

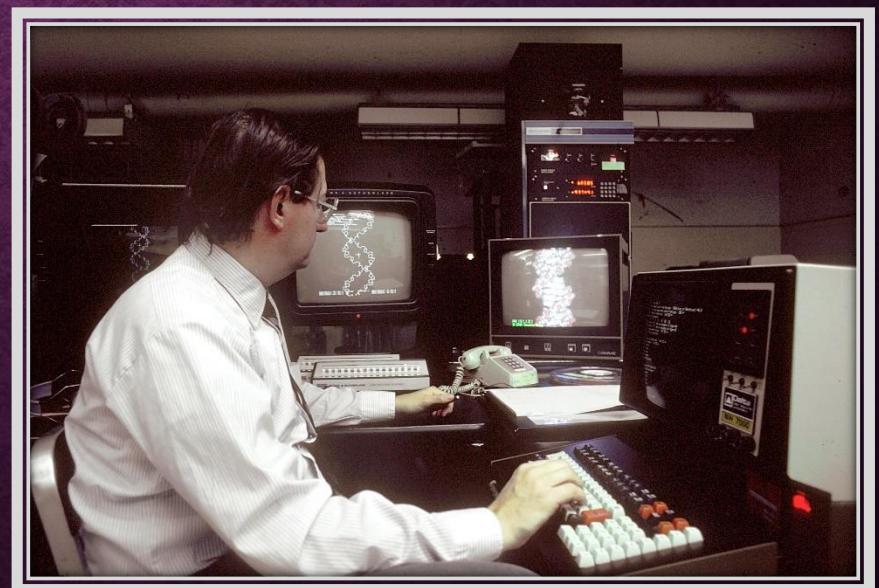
COMPUTER GRAPHICS HISTORY AND APPLICATIONS



Sergio Ruiz

CONTENT

- Basic concepts.
- Computer Graphics history.
- Applications and research areas.



BASIC CONCEPTS

Computer Graphics: image synthesis from computational models of real or virtual objects.

- **Modeling:** create and represent object geometry in a 3D environment.
- **Image Synthesis:** composing 2D images from objects.
- **Animation:** representing how objects change over time.

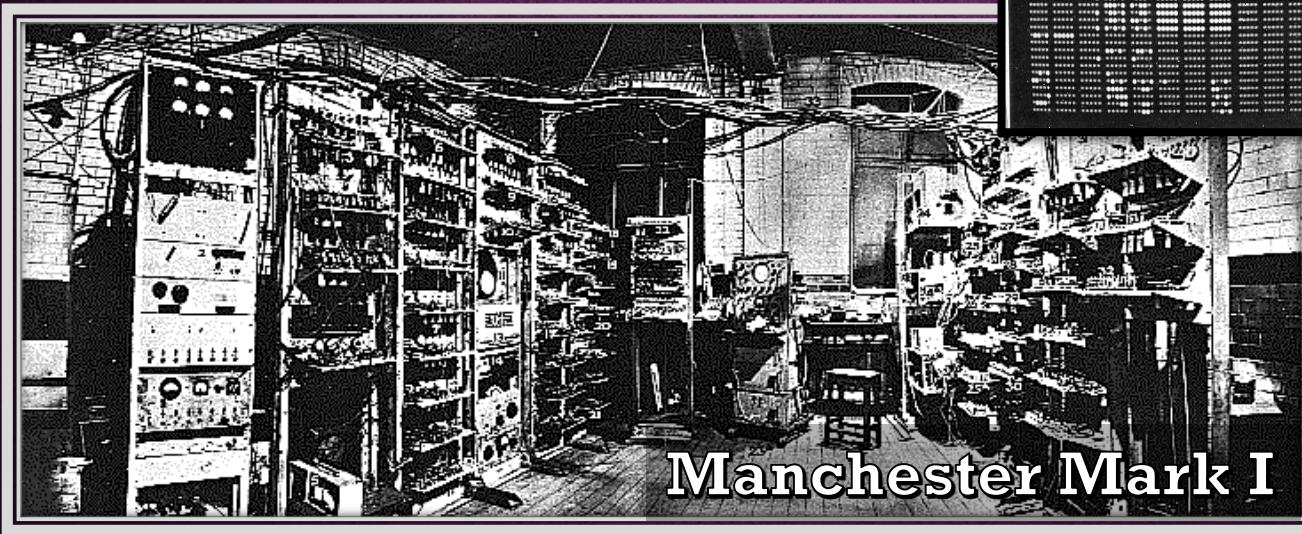
BASIC CONCEPTS

- **Image processing:** analysis or reconstruction of objects from images.

