

CHAPTER 1: INTRODUCTION TO COMPUTER GRAPHICS (PART 2)

Part I: Overview

- Introduction to Computer Graphics
- Basics
 - 2D Graphics
 - raster/vector graphics
 - colour and light
 - basic graphics system (hardware)
 - clipping
- The OpenGL API

Part II: Overview

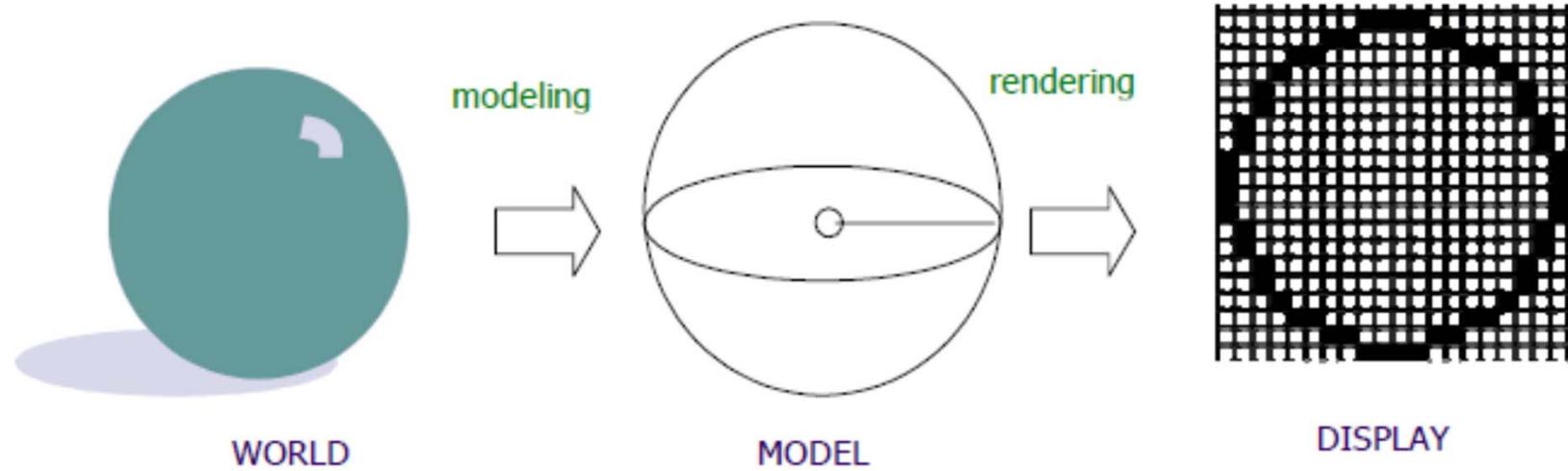
- 3D Computer Graphics
 - Modelling (Transformations + Basic Data Structures)
 - Viewing
 - Projection
 - Hidden Surface Removal
- Local Illumination (Phong Illumination)
- Shading Algorithm (Flat/Gouraud/Phong)

What is Computer Graphics?

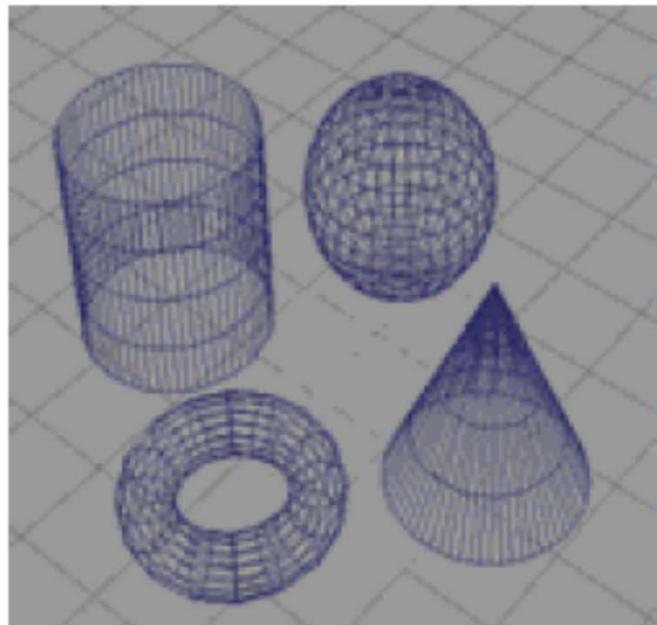
- The term “computer graphics” was coined in 1960 by William Fetter to describe new design methods he was pursuing at Boeing.
- Computer graphics is commonly understood to mean the creation, storage and manipulation of models and images.

