Introduction to Computer Graphics

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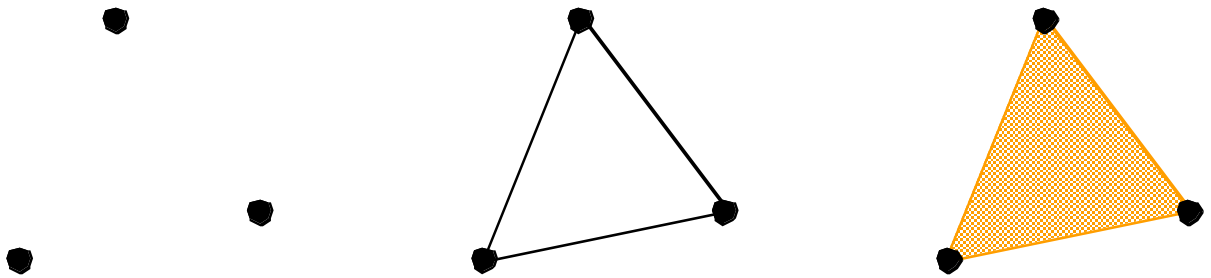
Today

- What is computer graphics?
- Contents of this course
- Syllabus

- Overview of course topics

What Is Computer Graphics?

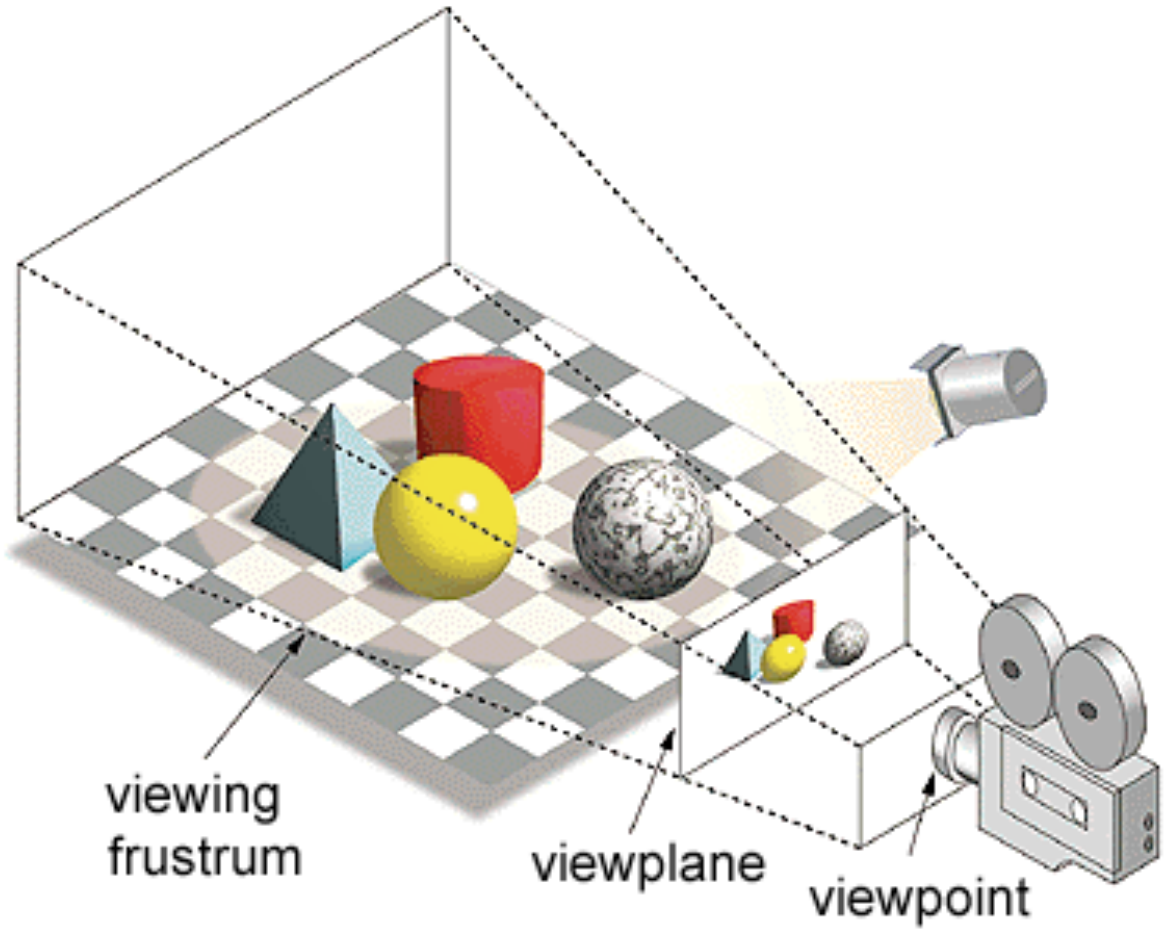
- Using a computer as a rendering tool for the generation (from models) and manipulation of images is called *computer graphics*
- More precisely: *image synthesis*



