GRAPHICS PIPELINE

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SCOPE, VIT-AP

OVERVIEW OF THE COURSE

Graphics Pipeline (Today)

Modelling

Surface / Curve modelling

Local lighting effects

Illumination, lighting, shading, mirroring, shadowing

Rasterization (creating the image using the 3D scene)

Ray tracing

Global illumination

Curves and Surfaces

GRAPHICS/RENDERING PIPELINE

Graphics processes generally execute sequentially

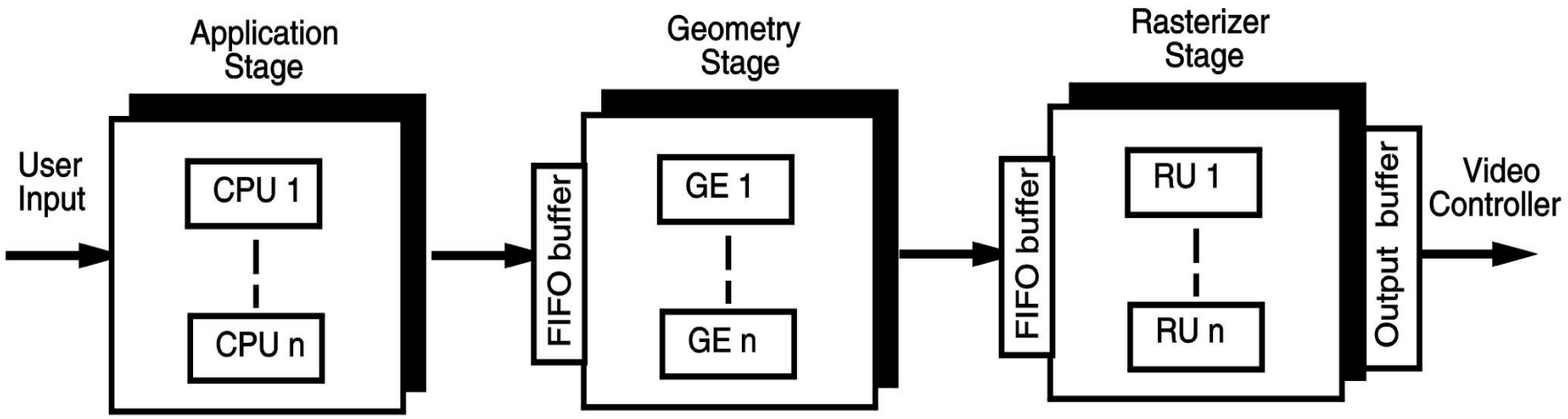
Pipelining the process means dividing it into stages

Especially when rendering in real-time, different hardware resources are assigned for each stage