Computer Graphics

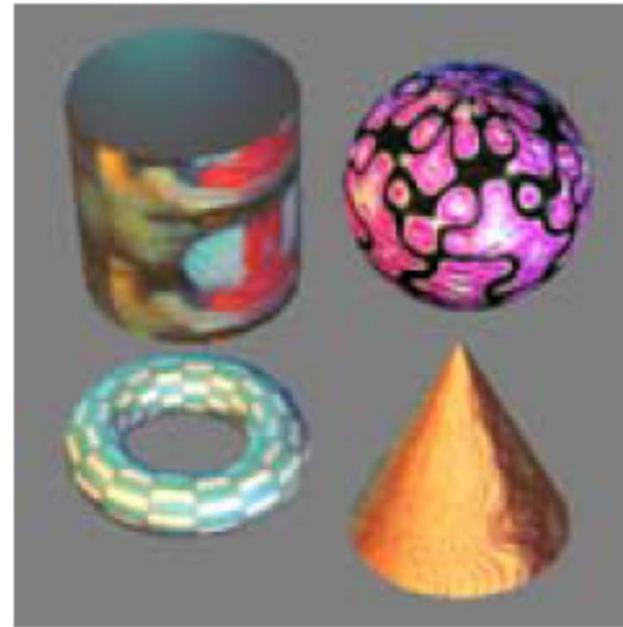
“Computer Graphic is concerned with producing images (or animations) using a computer”



