CSE 457: Computer Graphics

Offered: Fall 2020

Instructor: Adriana Schulz

Objectives:

- Broad introduction to the field of computer graphics
- Combination of
  - underlying theoretical principles
  - technical implementation
  - artistic expression
- Many demonstrations of concepts in class

Great Group of TAs

Peter Michael

My Tran

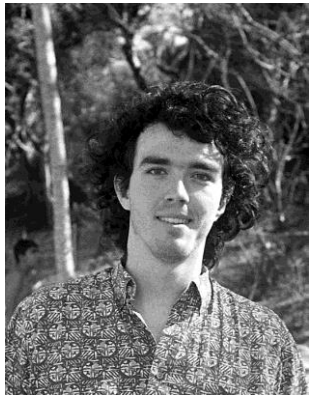
Xiao Liang

Carla Tjung

Dalton Hildreth

Dao Yi

Lily Zhao

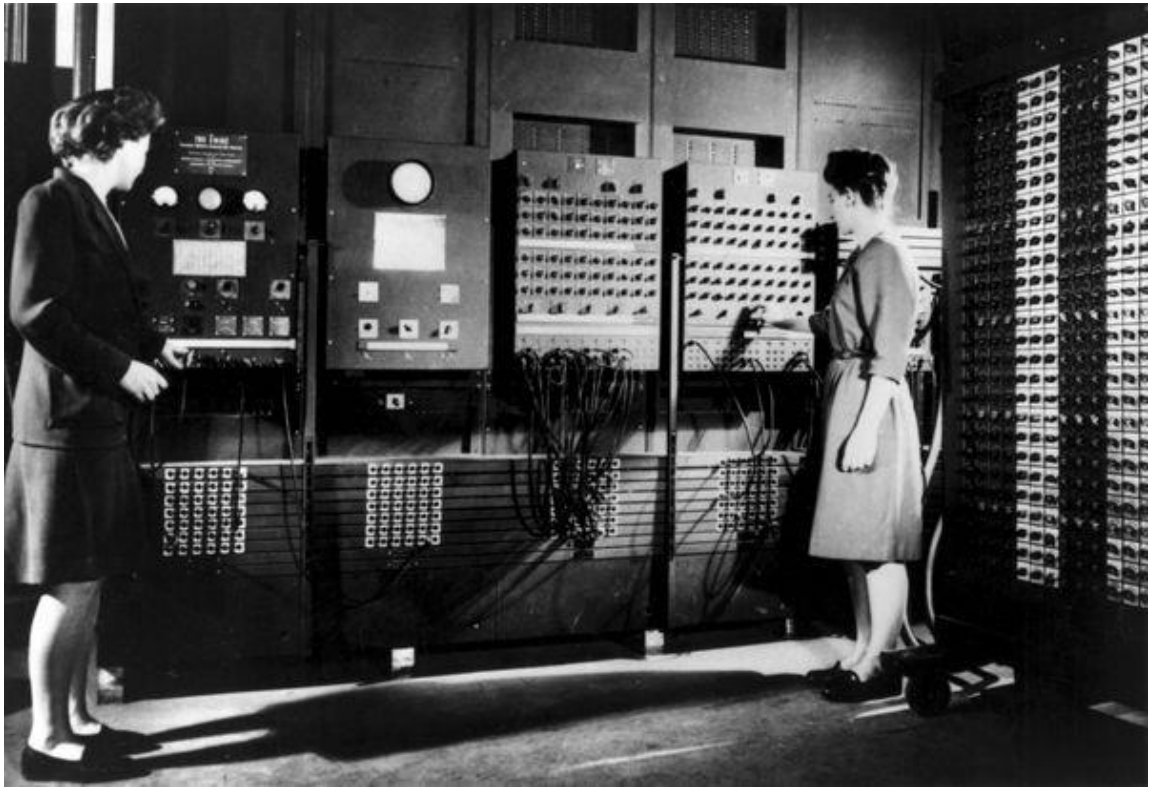


Phillip Quinn

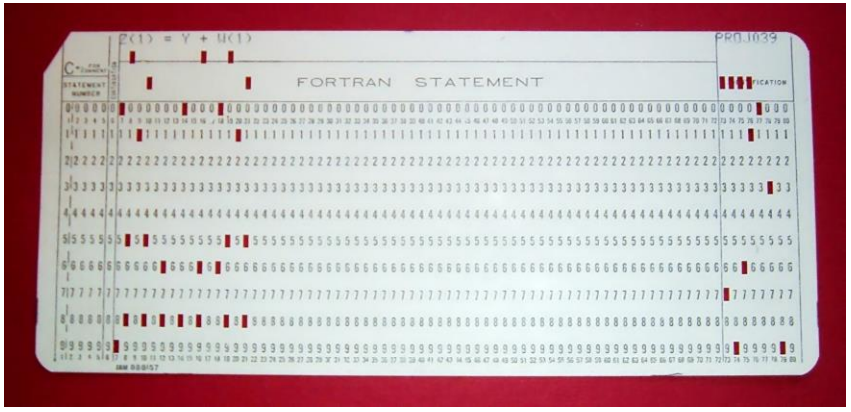
What is Computer Graphics?

Probably an image like this comes to mind:

Q: …ok, but more fundamentally: what is computer graphics (and why do we need it)?

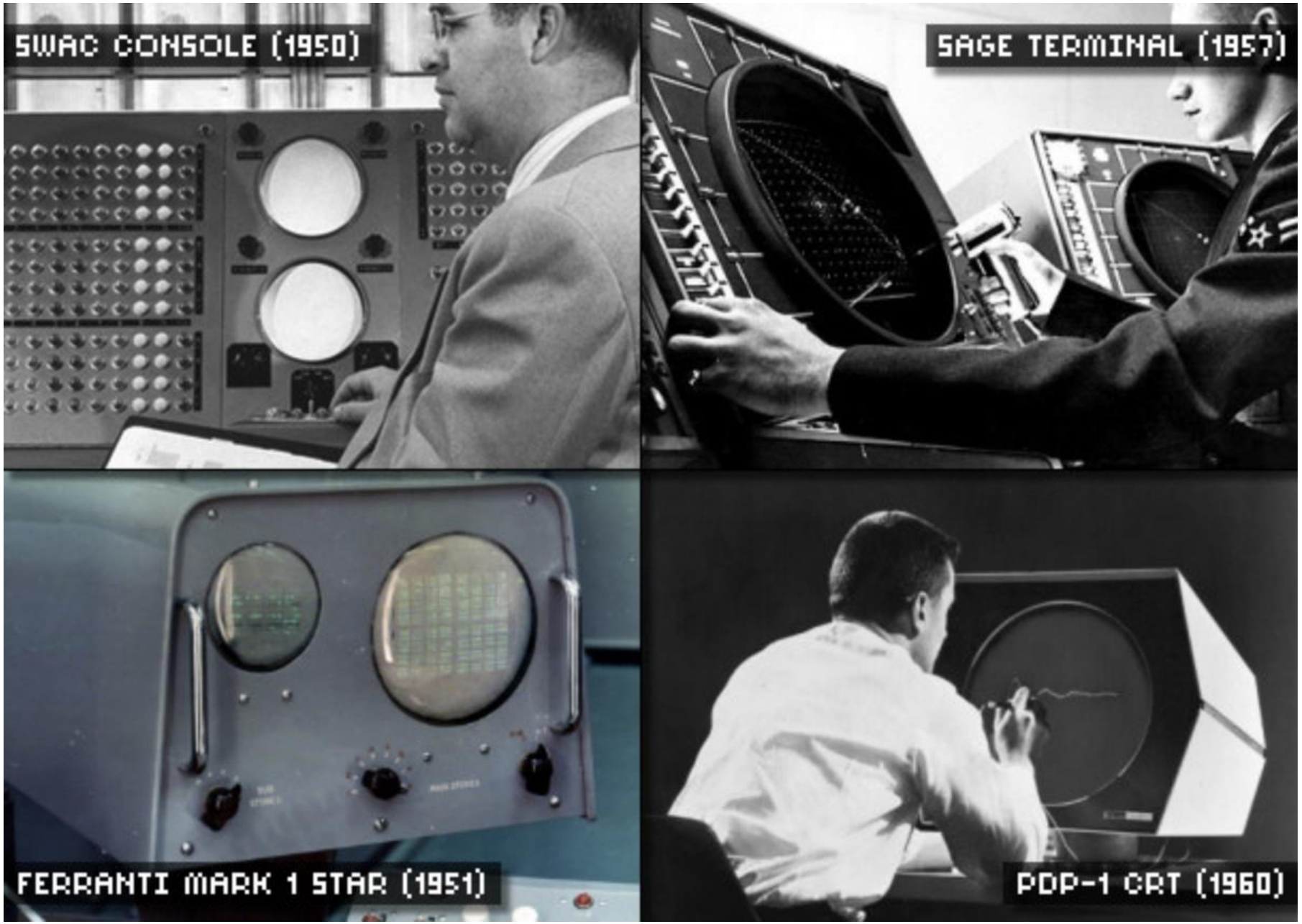


Early computer (ENIAC), 1945



punch card (~120 bytes)

There must be a better way!



