

CS4620/5620 Introduction to Computer Graphics

Prof. Steve Marschner

Computer graphics

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

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
- **Animation**
 - 2D: user interfaces, titles, 2D animated films, 2D games
 - 3D: technical illustration, animation, visual effects, games
- **Rendering**
 - 2D: drawing shapes, motion blur, simulating art materials
 - 3D: realistic rendering; non-photorealistic rendering

2D imaging



Alexandre Buisse



Alexandre Buisse

Do I need a wide angle lens?









[Chuang et al. 2001 website]



2D modeling

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

Regular 9 pt

Sierra
India
Lima
Alpha
Sierra

All weights 75 pt

Page 04

Bold 9 pt

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

10080 46543 46543
— 257 257 143 143 —

Bold 36 pt

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

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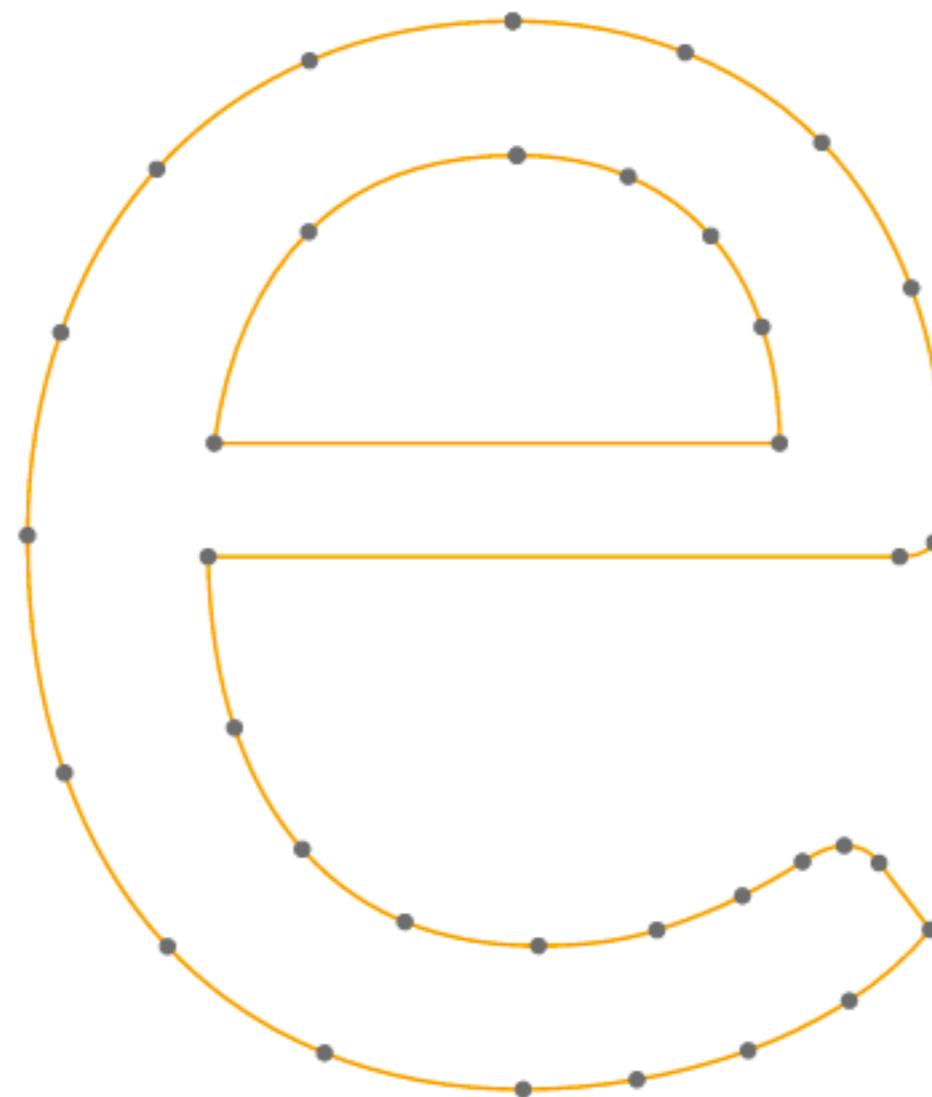
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FS Silas Sans

