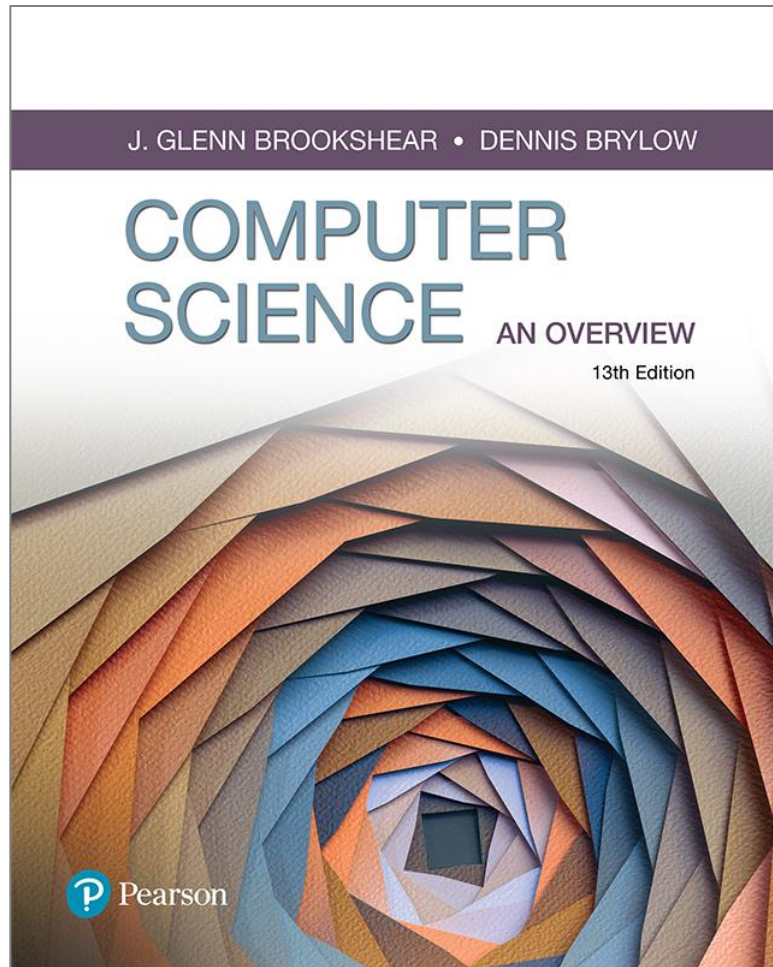


Computer Science An Overview

13th Edition



Chapter 10

Computer Graphics

Chapter 10: Computer Graphics

- 10.1 The Scope of Computer Graphics
- 10.2 Overview of 3D Graphics
- 10.3 Modeling
- 10.4 Rendering
- 10.5 Dealing with Global Lighting
- 10.6 Animation

