Computer Graphics

- History of Computer Graphics -

Philipp Slusallek

Based on the book by Wayne E. Carlson
Computer Graphics and Computer Animation – A Retrospective Overview
https://ohiostate.pressbooks.pub/graphicshistory/

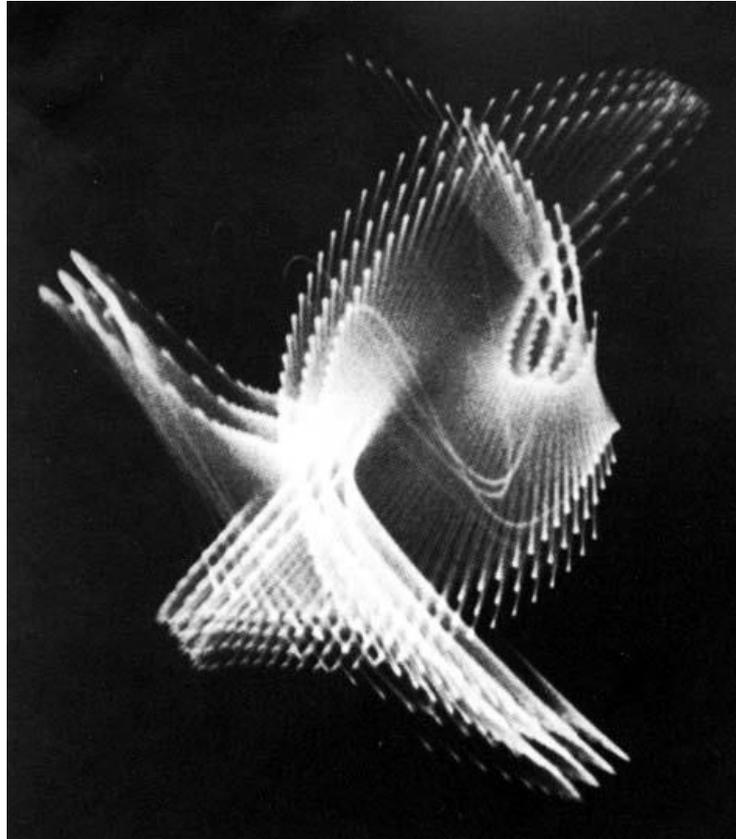# History of Computer Graphics

Once upon a time,

the human race was doomed to survive

without access to video games, …

… and our souls were without form, and void,

and darkness was upon the face of the deep,

until the day when …

History of Computer Graphics

- 1950: The first graphic images are created by Ben Laposky using an oscilloscope to generate waveform artwork produced by manipulating the analog electronic beam

History of Computer Graphics

- 1951: Designed to support military preparedness, **Jay Forrester and Robert Everett** of the Massachusetts Institute of Technology **(MIT)** produce the ***Whirlwind***, a mainframe computer with a CRT to plot blips representing incoming aircrafts based on radar-gathered data.
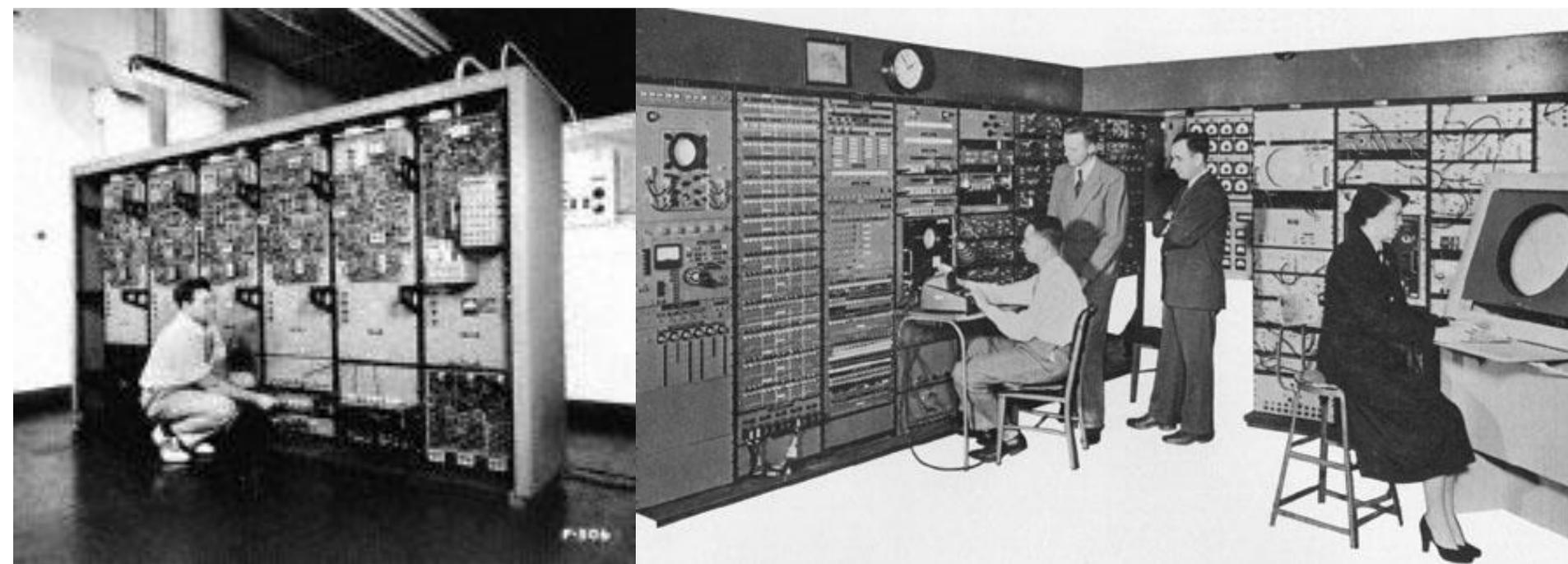
History of Computer Graphics

- 1955: Direct descendant of the Whirlwind, the SAGE (Semi-Automatic Ground Equipment) air defense system is designed by **Bert Sutherland** at **MIT**. It uses **simple vector graphics** to display on analog CRTs radar images with a wireframe outline of the region being scanned, as well as the **first light pen** as an input device that operators would use to pinpoint planes flying over regions of the United States. It becomes a key part of the US missile defense system.


SAGE demonstrated pioneering solutions to the problem of the user interface. The system displayed extremely large amounts of information to its operators using the then-new cathode ray tube; operators could then obtain additional information on aircraft tracks by selecting them with a light gun. Similar techniques are still in use today.

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History of Computer Graphics

- 1959: **General Motors and IBM** develop "DAC-1" (Design Augmented by Computers), the **first industrial CAD system** (Computer-Aided Design) used to help engineers design cars. It allows a user to rotate and view a simple drawings.

