UCS-505
Computer Graphics

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Introduction
(What is Computer Graphics?)

Computer graphics is an art of drawing pictures, lines, circles, charts, etc. using computers with the help of programming.

It involves display, manipulation and storage of pictures and experimental data for proper visualization using a computer.

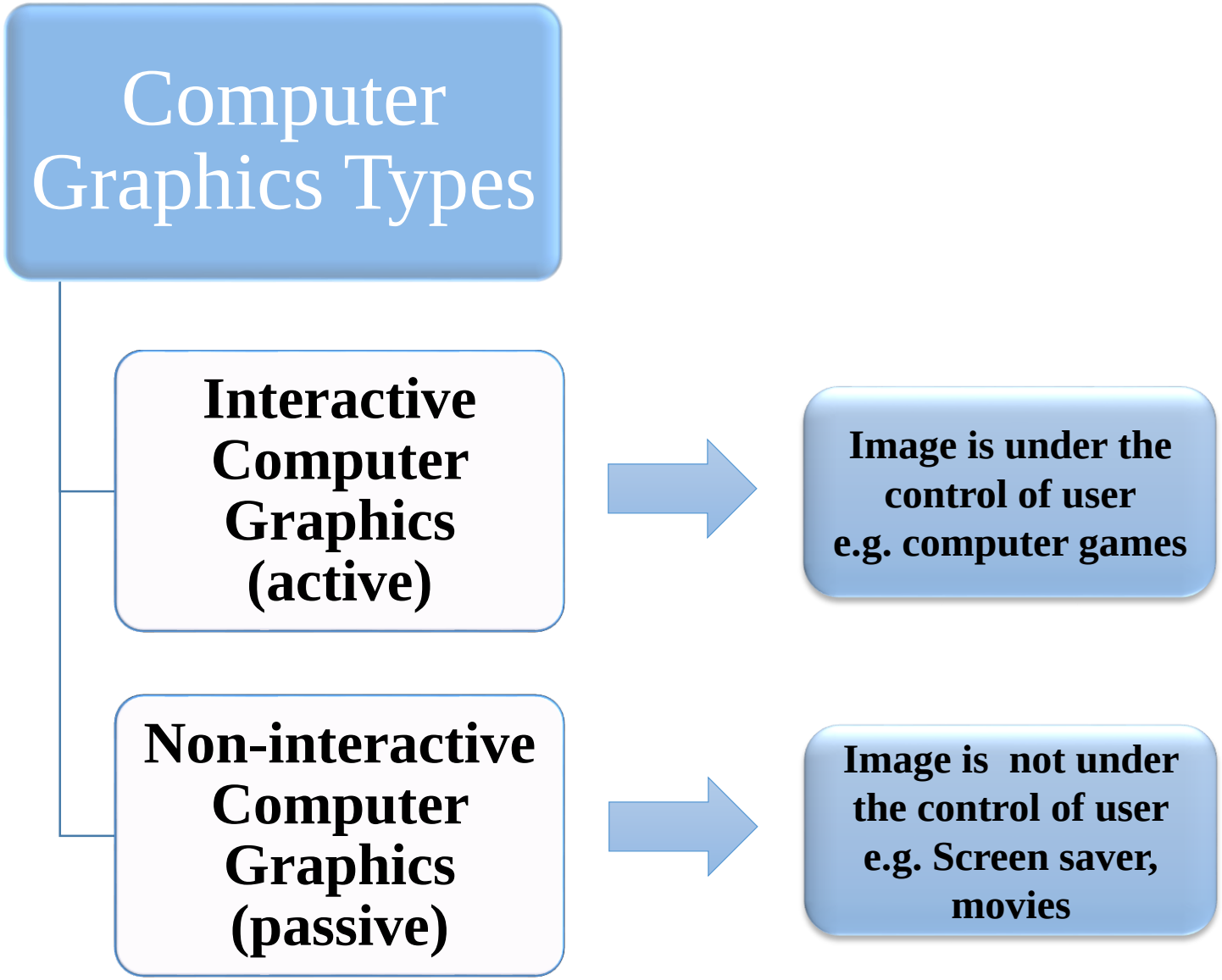
What is Computer Graphics?

- **Sliced by specialty**
  - Imaging = *representing 2D images*
  - Modeling = *representing 3D objects*
  - Rendering = *building 2D images from 3D models*
  - Animation = *simulating changes over time*
  - Hardware = *computer architecture for graphics*

- **Sliced by task**
  - Creating pictures on a computer
  - Interacting with those pictures
  - Drawing those pictures faster
  - Displaying those pictures bigger, brighter
  - Simulating physical phenomena
  - Visualization of complex data
  - Acquiring real-world geometry
  - Simulating plants
  - Video games
  - Breaking stuff

Why is Graphics Cool?

- Interdisciplinary
  - Biology, Physics, Math, Psychology, CS, Art
- Visual
- Interactive
- Work can be demoed to technically illiterate friends
- Movies
- Games
- Money
  - Video games: $60B (2020)
  - Movies: $270B (2020)


Computer Graphics Types
Interactive Computer Graphics (active)
Image is under the control of user e.g. computer games
Non-interactive Computer Graphics (passive)
Image is not under the control of user e.g. Screen saver, movies

