

# CS465: Computer Graphics I

Professor: Steve Marschner

# Introduction

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

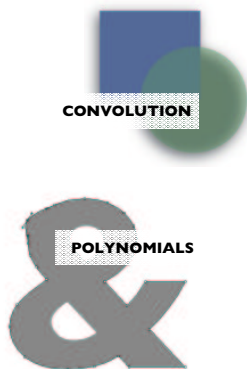
## Problems in graphics

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



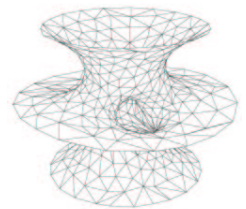
## Problems in graphics

- 2D imaging
  - compositing and layering
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## Problems in graphics CONT'D

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

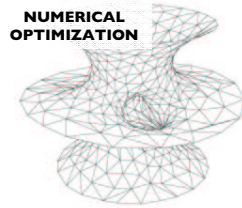


[Hoppe et al. 1993]

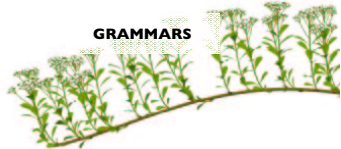
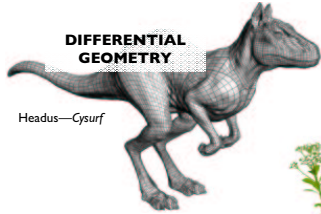
[Prusinkiewicz et al. 2001]

## Problems in graphics CONT'D

- 3D modeling
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  - polygons, curved surfaces, ...
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[Phope et al. 1993]



[Furukiewicz et al. 2001]

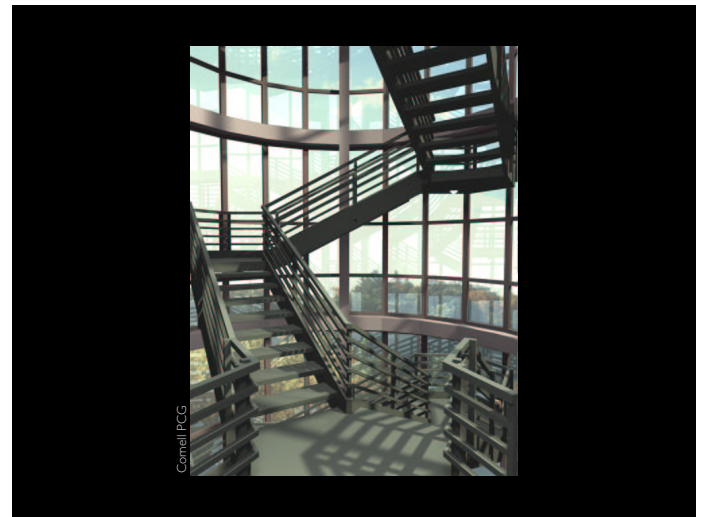
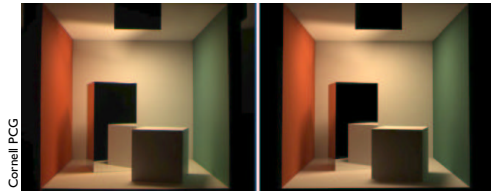
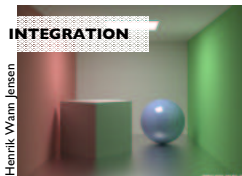
## Problems in graphics CONT'D

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



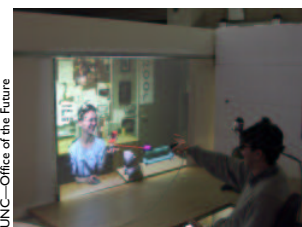
## Problems in graphics CONT'D

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  - removing hidden surfaces
  - lighting simulation



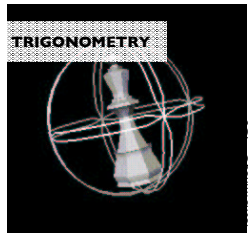
## Problems in graphics CONT'D

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



## Problems in graphics CONT'D

- Interaction
  - 2D graphical user interfaces
  - 3D modeling interfaces
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## Problems in graphics CONT'D