History of Computer Graphics

- 1961: *Spacewar*, the first video game, is developed by **MIT** student **Steve Russell** for the DEC PDP-1 minicomputer.
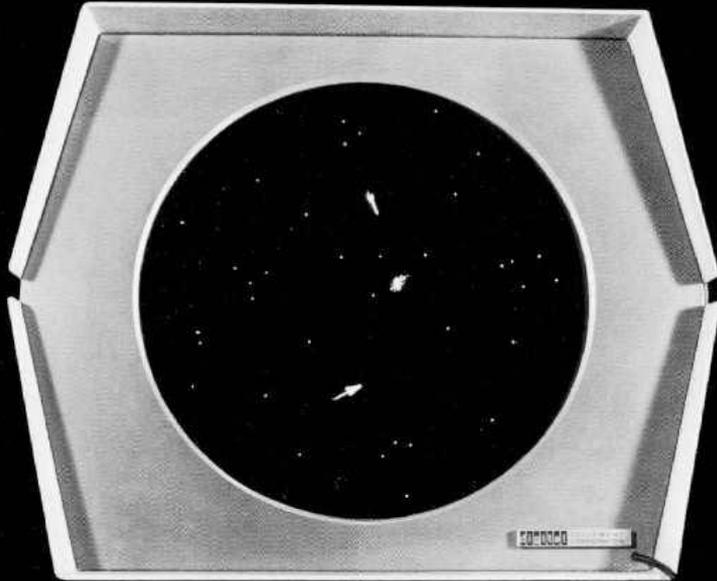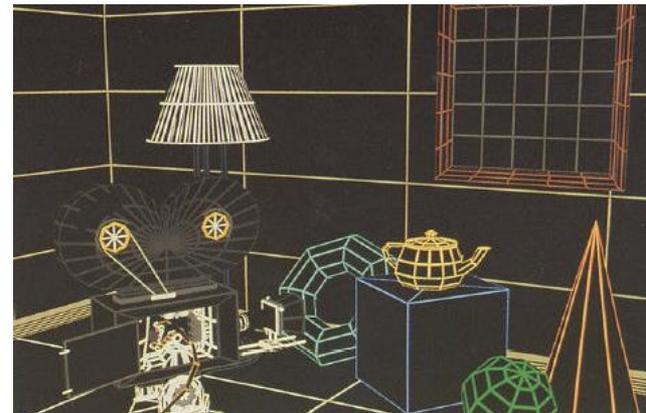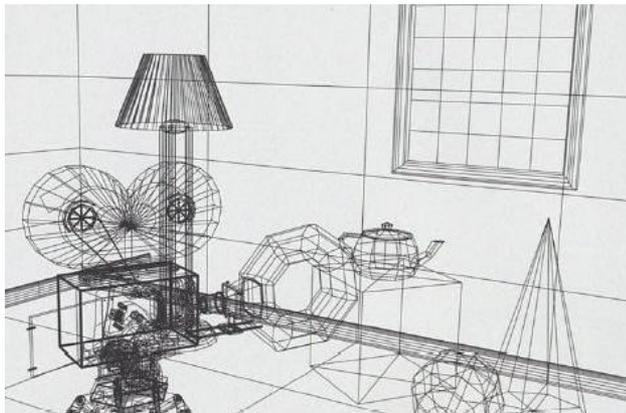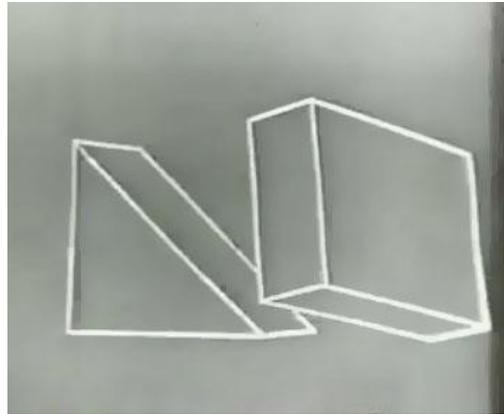
History of Computer Graphics

- 1963: For his doctoral thesis at MIT, **Ivan Sutherland** develops **Sketchpad**, the first **Computer-Aided Drafting and Design** (CADD) package allowing shapes to be interactively drawn on a vector-based display monitor using a **light pen input device** wired into the computer. The light pen uses a small photoelectric cell in its tip to emit an electronic pulse when the pen "sees" the electron beam.
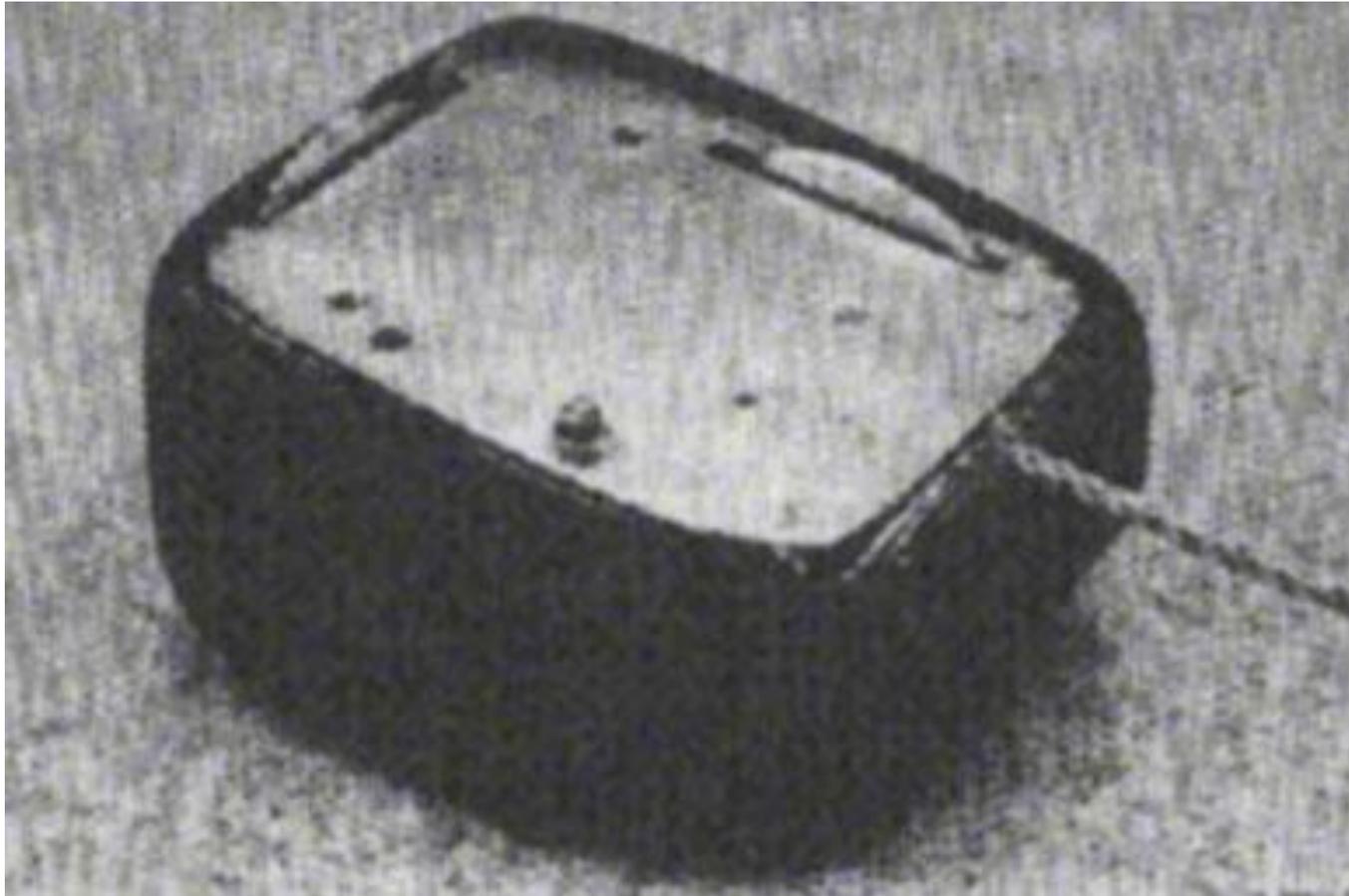
History of Computer Graphics