FS Silas Slab

Page 05

FS Silas Sans



Pavithra Solai, kint.io

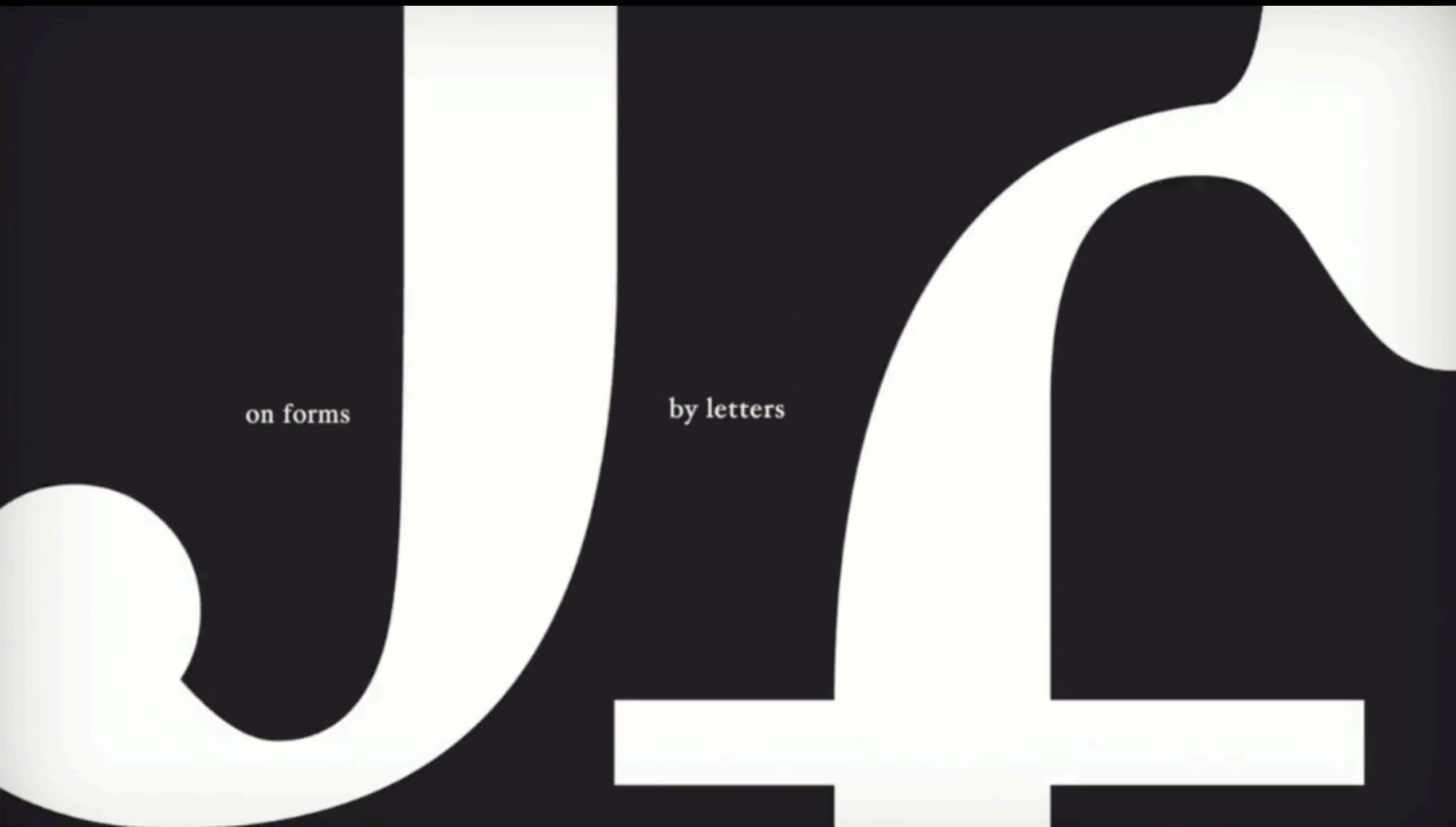


THE ICONIC WILDLIFE OF
GLACIER NATIONAL PARK

17

Tom Whalen | strongstuff.net

2D animation



on forms

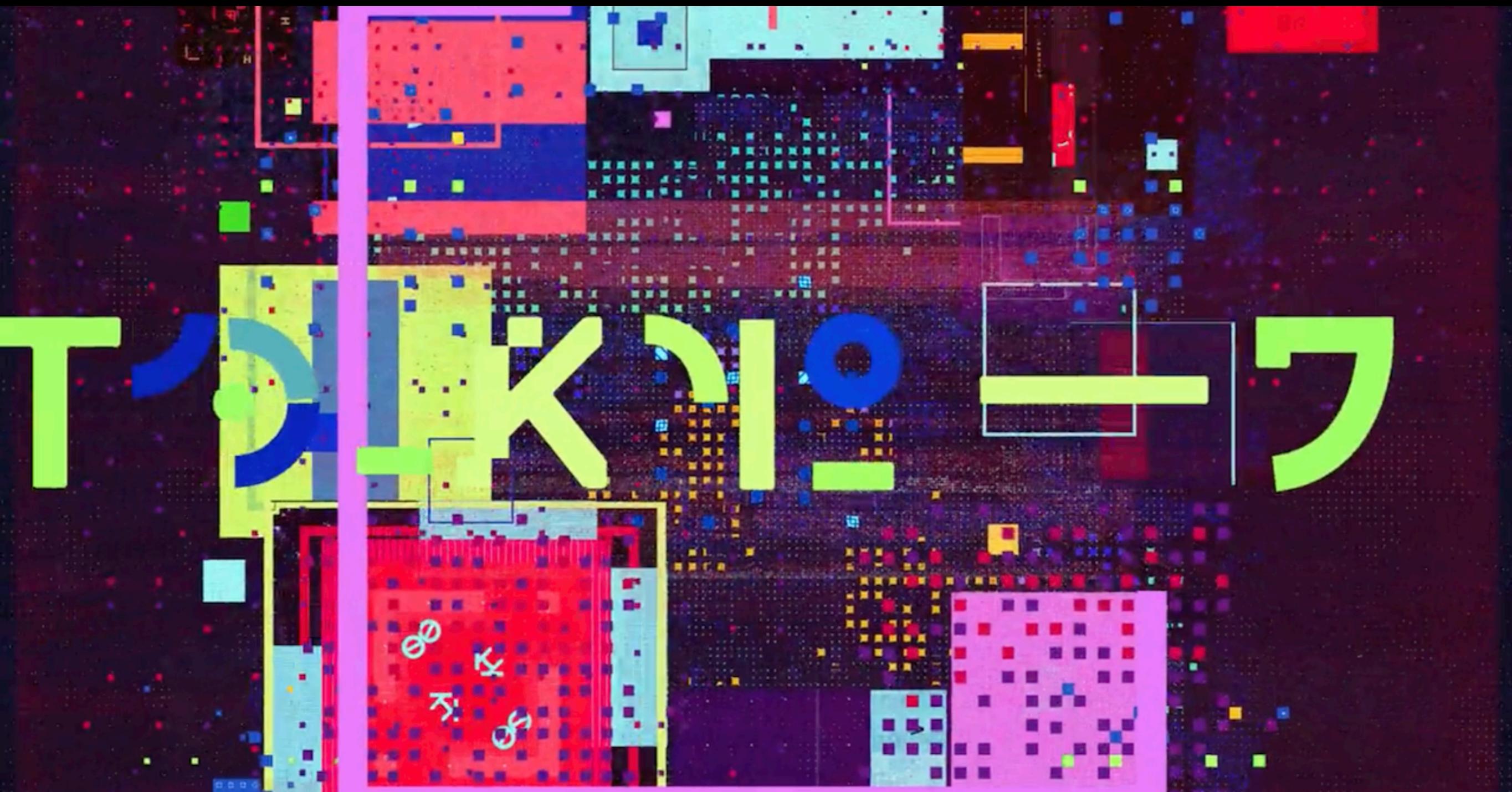
by letters



<https://vimeo.com/95943971>

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

Felix Meyer, Pascal Monaco | *Traveling Lights*



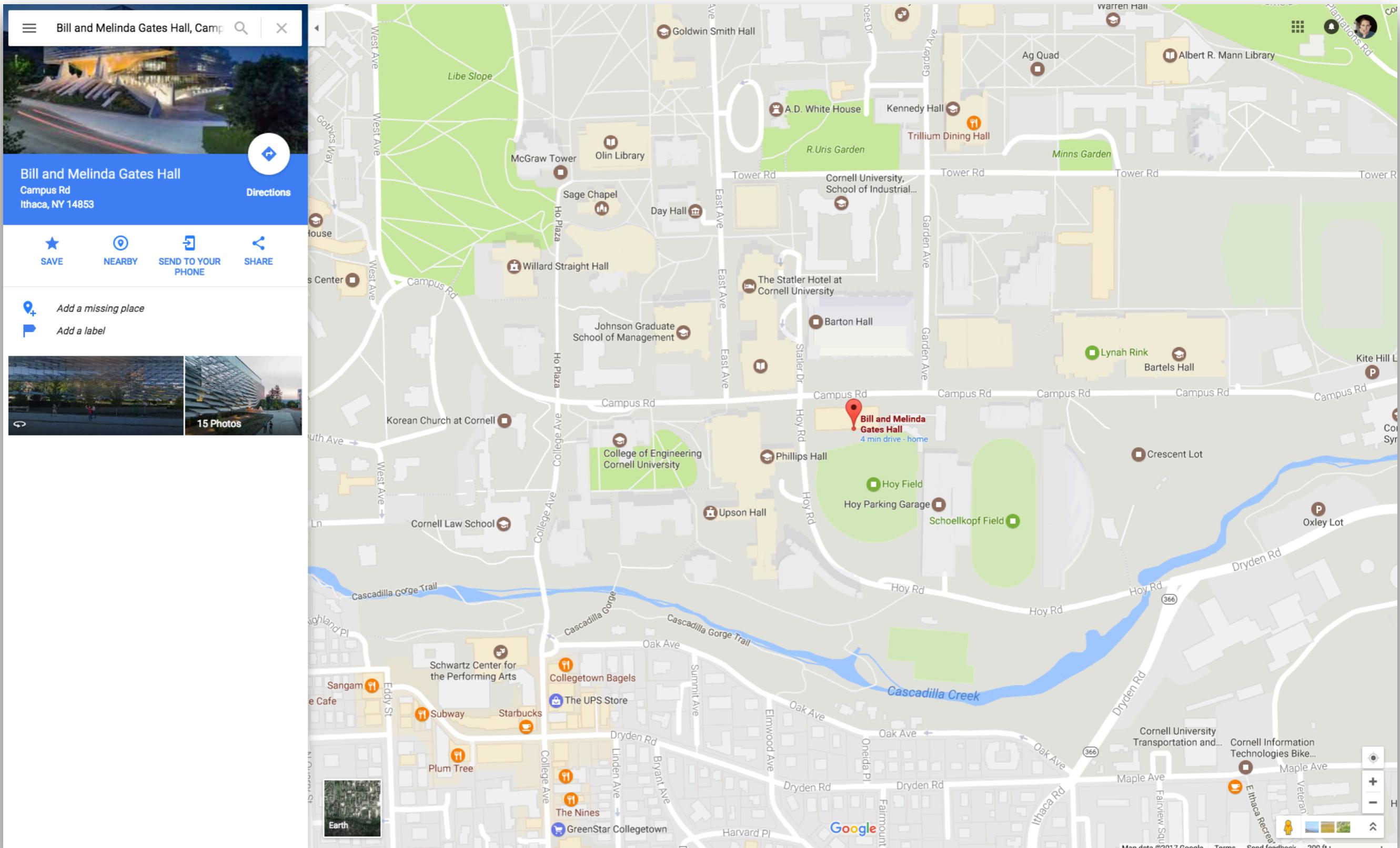
<https://vimeo.com/118919656>

Ash Thorpe | FITC Tokyo 2015 title sequence

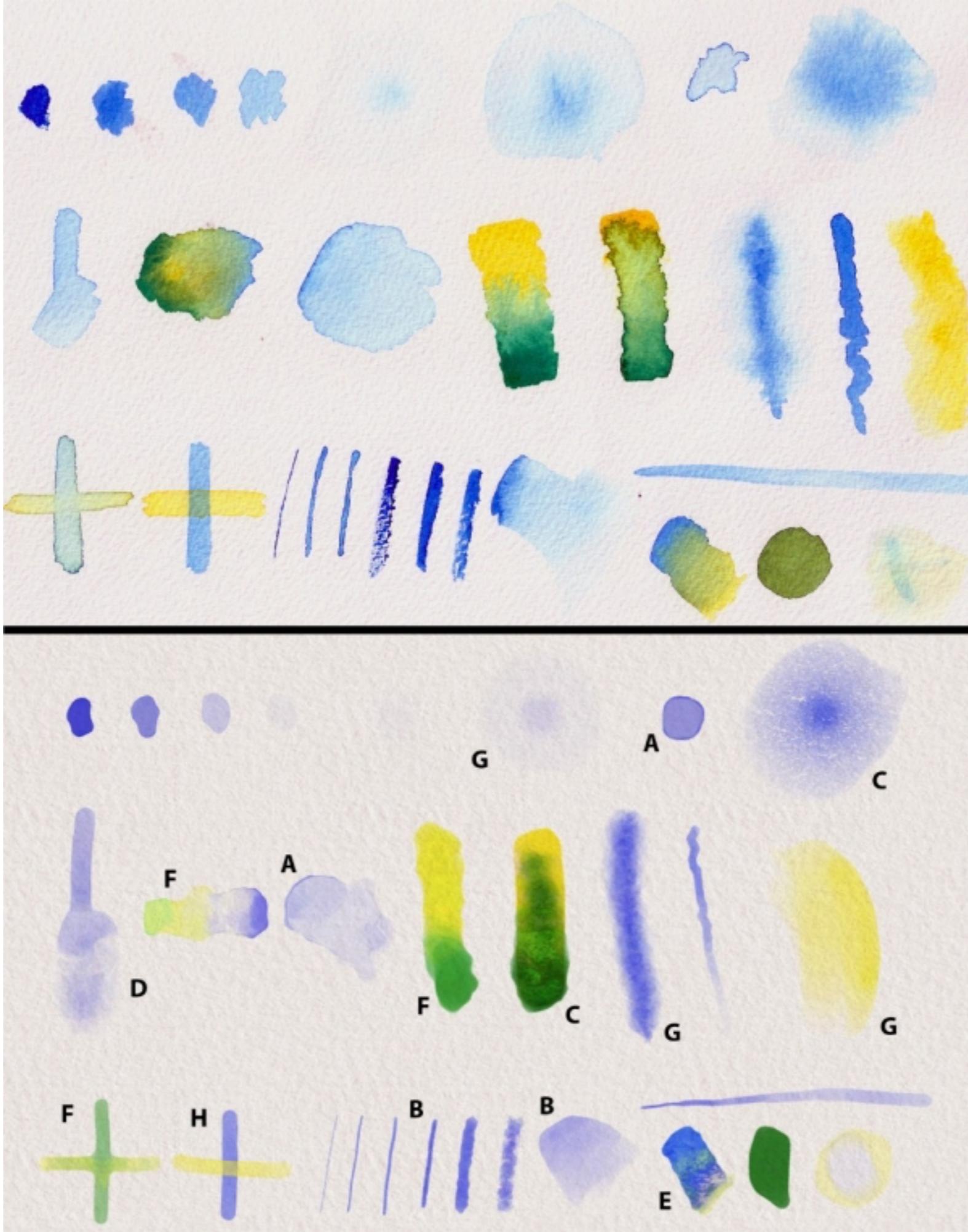


Polytron—*Fez* (2010)

