

Computer Graphics Introduction

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Course Code ITA 603

Computer Visualization Techniques

Objectives:

- To teach the students the fundamentals of **computer graphics** .
- Help the students to learn how to **design and develop** optimal graphics algorithms .

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Computer Visualization Techniques

Objectives:

The other concepts, namely,

- **2D & 3D transformation,**
- **windowing and clipping,**
- **3D graphics,**
- **removal of hidden surfaces,**
- To teach the students the fundamental concepts and essential skills required for a successful career in multimedia.

Contents

- Course Outline
- Definition - Computer Graphics
- Application Areas
- Books

Data visualization Techniques: An overview of Computer Visualization, Basic Charts and Plots, Multivariate Data Visualization, Principles of Perception, Color, Design, and Evaluation.

Scientific Visualization Techniques: Analysis Data for Visualization, Scalar Visualization Techniques Vector Visualization Techniques, Text Data Visualization, Temporal Data Visualization, and Interactivity and Animation.

A Unified Framework for Flow Visualization: Introduction, Flow Data, Visualization Mappings of Flow Data, Vector Mappings, Tensor Mappings

Continuum Volume Display: Introduction, Volume Rendering Terminology, Surface Rendering Techniques, Volume Rendering Techniques: Object-Order Techniques, Image-Order Techniques, Hybrid Techniques, Volume Rendering Optimizations, Geospatial Data Visualization

Design of data visualization: Redesign Principles and Design Dimensionality, Hierarchical Data Visualization, Network Data Visualization, Visualization Tools, and Visualization Case Studies.

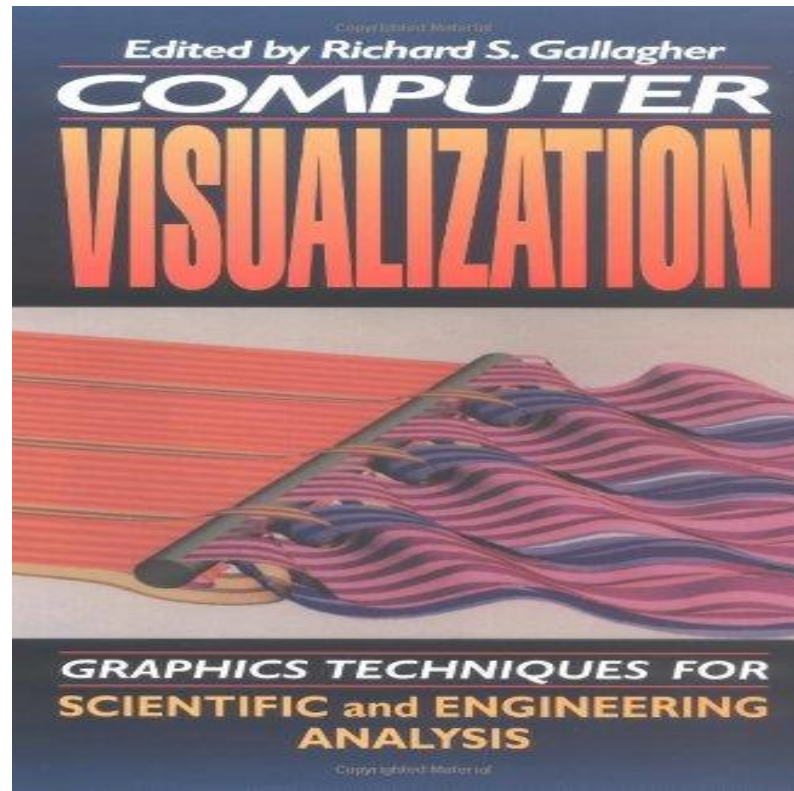
- **Reference Books**

1. Richard S. Gallagher, Computer Visualization: Graphics Techniques for Engineering and Scientific Analysis, 1995, *CRC Press*.
2. Watt A. and M. Watt, Advanced Animation and Rendering Techniques Theory and Practice, 1994, Addison-Wesley.
3. Colin Ware, —Information Visualization Perception for Design|| Morgan Kaufmann Publishers, 2004, 2nd edition.
4. Robert Spence —Information visualization – Design for interaction||, Pearson Education, 2nd Edition, 2007.
5. K. Engel, M. Hadwiger, J. Kniss, C. Rezk-Salama, and D. Weiskopf , Real Time Volume Graphics, A.K. Peters, 2006.

