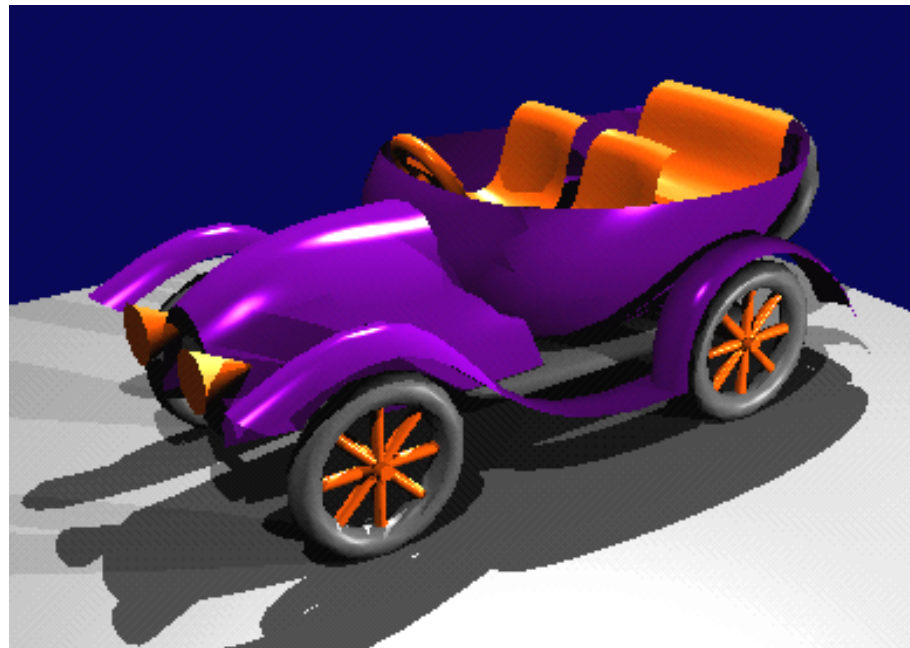# CEG476/CEG676

Computer Graphics I

Outline

1. **Introduction**

2. **Geometric primitives**

3. **Attributes of geometric primitives**

4. **Anti-aliasing techniques**

5. **Homogeneous coordinate system**

6. **2-D and 3-D viewing transformations**

7. **Structures and hierarchical modeling**

8. **Input devices and interactive techniques**

9. **Visible surface detection methods**

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Literature (books)

Hearn, Baker, **Computer Graphics with OpenGL**, Prentice Hall, 2004

Woo, Neider, Davis, Shreiner, **OpenGL Programming Guide**, Addison Wesley, 2000, http://fly.srk.fer.hr/~unreal/theredbook/

Foley, van Dam, Feiner und Hughes, **Computer Graphics: Principles and Practice**, Addison-Wesley, 1990

Alan Watt, Mark Watt, **Advanced Animation and Rendering Techniques**, Addison Wesley, 1992

Farin, **Curves and Surfaces for Computer Aided Geometric Design**, Academic Press, 1996

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Applications for Computer Graphics

- Computer games

- Special effects in movies

- Animation

- Advertisements

- Visualization of scientific data

Computer Games

Project Gotham Racing 3

Special effects in movies

Pirates of the Caribbean – Dead man's chest

ILM captured data from actors in gray costumes during principal photography (at left below), applied the data to "manikins" (middle below), and then fitted the manikins to specified creatures (at right below) to create a final performance (at left)

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Special effects in movies

Pirates of the Caribbean – Dead man's chest

Day Jone's performance by Bill Nighy wearing a gray suit with tracking markers and bands at left, top, was captured using ILM's proprietary Imocap system and then applied to the cursed creature at left, bottom. Keyframe animators and simulation artists performed the tentacles.

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# Special effects in movies

The DaVinci Code

Computer graphics, photographic textures, and a physical set comprise this scene inside Saint-Sulpice. Left is the final shot that appeared in the movie. Bottom left is a photographic image taken inside the actual church, whose textures were used for the final shot. Bottom right shows the 3-D wireframe imagery used to augment the sparse set.

