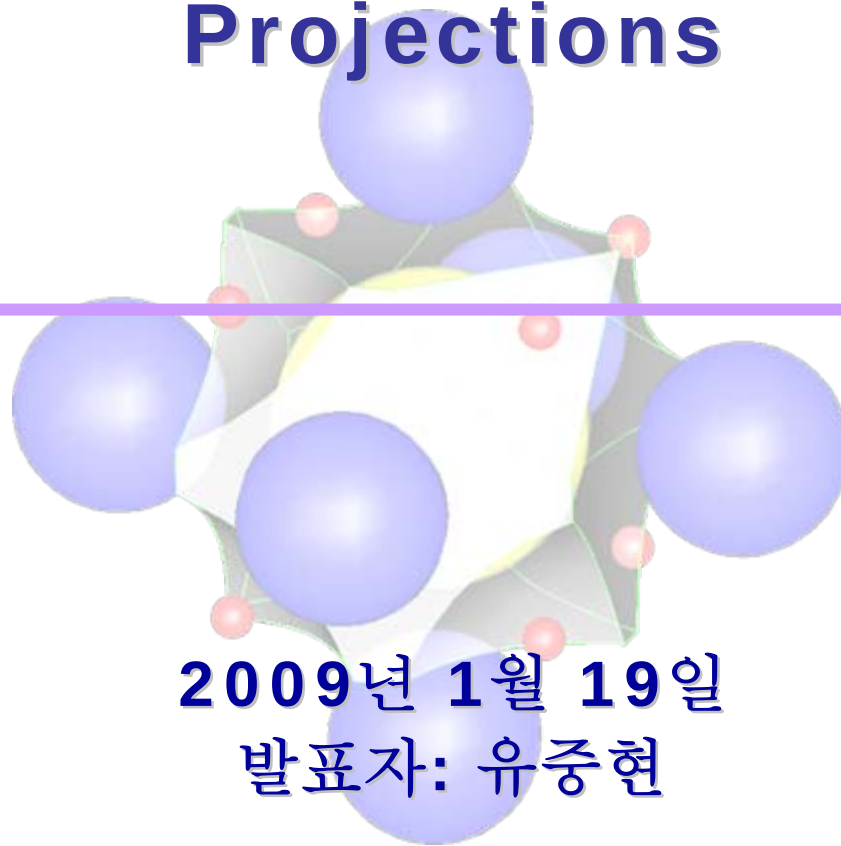
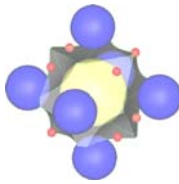


