

GRAPHICS WORKSTATIONS
(Section 2-3 in Computer Graphics)

DISPLAY PROCESSORS
(Section 2-4 in Computer Graphics)

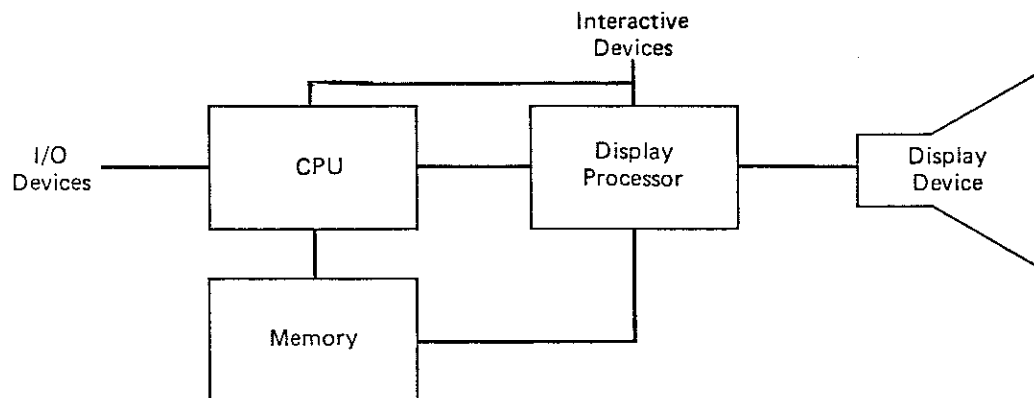
GRAPHICS SOFTWARE
(Section 2-5 in Computer Graphics)

GRAPHICS WORKSTATIONS

- **CPU and Memory**
- **Display Processors**
- **Input Devices**
 - keyboard
 - lightpen
 - joystick, mouse or tablet and stylus
 - function buttons
 - touch panel
 - voice system
 - three-dimensional input devices
- **Output Devices**
 - vector CRT
 - raster CRT
 - plasma panel
 - printer
 - plotter
- **see figure 2-23 on page 45**
 - an artist's workstation
- **see figure 2-24 on page 45**
 - a graphics workstation

Display Processors

- receives digital information from the CPU and memory
- provides analog information to the display device



- display graphics primitives
 - line segments
 - characters

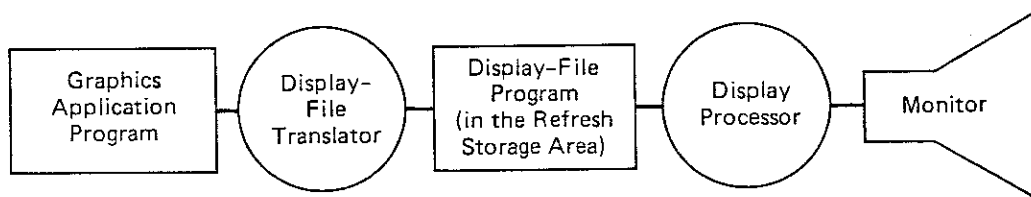
advanced display processors

- various line styles
- colored areas
- curved lines
- transformations

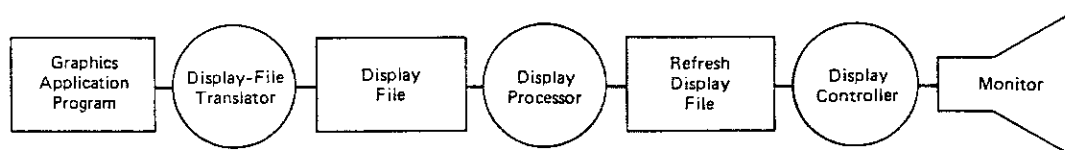
refresh display processors

- maintain the image (sometimes a task for the display controller)

random-scan systems



random-scan systems with a refresh display file



drawing primitives

- lines
 - defined by the coordinates of their endpoints
 - drawn with a vector generator
 - analog vector generator
 - digital vector generator
- curves
 - defined by a functional representation
 - drawn by
 - an analog curve generator
 - a digital curve generator
 - as a series of short lines
 - as a series of points
- characters
 - hardware or software
 - a series of short lines or a rectangular point grid (5-by-7 to 9-by-14)