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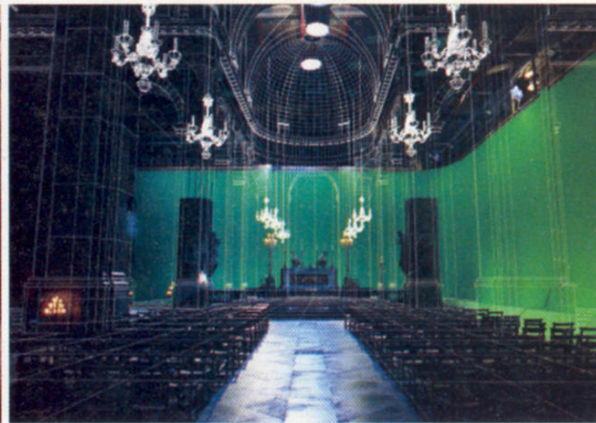
Special effects in movies

X-men 3 – The last stand

Artists applying the digital skin grafting techniques used to make Patrick Stewart and Ian McKellen look younger consulted with a plastic surgeon to avoid the men look androgynous.
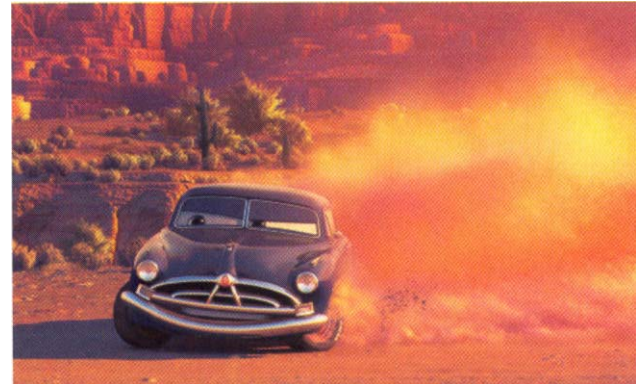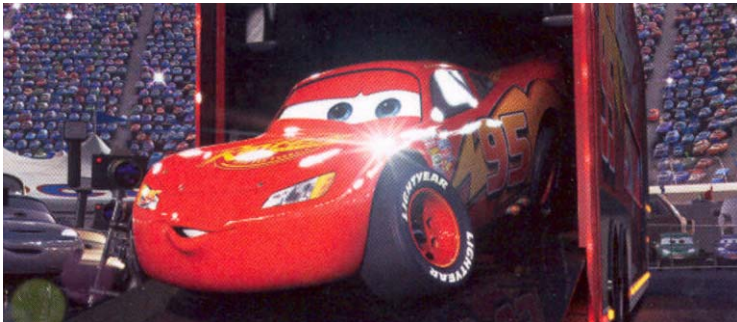
Example: Helm's Deep

http://www.lordoftherings.net/effects/

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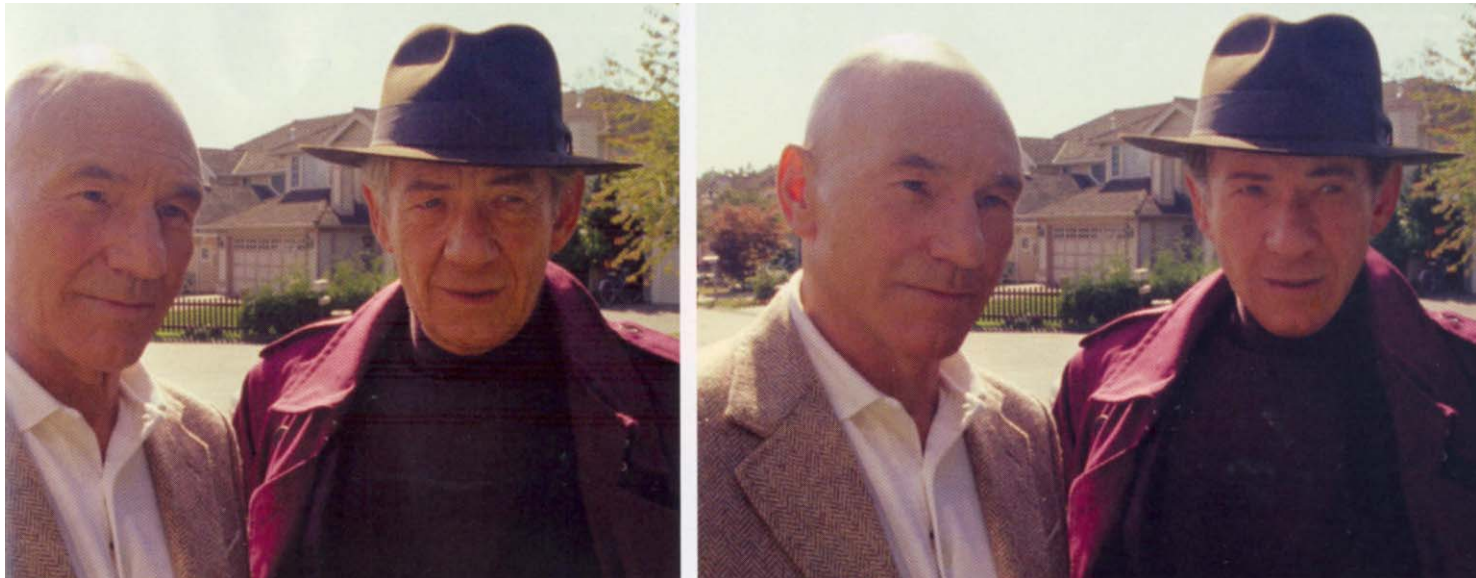
Animation