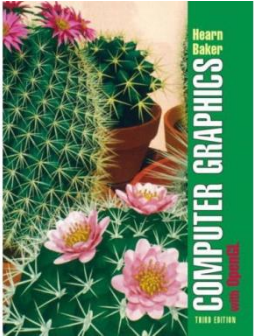
Books

- Richard S. Gallagher, Computer Visualization: Graphics Techniques for Engineering and Scientific Analysis, 1995, CRC Press.

Most of the course follows this book

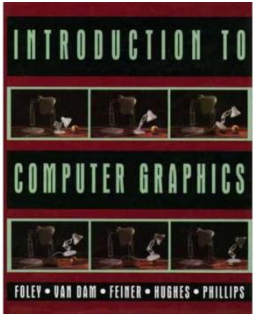


Books

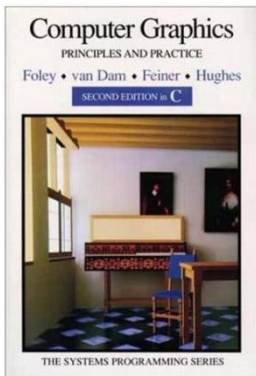


- “Computer Graphics with C”, D. Hearn & M. P. Baker, Prentice Hall, 2003

Most of the course follows this book



“Introduction to Computer Graphics”, J.D. Foley, A. van Dam, S.K. Feiner, J.F. Hughes & R.L. Phillips, Addison Wesley, 1997



“Computer Graphics: Principles and Practice”, J.D. Foley, A. van Dam, S.K. Feiner & J.F. Hughes, Addison Wesley, 1995

Great for really in-depth theory

Computer Graphics & Its Applications

What is Computer Graphics?

- Different things in different contexts:
 - i. **pictures, scenes** that are generated by a computer.
 - ii. **tools used to make such pictures, software and hardware, input/output devices.**
 - iii. Use of computer to **create, store, manipulate, interrogate and present pictorial output.**
 - iv. *“Computer graphics is simply the art/science of producing and manipulating images on a computer.*

Computer Graphics

- Computer graphics is an art of drawing pictures, lines, charts, etc using computers with the help of programming.
- Computer graphics is made up of number of pixels.
- Pixel is the smallest graphical picture or unit represented on the computer screen.

Basically there are **two types** of computer graphics namely.

1. **Interactive Computer Graphics**: Interactive Computer Graphics involves a two way communication between computer and user.
 - Here the observer is given some control over the image by providing him with an [input device](#)

Example : Computer Games (video game controller)

Computer Graphics

2. Non Interactive Computer Graphics: (passive computer graphics.)
- Here the user does not have any kind of control over the image.
 - The image is totally under the control of program instructions not under the user.

Example : screen savers.

Computer Graphics

Difference b/w Active and passive graphics

Passive

- ◆ Control
 - No Control
- ◆ Communication
 - One Way Communication
- ◆ Interaction
 - No Interaction b/w User and H/W
- ◆ Earlier supported
- ◆ Motion & Updation
 - No facility

Active

- ◆ Control
 - Dynamic nature
- ◆ Communication
 - 2-Way Communication
- ◆ Interaction
 - High bandwidth user interaction
- ◆ Modern Applications
- ◆ Motion & Updation
 - 2-D, 3-D Transformations

Computer Graphics

Another Definition of Computer Graphics?

Generating 2D images of a 3D world represented in a computer.

Main tasks:

- ***Modeling:*** *creating and* representing the geometry of objects in the 3D world.
- ***Rendering:*** *generating 2D images of the objects* (image synthesis)
- ***Animation:*** *describing how* objects change in time

Computer Graphics

Geometric Models

There are several methods to build and represent the objects in a scene.

- Set of vertices
- Polygonal meshes
- Curved surfaces
- parameterizations: e.g. Bezier surfaces, other spline surfaces
- Implicit representations (often used with real life surfaces)

