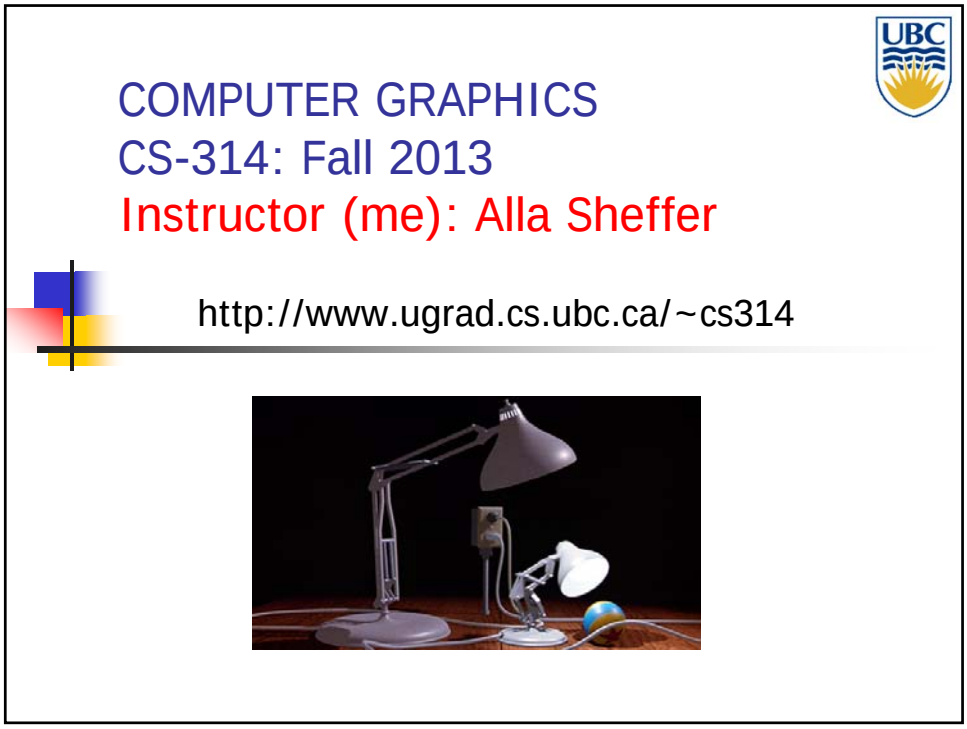
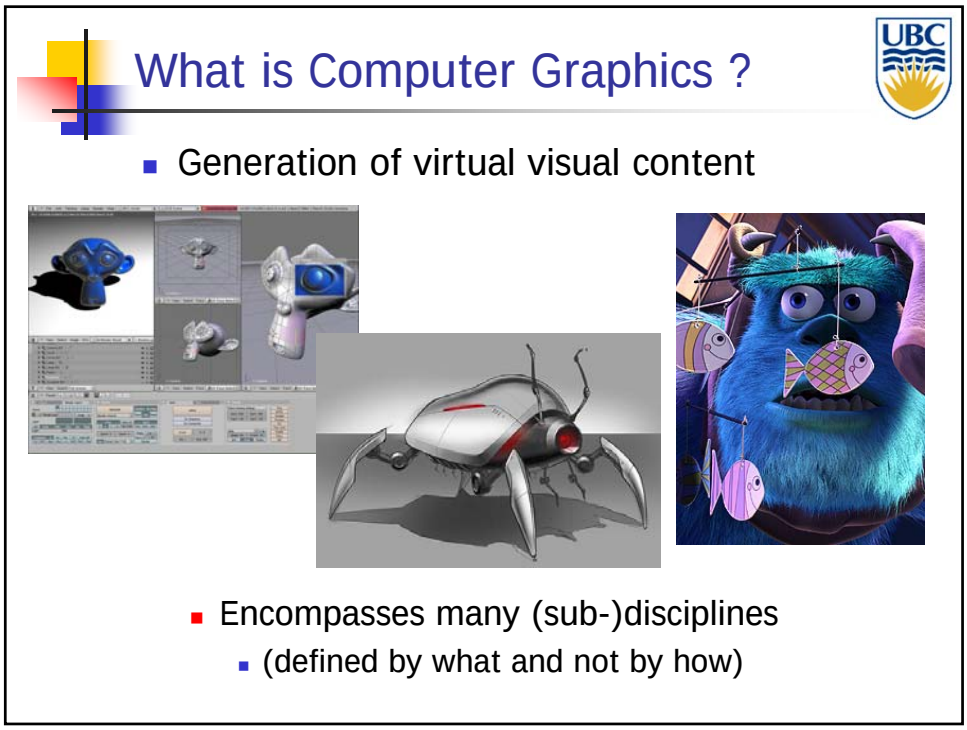




What is CG used for?