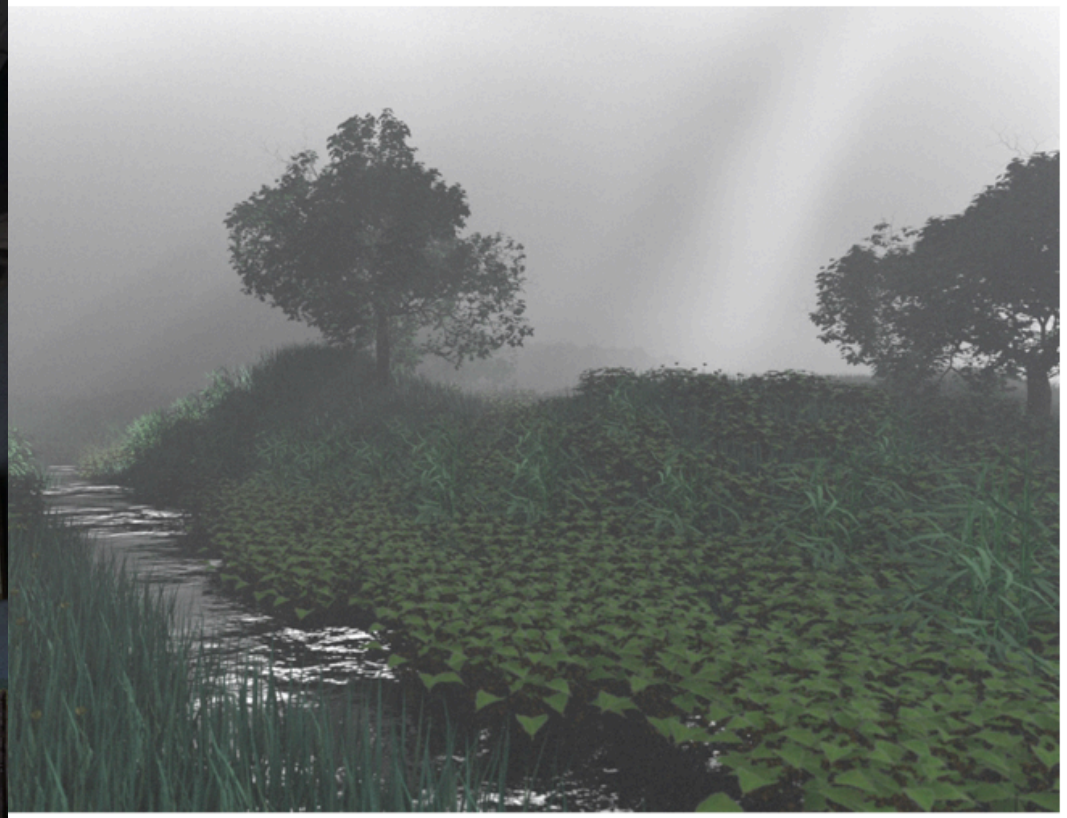
Goals of Computer Graphics

- Generate synthetic images
- Do it in a practical way and scientifically sound.
- In real time?
- And make it look easy…

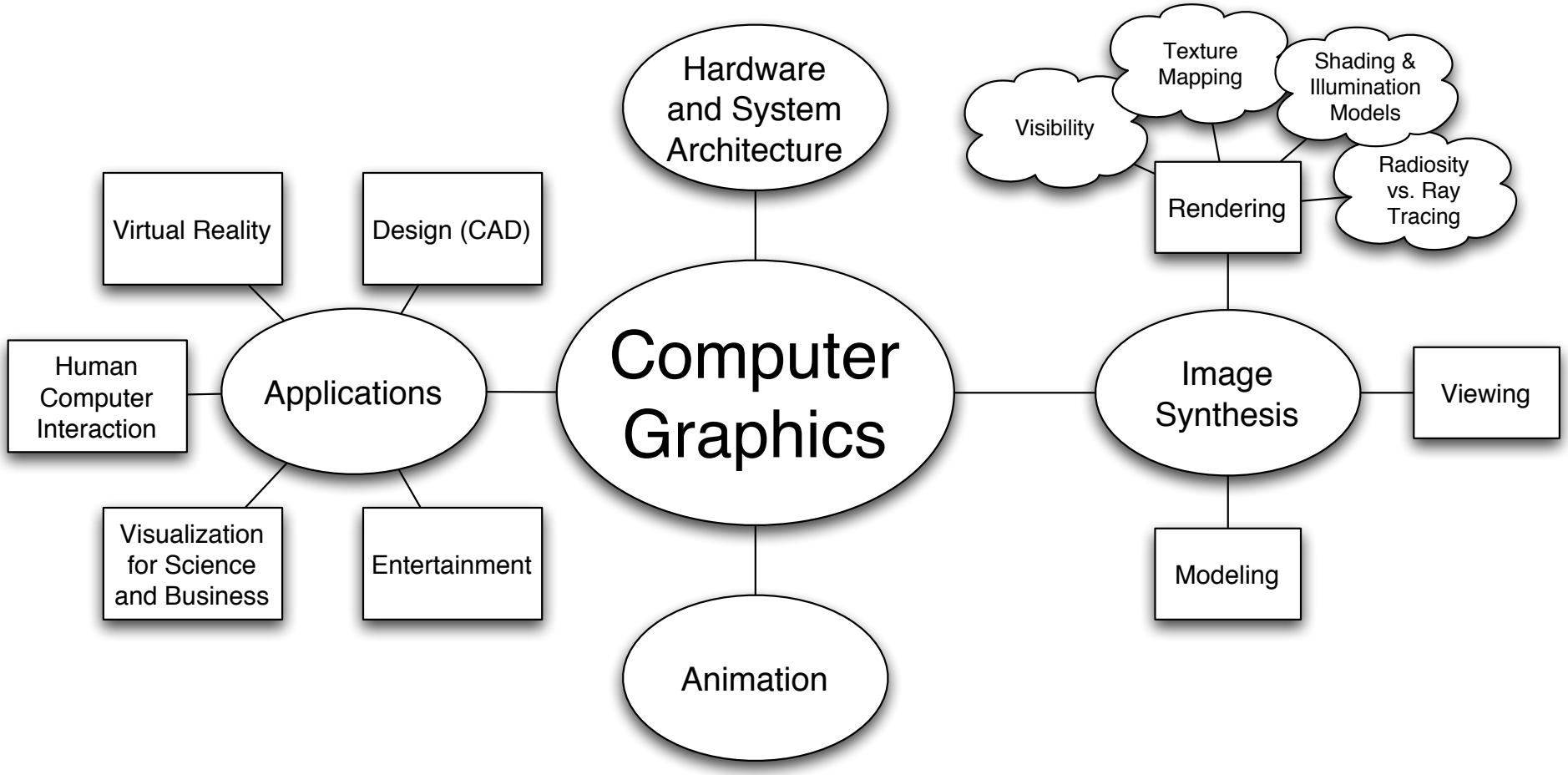
Cmpt 361



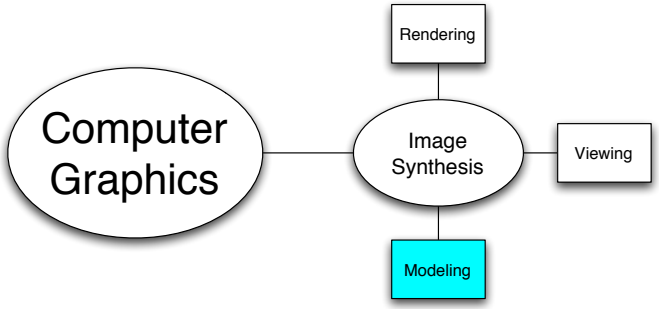
Cmpt 461/761



What Is Computer Graphics?

