CS4620/5620: Introduction to Computer Graphics

Professor: Steve Marschner

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

Or, to paraphrase Ken Perlin...

Computer graphics: What you need to show other people your dreams.

Graphics Applications

- Entertainment
  - film production
  - film effects
  - games
- Science and engineering
  - computer-aided design
  - visualization (scientific, information)
- Virtual Prototyping
- Cultural Heritage
- Training & Simulation
- Graphic Arts, Fine Art

Graphics Applications

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Pixar—*Toy Story*

(with previous instructors James/Bala)

Pixar—*The Blue Umbrella* (2013)

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


KING KONG
© 2005 Universal Studios. Used With Permission.

Crytek—*Crysis 3* (2013)

Quantic Dream—*Two Souls* (2013)

screenshot: videogamer.com

(with previous instructors James/Bala)

Polytron—*Fez* (2010)

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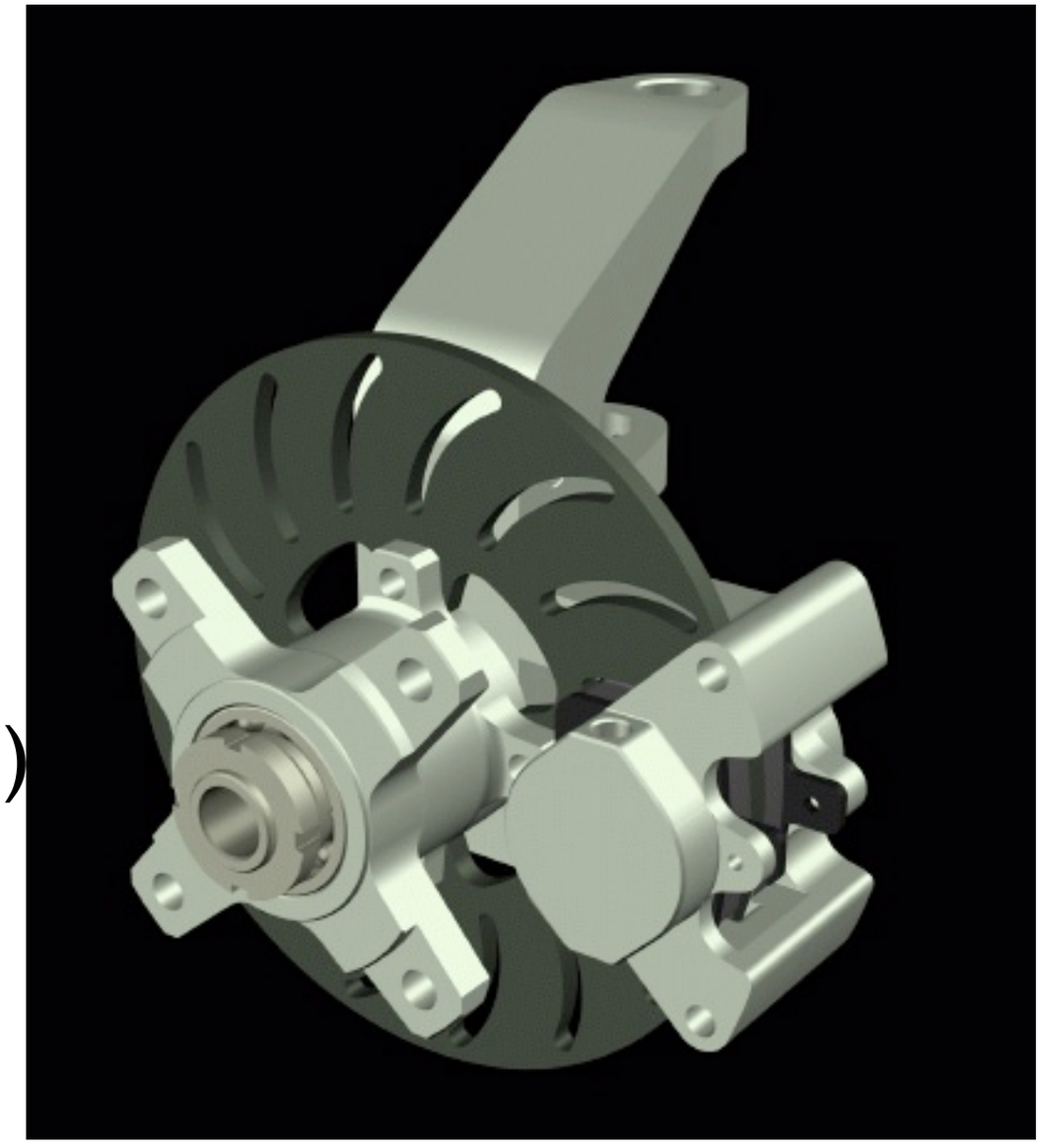
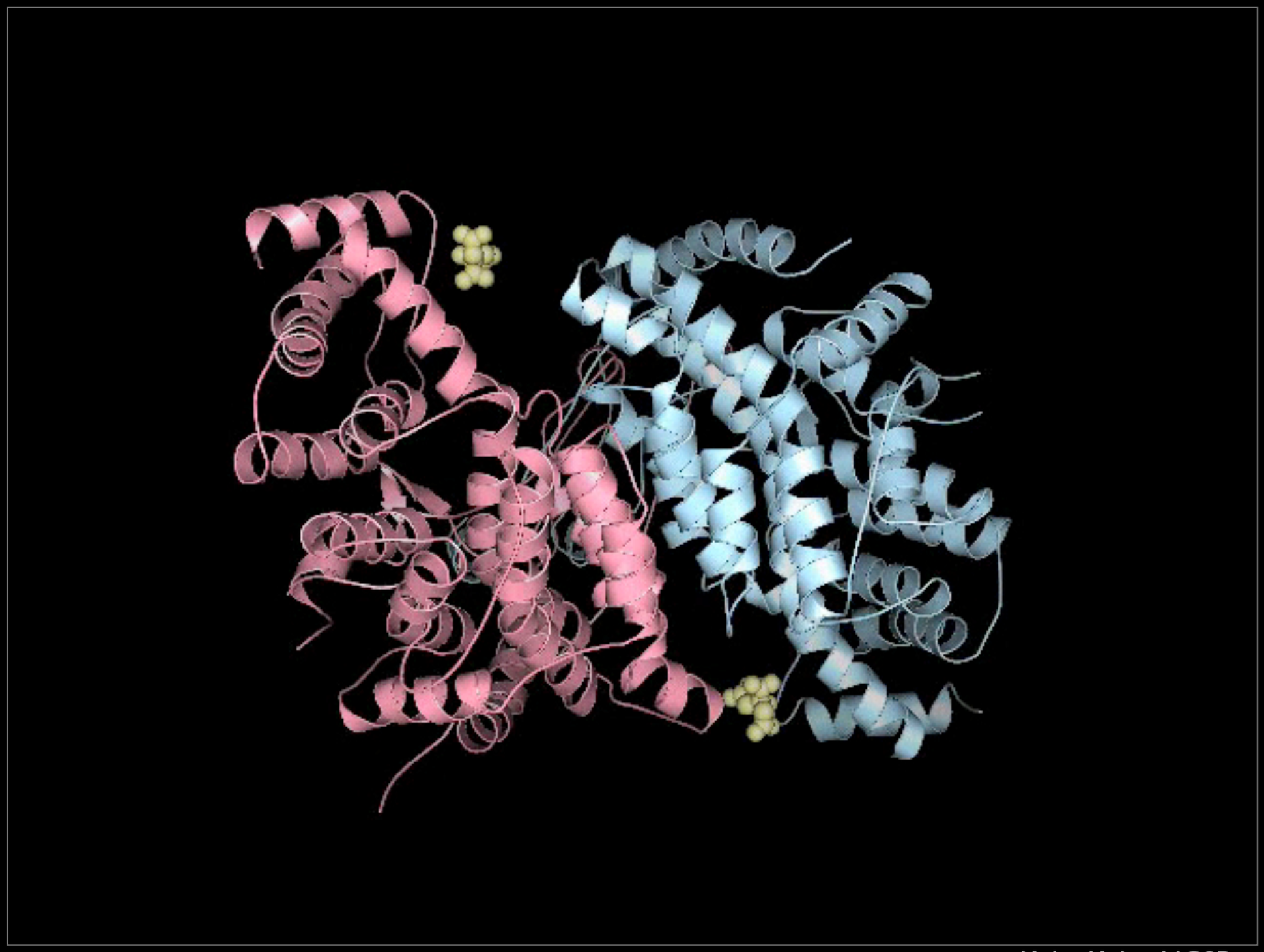
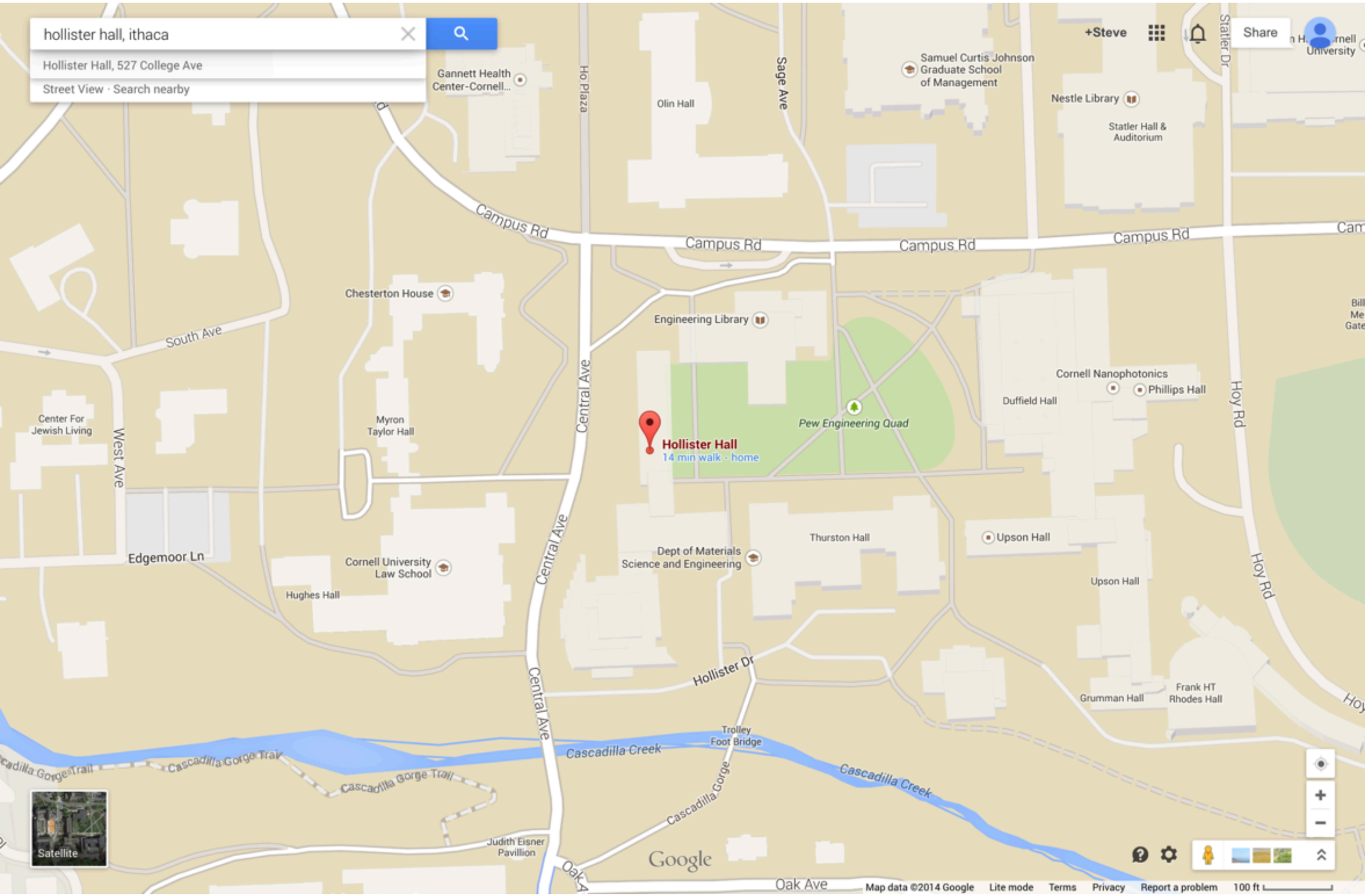