2D rendering



Google Maps



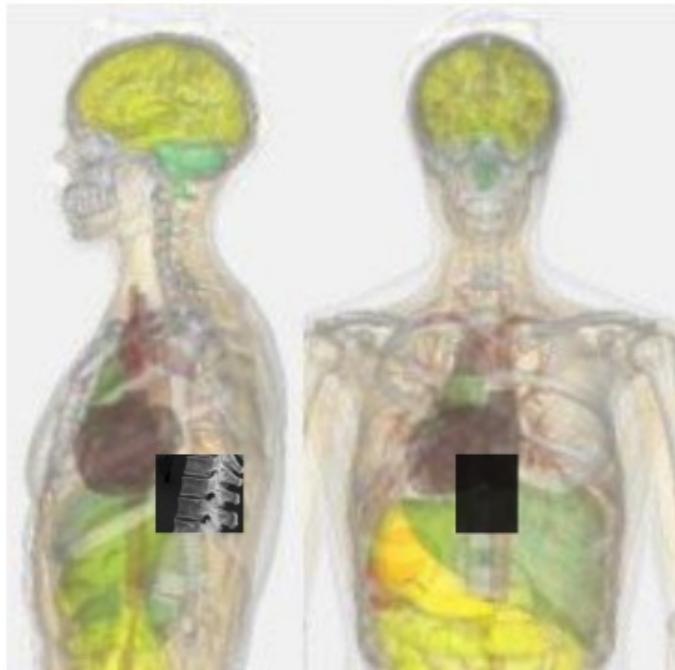
Daichi Ito et al.
Eazel
Adobe Research



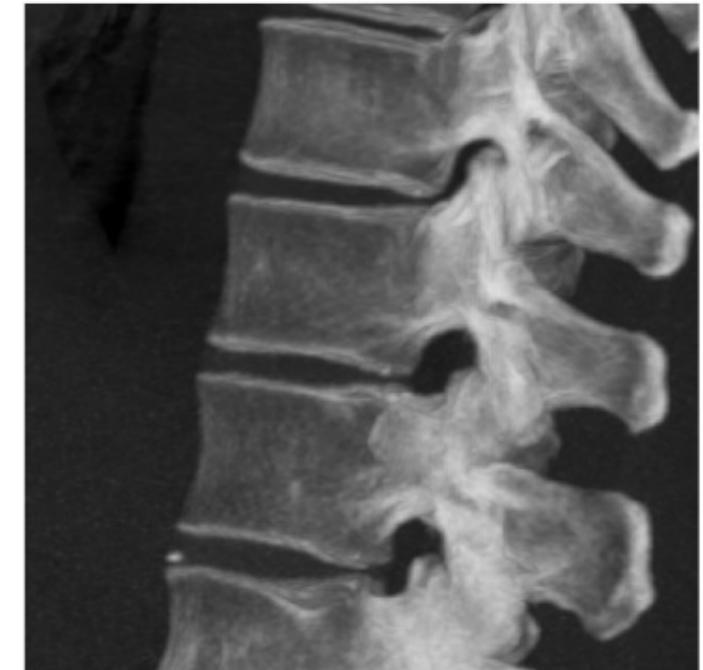
Playdead | *Limbo* (2010)

3D imaging

CT scan presentations



Average intensity projection



Maximum intensity projection



Thin slice



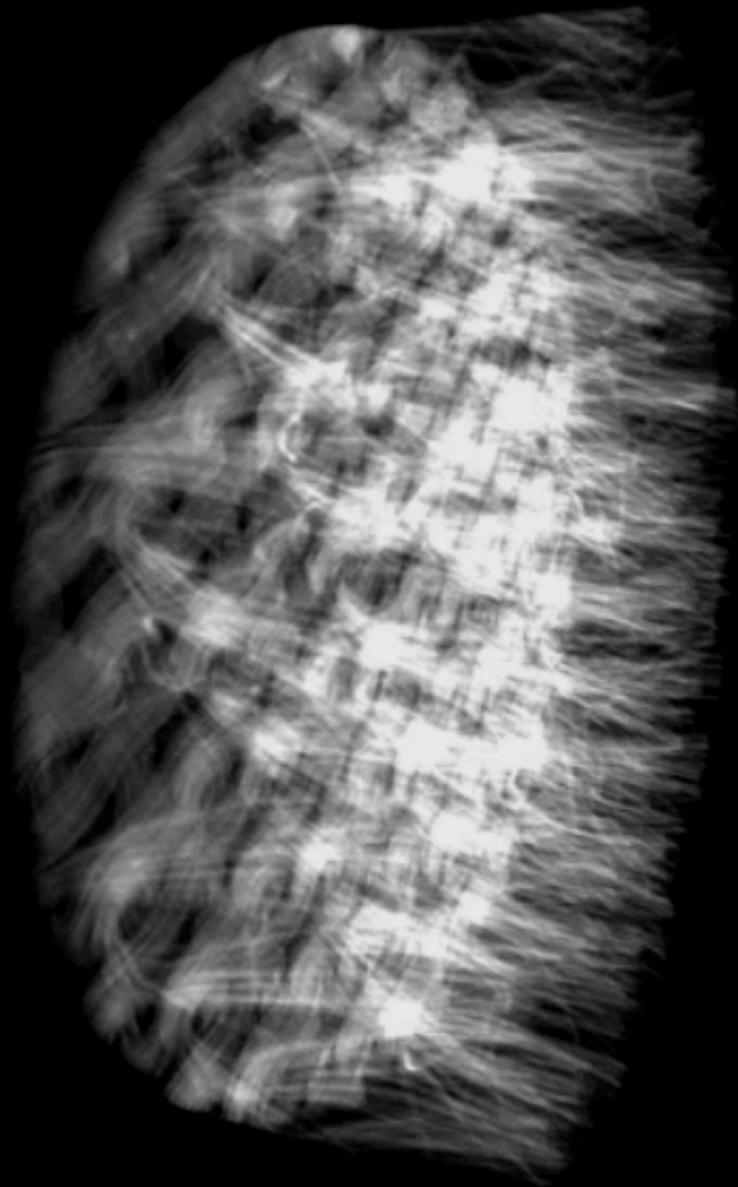
Volume rendering:
High threshold



Volume rendering:
Low threshold

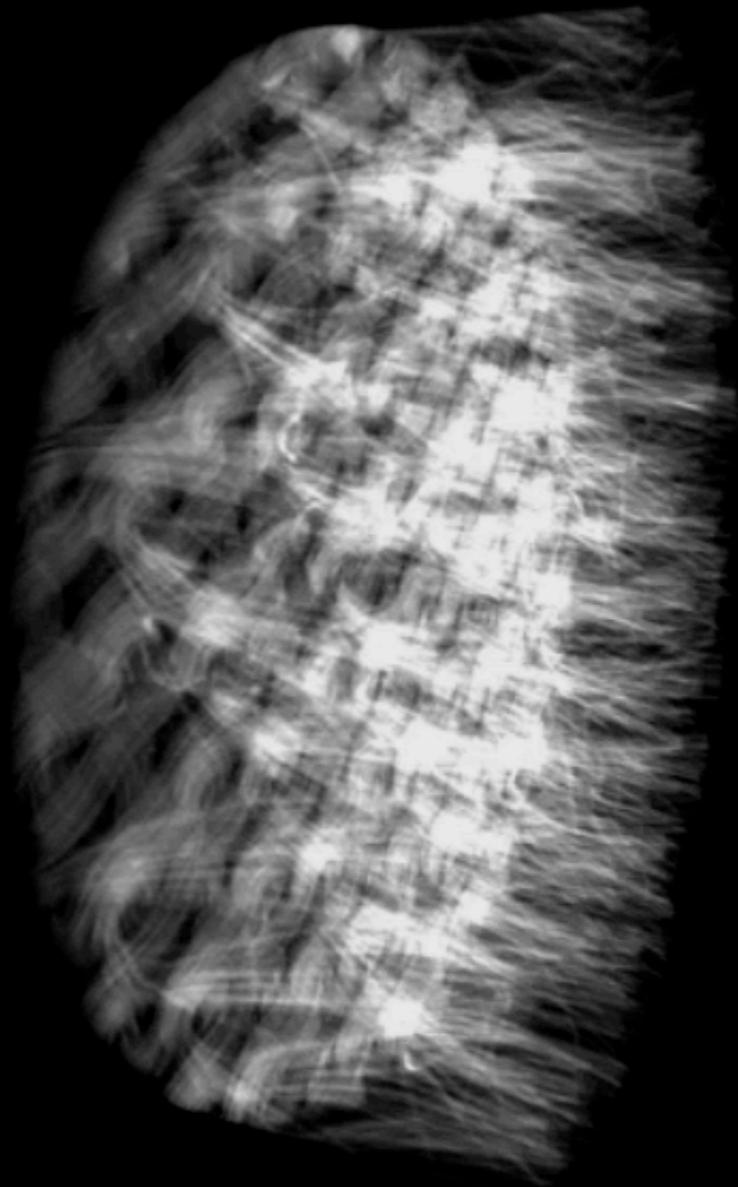
[Mikael Häggström & Anatomography]

Velvet



[Zhao et al. SIGGRAPH 2008]

Velvet



[Zhao et al. SIGGRAPH 2008]