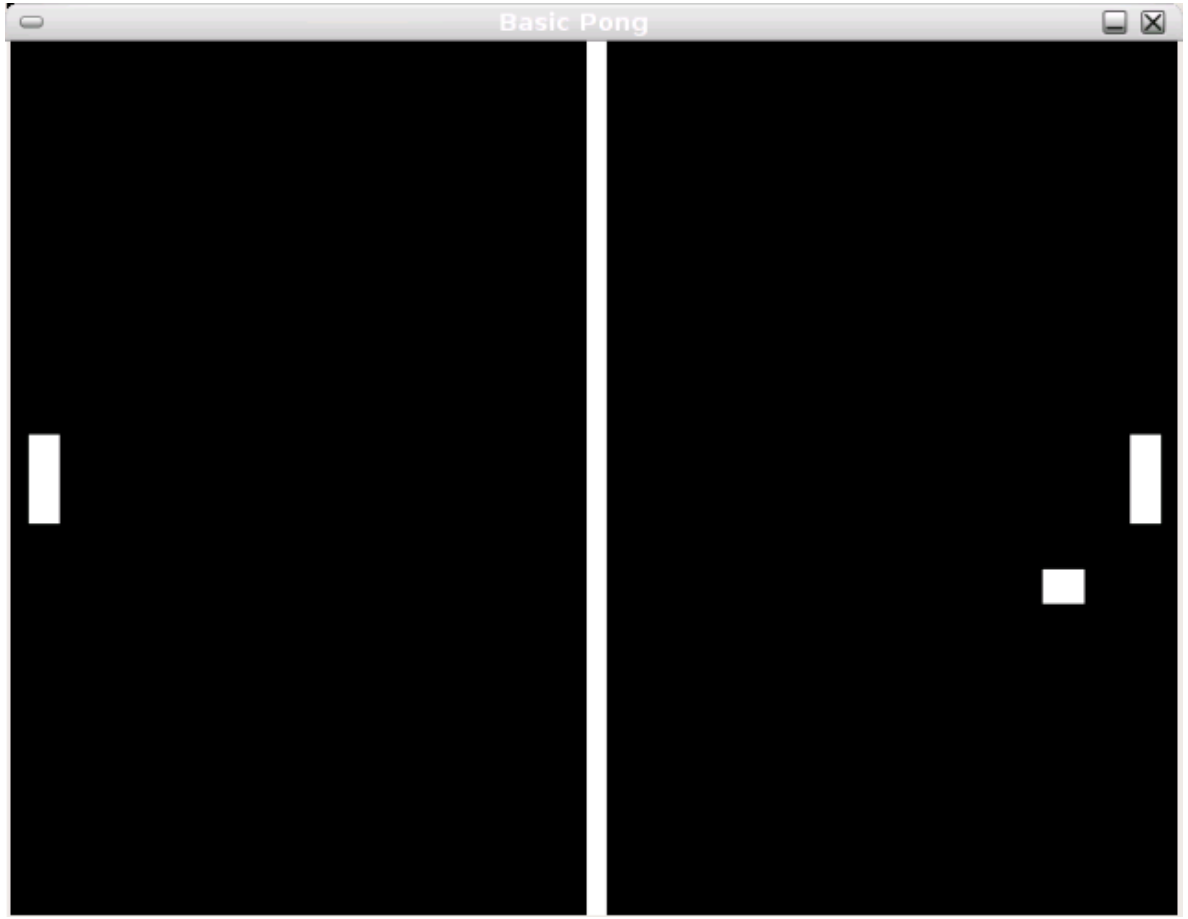
Applications
(What is it good for?)

Entertainment (passive)

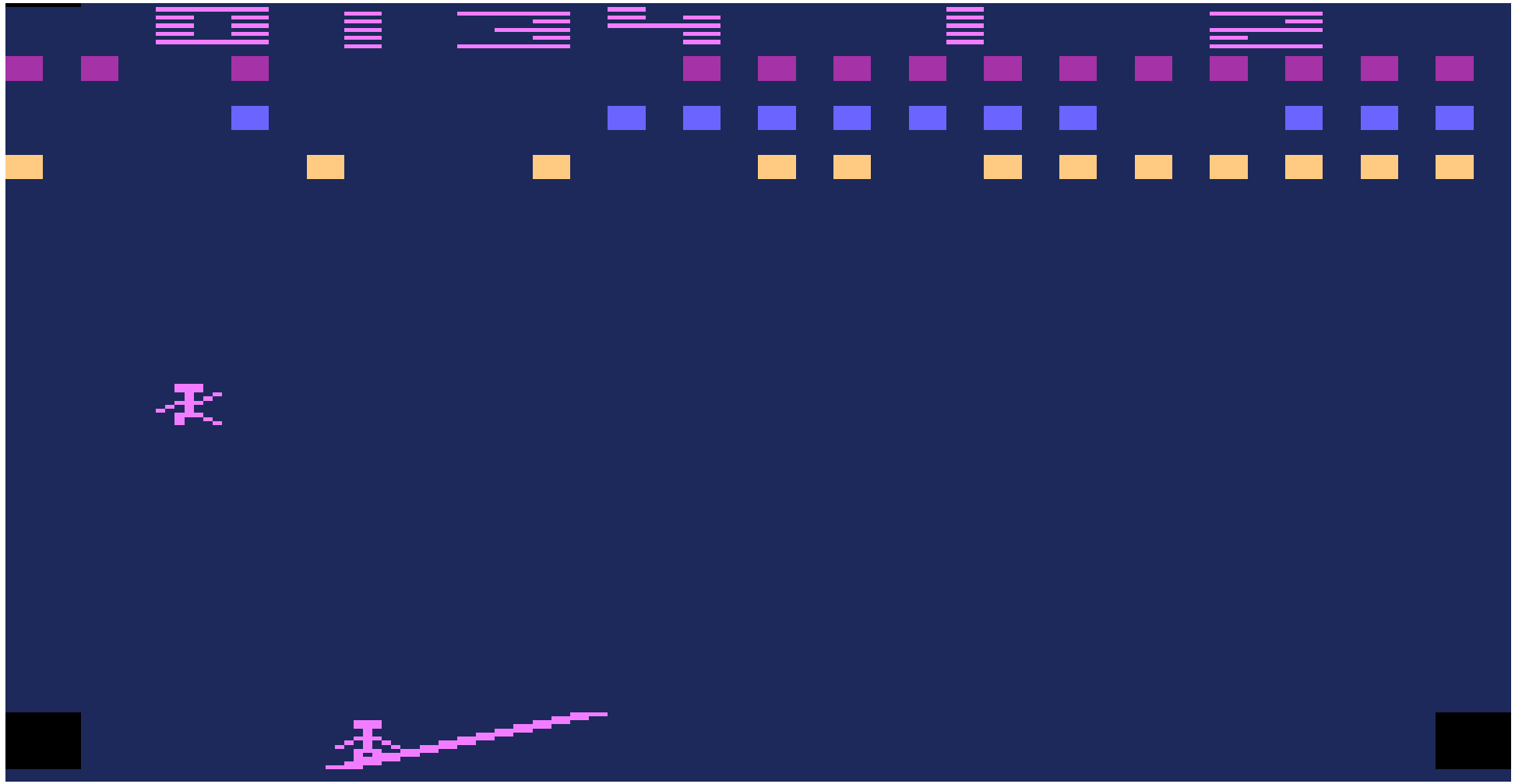
Final Fantasy *(Square, USA)*

A Bug’s Life *(Pixar)*

Entertainment (Active)



