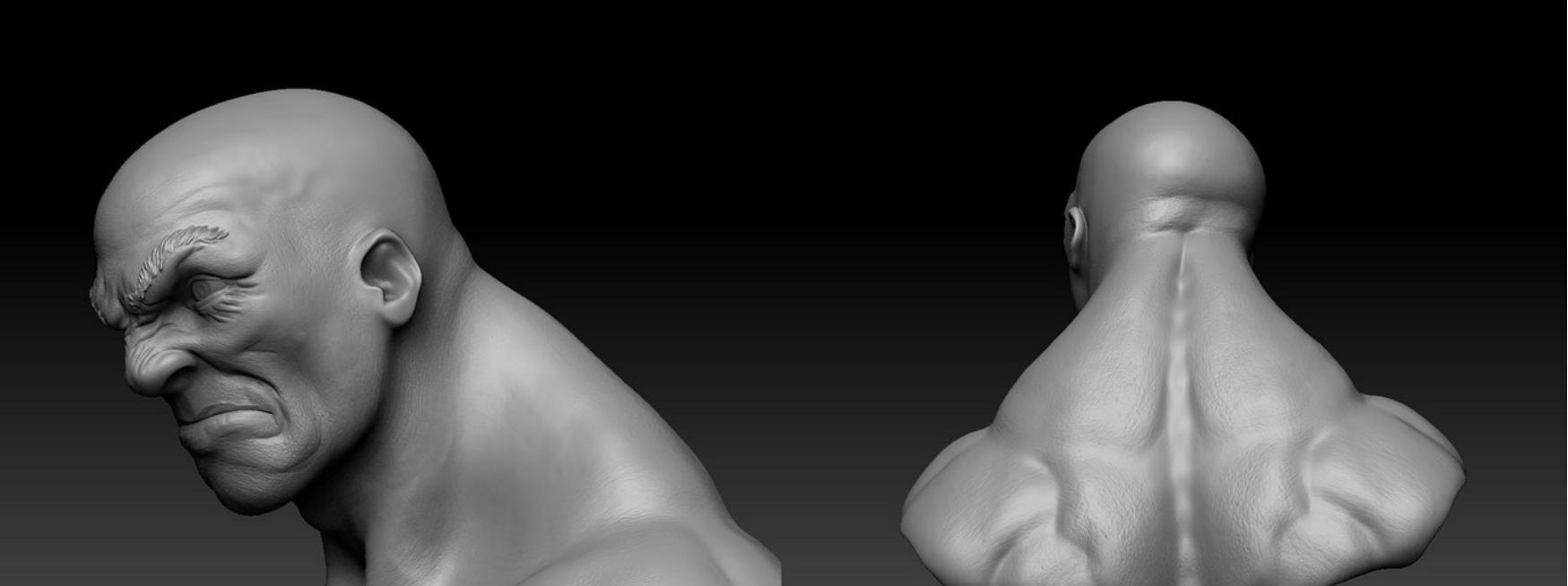
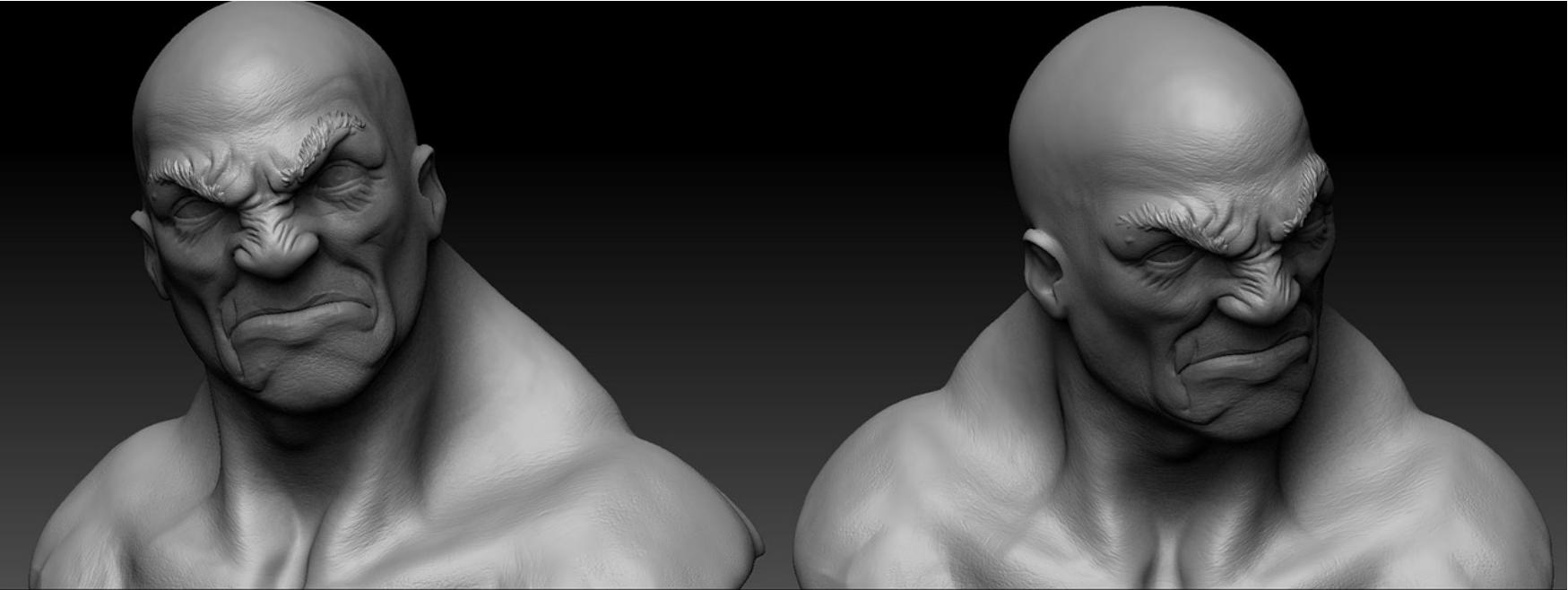