What is CG used for: Movies

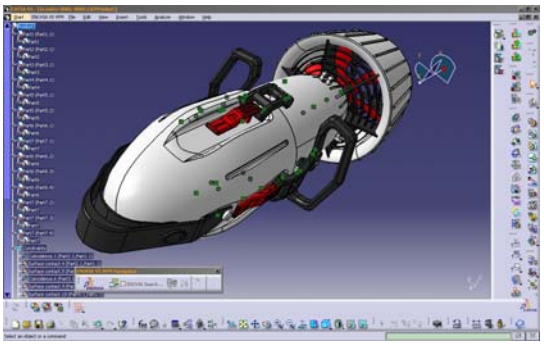
Animation

Special Effects (mixed reality)

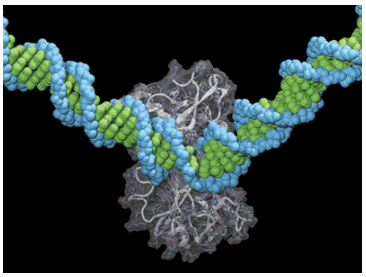
What is CG used for: Games

What is CG used for: Digital Media

What is CG used for: Everything ☺



Engineering (CAD)



Natural Sciences (Visualization/Simulation)

The Science of CG: Components

- Content Creation (3D):
  - Modeling - Representing object properties
    - Geometry: polygons, smooth surfaces etc.
    - Materials: reflection models etc.
  - Animation - Making geometric models move and deform
- Rendering - Generation of 2D images from (3D) models
  - Interactive rendering
  - Global (offline) methods: Ray-tracing, etc...
- Imaging – manipulation of 2D images

The Science of CG : Brief history

Then (1980s)

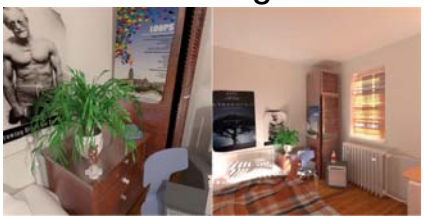
Now (trailer from SIGGRAPH'13)

The science of CG (circa 2013)