Credit: PC World, “A Brief History of Computer Displays”

Sketchpad (Ivan Sutherland, 1963)

APPLECOLOR HIGH-RESOLUTION RGB
AND MACINTOSH II (1987)

2018: Dell 8k monitor
7680x4320 (~95MB)

Coming down the pipe…

2018 Google/LG display: 2x 2160 x2160@ 90Hz => 2.3GB/s

What is computer graphics?

com•put•er graph•ics /kəm'pyo͞odər 'grafiks/ *n.*

The use of computers to synthesize visual information.

digital information

computation

visual information

Graphics has evolved a lot since its early days… no longer just about turning on pixels!

What is computer graphics?

com•put•er graph•ics /kəm'pyo͞odər 'grafiks/ *n.*
The use of computers to synthesize visual information.

Why only visual?

visual information

computation

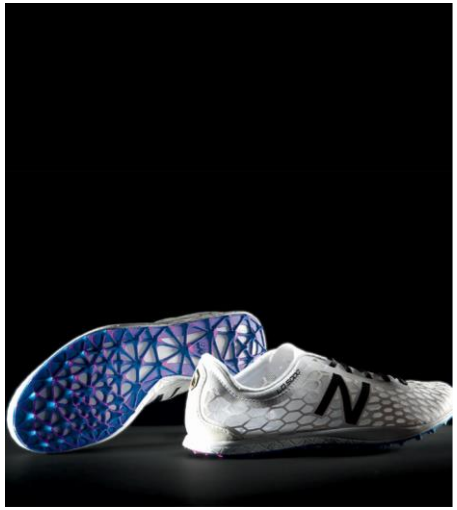
digital information

Information into sensory stimuli

Sound

Touch

Information into physical mater



Definition of Graphics, Revisited

com•put•er graph•ics /kəm'pyo͞odər 'grafiks/ *n.*

The use of computation to turn digital information into **sensory stimuli**.

Even this definition is too narrow…

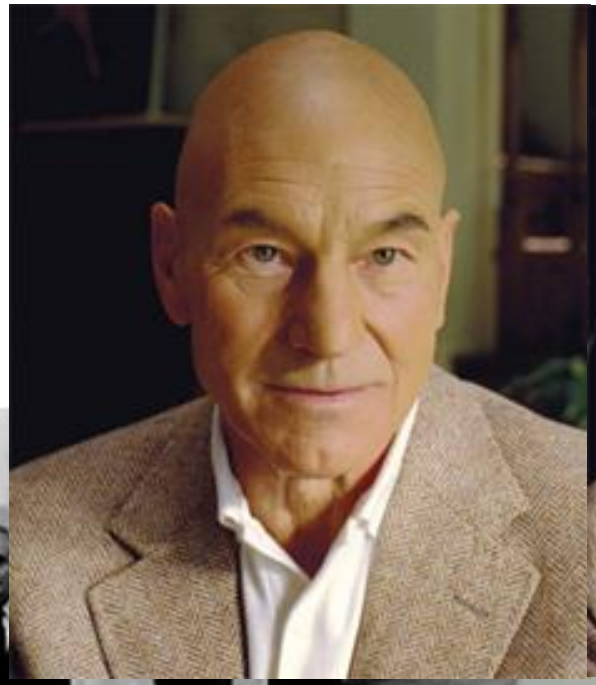
SIGGRAPH Technical Papers Trailer

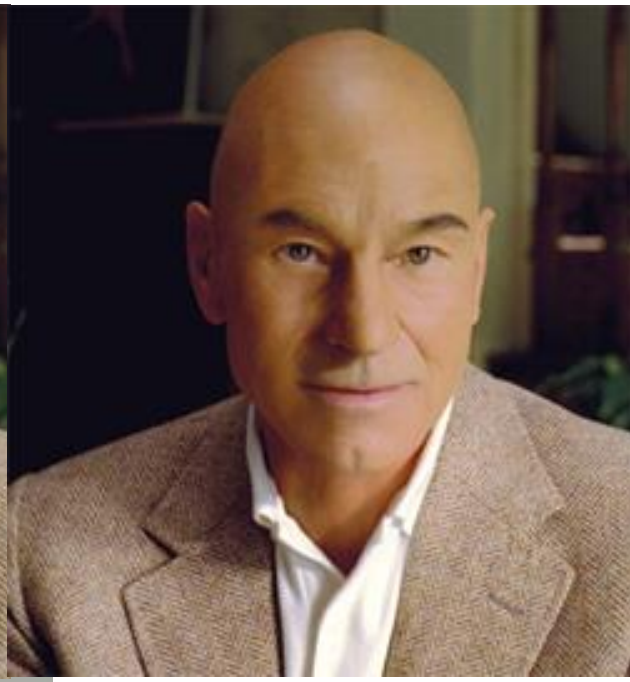
Computer graphics is everywhere!

Entertainment (movies, games)

Entertainment

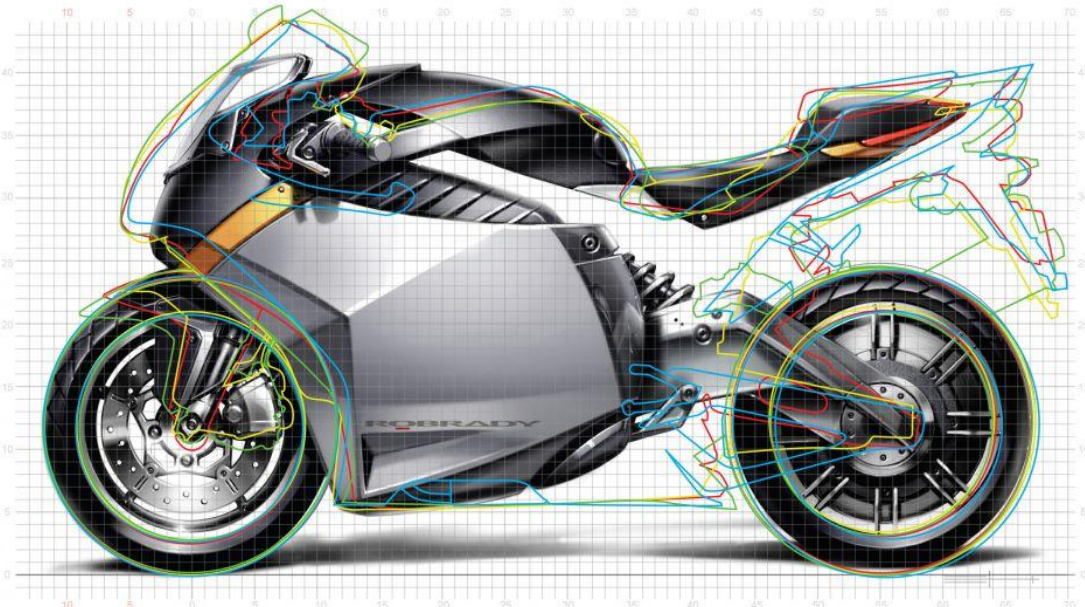
Not just cartoons!