# 3D Modeling

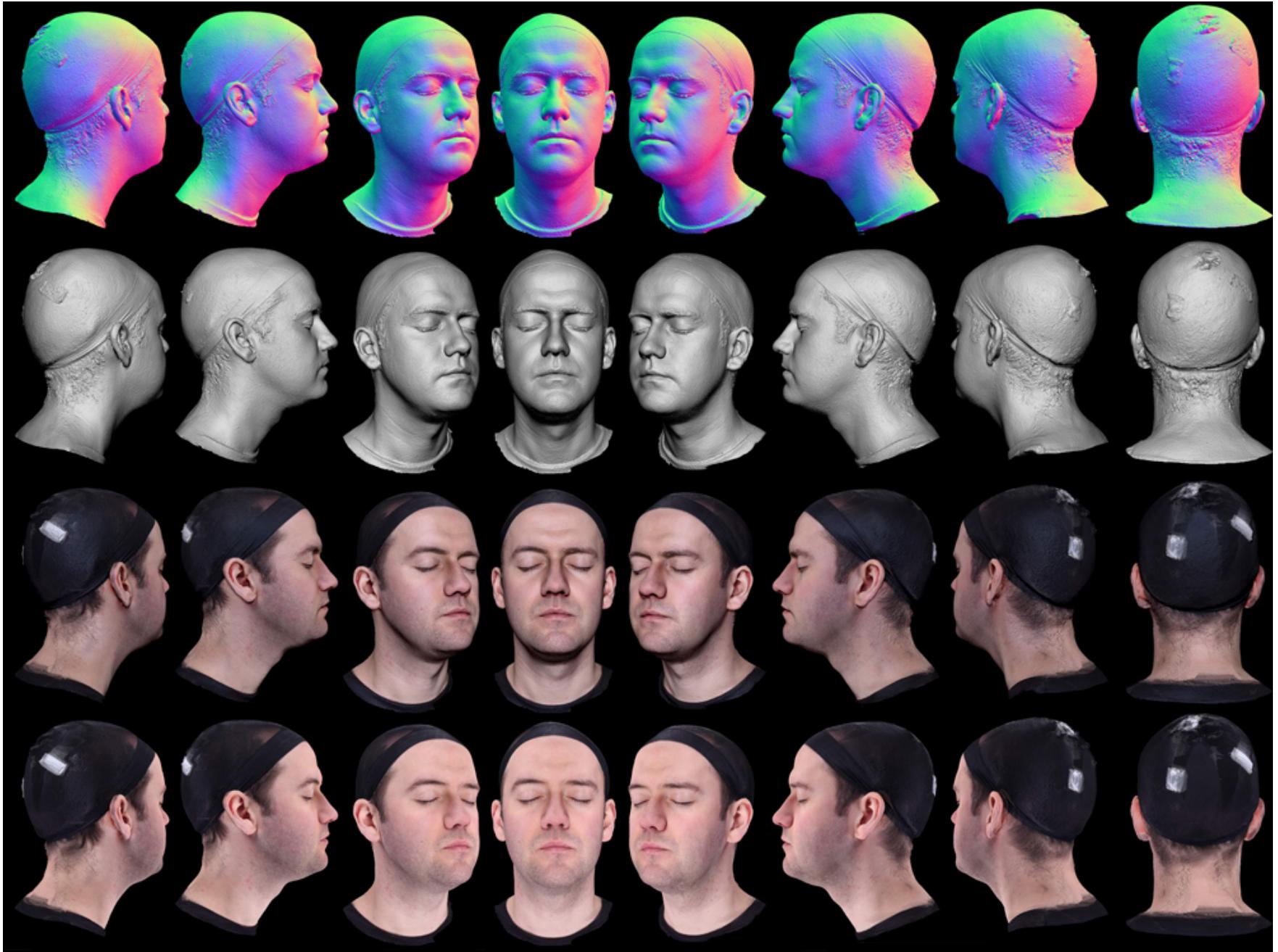


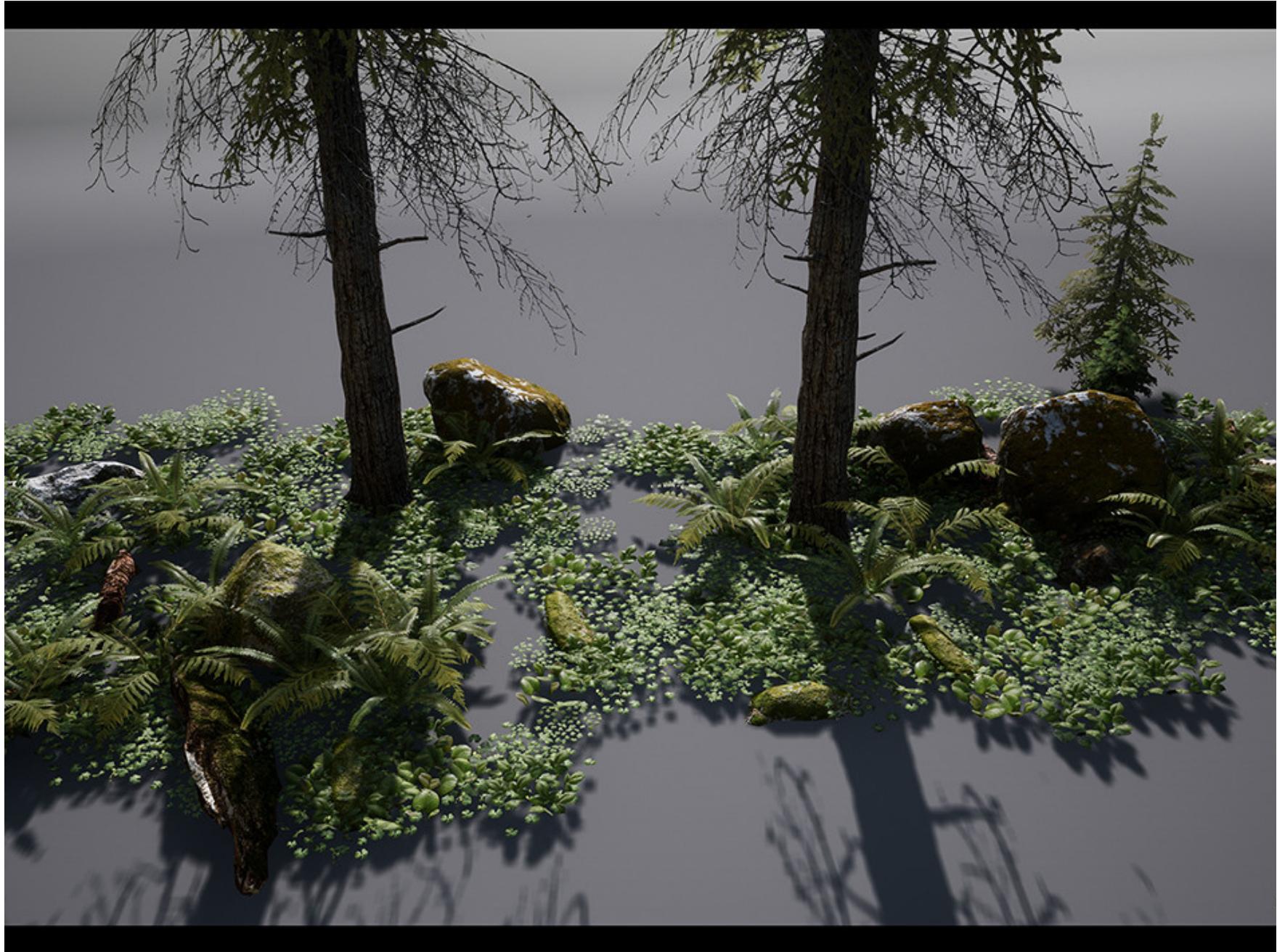


[Zorin et al]



