Computer Graphics 2019
Introduction

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https://ppt.cc/fLa73x

Utah teapot

Real teapot

TEAPOT

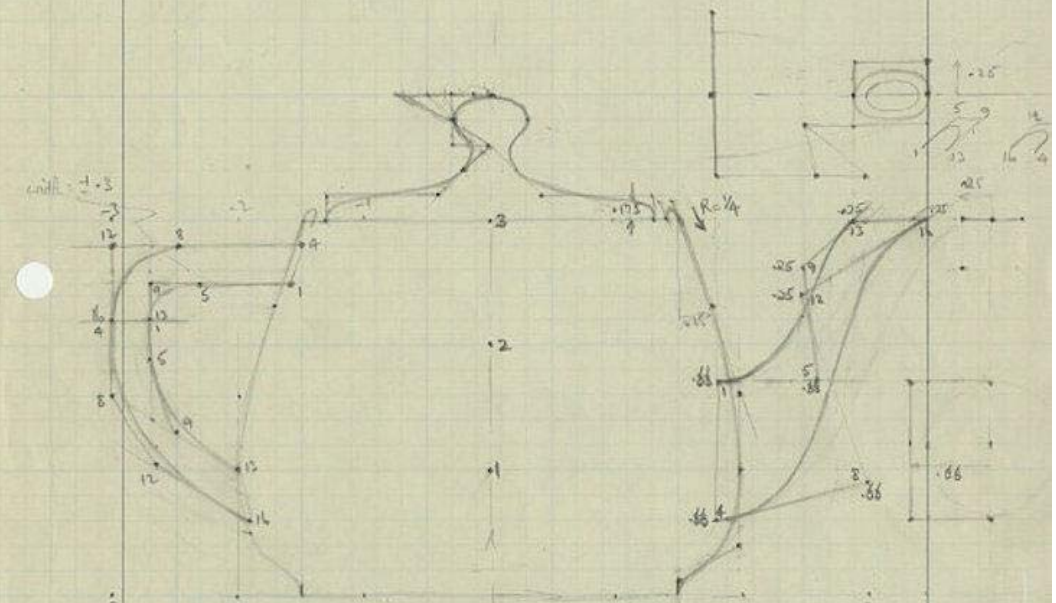
LID - separate mesh.

HANDLE - as for ~~mat~~ JUG, separate mesh.

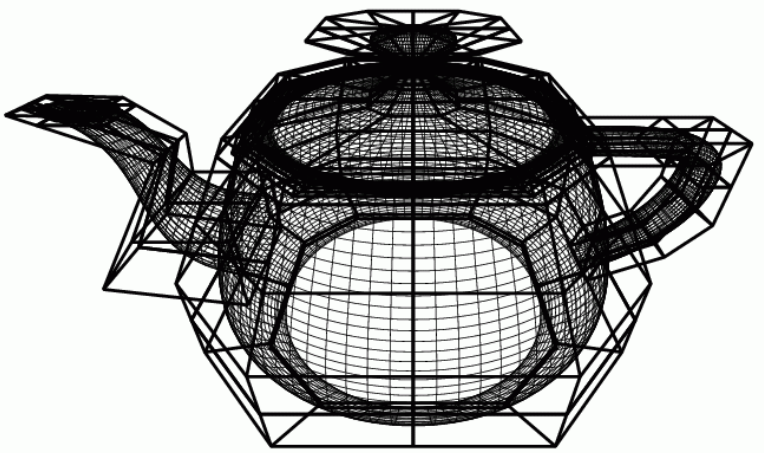
BODY - 4 patches round, 2 high - flat ridge on top.

SPOUT - separate mesh.

SIZE - Height of body = 3 (without lid)
Diam of body = 3 at top & bottom, 4½ at bulge.



Teapot's Data



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      8,   9,  10,  11,  12,  13,  14,  15 }
Body:
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     20,  21,  22,  23,  24,  25,  26,  27 }
  {  24,  25,  26,  27,  29,  30,  31,  32,
     33,  34,  35,  36,  37,  38,  39,  40 }
Lid:
  {  96,  96,  96,  96,  97,  98,  99, 100,
    101, 101, 101, 101,   0,   1,   2,   3 }
  {   0,   1,   2,   3, 106, 107, 108, 109,
    110, 111, 112, 113, 114, 115, 116, 117 }
Handle:
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     49,  50,  51,  52,  53,  54,  55,  56 }
  {  53,  54,  55,  56,  57,  58,  59,  60,
     61,  62,  63,  64,  28,  65,  66,  67 }
Spout:
  {  68,  69,  70,  71,  72,  73,  74,  75,
     76,  77,  78,  79,  80,  81,  82,  83 }
  {  80,  81,  82,  83,  84,  85,  86,  87,
     88,  89,  90,  91,  92,  93,  94,  95 }
```

```
Vertices:

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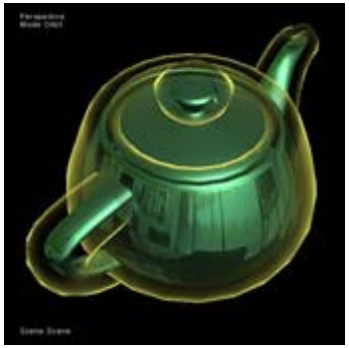
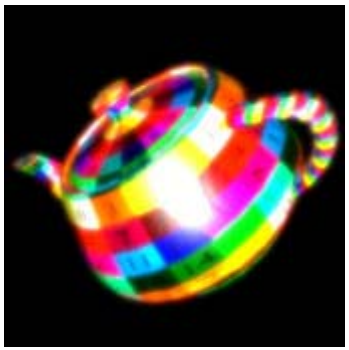






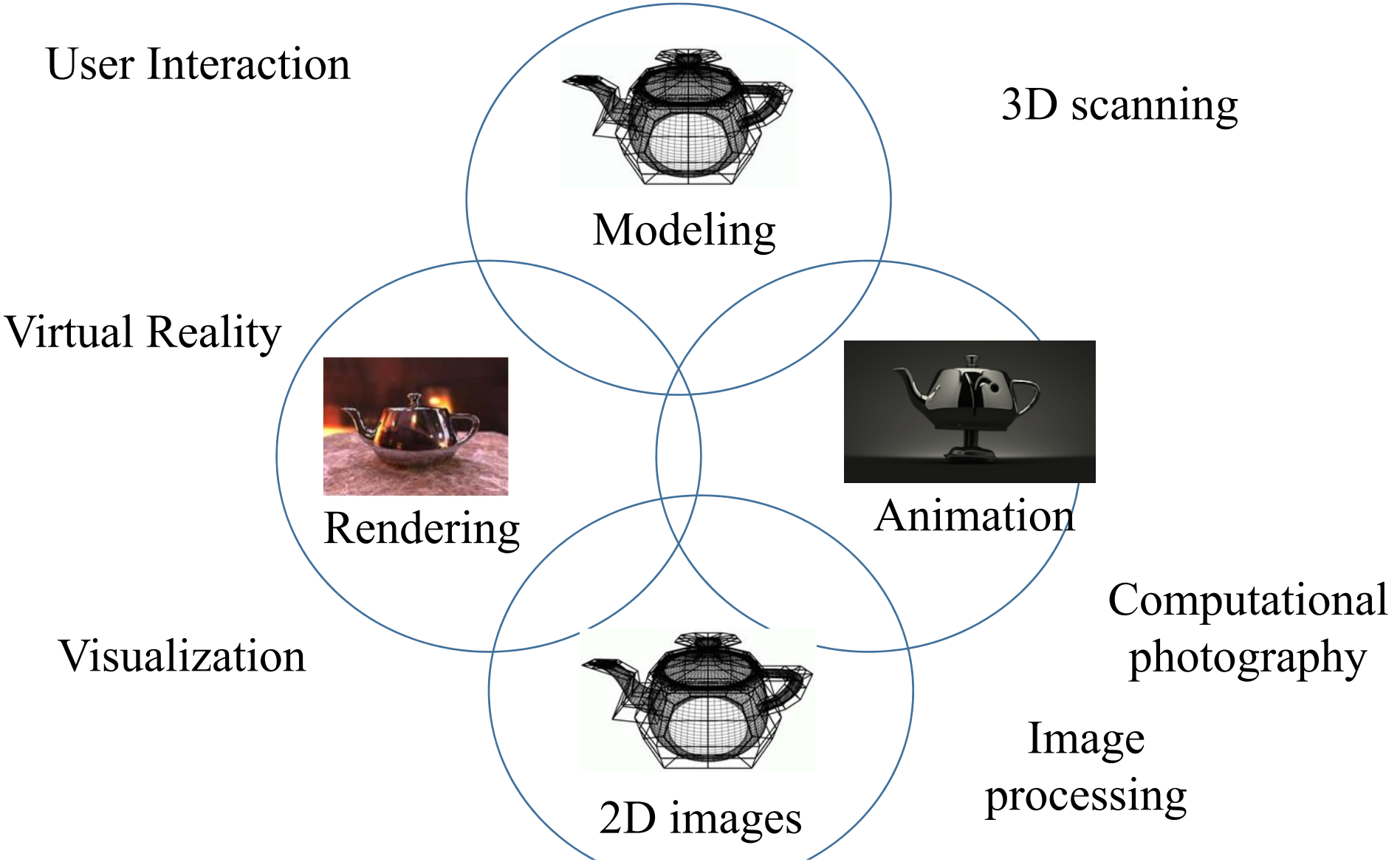


Computer Graphics

Computer Graphics

- ***The study of creating, manipulating, and using visual images in the computer.***

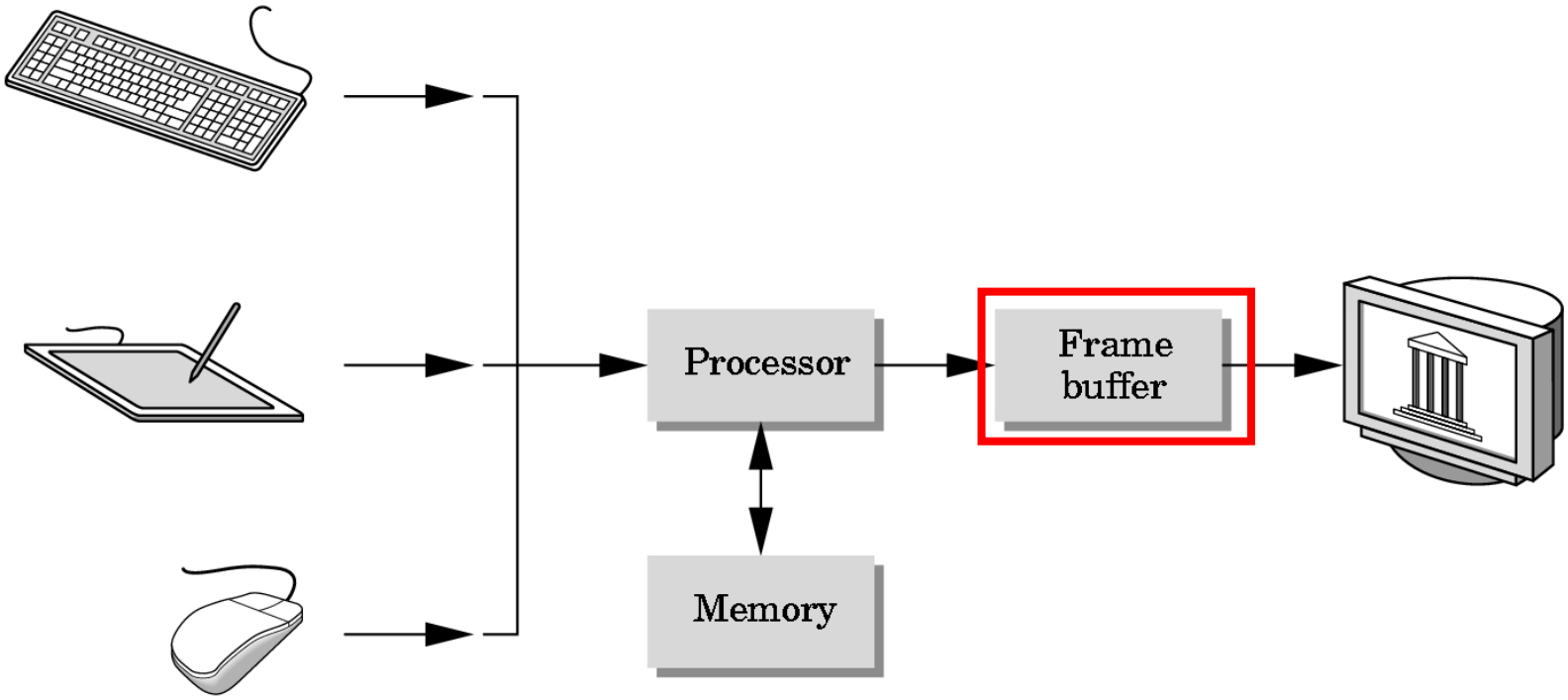
Computer Graphics Areas



Computer Graphics

- ***Computer graphics*** deals with all aspects of creating images with a computer
  - **Hardware**
  - **Software**
  - **Applications**