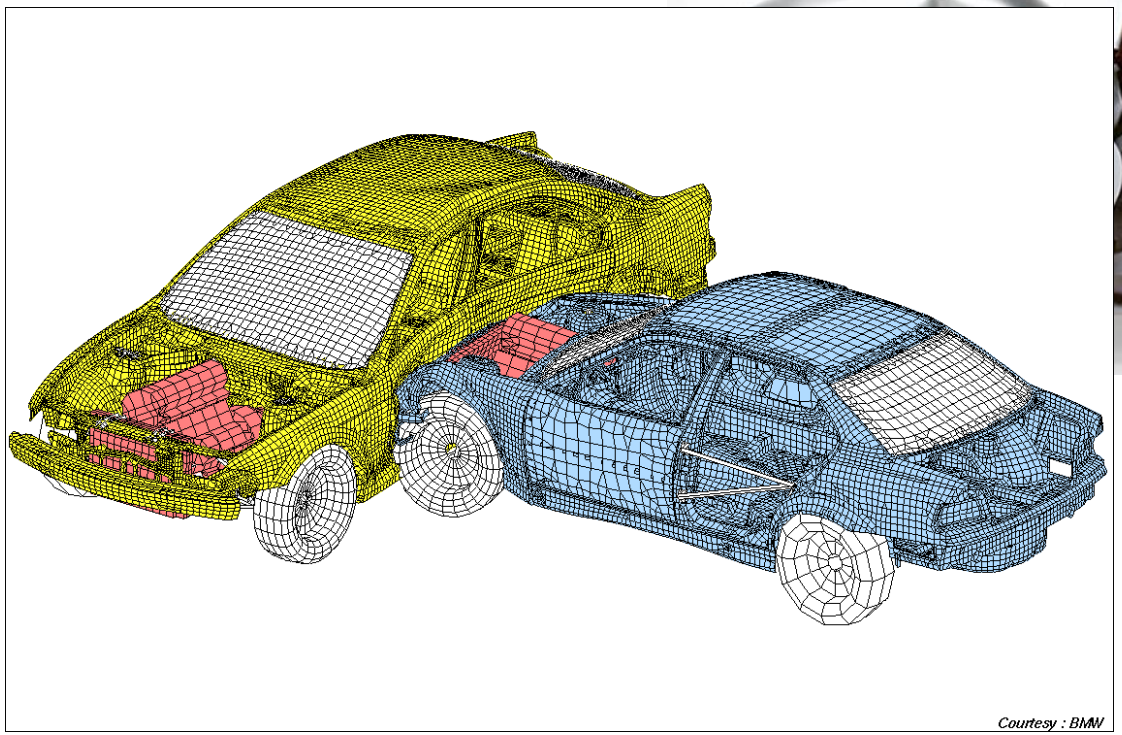


Art and design

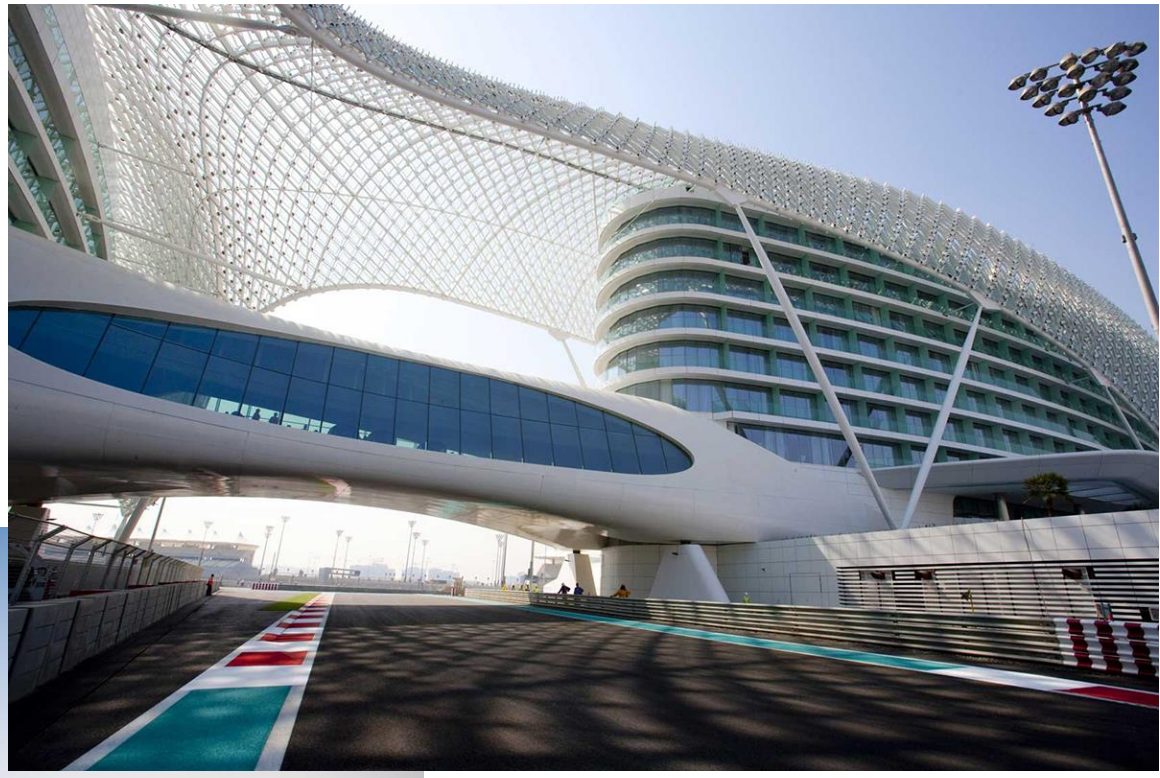
Industrial design

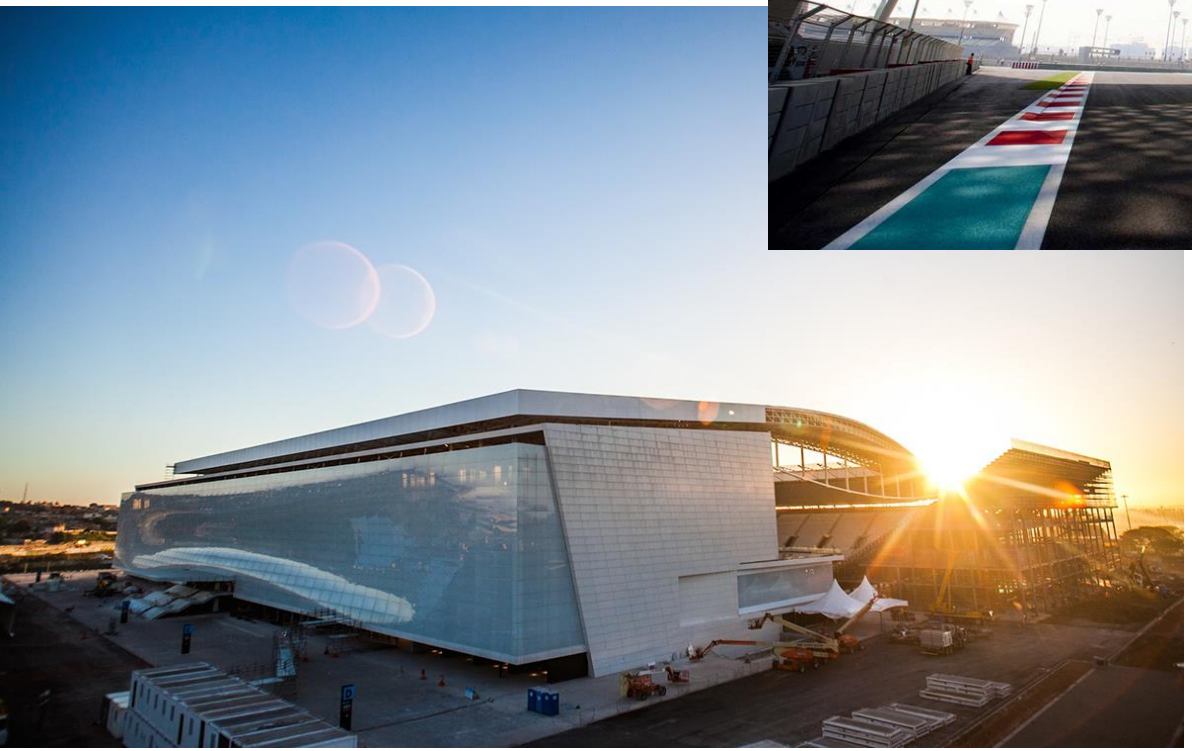


Computer Aided Engineering (CAE)

