**OVERVIEW: ------**

The term computer graphics includes almost everything on computers that is not text or sound. Today nearly all computers use some graphics and users expect to control their computer through icons and pictures rather than just by typing. The term Computer Graphics has several meanings:

the representation and manipulation of pictorial data by a computer

the various technologies used to create and manipulate such pictorial data

the images so produced, and

the sub-field of computer science which studies methods for digitally synthesizing and manipulating visual content, see study of computer graphics

Today computers and computer-generated images touch many aspects of our daily life. Computer imagery is found on television, in newspapers, in weather reports, and during surgical procedures. A well-constructed graph can present complex statistics in a form that is easier to understand and interpret. Such graphs are used to illustrate papers, reports, theses, and other presentation material. A range of tools and facilities are available to enable users to visualize their data, and computer graphics are used in many disciplines

**HISTORY: -------**

The phrase “Computer Graphics” was coined in 1960 by William Fetter, a graphic designer for Boeing. The field of computer graphics developed with the emergence of computer graphics hardware. Early projects like the Whirlwind and SAGE Projects introduced the CRT as a viable display and interaction interface and introduced the light pen as an input device.

Further advances in computing led to greater advancements in interactive computer graphics. In 1959, the TX-2 computer was developed at MIT's Lincoln Laboratory. The TX-2 integrated a number of new man-machine interfaces. A light pen could be used to draw sketches on the computer using Ivan Sutherland's revolutionary Sketchpad software. The development of Sketchpad made Ivan Sutherland the "grandfather" of interactive computer graphics and graphical user interfaces.[3]

The research at MIT would help shape the early computer and computer graphics industries. Major corporations soon became interested in the technology. IBM quickly responded by releasing the IBM 2250 graphics terminal, the first commercially available graphics computer.[4] Several computer graphics companies were founded in the mid 1960s including TRW, Lockheed-Georgia, General Electric and Sperry Rand.

In 1969, the ACM initiated A Special Interest Group in Graphics (SIGGRAPH) which organizes conferences, graphics standards, and publications within the field of computer graphics. In 1973, the first annual SIGGRAPH conference was held, which has become one of the focuses of the organization. SIGGRAPH has grown in size and importance as the field of computer graphics has expanded over time. Many of the most important early breakthroughs in computer graphics research occurred at the University of Utah in the 1970s.

In the 1980s, artists and graphic designers began to see the personal computer, particularly the Commodore Amiga and Macintosh, as a serious design tool, one that could save time and draw more accurately than other methods. In the late 1980s, SGI computers were used to create some of the first fully computer-generated short films at Pixar. The Macintosh remains a highly popular tool for computer graphics among graphic design studios and businesses. Modern computers, dating from the 1980s often use graphical user interfaces (GUI) to present data and information with symbols, icons and pictures, rather than text. Graphics are one of the five key elements of multimedia technology.

3D graphics became more popular in the 1990s in gaming, multimedia and animation. In 1996, Quake, one of the first fully 3D games, was released. In 1995, Toy Story, the first full-length computer-generated animation film, was released in cinemas worldwide. Since then, computer graphics have only become more detailed and realistic, due to more powerful graphics hardware and 3D modeling software

## The Age of Sutherland

In the early 1960's IBM, Sperry-Rand, Burroughs and a few other computer companies existed. The computers of the day had a few kilobytes of memory, no operating systems to speak of and no graphical display monitors. The peripherals were Hollerith punch cards, line printers, and roll-paper plotters. The only programming languages supported were assembler, FORTRAN, and Algol. Function graphs and ``Snoopy'' calendars were about the only graphics done.

In 1963 Ivan Sutherland presented his paper *Sketchpad* [1] at the Summer Joint Computer Conference. Sketchpad allowed interactive design on a vector graphics display monitor with a light pen input device. Most people mark this event as the origins of computer graphics.

## The Middle to Late '60's

## Software and Algorithms

Jack Bresenham taught us how to draw lines on a raster device. He later extended this to circles. Anti-aliased lines and curve drawing is a major topic in computer graphics. Larry Roberts pointed out the usefulness of homogeneous coordinates,  matrices and hidden line detection algorithms. Steve Coons introduced parametric surfaces and developed early computer aided geometric design concepts. The earlier work of Pierre Bézier on parametric curves and surfaces also became public. Author Appel at IBM developed hidden surface and shadow algorithms that were pre-cursors to ray tracing. The fast Fourier transform was discovered by Cooley and Tukey. This algorithm allow us to better understand signals and is fundamental for developing antialiasing techniques. It is also a precursor to wavelets.

