

# COMPUTER GRAPHICS

15-462

Srinivas Narasimhan

T-R: 1:30 pm - 2:50 pm  
HH B131

# INTRODUCTION

- Administrivia.
- What is computer graphics?
- What I do...
- Topics

# INTRODUCTION

- Administrivia.
- What is computer graphics?
- What I do...
- Topics

# GOALS OF COMPUTER GRAPHICS

- Faking reality – convincingly.
- Creating alternative reality.

# FAKING REALITY

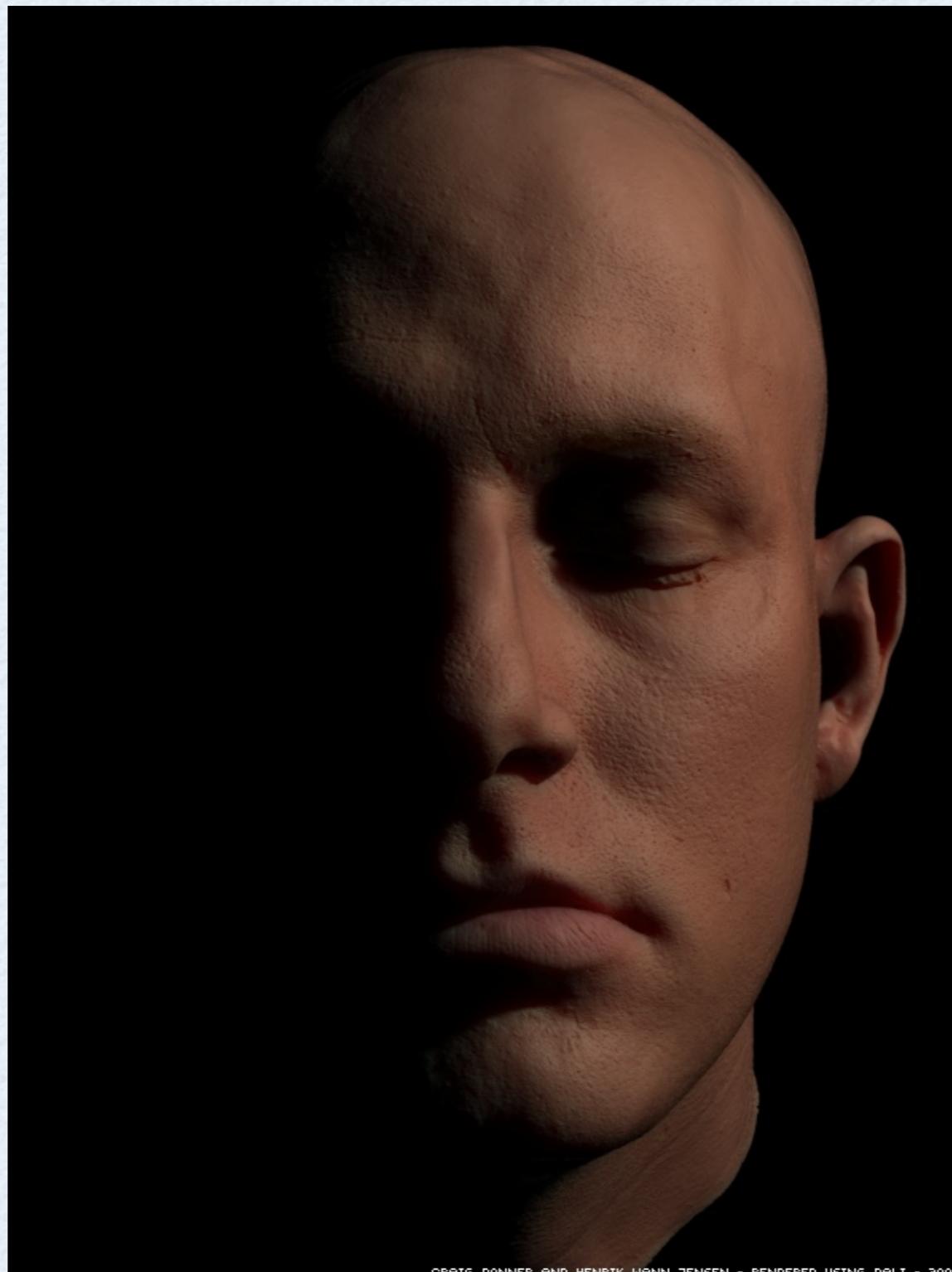


RENDERED USING DALI - HENRIK WANN JENSEN 2000

# FAKING REALITY



# FAKING REALITY



CRAIG DONNER AND HENRIK WANN JENSEN - RENDERED USING DALI - 2005

# ALTERNATIVE REALITY



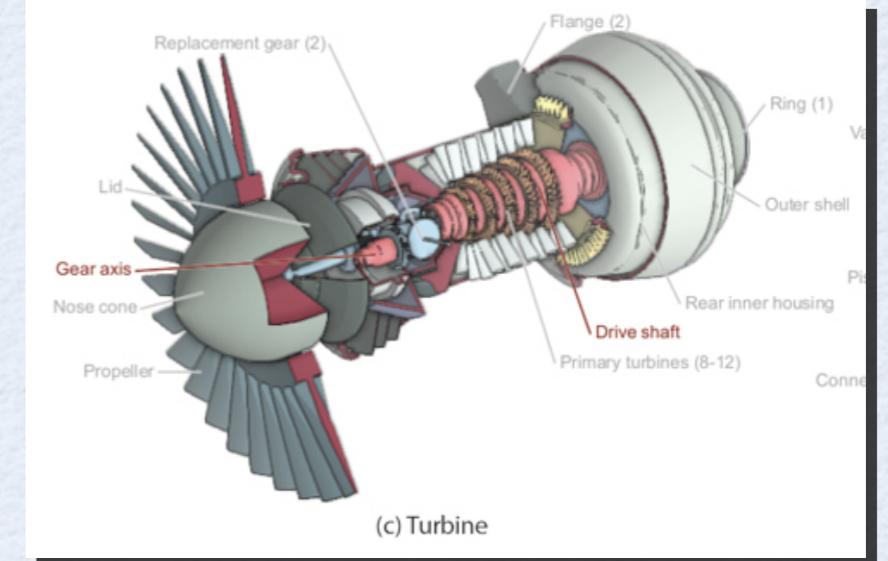
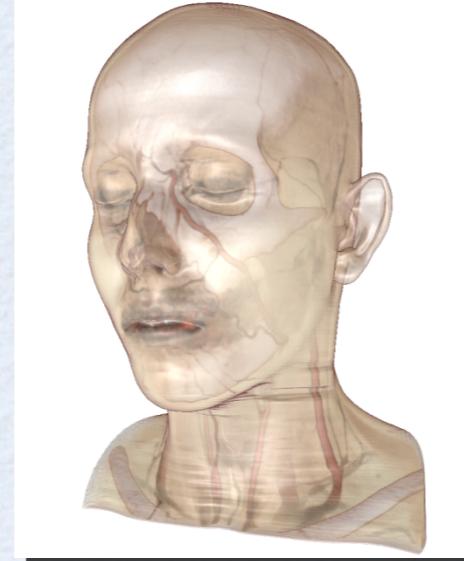
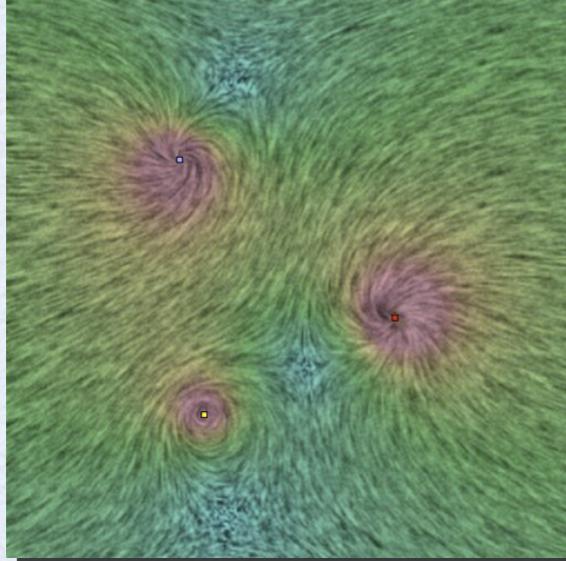
# MAKING OF THE GATORADE COMMERCIAL



# WHAT IS COMPUTER GRAPHICS?

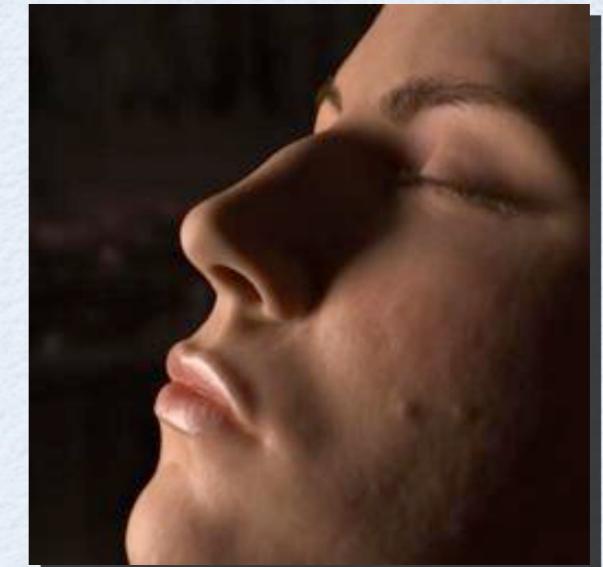
- 3D Modeling / Geometry
- Simulation / Animation / Character Animation
- Lighting / Light Transfer
- Textures and Color
- Post-Processing: Image Processing
- Camera tricks / Optics

# WHAT ELSE IS COMPUTER GRAPHICS



Scientific Visualization

Illustration



NPR / Art

Computational Photography

Virtual Life

*and much more....*

# WHO AM I

- I'm a vision/graphics researcher.
- I've been at SCS (Robotics Institute) for 7 yrs.
- PhD 2004 Columbia University.