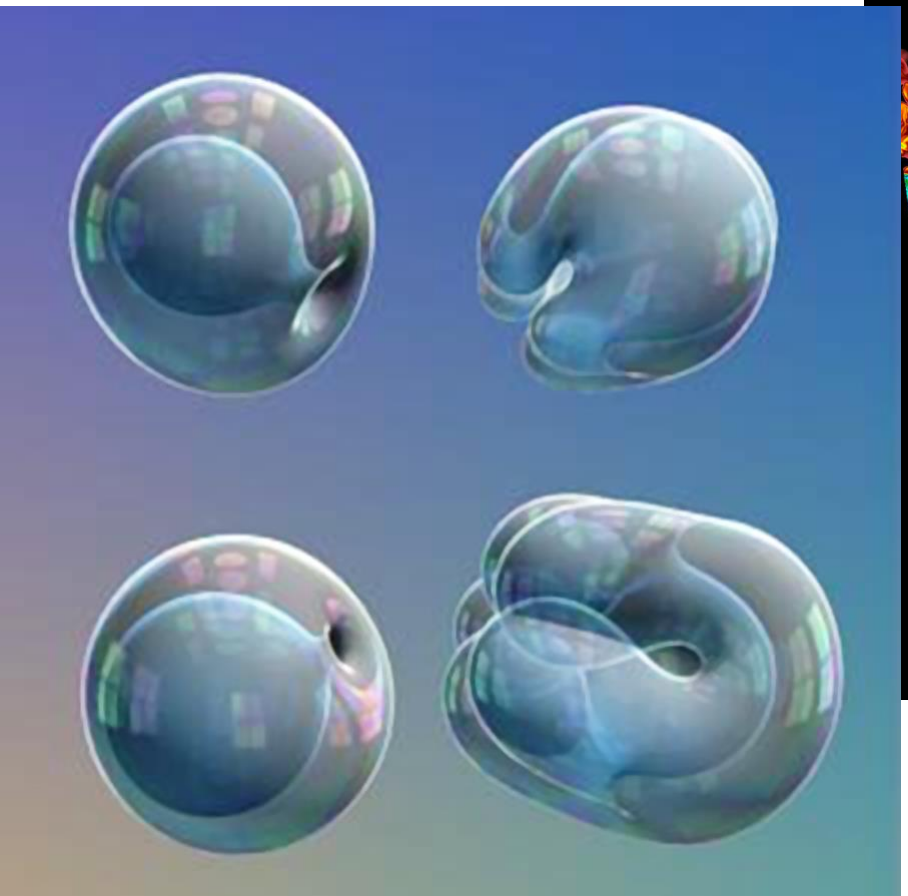


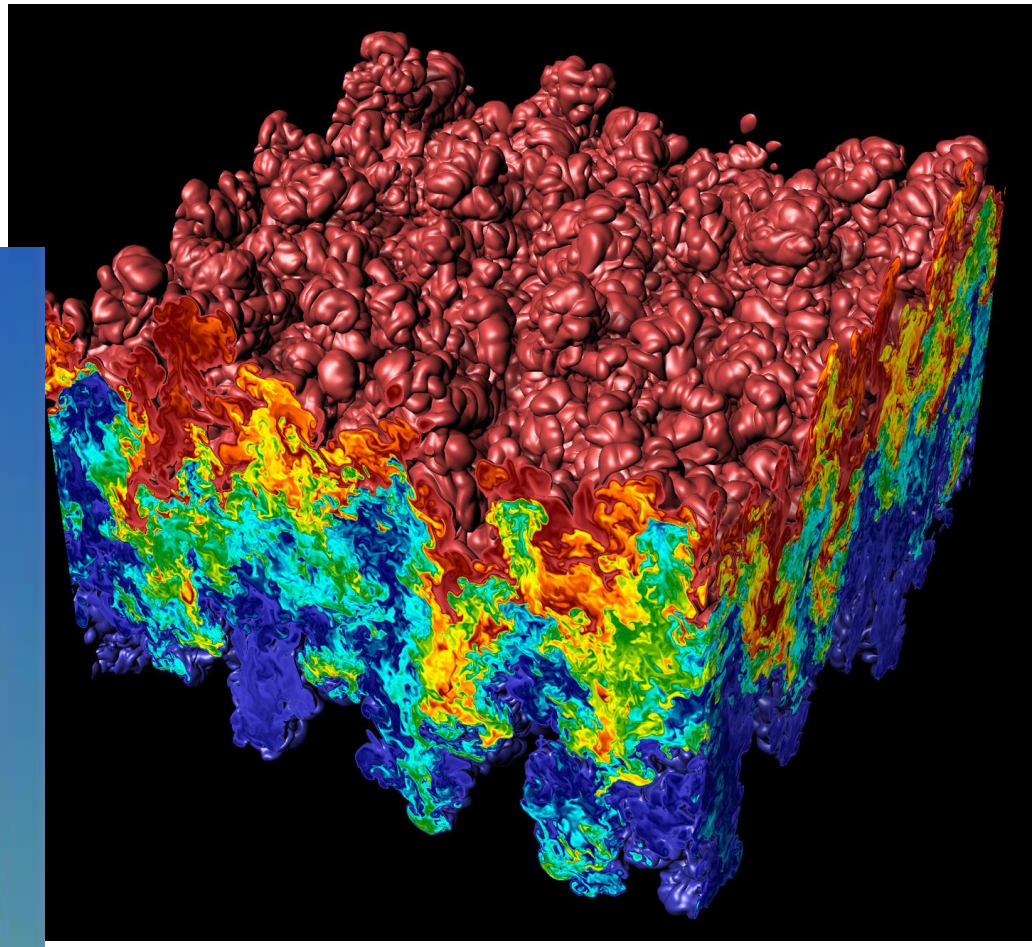
Architecture



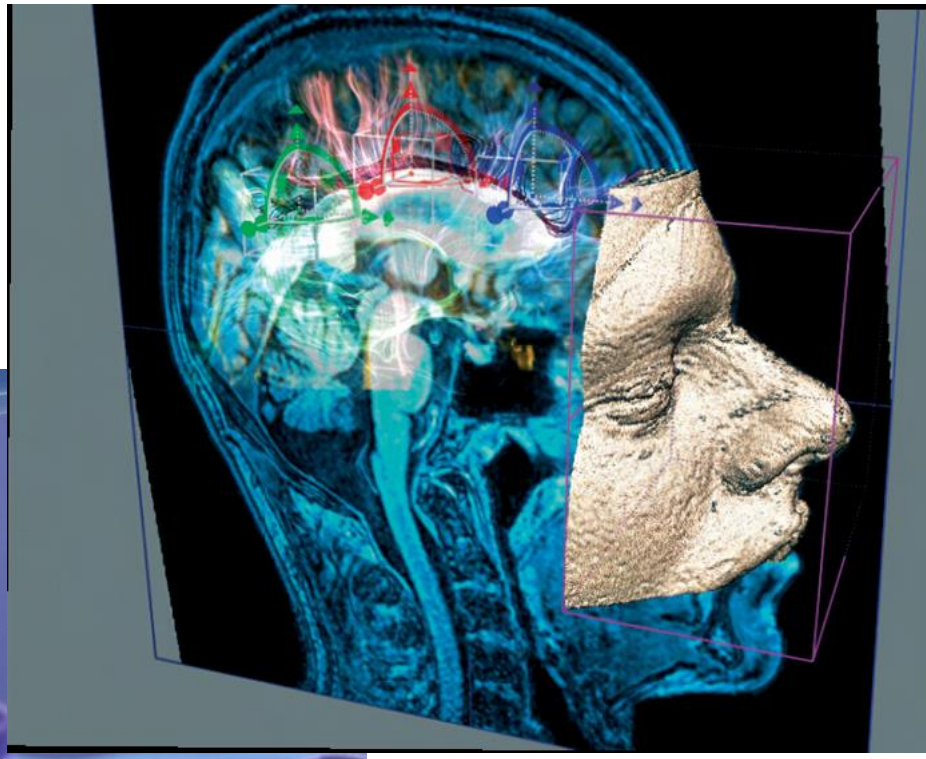


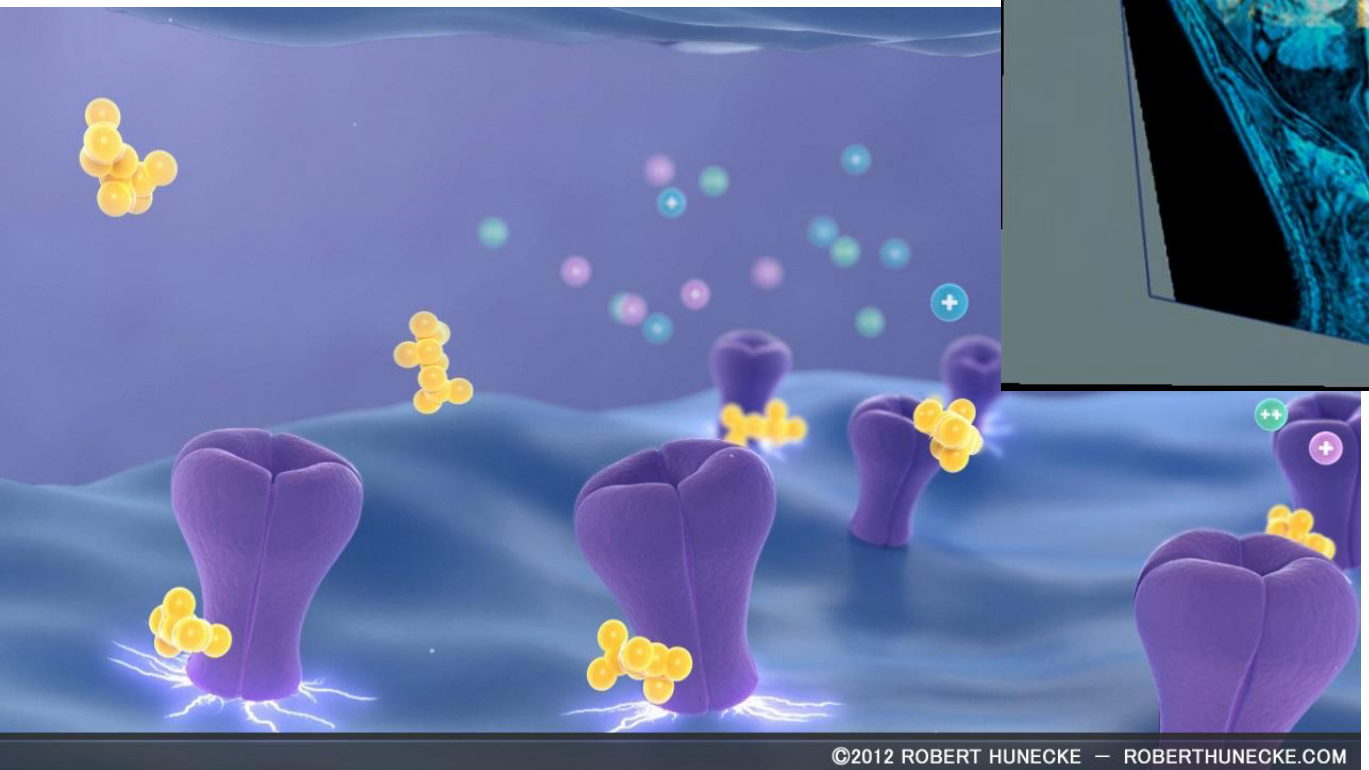
Scientific/mathematical visualization





Medical/anatomical visualization

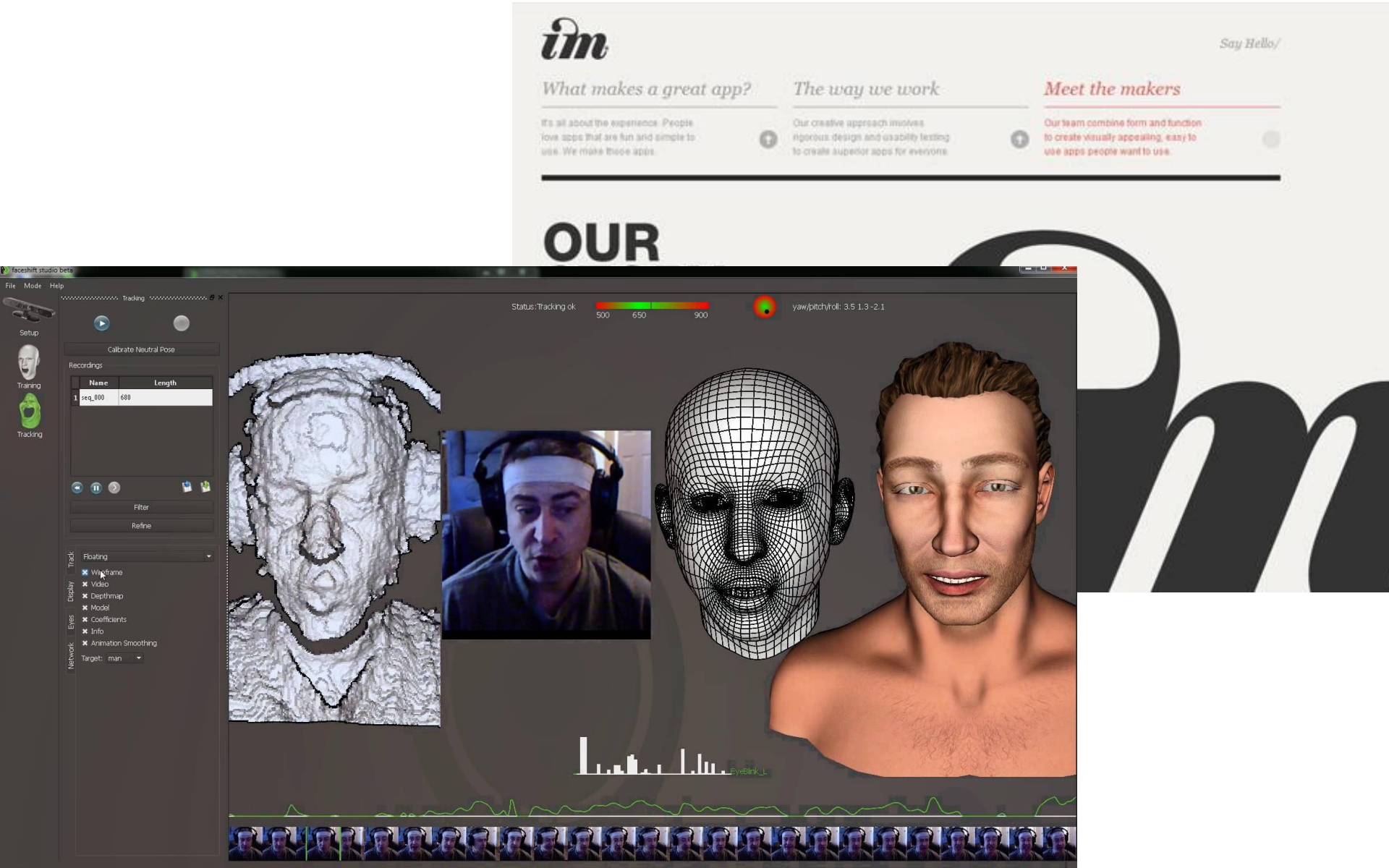




Navigation


No SIM
1:07 PM
30%
Directions
empire state building new york
Empire State Building

Communication



Interdisciplinary!

- Algorithms