- 1963: **Larry Roberts** develops the first effective **hidden-line removal algorithm**, the precursor to various subsequent hidden-line and hidden-surface algorithms.
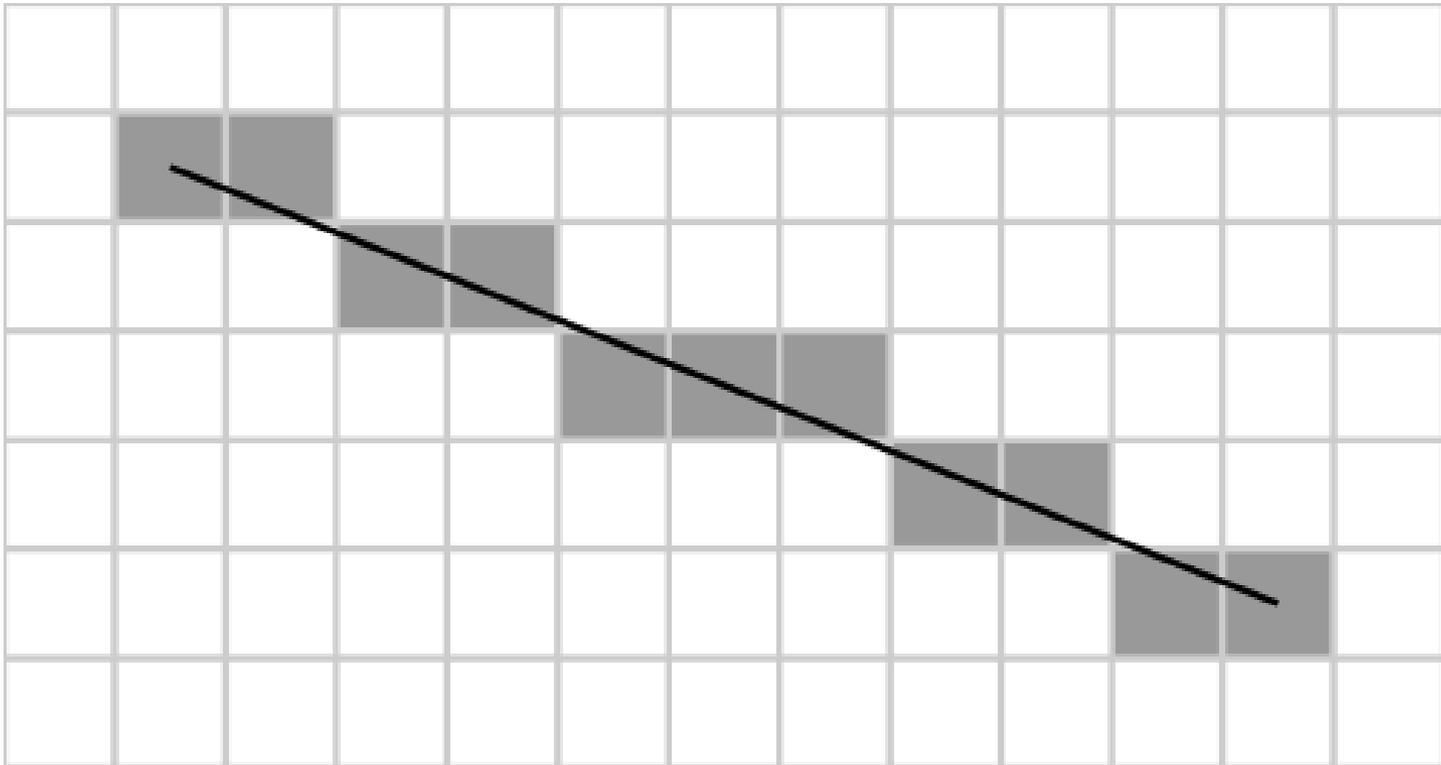
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- 1963: The **mouse** is invented by **Doug Englebart** at the **Stanford Research Institute** (SRI).


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- 1965: The **digital line drawing algorithm** for raster devices developed in 1962 by **Jack Bresenham** at **IBM** is published.
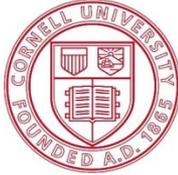
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- 1966: **Ivan Sutherland** creates the first **head-mounted display**, the *Sword of Damocles*, which displays separate wireframe images, allowing depth perception.

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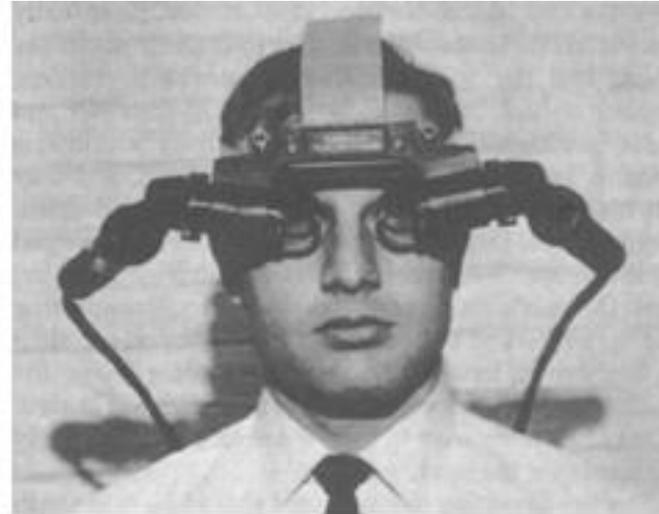
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- 1967: **MIT**'s **Center for Advanced Visual Studies** is founded by Gyorgy Kepes.

- 1967: **Don Greenberg** starts a program at **Cornell**.

- 1968: **Dave Evans** joins the computer science department at the **University of Utah** and forms a CG group. **Sutherland** also joins the University of Utah.

- 1968: Frustrated by the lack of graphics hardware available, **Evans & Sutherland** then found their own company.
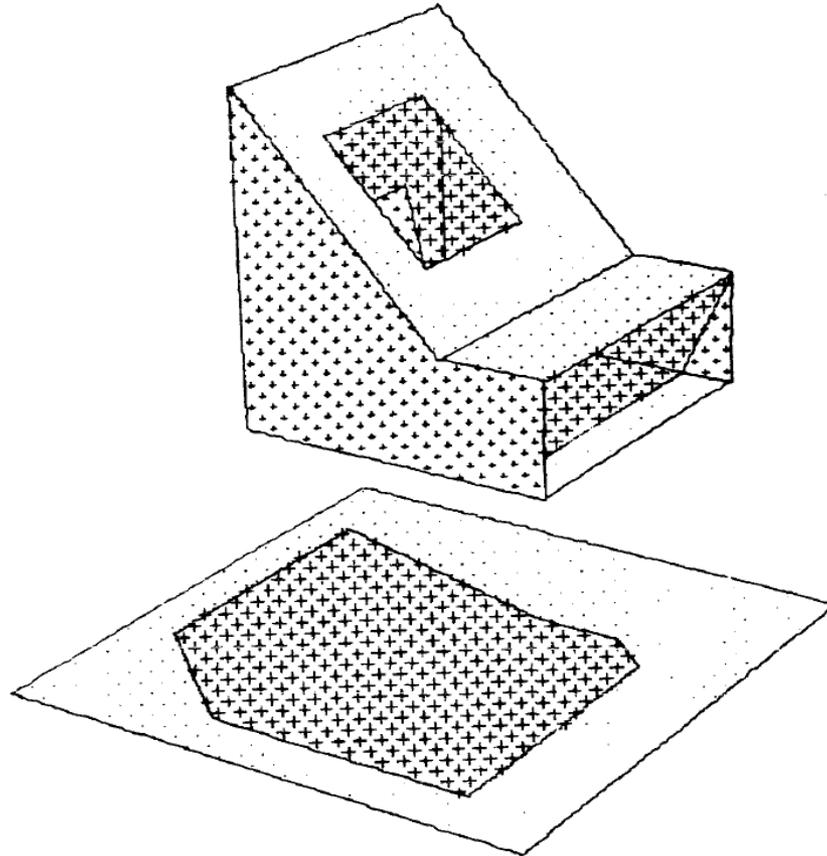
- 1968: **Intel** is founded.