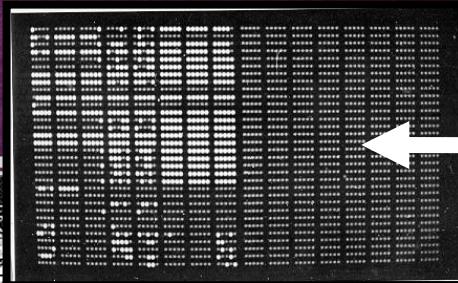


HISTORY → 1950'S

Until the 50's we had text only, no graphics displayed:



Manchester Mark I

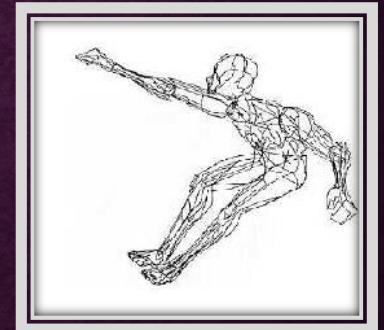


display

HISTORY → 1960'S

The term “**Computer Graphics**” was used first by William Fetter working at Boeing in 1960.

During this decade, computer systems and image creation techniques were limited and rudimentary (as seen from 2016, of course).

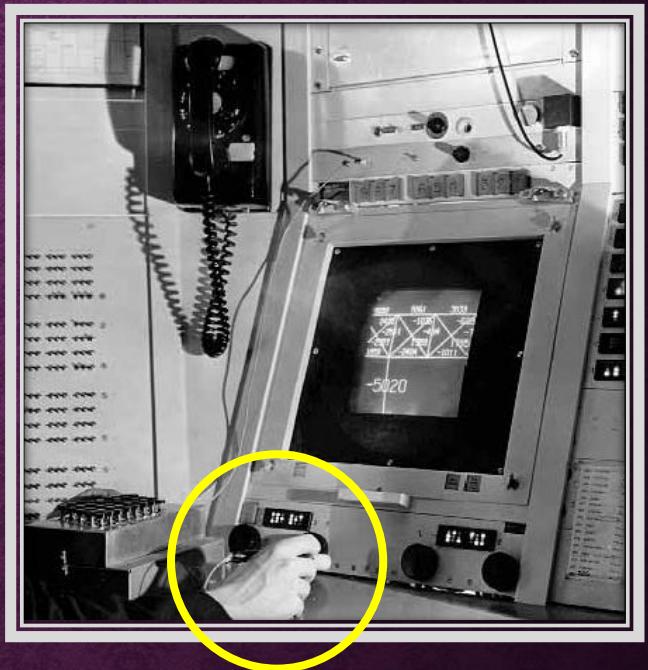


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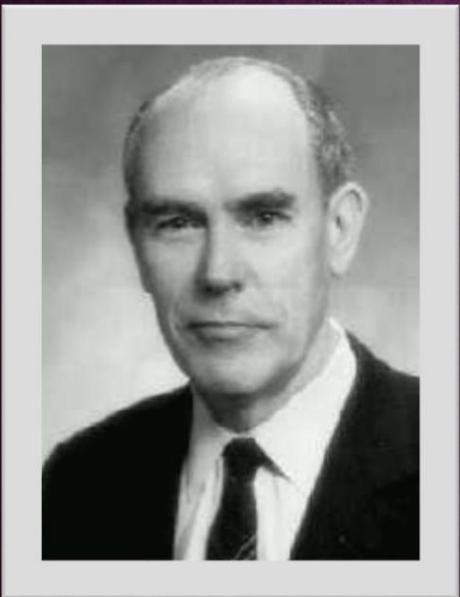
HISTORY → 1960'S

Sketchpad (Ivan E. Sutherland, MIT 1963):

- First interactive graphics system
- Pioneer of many current digital drawing concepts:
 - *Pop up menus.*
 - Hierarchical modeling.
 - Rendering cycle:
 1. Display.
 2. Stylus (yes, stylus in 1963) displacement.
 3. Redisplay.



IVAN E. SUTHERLAND

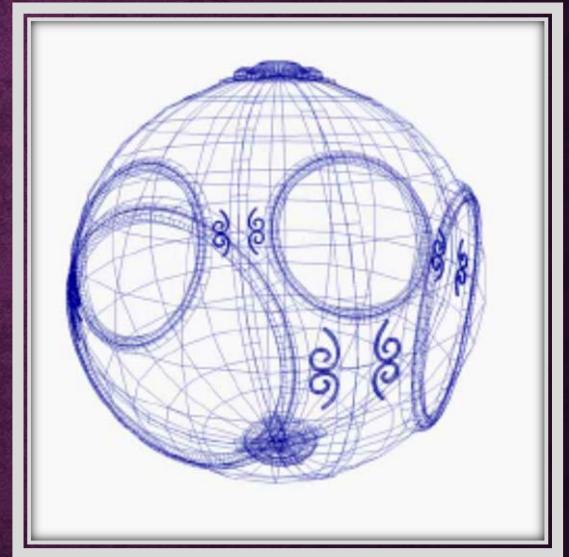


"A display connected to a digital computer gives us a chance to gain familiarity with concepts not realizable in the physical world.

It is a looking glass into a mathematical wonderland."