Architectural geometry: Projections



2009년 1월 19일
발표자: 유중현



Vector space

■ Geometric meaning

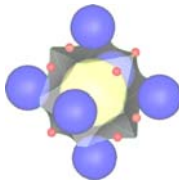
- Position vector
- Direction vector

■ Operations

- Addition
- Multiplication by a real number
- Zero vector
- Dot / Cross product

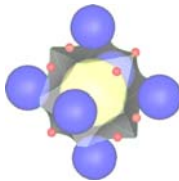
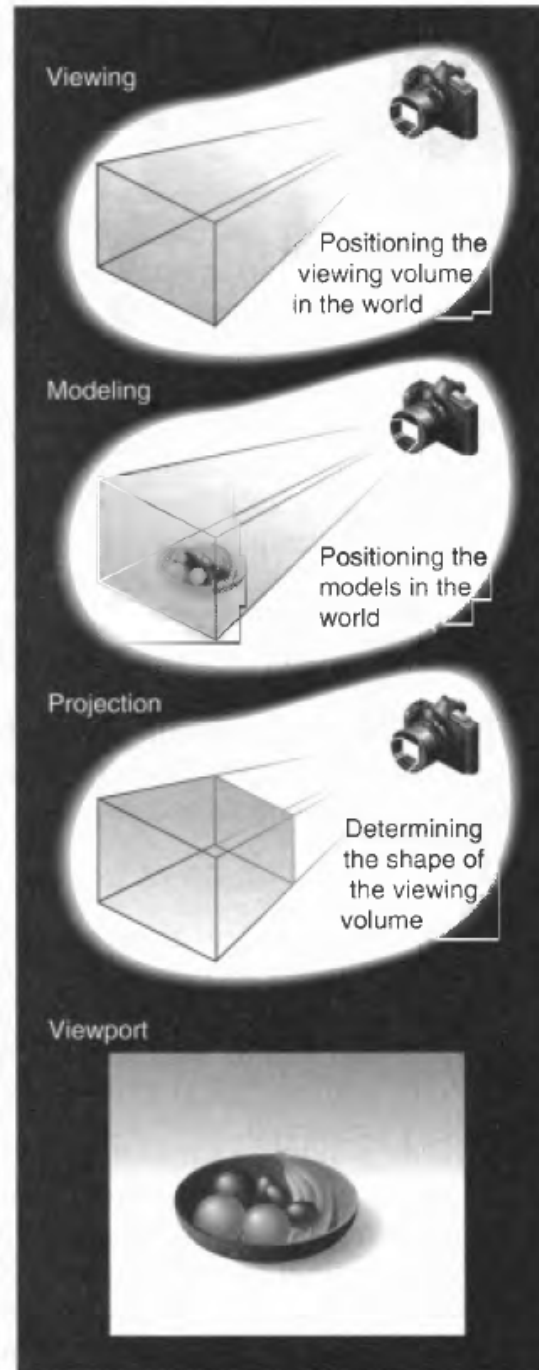
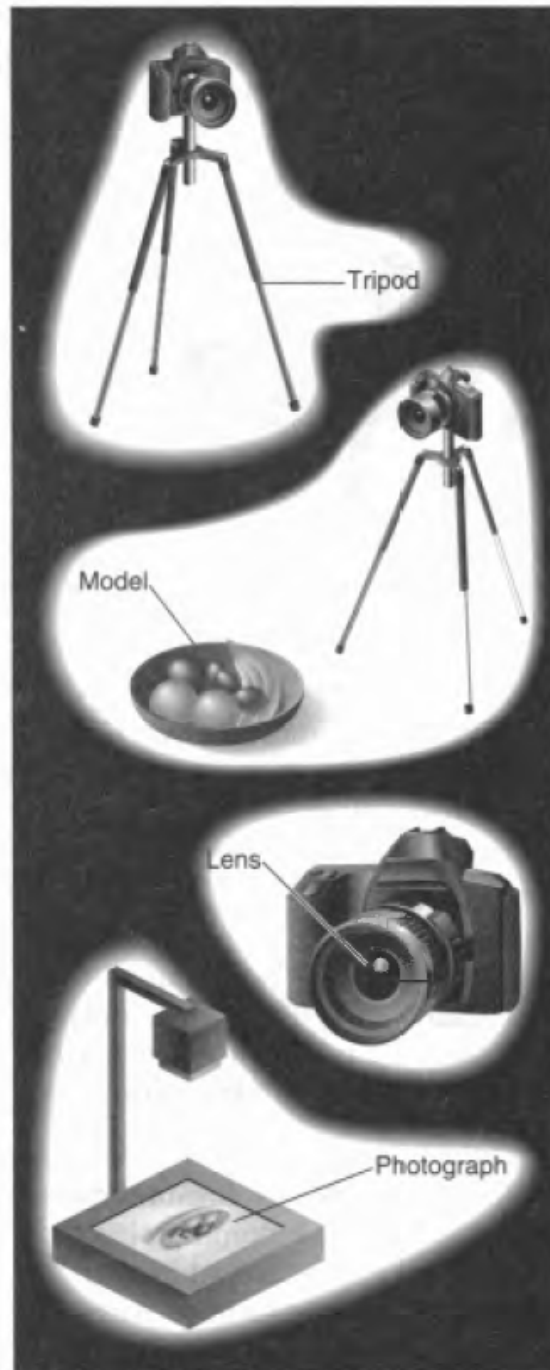
➤ **Linear combination** of vectors is also a vector

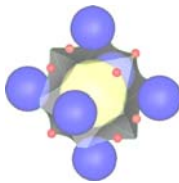
➤ $P \text{ (Point)} + V \text{ (Vector)} = ?$



Interpolation, line, plane

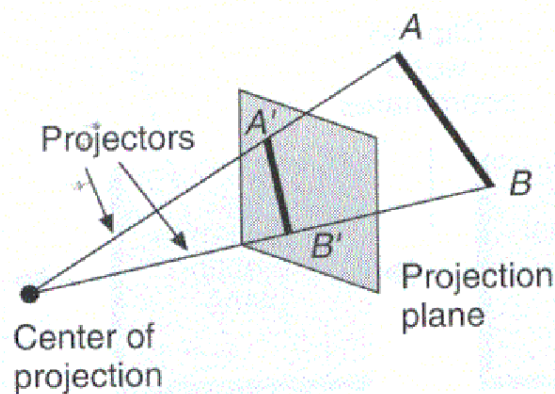
- Interpolation: find a curve that **exactly pass through** the given points
 - Approximation
- **Fitting** = interpolation + approximation
- Linear interpolation
 - Straight line
 - Parametric / Implicit form
- Plane
 - Parametric / Implicit form
- Polygon
 - Regular polygon



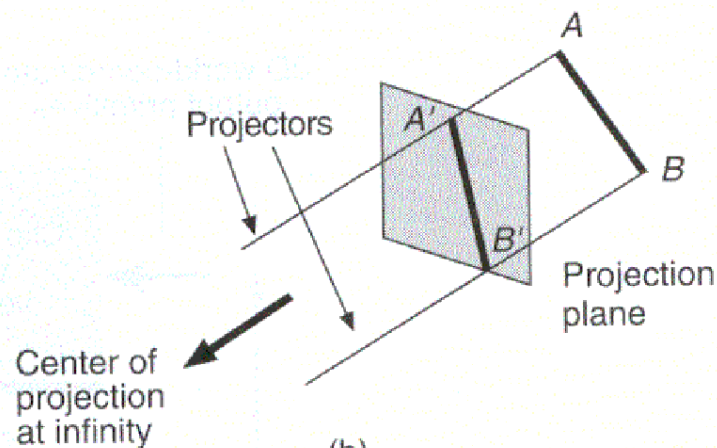


Projection

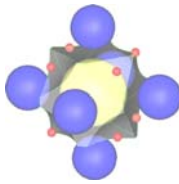
- Transformation of points (objects) in 3D into points (objects) in 2D
 - Center of projection
 - Projection ray (Projector)
 - Projection plane
- Parallel vs. Perspective (Central)



