

# COMPUTER GRAPHICS

- Computers have become a powerful tool for the rapid and economical production of pictures.
- There is virtually no area in which graphical displays cannot be used to some advantage, and so it is not surprising to find the use of computer graphics so widespread.

- Although early applications in engineering and science had to rely on expensive and cumbersome equipment, advances in computer technology have made interactive computer graphics a practical tool.
- Used in diverse areas as science, engineering, medicine, business, industry, government, art, entertainment, advertising, education and training
- Follows is a gallery of graphics applications

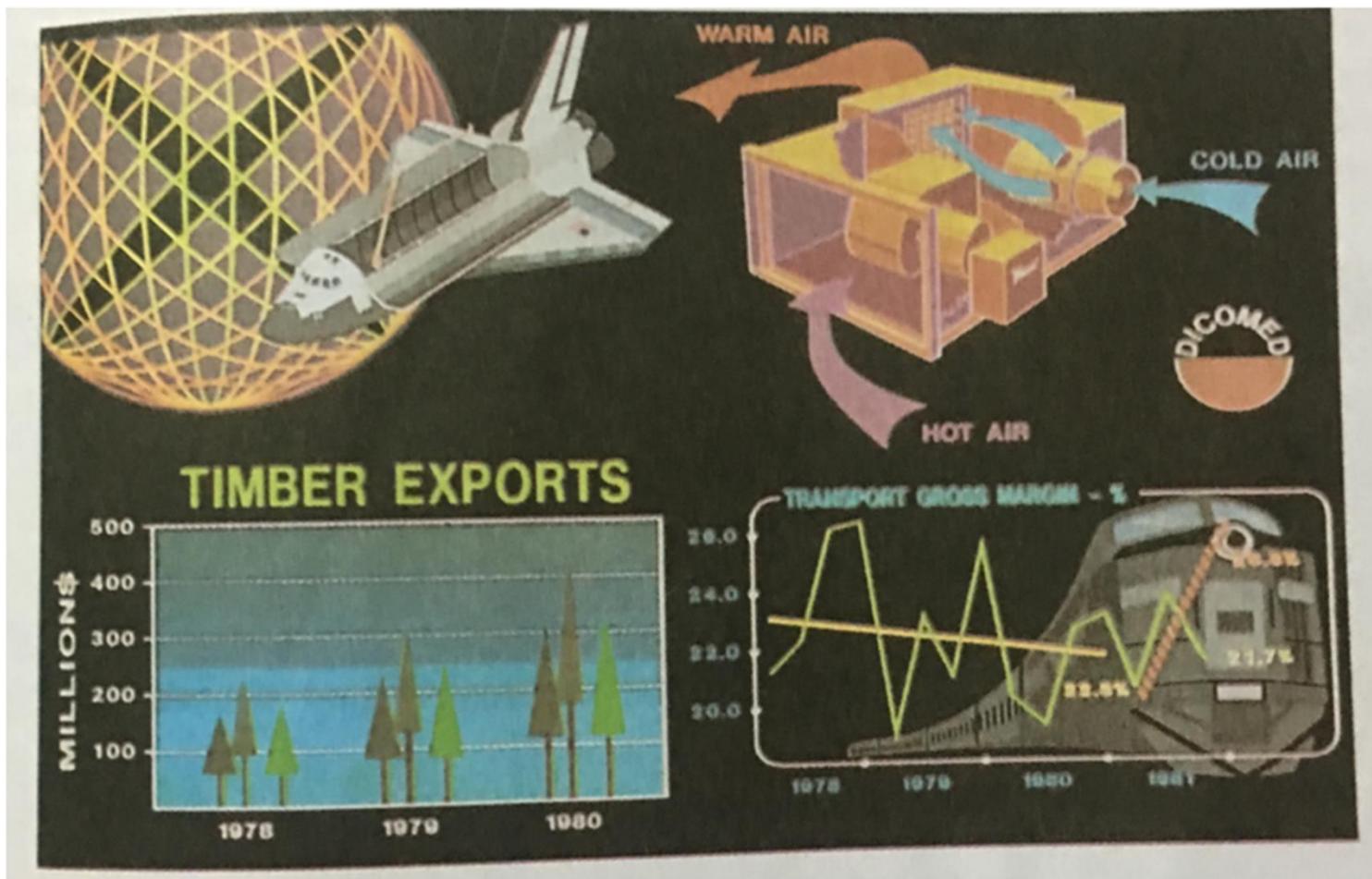


Fig 1.1 Examples of Computer Graphics applications

# 1. Computer-Aided Design

- For some design applications, objects are first displayed in a wireframe outline form that shows the over all shape and internal features of objects
- Wireframe displays also allow designers to quickly see the effects of interactive adjustments to design shapes
- Animations are also used in CAD