- Hardware
- Compilers
- HCI
- Visualization
- Image processing
- Computer vision
- Machine learning

- Computer Science
- Mathematics
- Physics
- Engineering
- Biology
- Psychology
- Art

Plan for the Quarter

Displays

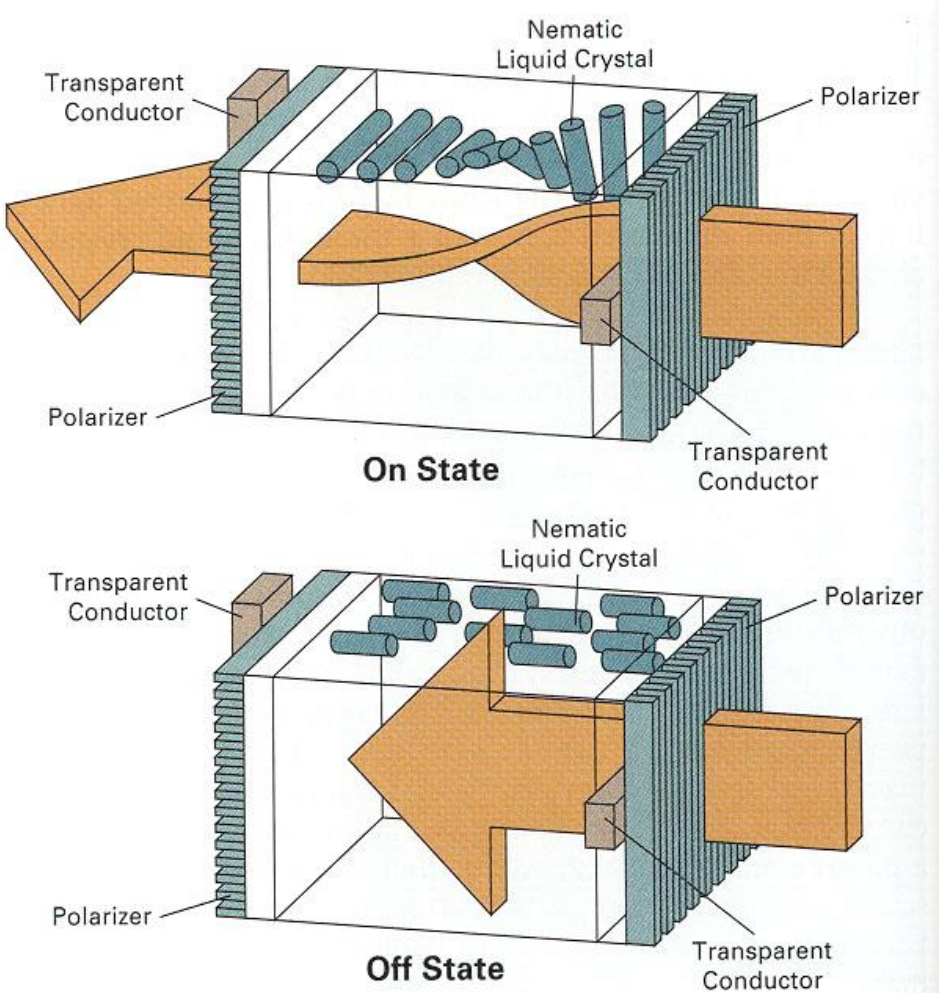

Nematic
Liquid Crystal
Transparent
Conductor
Polarizer
Polarizer
Transparent
Conductor
On State
Nematic
Liquid Crystal
Transparent
Conductor
Polarizer
Polarizer
Transparent
Conductor
Off State