U. of Utah—Alpha 1



Simulated deformation of citrate synthase during substrate binding

Kalju Kahn, UCSB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Hollister Hall, 527 College Ave
Street View · Search nearby
+Steve
Share
Gannett Health Center-Cornell...
Ho Plaza
Olin Hall
Sage Ave
Samuel Curtis Johnson Graduate School of Management
Nestle Library
Statler Hall & Auditorium
Statler Dr
Campus Rd
Campus Rd
Campus Rd
Campus Rd
Chesterton House
Engineering Library
South Ave
Central Ave
Cornell Nanophotonics
Phillips Hall
Duffield Hall
Hoy Rd
Center For Jewish Living
West Ave
Myron Taylor Hall
Pew Engineering Quad
Hollister Hall
14 min walk - home
Edgemoor Ln
Cornell University Law School
Hughes Hall
Dept of Materials Science and Engineering
Thurston Hall
Upson Hall
Upson Hall
Hollister Dr
Grumman Hall
Frank HT Rhodes Hall
Trolley Foot Bridge
Cascadilla Creek
Cascadilla Gorge Trail
Cascadilla Gorge
Satellite
Judith Eisner Pavillion
Oak Ave
Google
Map data ©2014 Google
Lite mode
Terms
Privacy
Report a problem
100 ft

8/26/2014 8:15 pm

8/26/2014 8/27/2014

Image Landsat

Google earth

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(with previous instructors James/Bala)

Autodesk 360 Cloud Render

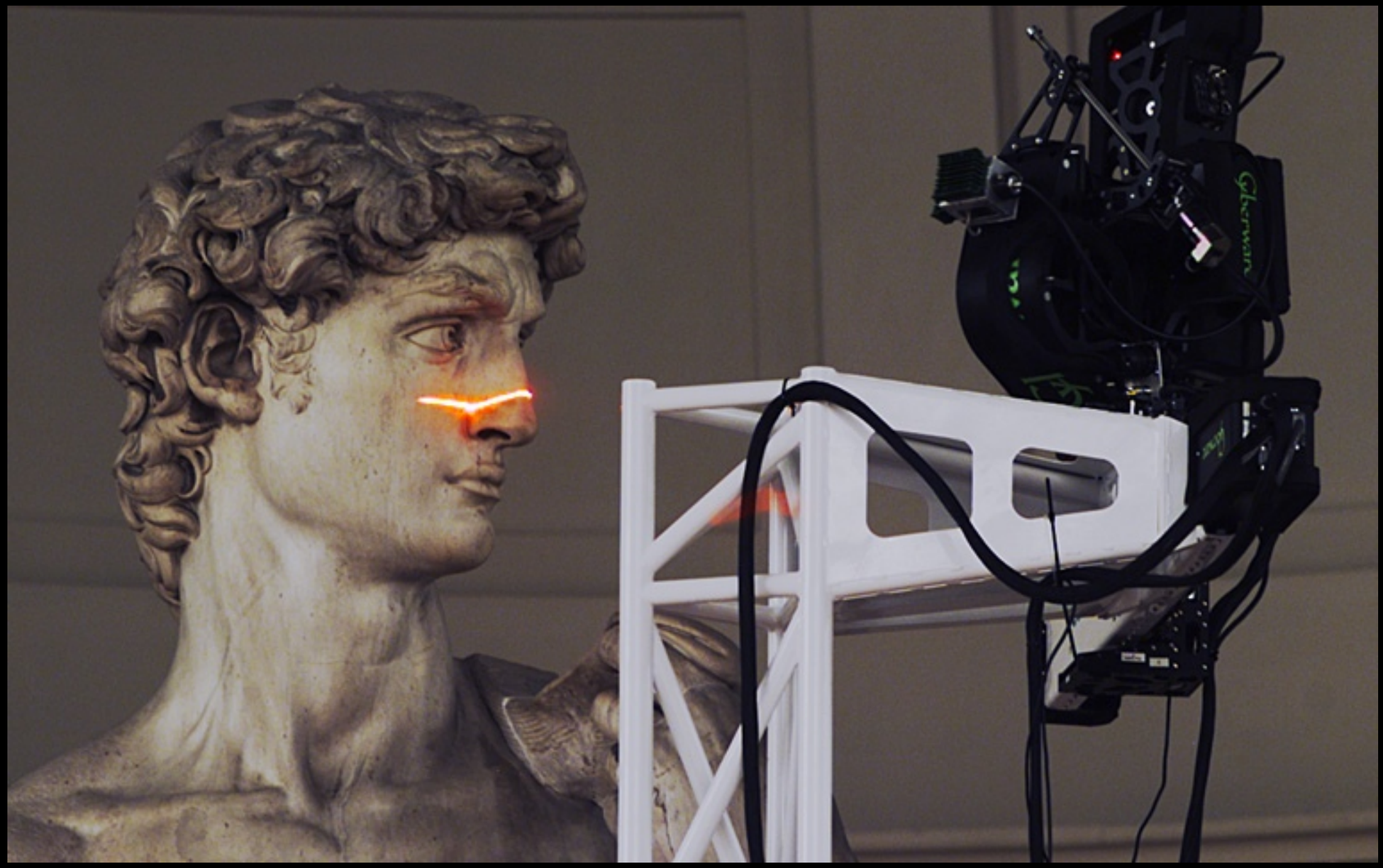
Autodesk 360 Cloud Render

Autodesk 360 Cloud Render

IKEA—rendered catalog image (2012)

[Walter et al. 2005]

model: University of Bristol



Digital
Michelangelo
Project
Marc Levoy, Stanford

Digital
Michelangelo
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NASA/Ames—ACFS

Army Research Lab—IES

(with previous instructors James/Bala)

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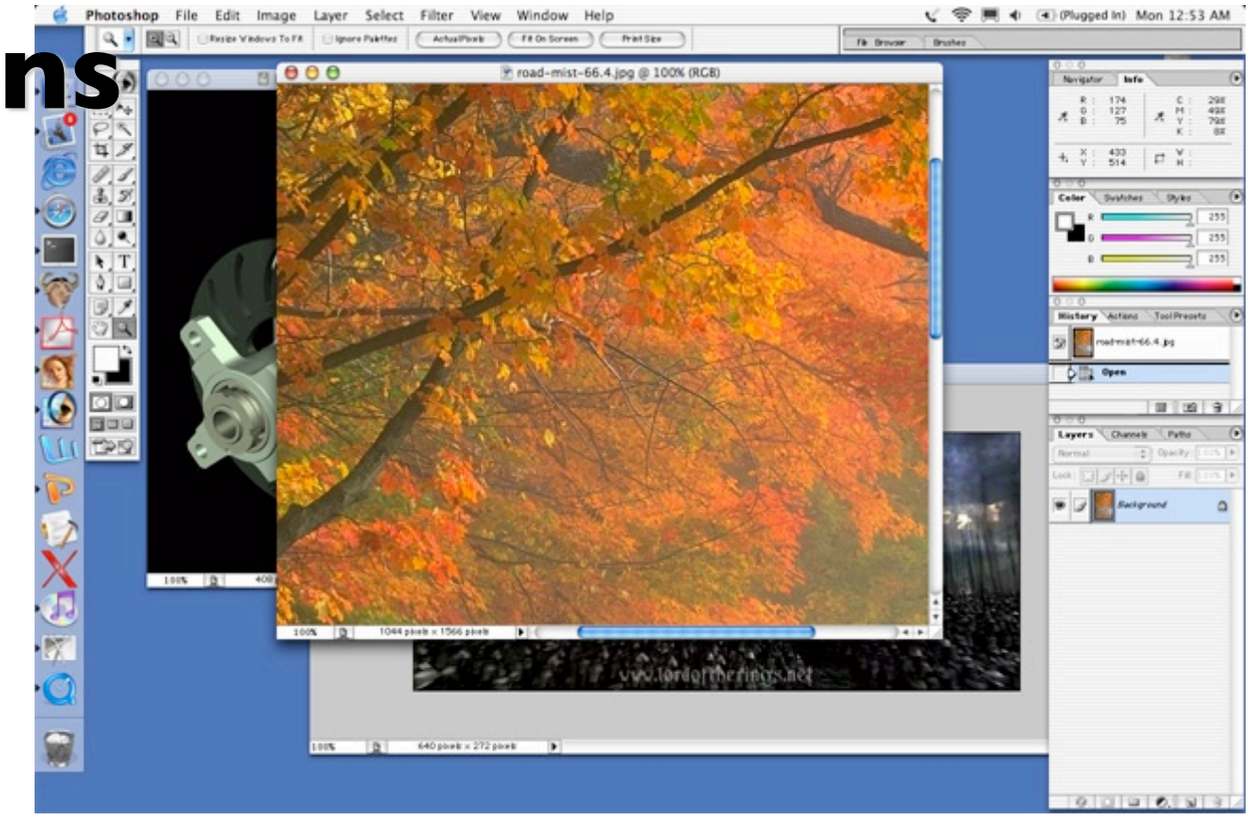
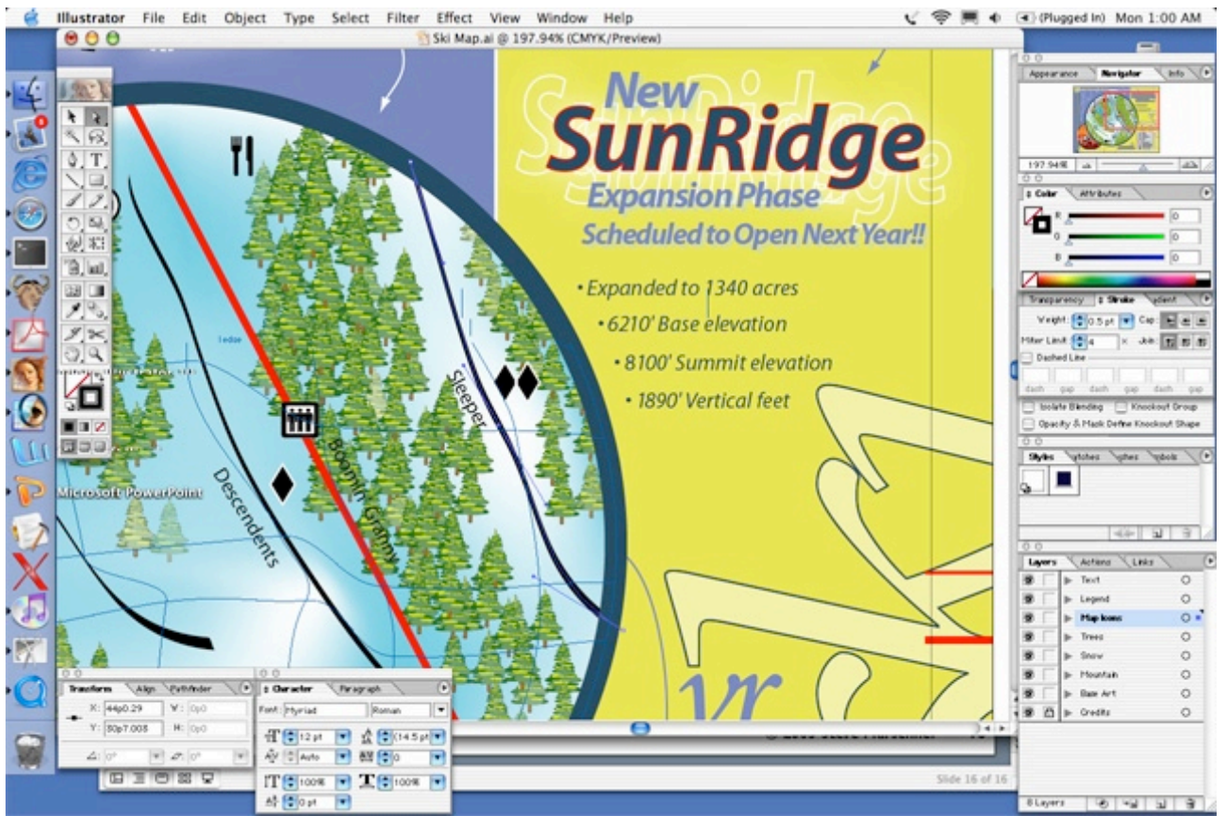