- Modeling

- Animation

- Rendering

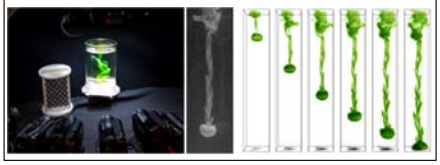


- Imaging

CG Research at UBC

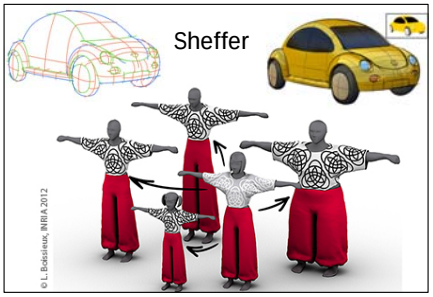
Van de Panne

Heidrich



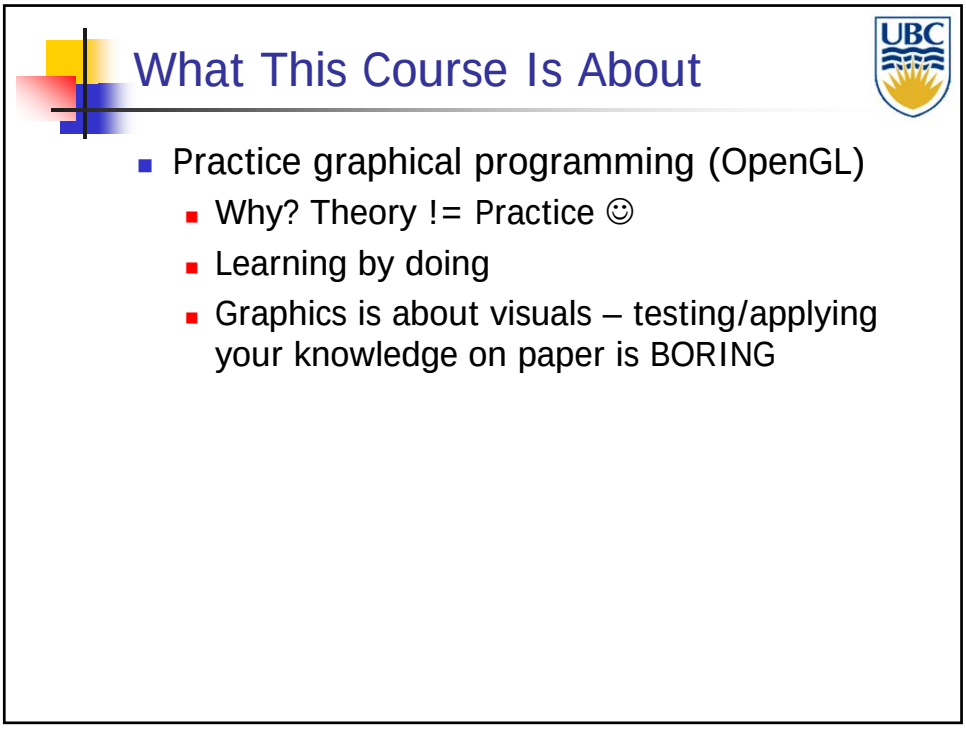
Pai

Sheffer



What This Course Is About

- Fundamental algorithms of computer graphics
- Course Focus: Rendering
  - Why?
    - Critical core graphics component
    - Lots of ideas/methods shared with other CG components
- Content creation addressed in detail by follow-up courses
  - Modeling – 424 (next year)
  - Animation – 426 (next term)
  - Grad level (rendering, modeling, animation)



Why study CG?

- It is fun – create visually appealing results
- Opens doors to lots of job opportunities
- Gain programming experience
  - Programming as means not end – lots of math, theory, intuition
- Warning: Not at easy course
  - heavy math
  - heavy programming

Course Info/Policies (boring stuff):
http:www.ugrad.cs.ubc.ca/~cs314

Teaching Staff

- Instructor: Alla Sheffer
- Office hours (in X651):
  - Monday 2-3PM
  - Tuesday 2-3PM
  - Wednesday 11-12AM
- Contact: sheffa@cs.ubc.ca
  - **Use only for personal stuff.**
  - **Use discussion board (piazza) for everything else**
- TAs: Chris Thompson, Russell Gillette, Boris Dalstein

Course Information

- Up-to-date information:
  - http://www.ugrad.cs.ubc.ca/~cs314
    - updated often, reload frequently
  - Discussion board on *Piazza* - to set up account follow link from course home page
- I assume that once information is posted on board or web-page students know it
  - within 2 workdays

More Info

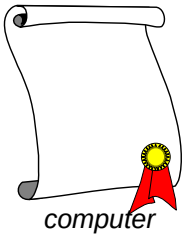
- Programming prereq
  - CPSC 221 or CPSC 260+EECE 320
  - Good knowledge of C++
- Math prereq
  - MATH 200 (Calculus III)
  - MATH 221 (Matrix Algebra)

Lectures/Labs

- Lectures: Mon Wed Fri 1PM–2PM (DMP 301)
  - Please arrive on time
- Labs:
  - Tue 13-14 Wed 12-13, Thu 15:30-16:30
  - Example problems in spirit of quizes and exams + help with programming assignments
- Attendance not a MUST ...but
  - Participation part of final grade (more later)
  - Strongly recommend that you attend both

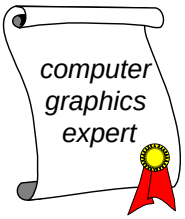
Grading

- Programming Assignments: 40%
- Weekly Mini Home Quizes: 3%
- Participation 5%
  - Note Taking
  - Classroom
  - Review question composition
- Two Midterms: 24%
  - 12% +12%
- Final Exam: 28% (must pass)



