

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
- **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

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

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

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

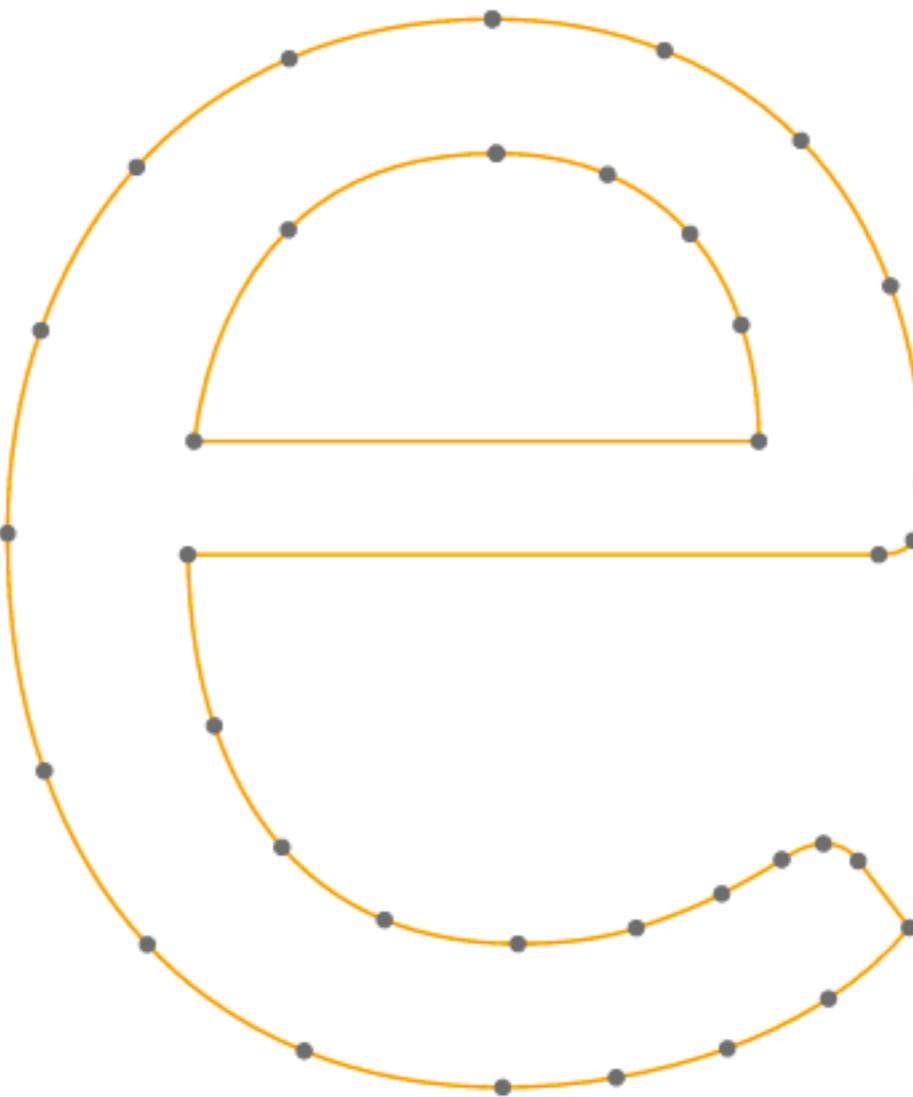
Extra Bold 110 pt