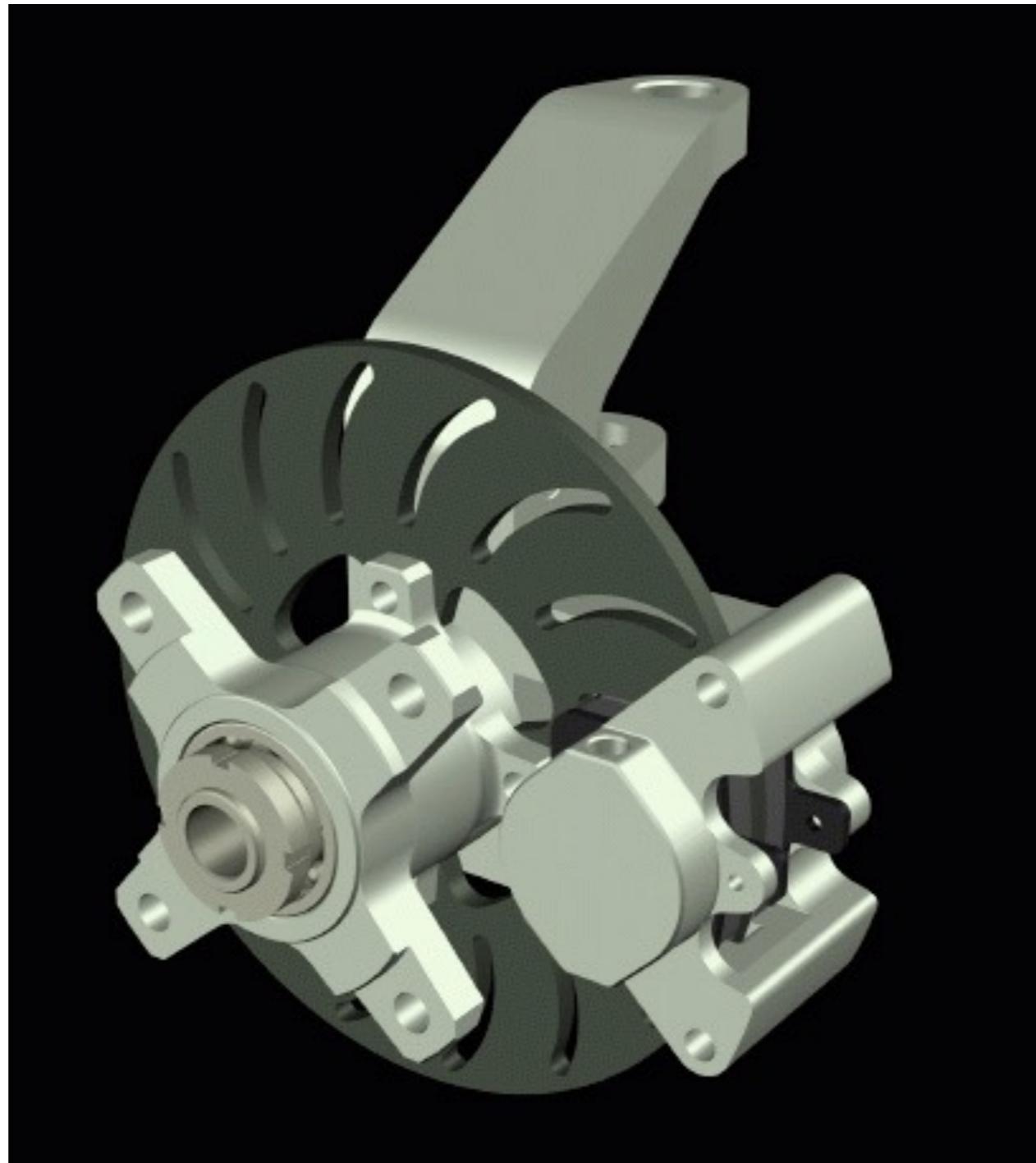


[Christian Lackas via Wikimedia Commons]



[Christian Lackas via Wikimedia Commons]

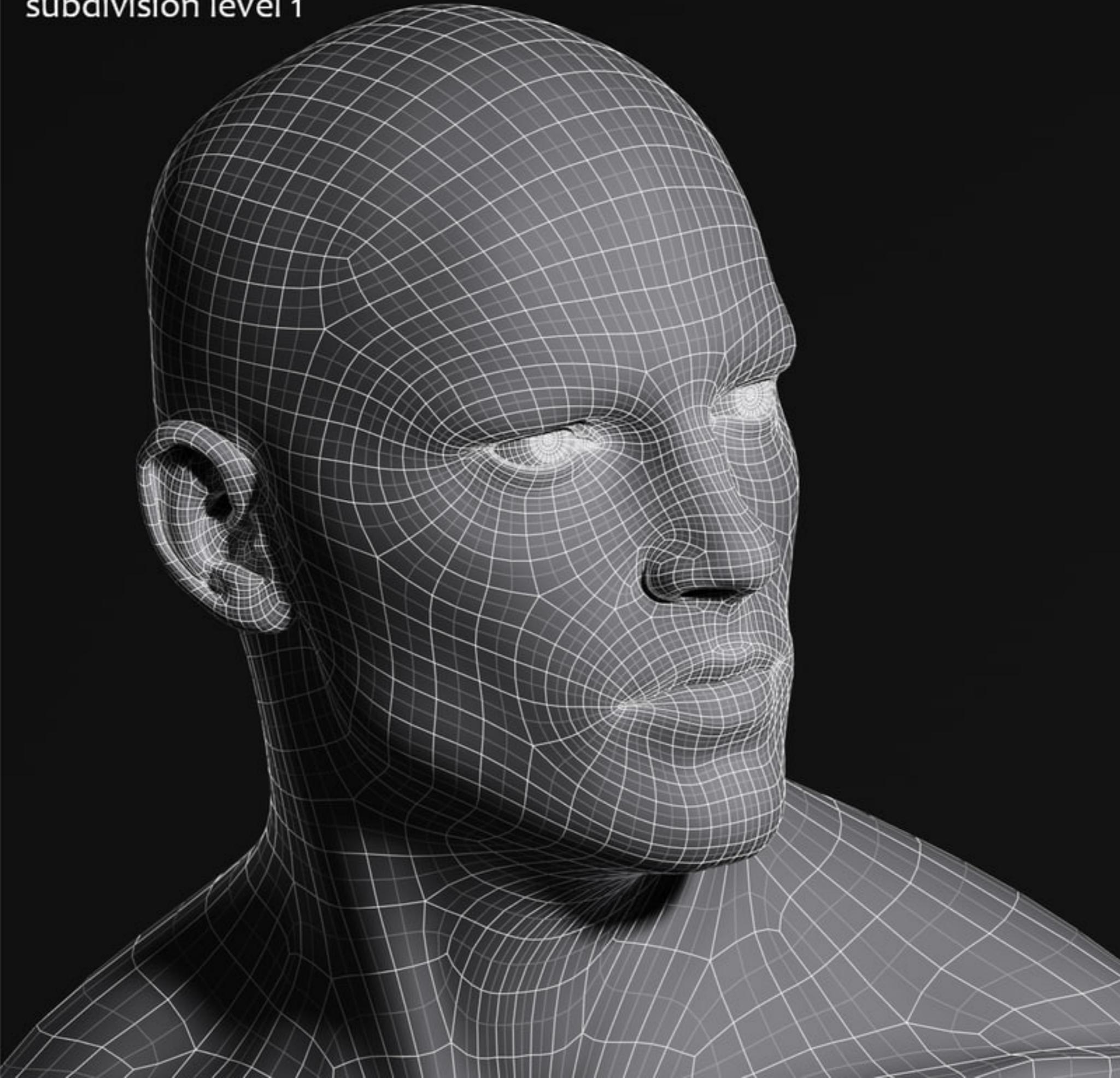
3D modeling



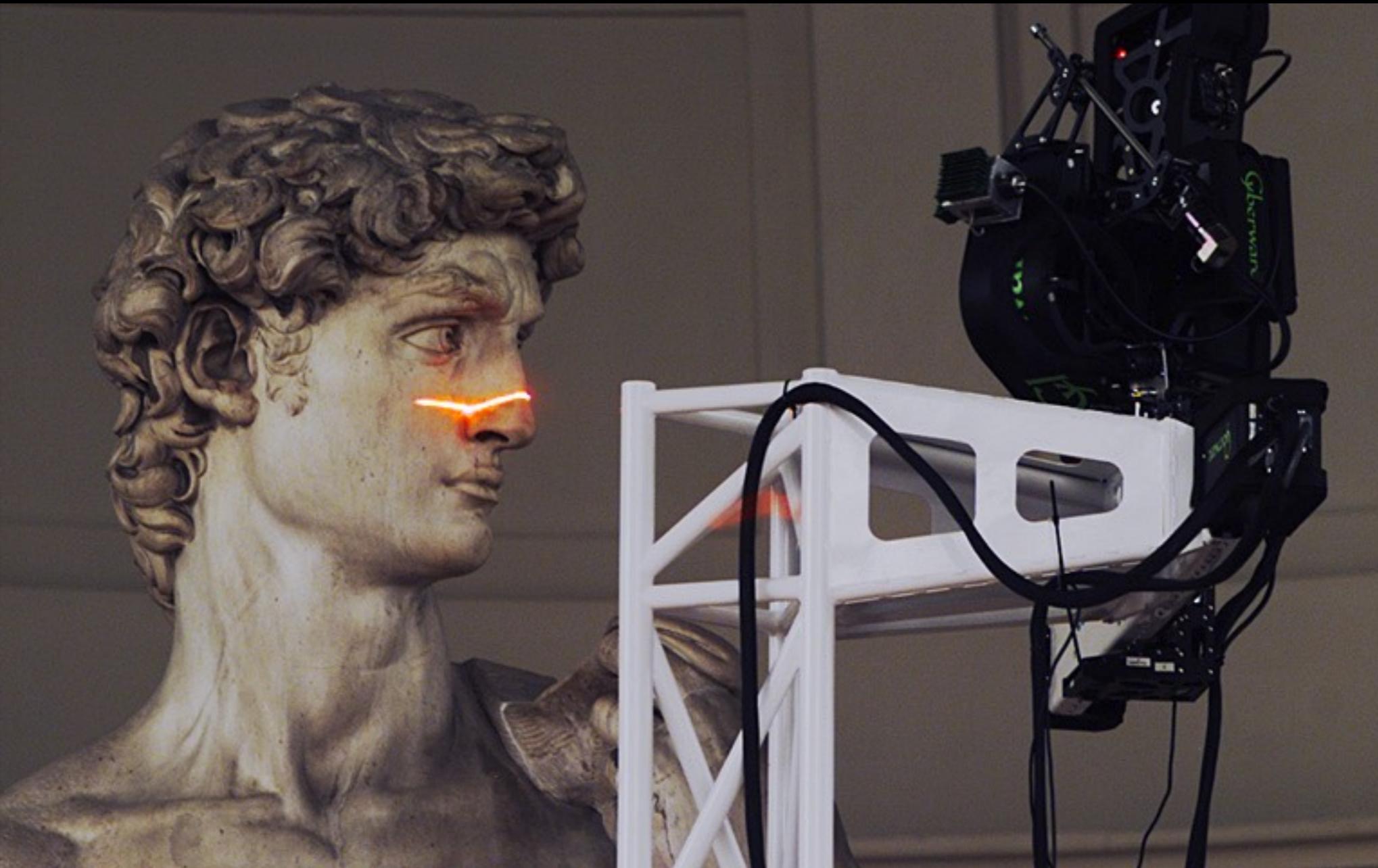
U. of Utah—Alpha I



subdivision level 1



[Andar Kollar via TurboSquid]