## Hardware and Technology

Doug Englebart invented the mouse at Xerox PARC. The Evans & Sutherland Corporation and General Electric started building flight simulators with real-time raster graphics. The floppy disk was invented at IBM and the microprocessor was invented at Intel. The concept of a research network, the ARPANET, was developed.

## The Early '70's

The state of the art in computing was an IBM 360 computer with about 64 KB of memory, a Tektronix 4014 storage tube, or a vector display with a light pen (but these were very expensive).

## Software and Algorithms

Rendering (shading) were discovered by Gouraud and Phong at the University of Utah. Phong also introduced a reflection model that included specular highlights. Keyframe based animation for 3-D graphics was demonstrated. Xerox PARC developed a ``paint'' program. Ed Catmull introduced parametric patch rendering, the *z*-buffer algorithm, and texture mapping. BASIC, C, and Unix were developed at Dartmouth and Bell Labs.

## Hardware and Technology

An Evans & Sutherland Picture System was the high-end graphics computer. It was a vector display with hardware support for clipping and perspective. Xerox PARC introduced the Altos personal computer, and an 8 bit computer was invented at Intel.

## The Middle to Late '70's

## Software and Algorithms

Turned Whitted developed recursive ray tracing and it became the standard for photorealism, living in a pristine world. Pascal was the programming language everyone learned.

# Hardware and Technology

The Apple I and II computers became the first commercial successes for personal computing. The DEC VAX computer was the mainframe (mini) computer of choice. Arcade games such as Pong and Pac Mac became popular. Laser printers were invented at Xerox PARC.

## The Early '80's

## Software and Algorithms

## Hardware and Technology

The IBM PC was marketed in 1981 The Apple MacIntosh started production in 1984, and microprocessors began to take off, with the Intel x86 chipset, but these were still toys. Computers with a mouse, bitmapped (raster) display, and Ethernet became the standard in academic and science and engineering settings.

## The Middle to Late '80's

## Software and Algorithms

Jim Blinn introduces blobby models and texture mapping concepts. Binary space partitioning (BSP) trees were introduced as a data structure, but not many realized how useful they would become. Loren Carpenter

starting exploring fractals in computer graphics. Postscript was developed by John Warnock and Adobe was formed. Steve Cook introduced stochastic sampling to ray tracing. Paul Heckbert taught us to ray trace Jello©(this is a joke;) Character animation became the goal for animators. Radiosity was introduced by the Greenberg and folks at Cornell. Photoshop was marketed by Adobe. Video arcade games took off, many people/organizations started publishing on the desktop. Unix and X windows were the platforms of choice with programming in C and C++, but MS-DOS was starting to rise.

## Hardware and Technology

Sun workstations, with the Motorola 680x0 chipset became popular as advanced workstation a in the mid 80's. The Video Graphics Array (VGA) card was invented at IBM. Silicon Graphics (SGI) workstations that supported real-time raster line drawing and later polygons became the computer graphicists desired. The data glove, a precursor to virtual reality, was invented at NASA. VLSI for special purpose graphics processors and parallel processing became hot research areas.

## The Early '90's

The computer to have now was an SGI workstation with at least 16 MB of memory, at 24-bit raster display with hardware support for Gouraud shading and *z*-buffering for hidden surface removal. Laser printers and single frame video recorders were standard. Unix, X and Silicon Graphics GL were the operating systems, window system and application programming interface (API) that graphicist used. Shaded raster graphics were starting to be introduced in motion pictures. PCs started to get decent, but still they could not support 3-D graphics, so most programmer's wrote software for scan conversion (rasterization) used the painter's algorithm for hidden surface removal, and developed ``tricks'' for real-time animation.

## Software and Algorithms

Mosaic, the first graphical Internet browser was written by xxx at the University of Illinois, National Center for Scientific Applications (NCSA). MPEG standards for compressed video began to be promulgated. Dynamical systems (physically based modeling) that allowed animation with collisions, gravity, friction, and cause and effects were introduced. In 1992 OpenGL became the standard for graphics APIs In 1993, the World Wide Web took off. Surface subdivision algorithms were rediscovered. Wavelets begin to be used in computer graphics.