(a)



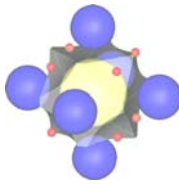
(b)



Projection

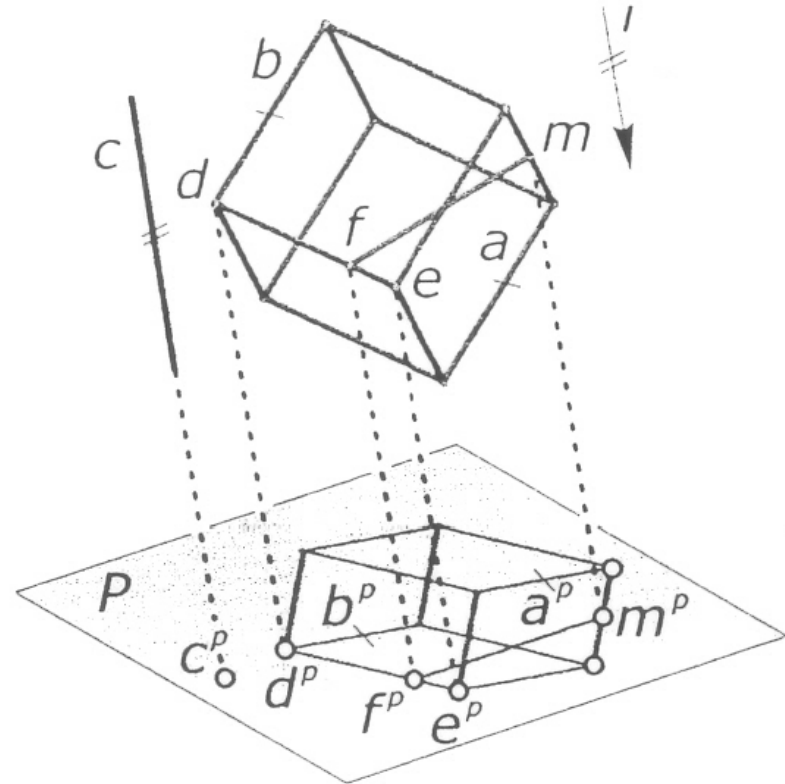
- Why do we need?
 - To visualize the object: **realistic rendering**
 - To share **proper information** between designer and manufacturer

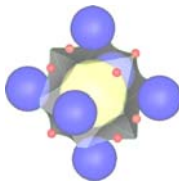
- From CAD system user point of view
 - To understand mechanism of the system
 - To **make best use of the available parameters** of the system