Adobe Photoshop [Photo: P. Greenspun]



Adobe Illustrator

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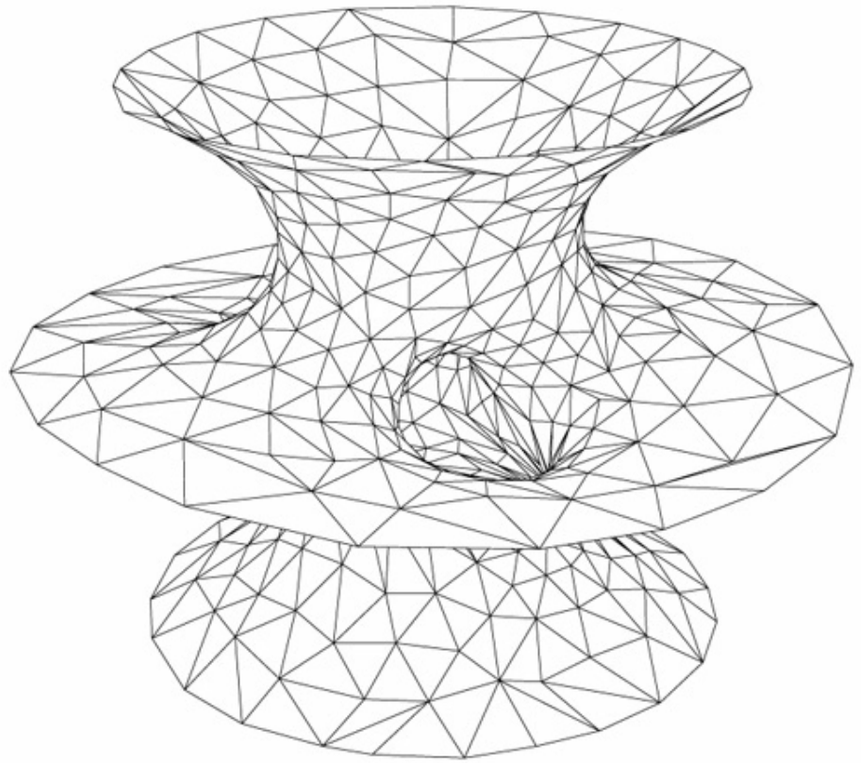
Computer aided sculptures
Ergun Akleman

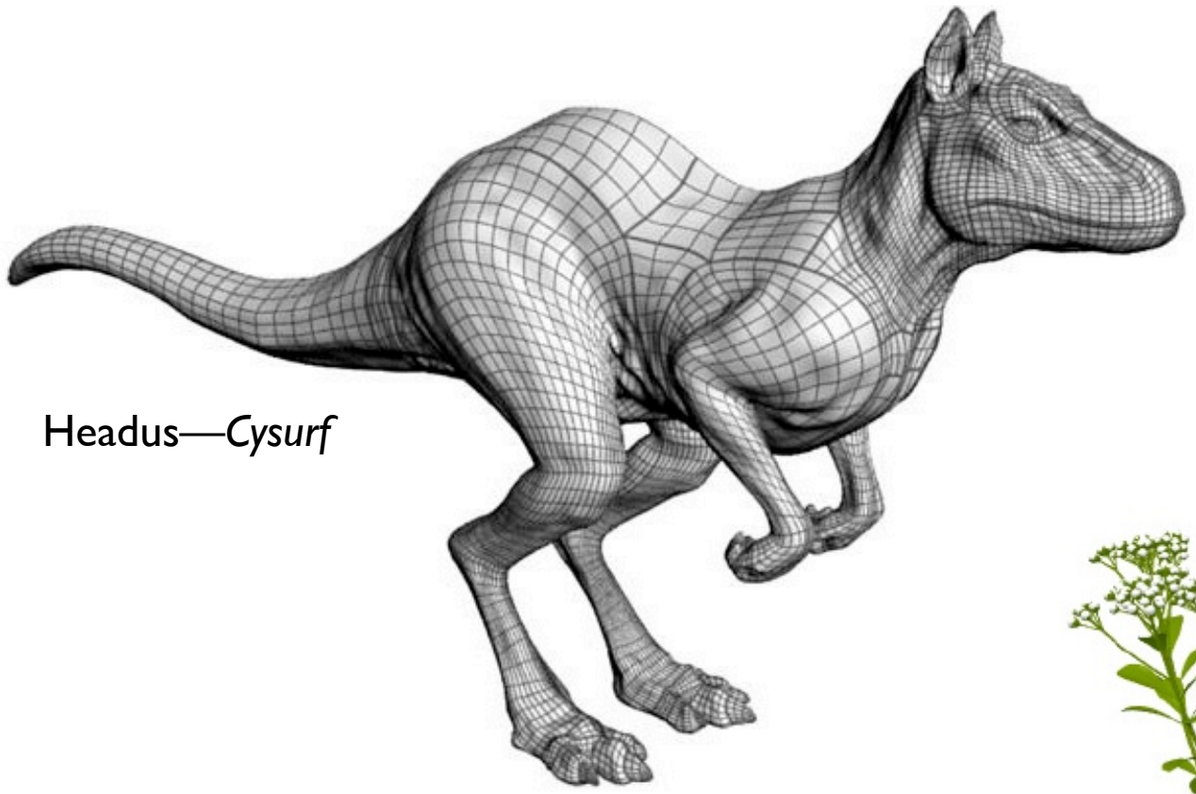
What is graphics about?

3D Modeling

- representing 3D shapes
- polygons, curved surfaces, …
- procedural modeling



[Hoppe et al. 1993]



Headus—*Cysurf*

[Prusinkeiwicz et al. 2001]

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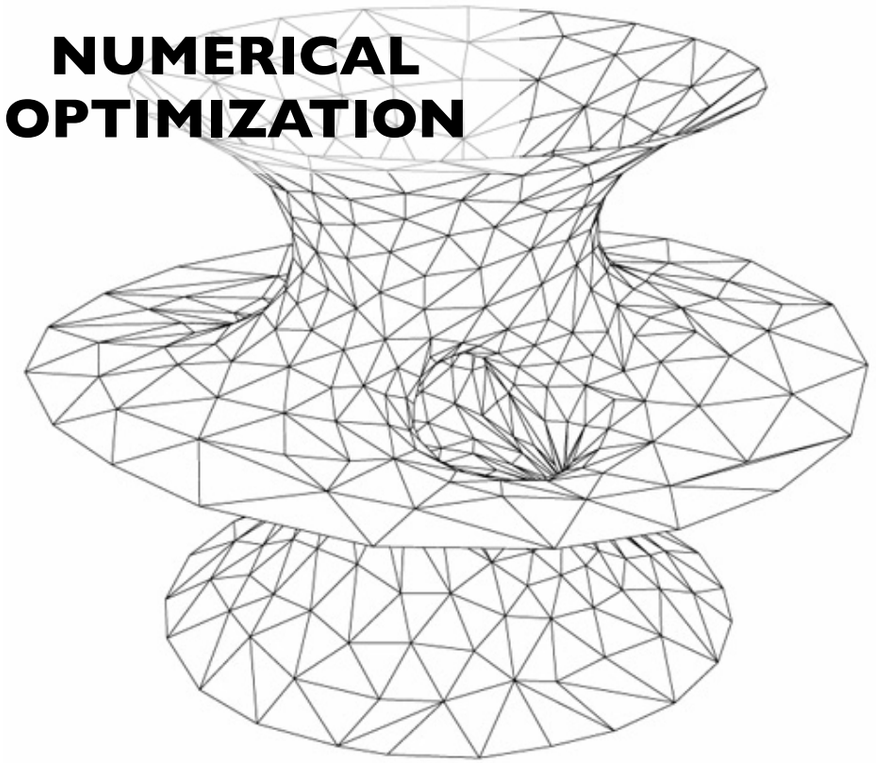

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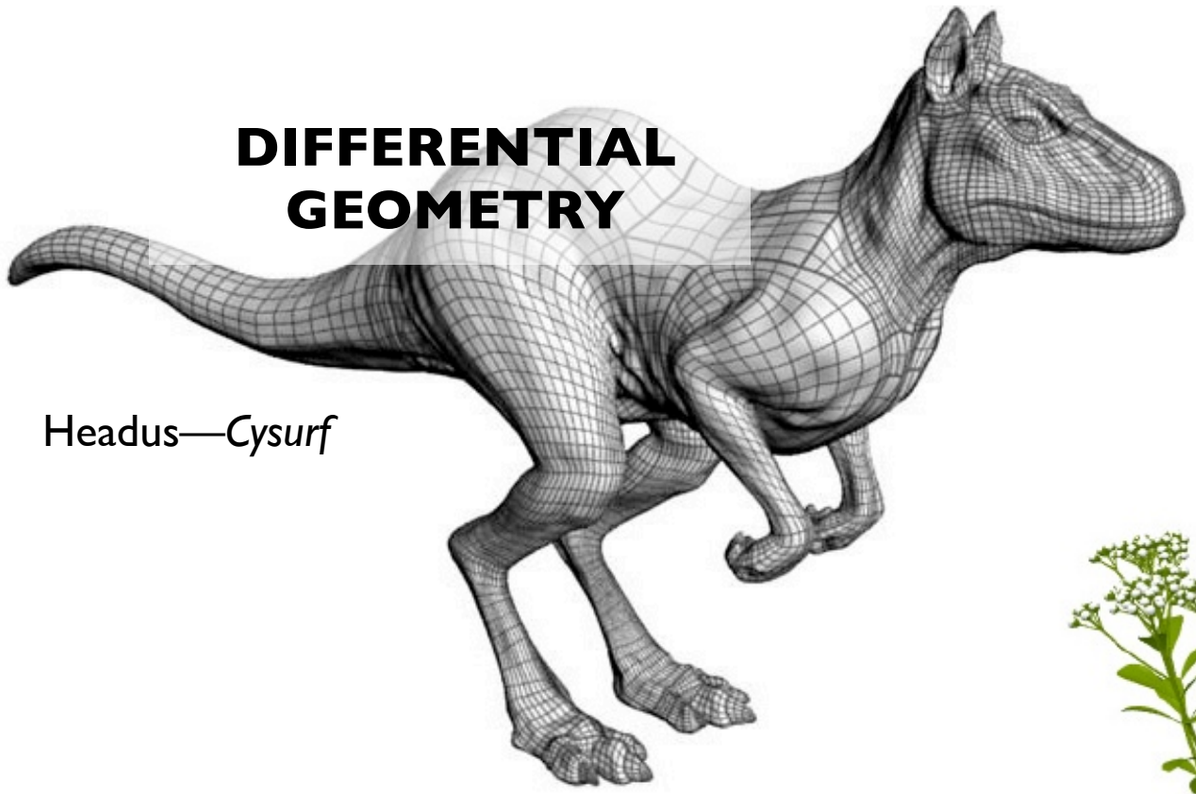