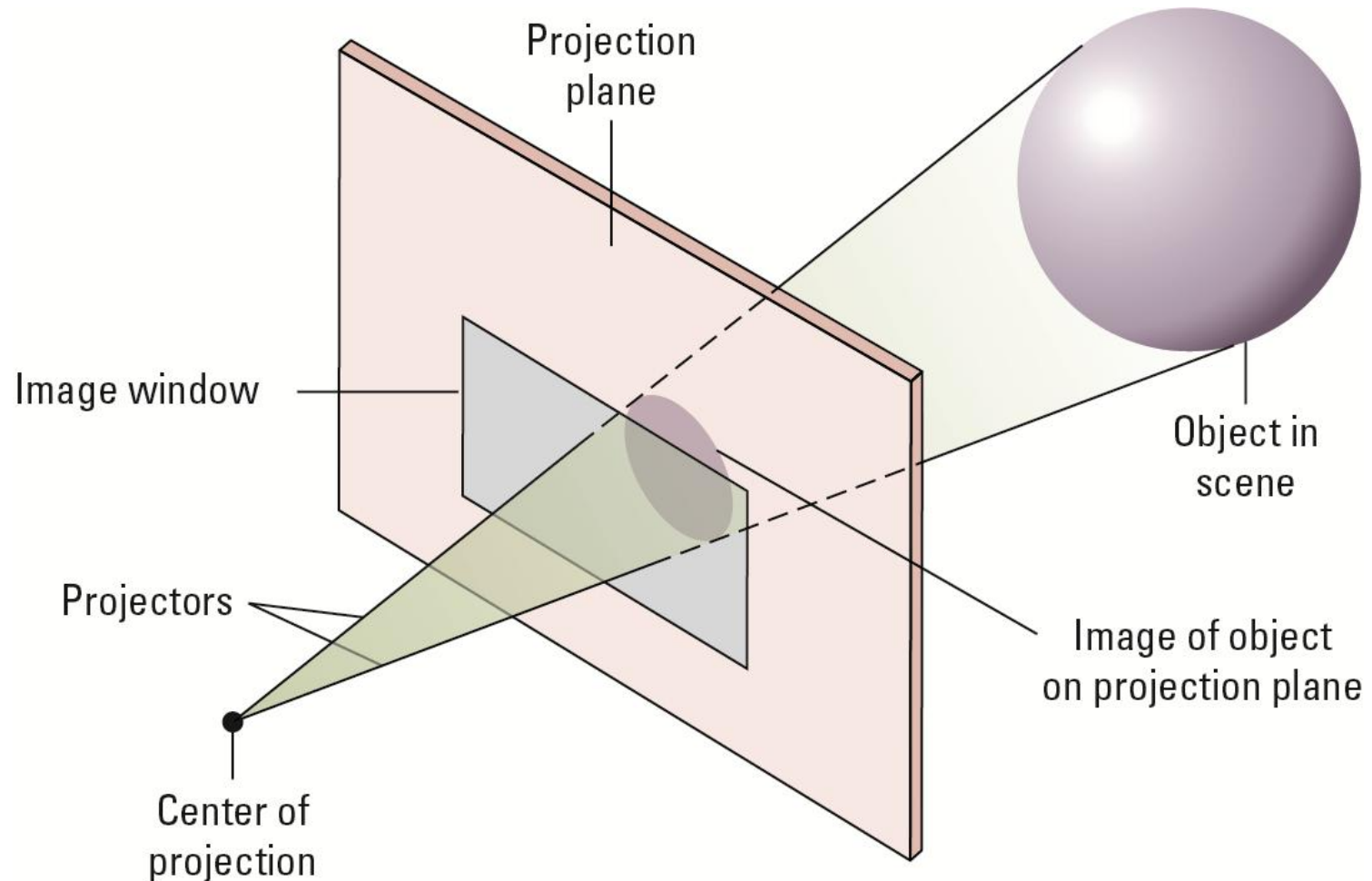
10.1 The Scope of Computer Graphics

- **2D Graphics:** Deals with manipulating two-dimensional images
- **3D Graphics:** Deals with producing and displaying images of three-dimensional virtual scenes.

10.2 Overview of 3D Graphics

- **Modeling:** Designing and constructing the digital scene
- **Rendering:** Applying mathematics to project the objects onto a flat surface and store the result as an image
- **Displaying:** Real time viewing (video games) or transfer to permanent storage (motion pictures)

Figure 10.1 The 3D graphics paradigm



10.3 Modeling Objects

- Shape: Represented by a polygonal mesh obtained from
 - Traditional mathematical equations
 - Berzier curves and surfaces
 - Procedural models
 - Other methods being researched
- Surface: Can be represented by a texture map

