

**Faculty of German Engineering and
Industrial Management Education - FDIBA**

Introduction to Computer Graphics



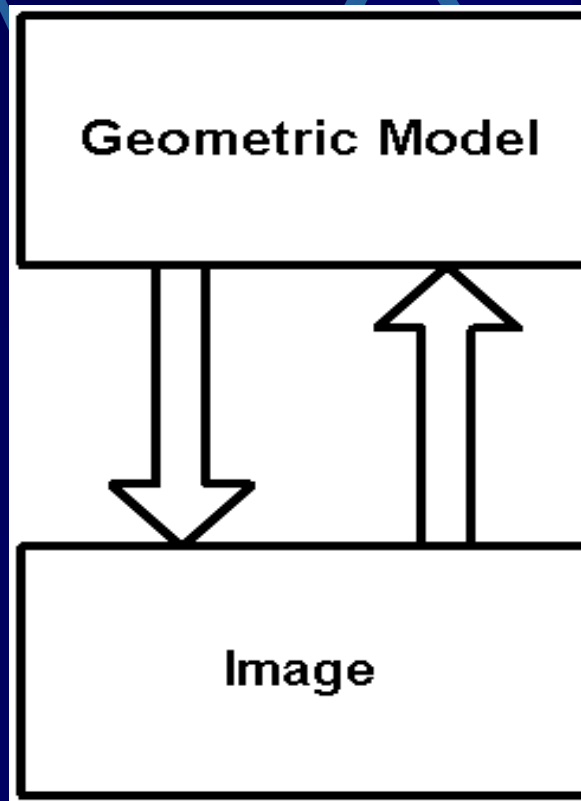
Graphics Systems

Assoc. Prof. Stoyan Maleshkov

Technical University of Sofia

Definition of Computer Graphics

- Basic Concepts
 - **Model** (Geometric Model)
 - **Image**



Geometric Model

- What is a Model?

- Geometric Model

Contains data, describing:

- **Geometry (Type and spatial location of basic elements – Primitives)**
- **Structure (Link between elements)**
- **Additional Information (attributes)**