Modelling and Rendering

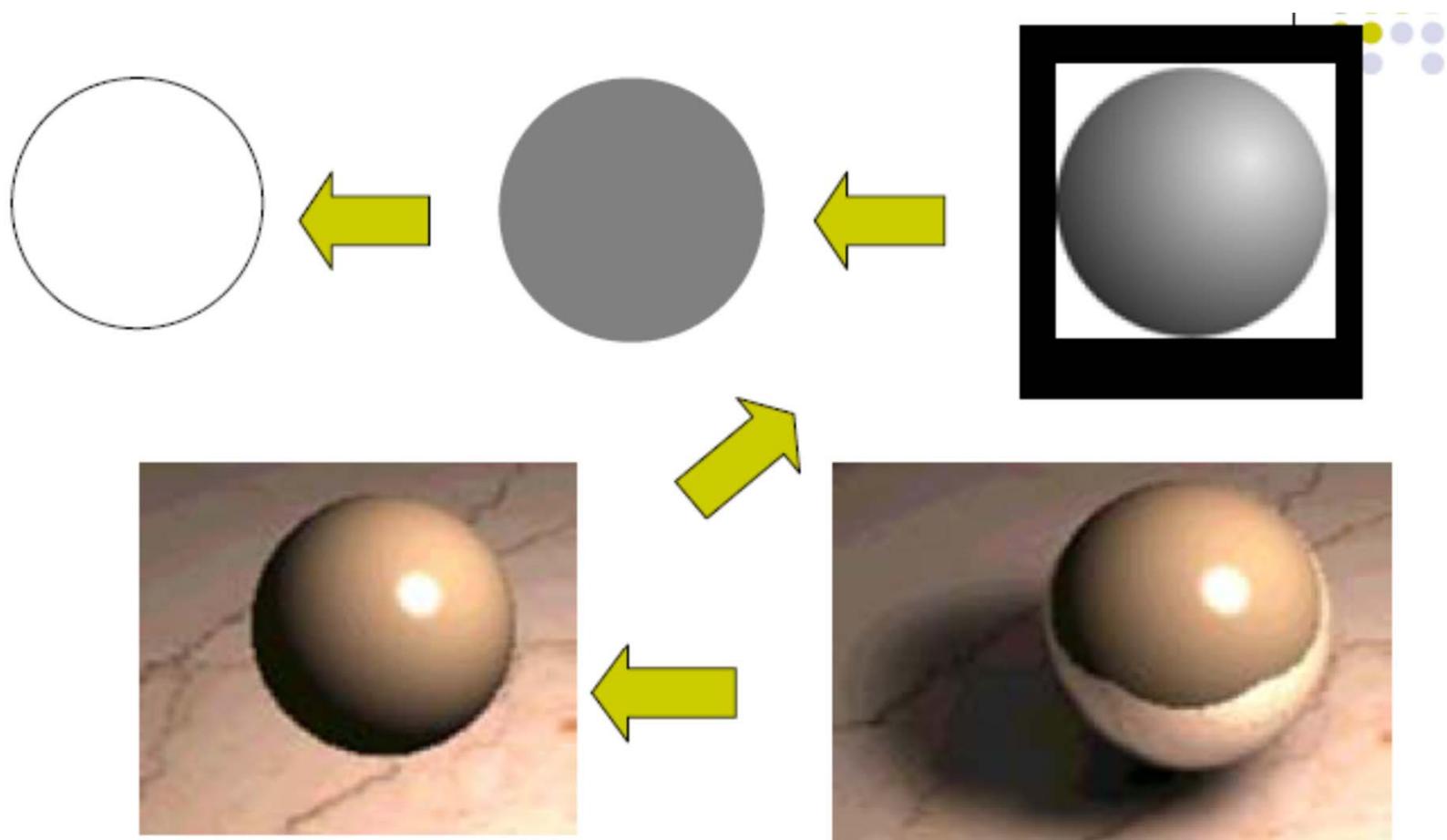


Representing a scene or object in a format that can be stored in computer memory.



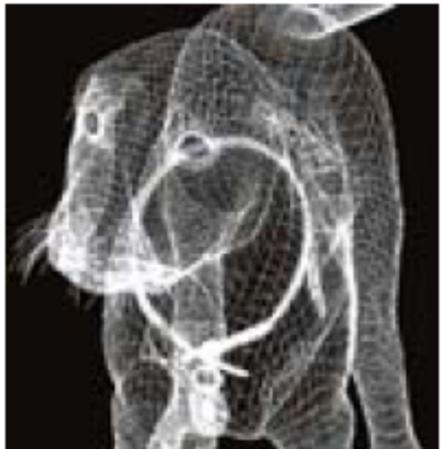
Various methods of outputting a visual representation of the model in output media to convey the original concept being modeled.

Rendering



Different ways to render the same object may be equally applicable for specific applications.