Digital
Michelangelo
Project
Marc Levoy, Stanford



Digital
Michelangelo
Project
Marc Levoy, Stanford



Results

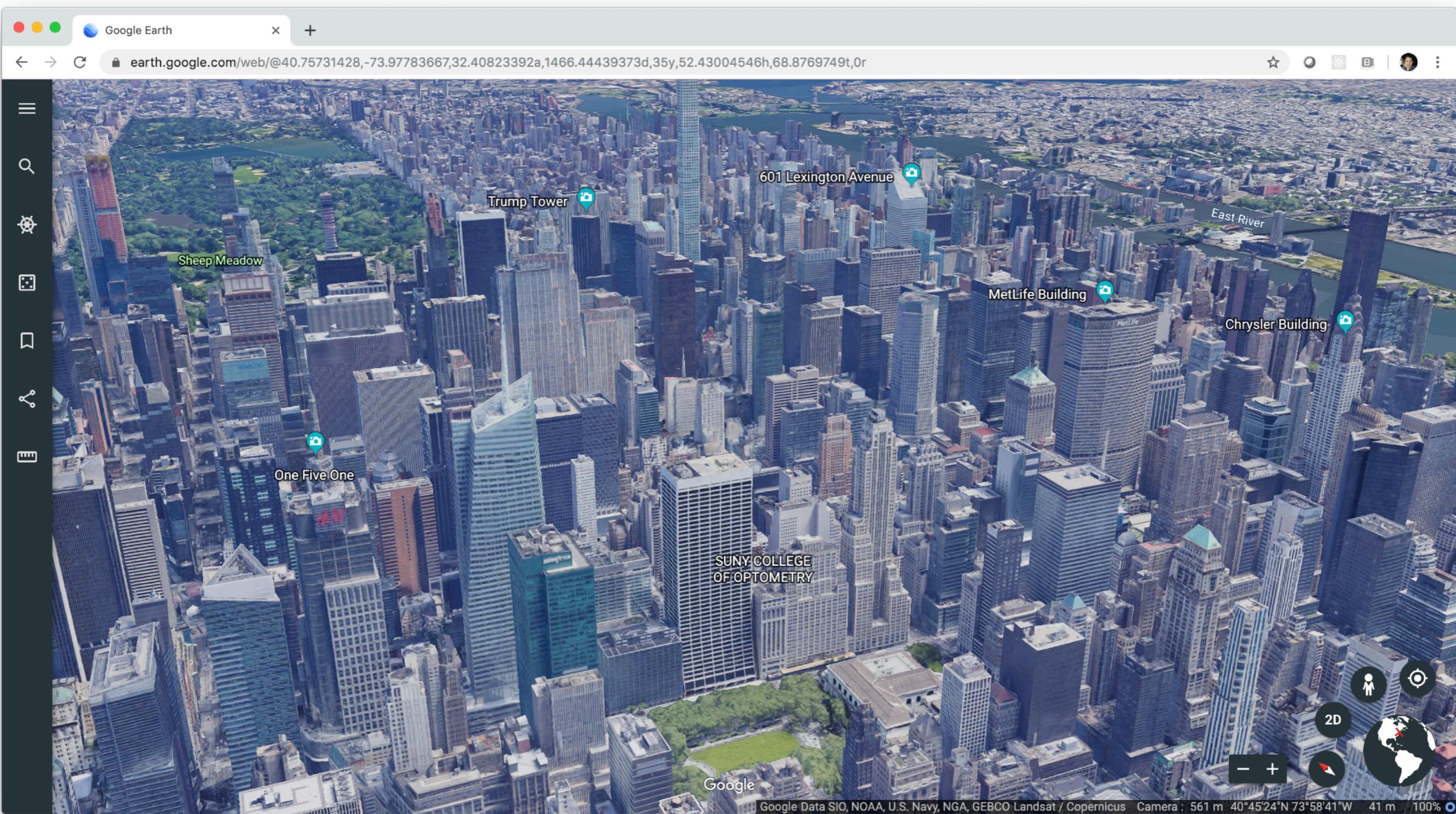


[Angela Dai et al. CVPR 2017]

Results

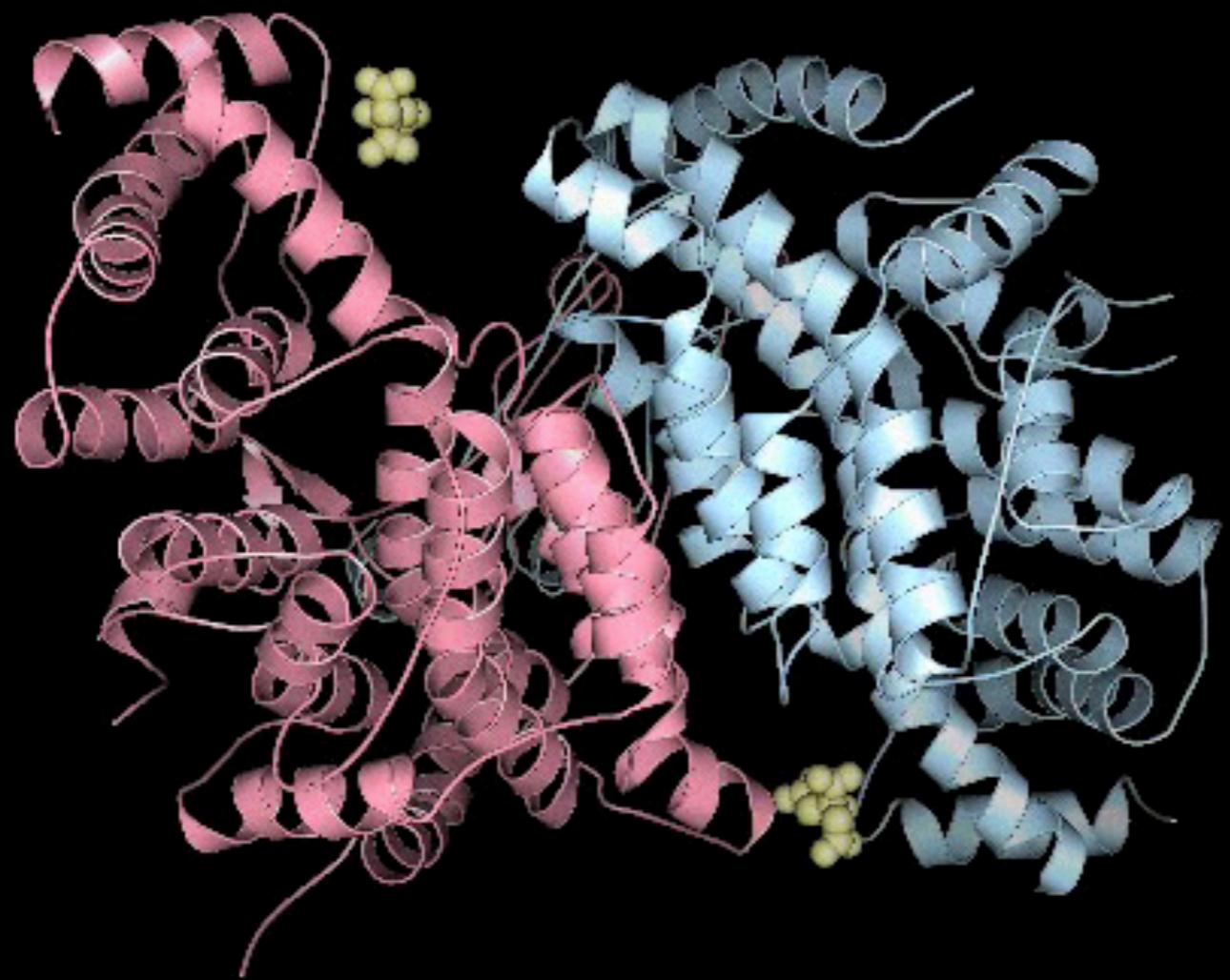


[Angela Dai et al. CVPR 2017]



