IT 2002 -GRAPHICS AND MULTIMEDIA

P.G.R Nayomi Gamlath
MSc(Pdn) , BSc (Rajarata)
ATI -Kurunegala

Week 5 & 6 – Raster & Vector

Introduction to graphic

- Normal term of graphic: Any picture or drawing object including engraving object.
- Also about the use of visual to explain concept (sometime difficult to explain with text)
- Efficient Information delivery resource and accepted by people

Computer Graphics

- Computer Graphics is... the technology for presenting information

- Computer Graphic: Any image that produced by graphic computer application

- From simple image to complex (fractal)

- Refers to any computer device or program that makes a computer capable of displaying and manipulating pictures.

- The term also refers to the images themselves.

- Many software applications include graphics components. Such programs are said to *support* graphics.

Computer Graphics?

- Different things in different contexts:
  - pictures, scenes that are generated by a computer.
  - tools used to make such pictures, software and hardware, input/output devices.
  - the whole field of study that involves these tools and the pictures they produce.

- Use of computer to define, store, manipulate, interrogate and present pictorial output.
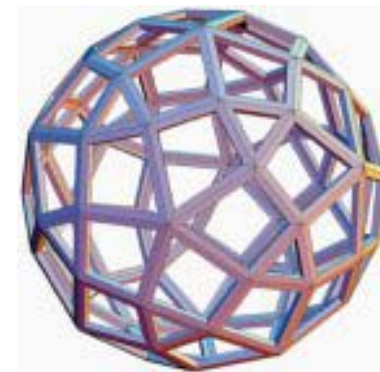
Example of computer graphic
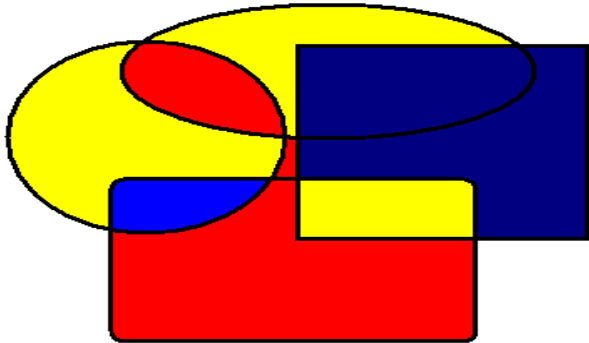
Basic form
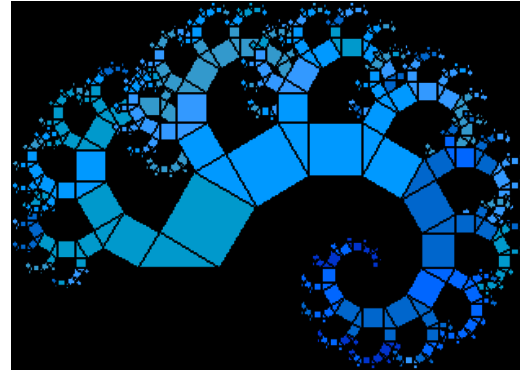
Fractal

Logo

Icosahedrons

Why study graphics?

- To make pretty pictures and funny movies ?
  - Yes, in part. But in addition…
- To improve:
  - Understanding
  - Expression
  - Communication
- Graphics is (or should be) essential to engineers and the practice of engineering!

Computer Graphic Application

- Computer based graphic industry growth in positive trend : Ability to help in work productivity.
- Uses in Project Management, Publication, Business, aerospace, automotive

Computer Graphic Application

E.g:

- Car model development
- Electronic circuit and engineering drawing.
- Computer aided design and engineering analysis
- Scientific Visualization
- Entertainment and Gaming
- Military Planning & Rehearsal
- Computer-Assisted Surgery Medical Education & Visualization
- Business presentation graphics

Graphics Applications

- **Paint programs :** Allow you to create rough freehand drawings. The images are stored as bit maps and can easily be edited.

- **illustration/design programs:** Supports more advanced features than paint programs, particularly for drawing curved lines. The images are usually stored in vector-based formats. Illustration/design programs are often called *draw programs*

- **Presentation graphics software :** Lets you create bar charts, pie charts, graphics, and other types of images for slide shows and reports. The charts can be based on data imported from spreadsheet applications.

Graphics Applications

- **Animation software:** Enables you to chain and sequence a series of images to simulate movement. Each image is like a frame in a movie.

- **CAD software:** Enables architects and engineers to draft designs.

- **Desktop publishing :** Provides a full set of word-processing features as well as fine control over placement of text and graphics, so that you can create newsletters, advertisements, books, and other types of documents.