# INTRODUCTION

- Administratrivia.
- What is computer graphics?
- What I do...
- Topics

# WHAT I DO



Merlot Wine



Chardonnay Wine

# WHAT I DO



Yuengling Beer



Coca-Cola

# WHAT I DO



Yuengling Beer



Milk

# WHAT I DO

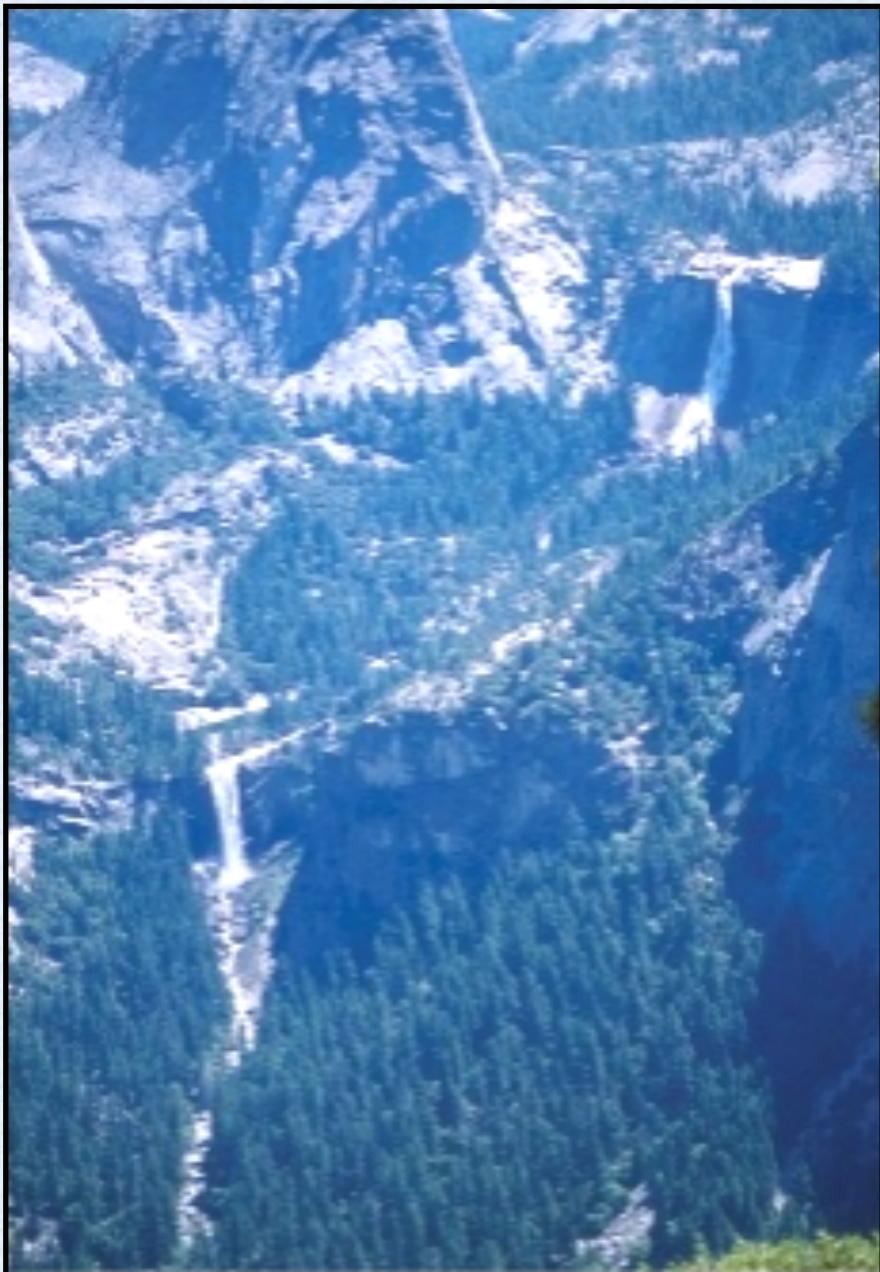


# WHAT I DO

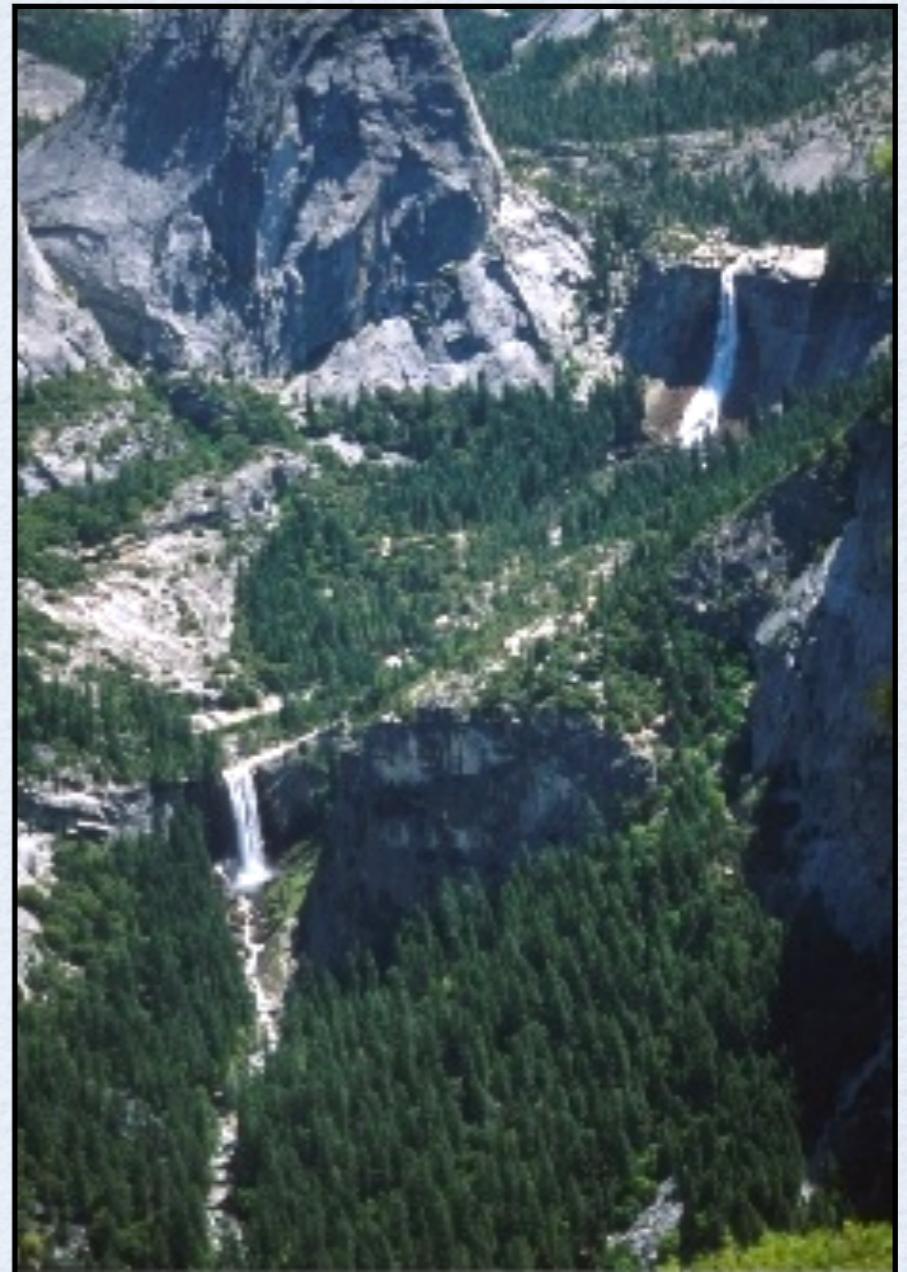


BesZ © TheReasoner.com

# WHAT I DO

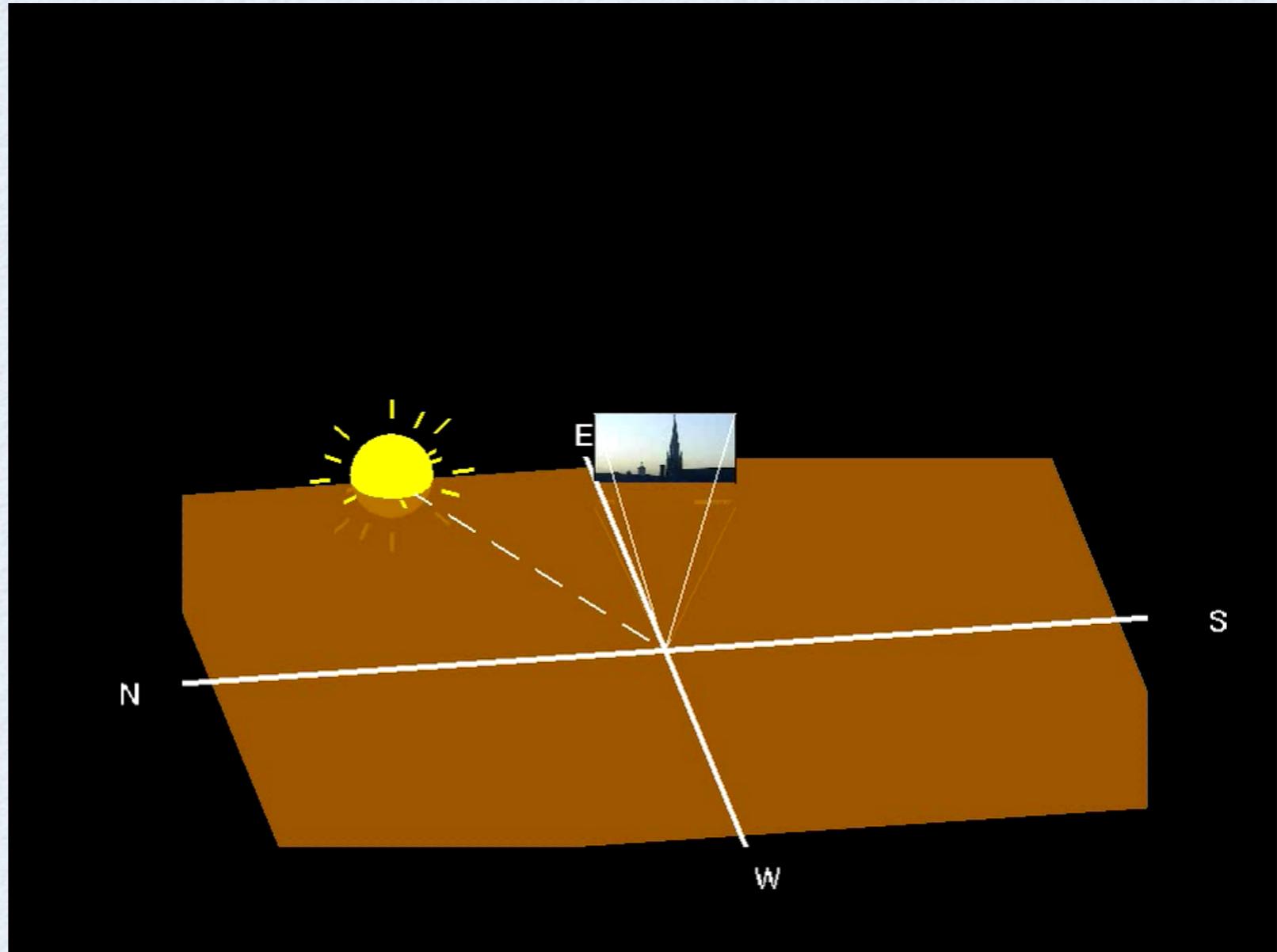


Haze



De-hazed

# WHAT I DO



# WHAT I DO

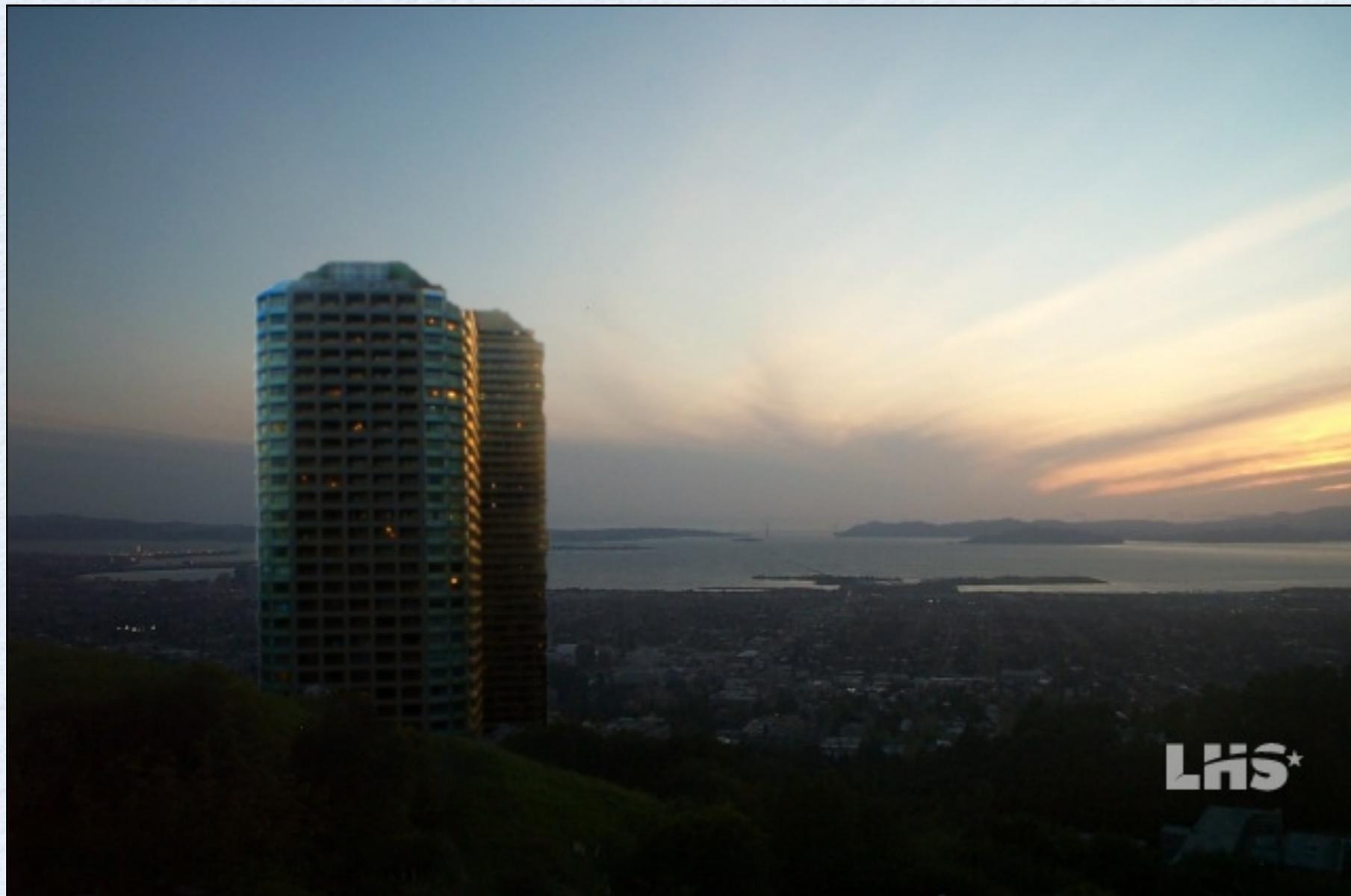


Tokyo Sky Scraper



Berkeley Scene

# WHAT I DO



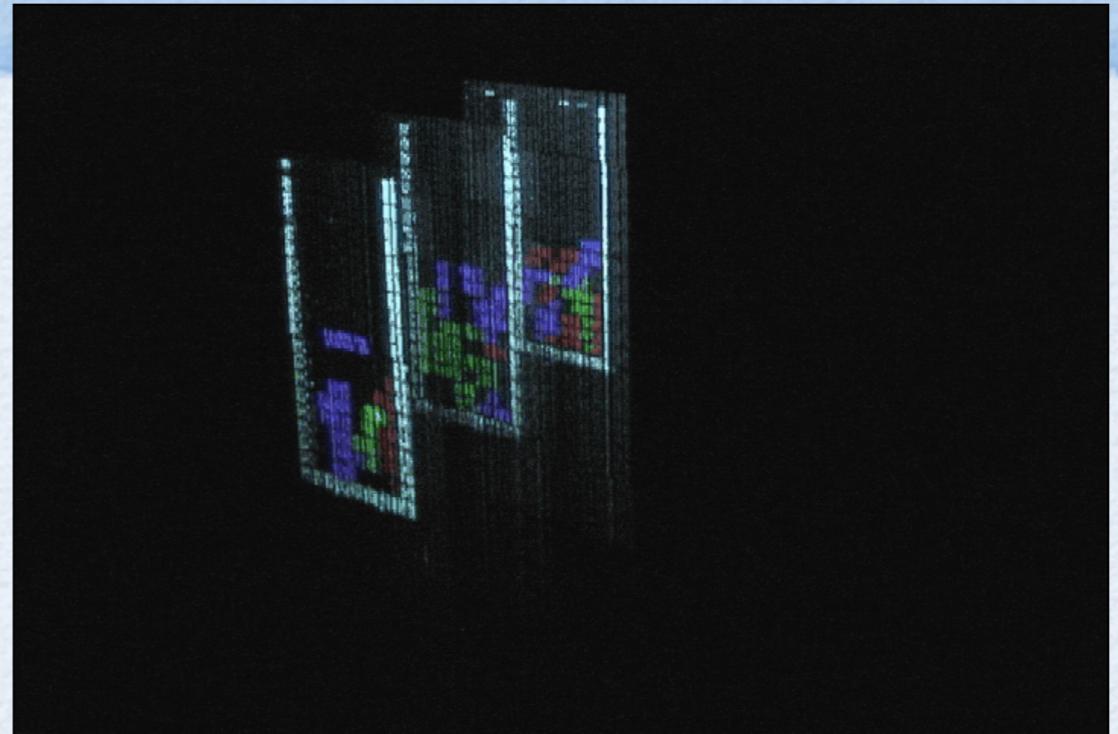
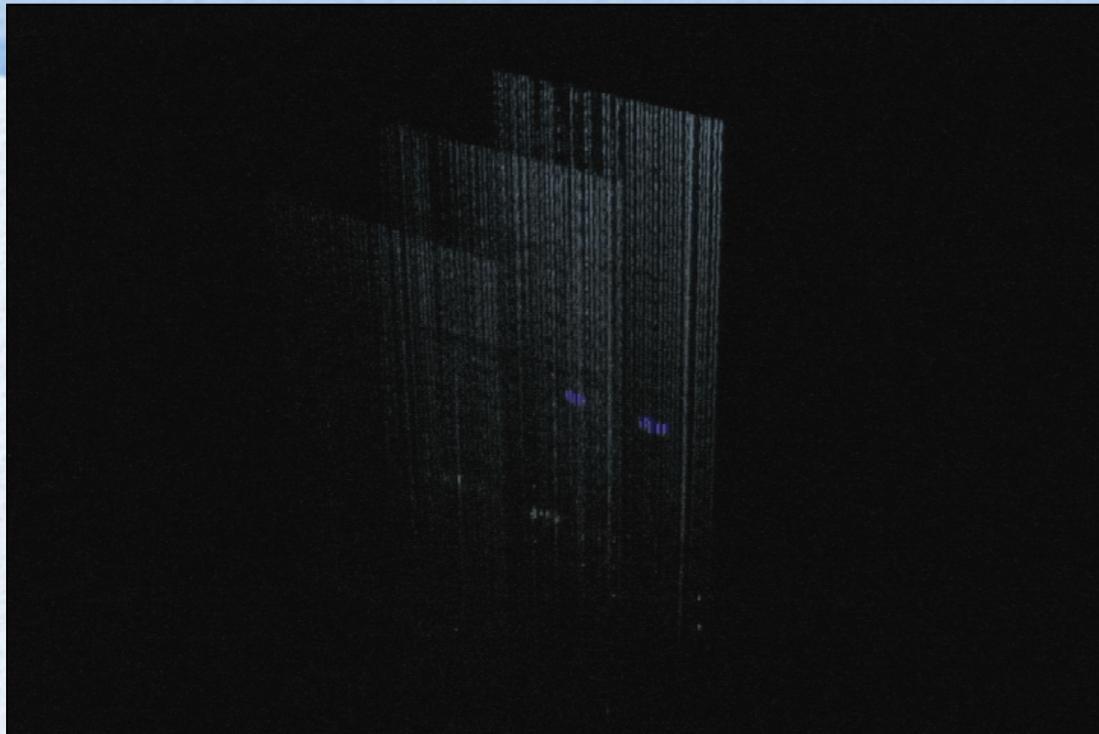
Tokyo Sky Scraper in Berkeley