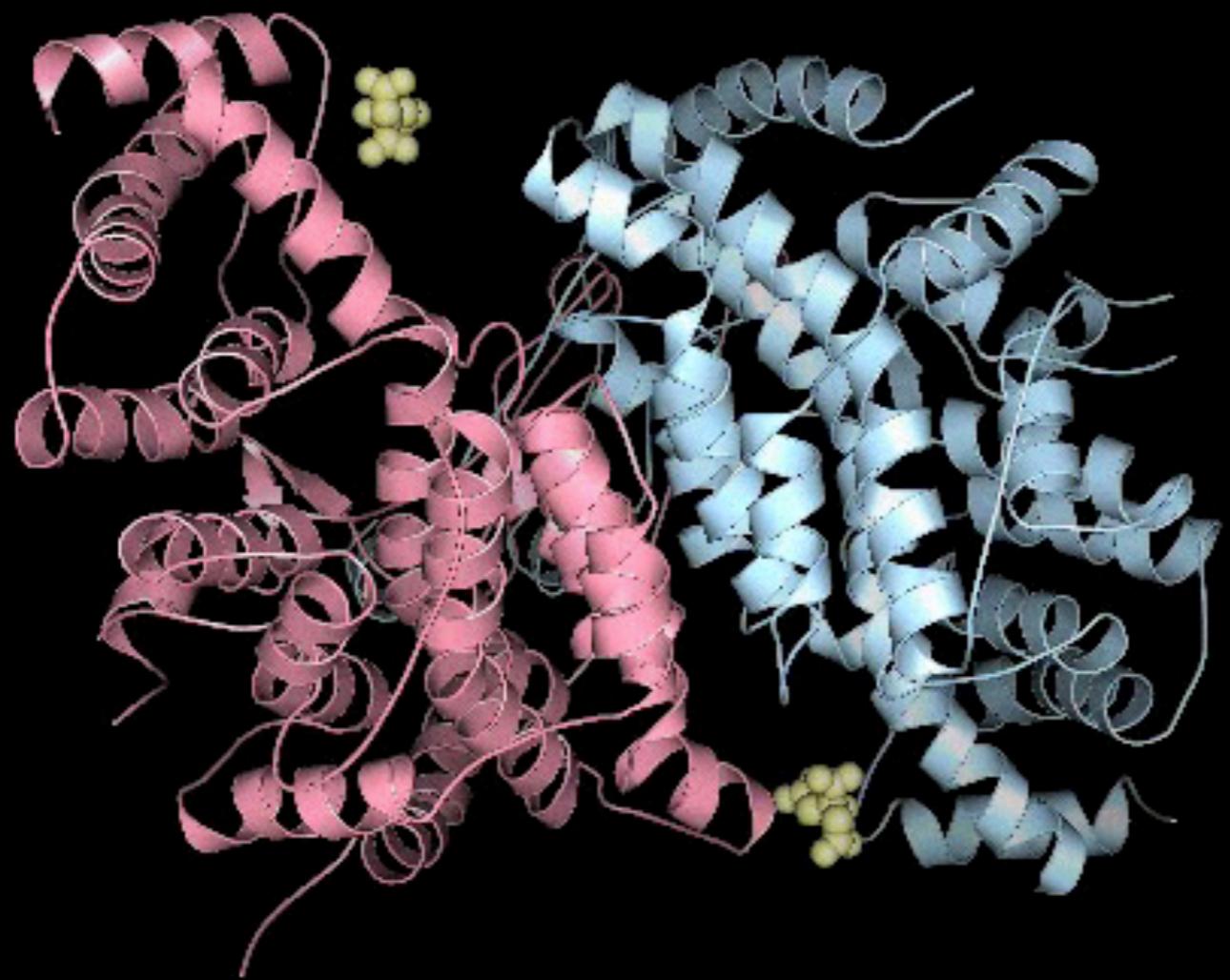
3D animation

Simulated
deformation of
citrate synthase
during substrate
binding

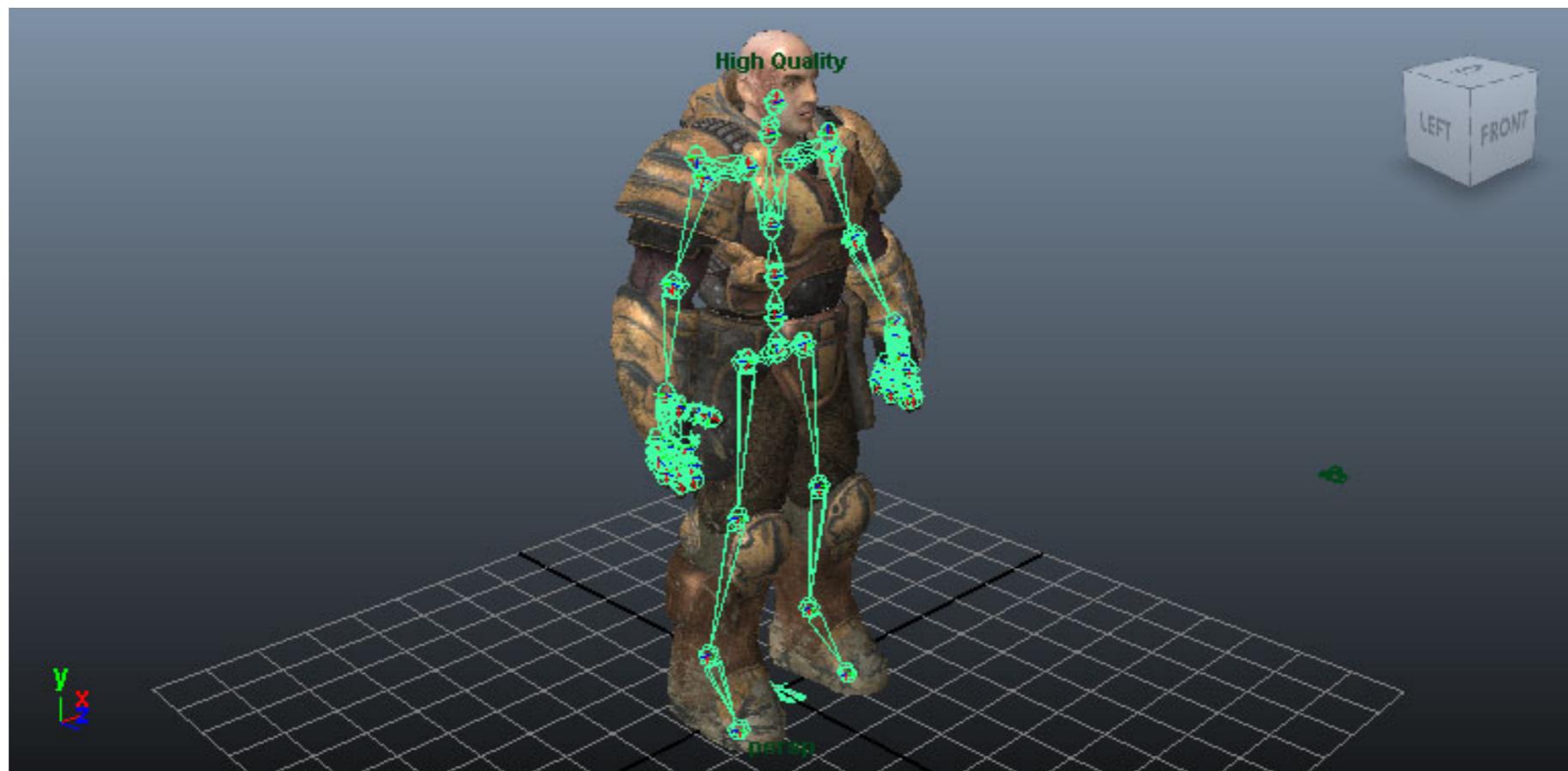
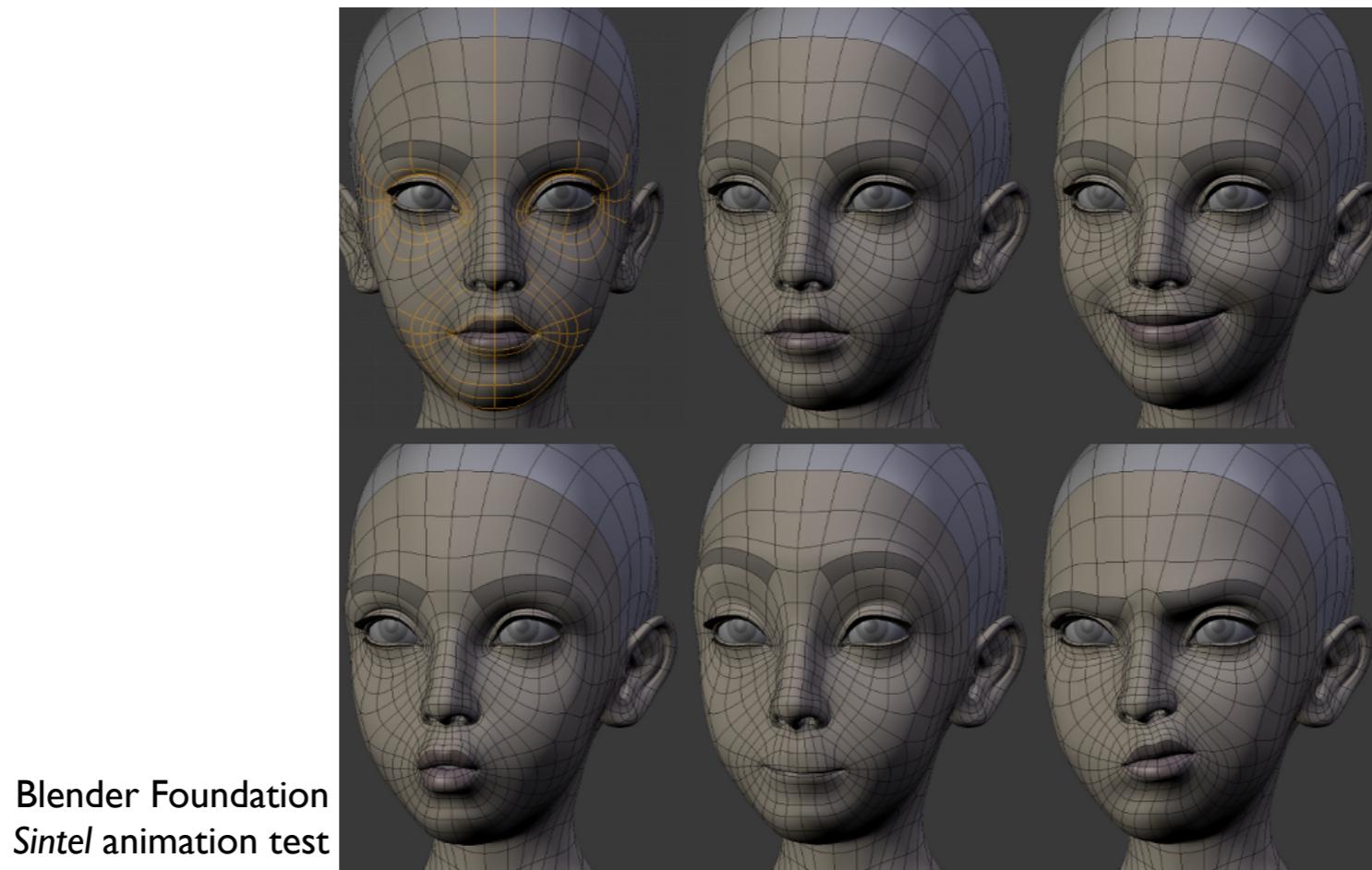


