CSCD18: Computer Graphics

Instructor: Leonid Sigal

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Instructor:

- Leonid Sigal (call me Leon)

  lsigal@utsc.utoronto.ca

  www.cs.toronto.edu/~ls/

  Office: SW626

  Office Hour: M, 12-1pm?

TA:

- Alexander Wong

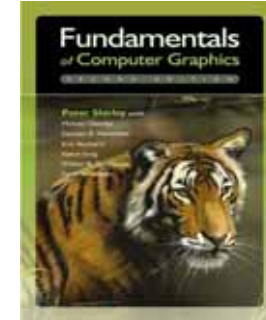 wongam@cs.toronto.edu

  Office Hour: TBA as needed

Lectures: M 10am (BV361)

W 10am (BV363)
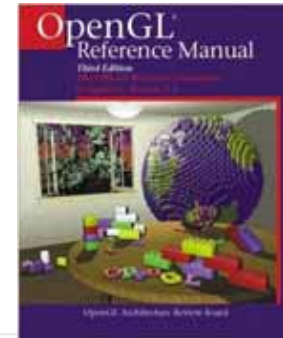
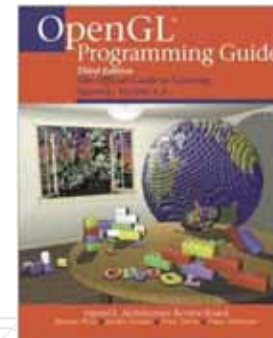**Tutorials:** M 4-5pm (SW221)

Background:

- Programming: C/C++
- Math: linear algebra, geometry, calculus (multivariate)

www.cs.toronto.edu/~ls/teaching.html

Textbooks and Reading

- *Required:* Fundamentals of Computer Graphics by P. Shirley (2nd Edition)

- *Reference:*
  OpenGL Programming Guide
  OpenGL Reference Manual
  (both available on-line … see course webpage)

- *Lecture Notes and Slides (required):* Designed augment textbook material. Will be made available from the course webpage as we cover relevant material.

www.cs.toronto.edu/~ls/teaching.html

Grading

Grading:

- Assignments: 50% [15%, 15%, 10%, 10%]
- Midterm Test: 15% (mid to end of October)
- Final Exam: 35%

Notes:

- Assignments 1/2/3 will have written portion (due dates fall on Wednesdays – due by 9:50am in the drop box) and programming portion (due dates fall on Fridays – due before 11:59pm electronically)
- Assignment 4 is programming only (due last day of classes)
- Extensive programming problems (begin early)
- One must obtain >35% on the final exam to pass the course.
- Assignment work submitted should be your own (unless otherwise specified)!

Late Policy:

- No Extensions (usually)
- Late Penalty (15% per day, up to 5 days)

Assignment (tentative schedule)

Assignment 1:
- Out: Wed, Sept 17th
- Written part due: Wed, Oct 1st
- Programming part due: Fri, Oct 10th

Assignment 2:
- Out: Wed, Oct 8th
- Written part due: Wed, Oct 22nd
- Programming part due: Fri, Oct 31st

Assignment 3:
- Out: Wed, Oct 29th
- Written part due: Wed, Nov 12th
- Programming part due: Fri, Nov 21st

Assignment 4:
- Out: Wed, Nov 17th
- Due: Mon, Dec. 1

All assignment are to be done individually (except otherwise stated)

Main forum for asking questions about the assignments will be bulletin board (UofT Portal/Blackboard) which will be monitored by myself and TA or the Tutorial Session

Scholarly Conduct

Full policy is on the course webpage and in the syllabus:

- You are allowed to discuss assignments on the level of ideas

- Copying or adapting code (for programming assignment) or derivations (for written assignments) is not allowed

- Any collaboration of the form noted in the previous bullet **must be acknowledged at the time of assignment submission** (and will lead to zero points for that portion of the assignment that was copied or adopted … but you will get credit for the portion of the assignment that is your own)

- If acknowledgement of other sources (be it books, web or other students in the class) is not given at the time of assignment submission, you are implicitly committing an act of academic dishonesty (for the purposes of this class) and it will be treated accordingly.