Figure 10.2 A polygonal mesh for a sphere

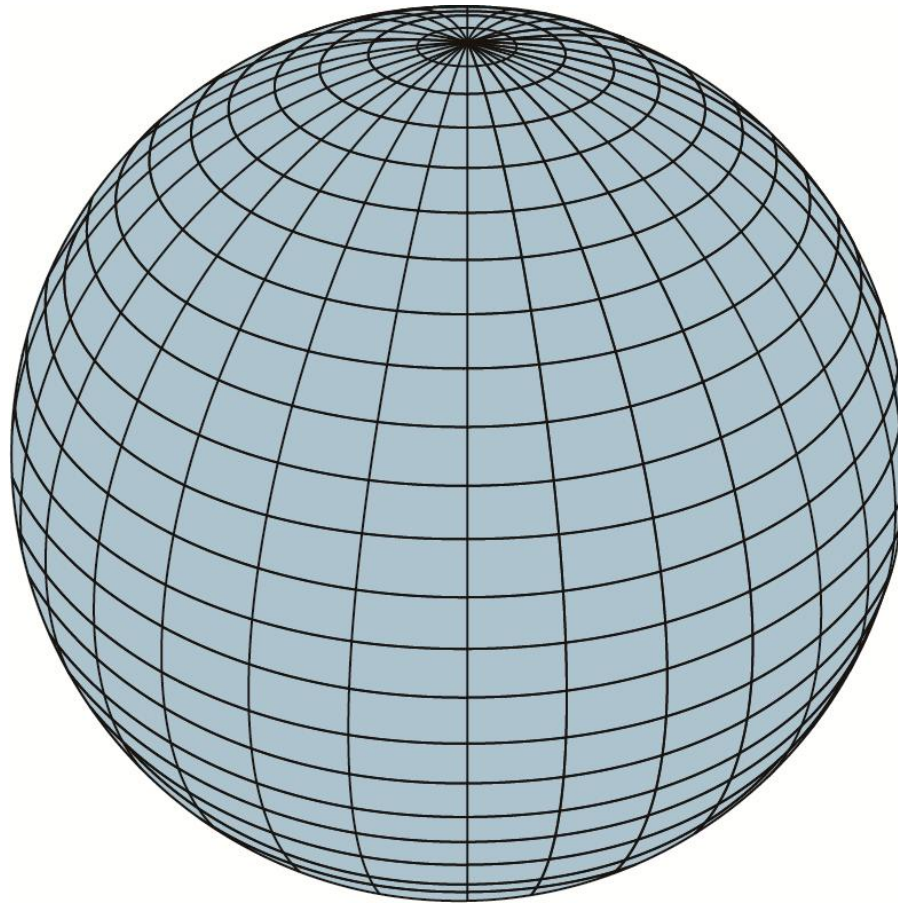


Figure 10.3 A Bezier curve

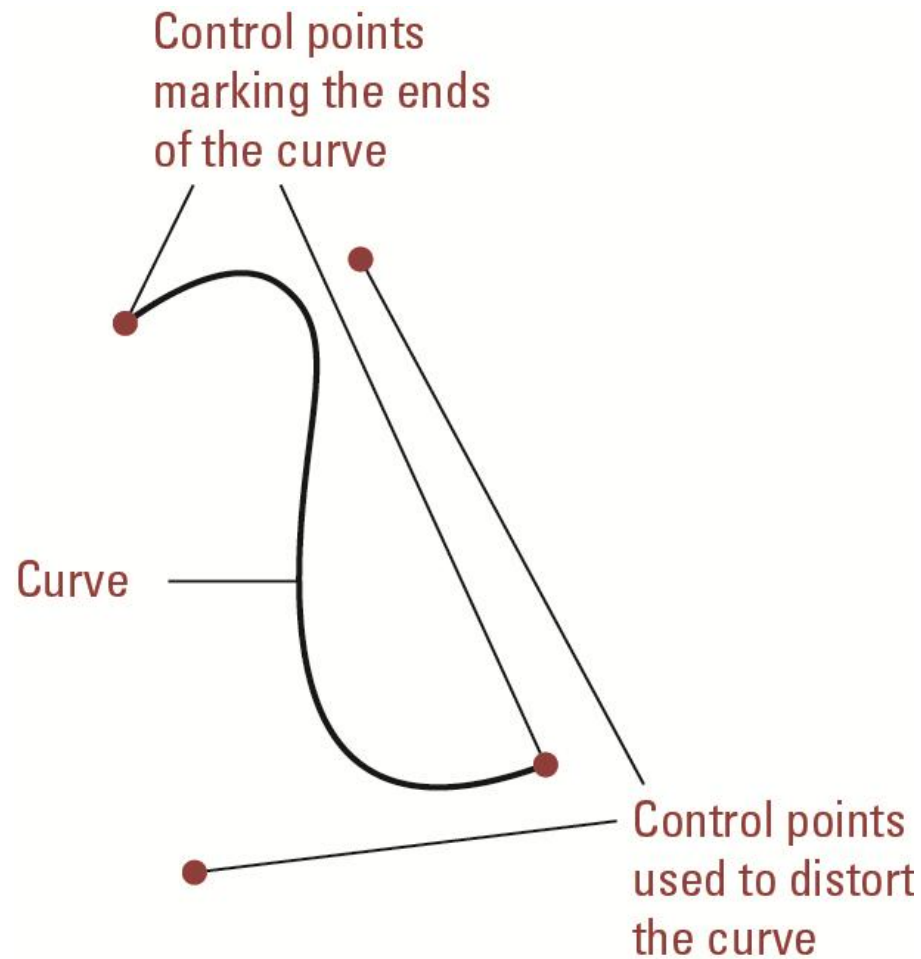
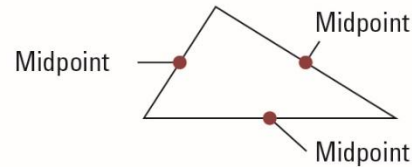
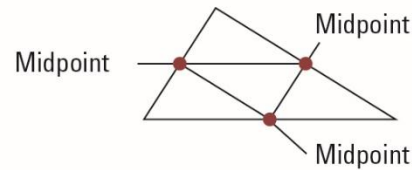


Figure 10.4 Growing a polygonal mesh for a mountain range

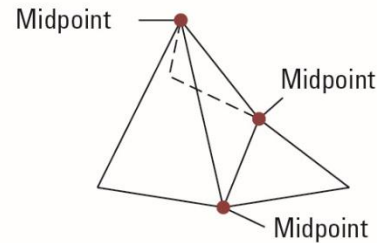
a. Identify the midpoints



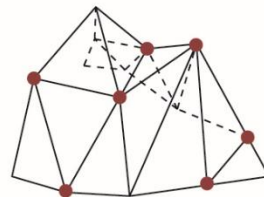
b. Connect the midpoints



c. Move the midpoints



d. Repeat the process on the smaller triangles



10.4 Rendering

- Reflection: Light rays bounce off surface.
 - Specular light
 - Diffuse light
 - Ambient light
- Refraction: Light rays penetrate surface.