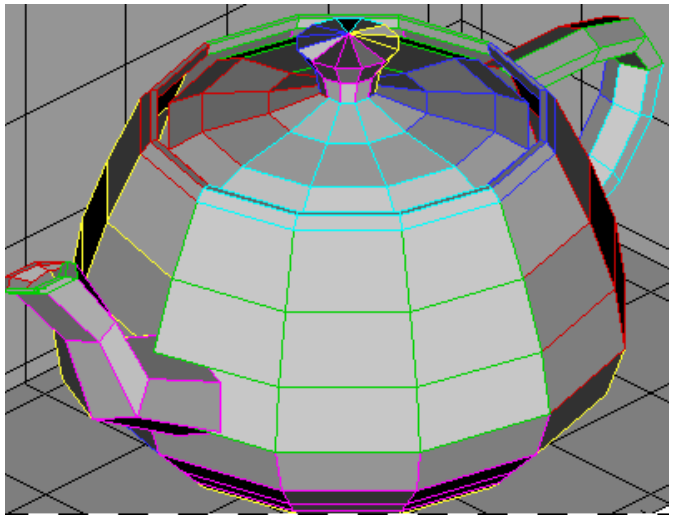


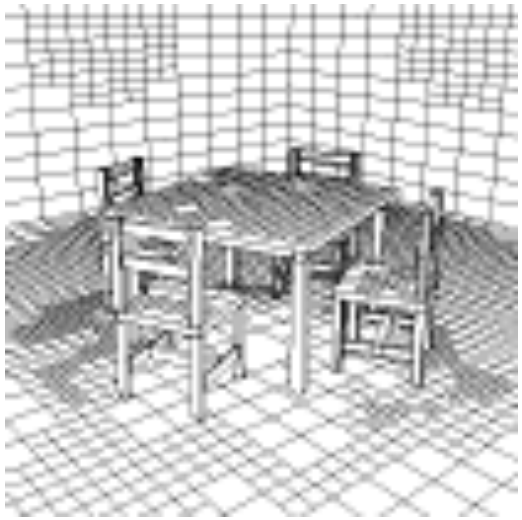
Modeling

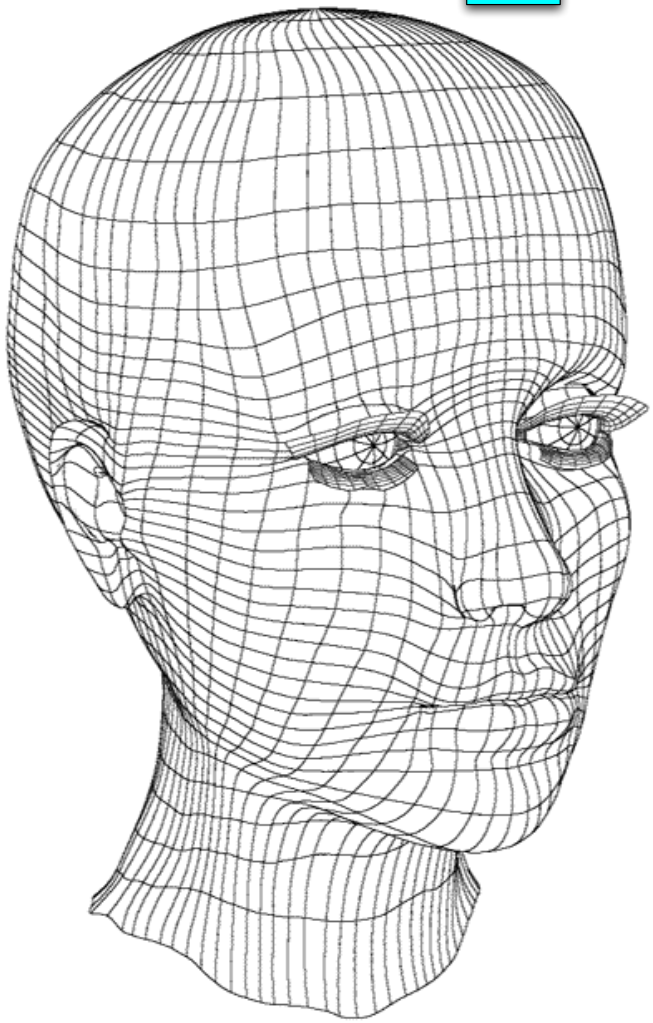


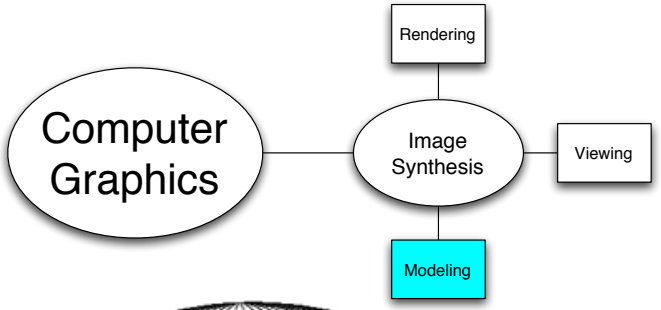
- How to represent real environments
  - Geometry: curves, surfaces, volumes
  - Photometry: light, color, reflectance
- How to build these representations
  - Interactive: sculpt it
  - Algorithmic: let it grow (fractals, extraction)
  - Scanning: via 3D sensing
- Generate primitives
  - Lines, triangles, quads, patches
  - Cylinder, spheres
  - Higher-order primitives
- See CMPT 464 / 461

Modeling: Interactive

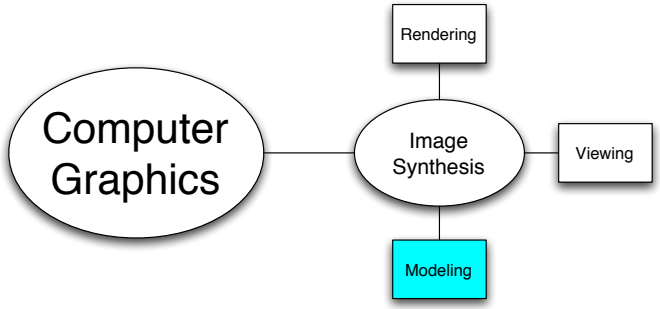


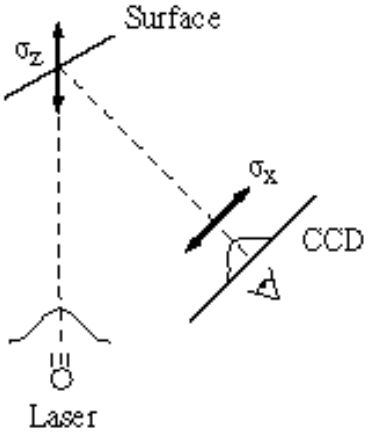




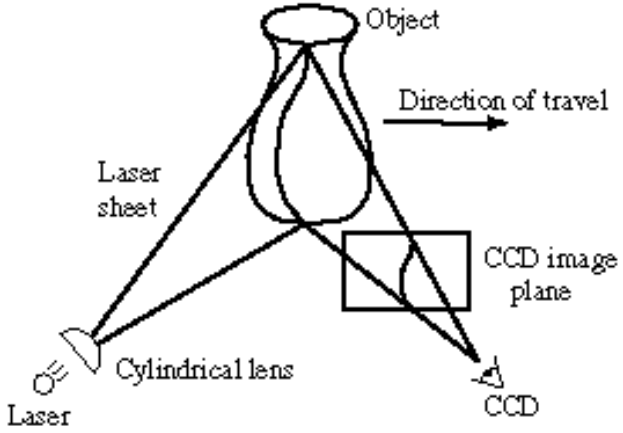


Modeling: Scanning





(a)