Grading: Programming Assignments

- 40% of the grade
- 2D Game: Intro to OpenGL (6%)
  - **out this week**
- 3D Transformations – modeling/animation (11%)
- Rendering pipeline (11%)
- Ray tracing (12%)



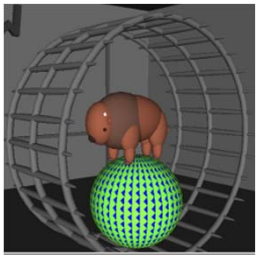
Grading: Participation (5%)

- Note taking: Record course notes & post on DB
  - At least three lectures (sign in for dates)
  - Points (bonuses) given for quantity & quality
    - quality evaluated by fellow students
- Classroom: ***Clicker*** responses + other Q&A
- Reviews: Post one or more weekly review questions
  - Based on material covered each week
  - Submit via DB (private, rev# tag)
    - till Mon noon
  - Include: question, multiple choice answers, explanation of correct answer

Grading: Mini Home Quizes: (3%)

- Online (connect.ubc.ca) quiz each week (from week 2)
- Released by Tue AM, Due Friday noon
- Multiple choice questions
  - Student/instructor composed
  - If your question selected double your quiz grade !!!
  - If two selected triple..

Important Dates



- Assignment 1 due: Sep 20
- Assignment 2 due: Oct 11
- Assignment 3 due: Nov 1
- Assignment 4 due: Nov 29

- Midterm 1: Oct 18
- Midterm 2: Nov 8

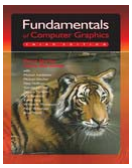
Course Organization

- Programming assignments:
  - C++, Windows or Linux
    - **Tested on department Linux machines**
  - OpenGL graphics library / GLUT for user interface
- **Face to face grading in lab**
  - Opportunity to show all the "cool" extra stuff
  - Test that you do *know* what every piece of your code does
- Hall of fame – coolest projects from 2002 on

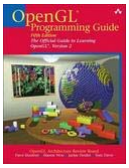
Late/Missing Work

- Programming Assignments:
  - 3 grace days **TOTAL**
    - for unforeseen circumstances
    - strong recommendation: don't use early in term
    - handing in late uses up automatically unless you tell us
- Home Quizes/Review Question Sets
  - Can miss *two* of each
- Exception: severe illness/crisis, as per UBC rules
  - MUST
    - Get approval from me ASAP (in person or email)
    - Turn in proper documentation

Literature (optional)



- Fundamentals of Computer Graphics
  - *Third edition (second is OK too – but note syllabus changes)*
  - Peter Shirley, A.K. Peters



- OpenGL Programming Guide
  - J. Neider, T. Davis and W. Mason, Addison-Wesley

Learning OpenGL

- This is a graphics course using OpenGL
  - not a course **ON** OpenGL
- Upper-level class: learning APIs mostly on your own
  - only minimal lecture coverage
    - basics, some of the tricky bits
  - OpenGL Red Book
  - many tutorial sites on the web
    - http://www.xmission.com/~nate/opengl.html

Plagiarism and Cheating

- Short Summary: Don't cheat
  - Home quizes and programming assignments are individual work
  - Can discuss ideas (including on DB), browse Web
  - But cannot copy code or answers/questions
    - If you REALLY think using a source is OK cite it
- **Must** be able to explain algorithms during face-to-face demo
  - or no credit for that assignment, possible prosecution

(Tentative) Lecture Syllabus

- Introduction + Rendering Pipeline (week 1)
- Transformations (week 2/3)
- Scan Conversion (week 4/5)
- Clipping (week 5)
- Hidden Surface Removal (week 6/7)
- Review & Midterm (week 7)
  - Midterm: Oct 18
- Lighting Models (week 8)
- Texture mapping (week 9/10)
- Review & Midterm (week 10)
  - Midterm: Nov 8
- Ray Tracing (week 11)
- Shadows (week 11/12)
- Geometric Modeling (week 12/13)
- Review/State of the art/Q&A (last lecture)