Pong

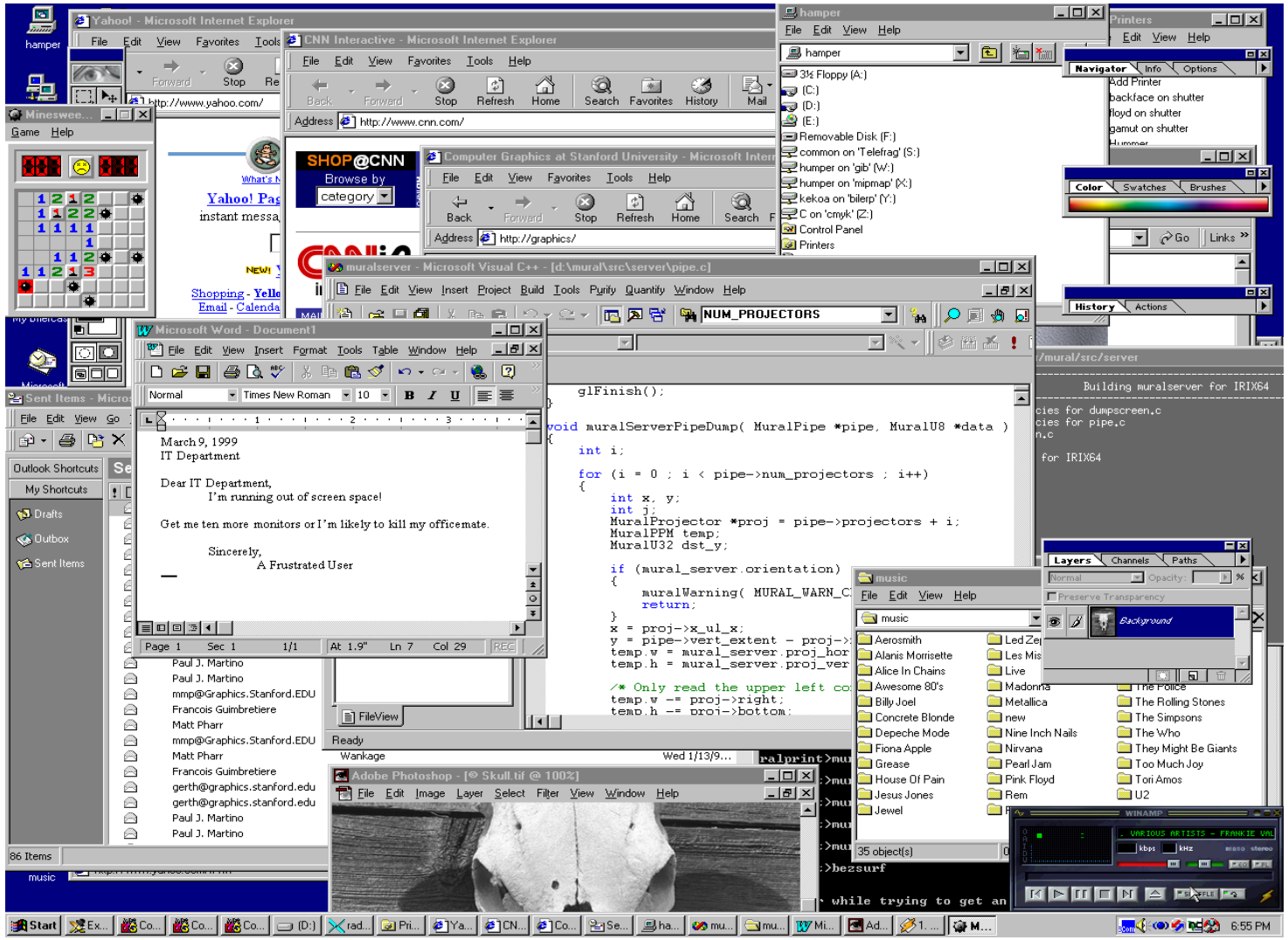


Circus Atari *(Atari)*

Doom *(ID Software)*

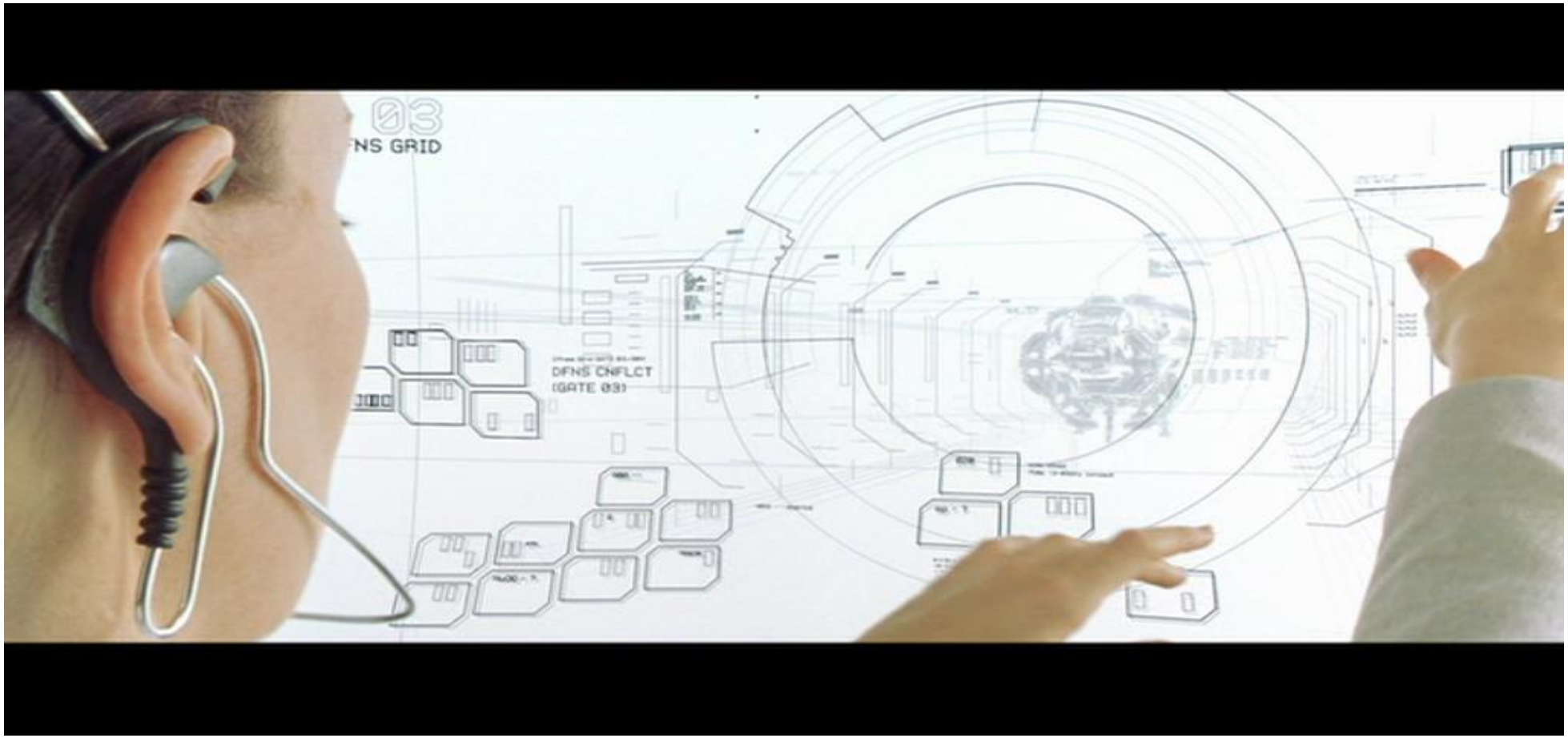
Doom III *(ID Software)*

Graphical User Interfaces