[giovanni gargiulo]

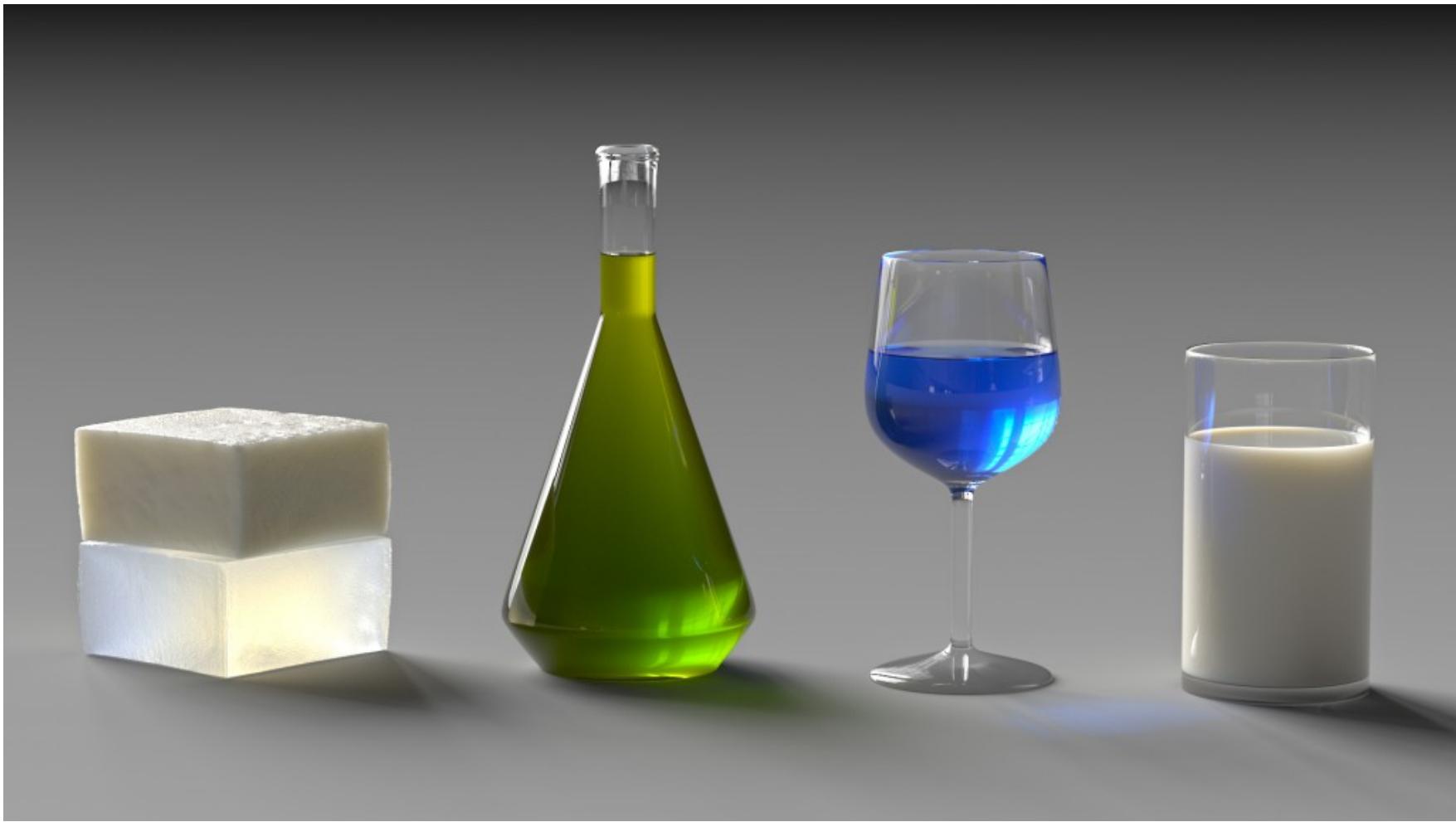




# 3D Rendering



[BlenderOpenMovies]