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FS Silas Slab

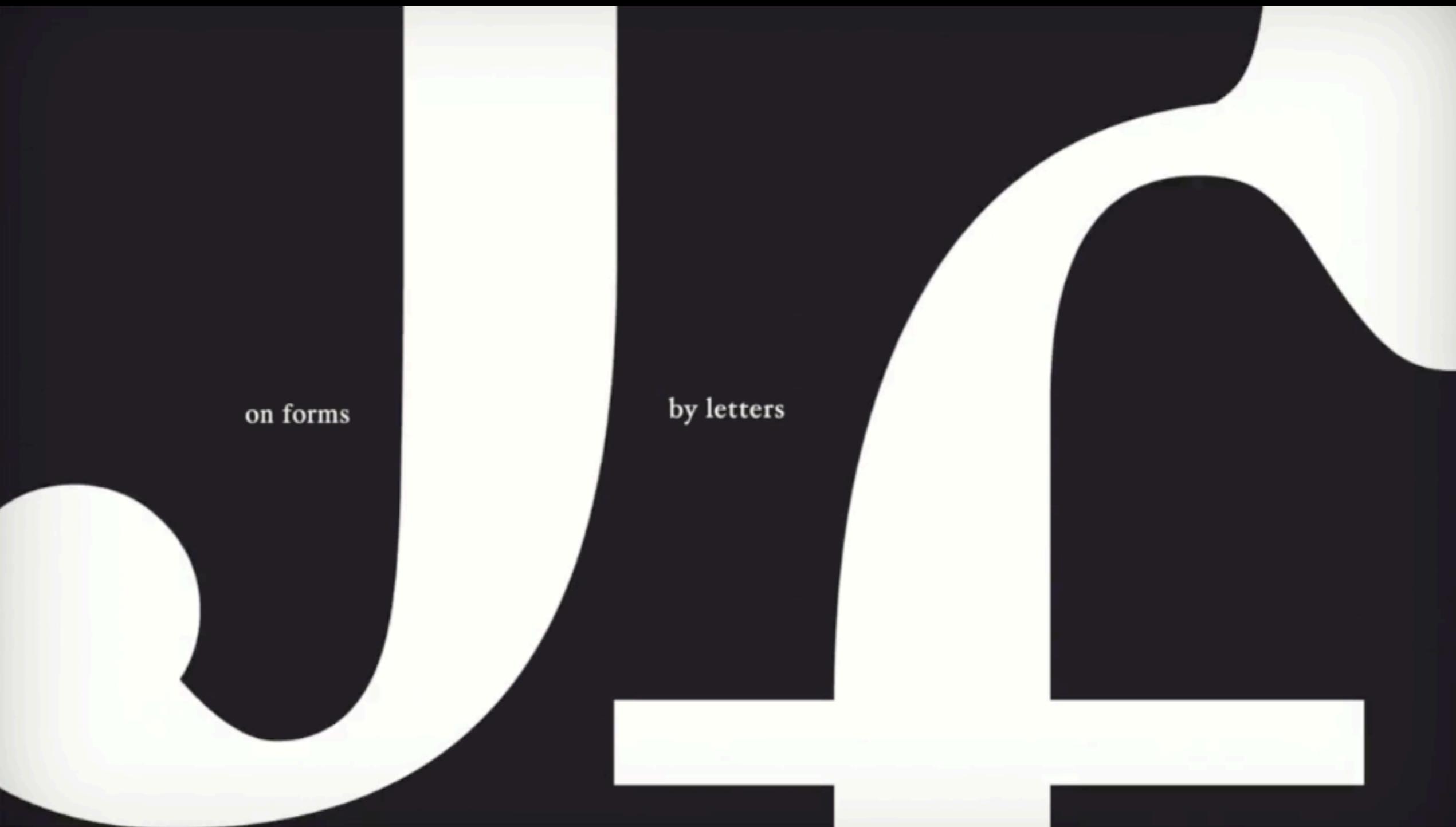
Page 05

FS Silas Sans



Pavithra Solai, kint.io

2D animation



on forms

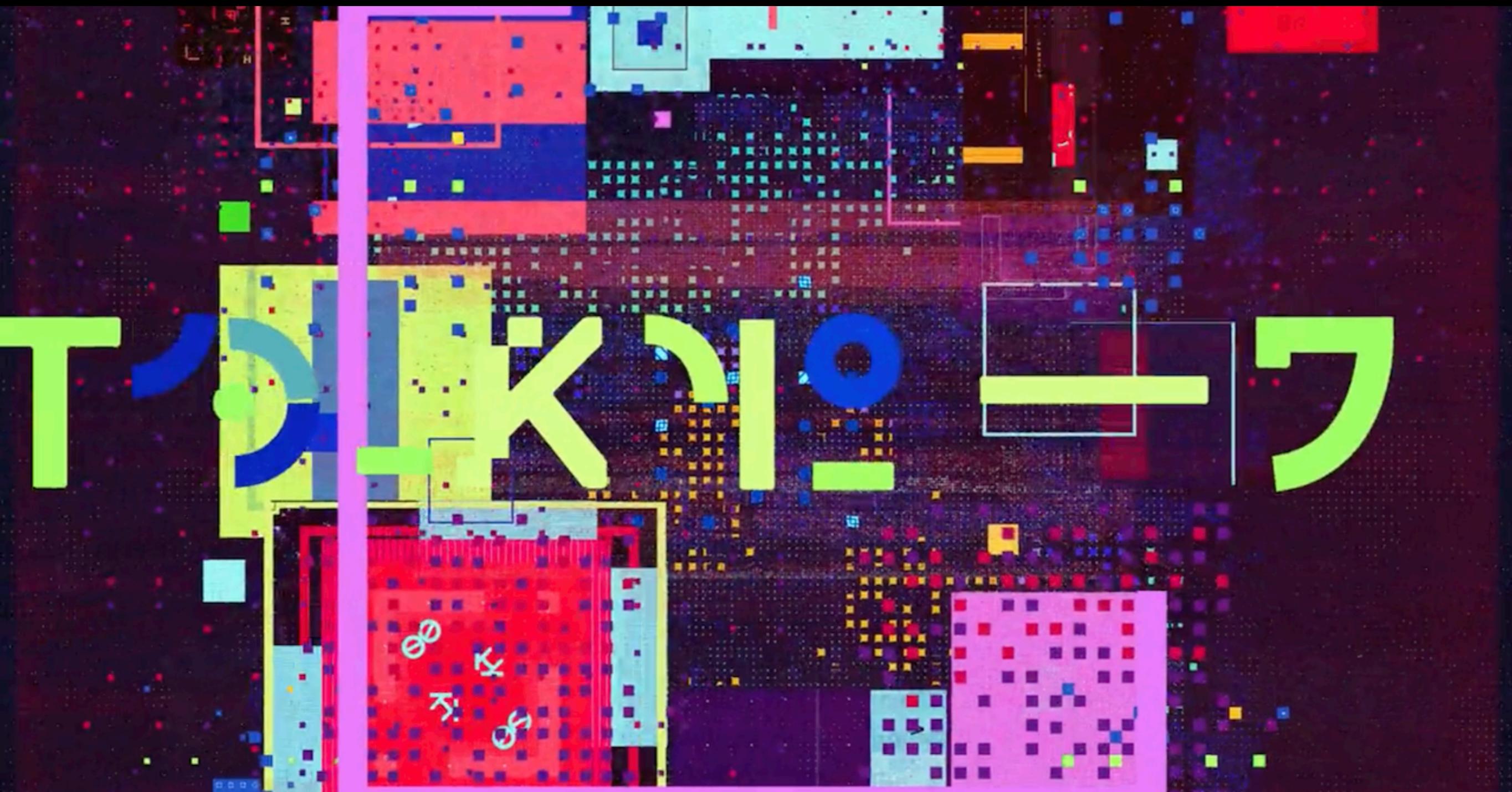
by letters



<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

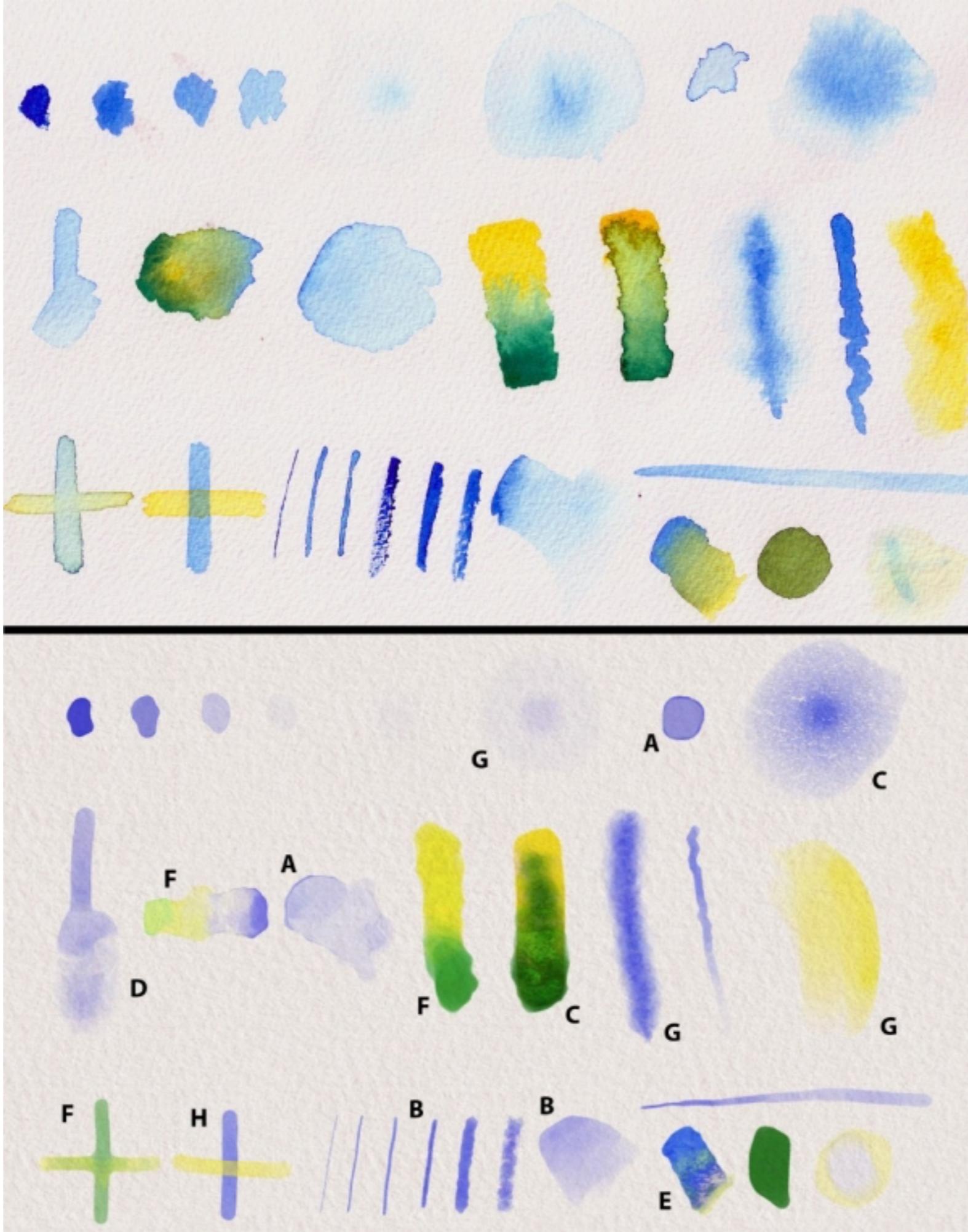


Playdead | *Limbo* (2010)