## Hardware and Technology

Hand-held computers were invented at Hewlett-Packard about 1991. Zip drives were invented at Iomega. The Intel 486 chipset allowed PC to get reasonable floating point performance. In 1994, Silicon Graphics produced the Reality Engine: It had hardware for real-time texture mapping. The Ninetendo 64 game console hit the market providing Reality Engine-like graphics for the masses of games players. Scanners were introduced.

## The Middle to Late '90's

The PC market erupts and supercomputers begin to wane. Microsoft grows, Apple collapses, but begins to come back, SGI collapses, and lots of new startups enter the graphics field.

## Software and Algorithms

Image based rendering became the area for research in photo-realistic graphics. Linux and open source software become popular.

## Hardware and Technology

PC graphics cards, for example 3dfx and Nvidia, were introduced. Laptops were introduced to the market. The Pentium chipset makes PCs almost as powerful as workstations. Motion capture, begun with the data glove, becomes a primary method for generating animation sequences. 3-D video games become very popular: DOOM (which uses BSP trees), Quake, Mario Brothers, etc. Graphics effects in movies becomes pervasive: Terminator 2, Jurassic Park, Toy Story, Titanic, Star Wars I. Virtual reality and the Virtual Reality Meta (Markup) Language (VRML) become hot areas for research. PDA's, the Palm Pilot, and flat panel displays hit the market.

## The '00's

Today most graphicist want an Intel PC with at least 256 MB of memory and a 10 GB hard drive. Their display should have graphics board that supports real-time texture mapping. A flatbed scanner, color laser printer, digital video camera, DVD, and MPEG encoder/decoder are the peripherals one wants. The environment for program development is most likely Windows and Linux, with Direct 3D and OpenGL, but Java 3D might become more important. Programs would typically be written in C++ or Java.

What will happen in the near future -- difficult to say, but high definition TV (HDTV) is poised to take off (after years of hype). Ubiquitous, untethered, wireless computing should become widespread, and audio and gestural input devices should replace some of the functionality of the keyboard and mouse.
You should expect 3-D modeling and video editing for the masses, computer vision for robotic devices and capture facial expressions, and realistic rendering of difficult things like a human face, hair, and water. With any luck C++ will fall out of favor.

## GRAPHICAL USER INTERFACES

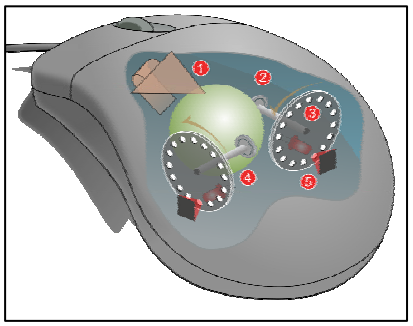
It is common now for software packages to provide a graphical interface. A major component of a graphical interface is a window manager that allows a user to display multiple-window areas. Each window can contain a different process that can contain graphical or non graphical displays. To make a particular window active, we simply click in that window using an interactive pointing device. Interfaces also display menus and icons for fast selection of processing options or parameter values. An icon is a graphical symbol that is designed to look like the processing option it represents. The advantages of icons are that they take up less screen space than corresponding textual descriptions and they can be understood more quickly if well designed. Menus contain lists of textual descriptions and icons.

### INPUT DEVICES:

Various devices *are* available for data input on graphics workstations. Most systems have a keyboard and one or more additional devices specially designed for interactive input. These include a mouse, trackball, space ball, joystick, digitizers, touch panels, image scanners, and voice systems.

**Keyboard:** In computing, a **keyboard** is an input device, partially modeled after the typewriter keyboard, which uses an arrangement of buttons or keys, to act as mechanical levers or electronic switches. Despite the development of alternative input devices, such as the mouse (computing mouse), touch sensitive screens, pen devices, character recognition, voice recognition, and improvements in computer speed and memory size, the keyboard remains the most commonly used and most versatile device used for direct (human) input into computers.

A keyboard typically has characters engraved or printed on the keys and each press of a key typically corresponds to a single written symbol. However, to produce some symbols requires pressing and holding several keys simultaneously or in sequence. While most keyboard keys produce letters, numbers or signs (characters), other keys or simultaneous key presses can produce actions or computer commands.