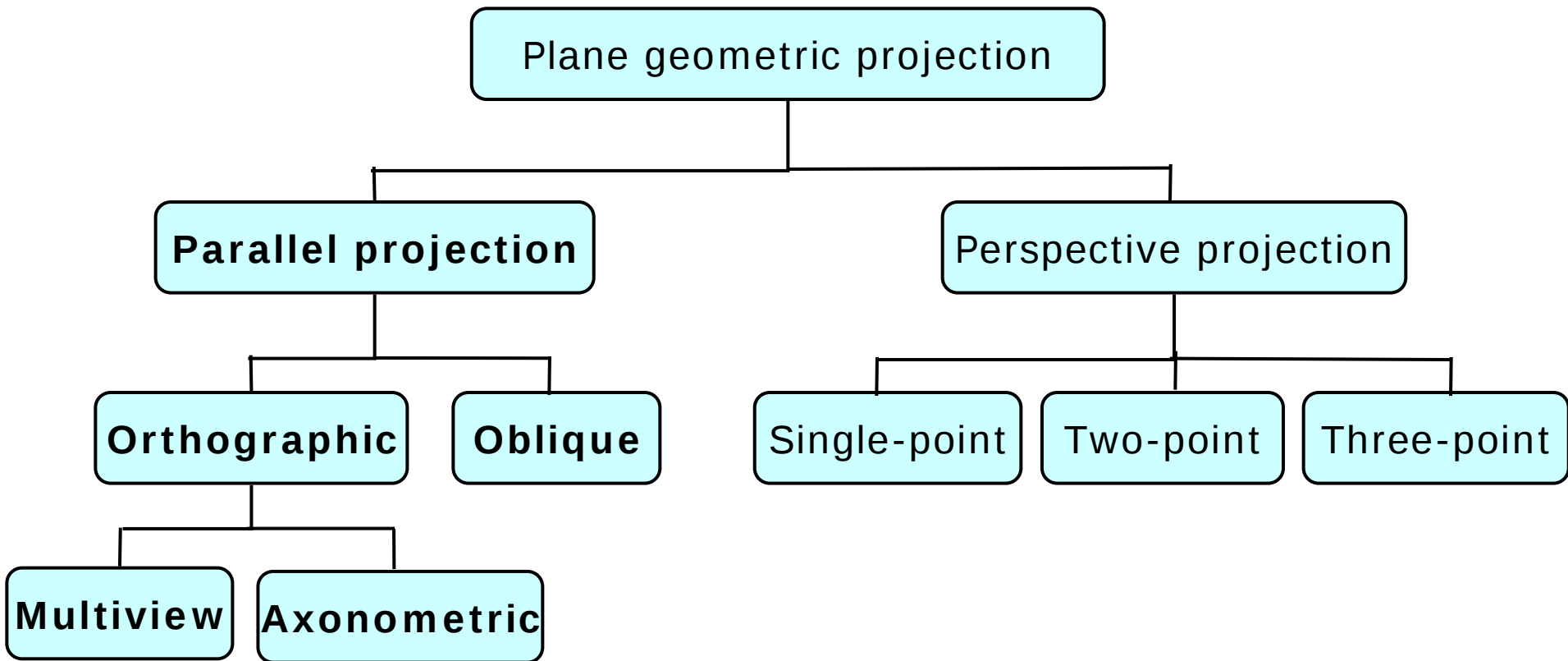
Parallel projection

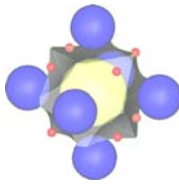
- Center of projection **at infinity**
 - Shadows generated by sunlight
- Distortion factor
- Properties:
 - Line $\rightarrow$ Line or Point
 - Parallel lines $\rightarrow$ Parallel lines
 - The ratio of distance is preserved