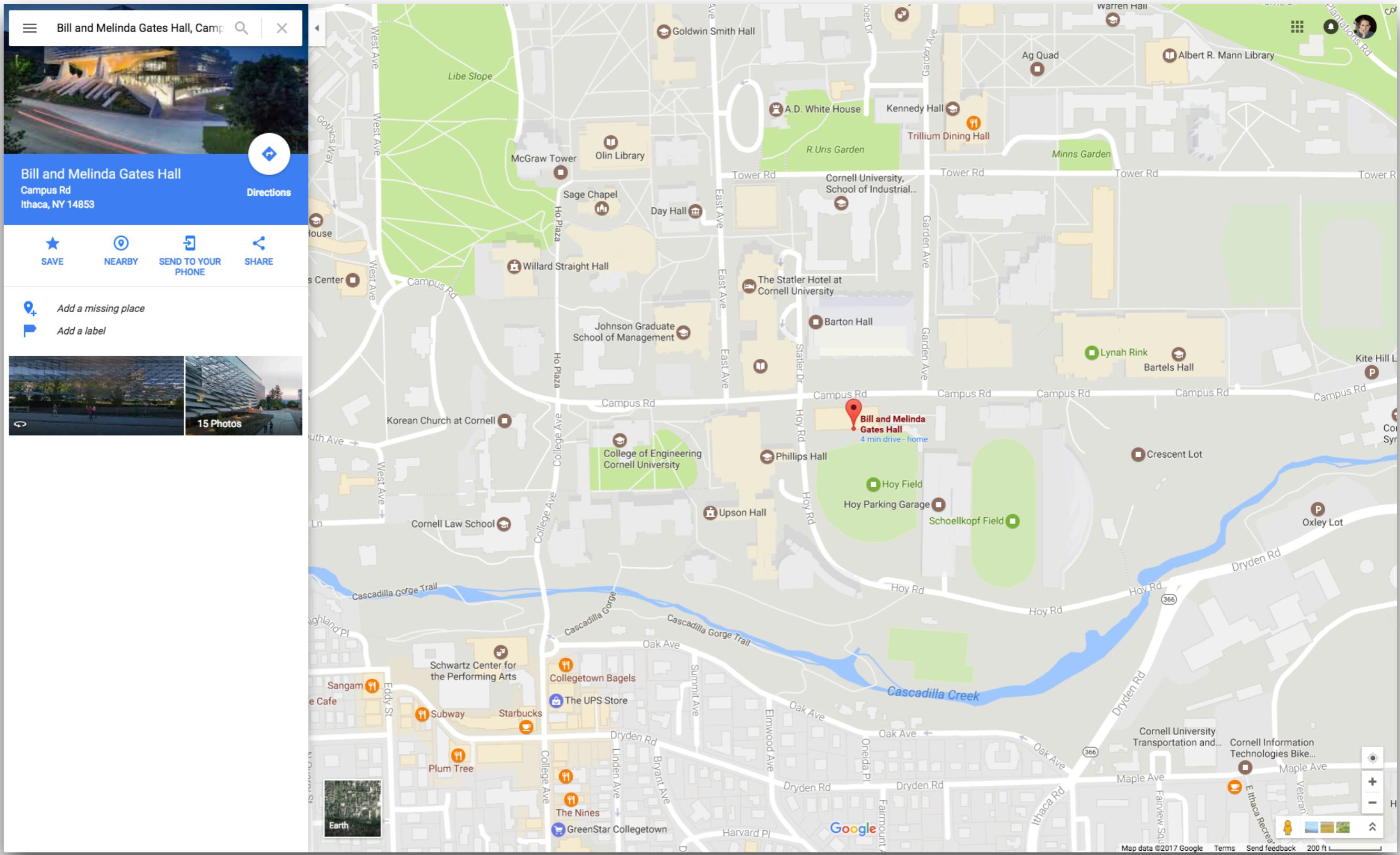


Polytron—*Fez* (2010)