GRAPHICS / RENDERING PIPELINE

There are three stages

- Application Stage
- Geometry Stage
- Rasterization Stage



APPLICATION STAGE

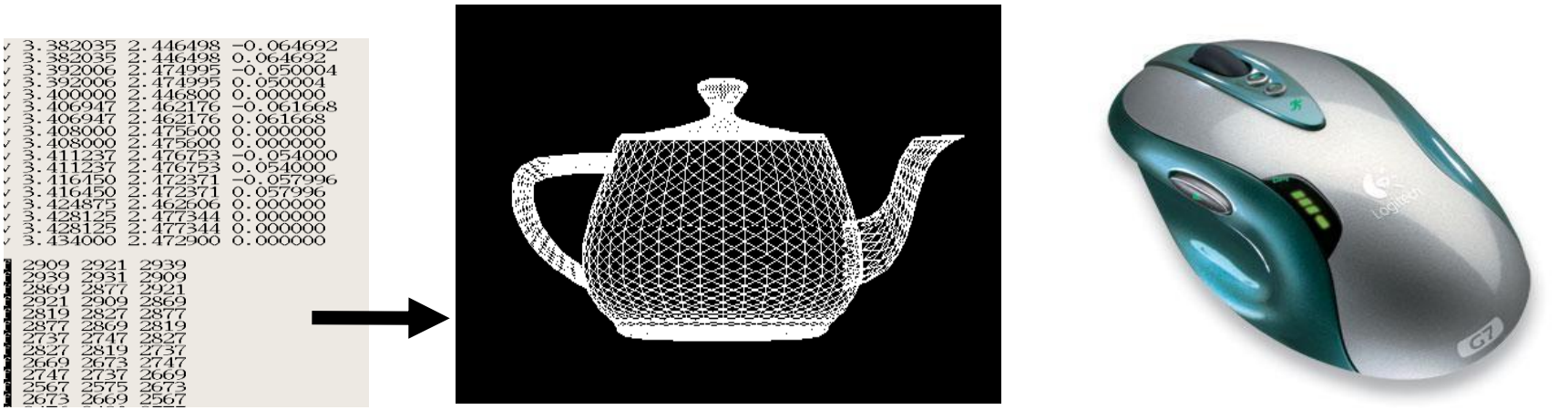
Entirely done in software by the CPU

Read Data

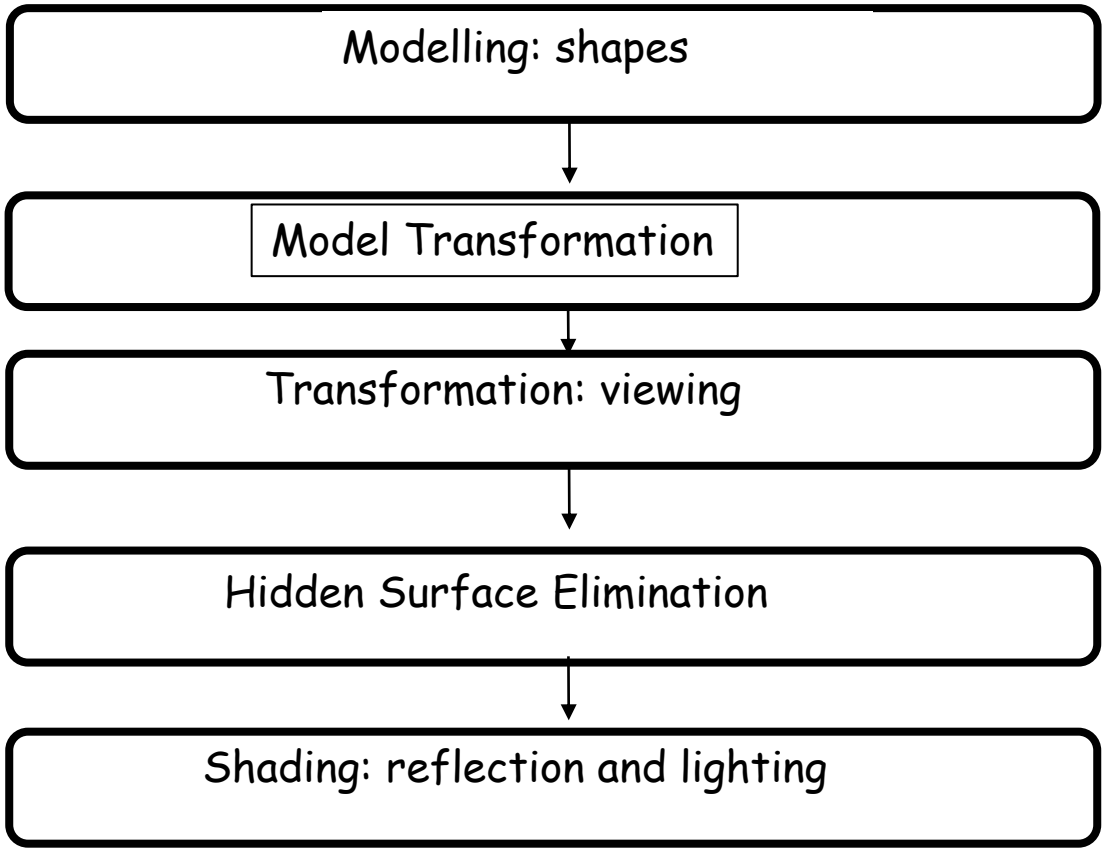
the world geometry database,

User's input by mice, trackballs, trackers, or sensing gloves

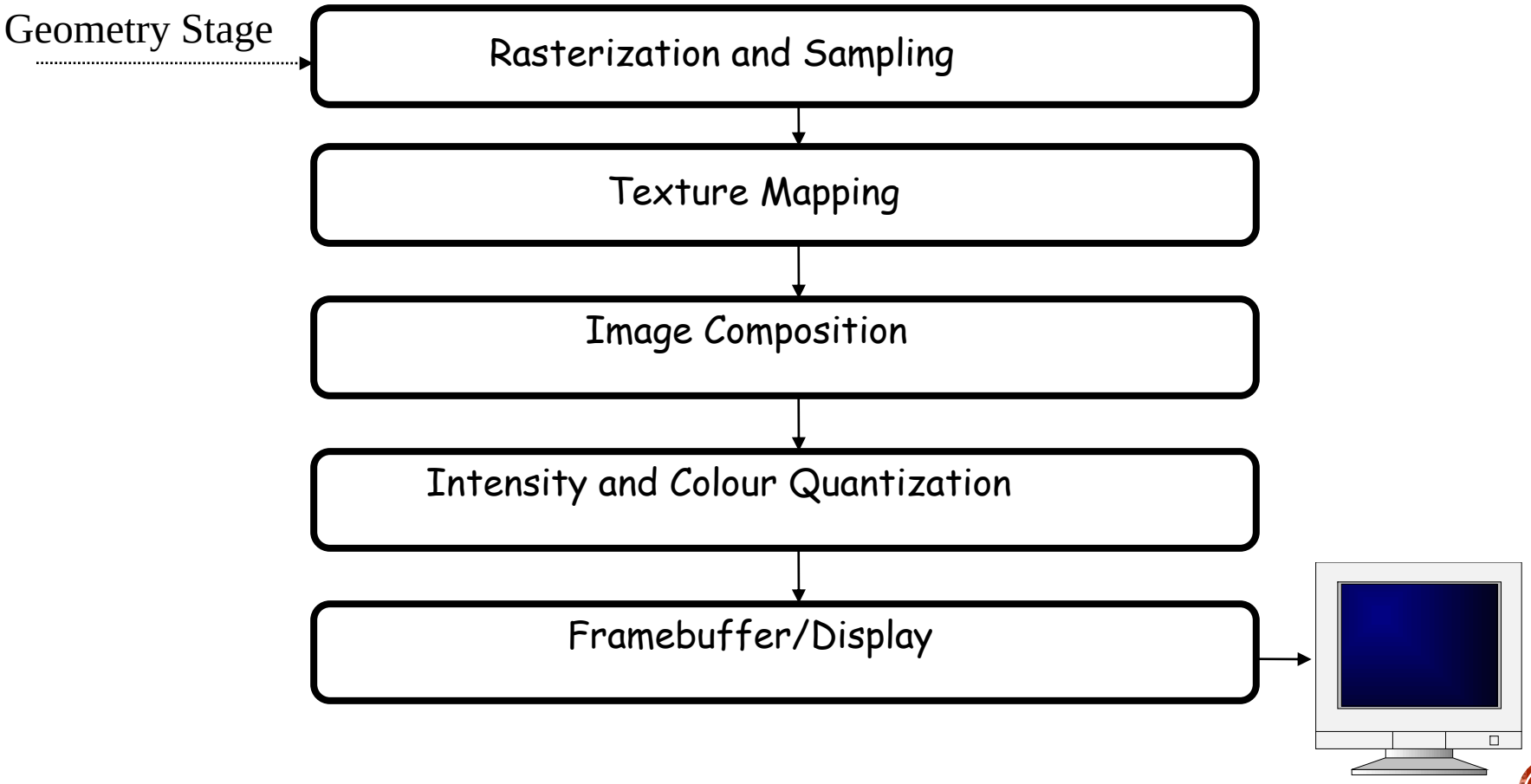
In response to the user's input, the application stage change the view or scene



GEOMETRY STAGE

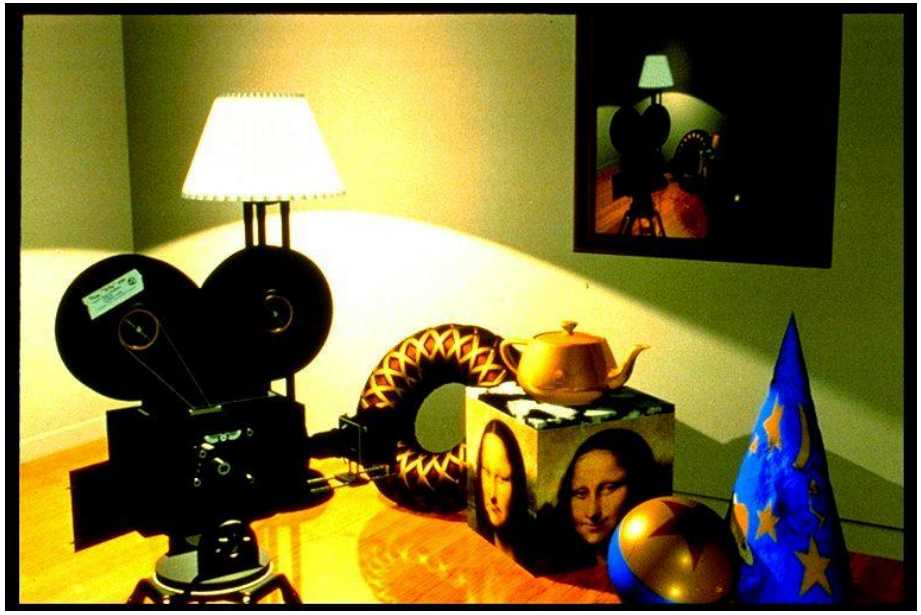


RASTERIZATION STAGE

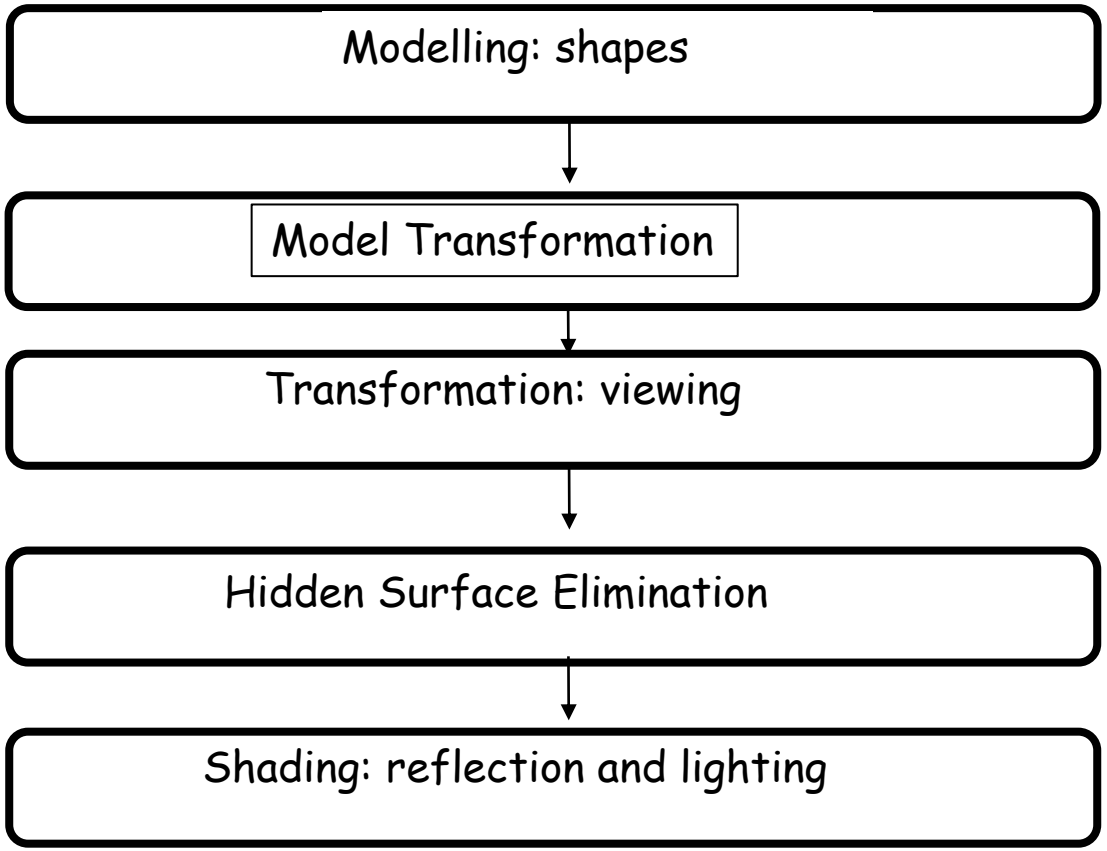


AN EXAMPLE THRO' THE PIPELINE...

The scene we are trying to represent:

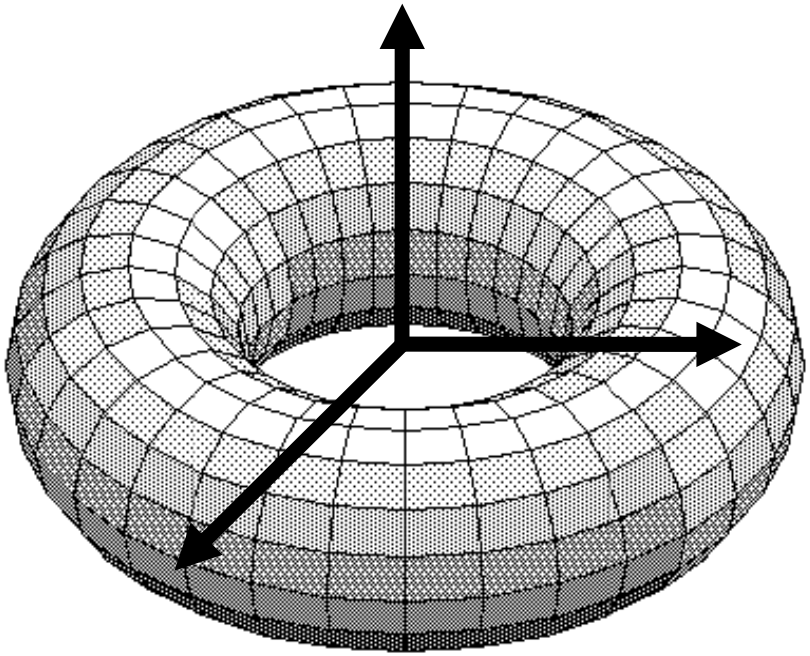


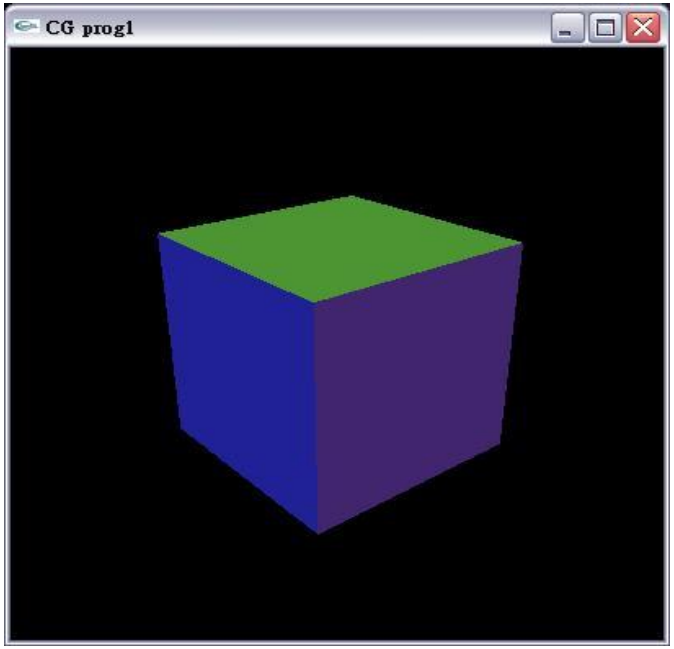
GEOMETRY STAGE



PREPARING SHAPE MODELS

- Designed by polygons, parametric curves/surfaces, implicit surfaces etc
- Defined in its own coordinate system