Image processing

Original

Smoothed

Sx + 128

Sy + 128

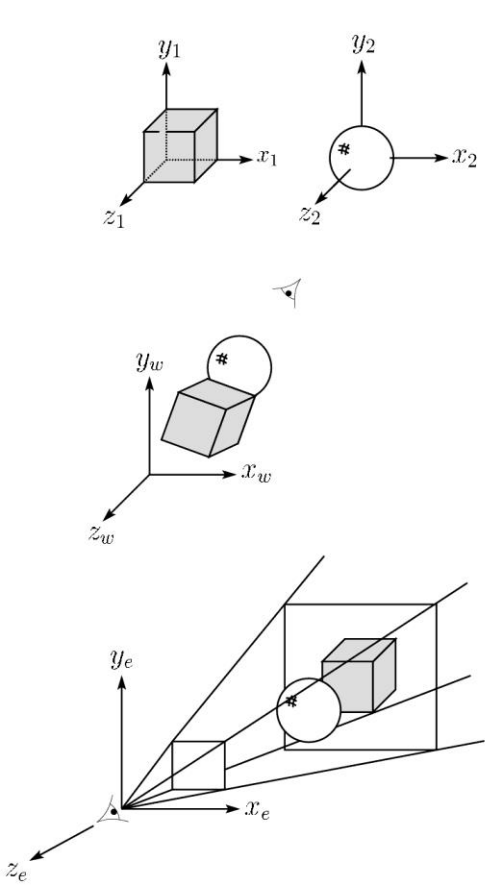
Magnitude

Threshold = 64

Threshold = 128

Project 1: Impressionist

Geometric transformations



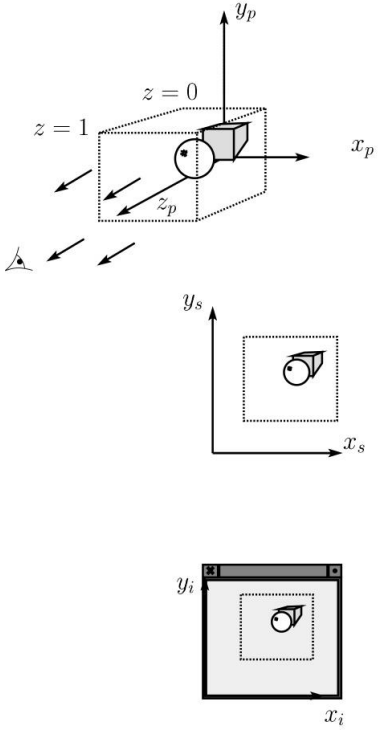
Model or object space

scale, translate, rotate, ...

World space

rotate, translate

Eye or camera space



Projective transformation, scale, translate

Normalized projection space

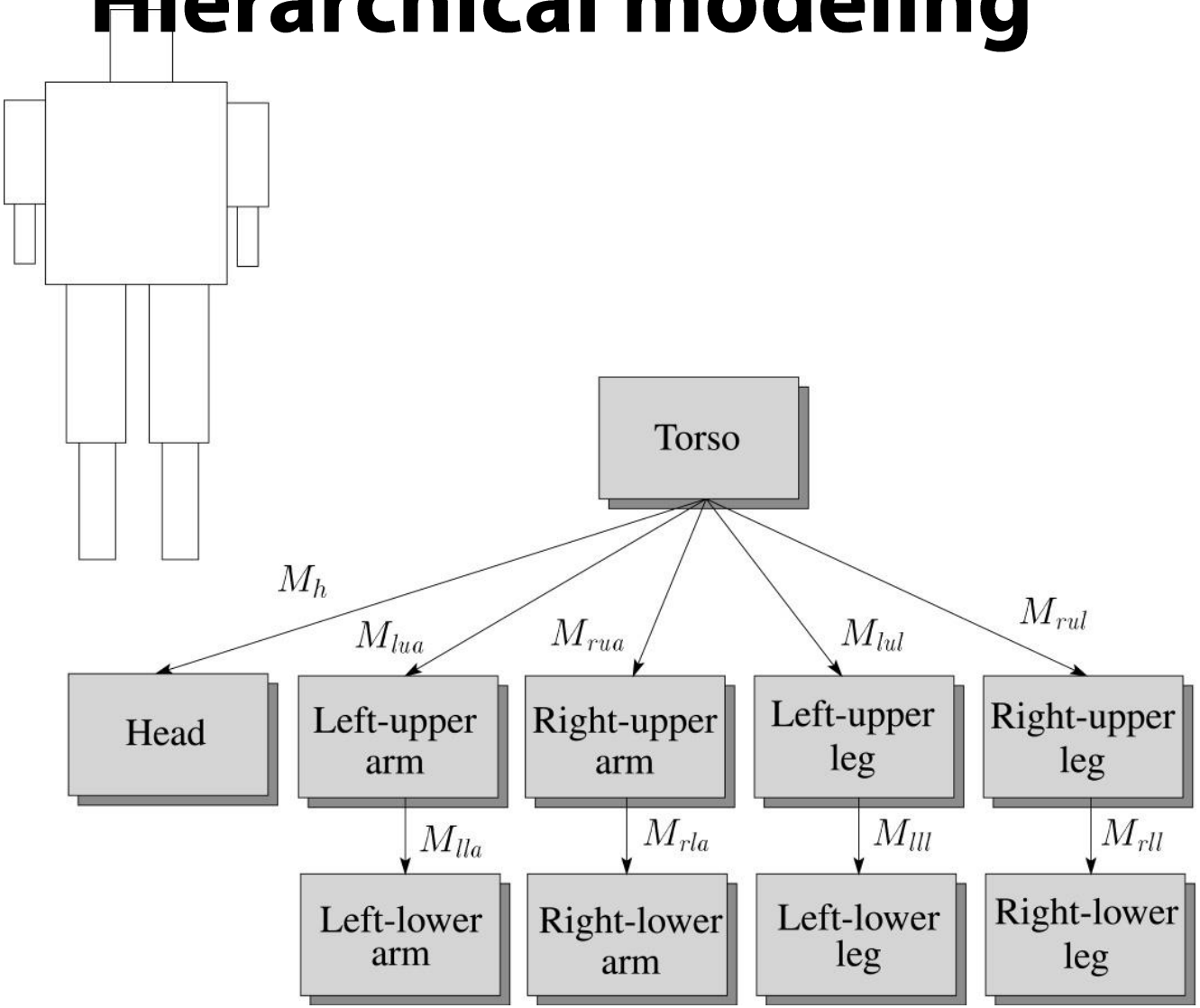
Project, scale, translate

Normalized device space
(Screen space)