**Mouse:** In computing, a **mouse** is a pointing device that functions by detecting two-dimensional motion relative to its supporting surface. Physically, a mouse consists of an object held under one of the user's hands, with one or more buttons. (Although traditionally a button is typically round or square, modern mice have spring-loaded regions of their top surface that operate switches when pressed down lightly.) It sometimes features other elements, such as "wheels", which allow the user to perform various system-dependent operations, or extra buttons or features that can add more control or dimensional input. The mouse's motion typically translates into the motion of a cursor on a display, which allows for fine control of a graphical user interface.

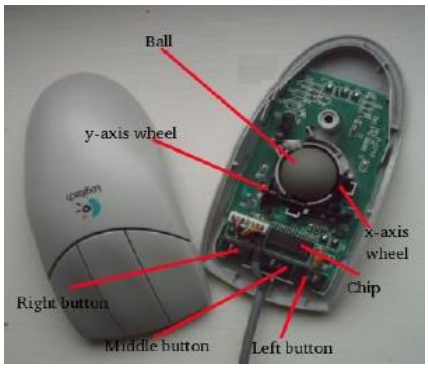
Operating an opto-mechanical mouse.

1. moving the mouse turns the ball.
2. X and Y rollers grip the ball and transfer movement
3. Optical encoding disks include light holes.
4. Infrared LEDs shine through the disks.
5. Sensors gather light pulses to convert to X and Y vectors.

## What is a mouse?

The mouse is a pointing device which helps us to operate the computer. Unlike the complicated hardwares such as Mother board,RAM, Hardisk, Processor of the computer, the mouse is designed with a simple circuit to process. Now a days, we get varieties of mouse with different technologies in the market.

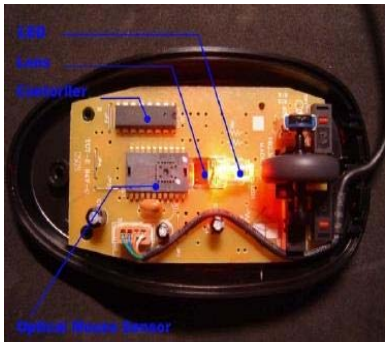
The developing applications in the computer field has not completely excluded the mouse yet. Although, we have switched to Touchpads in Laptops, "the function of mouse is easy and user-friendly when compared with touch pads for a new user", says the users. Mostly all the applications are operated with mouse for easy working. In recent days, the optical mouse had overcome the old ball mouse, because of its 'easy to use' function.




## Disadvantages of Ball mouse

With the previous ball-rolled mouses, the movement of the pointer in the computer is decided by the ball inside the mouse. So, if the ball gets damaged, or if dust gets clustered, the operation of the mouse becomes problem. When dust gathers, it takes some time to clear it too. With these disadvantages, the ball mouse was slowly moved away form the computer technology leaving the optical mouse to fill its space.

## Working of Optical mouse



Now, almost everyone tries to switch from ball/roller mouse to Optical mouse. As the cost of the mouse is also being decreasing, the replacement is quiet quicker. To connect this optical mouse, the necessity is PS/2 or USB plug, and windows, Macintosh or LINUX operating system installed in the computer.

The main components of the optical mouse are:

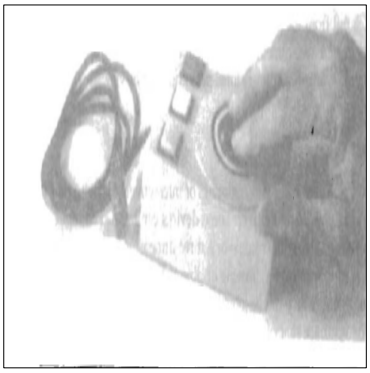
- Inbuilt optical sensor
- High speed camera which can take 1000 pictures at a time
- LED

These optical mouses do have an inbuilt optical sensor. The optical sensor reads the movements of the optical mouse (moved by the user) with the help of the light rays which comes out from the bottom. (The area in which a light glows). When the user moves the optical mouse, the LED (Light Emitting Diode) present inside the mouse emits the light according the minute movements. These movements are send to the camera as light rays. The camera captures the difference in light rays as images. When the camera captures the images, each and every pictures and compared to one another with the digital technology. With the comparison, the speed of the mouse and the direction of the movement of the mouse are rapidly calculated. According to the calculation, the pointer moves on the screen.