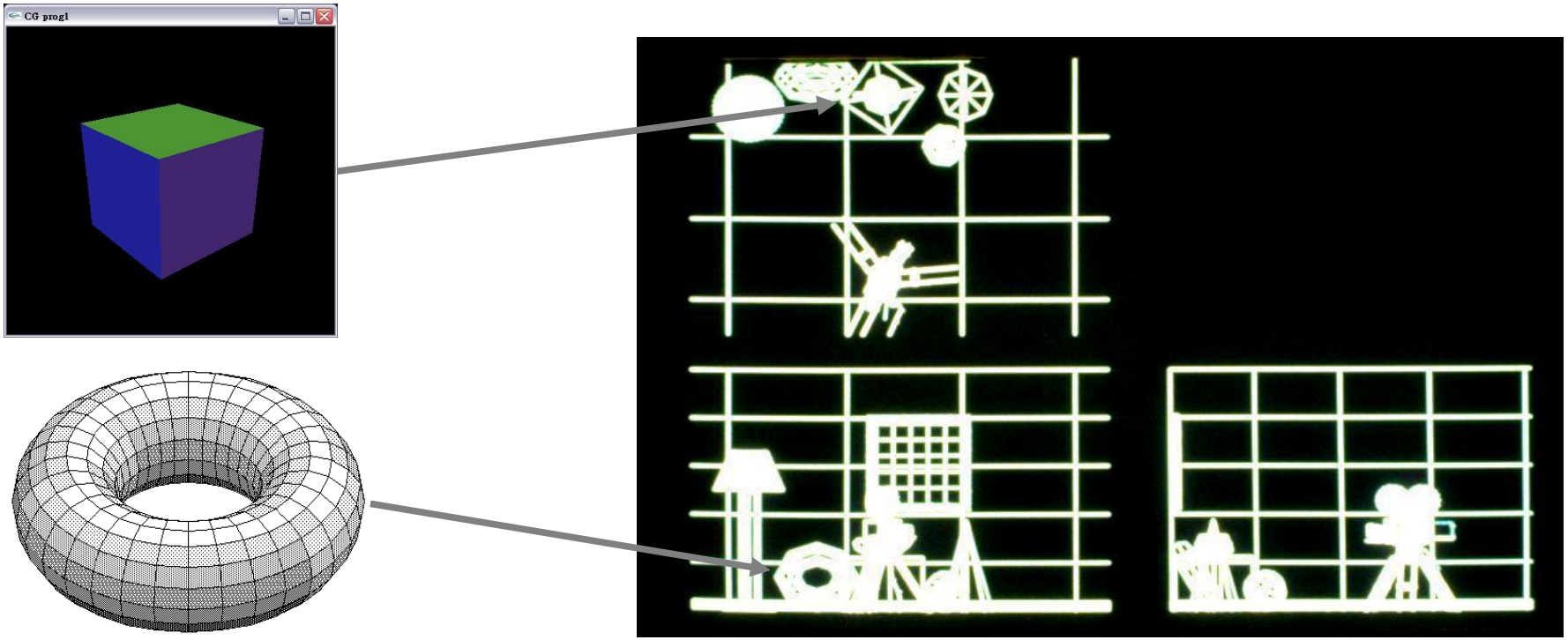


MODEL TRANSFORMATION

Objects put into the scene by applying translation, scaling and rotation

Linear transformation called homogeneous transformation is used

The location of all the vertices are updated by this transformation

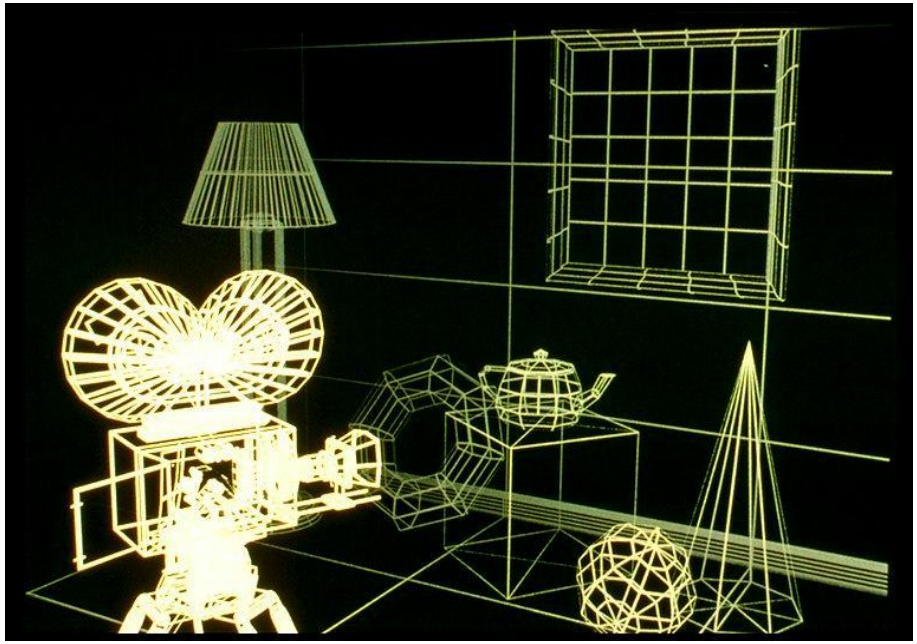


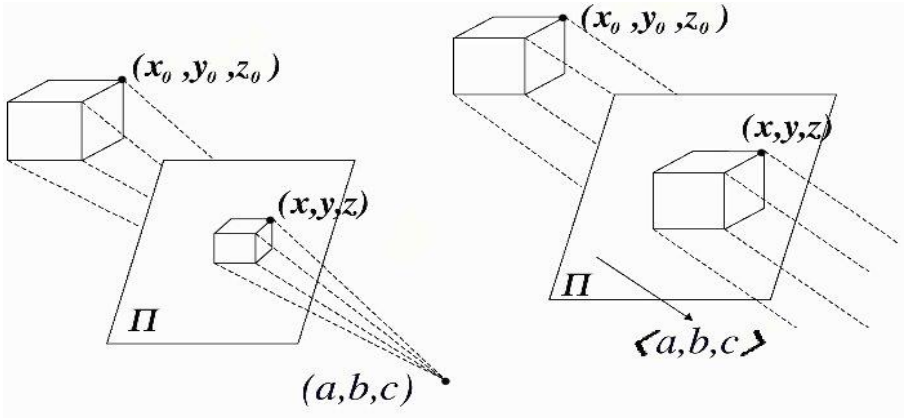
PERSPECTIVE PROJECTION/VIEWING

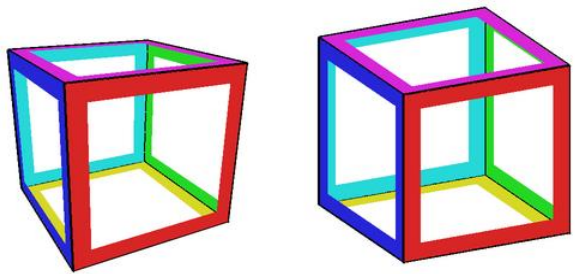
We want to create a picture of the scene viewed from the camera

We apply a perspective transformation to convert the 3D coordinates to 2D coordinates of the screen