[Activision]

Activision R&D. Property of Activision Publishing. N



[GuerrillaGames]



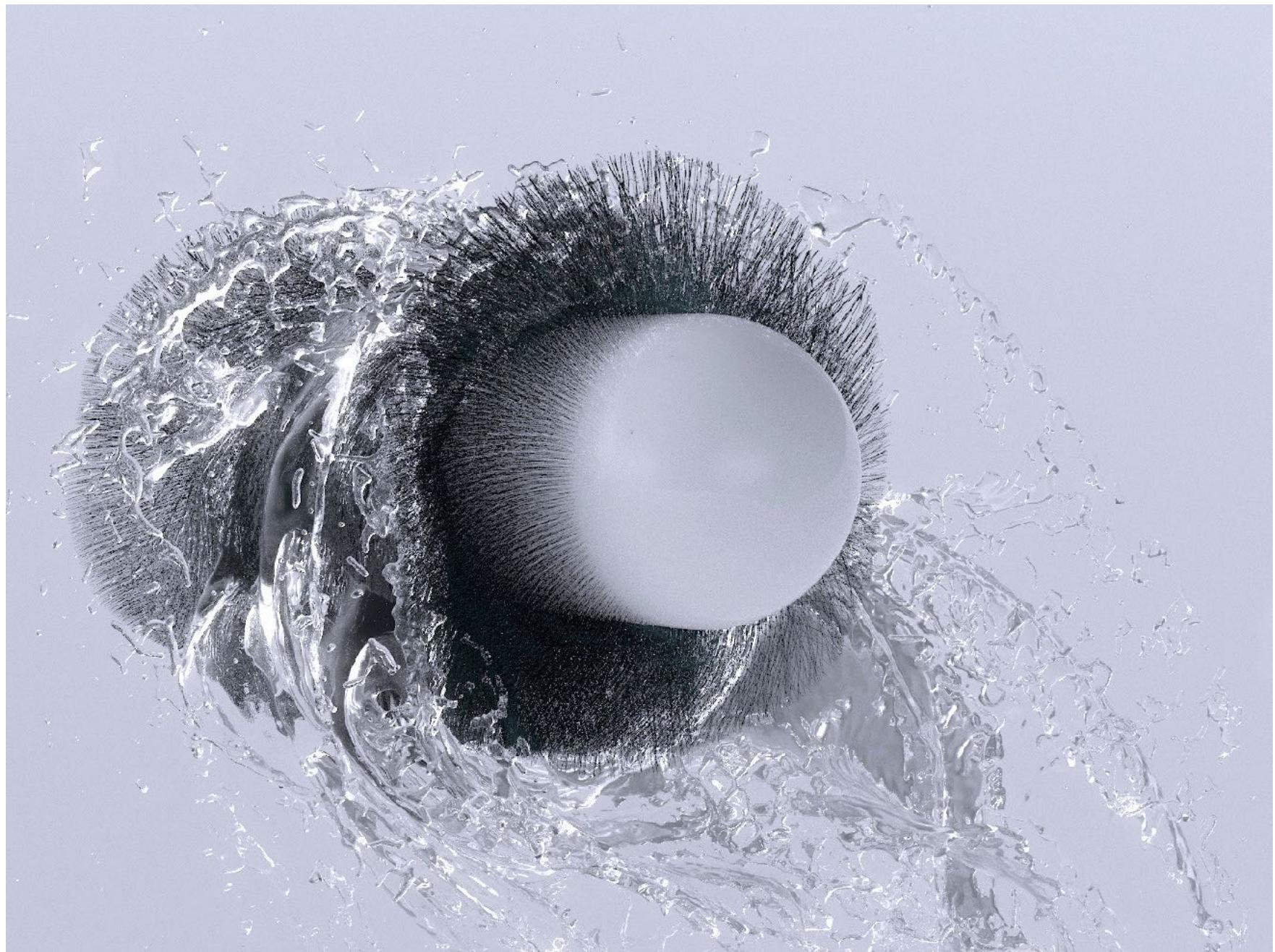
CALL OF DUTY<sup>®</sup>  
WWII

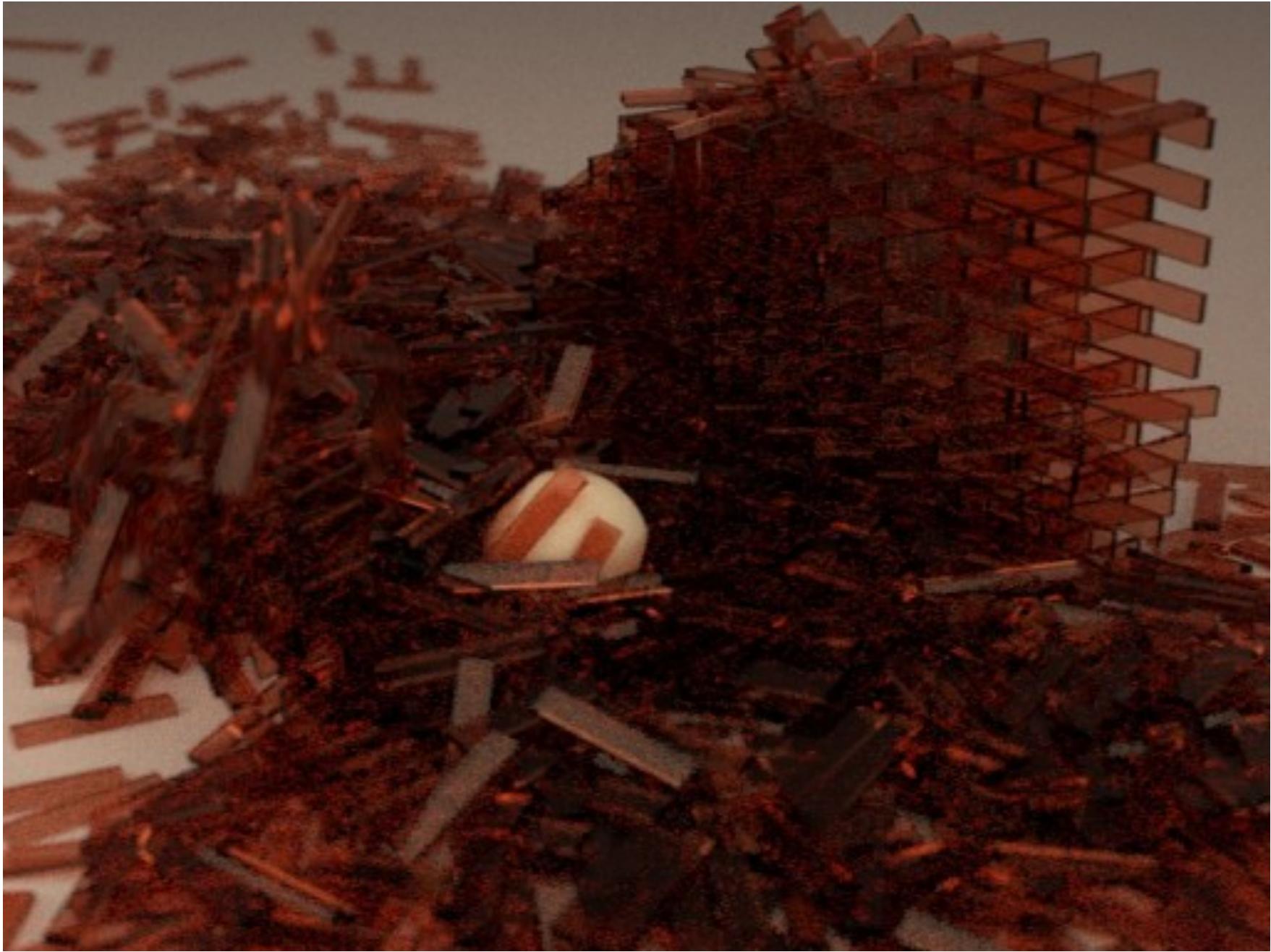
[Activision]



# 3D Animation









[Lord of The Ring]



[Dawn of the Planet of the Apes]

# Graphics Systems

SM

Instruction Cache

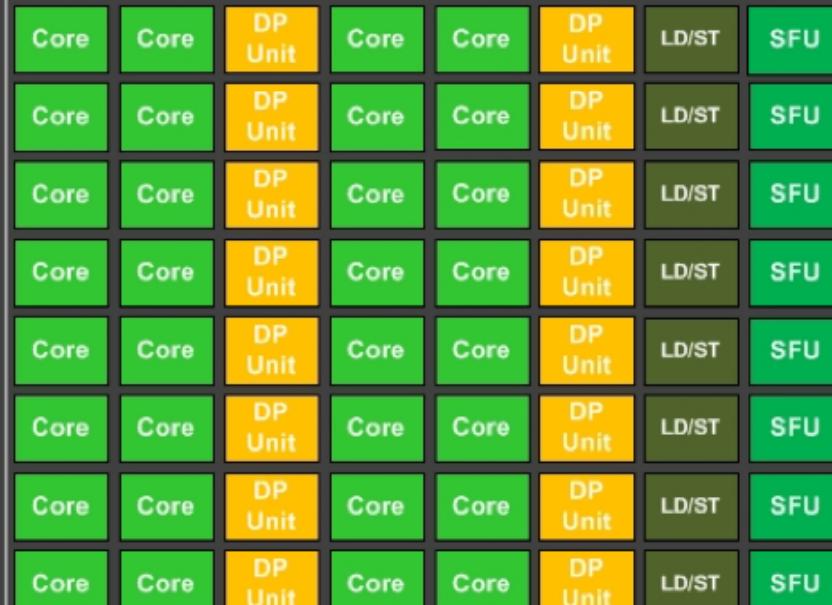
Instruction Buffer

Warp Scheduler

Dispatch Unit

Dispatch Unit

Register File (32,768 x 32-bit)