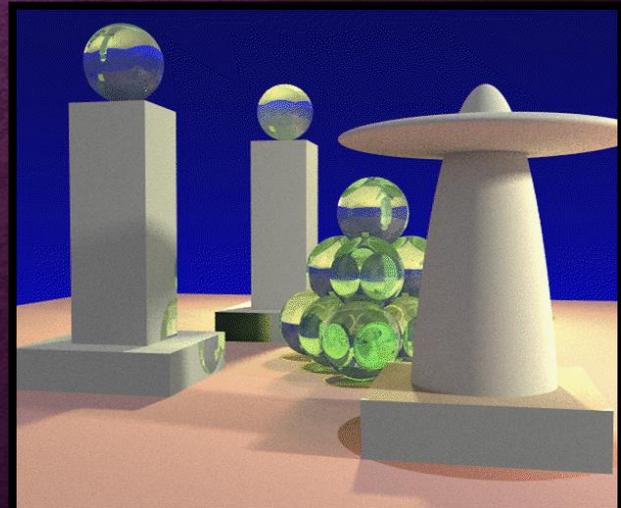
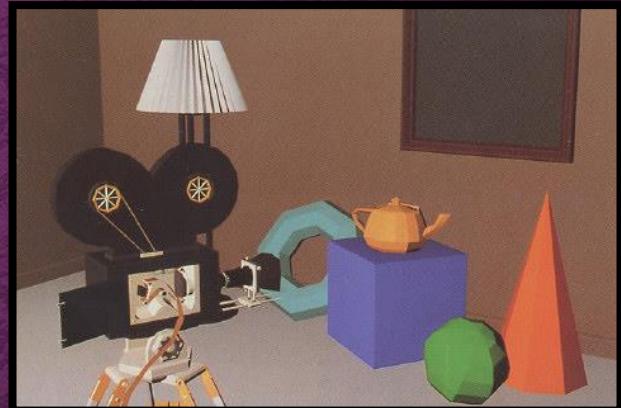
HISTORY → 1960'S

- Surfaces were displayed as a wireframe until the appearance of the first culling algorithm to eliminate hidden surfaces, and the first color shading hardware and algorithms.
- Hardware was expensive and limited.
- Software was not commercially available and interactive only in a few cases.



HISTORY → 1960'S (ART)

- For most visual artists the digital computer was cold and technical.
- The first images and animations were created in laboratories by engineers and other scientists, with an artistic intention.



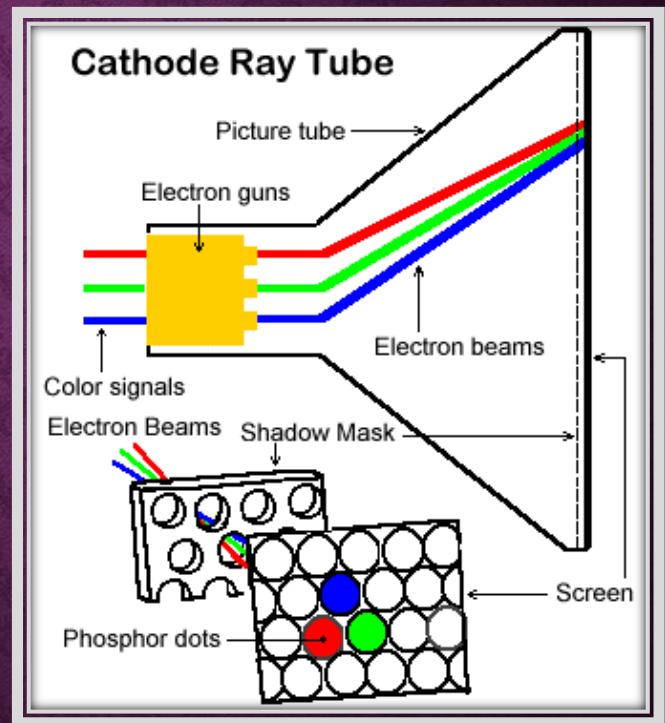
HISTORY → 1970'S & 1980'S

During the 70's and 80's computational technology became more practical and useful, resulting in a significant increase of visual creators interested in the use of computers.



HISTORY → 1970'S

Raster graphics are introduced. From the Latin word *rastrum* (rake) to describe how an electron beam sweeps a screen after exiting a cathode ray tube (CRT).