2D rendering



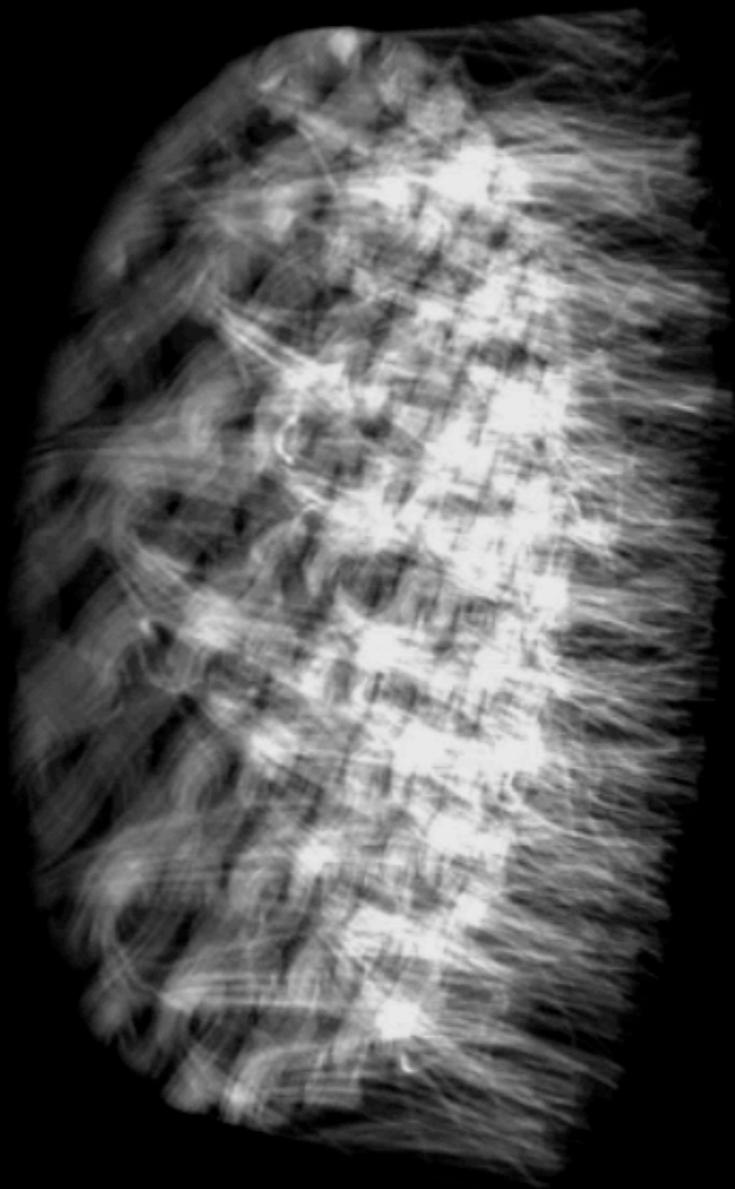
Daichi Ito et al.
Eazel
Adobe Research



Google Maps

3D imaging

Velvet



3D modeling



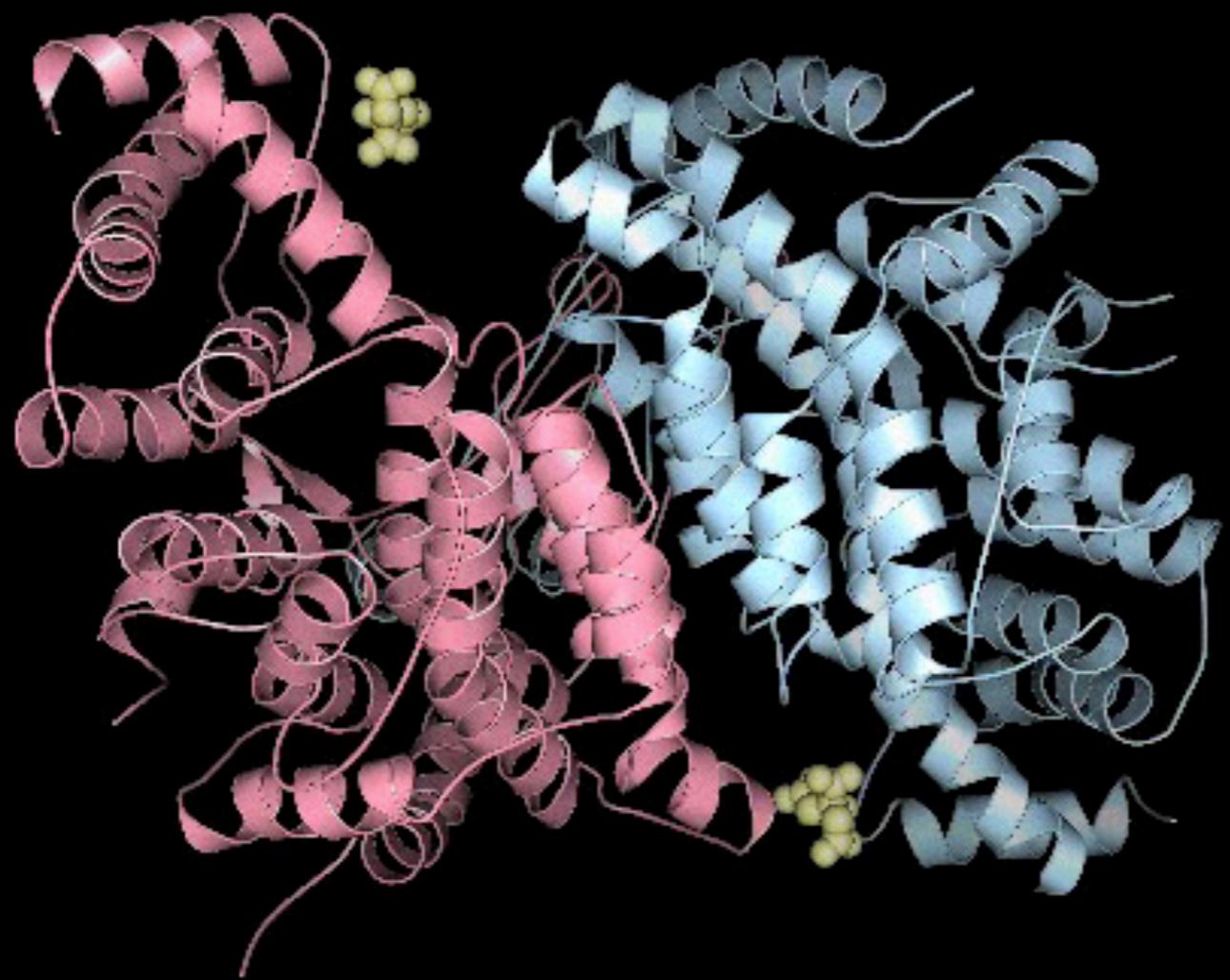
U. of Utah—Alpha I



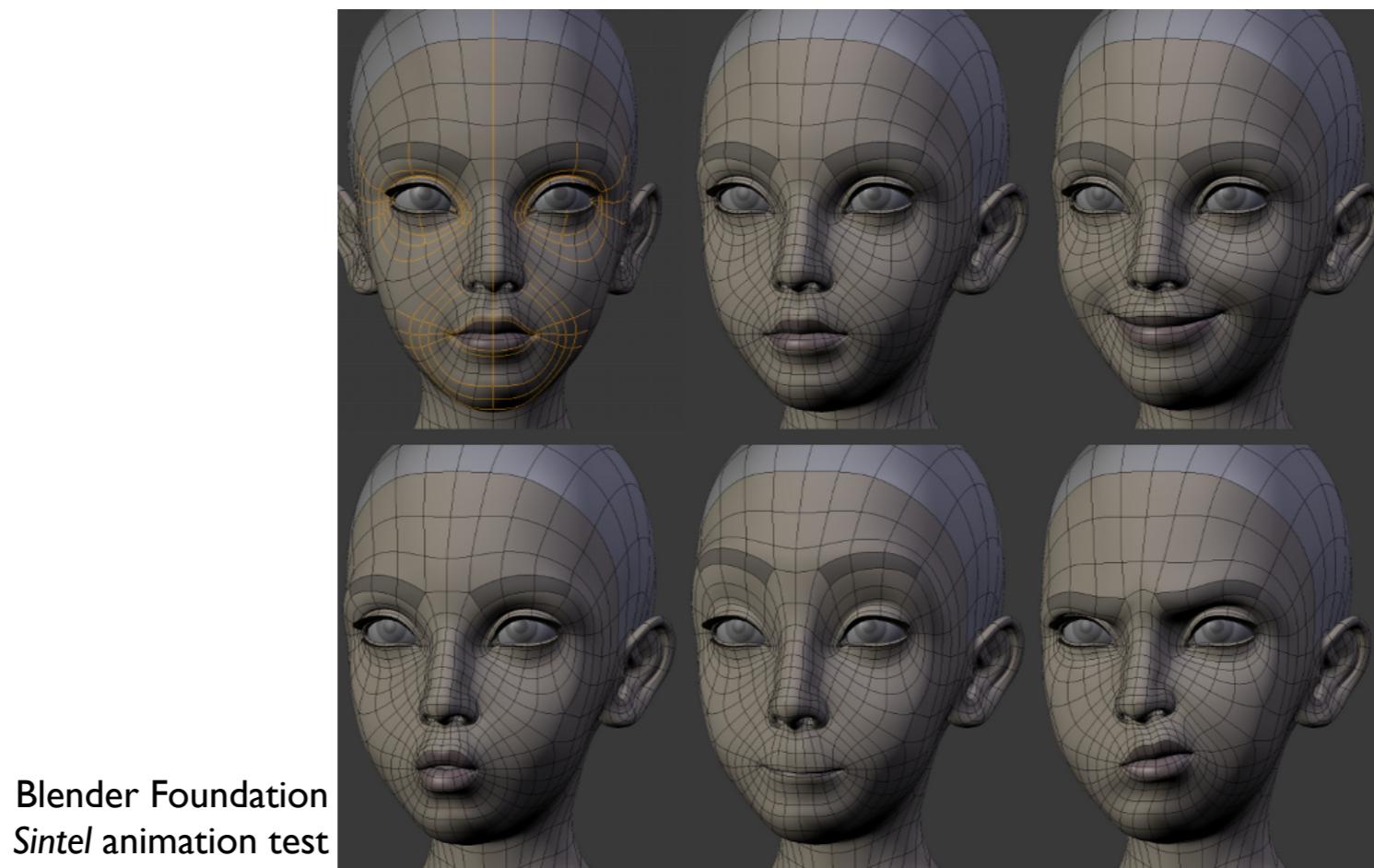
Richard Fox, rfoxart.com

3D animation

Simulated
deformation of
citrate synthase
during substrate
binding



Kalju Kahn, UCSB





Pixar—*Toy Story*



Walt Disney Animation Studios—*Moana*

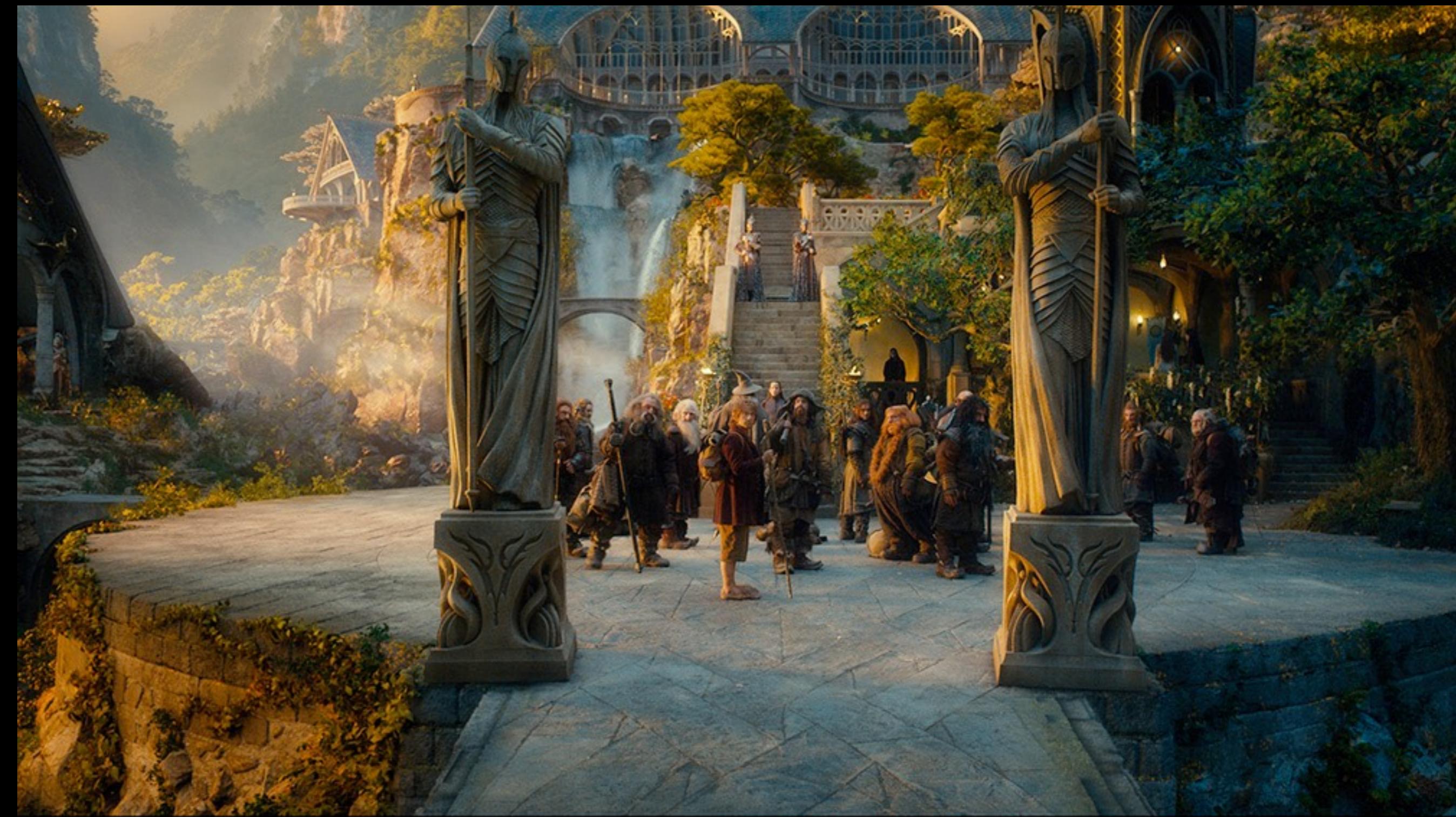


Pixar—Coco

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

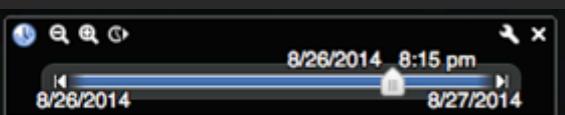


Image Landsat

Google earth

Autodesk 360 Cloud Render

Autodesk® 360 Rendering

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



Autodesk 360 Cloud Render



Builder Homesite, Inc. American Kitchen with Island

View 1 of 2

Appliances • Fixtures • Flooring • Counters
Cabinets • Walls

3 items

Merillat Masterpiece® cabinets with Laredo door ...

Merillat Masterpiece® cabinets with Laredo door ...

Merillat Masterpiece® cabinets with Laredo door ...

Autodesk Project Showroom

A screenshot of the Autodesk 360 Project Showroom interface. It shows a 3D rendering of a kitchen with wooden cabinets, a central island, and stainless steel appliances. Below the rendering, there's a catalog of cabinet options from Merillat, specifically the "Masterpiece®" series with "Laredo" doors. The interface includes navigation buttons for viewing multiple items and links to other product categories like fixtures and flooring.



IKEA—rendered catalog image (2012)



[Walter et al. 2005]

model: University of Bristol



Digital
Michelangelo
Project
Marc Levoy, Stanford



Computer graphics

Mathematics made visible.

Or, to paraphrase Ken Perlin...

Computer graphics

What you need to show other people
your dreams.

Introductions...