Objects far away appear smaller, closer objects appear bigger

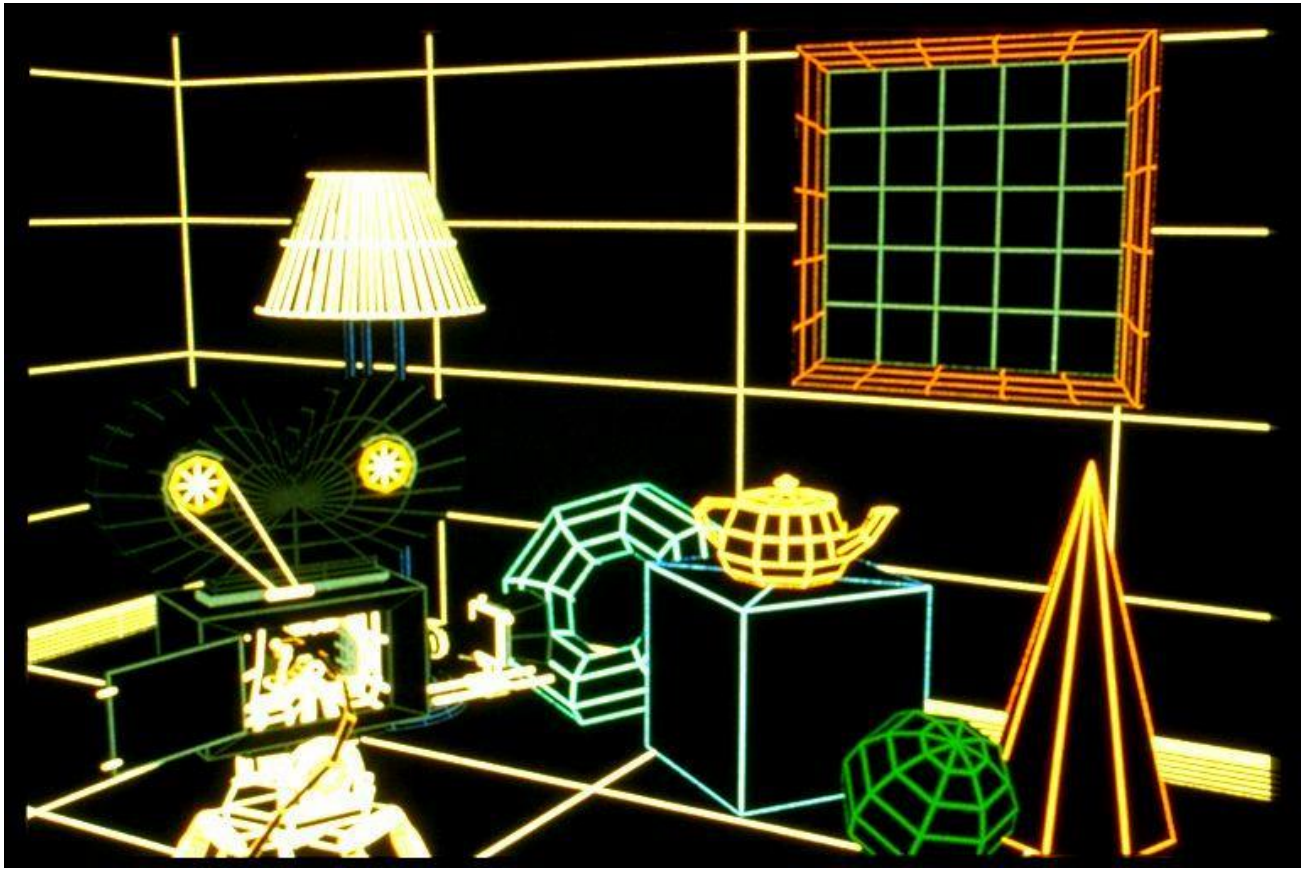






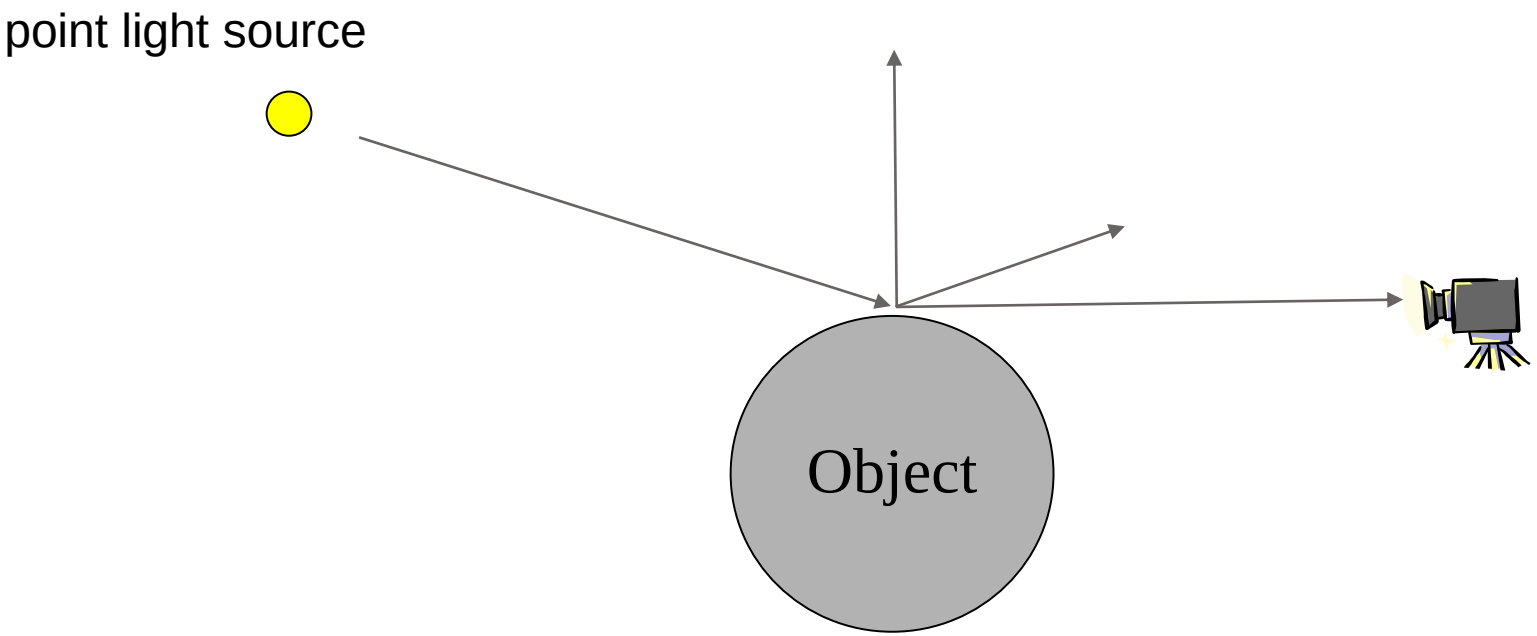
HIDDEN SURFACE REMOVAL

Objects occluded by other objects must not be drawn



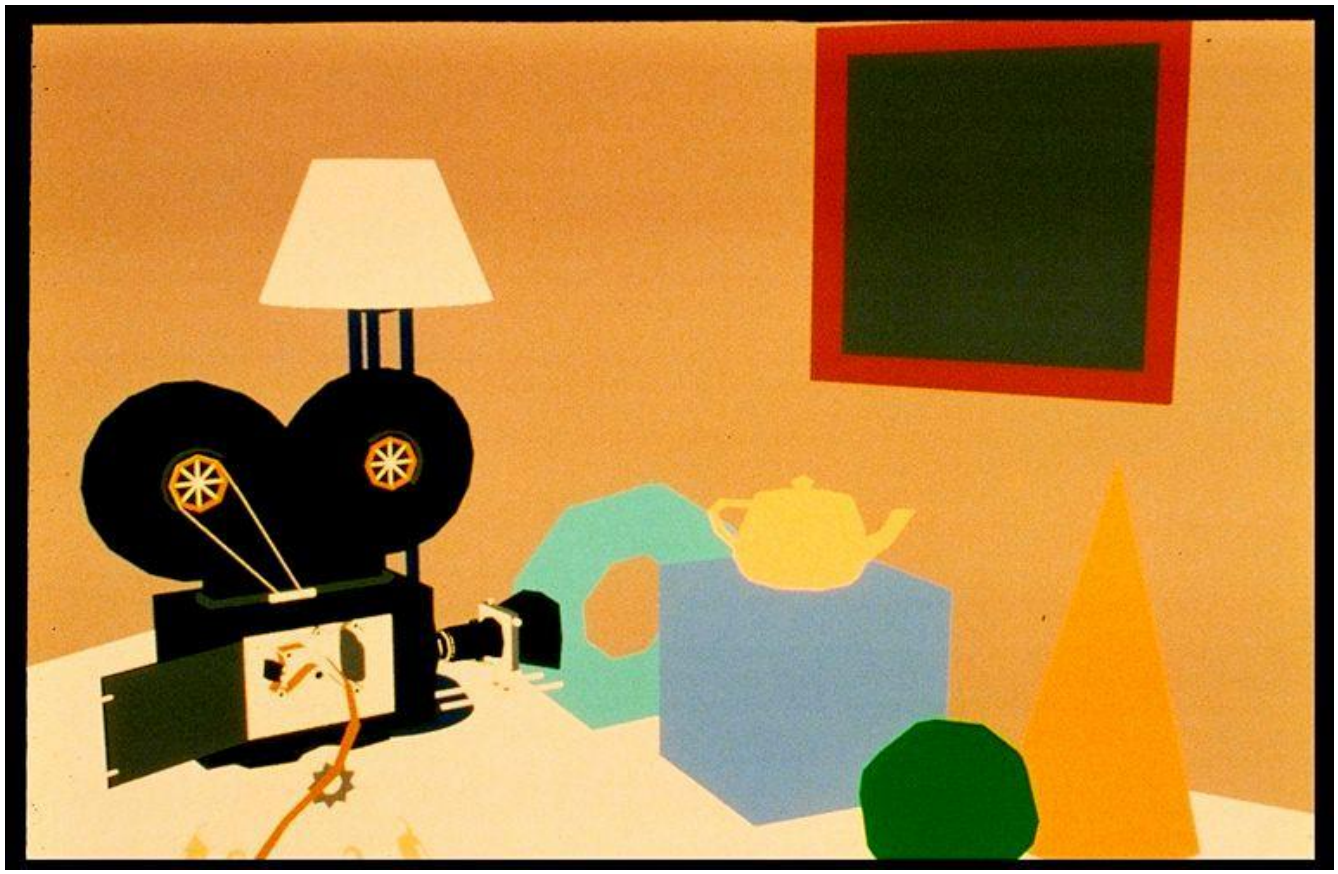
SHADING

Now we need to decide the colour of each pixels taking into account the object's colour, lighting condition and the camera position