Figure 10.5 Reflected light

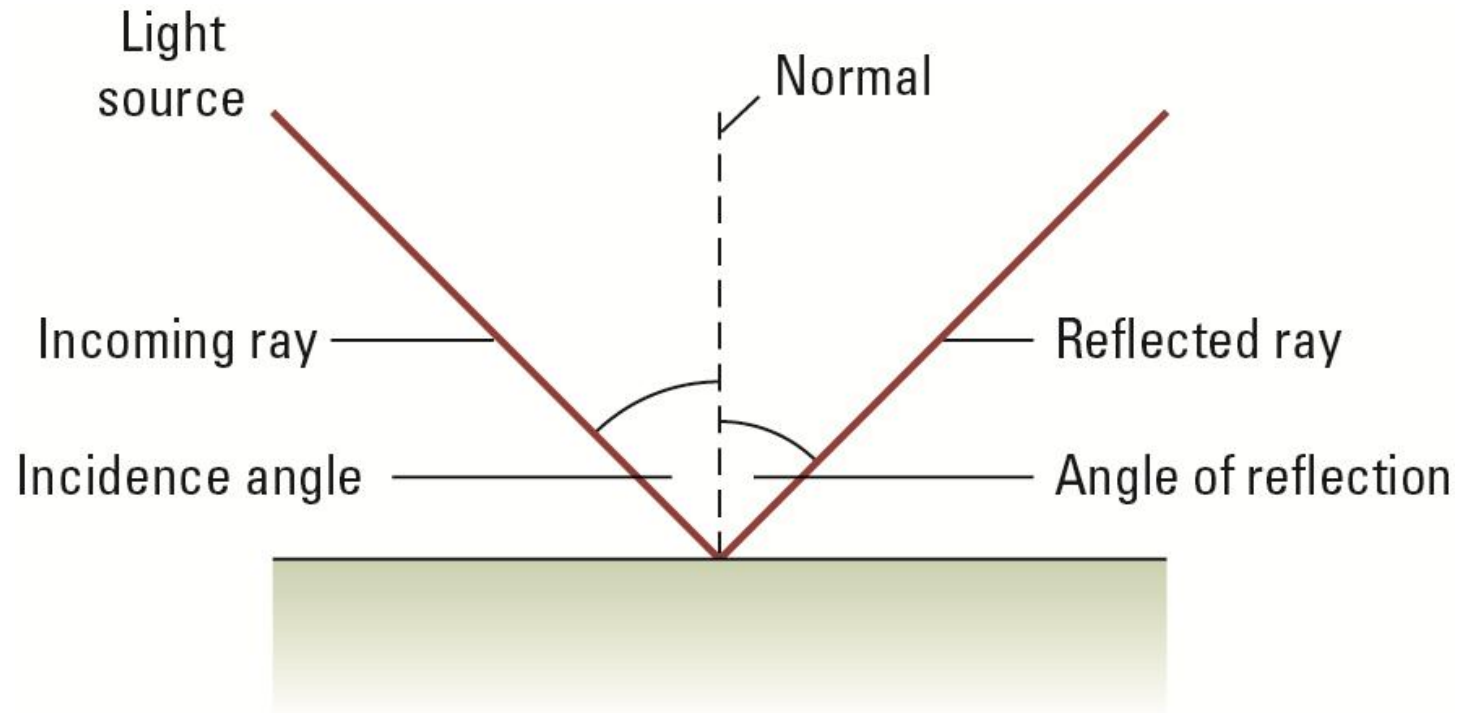


Figure 10.6 Specular versus