Window system and large-screen interaction metaphors *(François Guimbretière)*

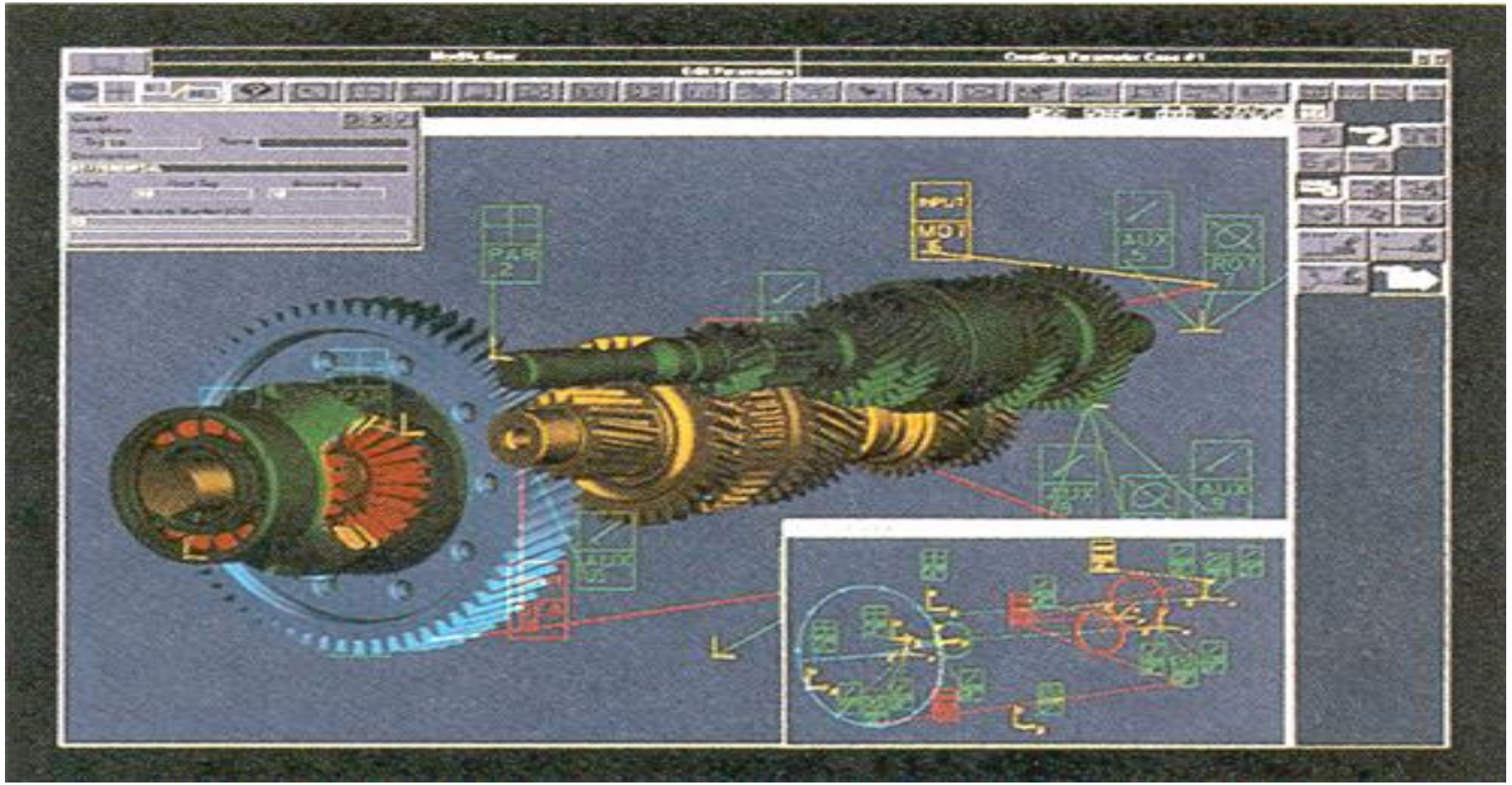
GUIs from The Matrix Reloaded



Matrix Reloaded

