

History of Computer Graphics

Sandro Spina 2004

Graphics Components

- **Hardware** (AGP + Graphics Cards)
- **Software** (2D, 3D, Z-Buffering, Rendering Algorithms, etc)
- **Applications** (Games, Films, Simulations, TV, etc)

The Birth of CG

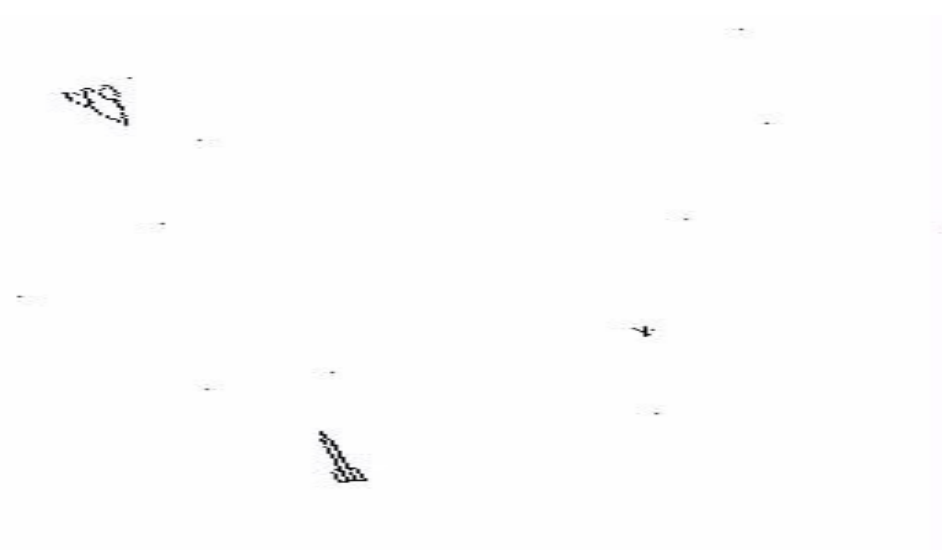
- (1963) **Ivan Sutherland** - creation of Sketchpad (received Turing Award in 1988)
- **Sketchpad** was the first program is ever utilise a complete Graphical User Interface. It used a Lincoln TX-2 computer at MIT (Vector based monitor).

Vector / Raster Graphics

- Vector graphics are composed of thin lines drawn between coordinates. Most 70s and mid-80s computers used vector graphics. Remember Asteroids Game.
- Nowadays video displays transform vector representations into raster format image, which contains a value for every pixel on the screen. Image is re-drawn according to the monitor refresh rate.

Video Games

- 1961 – Steve Russell at MIT created the first video game, **Spacewar**.



First Animations

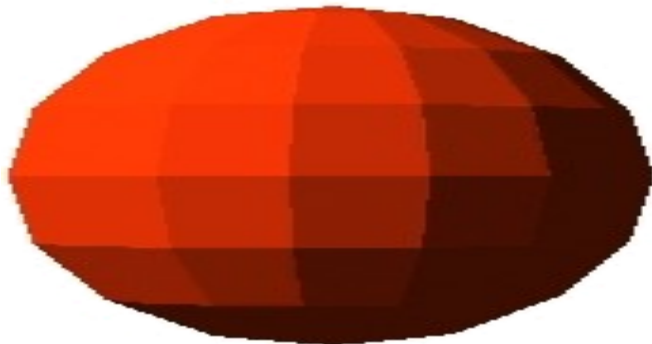
- 60s we start seeing various (very simple) computer generated films. Examples include Boeing's film called "Vibrations of an Aircraft"
- IBM released the IBM2250 graphics terminal, the first commercially available graphics computer !!

Algorithms

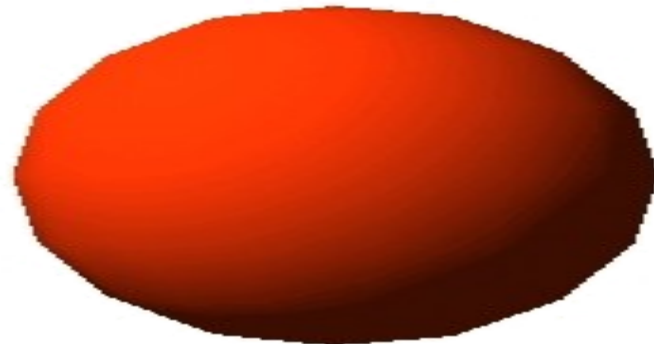
- The first major advances in 3D computer graphics were created at Utah University. These included the hidden-surface removal algorithm. With this algorithm the computer determines which surfaces are “behind” the object from the viewer’s perspective, and thus should be hidden when the computer renders the image.
- John Warnock – Founder of Adobe Systems (creator of the PostScript page description language)
- Jim Clark – Founder of Silicon Graphics Inc.

