

# CS465: Computer Graphics I

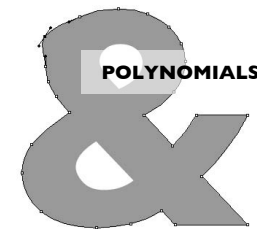
Professor: Steve Marschner

# Introduction

**Computer graphics:** The study of creating, manipulating, and using visual images in the computer.

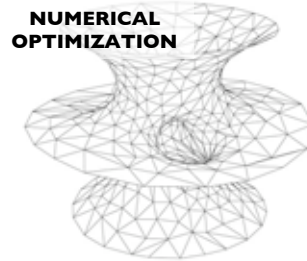
## Problems in graphics

- 2D imaging
  - compositing and layering
  - digital filtering
  - color transformations
- 2D drawing
  - illustration, drafting
  - text, GUIs



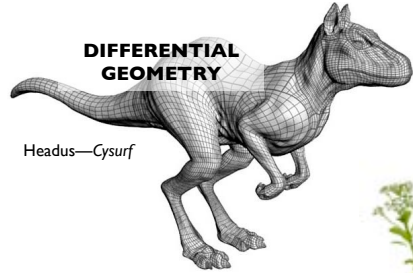
## Problems in graphics CONT'D

- 3D modeling
  - representing 3D shapes
  - polygons, curved surfaces, ...
  - procedural modeling



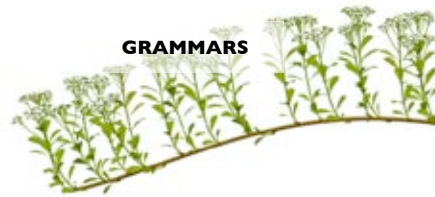
**NUMERICAL OPTIMIZATION**

[Hoppe et al. 1993]



**DIFFERENTIAL GEOMETRY**

Headus—Cysurf



**GRAMMARS**

[Prusinkewicz et al. 2001]

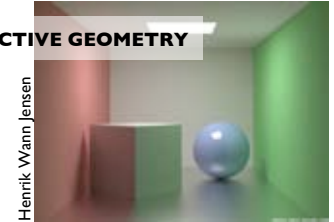
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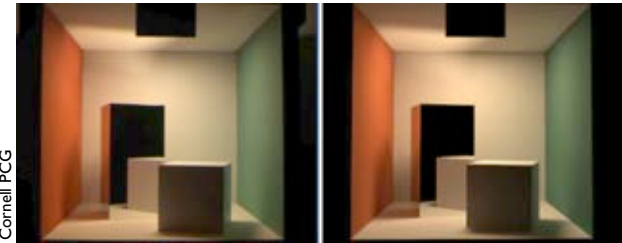
## Problems in graphics CONT'D

- 3D rendering
  - 2D views of 3D geometry
  - projection and perspective
  - removing hidden surfaces
  - lighting simulation