diffuse light

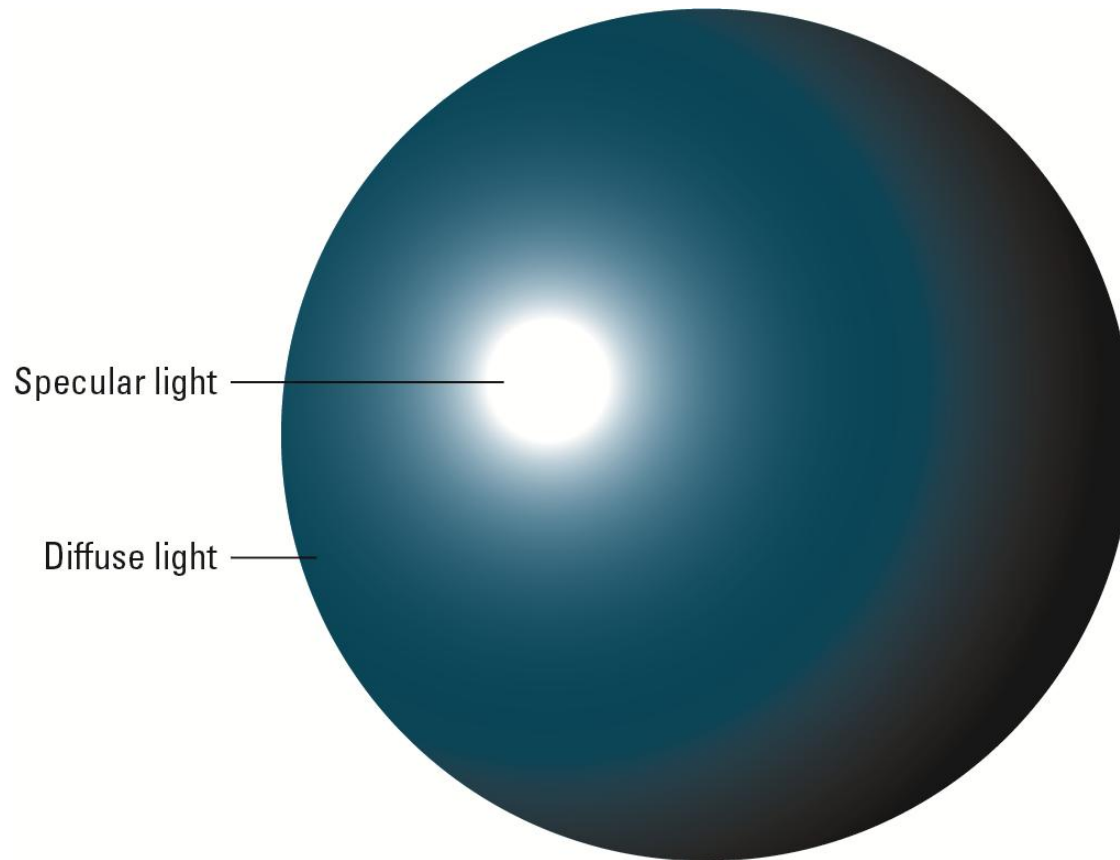
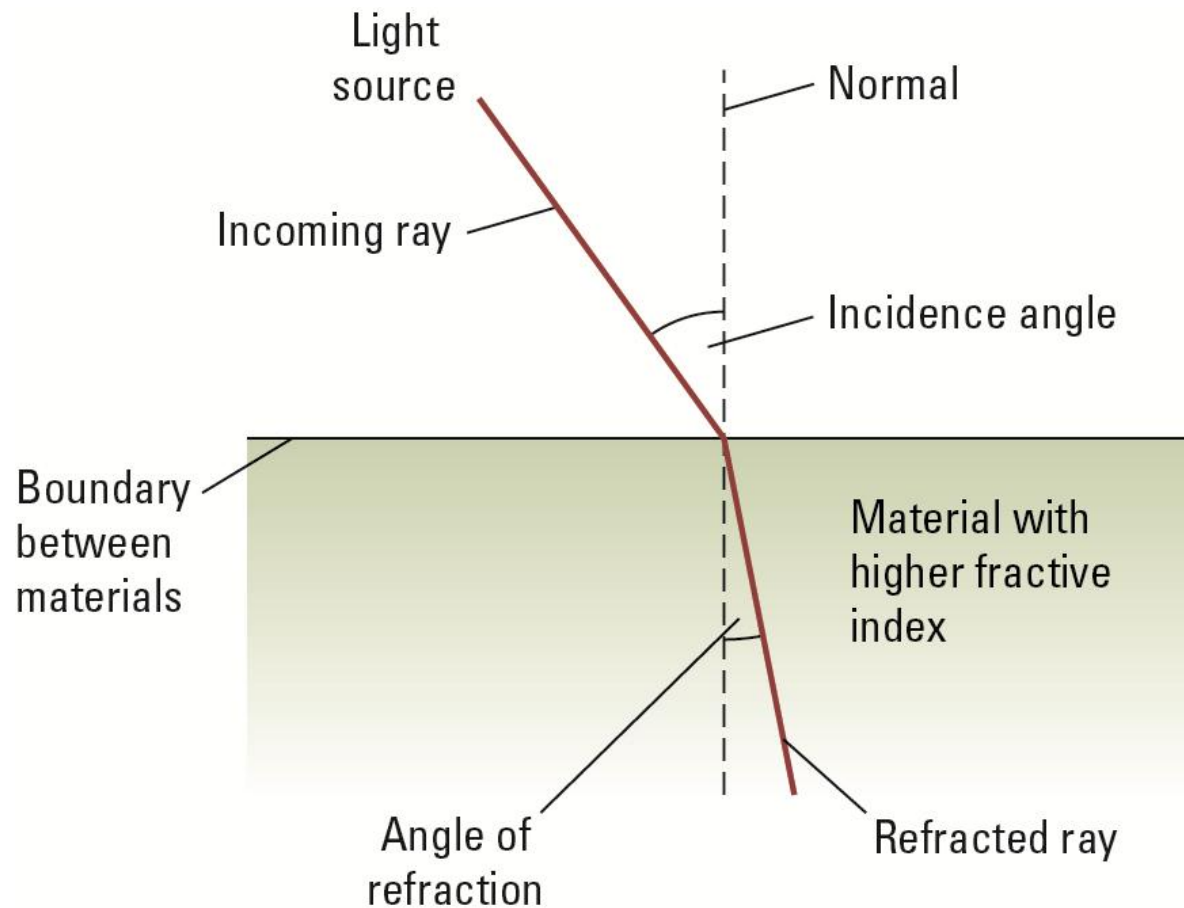