Computer Graphics

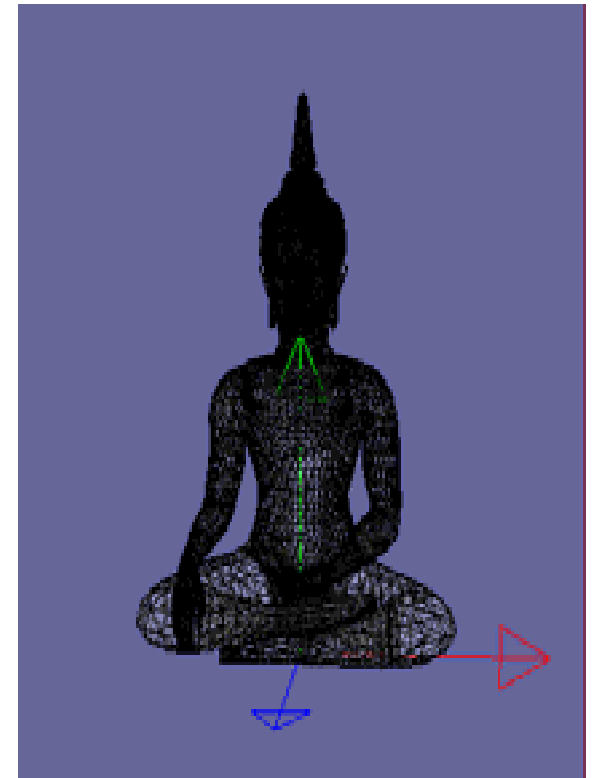
Modeling

- Describing objects
- Mainly, 3D object geometry
- Could include topology, material properties, photometry
- The objects could be real or artificial
- ***creating and representing the geometry of objects in the 3D world***