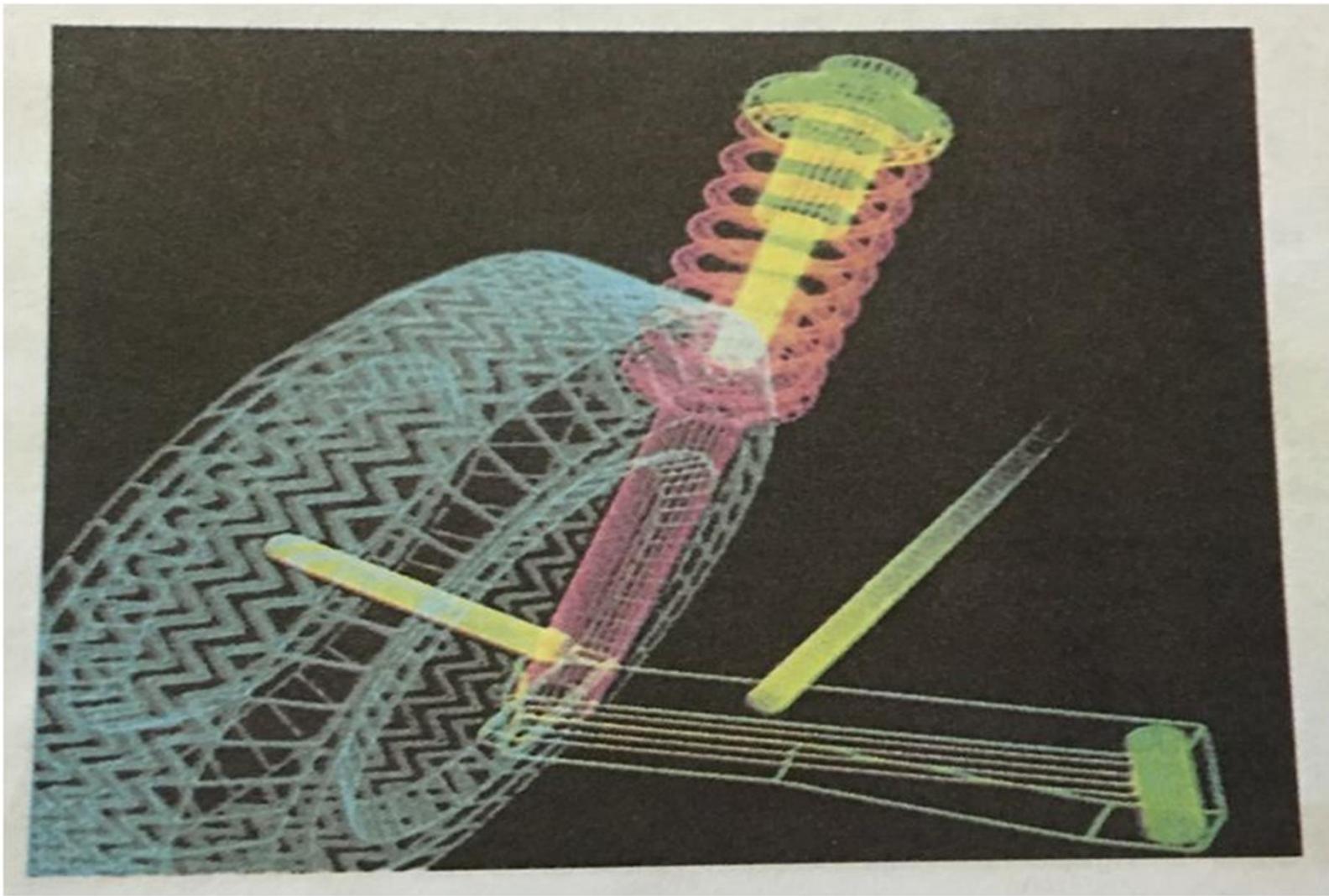


Fig 1.2 Color-coded wireframe display for an automobile wheel assembly

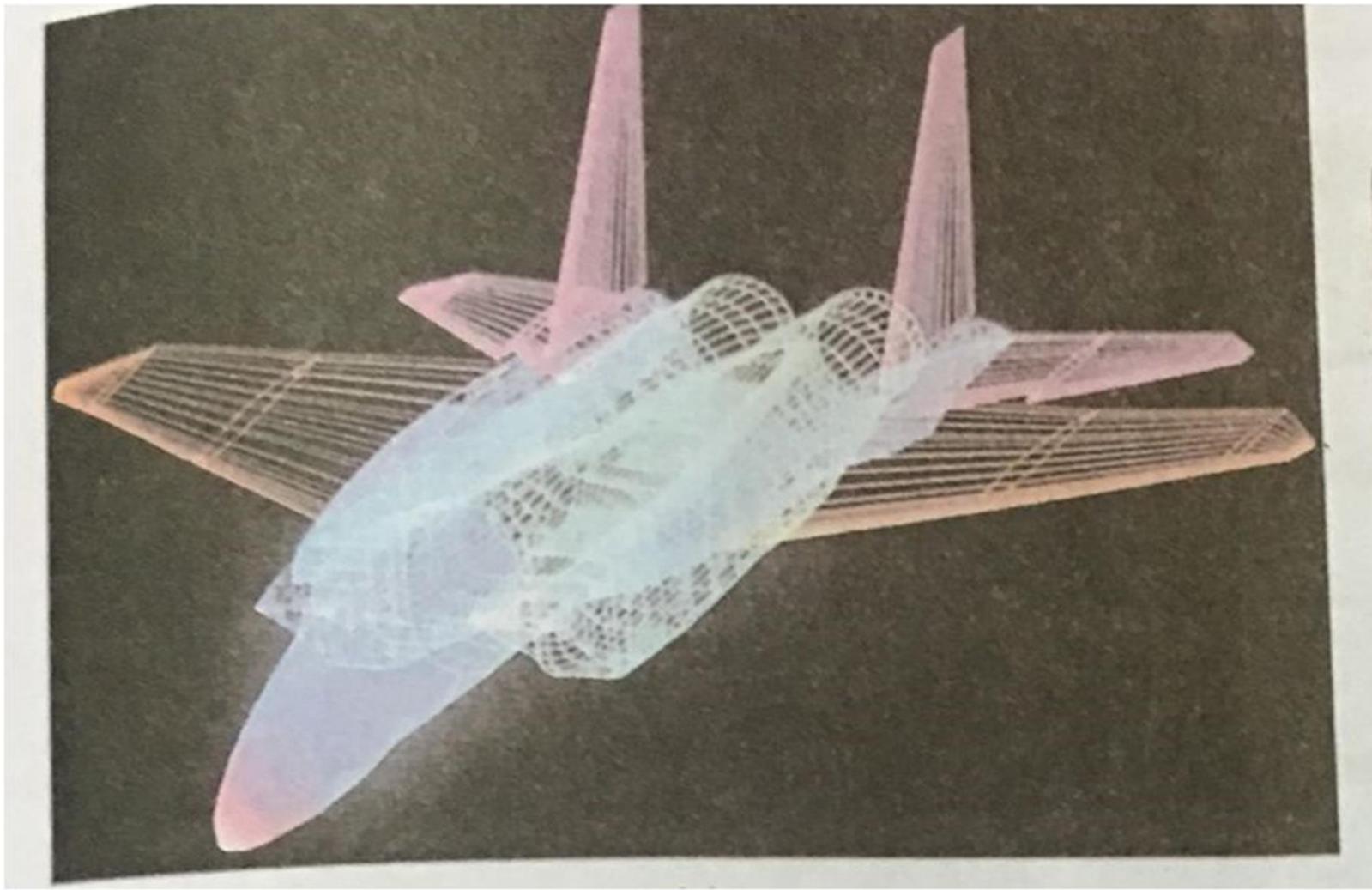


Fig 1.3 Color-coded wireframe displays of body designs for an aircraft

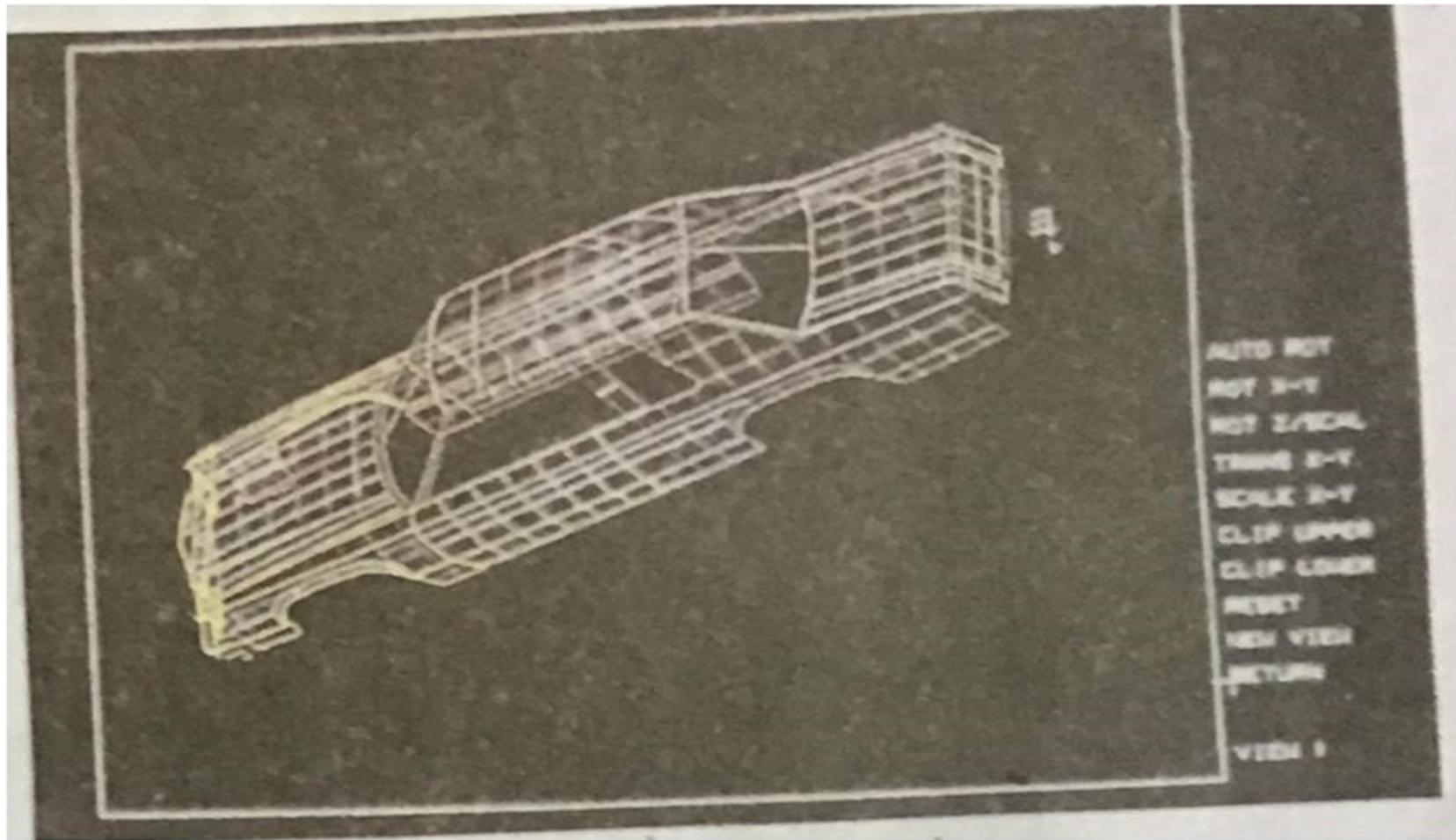


Fig 1.3 Color-coded wireframe displays for an automobile

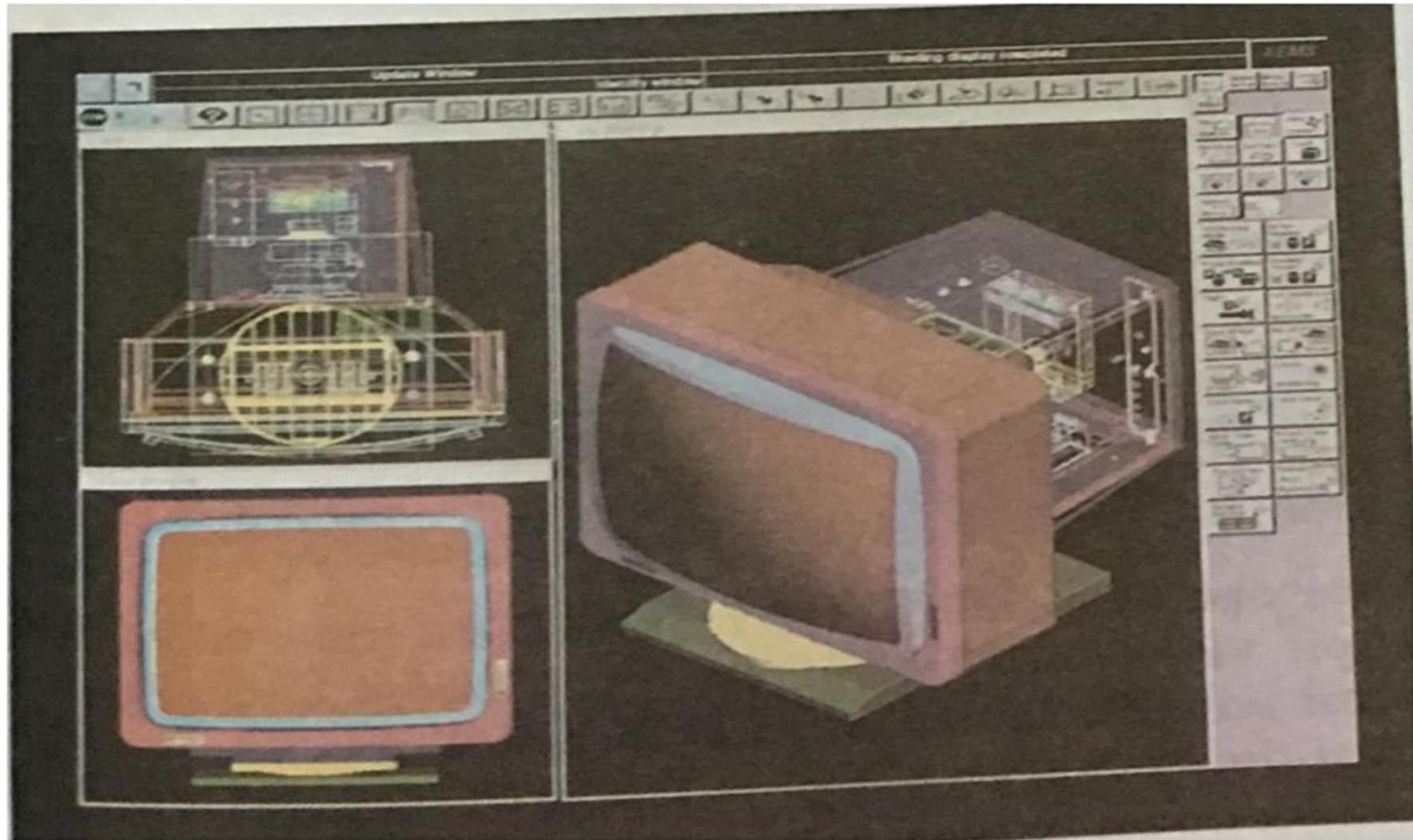


Fig 1.4a Multiple-window, color-coded CAD workstation displays

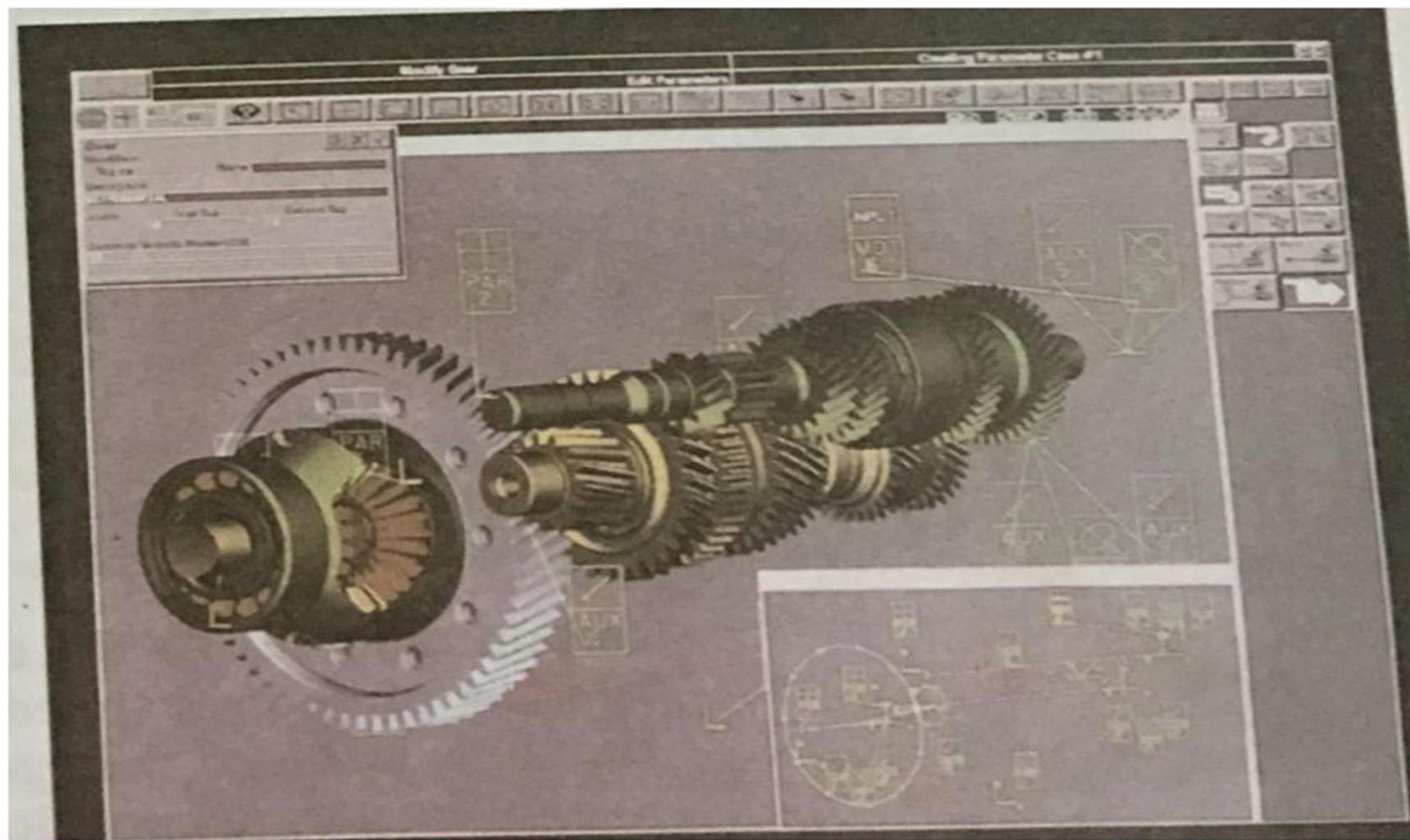


Fig 1.4 b

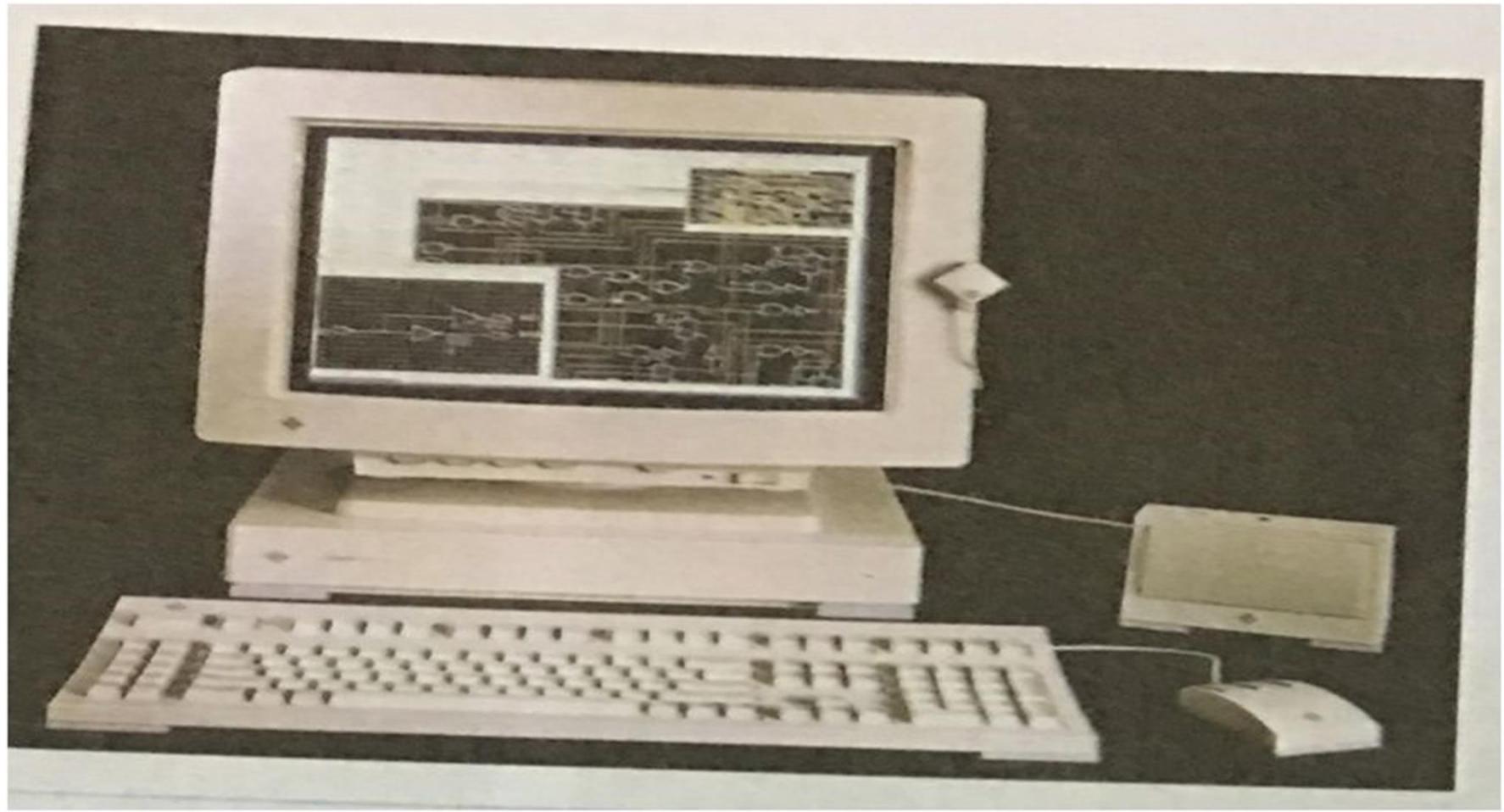


Fig 1.5 A circuit-design application, using multiple windows and color-coded logic component, displayed on a Sun work station with attached speaker and microphone

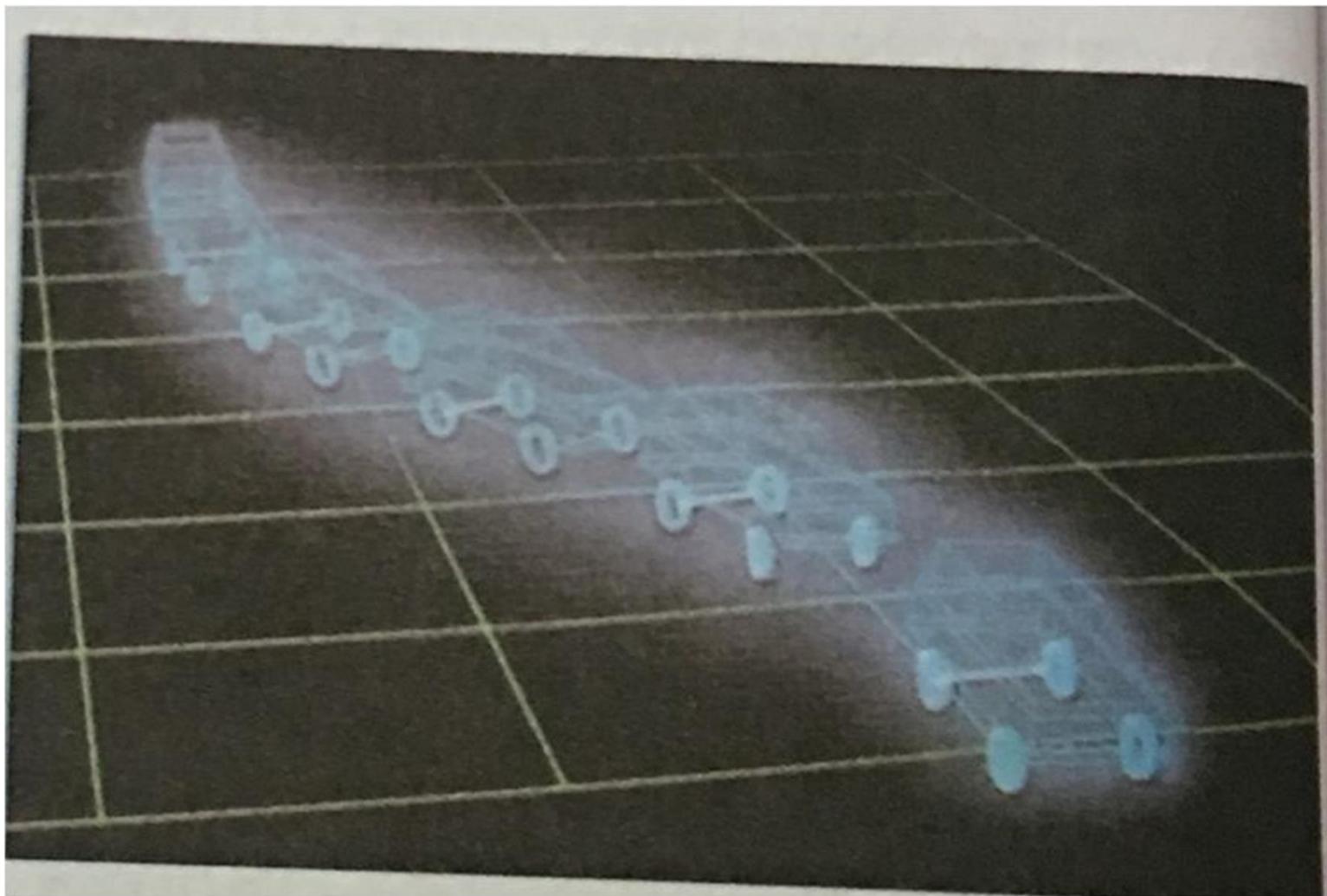


Fig 1.6 Simulation of vehicle performance during lane changes



Fig 1.7 Operating a tractor in a virtual-reality environment. As the controls are moved, the operator views the front loader, backhoe and surroundings through the headset

Smitha M. Jasmine, Asst Prof, II Dept, OCSE

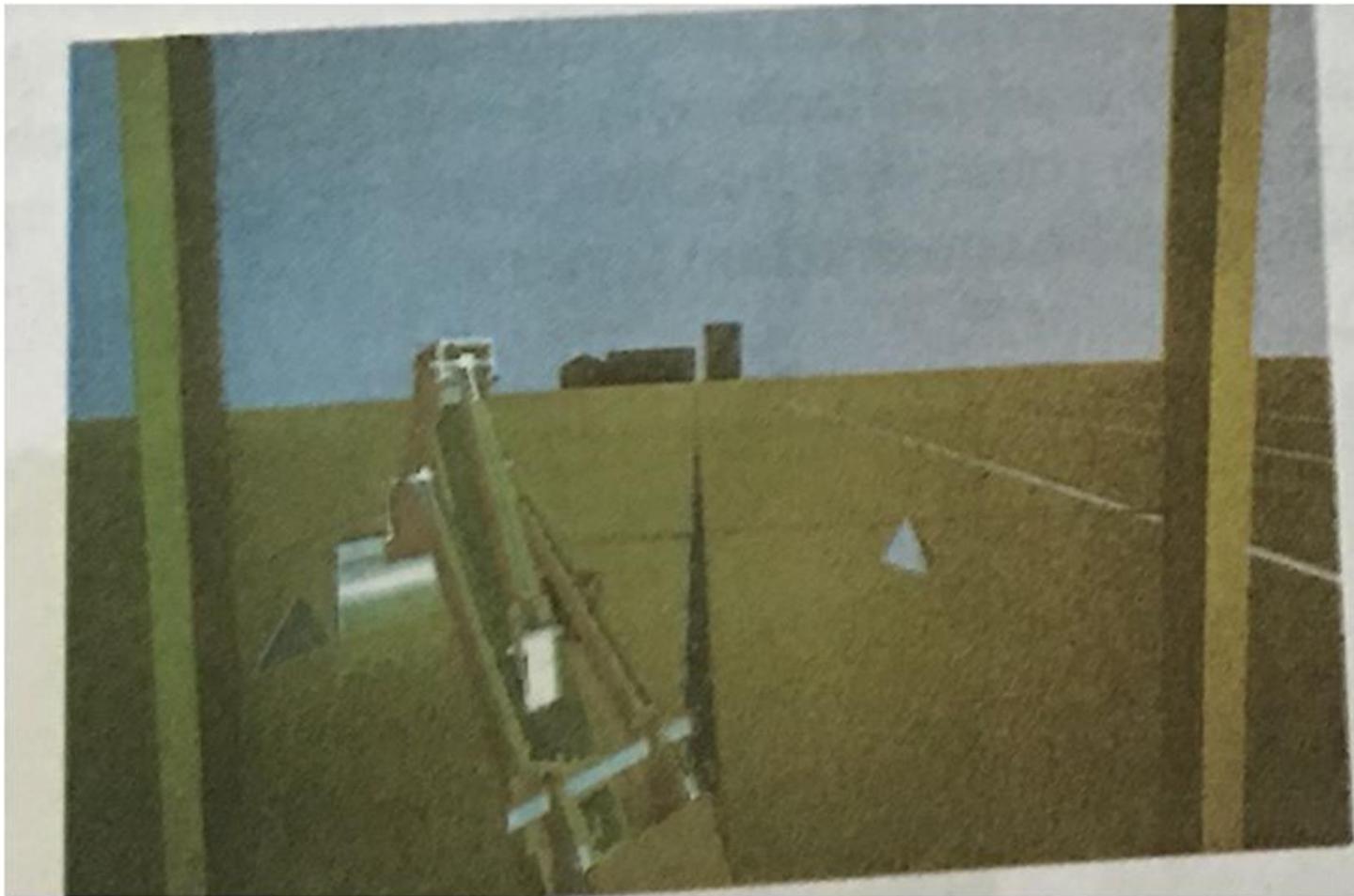


Fig 1.8 A headset view of the backhoe presented to the tractor operator



Fig 1.9 Operator's view of the tractor bucket, composed in several sections to form a wide-angle view on a standard monitor

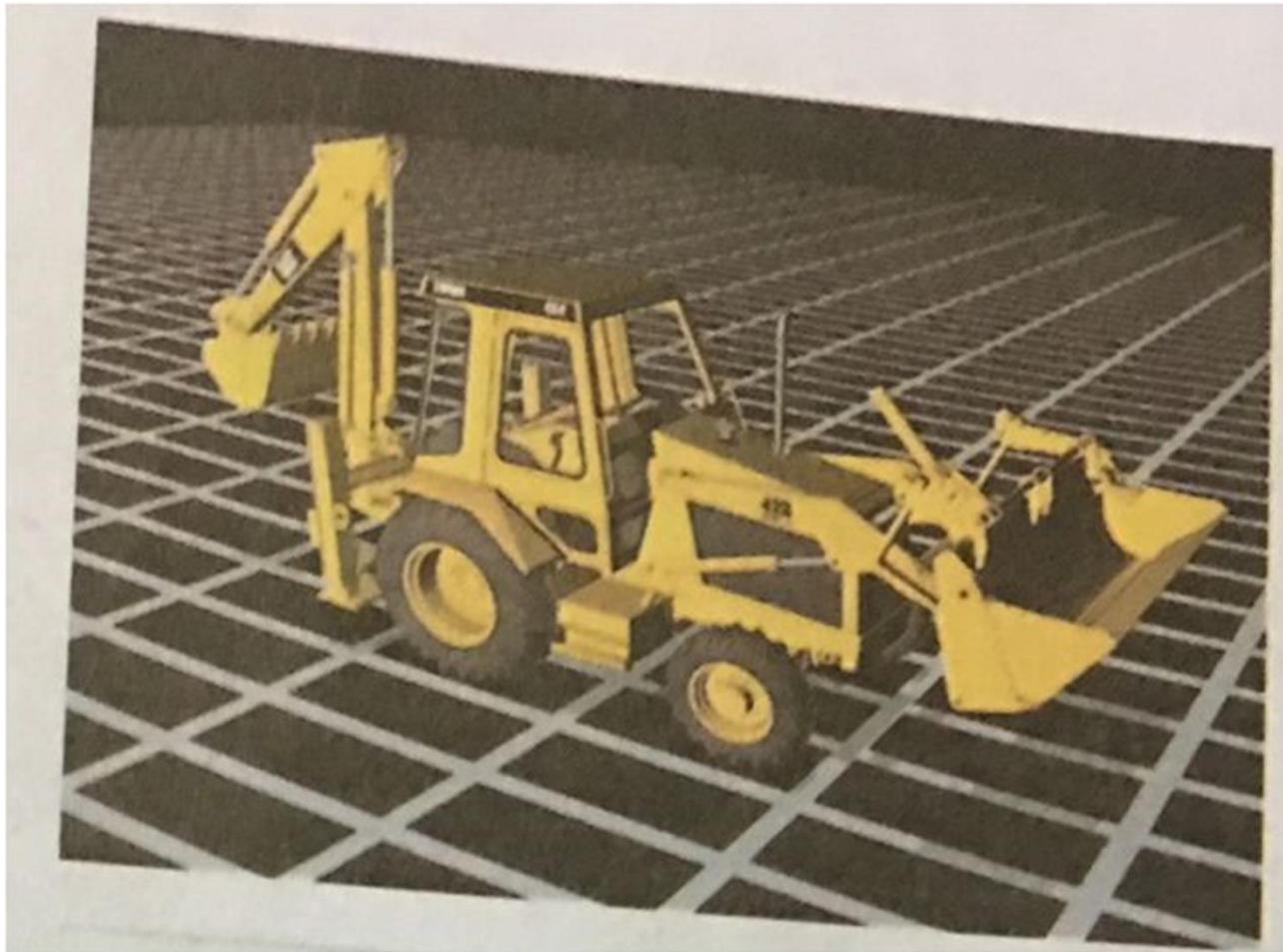
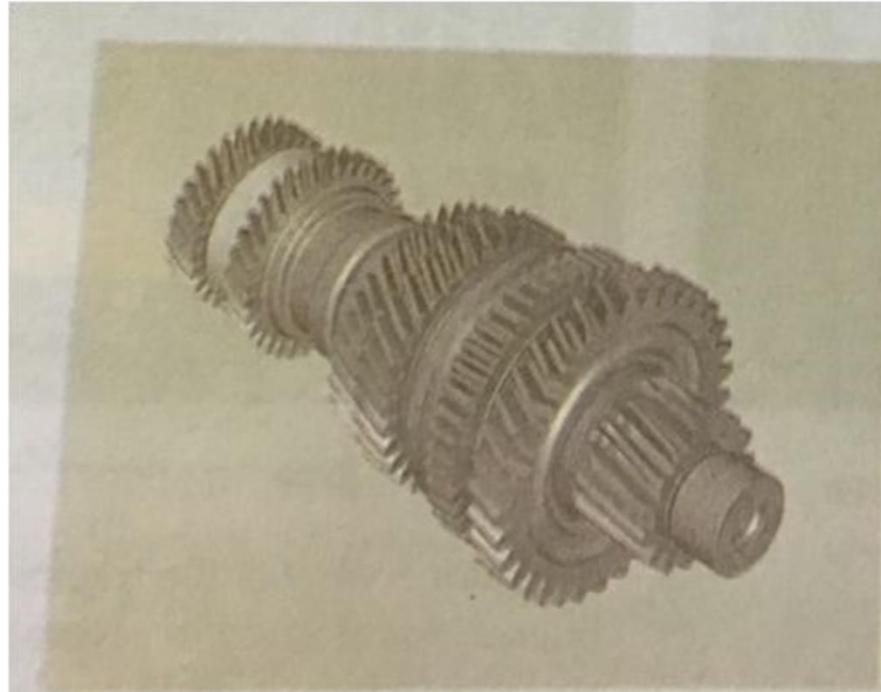
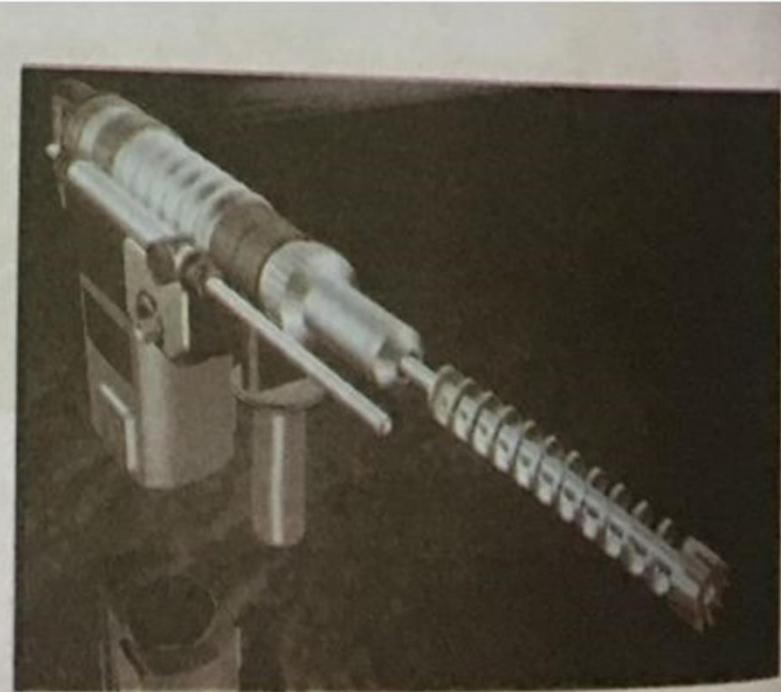


Fig 1.10 View of the tractor displayed on a standard monitor



(a)



(b)