Announcements

- There will be no tutorial this week !!!
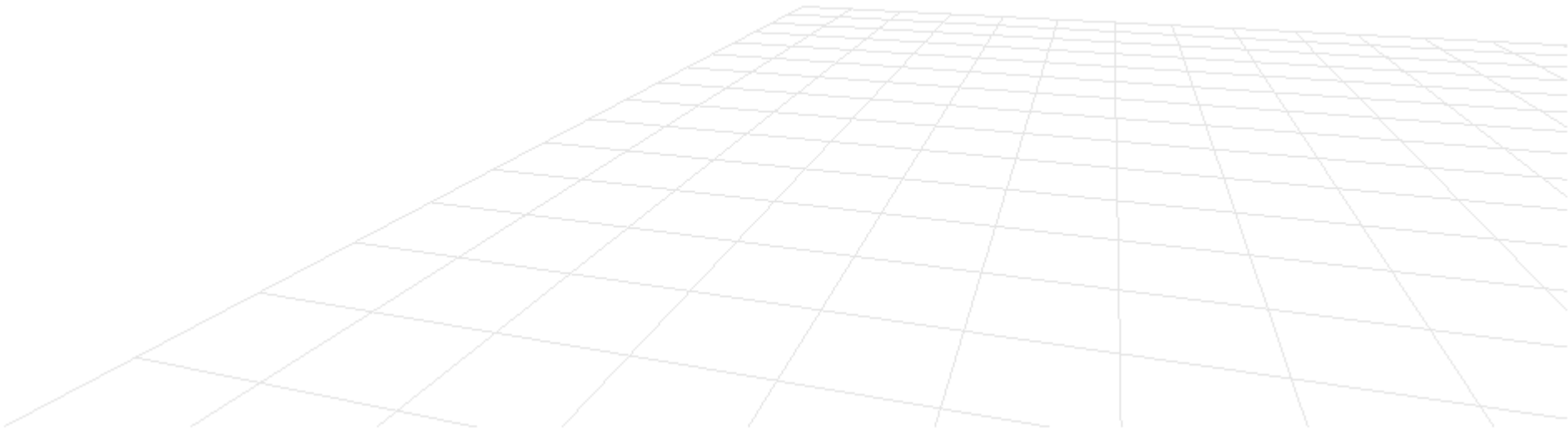
Introduction:
What is Computer Graphics?
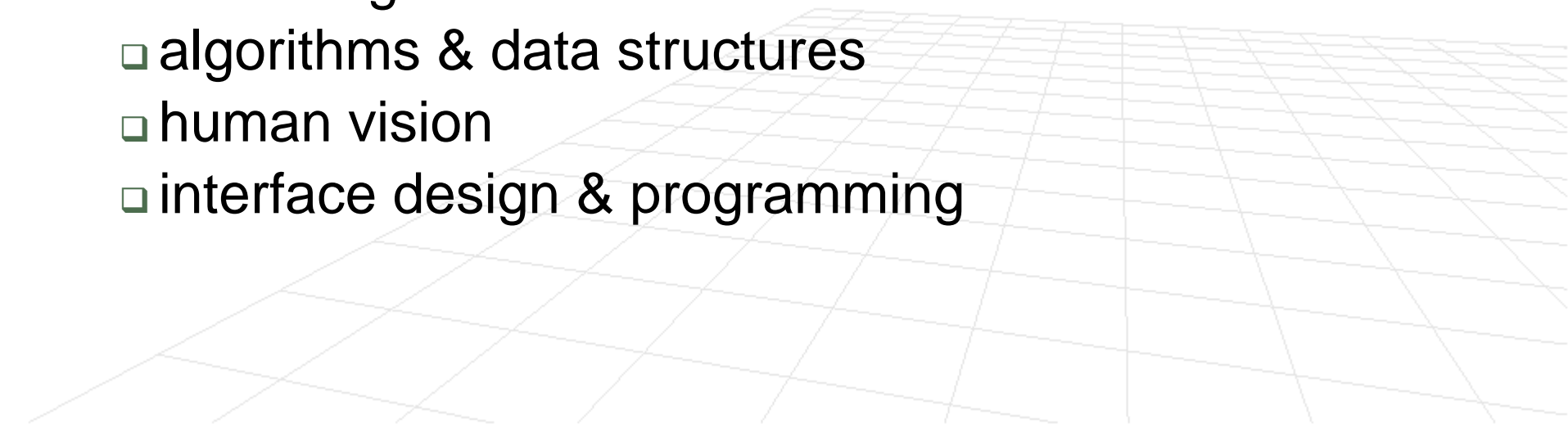
Computer Graphics, CSCD18

Fall 2008

Instructor: Leonid Sigal

What is Computer Graphics?