Types of Geometric Models

- Type of Elements
 - Wireframe (Line) Model
 - Surface Model
 - Volume Model

Types of Geometric Models

● Type of Description

- Accumulative
- Generative

● Examples

- Cube
- Circle

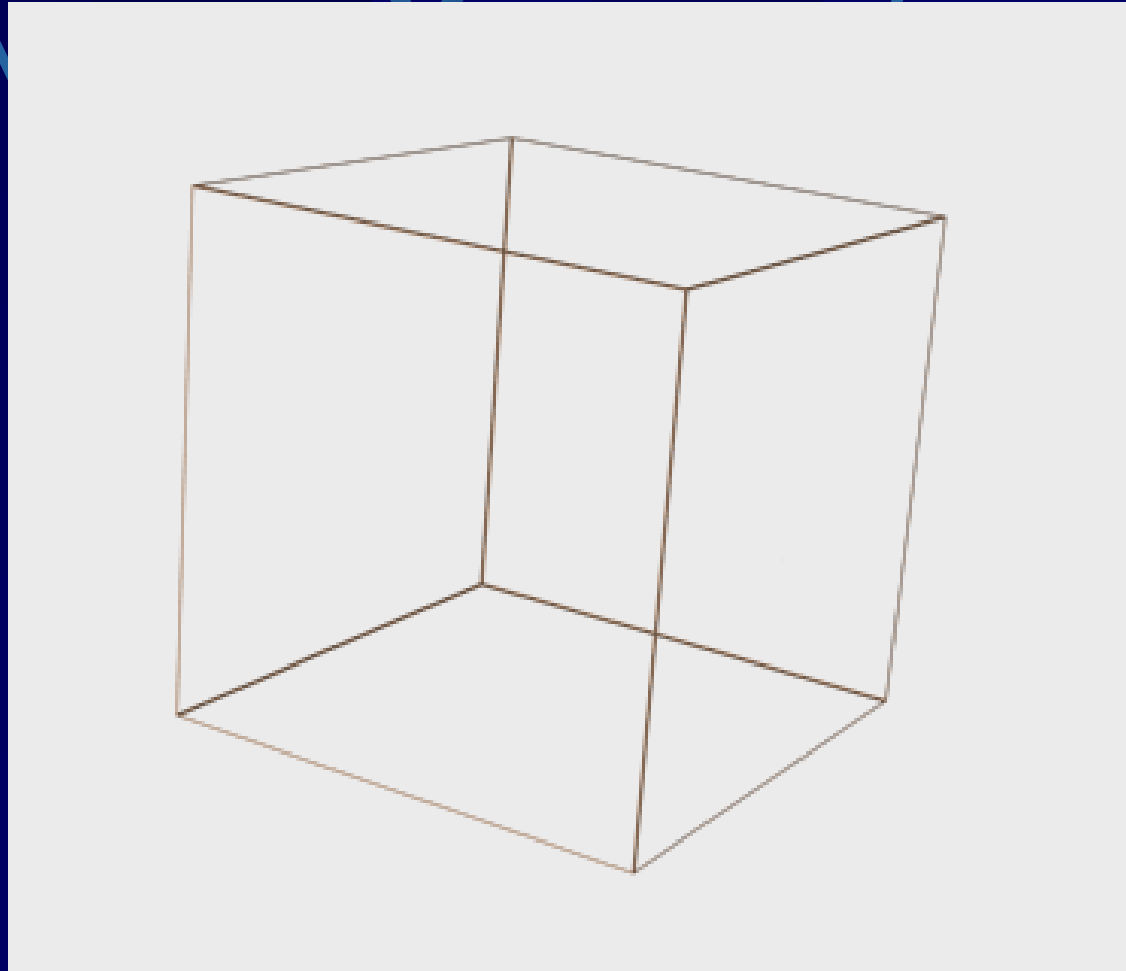
Types of Geometric Models

● Type of Description

- Accumulative
- Generative

● Examples

- **Cube**
- Circle



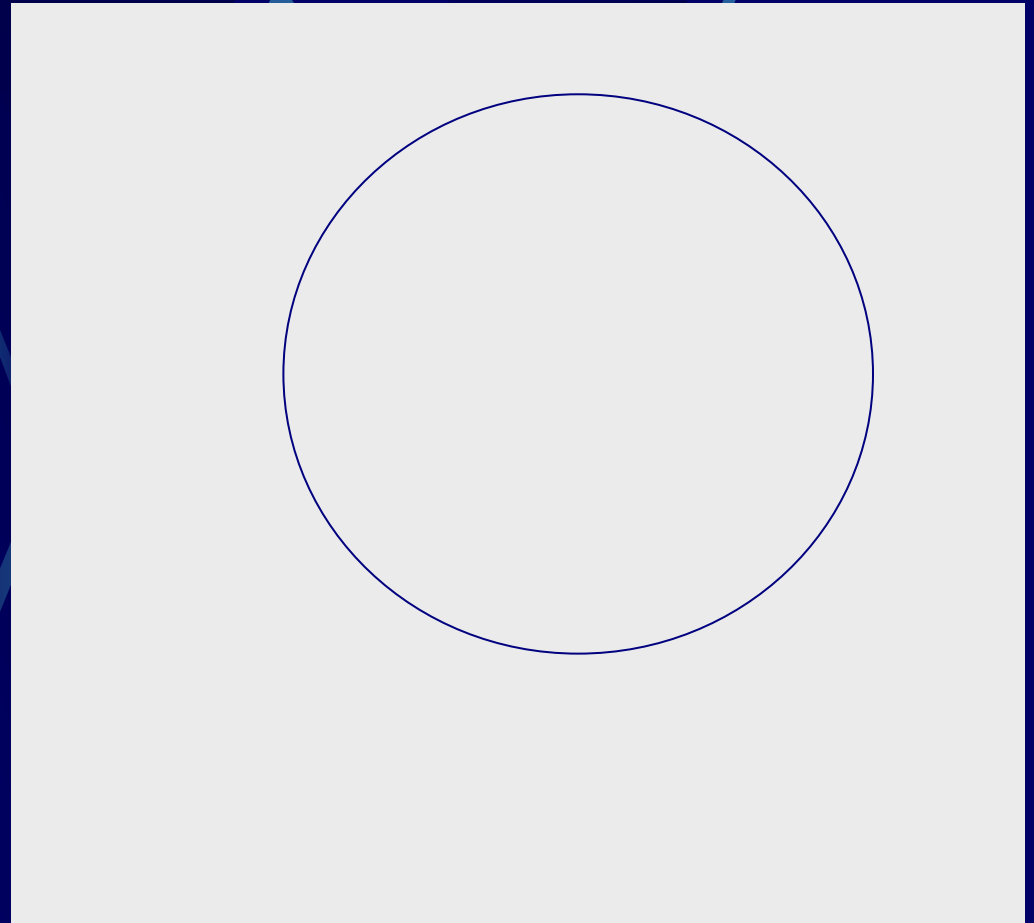
Types of Geometric Models

● Type of Description

- Accumulative
- Generative

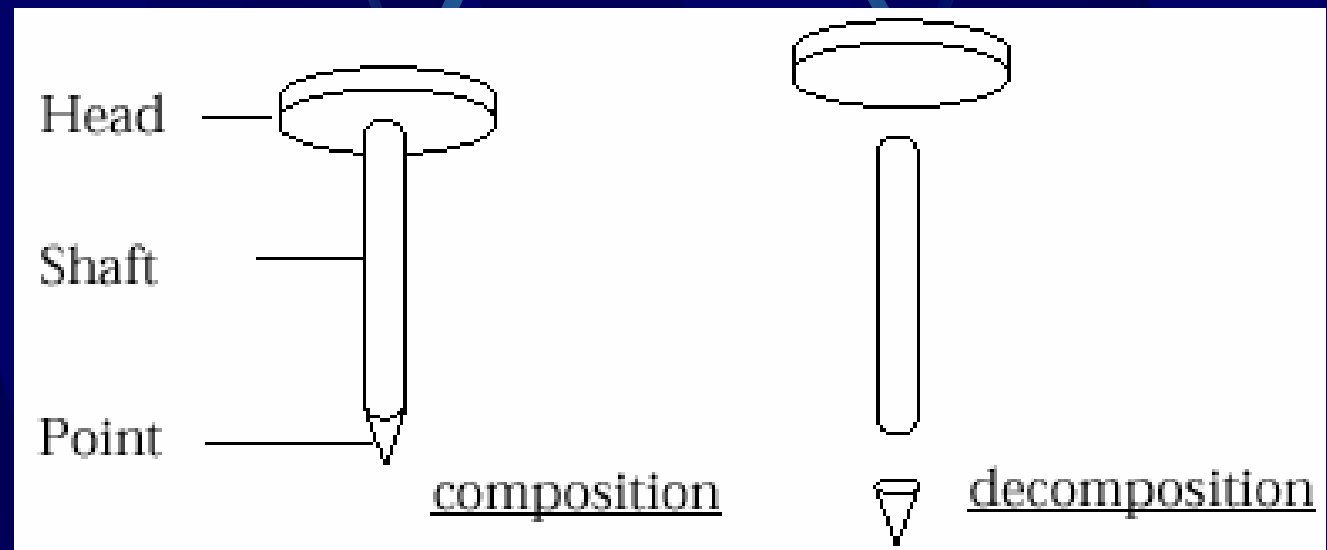
● Examples

- Cube
- **Circle**



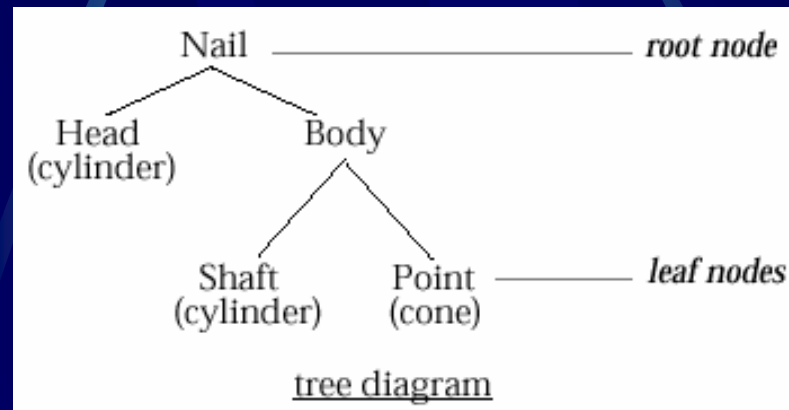