Fields of Computer Graphics

Computer-Aided Design and
Engineering Analysis
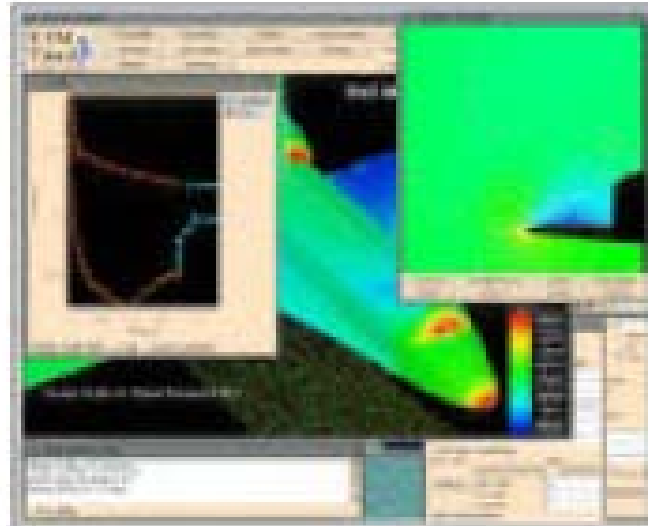
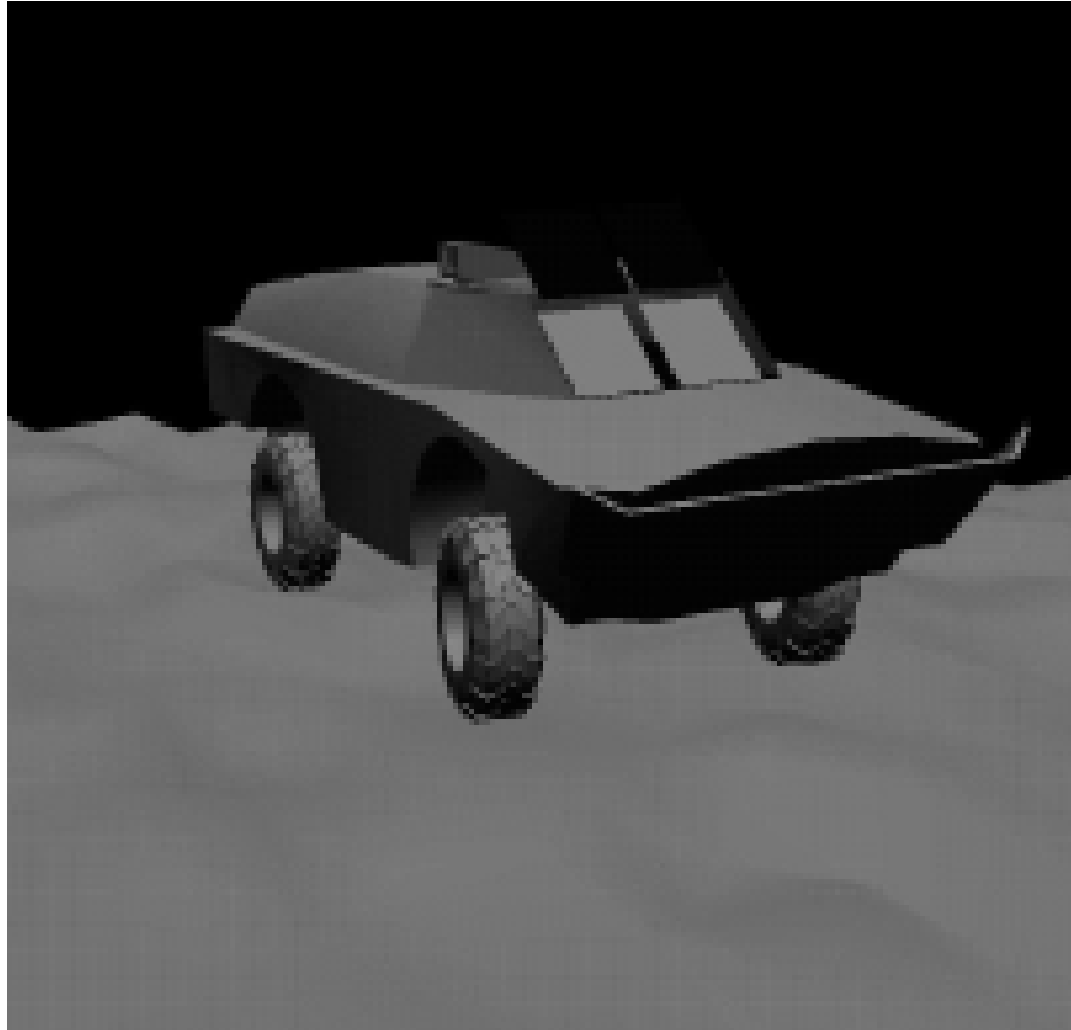# Effective Human-Computer Interaction (HCI)
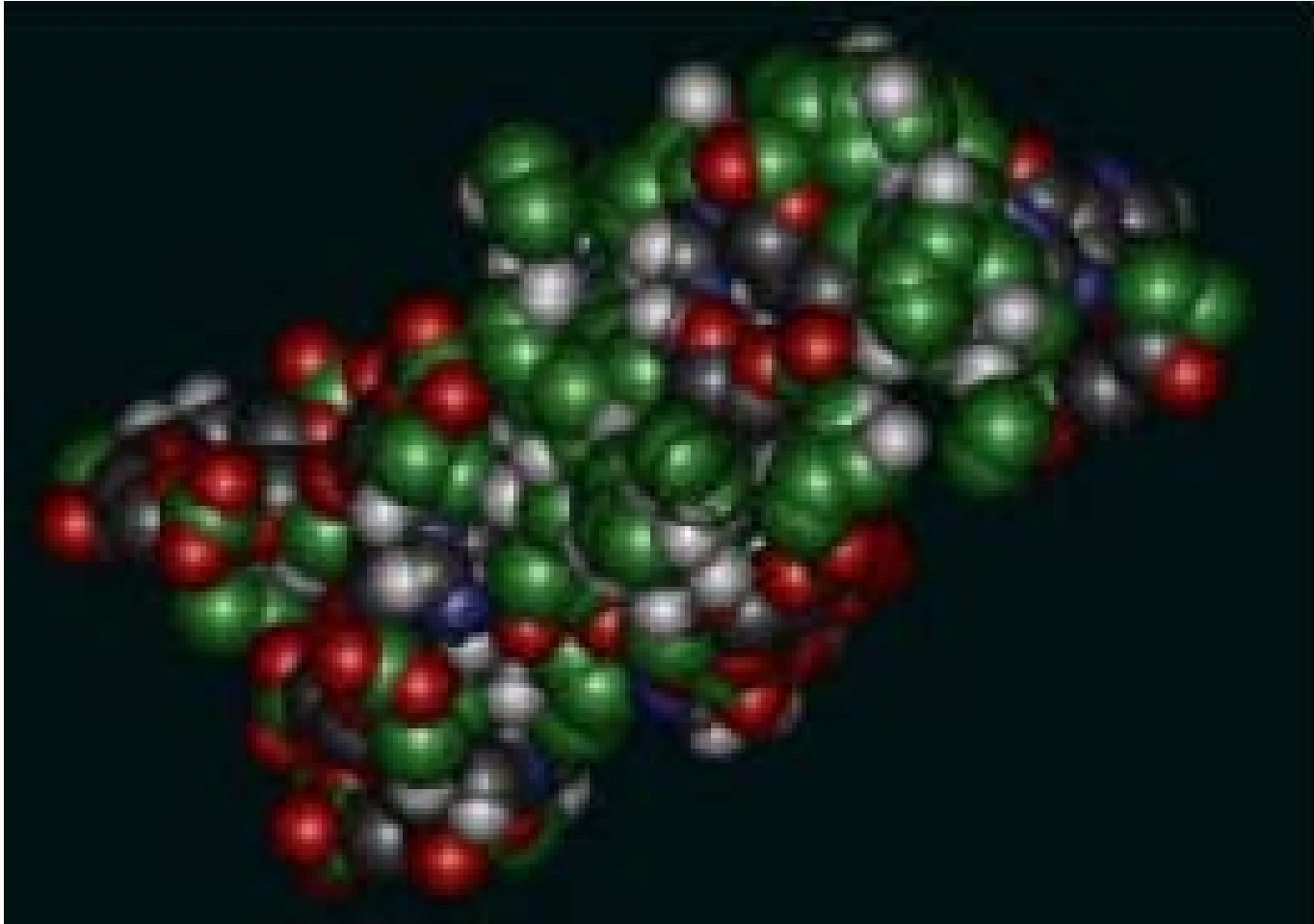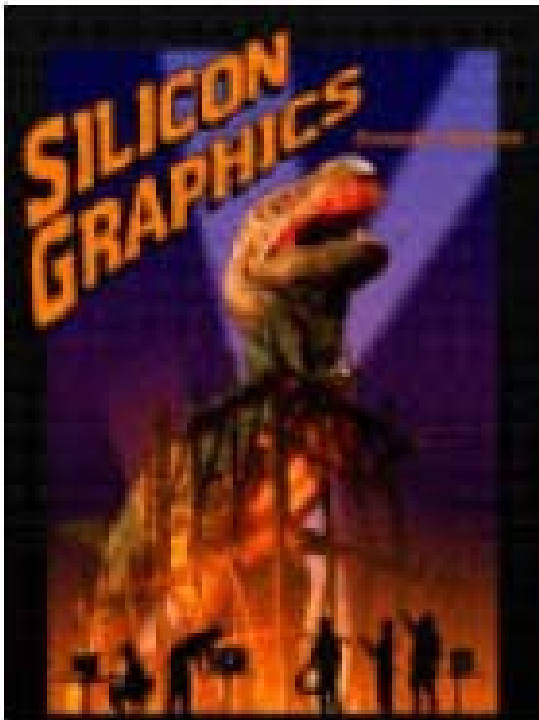
Scientific Visualization