Computer Aided Design

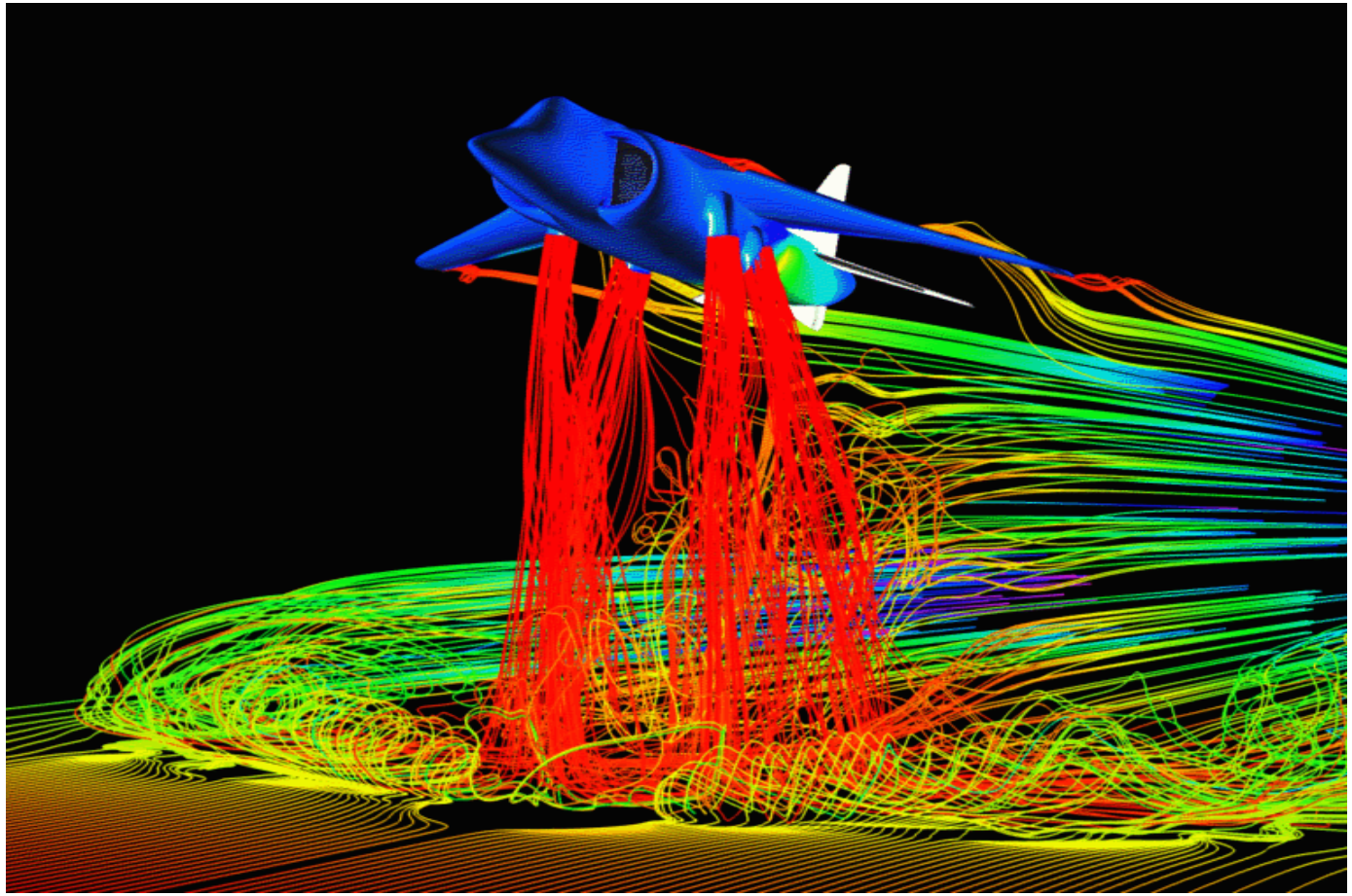
Los Angeles Airport *(Bill Jepson, UCLA)*



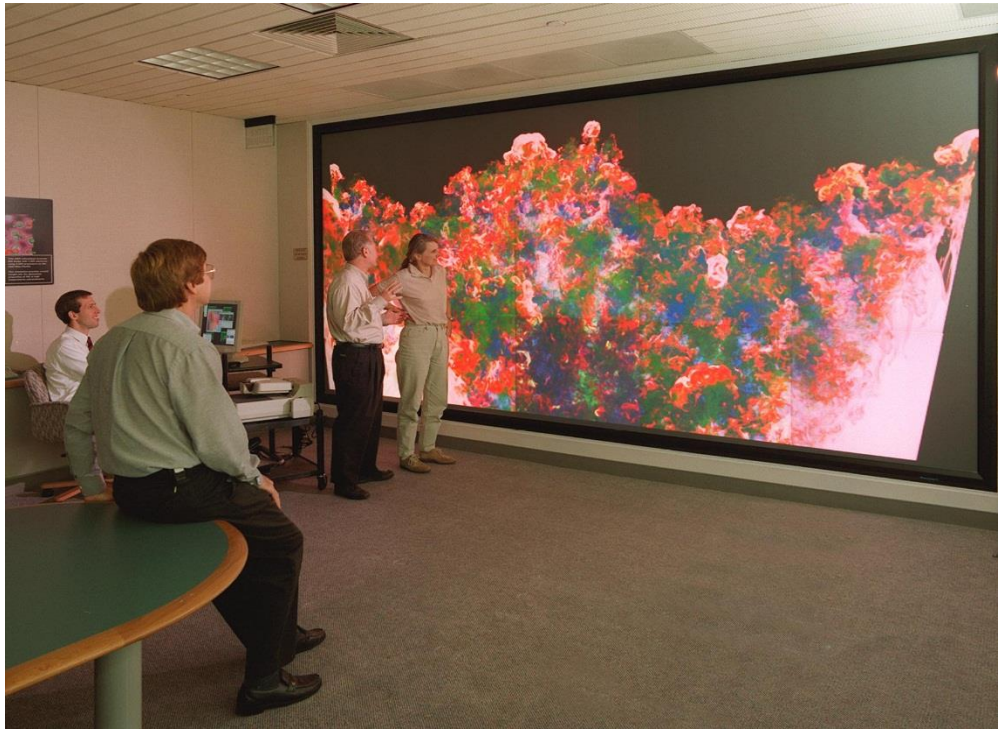
Gear Shaft Design *(Intergraph Corporation)*