Computer Graphics

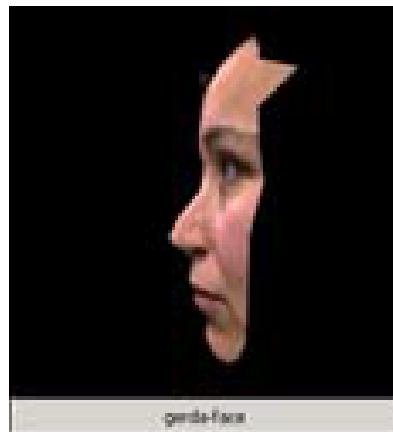
Modeling

- **Modeling: Design of an artificial object**



Computer Graphics Modeling

- 3D Modeling: mapping texture onto the recovered surface



Computer Graphics

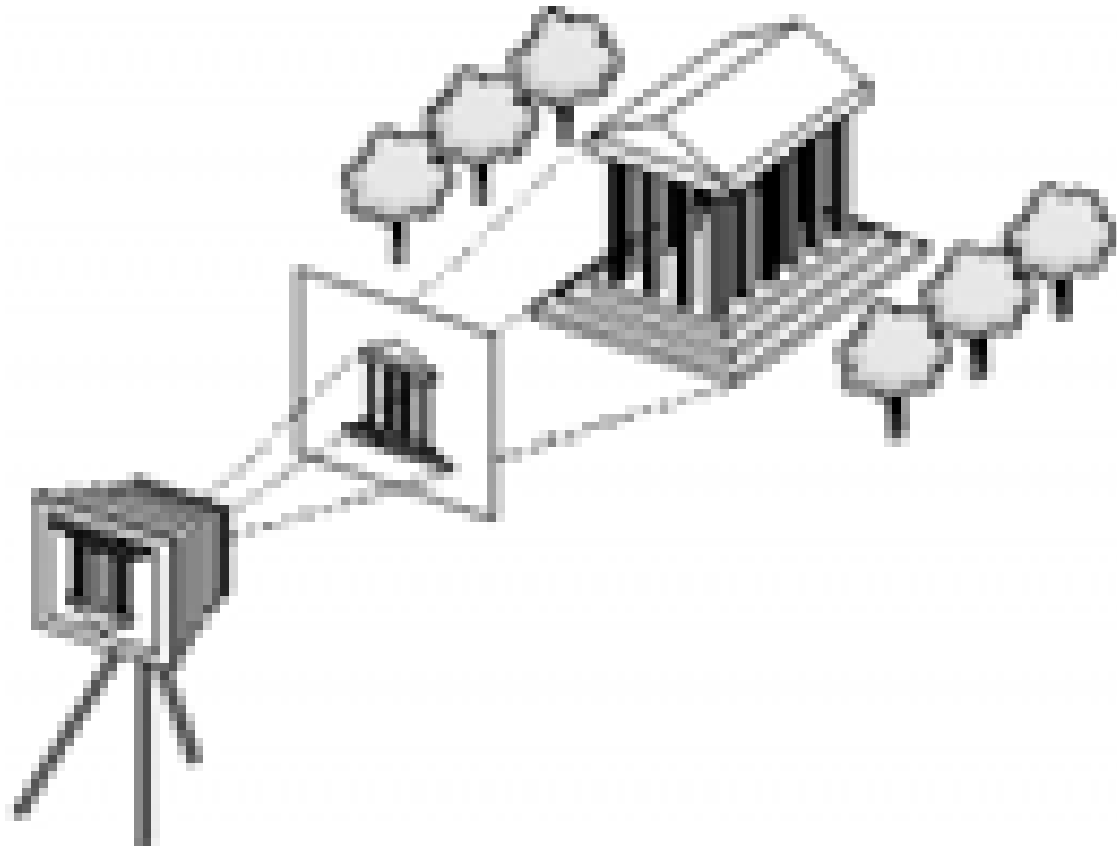
Rendering

- Generating 2D images of the modeled 3D objects
- Includes
 - Viewing model (where is the “camera” that takes the picture, how is it oriented)
 - Projection model (what are the “camera” parameters, like lens type, aperture)
 - Illumination model (what are the lighting conditions)
 - Shading model and surface properties (material, reflectance, specularities, texture)
 - Rasterization (from 2D continuous images to discretized image in the Frame Buffer)

Computer Graphics

Rendering

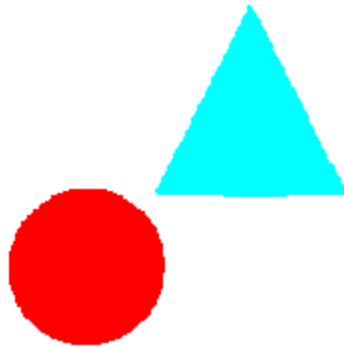
Rendering: from 3D to 2D



Computer Graphics

Rendering: color and shading

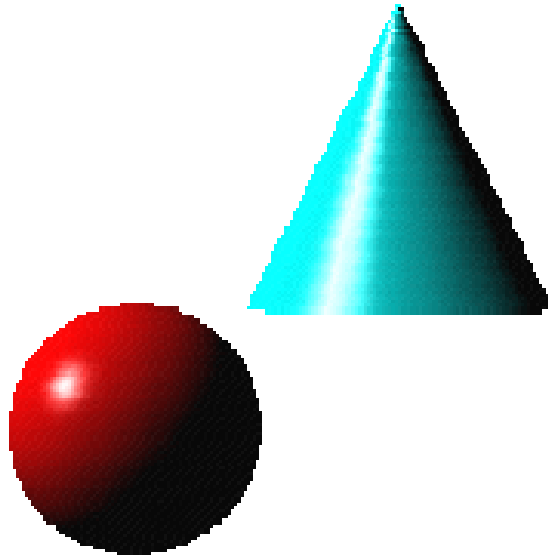
- Simple flat shading: a circle and a triangle or a sphere and a cone?