Steve

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

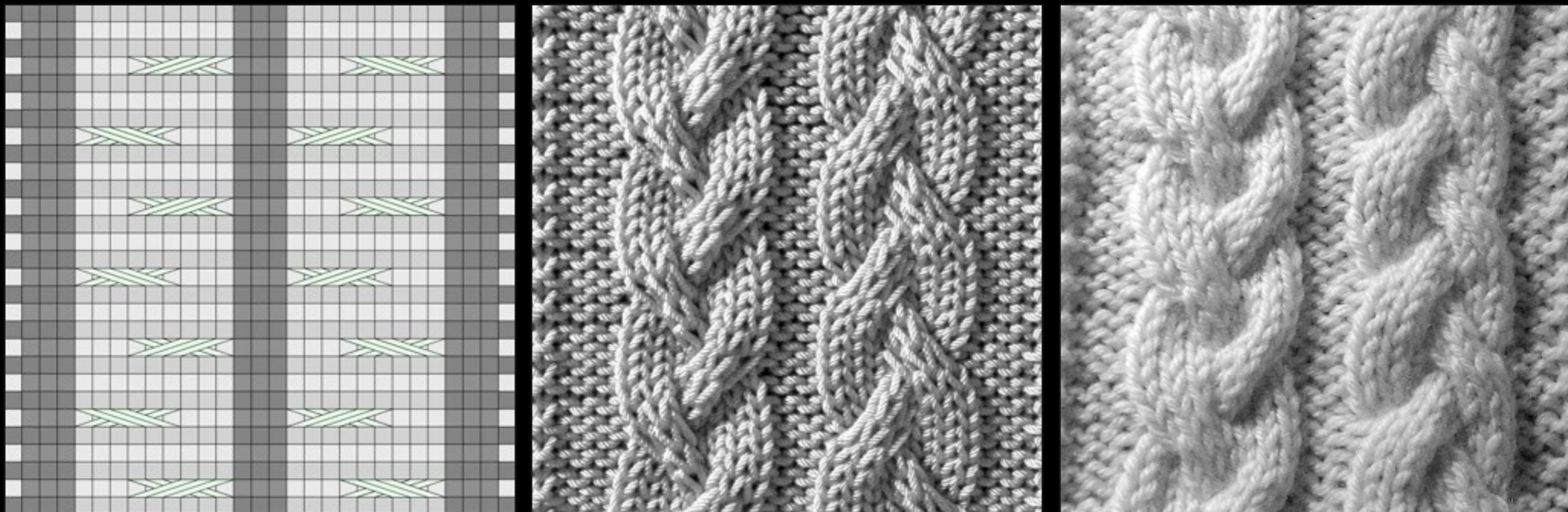
$a = 1.0$
 $a = 1.2$
 $a = 1.5$



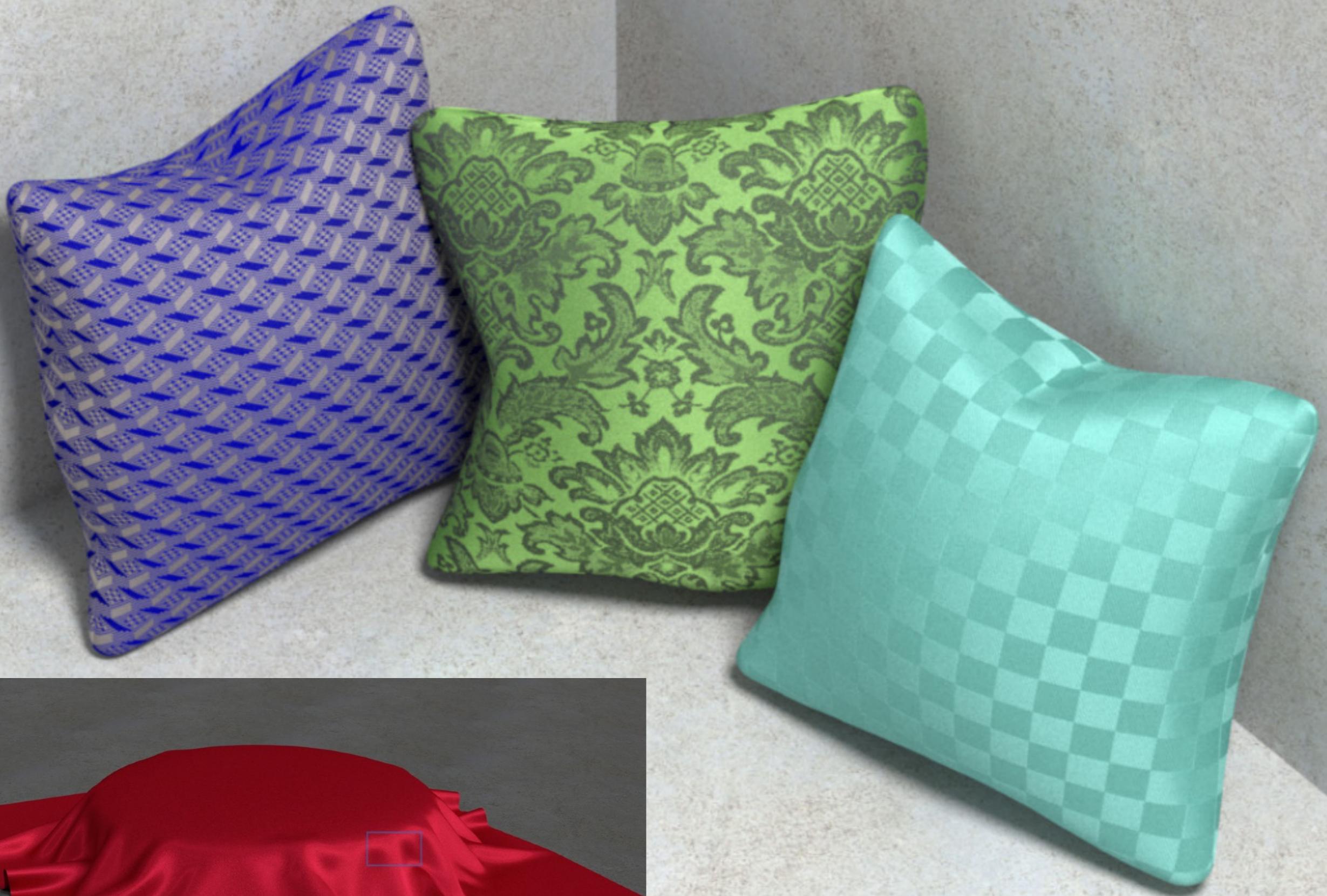
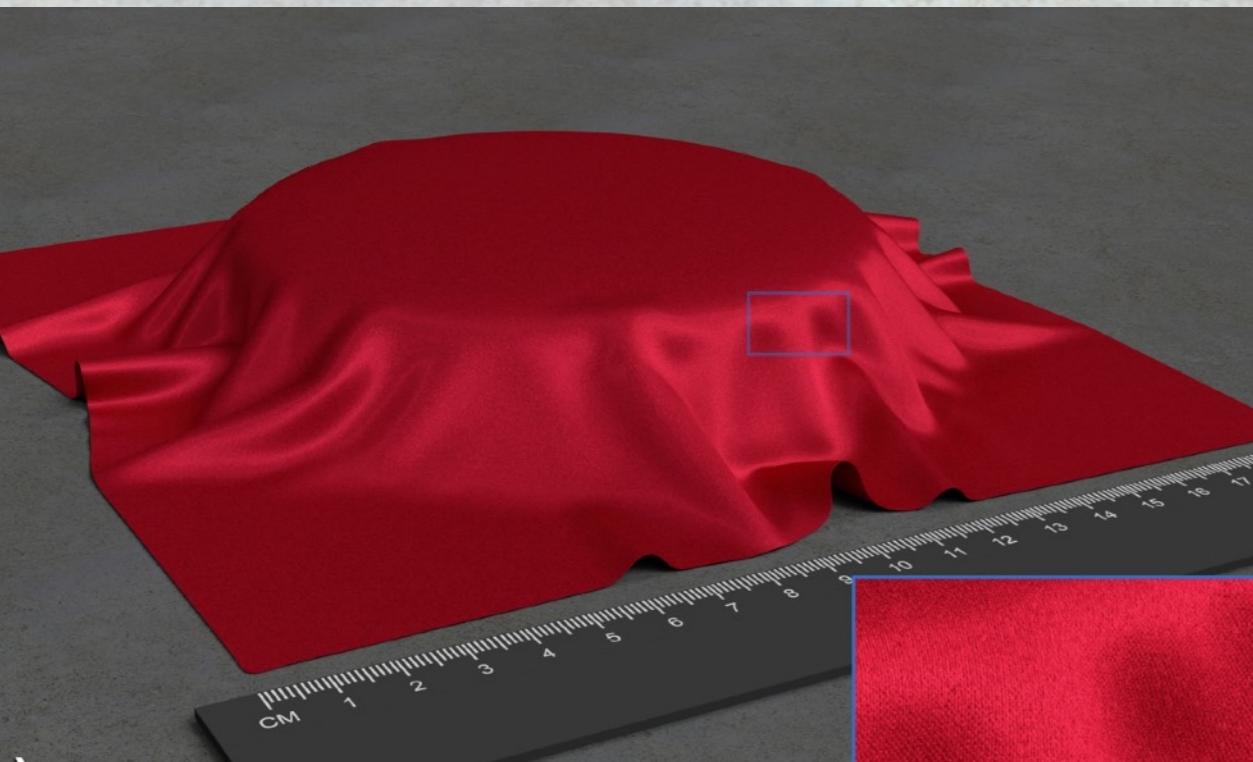
[Khungurn & Marschner 2017]