Decomposition of a Geometric Model

- Divide and Conquer
- Hierarchy of geometrical components
- Reduction to primitives (e.g., spheres, cubes, etc.)
- Simple vs. not-so-simple elements (nail vs. screw)



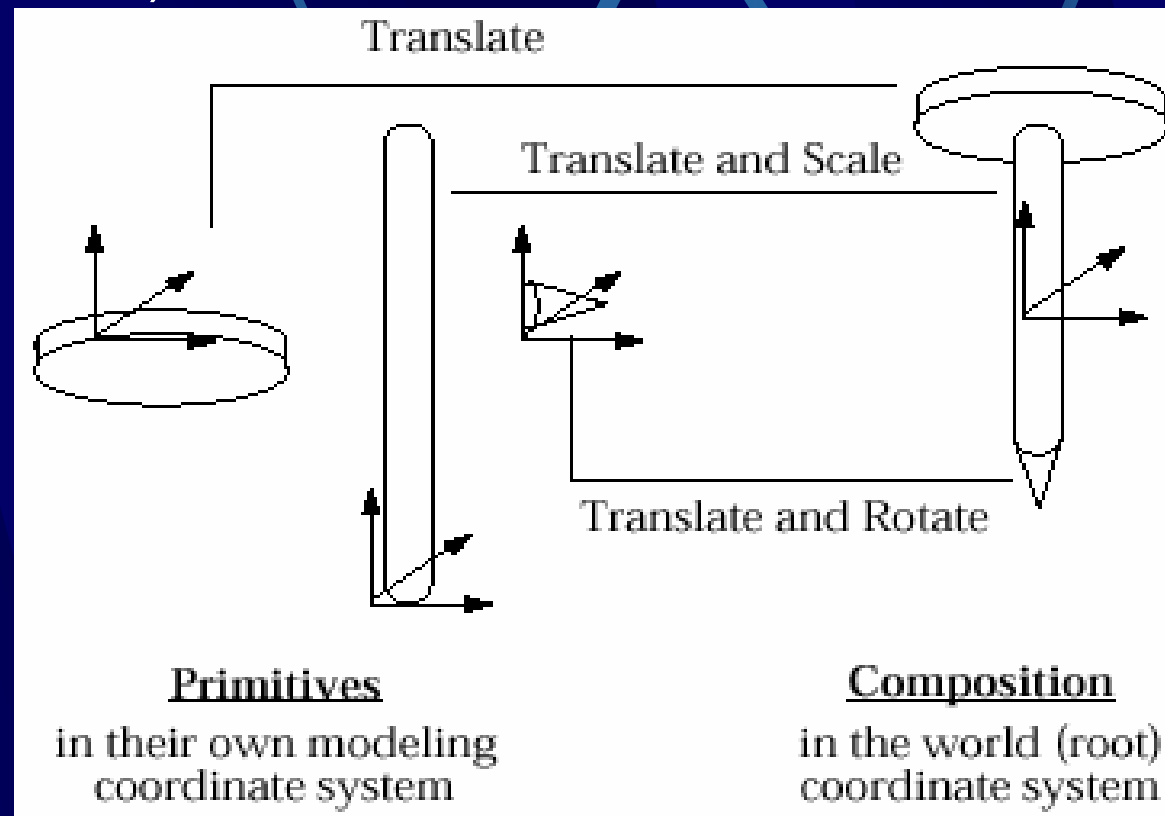
Hierarchical (Tree) Diagram of Nail

- The object to be modeled is (visually) analyzed, and then decomposed into collections of primitive shapes.
- The tree diagram provides a visual method of expressing the “composed of” relationships of the model.
- Such diagrams are sometimes part of 3D program interfaces (e.g., Alias|Wavefront Studio and Maya).