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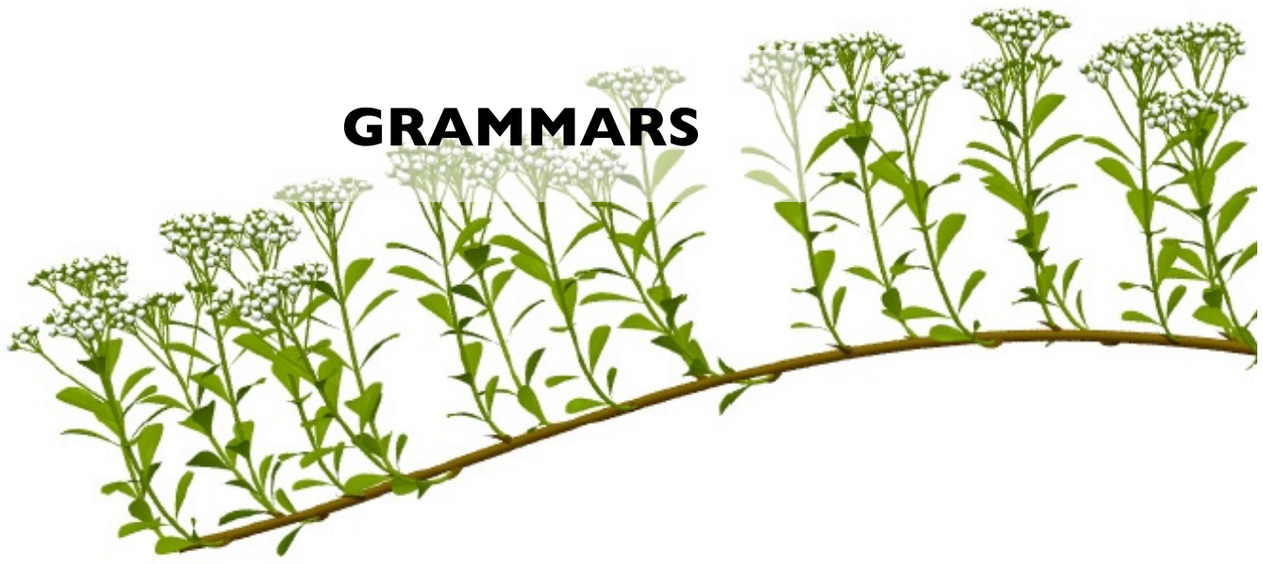
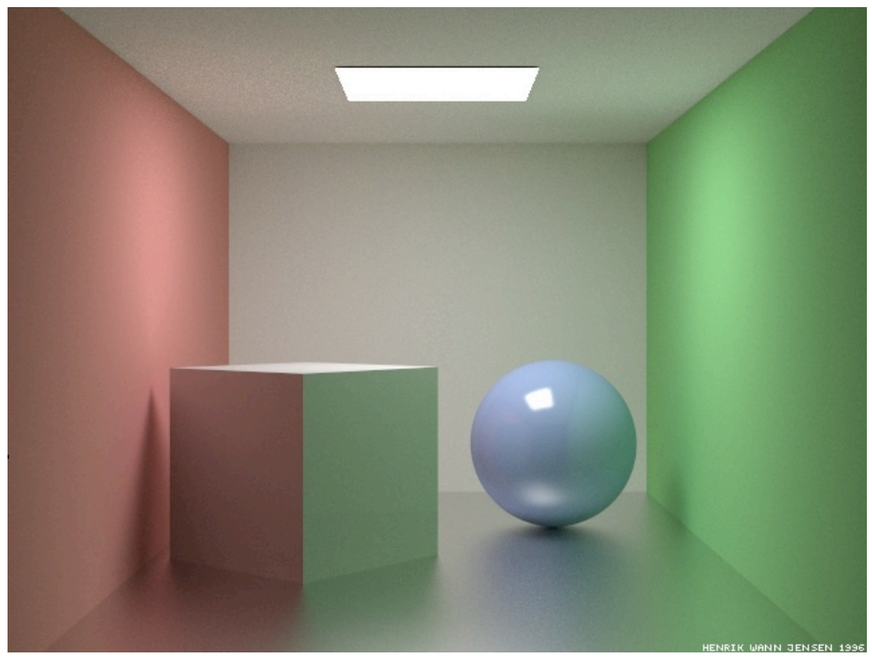


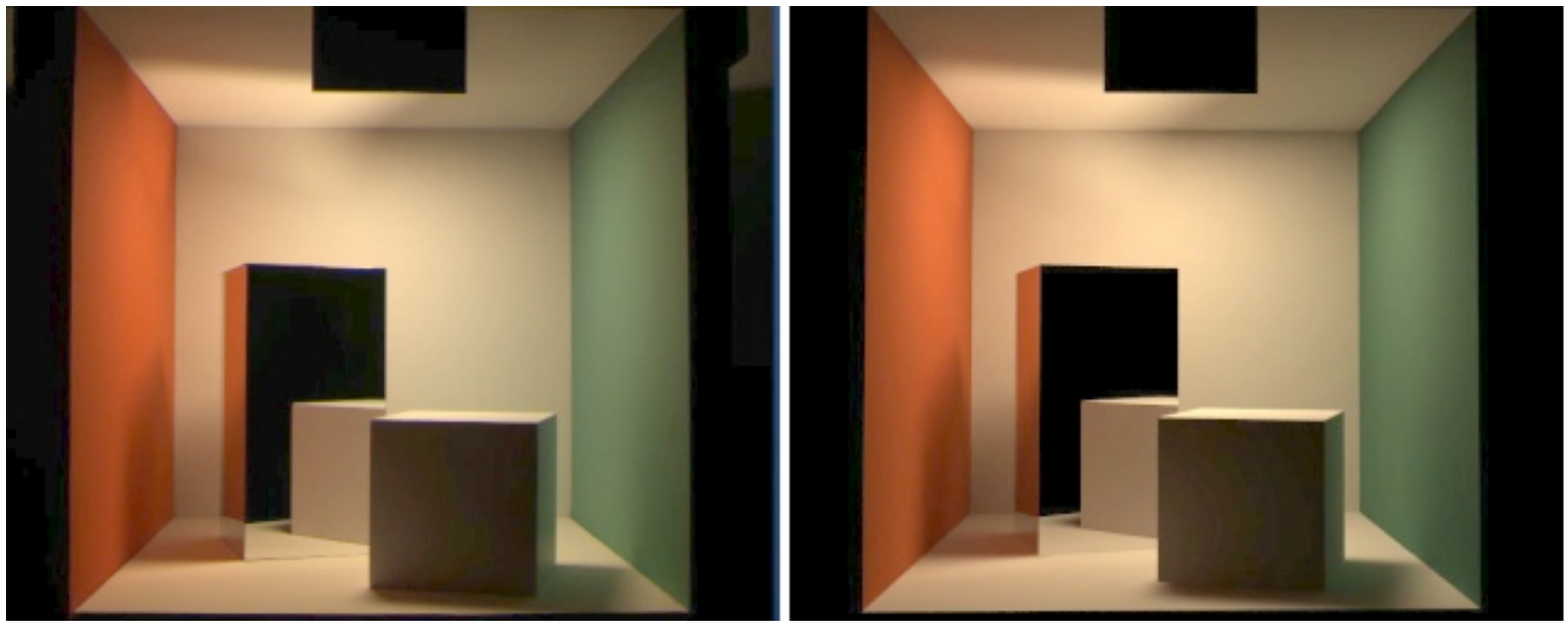
[Prusinkeiwicz et al. 2001]

3D Rendering

- 2D views of 3D geometry
- projection and perspective
- removing hidden surfaces
- lighting simulation



Henrik Wann Jensen



Cornell PCG

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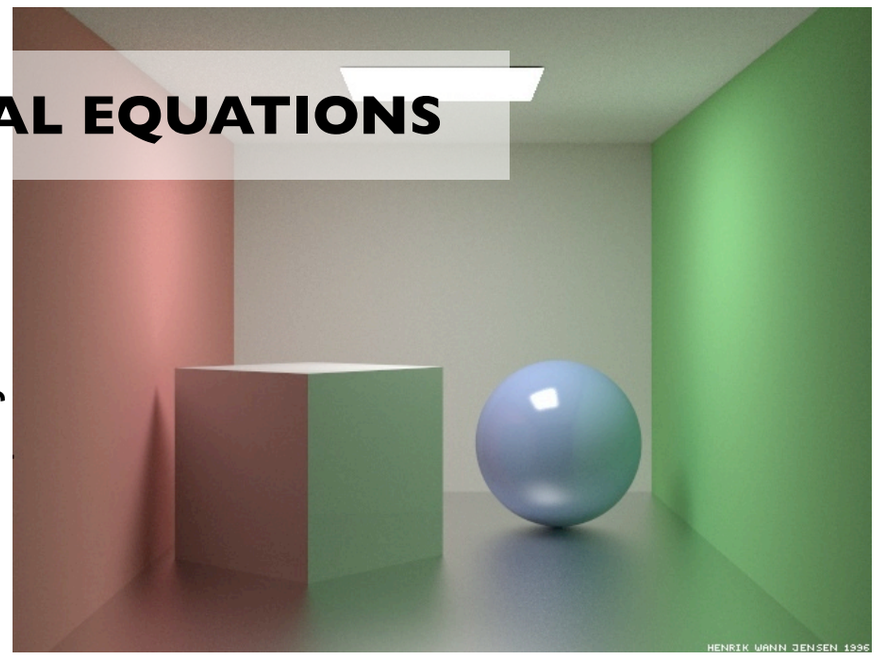