Fig 1.11 Realistic rendering of design products

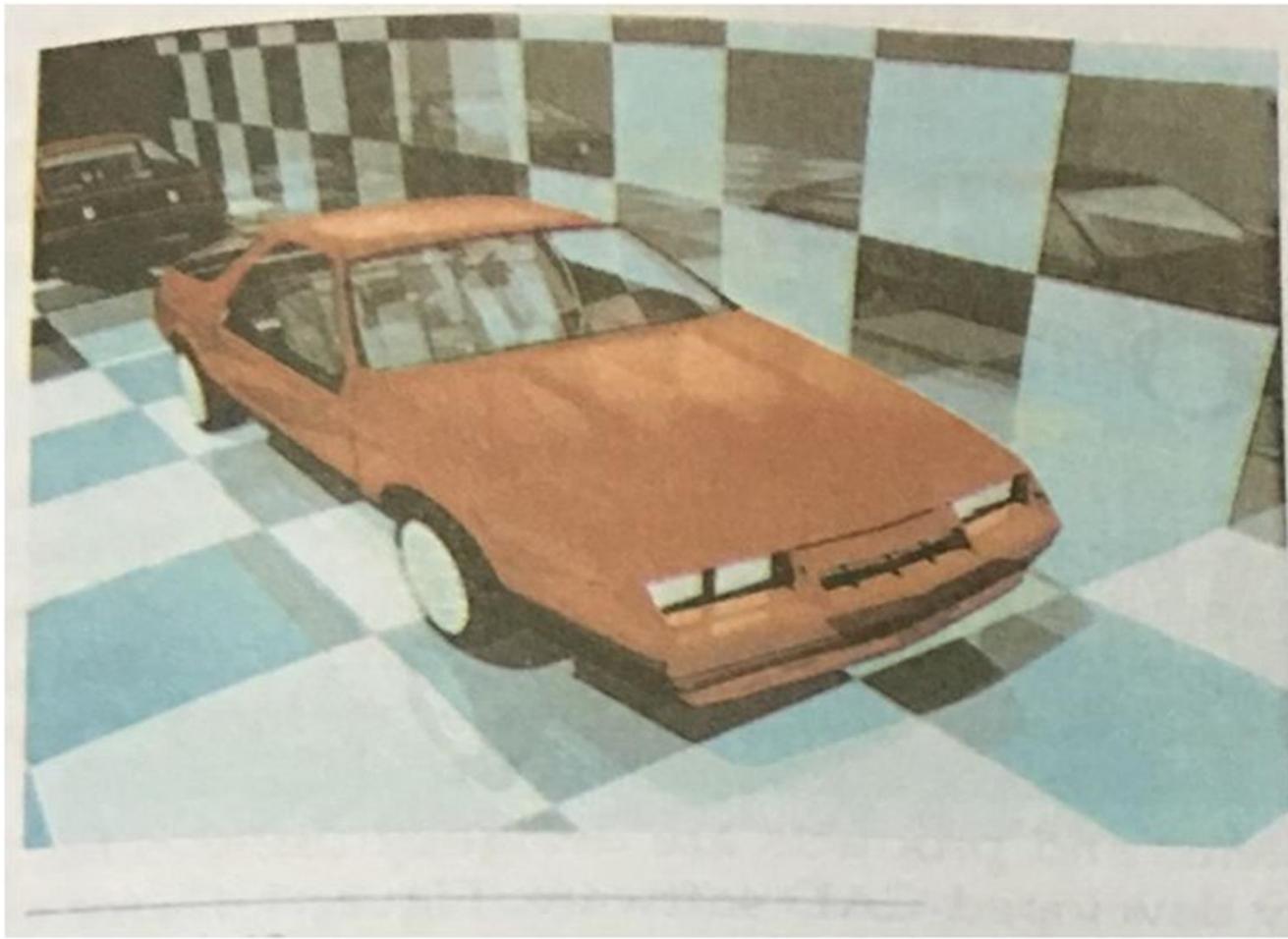


Fig 1.12 Studio lighting effects and realistic surface rendering techniques are applied to produce advertising pieces for finished products

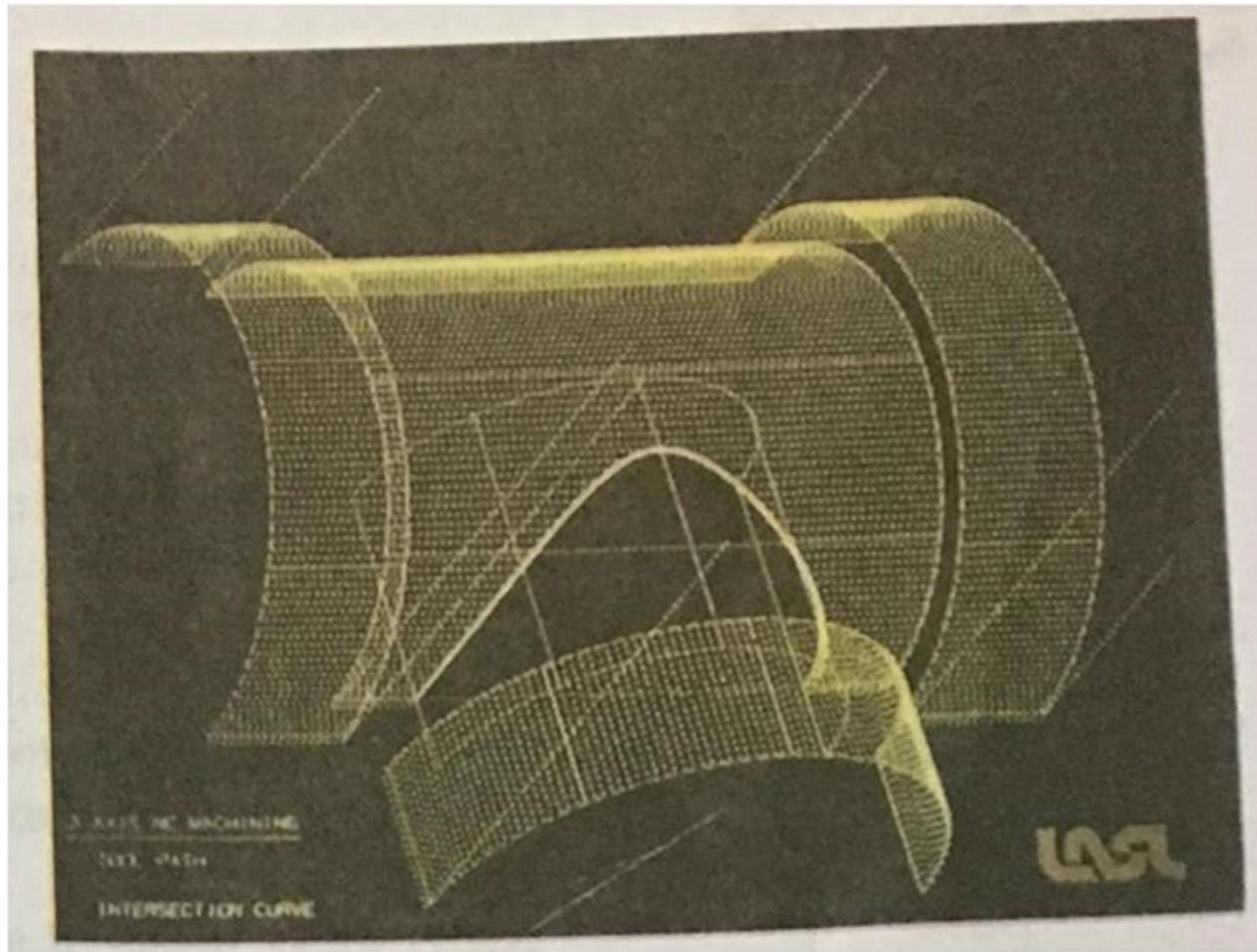


Fig 1.13 A CAD layout for describing numerically controlled machining of a part

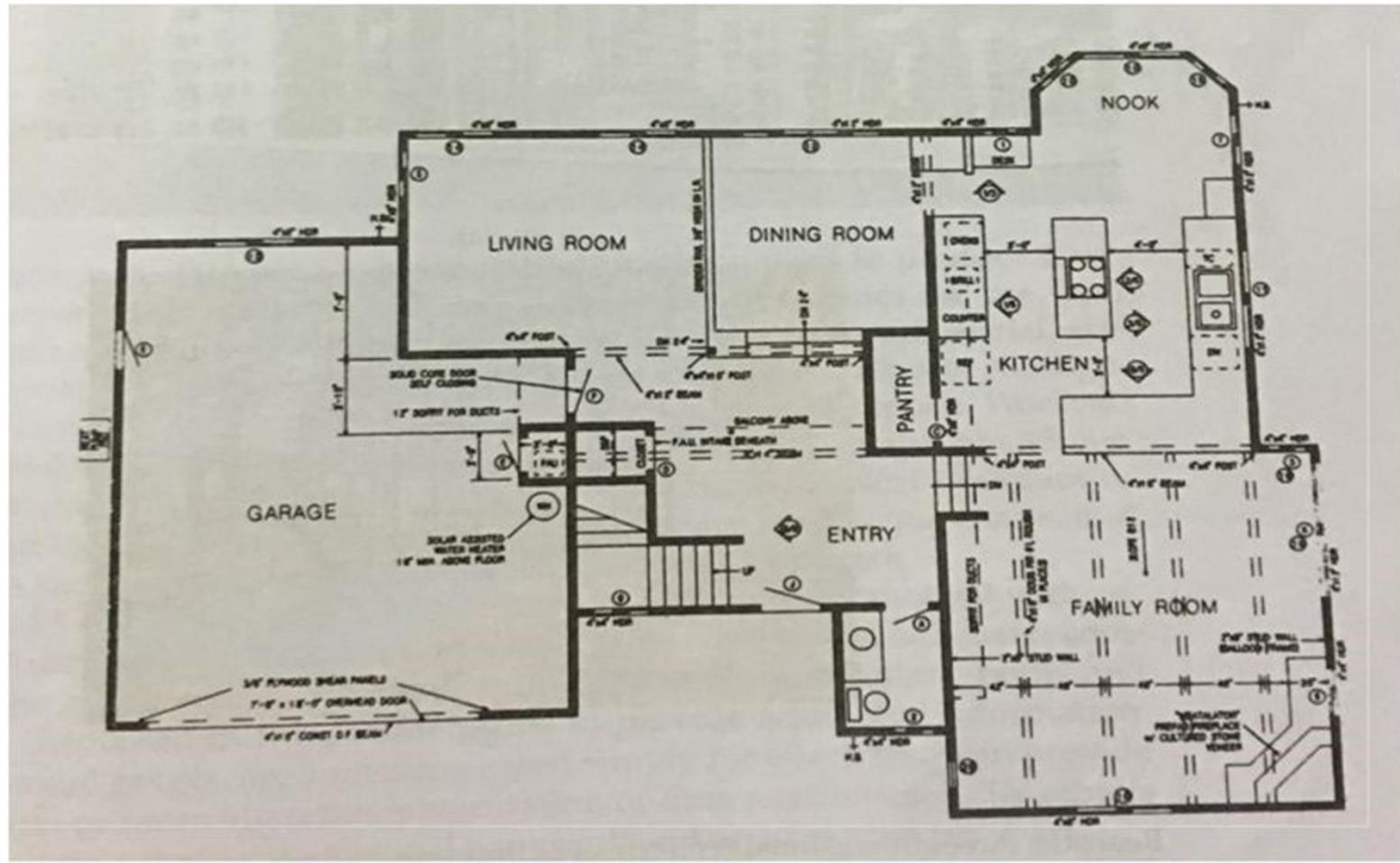


Fig 1.14 Architectural CAD layout for a building design



Fig 1.15 Realistic 3D renderings of building designs. a. street level representation of the World Trade Center Project.  
b)Architectural visualization of an atrium, created for a computer animation

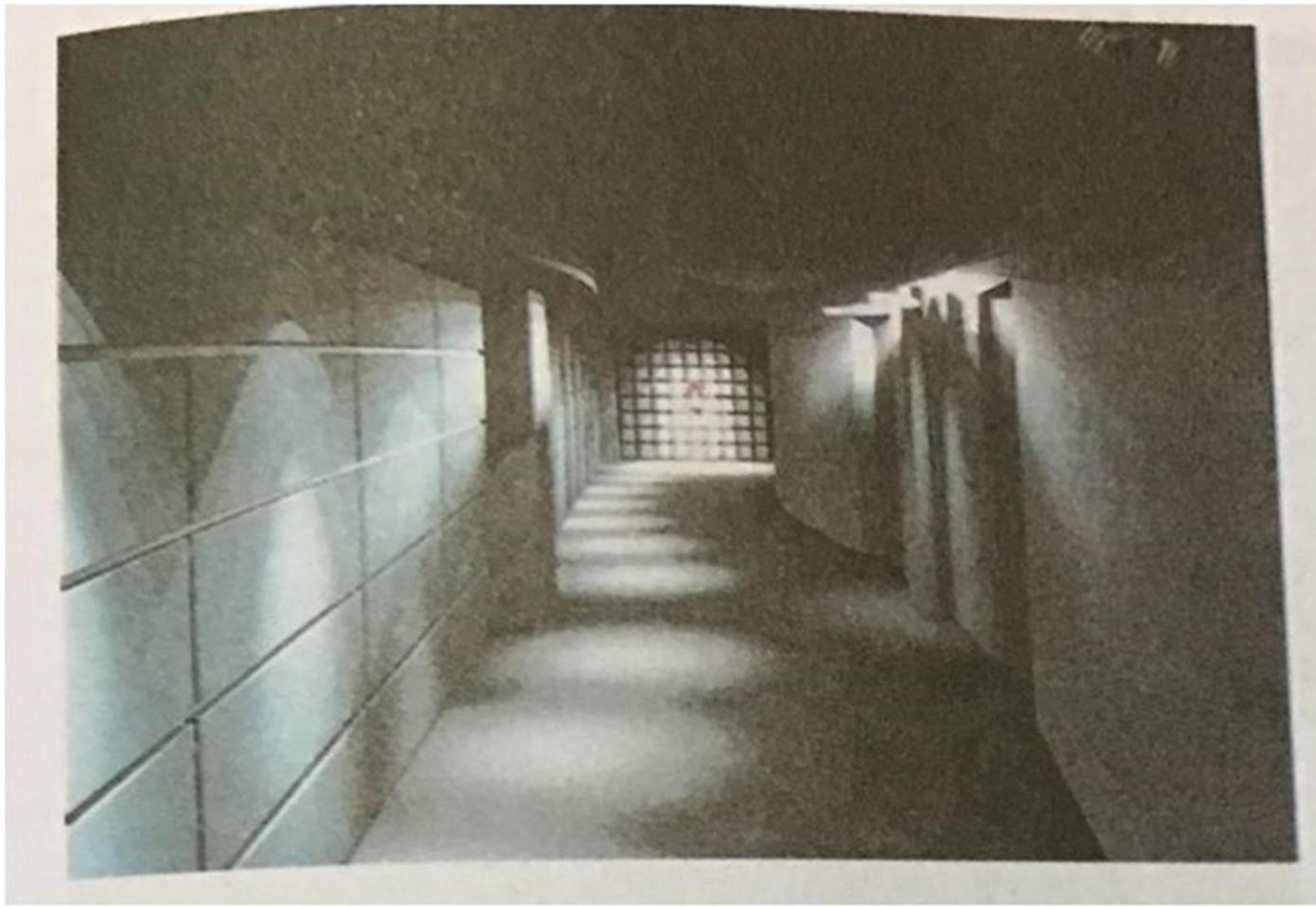


Fig 1.16 A hotel corridor providing a sense of movement by placing light fixtures along an undulating path and creating a sense of entry by using light towers at each hotel room



Fig 1.17 Oriental rug pattern created with computer graphics design methods

## 2. Presentation Graphics

- Used to produce illustrations for reports or to generate 35mm slides or transparencies for use with projectors
- Commonly used to summarize financial, statistical, mathematical, scientific and economic data for research reports, managerial reports
- Typical examples : Bar charts, Line graphs, Surface graphs, Pie charts

