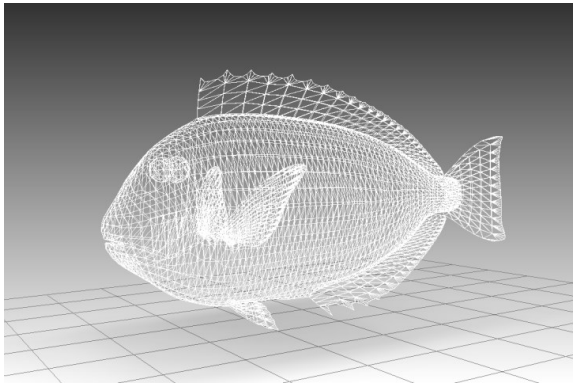
Computer Graphics Overview

Computer Graphics
Instructor: Sungkil Lee

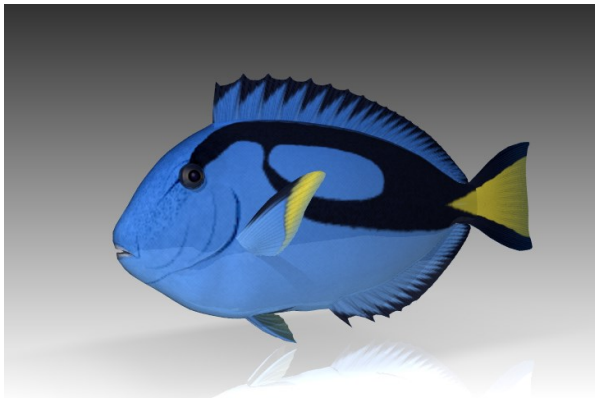
Big Picture of Computer Graphics (CG)

- **Computer graphics deals with:**
  - all the aspects of creating images with a computer in hardware, software, and applications.