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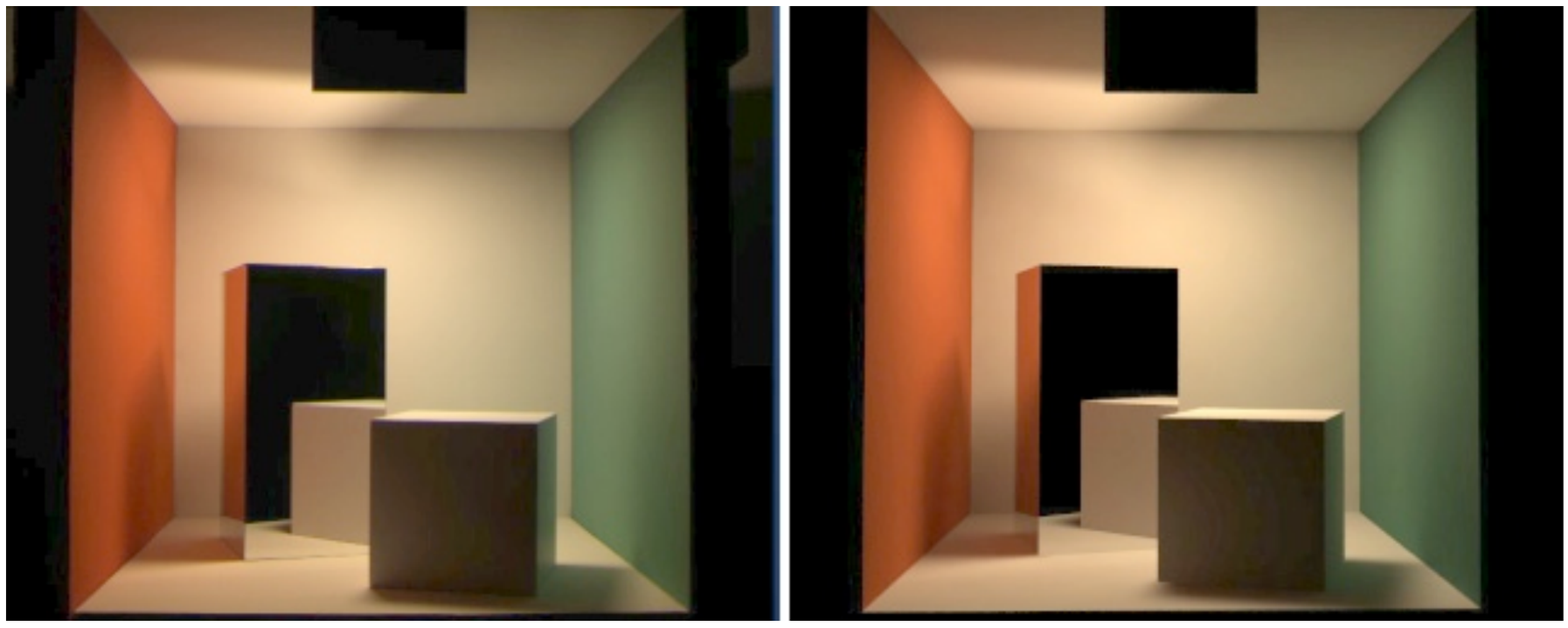

Cornell PCG

Cornell PCG

Kavita Bala, Bruce Wlater

Animation

- keyframe animation
- physical simulation

Avengers (2012)

Pixar

Animation

- keyframe animation
- physical simulation

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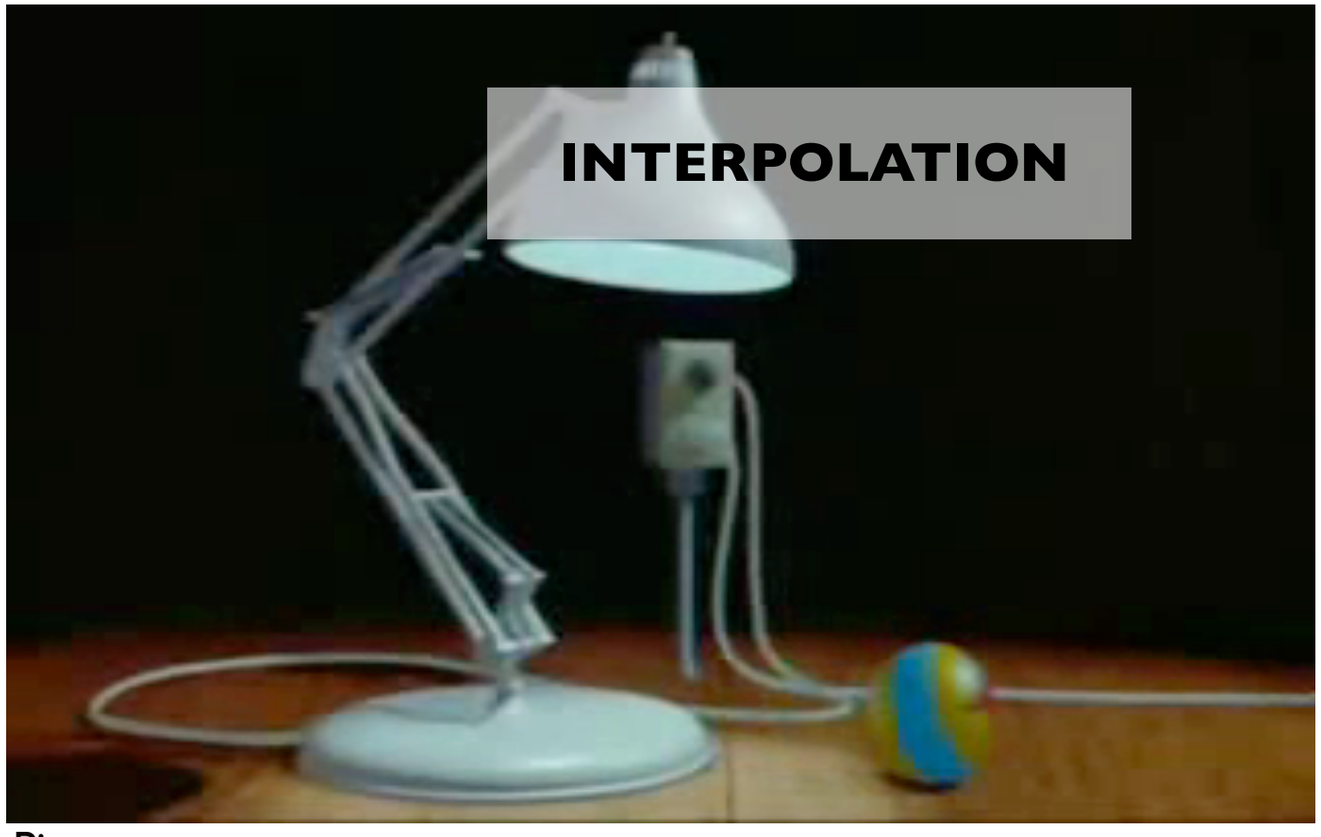

Pixar

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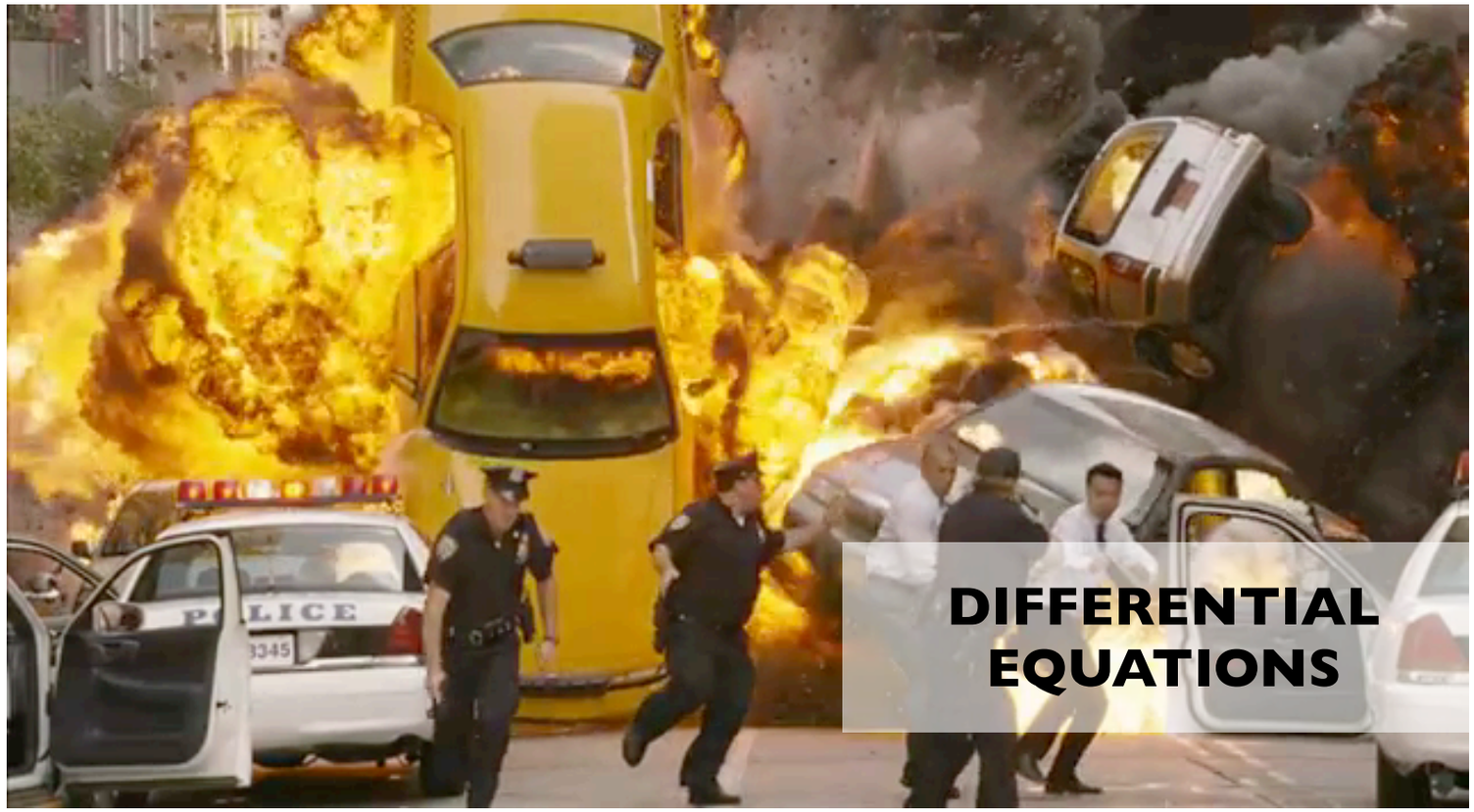
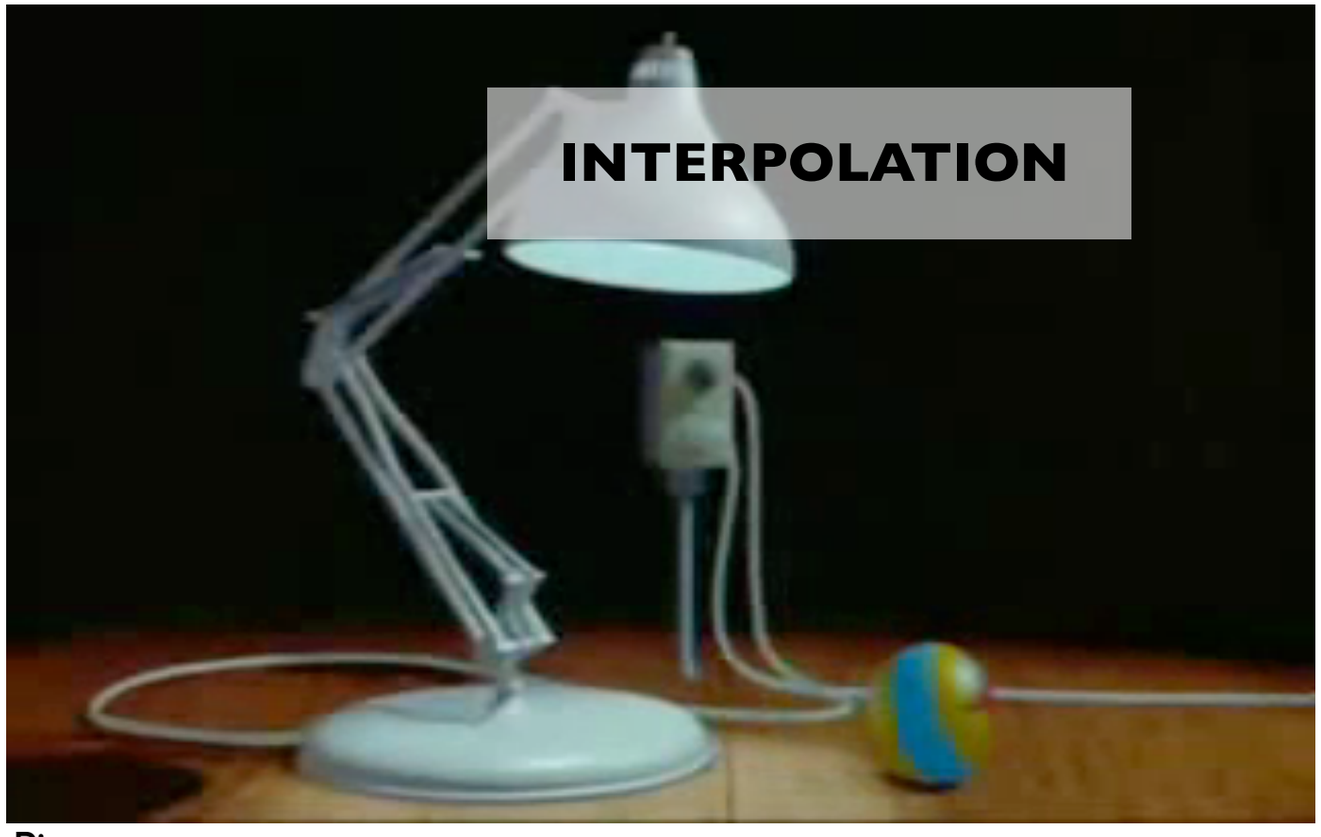