1970s - Shading Algorithms

- Polygons to represent objects. A **polygon** is an area defined by lines.
- **Flat shading** makes an object look as if it's solid. But this is not very realistic !!
- This problem can be solved by creating objects with more smaller polygons. But this effects performance of the computer rendering the object. It also adds complexity to the objects.
- Gouraud Shading (1971) – presents a method for creating the appearance of a curved surface by interpolating the colour across the polygons. Colours are assigned to the vertices of the polygon. Rendering is now more realistic !!



Flat



Gouraud

Phong Shading + Texture Mapping

- More complex version of shading, which is very rarely using in real-time rendering, due to its complexity.
- Works by averaging the colour of each pixel by averaging the colours of the pixels adjacent to it. As with Gouraud shading, Phong shading cannot smooth over the outer edges of 3D objects.
- Texture Mapping applies 2D images to 3D objects. The algorithms work by 'stretching' the 2D image over the 3D object like a skin. Usually textures are applied to the polygon surfaces. Texture mapping adds realism to a computer generated scene.
- (Later 80s) The map image may not represent colour only but also describe transparency or other surface properties to be used in lighting or shading calculations.

70's Major Events

- 1971 saw one of the most important advancements in GC – the microprocessor (CPU).
- In the 70's a number of animation houses were formed including Lucasfilm (George Lucas). Creators of the Star Wars films.
- 1973 was the setup of the Special Interest Group on Computer Graphics (ACM) and it's first major conference on computer graphics.
- In 1975 Mandelbrot describes Fractal Geometry. Fractals are used in computer graphics to create realistic simulations of natural phenomena such as mountains, coastlines, wood grain, etc.

Ray Tracing

- Turner Whitted (1980) came up with the idea of ray tracing. This was a new rendering method for simulating highly reflective surfaces. The algorithm works by tracing every ray of light, starting from the viewer's perspective back into the 3D scene to the objects. If an object happens to be reflective, the algorithm follows that ray of light as it bounces off the object until it hits something else (which is non-reflective)
- Ray tracing is clearly very computational intensive, however the realism that can be achieved is spectacular.

Radiosity

- Prior to 1985 all image synthesis methods in use were based on **incidental** light, where a light source is shining directly on a surface. However most of the light in the real world is diffused light or light reflected from other surfaces. To solve this problem a new rendering method (Radiosity) was introduced (Goral, Greenberg) which simulates the way heat is dispersed throughout a room to radiant energy between surfaces. By determining the exchange of radiant energy between 3D surfaces **very realistic** 3D scenes are possible.
- First global illumination method and unlike ray tracing it provides a computationally workable solution to diffuse interaction as opposed to specular reflection.
- Radiosity relies on computing the amount of light energy (emitted + reflected) transferred between two surfaces.

Macintosh and IBM-compatible PCs

- January 1984, Apple Computers released the first Macintosh computer. It was the first personal computer to use a **graphical interface**.
- However, Xerox's Alto PC featured the first (WYSIWYG) editor with menus, icons, etc.
- IBM-compatible PCs
- Commodore launch the new AMIGA personal computer line. Based on Motorola's 68000 microprocessor.
- 1990 Microsoft ships Windows v3

1990s - Many more films

- Most notably is “Toy Story” (Disney and Pixar) which is the first commercially successful computer animated full length film.
- Terminator 2
- Beauty and the Beast (Many scenes contained 3D animated objects which were flat shaded with bright colours so as to blend with the hand-drawn characters)
- Batman
- Jurassic Park

QUAKE

- 1996 saw a breakthrough in the 3D gaming industry with the release of Quake (Carmack) by ID Software. 3D graphics accelerators started to pop up. Most notably the 3DFX “Voodoo” chipset.
- Used 3D models for players and monsters instead of 2 dimensional sprites and the world in which play takes place is created as a true 3-dimensional space.
- Unreal + Half Life

Open Graphics Library (opengl)

- It is a specification defining a cross-language cross-platform API for writing applications that produce 3D computer graphics (and 2D as well).
- Efficient implementation for OpenGL exist for Windows, many Unix platforms and the MacOS.
- Graphics cards (nowadays ATI and nVidia) support the OpenGL standard.

DirectX (Microsoft)

- Developed jointly between Microsoft and nVidia.
- It's main purpose was to allow all versions of Microsoft Windows, starting with Windows 95, to incorporate quality multimedia and computer gaming into the Windows environment.
- Nowadays we see the API battles between OpenGL and DirectX. Really what can be done with one API can be done with the other. Performance depends also on graphics card implementing the APIs.

Present Situation

- Film industry (ex. Pixar's The Incredibles)
- nVidia + ATI Technologies push the performance of video cards on personal computers.
- OpenGL + DirectX moving forward.

Graphics Cards

- 3D pipelines
 - Optimised pipelines
 - Parallel Execution (16 vertices)
 - Programmable (Developers can implement their own shaders)
- ATI X800 Pro, nVidia GeForce 6800GT
- Increase memory bandwidth (30Gb/Sec)

Current Research - Algorithms

- Global Illumination (Real-time)
- Real-time Radiosity
- Real-time Raytracing
- Not rendering polygons any more !?!
- Ultimate Goal is Realism....