CS4620/5620 Introduction to Computer Graphics

Prof. Steve Marschner

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(with previous instructors James/Bala)

Computer graphics

The study of creating, manipulating, and using visual images in the computer.

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Topics in graphics

- **Imaging**
  - 2D: photography, image processing, compositing
  - 3D: texture mapping, volume imaging
- **Modeling**
  - 2D: page description (e.g. PDF), typography, user interfaces
  - 3D: objects, characters, scenes
- **Rendering**
  - 2D: drawing shapes, motion blur, simulating art materials
  - 3D: realistic rendering; non-photorealistic rendering
- **Animation**
  - 2D: user interfaces, titles, 2D animated films, 2D games
  - 3D: technical illustration, animation, visual effects, games

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2D imaging

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Alexandre Buisse

Alexandre Buisse

Do I need a wide angle lens?

[Chuang et al. 2001 website]

[Chuang et al. 2001 website]

[Chuang et al. 2001 website]

2D modeling

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Thin 9 pt

Pollard's father was a prominent professor of microbiology who often took his family with him to scientific conferences. *At least a dozen Nobel Prize winners attended young Pollard's fourth birthday party,* which was celebrated in Sweden where his father was attending a conference. At Stanford University Pollard was known as a teller of tall tales, but was so well informed and articulate that he "made what might otherwise have been an outlandish series of claims quite convincing". Pollard's Stanford senior yearbook photo listed him as "*Colonel*" Pollard, and he reportedly convinced almost everyone that secret intelligence was paying his fees.

Light 9 pt

At one point, Pollard received permission to establish a back-channel contact with South African intelligence through a South African friend

FS Silas Slab

All weights 75 pt

Regular 9 pt

Sierra
India
Lima
Alpha
Sierra

Bold 9 pt

Page 04

FS Silas Sans

Bold 48 pt

THE NUMBERS READ:

ExtraBold 134 pt

83912

Bold 28 pt

83912

Light 8 pt

Der russische Mann,
Familie 1 Unterfamilie A
KGB/FSB/GRU
[Die 00000-Familie]

Bold 28 pt

10080

Bold 36 pt

10080 46543 46543
— 257 257 143 143 —

Regular 6 pt

Enigma-ID: S06
Frequenzen: Diverse
Status: Aktiv
Stimme: männlich, autom

Regular 6 pt

Übertragungsart: USB + Kurier
Ort: Russland
Bekannte Referenzstationen:
E06, E17, G06, V06, V23, M14, M24

Extra Bold 110 pt

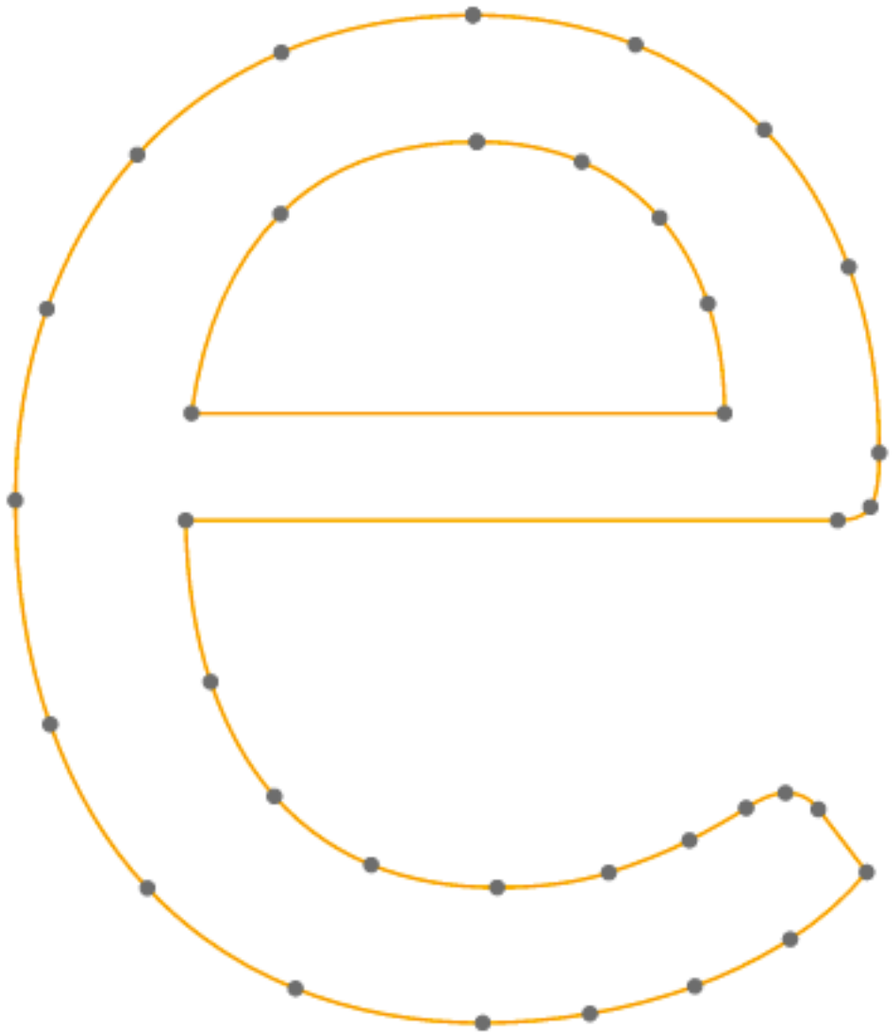
00000

FS Silas Slab

Page 05

FS Silas Sans

design: Believe in for Fontsmith | *Communication Arts* gallery



Pavithra Solai, kint.io

THE ICONIC WILDLIFE OF

GLACIER NATIONAL PARK

Tom Whalen | strongstuff.net

2D animation

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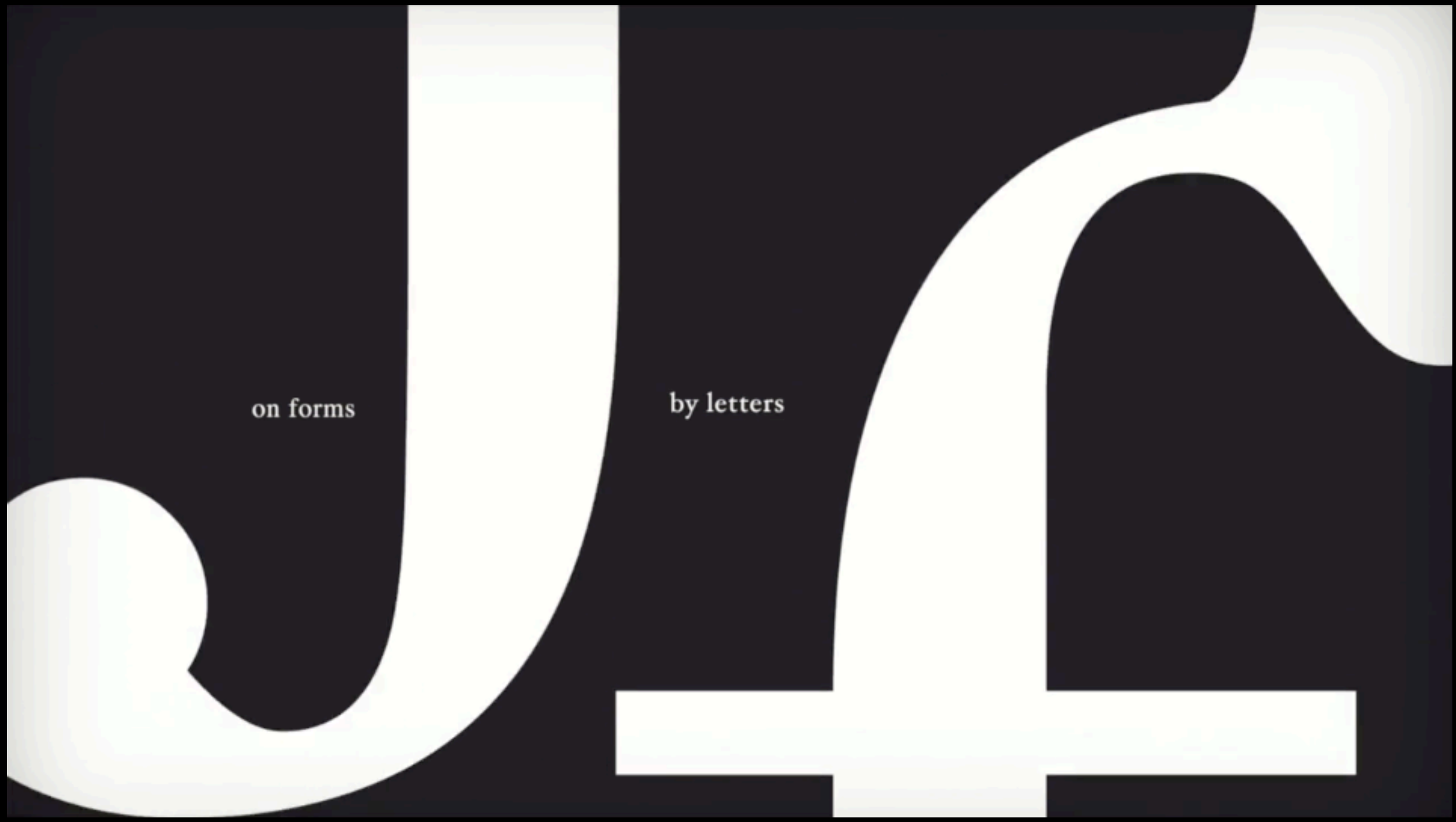
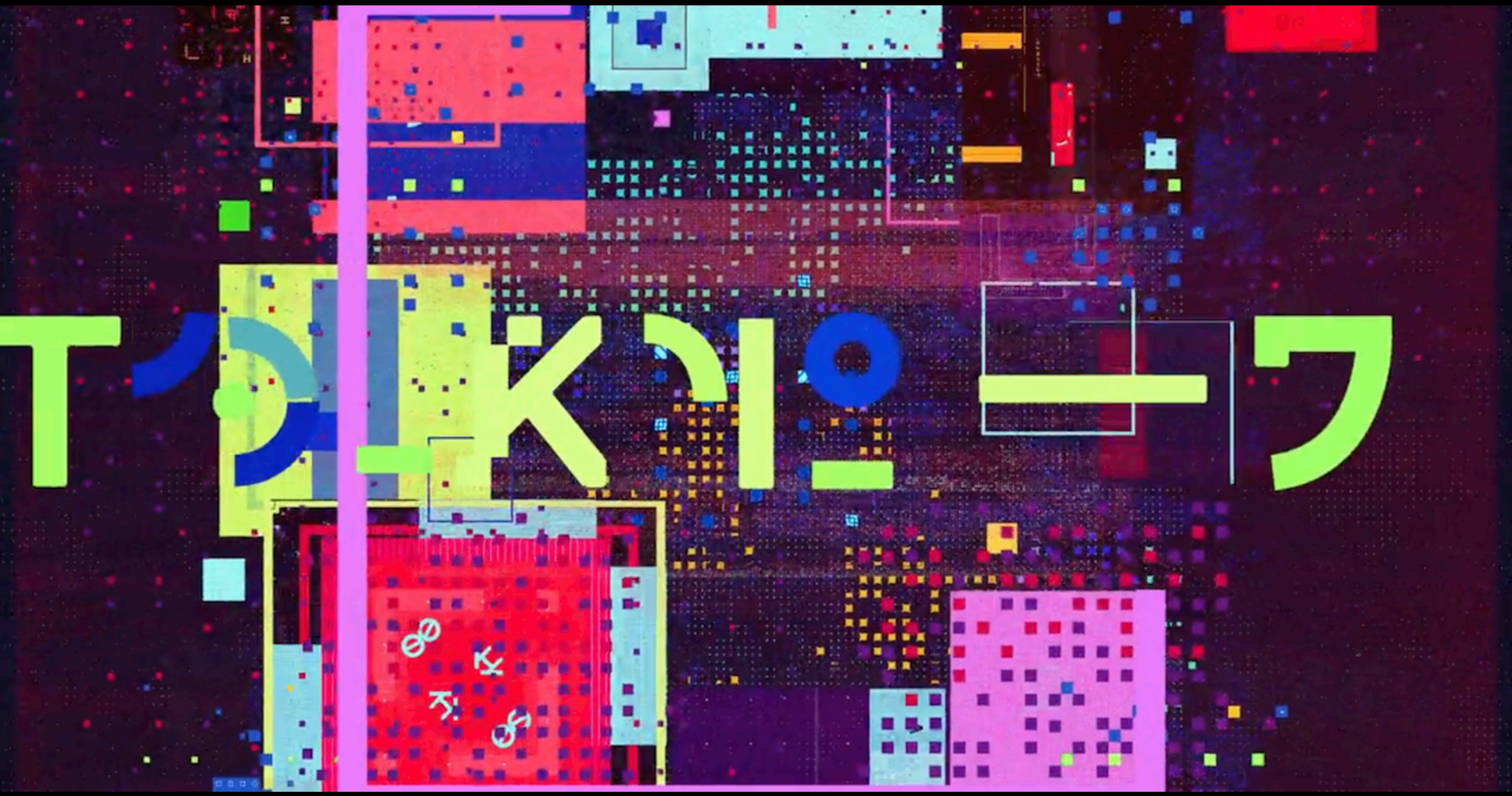