Plane geometric projections

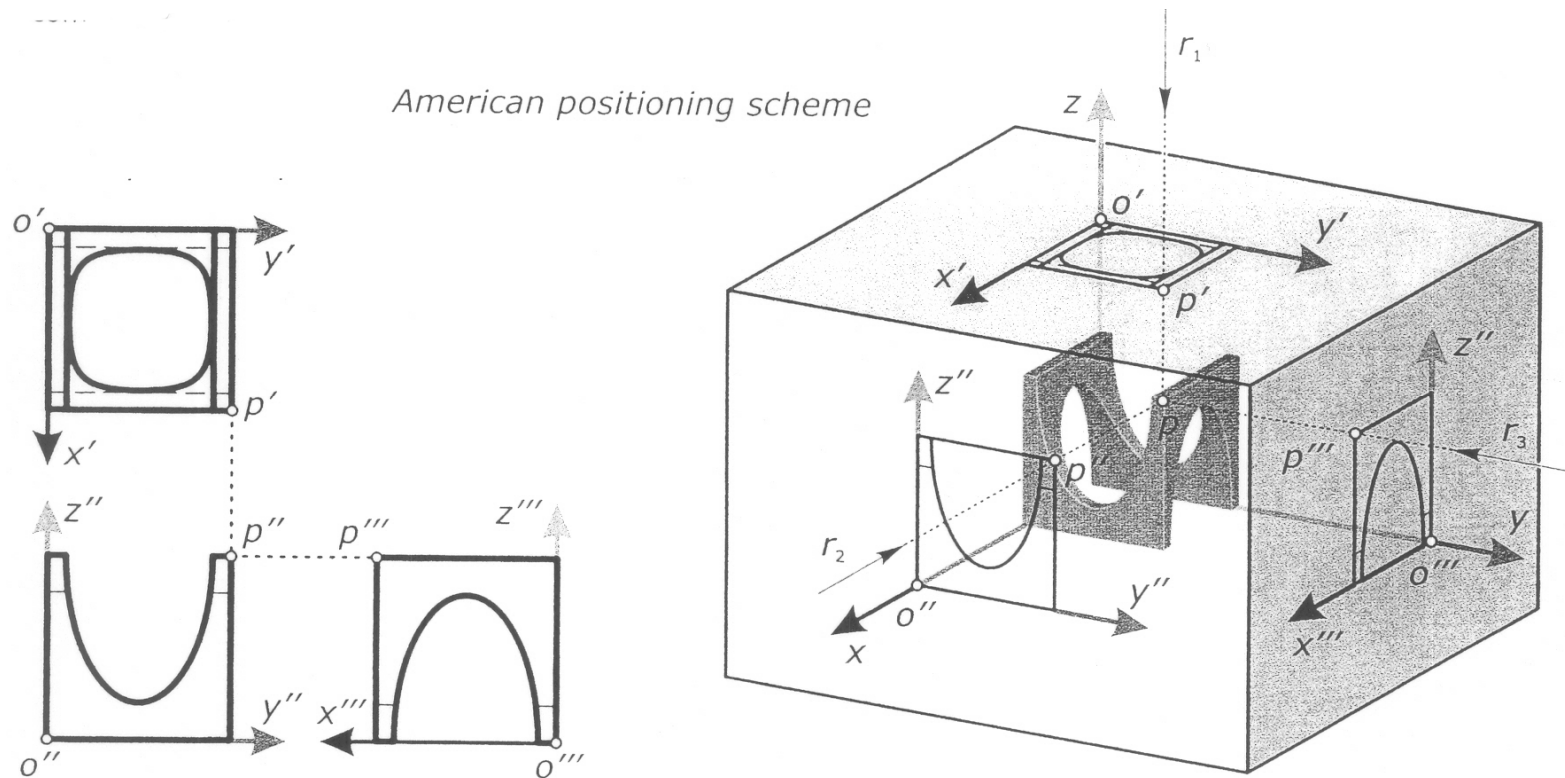


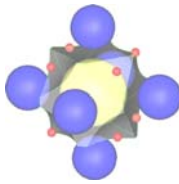


Orthographic projection

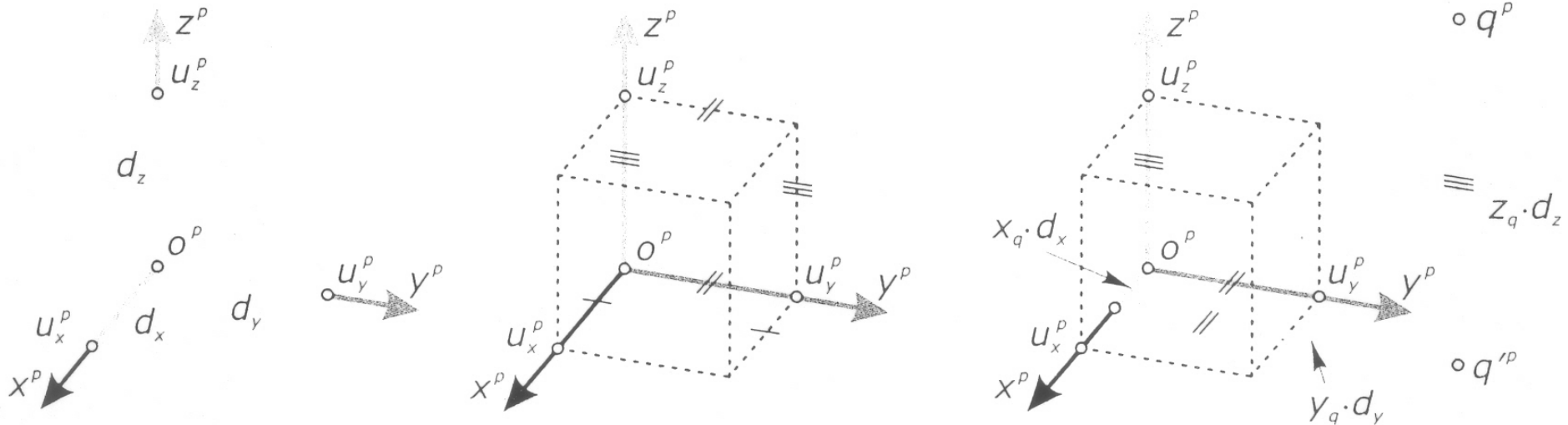
■ Multiple view

- (Normal projection)
- Top view, front view and side view

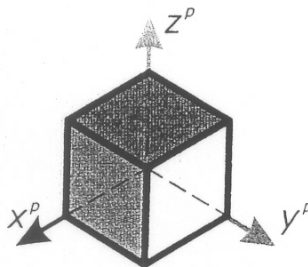
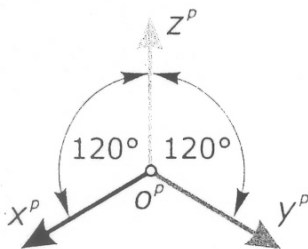




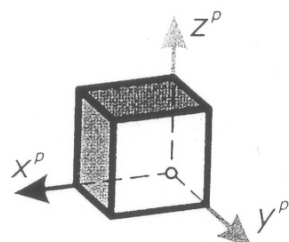
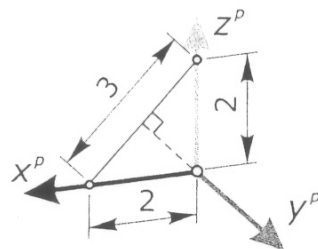
Axonometric projection



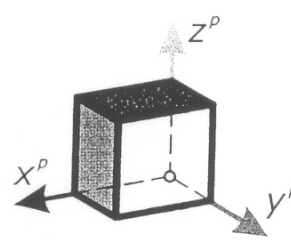
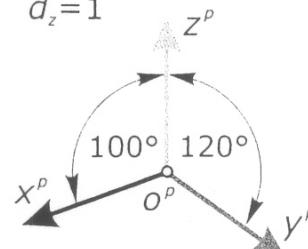
$$d_x = d_y = d_z = 1$$



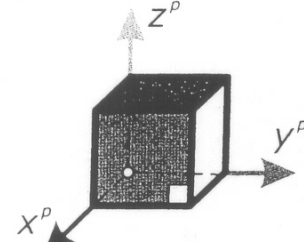
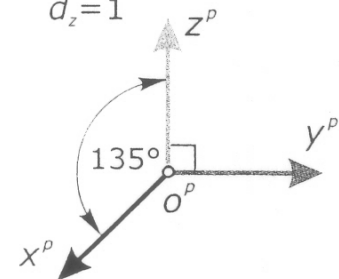
$$d_x = 1; d_y = 0.5; d_z = 1$$