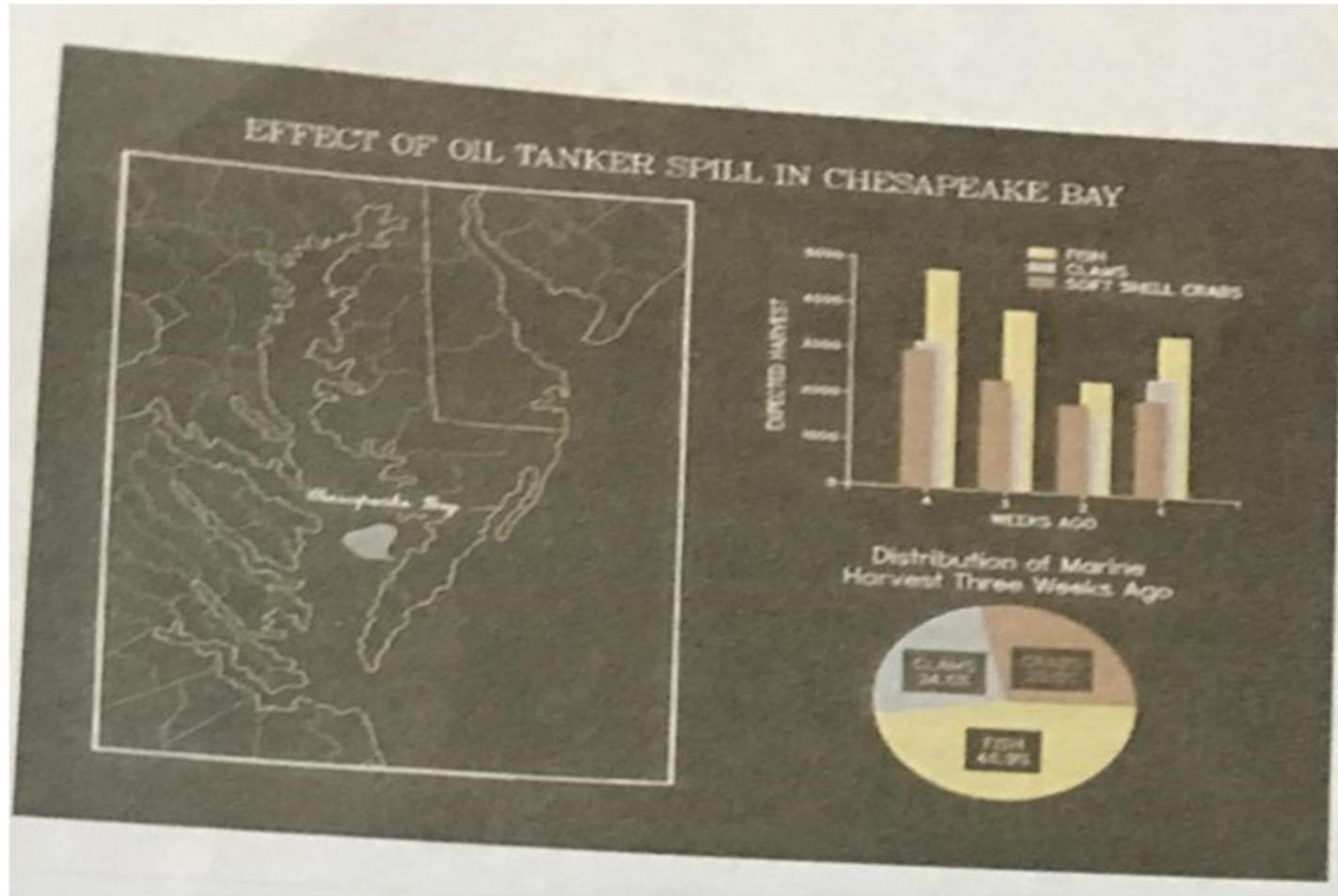


Fig 1.18 Two dimensional bar chart and pie chart linked to a geographical chart

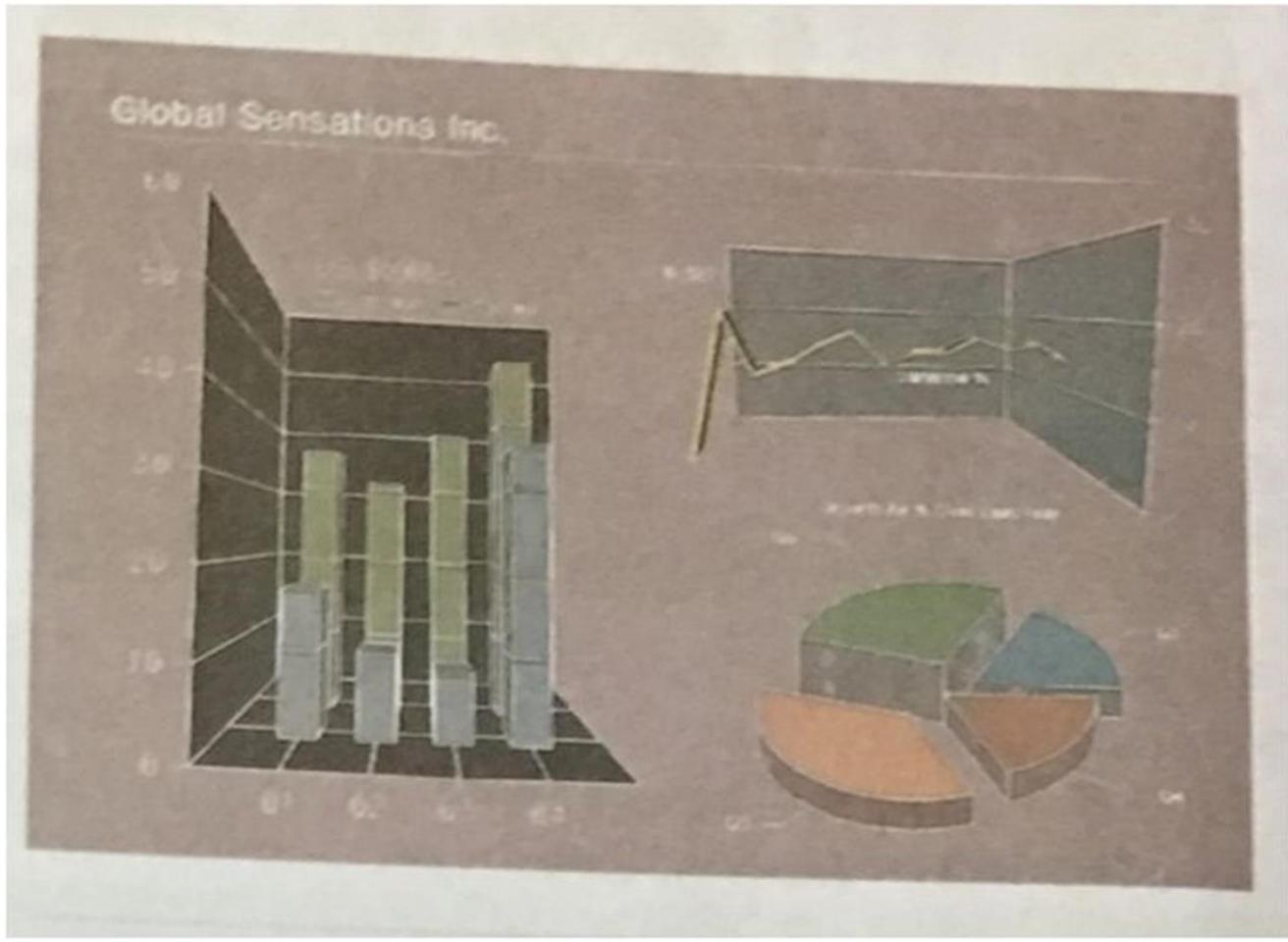


Fig 1.19 Two dimensional bar chart, exploded pie chart and line graph

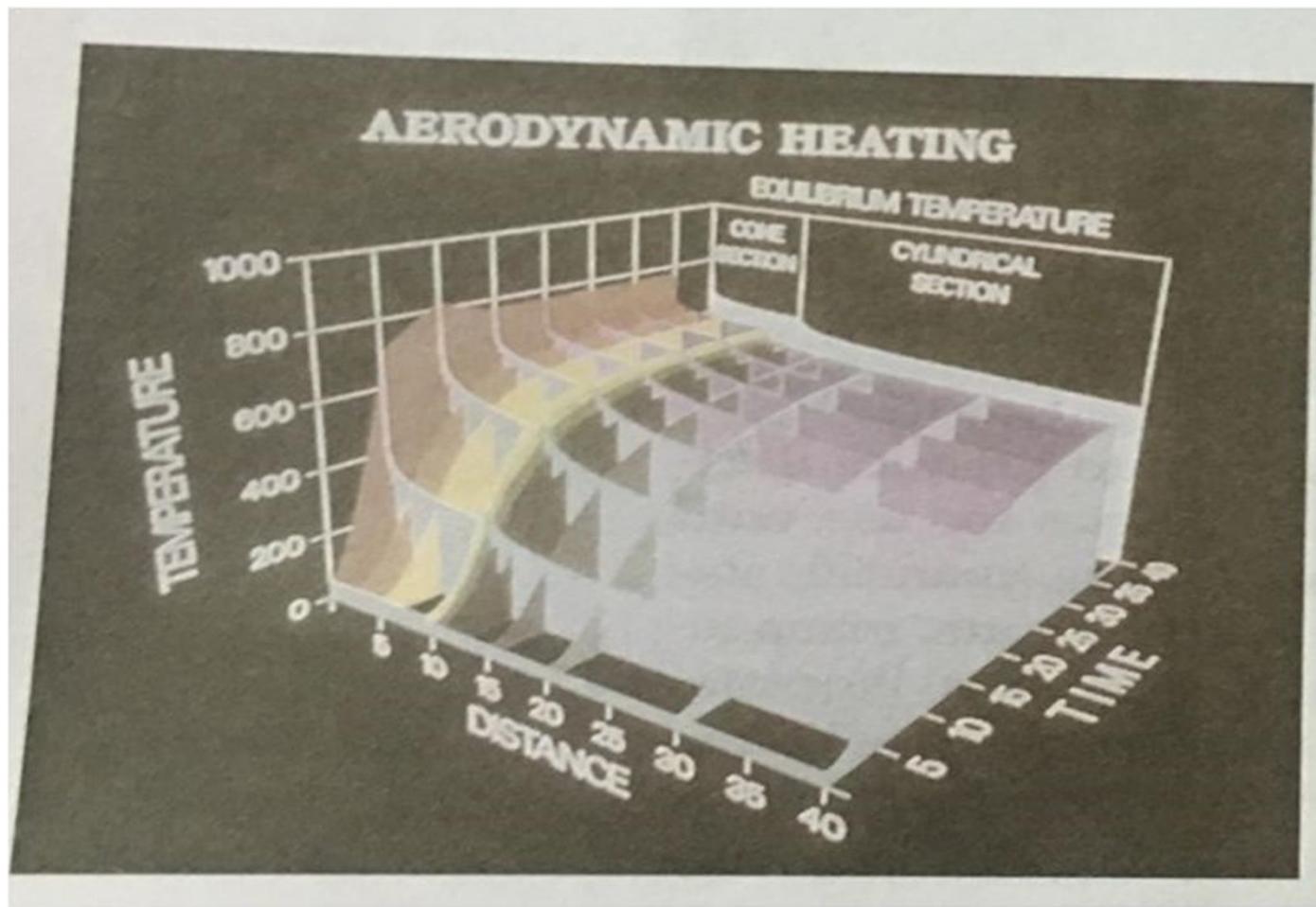


Fig 1.20 Showing relationships with a surface chart

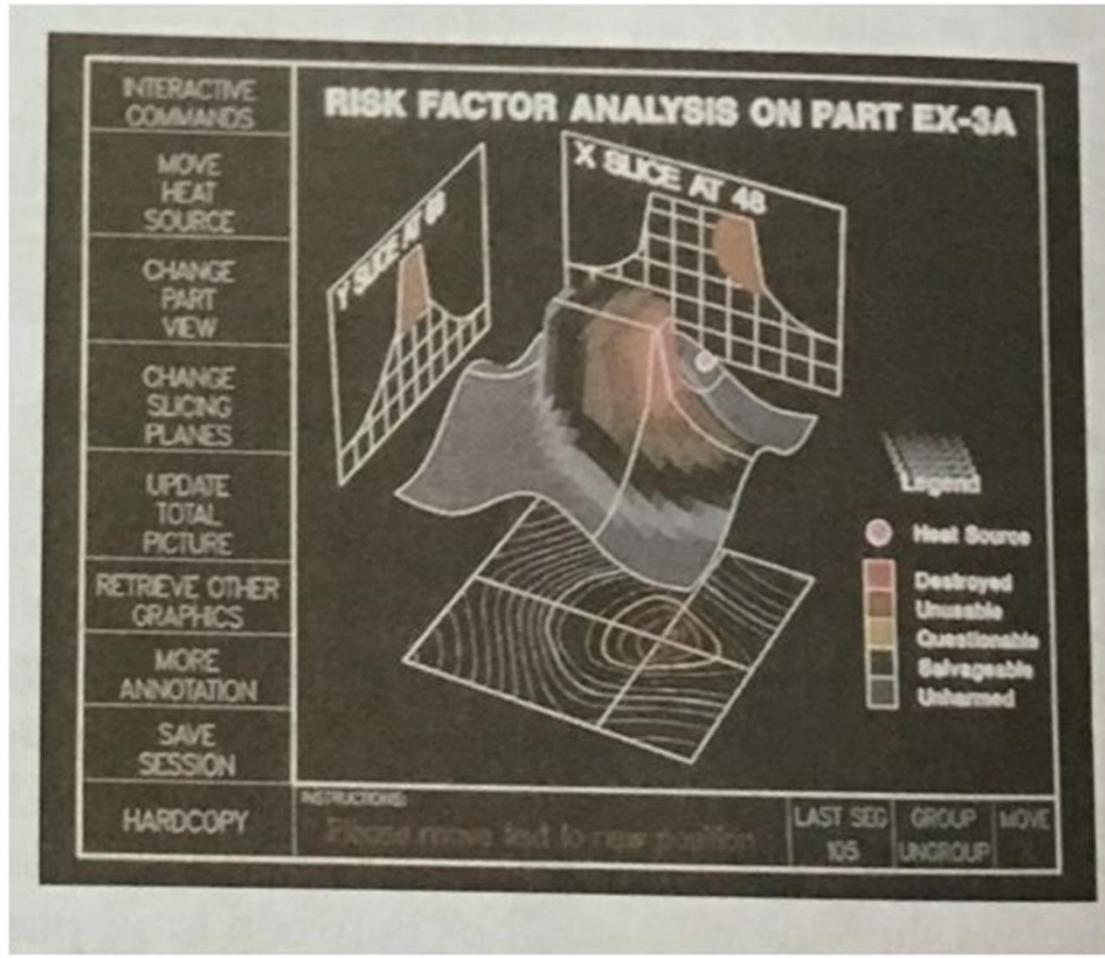


Fig 1.21 Plotting two dimensional contours in the ground plane with a height field plotted as a surface above the ground plane

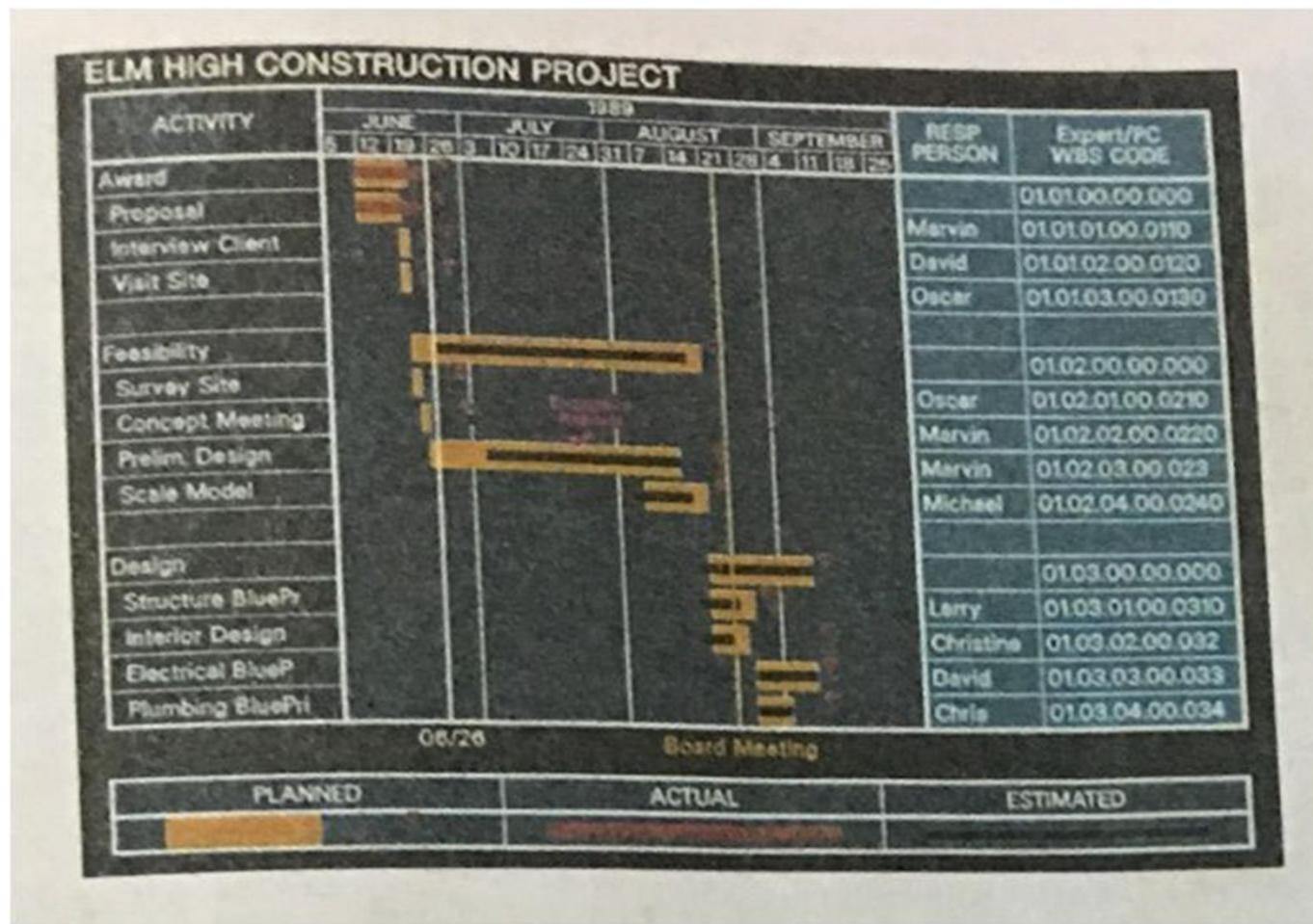


Fig 1.22 Time chart displaying relevant information about project tasks

# 3. Computer Art

- Used in both fine art and commercial art applications
- Methods
  - Special purpose hardware
  - Artist's paint brush programs



Fig 1.23 Cartoon drawing produced with a paintbrush program, symbolically illustrating an artist at work on a video monitor



Fig 1.24 Cartoon demonstrations of an “artist” creating a picture with a paintbrush system. The picture, drawn on a graphics tablet, is displayed on the video monitor as the elves look on. In (b), the cartoon is superimposed on the famous Thomas Nast drawing of Saint Nicholas, which was put to the systems with a videocamera,



Fig 1.25 A Van Gogh look-alike created by graphics artist Elizabeth O'Rourke with a cordless, pressure-sensitive stylus

Fig 1.26 An electronic watercolor, painted by John Derry of Time Arts, Inc using a cordless, pressure-sensitive stylus and Lumena gouache-brush software



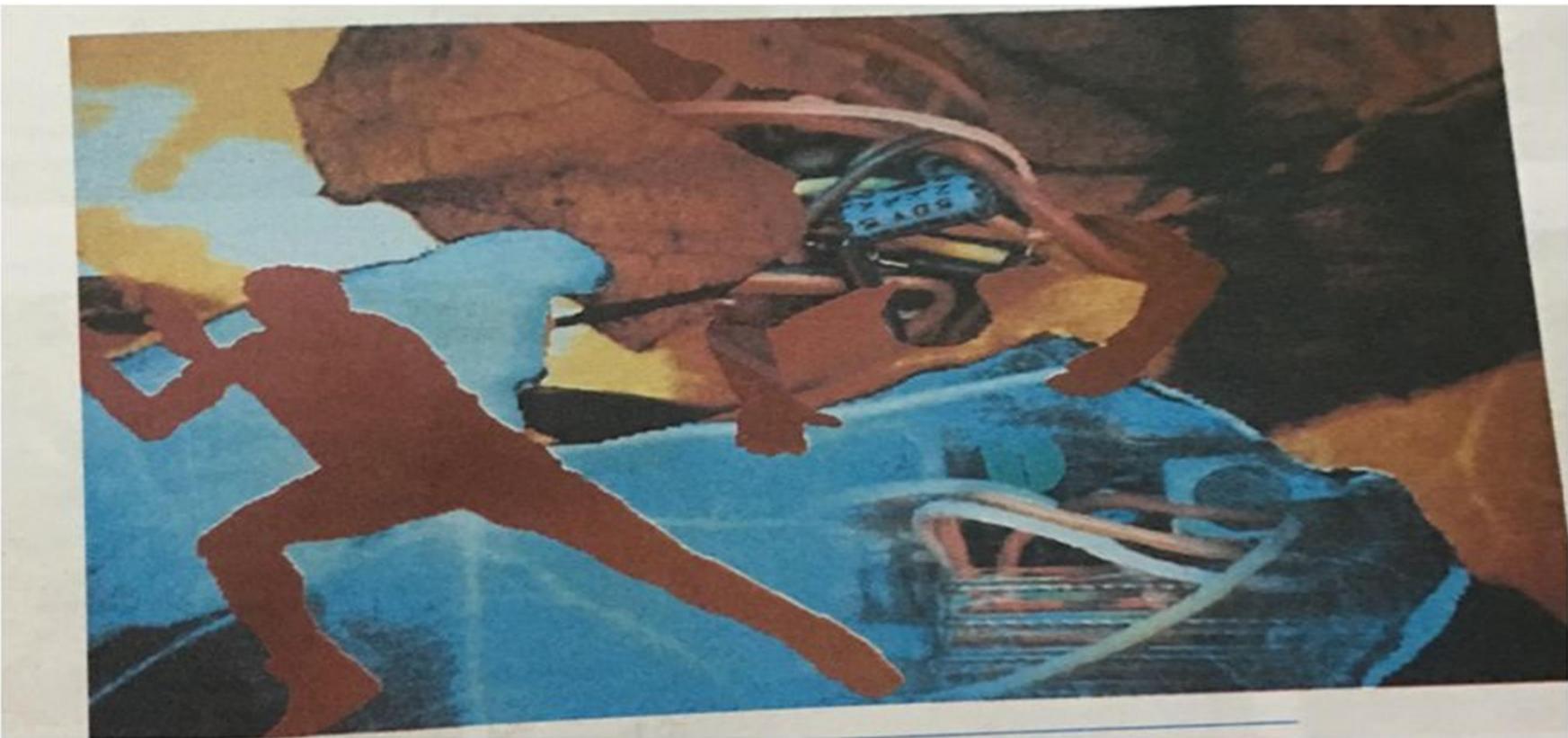


Fig 1.27 The artist of this picture, called Electronic Avalanche, makes a statement about our entanglement with technology using a personal computer with a graphics tablet and Lumena software to combine renderings of leaves, flower petals and electronic components with scanned images



Fig 1.28 From a series called Spheres of Influence, this electronic painting entitled “Whigmalaree” was created with a combination of methods using a graphics tablet, three dimensional modeling, texture mapping and a series of transformations

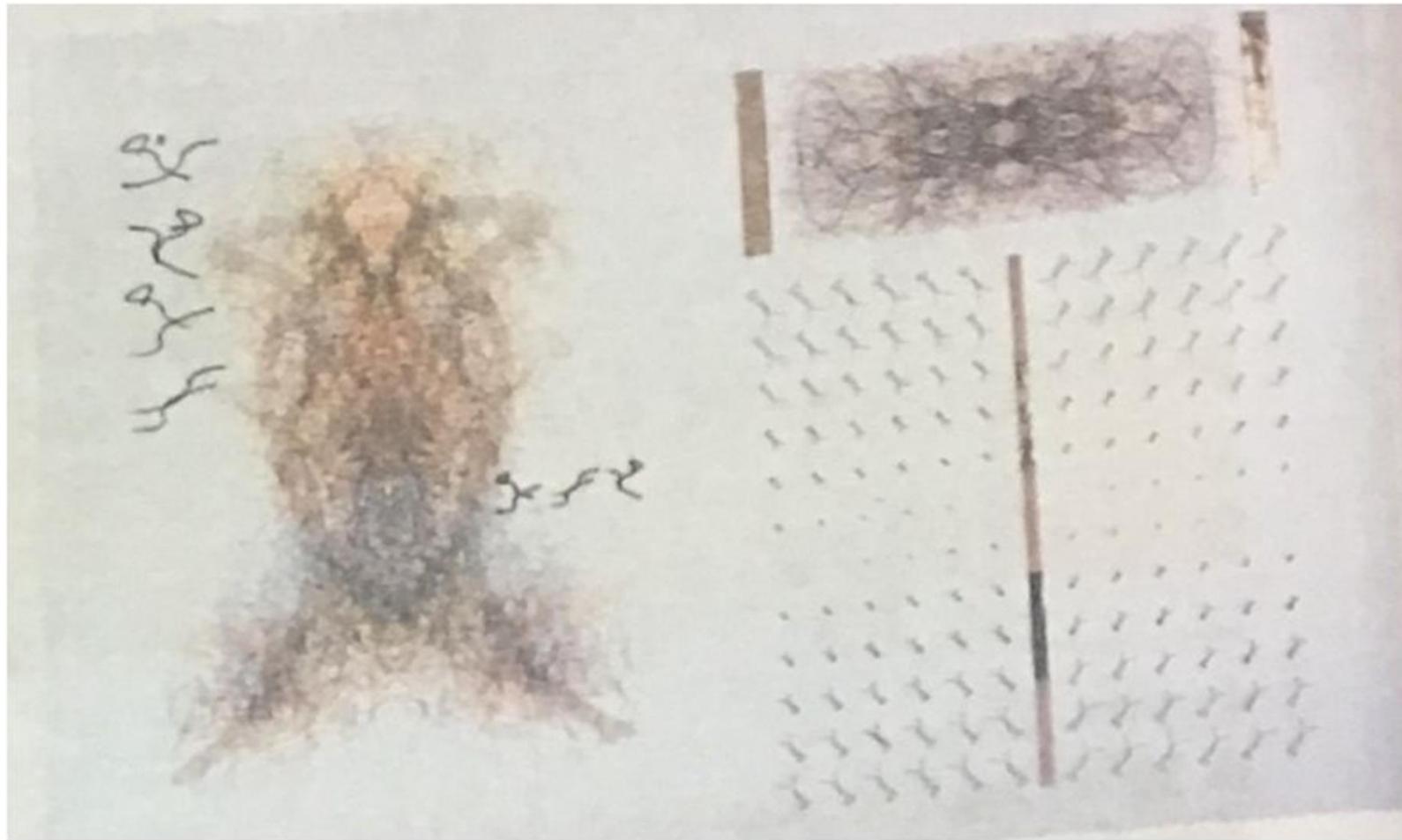


Fig 1.29 Electronic art output to a pen plotter from software. This pen plotter includes multiple pens and painting brushes

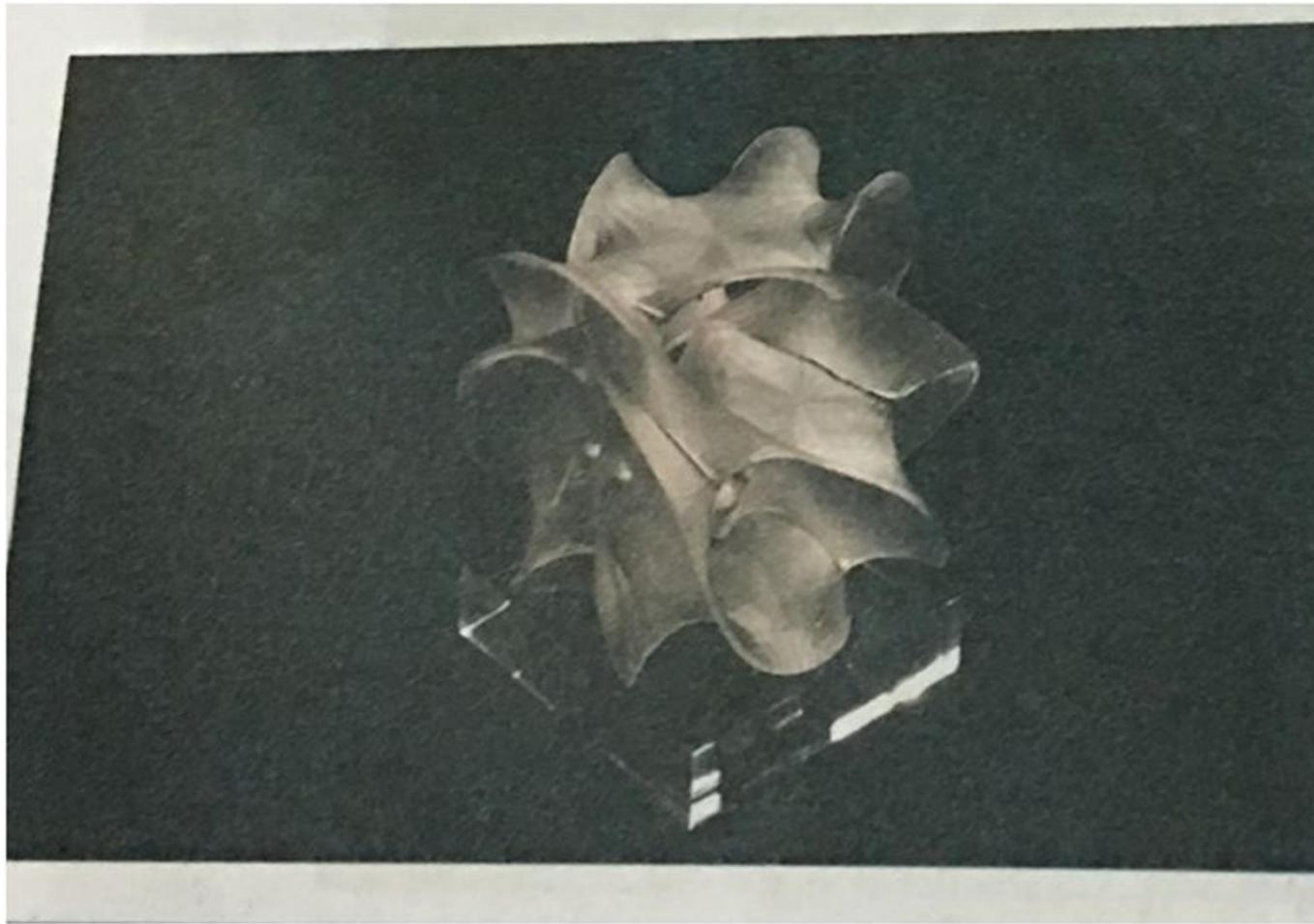


Fig 1.30 This creation is based on a visualization of Fermat's Last theorem  $x^n+y^n = z^n$ , with  $n=5$