DVST display processor

- refresh storage for "write-through"
- screen erasure

raster-scan systems

- refresh storage in the frame buffer (refresh buffer, raster, bit map)
 - each position is a pixel (picture element, pel)
 - each line is a scan line
 - generating pixel information for the frame buffer is called scan conversion
 - 1 to 24 bits/pixel

memory reduction

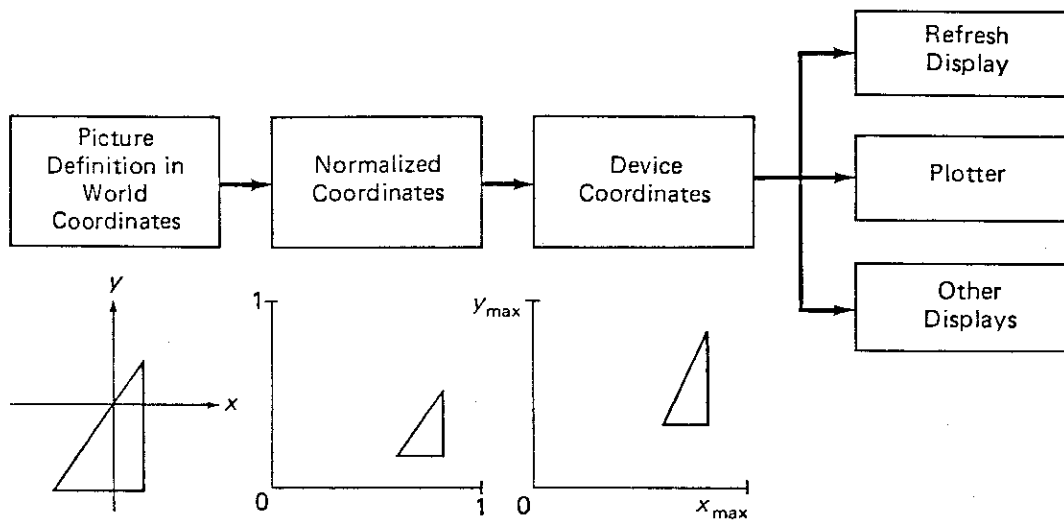
- 1024 x 1024 x 24 bits = 3 megabytes
- run-length encoding
 - scan line stored as a set of integer pairs
 - first element is an intensity value
 - second element is a pixel count
- cell encoding
 - encode the raster as a set of rectangular areas

GRAPHICS SOFTWARE

- **Graphics Packages**
 - generate picture components
 - set colors and intensities
 - select views
 - apply transformations
- **Applications Graphics Packages**
 - for nonprogrammer graphics users
 - art, business, medicine, CAD

coordinate representations

- usually Cartesian
- world coordinates for the user
- normalized device coordinates for the system
- physical device coordinates (screen coordinates) for the output device



graphics functions

- output primitives
 - geometric entities
 - character strings
- input operations
 - control and process data from interactive devices
- attributes
 - intensity
 - color
 - line style
 - text style
 - area-filling pattern
- segment processing
 - creation
 - deletion
 - transformation
- viewing
 - what portion of the world is seen
 - where is it presented
- general control
 - clear screen
 - initialize parameters

software standards

- portability of graphics software is the goal
- graphical kernal system (GKS), adopted by
 - International Standards Organization
 - American National Standards Institute
- Core Graphics Standard
 - developed by the Graphics Standards Planning Committee of SIGGRAPH (ACM)
- functions defined as abstract specifications
 - anticipates a language binding
 - example:polyline (n,x,y) (GKS)
 CALL GPL (N, X, Y) (FORTRAN)
 - bindings for
 - FORTRAN
 - Pascal
 - Ada
 - C
 - PL/I
 - COBOL

weaknesses of GKS

- **no standard for graphics interfaces to output devices**
 - **Computer Graphics Interface (CGI)**
- **no specifications for real-time modeling**
 - **Programmer's Hierarchical Interactive Graphics Standard (PHIGS)**
- **no specifications for storing and transmitting pictures**
 - **Computer Graphics Metafile (CGM)**

GRAPHICS WORKSTATIONS

- CPU and Memory
- Display Processor
- Input Devices
- Output Devices

DISPLAY PROCESSORS

- receive digital information from the CPU and memory
- provide analog information to the display device
- display graphics primitives

Advanced Display Processors

- various line styles
- colored areas
- curved lines
- transformations

Refresh Display Processors

- maintain the image (sometimes a task for the display controller)

GRAPHICS SOFTWARE

- Graphics Packages
- Applications Graphics Packages
- Coordinate Representations
- Graphics Functions
- Software Standards