HISTORY → 1970'S

Beginning of Computer Graphics standards:

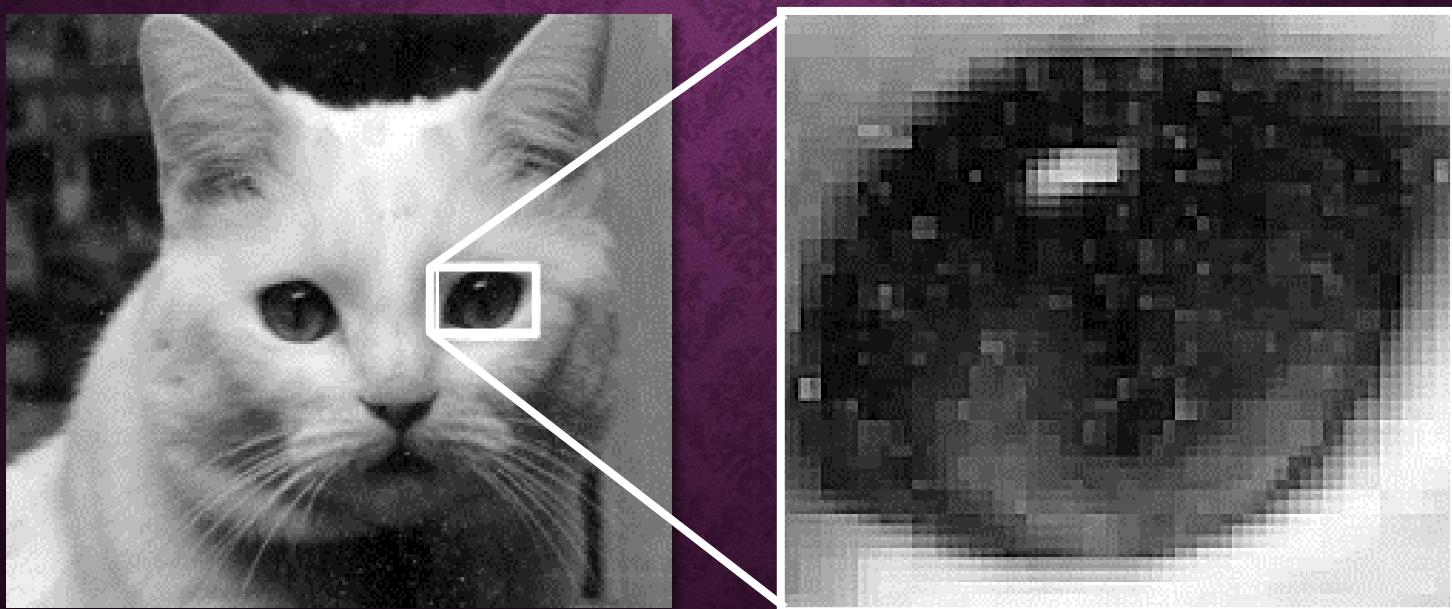
- **GKS** (Graphical Kernel System): Europe.
 - Became the ISO standard for 2D.
- **Core** (3D Core Graphics System): America.
 - 3D but fails to become an ISO standard.

Computer Graphics migrate to workstations and PCs.

HISTORY → 1970'S

Raster graphics:

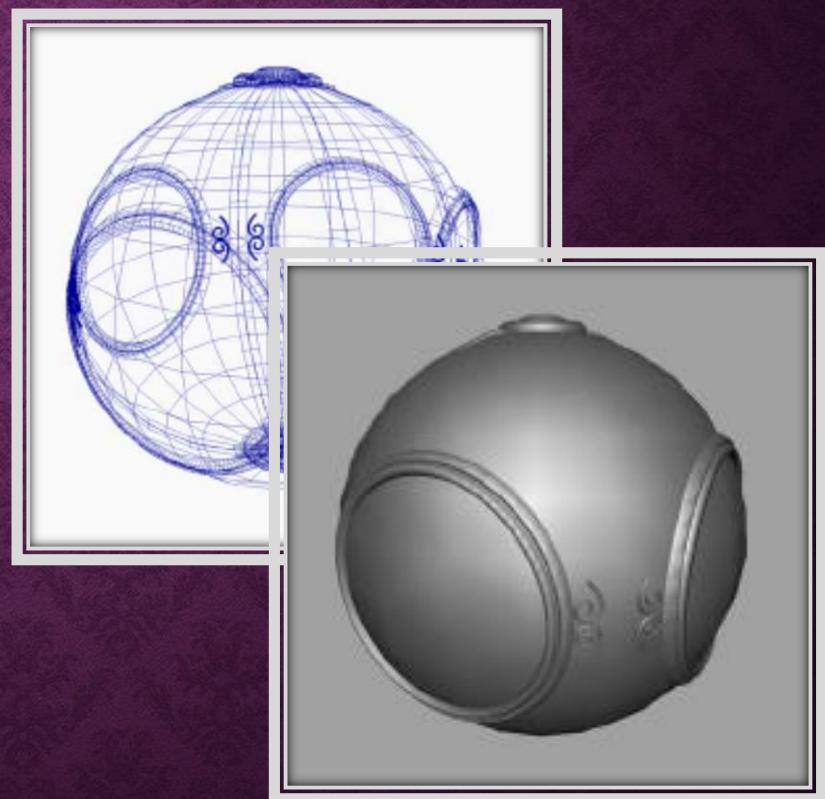
The image is composed by a two-dimensional *picture element* (pixel) array, not as drawn lines.



HISTORY → 1970'S

New shading and rendering algorithms:

- Gouraud.
- Phong.
- Curve surfaces.
- Anti-aliasing.