Figure 10.7 Refracted light



The Rendering Pipeline

- **Clipping:** Restricts attention to objects within view volume
- **Scan Conversion:** Associates pixel positions with points in scene
- **Hidden Surface Removal:** Discarding points that are blocked from view
- **Shading:** Determines appearance of points associated with pixels

Figure 10.8 Identifying the region of the scene that lies inside the view volume

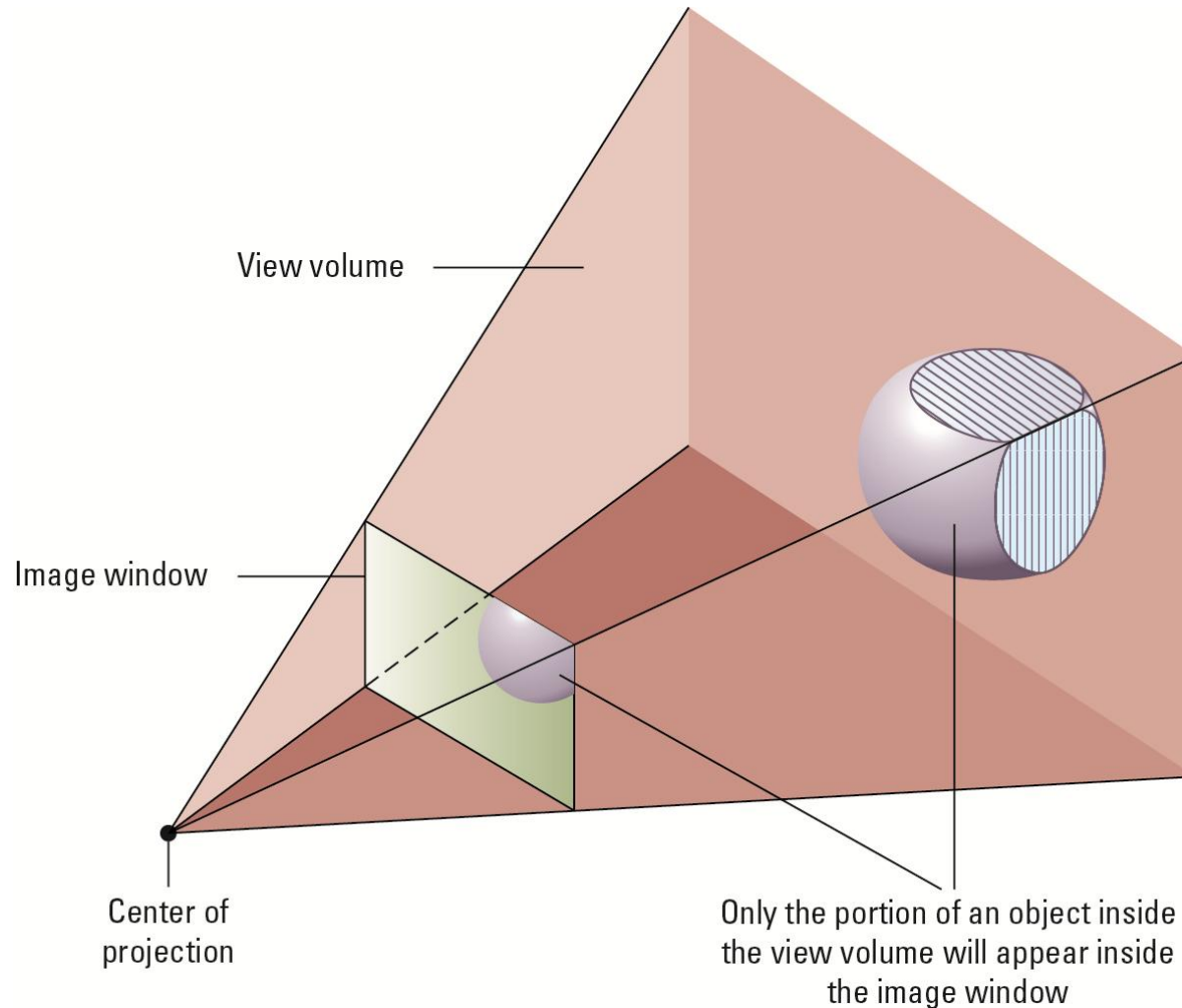
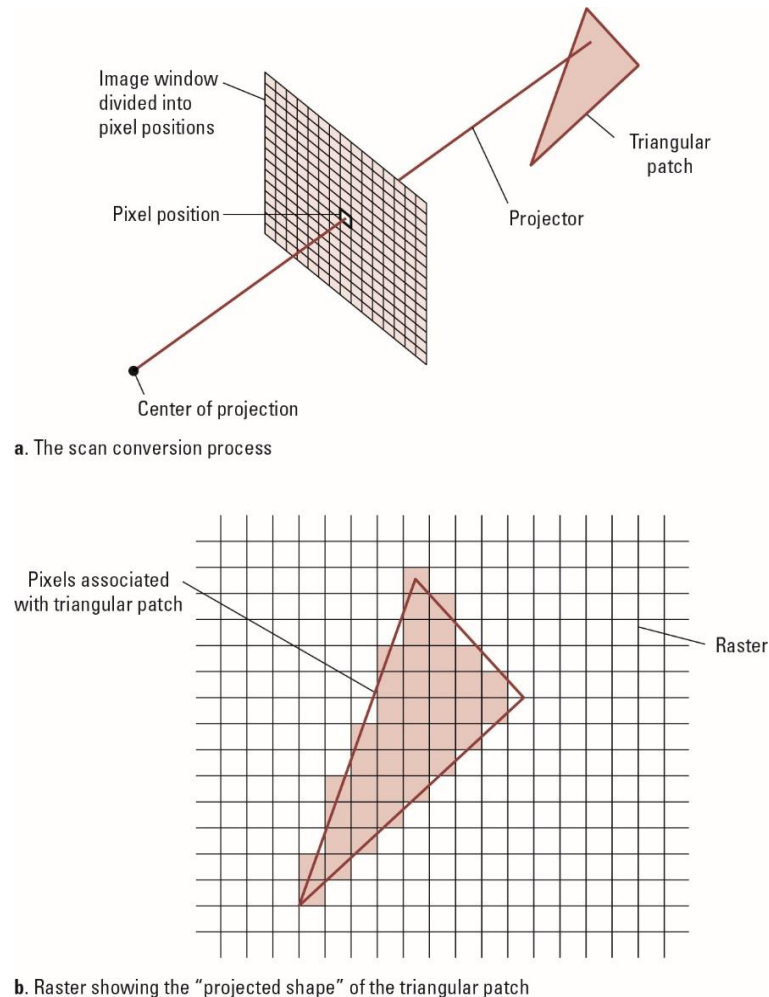


Figure 10.9 The scan conversion of a triangular patch



Shading Techniques

- **Flat Shading:** Creates faceted appearance
- **Gouraud and Phong Shading:** Creates smooth, rounded appearance
- **Bump Mapping:** Creates bumpy, rounded appearance