(b)

(c)

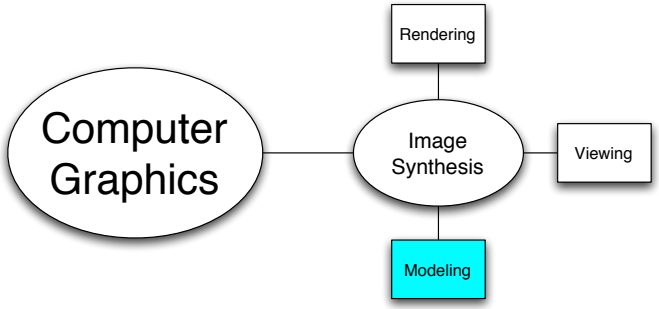
(d)

Hardware/Human

Points

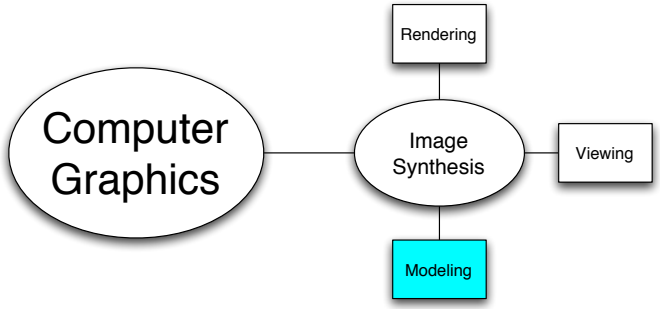
Primitives

Scanned 3D Objects

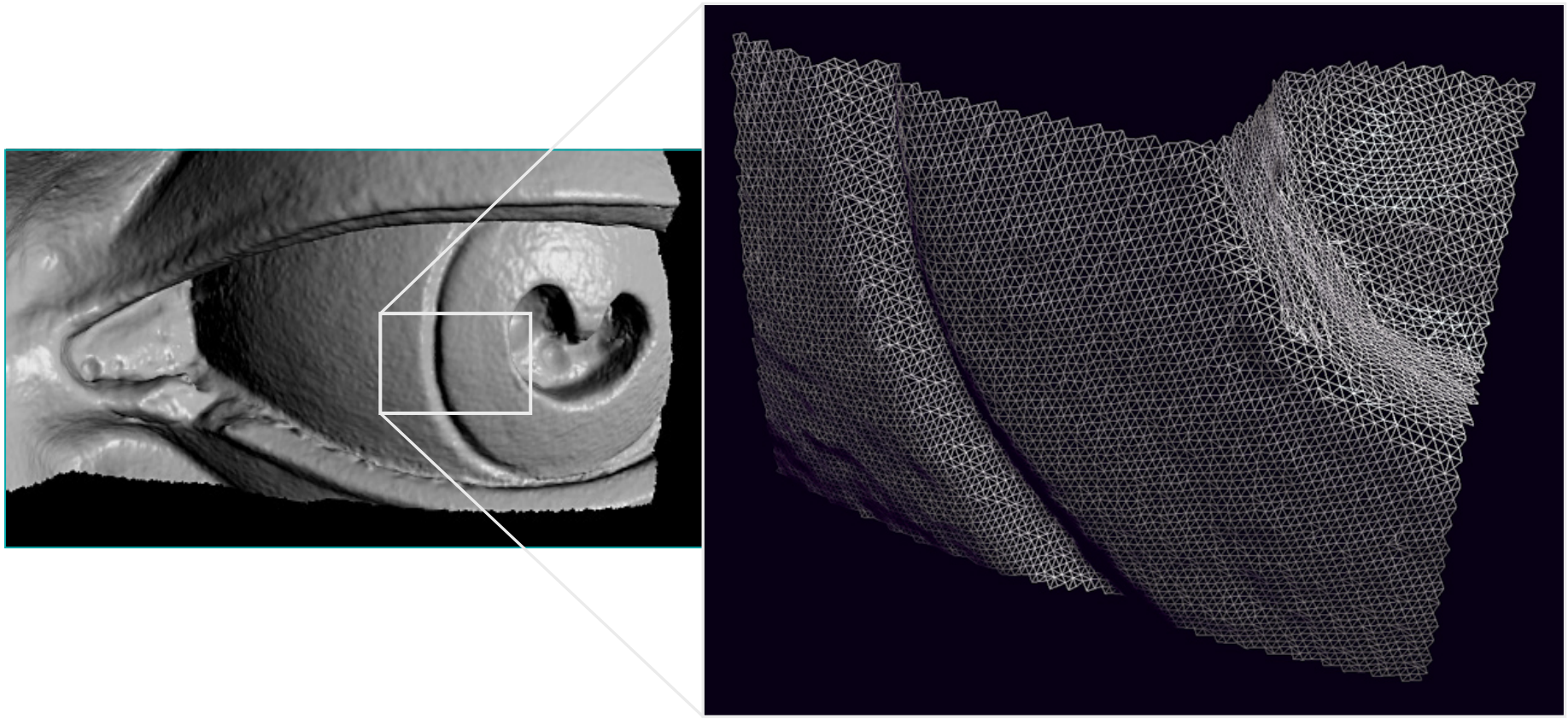


- Size of data sets?
- David:
  - 480 individually aimed scans
  - 2 billion polygons
  - 7,000 color images
  - 32 gigabytes
  - 30 nights of scanning
  - 22 people