Computer Graphics

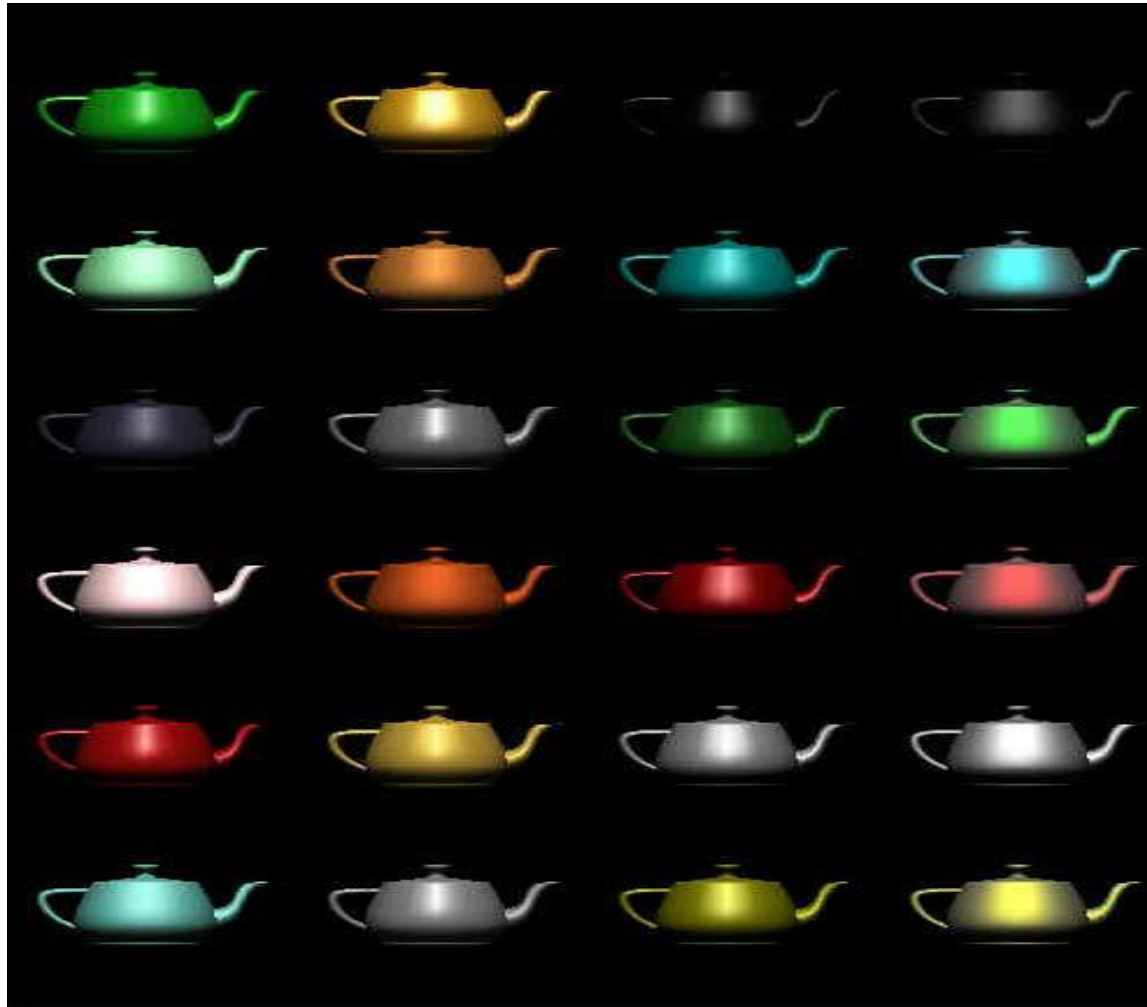
Rendering: illumination and shading

More realistic shading



Computer Graphics

Rendering: Teapots, Teapots, ...



Computer Graphics

Animation

- Modeling and rendering objects with attributes that change over time (position, geometry, topology, color, texture, etc.)



Computer Graphics

Overall -> Computer Graphics Involves

- How pictures are represented in computer graphics,
- How pictures are prepared for presentation,
- How interaction within the picture is accomplished.

Computer Graphics Applications

- Art, entertainment, and publishing
 - movie production, animation, special effects
 - computer games
 - World Wide Web
 - Book, magazine design, photo editing
- Simulations (education, training)
- CAD architectural, circuit design etc.
- Scientific analysis and visualization
- Graphical User Interfaces

Computer Graphics is about animation (films)



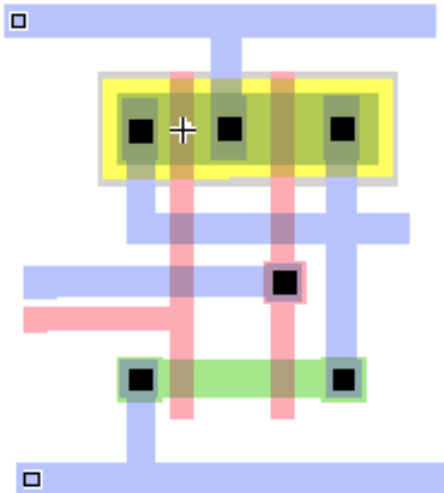
Games are very important in Computer Graphics