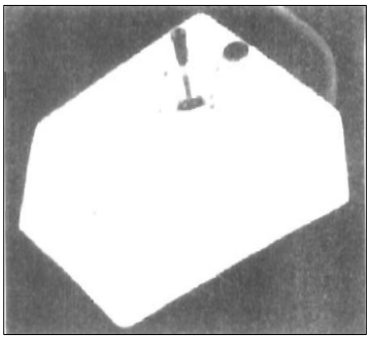
Comparison between a roller/ball mouse and optical mouse

- The optical mouse does not have any movable parts as of the ball mouse. So, the life of the optical mouse is long compared to the ordinary mouse.
- Since the mouse works with the sensor recognition, the movements are clearly captured and so the move gives out a same function in all moves.
- Since the ball is absent in the optical mouse, the weight of the optical mouse is less than that of the ball mouse.
- The dust clustering problem is abolished in the optical mouse as its parts are all static.

**Trackball and Spaceball:** As the name implies, a trackball is a ball that can be rotated with the fingers or palm of the hand, to produce screen-cursor movement. Potentiometers, attached to the ball, measure the amount and direction of rotation. While a trackball is a two-dimensional positioning device, a spaceball provides six degrees of freedom. Unlike the trackball, a spaceball does not actually move. Strain gauges measure the amount of pressure applied to the spaceball to provide input for spatial positioning and orientation as the ball is pushed or pulled in various directions. Spaceballs are used for three-dimensional positioning and selection operations in virtual-reality systems, modeling, animation, CAD, and other applications.



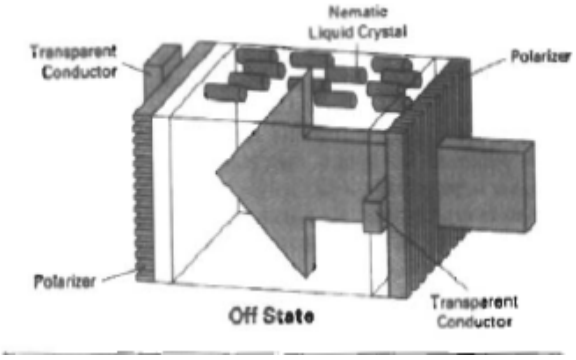
**Joysticks:** **A** joystick consists of a small, vertical lever (called the stick) mounted on a base that is used to steer the screen cursor **around.** Most joysticks select screen positions with actual stick movement; others respond to pressure on the stick. The distance that the stick is moved in any direction from its center position corresponds to screen-cursor movement in that direction. Potentiometers mounted at the base of the joystick measure the amount of movement, and springs **return** the stick to the center position when it is released. One or more buttons can be programmed to act as input switches to signal certain actions once a screen position has been selected.

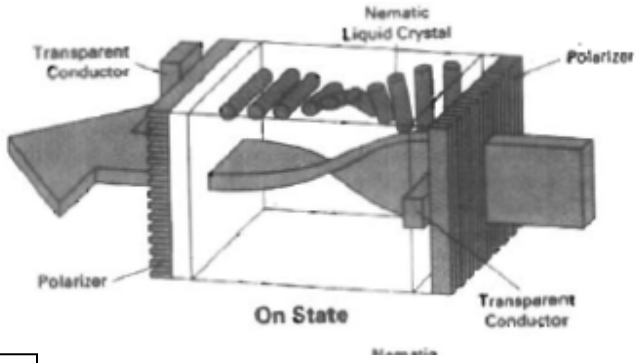


**Light Pens:** Figure shows the design of one type of light pen. Such pencil-shaped de**vices** are **used** to select **screen** positions by detecting the light coming from points on the **CRT** screen. They are sensitive to ***the*** short burst of light emitted **from** the phosphor coating at the instant the electron beam strikes a particular point. Other Light sources, such as the background light in the room, are usually not detected by a light pen. An activated light pen, pointed at a spot on the screen as the electron **beam lights** up that spot, generates an electrical pulse that **causes** the coordinate position of the electron beam to be recorded. As with cursor-positioning de**vices,** recorded Light-pen coordinates can be **used** to position an object or to select a processing option. Although Light pens **are** still with us, they are not as popular as they once were since they have **several** disadvantages compared to other input