Boeing 777 Airplane *(Boeing Corporation)*

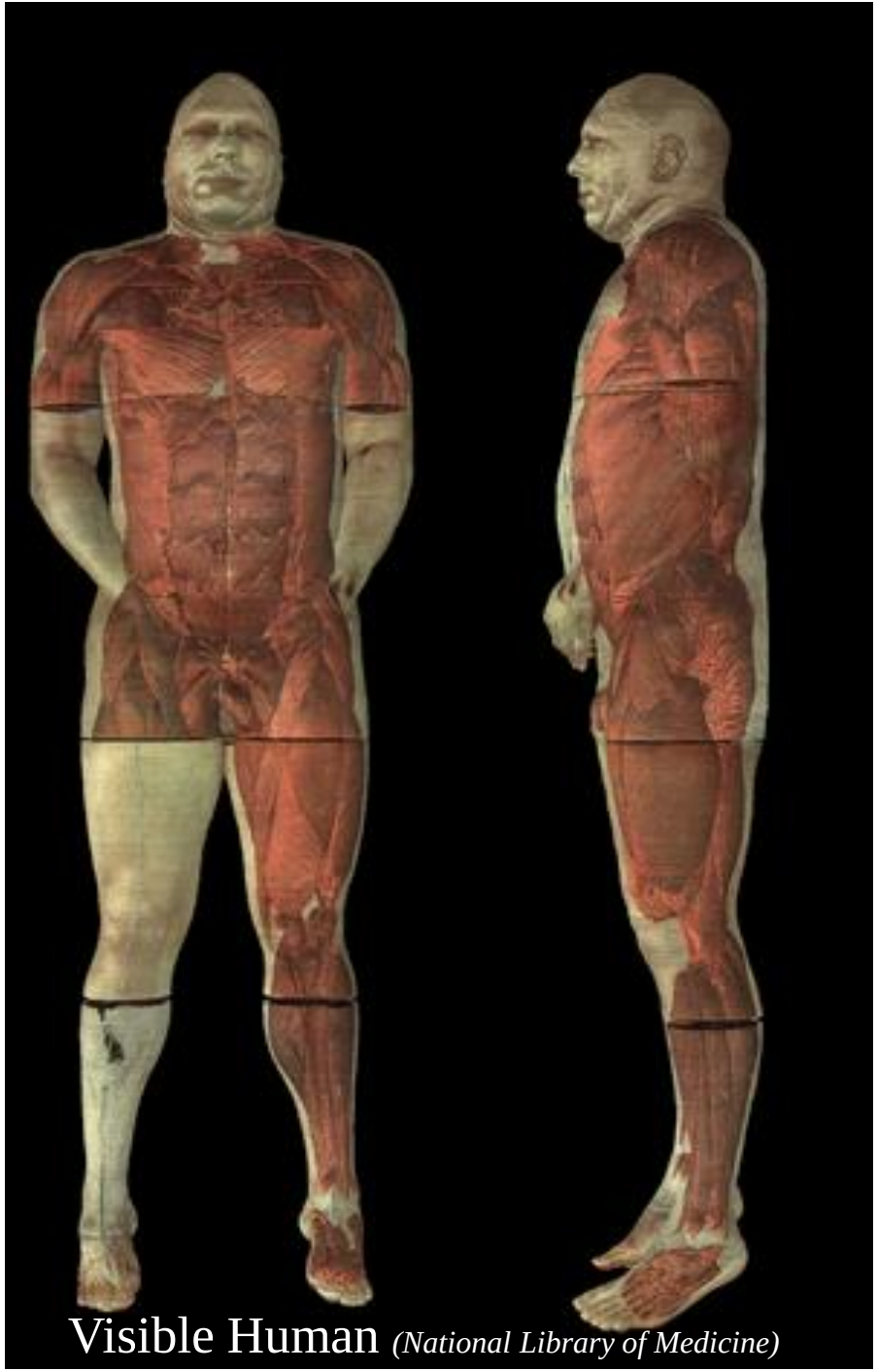
Scientific Visualization



Airflow around a Harrier Jet *(NASA Ames)*



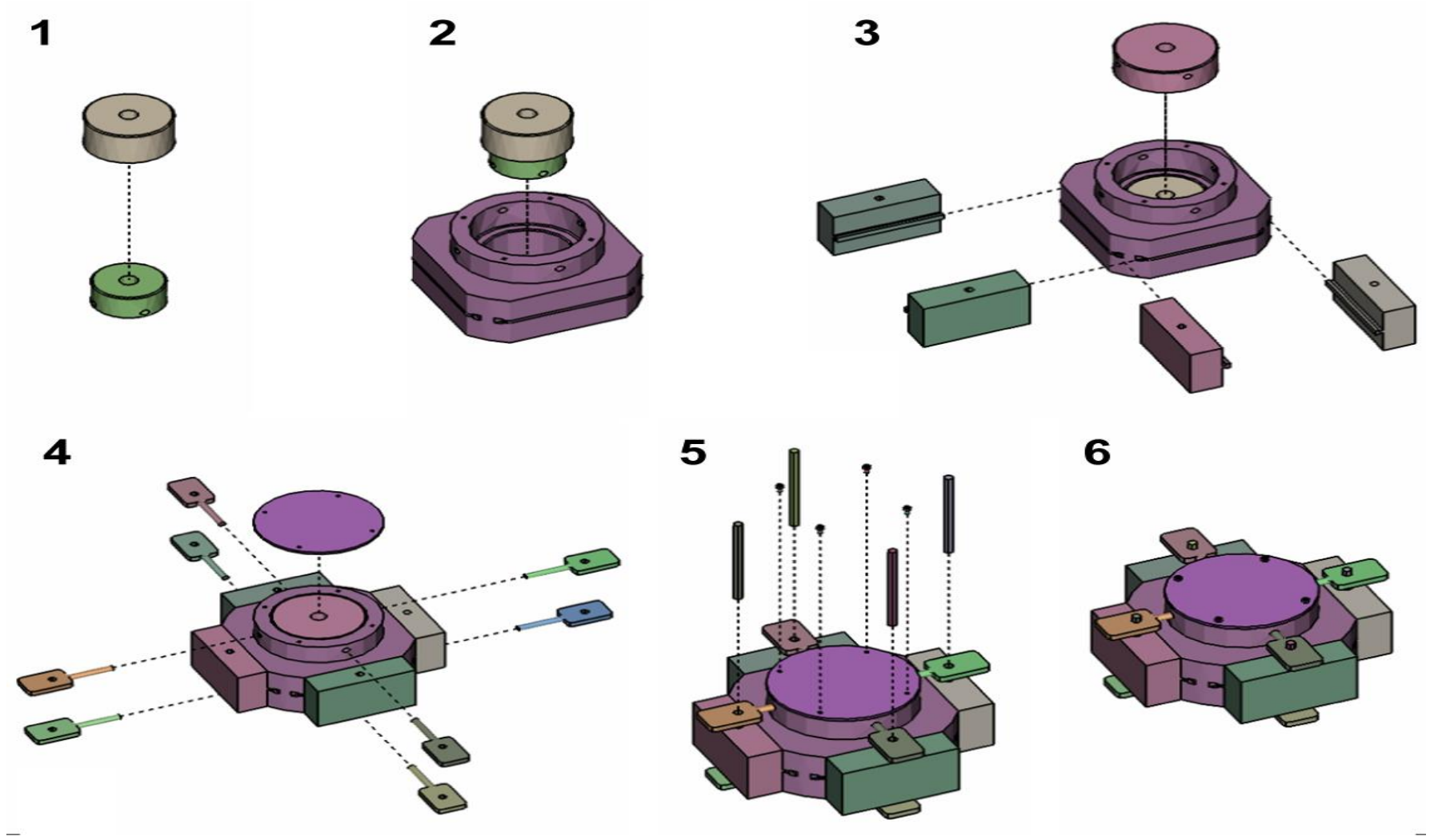
Compressible Turbulence *(Lawrence Livermore National Labs)*