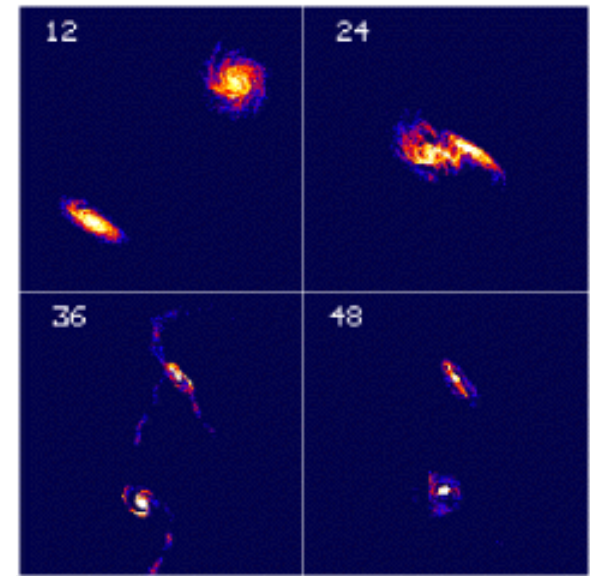
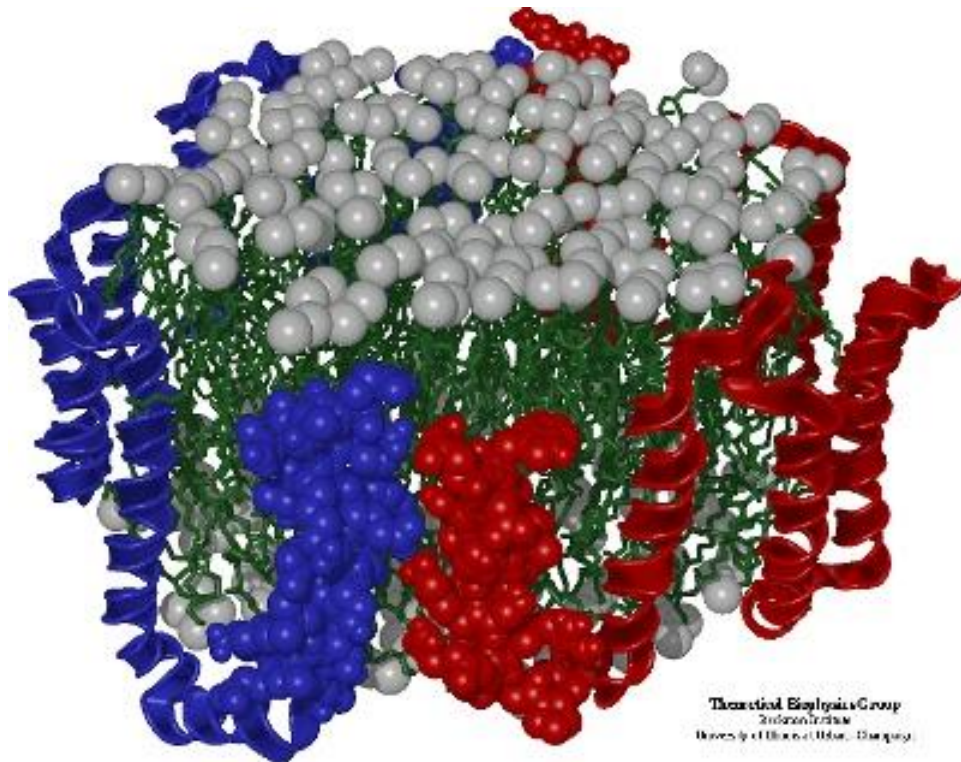
Medical Imaging is another driving force