# WHAT I DO

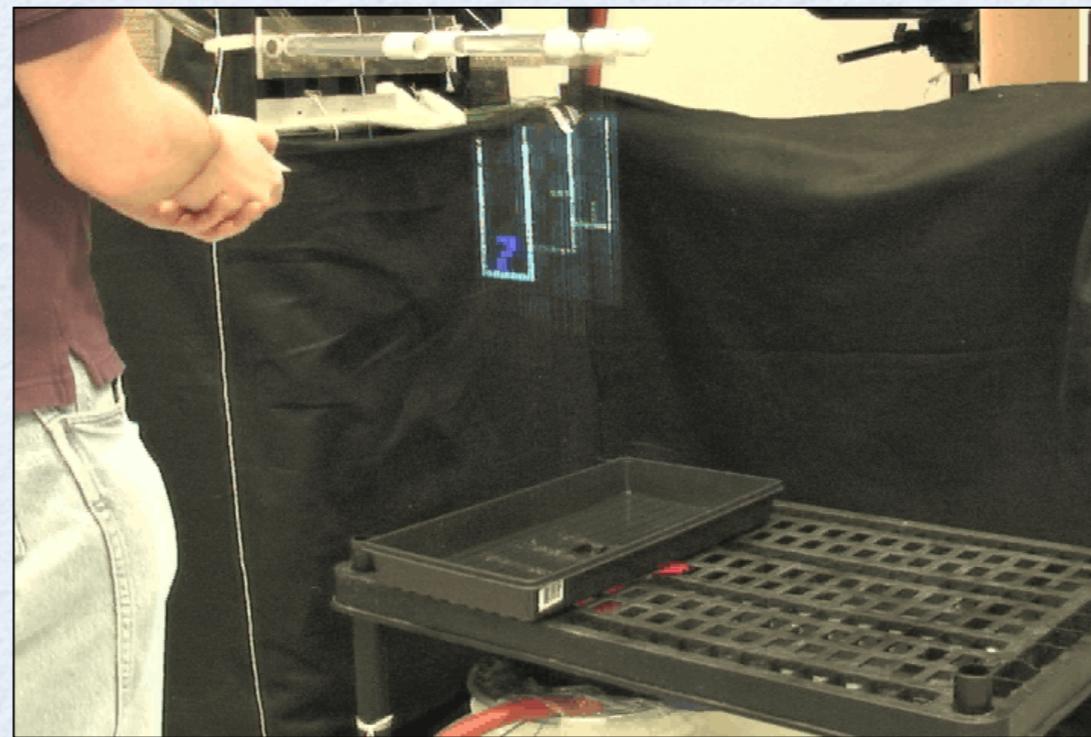


MOVIX

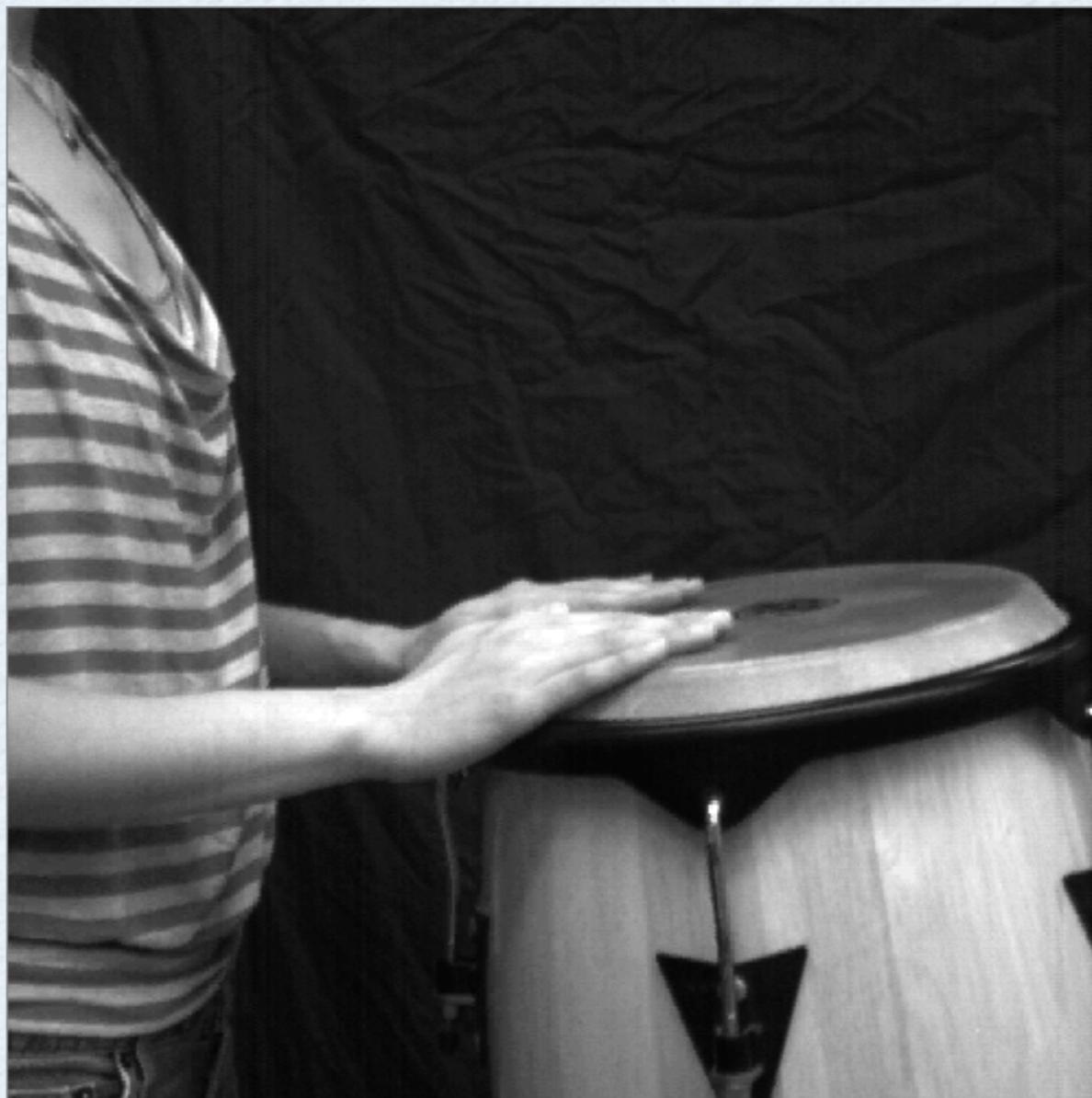
# WHAT I DO



“Honey! Look! The TV ran out of water again!!” – Youtube

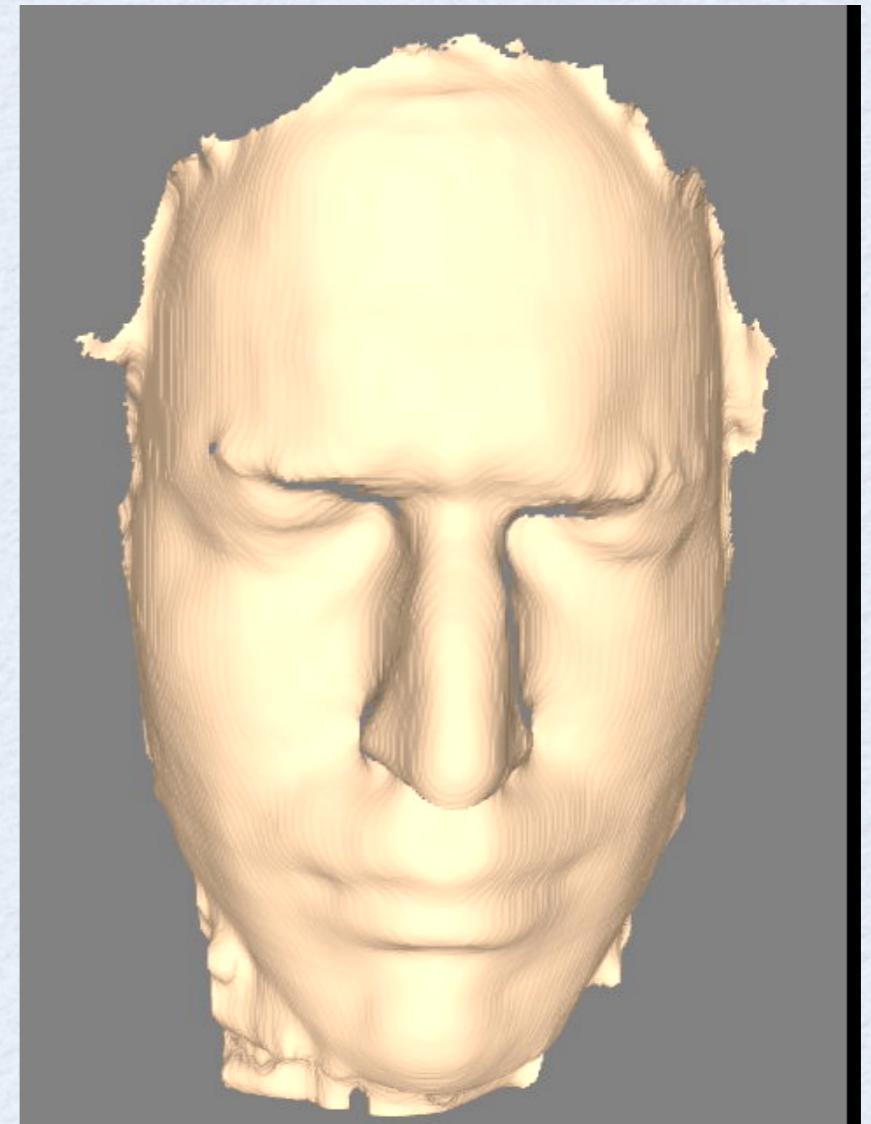
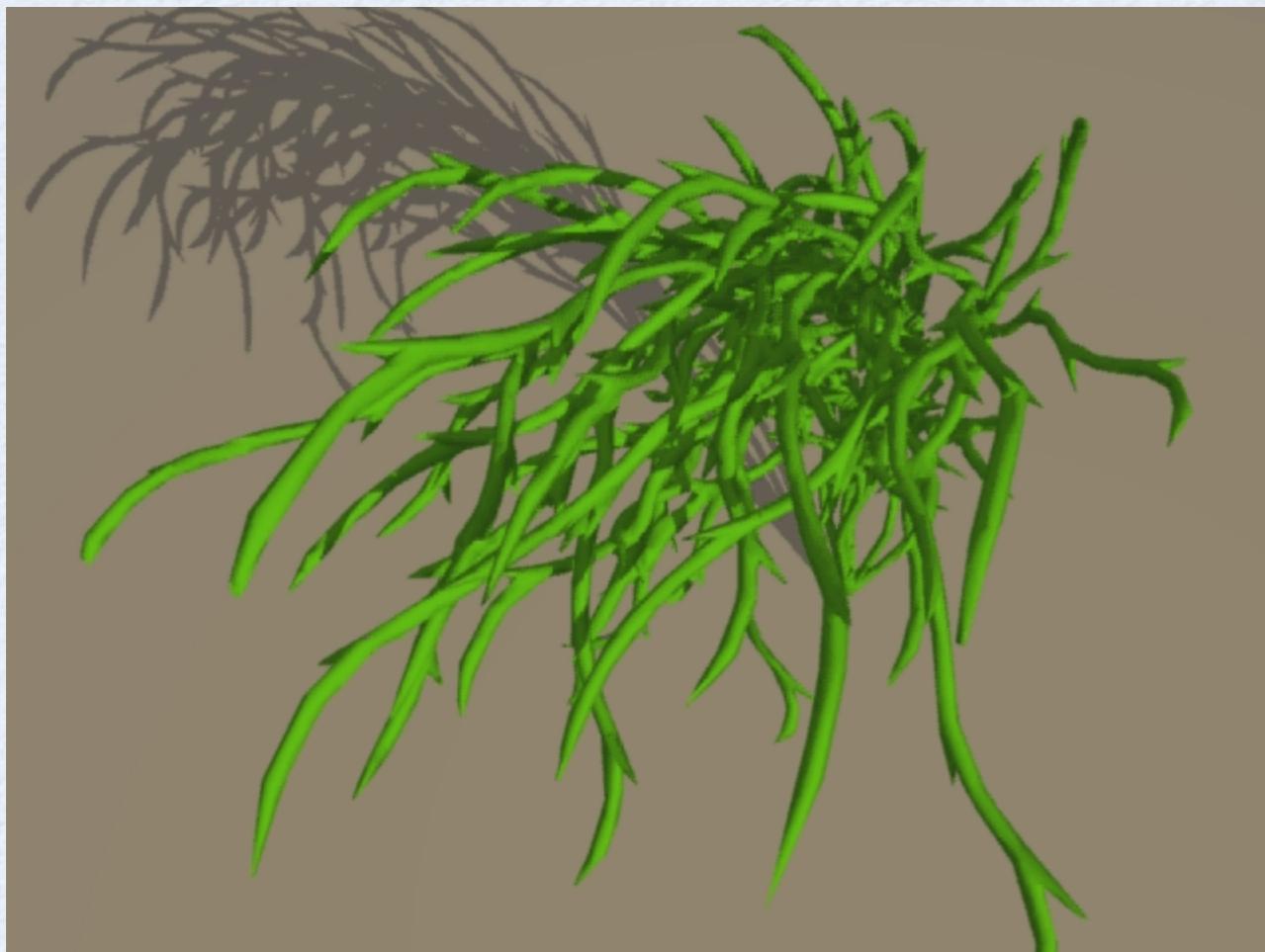


# WHAT I DO



Motion-aware camera

# WHAT I DO



# INTRODUCTION

- Administratrivia.
- What is computer graphics?
- What I do...
- Topics

# ADMINISTRATRIVIA

- Web Page

- <http://www.cs.cmu.edu/~15462/>
- linked from my web page

**Computer Graphics**

Number: CSD 15-462  
Instructor: [Adrien Treuille](#)  
Teaching Assistants: [Eric Butler](#)  
[Linus Li](#)  
[Frank Palermo](#)  
[Kristin Sisic](#)  
Office Hours: TBA  
Time: TR 10:30AM - 11:50AM  
Location: WEH 7500



**Summary**  
This course provides a comprehensive introduction to computer graphics modeling, animation, and rendering. Topics covered include basic image processing, geometric transformations, geometric modeling of curves and surfaces, animation, 3-D viewing, visibility algorithms, shading, and ray tracing.

**Overview**  
Prerequisites  
The programming assignments in this course will be written in C++ and require knowledge of mathematics involving matrices, vectors, etc. Therefore successful completion of the following courses is required:  
15-213/18-243 Introduction to Computer Systems  
and either  
18-202 Mathematical Foundations of Electrical Engineering  
or both  
21-241 Matrix Algebra, and  
21-259 Calculus in Three Dimensions  
Once you've completed 15-462, you may be interested in other [courses](#) offered by the Carnegie Mellon Graphics Lab.  
Textbook  
There is no required textbook for 15-462 this semester.  
Assignments & Grading  
This semester's offering of 15-462 will include four programming assignments. For detailed information, please visit the [projects](#) page.  
[Under Construction]

**Syllabus**  
Note: This syllabus may change during the course. Keep checking back.

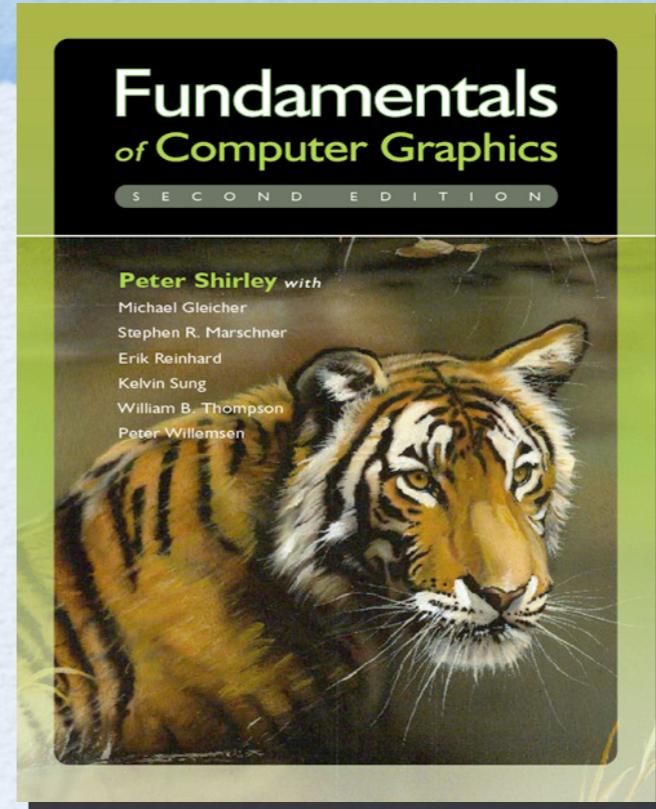
 Name: TBA  
Date: Tues 01/13

# TA OFFICE HOURS

- TAs:
  - Chun How Tan ([chunhowt@andrew.cmu.edu](mailto:chunhowt@andrew.cmu.edu)) Mon 8-10pm
  - Derek Basehore ([dbasehor@andrew.cmu.edu](mailto:dbasehor@andrew.cmu.edu)) Wed 8-10pm
- No office hours this week.