- Animation
  - keyframe animation
  - physical simulation



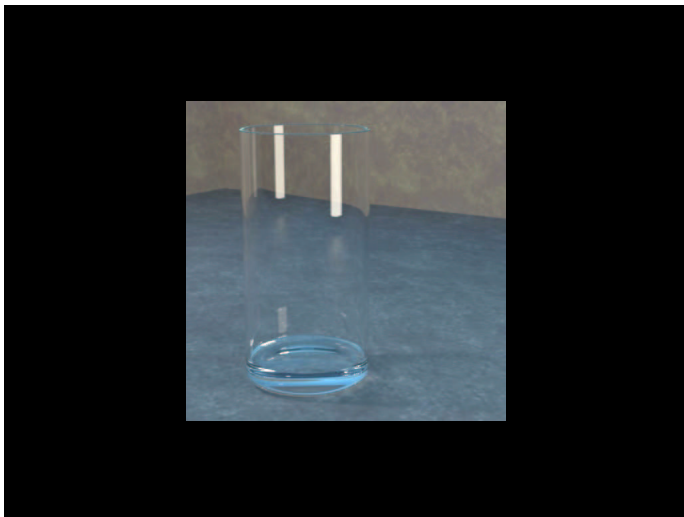
Pixar

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Enright et al. SIGGRAPH 2003

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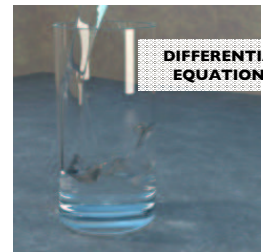
## Problems in graphics CONT'D

- Animation
  - keyframe animation
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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

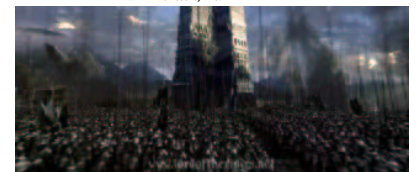
- Entertainment
  - film production
  - film effects
  - games



Pixar—Monsters, Inc.



ID Software—Quake III Arena



New Line Cinema—The Two Towers

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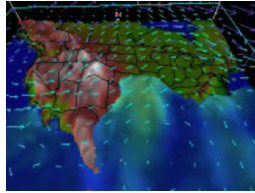
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## Graphics Applications

- Entertainment
  - film production
  - film effects
  - games
- Science and engineering
  - computer-aided design
  - scientific visualization



U. of Utah—Alpha I



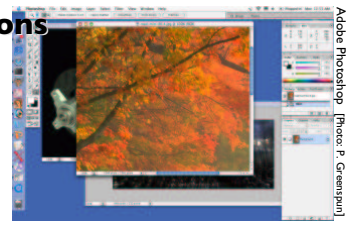
NCSA—Virtual Director

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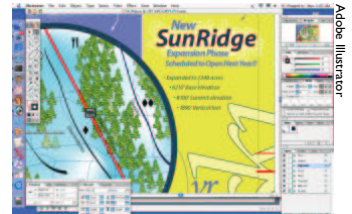
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## Graphics Applications

- Entertainment
  - film production
  - film effects
  - games
- Science and engineering
  - computer-aided design
  - scientific visualization
- Graphic Arts



Adobe Photoshop [Photo: P. Greenpaul]



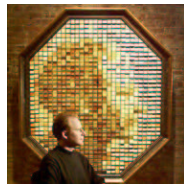
Adobe Illustrator

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## Graphics Applications

- Entertainment
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  - film effects
  - games
- Science and engineering
  - computer-aided design
  - scientific visualization
- Graphic Arts
- Fine Arts



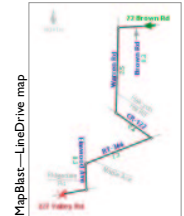
Daniel Rozin—Wooden Mirror

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## Graphics Applications

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



NASA/Ames—ACFS

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## Mechanics

## In this course

- You will:
  - explore fundamental ideas
  - learn math essential to graphics
  - implement key algorithms
  - write cool programs
- You will not:
  - learn OpenGL or DirectX  
(though you will understand basically how they work)
  - write big programs