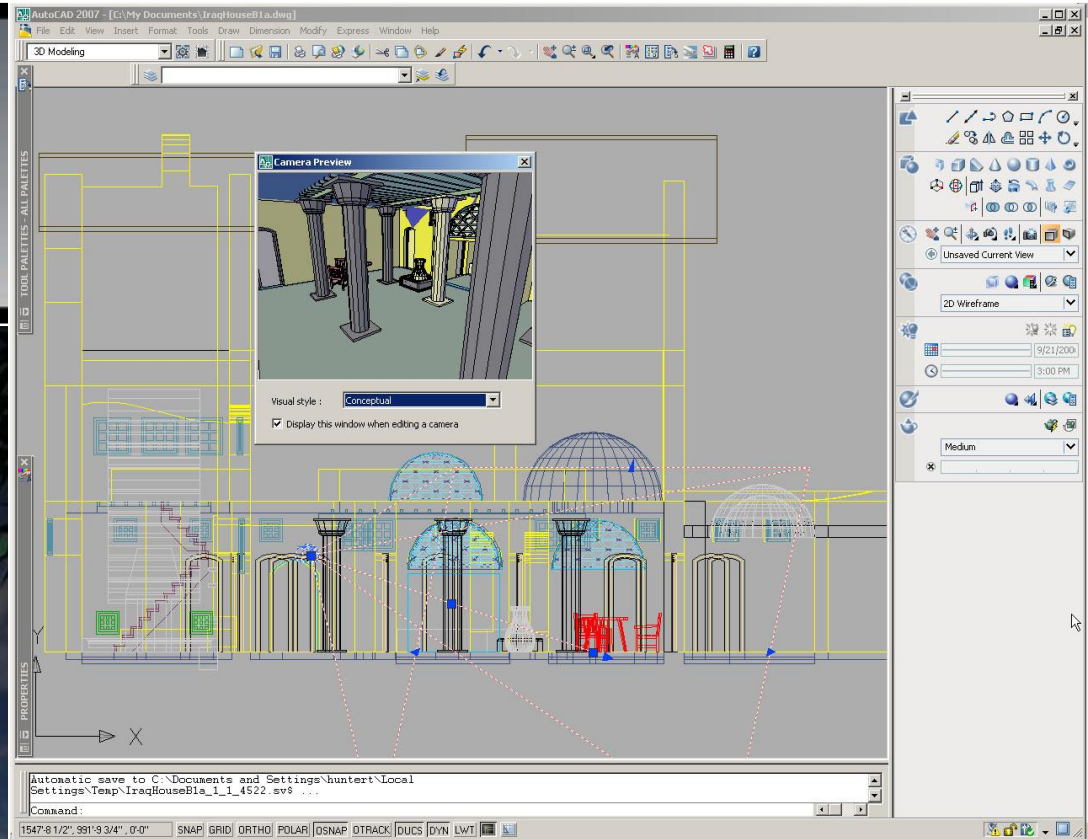
Computer Aided Design too



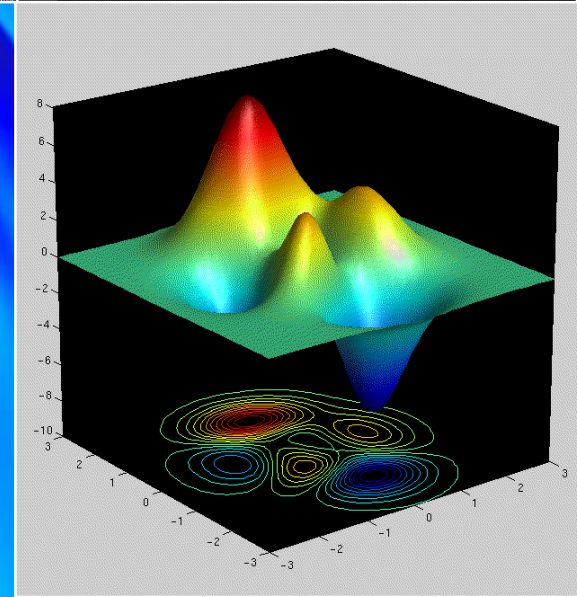
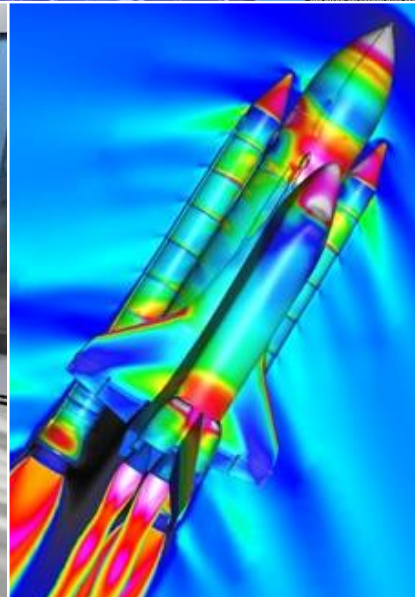
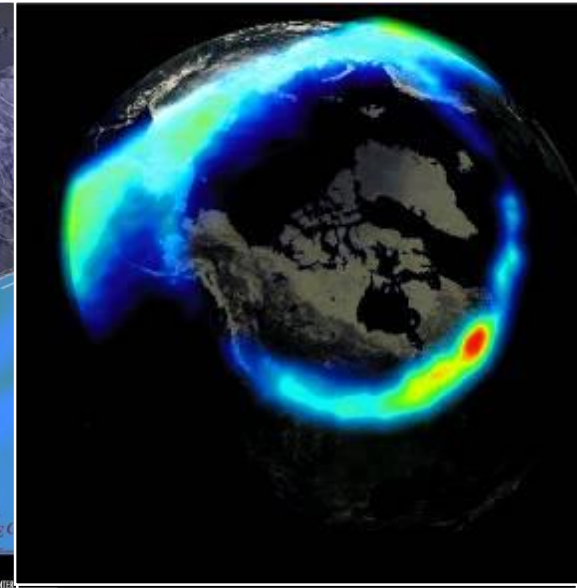
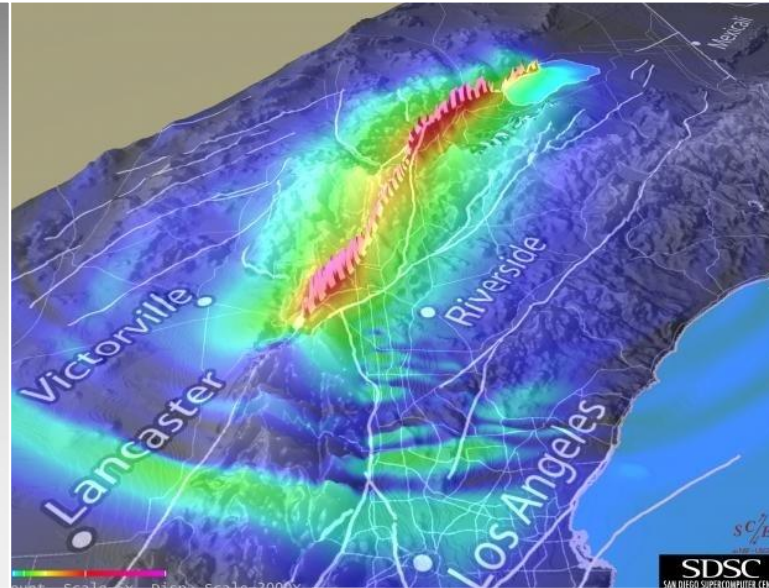
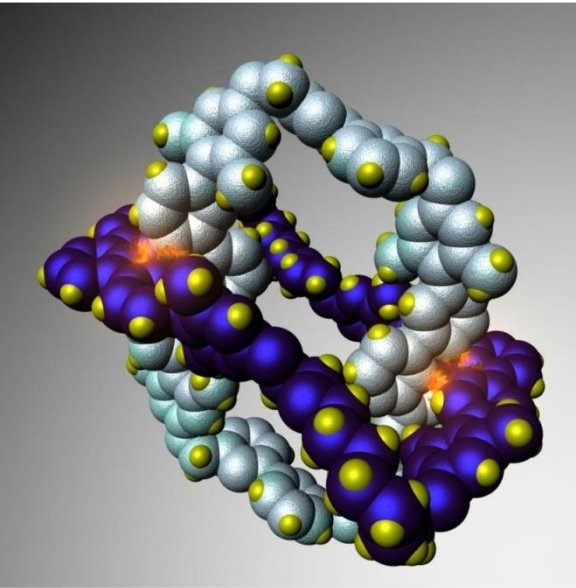
Scientific Visualisation