Fig 1.31 Using mathematical fractal procedures and super computers, this artist composer experiments with various designs to synthesize form and color with musical composition

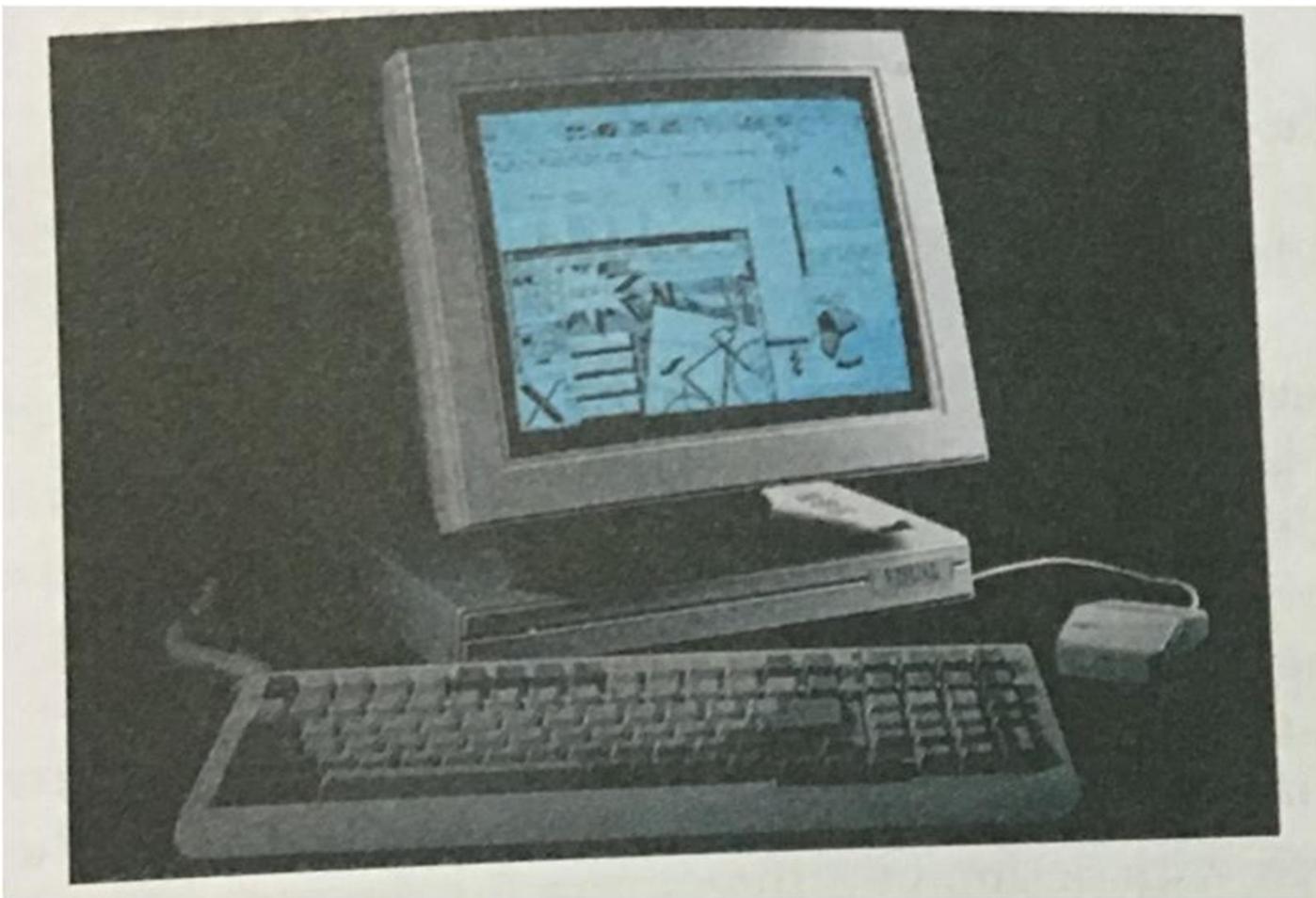
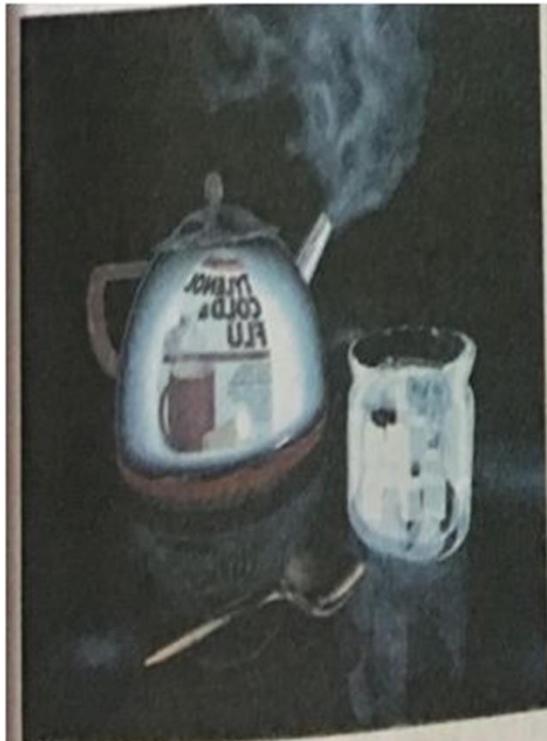


Fig 1.32 Page-layout workstation



Fig 1.33 Three dimensional rendering for a logo



(a)



(b)

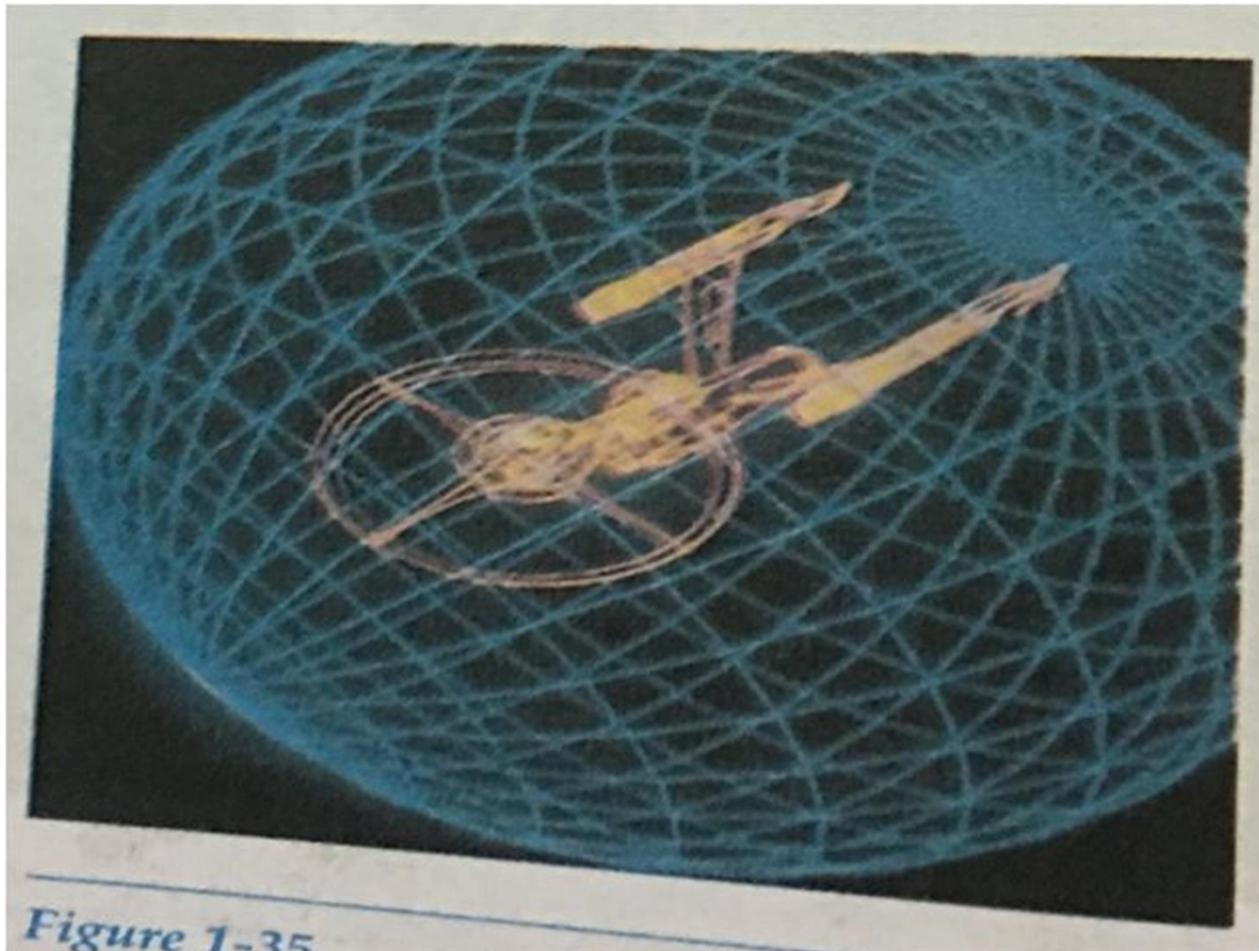


(c)

Fig 1.34 Product advertising

# 4. Entertainment

- Used in making motion pictures, music videos and television shows



*Figure 1-35*

Fig 1.35 Graphics developed for the Paramount Pictures movie Star Trek

- "Star Trek II" Includes the First Completely Computer-Generated

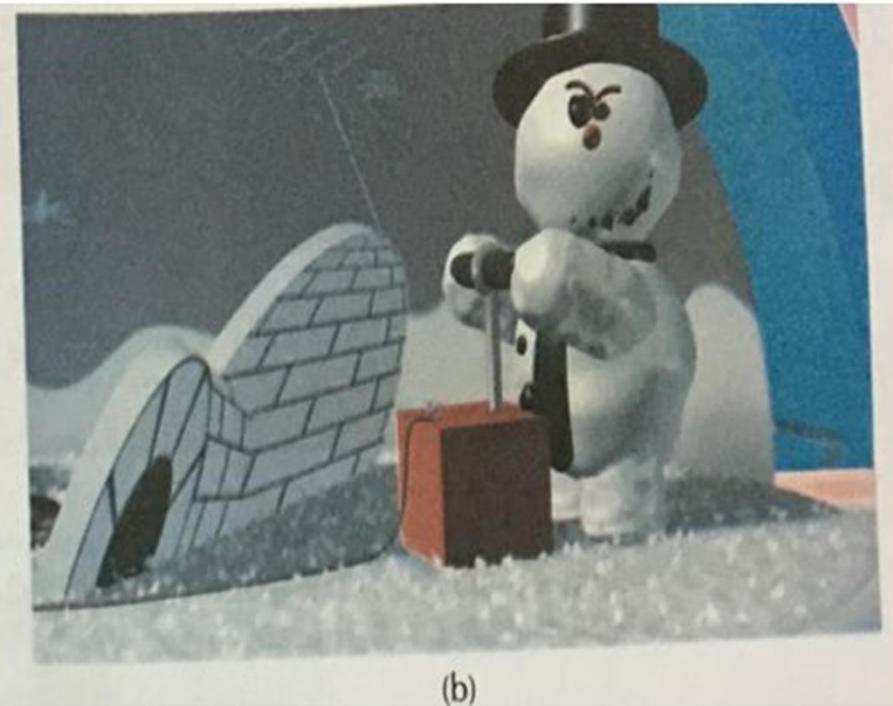
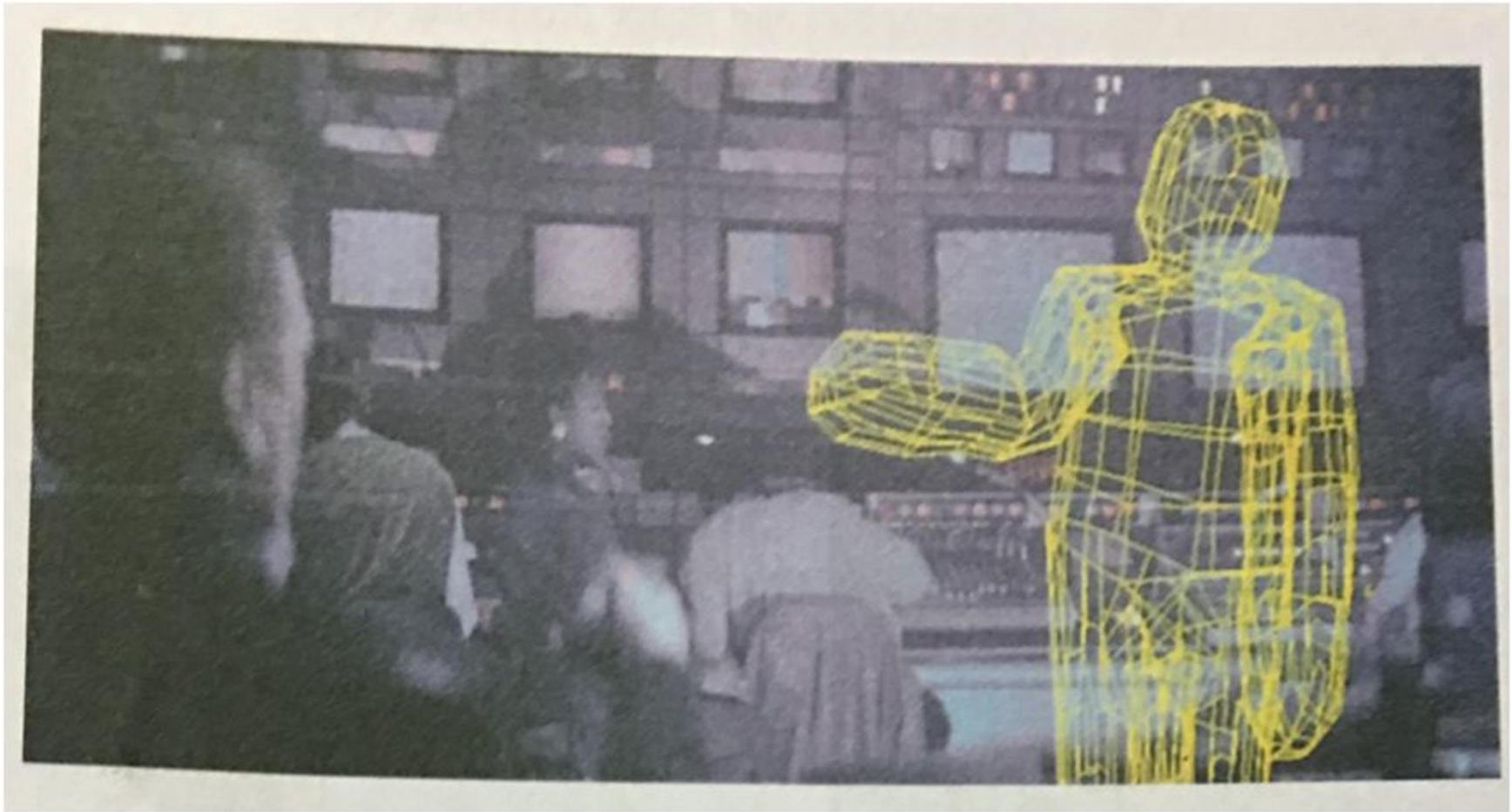


Fig 1.36 a. A computer-generated scene from the film Red's Dream  
b. A computer-generated scene from the film Knickknack



Fig 1.37 A graphics scene in the TV series Deep Space Nine



**Fig 1.38** Graphics combined with a live scene in the TV series Stay Tuned



Fig 1.39 An image from a reconstruction of 13<sup>th</sup> century Dadu (Beijing today)



Fig 1.40 Examples of morphing from David Byrne video She's Mad

# 5. Education and Training

- Models of physical, financial and economic systems are often used as educational aids

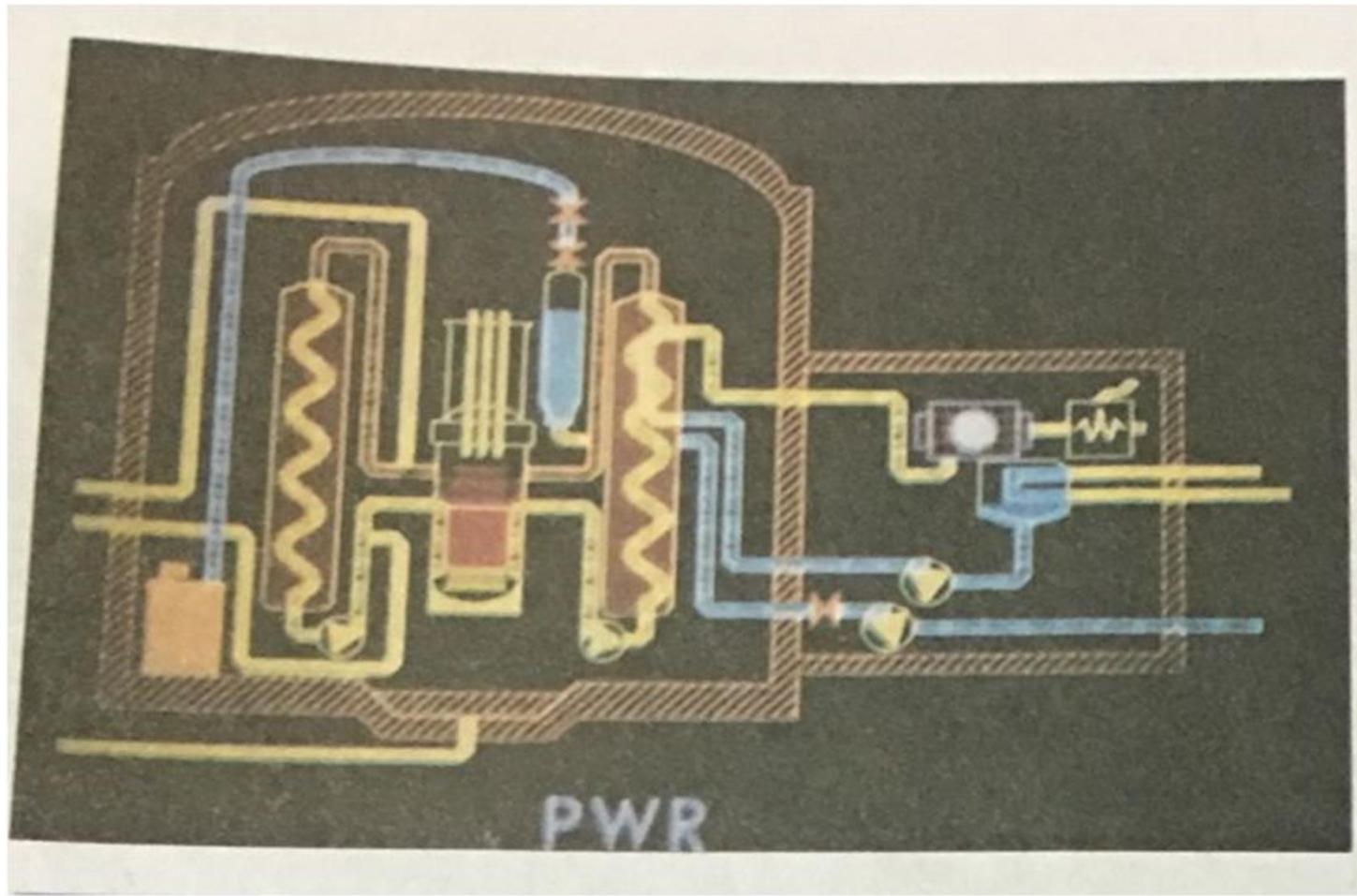


Fig 1.41 Color-coded diagram used to explain the operation of a nuclear reactor

Fig 1.42 A large, enclosed flight simulator with a full-color visual system and six degrees of freedom in its motion