Technology for generation of visual media (images & digital video) with control over style, appearance, realism, motion, …

Key Elements:

- modeling objects and scenes, animation, and rendering
- algorithms & data structures
- human vision
- interface design & programming

Goals of the course?

Technology for generation of visual media (images & digital video) with control over style, appearance, realism, motion, …

Goals:

- theoretical and practical foundations of computer graphics
- emphasis on core mathematics, physics, models, & methods
- experience with OpenGL (industry standard CG library) and creating CG scenes

CG is Movies

- Movies define directions in CG
- Set quality standards
- Driving medium for CG

Games

- Games emphasize the interactivity and AI
- Push the CG hardware to the limits (for real time performance)

(we will not be discussing games much in this class)
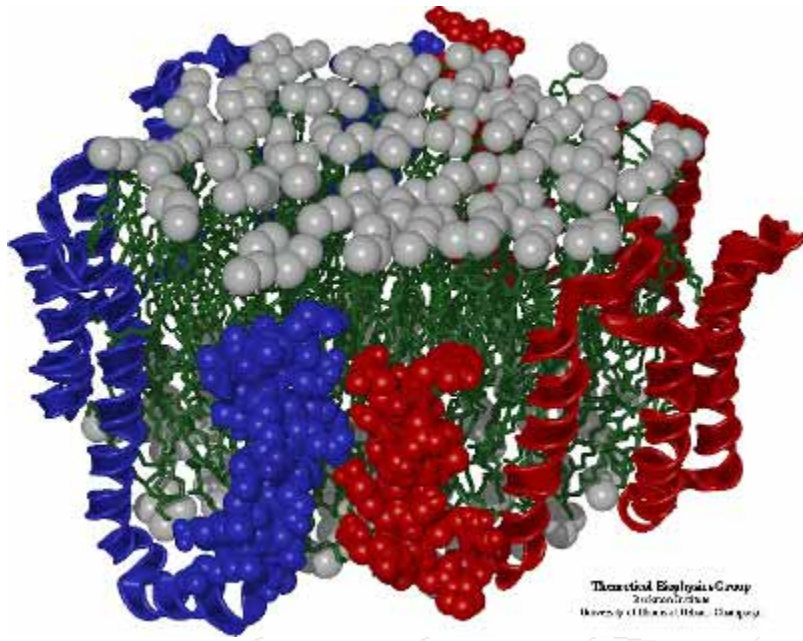
Industrial Design

- Costly to build physical prototypes
- Often CG models is the easier and cheaper alternative

- Requires precision modeling
- Interactive engineering visualization

Scientific Visualization

- Device integration
- Large datasets

environmental physics

molecular biology
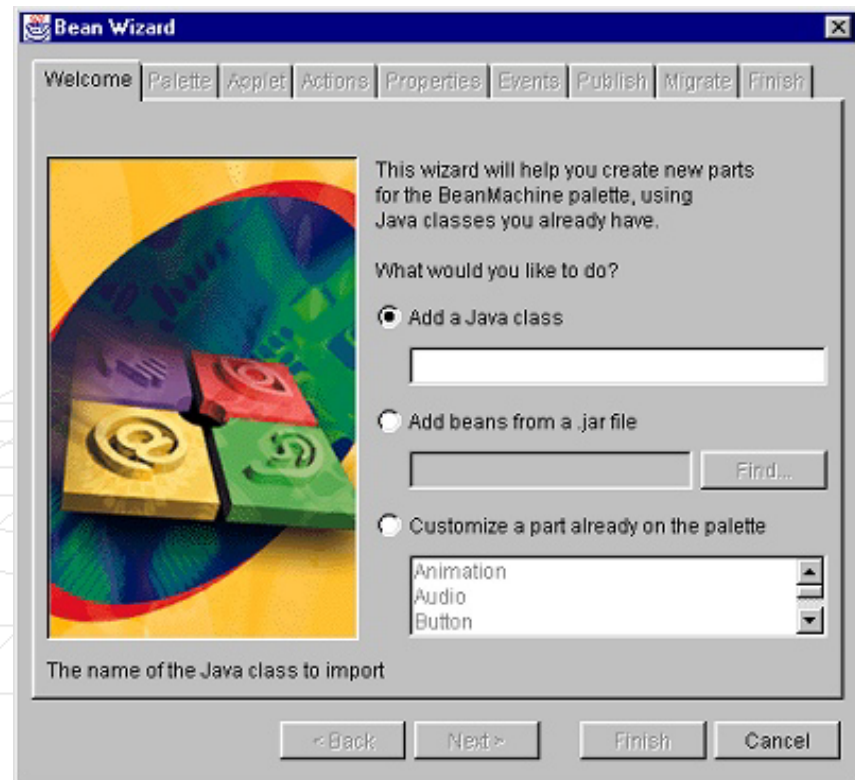
Medical Imaging and Computer Assisted Surgery