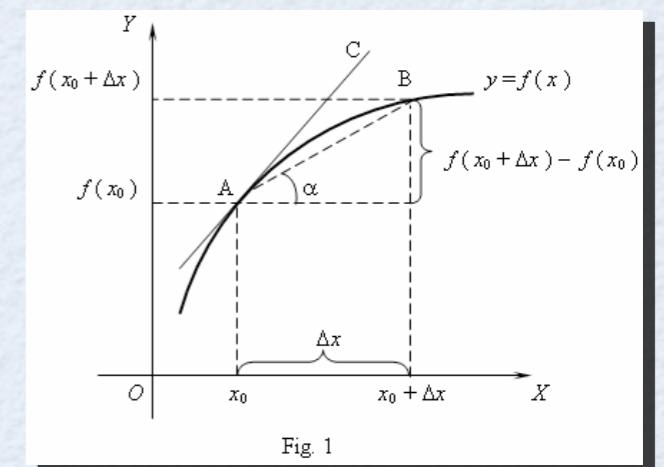
# TEXTBOOK

- Shirley, 2nd Edition
- OpenGL Red Book
  - <http://www.glprogramming.com/red/>
- For Thursday:
  - Red Book Chapters 1 and 2



# PRE-REQUISITES

- Talk to us if you're missing these!
  - 15-213: Introduction to Computer Systems
  - 21-241: Matrix Algebra (matrix & vector algebra)
  - 21-259: Calculus in Three Dimensions (i.e. planes, quadratic surfaces,
- Basic 3-D geometry / C++



# GRADING

- Project 1 (10%)
- Project 2 (10%)
- Project 3 (10%)
- Project 4 (15%)
- Project 5 (15%)
- Homework 1 (7.5%)
- Homework 2 (7.5%)
- Midterm (10%)
- Final Exam (15%)



# LATE POLICY

- 3 late days for projects.
- No further extensions without explicit permission 2 days before deadline.



# CHEATING – ZERO TOLERANCE

- Please don't cheat! Using code from the web is ok as long as it is a **SMALL** percentage of the code for written the assignment.
- Do projects and homeworks individually.



# TECHNICAL ISSUES

- Class bulletin board:
  - [cmu.cs.class.cs462](mailto:cmu.cs.class.cs462)
  - (ask the TAs about how to use this)
- To use the cluster:
  - SSH to one of the `unix.andrew.cmu.edu`
  - Execute: `/afs/cs.cmu.edu/project/weh5336/SetupAndrewAccount`
  - Username: <Your Andrew ID>`@ANDREW.CMU.EDU`
  - The execute:
    - `mkdir private`
    - `fs sa private system:anyuser none`
    - `fs sa private system:campusnet none`

# INTRODUCTION

- Administrivia.
- What is computer graphics?
- What I do...
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# SYLLABUS AND SCHEDULE

## Intro

- 01 Tues 08/30 - Introduction
- 02 Thur 09/01 - OpenGL  
**[PROJ 1 ASSIGNED]**

## Geometry

- 03 Tues 09/06 - Math for Computer Graphics
- 04 Thur 09/08 - Transformations
- 05 Tues 09/13 -Viewing/Camera
- 07 Thur 09/15 - Curves and Splines  
**[PROJ 1 DUE, HW1 ASSIGNED]**
- 08 Tues 09/20 - Meshes and Surfaces  
**[PROJ 2 ASSIGNED]**

## Light

- 09 Thur 09/22 – Shading/Light
- 10 Tues 09/27 – Materials
- 11 Thur 09/29 – Texture mapping + GLSL  
**[HW1 DUE]**

## NPR

- 12 Tues 10/04 – Non-photorealistic rendering  
**[PROJ 2 DUE, PROJ 3 ASSIGNED]**
- 13 Thur 10/06 – Illusions

## Ray Tracing

- 14 Tues 10/11 – Raycasting/Raytracing
- 15 Thur 10/13 – Spatial Data Structures **[P3 Check Point]**
- 16 Tues 10/18 – Midterm review
- 17 Thur 10/20 - **[MIDTERM EXAM]**

## Indirect Lighting

- 18 Tues 10/25 – Radiosity
- **[PROJ 3 DUE, PROJ 4 ASSIGNED]**
- 19 Thur 10/27 - Photon Mapping
- 20 Tues 11/01 – Direct-Indirect Separation

## Animation

- 21 Thur 11/03 - Animation and Mocap
- 22 Tues 11/08 - Differential Eqn & Particle Systems
- 23 Thur 11/10 – Fluids: Adrien Treuille  
**[HW2 ASSIGNED]**

## Images

- 24 Tues 11/15 - Image Processing  
**[PROJ 4 DUE, PROJ 5 ASSIGNED]**
- 25 Thur 11/17 – High Dynamic Range Imaging + Tone Mapping
- 26 Tues 11/22 – Photo and Webcam Clipart

## Advanced

- 27 Thur 11/24 – THANKSGIVING
- 29 Tues 11/29 – Displays  
**[PROJ 5 DUE]**
- 28 Thur 12/1 – Cool new research in Graphics  
**[HW 2 DUE]**

## Final

- 30 Tues 12/06 – Final Review
- 31 Thur 12/08 – Project Showcase
- 32 TBD – **[FINAL EXAM]**

# SYLLABUS AND SCHEDULE

## Intro

- 01 Tues 08/30 - Introduction
- 02 Thur 09/01 - OpenGL

**[PROJ 1 ASSIGNED]**

## Geometry

- 03 Tues 09/06 - Math for Geom
- 04 Thur 09/08 - Transformations
- 05 Tues 09/13 - Viewing Frustum
- 07 Thur 09/15 - Curves and Surfaces

**[PROJ 2 ASSIGNED]**

- 08 Tues 09/20 - Meshes and Mesh Processing

**[PROJ 2 ASSIGNED]**

## Light

- 09 Thur 09/22 - Shading and Raytracing
- 10 Tues 09/27 - Materials and Texturing
- 11 Thur 09/29 - Texturing and Webcams

**[HW1 DUE]**

## NPR

- 12 Tues 10/04 - Non-photon-based rendering

**[PROJ 3 DUE]**

- 13 Thur 10/06 - Illusions and Perception

## Ray Tracing

- 14 Tues 10/11 - Raycasting/Raytracing
- 15 Thur 10/13 - Spatial Data Structures
- 16 Tues 10/18 - Midterm review

**[PROJ 3 DUE, PROJ 4 ASSIGNED]**

- 17 Thur 10/20 - **[MIDTERM EXAM]**

## Indirect Lighting

- 18 Tues 10/25 - Radiosity
- 19 Thur 10/27 - Photon Mapping
- 20 Tues 11/01 – Direct-Indirect Separation

Adrien Treuille  
**[PROJ 4 DUE, PROJ 5 ASSIGNED]**

Adrien Treuille  
**[PROJ 5 ASSIGNED]**

Processing  
Dynamic Range Imaging + Tone Mapping  
and Webcam Clipart  
**[HW2 DUE]**

THANKSGIVING  
DAYS  
**[HW3 DUE]**

New research in Graphics

A

## Final

- 30 Tues 12/06 – Final Review
- 31 Thur 12/08 – Project Showcase
- 32 TBD – **[FINAL EXAM]**

# SYLLABUS AND SCHEDULE

## Intro

- 01 Tues 08/30 - Introduction
- 02 Thur 09/01 - OpenGL  
**[PROJ]**

## Geometry

- 03 Tues 09/06 - Math for
- 04 Thur 09/08 - Transfor
- 05 Tues 09/13 –Viewing
- 07 Thur 09/15 - Curves  
**[PROJ]**
- 08 Tues 09/20 - Meshes  
**[PROJ]**

## Light

- 09 Thur 09/22 – Shadirs
- 10 Tues 09/27 – Material
- 11 Thur 09/29 – Texturing  
**[HW1]**

## NPR

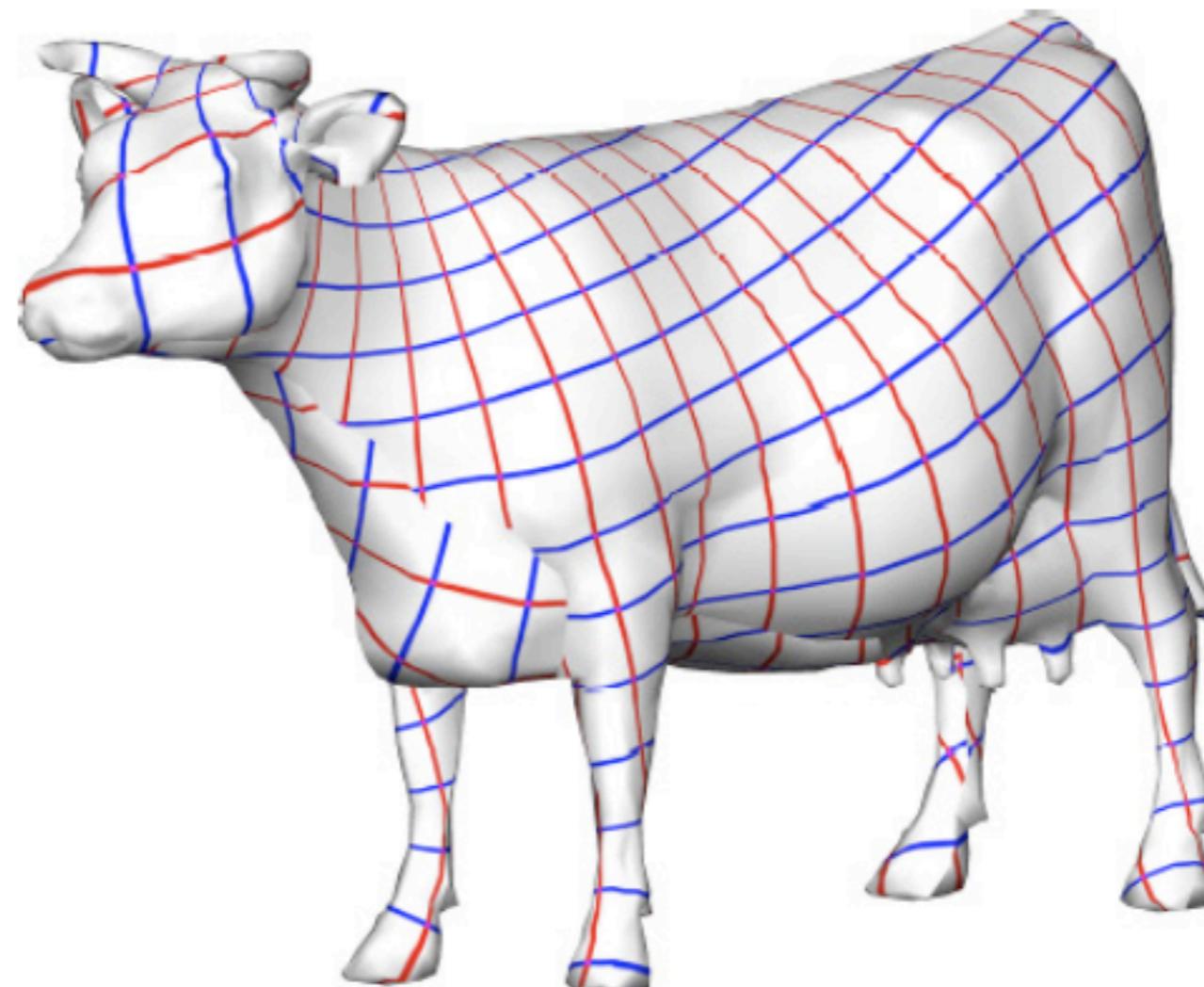
- 12 Tues 10/04 – Non-p
- [PROJ]**
- 13 Thur 10/06 – Illusio

## Ray Tracing

- 14 Tues 10/11 – Raycas
- 15 Thur 10/13 – Spatial Data Structures
- 16 Tues 10/18 – Midterm review  
**[PROJ 3 DUE, PROJ 4 ASSIGNED]**
- 17 Thur 10/20 - **[MIDTERM EXAM]**

## direct lighting

- 18 Tues 10/25 - Radiosity
- 19 Thur 10/27 - Photon Mapping
- 20 Tues 11/01 - Direct Indirect Separation



and Mocap  
Eqn & Particle Systems  
**[E, PROJ 5 ASSIGNED]**

en Treuille  
**[GNED]**

ssing  
mic Range Imaging + Tone  
ebcam Clipart  
**[E]**

VING

earch in Graphics

## Final

- 30 Tues 12/06 – Final Review
- 31 Thur 12/08 – Project Showcase
- 32 TBD – **[FINAL EXAM]**

# SYLLABUS AND SCHEDULE

## Intro

- 01 Tues 08/30 - Introduction
- 02 Thur 09/01 - OpenGL

**[PROJ 1 ASSIGNED]**

## Geometry

- 03 Tues 09/06 - Math for Computer
- 04 Thur 09/08 - Transformations
- 05 Tues 09/13 -Viewing/Camera
- 07 Thur 09/15 - Curves and Splines

**[PROJ 1 DUE, HW1 ASSIGNED]**  
**[PROJ 2 ASSIGNED]**

## Light

- 09 Thur 09/22 – Shading/Light
- 10 Tues 09/27 – Materials
- 11 Thur 09/29 – Texture mapping

**[HW1 DUE]**

## NPR

- 12 Tues 10/04 – Non-photorealistic
- 13 Thur 10/06 – Illusions

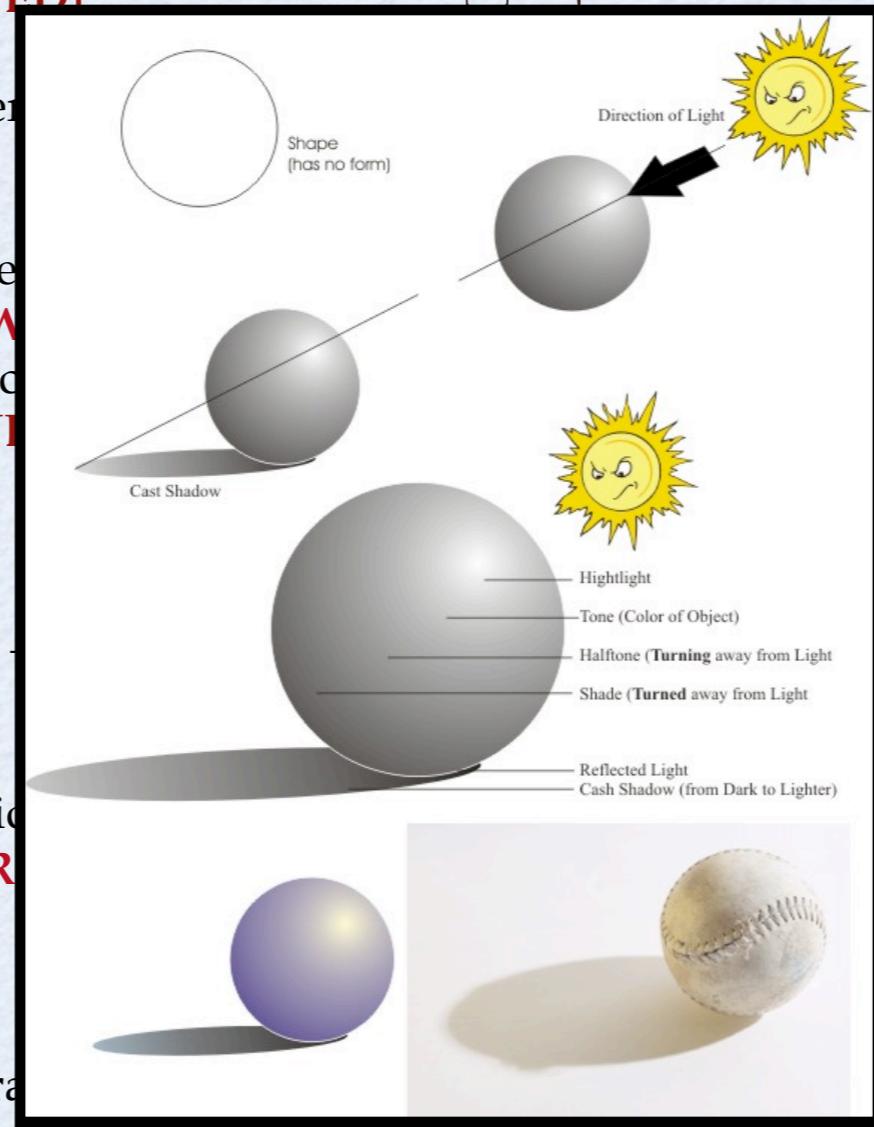
**[PROJ 2 DUE, PROJ 3 ASSIGNED]**

## Ray Tracing

- 14 Tues 10/11 – Raycasting/Raytracing
- 15 Thur 10/13 – Spatial Data Structures
- 16 Tues 10/18 – Midterm review