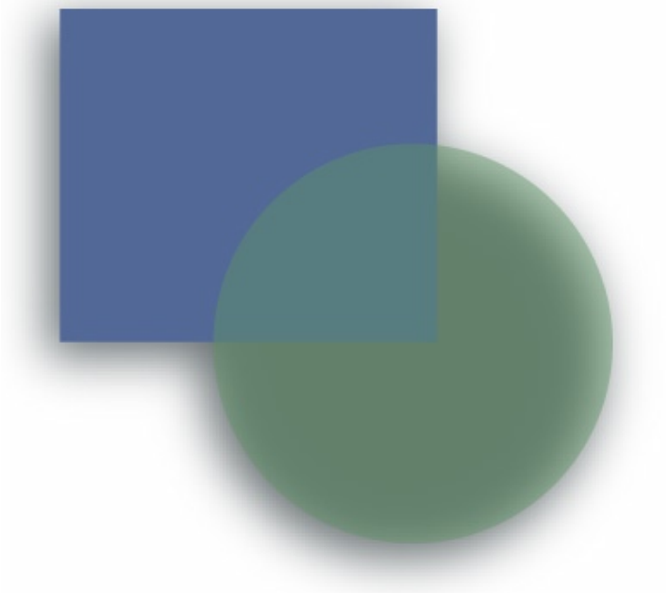
Avengers (2012)

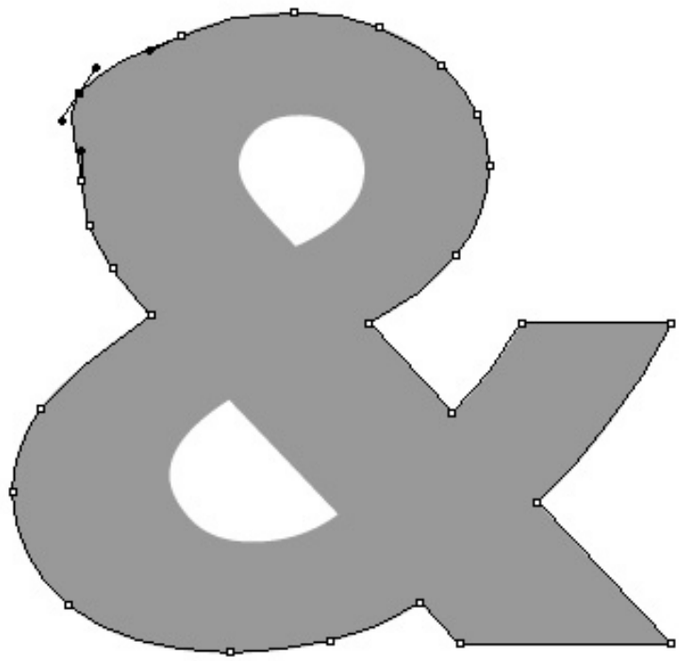


Pixar

Images

- 2D imaging
  - compositing and layering
  - digital filtering
  - color transformations
- 2D drawing
  - illustration, drafting
  - text, GUIs





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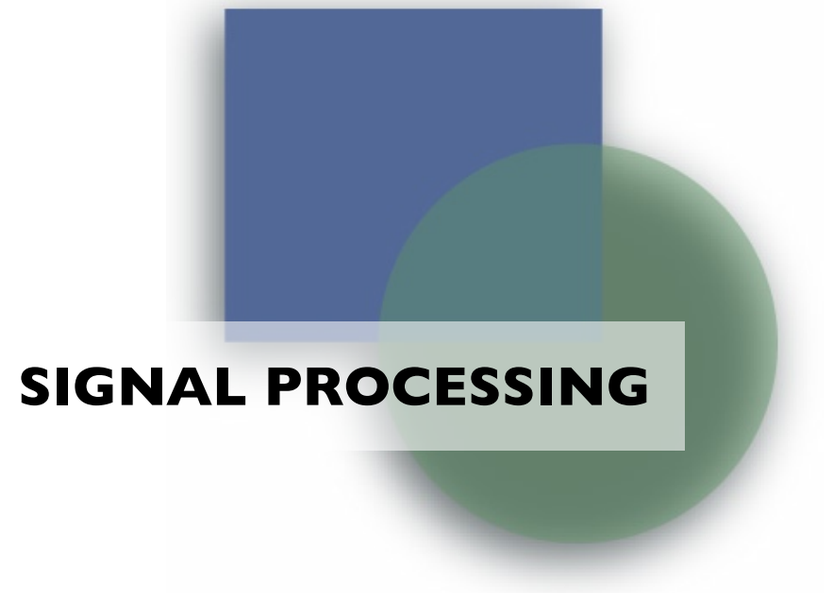
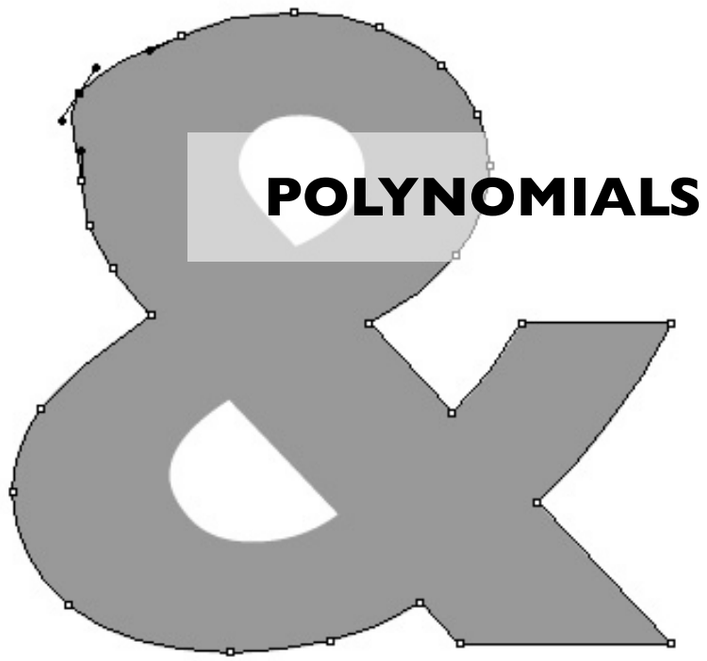
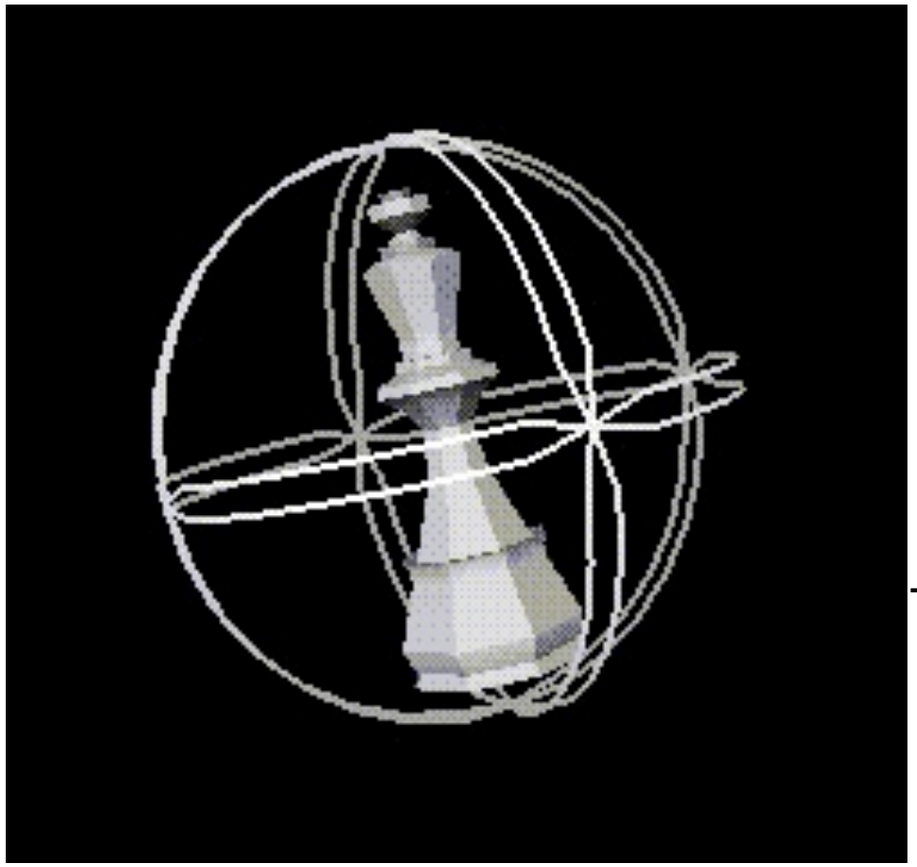




(with previous instructors James/Bala)

User Interaction

- 2D graphical user interfaces
- 3D modeling interfaces
- virtual reality



SGI—OpenInventor

TU Berlin

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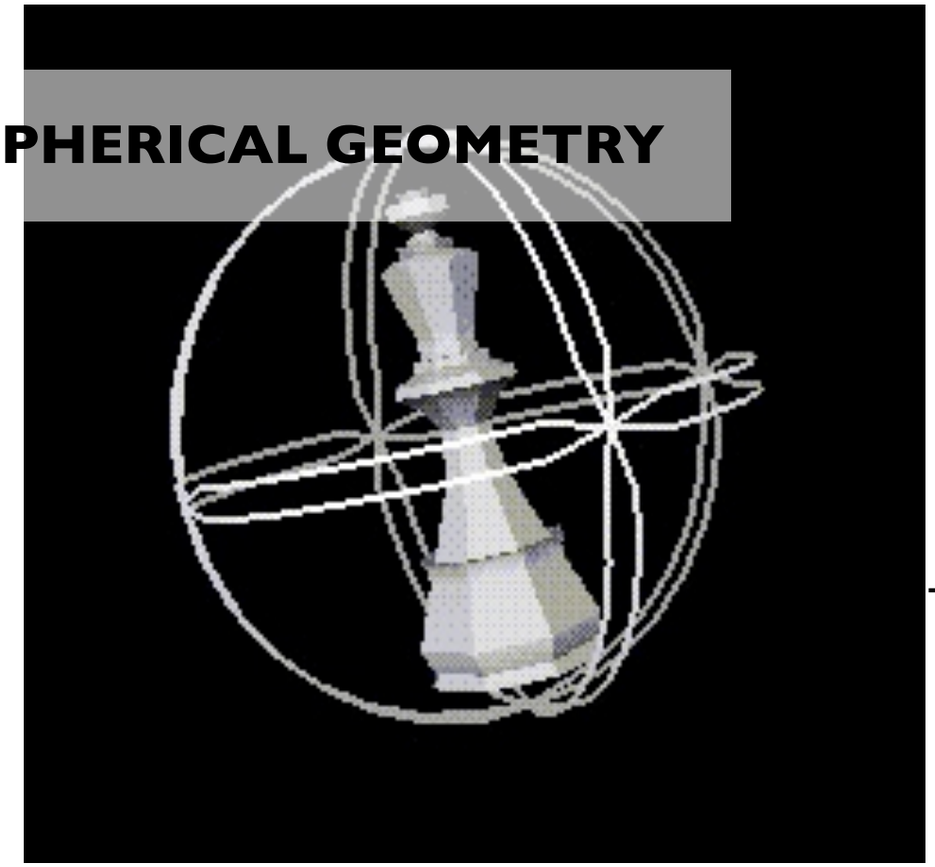