History of Computer Graphics

- 1968: **Arthur Appel** at IBM introduces **ray-casting**, a **precursor to ray-tracing** which combines a hidden-surface and shadow algorithm.
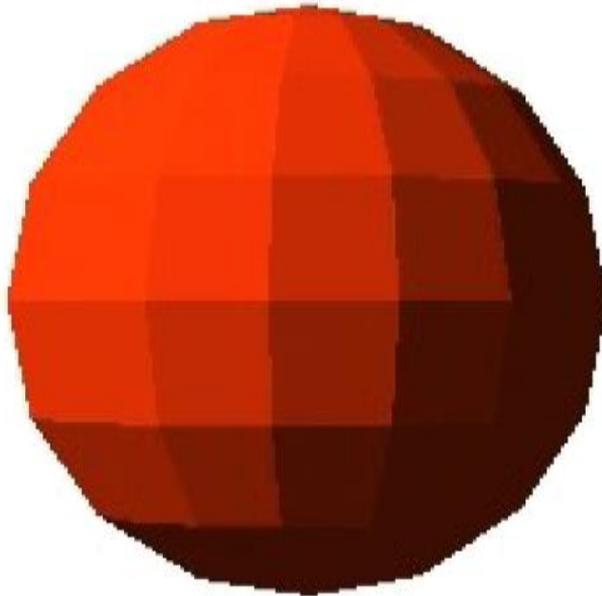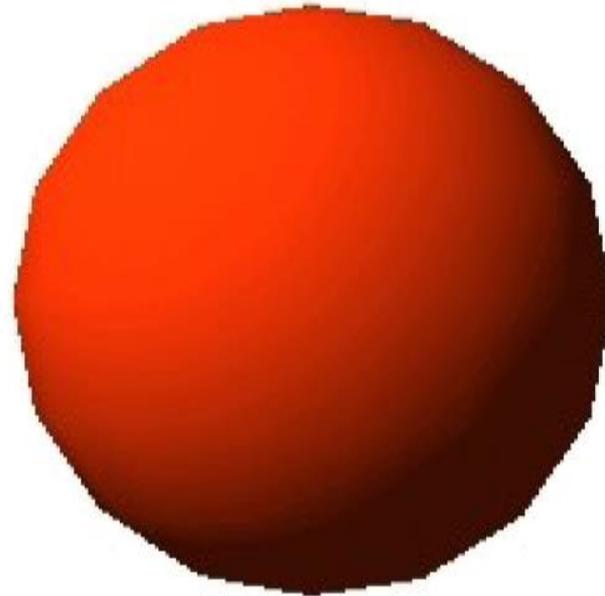
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- 1969: Initiated by Sam Matsa and Andy vanDam, ACM creates a special interest group on graphics, *SIGGRAPH*. The first **SIGGRAPH conference** held in Boulder in 1973 counts 1,200 attendees versus about 45k in top times.

- 1969: At the **Palo Alto Research Center** (PARC) of **Xerox**, Utah alumni **Alan Kay** develops the concept of **Graphical User Interface (GUI)**.

- 1969: The first **framebuffer** (with 3 bits per pixel) is built at **Bell Labs**, initiating the transition from vector graphics, i.e. drawing lines between coordinates, to raster video displays containing a value for each pixel on the screen, transforming vector representations into raster format images.

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History of Computer Graphics

- 1971: **Gouraud shading** is developed by **Utah** student **Henri Gouraud**. By interpolating intensity, visual improvements over flat shading may be achieved at a marginal cost.
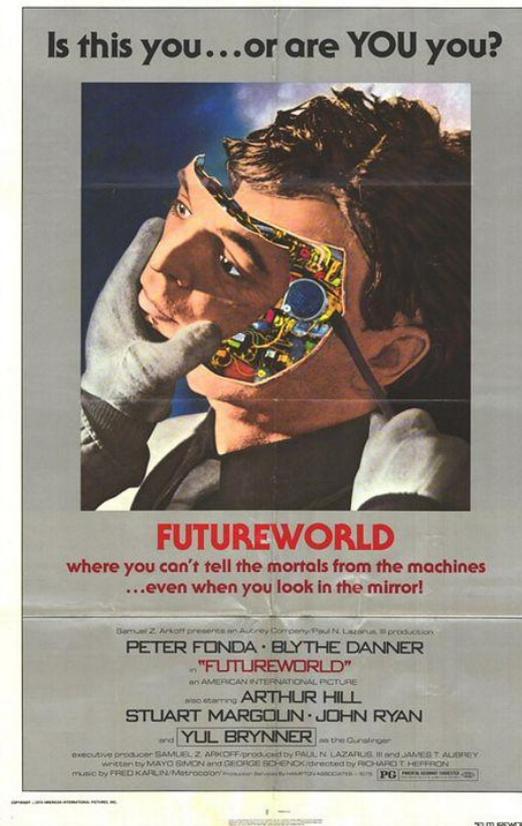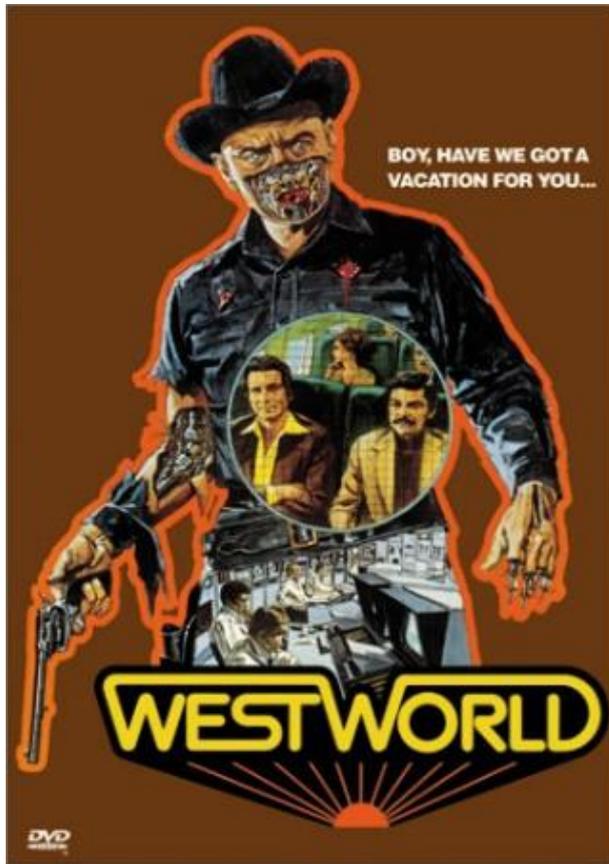

Flat   **Gouraud**

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- 1973: The entertainment feature film ***Westworld*** makes the **first use of 2D animation**, while **3D wireframe CGI** will first be used 3 years later in its sequel ***Futureworld***.