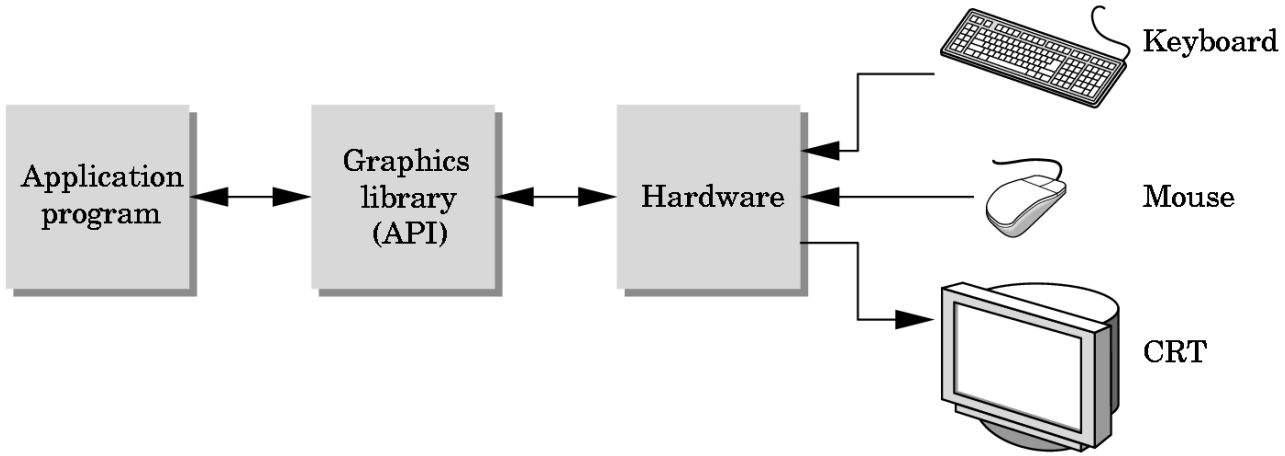
Basic Graphics System



Input devices Image formed in FB Output device

The Programmer's Interface

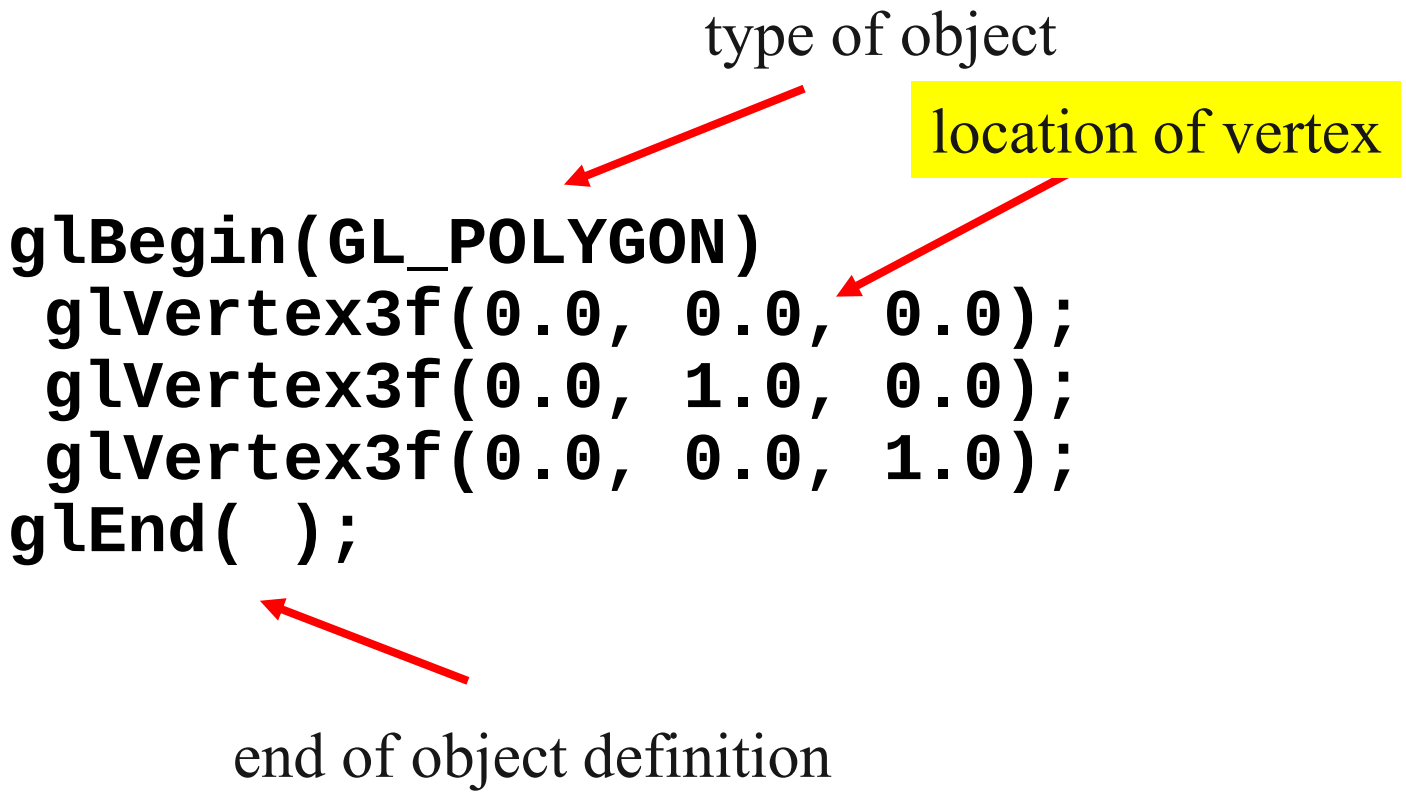
- Programmer sees the graphics system through an interface: the Application Programmer Interface (**API**)



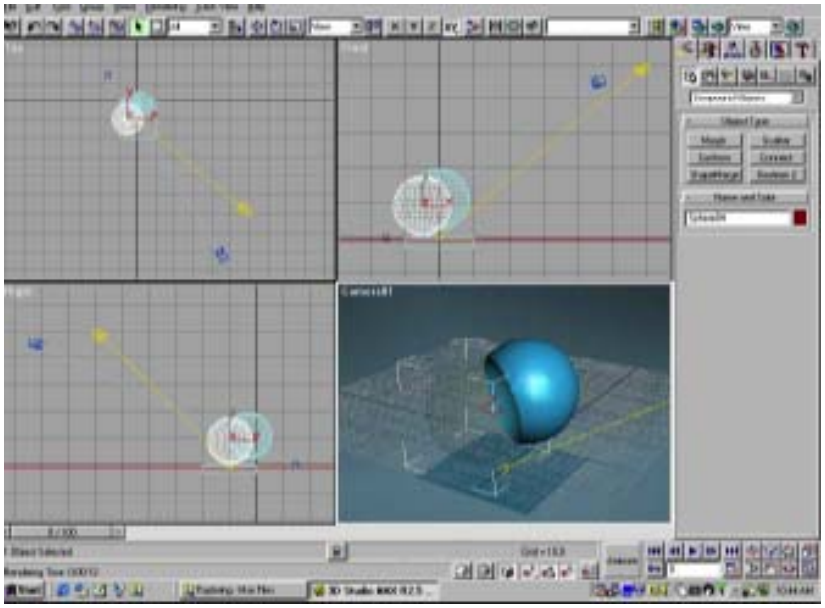
Object Specification

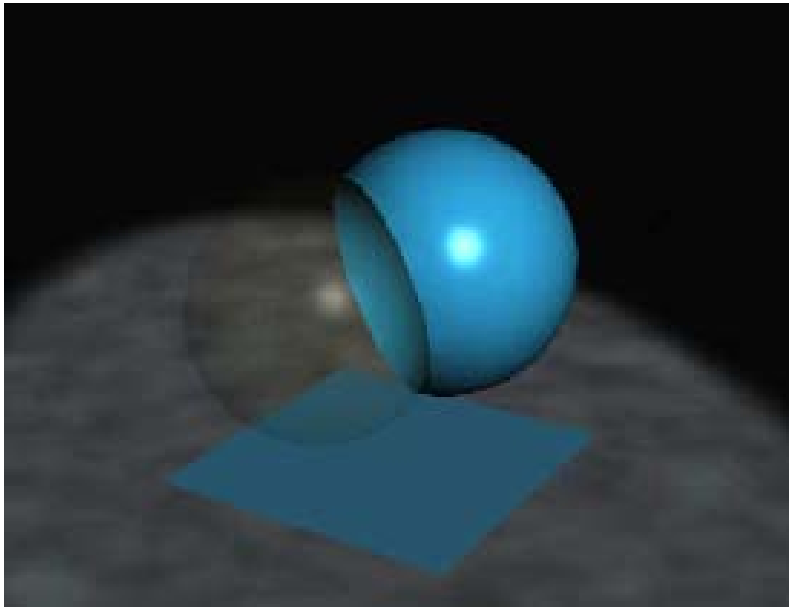
- Most APIs support a limited set of primitives including
  - Points (1D objects)
  - Line segments (2D objects)
  - Polygons (3D objects)
  - Some curves and surfaces
    - Quadrics
    - Parametric polynomial
- All are defined through locations in space or *vertices*

Example (OpenGL 1.X)