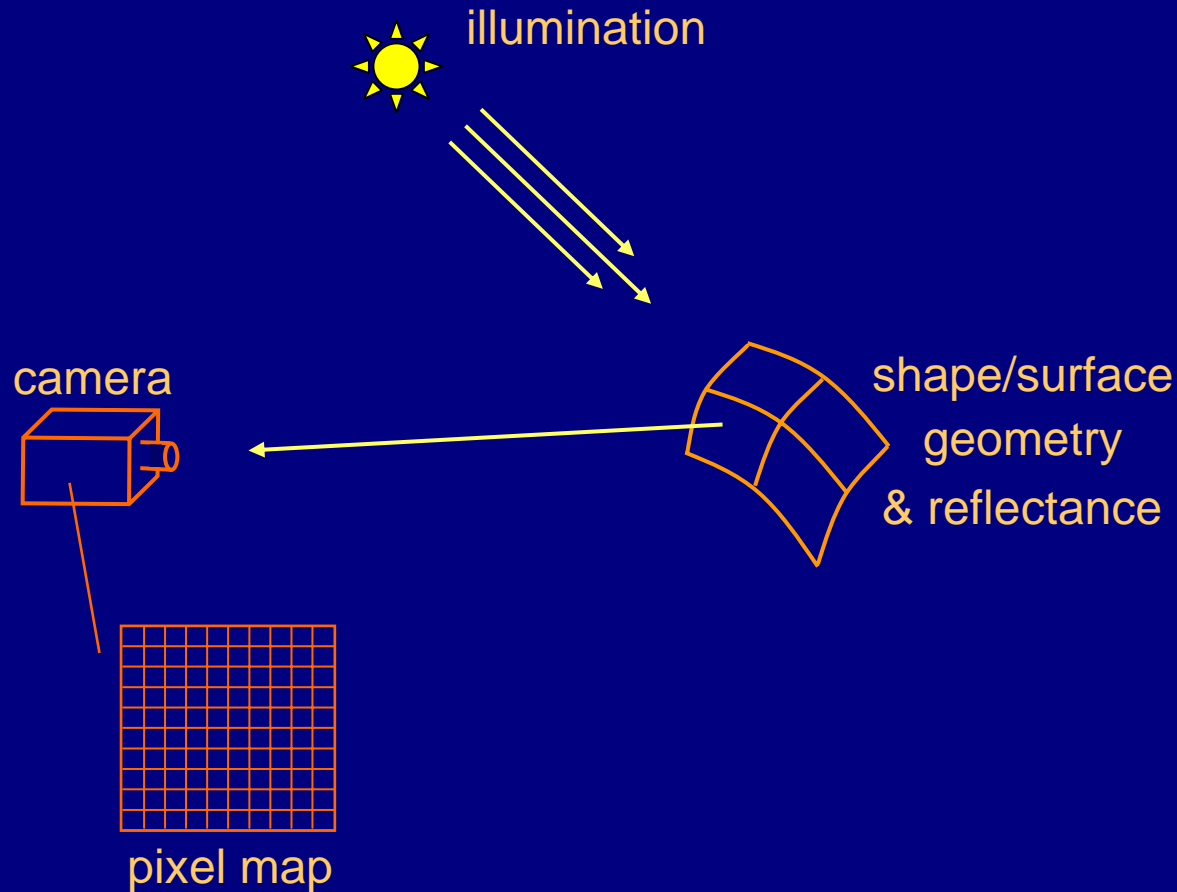- Device integration
- Large datasets

- Real-time interactive modeling

Graphical User Interfaces

- Interaction with software and hardware
- Emphasis on usability
- Typically simpler (only need to deal with simple 2D objects)