[Kaldor et al. 2008]

Modeling knit cloth

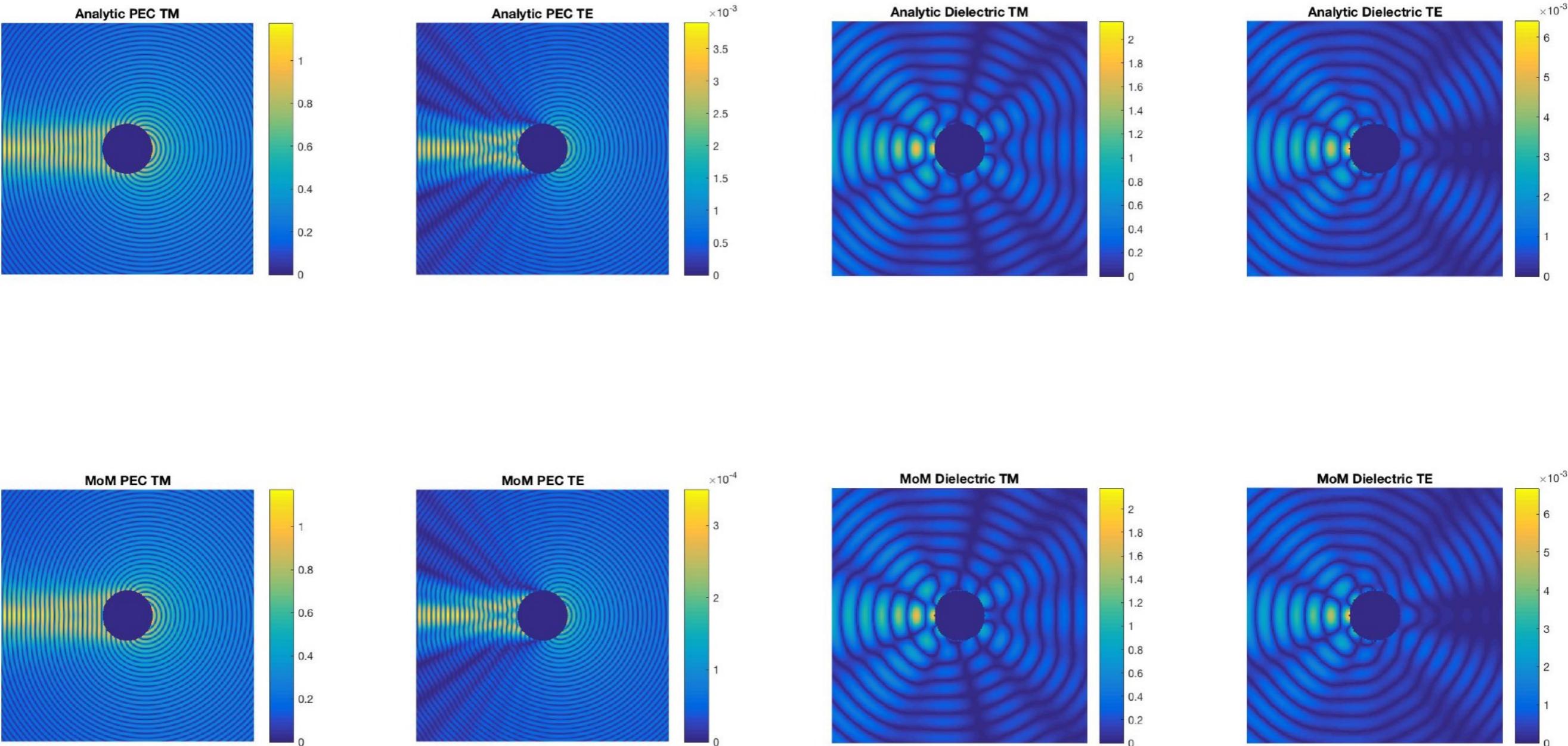


[Yuksel et al. 2012]



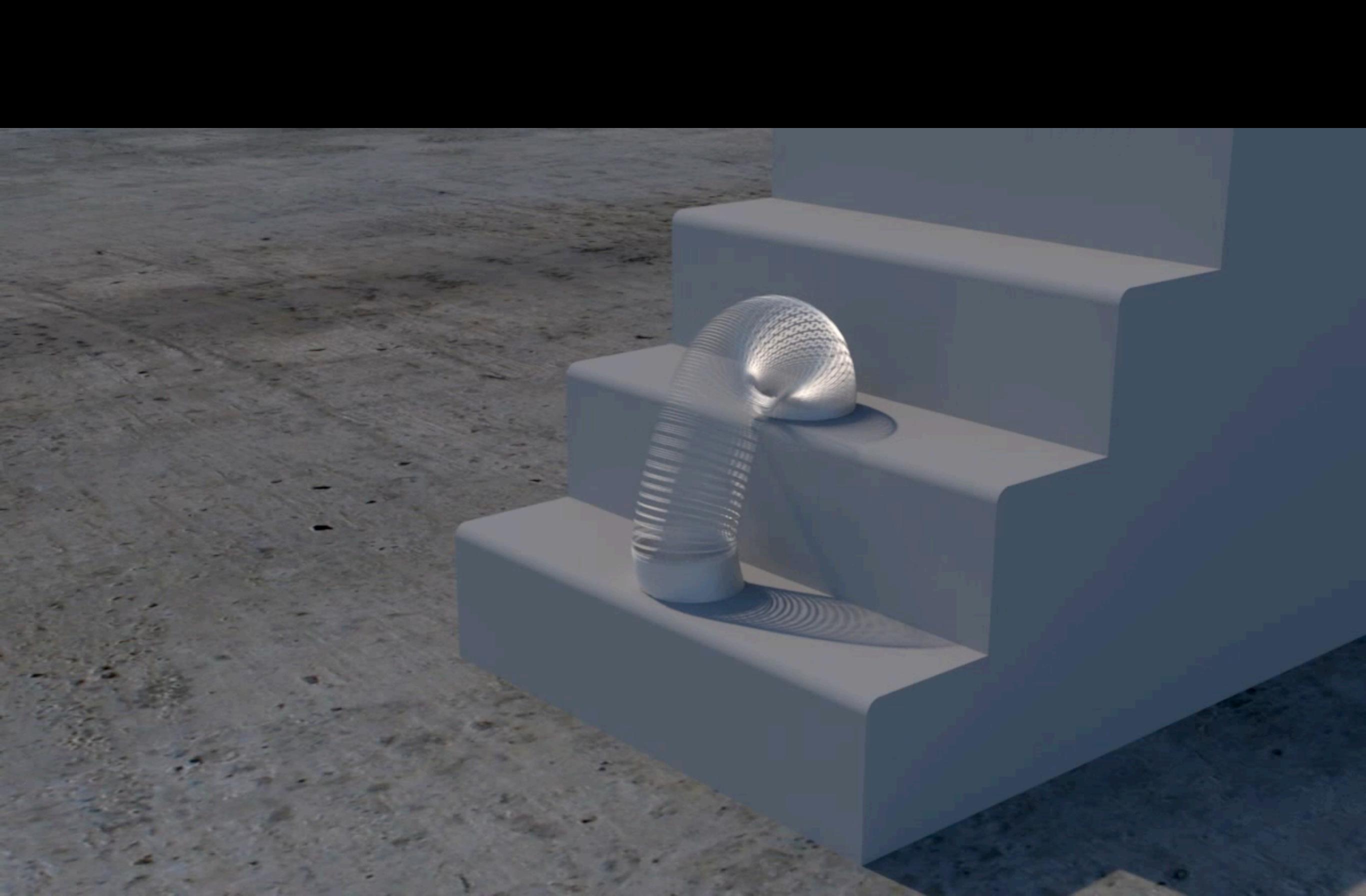
[Zhao et al. 2012]

Mandy



[Xia et al. (research in progress)]

Eston



[Schweickart et al. (submitted)]

course overview

Course mechanics

- **Web** <http://www.cs.cornell.edu/Courses/cs4620>
- **Teaching Assistants**
 - Eston Schweickart, 4621 Head TA
 - Mandy Xia, 4620 Head TA
 - Zechen Zhang, grad TA
 - Shiyu Wang, grad TA
 - Sandy Fang
 - Serge-Olivier Amega
 - ...and more!