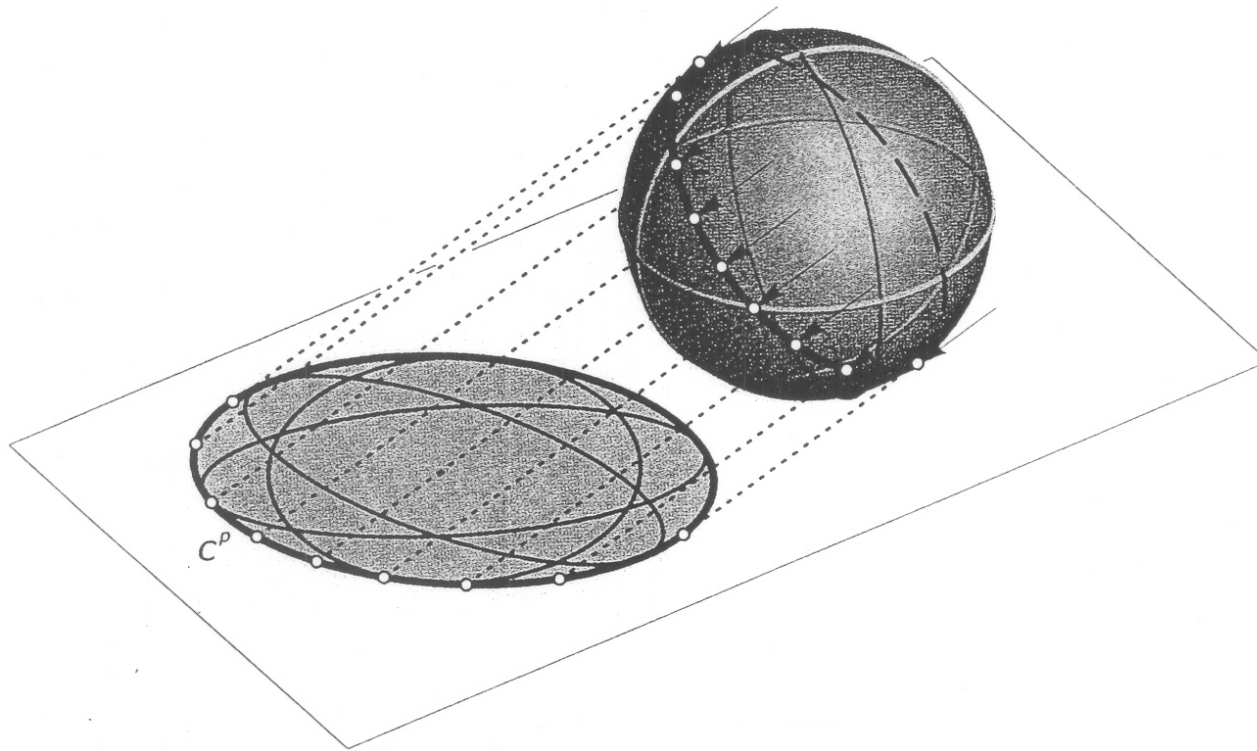
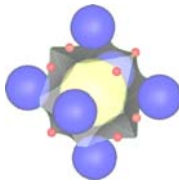
$$d_x = 1; d_y = 0.75; d_z = 1$$