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- 1974: **Wolfgang Strasser** in his dissertation describes the Z-Buffer. Together with **Jose Encarnacao** they can be seen as the fathers of CG in Germany

- 1974: Utah student **Edwin (Ed) Catmull** (last, president of **Walt Disney Animation Studios**) develops both the **Z-buffer hidden-surface algorithm** as well as **texture mapping**.
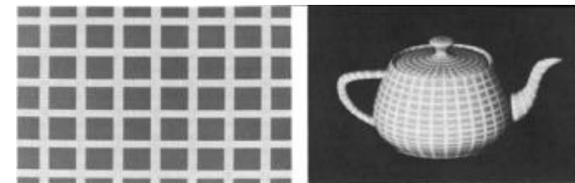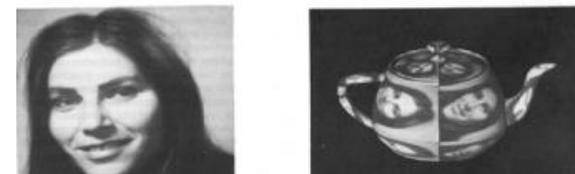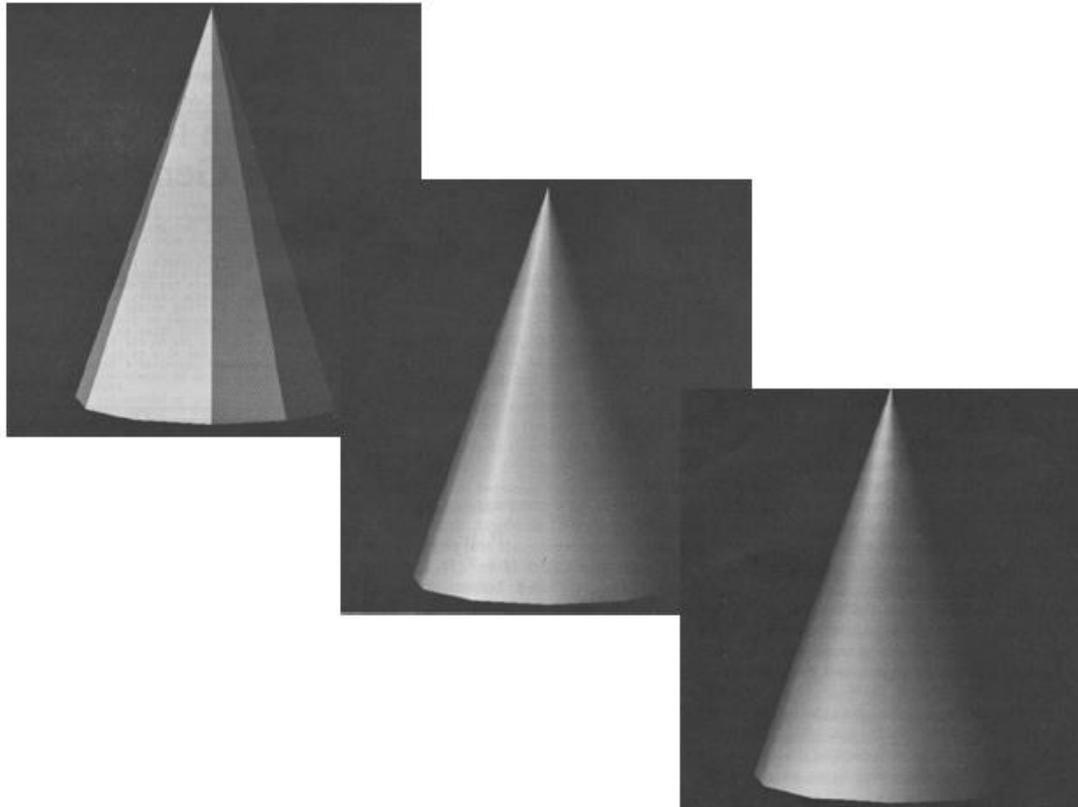
History of Computer Graphics

- 1974: Alexander (Alex) Schure, founder of the **New York Institute of Technology (NYIT)**, creates a new Computer Graphics Lab, naming **Ed Catmull** director. Joined by **Alvy Ray Smith** and others, the team develops interest in producing what could have been the first feature-length CGI film, *The Works,* but it was never completed.

History of Computer Graphics

- 1975: **Utah** student **Bui Tuong Phong** develops a **specular illumination model**. He also introduces the interpolation of normals for shading, now known as **Phong shading**.

History of Computer Graphics

- 1975: Using **Bezier patches**, Utah student **Martin Newell** creates a **3D computer model of a physical teapot**, now at the Computer Museum in Boston. Serving as a benchmark throughout history, the **Utah teapot** has become an **icon of 3D computer graphics**.
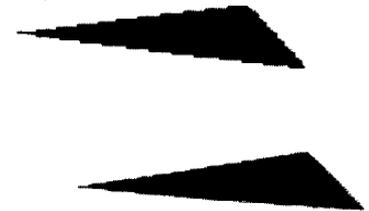
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- 1976: **Steve Jobs and Steve Wozniak** found **Apple**. After a visit of Xerox's PARC in 1979, introducing the **Macintosh** in 1984 which will spark the **graphical user interface revolution**.

- 1977: Utah alumni **Frank Crow** develops solutions to the **aliasing** problem, i.e. **anti-aliasing**.

- 1977: The **Academy of Motion Pictures Arts and Sciences** introduces the category titled *Visual Effects* for the Oscars. The *Best Animated Feature Film Award* will then be approved in 2001. **Technical Achievement Awards** existed since 1931.