Visible Human *(National Library of Medicine)*

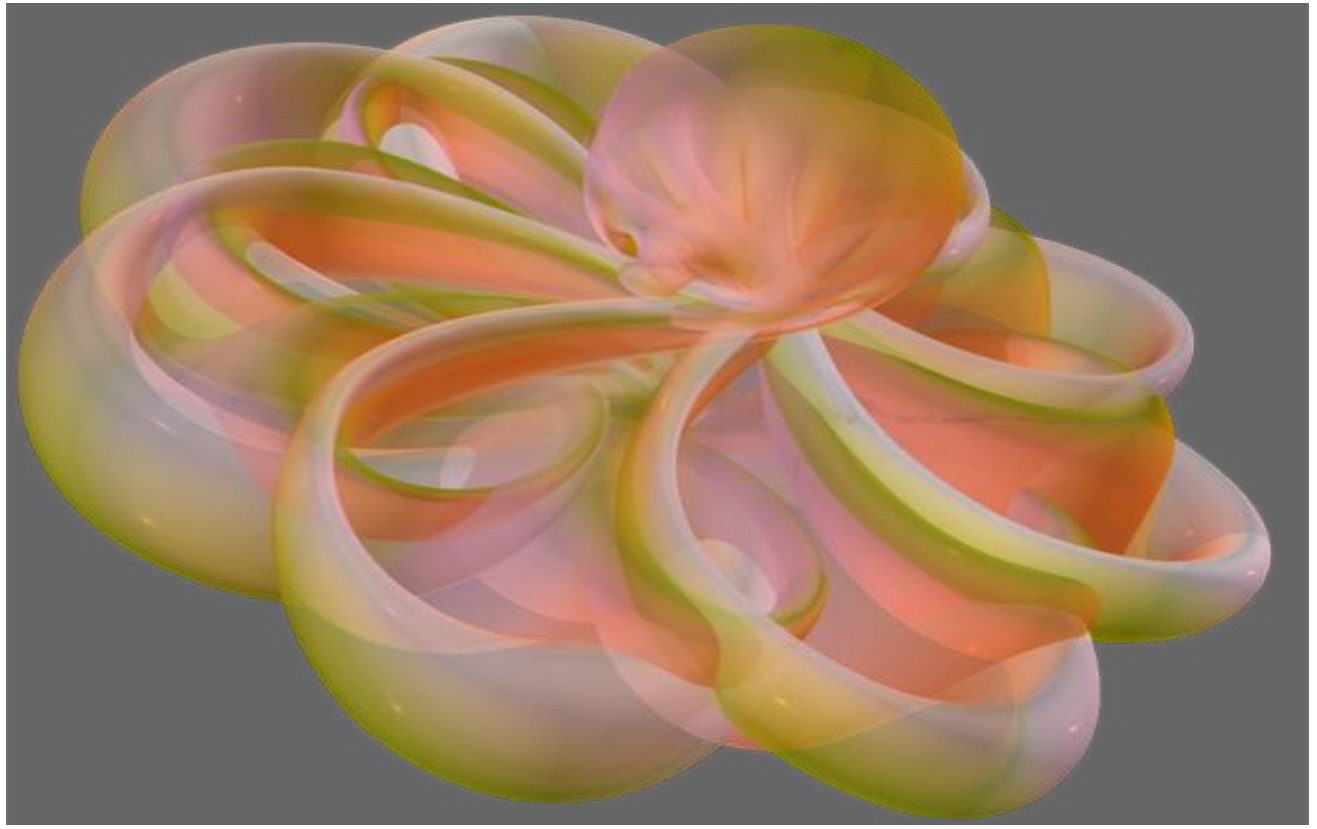
Training

Flight Simulator 2002 *(Microsoft)*



Designing Effective Step-By-Step Assembly Instructions *(Maneesh Agrawala et. al)*