Figure 10.10 A sphere as it might appear when rendered by flat shading

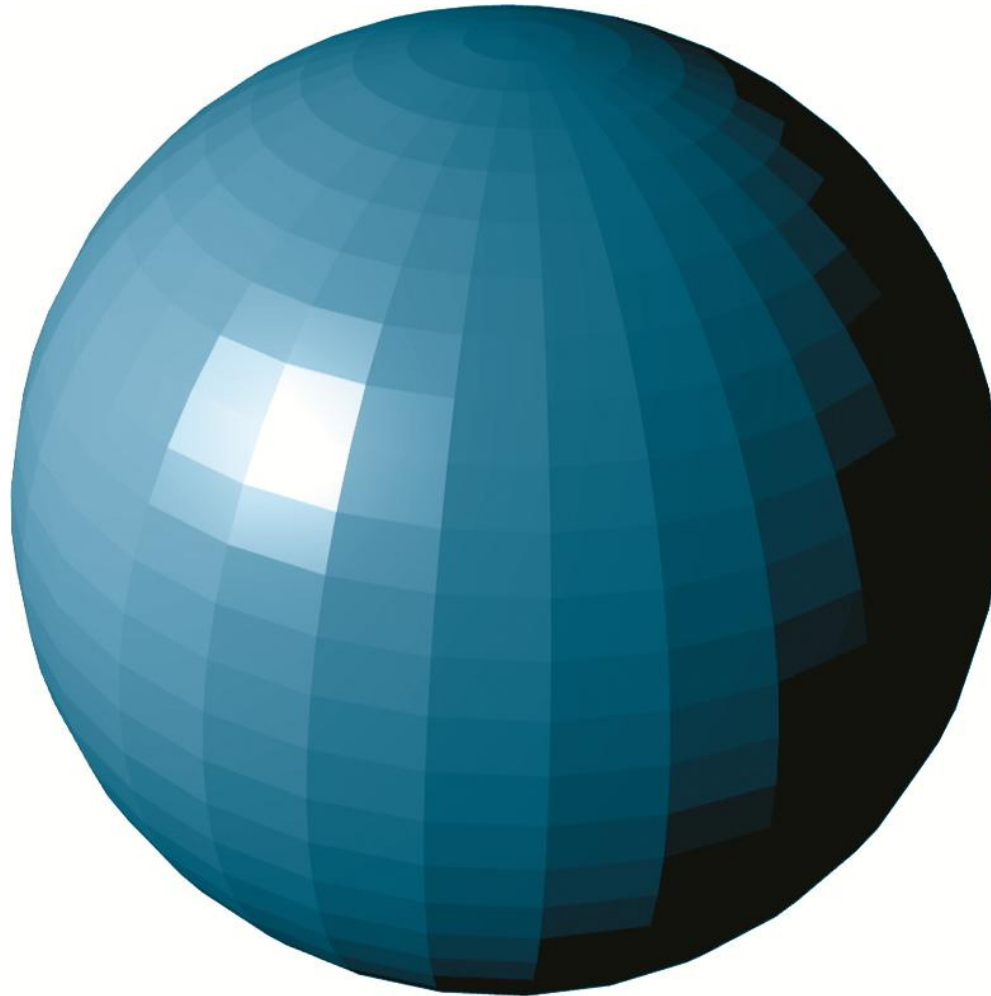


Figure 10.11 A conceptual view of a polygonal mesh with normal vectors at its vertices

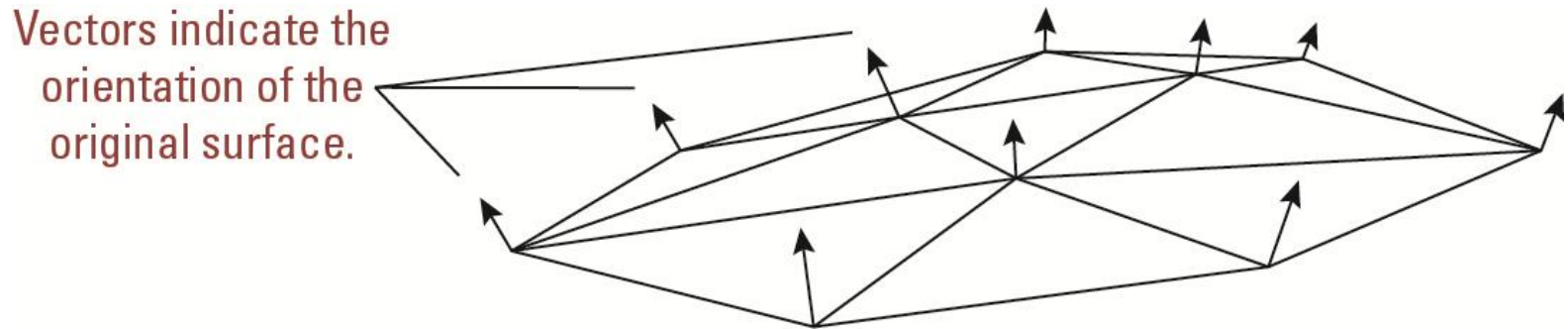
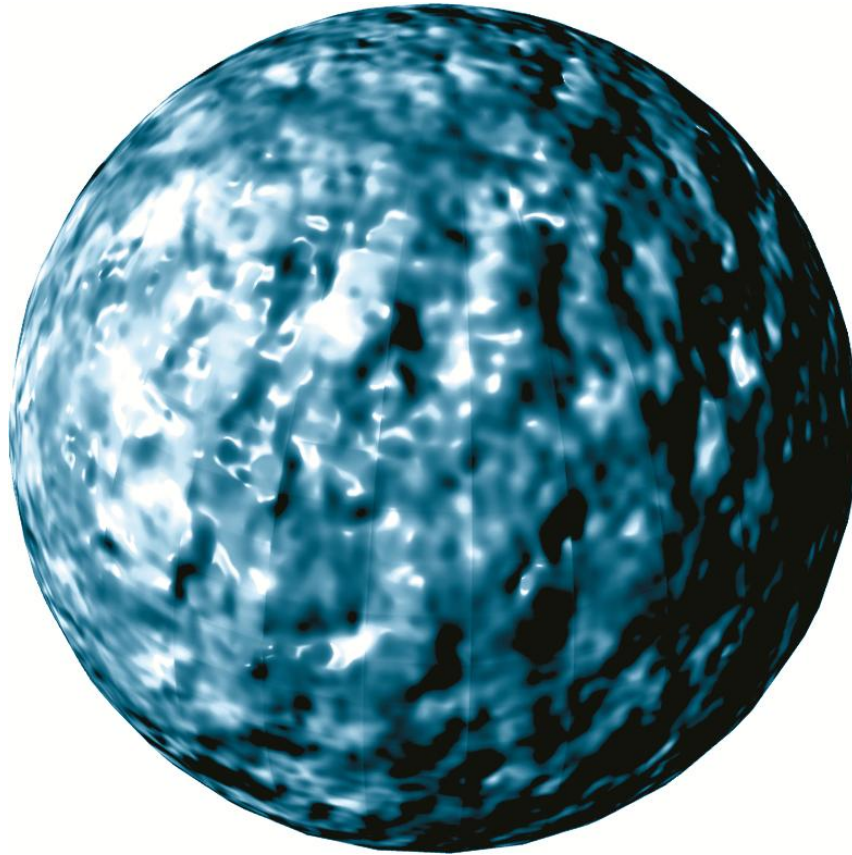