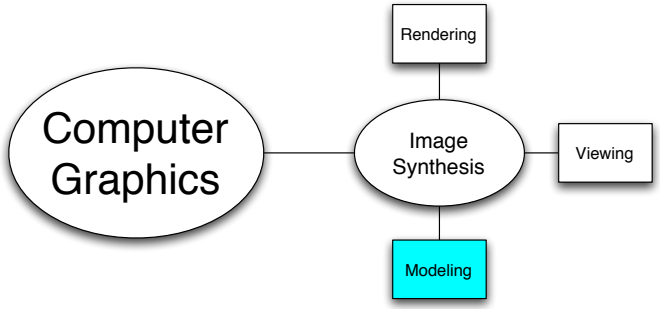
Scanned 3D Objects

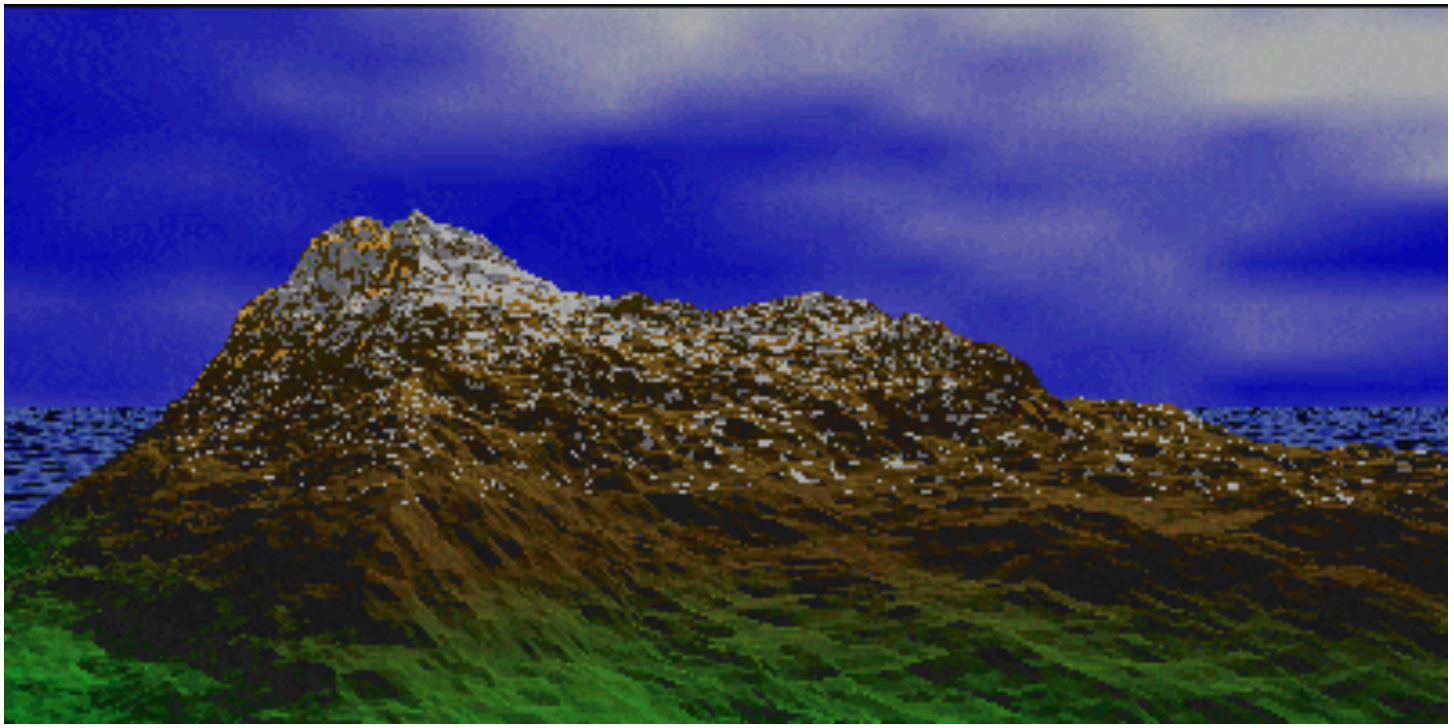


- David's left eye



Modeling: Algorithmic and Procedural

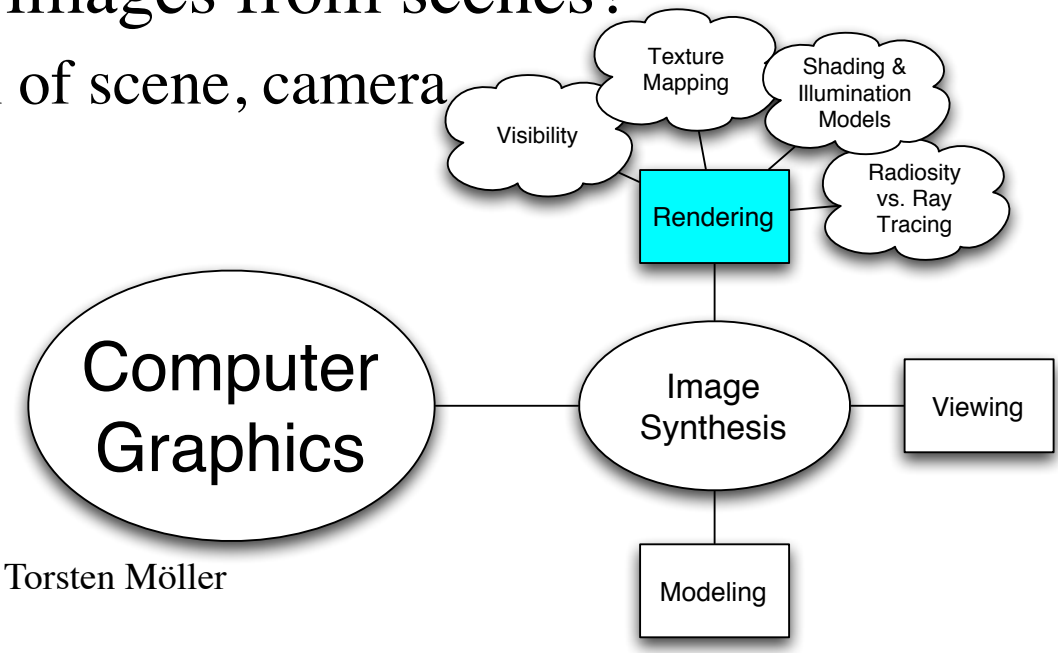




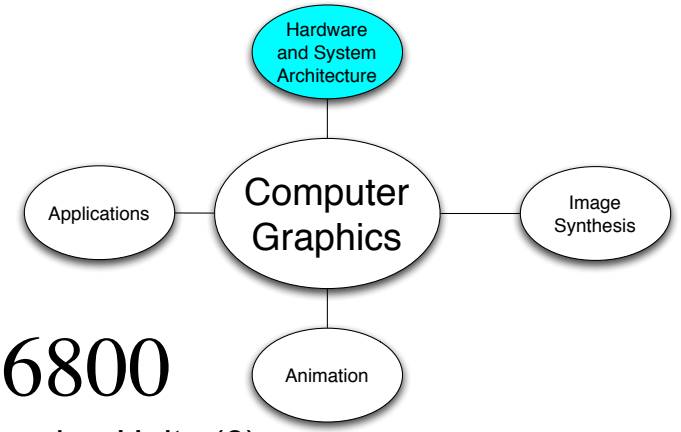
Out of nowhere - fractals

Rendering

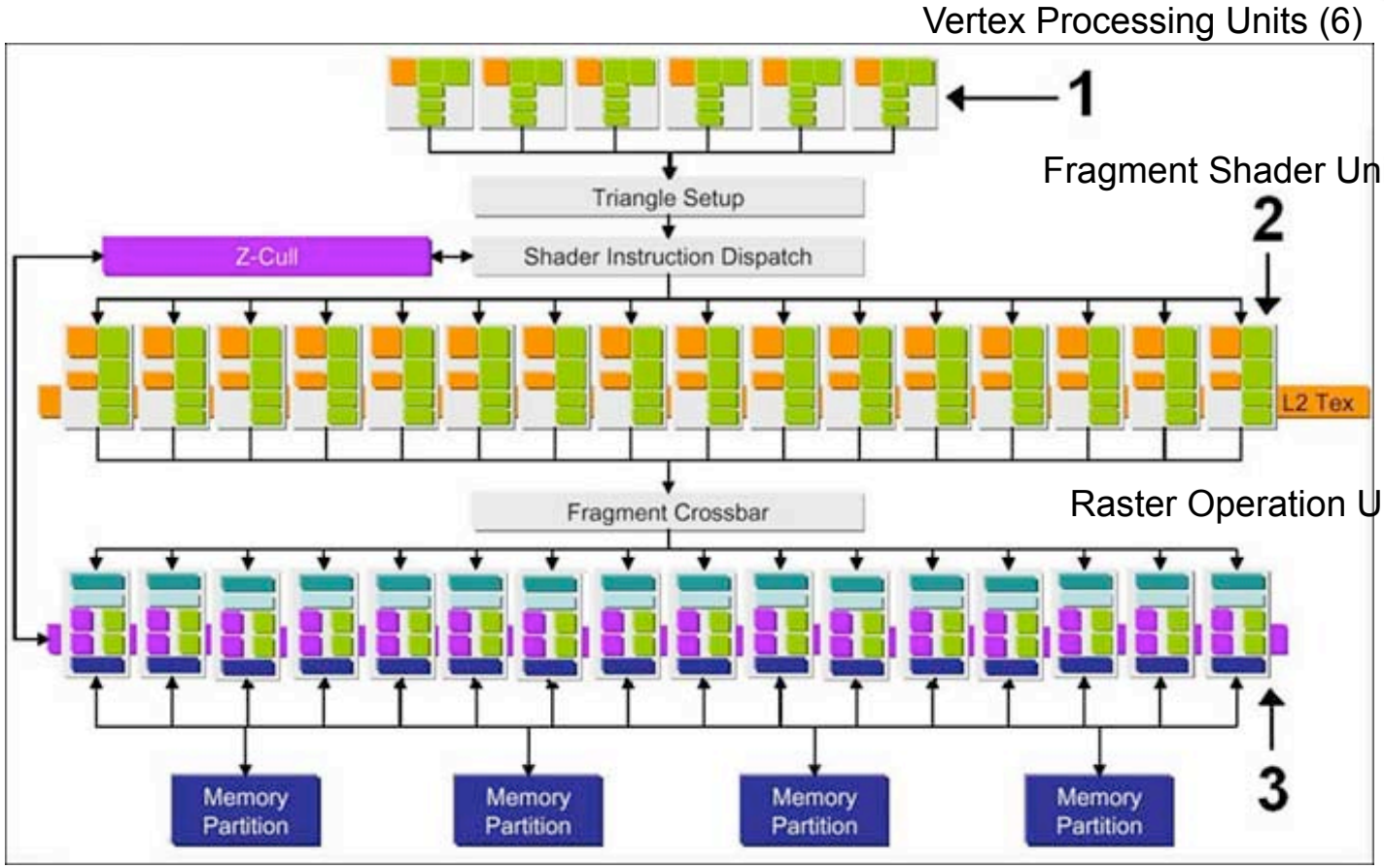
- What is an image?
  - Distribution of light energy on 2D “film”
- How do we represent and store images?
  - Sampled array of “pixels”: p[x,y]
- How do we generate images from scenes?
  - Input: 3D description of scene, camera
  - Project to camera’s viewpoint
  - Illumination
- See CMPT 461/761