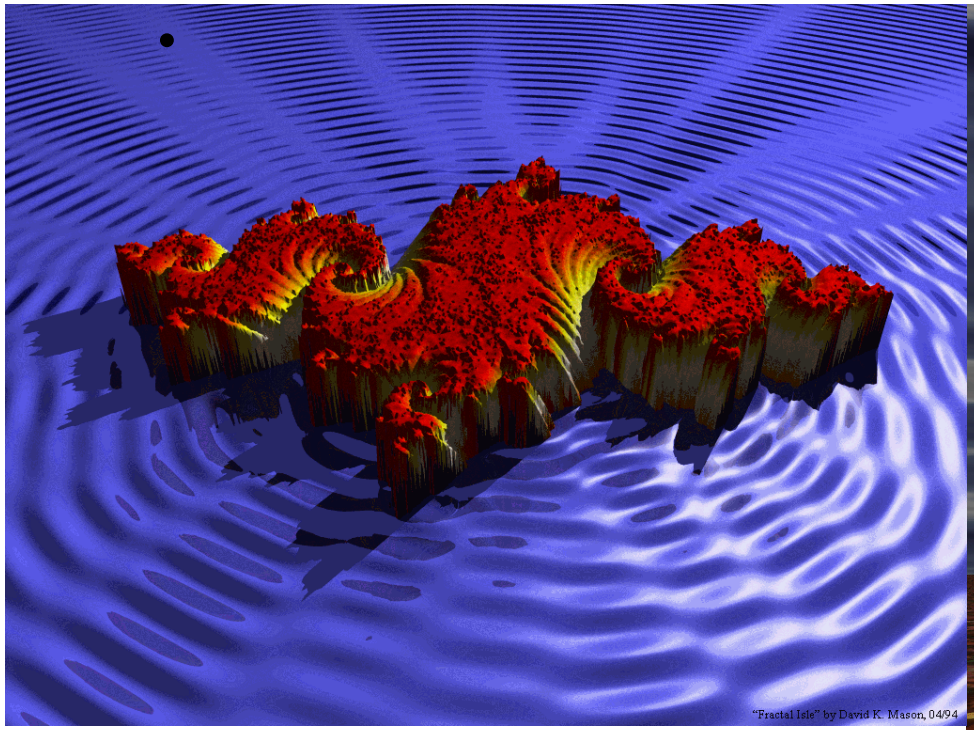
Modeling – Software Package

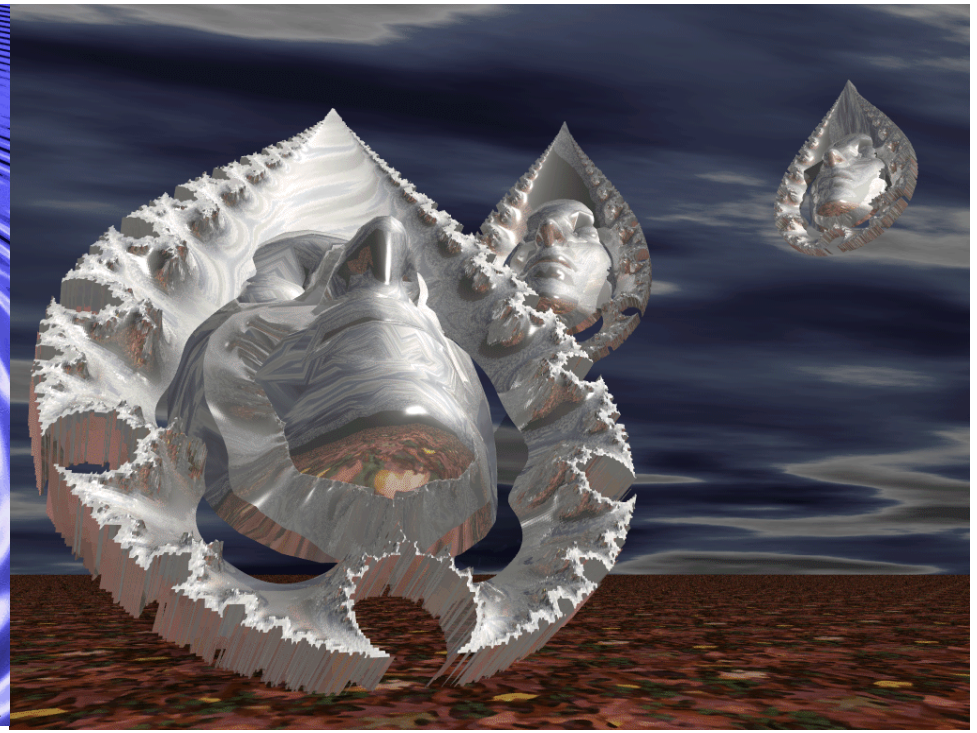




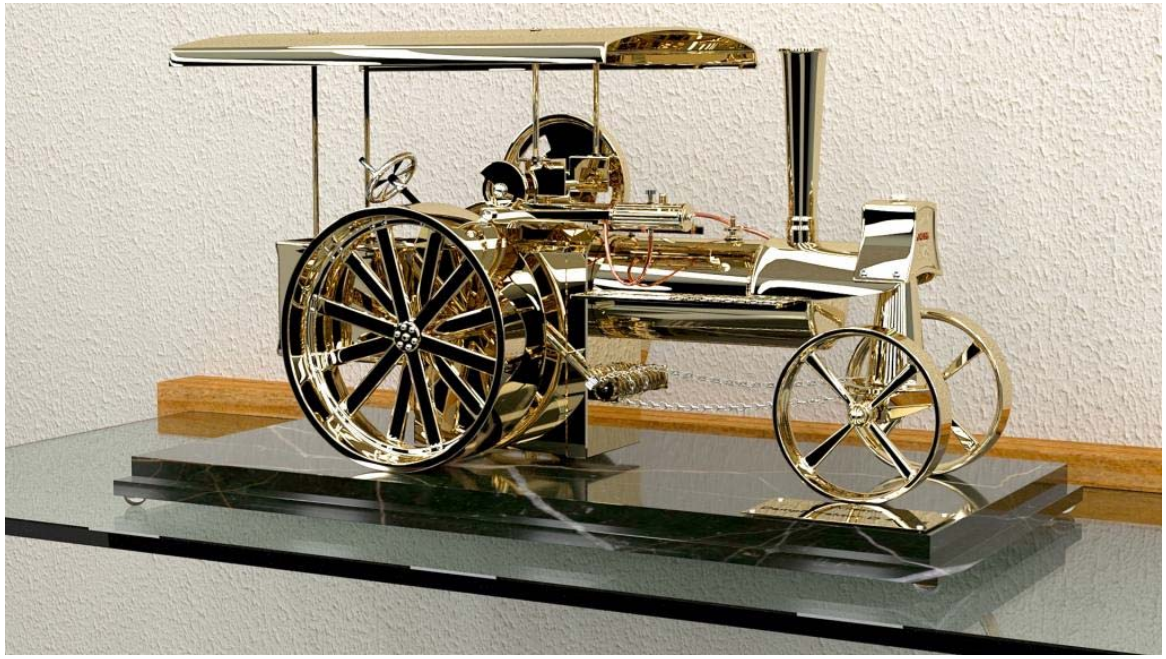
Rendering – ray-tracing software

- Povray - www.povray.org
-



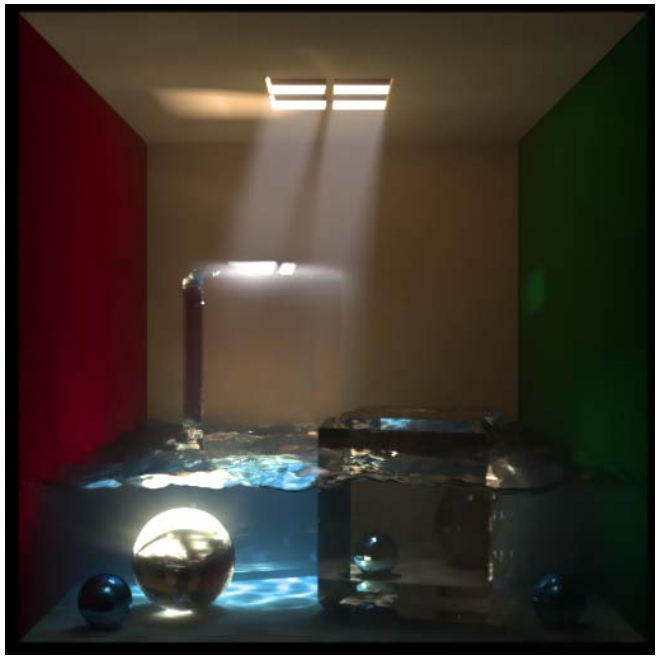


Redering - LuxRender



Dampftraktor

Wilesco Dampf
Traktor D 40 MS

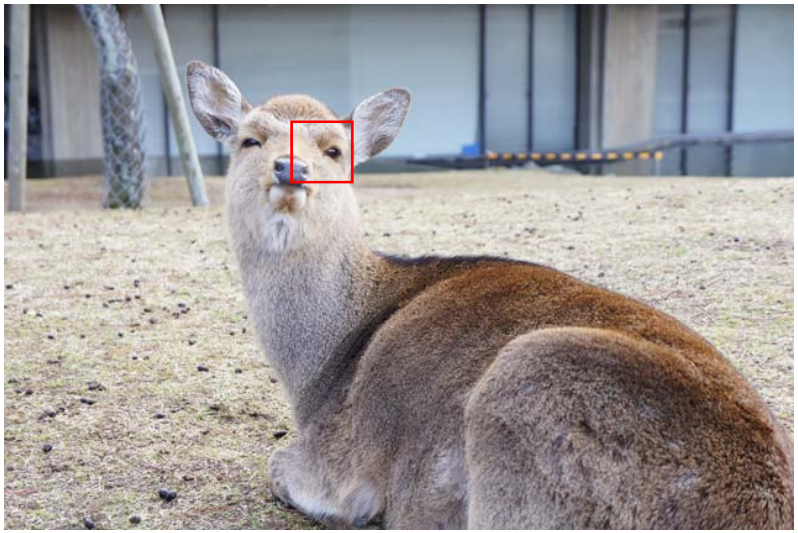


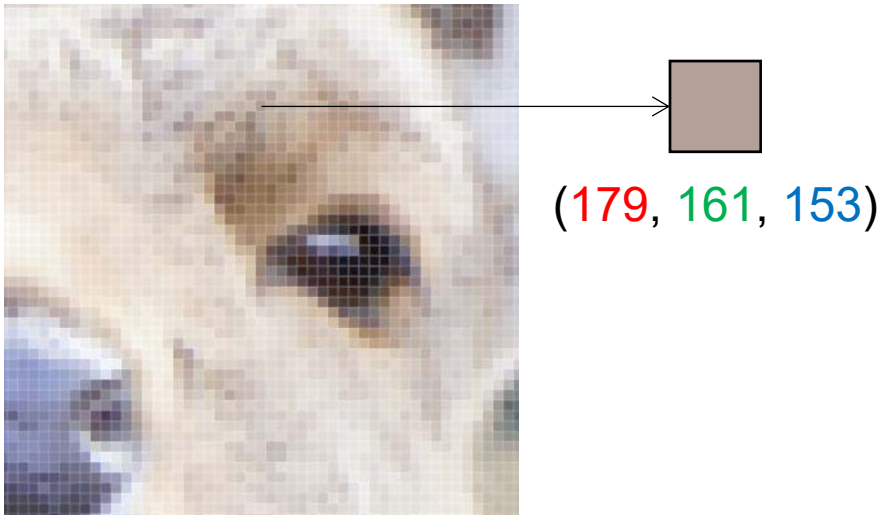
Cornell Box by A-man rendered to approximately 100k s/p

Displayer & Framebuffer

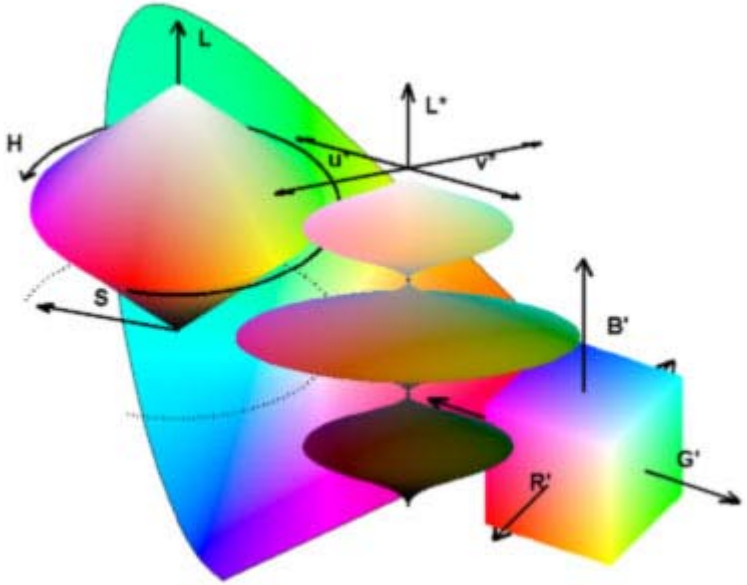
Raster Graphics

- Image produced as an array (the *raster*) of picture elements (*pixels*) in the *frame buffer*