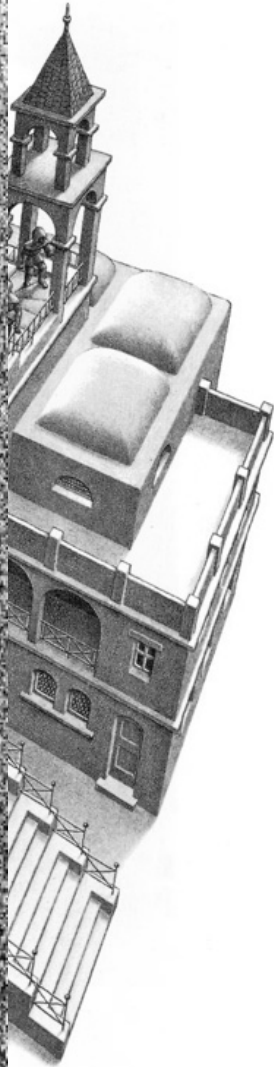
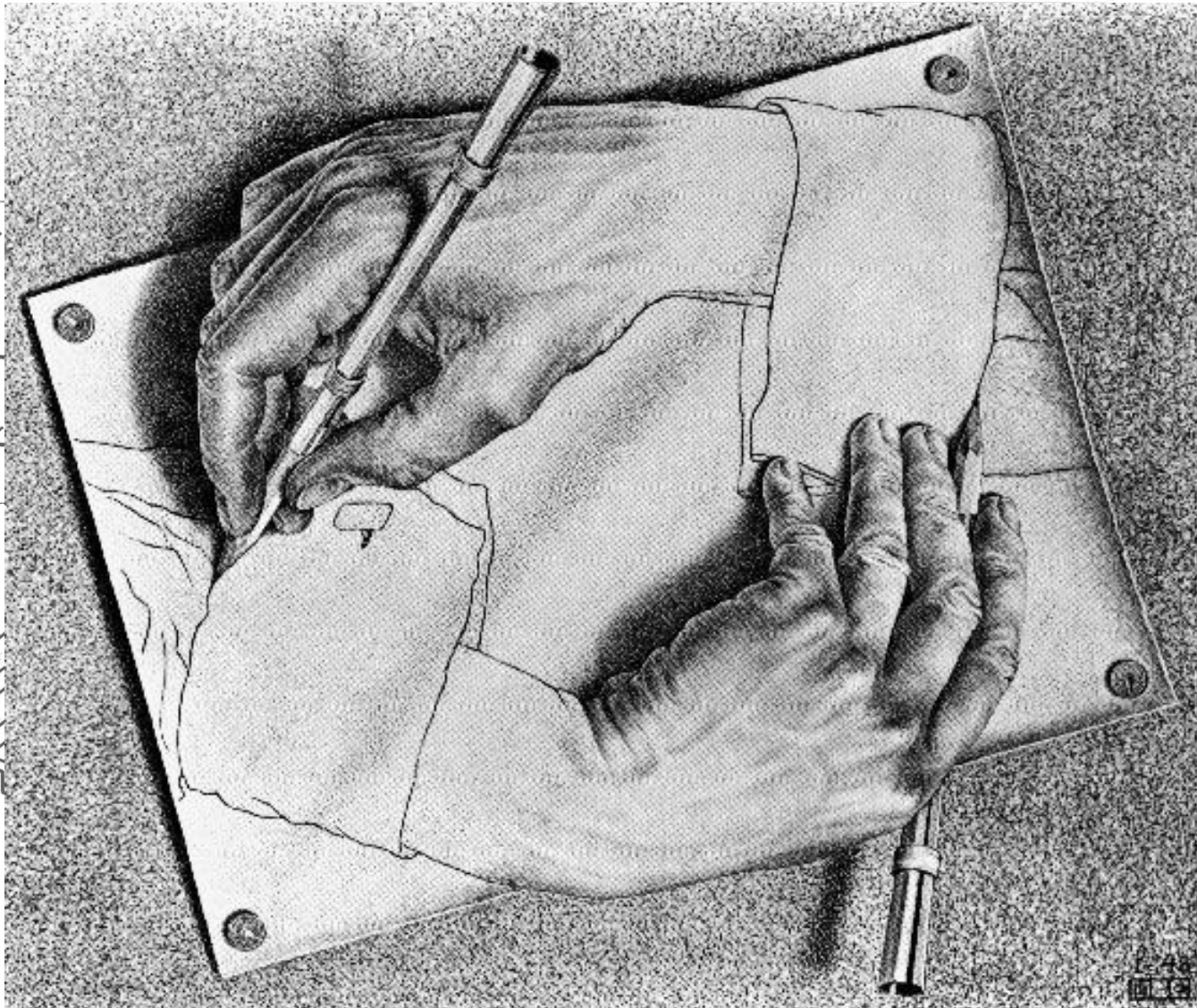
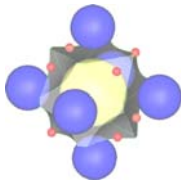
$$d_x = 0.5; d_y = 1; d_z = 1$$