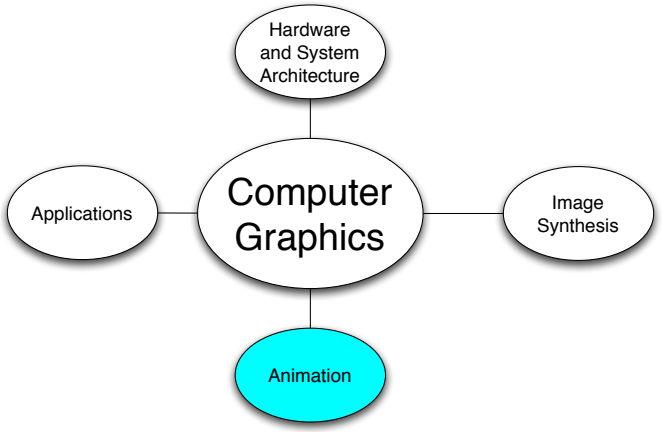
Hardware



- Example: NVIDIA GeForce 6800



Animation

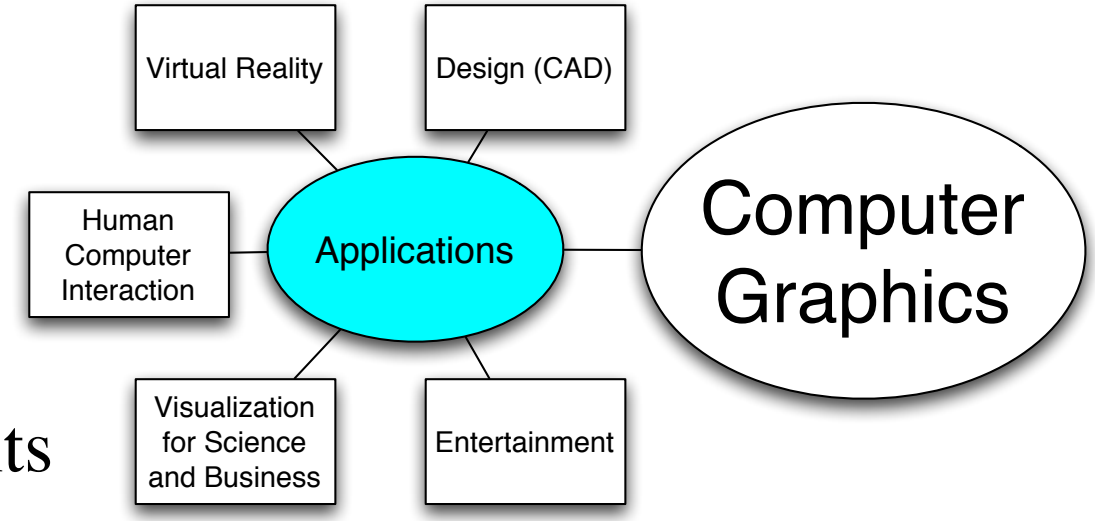


- Model how things move
- Temporal change of
  - Objects (position, orientation, size, shape, color, etc.)
  - Camera (position, direction, angle, focus, etc.)
  - Illumination (position, direction, color, brightness)
- Represent motion
  - Sequence of stills
  - Parameter curves

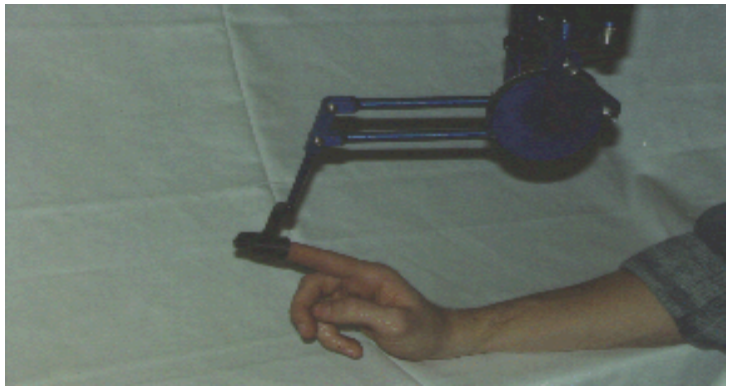
- See CMPT 466 (Animation)

Uses Of Graphics

- Special effects
- Feature animation
- Computer Games
- Virtual environments
- Visualization
  (science, business, cartography, ...)
- Design
- Interaction
- ...



Interaction



Geometric modeling in 361

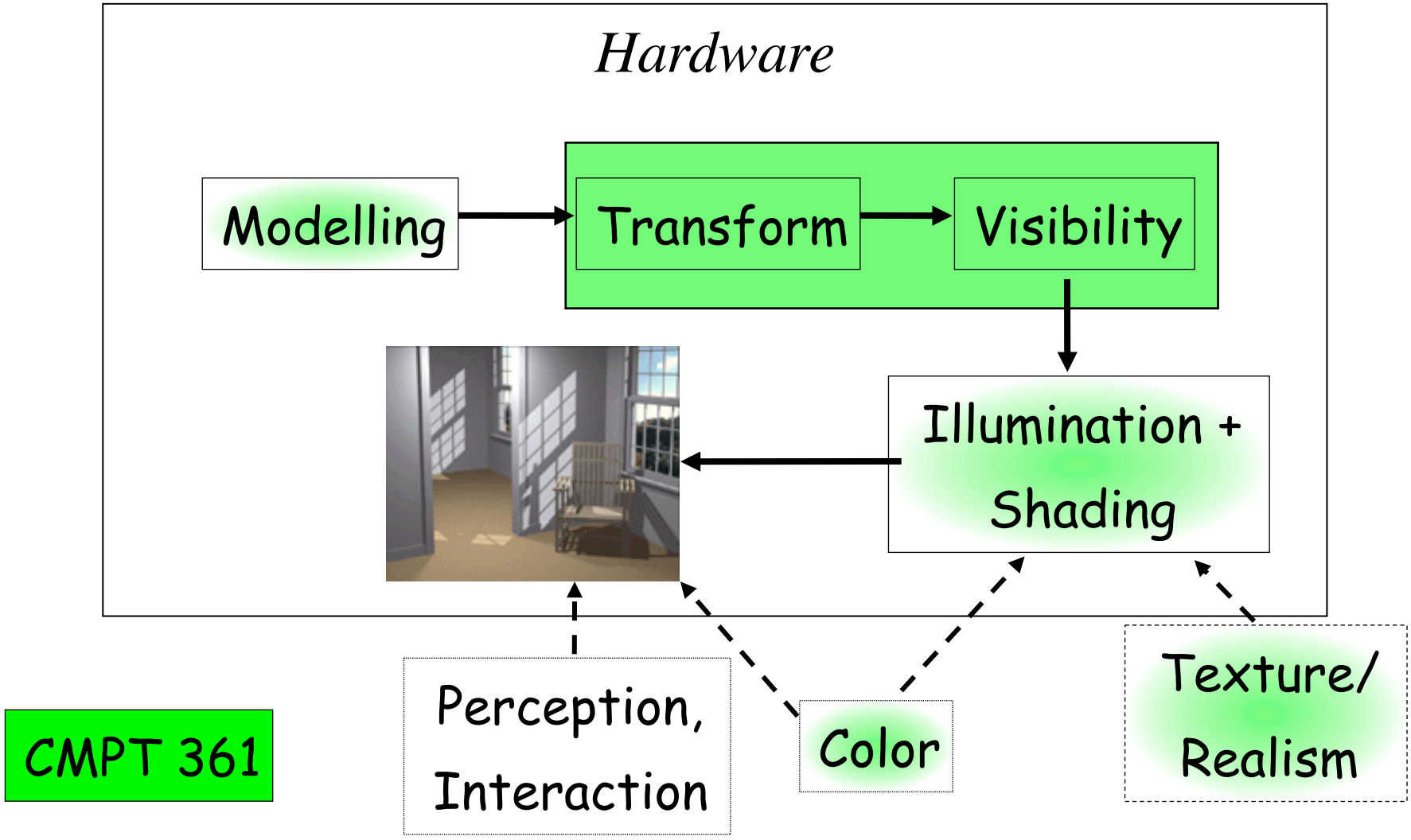
- Concentrate on polygonal models for geometry
  - Start in 2D: points, lines, and polygons
  - 3D polygonal meshes and subdivision surfaces
- A little bit of parametric curves and surfaces