Entertainment and Gaming

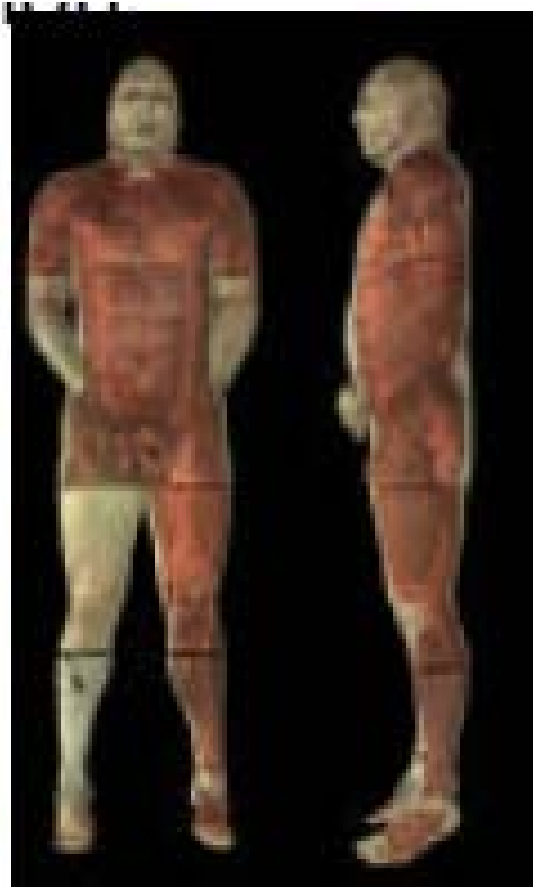# Military Planning & Rehearsal

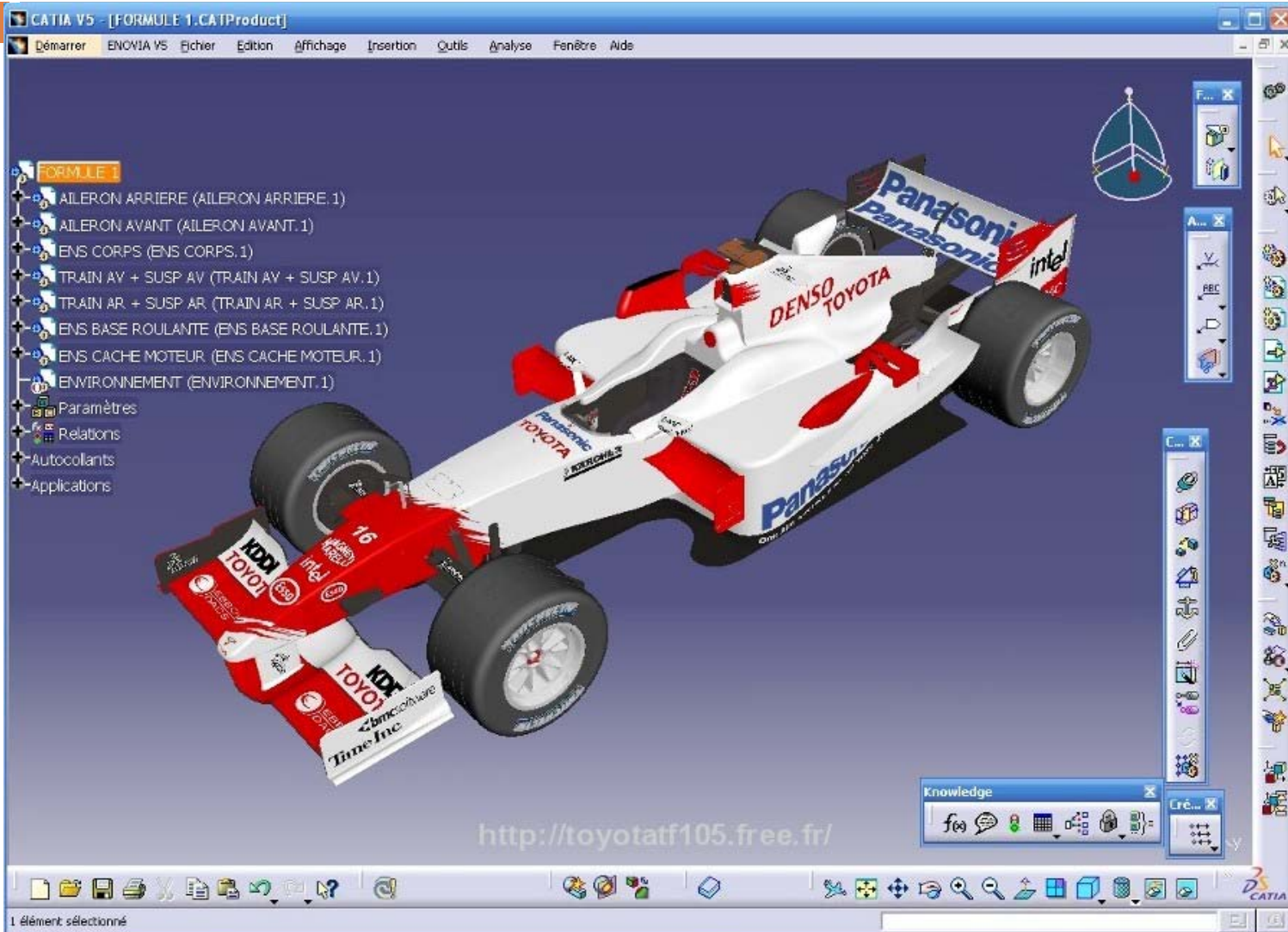# Computer-Assisted Surgery

Medical Education & Visualization

Model Development

Simulation

The Important of Graphic Application in Management

- Information delivery more accurate, clear, consistent and efficient compare with text

- Uses to emphasize certain info.

- Example usage: advertisement, presentation and company report

- Increase performance of management
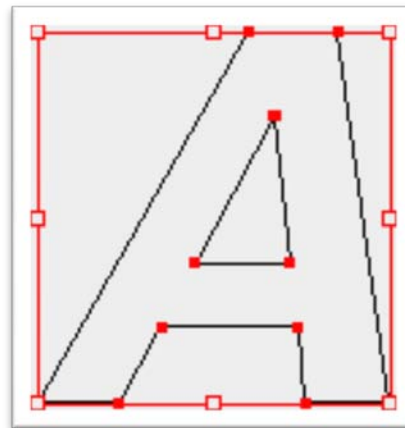
" A picture is worth than a thousand words."

Graphic Category

- Categorized into two main groups: bitmap and vector
- **Vector**: Object based image represented by geometric form
- **Bitmap**: The image represented by matrix pixels

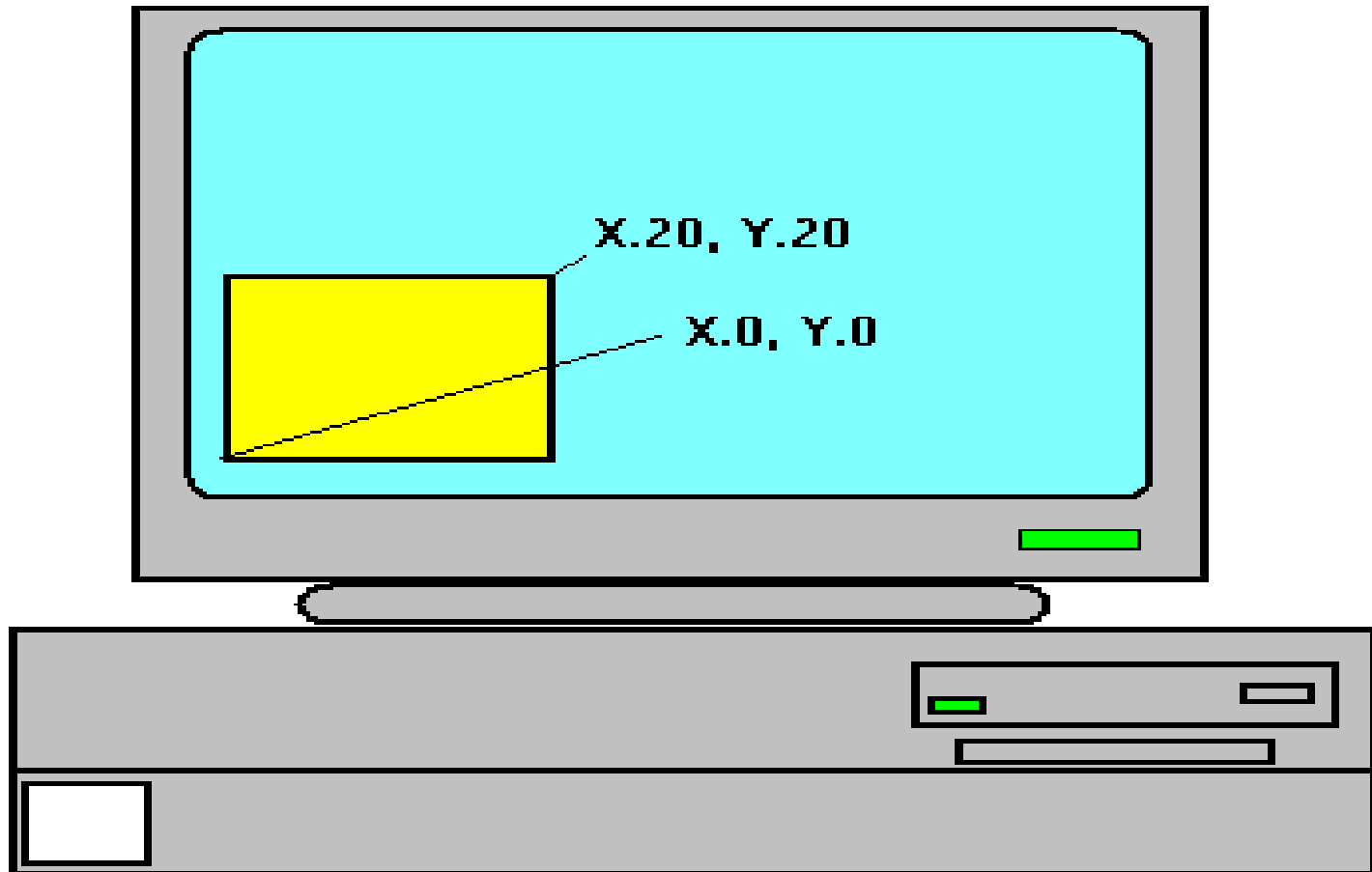   Also referred as Raster or Pixmap

Raster Graphics

Vector Graphics

Vector Image

- Draw type image or object oriented image
- Represented in geometric form (mathematical instruction) to create straight line, oval, curve and sphere.
- E.g instruction:
  - Line startcoord="x.0 y.0"
  - Endcoord="x.20 y.20"

Example

Vector Graphics

- Vector graphics (also called geometric modeling or object-oriented graphics) is the use of geometrical primitives such as points, lines, curves, and polygons, which are all based upon mathematical equations to represent images in computer graphics.

For example, consider circle of radius r. The main pieces of information a program needs in order to draw this circle are

- the radius r and equation of a circle

- the location of the center point of the circle

- stroke line style and color (possibly transparent)

- fill style and color (possibly transparent)