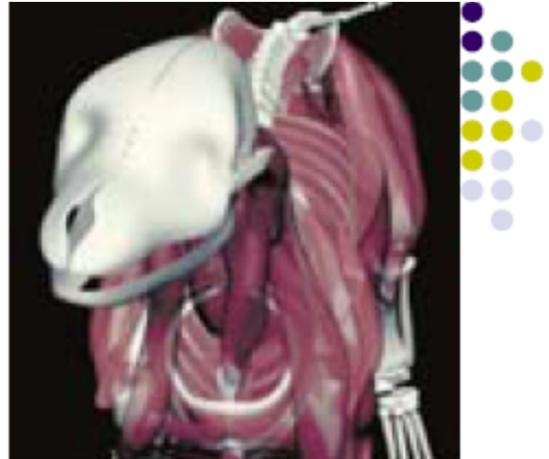
Rendering



Wireframe Model



Skeletal Model



Muscle Model



Skin



Hair

BITM 3213:Interactive Computer Graphics



© Walt Disney and TSL

Render and Touch up⁸

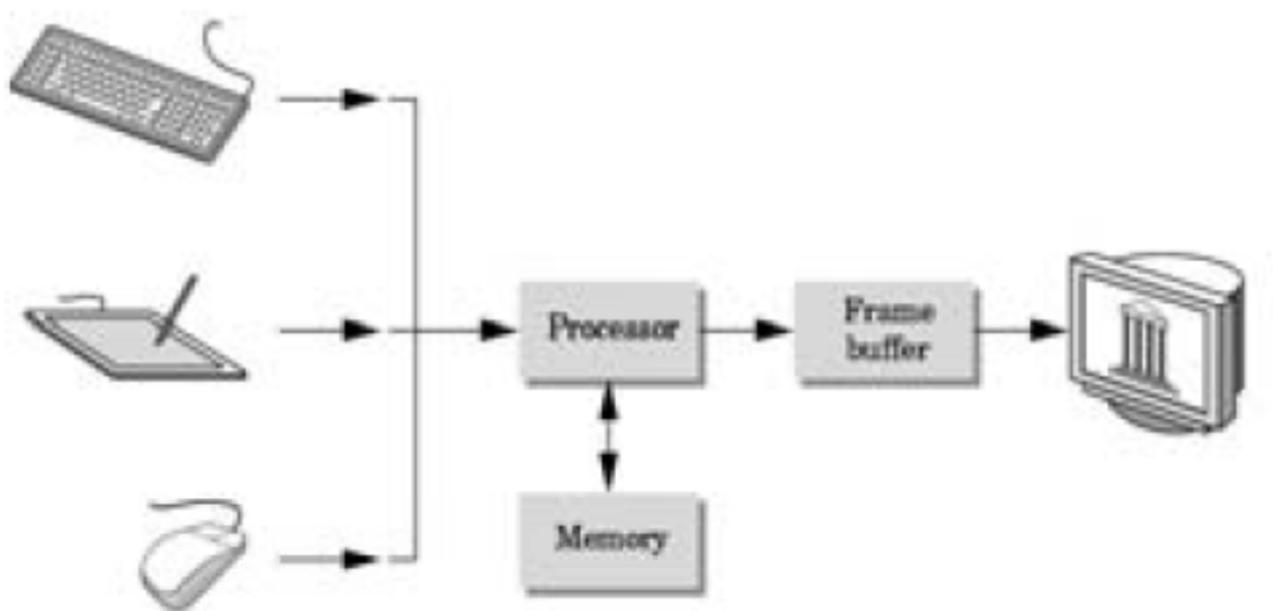
4 main Tasks:



To generalise, these are:

1. **IMAGING** : representing **2D** images
2. **MODELLING**: creating and representing the geometry of objects in the **3D** world
3. **RENDERING**: creating a image in 2D of these objects (constructing **2D images from 3D models**)
4. **ANIMATION**: describing how **objects change in time**

A Graphics System

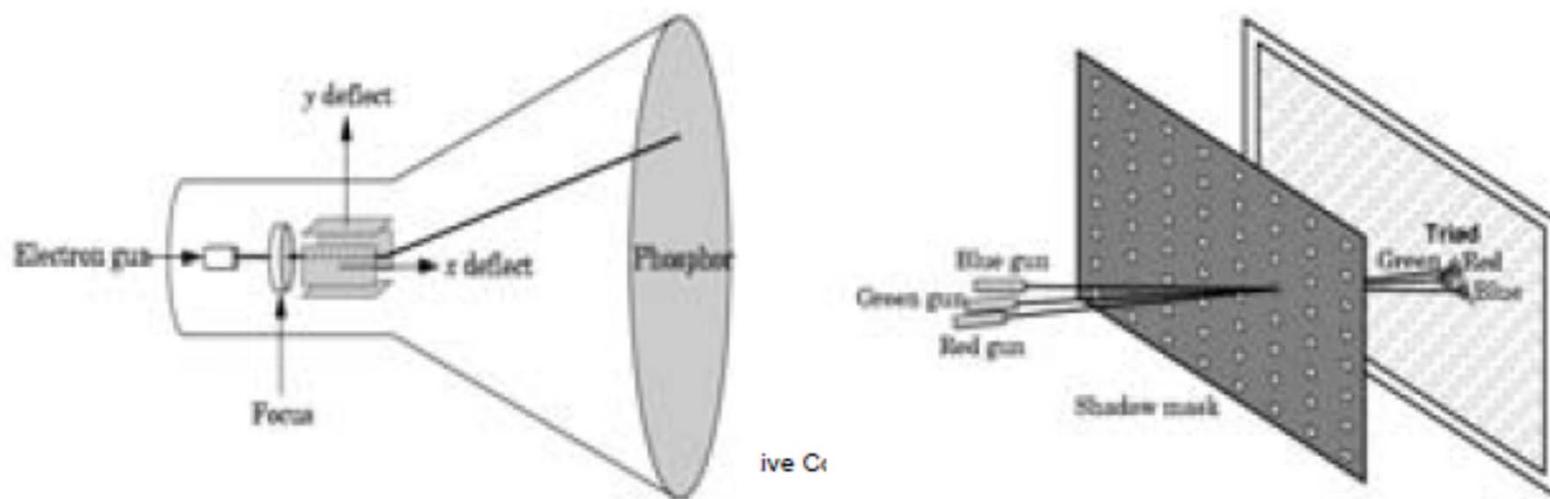


Elements of a CG System:

- Processor, Memory, Frame Buffer
- Input Devices, Output Devices

Output Devices

- **Cathode-Ray Tube (CRT)**
 - Electron beam steered by deflection plates to strike and activate phosphors
 - Only emits for milliseconds and needs to be refreshed



Video Display Monitors

The CRT can be 'driven' in 2 ways:

- **Vector (refreshed/random) mode**

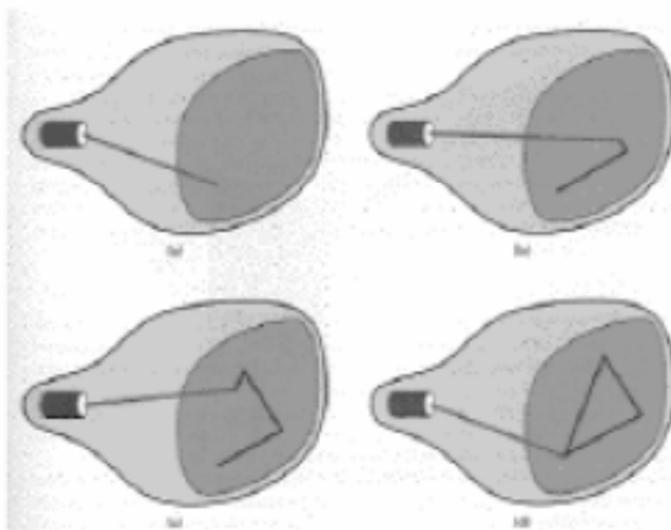
- Vector graphics monitors, where pictures are built up as a series of lines(vectors)
- Cannot display realistic shaded
- Higher resolution
- Produce smooth line drawing

● Raster scanned mode

- Raster scanned monitors, where pictures built up row by row
- Picture swept out in horizontal rows
- Display realistic shaded
- Lower resolution
- Produce jagged lines
- Flexibility
- Improve line drawing capabilities

Vector (refreshed/random) Scan

Random-scan CRTs



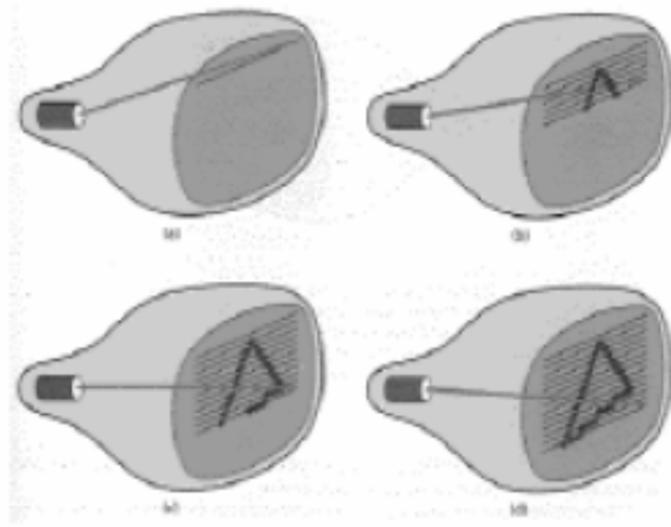
Electron beam is scanned along each line segment