HISTORY → 1970'S

The first GUIs are invented at **PARC** (Palo Alto Research Center, XEROX) around 1975.

Introduced with the Apple Macintosh and now used everywhere.

Xerox PARC

- laser printing
- object-oriented programming
- personal workstation
- Ethernet/ distributed computing
- Superpaint frame buffer
- WYSIWYG & file formatting
- solid-state lasers
- graphical user interface (GUI)
- VLSI circuit design
- worm
- natural language processing
- corporate ethnography

1975

graphical user interface (GUI)

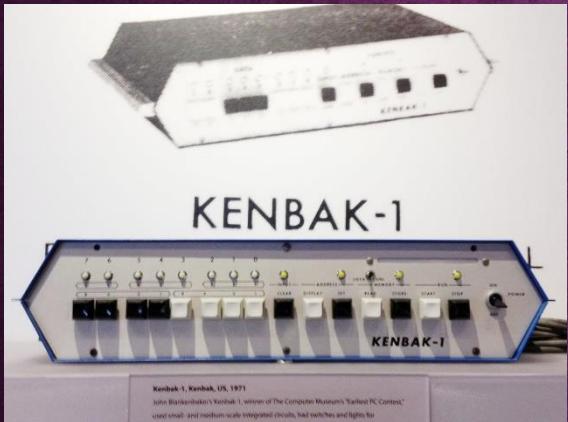
Xerox PARC debuts the first GUI, which uses icons, pop-up menus, and overlapping windows that can be controlled easily using a point-and-click technique. The GUI famously (or infamously) influences the development of all subsequent personal computer interfaces.

Human Communication Paths

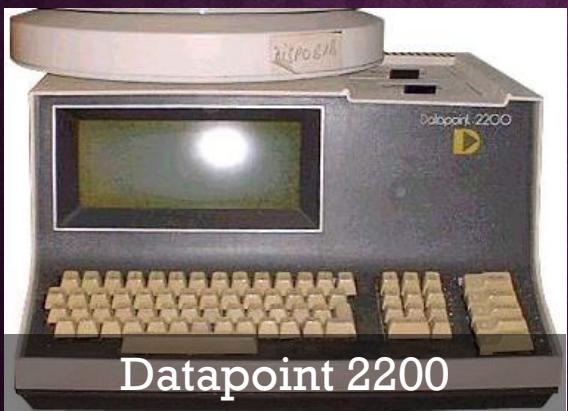
This is a document, created using the Smalltalk-80 Galley Editor. The editor supports an integration of textual and graphical images, including the use of graphics in page headings and footings.

Timeline: 1970, '73, '74, '75, '76, '77, 1980, 1990, 2000

HISTORY → 1970'S



KENBAK-1



Datapoint 2200



Xerox Alto

HISTORY → 1970'S

- Painting systems like **SuperPaint**: Richard Shoup, Alvy Ray Smith (**PARC**, 1973-1979).
- Warhol video.



HISTORY → 1970'S (ART)

Visual artists' interest begins:

- Vol Libre.
- Star Wars.
- Advertising.



HISTORY → 1980'S

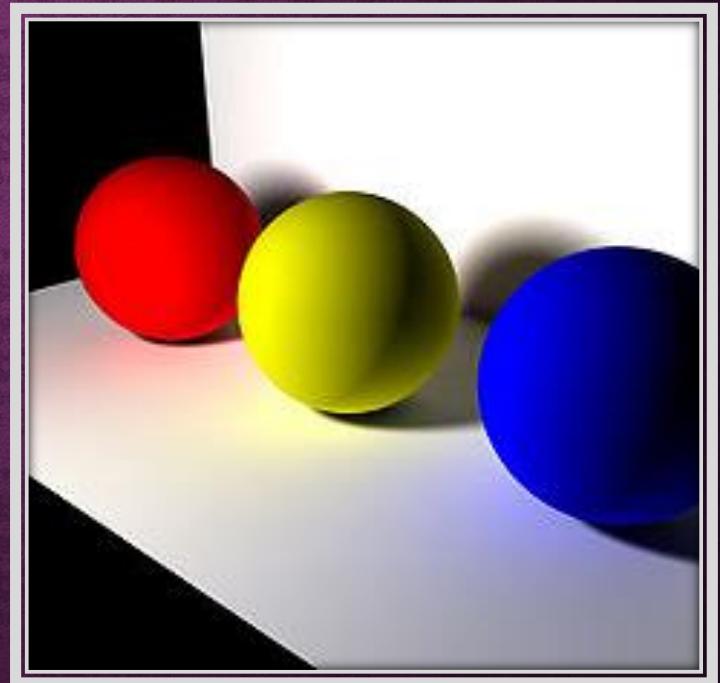


- Specific purpose hardware:
 - Silicon Graphics International (3D geometry engine).
- Industry-based standards:
 - RenderMan.
- Textures, environmental and height mapping.
- Global illumination.