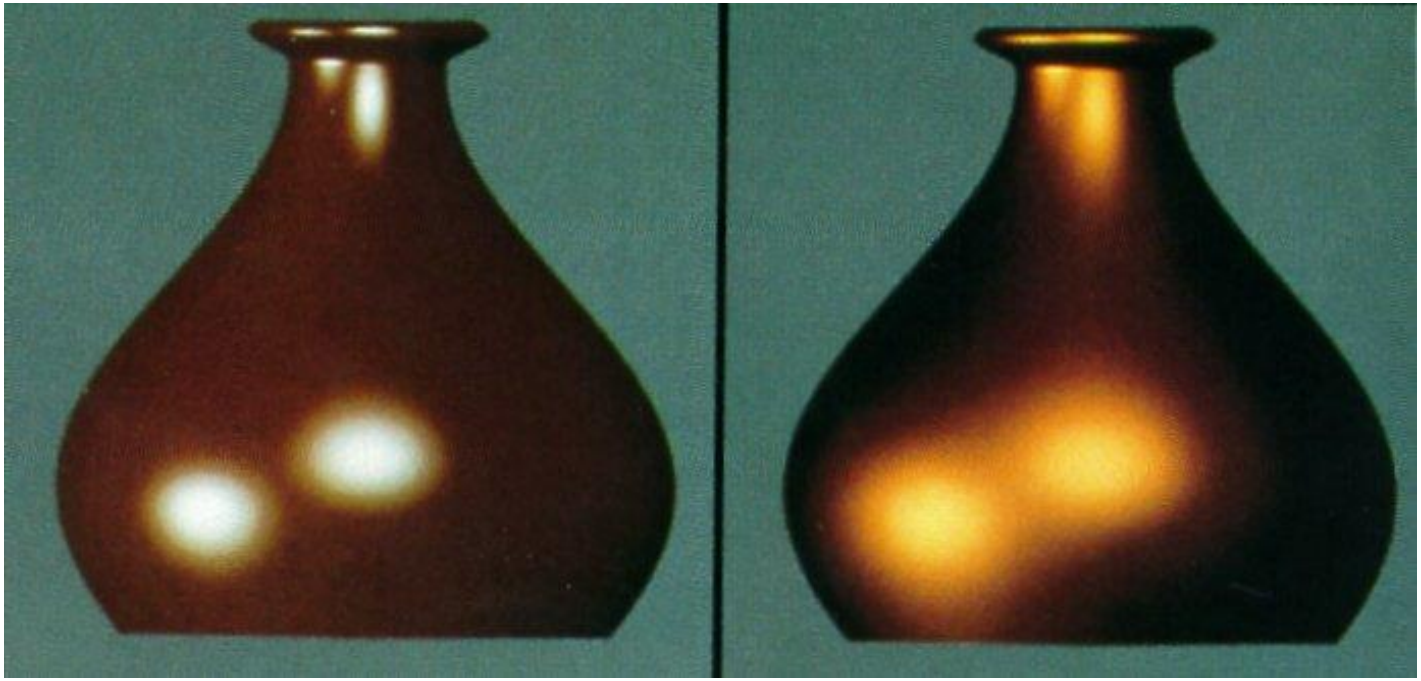
scale

Image space
(Window space)
(Raster space)
(Screen space)
(Device space)