Kalju Kahn, UCSB

Simulated
deformation of
citrate synthase
during substrate
binding



Kalju Kahn, UCSB





Pixar—Toy Story



Pixar—Toy Story



Walt Disney Animation Studios—*Moana*

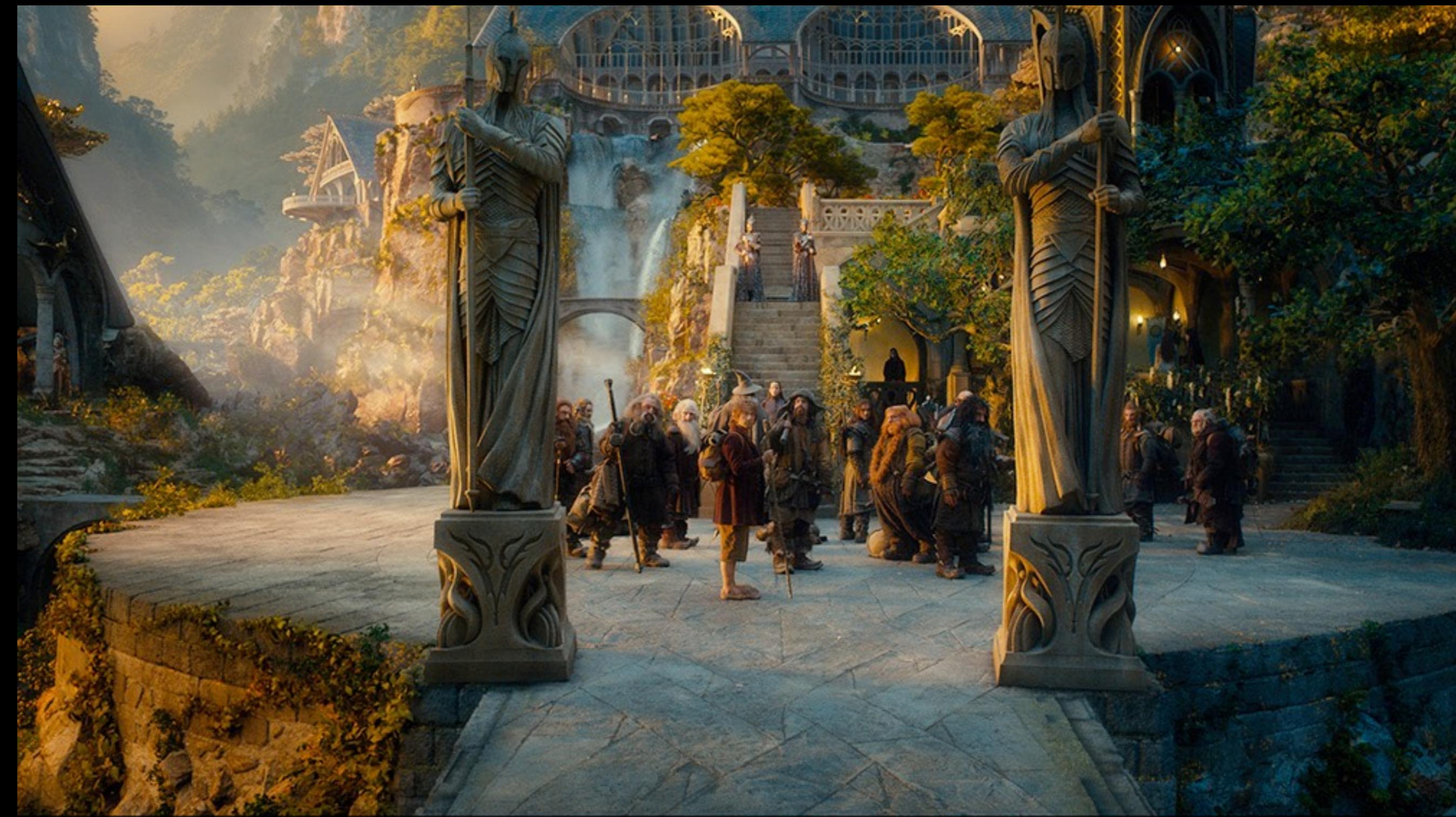


Pixar—Coco

3D rendering



Pixar—*The Blue Umbrella* (2013)



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

CRYYSIS® 3



Crytek—*Crysis 3* (2013)



Quantic Dream—*Two Souls* (2013)

screenshot: videogamer.com



Image Landsat

Google earth

Autodesk 360 Cloud Render

Autodesk® 360 Rendering

Create photorealistic Images and panoramas using our
Rendering cloud services with your Autodesk® 360





IKEA—rendered catalog image (2012)

(for more: <https://vimeo.com/163789781>)

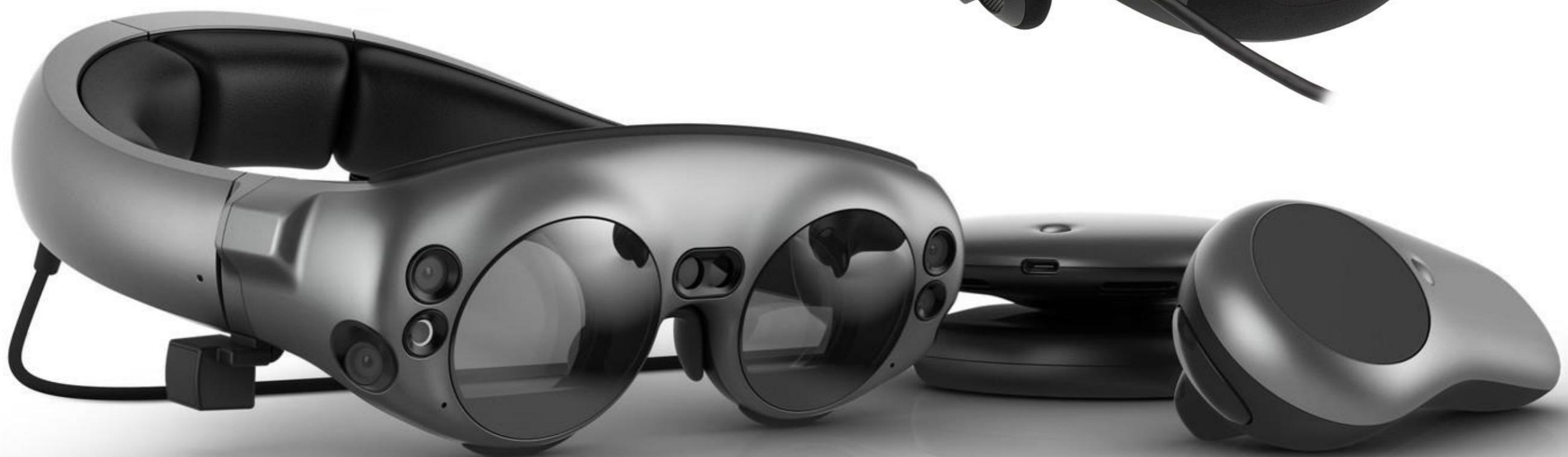
VR/AR

Virtual / mixed / augmented reality

Oculus Rift
VR headset



Oculus



Magic Leap

Magic Leap One
AR/MR headset



IKEA Place | iOS app

[More info...](#)

Computer graphics

Mathematics made visible.

Or, to paraphrase Ken Perlin...

Computer graphics

What you need to show other people
your dreams.

research

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

$a = 1.5$

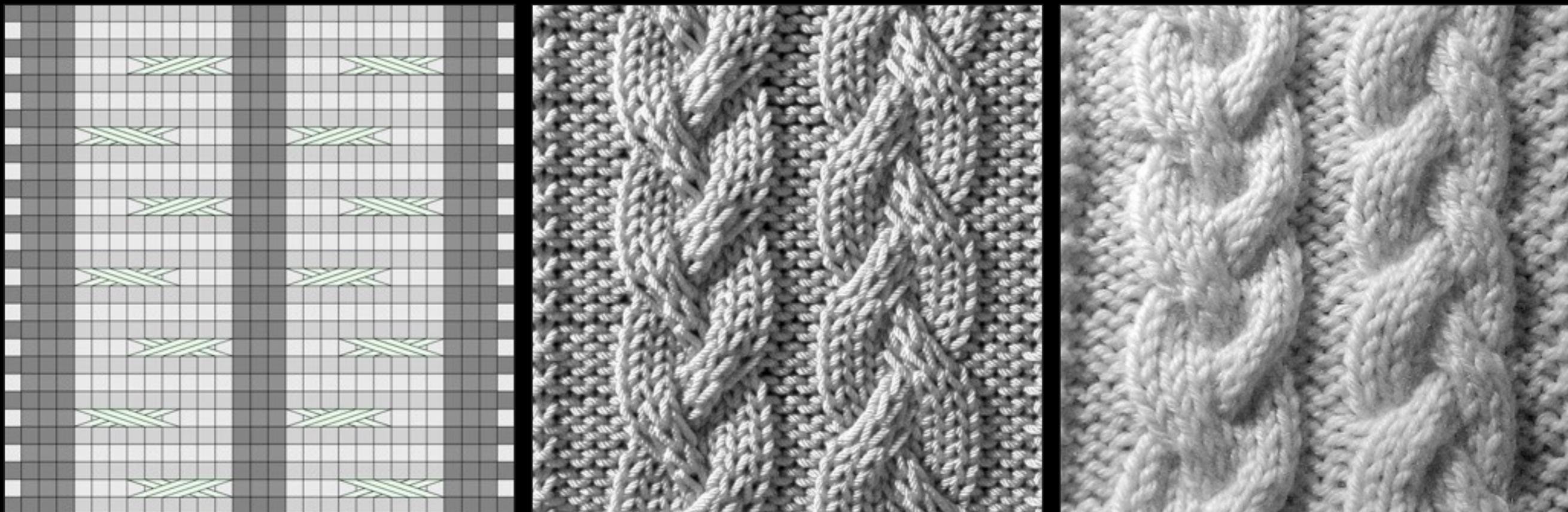


[Khungurn & Marschner 2017]