- OK, we have a geometric model, what now?
- Have to display it on the screen – rendering

Rendering in CMPT 361

- Add in viewing information:
  - Transformation: transform our geometric model depending on position and orientation of camera
  - Visibility: determine what can be seen (do not draw what cannot been seen)
- Add in light: illumination and shading
- Add in texture: texture mapping
- Add in color: some coverage on color models/ representations

Graphics Pipeline



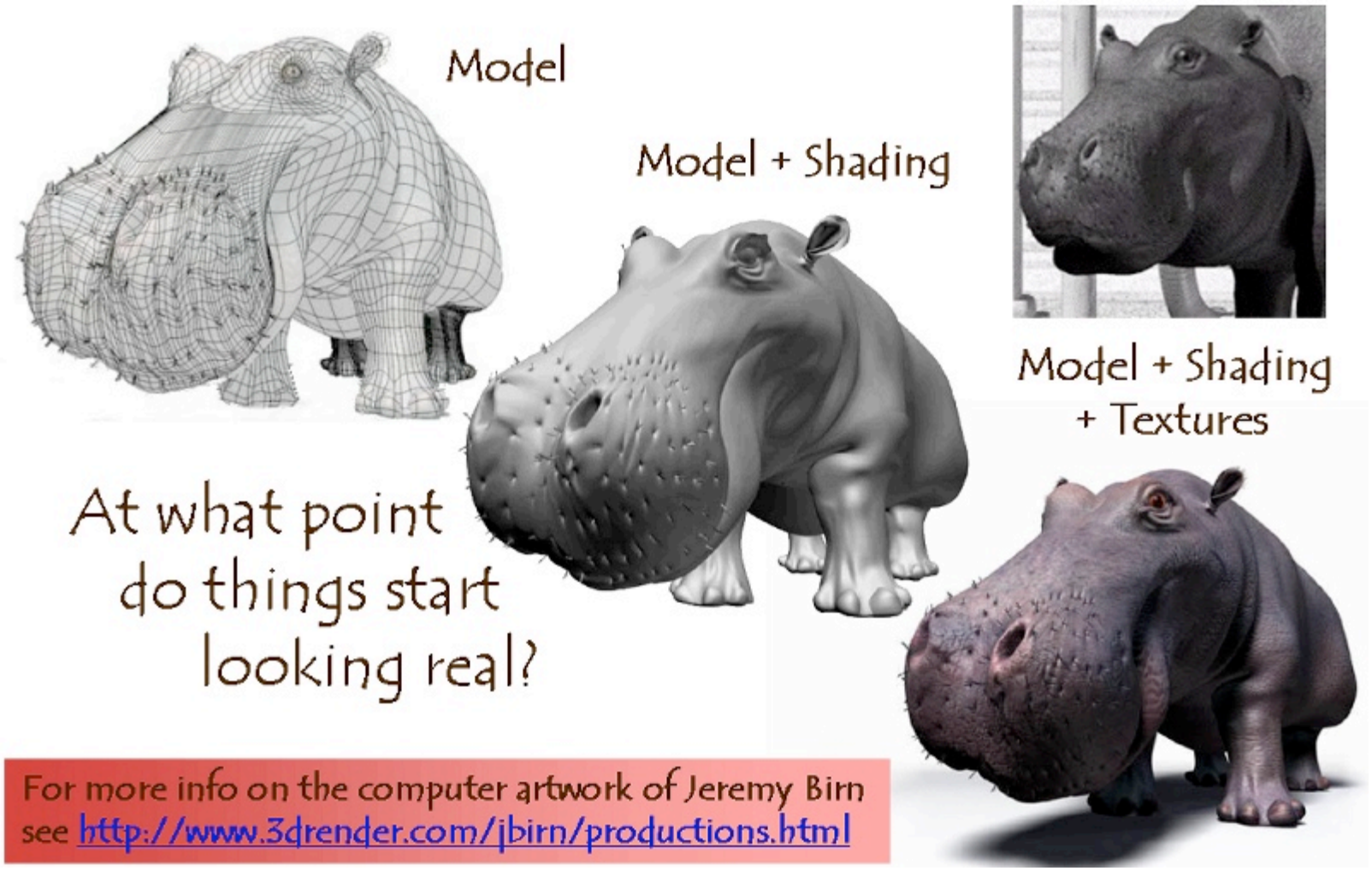
Topics of CMPT 361 (1)

- Image formation and two fundamental graphics algorithm used for image formation
- Graphics architectures
- Programming basics using OpenGL – the graphics library we use
- 2D raster graphics – scan conversion (rasterization) of simple primitives (lines, circles, polygons) and clipping
- 2D and 3D geometric transformations – rotation, translation, use of homogenous coordinates, etc.

Topics of CMPT 361 (2)

- 3D viewing – transformations, hidden surface removal, clipping, etc.
- Illumination and shading – local models, global models, color models, texture mapping
- Curves and surfaces
- Polygonal meshes and subdivision surfaces
- Sampling issues and antialiasing

The Quest for Visual Realism



Syllabus

See Web Page

What Is It I Expect?

- Good programming background
  - C/C++
  - Preferably some previous OpenGL exposure
- Good Unix exposure
  - Make files, etc.
- Basic computer science
  - Data structures, algorithms
- Basic math
  - Numerical integration
  - Linear algebra, systems of linear equations
  - Vectors, matrices
- Keeping up with the text(s) is very important

I Am Not Going To ...

- Teach C/C++
- Teach data structures
- Teach linear algebra and basic numerical methods
- Questions about C/C++ are low priority
- Lab procedures are your responsibility

Other Courses at CMPT

- CMPT 461/761 – Image Synthesis
- CMPT 464/764 – Geometric Modeling
- CMPT 467/767 – Visualization
- CMPT 466 – Animation

- CMPT 363/773 – User Interface Design
- CMPT 365/820 – Multimedia Systems
- CMPT 412, 414, 821, 822 – Computer/ Computational Vision
- CMPT 406/813 – Computational Geometry

Other Courses at SFU

- Cmpt 340 – Biomedical Computing
- Cmpt 468/768 - Computer Music
- Cmpt 419/726 - Machine Learning
- Ensc 489/889 – Computer Aided Design, 3D object modeling
- Ensc 424 – Multimedia Communications Eng.; Image/Video Coding
- Ensc 429 – Signal Processing