**PROJECTIVE GEOMETRY**



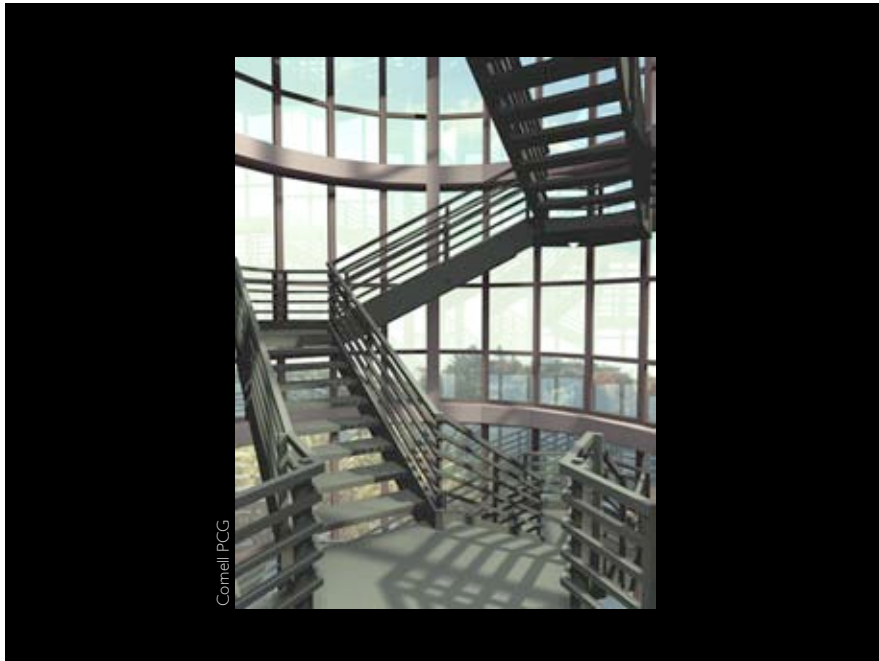
Henrik Wann Jensen



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## Problems in graphics CONT'D

- User Interaction
  - 2D graphical user interfaces
  - 3D modeling interfaces
  - virtual reality



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SGI OpenInventor

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## Problems in graphics CONT'D

- Animation
  - keyframe animation
  - physical simulation



Pixar

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Enright et al. SIGGRAPH 2003

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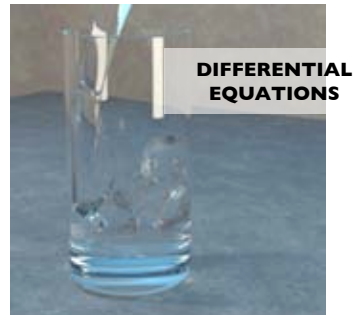
## Problems in graphics CONT'D

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Pixar

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Enright et al. SIGGRAPH 2003

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**Computer graphics:**  
Mathematics made visible.

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## Graphics Applications

- Entertainment
  - film production
  - film effects
  - games
- Science and engineering
  - computer-aided design
  - scientific visualization
- Training & Simulation
- Graphic Arts
- Fine Art

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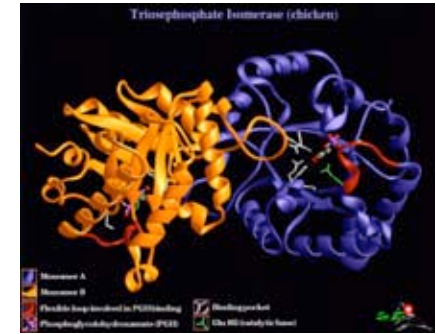




Electronic Arts—NBA Live 07 (screenshot: gamespy.com)

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RIT Biochem. 502—Paul Craig

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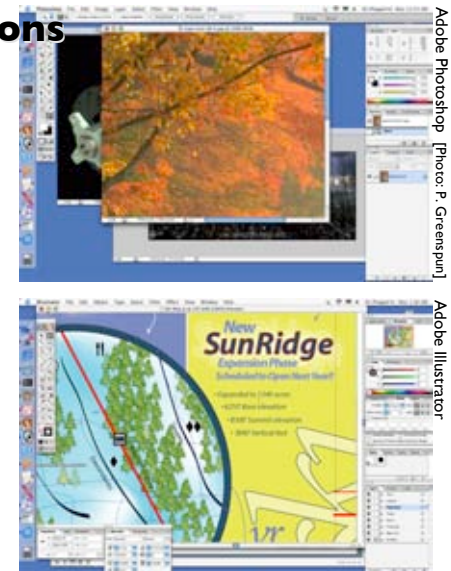
NASA/Ames—ACFS



Amy Research Lab—IES

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Adobe Photoshop [Photo: P. Greenspun]

Adobe Illustrator

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Computer aided sculptures  
Ergun Akleman

## Course Overview

## In this course

- You will:
  - explore fundamental ideas
  - learn math essential to graphics
  - implement key algorithms
  - write cool programs
- You will not:
  - learn a lot about OpenGL or DirectX  
(though you will use some OpenGL)
  - write big programs