The usage of vector image

- Store computer file in clip art form for marketing purposes

- Use in technical fields such as CAD/CAM/ architecture, scientific modeling

- Graphic art and multimedia using vector graphic application such as Macromedia Freehand, Adobe Illustrator and AutoCAD.
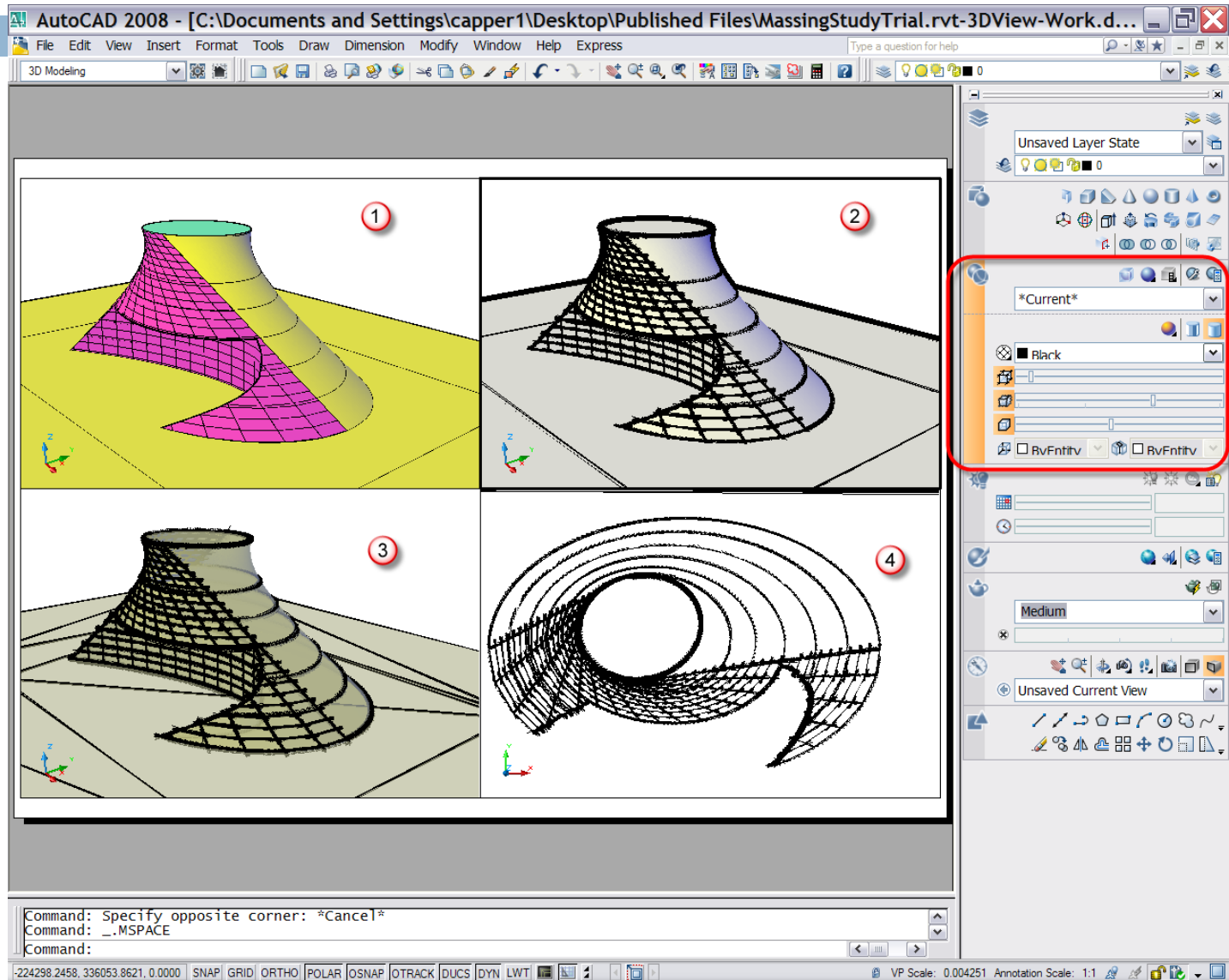
# Macromedia Freehand

Adobe Illustrator
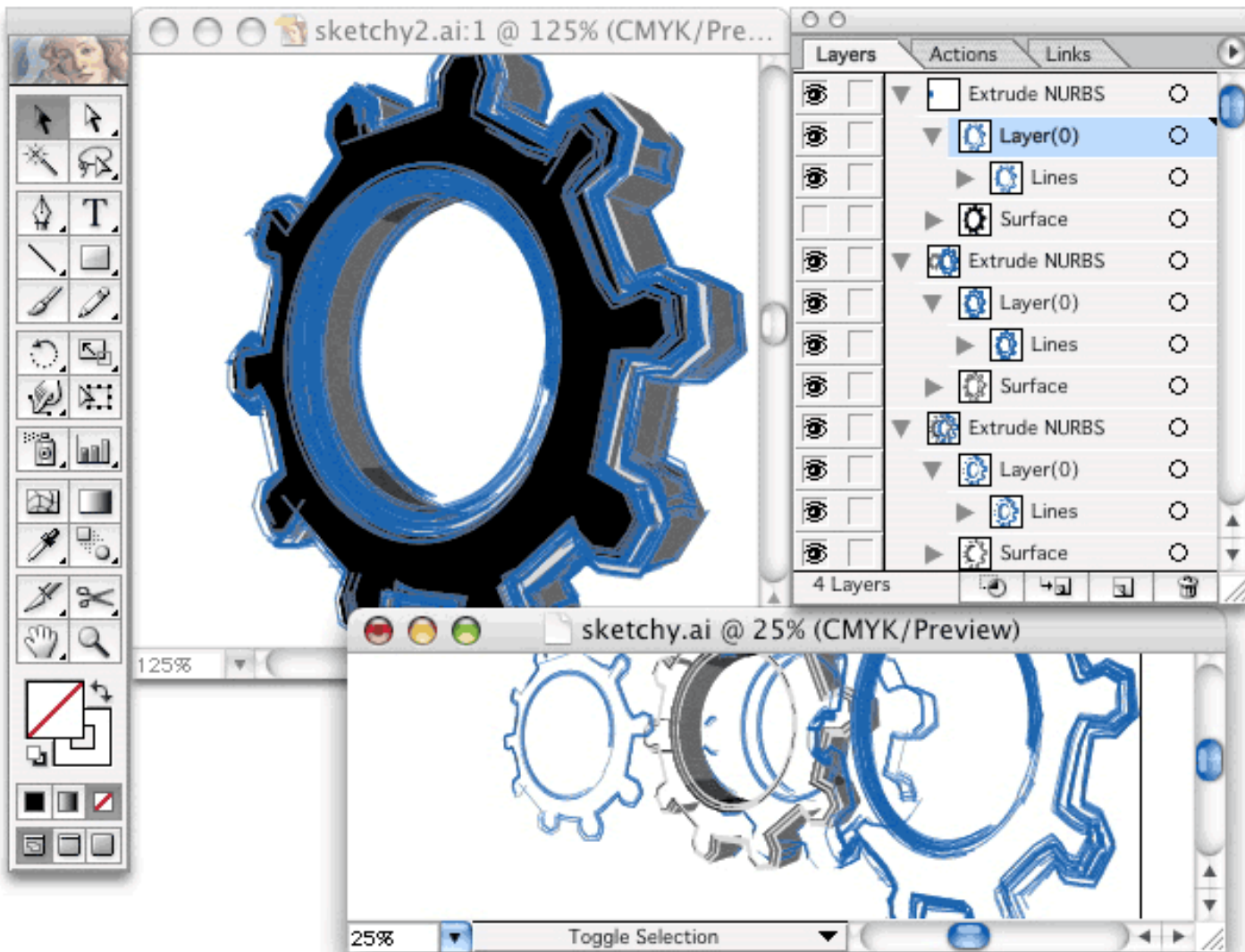
AutoCAD

Bitmap Image

- Also known as raster image

- Representing image in dot form known as pixel or bit

- Arrange in simple matrix

- For monochrome monitor, needs a matrix dimension.

- The depth needed to view color image such as 4, 8, 16, 24 bit.

Raster Graphics (BITMAP)

- A raster graphics image or bitmap, is a data structure representing a generally rectangular grid of pixels, or points of color, viewable via a monitor, paper, or other display medium.

- Raster graphics are technically characterized by the width and height of the image in pixels and by the number of bits per pixel (a color depth, which determines the number of colors it can represent).
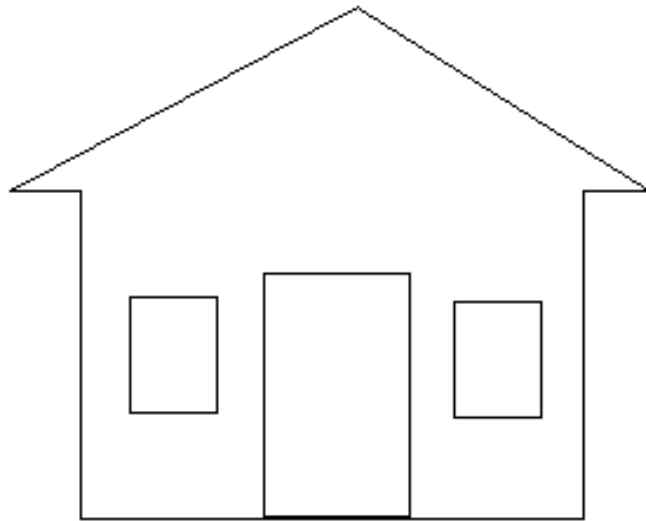
Raster Graphics (BITMAP)
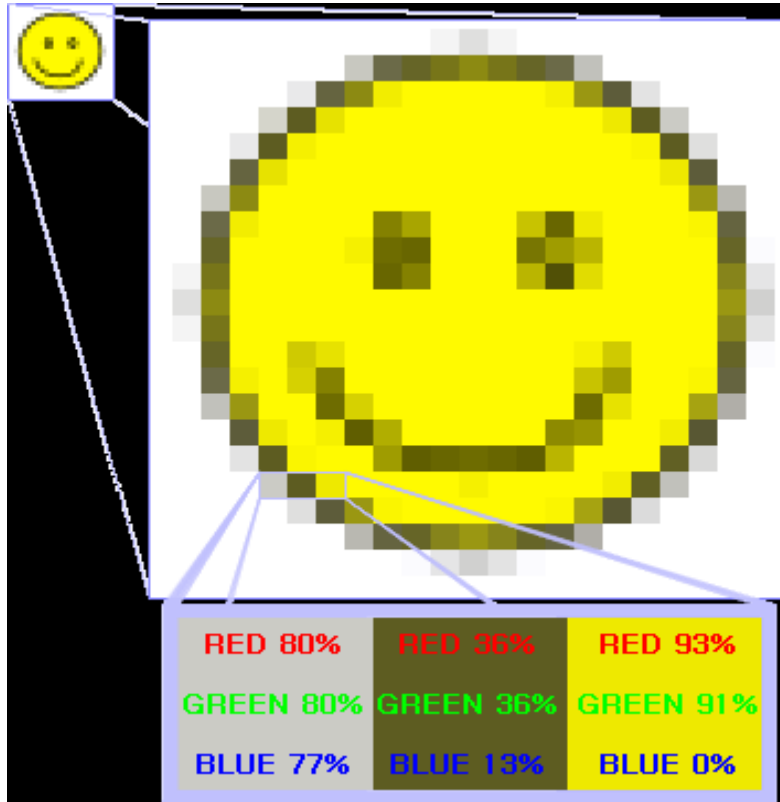
- Imagine the smiley face in the top left corner as an RGB bitmap image. When zoomed in, it might look like the big smiley face to the right.