History of Computer Graphics

- 1977: **Utah** student **James (Jim) Blinn** presents a **new illumination model** that considers surface facets, and a year later, introduces **bump-mapping**.
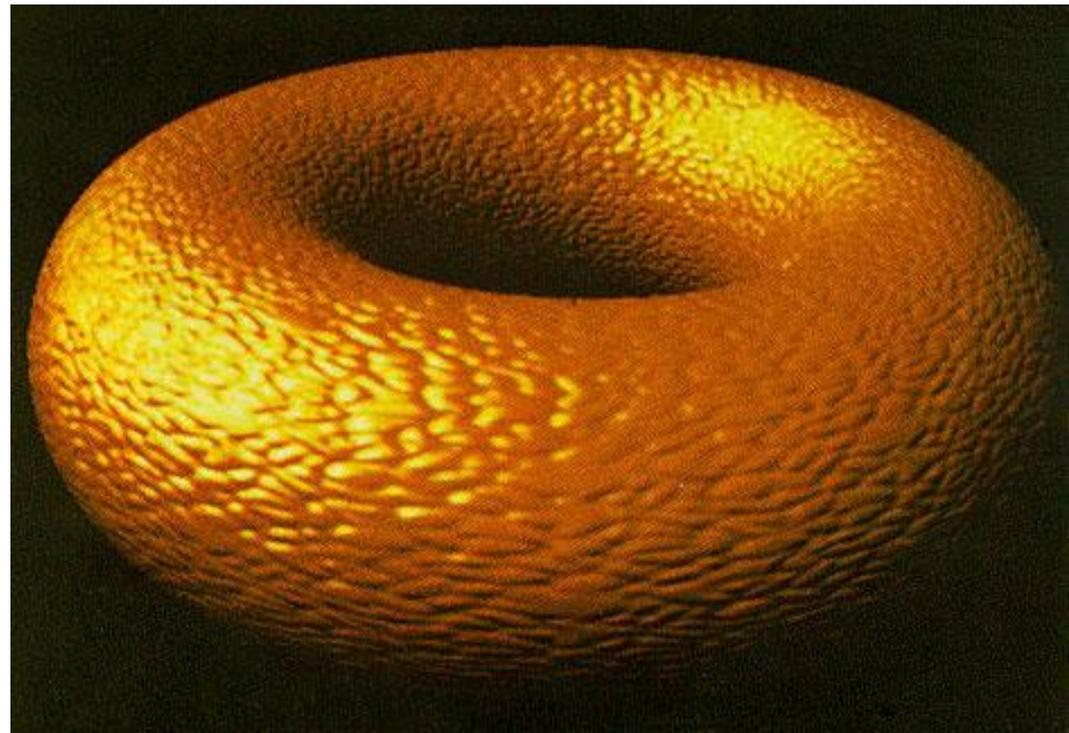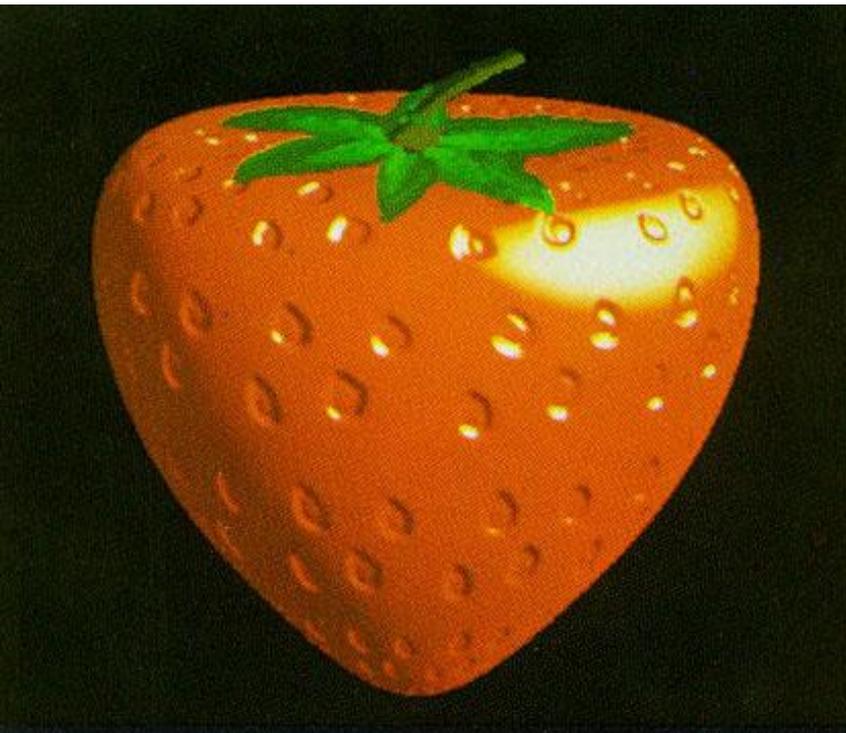
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- 1979: **George Lucas** hires **Ed Catmull** and many others from the NYIT, to form **Lucasfilm's CG team** in San Rafael, CA.

History of Computer Graphics

- 1980: **Turner Whitted** at Bell Labs (now at Microsoft Research) introduces a **general ray tracing** paradigm which incorporates reflection, refraction, antialiasing, and shadows.
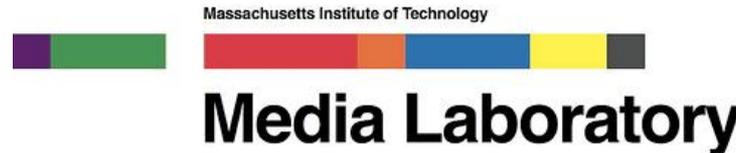
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- 1980: The **European Association for Computer Graphics** is formed and the first **EUROGRAPHICS** conference held in Geneva.

- 1980: The **MIT Media Lab** is founded by **Nicholas Negroponte**.

- 1980: The computer animation production studios **Pacific Data Images (PDI)** is founded by **Carl Rosendahl**.

History of Computer Graphics

- 1981: After some work on fractals while at Boeing in 1980, **Loren Carpenter** is hired by **Lucasfilm** and, in collaboration with **Cook and Catmull**, writes their first renderer, called **REYES (Renders Everything You Ever Saw)**. It included the **RenderMan Shading Language** (**Pat Hanrahan**) and would eventually turn into the **Renderman rendering engine**.
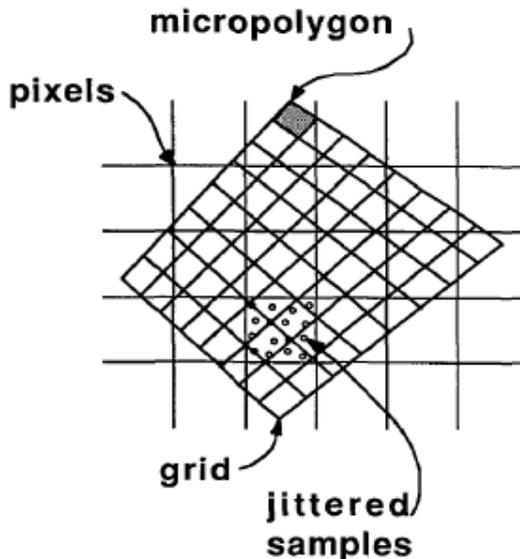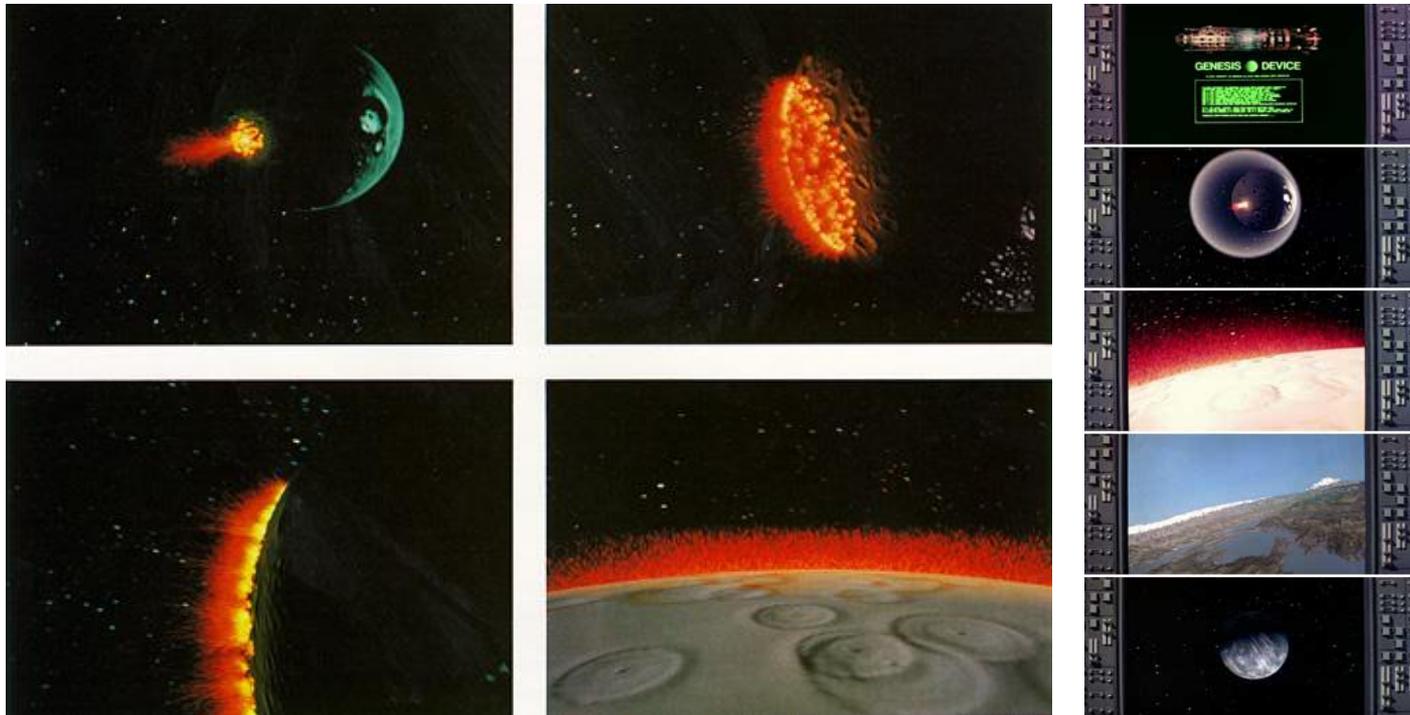
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- 1981: **IEEE Computer Society** starts publishing a new journal, **Computer Graphics and Applications**.

