

## UNIT - 2

### Hardcopy Technology

\* Hardcopy Technology :- There are two broad categories of hardcopy devices -

1- Printer

2- Plotter

Plotter has limited and specialised use where printer is a common purpose use. Most of the computer graphics creation have their ultimate utilization printed / plotted form that are used for design documentation, exhibition and obligation in books or other print media. So it is the quality of printed / plotted output that make computer graphics application software appealing for their various business purpose.

Objective of hardcopy technology -

- 1- Understanding the basic printing technology and major category of hardcopy devices with reference to factors that effect the printing / plotter quality.
- 2- Describing the structure and function of each hardcopy devices.

- 3- Highlighting the usual application (business) area of each device.
- 4- Understanding how a computer communicate with state of art printed / plotted.

\* Printer :- The printer is an important accessory of any computer system, specially for a computer graphics system. This is because most of graphics creation software uses the hardcopy devices.

Printer helps to utilization in printed form of documentation, publication and exhibition.

Based on the available printing technology, the major factors which control the quality of printer are individually dot-size on the paper and number of dot per-inch (DPI).

There are two types of printers in current printer technology -

- 1- Impact printer
- 2- Non-impact printer

- Impact printer - These printers have a mechanism whereby formed characters phases are pressed against

an inked ribbon onto the paper in order to create an image.

The example of impact printer is dot-matrix printer and line printer.

- (i) Dot-matrix printer - Dot matrix printers are character printers that print one character at a time. They form characters and all kinds of images as pattern of dots. It produces characters and illustrations by striking pins against an ink ribbon to print closely spaced dots in the appropriate shape.

#### Advantages -

1. A dot matrix printer is practically cheaper and easily available.
2. Can print carbon copies.
3. Indication of ribbon replacement.

#### Disadvantages -

1. Output is not high resolution, the color printout is limited while print speed is lesser.
2. Pins can bend easily.
3. Time-consuming and prone to paper jamming.

(ii) Line Printer - Line printer can print one line at a time. The line printer is a form of high speed impact printers. They can print 300 to 3000 lines per minute, so that they are very fast. Large computer system typically use line printer. They are of two types - Drum printers and chain printers.

#### Advantages -

They are very fast, the entire line of printer can be struck at once.

#### Disadvantages -

The standard line printer can only use pin feed paper, cannot use other than standard widths typical. No color other than black.

- Non-impact printer - These printer do not touch the paper, rather use a laser technology, ink spray, zetrographics, electrostatic methods to produce the image on the paper.

The example of non-impact printer is laser printer, inkjet printer, electrostatic printer, drum-plotter, flatbed plotter.

(i) Laser Printer - A laser printer uses a laser and electrical charge model instead of traditional printing of ink onto paper. They print the whole page at once. They form characters by very tiny ink particles.

#### Advantages -

1. Faster compared to inkjet printers.
2. Sharp and precise, can print even the smallest detail perfectly.
3. Durable and reliable type of printer.

#### Disadvantages -

1. Higher overall price.
2. No variety of paper allowed, require standard style paper only.
3. Not suitable for printing photos.

(ii) Inkjet Printer - The inkjet technology works by spraying very fine drops of ink on a sheet of paper. Inkjet printers produce printed output as pattern of tiny dots.

#### Advantages -

1. High quality of output, capable of printing fine and smooth details.
2. Low cost.
3. Capable of printing vivid color, good for printing pictures.
4. Easy to use.

### Disadvantages -

1. Print head is less durable.
2. Not good for high volume printing.
3. Ink bleeding, ink carried sideways causing blurred effects on some papers.

(iii) **Electrostatic Printer** - A printer used to print an optical image on a specially treated paper. Light and dark portions of the original image are illustrated by electrostatically charged and uncharged portions of the paper.

### Advantages -

1. Lowest-cost per page.
2. Ability to print multi-page documents.
3. Print up to 5000 lines per minute.

### Disadvantages -

1. Very noisy.
2. Slow speed.
3. Space consuming.

(iv) **Drum-plotter** - A drum-plotter is a type of printer used to produce graphics such as architectural blueprints created with CAD applications.

The drum plotter uses a drum to move the paper left and right while one or more pens draw up and down.