- Every square represents a pixel. Zooming in further, the individual pixels can be analyzed, with their colors constructed by adding the values for red, green and blue.
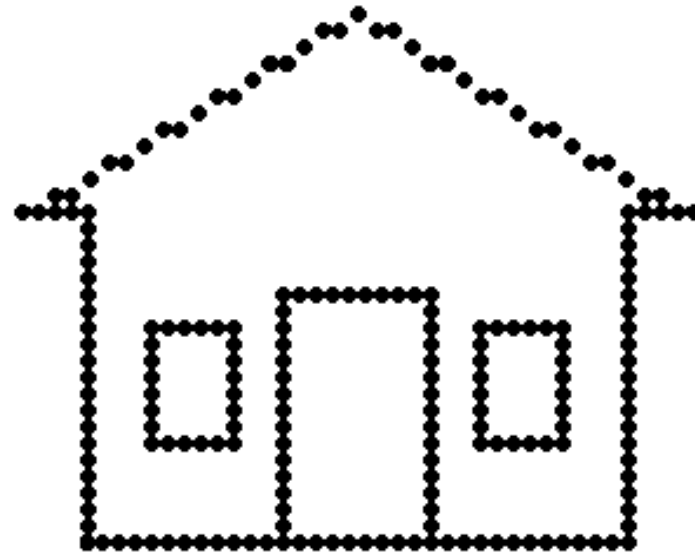
Raster Graphics (BITMAP)

- Raster image (or **pixmap ,Bitmap**) will usually have pixels with between one and eight bits for each of the red, green, and blue components

- The total number of pixels (*resolution*), and the amount of information in each pixel (often called *color depth*) determine the quality of a raster image.

- Raster graphics are resolution dependent.

- Modern computer-monitors typically display about 72 to 130 pixels per inch (PPI), and some modern consumer printers can resolve 2400 dots per inch (DPI) or more

Raster and Vector graphics

Vector Graphics

Raster Graphics

Method to produce bitmap image

□ 3 main method to produce bitmap image:

    a. Use computer based drawing application such as Microsoft Paint

    b. Screen capture

    c. Use scanner, digital camera and video card

Graphic software uses to amend bitmap image :
Adobe Photoshop, Painter, PrintShop Artist, GIMP etc.
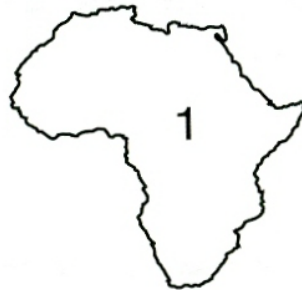
Graphics in Deep

- ☐ Raster uses a grid cell structure, whereas vector is more like a drawn map.

- ☐ Vector format has points, lines, polygons that appear normal, much like a map.

- ☐ Raster format generalizes the scene into a grid of cells, each with a code to indicate the feature being depicted. The cell is the minimum mapping unit.

- ☐ Raster has generalized reality: all of the features in the cell area are reduced to a single cell identity.

Vector and Raster Formats

Image 1: Vector and Raster Data Structure

O	O	1	1	1	1	O	O
O	1	1	1	1	1	O	O
1	1	1	1	1	1	1	1
O	1	1	1	1	1	1	O
O	O	O	1	1	1	1	O
O	O	O	1	1	1	1	O
O	O	O	O	1	1	O	O

Vector
Points, lines, polygons
Map analog

Raster
Grid structure
Generalized reality

Image 2: Raster Cell Coding
Multiple land uses in one cell
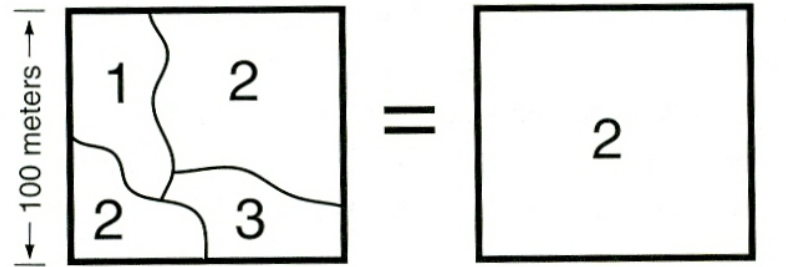
Land uses in
100-meter cell area

Raster cell code
(dominant land use)

Resolution and color in bitmap image

- Resolution determined by image dimension vertically and horizontally. E.g 640x480

- The highest pixel make an image more clear

- Color depth determined by total memory for each pixel

- 4 bit = 16 color, 24 bit = 16 million of color - Near to real life.

- Increasing the number of cells on a data set increases spatial resolution, which helps to increase spatial accuracy.

- One advantage to using relatively few cells is the short processing time and ease of analysis.

Raster Resolution

Low resolution
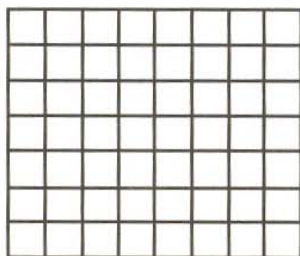
8 x 7 grid
1 cell = 1,210,000 km^2
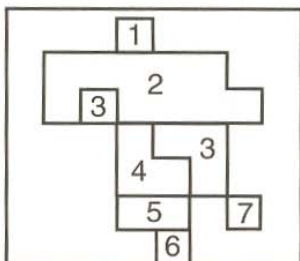
Digitized Vector Map
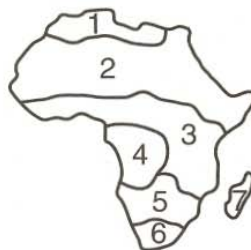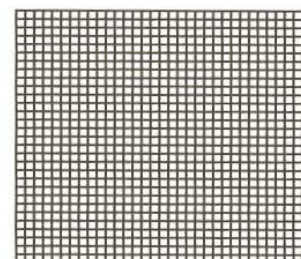
High resolution

33 x 30 grid
1 cell = 90,000 km^2

Gridded
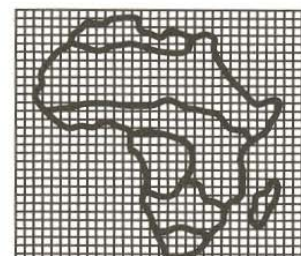
Raster Map
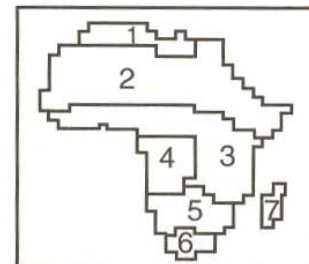
1 bit vs 4 bits vs 8 bits vs 24+ bits Colors