https://vimeo.com/69375692

https://vimeo.com/95943971

(see also https://vimeo.com/151850021)

Felix Meyer, Pascal Monaco | *Traveling Lights*



https://vimeo.com/118919656

Ash Thorpe | *FITC Tokyo 2015 title sequence*

Polytron—*Fez* (2010)

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2D rendering

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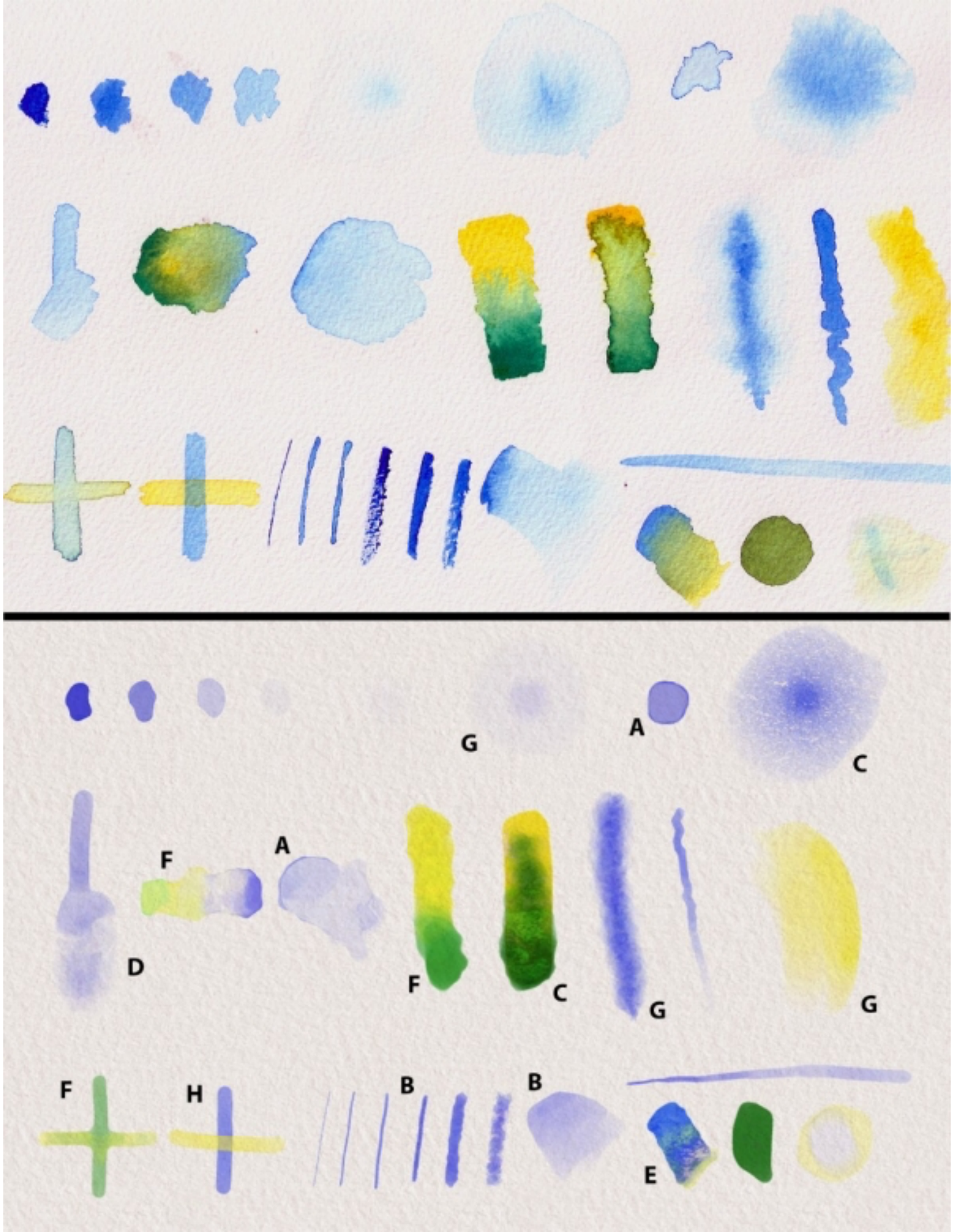
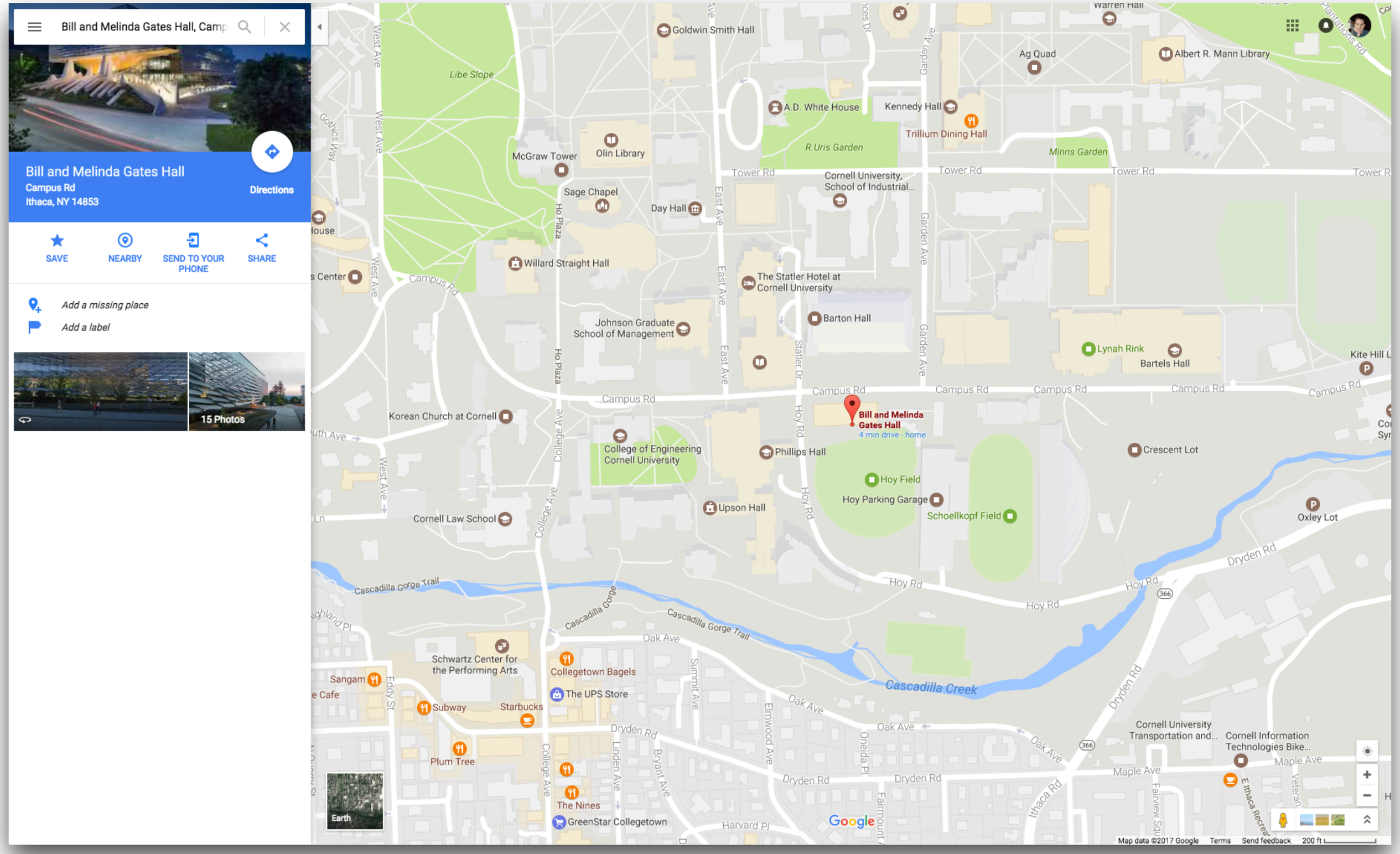