Capable of displaying continuous lines and very high resolution curves

High-end displays capable of 100k lines per refresh

Raster Scan

Raster-scan CRTs

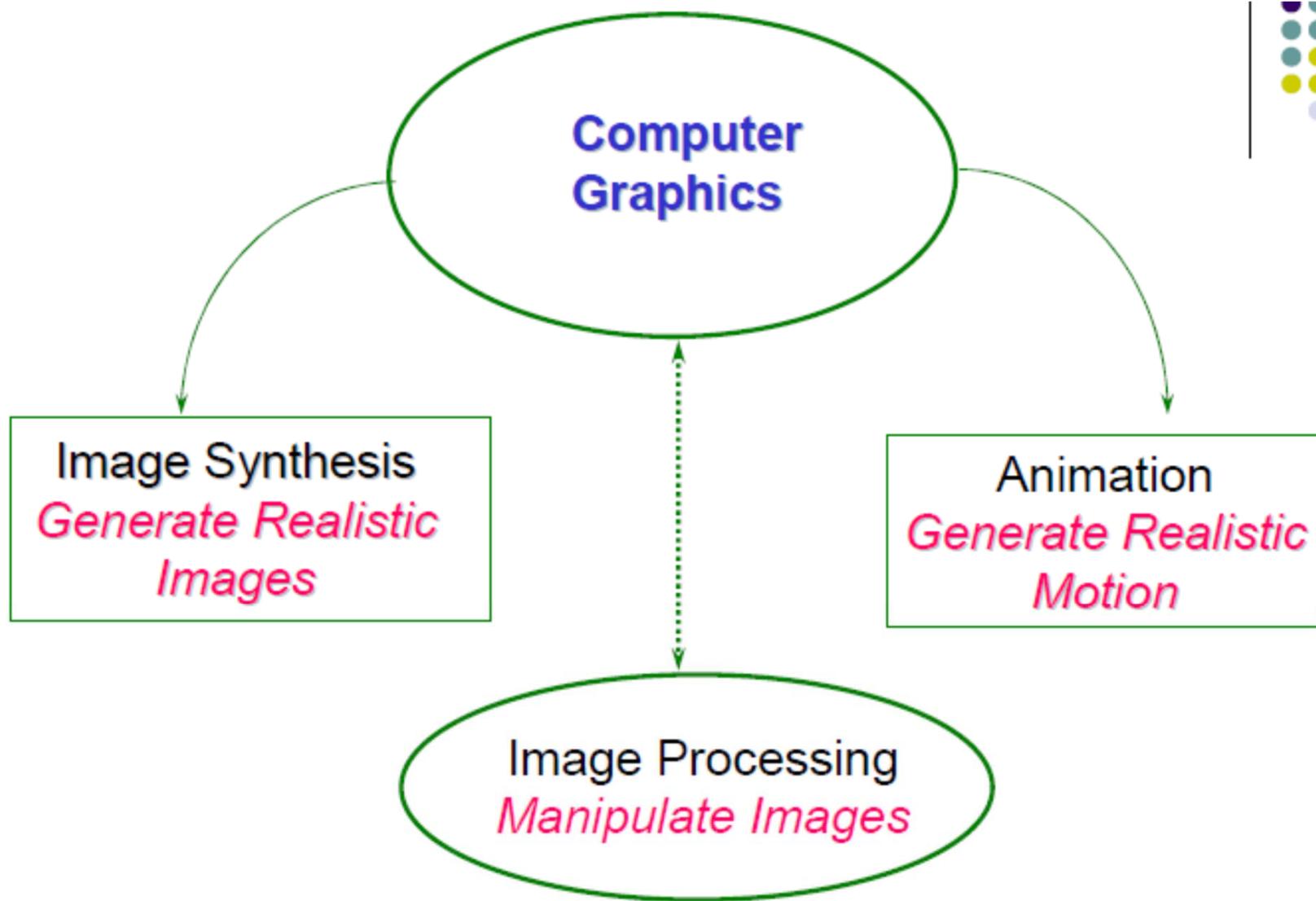


Electron beam is scanned left-to-right, top-to-bottom

Beam retraces to top-left after reaching bottom-right (vertical retrace)

Capable of displaying continuous range of intensities at discrete positions

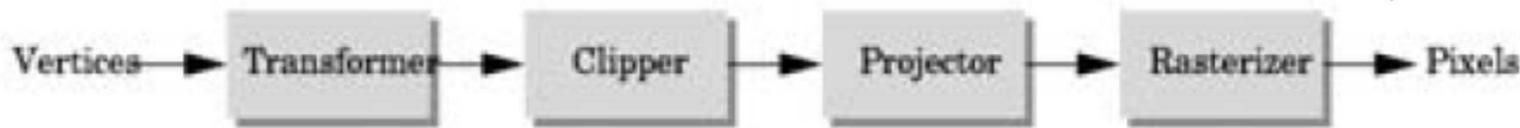
High-end displays capable of 4k x 4k @ 120 Hz



Pixels and Frame Buffer

- **Pixels** (picture elements)
 - Squares of a uniform color on a grid
- **Frame buffer**
 - Memory store of pixels
 - Key component in raster graphics system
- **Depth**
 - Number of bits used for a pixel
 - Often use RGB, a combination of red, green, blue primaries

Geometric Pipeline



Transformations:

- Need to transform from object to camera to screen coordinates
- Encoded as a 4x4 matrix

Clipping:

- Limited field of view so cut geometry against the clipping rectangle

Projection:

- Flatten objects from 3-D to 2-D

Rasterization (scan conversion)

- converting geometric primitives (lines, polygons) to pixels

Image Formation

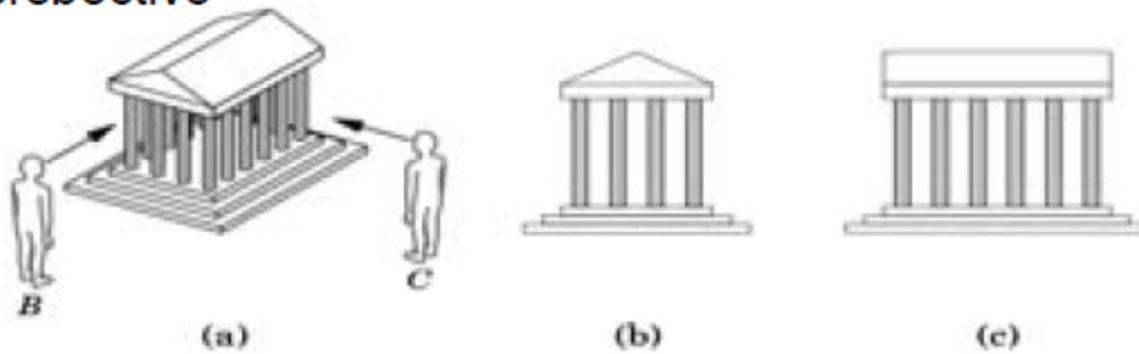
Combining **objects** and **viewers** to produce an **image**

- **Objects:**

- Exist independently of image formation
- Constructed from geometric primitives (vertices)

- **Viewers:**

- Form the 2-D image of the objects from a particular perspective



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Some History....



Whirlwind: early graphics using VectorScope (1951)



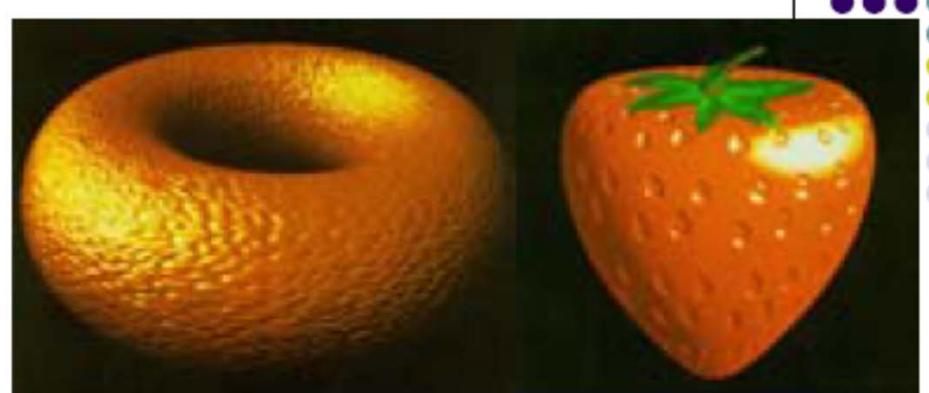
first CAD system (IBM 1959)



SketchPad: first interactive graphics (1961)



Early texture-mapped image (Catmull 1974)



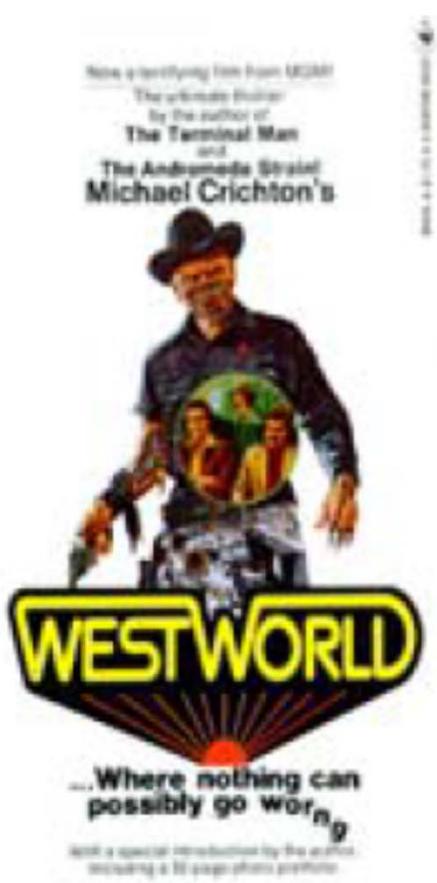
First bump-mapped images (Blinn 1978)