- 1982: **ACM** starts publishing **Transactions on Graphics TOG**.

- 1982: **Utah** alumni **James (Jim) Clark** founds **Silicon Graphics Inc. (SGI)**, a leader in producing low-end to high-end graphics workstations and supercomputers.

- 1982: After inventing the **Postscript language**, **Utah** alumni **John Warnock** founds **Adobe Systems**.

- 1982: **Autodesk** is founded and **AutoCAD** released.

History of Computer Graphics

- 1982: **Lucasfilm** computer graphics division develops a one-minute shot for ***Star Trek II: The Wrath of Khan*** making the first use of fractal-generated landscape in a film. **William (Bill) Reeves** leads the ***Genesis Effect*** programming team and creates the so-called **Particle Systems**.

History of Computer Graphics

- 1982: **Disney** releases *Tron*, the first film with **15 minutes of fully computer generated 3D shots** including the famous Light Cycle sequence inside a videogame. The movie is now recognized as a landmark despite its box office failure.

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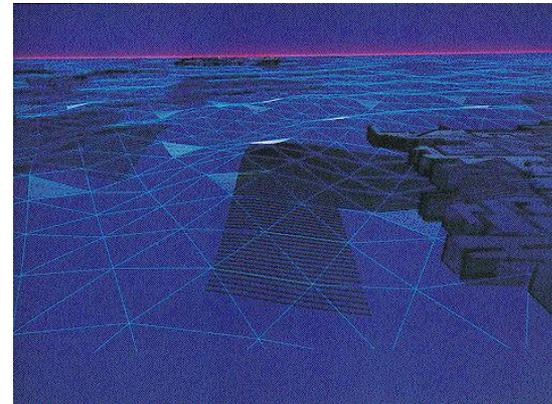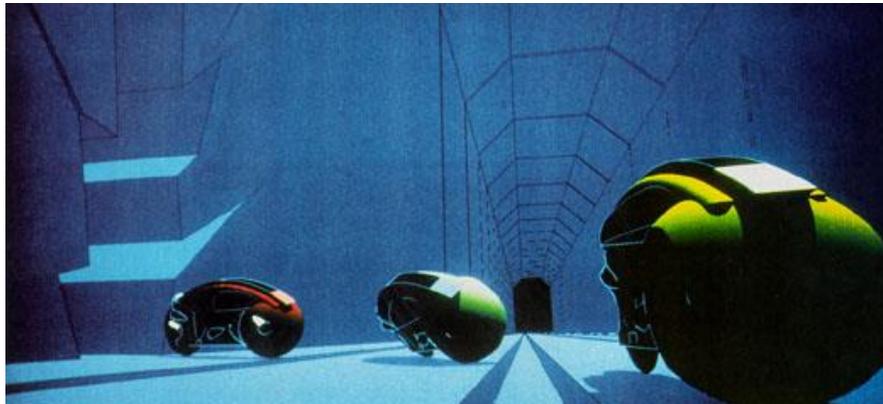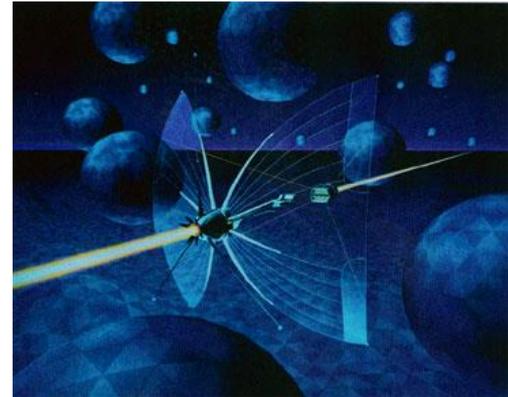
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- 1984: The first movie to use "**integrated CGI**" where the effects are supposed to represent real world objects is released. *The Last Starfighter* includes CG spaceships, planets, and high-tech hardware integrated into live-action scenes, but will also be a box office failure.
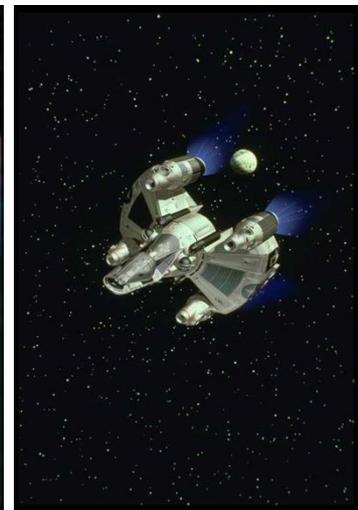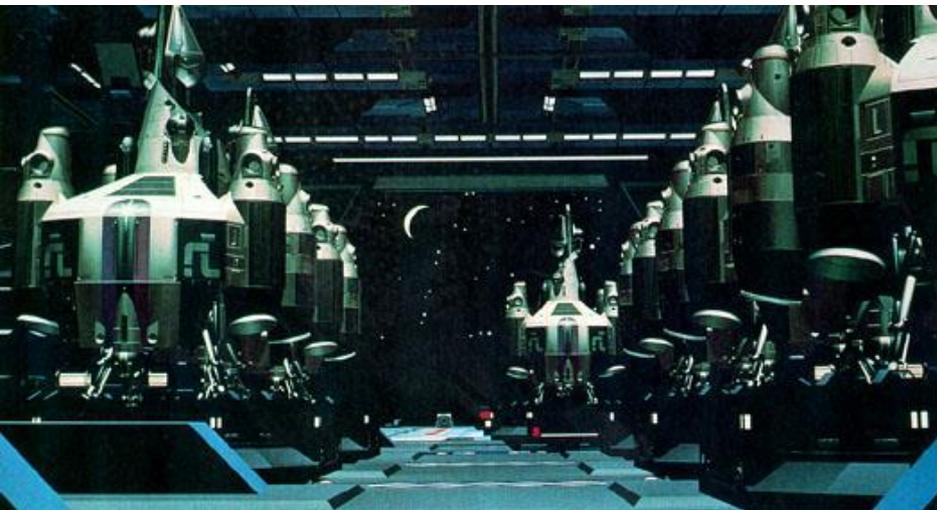
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- 1984: **Michael Cohen** introduces the **Cornell Box** which will symbolize the approach to **physically-based rendering**.