Daichi Ito et al.
Eazel
Adobe Research



Google Maps

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Playdead | *Limbo* (2010)

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3D imaging

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[Christian Lackas via Wikimedia Commons]

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[Christian Lackas via Wikimedia Commons]

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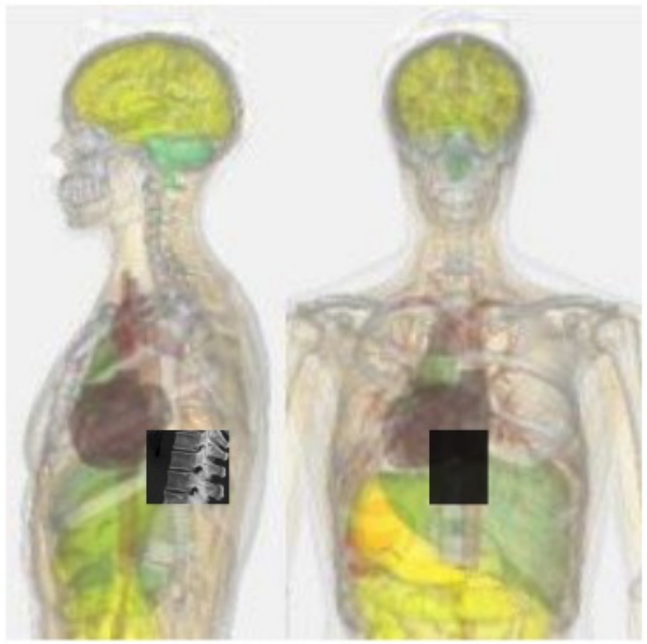
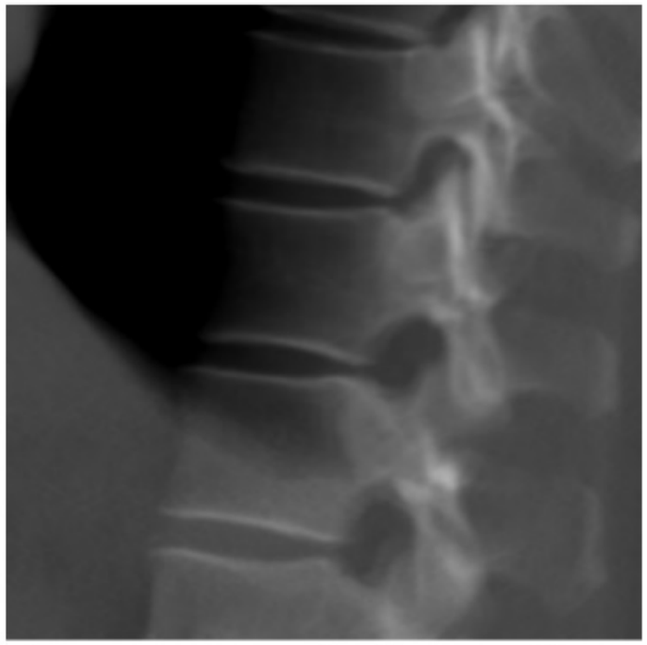
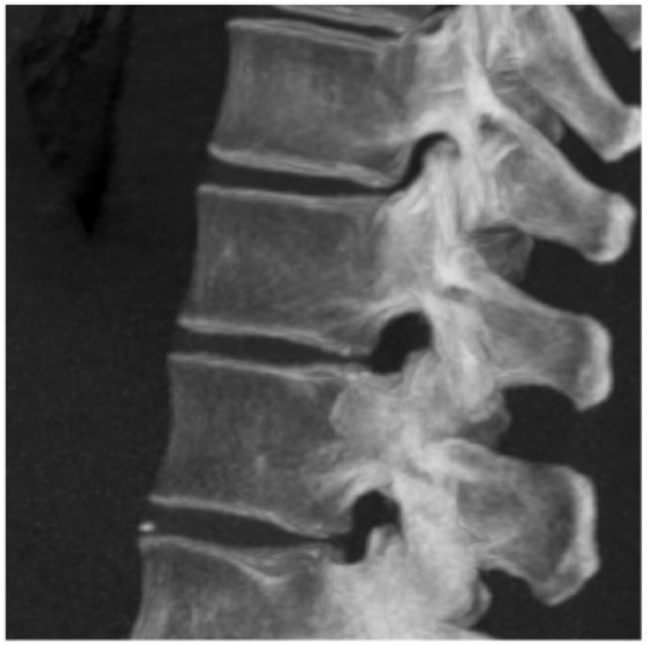
CT scan presentations





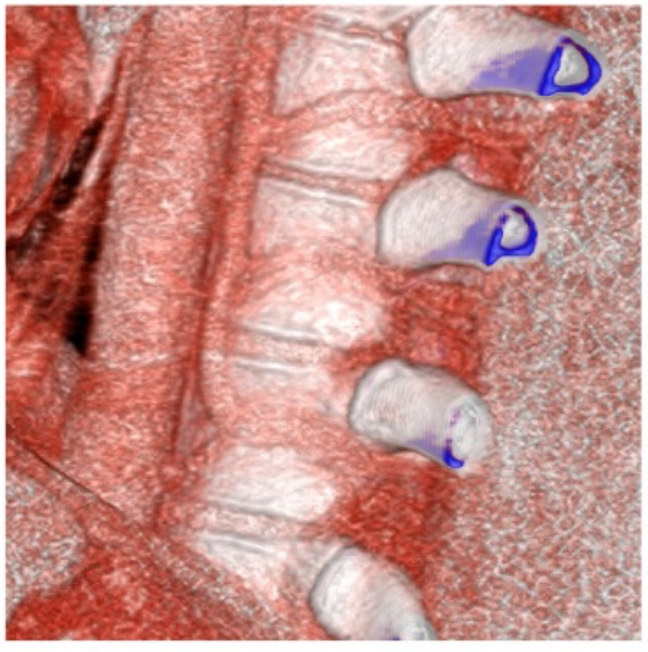
Average intensity projection



Maximum intensity projection

Thin slice

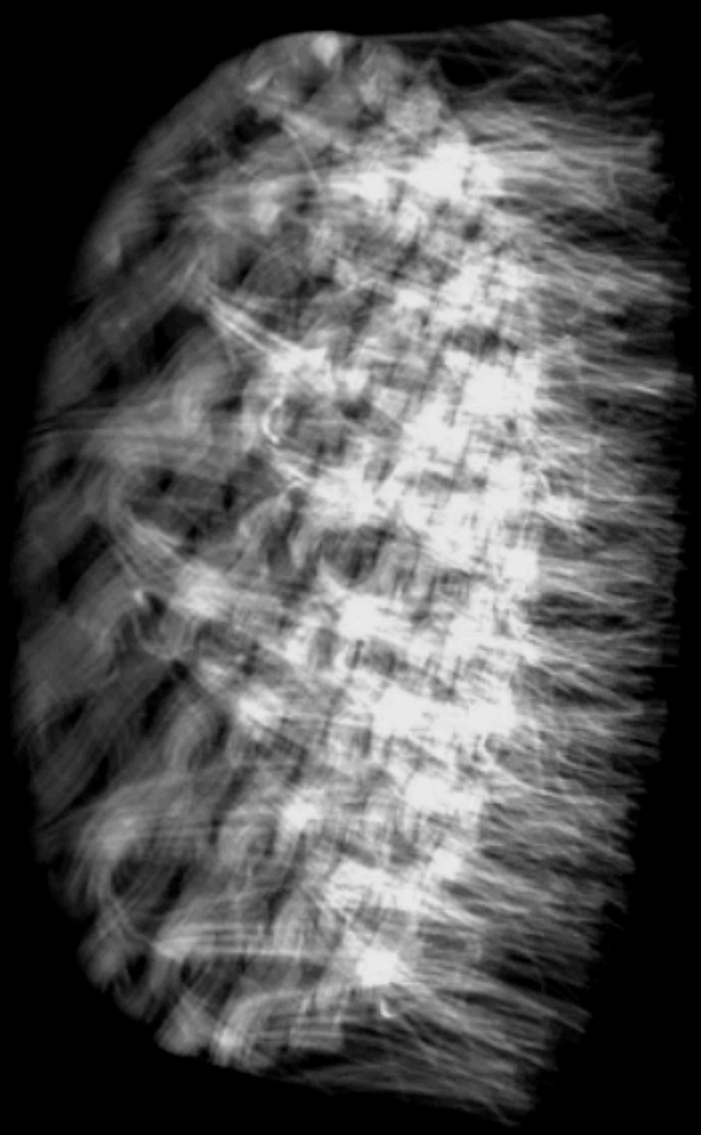
Volume rendering: High threshold



Volume rendering: Low threshold

[Mikael Häggström & Anatomography]

Velvet



[Zhao et al. SIGGRAPH 2008]

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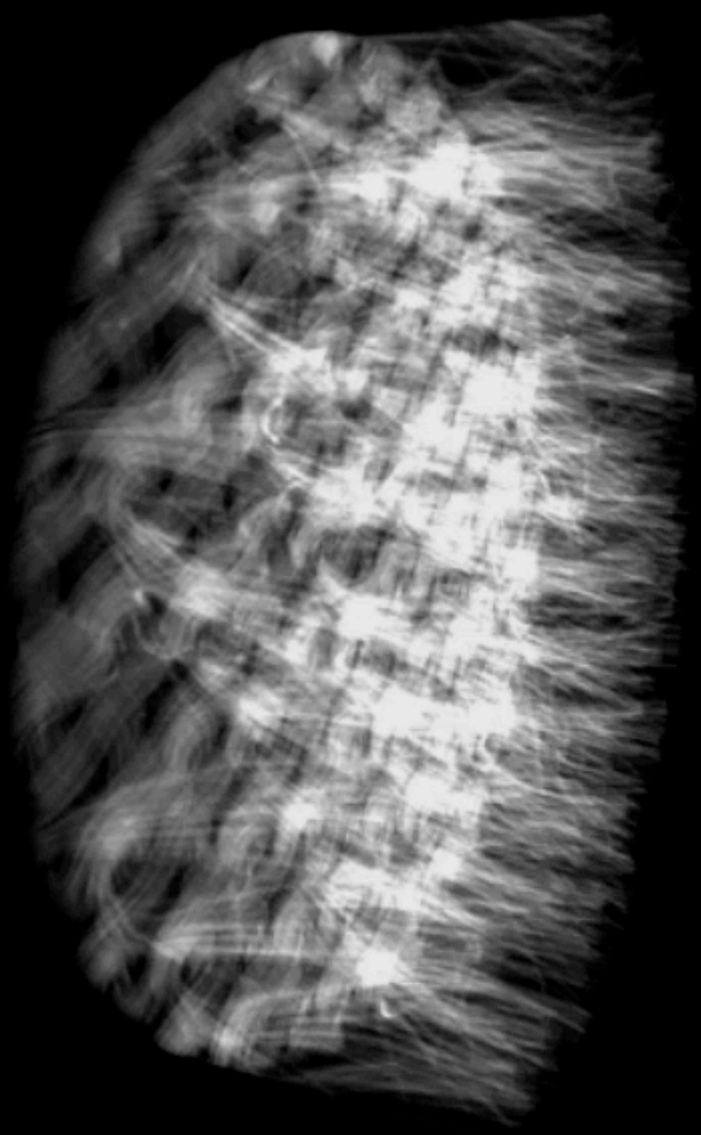
Velvet



[Zhao et al. SIGGRAPH 2008]

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3D modeling

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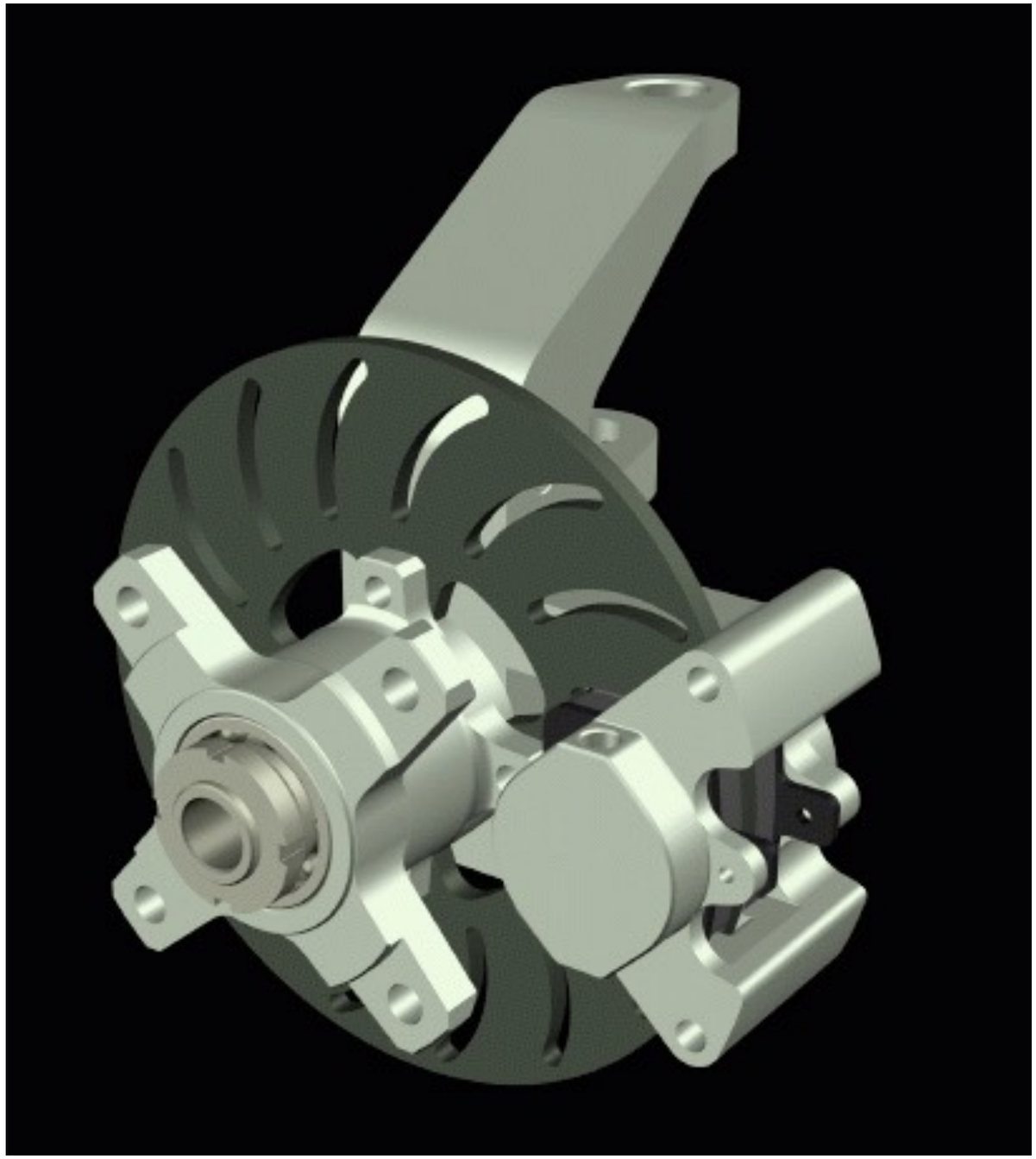

U. of Utah—Alpha 1

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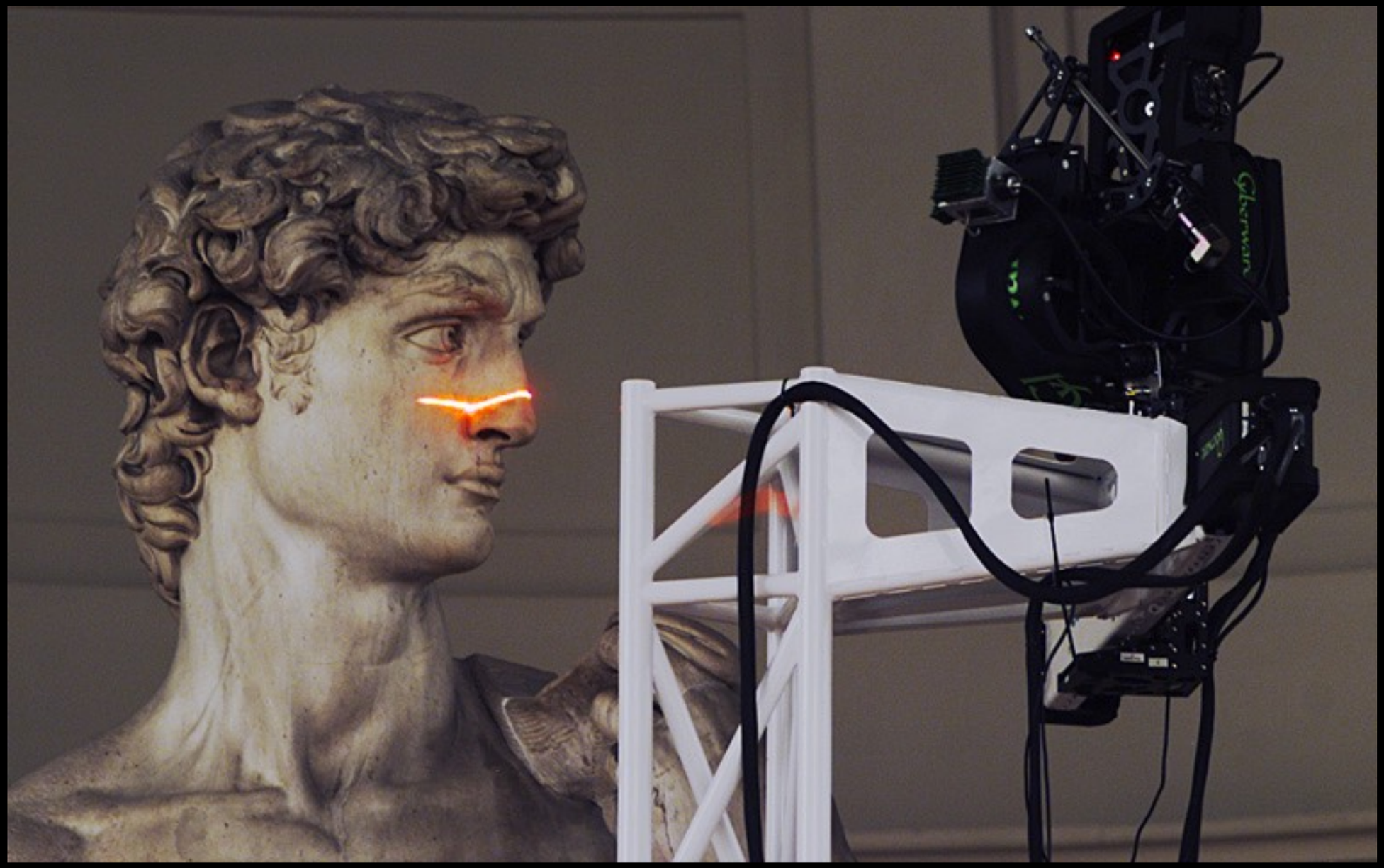