Figure 10.12 A sphere as it might appear when rendered using bump mapping



Rendering Pipeline Hardware

- Graphics Card
 - Attached to the computer's bus
- Graphics Processor Unit (GPU)
 - Allow for fast graphics computations
 - Can be programmed to perform non-graphic calculations

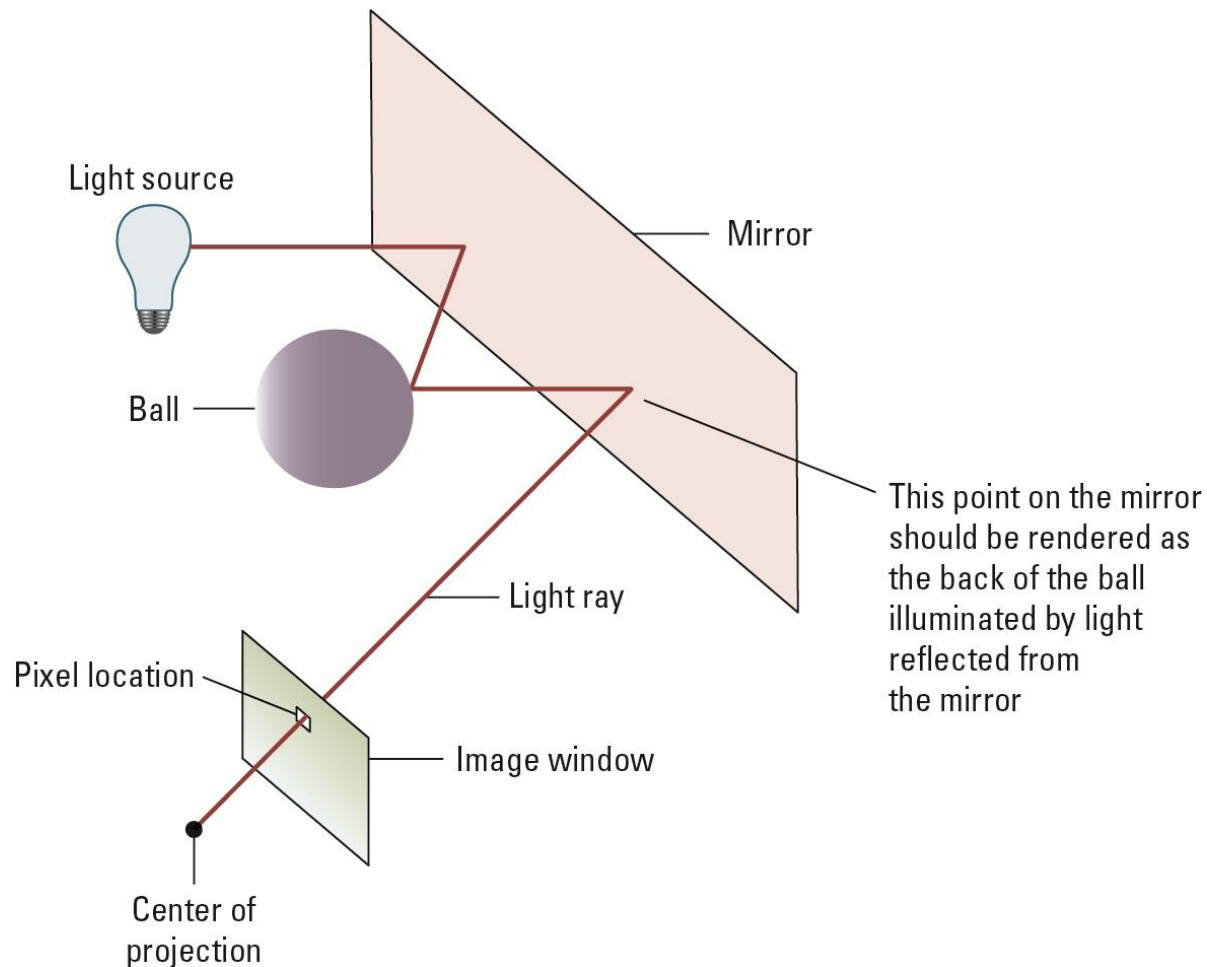
Local Versus Global Lighting

- Local Lighting Model: Does not account for light interactions among objects
- Global Lighting Model: Accounts for light interactions among objects
 - Ray Tracing
 - Radiosity

10.5 Dealing with Global Lighting

- **Ray Tracing:** Following individual rays of light backward to find their source
- **Radiosity:** Determining the appearance of each object by considering the light energy it receives from other objects

Figure 10.13 Ray tracing



10.6 Animation

- **Storyboard:** A sequence of sketches summarizing the entire animation
- **Frame:** One of many images used to create animation
- **Key Frames:** Frames capturing the scene at specified points in time
- **In-betweening:** Producing frames to fill the gaps between key frames

Simulating Motion

- **Dynamics:** Applies laws of physics to determine position of objects
- **Kinematics:** Applies characteristics of joints and appendages to determine position of objects
 - Avars
 - Motion Capture

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