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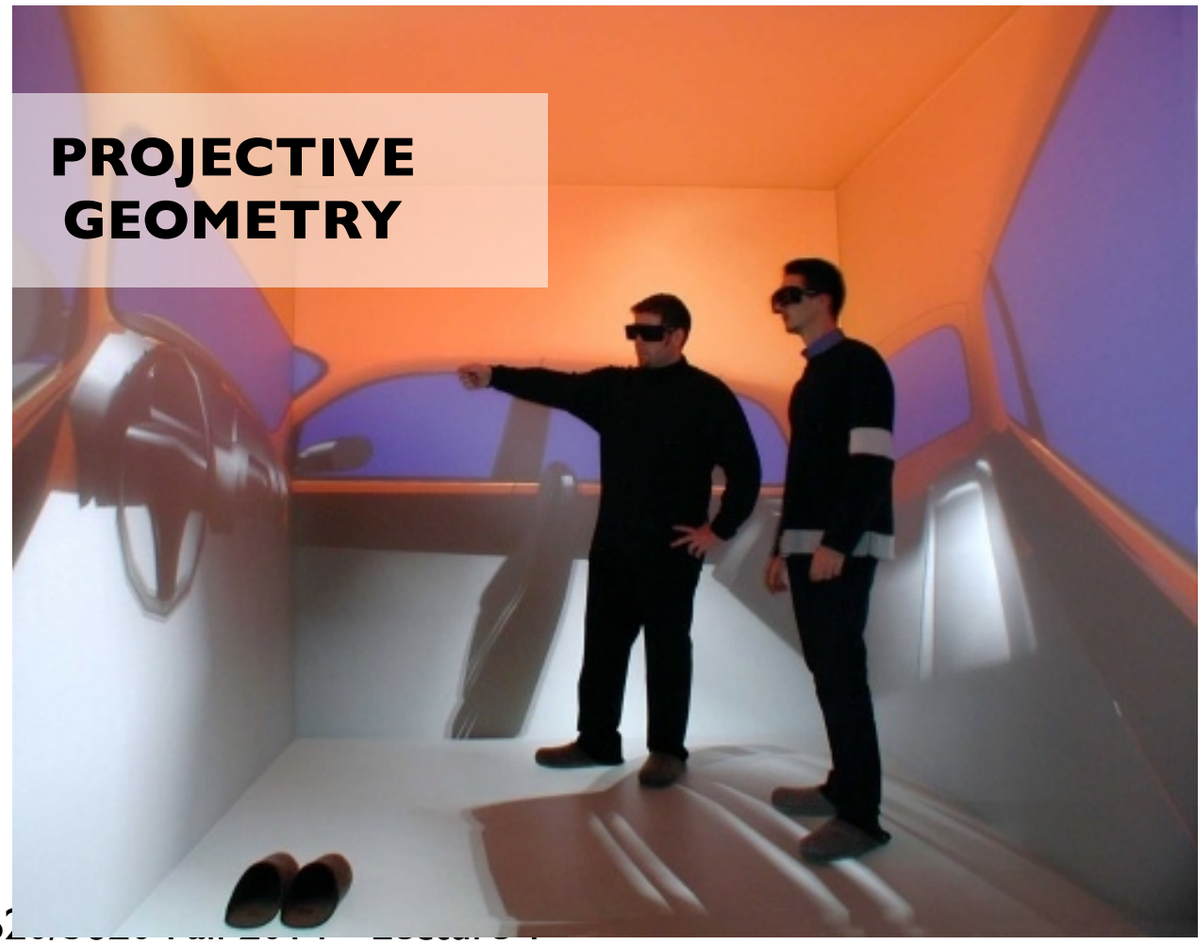
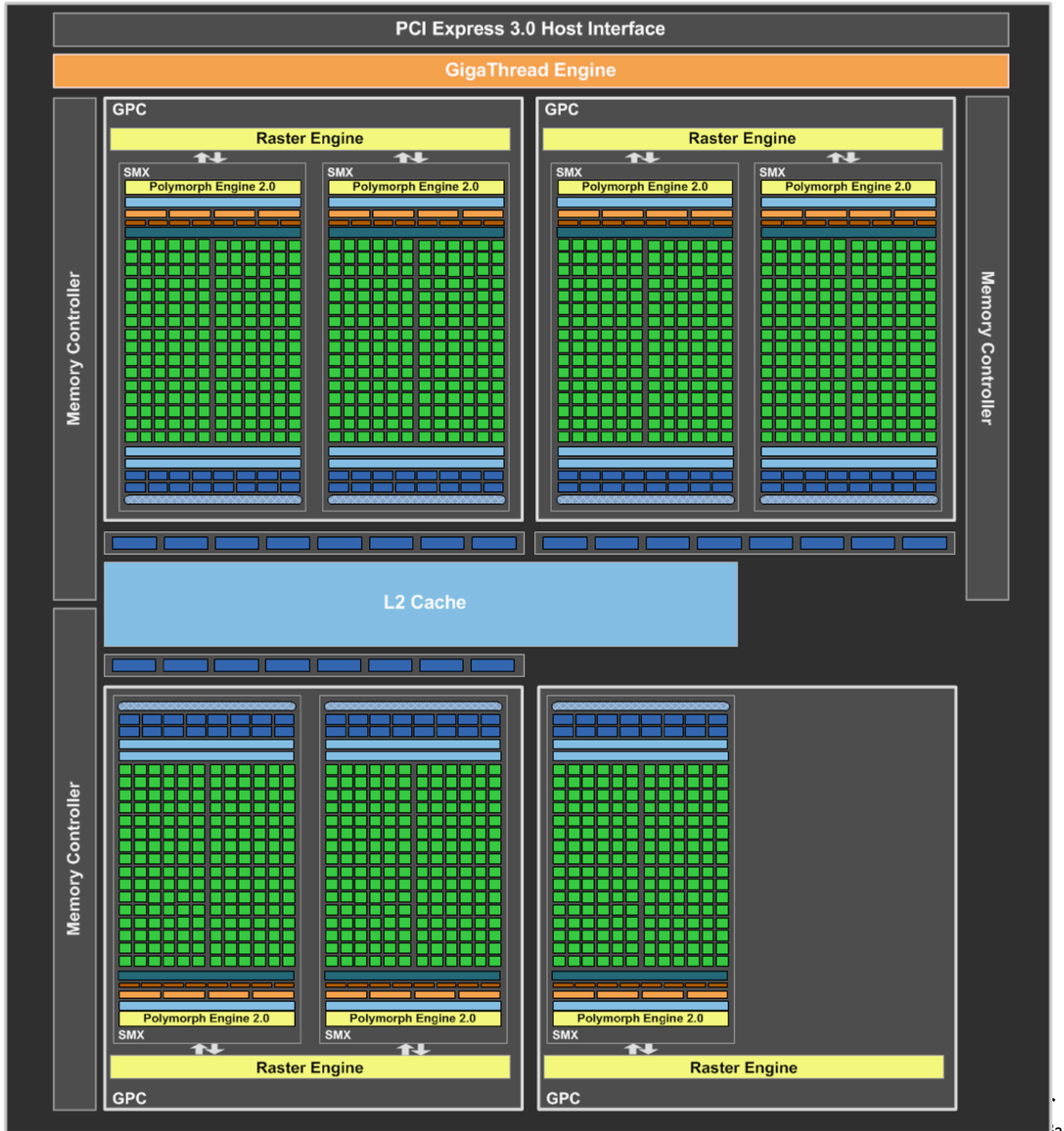


TU Berlin

Graphics Hardware



Computer graphics:

Mathematics made visible.

Introductions…

Translucent materials

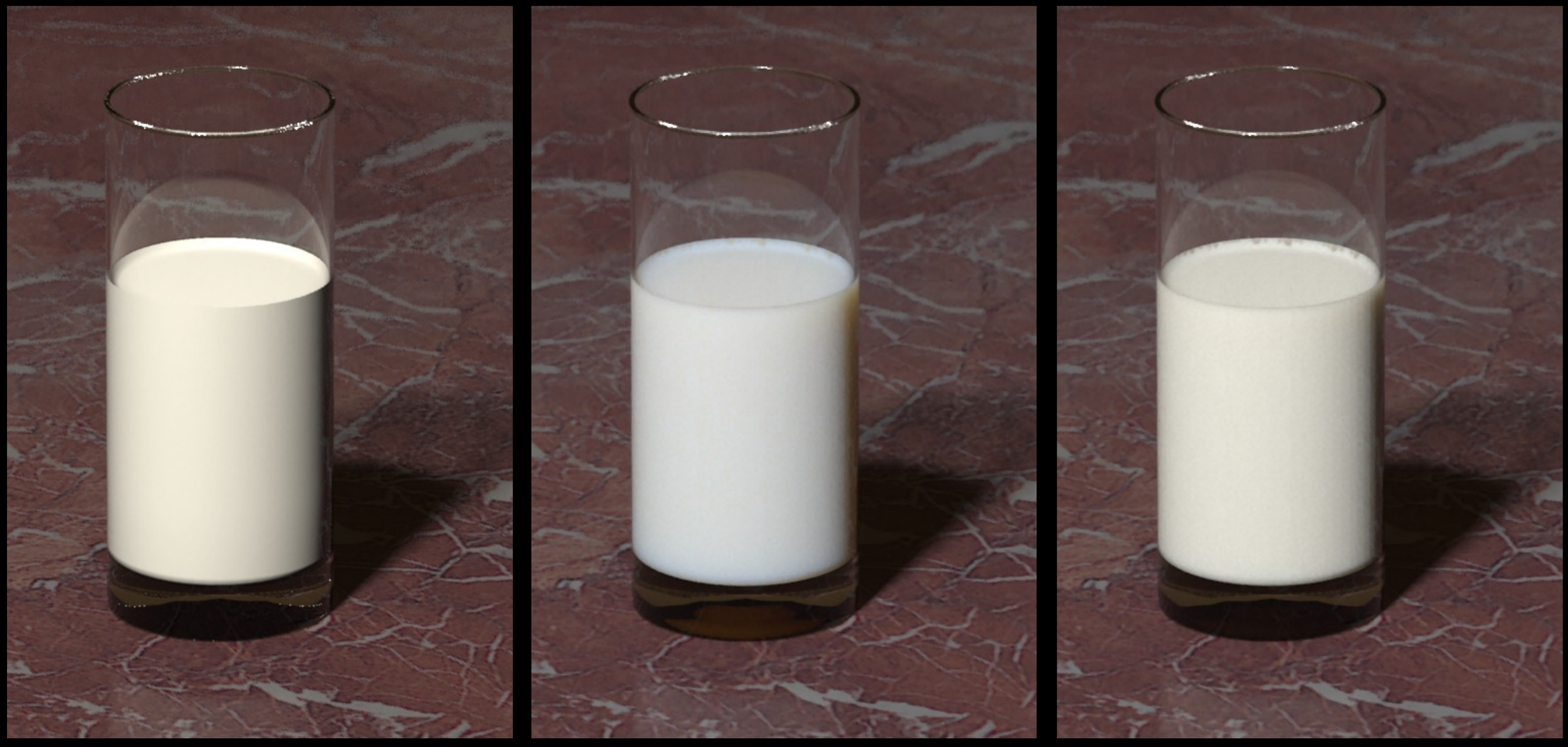
Diffuse “milk”