First ray traced image (Whitted 1980)

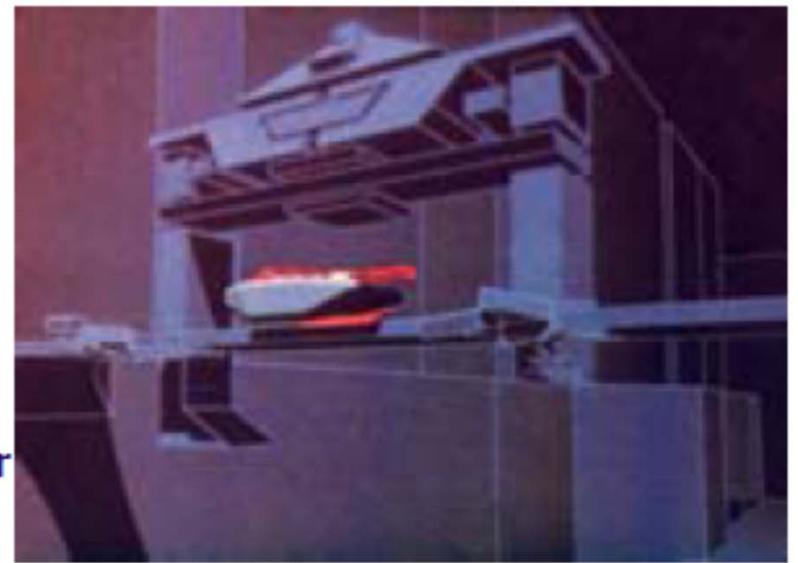
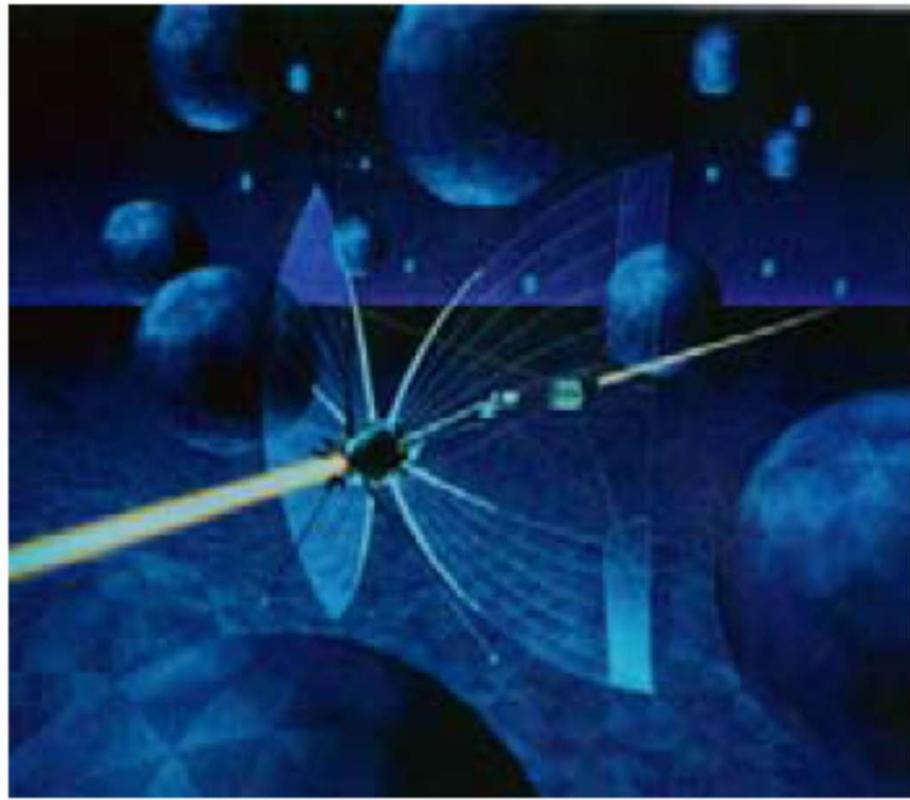


First distributed ray traced image (Cook 1984)



Westworld (1973)

First movie to feature computer graphics.
Used in various graphics displays within the Westworld center.



Tron (1980)

First time computer graphics were used for live action sequences.