- **Three primary research areas in CG**



Modeling

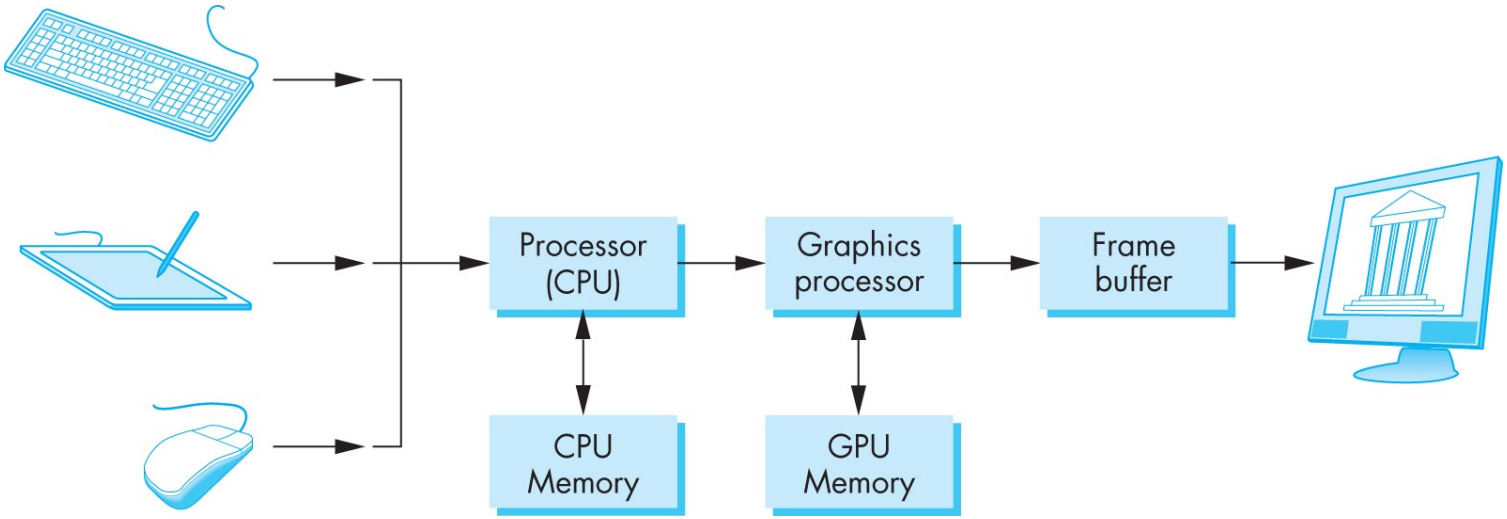


Rendering

Animation

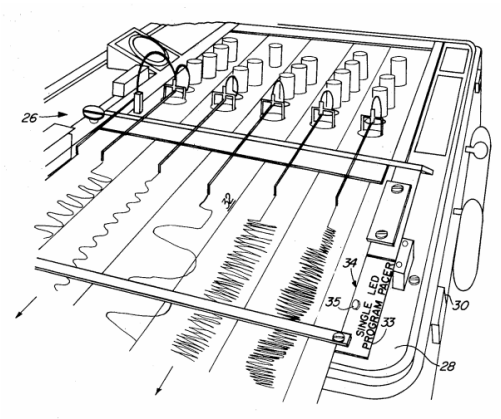
Interactive Graphics System

- **Basic system for interactive graphics**
  - Recent mobile systems include touch-sensitive display for input.



Brief History

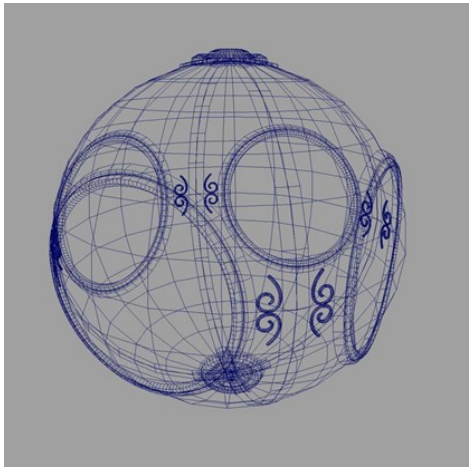
- **1950s:**
  - Computer graphics goes back to the earliest days of computing
  - Strip chart recorder, pen plotters



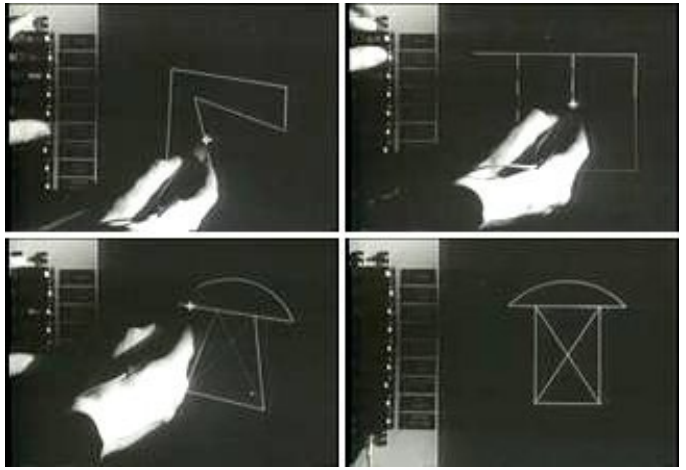
Strip chart recorder and pen plotters
(HP 7035B, Robotron K6418)

Brief History

- **1960s:**
  - Raster graphics with wireframe display
    - Early predecessor of the modern raster graphics
  - Sketchpad (Turing-awarded, 1988)
    - Software written by Ivan Sutherland (Ph.D. thesis at MIT).
    - The early concept of display loop, still common in computer graphics
    - A computer displays new images by light pen movements



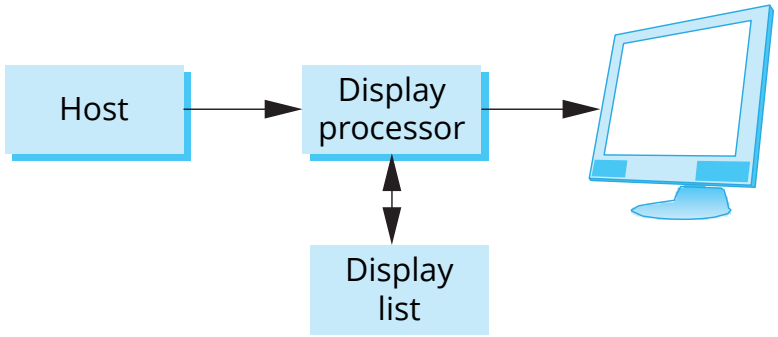
Wireframe display



Sketchpad (Sutherland)