## Topics

- Rendering 3D scenes  
(ray tracing as the basic model)
- Images and image processing  
(featuring sampling and reconstruction)
- Geometric transformations
- The graphics pipeline  
(with a slant toward understanding graphics hardware)
- Modeling in 2D and 3D
- Color science

## Images

- What is an image?
- Compositing
- Resampling



[Titanic : DigitalDomain, vrbhq.com]

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## Rendering

- ray tracing
- shading & shadows
- transparency
- texture mapping



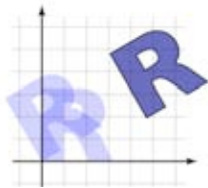
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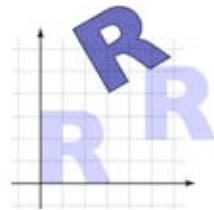
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## Geometric transformations

- affine transforms
- perspective transforms
- viewing



rotate, then translate



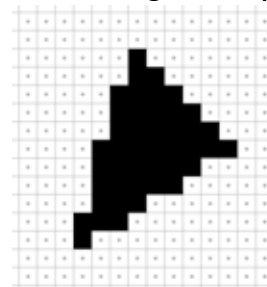
translate, then rotate

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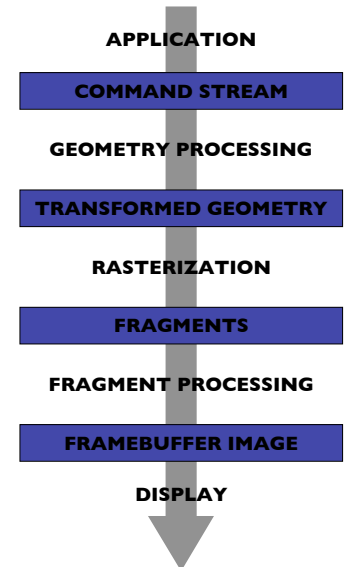
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## Graphics pipeline

- rasterization
- interpolation
- z-buffer
- vertex and fragment ops



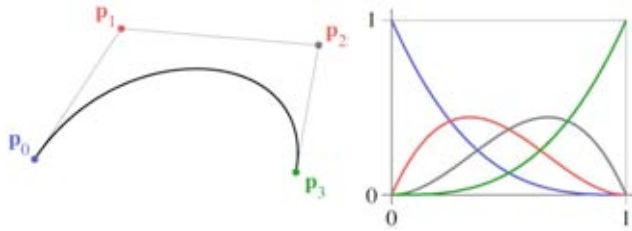
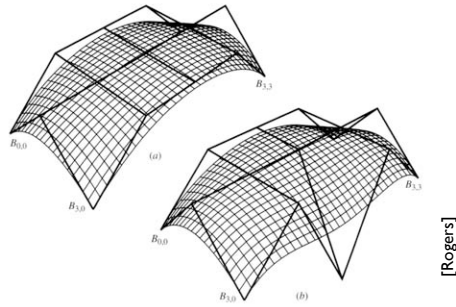
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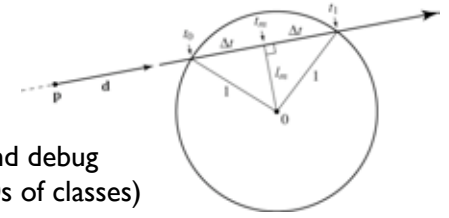
## Modeling

- splines
- parametric surfaces
- triangle meshes



## Prerequisites

- Programming
  - ability to read, write, and debug small Java programs (10s of classes)
  - understanding of very basic data structures
  - no serious software design required
- Mathematics
  - vector geometry (dot/cross products, etc.)
  - linear algebra (just basic matrices in 2-4D)
  - basic calculus (simple derivatives)
  - graphics is a good place to pick up some, but not all, of this



## Course mechanics

see web site:

<http://www.cs.cornell.edu/Courses/cs465/2006fa/>