Cars

Pixar used custom crowd-simulation software to cue specific actions within the thousands of cars in the stadium, and Softimage XSI's behaviour software to control cars queuing up in line.


Thousands of tiny Maya particles rendered with PRMan point primitives kicked up dust behind the 1951 Hudson Hornet, Doc. Large particles rendered volumetrically formed distant, billowing dust clouds.

Animation

Happy Feet

Rendering water and waves was a challenge for a long time due to the complexity. Besides the geometry that is needed for creating a realistic looking wave, particle spray has to be added.
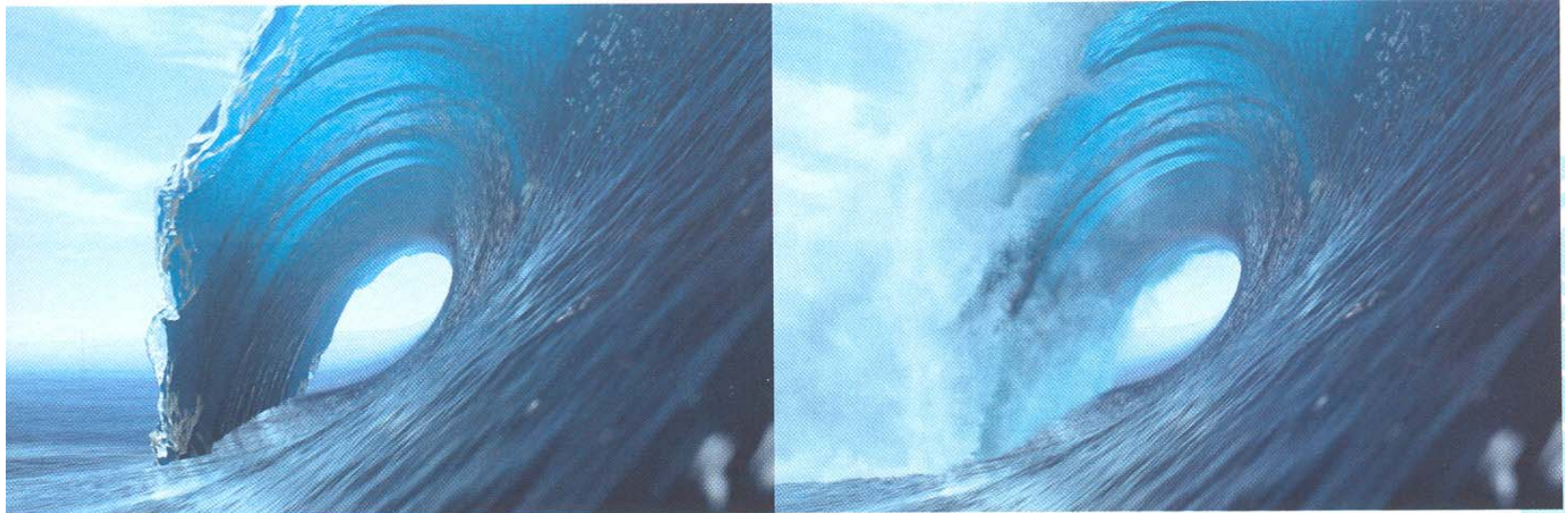
Animation

Fantastic Machine

ANIMUSIC (computer animated music)

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Special effects

Bones

For this scene, the team from Look Effects filmed at an arboretum, where set dressers had added Styrofoam headstones, which were digitally multiplied, to simulate Arlington Cemetery. CG elements and greenscreened actors were also added later.