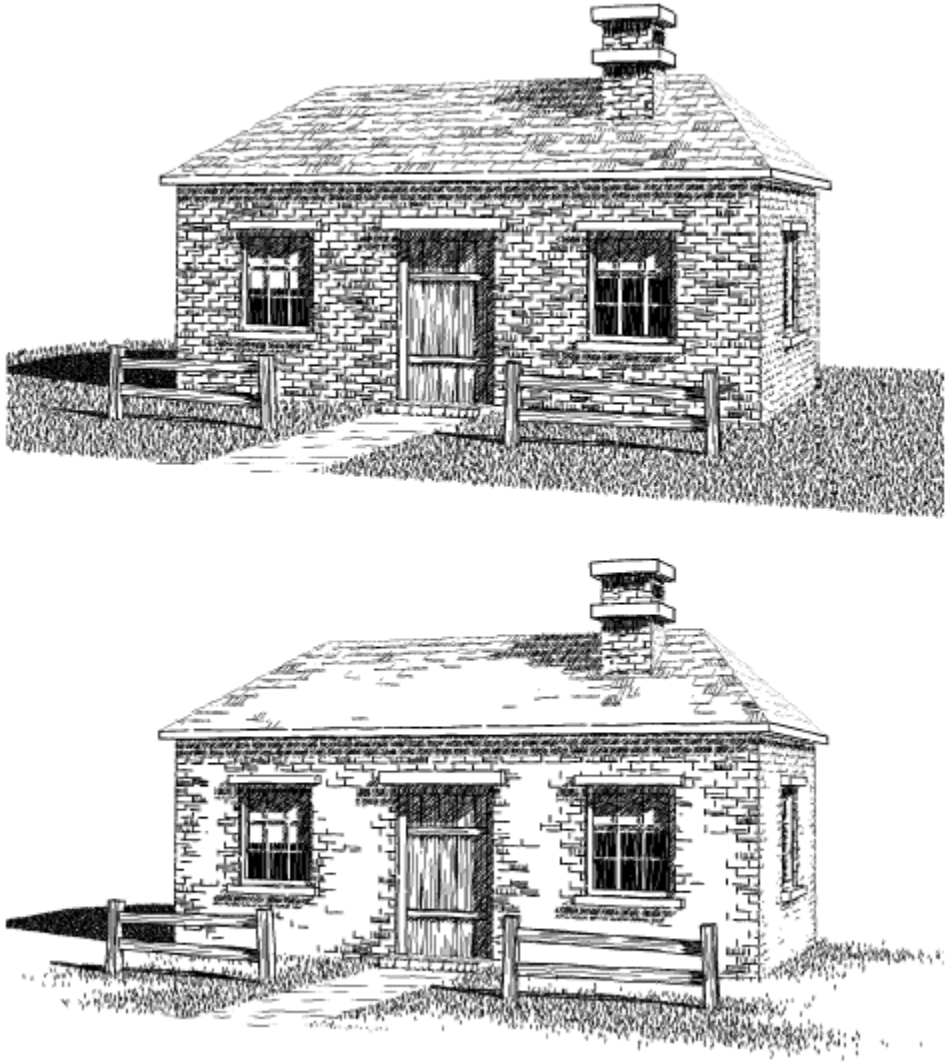
Education



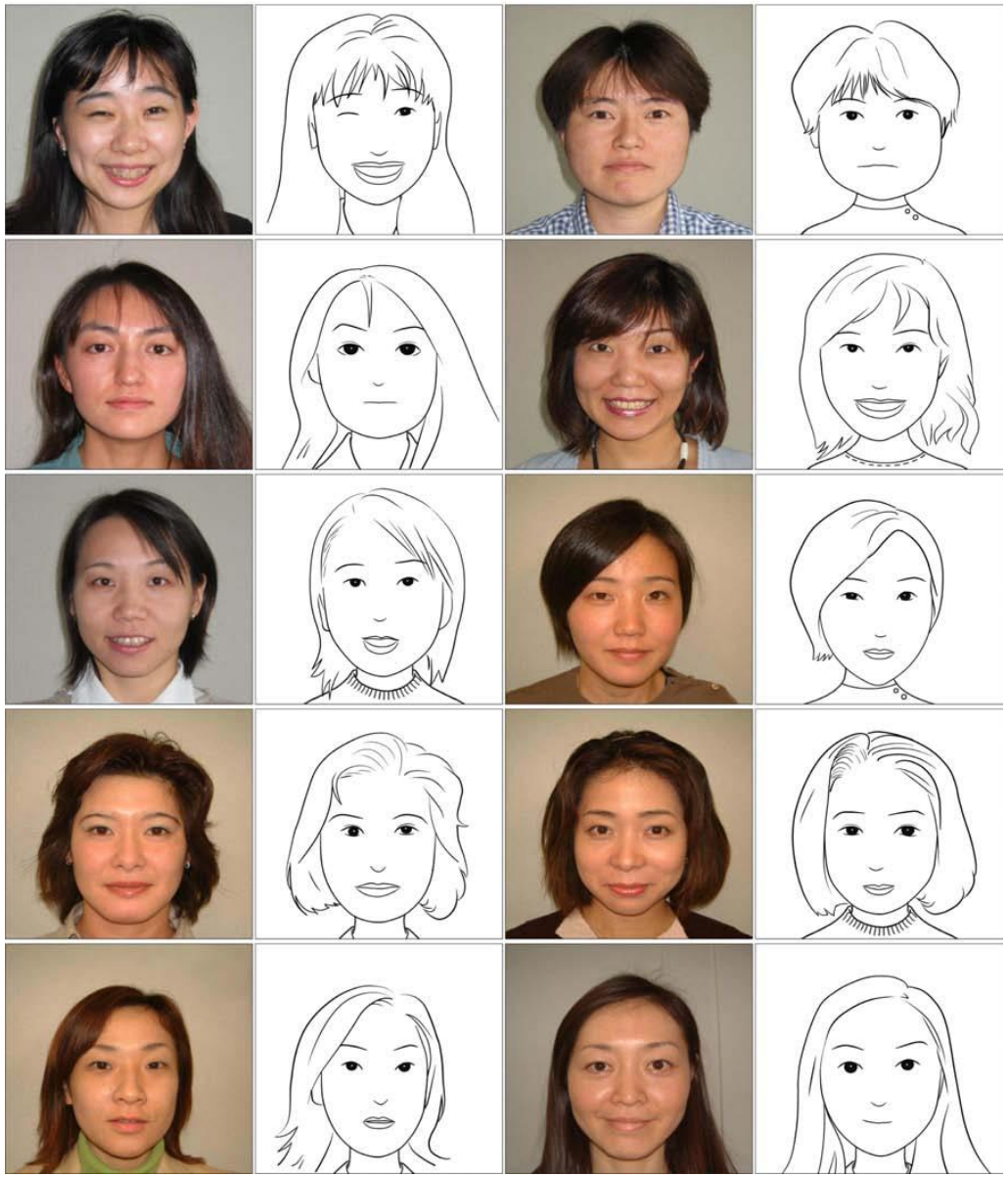
Outside In *(Geometry Center, University of Minnesota)*

Art

Blair Arch *(Marissa Range, Princeton University)*



Computer Generated Pen-and-Ink Illustration *(Winkenbach and Salesin, University of Washington)*



Example-Based Composite Sketching of Human Portraits *(Chen et al., MSRA, UCLA, MSR, UW, Microsoft)*

Photo Editing

Pocket PC *(Jon Manning, www.worth1000.com)*

Syllabus
(What you will learn in this course?)

Syllabus

Fundamentals of Computer Graphics: Applications of computer Graphics in various fields, Evolution of computer Graphics, Graphical Input-Output Devices, Random scan displays, Raster scan displays.

Graphics Primitives: Algorithms for drawing various output primitives - Line, circle, ellipse, arcs & sectors, Boundary Fill & Flood Fill algorithm, Color Tables.

2-D & 3-D Geometrical Transformations: Translation, Rotation, Scaling, Shear, Reflection, Homogenous coordinate system, Composite transformations.

Viewing & Clipping in 2-D: Window to View port transformation, Cohen Sutherland, Liang Barsky, Nicholl-Lee-Nicholl Line clipping algorithms, Sutherland Hodgeman, Weiler Atherton Polygon clipping algorithm.

Three Dimensional Viewing & Clipping: 3-D Viewing, Projections, Parallel and Perspective projections, Clipping in 3-D.

Curves& Surfaces: Curved Lines & surfaces, Interpolation & Approximation splines, Parametric & Geometric Continuity conditions, Bezier Curves & surfaces, B-spline curves & surfaces.

Visible Surface Detection Methods: Classification of visible surface detection algorithms, Depth buffer method, Scan-line method, Depth-Sorting method, Subdivision Algorithm.

Illumination Models & Surface Rendering: Light sources, Illumination models, Surface Rendering methods, Basic Ray tracing algorithm.

Text Books

- *Donald D Hearn, M. Pauline Baker, "Computer Graphics, C version", 2nd Edition, Pearson Education (1997).*
- *James D. Foley, Andries van Dam, Steven K. Feiner, John F. Hughes, "Computer Graphics: Principles & Practice in C", Second Edition, Addison Wesley Longman (1995).*

Reference Books

- *Donald Hearn and M Pauline Baker, "Computer Graphics with OpenGL", Pearson education, 2004.*
- *Zhigang Xiang, Roy A Plastock, "Computer Graphics", Schaums Outline, TMH (2007).*
- *Dave Shreiner, Mason Woo, Jackie Neider, Tom Davis, "OpenGL Programming Guide: The Official Guide to Learning OpenGL" (2013).*

Course Learning Outcomes (CLOs)/ Course Objectives (COs)

1. Comprehend the concepts related to basics of computer graphics and its applications in various fields.
2. Apply algorithms to scan convert various output primitives and alters the coordinate descriptions of objects using 2-D & 3-D geometric transformations.
3. Understand and apply various concepts of viewing & clipping in 2-D & 3-D.
4. Comprehend the concepts related to curve design and identify visible surfaces in three dimensional scene using visible surface detection methods.
5. Apply OpenGL to create various primitives of computer graphics.

https://www.youtube.com/watch?v=UTJO5Wc7sfw