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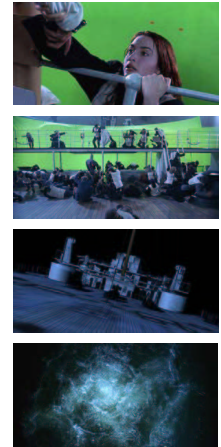
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## Topics

- Images and image processing
- Mathematical background
- Rendering 3D scenes
- Geometric transformations
- The graphics pipeline
- Modeling in 2D and 3D
- Color science

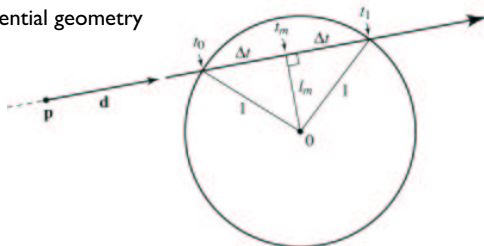
## Images

- What is an image?
- Compositing
- Resampling



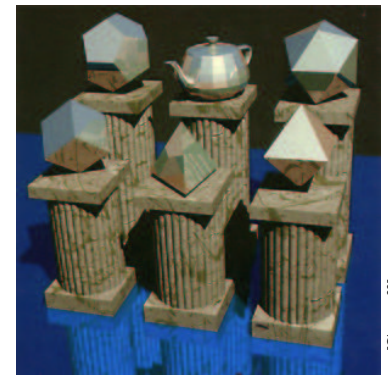
## Mathematical background

- Review of bits of:
  - linear algebra
  - geometry
  - calculus
  - differential geometry



## Rendering

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



## Geometric transformations

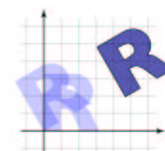
- affine transforms
- perspective transforms
- viewing

rotate, then translate

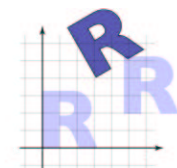
translate, then rotate

## Geometric transformations

- affine transforms
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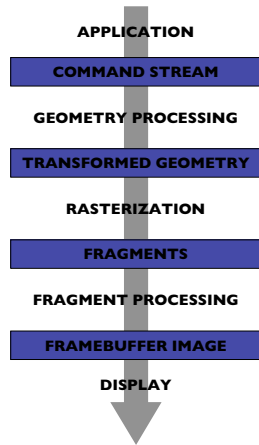
rotate, then translate



translate, then rotate

## Graphics pipeline

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

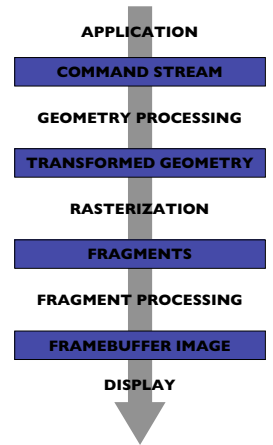
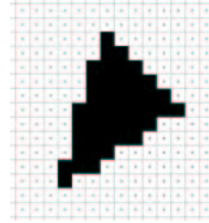


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## Graphics pipeline

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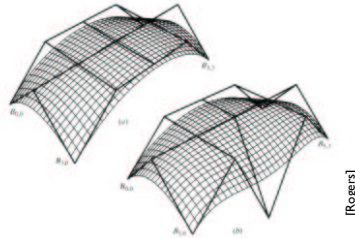


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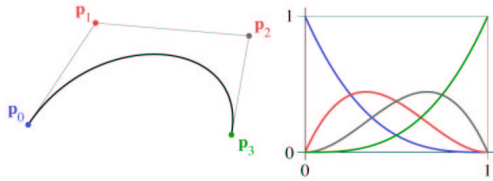
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## Modeling

- splines
- parametric surfaces
- triangle meshes



[Rogers]



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