Brief History

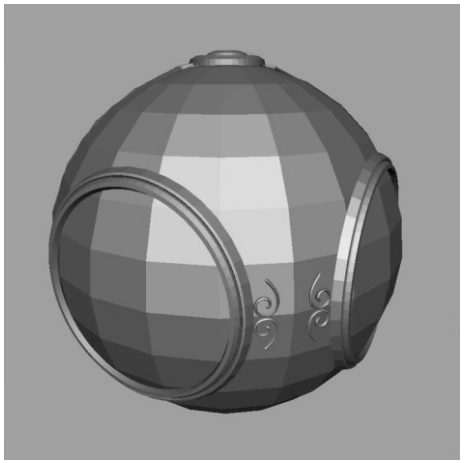
- **1960s:**
  - Display processors
    - Rather than have the host computer try to refresh display use a special purpose computer called a *display processor* units (DPUs)
    - Host compiles display list and sends to DPU.



Display-processor architecture

Brief History

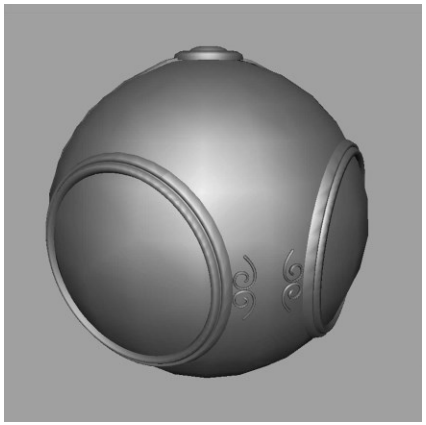
- **1970s:**
  - Two graphics standard committees formed by International Federation of Information Processing Societies (IFIPS; 1973)
    - GKS: European effort (becomes ISO 2D standard)
    - Core: North American effort (3D but fails to become ISO Standard)
  - Raster graphics
    - Allows us to go from lines and wireframe images to filled polygons
    - Image produced as an array of picture elements (pixels) in the frame buffer



Early raster display

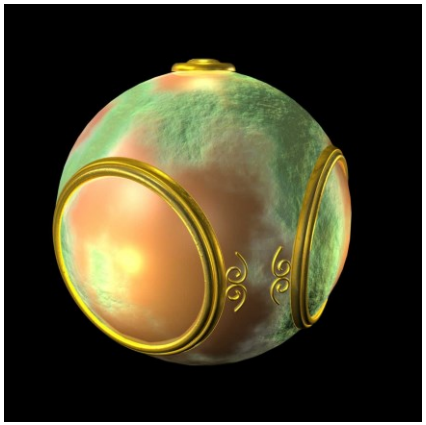
Brief History

- **1980s:**
  - Hardware (VLSI) geometry engine by Silicon Graphics Inc. (SGI, 1982)
    - Irix and Iris GL: Operating system and Graphics API of SGI



Smooth shading

Environment mapping



Bump mapping

  - Industry-based standards
    - Pixar: RenderMan API (and REYES architecture)
  - Networked graphics
    - X Windows system (by DEC/MIT) with client-server architecture

Brief History

- **1990s:**
  - Iris GL later became OpenGL (1992)
    - a platform-independent (no windowing support) rendering API
    - close enough to hardware to get excellent performance
  - New hardware capabilities
    - Texture mapping, blending, accumulation, stencil buffers
  - *Toy Story*:
    - the first completely computer-generated feature-length movie

Toy story, Pixar (1995)