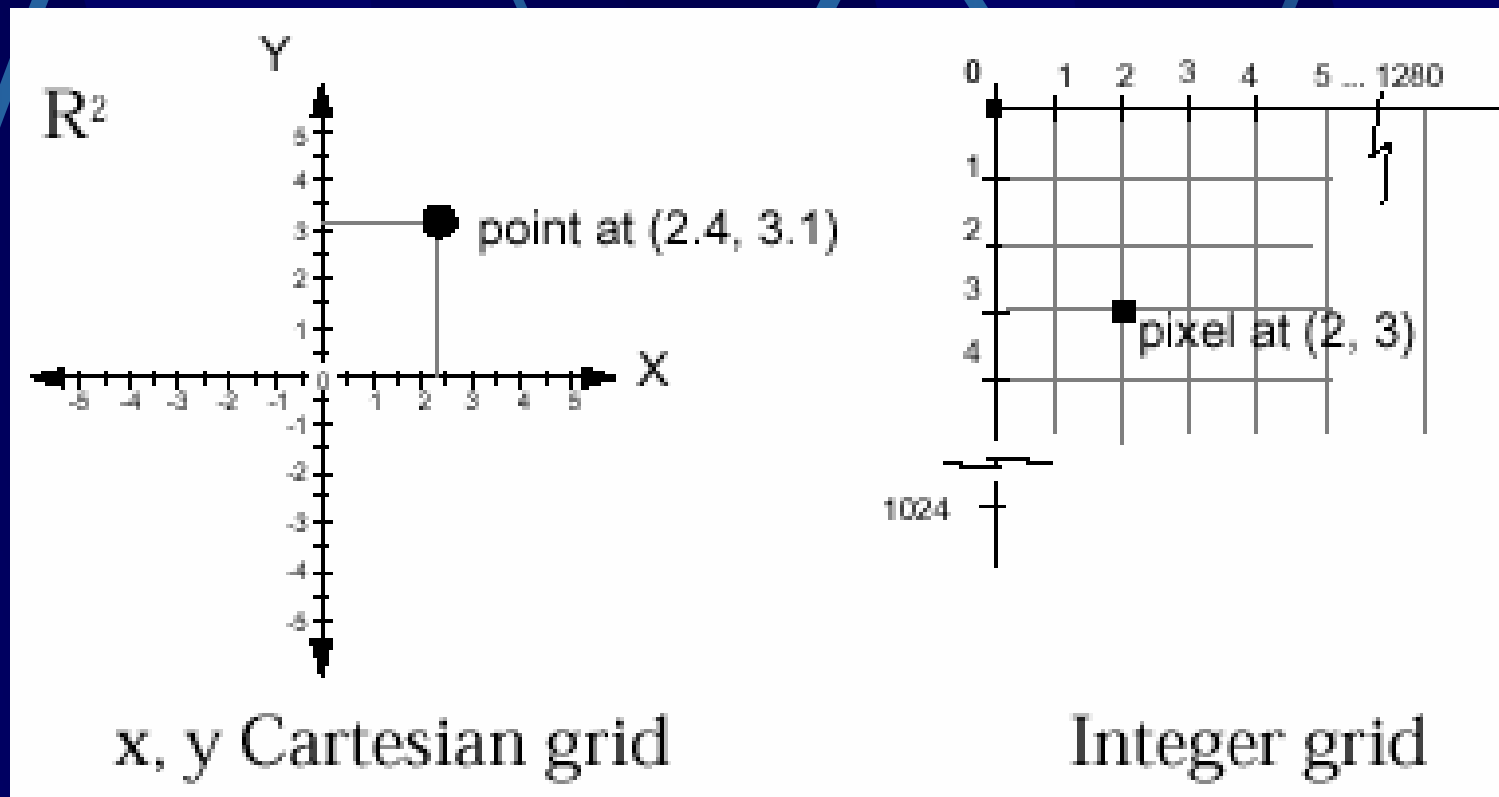
Hierarchical (Tree) Diagram of Nail

The primitives created in the decomposition process must be assembled to create the final object. This is done with “affine transformations”, T, R, S (as in the example above).