SHADING : CONSTANT SHADING - AMBIENT

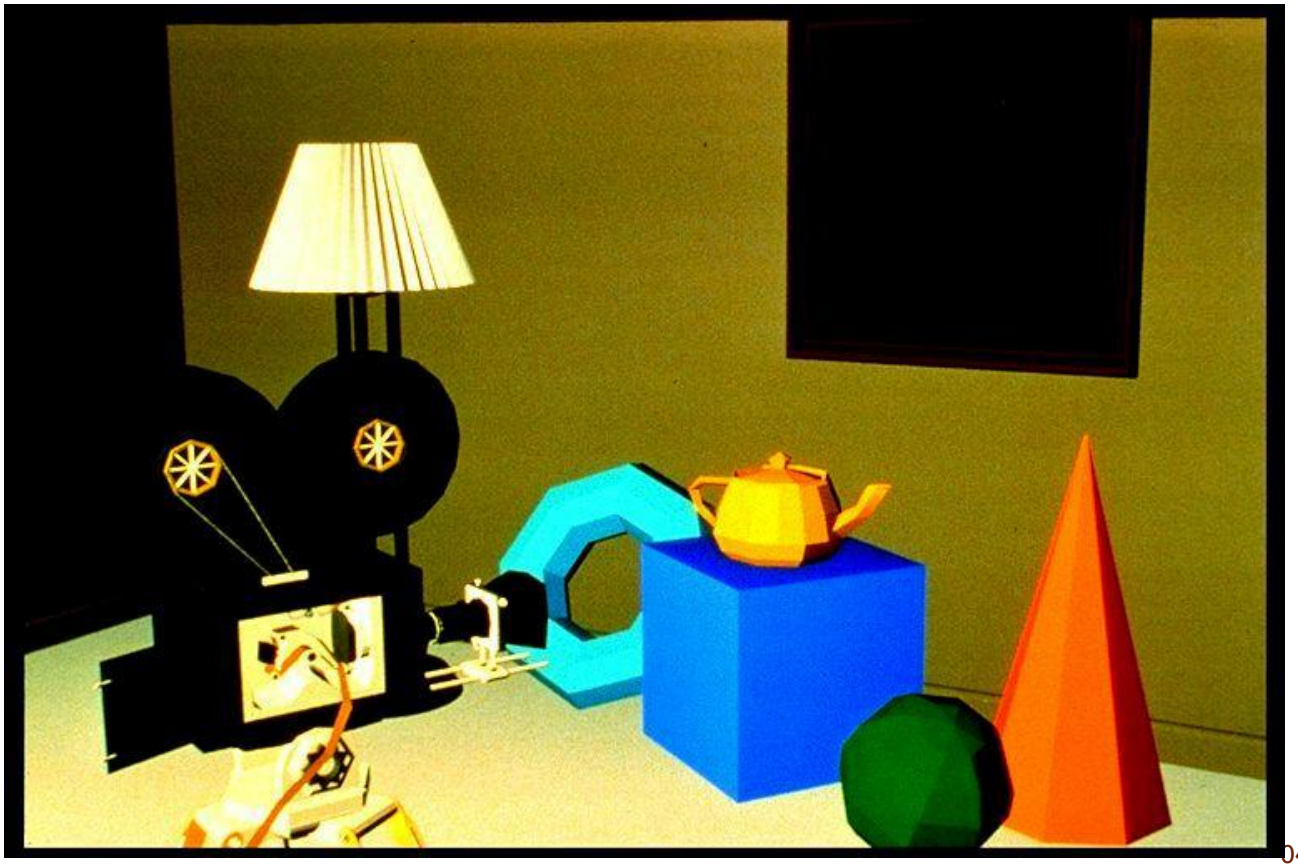
Objects colours by its own colour



SHADING – FLAT SHADING

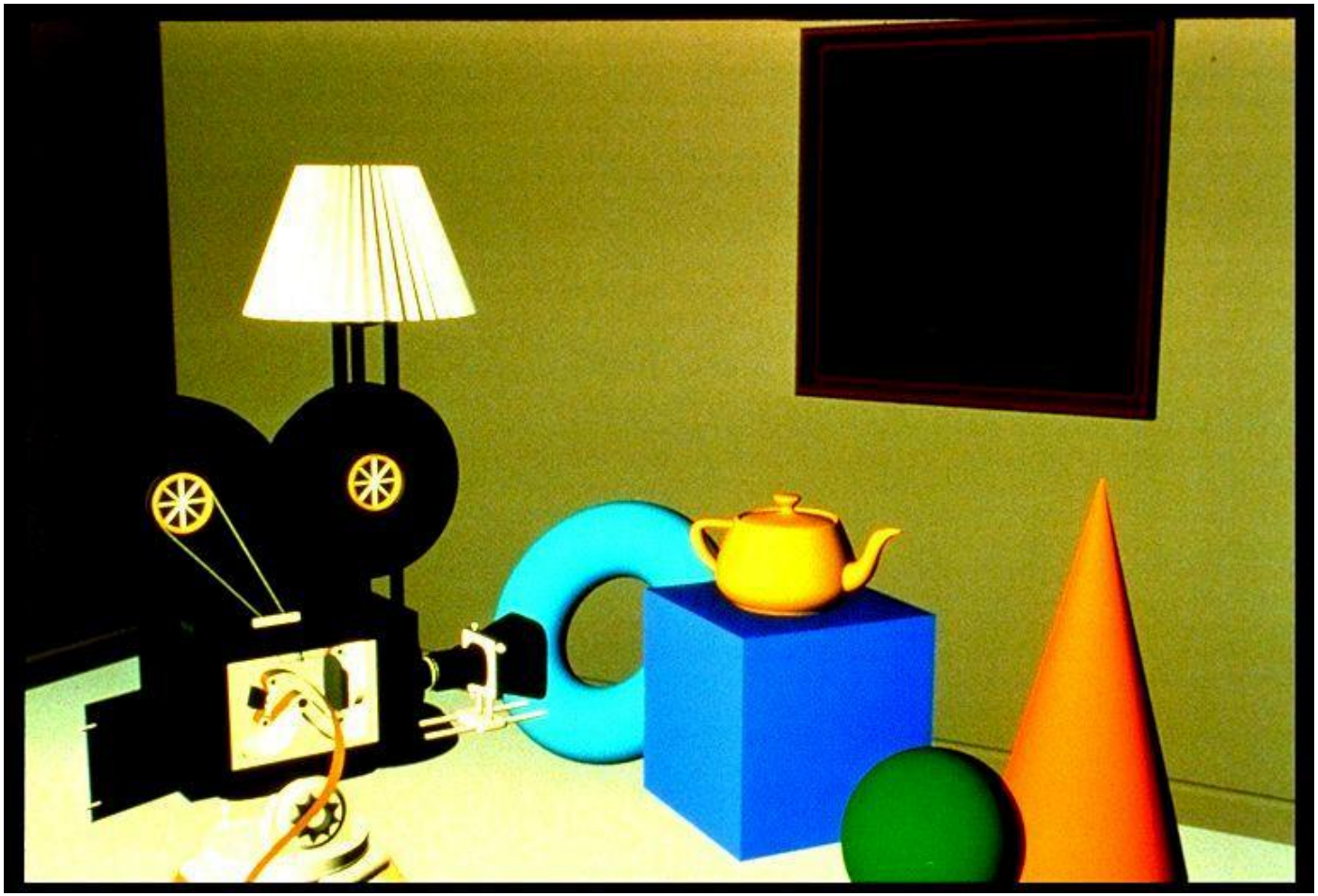
Objects coloured based on its own colour and the lighting condition