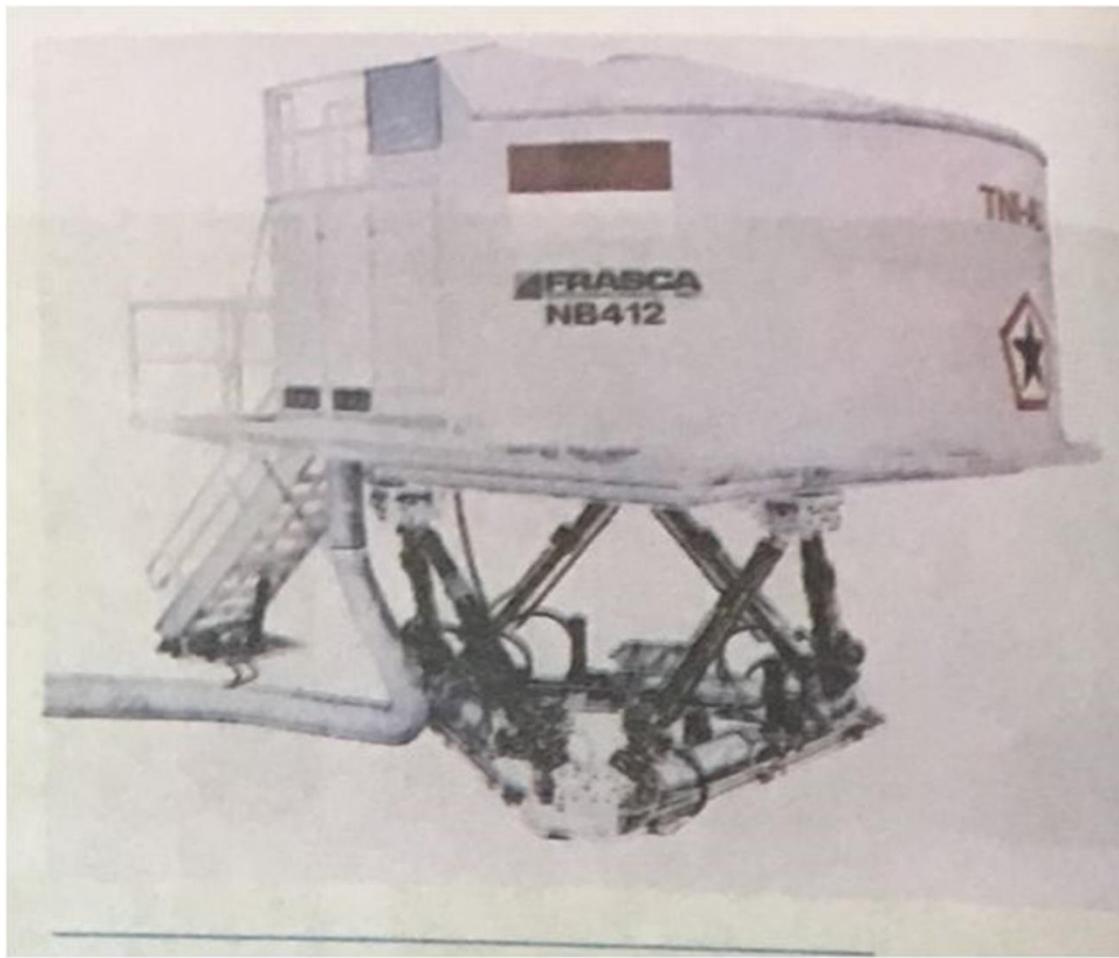




Fig 1.43 A military tank simulator with a visual imagery system



Fig 1.44 a. A flight simulator with an external full-color viewing system

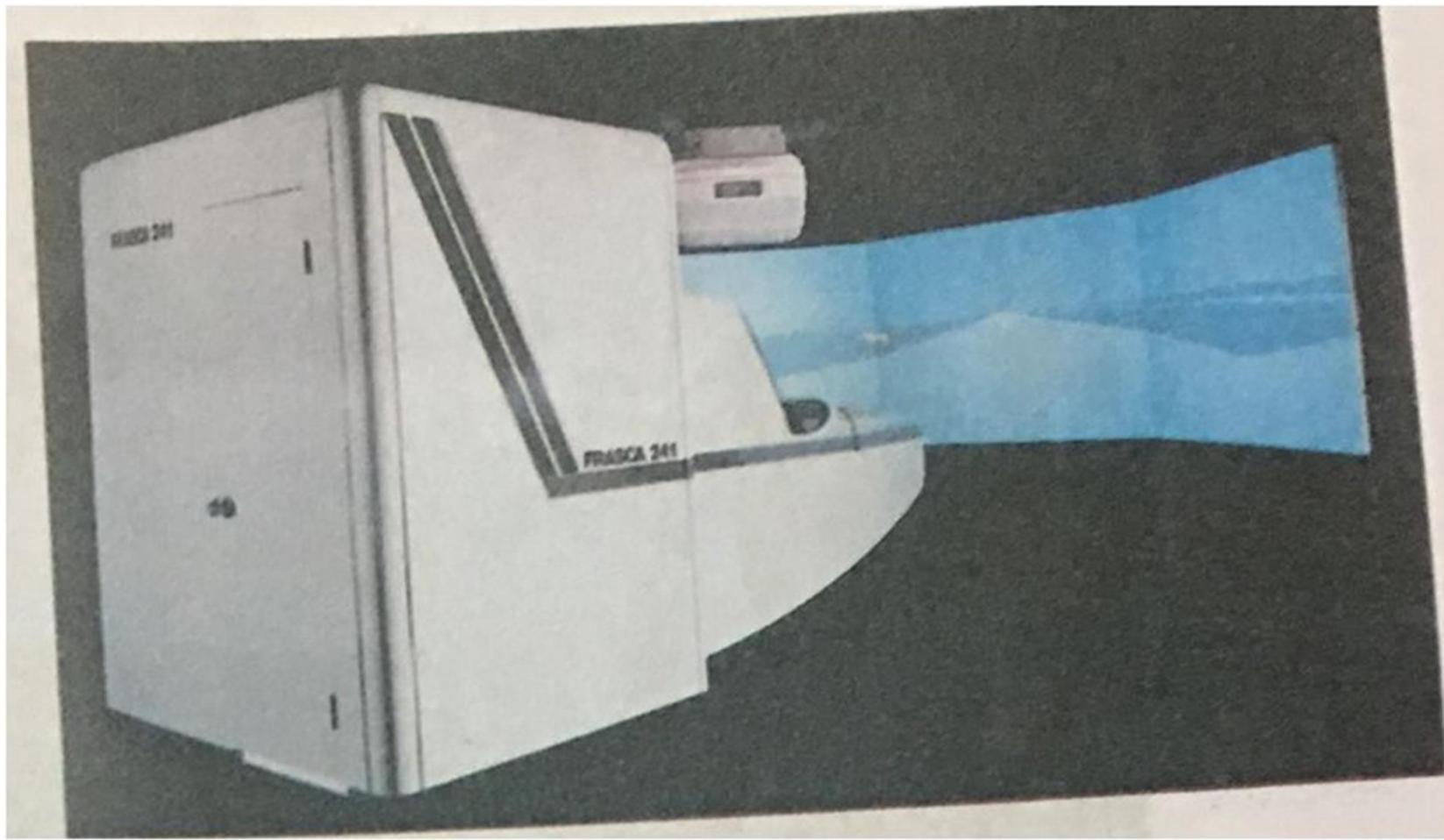


Fig 1.44 b. A flight simulator with an external full-color viewing system



Fig 1.45 An instructor's area in a flight simulator. The equipment allows the instructor to monitor flight conditions and to set airplane and environment parameters



Fig 1.46 Flight-simulator imagery

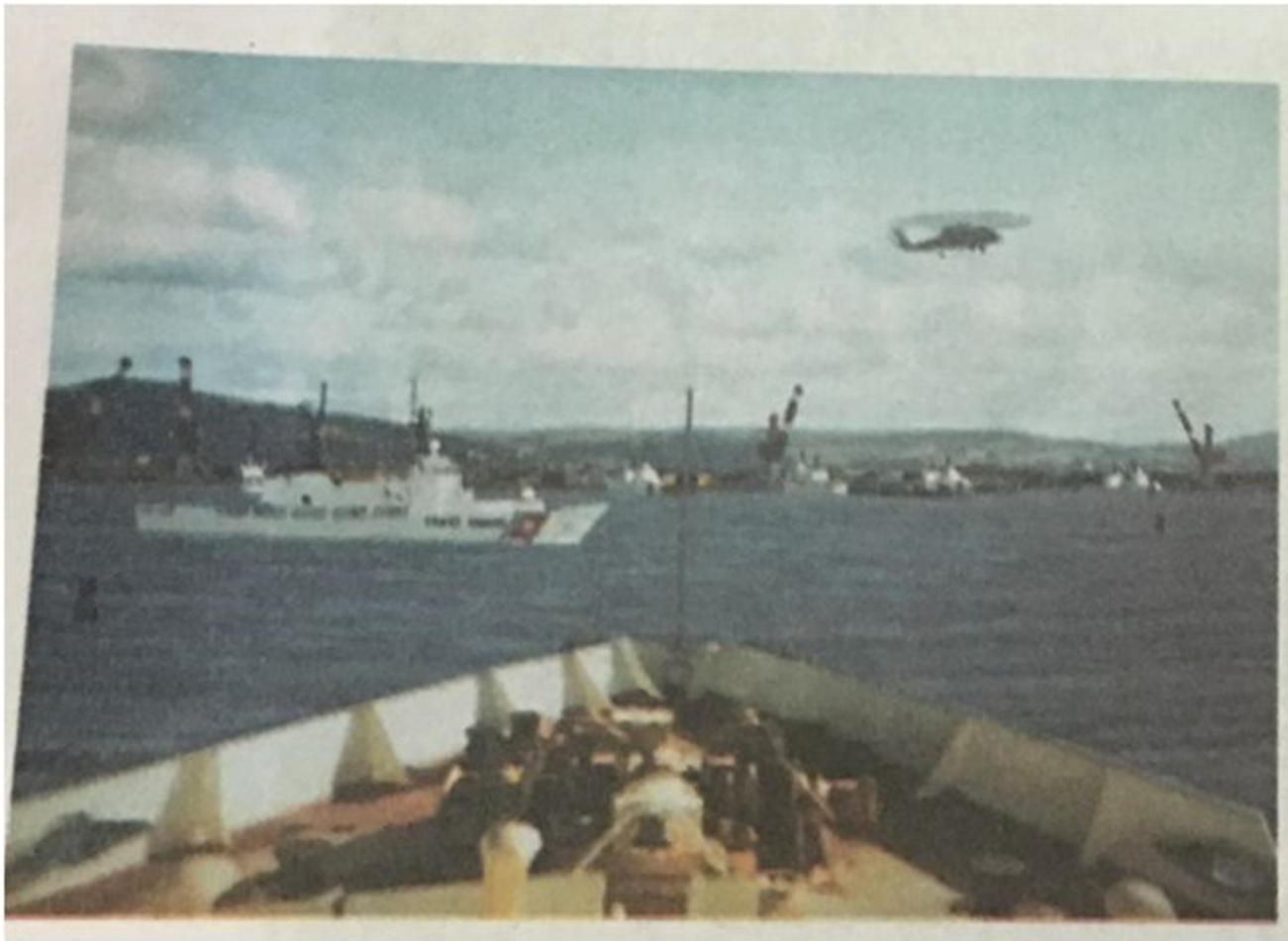


Fig 1.47 Imagery generated for a naval simulator

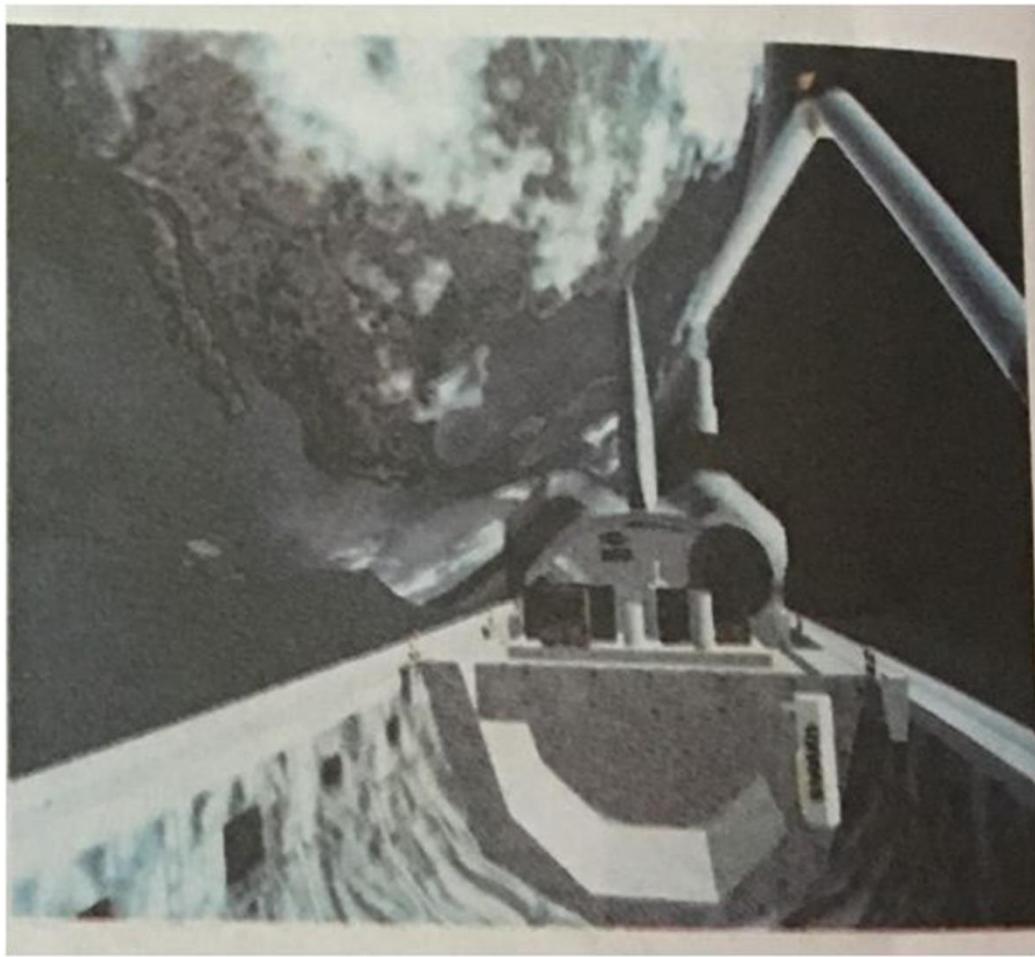


Fig 1.48 Space shuttle imagery



Fig 1.49 Imagery from an automobile simulator used to test driver reaction

# 6. Visualization

- Scientists, engineers, medical personnel, business analysts and others often need to analyze large amounts of information or to study the behavior of certain processes
- Numerical simulations carried out on super computers frequently produce data files containing millions of data values
- Scientific visualization : Producing graphical representations for scientific, engineering and medical data sets and processes

- Business visualization : used in connection with data sets related to commerce, industry and other nonscientific areas
- Important things : Data sets & Visualization techniques
- Data sets
  - Scalar
  - Vectors
  - Higher-order tensors
  - Any combination of these data types

- Visualization methods
  - Color coding
  - Contour plots
  - Graphs and charts
  - Surface renderings
  - Visualization of volume interiors
  - Image processing

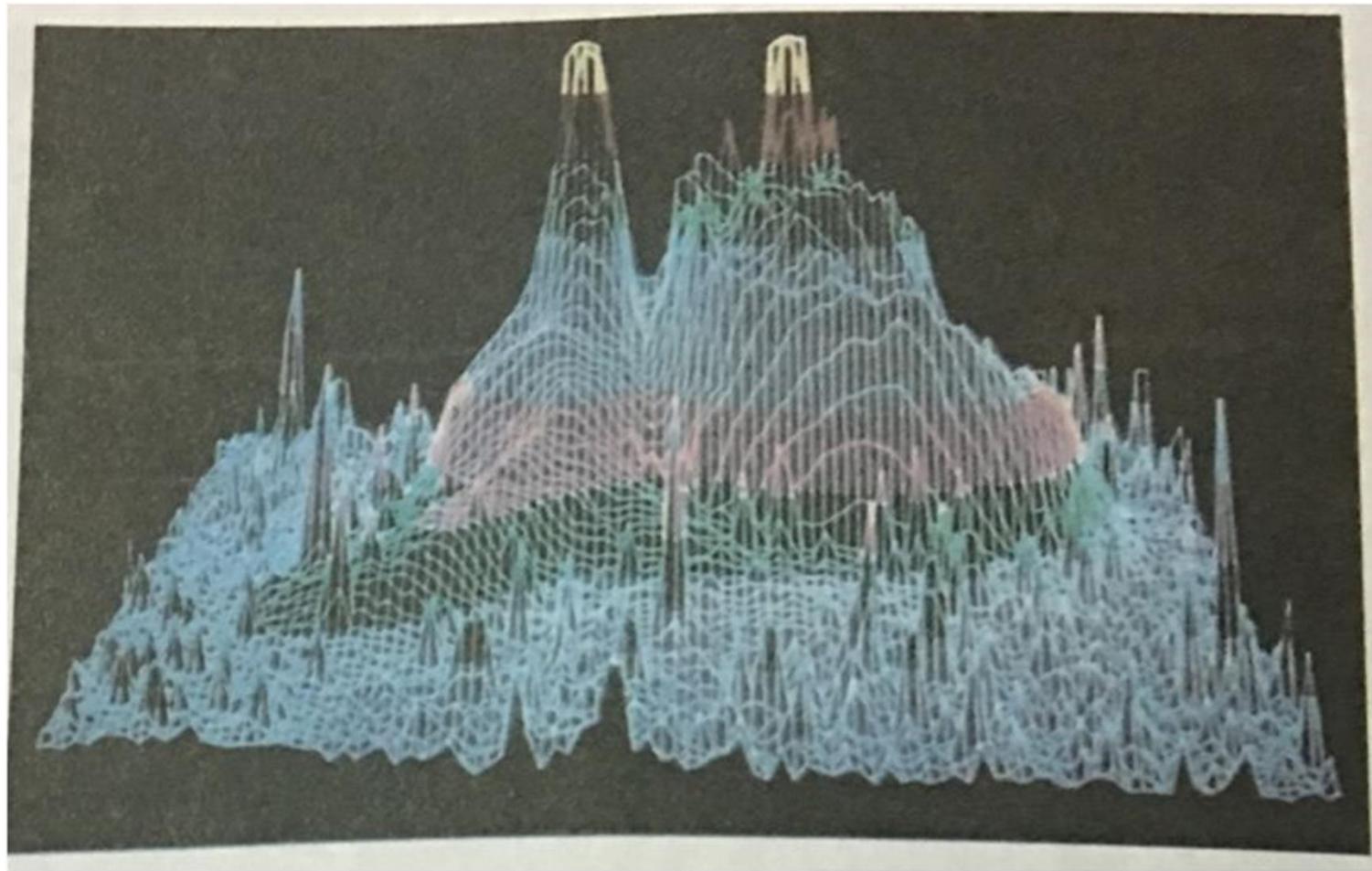


Fig 1.50 A color-coded plot with 16 million density points of relative brightness observed for the Whirlpool Nebula reveals two distinct galaxies

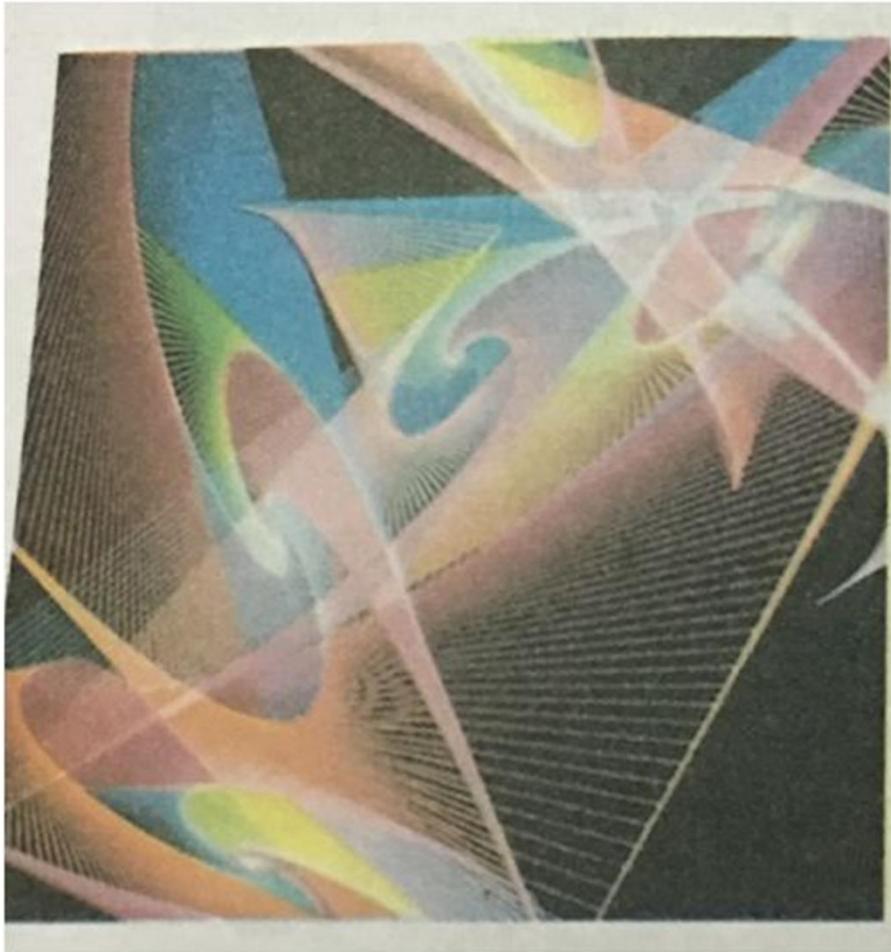


Fig 1.51 Mathematical curve functions plotted in various color combinations

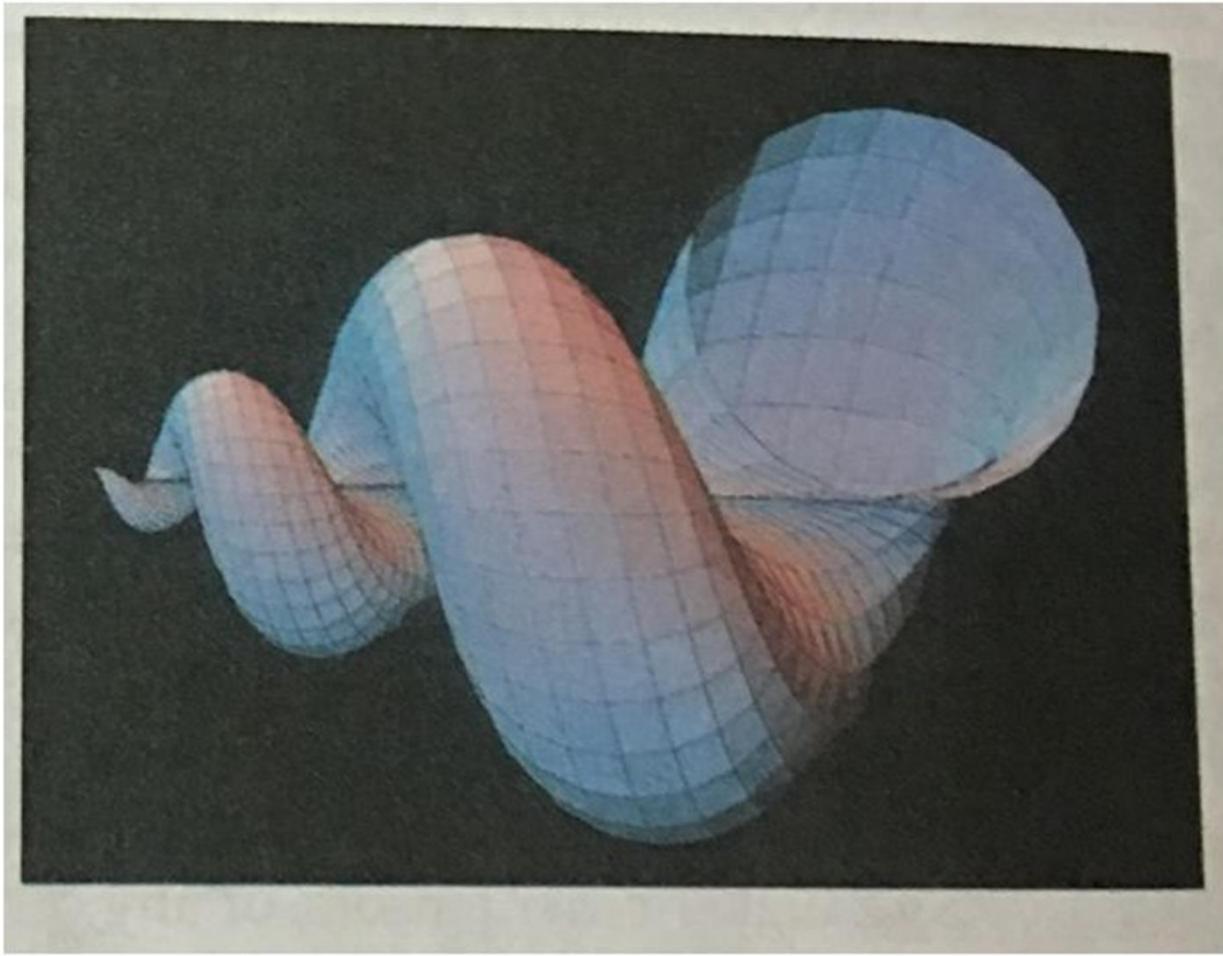


Fig 1.52 Lighting effects and surface-rendering techniques were applied to produce this surface representation for a three dimensional function