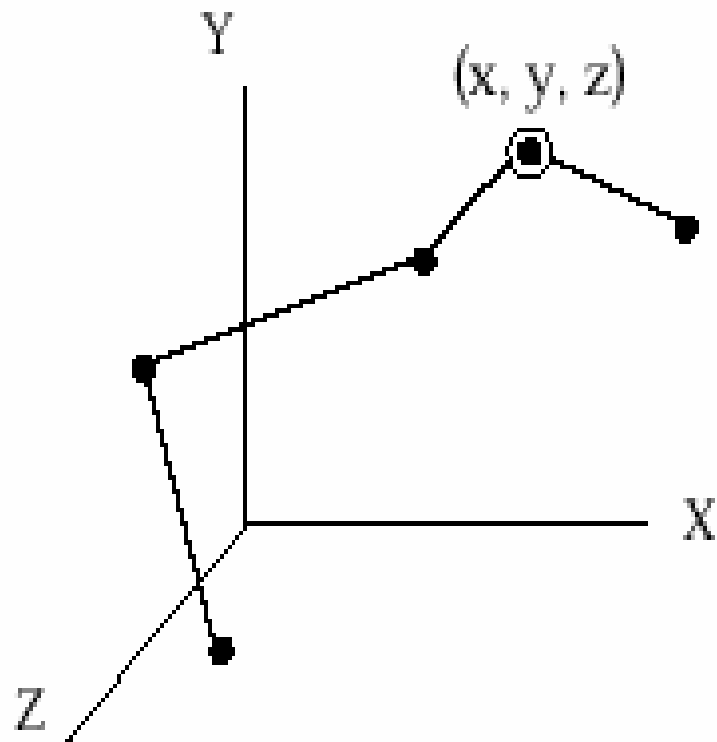
Coordinate Systems

- Cartesian Coordinates
- Typically **modeling** space is floating point, **screen** space is integer