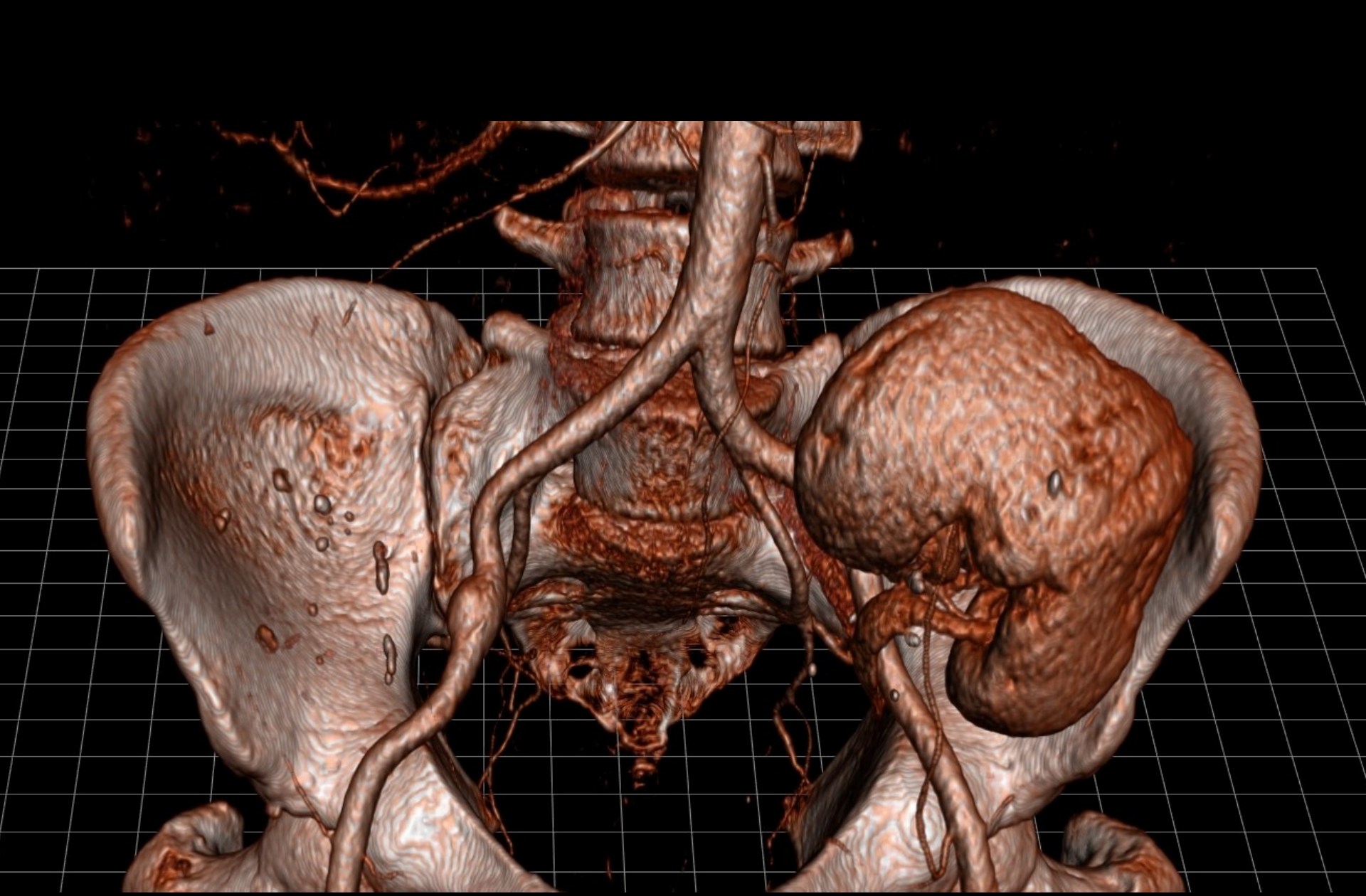
Brief History

- **2000s-now:**
  - Graphics cards for PCs dominate market
    - NVIDIA, ATI (now AMD), 3DLabs
  - Game consoles and game players determine direction of market
    - Playstation, Wii, XBOX (+Kinect), …
  - Computer graphics software in movie industry
    - 3DS Max, Maya, Lightwave
  - Display technology
    - LCD, PDP (Plasma display panel), LED, OLED, …
  - Programmable rendering pipelines
    - **GPU** named by NVIDIA

Applications:
What can we do with CG?