Fig 1.53 A four-dimensional object projected into three-dimensional space, then projected to a video monitor and color-coded . The object was generated using quaternions and fractal squaring procedures, with an octant subtracted to show the complex Julia set

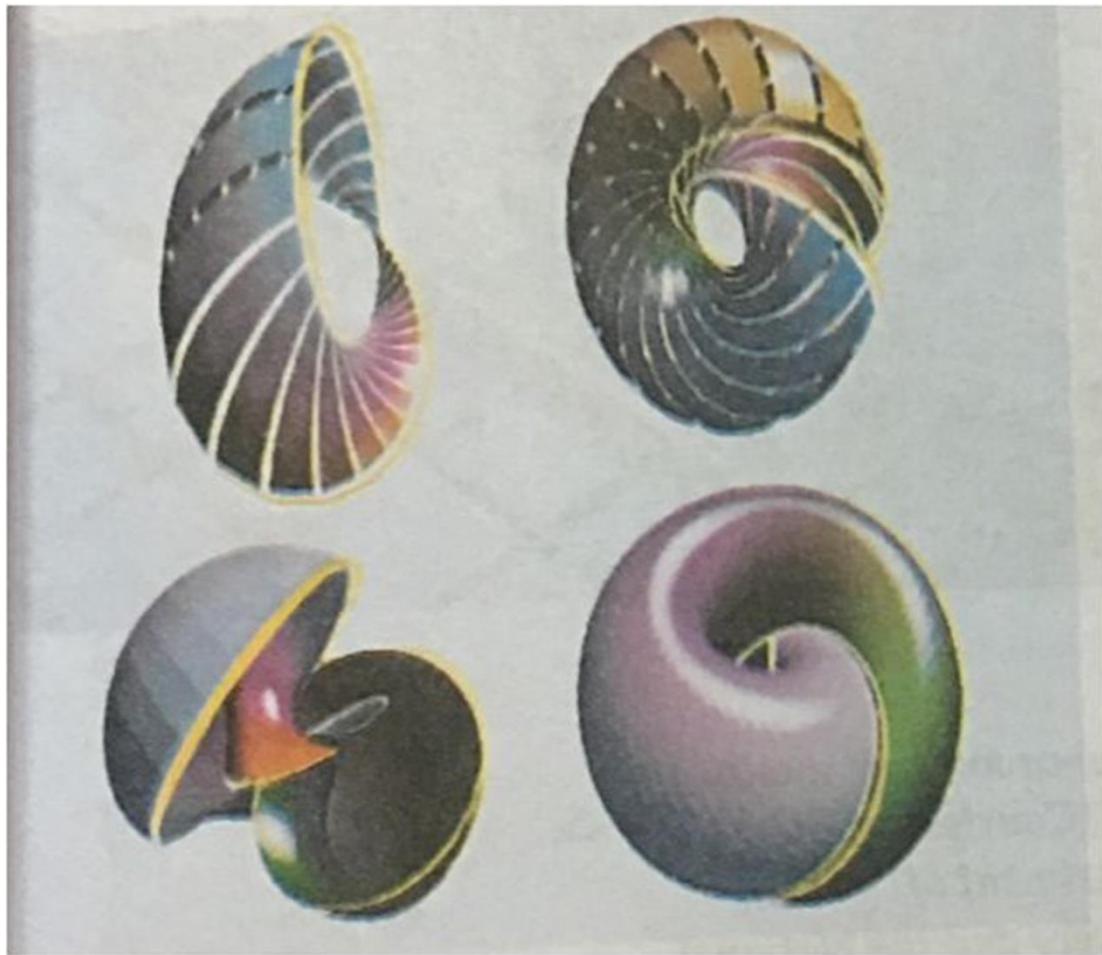


Fig 1.54 Four views from a real-time interactive computer animation study of minimal surfaces (“snails”) in the 3-sphere projected to 3D Euclidean space



Fig 1.55 A method for graphing and modeling data distributed over a spherical surface

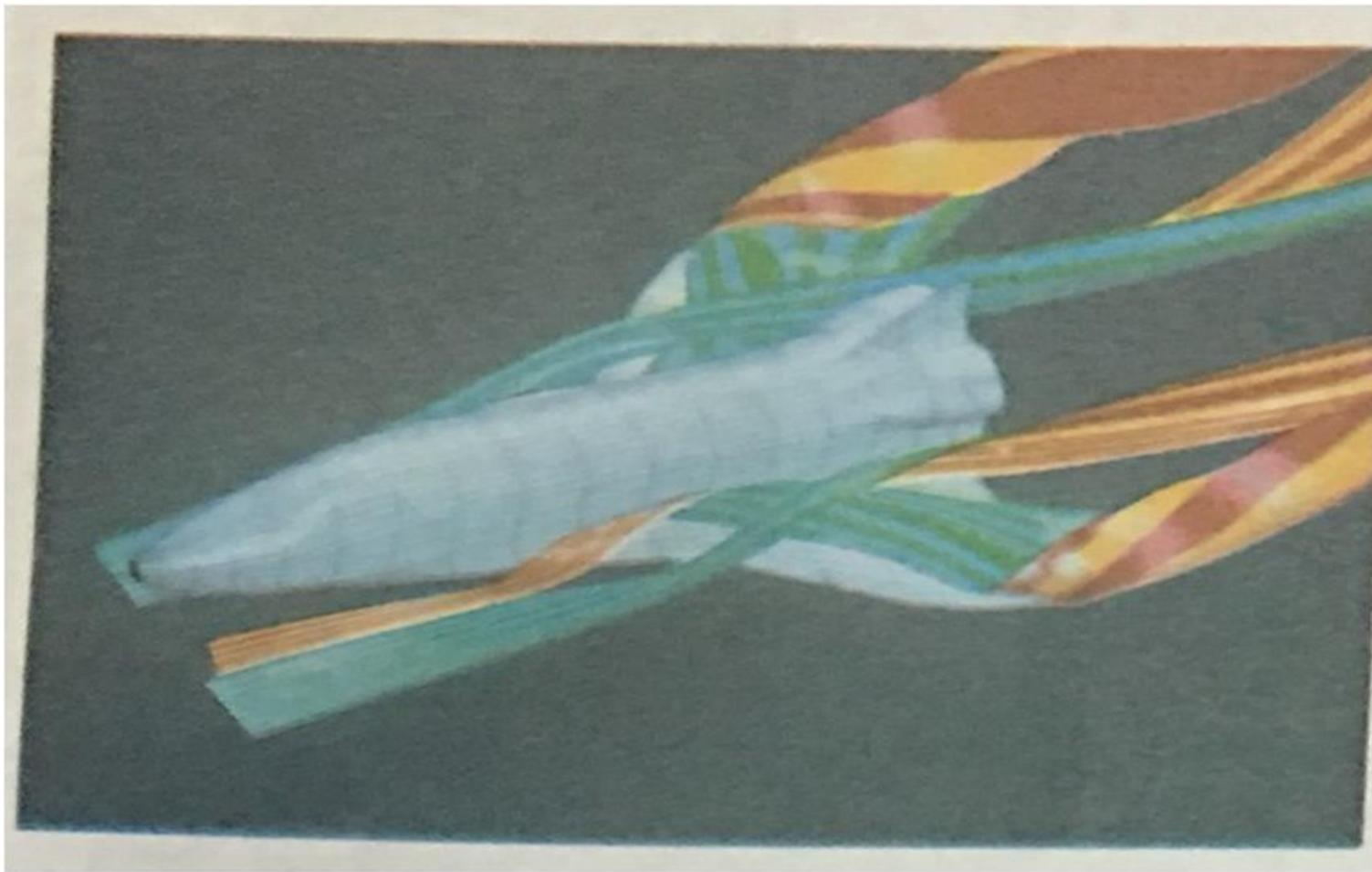


Fig 1.56 A visualization of stream surfaces flowing past a space shuttle

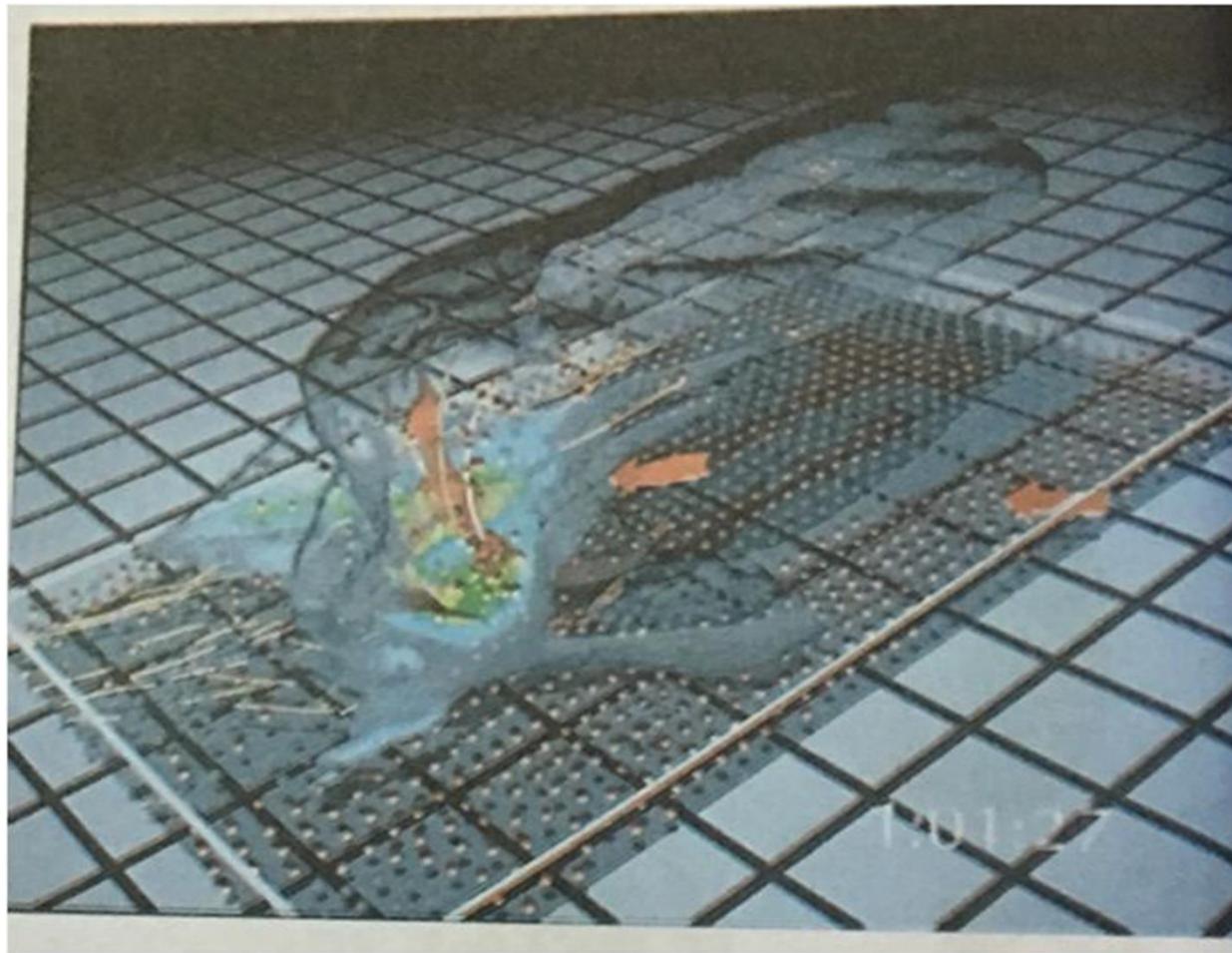


Fig 1.57 Numerical model of airflow inside thunderstorm



Fig 1.58 Numerical model of the surface of a thunderstorm

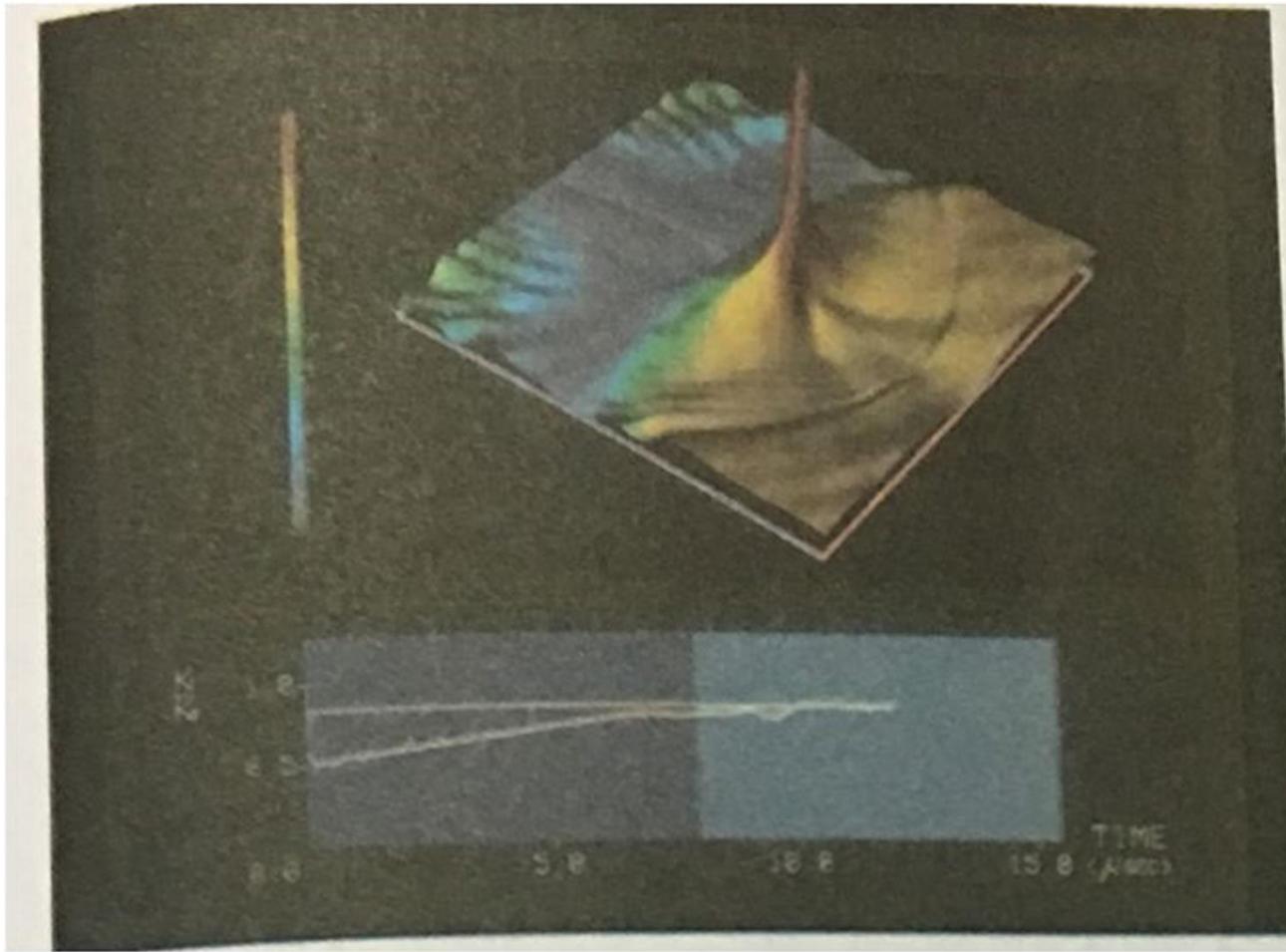


Fig 1.59 Color-coded visualization of stress energy density in a crack-propagation study for metal plates, modeled by Bob Haber

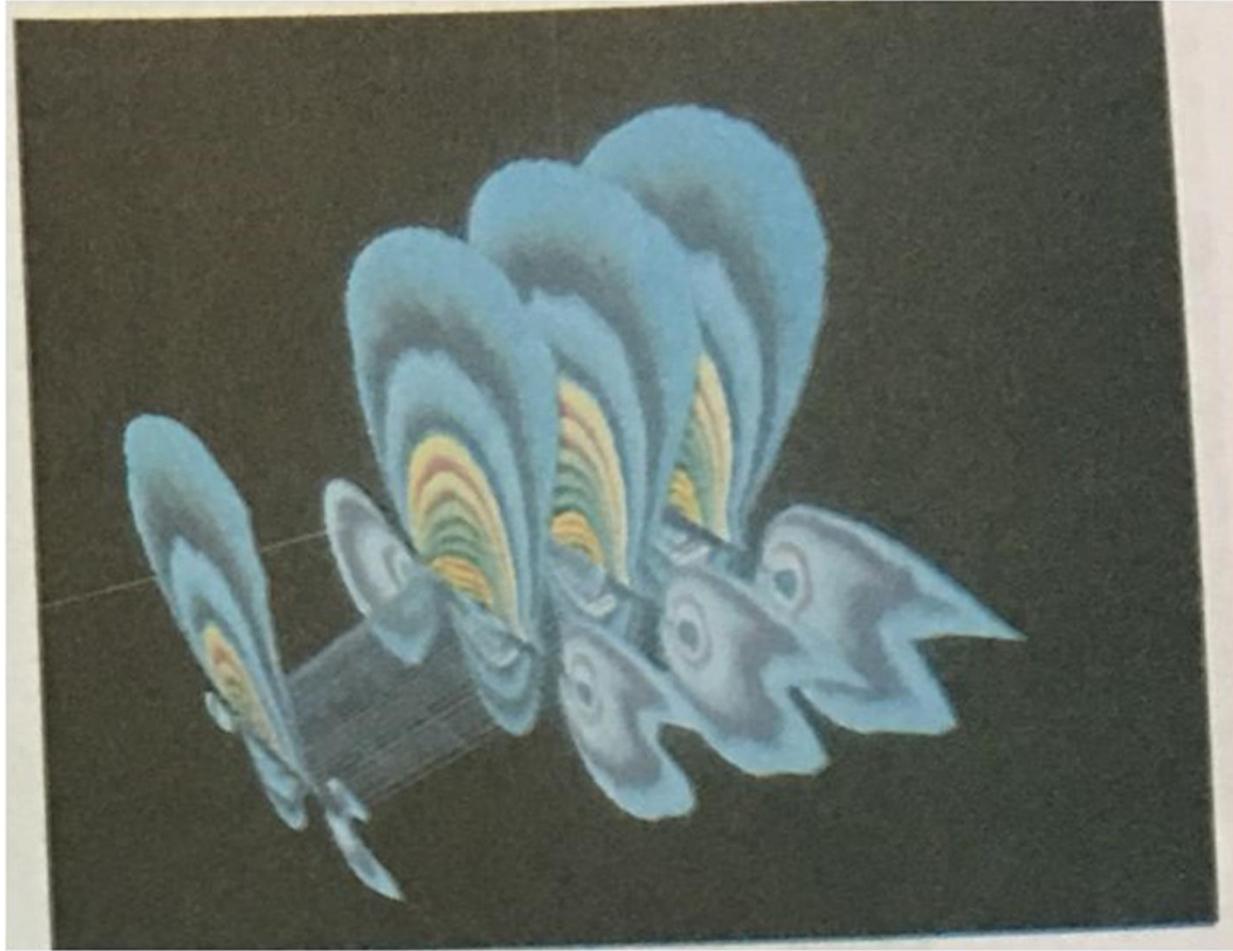


Fig 1.60 A fluid dynamic simulation, showing a color-coded plot of fluid density over a span of grid planes around an aircraft wing



Fig 1.61 Commercial slicer-dicer software, showing color-coded data values over cross-sectional slices of dataset