Special effects

Crossing Jordan

Stargate Digital utilizes its Virtual Blacklot to re-create a Boston backdrop, since it is far easier to generate a virtual version of the city than it is to film the actors there.

Special effects

These images are from Stargate Digital's Virtual Backlot Russia location, for a project the group completed last year. The first image is a greenscreen shot, with the digital set applied to the final (below).
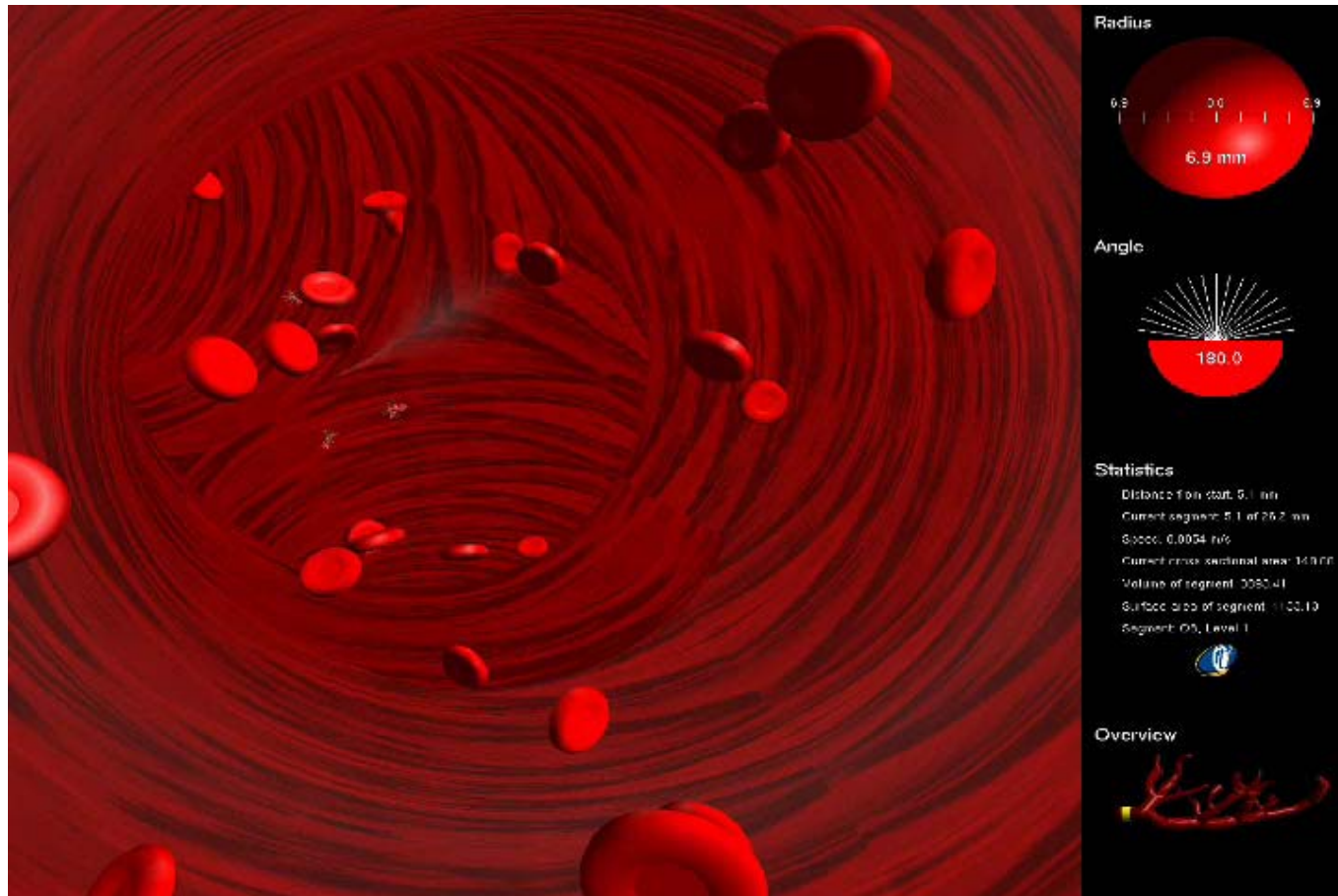
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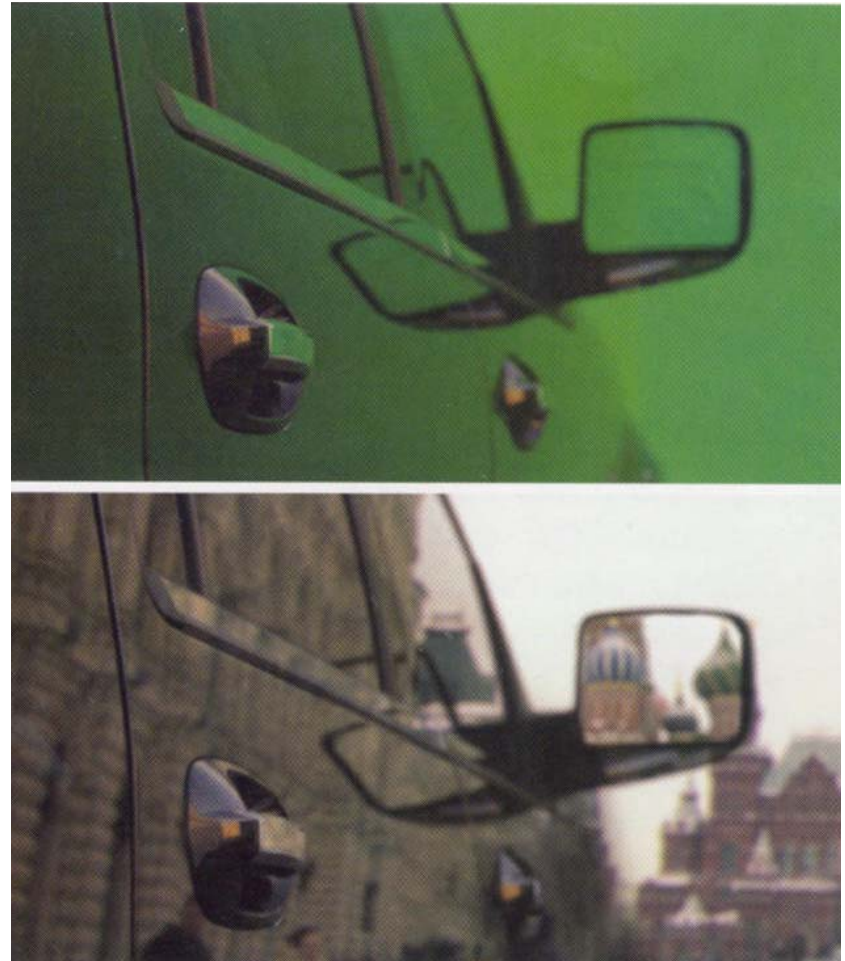
Advertisement

