

**Faculty of German Engineering and
Industrial Management Education - FDIBA**

Introduction to Computer Graphics



Basic Concepts

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● Faculty of German Engineering Education

- Mechanical Engineering
- Computer Science
- Master of Business Administration



Computer Graphics

● What computers do....

- process, transform, and communicate information

● Aspects of Communication

- Origin (where does it come from?)
- Throughput (how long will it take to get here?)
- Latency (how long do I have to wait before something happens?)
- Presentation (what does it look like?)

Computer Graphics

- Computer Graphics is...
**the technology for presenting
information**

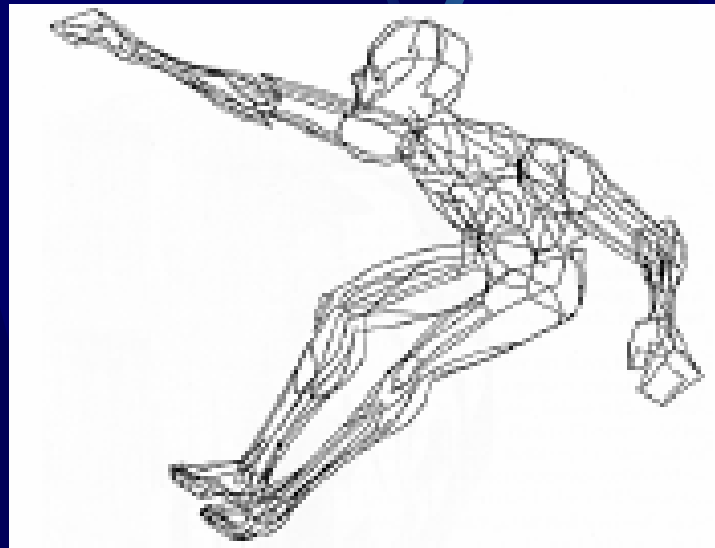


What is Computer Graphics

- Traditional meaning: **Synthesis, Generating of Drawings and Images by user defined specifications.**
- Today: **Creation, Storing and Manipulation of Models and Images of Objects.**
- Such **models** come from a diverse set of fields including physical, mathematical, artistic, biological, and even conceptual (abstract) structures.

What is Computer Graphics (2)

- The term “computer graphics” was coined in 1960 by **William Fetter** to describe new design methods he was pursuing at Boeing.
- He created a series of widely reproduced images on a plotter exploring cockpit design using a 3D model of a human body.



What is **Interactive** Computer Graphics

- User controls:
 - contents
 - structure
 - and appearance of objects and their displayed images via rapid **visual feedback**

What is **Interactive** Computer Graphics

- Basic components of an interactive graphics system
 - input (e.g., mouse, tablet and stylus, force feedback device, scanner...)
 - processing (and storage)
 - display/output (e.g., screen, paper-based printer, video recorder...)

First Interactive Computer Graphics System

- 1963 Ivan Sutherland - MIT
 - PhD Thesis - **Sketchpad: A Man-Machine Graphical Communication System**



Before Sketchpad

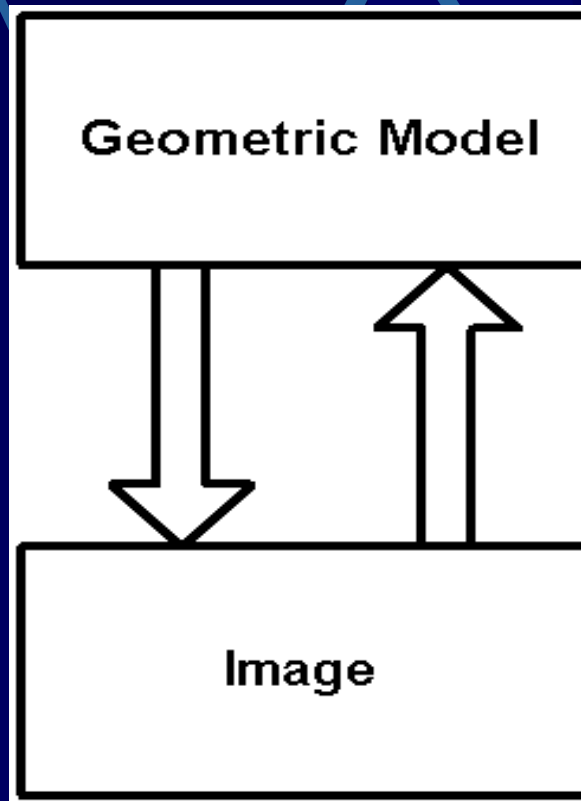
- output via plotters/printers, input via keypunch, both in batch



- Card punching (left). The IBM 704 (right) took up a whole room and had less computing power than a Mac Plus.

Definition of Computer Graphics

- Basic Concepts
 - **Model** (Geometric Model)
 - **Image**



Application Distinctions

- **Two basic paradigms:**
 - **Sampled-based graphics**: discrete samples are used to describe visual information
 - **Geometry-based graphics**: a geometrical model is created, along with various attributes, and is then sampled for visualization (this process is called rendering)

Application Distinctions

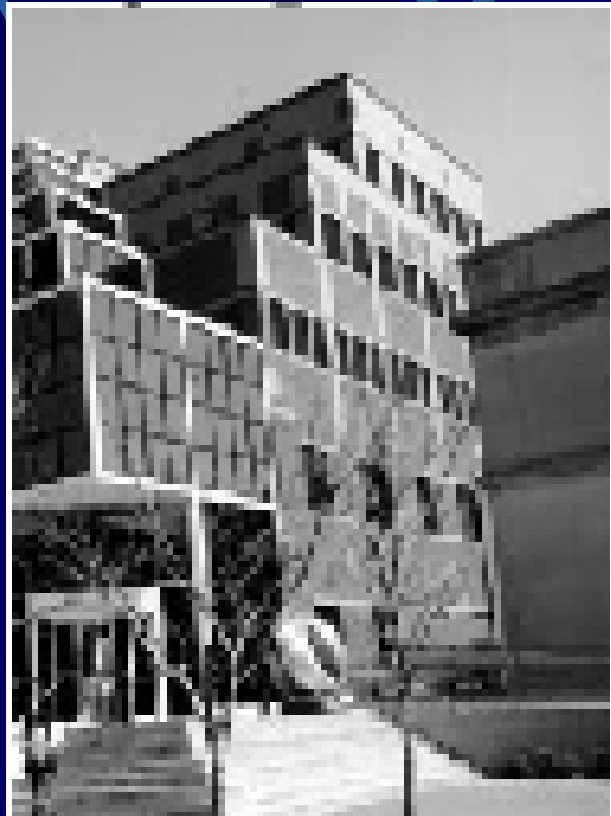
- Two basic paradigms:
 - Sampled-based graphics: discrete samples are used to describe visual information
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Sample-based Graphics

- Samples can be created directly in a paint-type program, or as a result of sampling continuous (analog) visual materials, using scanners, cameras etc.
- Sample values can also be input numerically (e.g., with numbers from a computed data set)
- Once an image is defined as a pixel-array, it can be manipulated