Digital
Michelangelo
Project
Marc Levoy, Stanford

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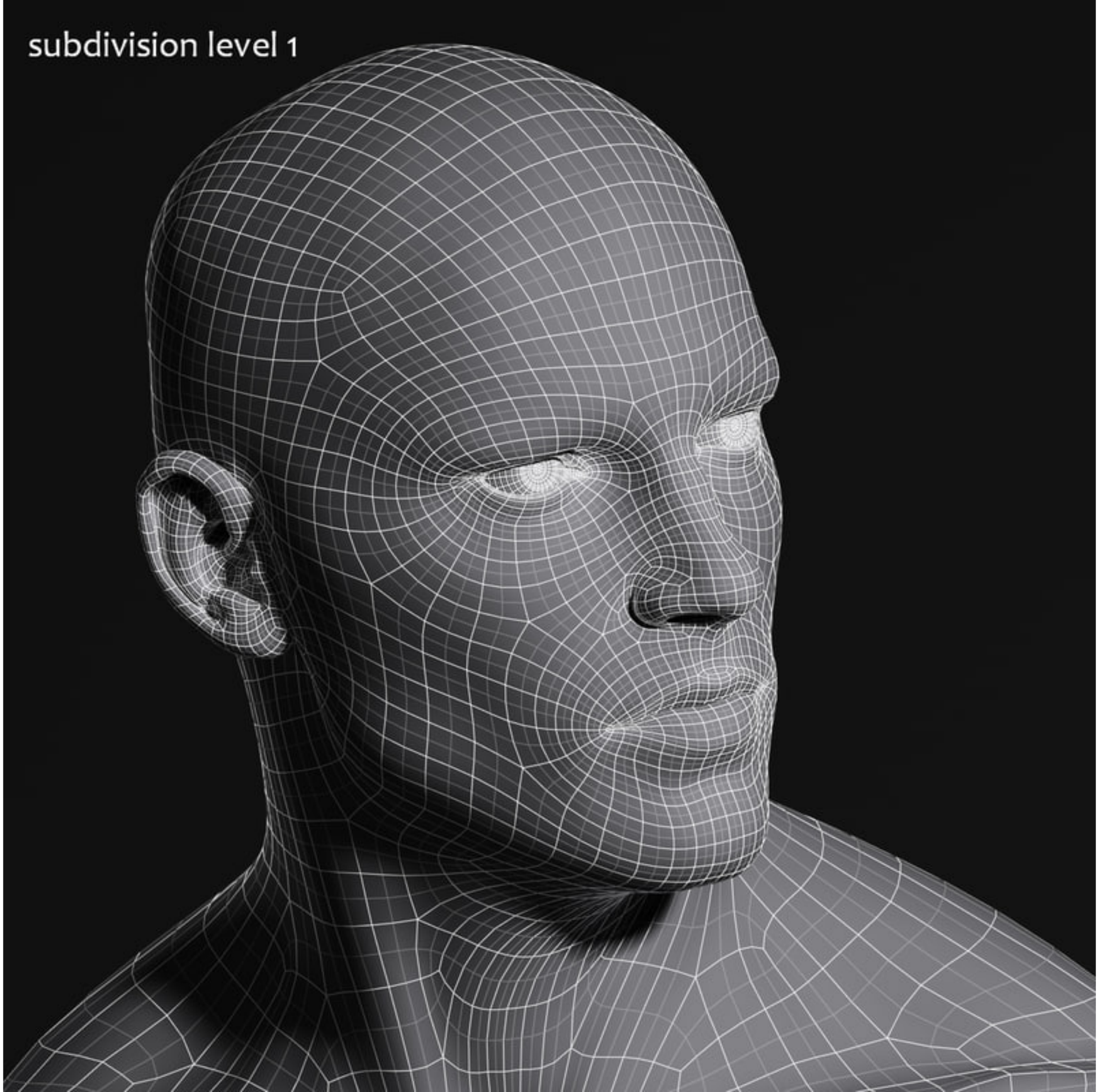
Digital
Michelangelo
Project
Marc Levoy, Stanford


DR
CL CK
CITY
MEMORIAL
The
Junction



[Andar Kollar via TurboSquid]

3D animation

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Simulated deformation of citrate synthase during substrate binding

Kalju Kahn, UCSB

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Simulated deformation of citrate synthase during substrate binding

Kalju Kahn, UCSB

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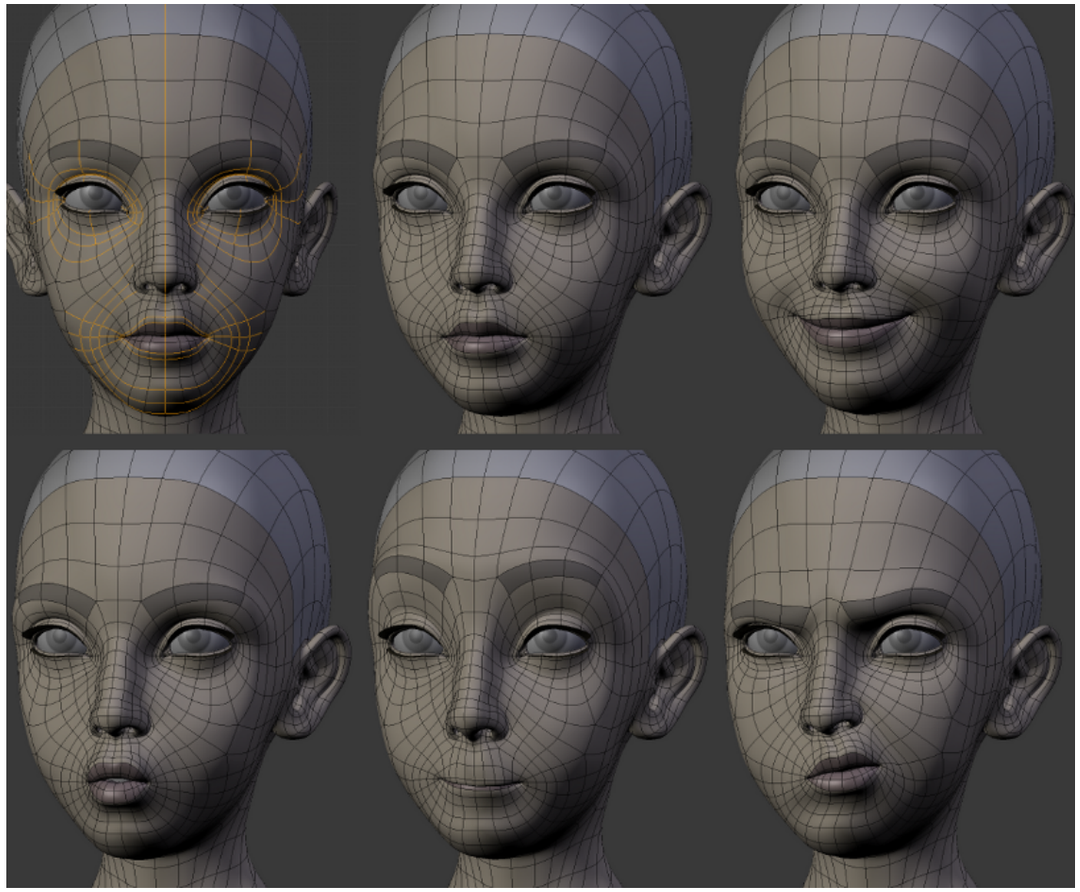
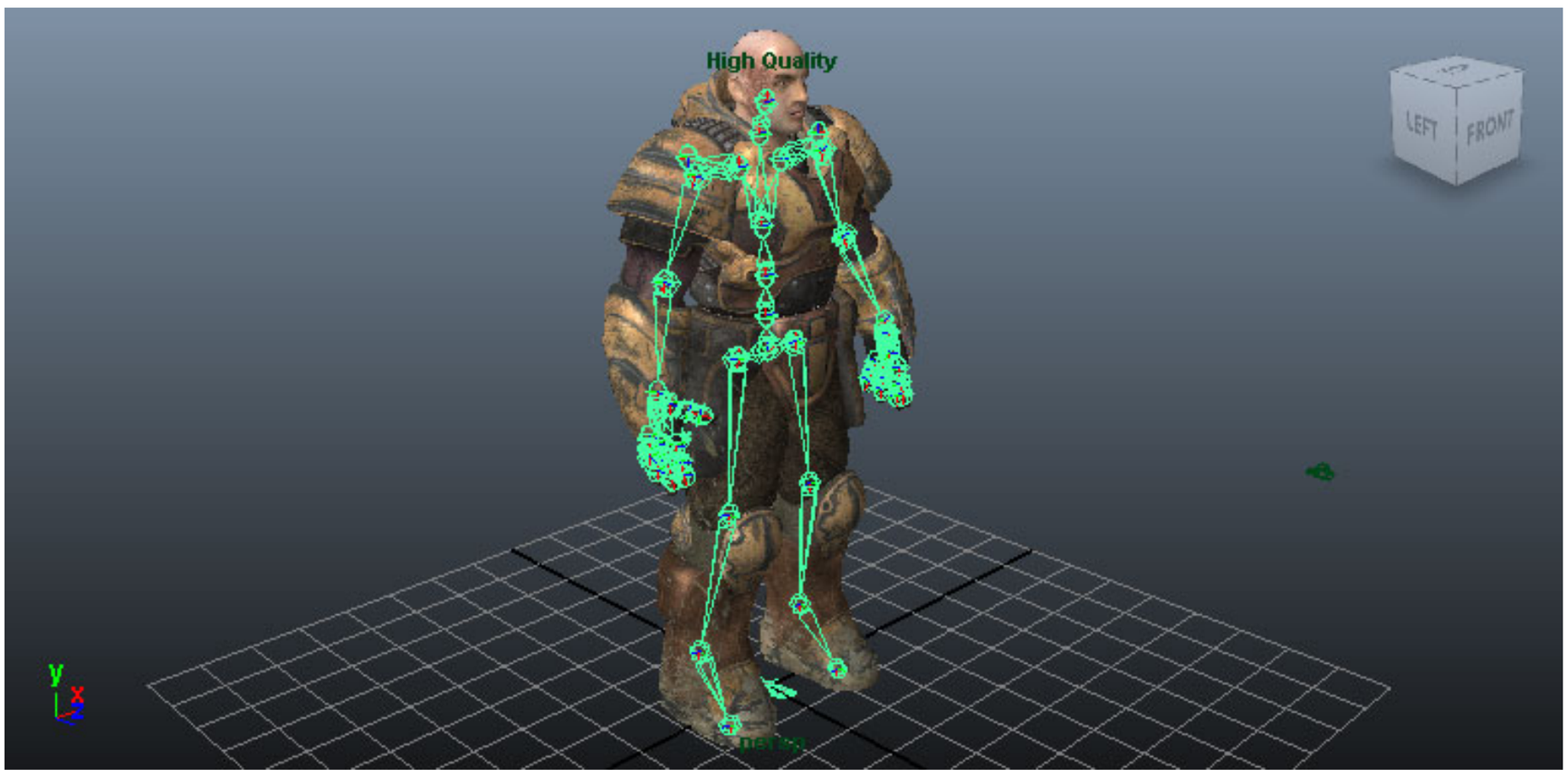