1 bit color
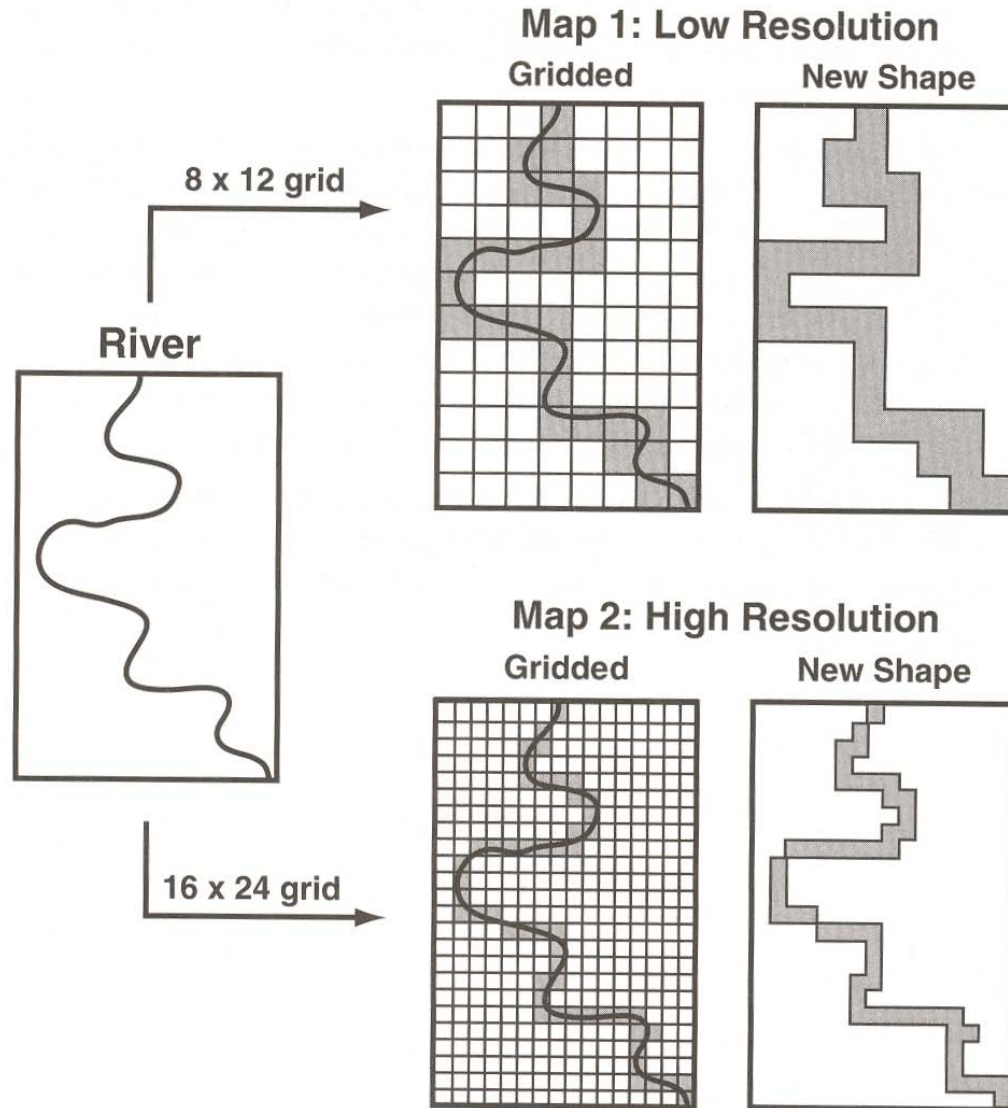

4 bits color

8 bits color

24+ bits color
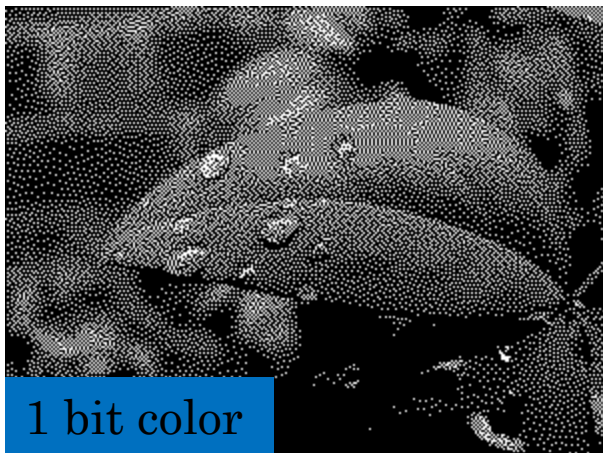
Gridding and Linear Features

- Low-resolution raster results in a rather generalized and crude shape.

- High-resolution raster shape appears more realistic, though still a long way from the vector shape and spatial accuracy

Raster Gridding
Linear Features

Map 1: Low Resolution

Gridded New Shape

8 x 12 grid

River

Map 2: High Resolution

Gridded New Shape

16 x 24 grid

Raster and Vector Data Models

- Raster: Because the raster cell's value or code represents all of the features within the grid, it does not maintain true size, shape, or location for individual features. Even where "nothing" exists (no data), the cells must be coded.

- Vector: vectors are data elements describing position and direction. vector is the map-like drawing of features, without the generalizing effect of a raster grid. Therefore, shape is better retained. Vector is much more spatially accurate than the raster format.

Raster Coding

- In the data entry process, maps can be digitized or scanned at a selected cell size and each cell assigned a code or value.

- The cell size can be adjusted according to the grid structure or by ground units, also termed resolution.

Raster Coding
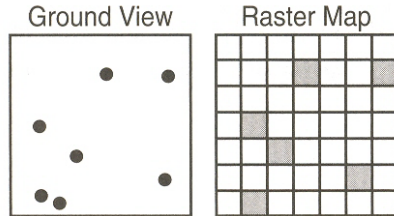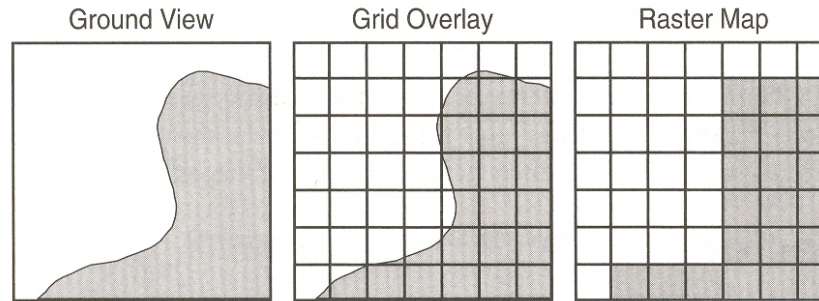
Map 1: Presence/Absence, Points

Ground View | Raster Map
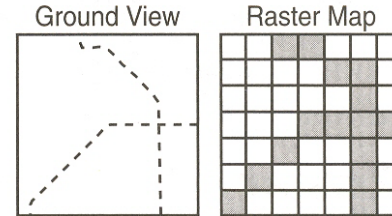
Map 2: Presence/Absence, Lines

Ground View | Raster Map
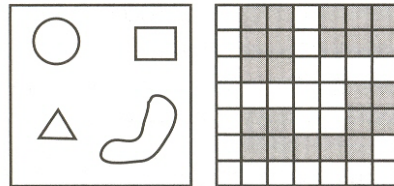
Map 3: Presence/Absence, Polygons
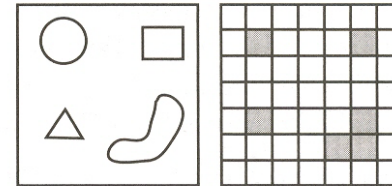
Map 4: Center Point, Polygons

Map 5: Dominant Area

Ground View | Grid Overlay | Raster Map

Map 6: Percentage Cover

Forest Percentage

0	0	0	0	10	15	0
0	0	0	0	80	100	90
0	0	0	10	100	100	100
0	0	0	0	85	100	100
0	0	0	0	75	100	100
0	0	10	45	95	100	100
15	75	100	100	100	100	100

Water Percentage

100	100	100	100	90	85	100
100	100	100	100	80	0	80
100	100	100	90	0	0	0
100	100	100	100	80	0	0
100	100	100	100	75	0	0
100	100	90	50	0	0	0
85	75	0	0	0	0	0

Raster Coding Problems

☐ A major problem with the raster structure is that the shape of features is forced into an artificial grid cell format.

☐ One possible solution is to increase the resolution by increasing the number of cells, making each one smaller and therefore more sensitive to accurate classification.
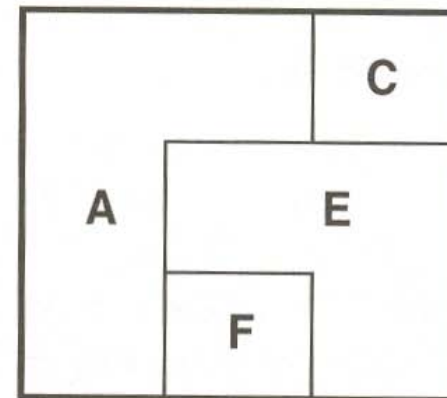
Raster Coding Problems
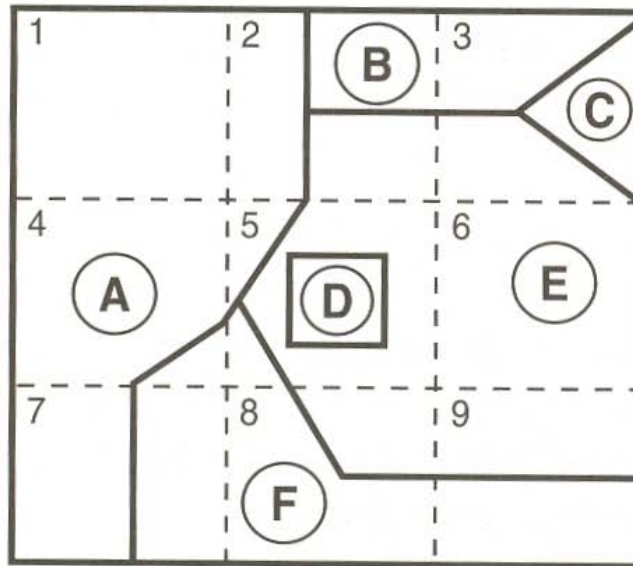
Coding for raster cells

1. Clearly Class A.
2. More A than B or E.
3. B, C, or E? 34% C.
4. Clearly A,
5. Mostly E. What about D?
6. Clearly E.
7. 55% A.
8. Mostly F.
9. 50% E and F.

Final coding

Final map

Raster Mapping
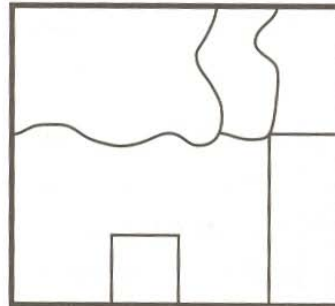
Polygons

Map data
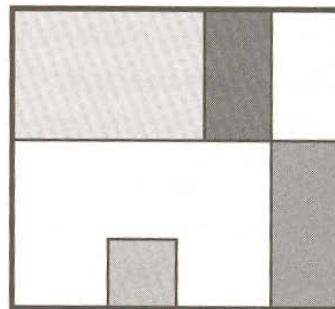
Coded cells

Shaded map

Lines
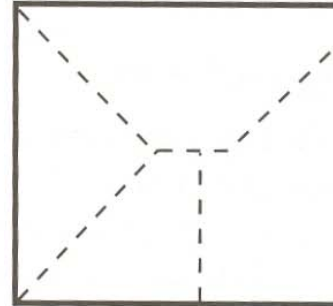
Map data

Coded cells
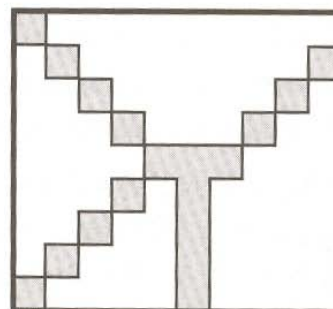
Shaded map

Raster Precision and Accuracy

- Questions of raster data precision (the exact location) and accuracy (maximum spatial truth) are often a problem.