Computer Aided Design



Scientific Visualisation



Computer Graphics

EDUCATION AND TRAINING

- ◆ Computer Graphics is almost used in every field to teach and train
- ◆ Medicine
 - ◆ Human Anatomy Models
- ◆ Engineering
 - ◆ Animated Models :
Explaining the working of different models
- ◆ Fashion Designing
 - ◆ Designing and Creating new Patterns



Human Skeleton

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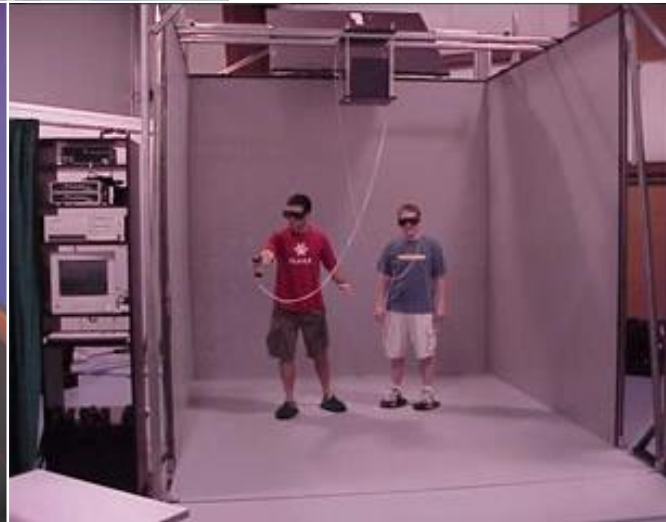
Films



Games

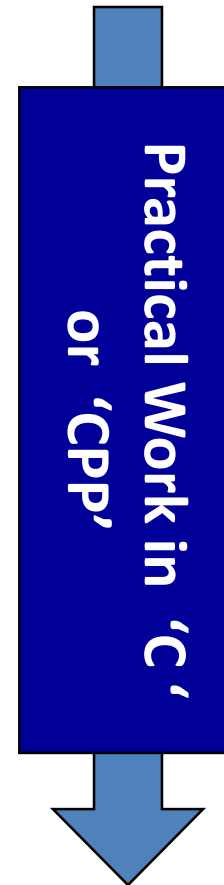


Virtual/Augmented Reality



Course Outline

- The course will follow this broad-strokes outline:
 - Maths Preliminaries
 - Overview of Graphics systems
 - Output Primitives
 - Transformations in 2D & 3D
 - Viewing in 2D & 3D
 - Clipping in 2D & 3D
 - Hidden Line Elimination
 - Curves
 - Colour Models
 - Illumination and Surface Rendering
 - Applications



- Any Questions?