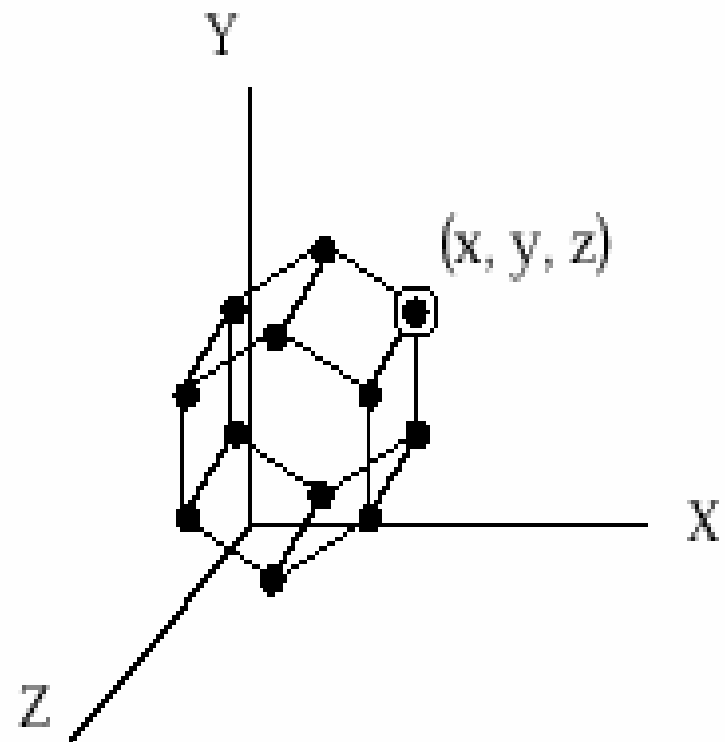


Example 3D Primitives

Polyline

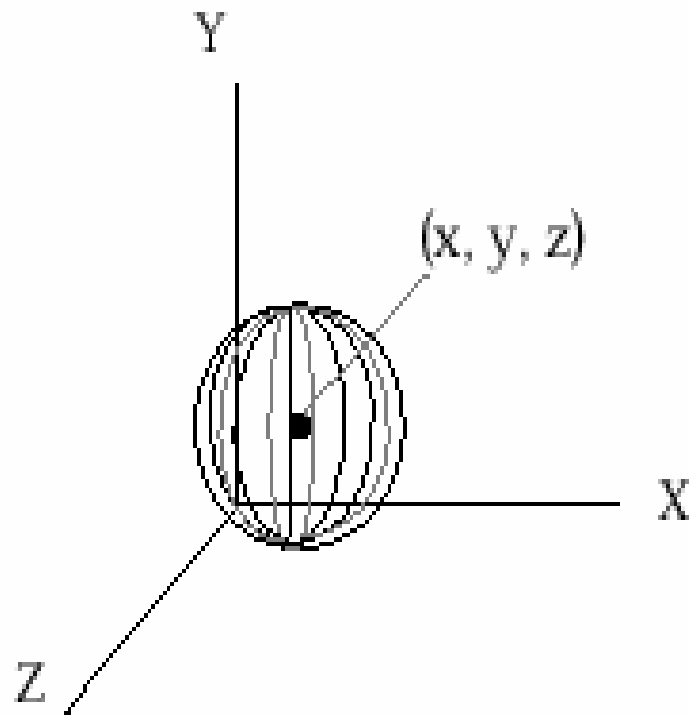


Polyhedron

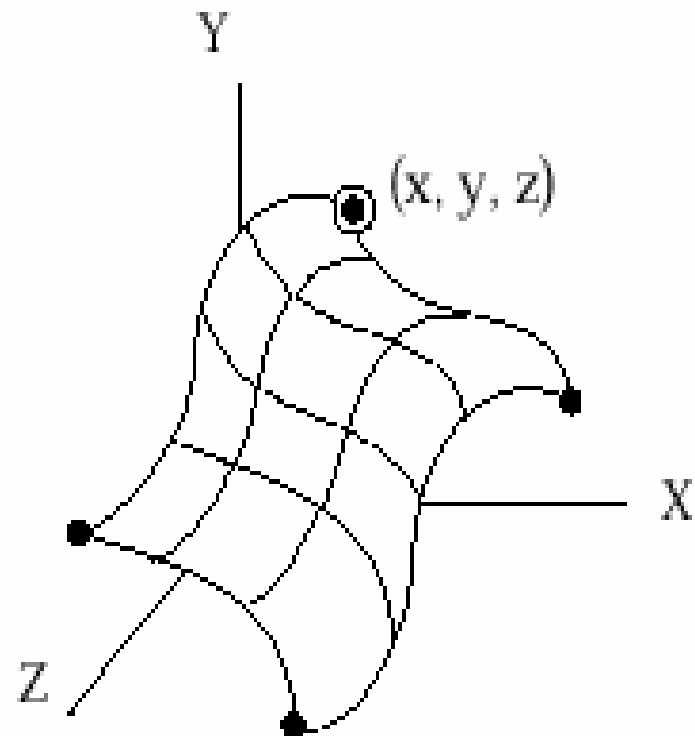


Example 3D Primitives

Sphere

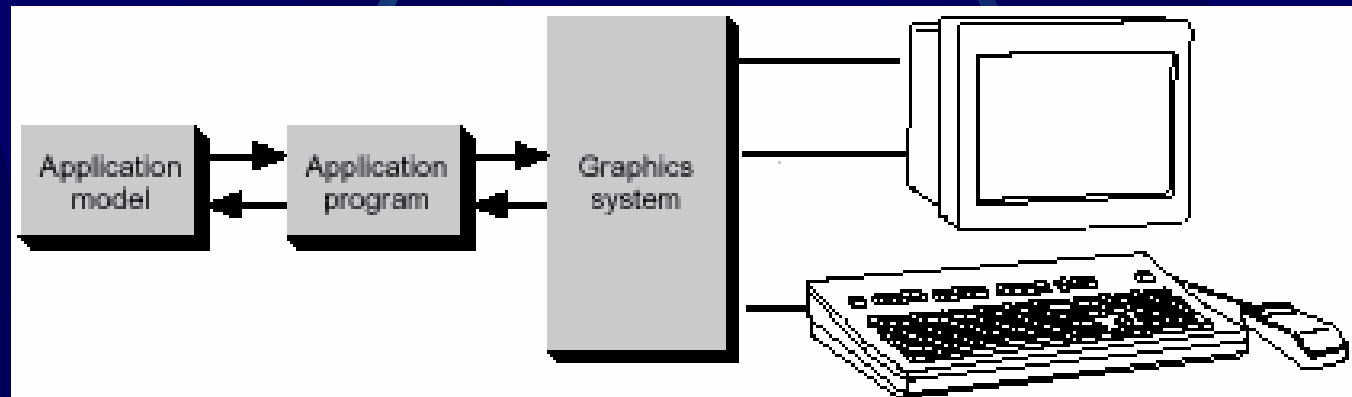


Patch



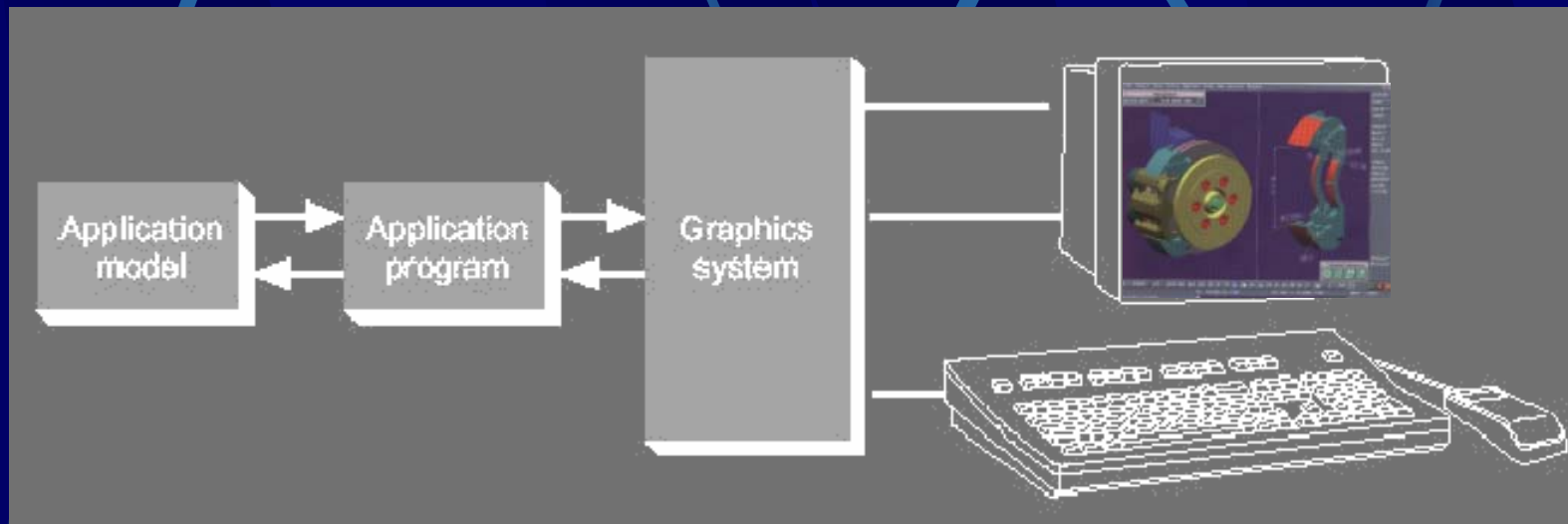
Conceptual Framework for Interactive Graphics