One colour for one face

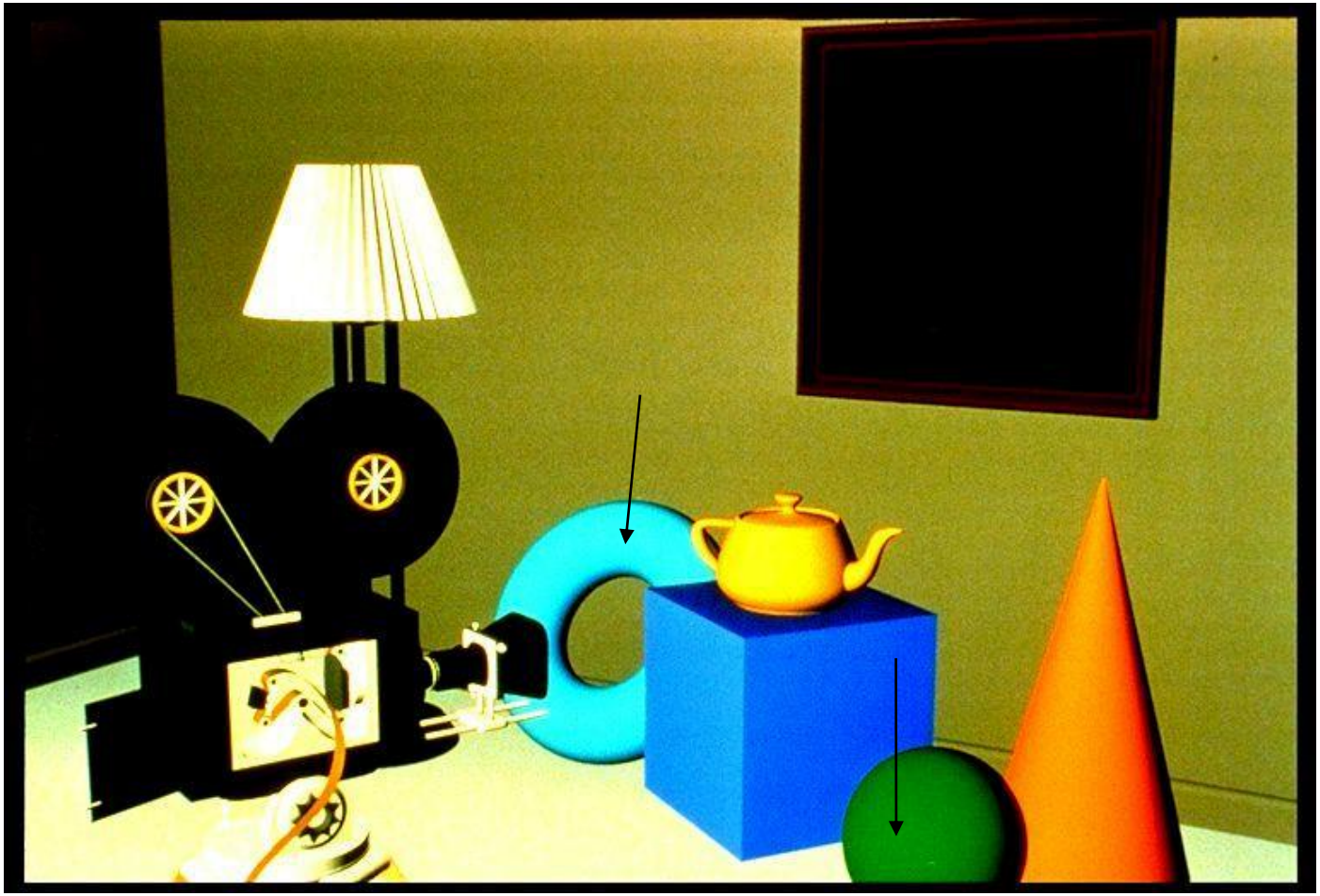


Gouraud shading, no specular highlights

Lighting calculation per vertex

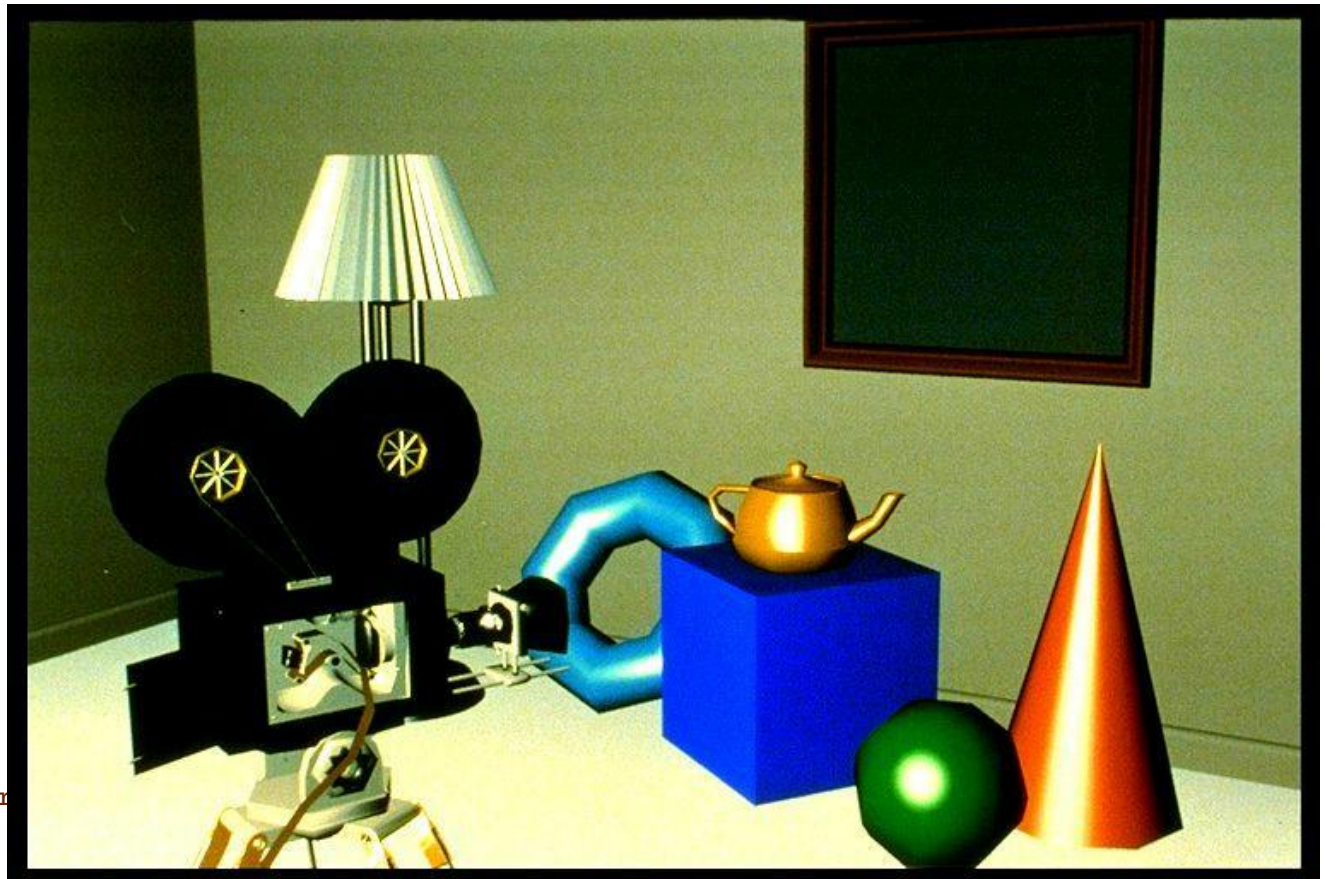


SHAPES BY POLYNOMIAL SURFACES

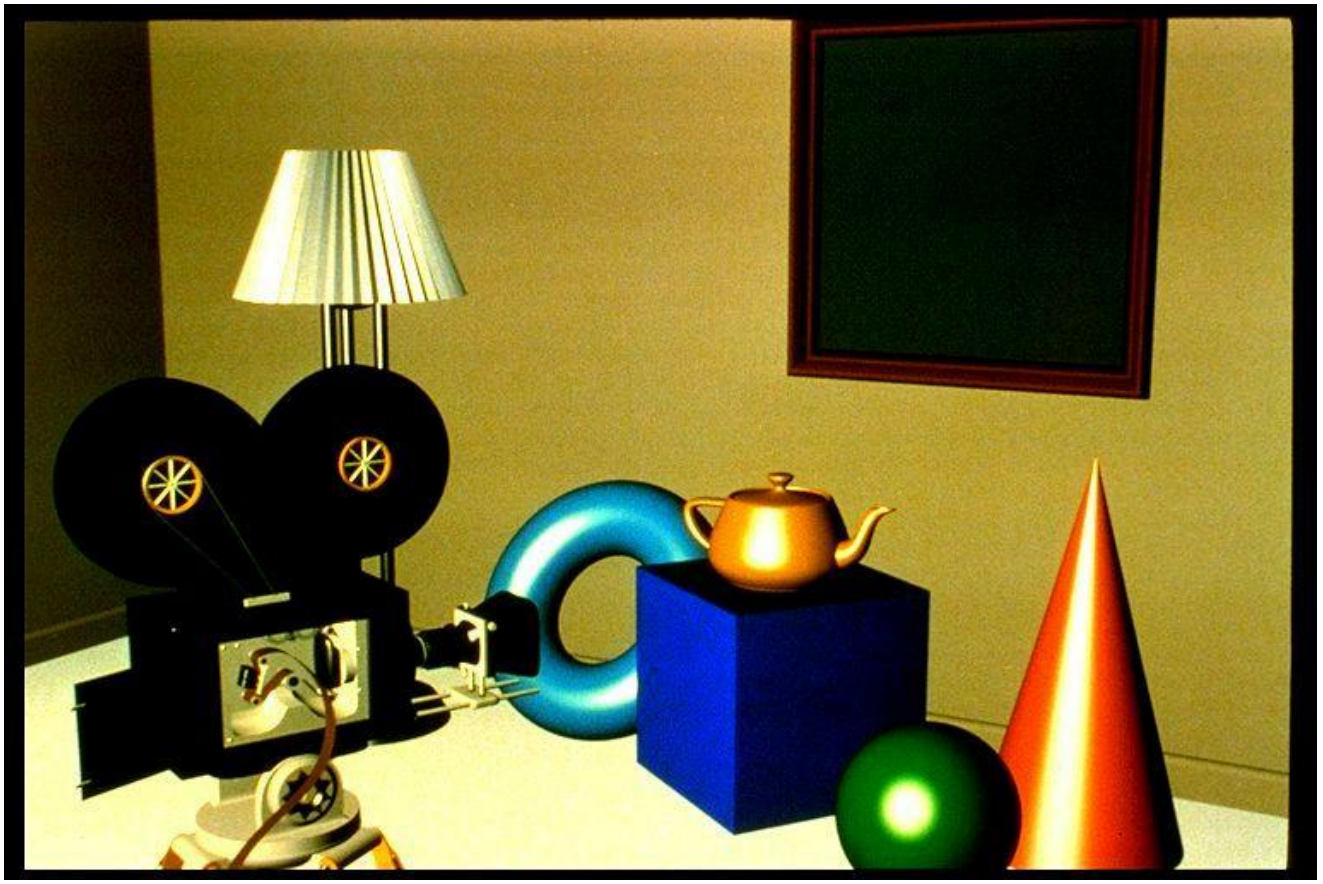


SPECULAR HIGHLIGHTS ADDED

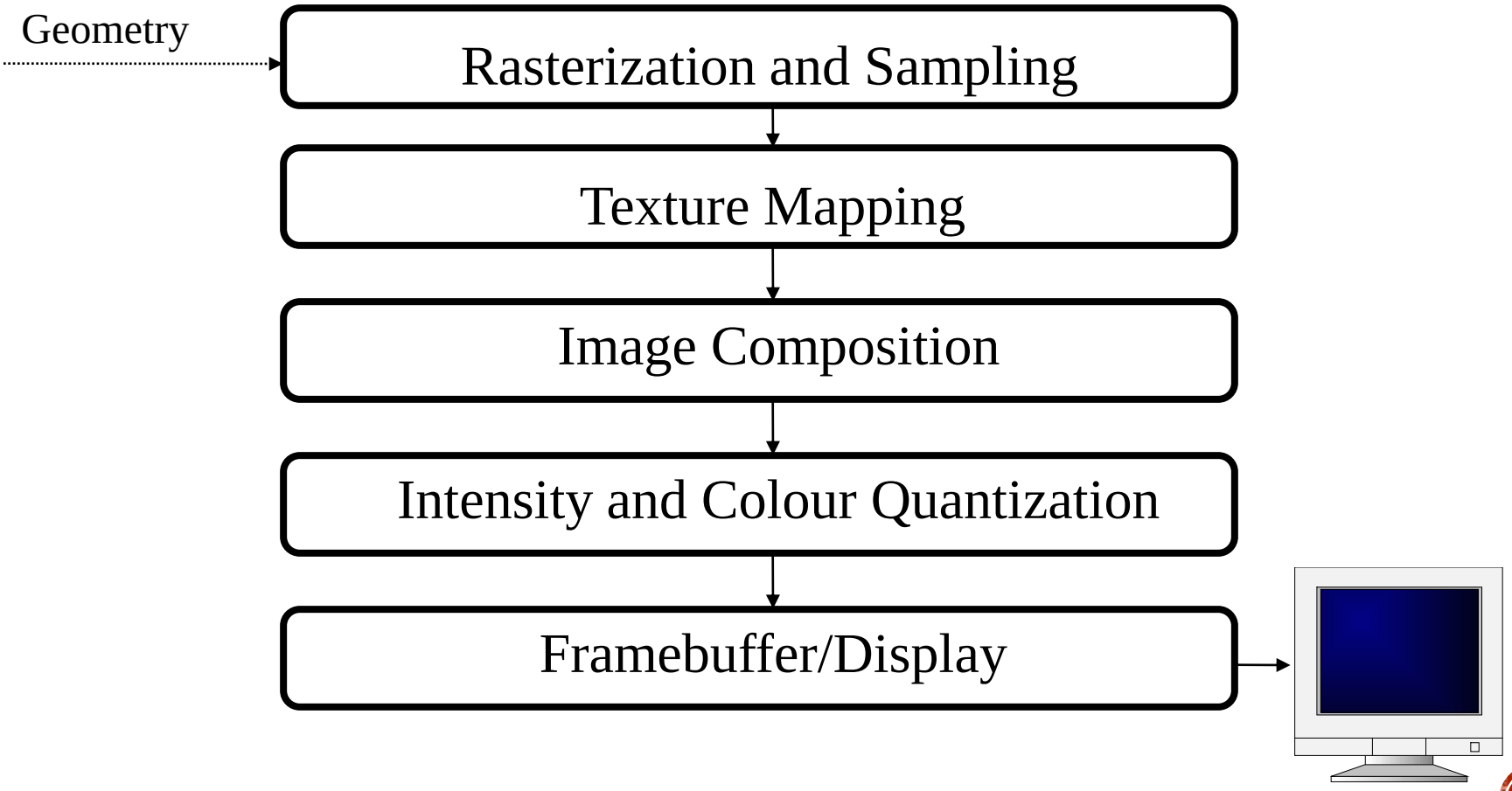
Light perfectly reflected in a mirror-like way



PHONG SHADING



NEXT, THE IMAGING PIPELINE

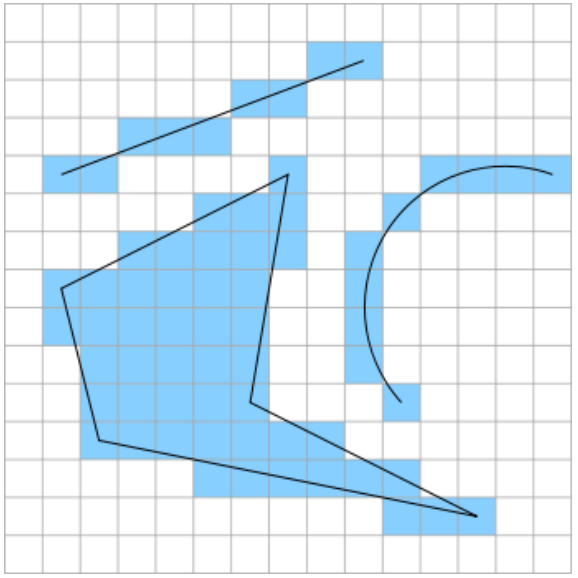


RASTERIZATION