Blender Foundation
Sintel animation test



Unreal Engine 4
documentation

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Pixar—*Toy Story*

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Pixar—*Toy Story*

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Walt Disney Animation Studios—*Moana*

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Pixar—*Coco*

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3D rendering

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Pixar—*The Blue Umbrella* (2013)

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The Hobbit: An Unexpected Journey (New Line Cinema, 2012)—visual effects by Weta Digital

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Crytek—*Crysis 3* (2013)

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Quantic Dream—*Two Souls* (2013)

screenshot: videogamer.com

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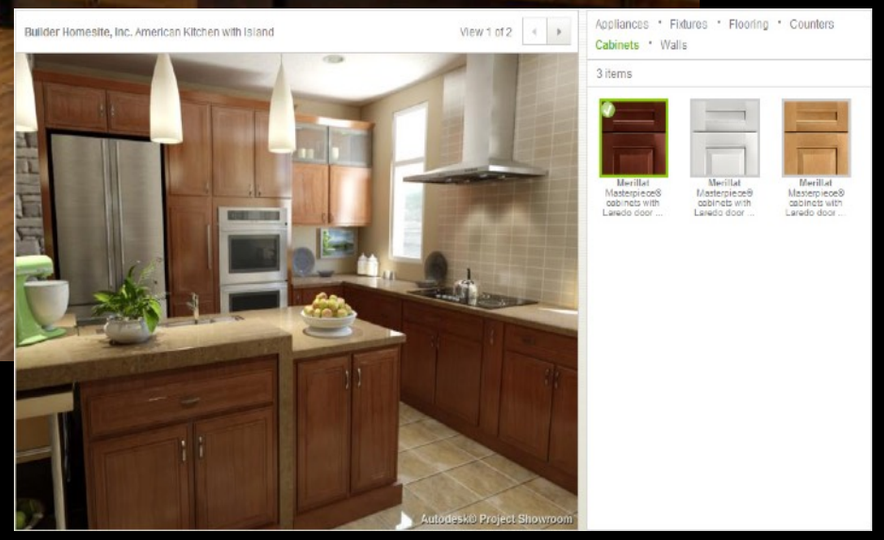
8/26/2014 8:15 pm
8/26/2014
8/27/2014
Image Landsat
Google earth

Autodesk 360 Cloud Render

Autodesk 360 Cloud Render

Autodesk 360 Cloud Render



IKEA—rendered catalog image (2012)
(for more: https://vimeo.com/163789781)

VR/AR

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Virtual / mixed / augmented reality

Oculus Rift
VR headset

HoloLens
AR/MR headset

Ramadhanakbr via Wikimedia Commons

Pokémon Go
Phone based AR game

Niantic Labs

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IKEA Place | iOS app

More info…

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Computer graphics

Mathematics made visible.

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Or, to paraphrase Ken Perlin...

Computer graphics

What you need to show other people your dreams.

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research

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Translucent materials

Diffuse “milk”

Translucent materials

Diffuse “milk”

Skim milk

Translucent materials

Diffuse “milk”

Skim milk

Whole milk

Digital characters

[New Line Productions]

Gollum from *The Lord of the Rings*: hair and skin are two major rendering challenges in film effects

Rendering hair

a = 1.0

[Khungurn & Marschner 2017]

Rendering hair

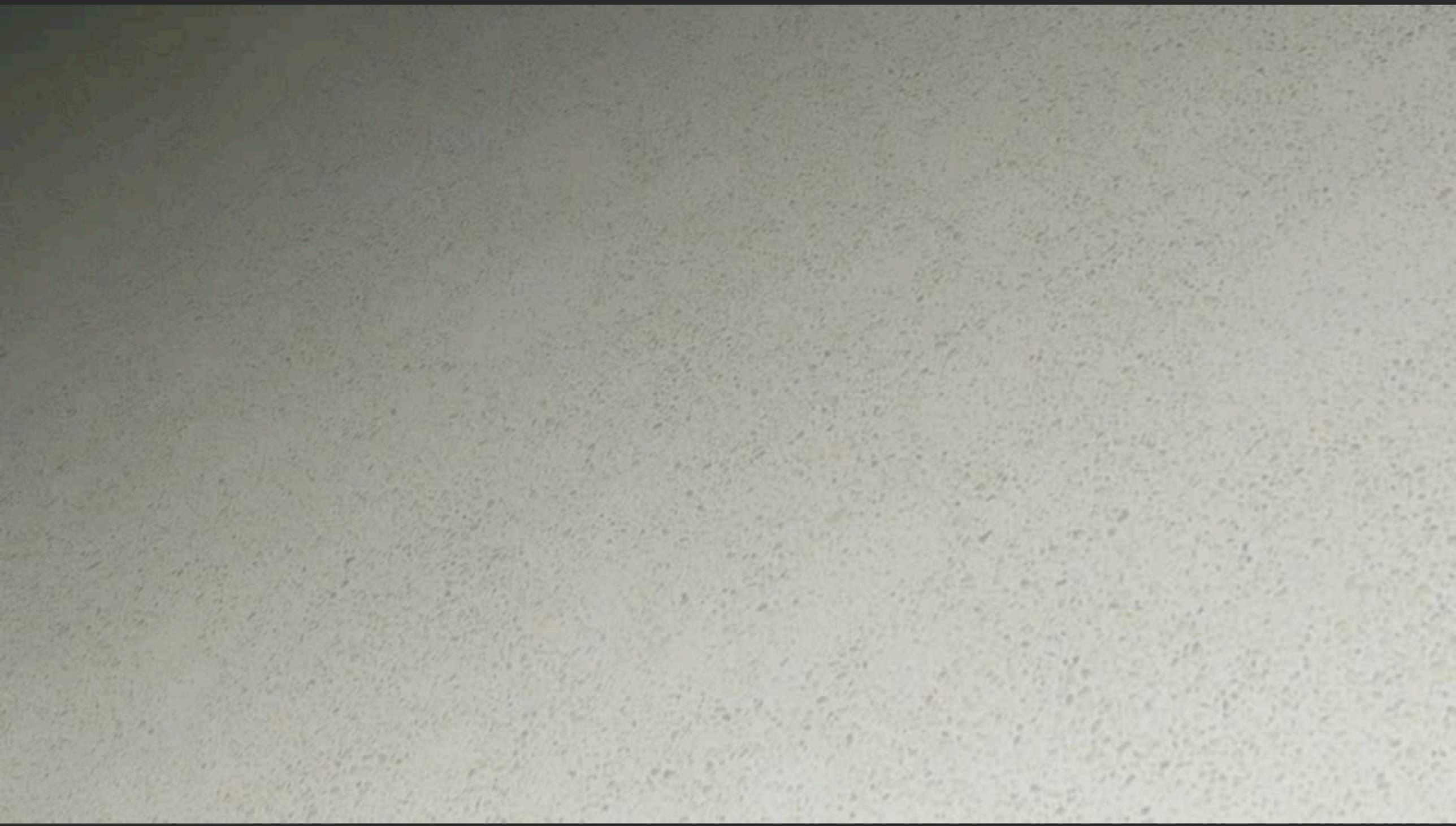
a = 1.2

[Khungurn & Marschner 2017]