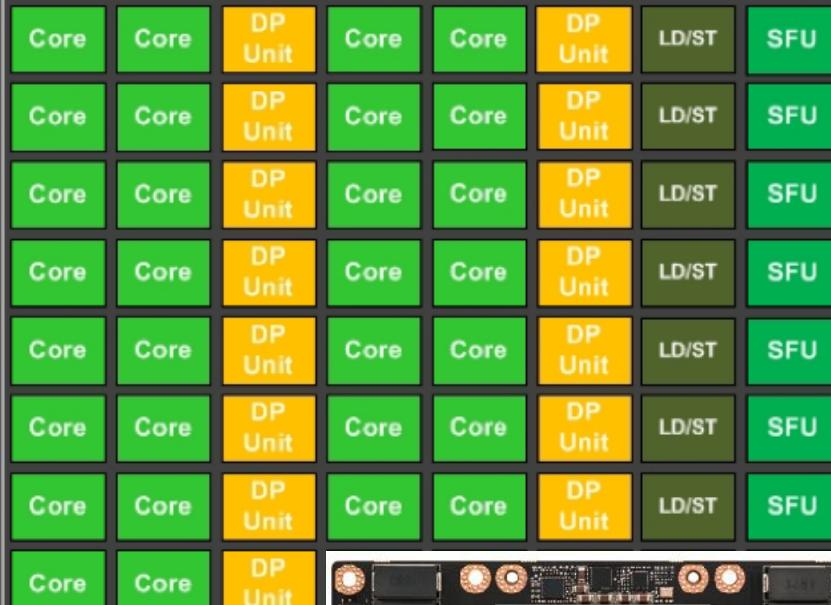
Instruction Buffer

Warp Scheduler

Dispatch Unit

Dispatch Unit

Register File (32,768 x 32-bit)