Sampling an Image

- Lets do some sampling of the a building



The 3D scene

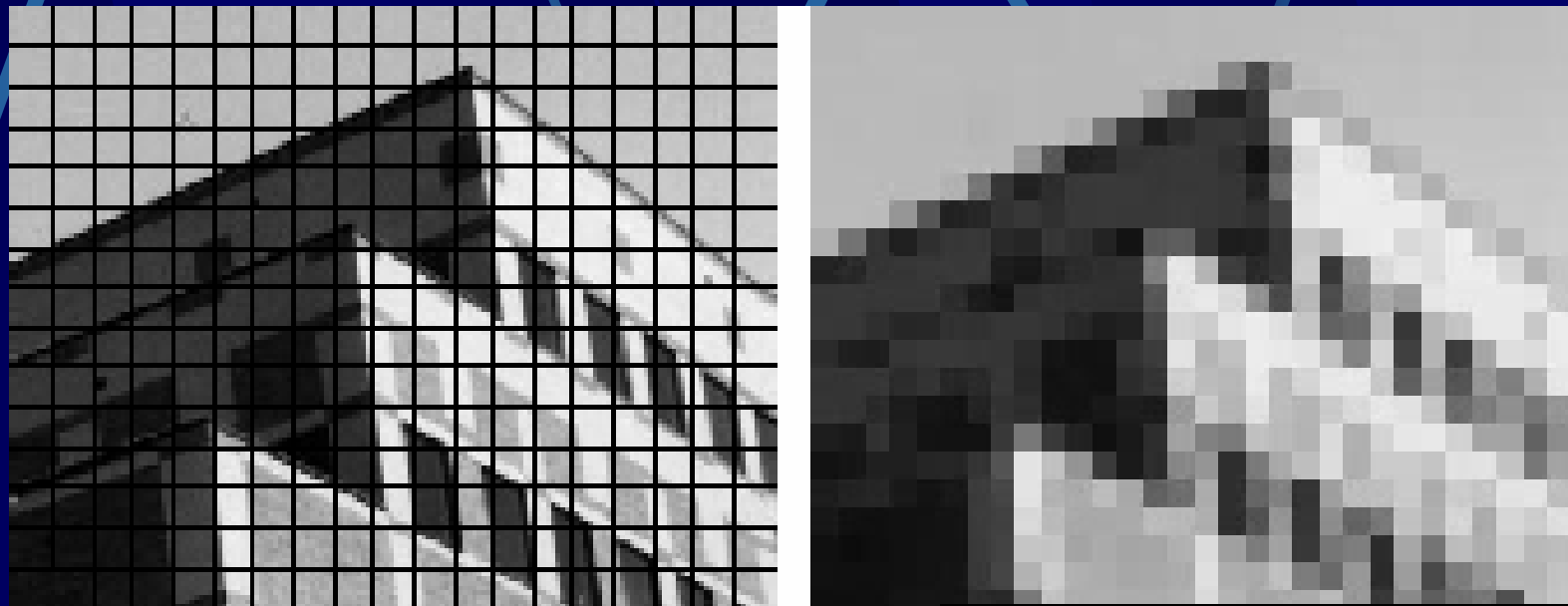
Sampling an Image

A color value is measured at every grid point
and used to color a corresponding grid square
0 = white 5 = gray 10 = black



Sampling an Image

- poor sampling and image reconstruction method creates a blocky image



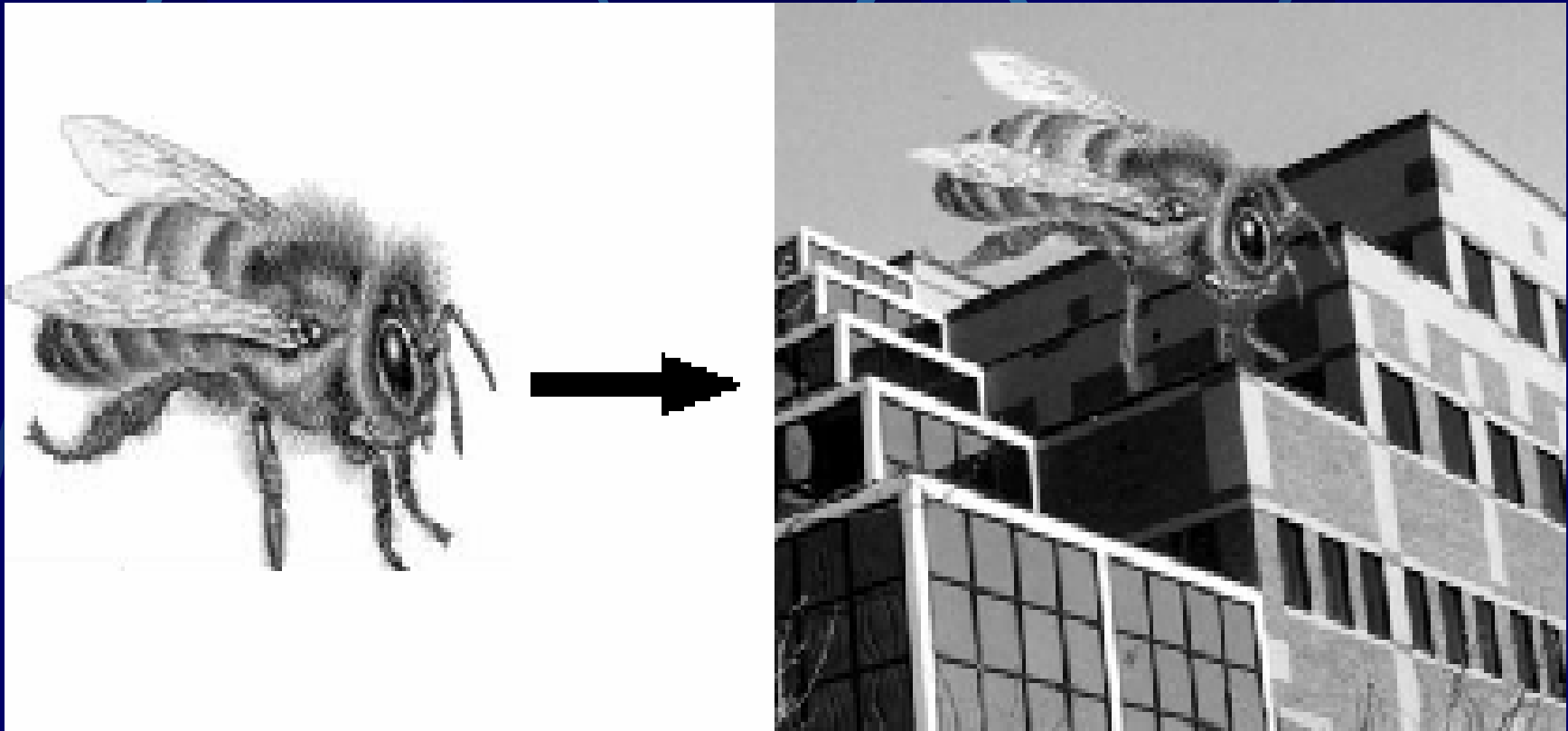
What's the Advantage?

Once image is defined in terms of colors at (x, y) locations on grid, can change image easily by altering location or color values • E.g., if we reverse our mapping above and make 10 = white and 0 = black, the image would look like this:



What's the Advantage?

Pixel information from one image can be copied and pasted into another, replacing or combining with previously stored pixels



What's the Disadvantage?

- WYSIWYG (What You See Is What You Get):
- There is no additional information – no depth information
 - can't examine scene from a different point of view
 - at most can play with the individual pixels or groups of pixels to change colors, enhance contrast, find edges, etc.

Application Distinctions

- **Two basic paradigms:**
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Geometry-Based Graphics

- **Applications** store mathematical descriptions, or “models,” of geometric elements (lines, polygons, polyhedrons...) and their associated attributes (e.g., color, material properties). These elements are primitive geometric shapes, primitives for short.