HISTORY → 1980'S

Lots of CG research at universities:

- **Cornell** Radiosity.
- **Berkeley** Splines.
- **Ohio** Inverse kinematics.
- **Montreal** Character animation.
- **Tokyo** Implicit surfaces.

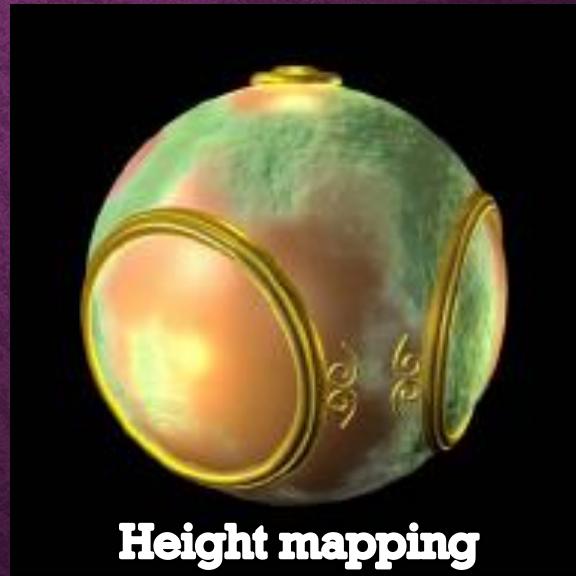


HISTORY → 1980'S

Realistic shadows and texture mapping:



Environmental mapping

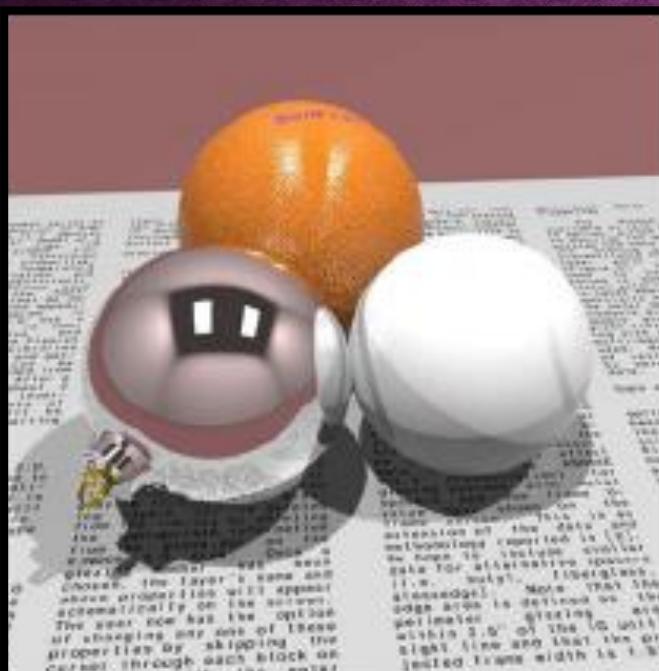


Height mapping

HISTORY → 1980'S

Global illumination techniques:

Ray tracing



Radiosity



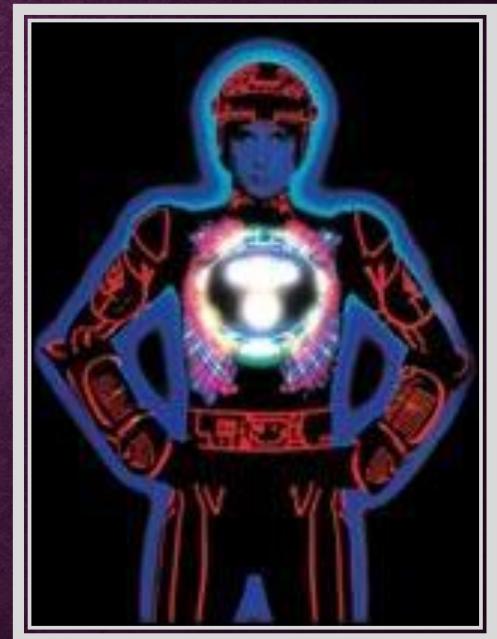
HISTORY → 1980'S

- General purpose, more powerful microprocessors are made available.
- 3D production systems consisted of one or many 32-bit processors +50Mhz, xMb of RAM.



HISTORY → 1980'S (ART)

- TRON (20 animation minutes).
- Special effects for movies continue in development.
- First “realistic” human characters.
- Many production companies appear.
- Pixar begins to use now traditional animation techniques.



HISTORY → 1990'S

During the 90's the fall in PC prices, along with the rise in their processing power, led to many visual professionals being able to acquire and integrate CG technology to their work.



HISTORY → 1990'S

- Research to improve efficiency, lower costs and produce easy to use interfaces.
- Software optimization.
- The **OpenGL** API is created.
- Videogame industry rebirth.
- PlayStation 2 (128bits, 66 million polygons per second).



HISTORY → 1990'S

New techniques appear:

- Non-photorealistic images.
- Fire and fabric animation.
- Human animation.
- Subdivision surfaces.
- Fluid simulation (gas and water).