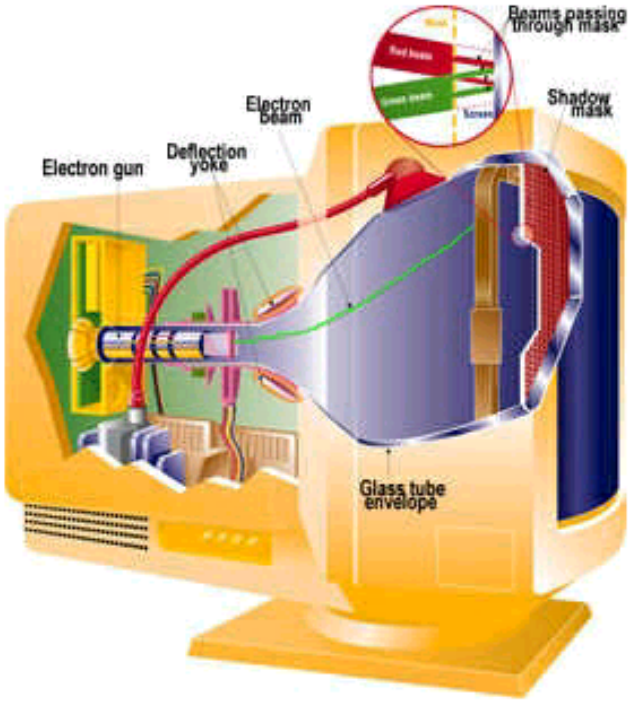




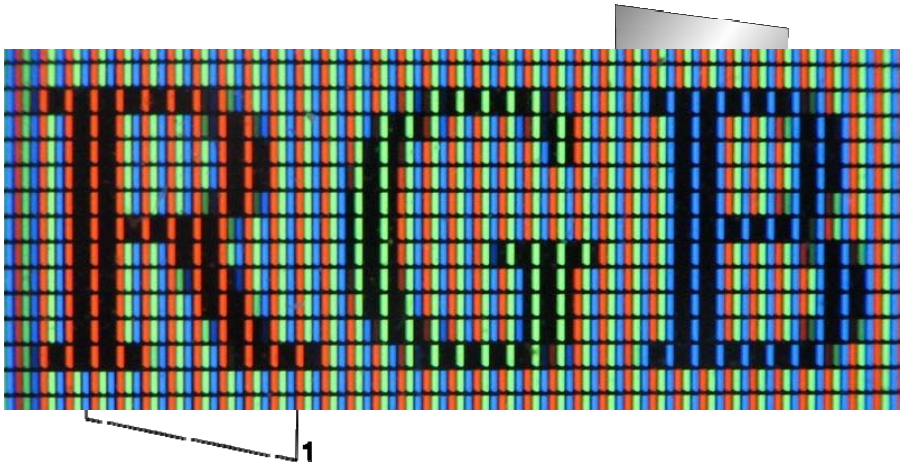
Color space and Filters



Display Technologies



CRT



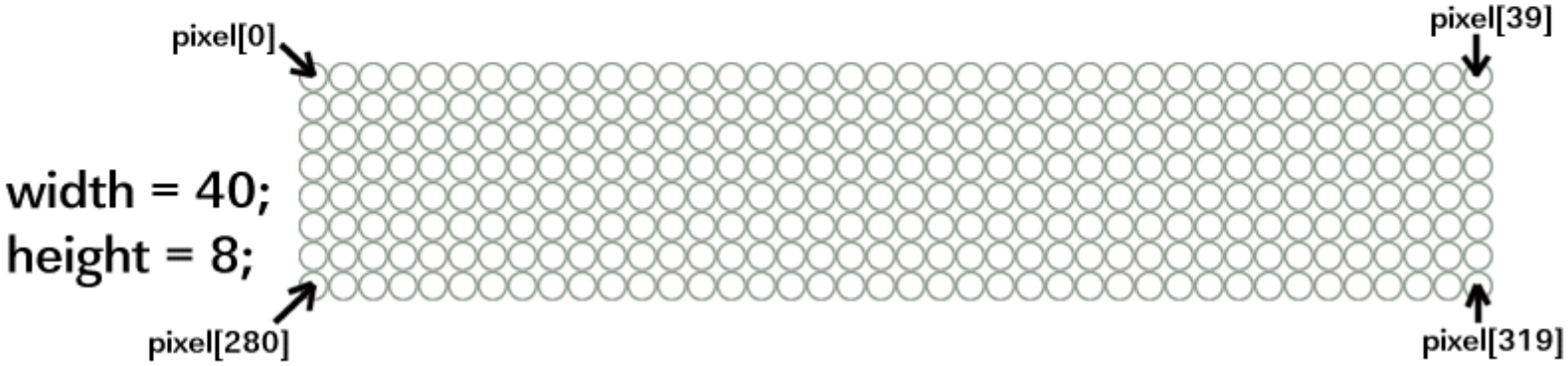
LCD

Lets Talk About Pixels

- Pixels are stored as a 1-dimensional array of *int*s
- Each *int* is formatted according to Java's standard pixel model

The 4 bytes of a 32-bit *Pixel* int.
if Alpha is 0 the pixel is transparent.
if Alpha is 255 the pixel is opaque.

- Layout of the pixel array on the display:



- This is the image format used internally by Java

Caves and Fish Bowls

Alternate left and right eye images on a single display

- Electronic shutters
- Polarization
- Red/Green
- Barriers

+Lighter or no headware
+High resolution
-Significant infrastructure
(5-wall caves have been built)
-Personal
-Still needs tracking

Head-Mounted Displays

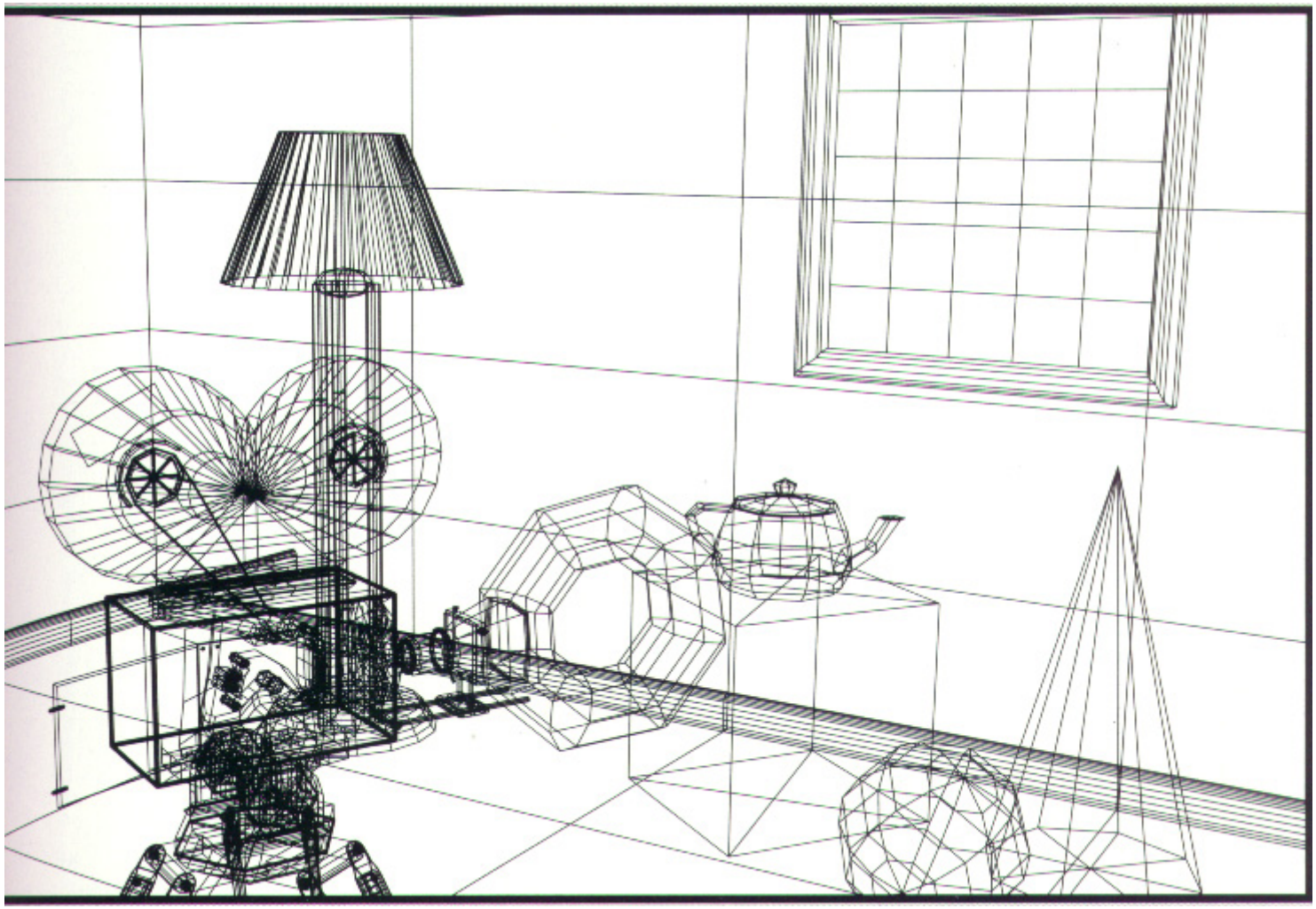
Htc vive

Oculus Rift

Sony VR

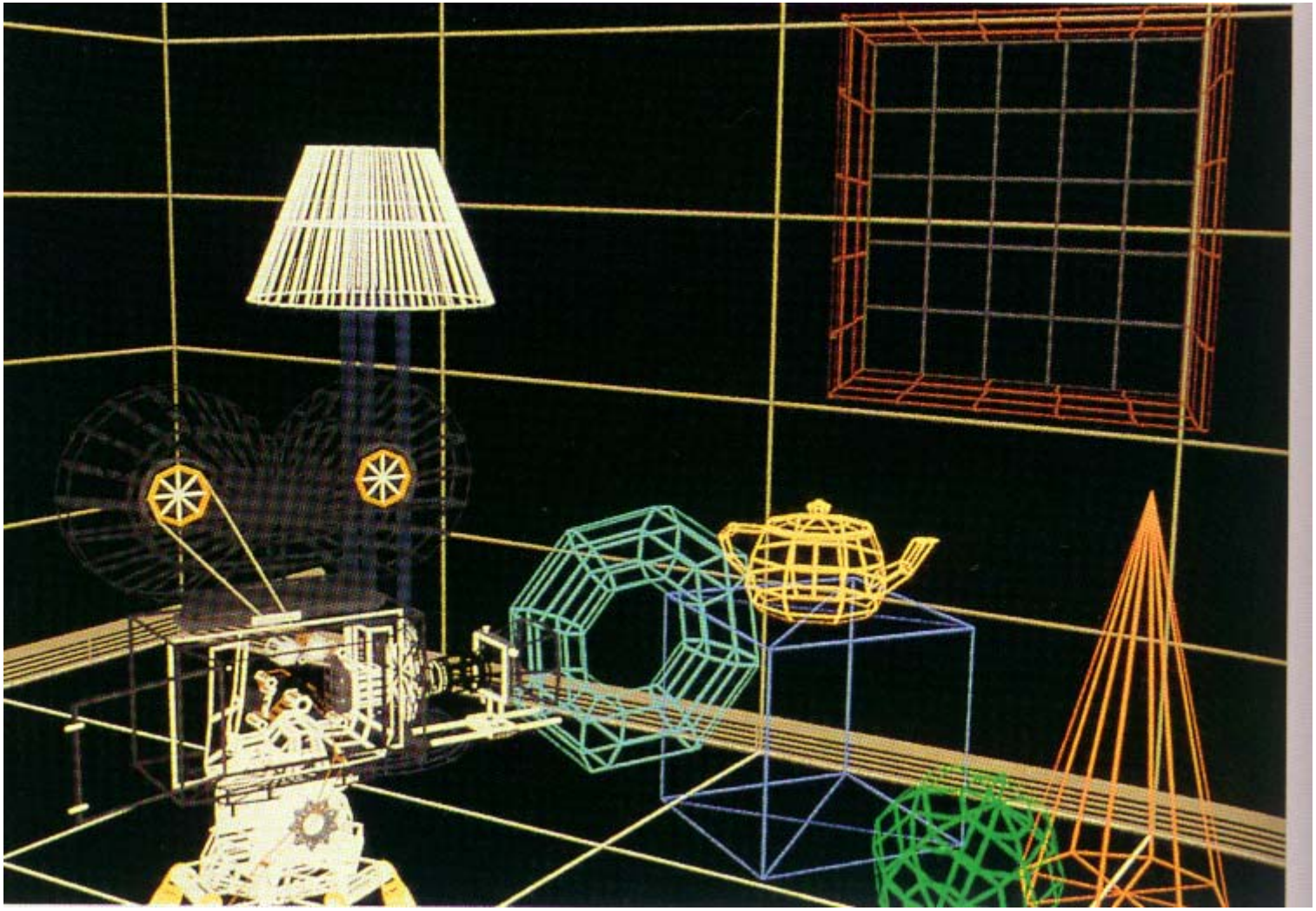
Evolution

Wire-Frame



Shutterbug: Copyright 1990 Pixar - Rendered by Thomas Williams and H. B. Siegel using Pixar's RenderMan™