Texture / L1 Cache

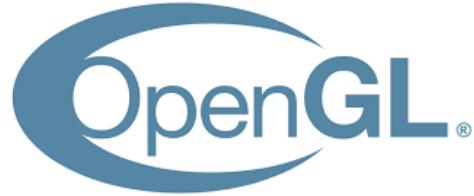
Tex

Tex

Tex

64KB Shared Memory



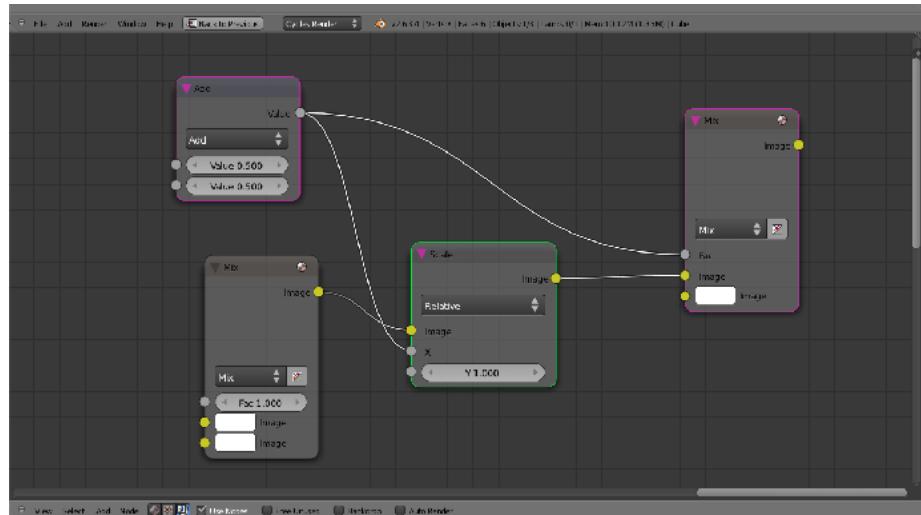


```
layout(location = 0) in vec3 vert_pos;
layout(location = 1) in vec3 vert_norm;
layout(location = 2) in vec2 vert_texcoord;