- Because the raster cell is the maximum resolution and the minimum mapping unit, there is no way to know exactly where small feature occurs.

- Smaller cells have less spatial error because the area of doubt is smaller.

- Uncertainty becomes greater when measuring across cells.

Raster Accuracy and Precision

Image 1: Location Within Cell
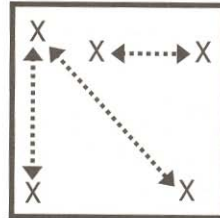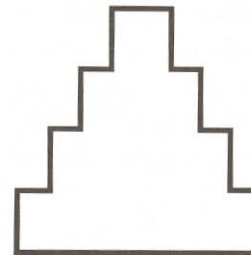

Image 2: Location Between Cells
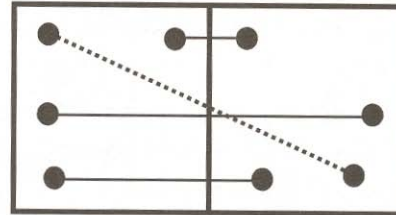
Image 3: Area Errors

Vector
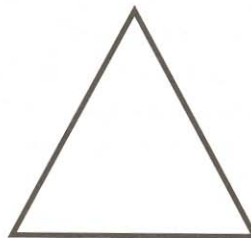
Area = 30 units
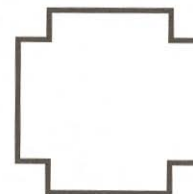
Raster

Area = 40 cells

Vector

Area = 28.26 units

1 unit

Raster

Area = 32 cells

Vector Data

☐ Vector features appear more realistic than raster features and have better spatial accuracy.

☐ Vector features are defined primarily by their shapes, more specifically by the outline of their shapes. The vector system is a coordinate-based data structure.

Vector Data

- Shape points are the ends and bends that define the feature's outline.

- At the beginning and end of every line or polygon feature is a node.

- At each bend (change of direction) is a vertex (plural: vertices).

- Node are end points and vertices are between, defining the shape.

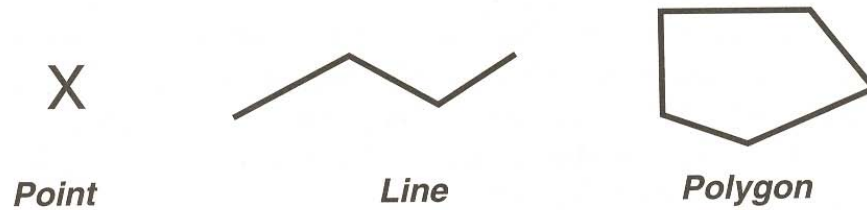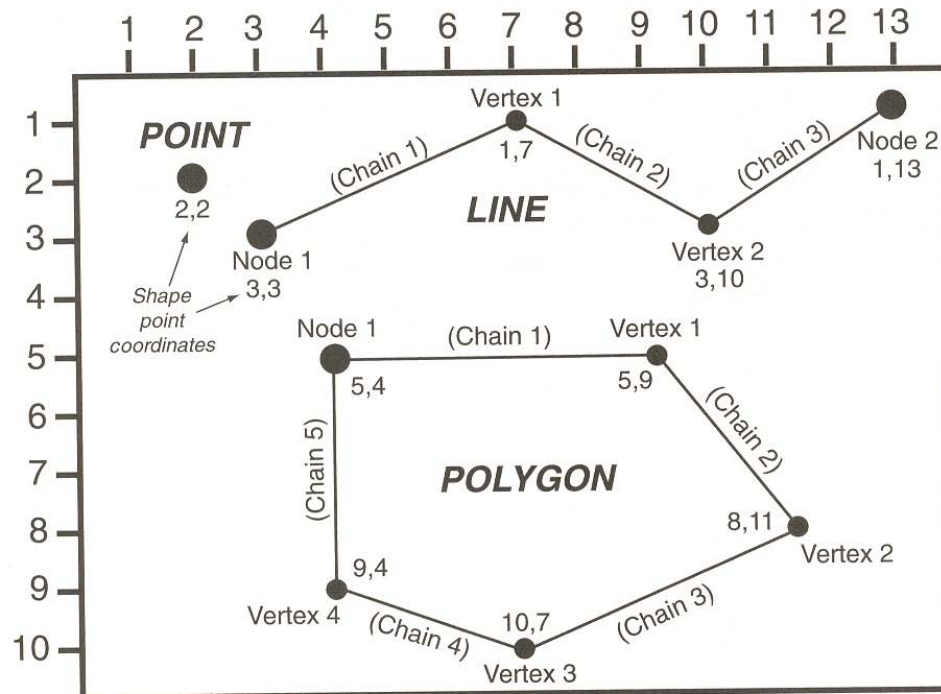- Point features are standalone nodes.

Vector Data

Image 1: GIS Features

Image 2: Vector Data Structure

Raster and Vector Structures

- Raster and vector structure have different methods of storing and displaying spatial data.

- Raster cells are stored and displayed as cells, but in the vector format only the nodes and vertices are stored. This results in considerable data storage differences.

Raster and Vector Structures

- A point in a raster system is a single cell, but in a vector system it is only a node represented by a symbol with its coordinate position noted.

- A simple line in a raster system consists of a sequence of cells. In a vector system, a simple line consists of two nodes and a chain that connects them.

Raster and Vector Structures

- A more complex raster line consists of connected cells, sometimes in stair-step fashion when they are diagonal. Complex lines in the vector format have vertices to mark changes in direction, with nodes at each end.
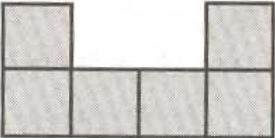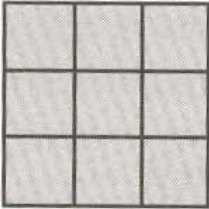
Raster and Vector Structures

- Raster polygons are filled with cells. For single polygons, the vector format usually has a single node and several vertices to mark the boundary direction changes.

- Connected polygons are simply two blocks of cells in the raster format, but in vector they share a common border and some common nodes.

Raster and Vector Data Structure

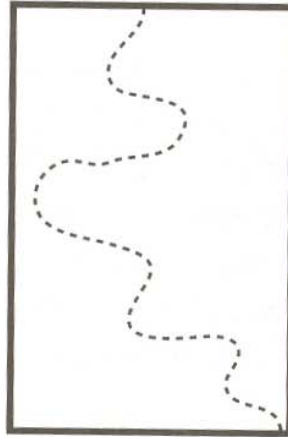|	Raster	Vector
Point		
Simple line		
Complex line		Node / Vertex
Single polygon		
Connected polygons	A B	A B

Raster to Vector Conversion

☐ There are reasons to convert from raster to vector

(1) better visual appearance of vector features

(2) some plotter work only on vector data

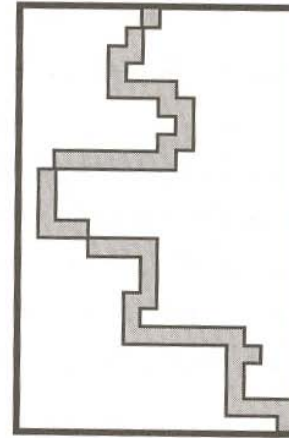(3) comparison with vector data is best when both data files have identical formats
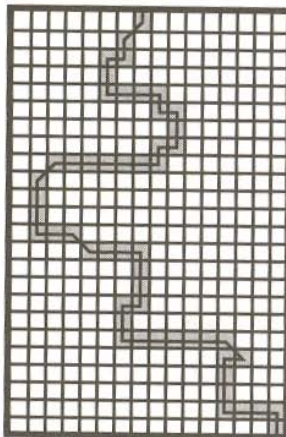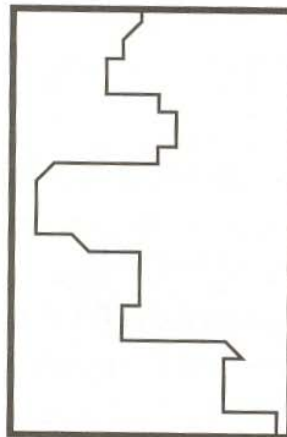
Raster to Vector Conversion

Map 1: Original River

Map 2: Raster Version

Map 3: Cell-Center Connections
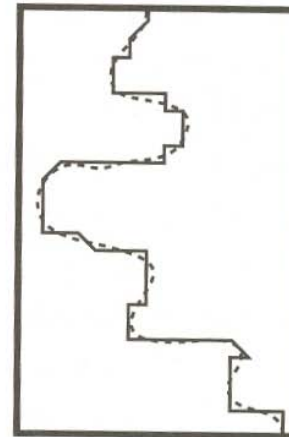
Map 4: Vectorized River

Map 5: Comparison: Original Versus Vectorized

Raster Advantages

- A relatively simple data structure;

- The simple grid structure makes analysis easier.