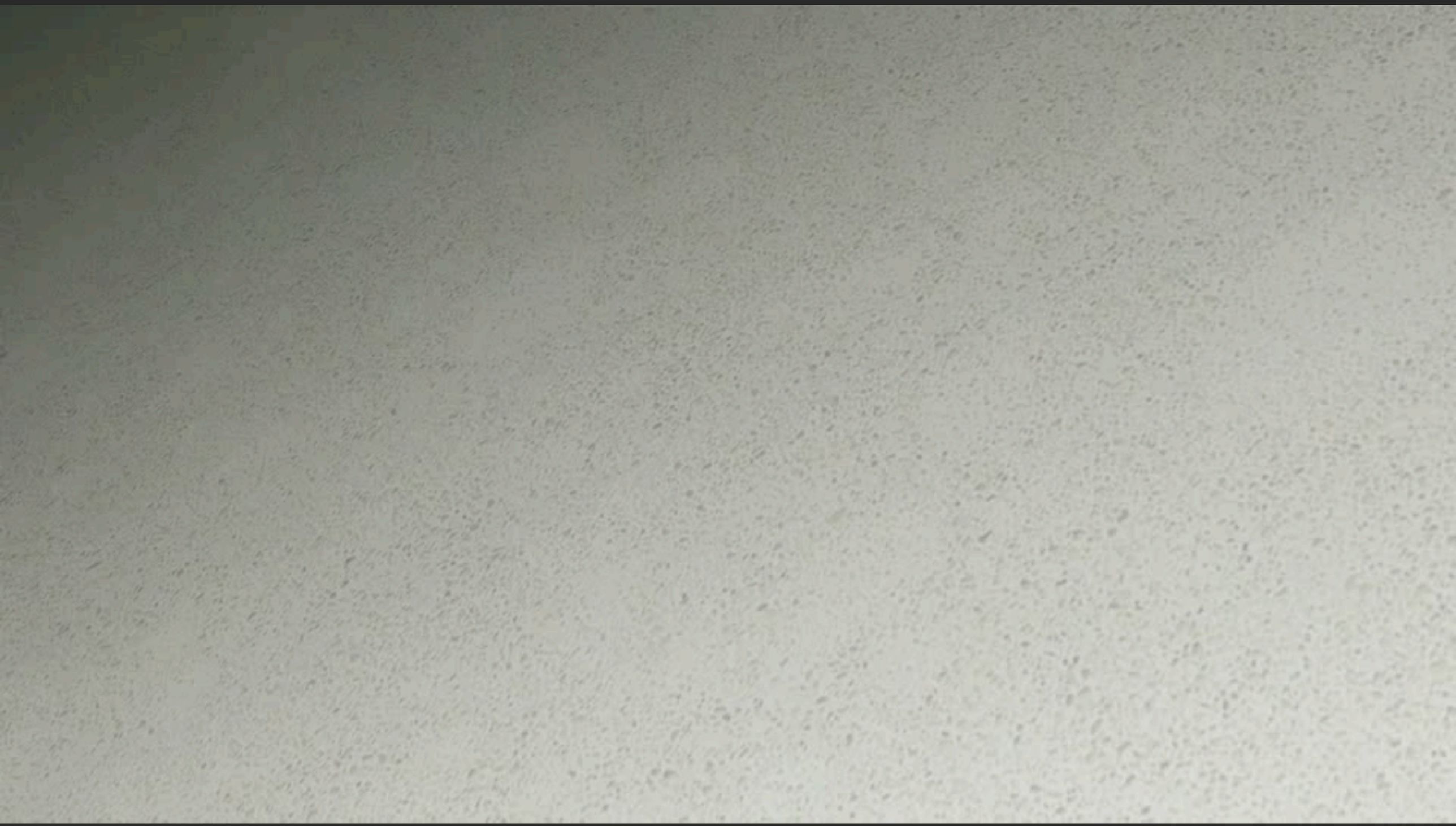
Rendering hair

a = 1.5

[Khungurn & Marschner 2017]

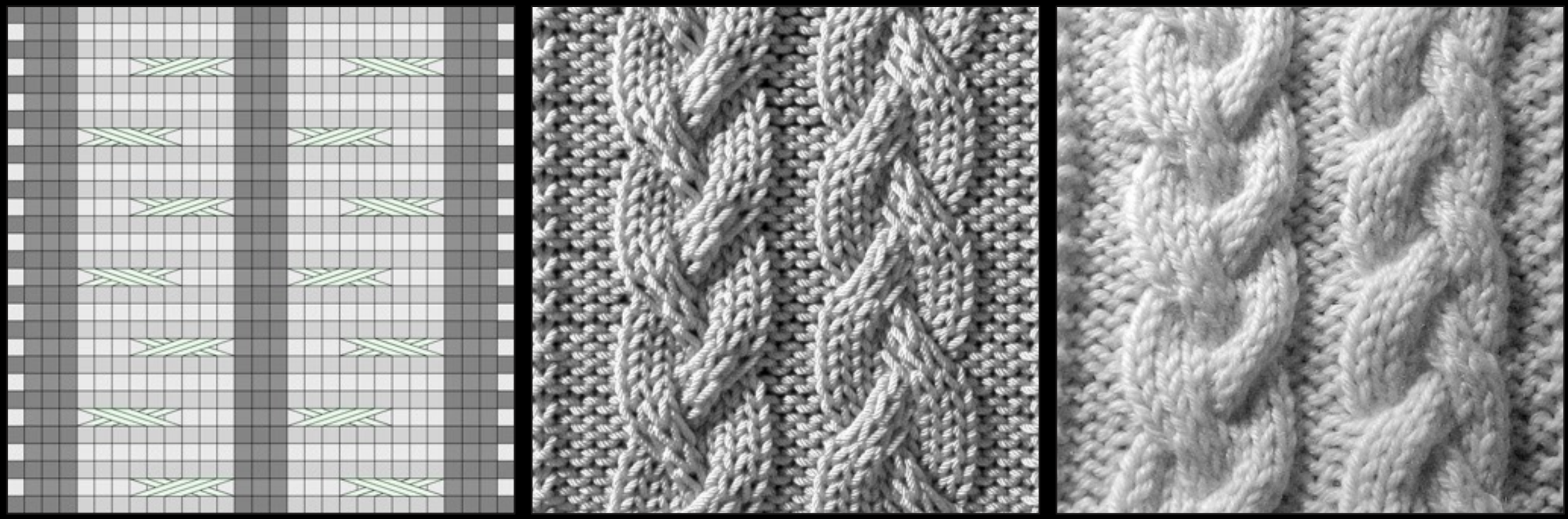


[Kaldor et al. 2008]



[Kaldor et al. 2008]

Modeling knit cloth



[Yuksel et al. 2012]

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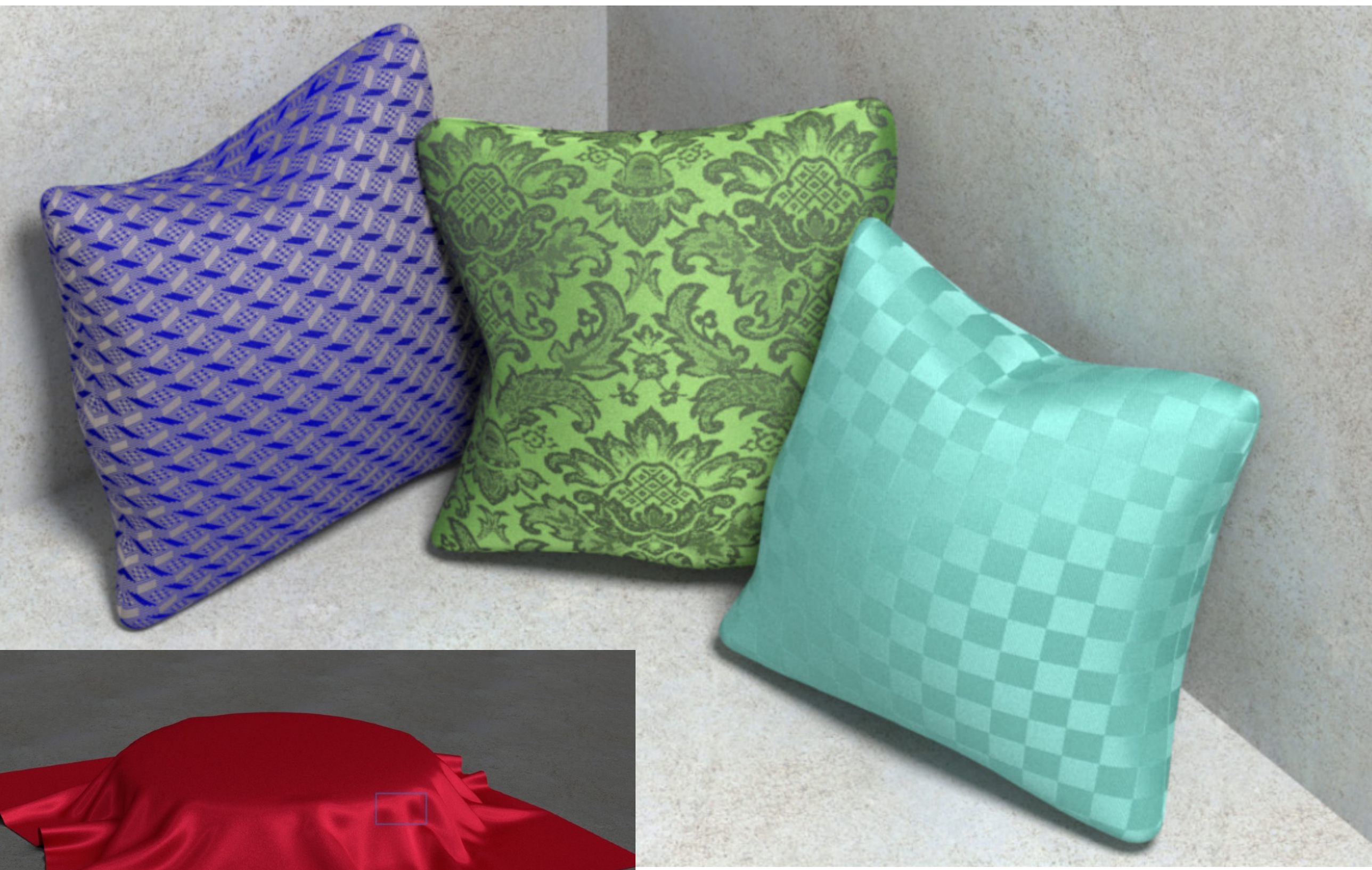