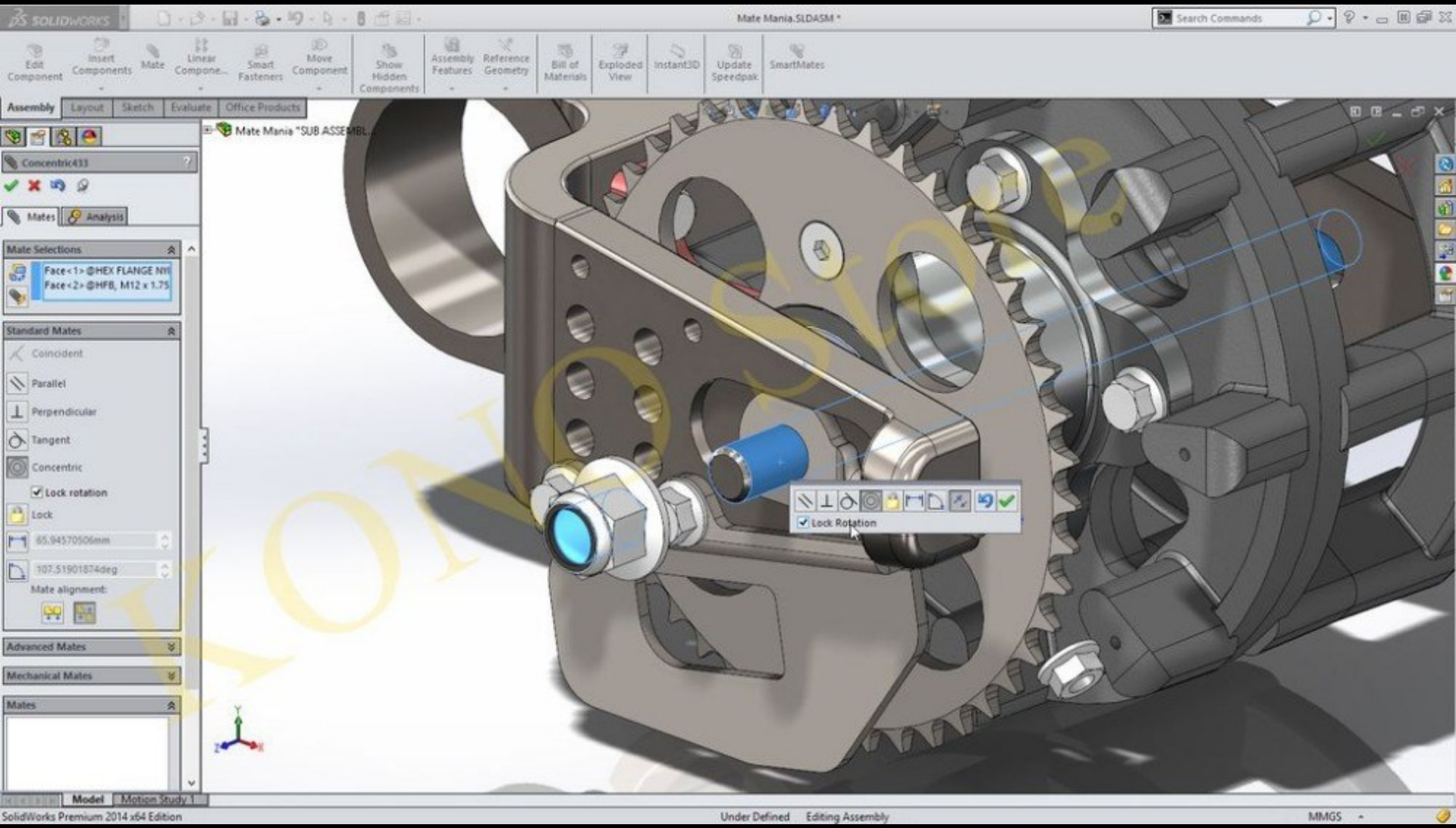
Entertainment - Film Production (Toy Story, Pixar 1995)
First CG-Generated Full-Length Movie

Entertainment - Games (Unreal Engine RTX Demo, Epic Games)



Science and Engineering - Medical Visualization

Science and Engineering - Data Visualization



Science and Engineering - CAD (Virtual prototyping)

Training and Simulation - Virtual Reality (Flight Simulation)

Training and Entertainment - Virtual Reality (Oculus VR)

Any questions?