Works Zebra creates visualizations of Lexus car models so that customers can see the new cars in action – even before the vehicles roll off the production line.

Department of Computer Science and Engineering

Visualization of scientific data

CEG476 Computer Graphics I

After the course, you should be familiar with the following techniques:

- Raster algorithms
- Geometric primitives and their attributes
- Clipping
- Anti-aliasing
- Geometric transformations
- Structures and hierarchical models
- Input devices
- Interactive techniques

Raster Algorithms

- Bresenham algorithm for
    - Lines
    - Circles
    - Ellipse

- Polygon filling algorithm
    - Scan line algorithms
    - Seed fill algorithms

- Anti-aliasing

Geometric primitives and their attributes

- Line attributes:
  - Width, style, …

- Polygon attributes:
  - Fill styles
  - Fill color (solid, blended)

- Fill algorithms:
  - Flood fill
  - Scan-line fill

- Anti-aliasing

Department of Computer Science and Engineering

Clipping

- Line clipping algorithms
  - Cohen-Sutherland algorithm
  - Nichol-Lee-Nichol algorithm

- Polygon fill-area clipping
  - Sutherland-Hodgman algorithm
  - Weiler-Atherton algorithm

- Text clipping

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Geometric Transformations

- Affine transformations

    - Rotation

    - Scaling

    - Transformation

- Homogeneous coordinates

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Structures and Hierarchical Models

Reuse of geometry

Example:

Car with four wheels:

Geometry for each wheel can be reused and displayed at all four locations using different translation matrices

Input Devices

- Mouse

- Keyboard

- Scanner

- Digital camera

- Tracked stylus (virtual environment)

- Haptic devices (e.g. cyber grasp)

Interactive Techniques

- Camera flight path