**[PROJ 3 DUE, PROJ 4 ASSIGNED]**

- 17 Thur 10/20 - **[MIDTERM EXAM]**



## Indirect lighting

- 18 Tues 10/25 - Radiosity
- 19 Thur 10/27 - Photon Mapping
- 20 Tues 11/01 – Direct-Indirect Separation

## Final

- 30 Tues 12/06 – Final Review
- 31 Thur 12/08 – Project Showcase
- 32 TBD – **[FINAL EXAM]**

- 03 - Animation and Mocap
- 08 - Differential Eqn & Particle Systems

**[PROJ 4 DUE, PROJ 5 ASSIGNED]**

- 10 – Fluids: Adrien Treuille

**[HW2 ASSIGNED]**

- 15 - Image Processing
- 17 – High Dynamic Range Imaging + Tone Mapping
- 22 – Photo and Webcam Clipart

**[PROJ 5 DUE]**

- 24 – THANKSGIVING

- 29 – Displays

**[HW 2 DUE]**

- 1 – Cool new research in Graphics

# SYLLABUS AND SCHEDULE

## Intro

- 01 Tues 08/30 - Introduction
- 02 Thur 09/01 - OpenGL  
**[PRO]**

## Geometry

- 03 Tues 09/06 - Math Review
- 04 Thur 09/08 - Transformations
- 05 Tues 09/13 - Viewing Frustum
- 07 Thur 09/15 - Curves and Surfaces  
**[PRO]**
- 08 Tues 09/20 - Meshes and Ray Tracing  
**[PRO]**

## Lighting

- 09 Thur 09/22 – Shading
- 10 Tues 09/27 – Materials
- 11 Thur 09/29 – Texturing  
**[HW]**

## NPR

- 12 Tues 10/04 – Non-Photorealistic Rendering  
**[PRC]**
- 13 Thur 10/06 – Illusions  
**[HW]**

## Ray Tracing

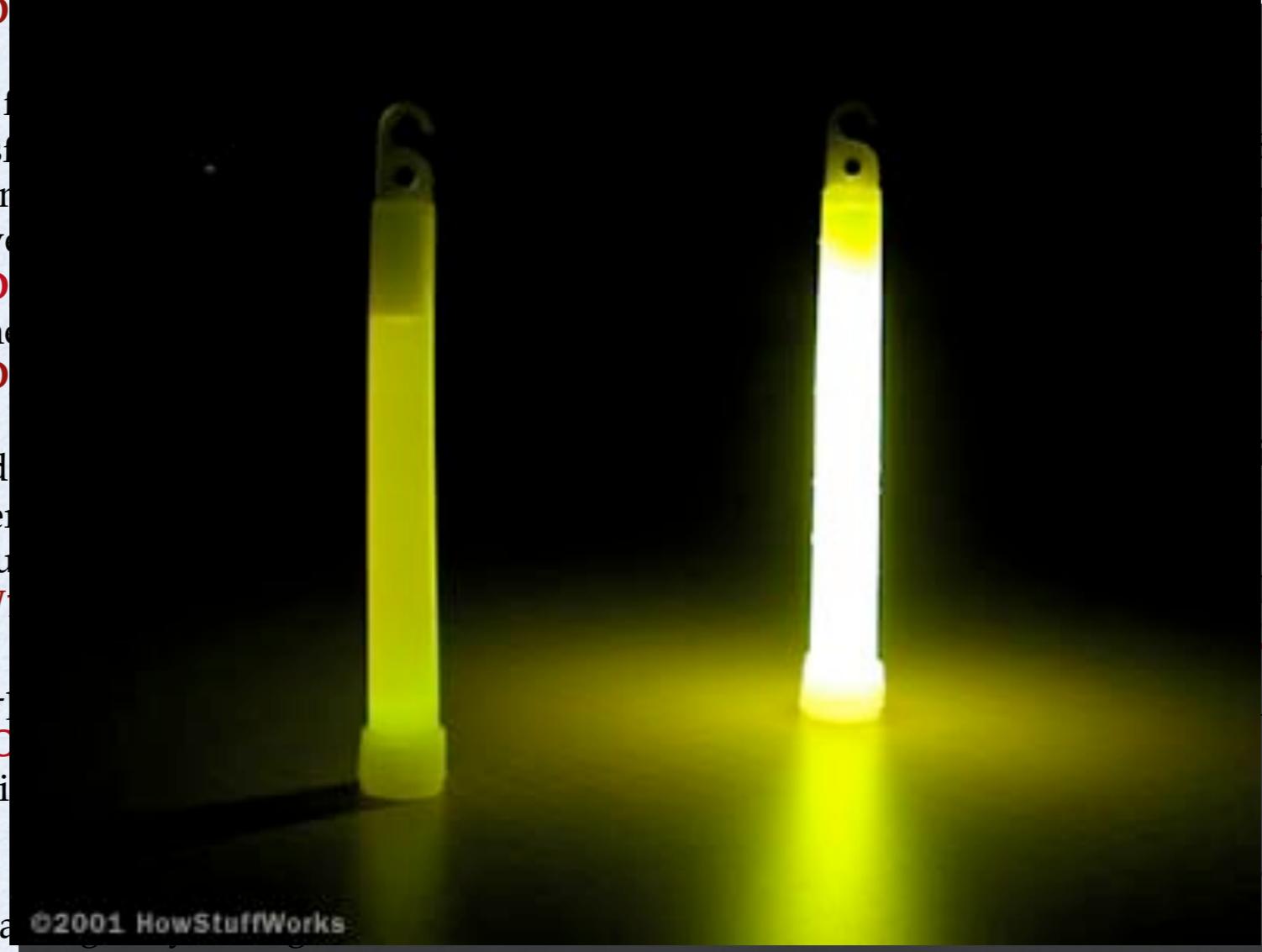
- 14 Tues 10/11 – Raycasting  
**[HW]**
- 15 Thur 10/13 – Spatial Data Structures
- 16 Tues 10/18 – Midterm review  
**[PROJ 3 DUE, PROJ 4 ASSIGNED]**
- 17 Thur 10/20 - **[MIDTERM EXAM]**

## Indirect Lighting

- 18 Tues 10/25 - Radiosity
- 19 Thur 10/27 - Photon Mapping
- 20 Tues 11/01 – Direct-Indirect Separation

## Final

- 30 Tues 12/06 – Final Review
- 31 Thur 12/08 – Project Showcase
- 32 TBD – **[FINAL EXAM]**



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# SYLLABUS AND SCHEDULE

## Intro

- 01 Tues 08/30 - Introduction
- 02 Thur 09/01 - OpenCourseWare [PROJ]

## Geometry

- 03 Tues 09/06 - Math for Computer Graphics
- 04 Thur 09/08 - Transformations
- 05 Tues 09/13 - Viewframing
- 07 Thur 09/15 - Curves and Surfaces [PROJ]
- 08 Tues 09/20 - Meshes and Mesh Processing [PROJ]

## Light

- 09 Thur 09/22 – Shading
- 10 Tues 09/27 – Materials
- 11 Thur 09/29 – Texturing [HW1 DUE]

## NPR

- 12 Tues 10/04 – Non-projective Ray Tracing [PROJ]
- 13 Thur 10/06 – Illusionism

## Ray Tracing

- 14 Tues 10/11 – Raycasting
- 15 Thur 10/13 – Spatial Hashing
- 16 Tues 10/18 – Midterm Exam [PROJ] [MIDTERM EXAM] [DUE, PROJ 4 ASSIGNED]
- 17 Thur 10/20 - [MIDTERM EXAM]



Direct  
Sampling

• 18 Tues 10/25 - Radiosity

Mapping  
Indirect Separation

• 19 Tues 11/01 - Motion and Mocap  
• 20 Thur 11/03 - Potential Eqn & Particle Systems

[HW2 DUE, PROJ 5 ASSIGNED]

Adrien Treuille  
[ASSIGNED]

• 21 Tues 11/08 - Image Processing  
• 22 Thur 11/10 - Dynamic Range Imaging + Tone Mapping  
• 23 Tues 11/15 - Hand Webcam Clipart [HW3 DUE]

THANKSGIVING

• 26 Tues 11/29 -

[HW4 DUE]  
New research in Graphics

• 27 Thur 12/01 -

View

Showcase

Final  
Grade  
• 32 TBD

- [FINAL EXAM]

# SYLLABUS AND SCHEDULE



|             |                                 |                                 |                                 |                                     |                                 |                                     |                                 |                                 |                                     |                                 |                                 |                                 |                                 |                                  |                                 |                                  |                                 |                                    |                              |                                    |                              |                              |                                    |                              |                              |                              |                              |                                    |                             |                                    |                         |
|-------------|---------------------------------|---------------------------------|---------------------------------|-------------------------------------|---------------------------------|-------------------------------------|---------------------------------|---------------------------------|-------------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|----------------------------------|---------------------------------|----------------------------------|---------------------------------|------------------------------------|------------------------------|------------------------------------|------------------------------|------------------------------|------------------------------------|------------------------------|------------------------------|------------------------------|------------------------------|------------------------------------|-----------------------------|------------------------------------|-------------------------|
| Intro       | • 01 Tues 08/28 - [MATERIALS]   | • 02 Thur 09/03 - [MATERIALS]   | • 03 Tues 09/08 - Ray Tracing   | • 04 Thur 09/10 - Ray Tracing       | • 05 Tues 09/15 - Ray Tracing   | • 07 Thur 09/17 - Ray Tracing       | • 08 Tues 09/22 - Ray Tracing   | • 09 Thur 09/24 - Ray Tracing   | • 10 Tues 09/29 - Ray Tracing       | • 11 Thur 10/01 - Ray Tracing   | • 12 Tues 10/06 - Ray Tracing   | • 13 Thur 10/08 - Ray Tracing   | • 14 Tues 10/13 - Ray Tracing   | • 15 Thur 10/15 - Ray Tracing    | • 16 Tues 10/19 - Ray Tracing   | • 17 Thur 10/20 - [MIDTERM EXAM] | • 18 Tues 10/25 - Radiosity     | • 19 Thur 10/27 - Radiosity        | • 20 Tues 11/01 - Radiosity  | • 21 Thur 11/03 - Radiosity        | • 22 Tues 11/08 - Radiosity  | • 23 Thur 11/10 - Radiosity  | • 24 Tues 11/15 - Radiosity        | • 25 Thur 11/17 - Radiosity  | • 26 Tues 11/22 - Radiosity  | • 27 Thur 11/24 - Radiosity  | • 28 Tues 11/29 - Radiosity  | • 29 Thur 12/01 - Radiosity        | • 30 Tues 12/06 - Radiosity | • 31 Thur 12/08 - Project Showcase | • 32 TBD - [FINAL EXAM] |
| Geometry    | • 03 Tues 09/08 - [GEOMETRY]    | • 04 Thur 09/10 - [GEOMETRY]    | • 05 Tues 09/15 - [GEOMETRY]    | • 07 Thur 09/17 - [GEOMETRY]        | • 08 Tues 09/22 - [GEOMETRY]    | • 09 Thur 09/24 - [GEOMETRY]        | • 10 Tues 09/29 - [GEOMETRY]    | • 11 Thur 10/01 - [GEOMETRY]    | • 12 Tues 10/06 - [GEOMETRY]        | • 13 Thur 10/08 - [GEOMETRY]    | • 14 Tues 10/13 - [GEOMETRY]    | • 15 Thur 10/15 - [GEOMETRY]    | • 16 Tues 10/19 - [GEOMETRY]    | • 17 Thur 10/20 - [MIDTERM EXAM] | • 18 Tues 10/25 - [GEOMETRY]    | • 19 Thur 10/27 - [GEOMETRY]     | • 20 Tues 11/01 - [GEOMETRY]    | • 21 Thur 11/03 - [GEOMETRY]       | • 22 Tues 11/08 - [GEOMETRY] | • 23 Thur 11/10 - [GEOMETRY]       | • 24 Tues 11/15 - [GEOMETRY] | • 25 Thur 11/17 - [GEOMETRY] | • 26 Tues 11/22 - [GEOMETRY]       | • 27 Thur 11/24 - [GEOMETRY] | • 28 Tues 11/29 - [GEOMETRY] | • 29 Thur 12/01 - [GEOMETRY] | • 30 Tues 12/06 - [GEOMETRY] | • 31 Thur 12/08 - Project Showcase | • 32 TBD - [FINAL EXAM]     |                                    |                         |
| Light       | • 09 Thur 09/17 - [LIGHTING]    | • 10 Tues 09/22 - [LIGHTING]    | • 11 Thur 09/24 - [LIGHTING]    | • 12 Tues 10/06 - [LIGHTING]        | • 13 Thur 10/08 - [LIGHTING]    | • 14 Tues 10/13 - [LIGHTING]        | • 15 Thur 10/15 - [LIGHTING]    | • 16 Tues 10/19 - [LIGHTING]    | • 17 Thur 10/20 - [MATERIAL REVIEW] | • 18 Tues 10/25 - [LIGHTING]    | • 19 Thur 10/27 - [LIGHTING]    | • 20 Tues 11/01 - [LIGHTING]    | • 21 Thur 11/03 - [LIGHTING]    | • 22 Tues 11/08 - [LIGHTING]     | • 23 Thur 11/10 - [LIGHTING]    | • 24 Tues 11/15 - [LIGHTING]     | • 25 Thur 11/17 - [LIGHTING]    | • 26 Tues 11/22 - [LIGHTING]       | • 27 Thur 11/24 - [LIGHTING] | • 28 Tues 11/29 - [LIGHTING]       | • 29 Thur 12/01 - [LIGHTING] | • 30 Tues 12/06 - [LIGHTING] | • 31 Thur 12/08 - Project Showcase | • 32 TBD - [FINAL EXAM]      |                              |                              |                              |                                    |                             |                                    |                         |
| NPR         | • 12 Tues 10/06 - [NPR]         | • 13 Thur 10/08 - [NPR]         | • 14 Tues 10/13 - [NPR]         | • 15 Thur 10/15 - [NPR]             | • 16 Tues 10/19 - [NPR]         | • 17 Thur 10/20 - [MATERIAL REVIEW] | • 18 Tues 10/25 - [NPR]         | • 19 Thur 10/27 - [NPR]         | • 20 Tues 11/01 - [NPR]             | • 21 Thur 11/03 - [NPR]         | • 22 Tues 11/08 - [NPR]         | • 23 Thur 11/10 - [NPR]         | • 24 Tues 11/15 - [NPR]         | • 25 Thur 11/17 - [NPR]          | • 26 Tues 11/22 - [NPR]         | • 27 Thur 11/24 - [NPR]          | • 28 Tues 11/29 - [NPR]         | • 29 Thur 12/01 - [NPR]            | • 30 Tues 12/06 - [NPR]      | • 31 Thur 12/08 - Project Showcase | • 32 TBD - [FINAL EXAM]      |                              |                                    |                              |                              |                              |                              |                                    |                             |                                    |                         |
| Ray Tracing | • 14 Tues 10/13 - [RAY TRACING] | • 15 Thur 10/15 - [RAY TRACING] | • 16 Tues 10/19 - [RAY TRACING] | • 17 Thur 10/20 - [MATERIAL REVIEW] | • 18 Tues 10/25 - [RAY TRACING] | • 19 Thur 10/27 - [RAY TRACING]     | • 20 Tues 11/01 - [RAY TRACING] | • 21 Thur 11/03 - [RAY TRACING] | • 22 Tues 11/08 - [RAY TRACING]     | • 23 Thur 11/10 - [RAY TRACING] | • 24 Tues 11/15 - [RAY TRACING] | • 25 Thur 11/17 - [RAY TRACING] | • 26 Tues 11/22 - [RAY TRACING] | • 27 Thur 11/24 - [RAY TRACING]  | • 28 Tues 11/29 - [RAY TRACING] | • 29 Thur 12/01 - [RAY TRACING]  | • 30 Tues 12/06 - [RAY TRACING] | • 31 Thur 12/08 - Project Showcase | • 32 TBD - [FINAL EXAM]      |                                    |                              |                              |                                    |                              |                              |                              |                              |                                    |                             |                                    |                         |

[PROJ 3 DUE, PROJ 4 ASSIGNED]  
[MIDTERM EXAM]