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

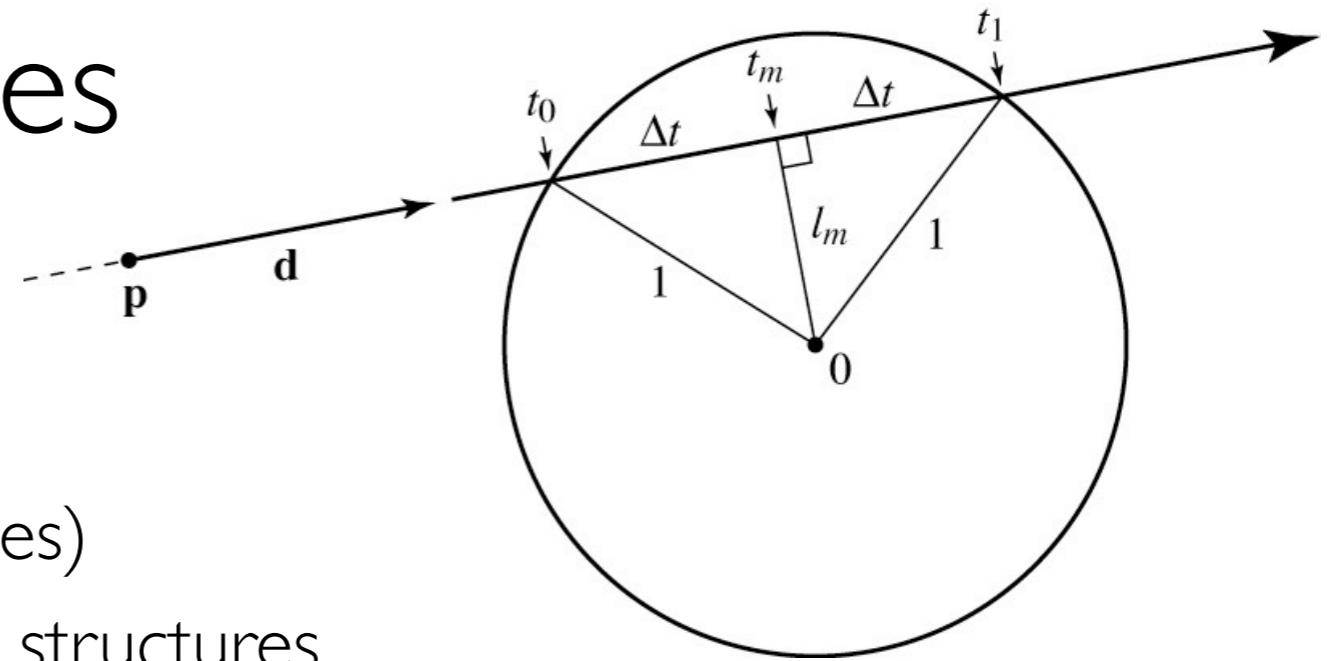
Topics

- **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 (10s of classes)
- understanding of very basic data structures
- no serious software design required



- **Mathematics**

- vector geometry (dot/cross products, etc.)
- linear algebra (just basic matrices in 2-4D)
- basic calculus (simple derivatives)
- graphics is a good place to pick up some, but not all, of this

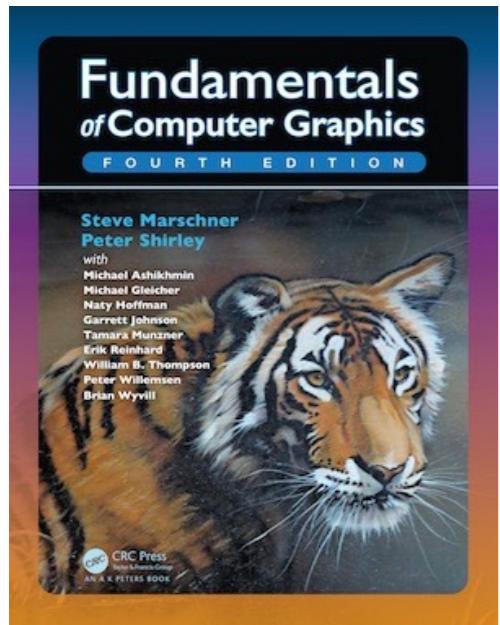
In CS462 I

- **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 this Friday!**

Workload

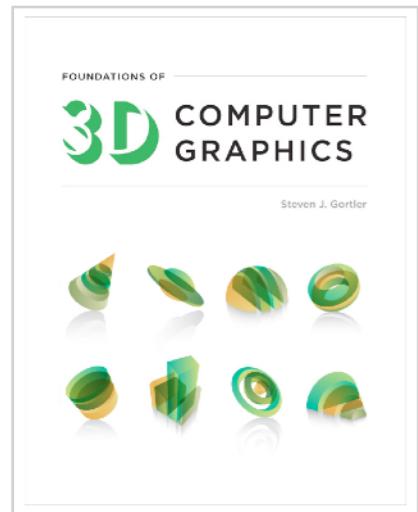
- **CS 4620/5620**
 - 7 written assignments
 - 7 programming assignments
 - 1 free late assignment (up to 1 week), else 10% per day
 - 2 exams (midterm + final)
- **CS 4621/5621**
 - 3 programming assignments
 - one open-ended project

Textbook

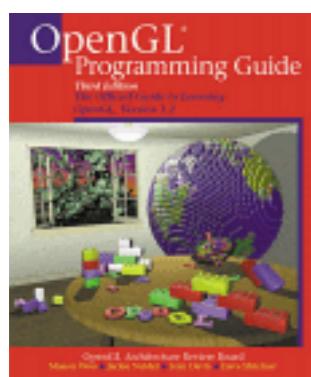


Marschner & Shirley
Fundamentals of Computer Graphics
fourth edition

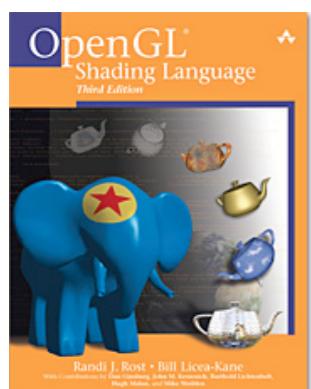
More books



Steven Gortler
Foundations of Computer Graphics
first edition



OpenGL Programming Guide
(a.k.a. the "Red Book")
Older version available online:
http://www.opengl.org/documentation/red_book/



GLSL Shading Language
(a.k.a. the "Orange Book")

Academic Integrity

Course mechanics

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