Converts the vertex information output by the geometry pipeline into pixel information needed by the video display

Aliasing: distortion artifacts produced when representing a high-resolution signal at a lower resolution.

Anti-aliasing : technique to remove aliasing



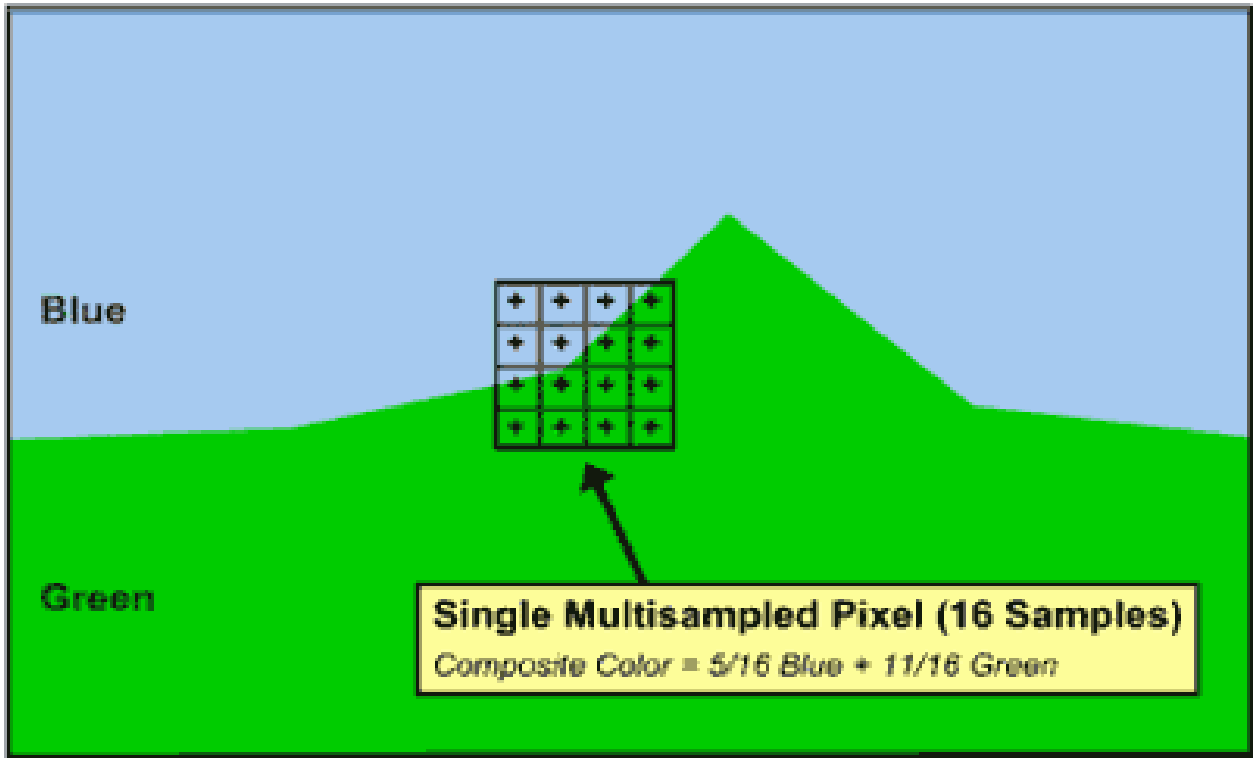
ANTI-ALIASING

Aliased polygons (jagged edges)

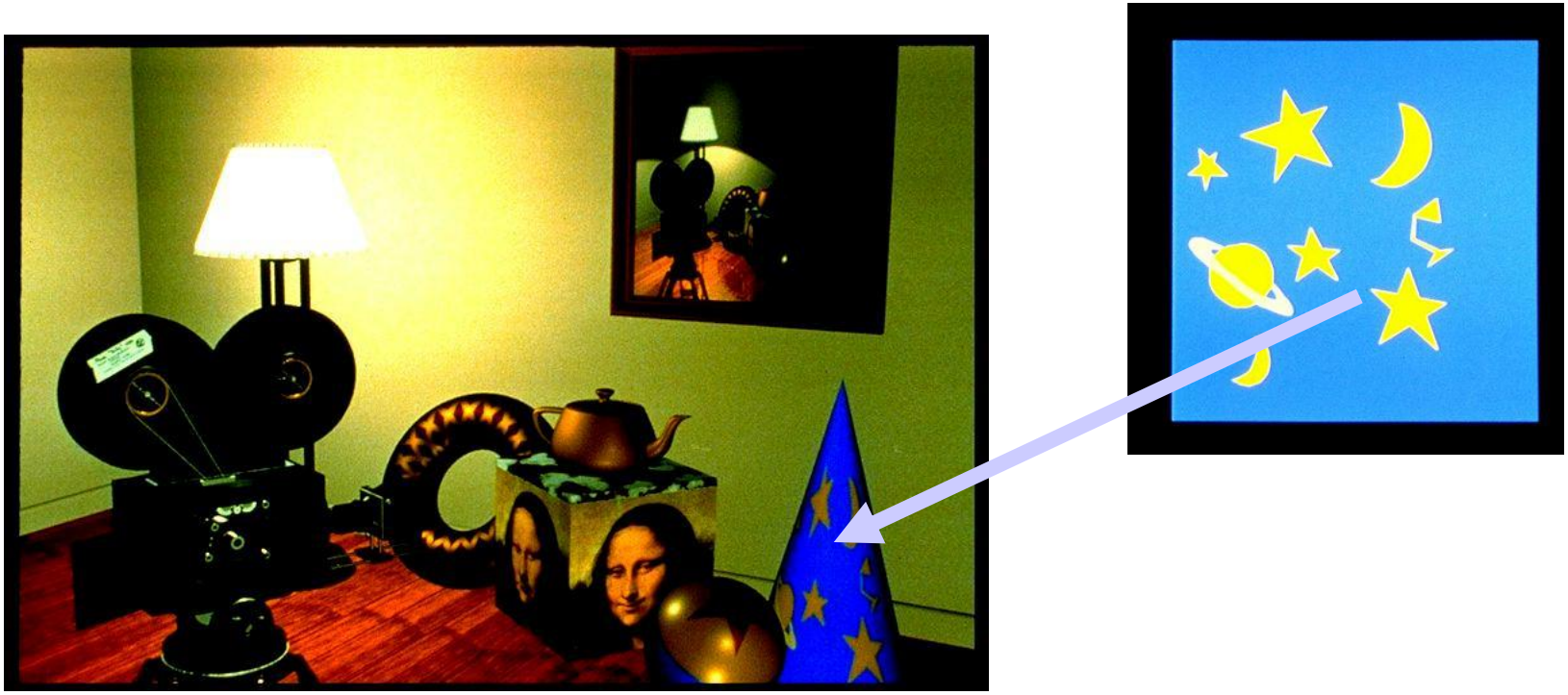
Anti-aliased polygons

✓**How is *anti-aliasing* done? Each pixel is subdivided (sub-sampled) in n regions, and each sub-pixel has a color;**