- The computer platform can be "low tech" and inexpensive.

- Modification level is higher depend on the depth of an image

- Remote sensing imagery is typically obtained in raster format.

Raster Advantages

Image 1: Simple Data Structure

3	1	1	1	0	0
0	3	2	3	3	1

Image 2: Easy Analysis

Theme A

3	3	1
2	1	1
1	2	1

Theme B

6	6	6
4	4	4
2	2	2

Theme C

2	2	2
1	1	1
3	1	1

New theme

6		

HIGHEST VALUE

Image 3: Low-Tech Platforms

Image 4: Remote Sensing Data

Image 5: Modeling

Slope

+

Soil

X 2.5

Erosion potential
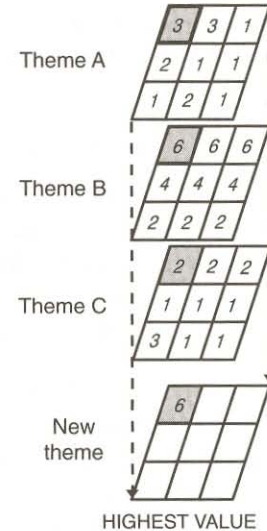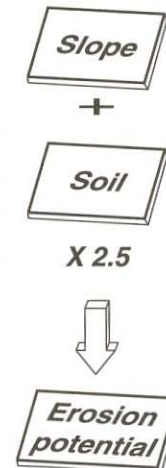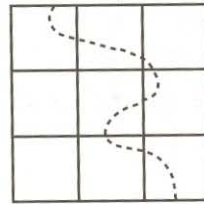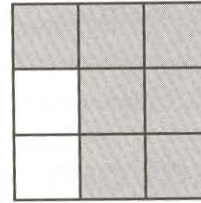
Raster Disadvantages

❑ Spatial inaccuracies

❑ Because each cell tends to generalize a landscape, the result is relatively low resolution compared to the vector format.

❑ Because of spatial inaccuracies caused by data generalization, a raster format cannot tell precisely what exists at a given location.

❑ Each cell must have a code, even where nothing exists.

❑ File size is bigger -High computer memory

❑ The process of resize make the image fuzzy and jaggies

Raster Disadvantages
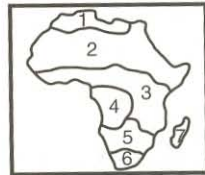
Image 1: Spatial Inaccuracy
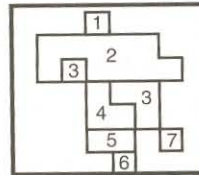

Vector river   Raster version
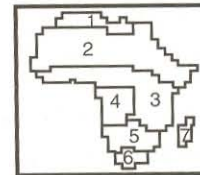
Image 2: Generalization

Original map   Low-resolution raster   High-resolution raster

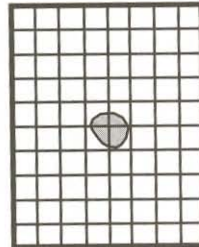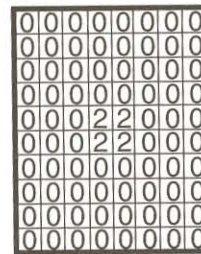## Image 3: Implicit Data
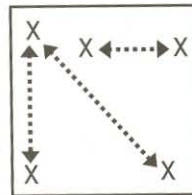
Implied location

Image 4: Large Data Sets

Single feature
(Code 2)   Every cell coded

Vector Advantages

- ❑ In general, vector data is more map-like.
- ❑ Is very high resolution.
- ❑ The high resolution supports high spatial accuracy.
- ❑ Vector formats have storage advantages.
- ❑ The general public usually understands what is shown on vector maps.

Vector Advantages

Image 1: High-resolution Map Analog
Scale-independent Resolution
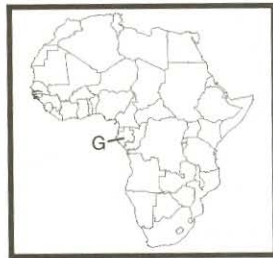
Africa

G = Gabon

Zoom 1

Zoom 2

Image 2: Node-Vertex Storage

Map 1: Vector Display
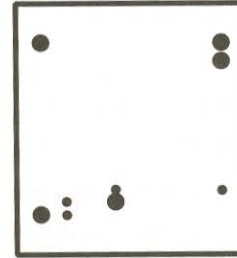
Map 2: Shape Point Storage

Image 3: Understandable

Vector   Raster

?

Image 4: Topology

River Topology

N3   N1

C3   C1

C2   N4

N2
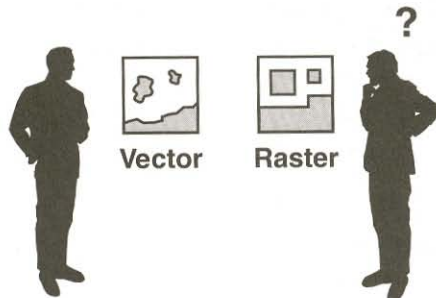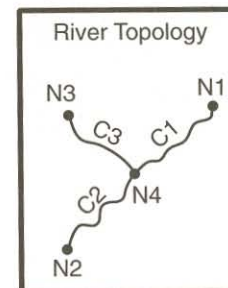
Vector Disadvantages

❑ May be more difficult to manage than raster formats.

❑ Require more powerful, high-tech machines.

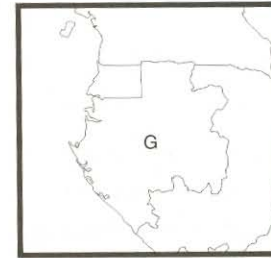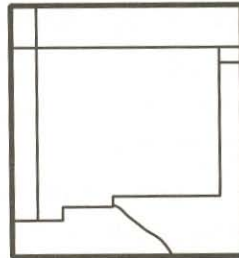❑ Need high skill to draw high quality vector image

    ❑ The use of better computers, increased management needs, and other considerations often make the vector format more expensive.

    ❑ Learning the technical aspects of vector system is more difficult than understanding the simplicity of the raster format, particularly when topology is introduced.

❑ Produced by computer so less/not realistic

❑ The complex object make the image instruction processing slower.

Vector Disadvantages

Image 1: Complex Data Structure

Chain Topology

Chain	Start Node	End Node
1	1	2
2	2	3
3	3	5
4	4	5
5	5	6

Node Topology

Node	Chains
1	1
2	1,2,3
3	2
4	4
5	3,4,5
6	5

Chain Coordinates

Chain	Coordinates
1	70,22 71,23
2	71,23 73,23
3	71,23 71,51 71,21
4	70,21 71,21
5	70,21 72,21 72,22 73,22

Node Coordinates

Node	X	Y
1	70	22
2	71	23
3	73	23
4	70	21
5	71	21
6	73	22

Image 2: Demanding Teaching
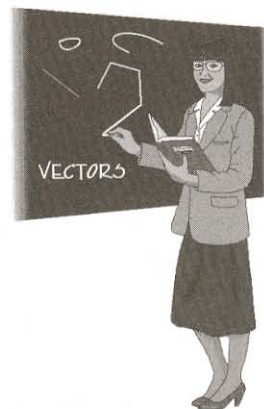
VECTORS

Technical skill required

Image 3: Introductory Training

Raster or Vector
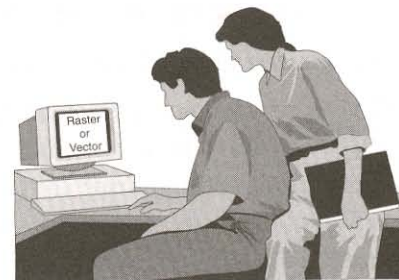
Decisions of cost, needed technical skill, applications, relevancy, and other considerations

Advantages of vector graphics over raster graphics

- Minimal amount of information translates to a much smaller file size compared to large raster images.
  - The storage is small because just store computer drawing instruction. E.g line (x1,y1, x2,y2)
- The parameters of objects are stored and can be later modified.
  - Easy to make amendment toward image
- Ability to change the size of graphic without effect image quality
  - Can be infinitely zoom with out distorting

More …

- Vector art is key for printing. Since the art is made from a series of mathematical curves it will print very crisp even when resized.

- For instance one can take the same vector logo and print it on a business card, and then enlarge it to billboard size and keep the same crisp quality.

- A low-resolution raster graphic would blur incredibly if it were enlarged from business card size to billboard size

Standard/format graphic.

- To determine quality, size and purpose of uses.
- BMP (bitmap) – An old image format. Image decompress, big in size and accepted
- TIFF (Tagged Image File Format)- Uses for image generated by scanner etc.
- PICT- For Macintosh Image format. Suitable for presentation, video and screen view
- TGA (Targa)- first format support 24 bit of color)
- EPS (encapsulated PostScript); Image for PostScript illustration

Standard/format graphic.

- GIF (Graphics Interchange Format) – Standard image for online interchange, 8 bit image compression and small size

- WMF (Windows Metafile Format)- Use in Windows operating system. Usually use for image vector clipart.

- JPEG (Joint Photographic Expert Group)- Method uses to compress an image, suitable for photo picture. Not suitable for characters.