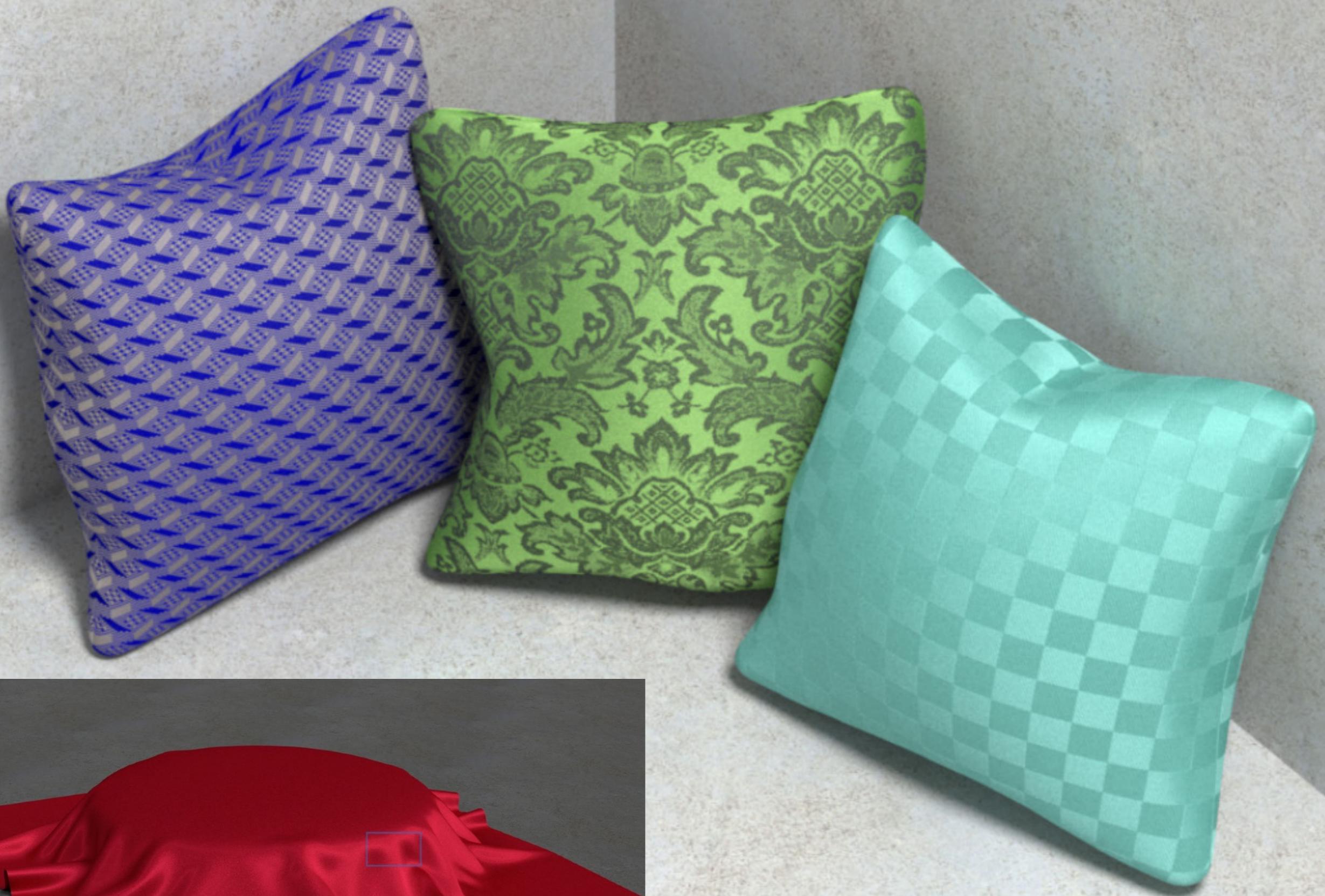
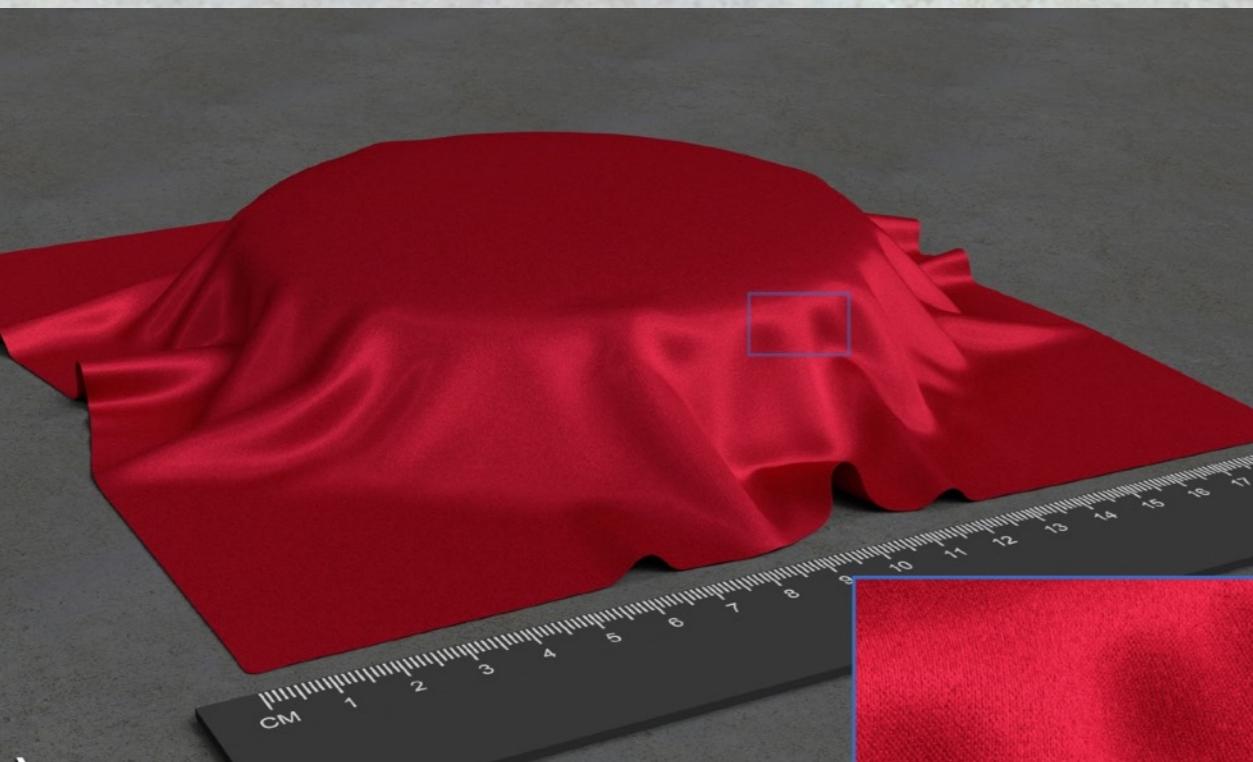
[Kaldor et al. 2008]

[Kaldor et al. 2008]

Modeling knit cloth



[Yuksel et al. 2012]



[Zhao et al. 2012]

course overview

Course mechanics

- **Web** <http://www.cs.cornell.edu/Courses/cs4620>
- **Teaching Assistants**
 - Ruojin Cai (Head TA)
Joy Zhang
Xi Deng
 - Seth Brunell
Sitian Chen
Lily Lin
Zhiqiu Lin
Nayanathara Palanivel
Olivia Xiang

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 little bit about WebGL and doing graphics in the browser
- **You will not:**
 - write very big programs

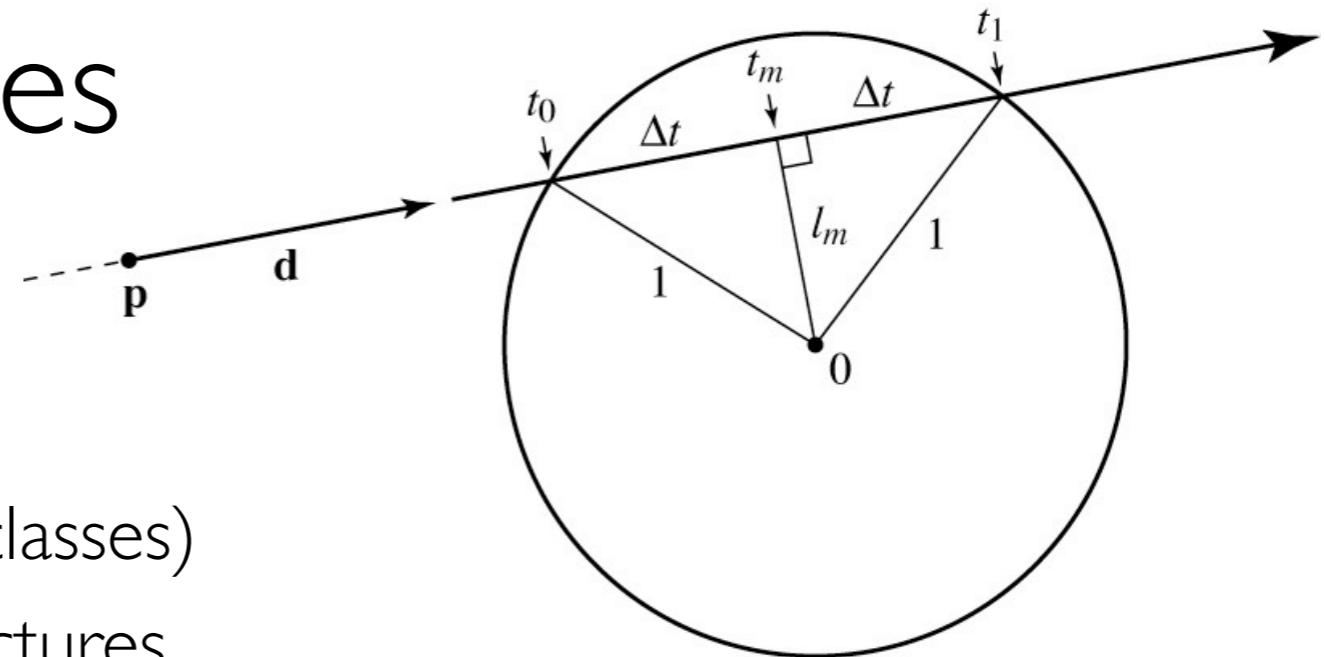
Topics

- **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**

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 2D and 3D, dot/cross products, etc.)
- linear algebra (mainly linear transformations in 2 to 4D)
- basic calculus (calculating derivatives, understanding integration)
- graphics is a good place to pick up some, but not all, of this

In CS462 I

- **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 CS462 I meeting a week from Monday**

Workload (tentative!)

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

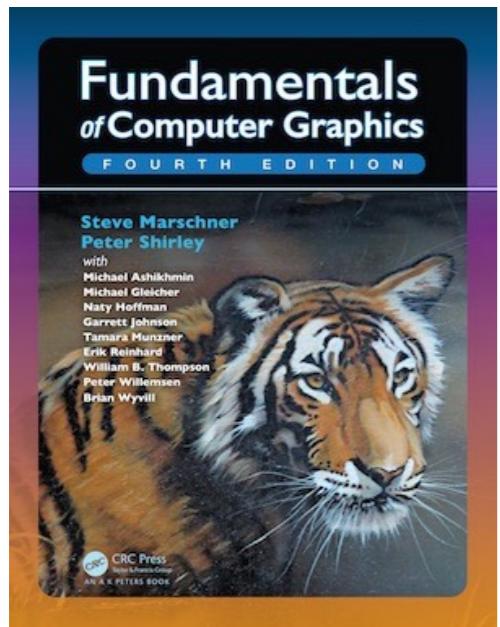
Academic Integrity

- Please see statement on course website

CS4620/2 | late policy

- **We use slip days**
- **You have 7 slip days for 4620, 4 separate ones for 4621**
 - e.g. you could turn in Ray pt1 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 4 days late
- **Accounting is separate per individual**
 - so it's possible for you to have slip days left but your partner not to
- **Each additional late day 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**

Textbook



Marschner & Shirley
Fundamentals of Computer Graphics
fourth edition

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