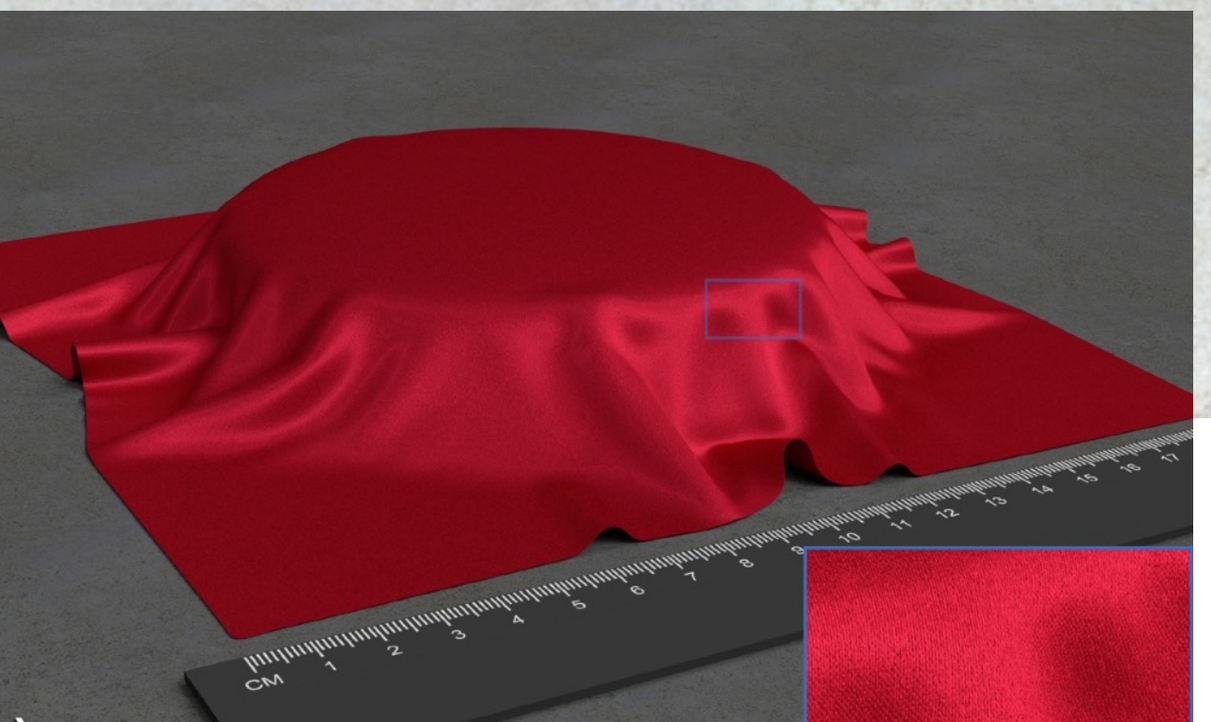

[Zhao et al. 2012]

course overview

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Course mechanics

- **Web** `http://www.cs.cornell.edu/Courses/cs4620`
- **Teaching Assistants**
  - Zekun Hao (CS4620 head TA)
    Rundong Wu (CS4621 head TA)
    Zechen Zhang
    Gregory Yauney
    Tomasz Chmielewski
  - Jason Liu
    Sandy Fang
    Serge-Olivier Amega
    Meredith Young-Ng
    Lily Lin
    Sitian Chen

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In CS4620/5620

- **You will:**
  - explore fundamental ideas
  - learn math essential to graphics
  - implement key algorithms
  - write cool programs
  - learn the basics of OpenGL
  - learn a bit about WebGL and doing graphics in the browser
- **You will not:**
  - write very big programs

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Topics

- **Images, image processing, color science**
- **Modeling in 2D and 3D**
- **Rendering 3D scenes**

  (using ray tracing and using the GPU)
- **Geometric transformations**
- **The graphics pipeline**
- **Animation**

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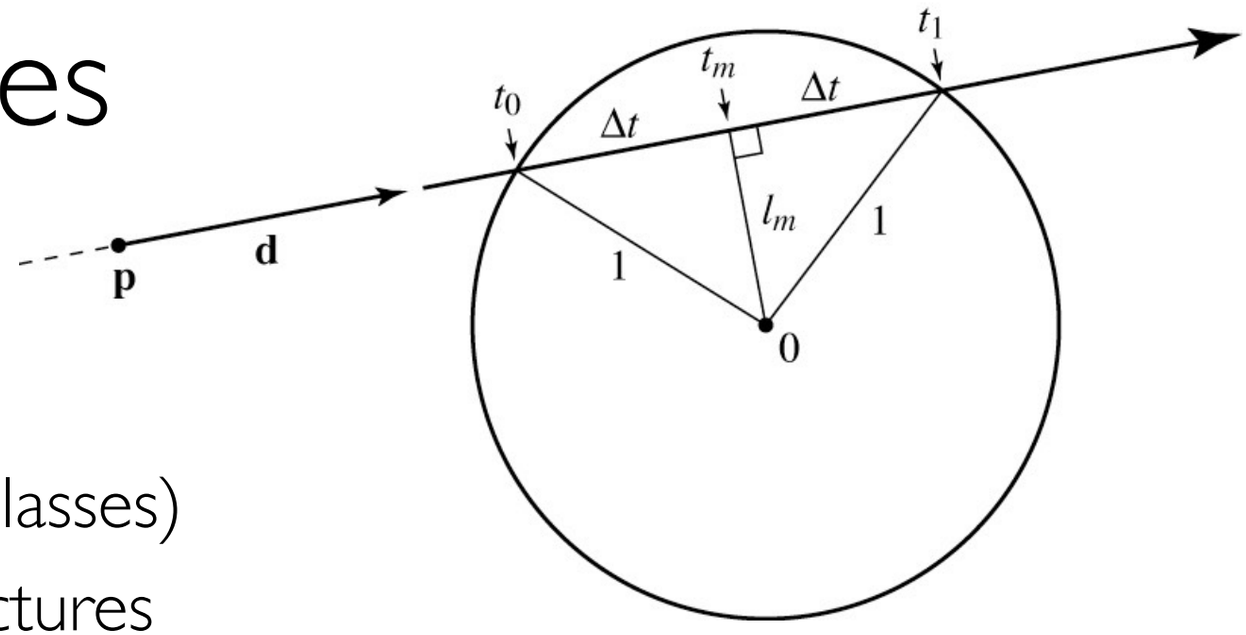
CS4620 Prerequisites



- **Programming**
  - ability to read, write, and debug small Java programs (dozens of classes)
  - understanding of basic data structures
  - serious software design not required
- **Mathematics**
  - vector geometry (vectors in in 2D and 3D, dot/cross products, etc.)
  - linear algebra (mainly linear transformations in 2 to 4D)
  - basic calculus (calculating derivatives, understanding integration)
  - probability (continuous probability for Monte Carlo)
  - graphics is a good place to pick up some, but not all, of this

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In CS4621

- **You will also:**
  - do assignments that go deeper into OpenGL and WebGL
  - propose and implement an independent group project
  - learn a lot more about
    - OpenGL and WebGL
    - architecting good-sized interactive programs
    - working effectively in software teams
    - graphics topics of your choosing!
- **First CS4621 meeting on Monday!**

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Workload

- **CS 4620/5620**
  - 7 written assignments
  - 7 programming assignments
  - 2 exams (midterm + final)
- **CS 4621/5621**
  - 3 programming assignments
  - one open-ended project

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Academic Integrity

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CS4620/21 late policy

- **We use slip days**
- **You have 7 slip days for 4620, 7 separate ones for 4621**
  - e.g. you could turn in Ray 1 4 days late and Splines 3 days late. You are out of slip days for further 4620 assignments, but you could still turn in one 4621 assignment 7 days late
- **Accounting is separate per individual**
  - so it's possible for you to have slip days left but your partner not to
- **Each late day beyond 7 incurs a 10 point late penalty**
  - i.e. project earns 93/100, is 2 days late, receives 73/100
- **Regardless of late penalties, assignments can't be turned in more than 7 days late**
- **No slip days for 4621 final project**

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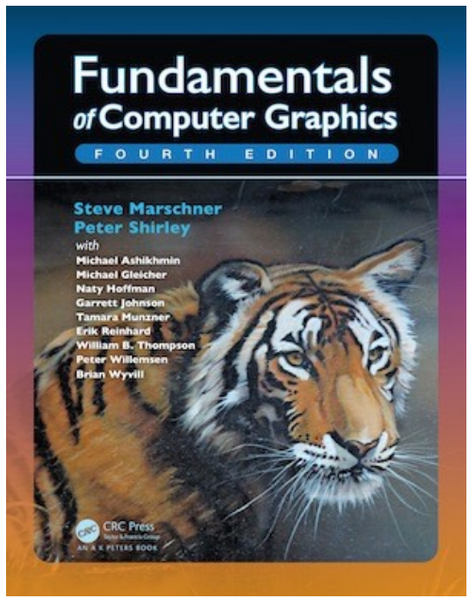
Textbook



Marschner & Shirley

Fundamentals of Computer Graphics

fourth edition

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http://www.cs.cornell.edu/Courses/cs4620

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