Coloring



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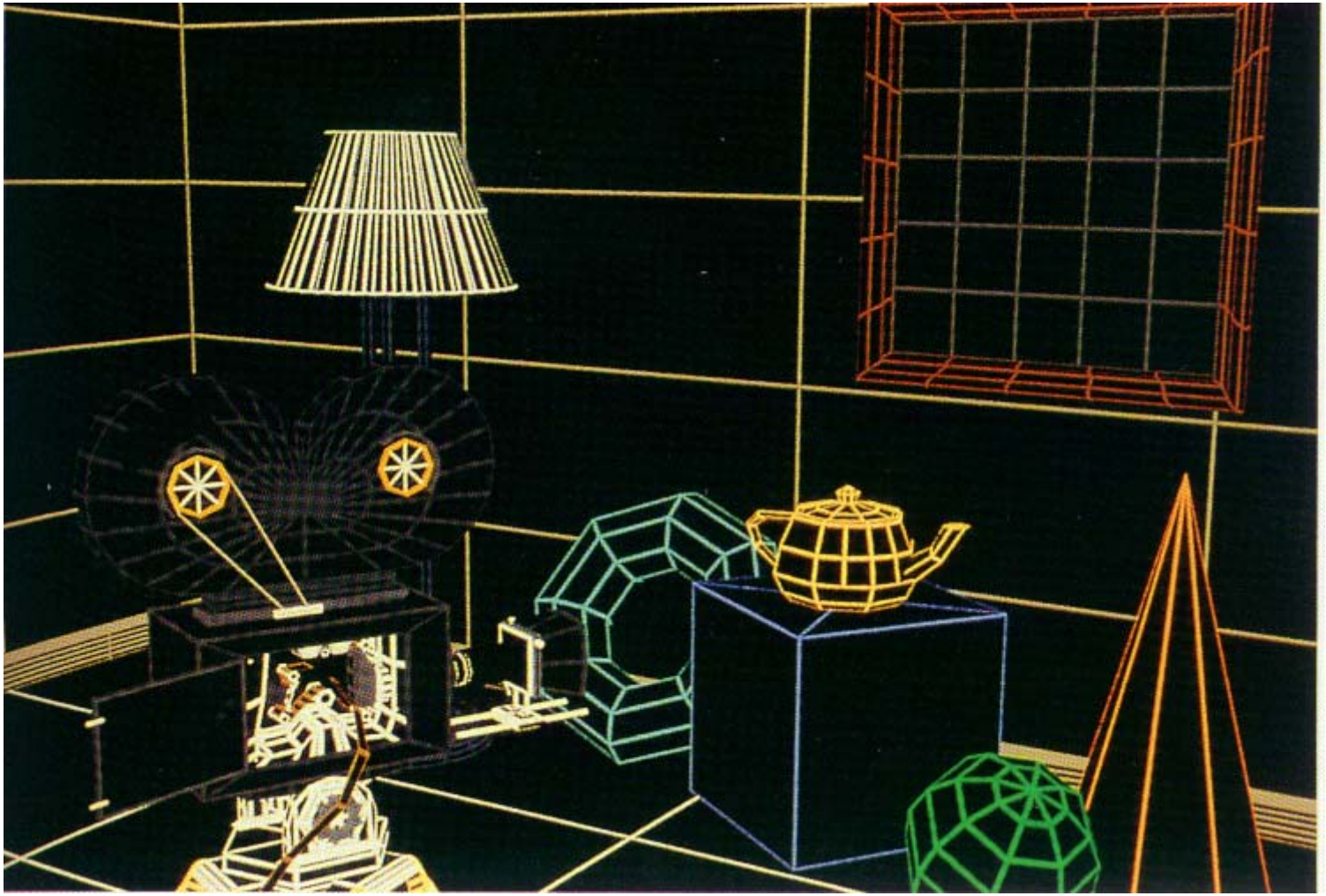
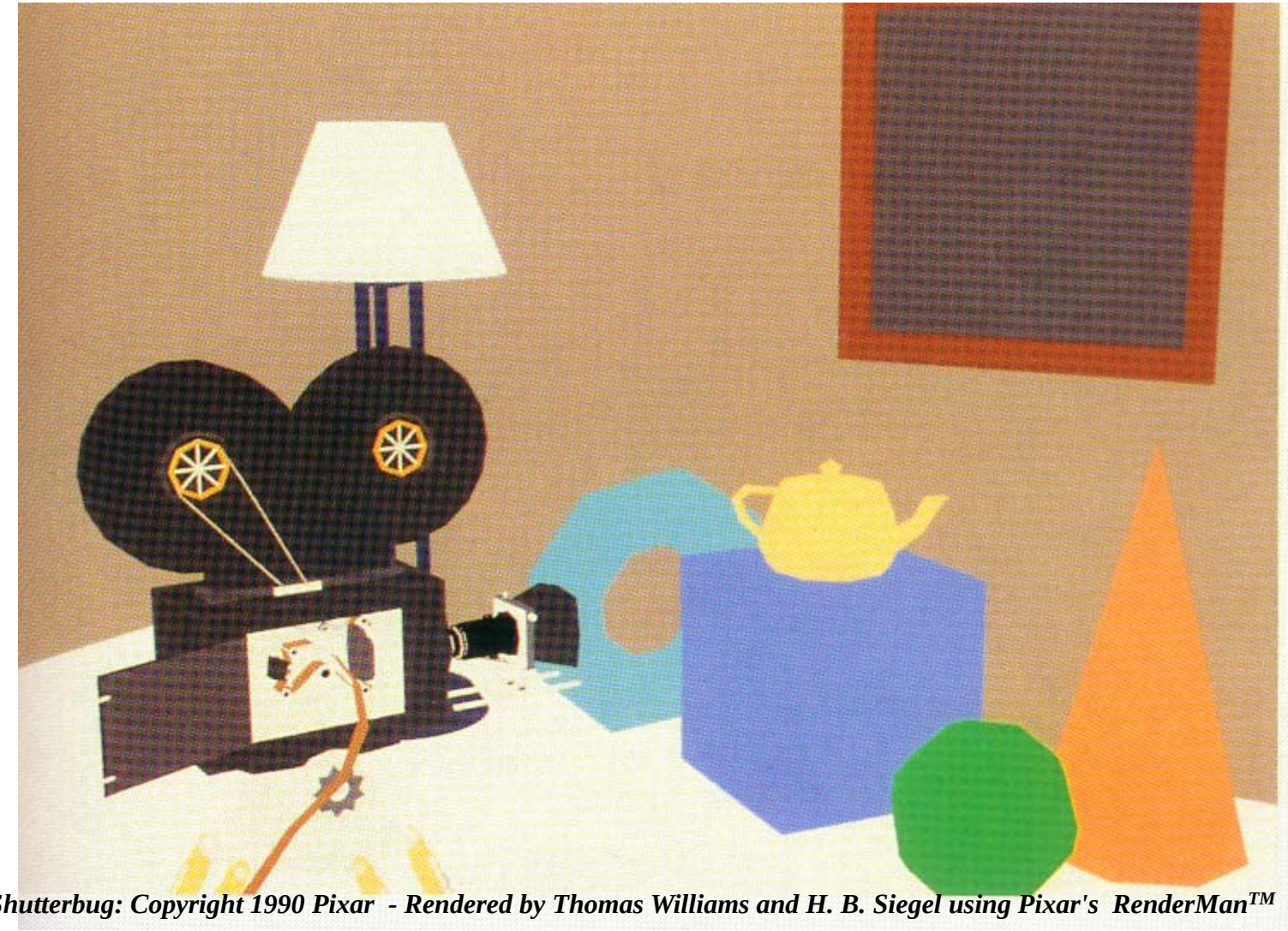
Hidden Surface Removal



Constant Rendering

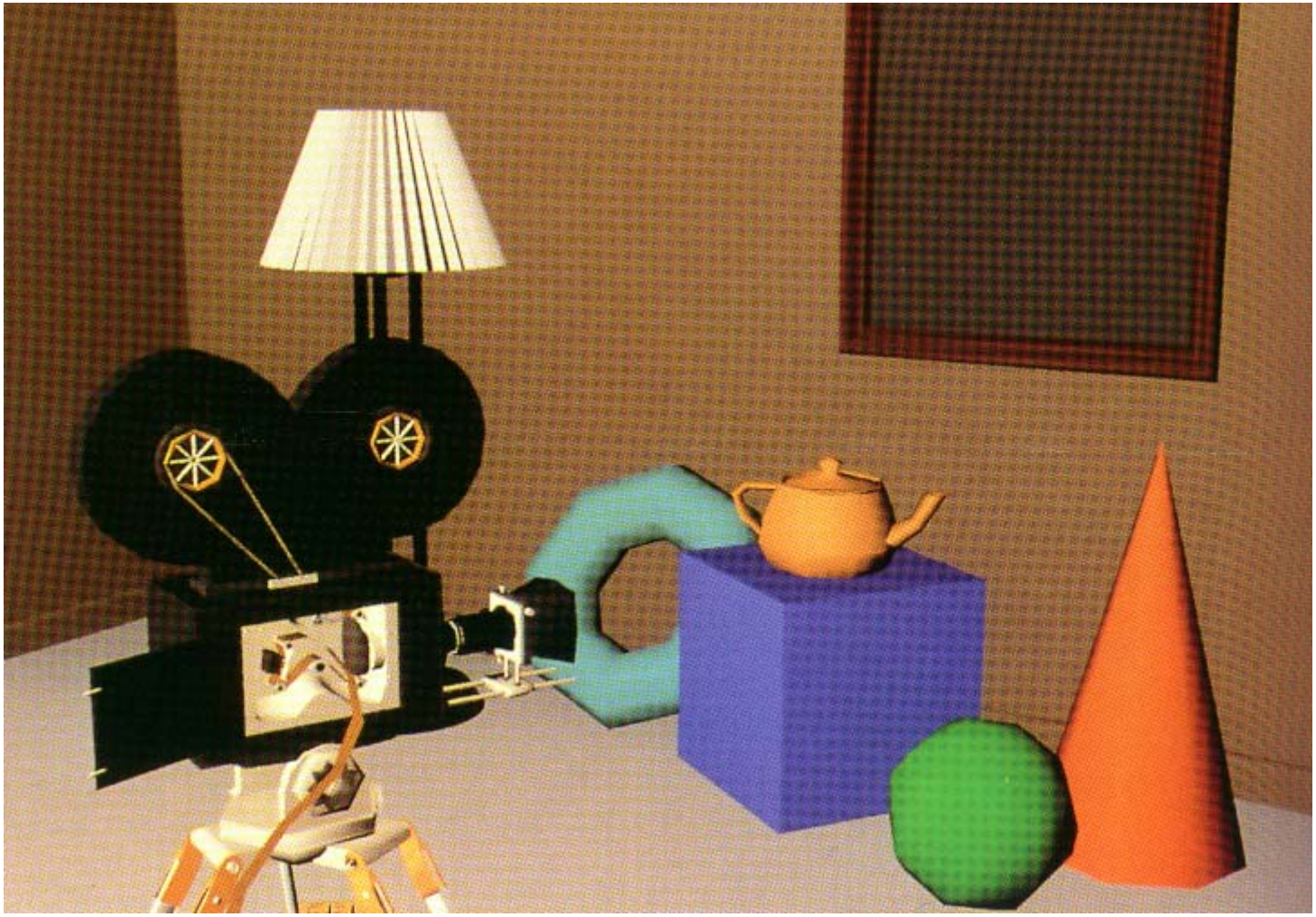


Shutterbug: Copyright 1990 Pixar - Rendered by Thomas Williams and H. B. Siegel using Pixar's RenderMan™

Facet Shading

Shutterbug: Copyright 1990 Pixar - Rendered by Thomas Williams and H. B. Siegel using Pixar's RenderMan™