layout(location = 3) in vec4 vert_color;
layout(location = 4) in vec4 vert_tangsp;

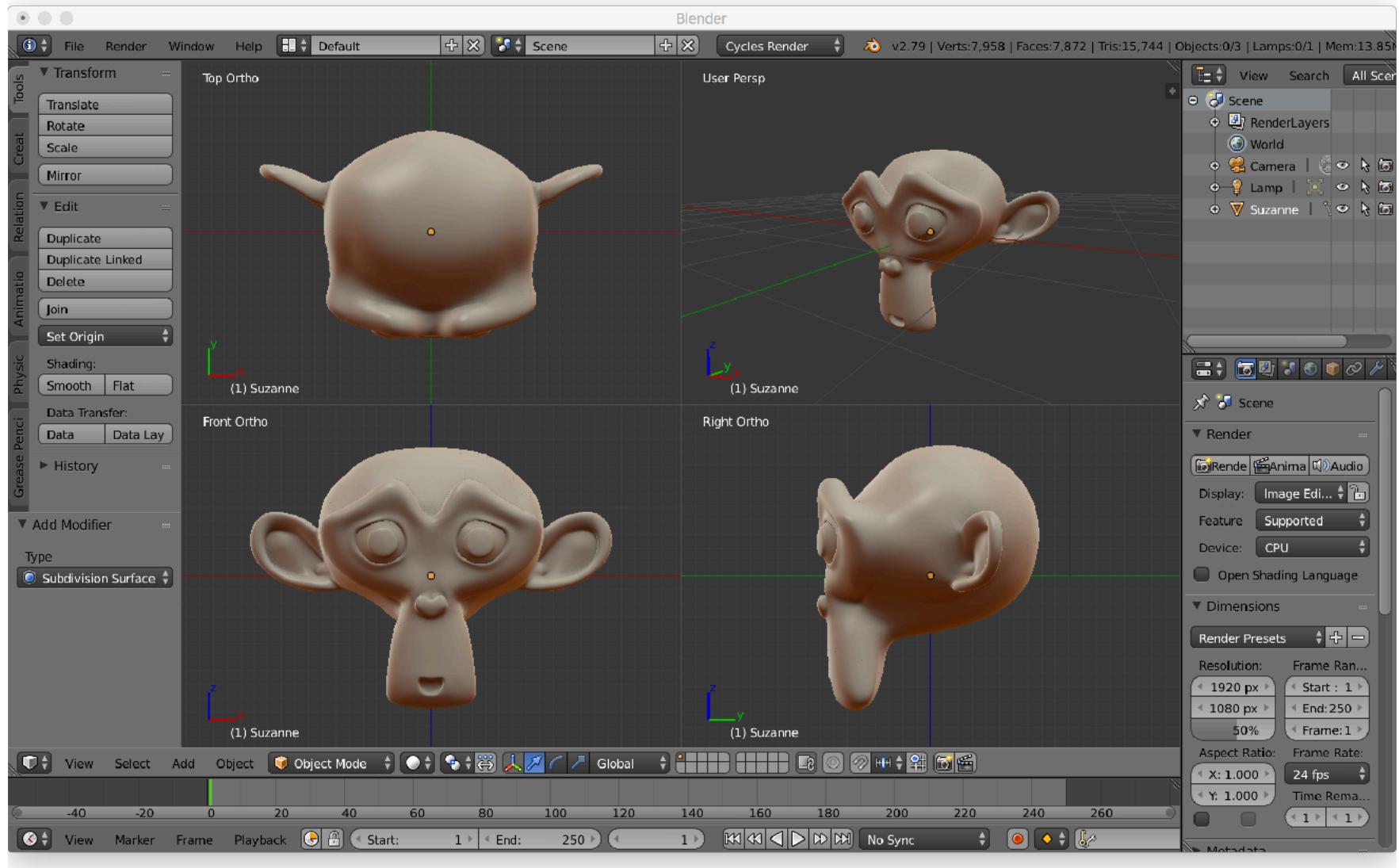
uniform mat4 shape_xform;

struct Camera {
    mat4 xform;
    mat4 xform_inv;
    mat4 proj;
};

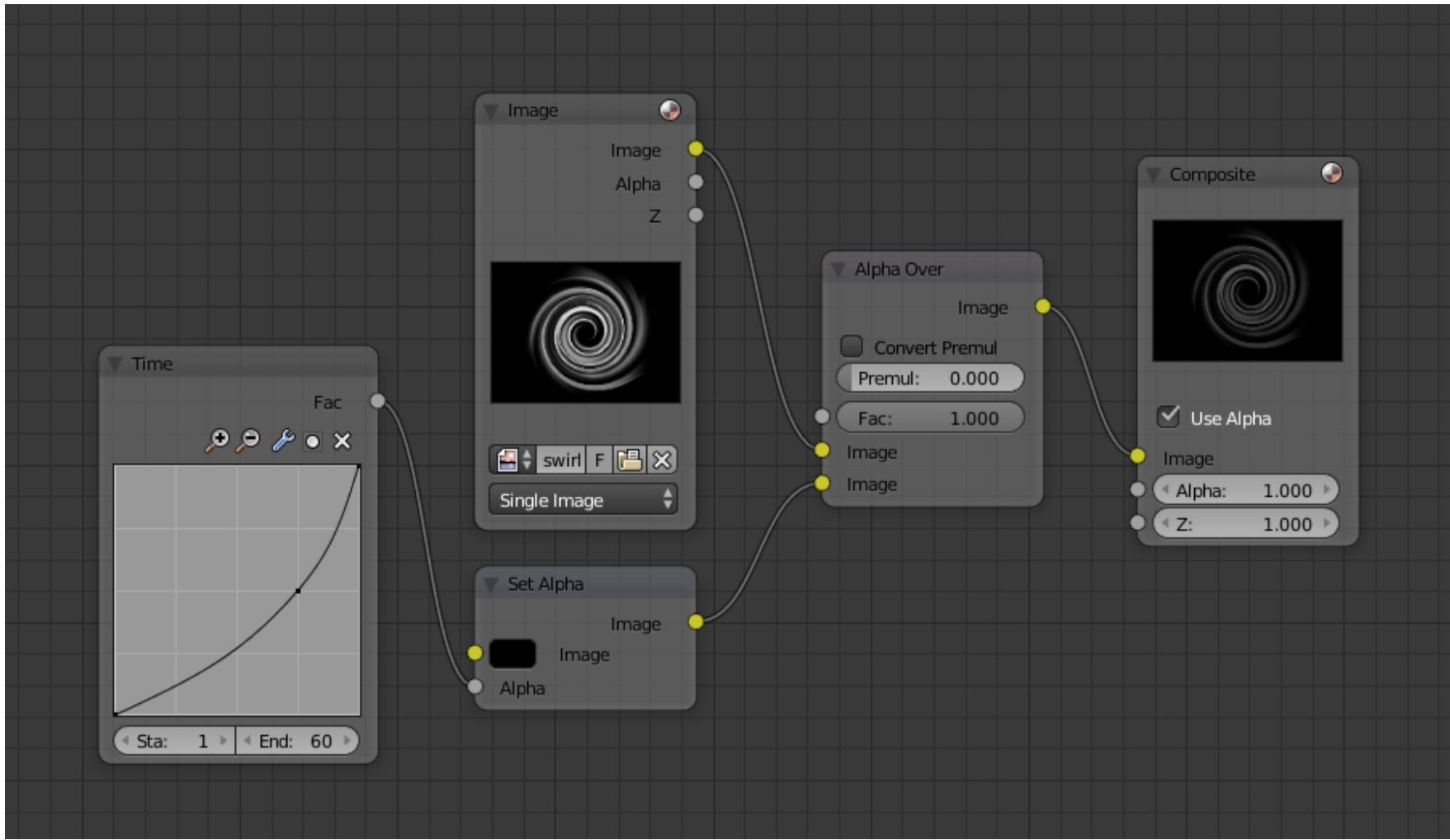
uniform Camera camera;
```