Fig 1.62 Visualization of a protein structure



Fig 1.63 Stereoscopic viewing of a molecular structure using a “boom” device

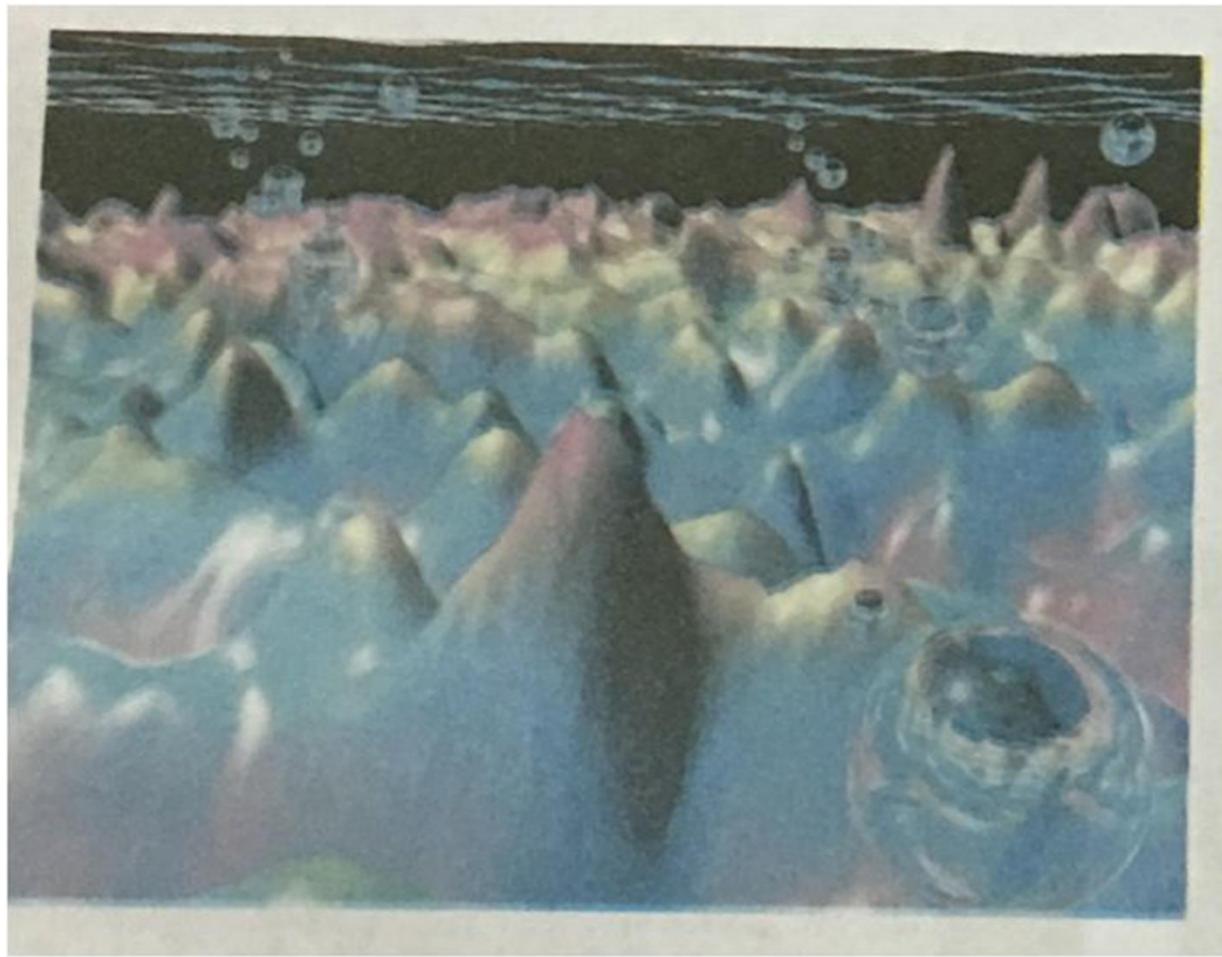


Fig 1.64 One image from a stereoscopic pair, showing a visualization of the ocean floor obtained from satellite data



Fig 1.65 A simulation of the effects of the Kuwait oil fire

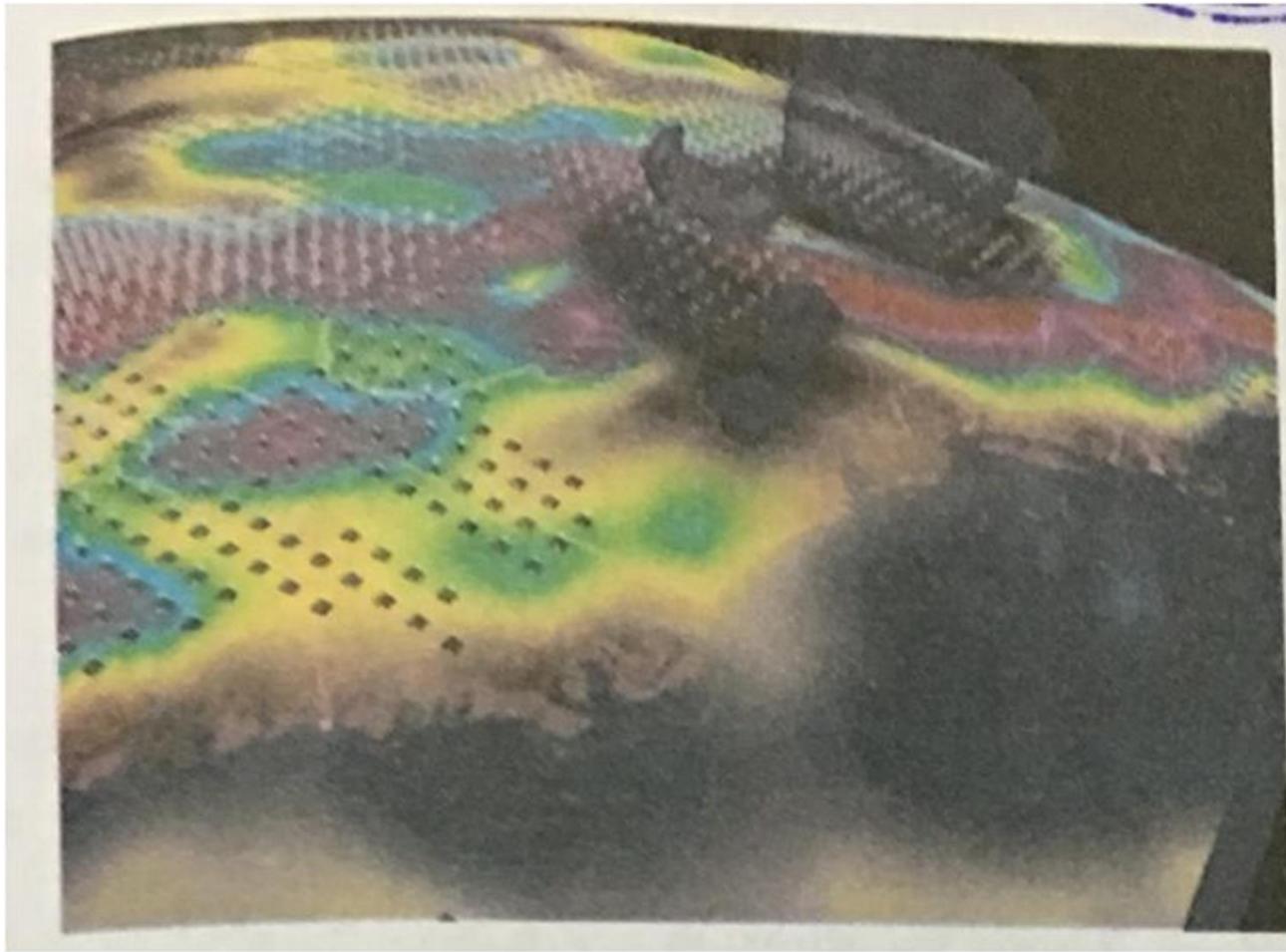


Fig 1.66 A visualization of pollution over the earth's surface



Fig 1.67 One frame of an animation sequence showing the development of a corn ear

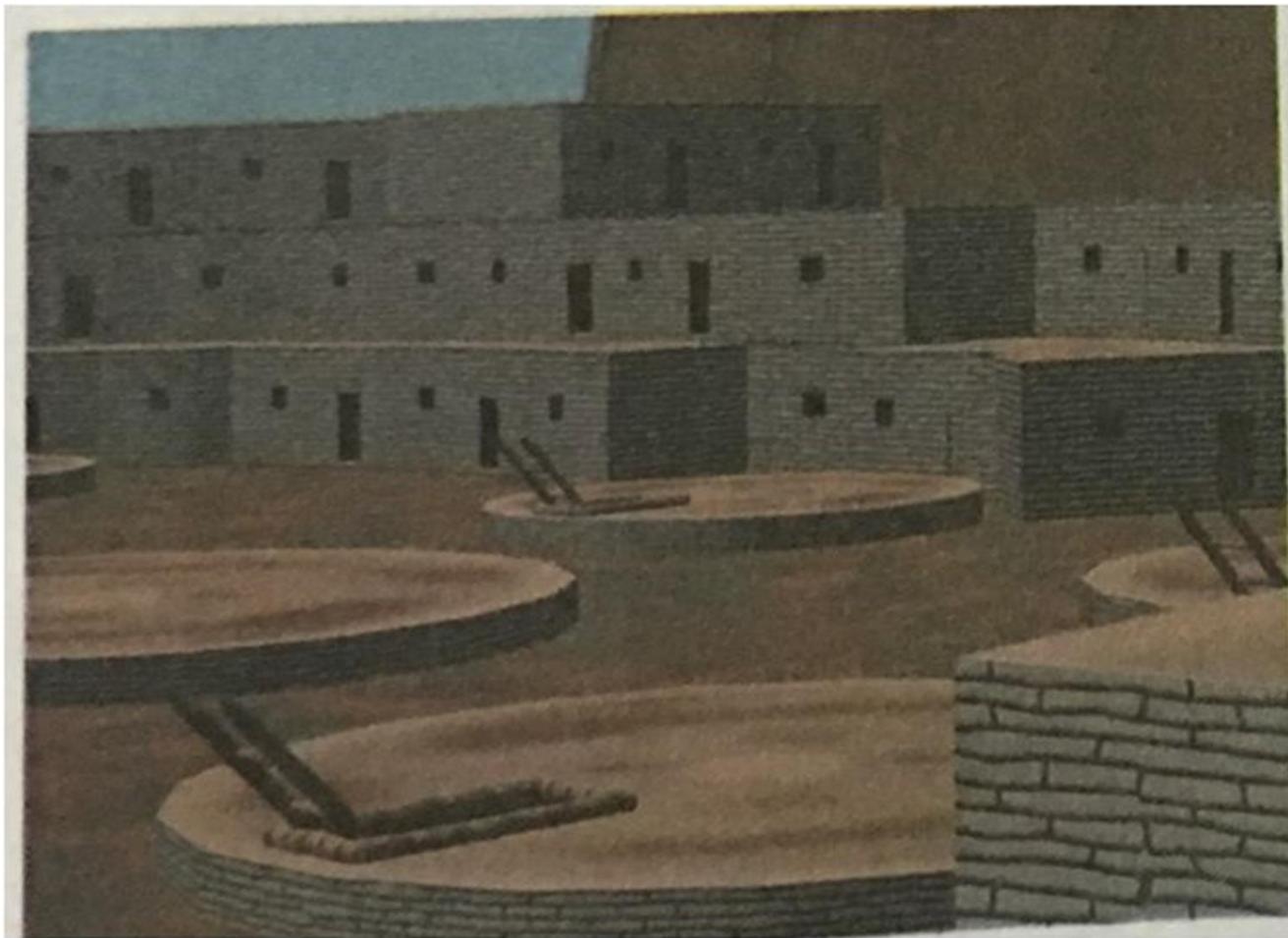


Fig 1.68 A visualization of the reconstruction of the ruins at Chao Canyon

- By mapping the class proportions onto the group bars, we can see the correlation between the pedestrian injury and other attributes!

## Statistical Analysis

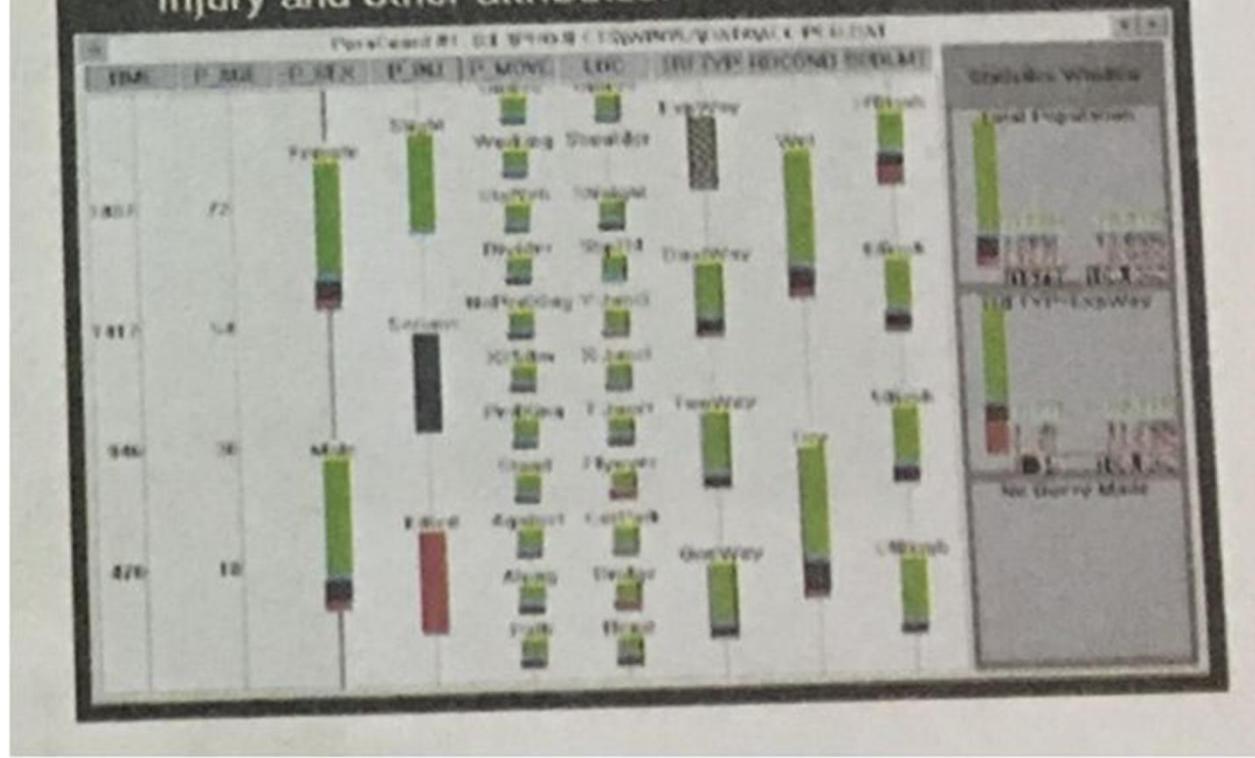


Fig 1.69 A prototype technique, called WinViz, for visualizing tabular multidimensional data is used here to correlate statistical information on pedestrians involved in automobile accidents.

# 7. Image Processing

- Computer graphics : A computer is used to create a picture
- Image processing : Applies techniques to modify or interpret existing pictures such as photographs and TV scans
- 2 principal applications of image processing
  - Improving picture quality
  - Machine perception of visual information as used in robotics

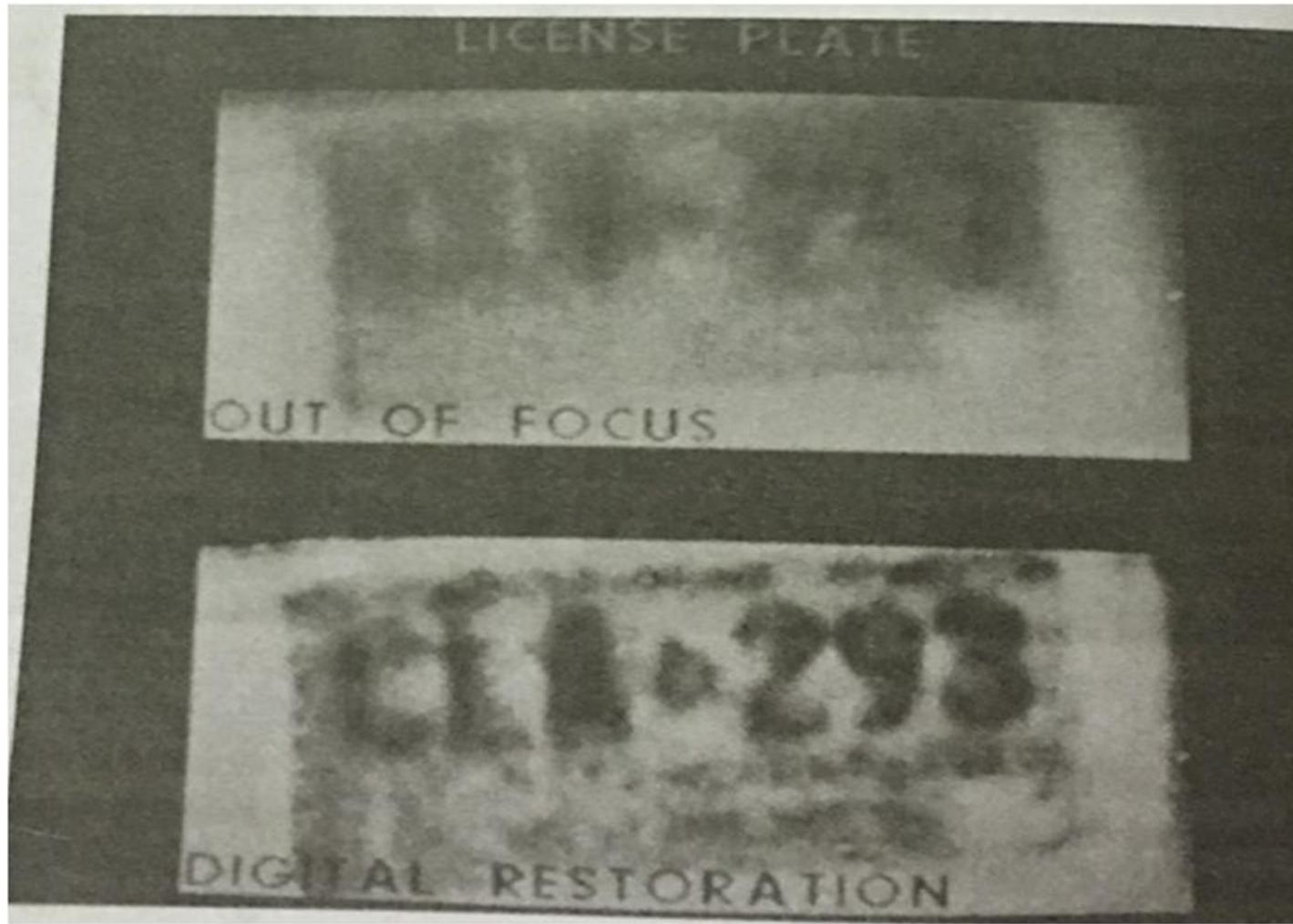


Fig 1.70 A blurred photograph of a license plate becomes legible after the application of image processing techniques



Fig 1.71 One frame from a computer animation visualizing cardiac activation levels within regions of a semi-transparent volume-rendered dog heart

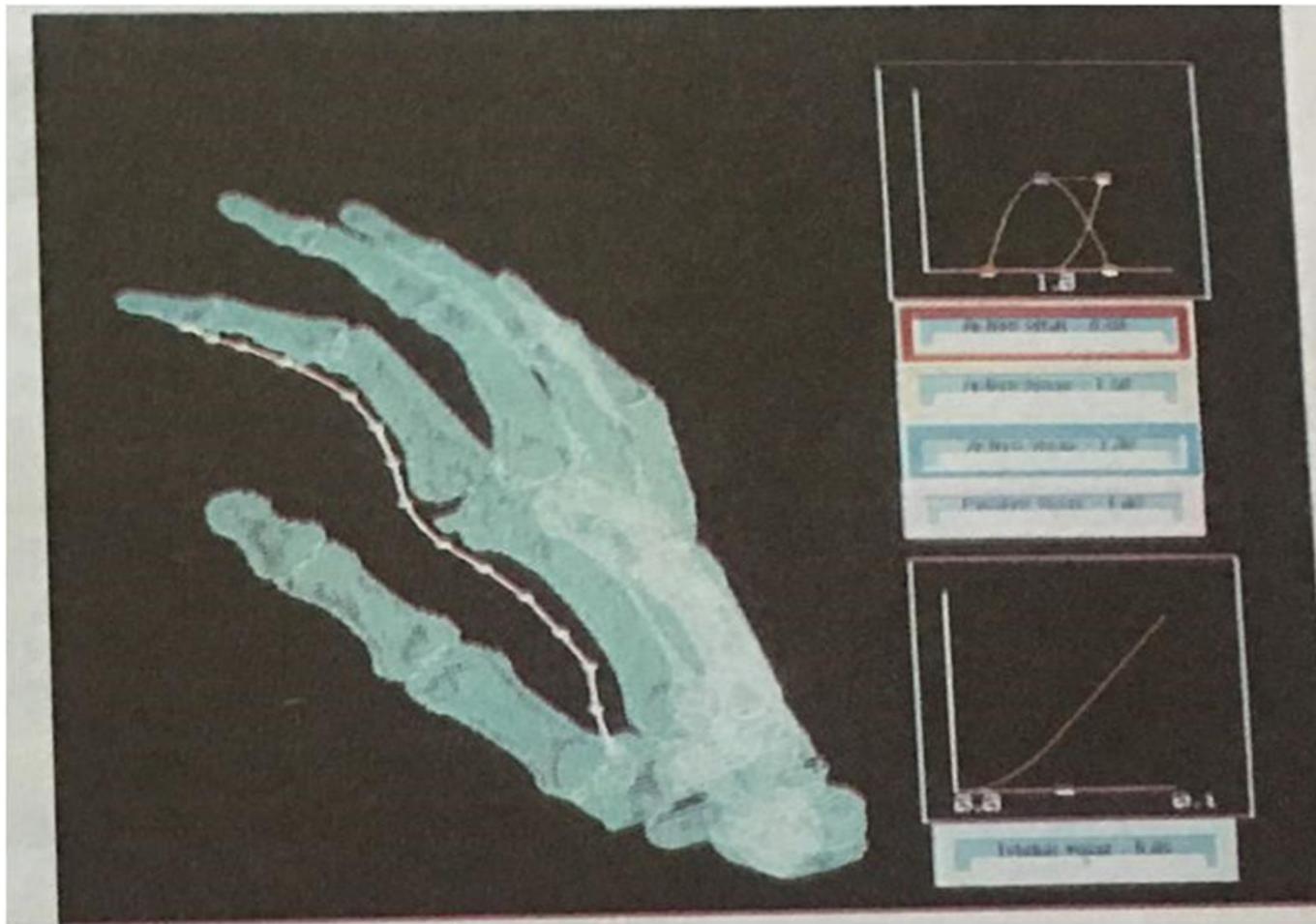


Fig 1.72 One image from a stereoscopic pair showing the bones of a human hand. These images show a possible tendon path for reconstructive surgery

Smith, M. L. Jasmine. Ast Photo, Dept of QSS.

# 1.8 Graphical User Interfaces

- Provided by most software packages
- A major component is a window manager that allows a user to display multiple window areas
- Each window can contain a different process that can contain graphical and non-graphical displays
- To make a particular window active just click on the 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
- Advantages of icons
  - Take up less screen space
  - Can be understood more quickly if well designed



Fig 1.73 A GUI showing multiple window areas, menus, and icons