Technical Elements of Computer Graphics

Graphics Pipeline

Modeling	→	Animation	→	Rendering

- Geometry: points, curves, & surfaces
- Scene Objects: parts, relations, & pose
- Texture and reflectance (e.g., color, diffusivity, opacity, refractions)
- …

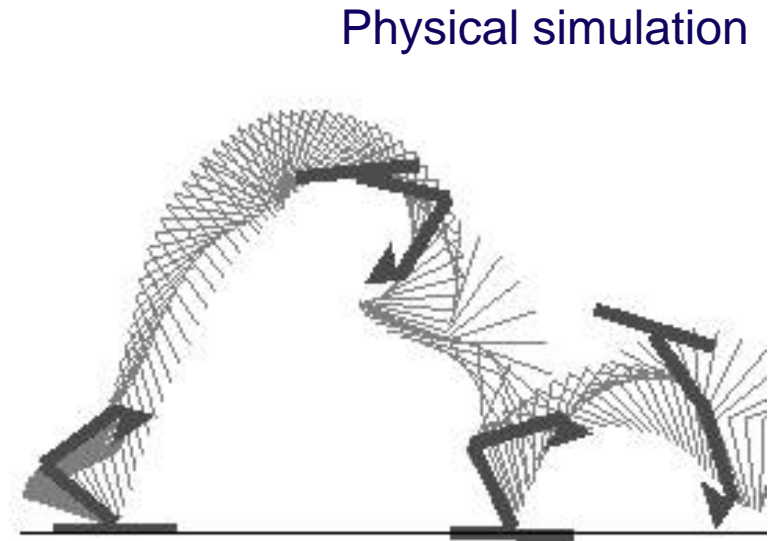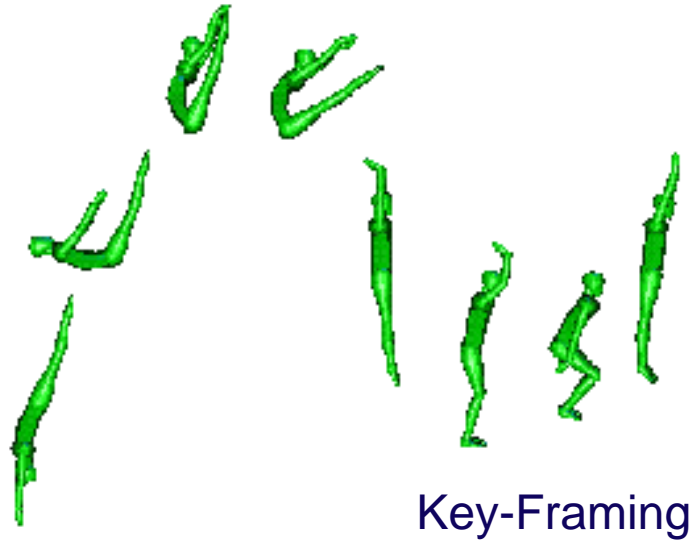- Key-frame, motion capture, inverse kinematics, dynamics, behaviors, motion planning, …

- Visibility
- Simulation of light (e.g., illuminants, emissive surfaces, scattering, transmission, diffraction, …)
- Special effects (e.g., anti-aliasing, motion blur, non-photorealism)

Graphics Pipeline: Modeling

How do we represent an object geometrically on a computer?