### Advantages-

Drawings are of the same quality as if an expert drew them.

### Disadvantages-

1. More expensive
2. They do not produce very high quality text printouts.

(U) Flatbed plotter - In the flatbed plotter, the paper is fixed on a flat surface while the pens are mentioned to draw the image. This is the plotter which can successfully use several colored pens for the purpose of the effect is different from the regular.

### Advantages -

1. Large plotter printers are capable of printing on material which is as large as 60 inches wide.
2. Quality every time, it can reproduce the same template again and again.

### Disadvantages-

1. Needs a large space.
2. High price.

\* Plotter :- In contrast to the printer which is primarily are raster scan devices, plotter is a vector printing devices. The microprocessor in the plotter receive the instruction from the host computer and execute commands like move (moving the carriage) to a given position with pen up) and draw (drawing geometric entities like- line, point, circle etc with pen-down) since the plotter is a vector hardcopy devices, it can directly reach specific position on the printer paper without following raster row sequence.

In flatbed plotter the paper lies flat and stationary while the pen move from one location to another location on the plotter but in drum plotter, the paper itself slide on a cylindrical drum and the pen move over the drum.

\* Display Technology :-

This display medium for computer graphics generated pictures had becomes widely use. Typically examples are CRT (Cathod ray tube), LCD, LED, Raster

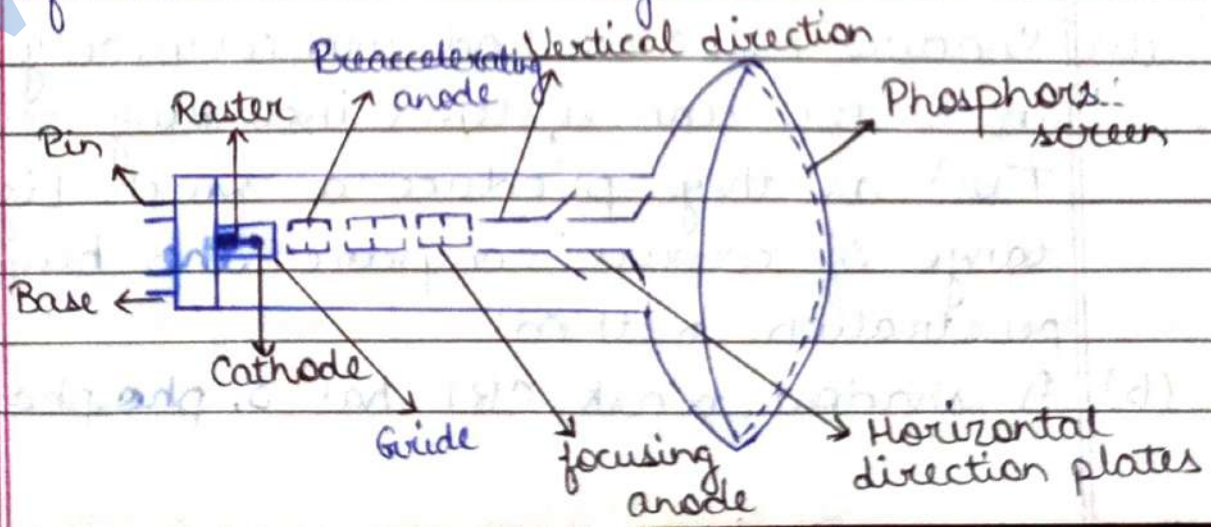


display and Random display.  
Most of the basic display fundamental concepts used CRT technology.

\* Objective of display technology -

- 1- Understanding the basic concepts and parameters base on an image and physical display screen.
- 2- Understanding the basic display concepts employ it in raster scan with reference to the architecture of CRT.
- 3- Understanding the theory of colours display with reference to graphics memory and CRT and circuitry.
- 4- Outlining the display system and display technology.

\* CRT :- A CRT monitor display colour's picture by using combination of phosphorus that emit coloured lights by combining light from the different phosphorus range of colour is to be generated.



There are two methods for producing coloured display with a CRT -

1. Beam Penetration
2. Shadow mask method

### 1- Beam Penetration Method -

- (a) The beam penetration method for displaying colour pictures has been used with random scan monitors.
- (b) Two layers of phosphors usually red and green are coated onto the inside of CRT screen and the displayed colour depends on how far the electron beam penetrates onto the phosphor layers.
- (c) A beam of slow electrons exist only outer red layer and faster electrons contact to inner green layer.
- (d) The speed of electrons and hence the screen colour at any point is controlled by beam acceleration voltage.

### 2- Shadow Mask Method :-

- (a) Shadow mask method are commonly used in Raster scan system (including colour T.V.) as they produce a much bigger range of colours compare to the beam penetration method.
- (b) A shadow mask CRT has 3 phosphors.

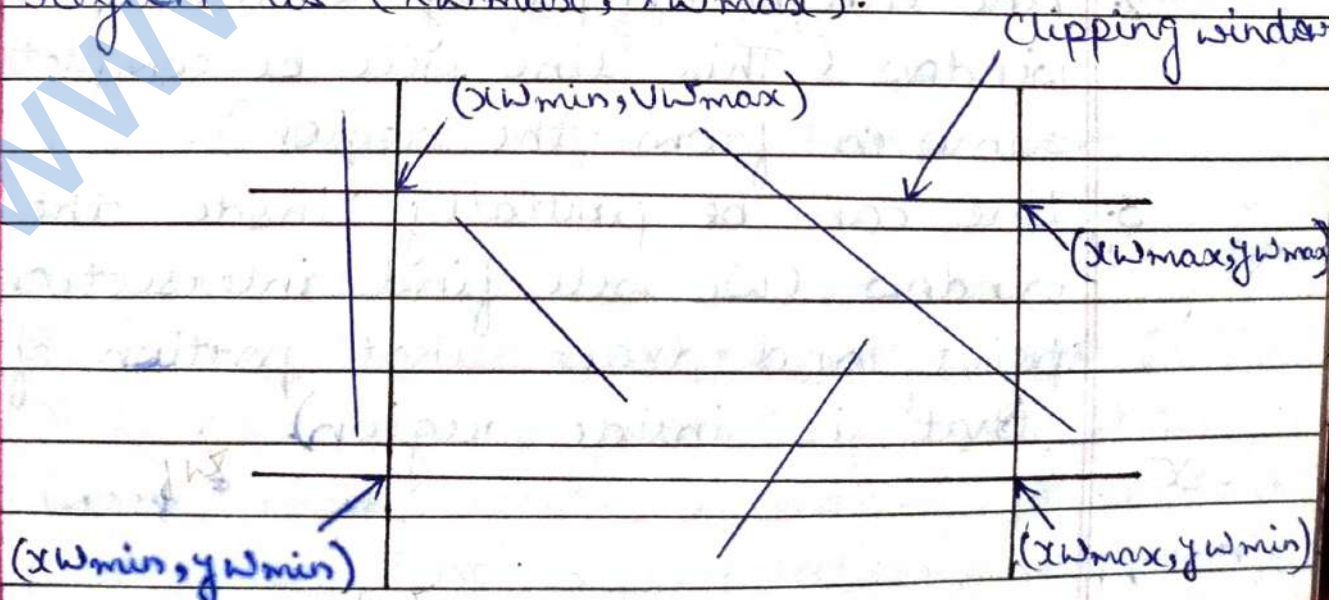
colour dots (red, green, blue) at each pixel position.

(c) One phosphorus dot emits a red light. Second phosphorus dot emits a green light and third phosphorus dot emits a blue light.

(d) Shadow mask display CRT has 3 electrons gun. One for each colour dot and a shadow mask grid just behind the phosphorus coated screen.

### \* Cohen - Sutherland Line Clippings Algorithm:

This algorithm uses the clipping window as shown in the following figure. The minimum coordinate for the clipping region is  $(x_w \min, y_w \min)$  and the maximum coordinate for the clipping region is  $(x_w \max, y_w \max)$ .



We will use 4-bits to divide the entire region. These 4-bits represent the Top, Bottom, Right and Left of the region as shown in the following figure. Here, the TOP and LEFT bit is set to 1 because it is the TOP-LEFT corner.

	BOTTOM RIGHT	
TOP	↓	↘
	LEFT	
1001	1000	1010
0001	0000	0010
0101	0100	0110

There are 3 possibilities for the line-

1. Line can be completely inside the window. (This line should be accepted).
2. Line can be completely outside of the window (This line will be completely removed from the region).
3. Line can be partially inside the window. (We will find intersection point and draw that portion of line that is inside region)

(circle, circle)

## Algorithm :-

Step 1- Assign a region code for each end points.

Step 2- If both endpoints have a region code 0000 then accept this line.

Step 3- Else, perform the logical AND operation for both region codes.

(a) If the result is not 0000, then reject the line.

(b) Else you need clipping.

(i) Choose an endpoint of the line that is outside the window.

(ii) Find the intersection point at the window boundary (base on region code).

(iii) Replace endpoint with the intersection point and update the region code.

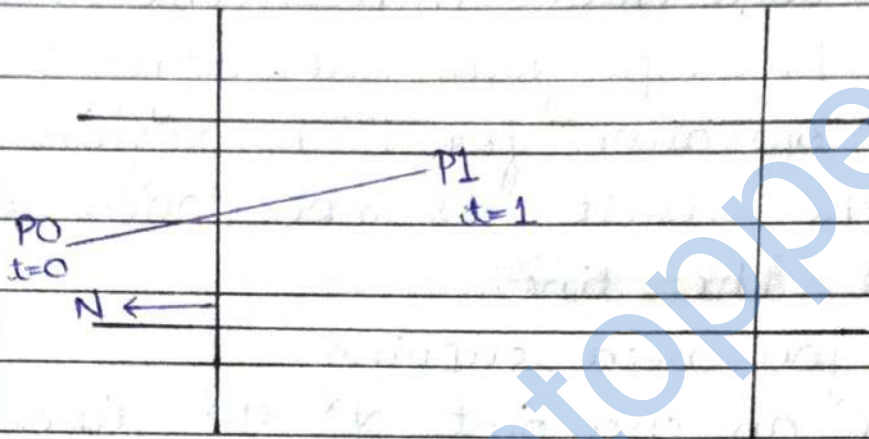
(iv) Repeat step 2 until we find a clipped line either trivially accepted or trivially rejected.

Step 4- Repeat step 1 for other lines.

## \* Cyrus-Beck Line Clipping Algorithm :-

This algorithm is more efficient than Cohen-Sutherland algorithm. It employs parametric line representation and simple dot products.

Cyrus-Beck is a general algorithm and can be used with a polygon clipping window unlike Sutherland-Cohen, which can be used only on a rectangular clipping area.



Here the parametric equation of a line in the view plane is -

$$p(t) = tp_1 + (1-t)p_0$$

where  $0 \leq t \leq 1$

Now to find the intersection point with the clipping window we calculate the value of the dot product.

Let  $p_E$  be a point on the clipping plane  $E$ .

Calculate  $n \cdot (p(t) - p_E)$

If  $< 0$ , vector pointed towards interior.

If  $= 0$ , vector pointed parallel to plane containing  $p$ .

If  $> 0$ , vector pointed away from interior.

Here  $n$  stands for normal of the current

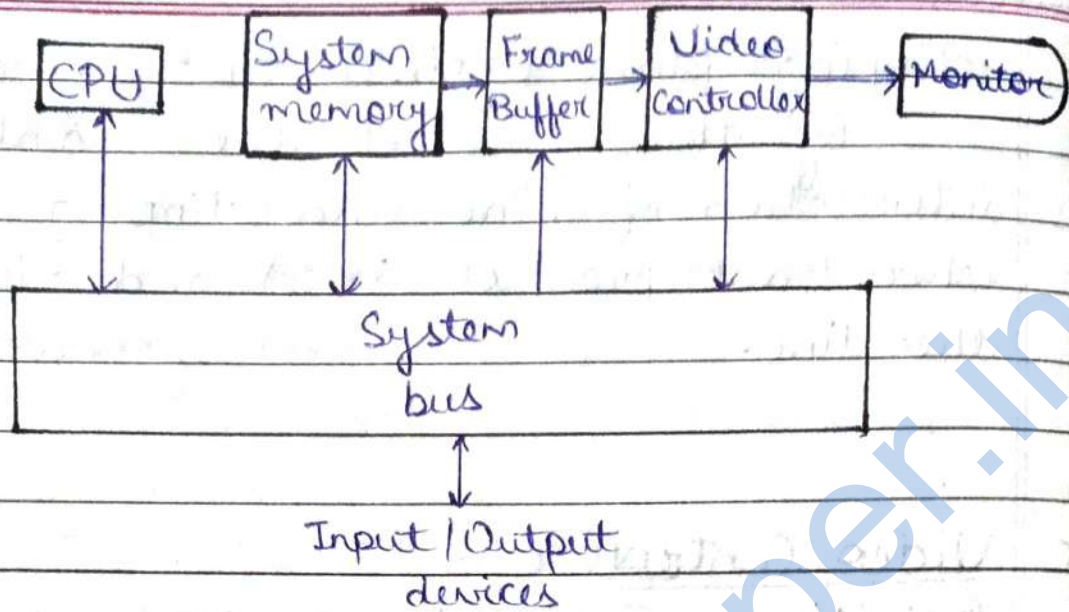
clipping plane (pointed away from interior)

By this we select the point of intersection of line and clipping window where (dot product is 0) and hence clip the line.

### \* Video Controller :-

Definition - Just like a text, audio and image, digital videos are also a powerful element of multimedia system. To understand how digital video is used as a media we need to understand the fundamental concept (motion, image, audio, text) of video technology.

In Central Processing Unit (CPU) there is a special purpose processor called video controller or display controller. This processor is used to control the operation of display devices. Simply means, a video controller is a processor that is used to control all operations required by display devices.



### Architecture of raster graphic system

A fixed area of the system memory is reserved for the framebuffer and video-controller is given direct access to framebuffer memory. Framebuffer location and the corresponding screen position are referenced in a simple raster scan system.

Since the screen must be refresh 60 frames per second. The cycle time is too slow. To speed up pixel processing video controller can retrieve multiple pixels values from the framebuffer.

- \* Input devices in computer graphics-
1. Key-board
  2. Mouse
  3. Track ball and space ball
  4. Joysticks



5. Data glove
6. Digitizer
7. Image scanner

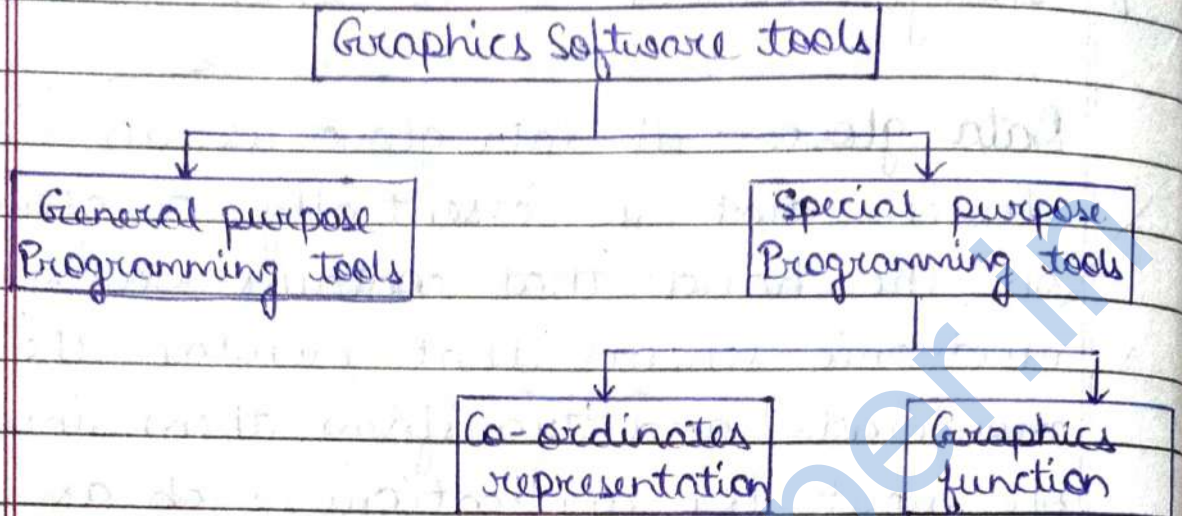
**Data glove** - A data glove is an input device that is essentially a glove worn on the hand that contains various electronic sensors that monitor the hand's movements and transform them into a form of input for applications such as virtual reality and robotics.

**Digitizer** - A digitizer (also known as a graphic tablet, drawing tablet, pen tablet or digital art board) is a computer input device that enables a user to hand-draw images, animations and graphics, with a special pen-like stylus, similar to the way a person draws images with a pencil and paper. These tablets may also be used to capture data or handwritten signatures.

### \* Graphics Tools :-

In computer graphics, graphic tools is a mechanism to provide the functionality to create graphics objects. There are many types of software package, with the help of them we can create graphics software like - dream viewer, series of Adobe photoshop.

## Classification of computer graphics tools -



- **General purpose programming tools** - The general purpose programming package provide an extensive set of graphics function that can be used in high level programming language like - C and Fortran, C++.

An example of general purpose graphics programming package is GL (Graphics Library). Basic functions in general purpose programming package include those generating picture component. (straight line, circle, polygon and ellipse etc.)

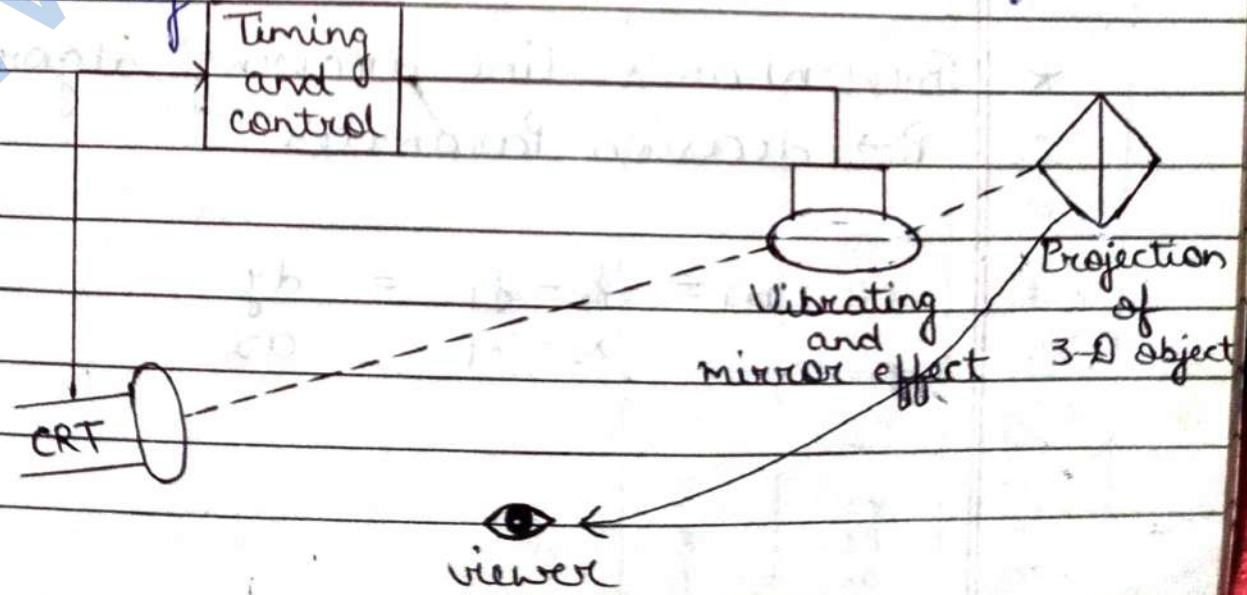
- **Special purpose programming tools** - The application graphics package are designed for special purpose, so that user can generate display without

working graphics operation work. The interface in graphics routines in such package allow the users to communicate with programs in their own terms.