- Graphics library/package (e.g., OpenGL) is intermediary between application and the display hardware
- Application program maps application objects to views (images) of those objects by calling on graphics library
- User interaction results in modification of model and/or image
- Images are usually means to an end: synthesis, design, manufacturing, visualization,...
- This framework is 3 decades old but is still useful, indeed dominant

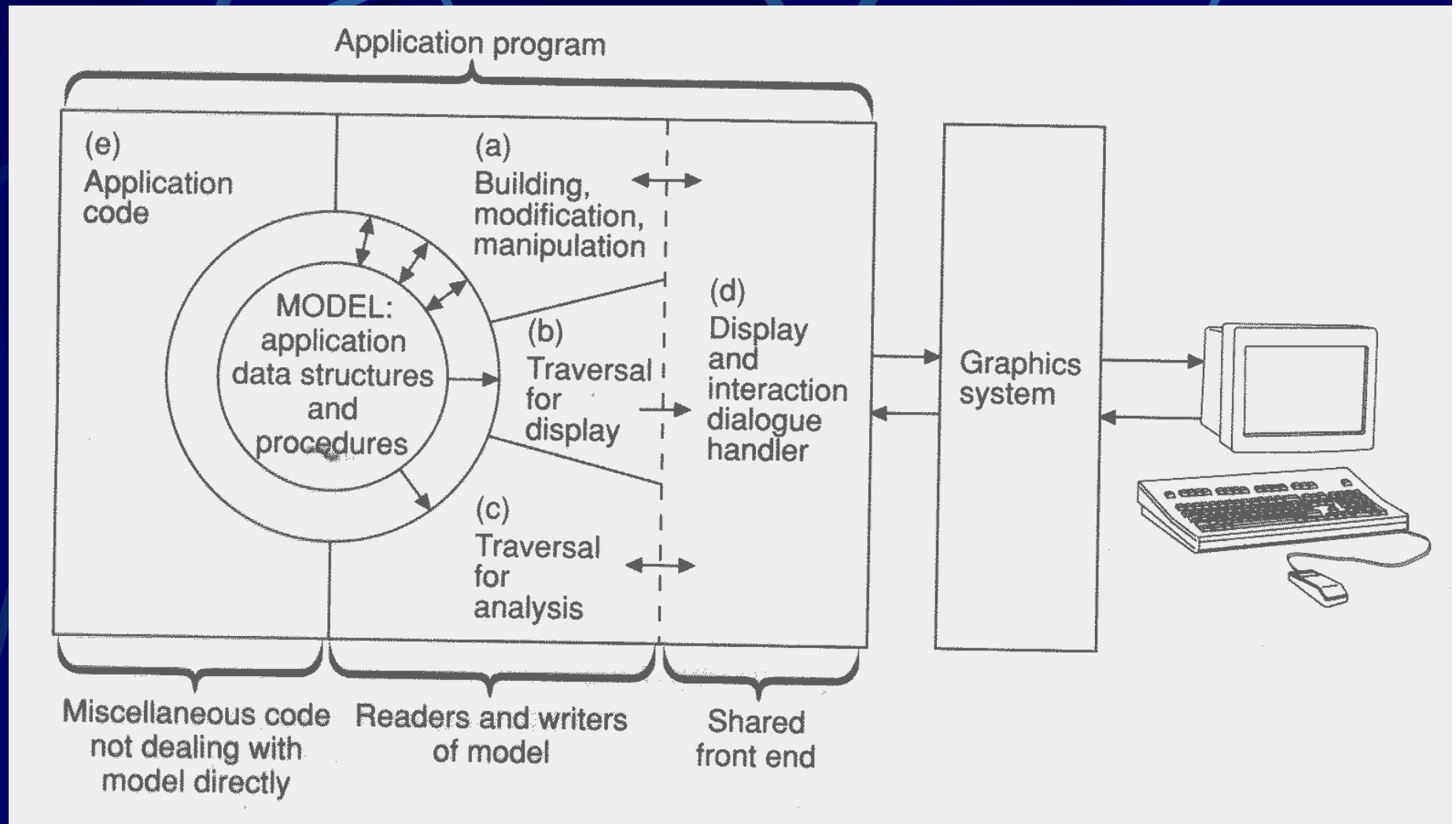


Conceptual Framework for Interactive Graphics

- Interaction

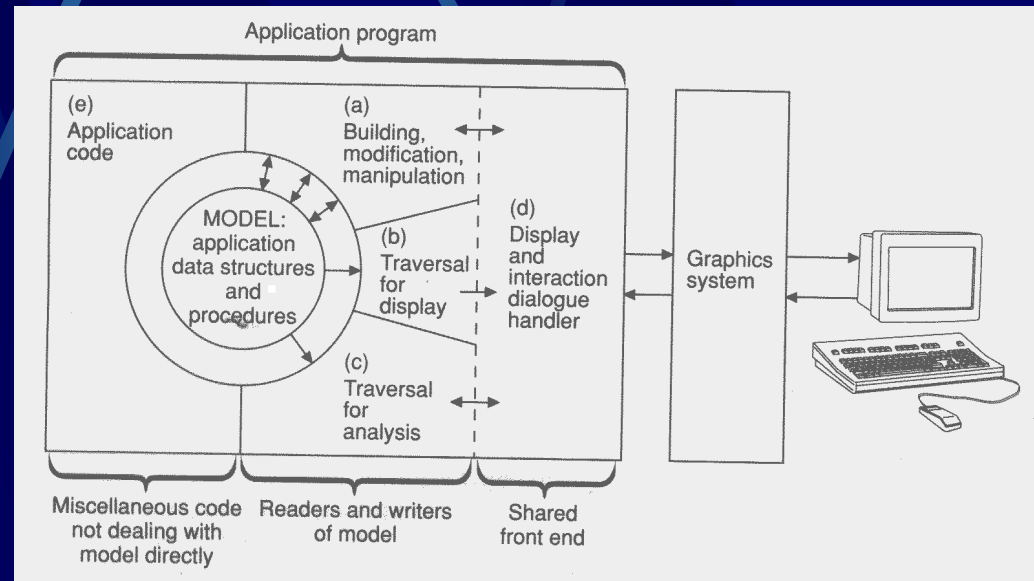


Interactive Graphics System



Interactive Graphics System

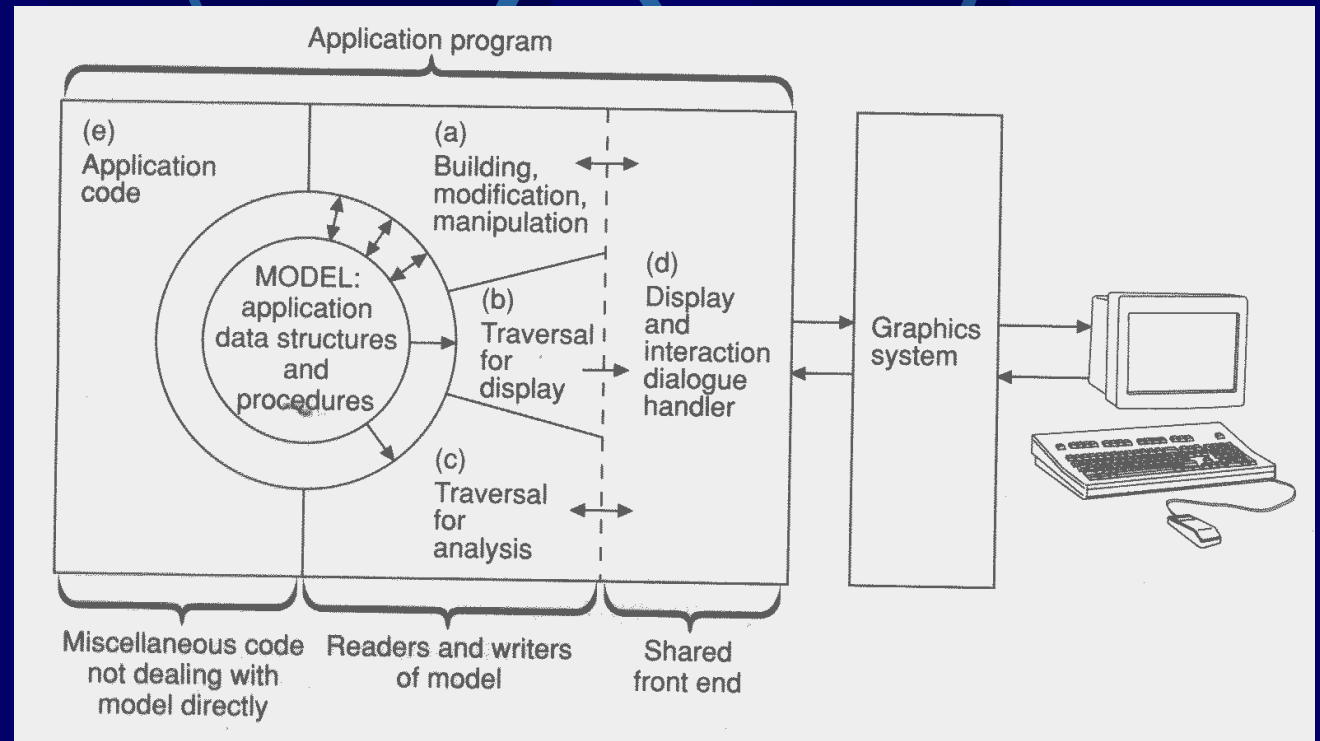
- Application Model – Geometric model
- Application
 - Creates and manipulates the Geometric model
 - Traversal for:
 - Display
 - Analysis
- Graphics System



Interactive Graphics System

Graphics System:

- Graphics Library
- Drivers



Graphics Library

Basic Features:

- State Control
- Primitives
- Attributes
 - – color
 - – line style
 - ...
 - – material properties for 3D
- Transformations
- Inquiries (about state, current attributes etc.)
- Input

Graphics Library (2)

- Immediate mode vs. retained mode
 - immediate mode: no stored representation, package holds only attribute state, and application must completely draw each frame
 - retained mode: library compiles and displays from a “scene graph”