Hierarchical modeling

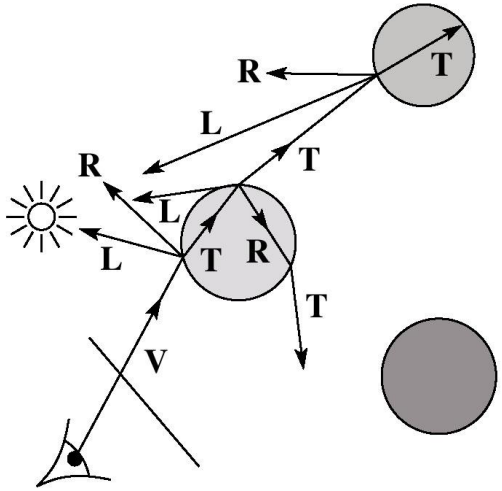


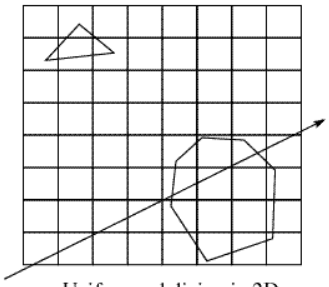
Shading



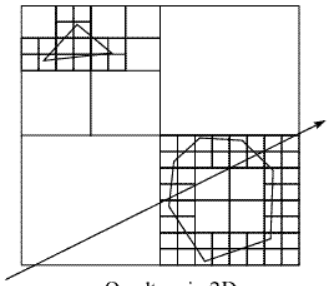
Project 2: Modeler

Rendering

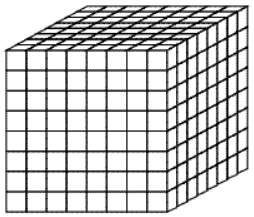




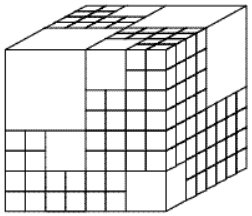
Uniform subdivion in 2D



Quadtree in 2D



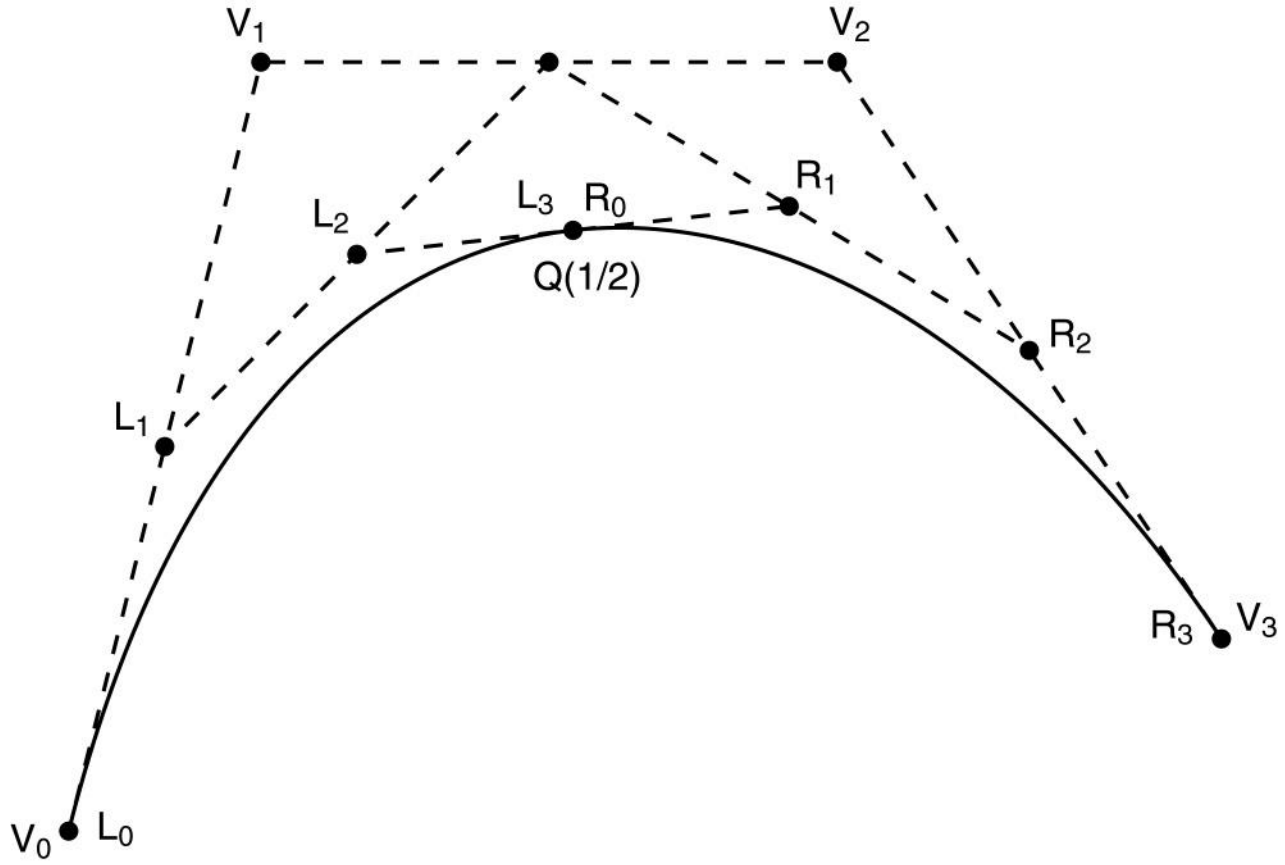
Uniform subdivion in 3D



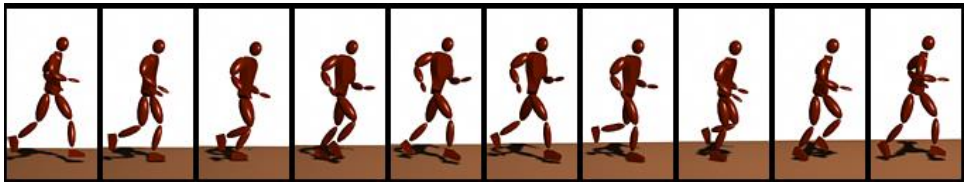
Octree in 3D

Project 3: Trace

Curves

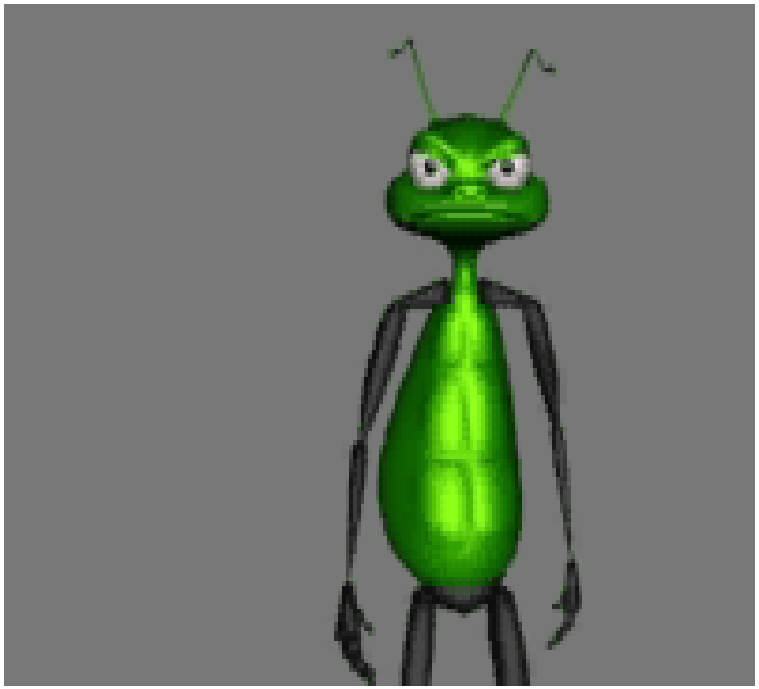


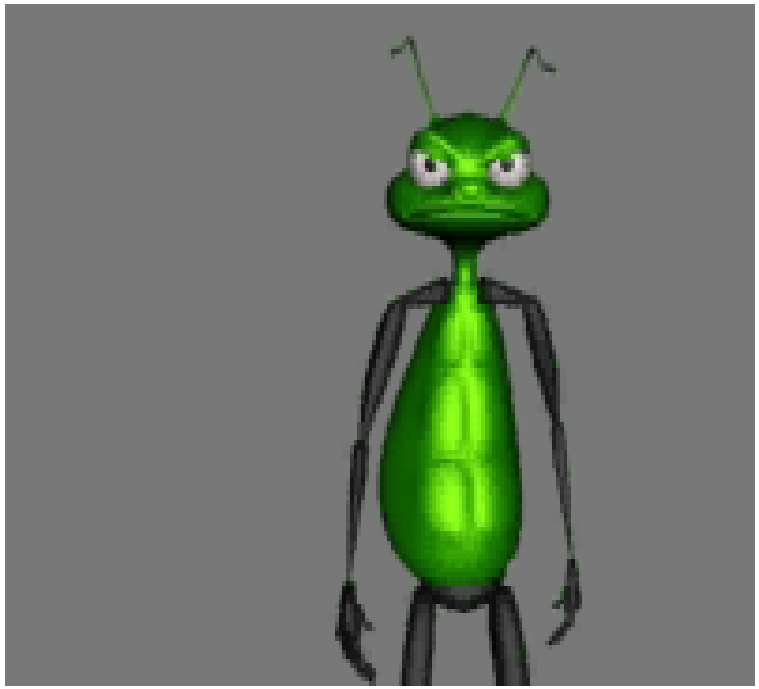
Animation



- Keyframing
- Physical simulations

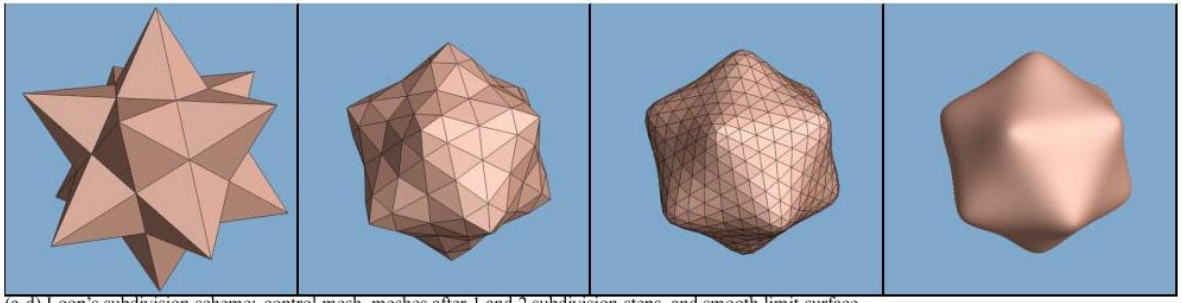
Principles of character animation





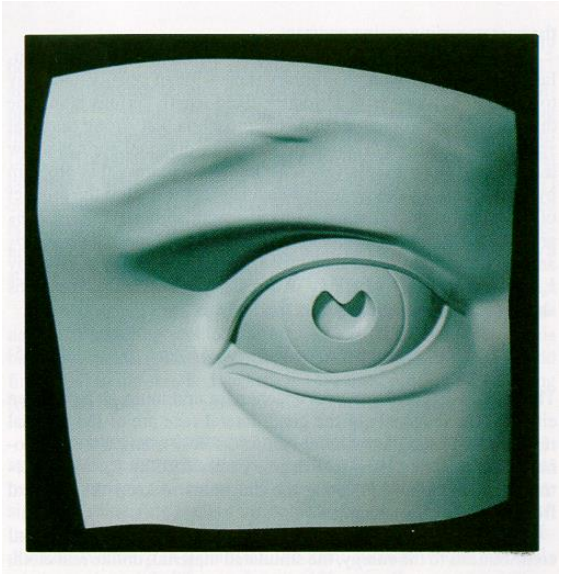
Project 4: Animator

Surfaces



(a-d) Loop's subdivision scheme: control mesh, meshes after 1 and 2 subdivision steps, and smooth limit surface

(e-h) Our piecewise smooth subdivision scheme: tagged control mesh, meshes after 1 and 2 subdivision steps, and piecewise smooth limit surface



Some Administrative Things…

Prerequisites

- Data structures
- C (C++) programming
- Linear algebra (very basic)
- Some mathematical sophistication
- No prior knowledge of graphics is assumed

Communication

- Announcements: email
- Everything else: **main website**
  - Ed Discussion Board (link on website)
  - Canvas for Lectures/Grades/Submitting Homeworks (link on website)
  - Gitlab for Projects (sent to your email)
  - Calendar (link on website)
- Need to reach us?
  - For fast response: cse457-staff@cs.washington.edu
  - Individual emails (not recommended)

Deliverables

- 4 Projects + Artifacts
- 8 HWs **(new! goal: make it easier)**
- No final
- Check calendar (main website)
- Late Policy **(note: no late days)**

All assignments (projects, artifacts, and homework) must be submitted by 10pm on the due date. Late assignments are marked down at a rate of 25% per day (not per lecture), meaning that if you fail to turn in an assignment on time it is worth 75% for the first 24 hours after the deadline, 50% for the next 24 hours, 25% for the next 24 hours, and then it is worth nothing after that. **Exceptions will be given only in extreme circumstances with prior instructor approval**.

Grades

- 70% Projects
- 25% Homework
- 5% Participation

  1 point for each class you are **actively** present.

  Being actively present means you engage in the class in some form: you say something out loud with audio, type something on the chat, or simply keep your video throughout the class and engage by nodding/shaking your head/smiling/looking skeptical... **Anything that gives the instructor feedback on your understanding.**

  2 points for Ed **response**

  Ed participation will be given **every time** a student responds to a question in a way that is helpful to the student who asked the question, but please make sure to **never completely give away the answer to a graded problem**. So if you can't attend the class because of internet problems, you still have a chance to get participation credit!

  >=15 points = 100% score

Projects

- Done in Pairs
  - You can pick or be auto-assigned

  Exceptions will be given only in extreme circumstances with prior instructor approval.
- Help Session (will be recorded)
- Virtual “in person” grading
- Artifact
- Opportunity for extra credit

Ethics, Diversity, Equity and Inclusion

- How do these topics relate to computer graphics?
- As we go through the topics in this course, let's ask ourselves:
  - Are specific algorithms or applications biased in certain ways?
  - Any environmental impact concerns?
  - Or more positively, how we use these ideas to drive invasions that will help address some of the existing issues we face in the world?

Let's think together and learn from each other!

Making our course inclusive

You all belong in this class and as such should expect to be treated by your classmates and the course staff with respect. It is our goal, as the course staff, to provide an interesting and challenging environment that is conducive to your learning. If any incident occurs that challenges this commitment to a supportive and inclusive environment, please let the instructor know so the issue can be addressed.

A personal Story from my undergrad

I once asked in a Control Theory class:

“Excuse me professor, what is a joystick?”

We all have different backgrounds! Let us know if we use any expressions that just don’t feel right to you.

Summary

- Broad view of graphics
- Hands-on experience with focus on ideas and algorithms
- Structured to allow you to budget time according to your interests and constraints
- Balance of technical and artistic expression
- You will see the world in a different way, I guarantee it!