Smooth Shading



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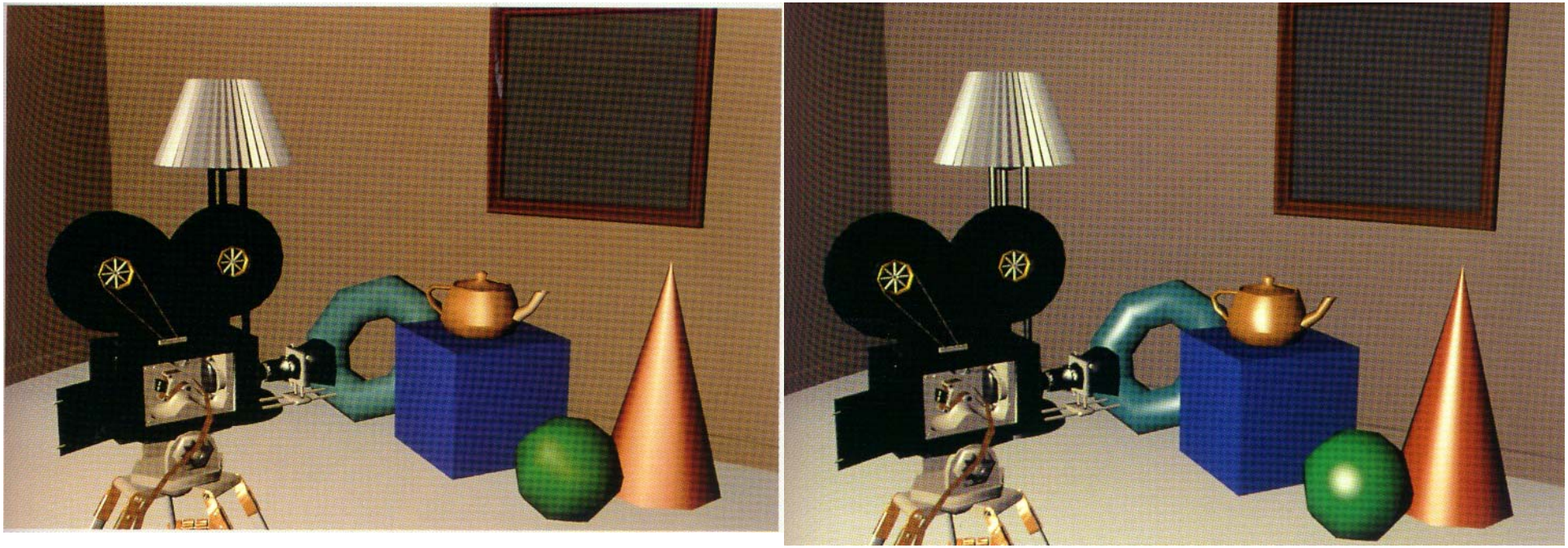
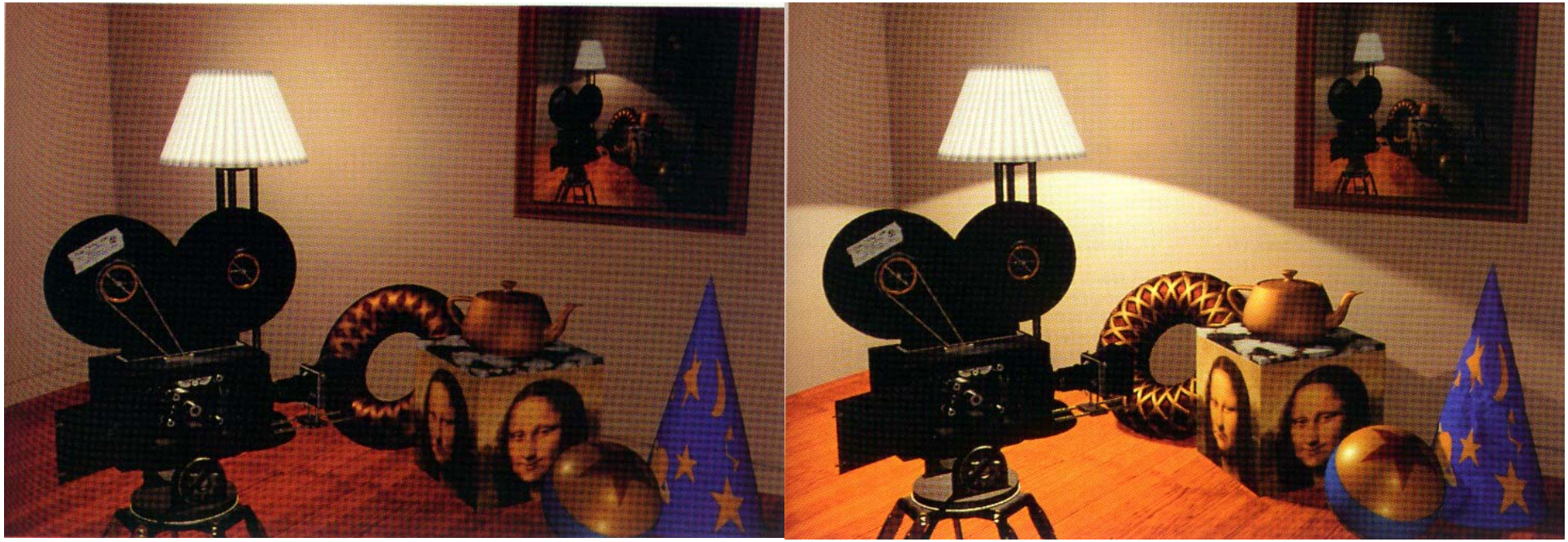
Correct Highlight



Shutterbug: Copyright 1990 Pixar - Rendered by Thomas Williams and H. B. Siegel using Pixar's RenderMan™

Texture & Shadow



Shutterbug: Copyright 1990 Pixar - Rendered by Thomas Williams and H. B. Siegel using Pixar's RenderMan™

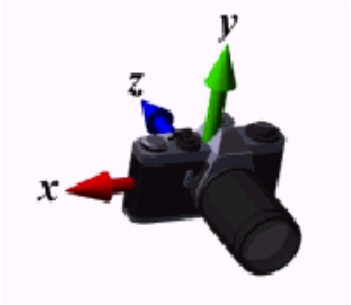
Reflection

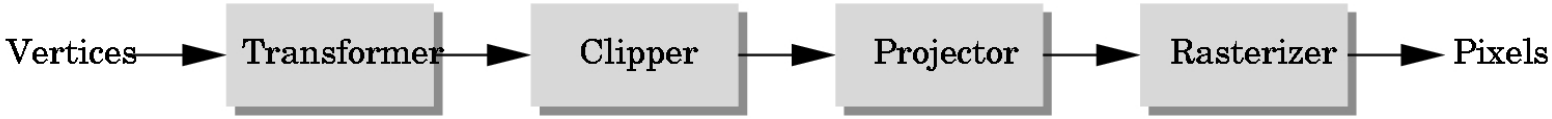
Shutterbug: Copyright 1990 Pixar - Rendered by Thomas Williams and H. B. Siegel using Pixar's RenderMan™

Rendering pipeline

Following the Pipeline: Transformations

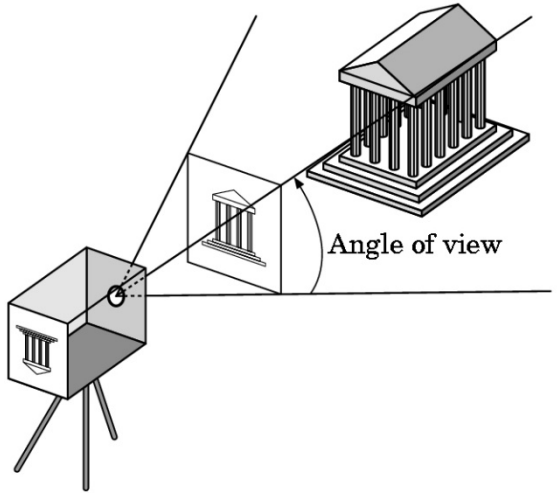
- Much of the work in the pipeline is in converting object representations from one coordinate system to another
  - World coordinates
  - Camera coordinates
  - Screen coordinates
- Every change of coordinates is equivalent to a matrix transformation

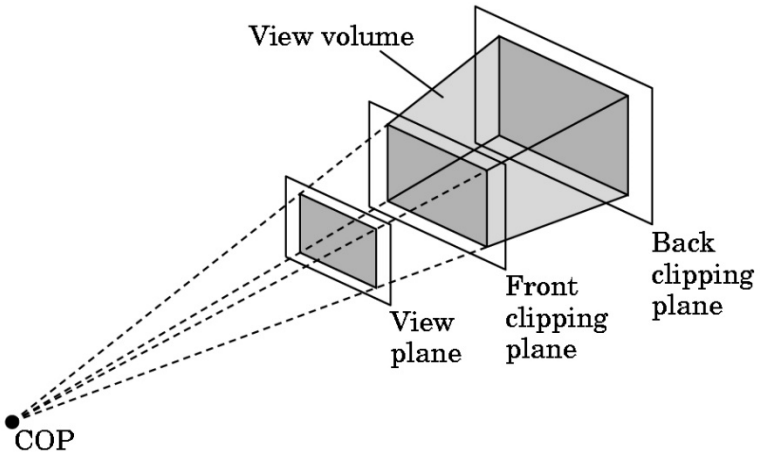




Clipping

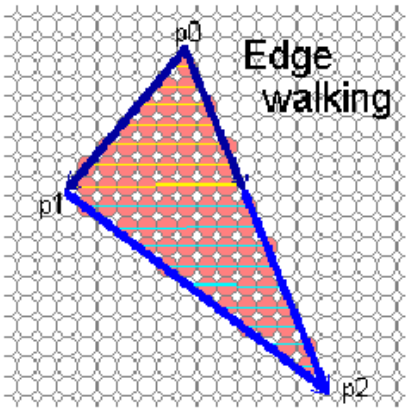
- Just as a real camera cannot “see” the whole world, the virtual camera can only see part of the world space
  - Objects that are not within this volume are said to be *clipped* out of the scene

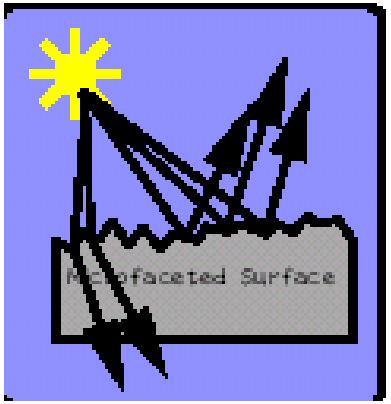


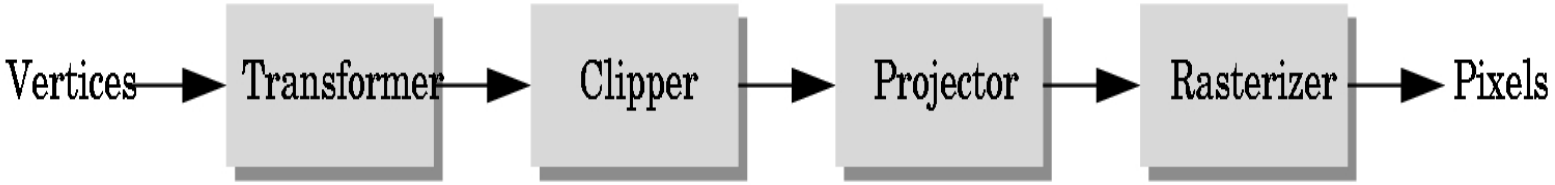


Rasterization

- If an object is visible in the image, the appropriate pixels in the frame buffer must be assigned colors
  - Vertices assembled into objects
  - Effects of lights and materials must be determined
  - Polygons filled with interior colors/shades
  - Must have also determine which objects are in front (hidden surface removal)