HISTORY → 1990'S

Non-photorealistic images:



HISTORY → 1990'S

Modeling and animation of humans and clothing:



HISTORY → 1990'S (ART)

- Demand for special effects and advertising artists rises.
- **Disney** and **Pixar** associate.
- Many high-level short animations appear (**Geri's Game**).
- Toy Story (first CG movie), Antz and Bugs.
- Jurassic Park, Jumanji and Titanic.
- Hercules, Mulan, Lion King and Tarzan.
- Matrix.



HISTORY → 2000'S +

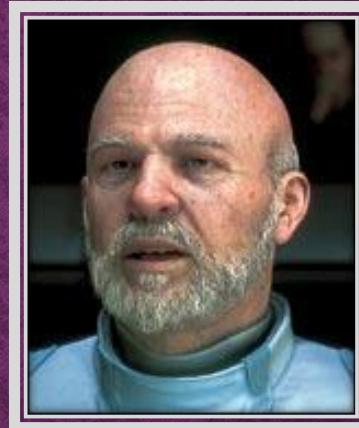
- PC graphics cards commercially available with great success.
- Graphics Processing Units (GPUs) appear.
- Gaming systems control the market.
- Computer graphics enter the filming industry process standard.
- New techniques for non-photorealistic images appear.



HISTORY → 2000'S+ (ART)

Movies:

- Final Fantasy.
- Panic Room.
- Attack of the Clones.
- The Lord of the Rings.
- Monster's Inc., Shrek.
- Ice Age.
- Finding Nemo.
- Many more.



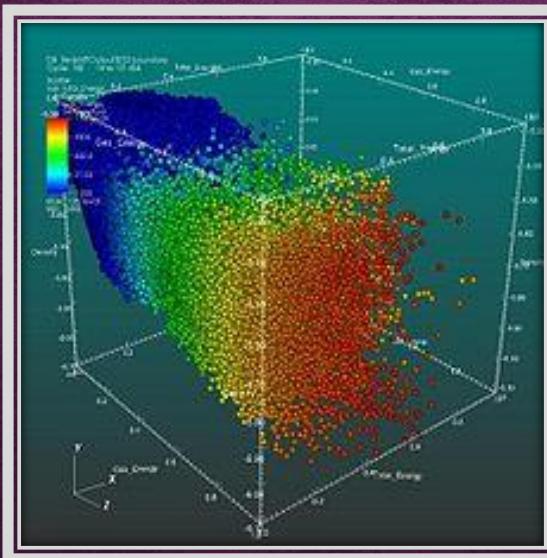
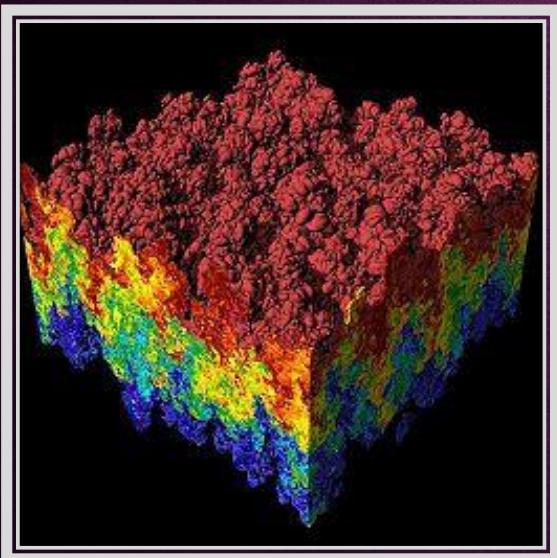
APPLICATIONS

Architecture and Industrial Design:



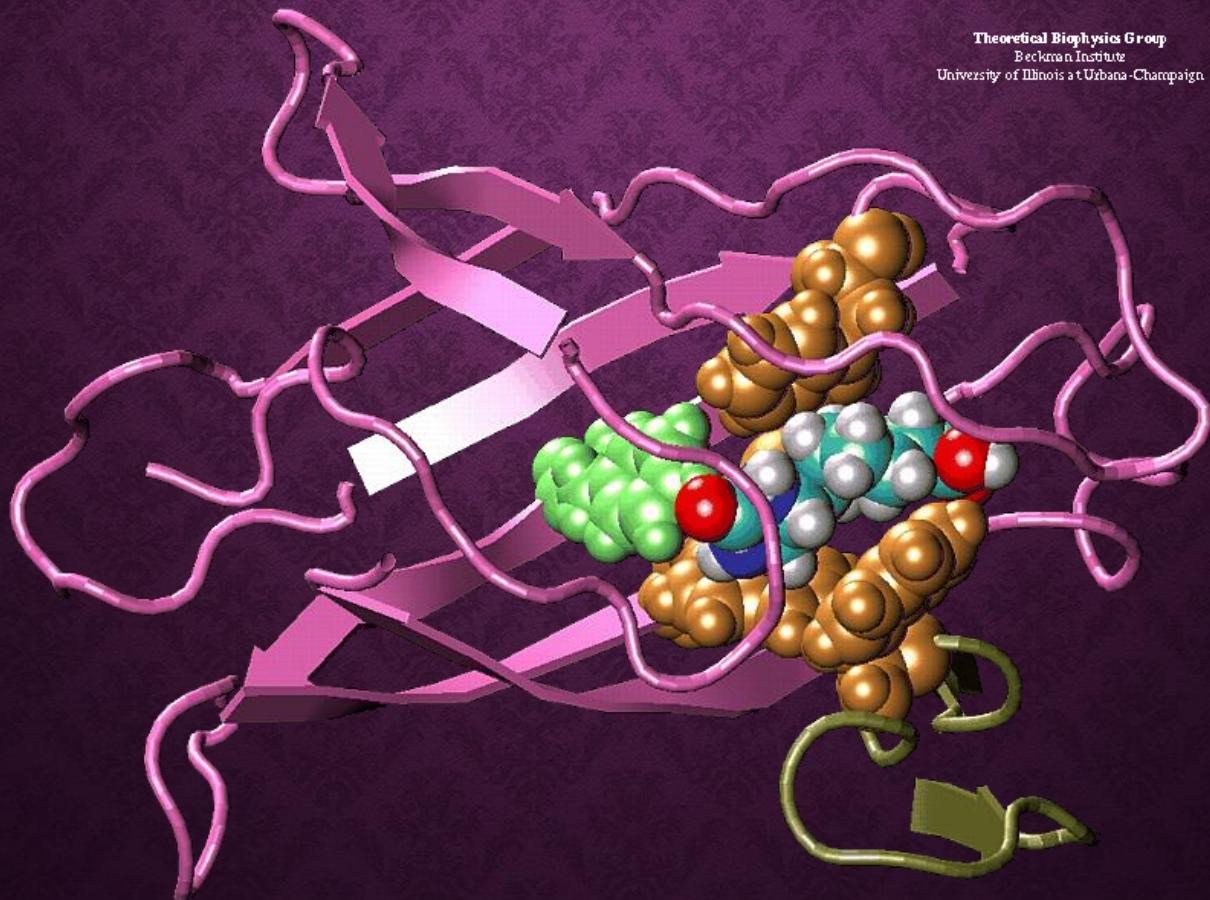
APPLICATIONS

Climate and geographic data visualization:



APPLICATIONS

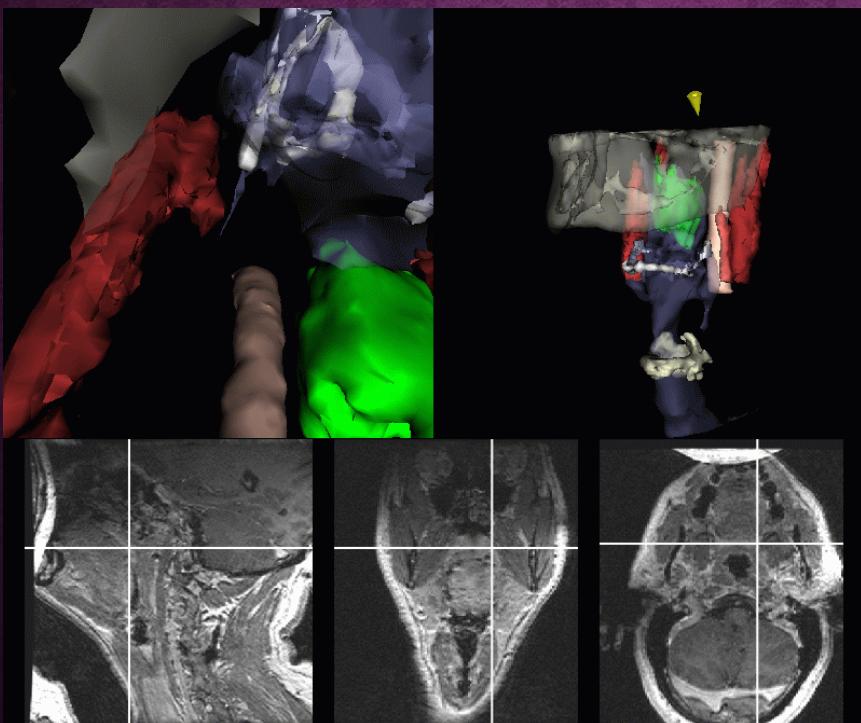
Scientific data visualization:



Theoretical Biophysics Group
Beckman Institute
University of Illinois at Urbana-Champaign

APPLICATIONS

Medical imaging:



MIT: Image-Guided Surgery Project



The Visible Human Project

APPLICATIONS

Flight simulation:



APPLICATIONS

Videogames:



APPLICATIONS

Films and TV:



APPLICATIONS

Internet content:



APPLICATIONS

Virtual Reality:



APPLICATIONS

Military training:



APPLICATIONS

Crowd simulation:



APPLICATIONS

Decision making:

