

## **1. Directed-beam refresh/vector refresh and stroke-writing refresh -**

It utilizes the stroke-writing approach to generate the image on the CRT screen. The term refresh in the name refers to the fact that the image must be regenerated many times per second in order to avoid noticeable flicker of the image. It is also possible to provide animation of the image with a refresh tube. The directed-beam refresh system is the oldest of the modern graphics display technologies.

**2. Direct-view storage tube (DVST):-** also use the stroke-writing approach to generate the image on the CRT screen. The term storage tube refers to the ability of the screen to retain the image which has been projected against it, thus avoiding the need to rewrite the image which has been projected against it, thus avoiding the need to rewrite the image constantly.

image on the CRT screen is flicker-free. Storage tubes have historically been the lowest-cost terminals and are capable of displaying large amounts of data, either graphical or textual.

disadvantage of a storage CRT is that selective erasure is not possible. Instead, if the user wants to change the picture, the change will not be manifested on the screen until the entire picture is regenerated. Other disadvantages include its lack of color capability, the inability to use a light pen as a data entry, and its lack of animation capability.

**3. Raster scan :-** Raster scan terminals operate by causing an electron beam to trace a zigzag pattern across the viewing screen, as described earlier.

raster scan ICG terminal uses digital signals generated by a computer. For this reason, the raster scan terminals used in computer graphics are sometimes called digital TVs.

the simplest and lowest-cost terminal in this category uses only two beam intensity levels, on or off. This means that each pixel in the viewing screen is either illuminated or dark.

A picture tube with 256 lines of resolution and 256 addressable points per line to form the image would require  $256 \times 256$  or over 65,000 bits of storage. Each bit of memory contains the on/off status of the corresponding pixel on the CRT screen. This memory is called the frame buffer or refresh buffer.

The picture quality can be improved in two ways: by increasing the pixel density or adding a gray scale (or color). Increasing pixel density for the same size screen means adding more lines of resolution and more addressable points per line. A  $1024 \times 1024$  raster screen would require more than 1 million bits of storage in the frame buffer.

A gray scale is accomplished by expanding the number of intensity levels which can be displayed on each pixel. This requires additional bits for each pixel to store the intensity level. Two bits are required for four levels, three bits for eight levels, and so forth. Five or six bits would be needed to achieve an approximation of a continuous gray scale.

For a color display, three times as many bits are required to get various intensity levels for each of the three primary colors: red, blue, and green.

	<b>Directed-beam refresh</b>	<b>DVST</b>	<b>Raster scan</b>
Image generation	Stroke writing	Stroke writing	Raster scan
Picture quality	Excellent	Excellent	Moderate to good
Data content	Limited	High	High
Selective erase	Yes	No	Yes
Gray scale	Yes	No	Yes
Color capability	Moderate	No	Yes
Animation capability	Yes	No	Moderate

The advantages of the present raster scan terminals include the feasibility to use low-cost TV monitors, color capability, and the capability for animation of the image. These features, plus the continuing improvements being made in raster scan technology, make it the fastest-growing segment of the graphics display market.

The typical color CRT uses three electron beams and a triad of color dots on the phosphor screen to provide each of the three colors, red, green, and blue. By combining the three colors at different intensity levels, a variety of colors can be created on the screen.

The problem in the raster terminals is the memory requirements of the refresh buffer. Each pixel on the viewing screen' may require up to 24 bits of memory in the refresh buffer in order to display the full range of color tones. When multiplied by the number of pixels in the display screen, this translates into a very large storage buffer.

# OPERATOR INPUT DEVICES

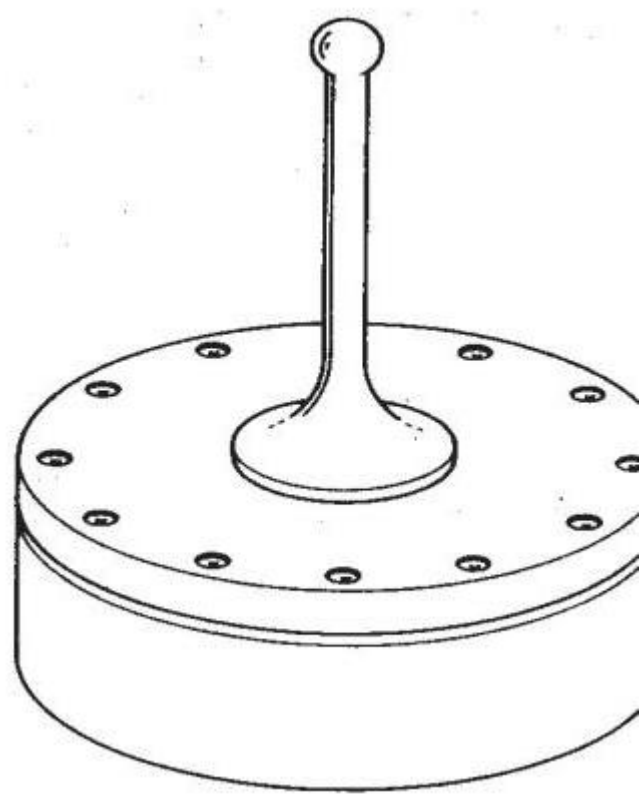
Different CAD system vendors offer different types of operator input devices. These devices can be divided into three general categories:

1. Cursor control devices
2. Digitizers
3. Alphanumeric and other keyboard terminals

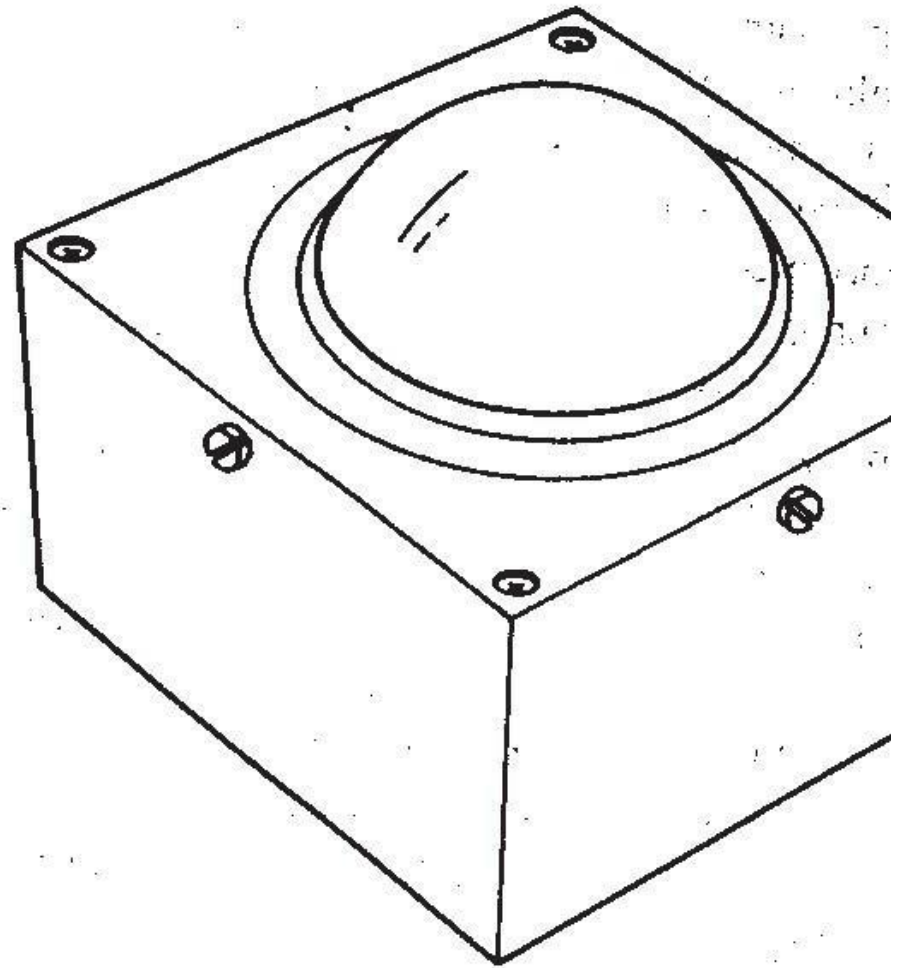
**1. Cursor control devices** -There are a variety of cursor control devices which have been employed in CAD systems. These include:

- Thumbwheels
- Direction keys on a keyboard terminal
- Joysticks
- Tracker ball
- Light pen

The last two devices in the list require the user to control the cursor by touching the screen (or some other flat surface which is related to the screen) with a pen-type device.



Joystick input device for interactive computer graphics



Tracker ball input device for interactive computer graphics.

**PLOTTERS AND OTHER OUTPUT DEVICES-**There are various types of output devices used in conjunction with a computer-aided design system. These output devices include:

- Pen plotters
- Hard-copy units
- Electrostatic plotters Computer-output-to-microfilm (COM) units

### **COMPUTER GRAPHICS SOFTWARE AND DATA BASE-**

The graphics software is the collection of programs written to make it convenient for a user to operate the computer graphics system. It includes Programmes to generate images on the CRT screen, to manipulate the images, and to accomplish various types of interaction between the user and the system. In addition to the graphics software, there may be additional programs for implementing certain specialized functions related to CAD/CAM. These include design analysis programs(e.g., finite-element analysis and kinematic simulation) and Manufacturing planning programs (e.g., automated process planning and numerical control part programming). This chapter deals mainly with the graphics software.