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

Rendering hair

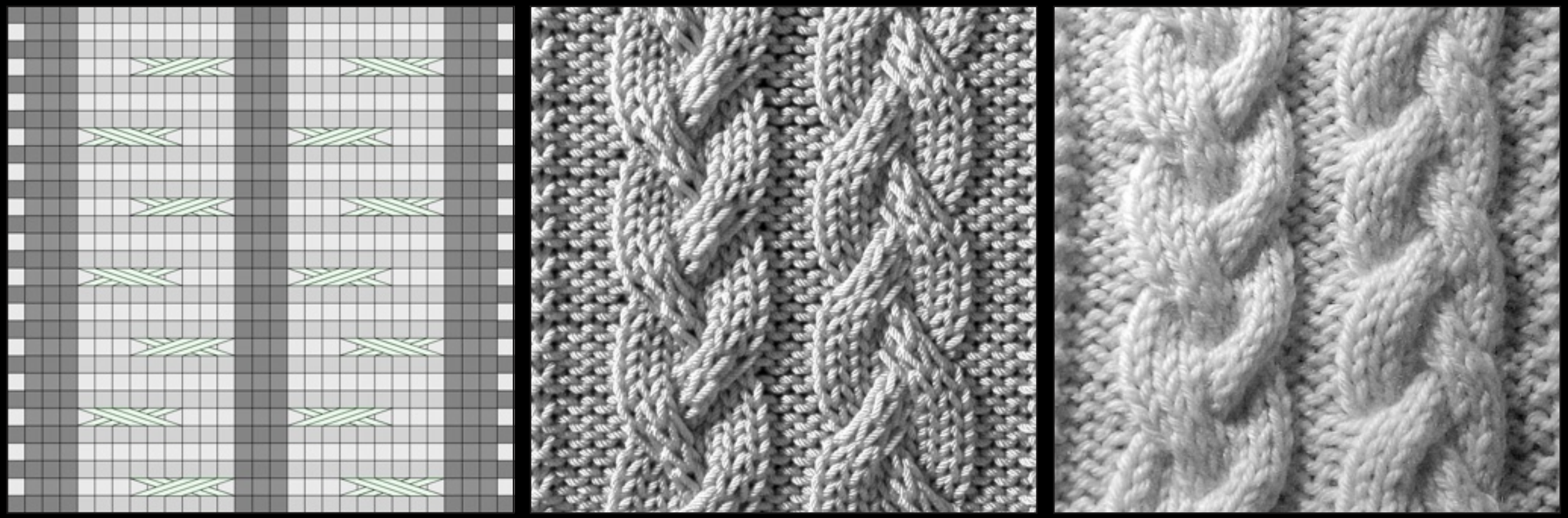
a = 1.2

Rendering hair

a = 1.5

[Kaldor et al. 2008]

Modeling knit cloth



[Yuksel et al. 2012]

[Yuksel et al. 2012]

High-quality woven cloth appearance

[Zhao et al. 2012]

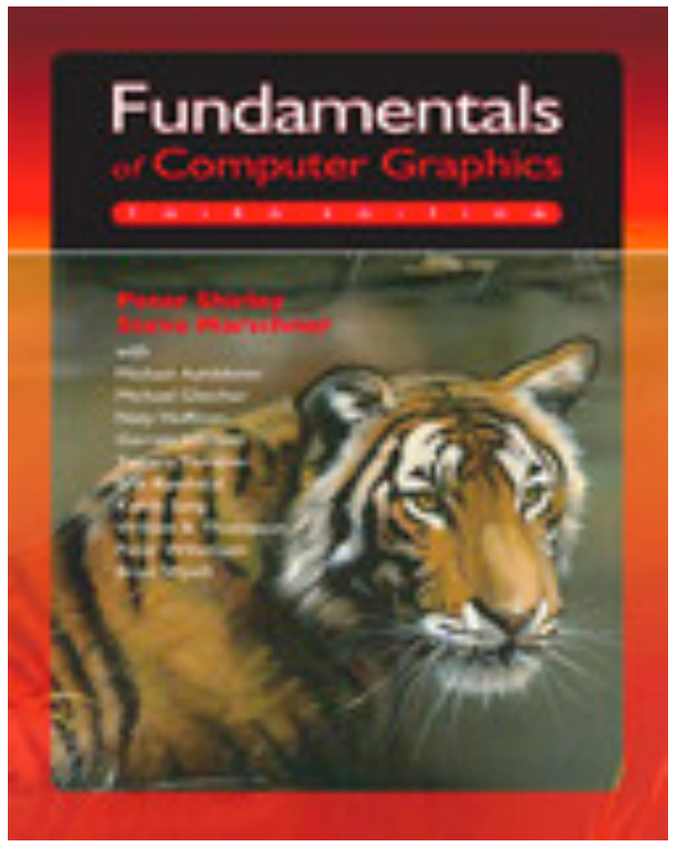
Course Overview

Course mechanics

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

Teaching Assistants (6 PhD/MS/MEng, ≥6 ugrad)

Eston Schweickart, Ph.D. TA emeritus
Rundong Wu, grad TA
Balazs Kovacs, grad TA
Nicolas Savva, grad TA
Deedy Das, grad TA
Jack Hessel, grad TA
Cristian Zaloj, software architect
and many more…



Piazza: Please sign up!

(with previous instructors James/Bala)

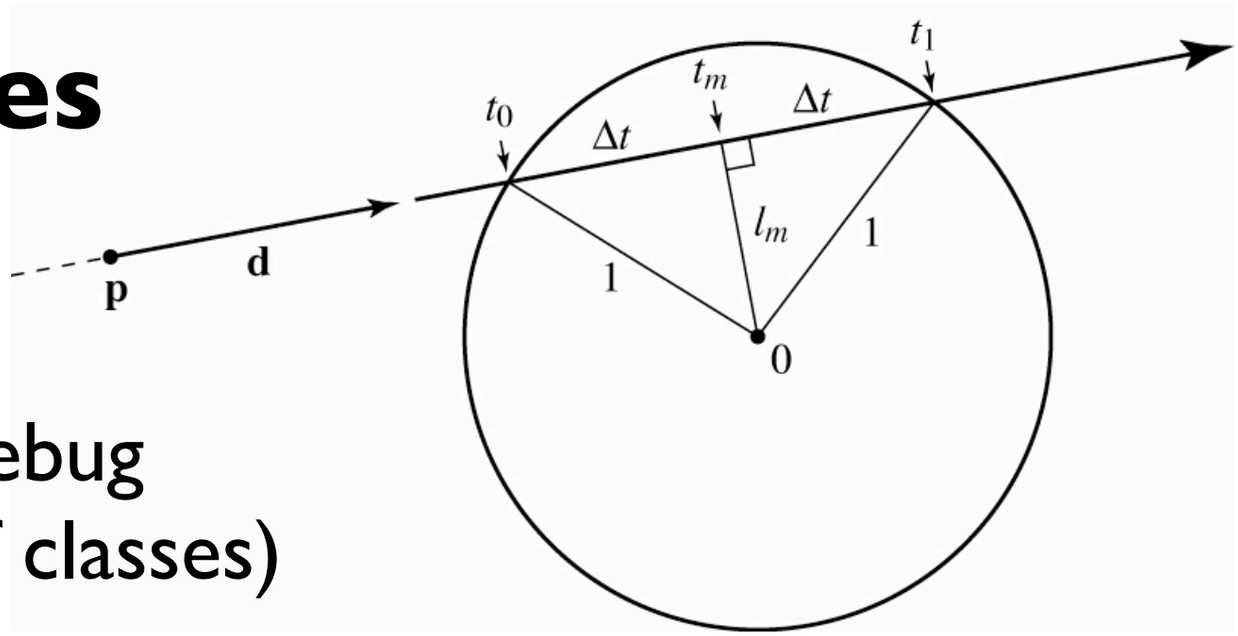
In CS4620/5620

- You will:
  - explore fundamental ideas
  - learn math essential to graphics
  - implement key algorithms
  - write cool programs
  - learn the basics of OpenGL
- 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

(with previous instructors James/Bala)

In CS4621

- You will also:
  - implement a modeling, rendering, animation system
    - in groups
  - learn a lot about
    - architecting good-sized interactive programs
    - OpenGL
    - programmable shaders, textures, animation

(with previous instructors James/Bala)

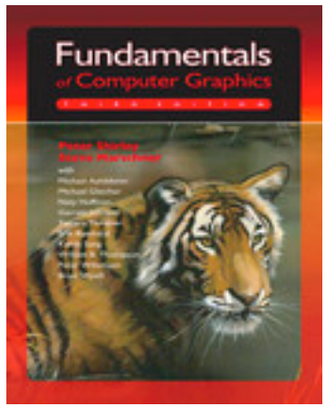
Workload

- CS 4620/5620
  - 7 assignments (written + programming)
  - 1 free late assignment (up to 1 week), else 10% per day
  - 2 exams (midterm + final)

- CS 4621/5621
  - one open-ended project

(with previous instructors James/Bala)

Textbook

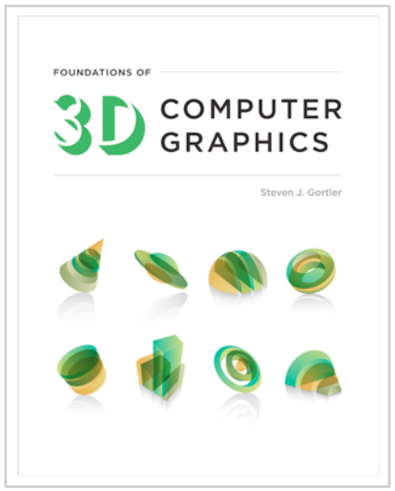


Shirley & Marschner

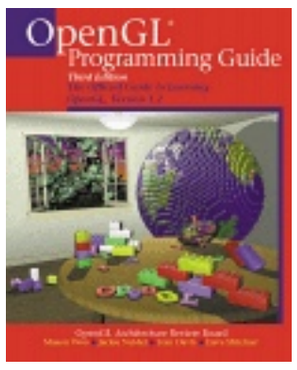
Fundamentals of Computer Graphics

third edition

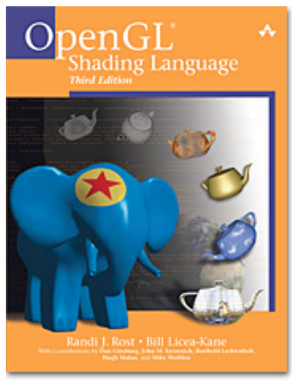
More books



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")

(with previous instructors James/Bala)

Academic Integrity

Course mechanics

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

Schedule, handouts, etc. all on the web page

Practicum

- See schedule on website
- Not this Friday
- First planned meeting Sept 9

(with previous instructors James/Bala)