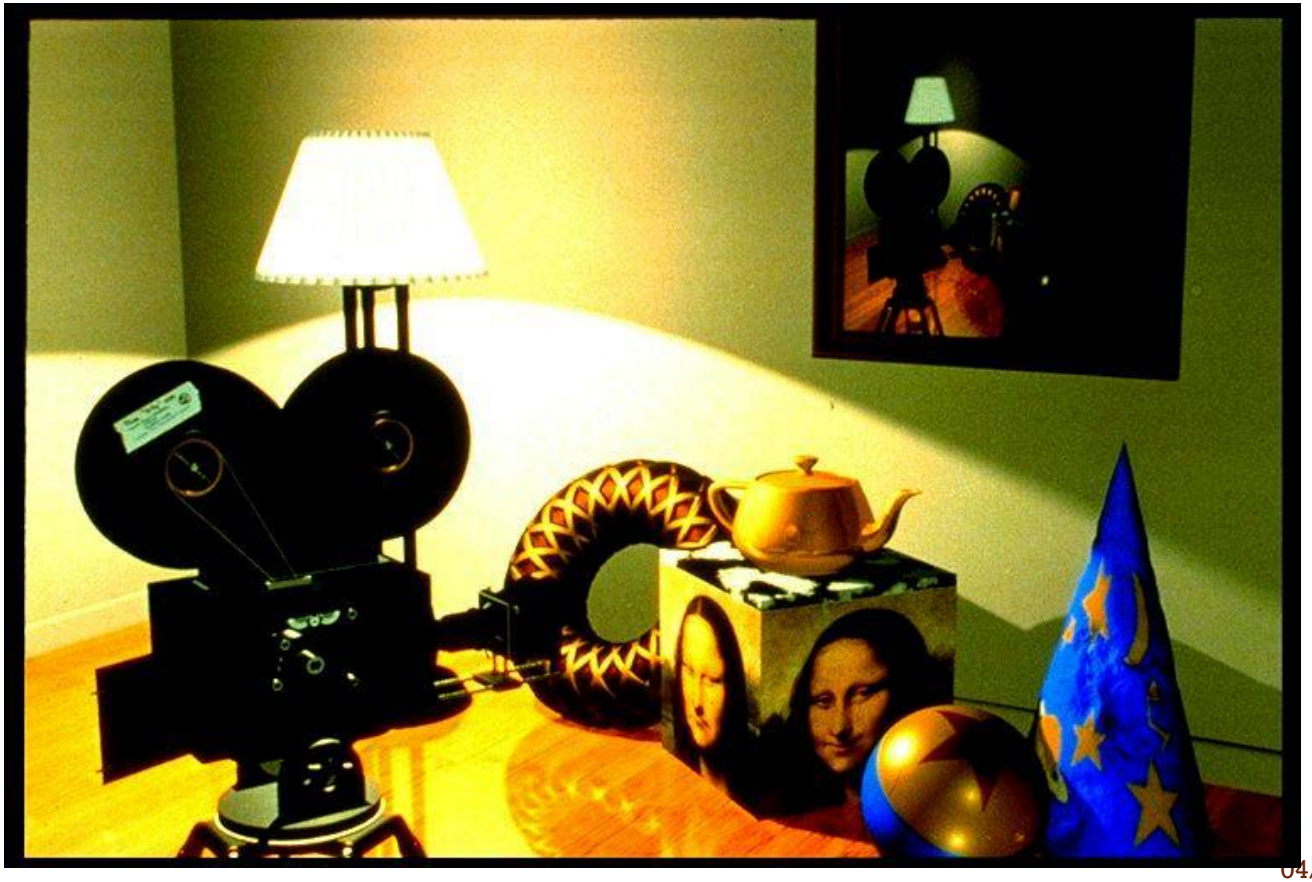
✓**Compute the average color value**



TEXTURE MAPPING

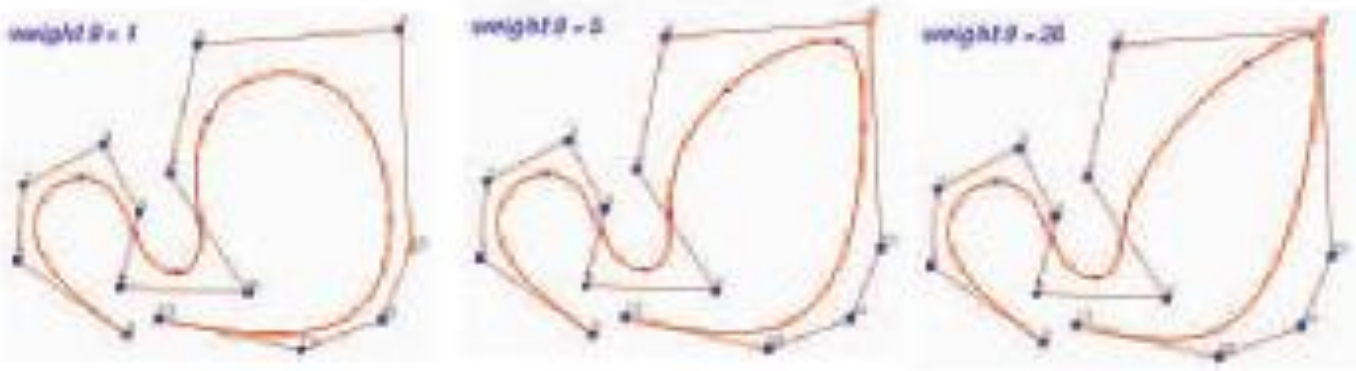


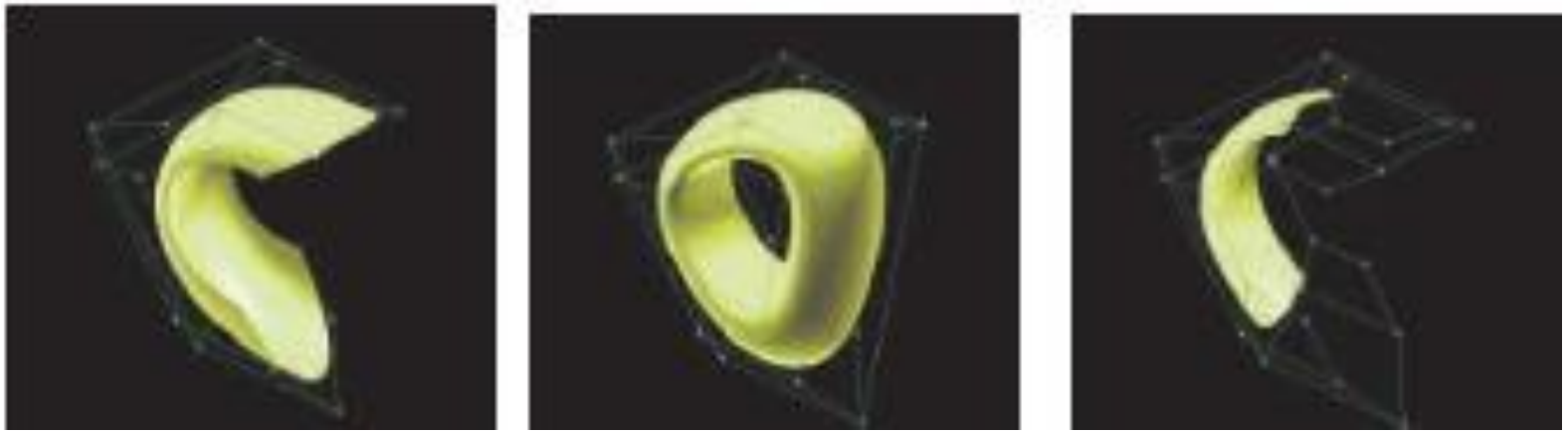
Other covered topics: Reflections, Shadows & Bump Mapping



Other covered topics: Global illumination

POLYNOMIAL CURVES, SURFACES





GRAPHICS DEFINITIONS

Point

- a location in space, 2D or 3D
- sometimes denotes one pixel

Line

- straight path connecting two points
- infinitesimal width, consistent density
- beginning and end on points

GRAPHICS DEFINITIONS

Vertex

point in 3D

Edge

line in 3D connecting two vertices

Polygon/Face/Facet

arbitrary shape formed by connected vertices

fundamental unit of 3D computer graphics

Mesh

set of connected polygons forming a surface (or object)

:

GRAPHICS DEFINITIONS

Rendering : process of generating an image from the model

Framebuffer : a video output device that drives a video display from a memory containing the color for every pixel

SUMMARY

The course is about algorithms, not applications

- Lots of mathematics

Graphics execution is a pipelined approach

Basic definitions presented

Some support resources indicated