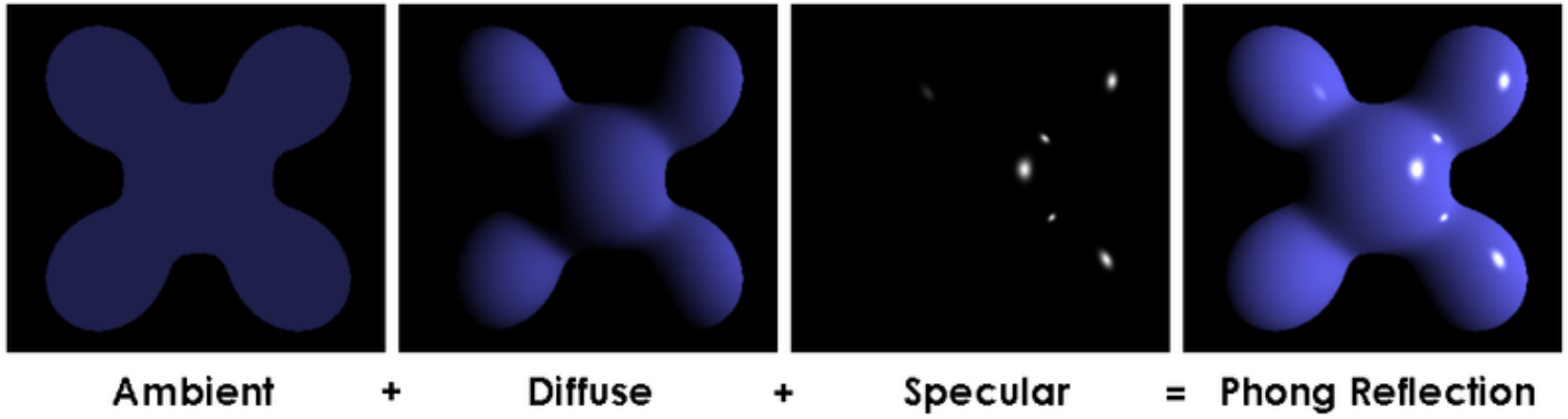




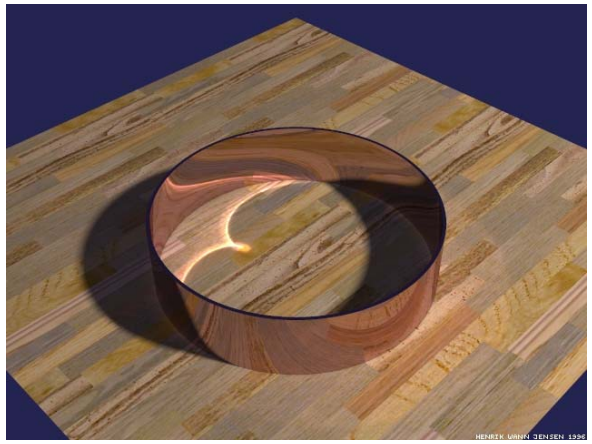


Shading

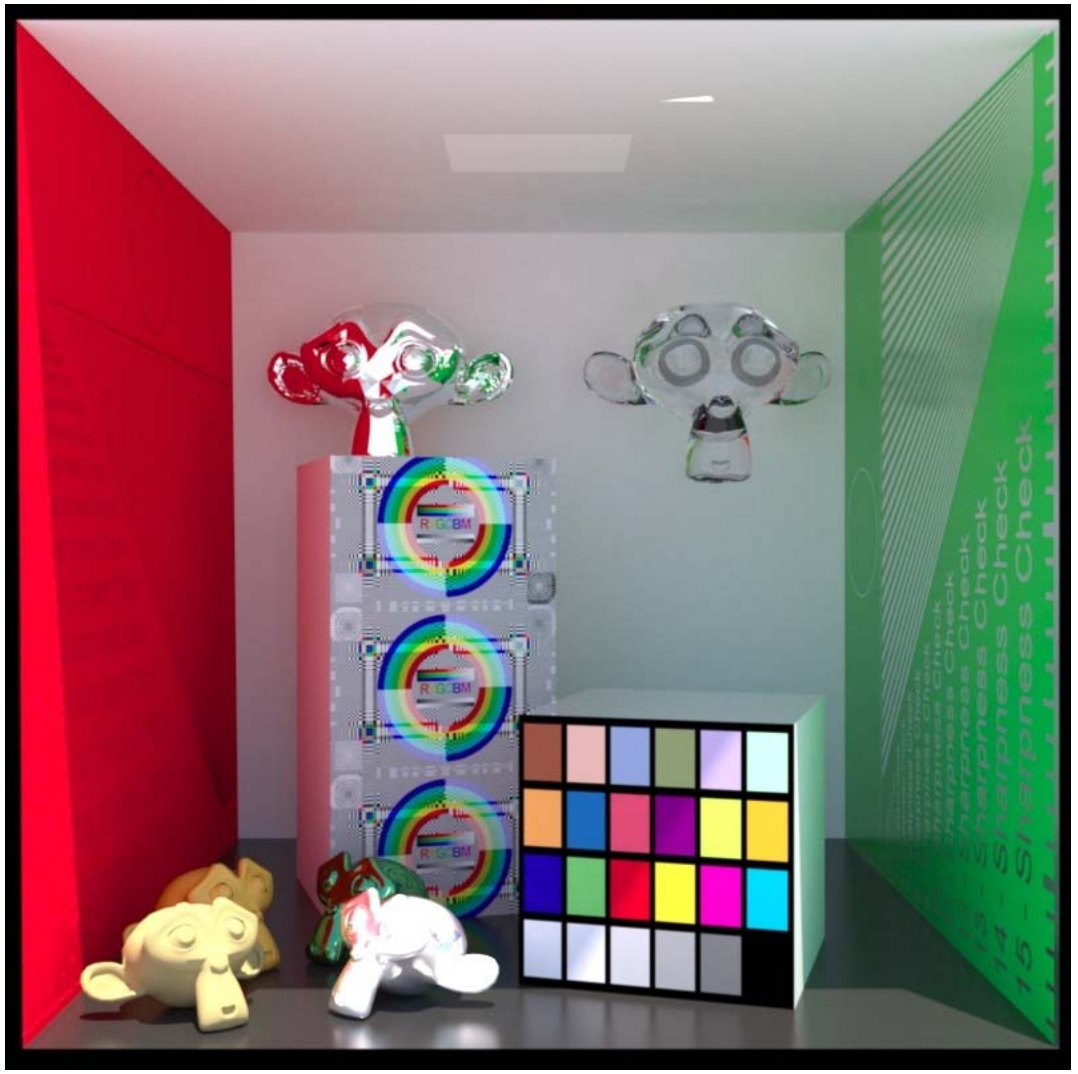
- Shading refers to depicting depth perception in 3D models or illustrations by varying levels of darkness.



Global Illumination

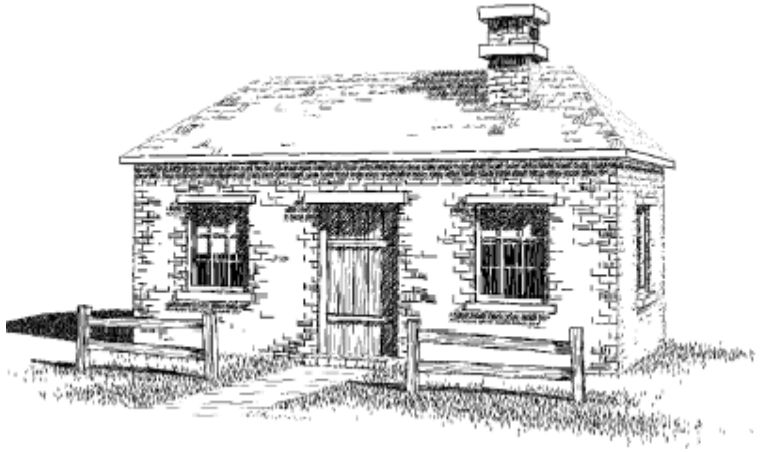


Cornell box



Test scene by Luxrender

Non-photorealistic Rendering



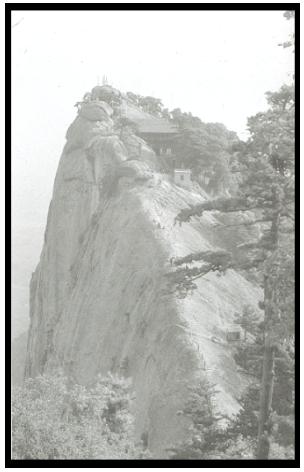
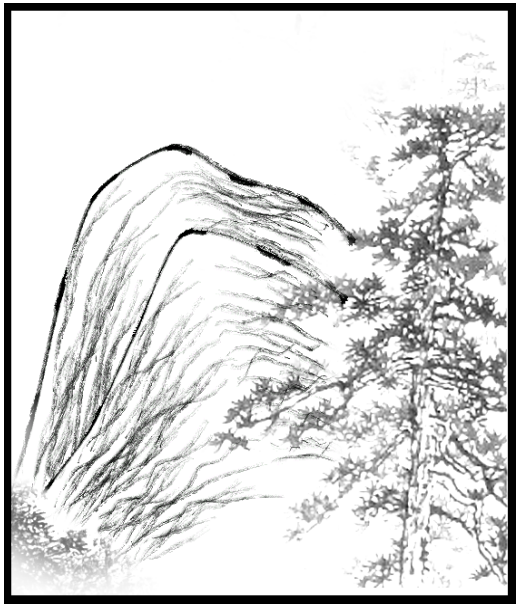


Photo image of the real scene



Applications

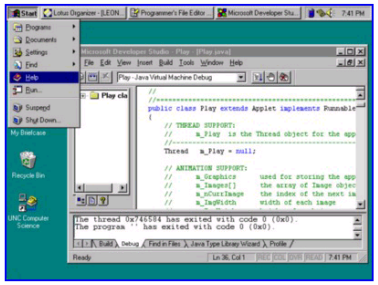
Major Applications

- Video games
- Cartoons
- Visual effects
- Animated films
- CAD/CAM
- Simulation
- Medical imaging
- Information visualization

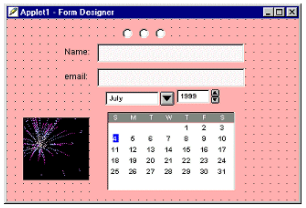
Computer Graphics is about Movies!

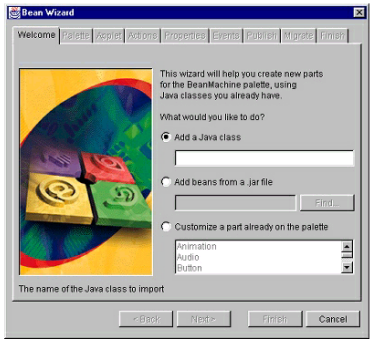
Games are OK here

Graphical User Interfaces (GUIs)



Computer graphics is an integral part of every day computing. Nowhere is this fact more evident than the modern computer interface design. Graphical elements such as windows, cursors, menus, and icons are so common place it is difficult to imagine computing without them. Once graphics programming was considered a speciality. Today, nearly all professional programmers must have an understanding of graphics in order to accept input and present output to users.