- 1984: Based on heat transfer, **Cindy Goral, Kenneth Torrance, Don Greenberg and Bennett Battaile** at Cornell University introduce *Radiosity*, allowing realistic renderings.
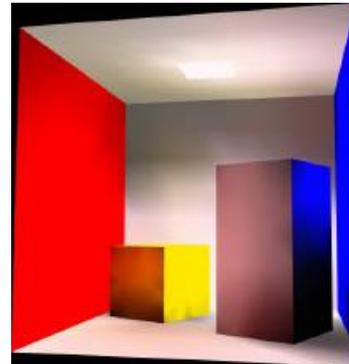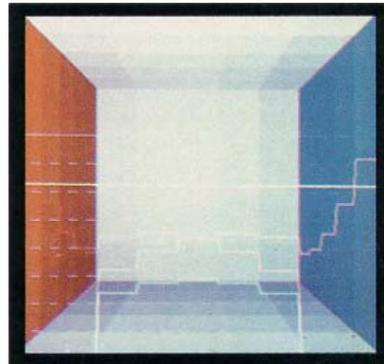
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- 1984: Part of **Lucasfilm**'s team, Cornell alumni **Robert (Rob) Cook** proposes an extended version of ray-tracing. **Distribution ray-tracing** allows the realistic simulation of **motion blur, depth of field, soft shadows**, etc…

History of Computer Graphics

- 1984: **Lucasfilm**'s computer animation division creates *The Adventures of André and Wally B.*, the **first all-CGI animated short film**, followed by Pixar's *Luxo Jr.* in 1985.

History of Computer Graphics

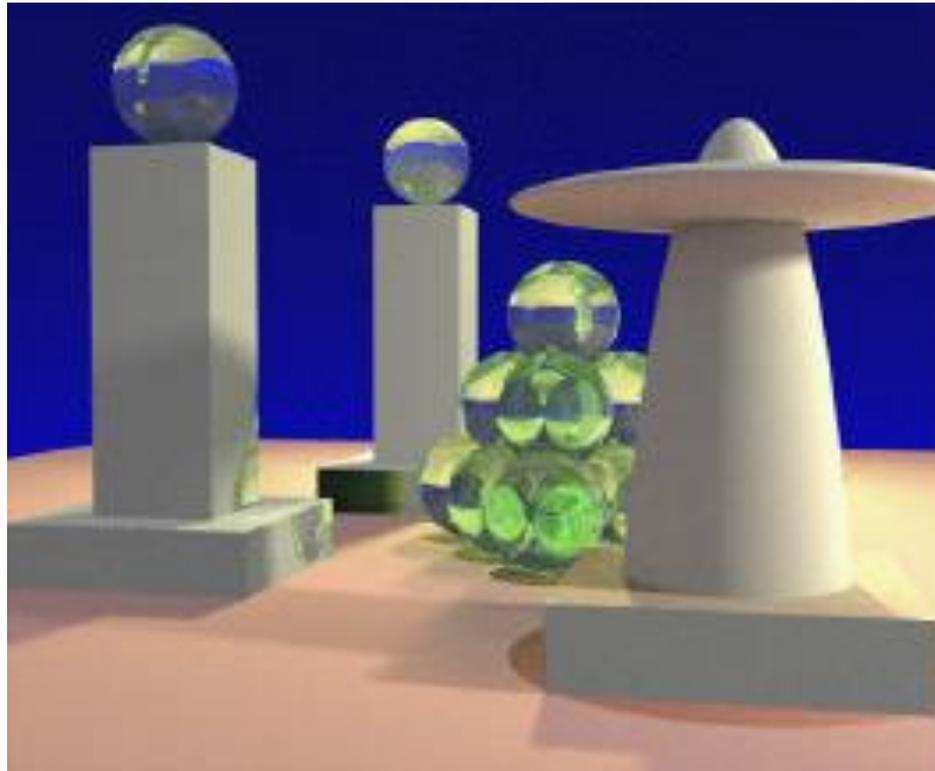- 1985: **Ken Perlin** introduces **noise functions** as a means of creating natural patterns such as marble, wood, …

History of Computer Graphics

- 1986: Utah alumni **James (Jim) Kajiya** introduces the **Rendering Equation** allowing realistic light inter-reflections to be **path-traced**.

History of Computer Graphics

- 1986: The computer graphics division of Lucasfilm splits off as a separate company focused on animated films, **Pixar**, headed by **Ed Catmull** and purchased by **Steve Jobs**.

- 1986: **Industrial Light and Magic (ILM)**, the special effects division of Lucasfilm, starts a CGI group.

- 1986: **Mental Images** is founded in Berlin, bought by **Nvidia** in 2007.

- 1989: REYES-based **Pixar's RenderMan system** is released and a year later its shading language by **Jim Lawson and Pat Hanrahan.**

History of Computer Graphics

- 1991: Although 3D computer graphics debuted in earlier in **Disney** productions, ***Beauty and the Beast*** is the first where hand-drawn characters appear with **3D animated objects**.

History of Computer Graphics

- 1992: **Silicon Graphics Inc. (SGI)** releases the **Open Graphics Library (OpenGL)** specification defining a standard cross-language cross-platform API for computer graphics (now managed by Khronos, being replaced by Vulkan).
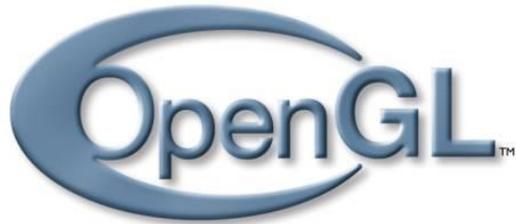
- 1993: **Nvidia** is founded, later attracts many engineers from SGI and other companies to become the **main graphics HW company** (besides AMD and Intel today).

History of Computer Graphics

- 1995: **Pixar** Animation Studios produce *Toy Story*, the **first computer-animated full-length feature film**, demonstrating the possibilities of CGI graphics in movie-making.

History of Computer Graphics

- 1996: The 3D gaming industry sees a breakthrough with the release of *Quake*, lead by **John Carmack** at **ID Software**, which used actual 3-D models in a truly 3-D space.

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History of Computer Graphics

- 2001: Although it fails commercially, *Final Fantasy - The Spirits Within* is the **first feature-length digital film** that includes a cast of **photorealistic digital actors**, stirring the imagination of the press and CG community. Raises awareness of the "**uncanny valley**".

History of Computer Graphics

- Nowadays:
    - Few but big graphics-hardware vendors: Nvidia, AMD, Intel…
    - Mobile devices and casual gaming taking over
    - Few key HW-oriented APIs: Vulkan/SPIR-V, OpenGL, DirectX, Metal, …
    - Many rendering packages:
        - RenderMan, Arnold, Vray, Corona, Maxwell,...
    - Many animation studios:
        - Pixar, Weta Digital, ILM, Dreamworks/PDI, Digital Domain, …
    - Many game companies:
        - Activision, Electronic Arts, Roblox, Epic/Unreal, Unity, Valve, …
    - Interactive 3D graphics on the Web (e.g. WebGL, WebGPU)
    - Trend toward VR (Oculus, …) and AR (HoloLens)
    - Possible new market beyond games & film/video:
        - Predictive rendering (e.g. Radar)
        - Digital Reality & AI

- **Graphics is now ubiquitous – but much remains to be done!**

History of Computer Graphics

- More details in:

  – Wayne E. Carlson's timeline:
    http://design.osu.edu/carlson/history/timeline.html

  – ~~Oscar Chavarro's adaptation of Wayne E. Carlson's timeline:~~
    ~~http://sophia.javeriana.edu.co/~ochavarr/computer_graphics_history/historia/~~

  – Excerpt from *Becoming a Computer Animator* by Michael Morrison:
    http://www.danielsevo.com/hocg/hocg_intro.htm

  – Arden Jacob DeCuir's video on the history of 3D CGI:
    http://www.youtube.com/watch?v=gCj2QNJT4XA