Geometry-Based Graphics

- **Images** are created as pixel arrays (via sampling of the geometry) for viewing, but are not stored as part of the model. Images of many different views can be generated from the same model.
- One cannot usually work directly with the individual pixels in a geometry-based program; one manipulates the geometric elements, then they are resampled and redisplayed.

What is Geometric Modeling?

- What is a model?
- Captures the salient features (data, behavior) of the thing/phenomenon being modeled
- Real: some geometry inherent
 - physical (e.g., actual object such as a pump)
 - non-physical (e.g., mathematical function, weather data)

What is Geometric Modeling? (2)

- What is a model?
- Abstract: no inherent geometry, but for visualization
 - organizational (e.g., company org. chart)
 - quantitative (e.g., graph of stock market data)
- Modeling is coping with complexity

Application Areas

- **Computer Graphics is about Movies!**
- Computer graphics is now as much a part of the entertainment industry as stunt men and makeup
- There are music videos, and spinning logos on the 6 o'clock news
- More and more of these images exist only within the memory of a computer

Application Areas - Movies

Jurassic park



Application Areas - Movies

Geri's Game – Pixar



Application Areas - Games

Quake II



Application Areas - Games

Riven



Application Areas - Medical Imaging

- Computer graphics plays an significant role in saving lives
- Computer graphics is a *tool* in medical applications
- No cheating or tricks allowed

Application Areas - Medical Imaging

- New data representations and modalities
- Drive issues of precision and correctness
- Focus on presentation and interpretation of data
- Construction of models from acquired data

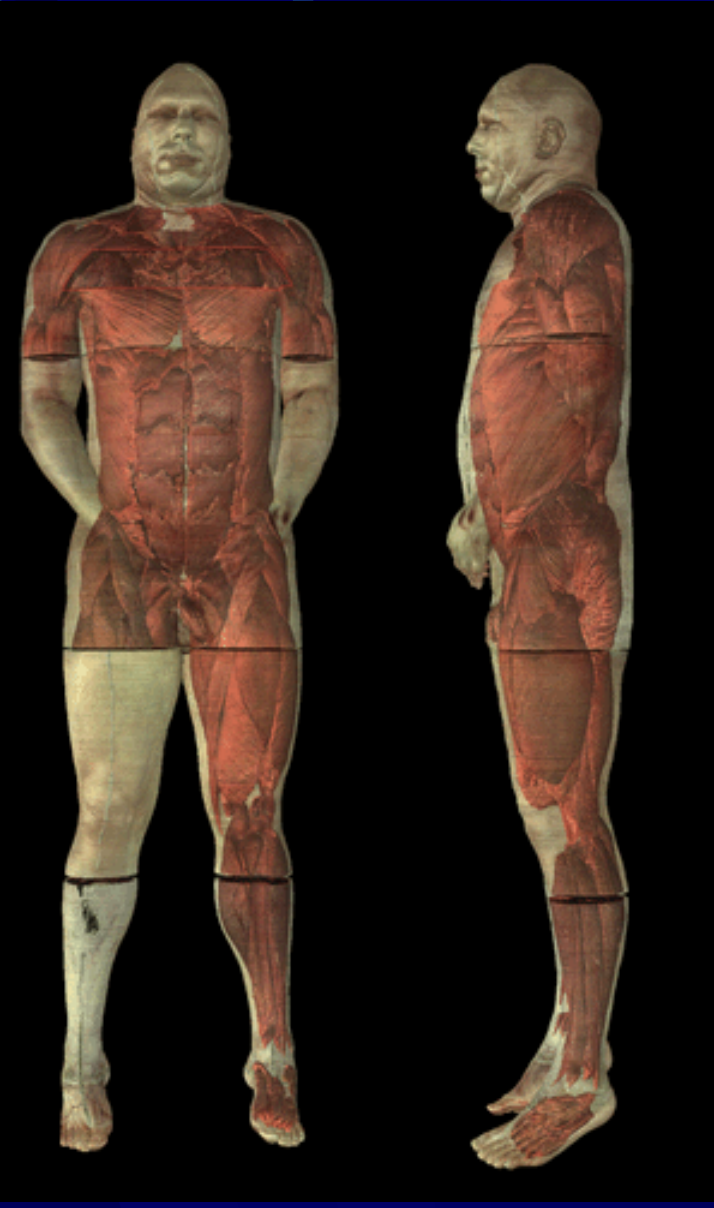
Application Areas - Medical Imaging

- Vision guided surgery at MIT



Application Areas - Medical Imaging

● Visible Human Project



Application Areas - Computer Aided Design

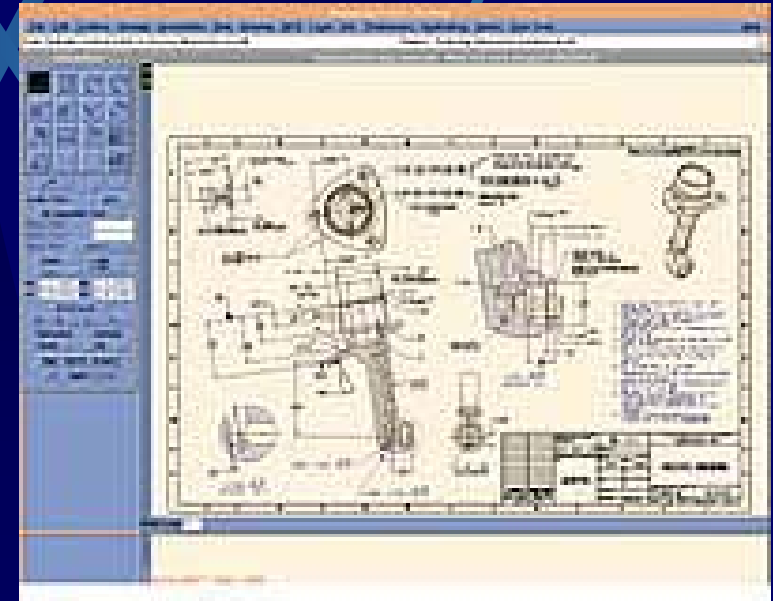
- Computer graphics has had a dramatic impact on the design process
- Today, most mechanical and electronic designs are executed entirely on computer
- CAD designs also play a key role in a wide range of processes from the design of tooling fixtures to manufacturing

Application Areas - Computer Aided Design

- CAD has had the follow impact on computer graphics:
 - Drives the high-end of the HW market
 - Integration of computing and display resources
 - Reduced design cycles (faster systems sooner)

Application Areas - Computer Aided Design

- Unigraphics

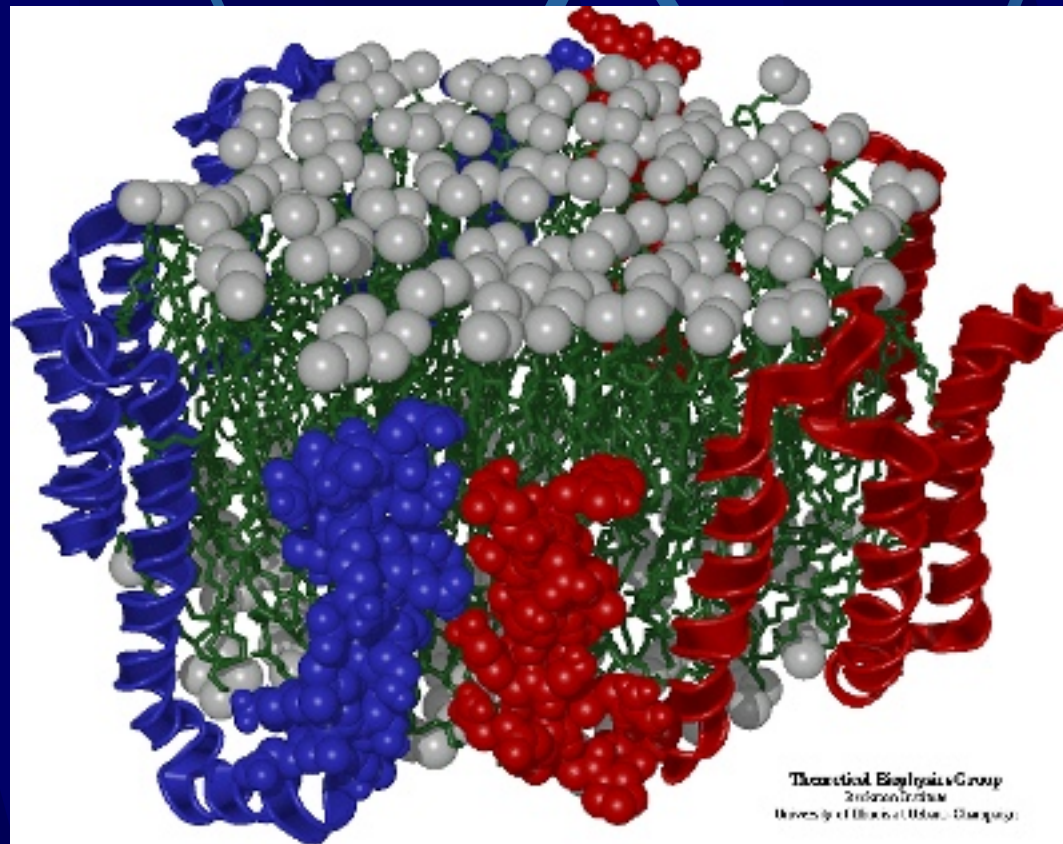


Application Areas - Scientific Visualization

- Computer graphics makes vast quantities of data accessible
- Numerical simulations frequently produce millions of data values
- Satellite-based sensors amass data at rates beyond our abilities to interpret them by any other means than visually
- Mathematicians use computer graphics to explore abstract and high-dimensional functions and spaces

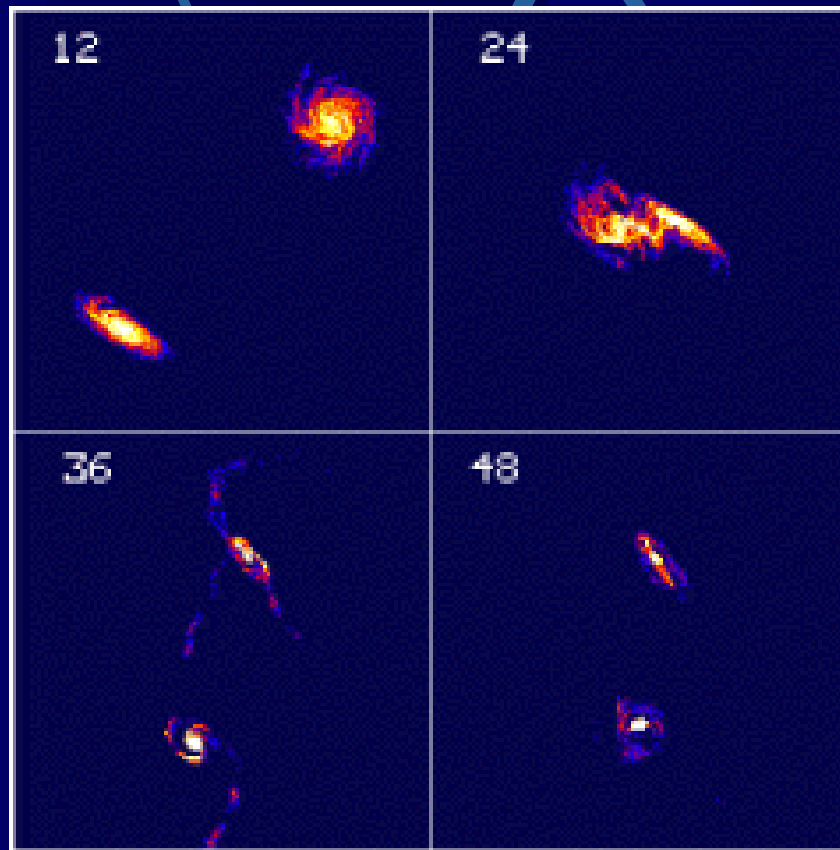
Application Areas - Scientific Visualization

Molecular Modeling



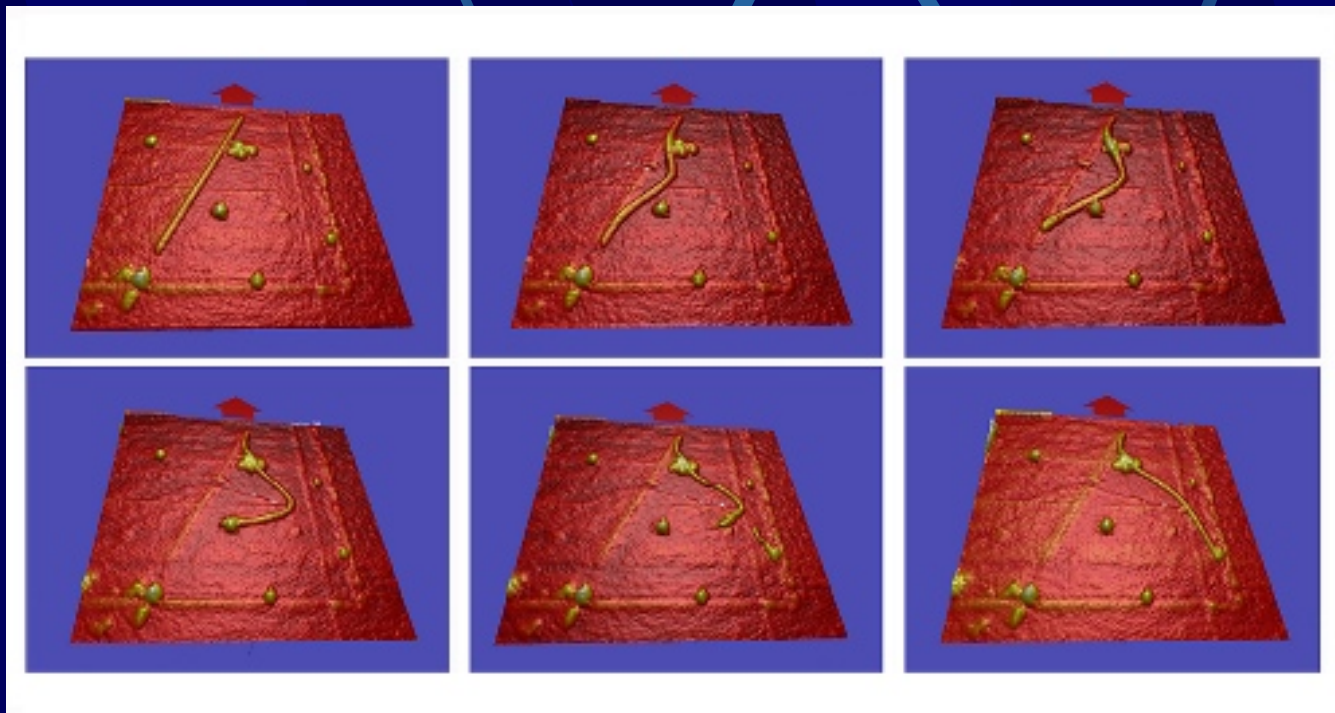
Application Areas - Scientific Visualization

Colliding Galaxies



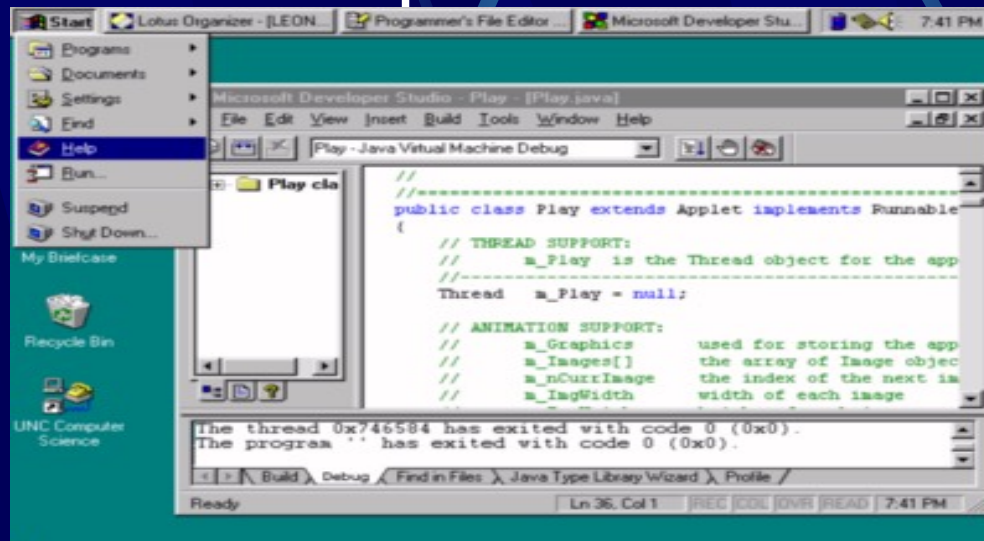
Application Areas - Scientific Visualization

Nanomanipulator



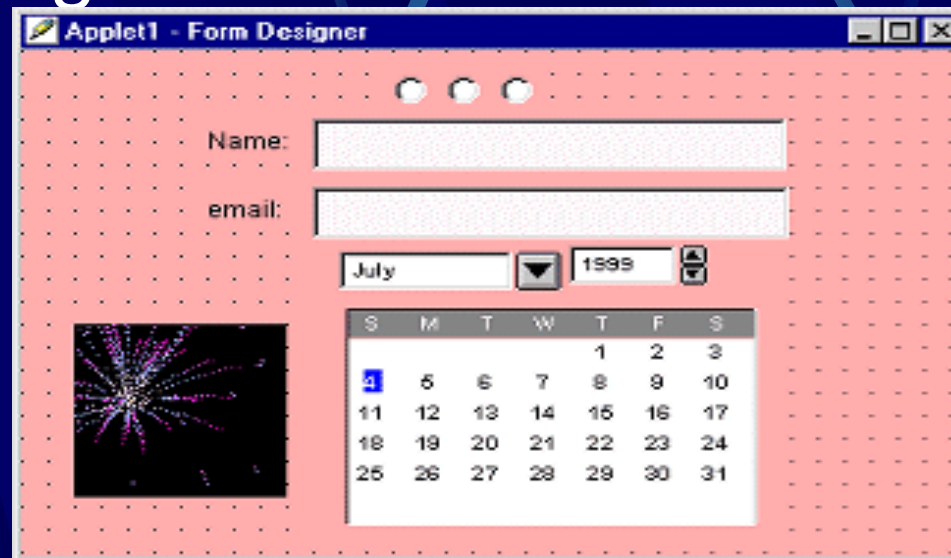
Application Areas - Graphical User Interfaces

- Computer graphics is an integral part of every day computing
- Nowhere is this fact more evident than the modern computer interface design



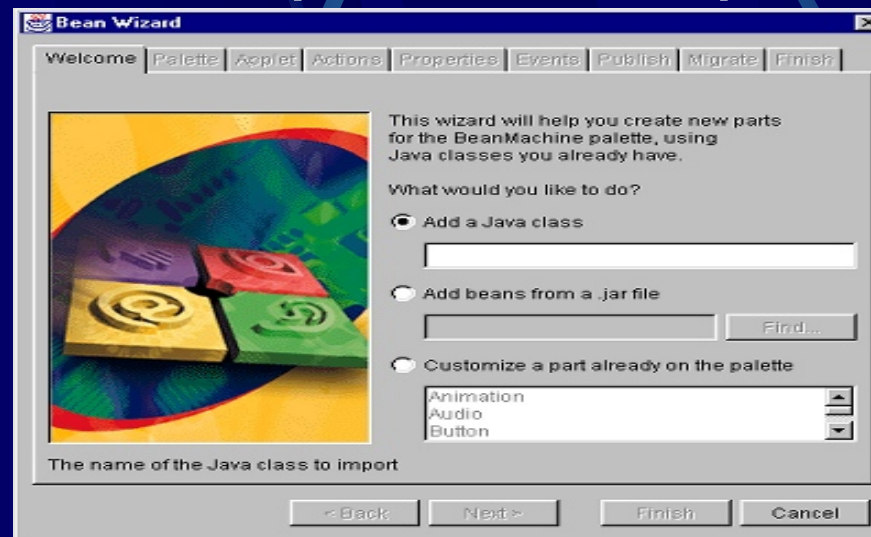
Application Areas - Graphical User Interfaces

- Graphical elements such as windows, cursors, menus, and icons are so common place it is difficult to imagine computing without them



Application Areas - Graphical User Interfaces

- Once graphics programming was considered a specialty. Today, nearly all professional programmers must have an understanding of graphics in order to accept input and present output to users.



Computer Graphics Associations

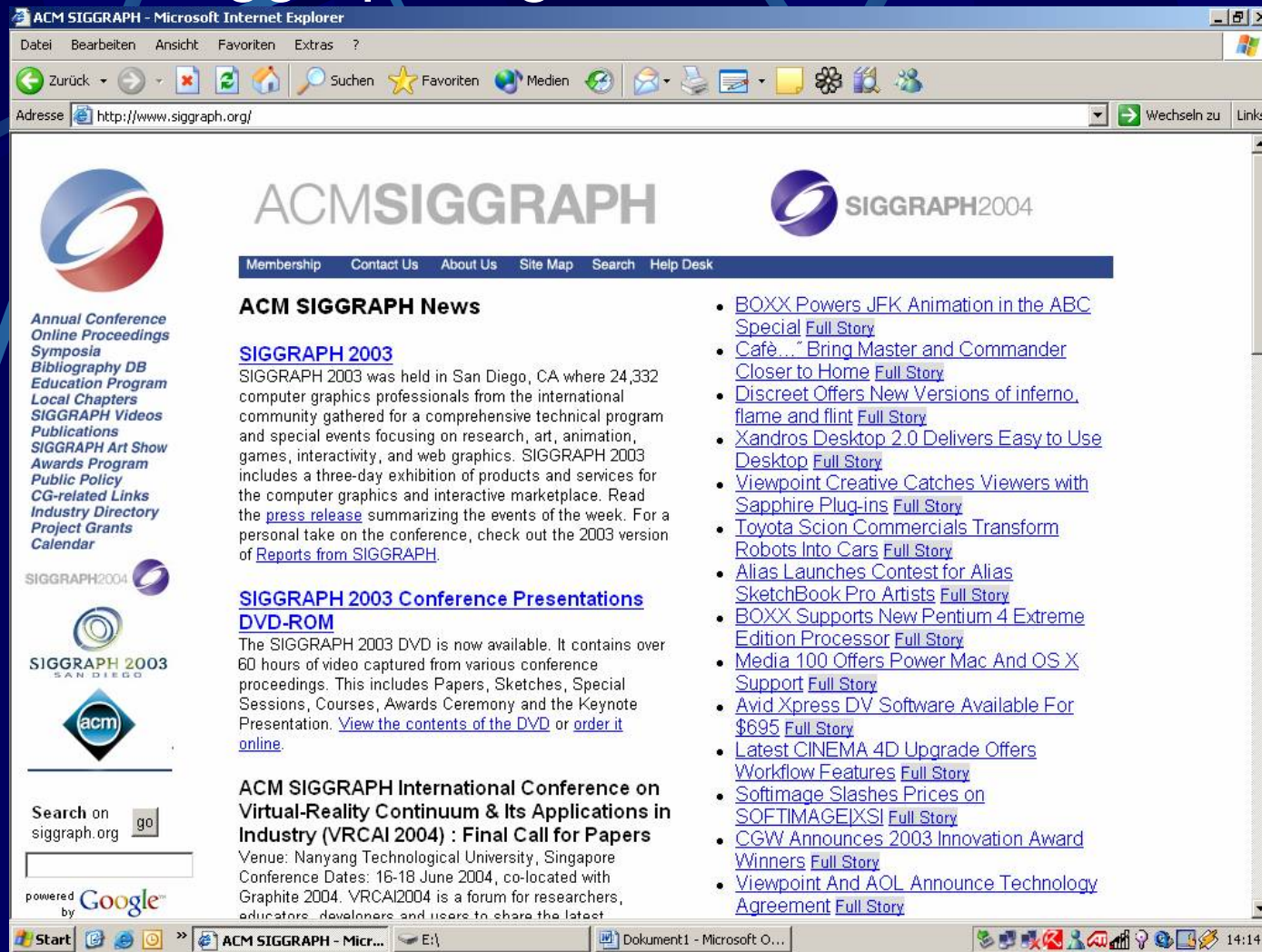
- ACM SIGGRAPH
- IEEE
- Eurographics

For More Information

Web Sites ...

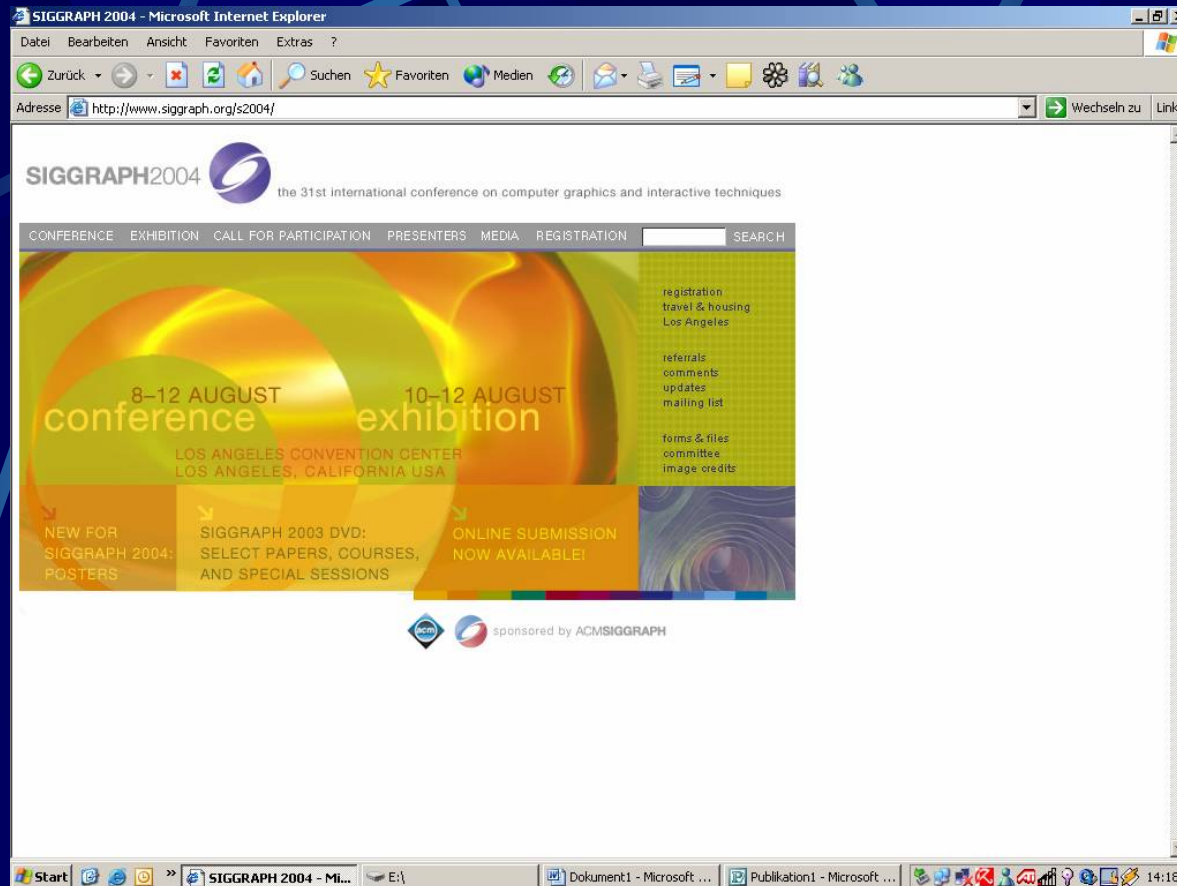
Computer Graphics Associations

www.siggraph.org



Computer Graphics Associations

■ SIGGRAPH Conference



2004: Los Angeles: August 8 – 12

2005: Los Angeles:

SIGGRAPH Educational Committee

The screenshot shows a web browser window titled "ACM SIGGRAPH Education Committee - Microsoft Internet Explorer". The address bar displays "http://www.siggraph.org/education/". The website features a logo on the left and a main content area. A sidebar on the left contains a list of links: "SIGGRAPH Education Directory", "The Education Committee", "Educational Resource Projects", "Student Gallery", "Career & Business Information", "Conference & Workshop Activities", "Instructional Materials", "Educators' Listserve", "Site Search", and "Related Sites". The main content area includes a paragraph about the committee's mission and a "New Content" section with links to "SIGGRAPH 2004 Education Committee Conference Activities", "History of Computer Graphics and Art", "SPACE 2003 Slide Set", "Eurographics/SIGGRAPH Workshop on Computer Graphics Education 2004", and "SPACE 2003 Winners". The browser's taskbar at the bottom shows the Start button and several open applications, including "ACM SIGGRAPH...", "Dokument1 - Mic...", "Publikation1 - Mic...", and "Publikation2 - Mic...". The system clock indicates the time is 14:20.

ACM SIGGRAPH Education Committee

SIGGRAPH Education Directory

The Education Committee

Educational Resource Projects

Student Gallery

Career & Business Information

Conference & Workshop Activities

Instructional Materials

Educators' Listserve


Site Search

Related Sites

ACM SIGGRAPH Education Committee

ACM SIGGRAPH is the Special Interest Group on Computer Graphics. ACM SIGGRAPH is extremely interested in supporting both Computer Graphics education and the use of Computer Graphics in education. The ACM SIGGRAPH Education Committee was established to accomplish this task. The Education Committee has many different projects, involving volunteers from around the world in the areas of curriculum studies, resources for educators, and SIGGRAPH conference related activities. The Education Committee is always soliciting new ideas and volunteers to implement the ideas. [Read ACM SIGGRAPH's Mission, Purpose, and Values.](#) [Join ACM SIGGRAPH now!!](#)

New Content

 [SIGGRAPH 2004 Education Committee Conference Activities](#)

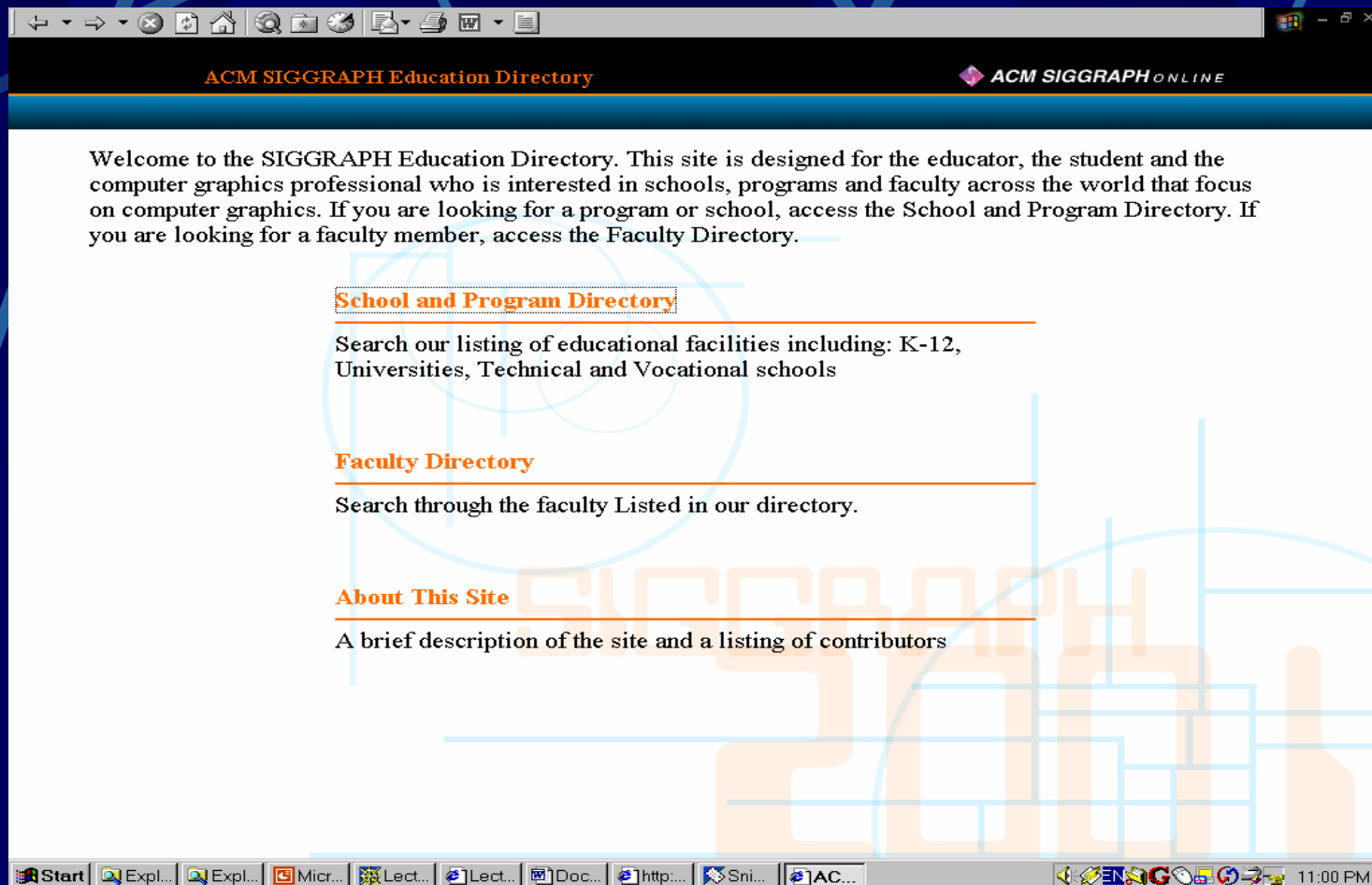
[History of Computer Graphics and Art](#)

[SPACE 2003 Slide Set](#)

[Eurographics/SIGGRAPH Workshop on Computer Graphics Education 2004](#)

[SPACE 2003 Winners](#)

SIGGRAPH Education Directory



Computer Graphics Solutions

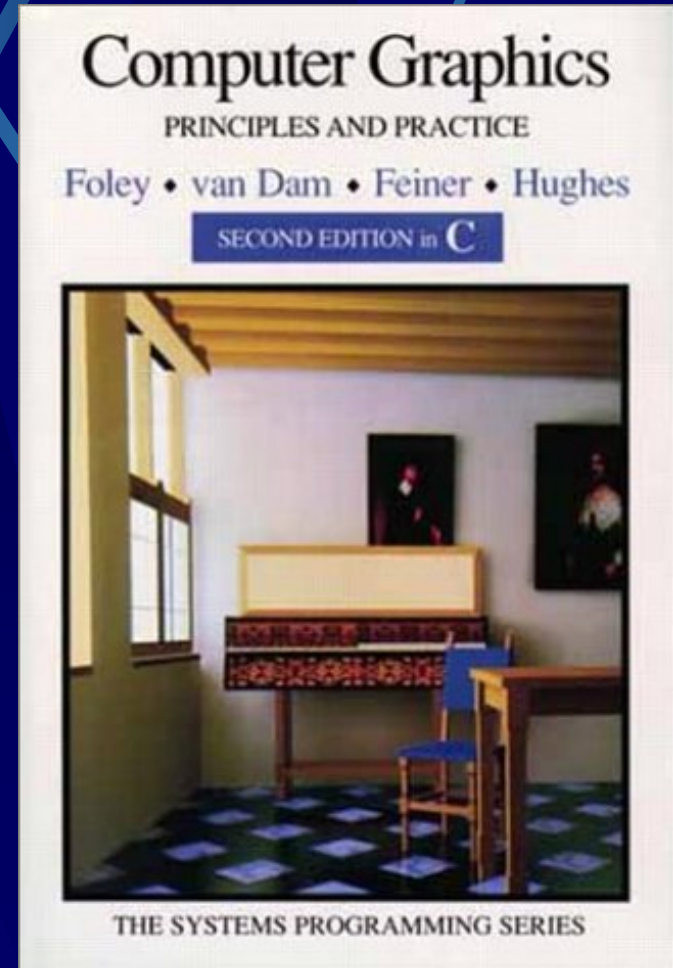
● Two Approaches:

- **Programming approach** – develop programs with graphics output and input using Graphics Libraries
 - C with OpenGL
 - Java
- **Application Approach** – use complete graphics systems and solve application tasks
 - AutoCAD
 - SD Studio Max
 - Maya

Computer Graphics Text Books:

Computer Graphics : Principles and Practice, Second Edition in C

by James D. Foley,
Andries van Dam,
Steven K. Feiner,
John F. Hughes
Addison-Wesley, 1996



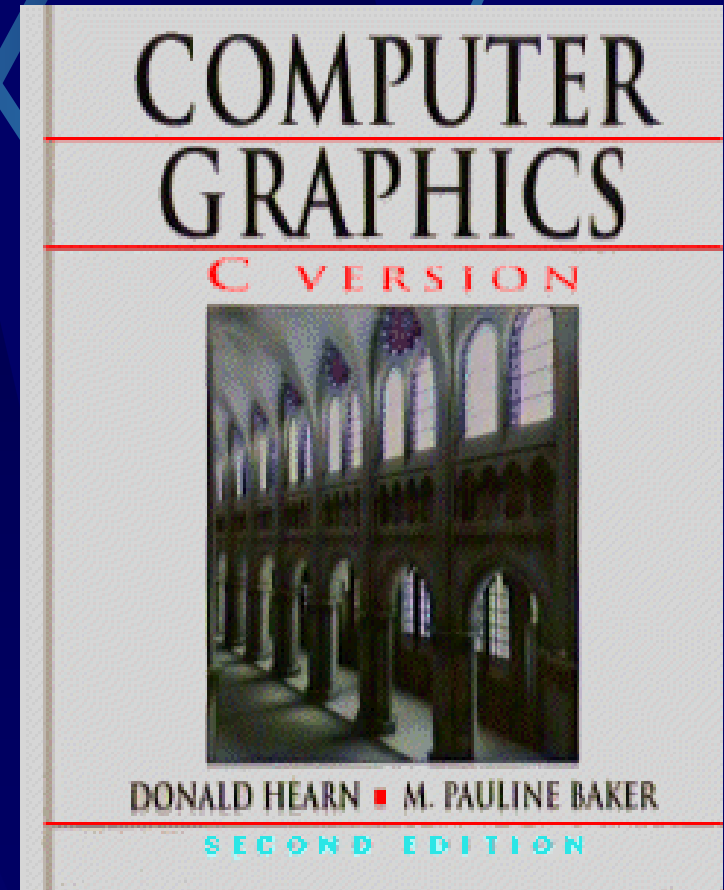
Computer Graphics Text Books:

Computer Graphics, C Version

by Donald Hearn, M.
Pauline Baker

2 edition

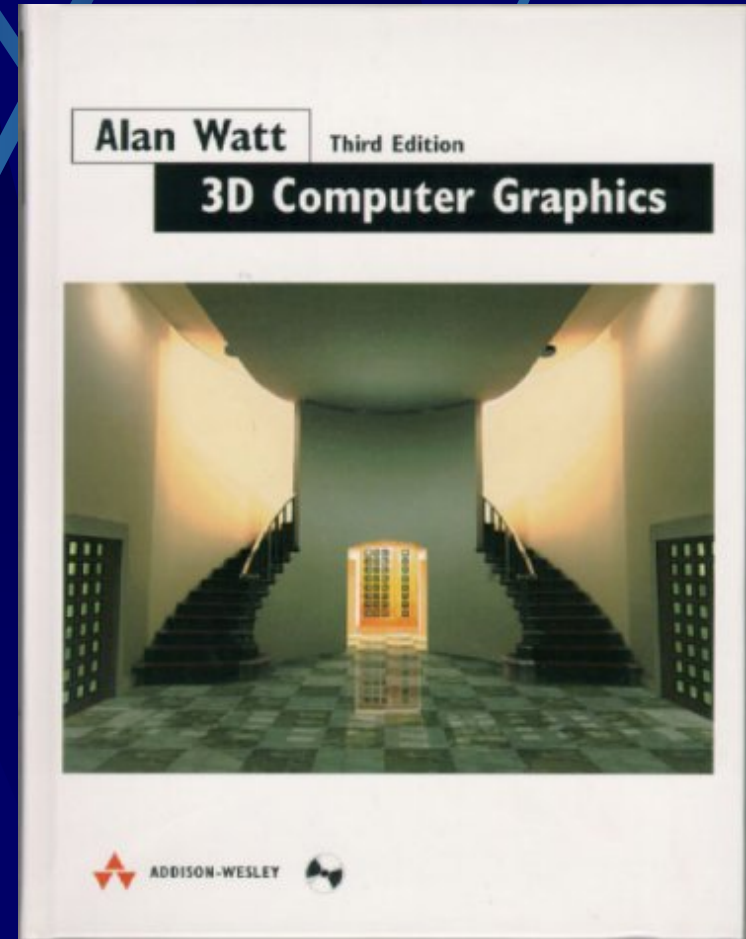
Prentice Hall; 1996



Computer Graphics Text Books:

**3D Computer
Graphics (3rd
edition)**
by Alan H. Watt

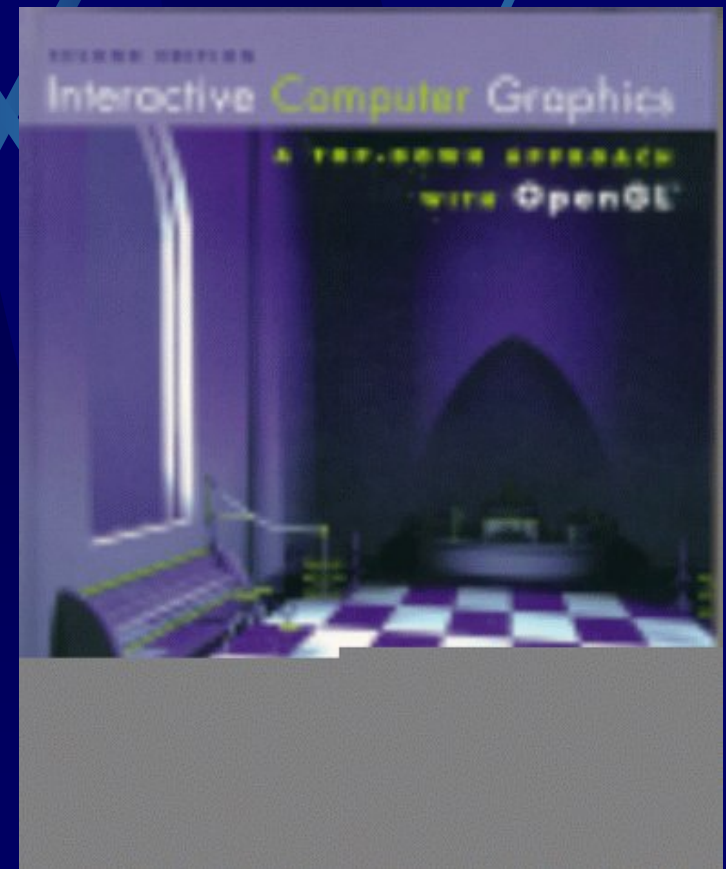
Hardcover - 608 pages
3rd edition
Addison-Wesley, 1999



Computer Graphics Text Books:

Interactive Computer Graphics: A Top- Down Approach with OpenGL by Edward Angel

613 pages, 2nd edition
Addison-Wesley, 1999



Materials used in the Lectures

- SIGGRAPH Education Committee Materials
- Courses in Computer Graphics by Prof. A. van Dam, Brown University
- Courses in Computer Graphics, Computer Graphics Group, MIT