HENRIK WANN JENSEN 1995

# SYLLABUS AND SCHEDULE

## Intro

- 01 Tues 08/30
- 02 Thur 09/01

tion

## Geometry

- 03 Tues 09/06
- 04 Thur 09/08
- 05 Tues 09/13
- 07 Thur 09/15
- 08 Tues 09/20

Particle Systems  
**[5 ASSIGNED]**

## Light

- 09 Thur 09/22
- 10 Tues 09/27
- 11 Thur 09/29

Image + Tone  
Slipart

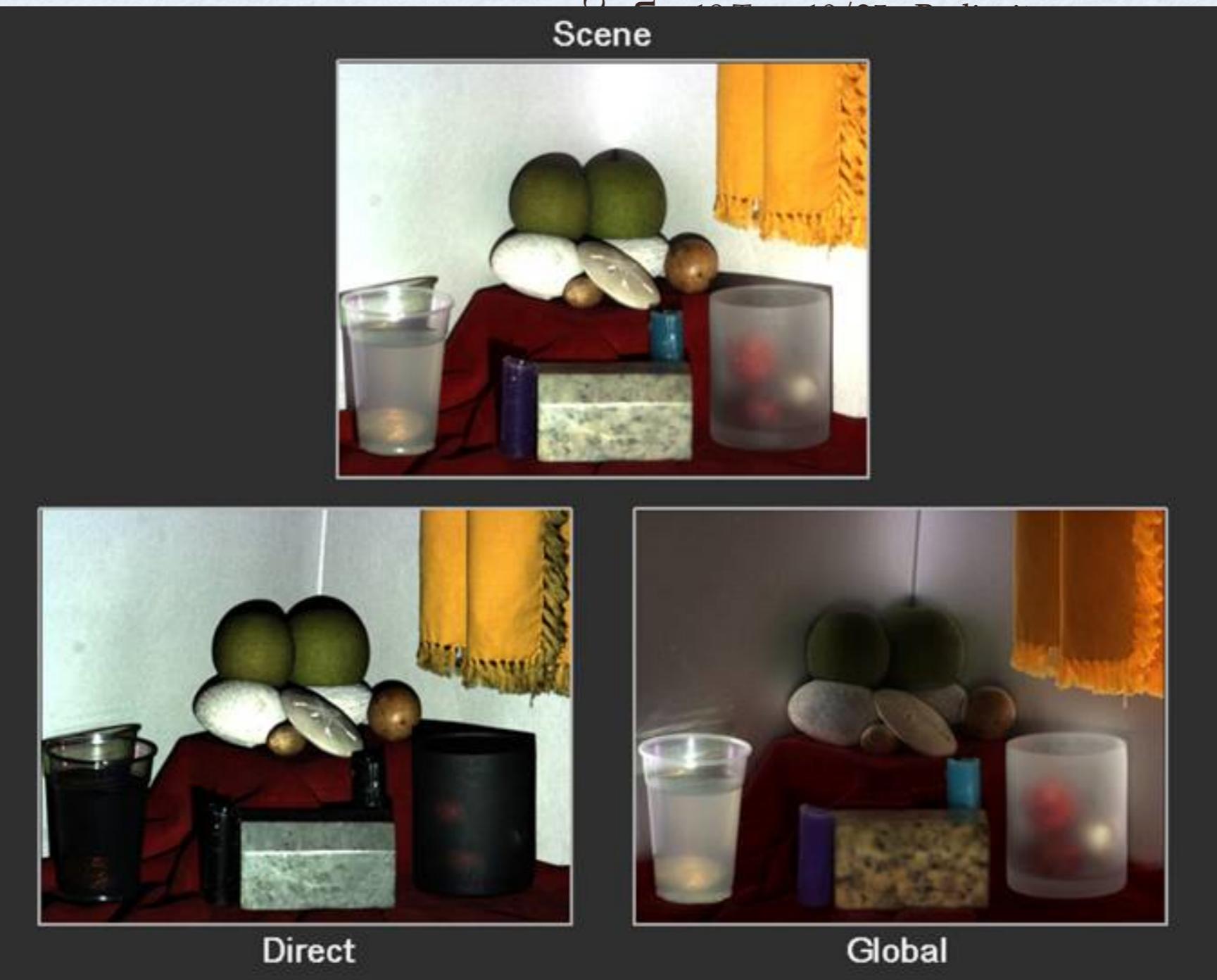
## NPR

- 12 Tues 10/04
- 13 Thur 10/06

Graphics

## Ray Tracing

- 14 Tues 10/11
  - 15 Thur 10/13
  - 16 Tues 10/18
- 17 Thur 10/20 - **[MIDTERM EXAM]**



**[PROJ 3 DUE, PROJ 4 ASSIGNED]**

• 31 Thur 12/08 - Project Showcase

• 32 TBD

- **[FINAL EXAM]**

# SYLLABUS AND SCHEDULE

## Intro

- 01 Tues 08/30 - Introduction
- 02 Thur 09/01 -

## Geometry

- 03 Tues 09/06 -
- 04 Thur 09/08 -
- 05 Tues 09/13 -
- 07 Thur 09/15 -
- 08 Tues 09/20 -

## Light

- 09 Thur 09/22 -
- 10 Tues 09/27 -
- 11 Thur 09/29 -

## NPR

- 12 Tues 10/04 -
- 13 Thur 10/06 -

## Ray Tracing

- 14 Tues 10/11 -
- 15 Thur 10/13 -
- 16 Tues 10/18 – Midterm review  
**[PROJ 3 DUE, PROJ 4 ASSIGNED]**
- 17 Thur 10/20 - **[MIDTERM EXAM]**



## Direct Lighting

- 18 Tues 10/25 - Radiosity
- 19 Thur 10/27 - Photon Mapping

## Separation

Mocap  
Motion & Particle Systems

**PROJ 5 ASSIGNED**  
Treuille  
**NED**

Lighting  
Depth Range Imaging + Tone  
Cam Clipart

NG

Search in Graphics

## Final

- 30 Tues 12/06 – Final Review
- 31 Thur 12/08 – Project Showcase
- 32 TBD – **[FINAL EXAM]**

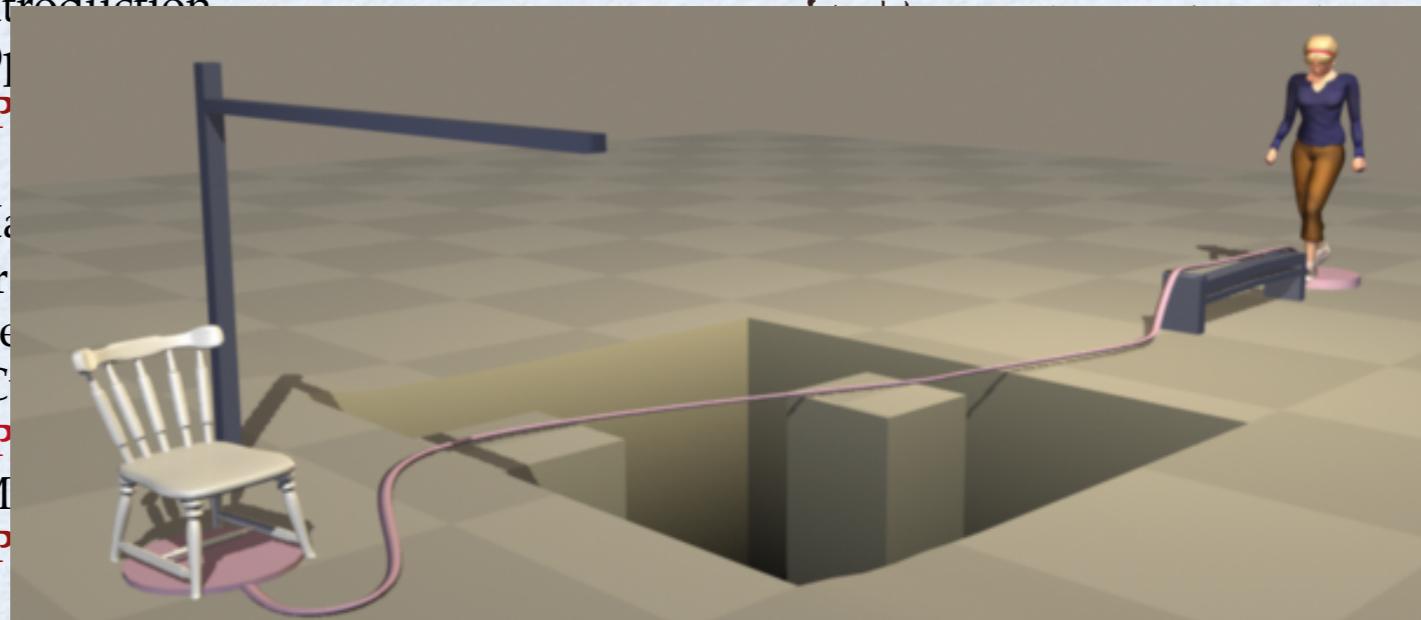
# SYLLABUS AND SCHEDULE

## Intro

- 01 Tues 08/30 - Introduction
- 02 Thur 09/01 - OpenGL [P]

## Geometry

- 03 Tues 09/06 - Meshes
- 04 Thur 09/08 - Trimesh
- 05 Tues 09/13 - View Frustum Culling
- 07 Thur 09/15 - Collision Detection [P]
- 08 Tues 09/20 - Mesh Processing [P]



## Direct Tracing

- 18 Tues 10/25 - Radiosity

Mapping  
Indirect Separation

## Light

- 09 Thur 09/22 - Sampling
- 10 Tues 09/27 - Mipmapping
- 11 Thur 09/29 - Tone Mapping [I]



Processing  
Dynamic Range Imaging + Tone  
Mapping  
and Webcam Clipart  
**5 DUE**

## NPR

- 12 Tues 10/04 - Normal Maps [I]
- 13 Thur 10/06 - Illusions

KSGIVING  
vs  
**DUE**

New research in Graphics

## Ray Tracing

- 14 Tues 10/11 – Ray Tracing [PROJ 3 DUE, PROJ 4 ASSIGNED]
  - 15 Thur 10/13 – Self-Intersection
  - 16 Tues 10/18 – Memory Management
- 17 Thur 10/20 - **[MIDTERM EXAM]**

## Final

- 31 Thur 12/08 – Project Showcase
- 32 TBD – **[FINAL EXAM]**

# SYLLABUS AND SCHEDULE

## Intro

- 01 Tues 08/30 - Introduction
- 02 Thur 09/01 - OpenGL  
**[PROJ 1 ASSIGNED]**

## Geometry

- 03 Tues 09/06 - Math for CG
- 04 Thur 09/08 - Transformations
- 05 Tues 09/13 –Viewing/Clipping
- 07 Thur 09/15 - Curves and Surfaces  
**[PROJ 1 IN PROGRESS]**
- 08 Tues 09/20 - Meshes and Ray Tracing  
**[PROJ 2 ASSIGNED]**

## Light

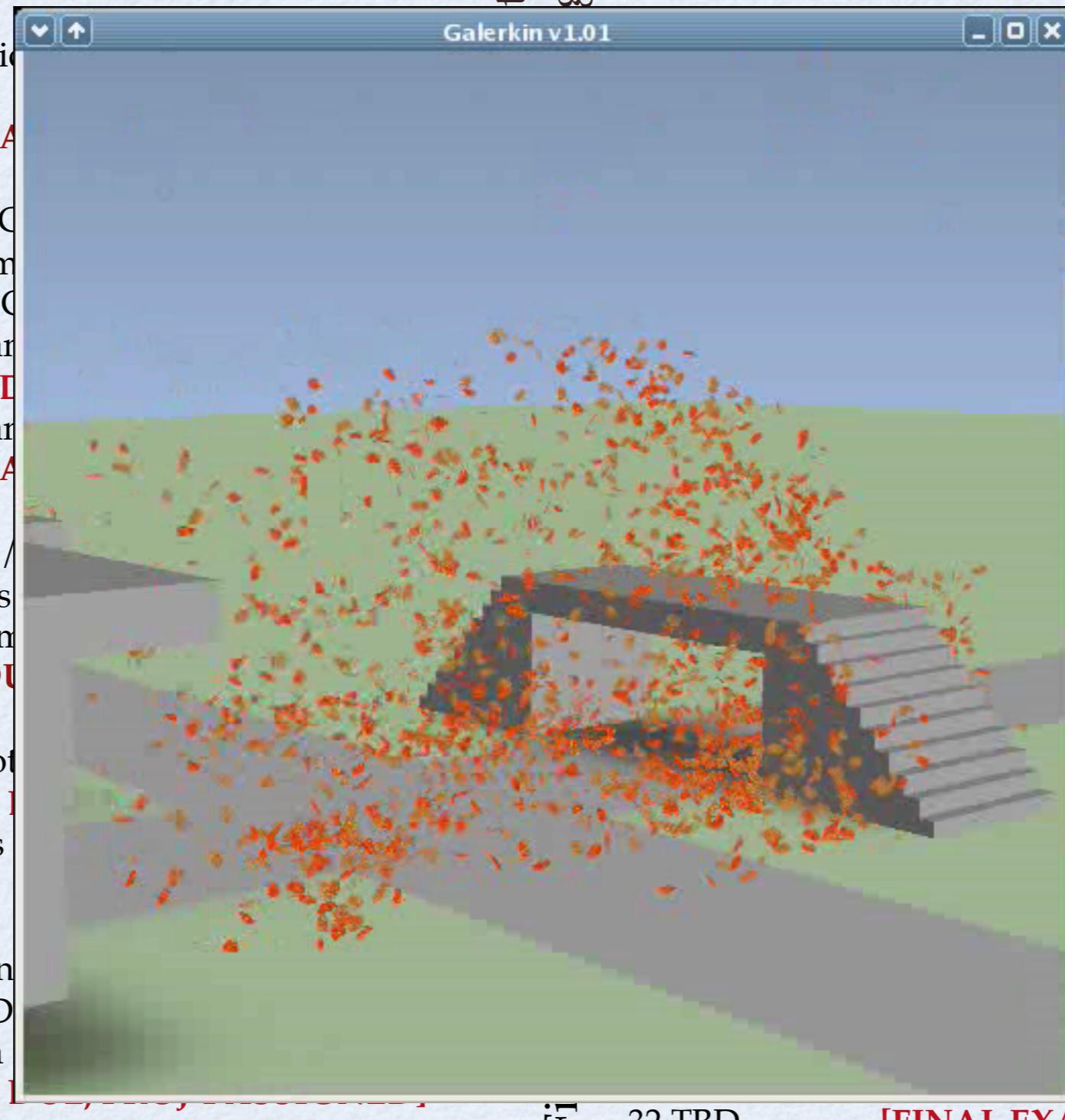
- 09 Thur 09/22 – Shading / Ray Tracing
- 10 Tues 09/27 – Materials and Shaders
- 11 Thur 09/29 – Texture mapping and Sampling  
**[HW1 DUE]**

## NPR

- 12 Tues 10/04 – Non-photorealistic rendering  
**[PROJ 2 IN PROGRESS]**
- 13 Thur 10/06 – Illusions

## Ray Tracing

- 14 Tues 10/11 – Raycasting and Ray Tracing
- 15 Thur 10/13 – Spatial Data Structures
- 16 Tues 10/18 – Midterm  
**[PROJ 3 ASSIGNED]**
- 17 Thur 10/20 - **[MIDTERM EXAM]**



ing  
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d Mocap  
qn & Particle Systems  
**E, PROJ 5 ASSIGNED]**  
en Treuille  
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ic Range Imaging + Tone  
ebcam Clipart  
**E]**  
VING  
|  
earch in Graphics  
case

# SYLLABUS AND SCHEDULE

## Intro

- 01 Tues 08/30 - Introduction
- 02 Thur 09/01 - OpenGL

[PROJ 1 ASSIGNED]

## Geometry

- 03 Tues 09/06
- 04 Thur 09/08
- 05 Tues 09/13
- 07 Thur 09/15
- 08 Tues 09/20

## Light

- 09 Thur 09/22
- 10 Tues 09/27
- 11 Thur 09/29

## NPR

- 12 Tues 10/04
- 13 Thur 10/06

## Ray Tracing

- 14 Tues 10/11
  - 15 Thur 10/13 – Spatial Data Structures
  - 16 Tues 10/18 – Midterm review
  - 17 Thur 10/20 - [MIDTERM EXAM]
- [PROJ 3 DUE, PROJ 4 ASSIGNED]