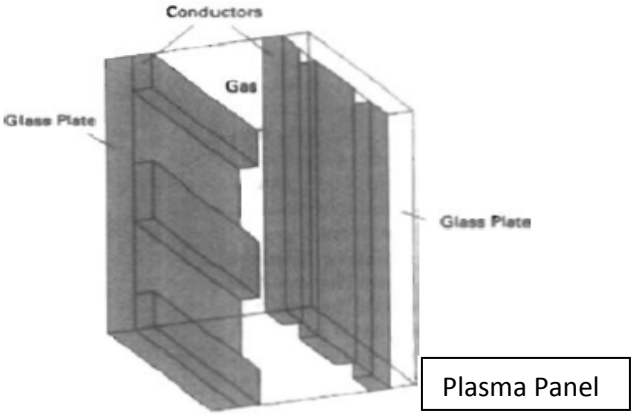
devices that have been developed. For one, when a light pen is pointed at the screen, part of the Screen image is obscured by the hand and pen. And prolonged **use** of the **lig**ht pen can cause arm fatigue. Also, light pens require special implementations for some applications **because** they cannot **detect positions** within blank areas. To be able **b** select positions in any screen area with a light pen, we must have some nonzero intensity assigned to each screen pixel. In addition, light pens. Sometimes give false **readings** due to background lighting in a room.

**Digitizers:** **A** common device for drawing, painting, or interactively selecting coordinate positions on an object is a digitizer. **These** devices can be used to input coordinate values in either a two-dimensional or a three-dimensional space. Typically, a digitizer is used to **scan** over a drawing or object and to input a set of discrete coordinate positions, which can be joined with straight-line segments to approximate the curve or surface shapes. One **type** of digitizer ***is*** the graphics tablet (also referred to as a data tablet), which is **used** to input two-dimensional coordinates by activating a hand cursor or stylus at selected positions on a flat surface. **A** hand cursor contains cross hairs for sighting positions, while a stylus is a pencil-shaped device that is pointed at positions on the tablet.

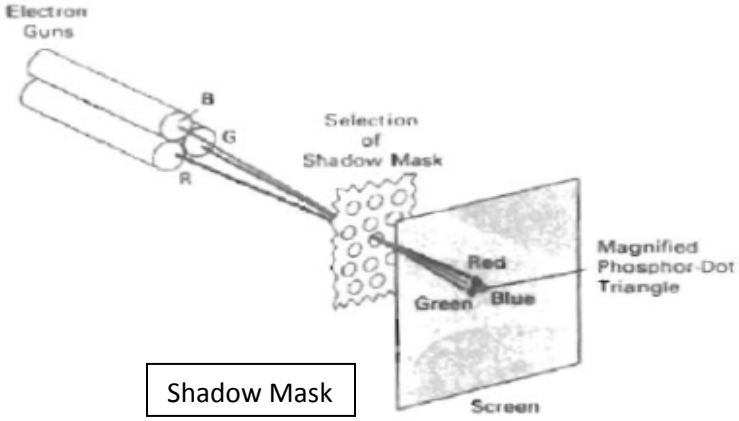


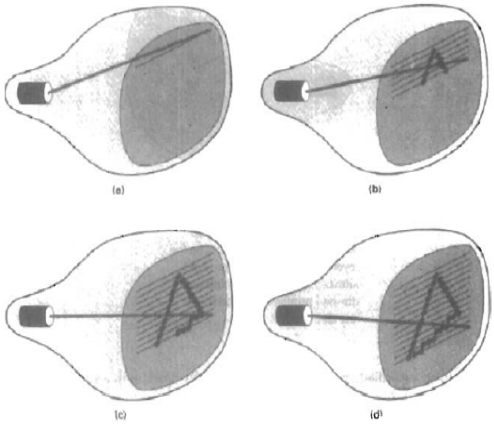

LCD



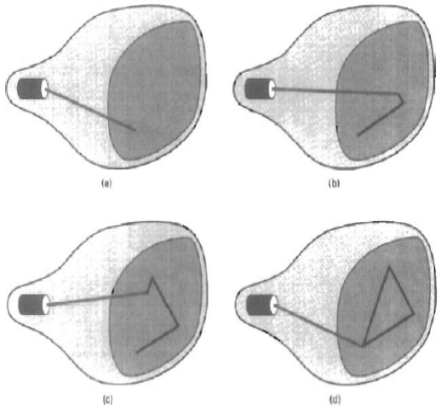

Plasma Panel




Shadow Mask



Raster scan



Random scan