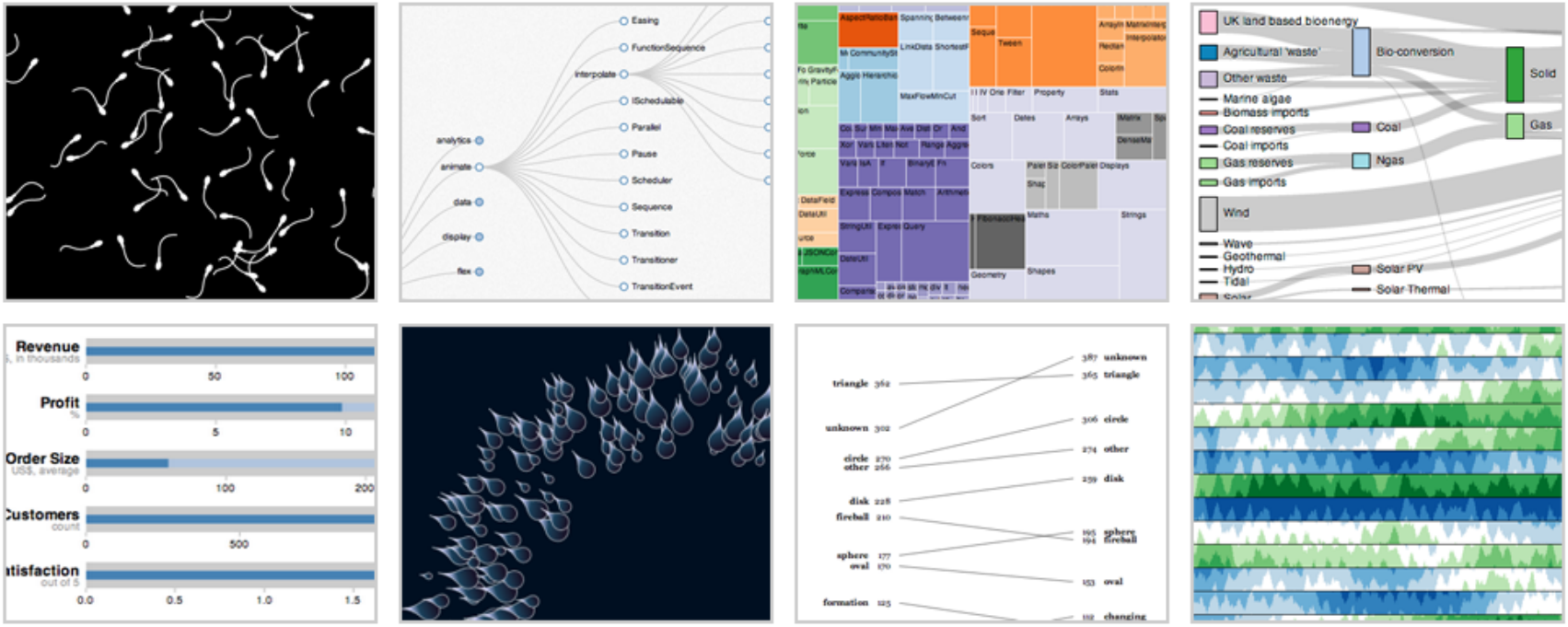




Visualization

- http://d3js.org/

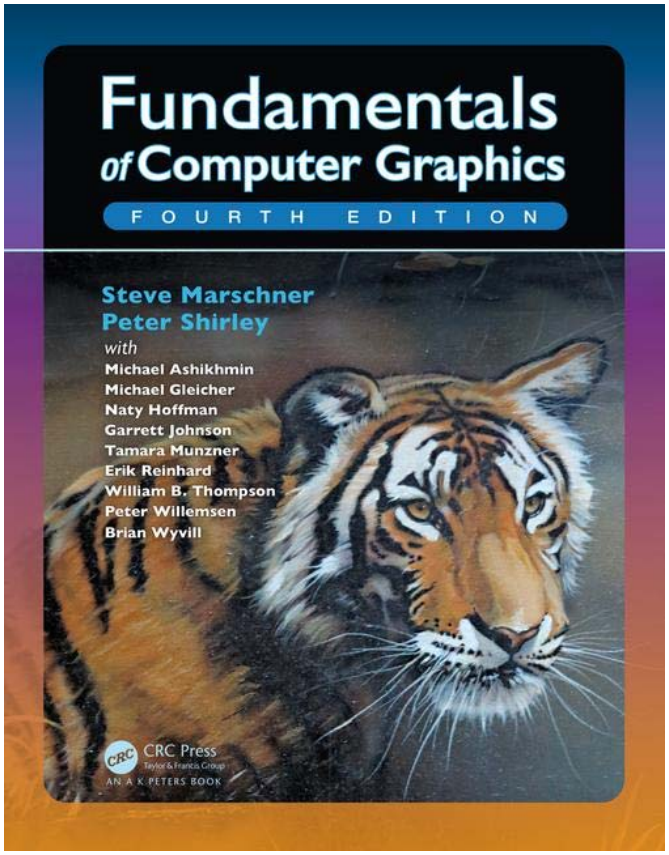
Data-Driven Documents

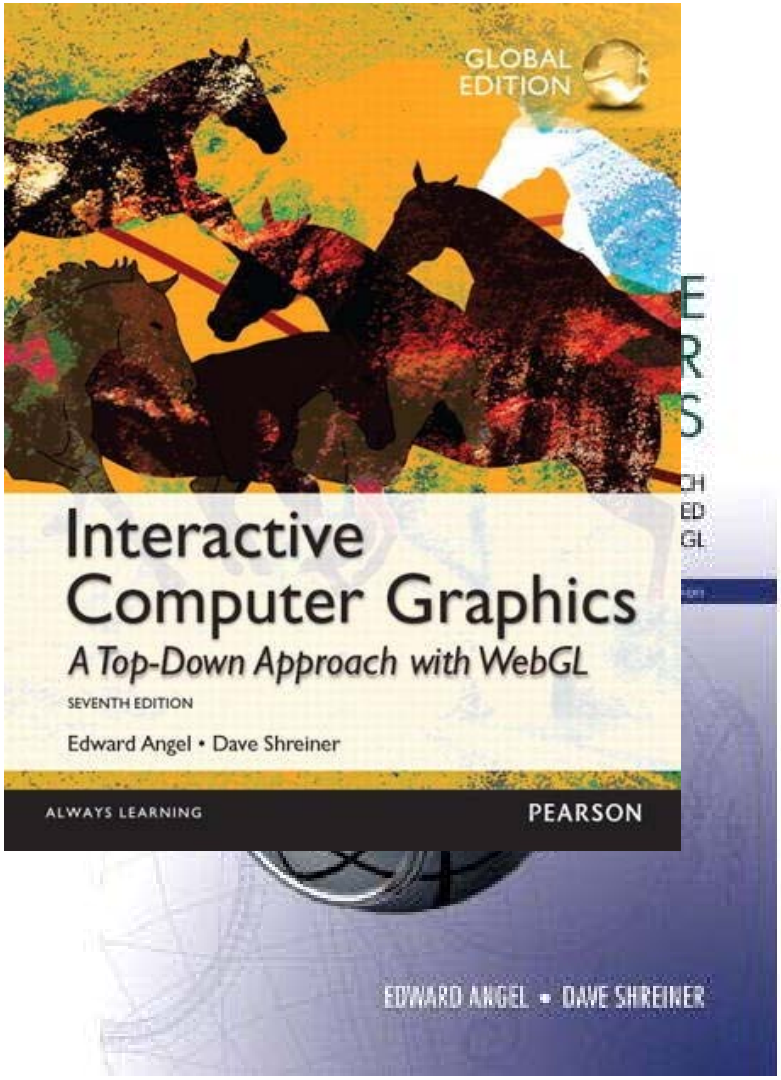


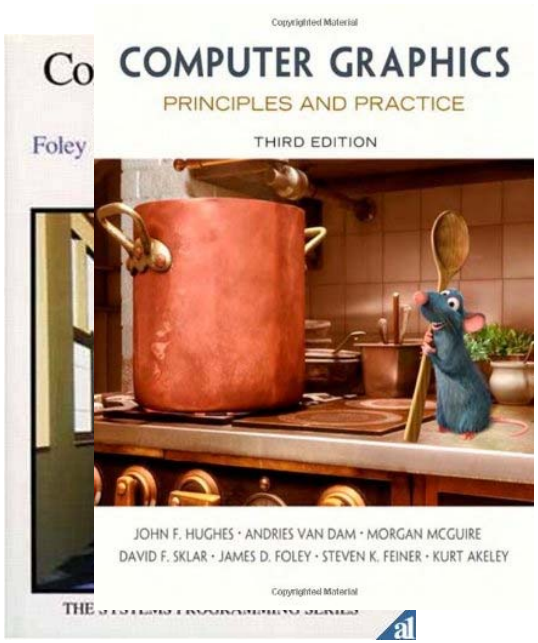
Medical Applications

Reference

Textbooks


Fundamentals
of Computer Graphics
FOURTH EDITION
Steve Marschner
Peter Shirley
with
Michael Ashikhmin
Michael Gleicher
Naty Hoffman
Garrett Johnson
Tamara Munzner
Erik Reinhard
William B. Thompson
Peter Willemsen
Brian Wyvill
CRC Press
AN A K PETERS BOOK


GLOBAL
EDITION
Interactive
Computer Graphics
A Top-Down Approach with WebGL
SEVENTH EDITION
Edward Angel • Dave Shreiner
ALWAYS LEARNING
PEARSON
EDWARD ANGEL • DAVE SHREINER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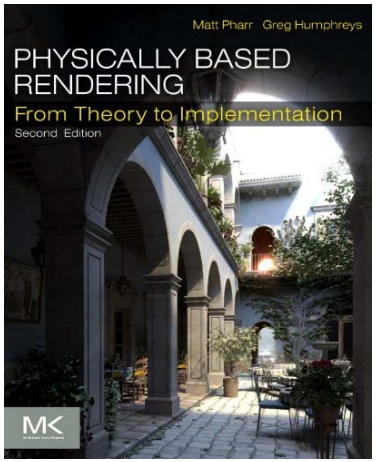
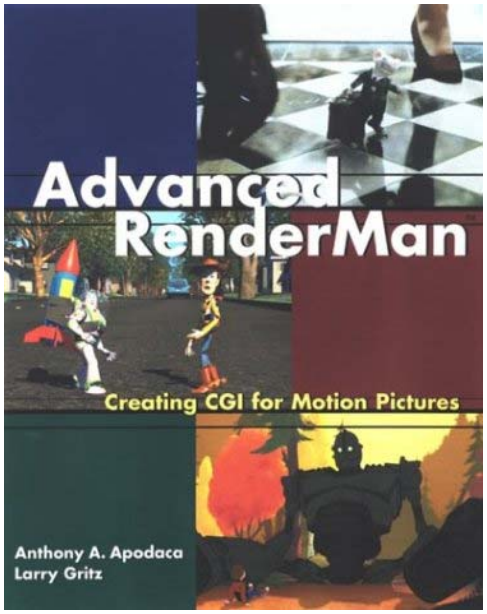
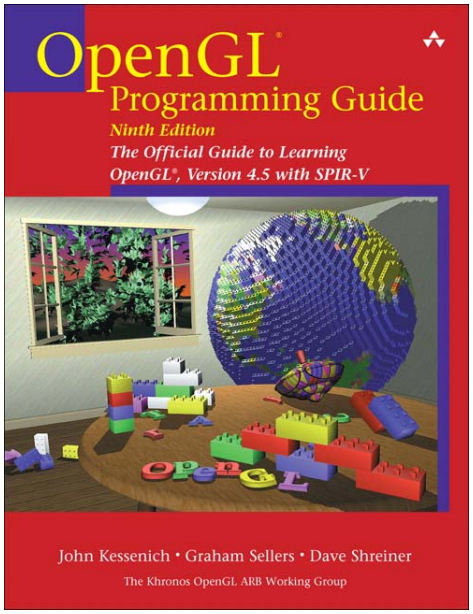
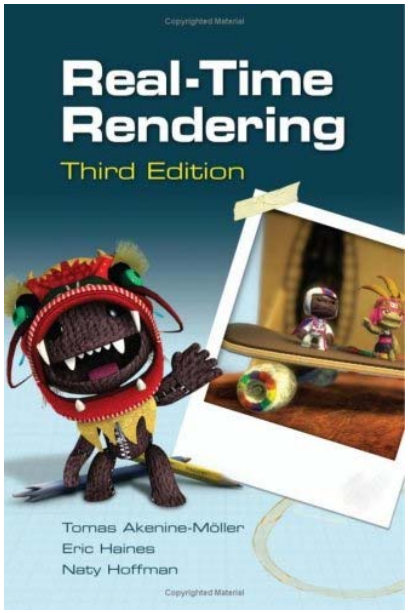

Matt Pharr Greg Humphreys
PHYSICALLY BASED RENDERING
From Theory to Implementation
Second Edition


RAY TRACING
IN ONE WEEKEND
PETER SHIRLEY


Advanced RenderMan
Creating CGI for Motion Pictures
Anthony A. Apodaca
Larry Gritz


OpenGL
Programming Guide
Ninth Edition
The Official Guide to Learning
OpenGL, Version 4.5 with SPIR-V
John Kessenich • Graham Sellers • Dave Shreiner
The Khronos OpenGL ARB Working Group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Resource

- http://www.opengl.org

- OpenGL software implementation
  - http://www.mesa3d.org/

- http://nehe.gamedev.net/
- Computer Graphics Paper Collection
  - http://kesen.realtimerendering.com