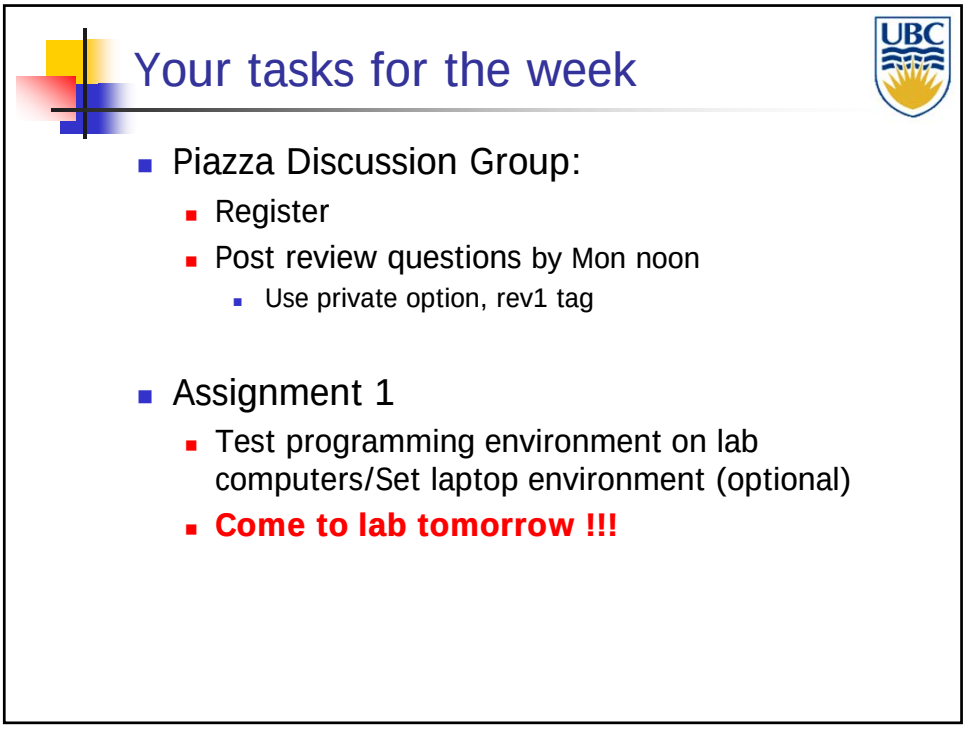
Coming Up...:

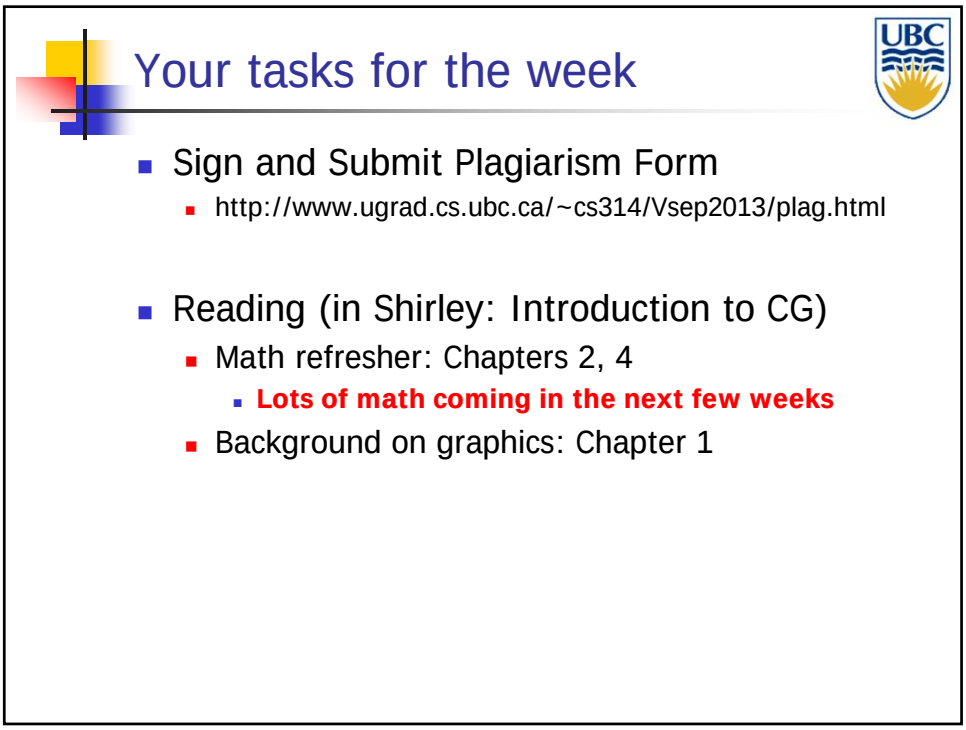
Fri:

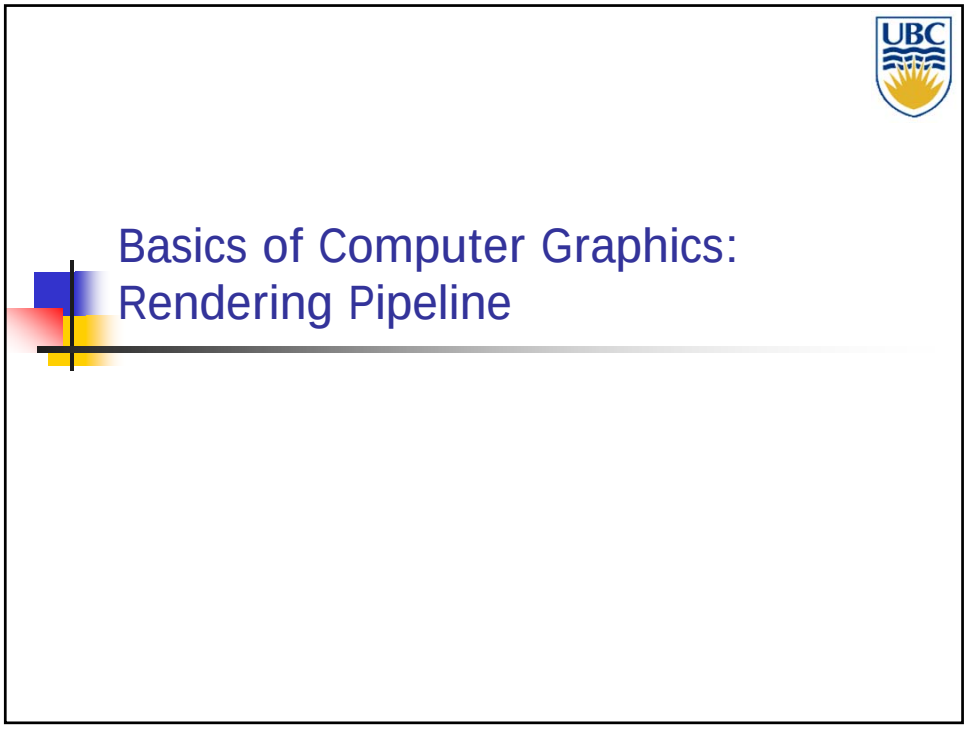
- Rendering pipeline

Next Week:

- Geometric transformations







Rendering

Goal:

- Transform (3D) computer models into images
- Photo-realistic (or not)

Interactive rendering:

- Fast, but until recently low quality
- Roughly follows a fixed patterns of operations
  - **Rendering Pipeline**

Offline rendering:

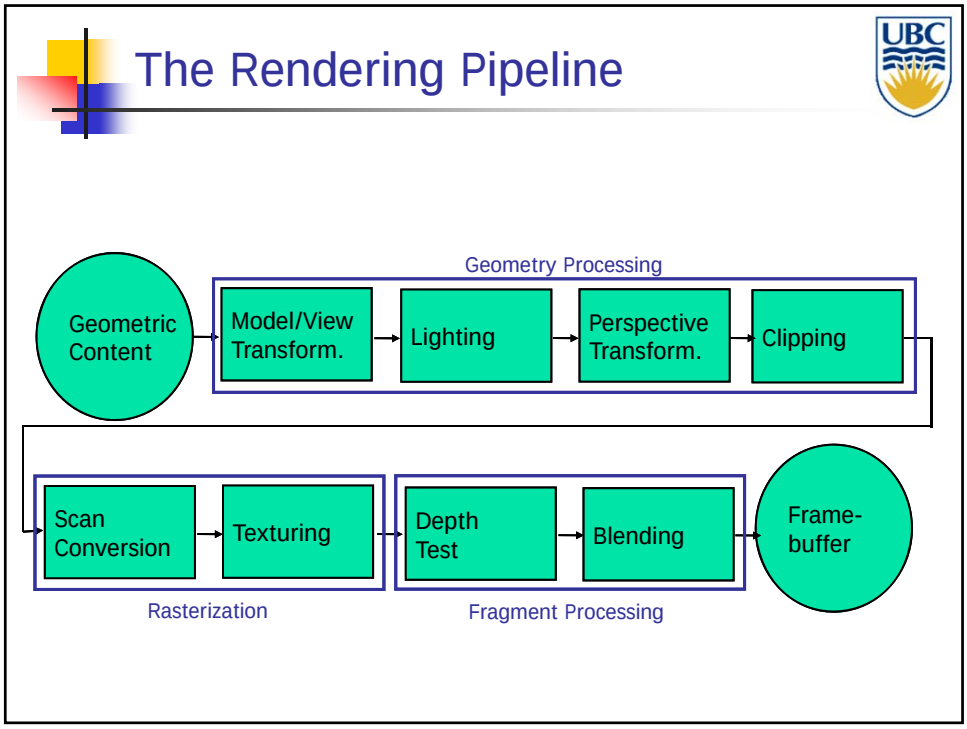
- Ray-tracing
- Global illumination

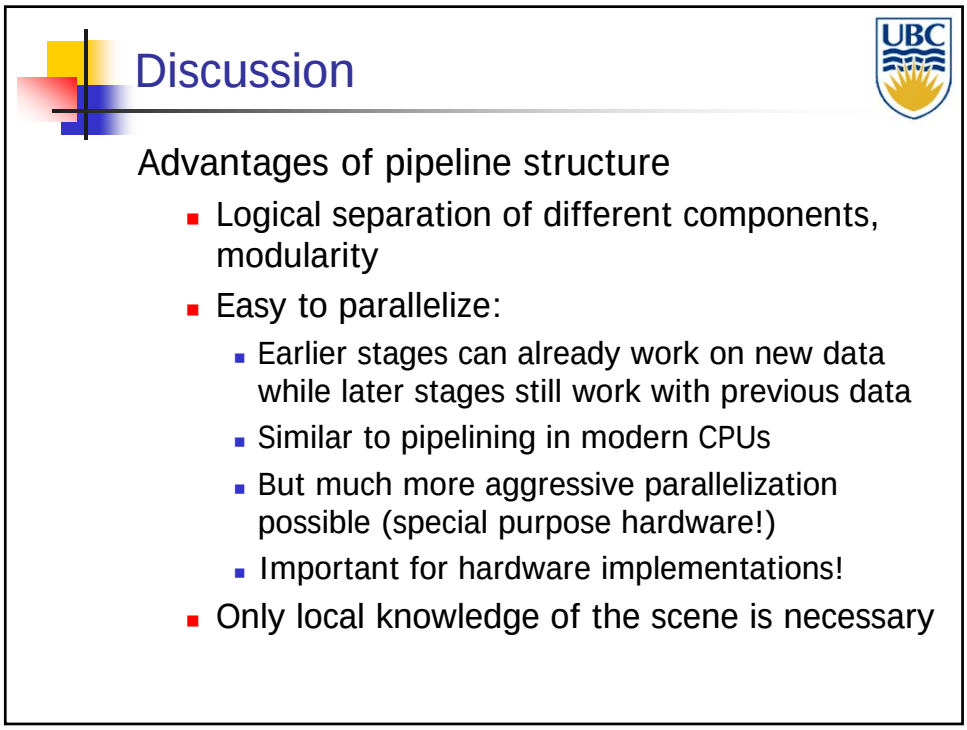
Rendering Tasks (no particular order)

- Project 3D geometry onto image plane
  - Geometric transformations
- Determine which primitives/parts of primitives are visible
  - Hidden surface removal
- Determine which pixels geometric primitive covers
  - Scan conversion
- Compute color of every visible surface point
  - Lighting, shading, texture mapping

Rendering Pipeline

- What is it? All of this:
  - Abstract model - sequence of operations to transform geometric model into digital image
  - Abstraction of how graphics hardware works
  - Underlying API (application programming interface) model for programming graphics hardware
    - OpenGL
    - Direct 3D
- Actual implementations vary





Discussion

Disadvantages:

- Limited flexibility
- Some algorithms would require different ordering of pipeline stages
  - Hard to achieve while still preserving compatibility
- Only local knowledge of scene is available
  - Shadows
  - Global illumination