# Graphics Interfaces







# This Course Perspective



Create Images that are  
Indistinguishable from Reality

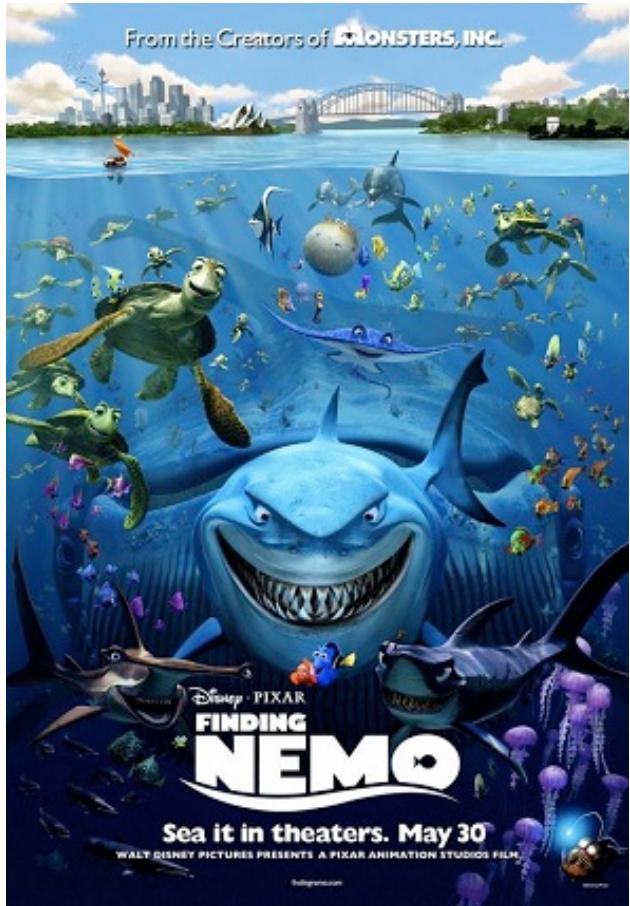


[Wikimedia Commons]

... but Reality is complex

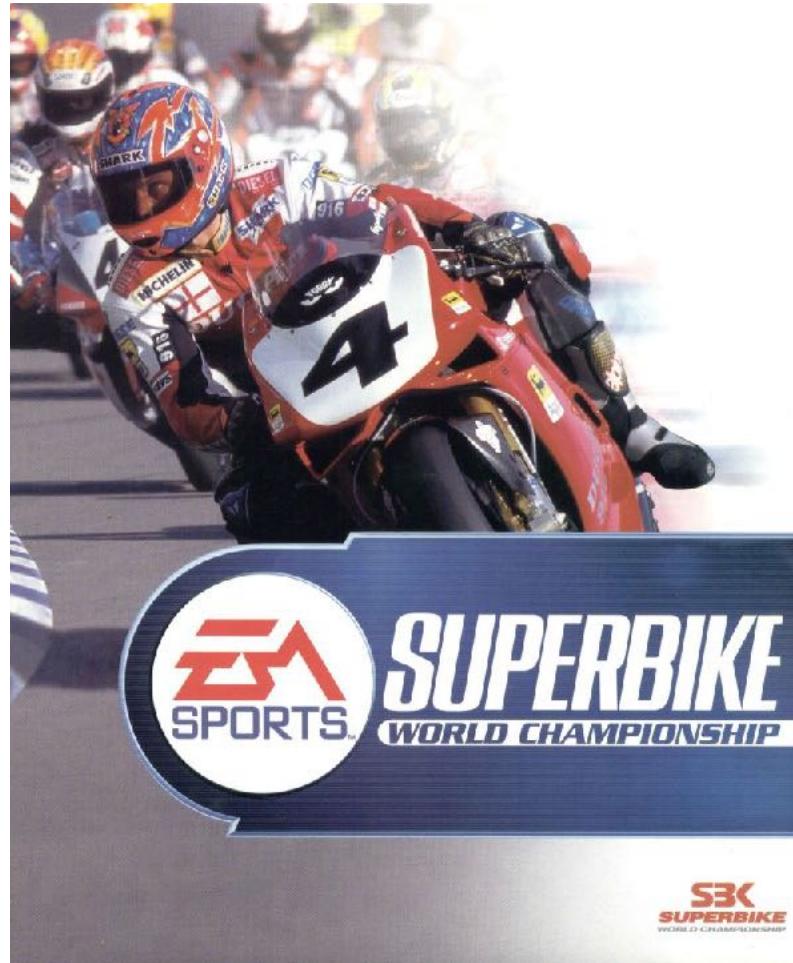
To handle all this complexity,  
Computer Graphics uses  
sophisticated math,  
high performance systems,  
and some physics

# Instructor



[Disney/Pixar]

## My Background



## My Background



# SIGGRAPH



## My Research: Content Creation Systems

# Course

# Course Topics

- What you will learn:
  - Main Computer Graphics algorithms
  - Introduction to Graphics APIs (OpenGL/GLSL)
  - Demos with Software (Blender, Unity, Research Code, ...)
  - How to implement Computer Graphics algorithms
    - With C++/Git/CMake/Debuggers
- What you will not learn:
  - Building large system
  - Creating Art Assets
  - Designing Games

# Course Prerequisites

- Vector Geometry: points, vectors, and their products
  - Basic understanding of Linear Algebra:  $2 \times 2$  to  $4 \times 4$  matrices
  - Basic understanding of Calculus: simple derivates and integrals
  - C or C++
- 
- We will review all this material in class.

# Course Mechanics

- All information on the course website
  - Teaching Material
  - Schedule
  - Homeworks
  - Grading Policies
- Communication
  - Before and after class
  - Office hours
  - Direct email for personal questions