## Indirect Lighting

- 18 Tues 10/25 - Radiosity
- 19 Thur 10/27 - Photon Mapping
- 20 Tues 11/01 – Direct-Indirect Separation



Mocap  
& Particle Systems  
[PROJ 5 ASSIGNED]  
Treuille  
[TBD]

Range Imaging + Tone  
Cam Clipart

NG

Search in Graphics

## Final

- 30 Tues 12/06 – Final Review
- 31 Thur 12/08 – Project Showcase
- 32 TBD – [FINAL EXAM]

# SYLLABUS AND SCHEDULE

## Intro

- 01 Tues 08/30 - Introduction
- 02 Thur 09/01 - OpenGL

**[PROJ 1 ASSIGNED]**

## Geometry

- 03 Tues 09/06 - Math for Computer Graphics
- 04 Thur 09/08 - Transformations
- 05 Tues 09/13 –Viewing/Camera
- 07 Thur 09/15 - Curves and Surfaces

**[PROJ 1 DUE]**

- 08 Tues 09/20 - Meshes and Surface Processing

**[PROJ 2 ASSIGNED]**

## Light

- 09 Thur 09/22 – Shading/Lighting
- 10 Tues 09/27 – Materials
- 11 Thur 09/29 – Texture mapping

**[HW1 DUE]**

## NPR

- 12 Tues 10/04 – Non-photorealistic rendering

**[PROJ 2 DUE]**

- 13 Thur 10/06 – Illusions

## Ray Tracing

- 14 Tues 10/11 – Raycasting/Ray Tracing
- 15 Thur 10/13 – Spatial Data Structures
- 16 Tues 10/18 – Midterm review

**[PROJ 3 DUE, PROJ 4 ASSIGNED]**

- 17 Thur 10/20 - **[MIDTERM EXAM]**

## Direct Lighting

- 18 Tues 10/25 - Radiosity
- Photon Mapping
- Direct-Indirect Separation

Animation and Mocap  
Differential Eqn & Particle Systems

**[PROJ 4 DUE, PROJ 5 ASSIGNED]**

Fluids: Adrien Treuille  
**[HW2 ASSIGNED]**

Image Processing  
- High Dynamic Range Imaging + Tone Mapping  
- Photo and Webcam Clipart

**[PROJ 5 DUE]**

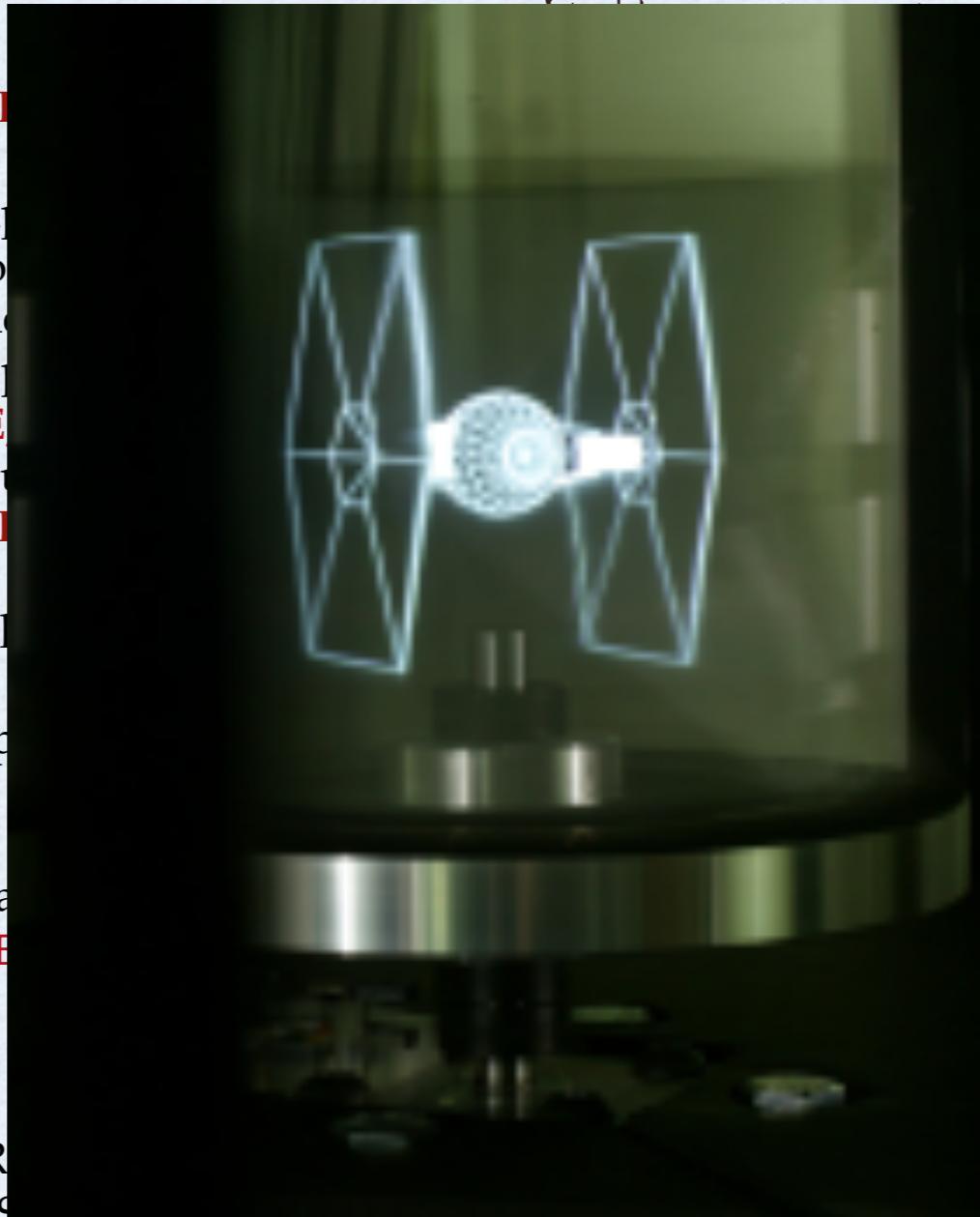
- THANKSGIVING  
- Displays

**[HW 2 DUE]**

Cool new research in Graphics

## Final

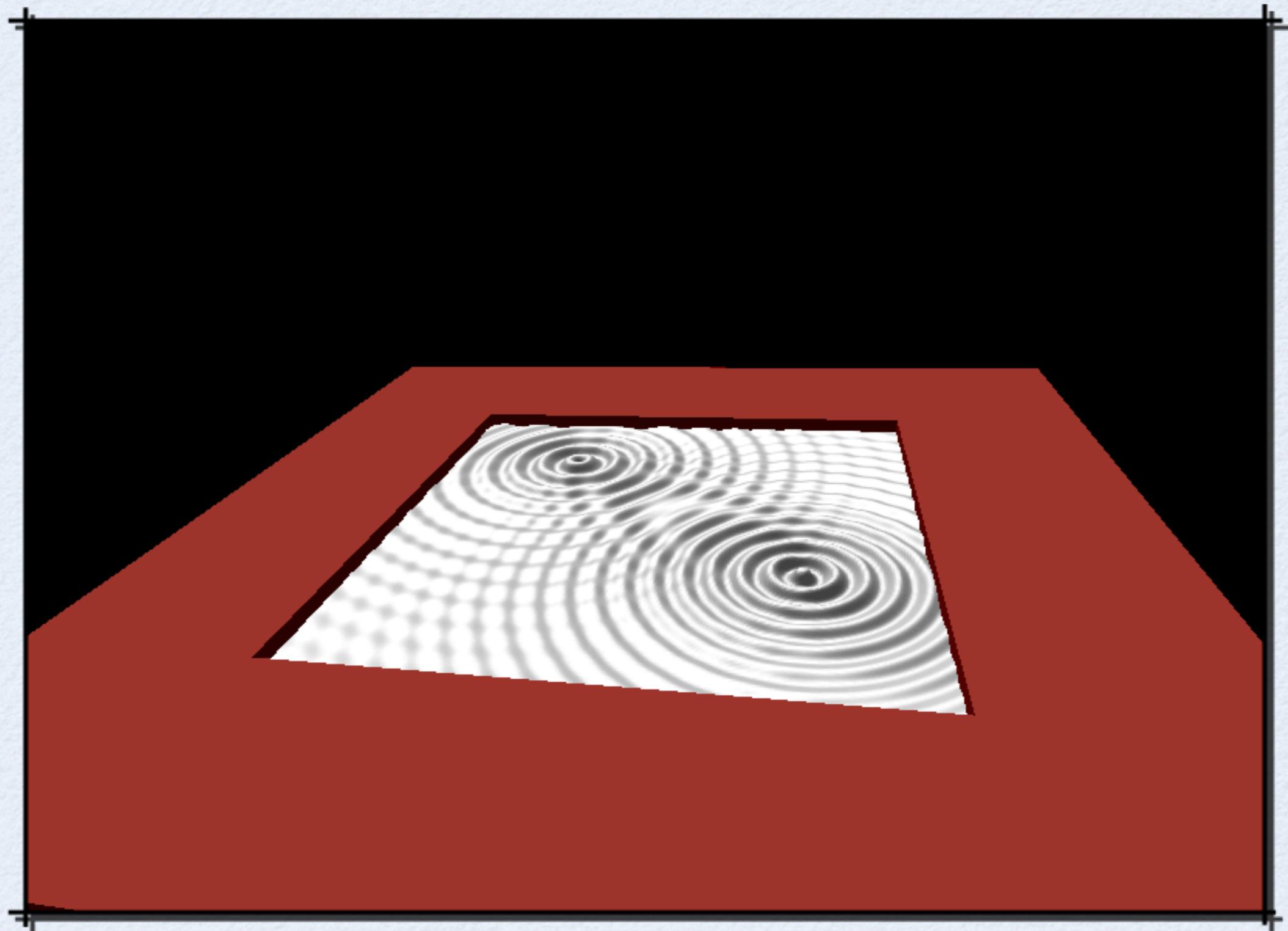
- 30 Tues 12/06 – Final Review
- 31 Thur 12/08 – Project Showcase
- 32 TBD – **[FINAL EXAM]**



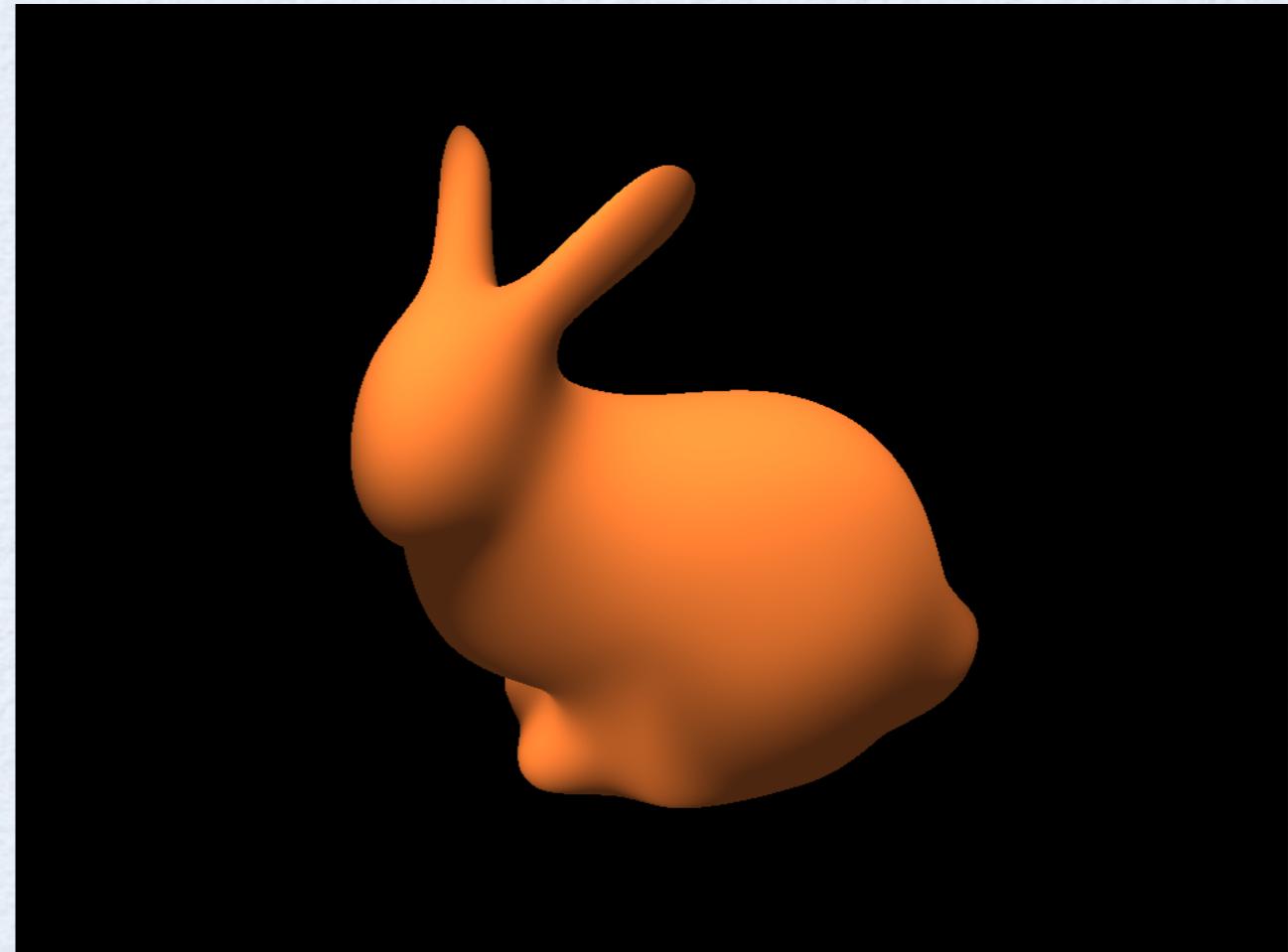
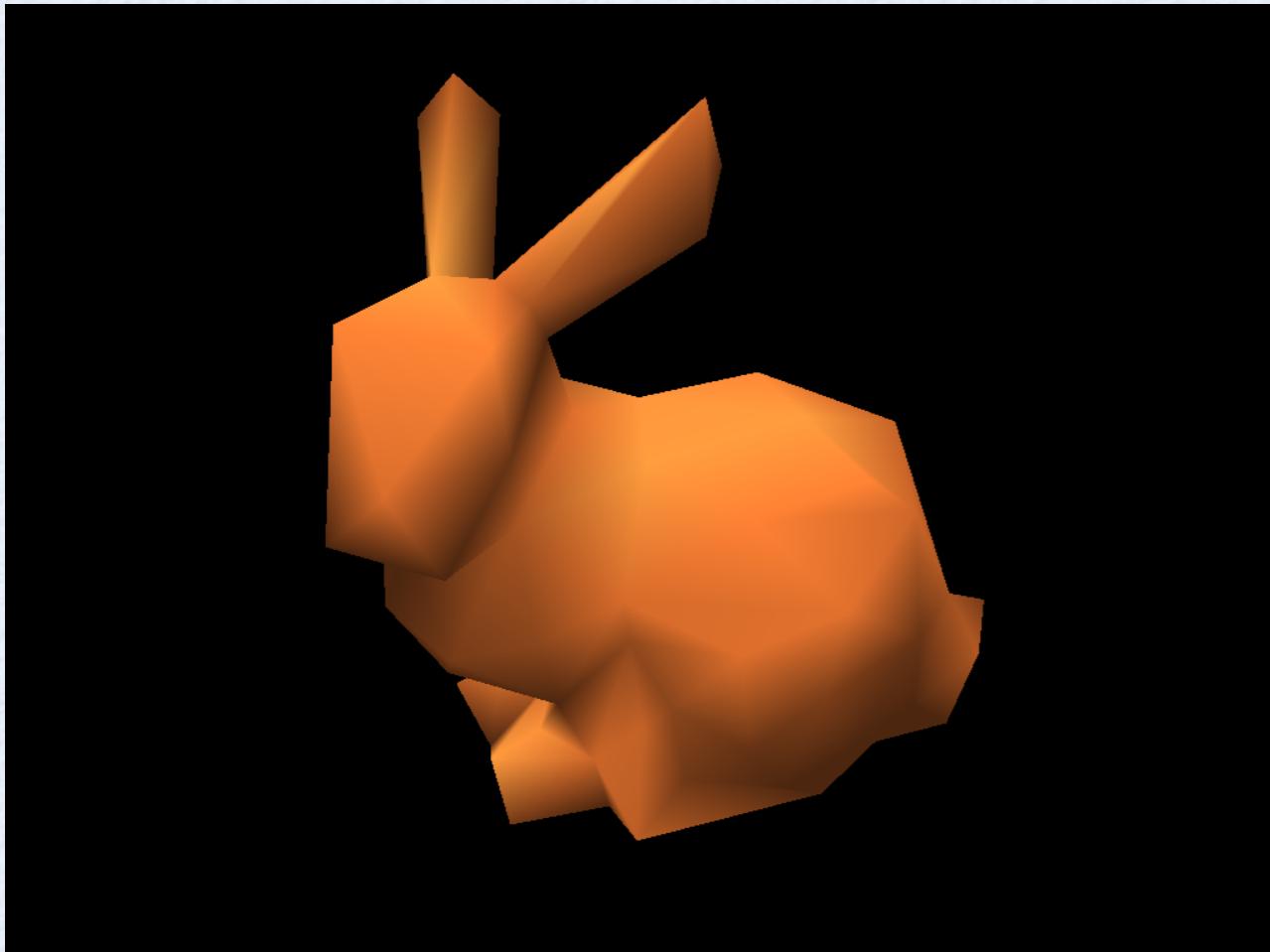
# PROJECTS