\* 3-D effect:-

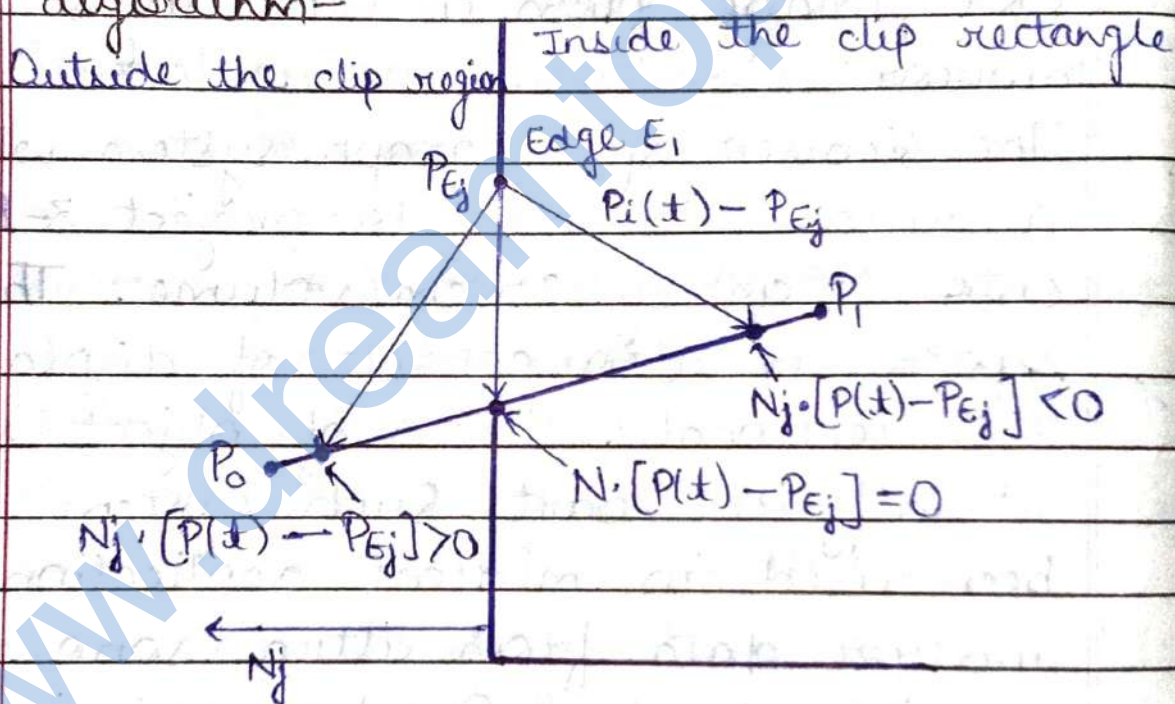
In computer graphics, for display of 3-dimensional screen (object) have been devised using techniques that reflect a CRT image from a vibrating, flexible mirror.

The Genisco space-graph system which use a vibrating mirror to project 3-D object onto 25 cm by 25 cm volume. This graph system is also capable of displaying 2-D sectional (slices) of object selected at different part. Such system have been used in medical application to analyze data from ultra-sono graphics. The effect of 3-D also used in simulation modelling.



Another technique for representing 3-D object is displaying stereoscopic views. This method does not produce 3-D image but it provides a 3-D effect by presenting different views to user's eye.

\* Diagram of Cyrus-Beck line clipping algorithm-



\* Bresenham's line drawing algorithm-

$P \rightarrow$  decision Parameter

$$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{dy}{dx}$$

$m < 1$		else	
$P < 0$	else	$P < 0$	
$x = x + 1$	$x = x + 1$	$x = \text{NO change}$	$x = x + 1$
$y = \text{no change}$	$y = y + 1$	$y = y + 1$	$y = y + 1$
$P = P + 2dy$	$P = P + 2dy - 2dx$	$P = P + 2dy$	$P = P + 2dy - 2dx$

Q- (1,1), (8,5)  
 slope =  $\frac{4}{7} = 0.57$

P	x	y
1	1	1
-5	2	2
3	3	2
-3	4	3
5	5	3
-1	6	4
7	7	4
1	8	5

Q- (20,10) (30,18)  
 slope =  $\frac{18-10}{30-20}$   
 $= \frac{8}{10} = \frac{4}{5}$   
 $= 0.8$

P	x	y
1	20	10
-1	21	11
7	22	11
5	23	12
3	24	13
1	25	14
-1	26	15
7	27	15
5	28	16
3	29	17
1	30	18