Point clouds

Texture maps

Polygon meshes

Smooth surface patches

Parametric curves
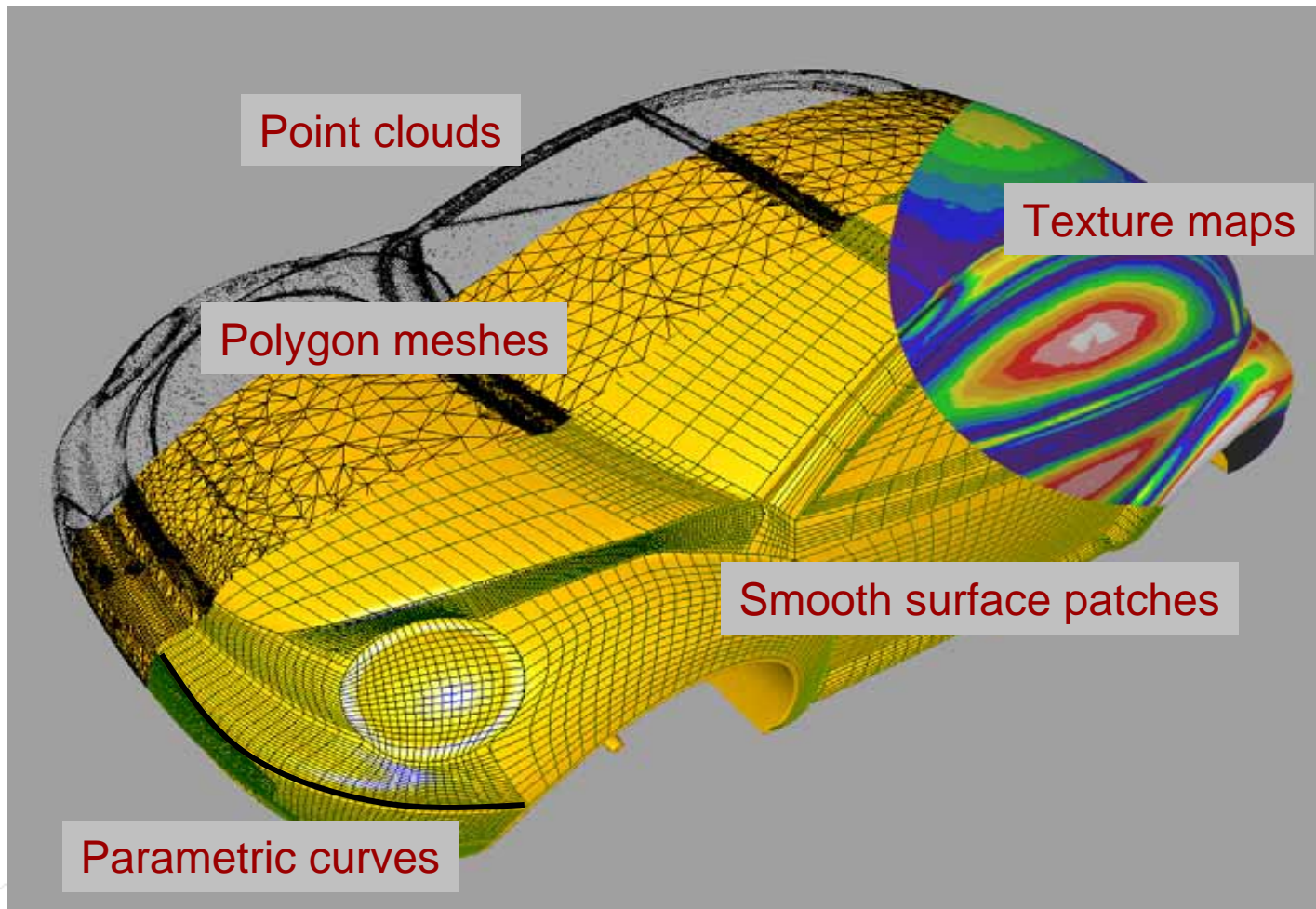
Graphics Pipeline: Animation

Physical simulation

Key-Framing

Behavior rules

Key-frame Animation (example)

Luxo Jr., Pixar

Graphics Pipeline: Rendering

- **Inputs**
  - **Scene Description:**
    - What objects are in the scene?
    - What are relationships between them?
  - **Lighting:**
    - Where are the lights?
    - What are the properties of the lights?
  - **Camera:** Location and viewing direction

- **Output**
  - **Image that the camera will observe**
  - Must consider:
    - Visibility
    - Clipping
    - Scan conversion
    - Projection
    - Textures
    - …

Putting it all together

Geri's Game, Pixar