- We will have full class votes and prizes too!
- Five Projects:
  - Starter project - OpenGL
  - Geometry and Meshes
  - GLSL Shader Language – Special effects
  - Ray Tracing
  - Animation and Physical Simulation

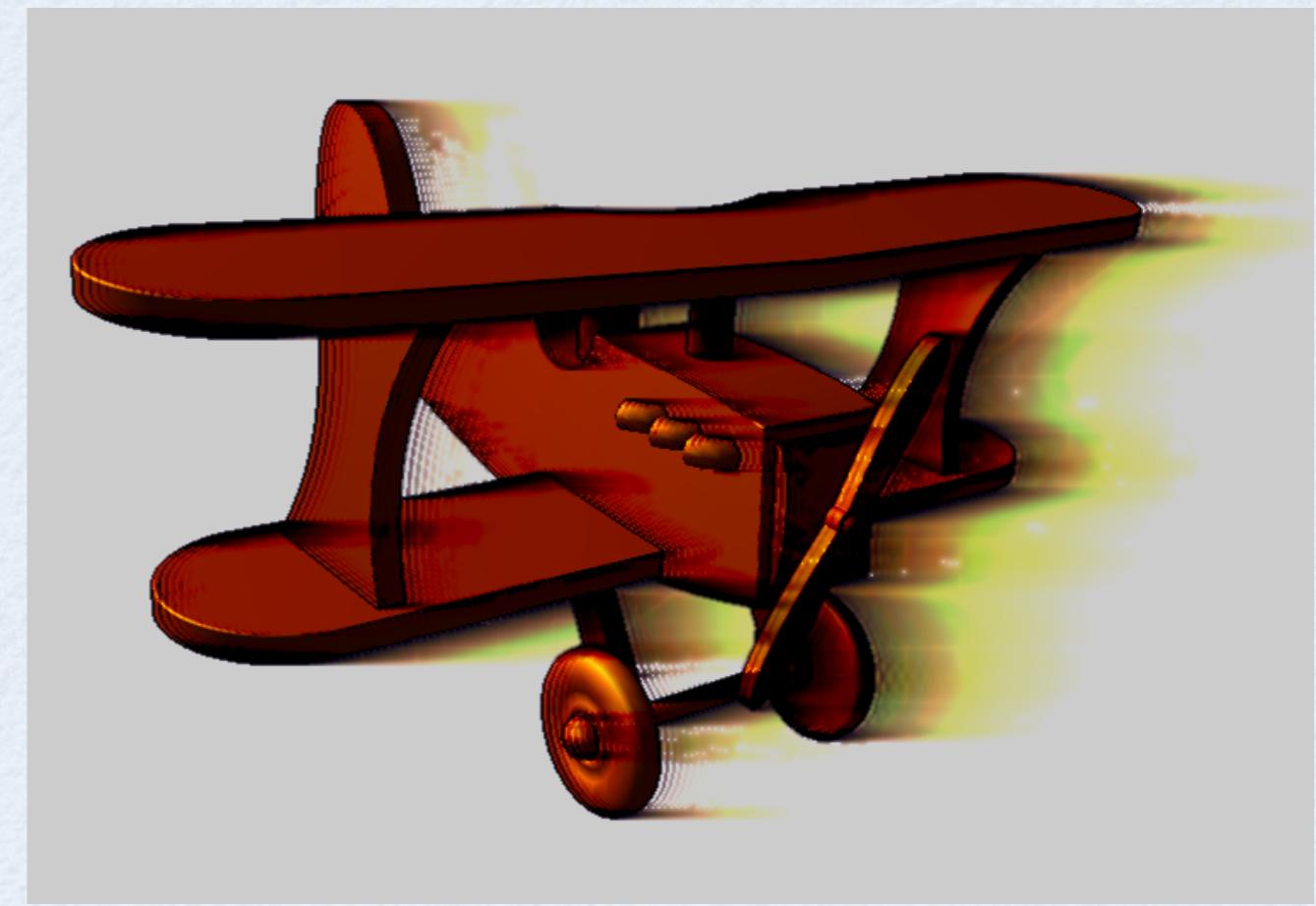
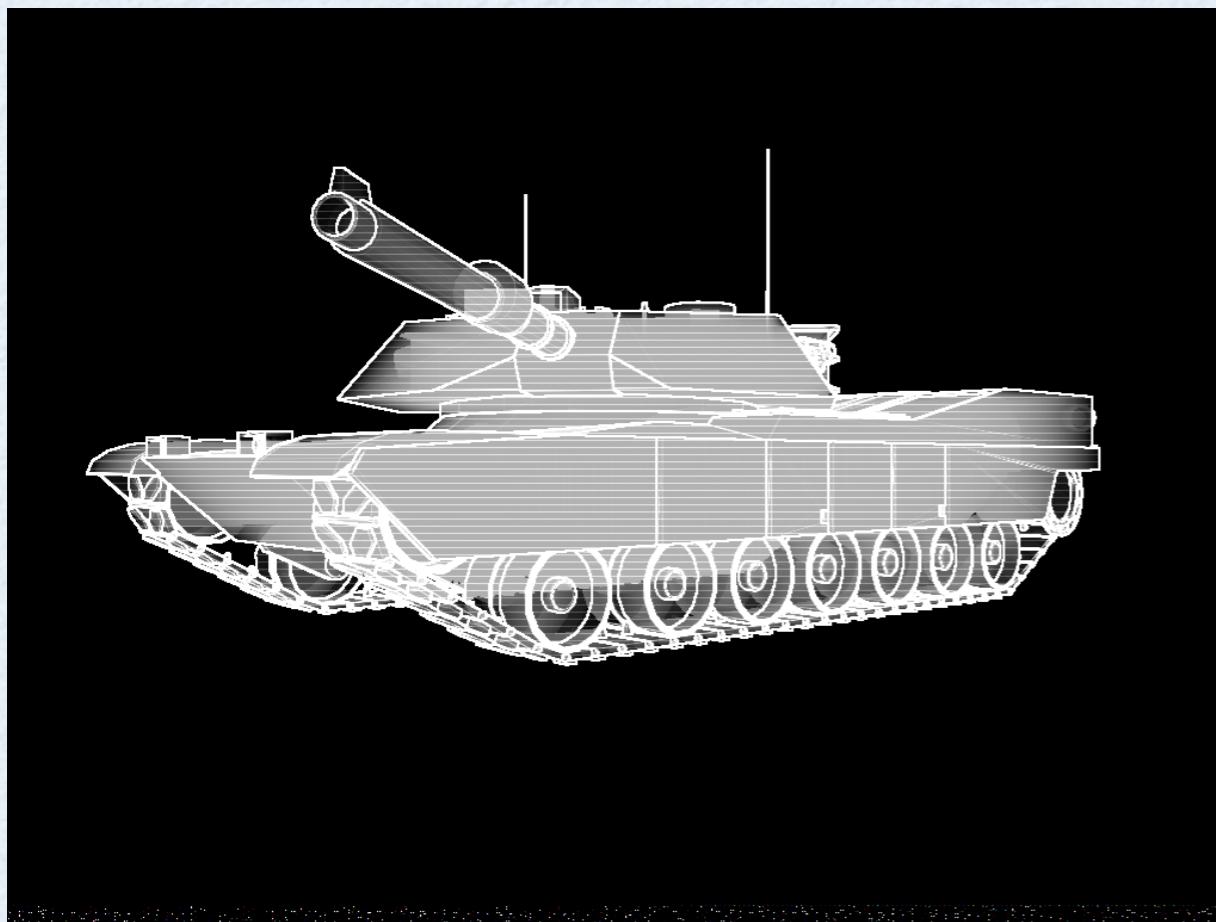
# PROJECT 1: BASICS OF OPENGL



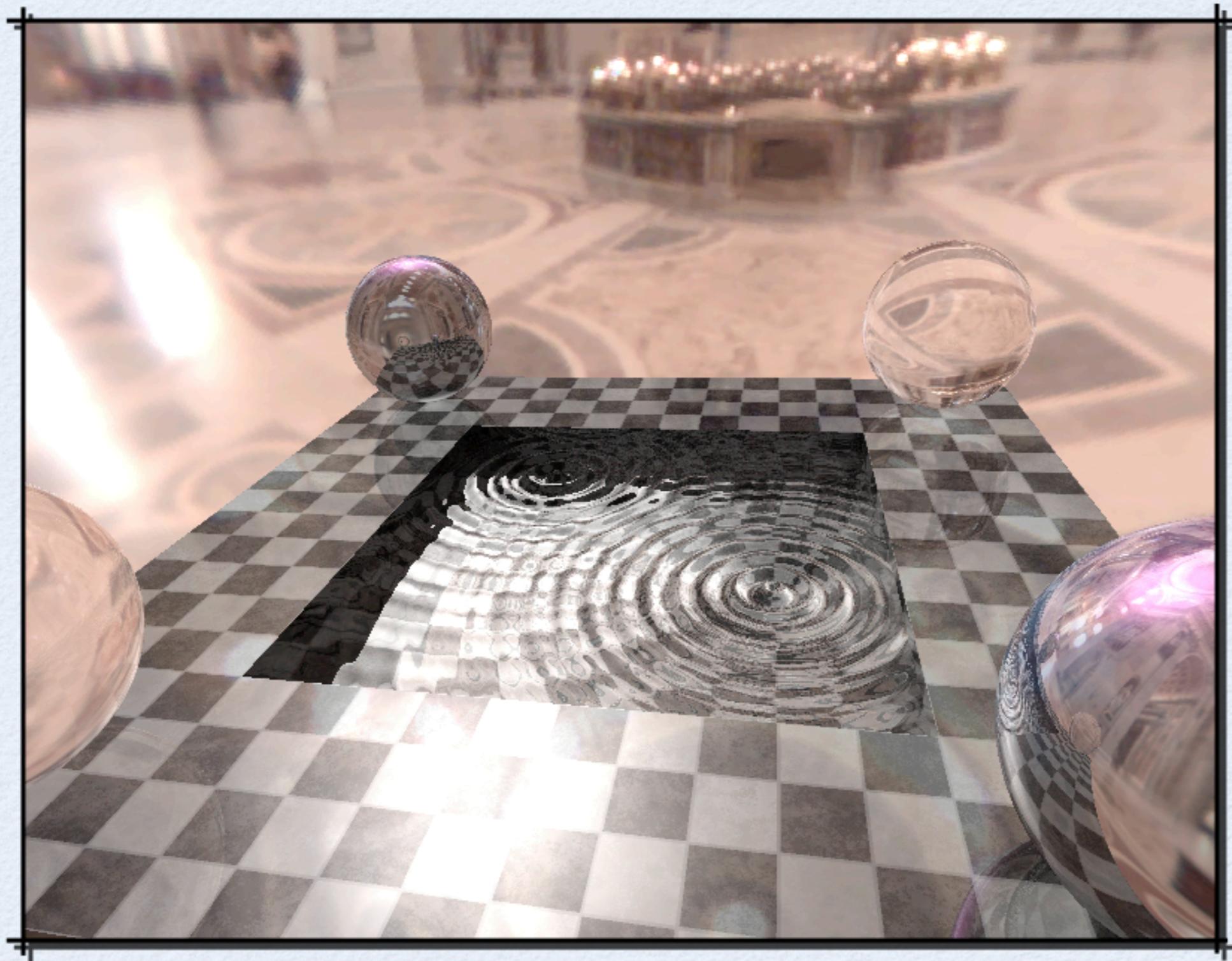
# PROJECT 2: GEOMETRY AND MESHES



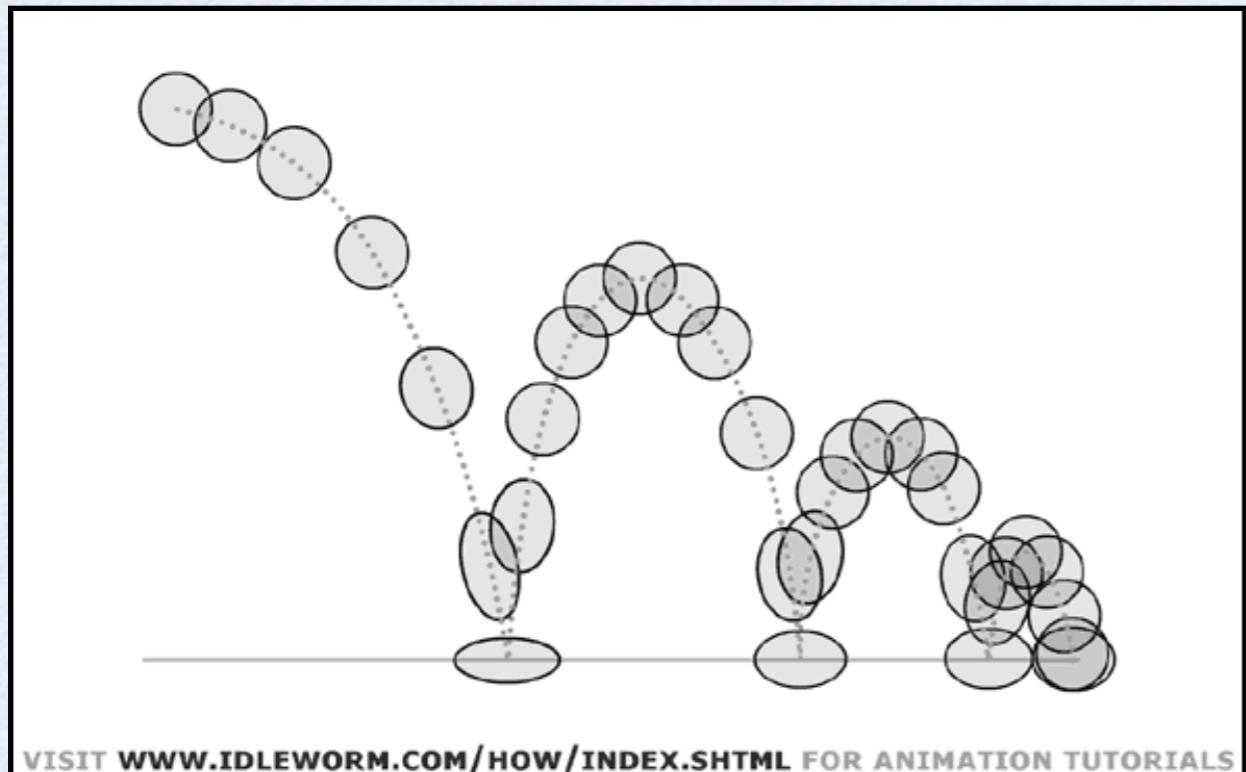
# PROJECT 3: OPENGL SHADERS



# PROJECT 4: RAY TRACING



# PROJECT 5: PHYSICAL SIMULATION



# NEXT LECTURE

- Basics of OpenGL
- How to access CMU machines and start programming
- Project 1 assigned