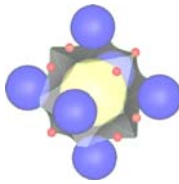


Oblique projection

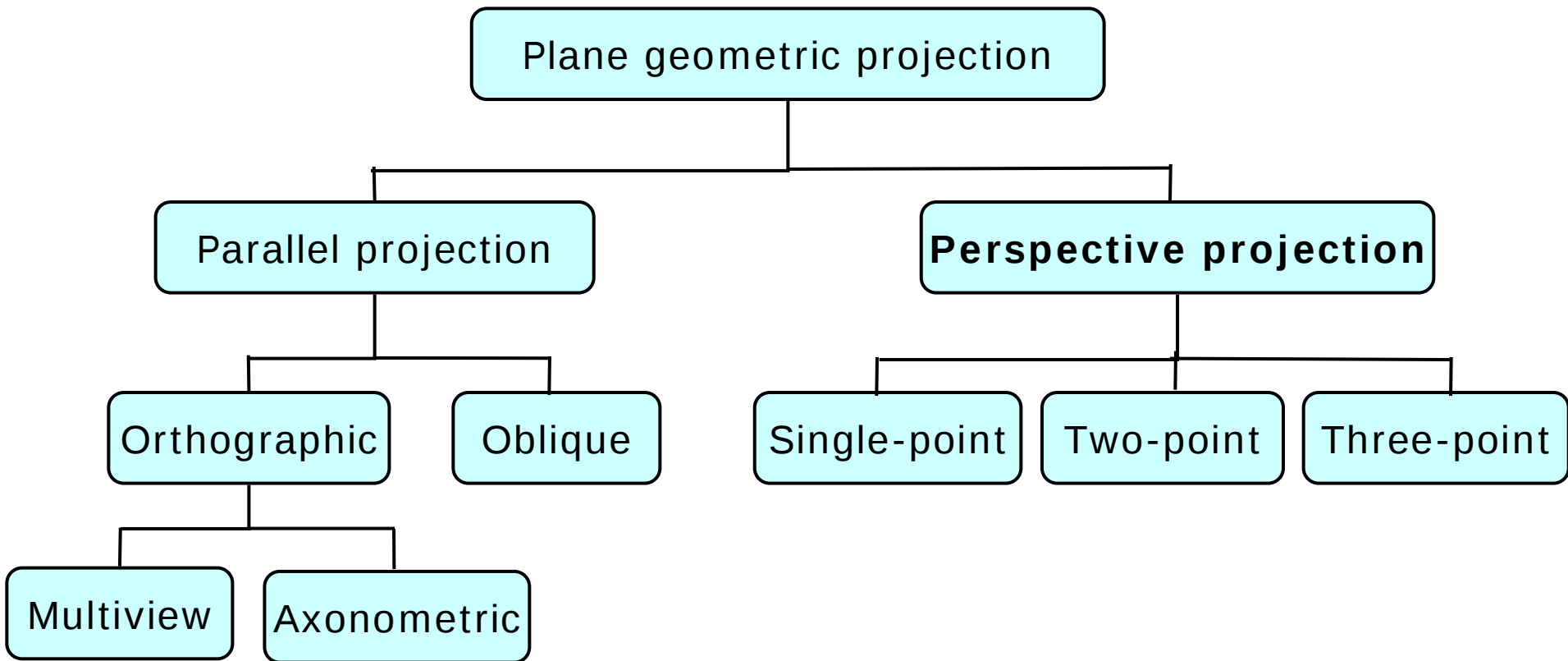


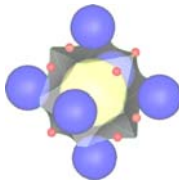
Impossible object (M. C. Escher)





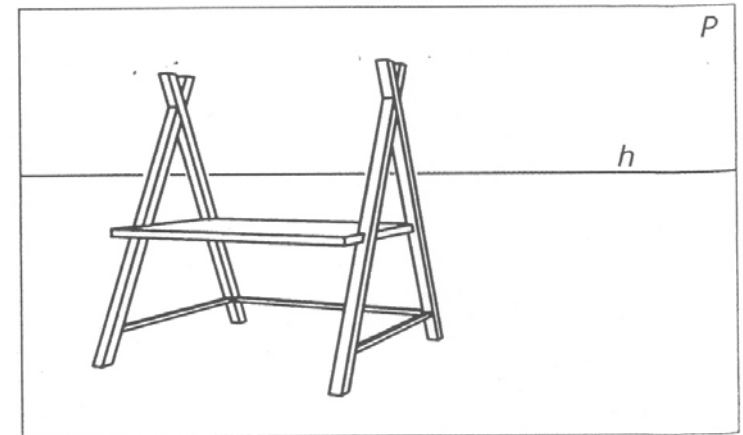
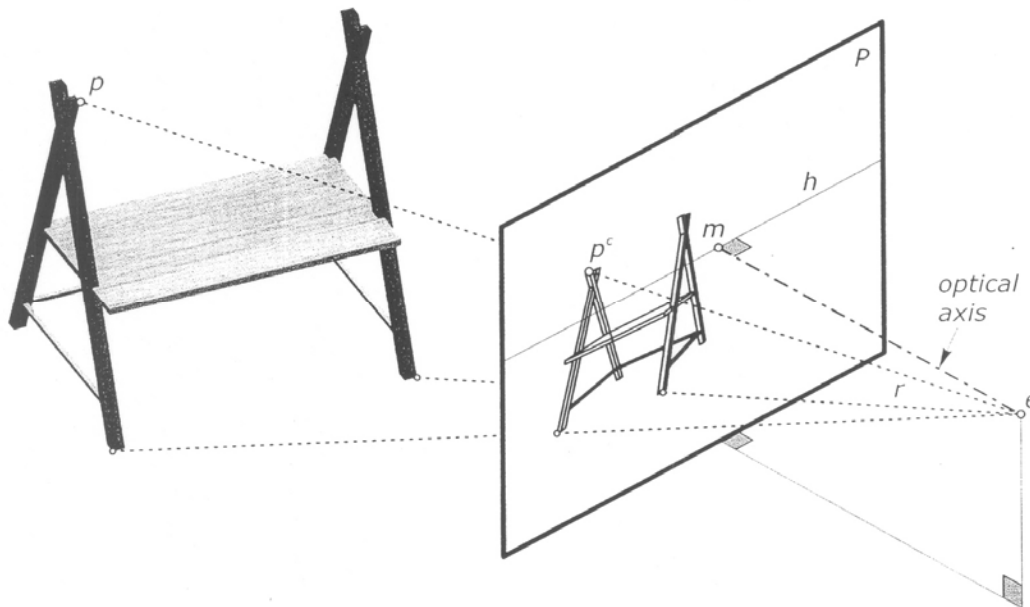
Plane geometric projections

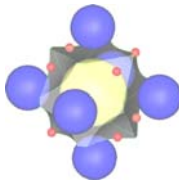




Perspective projection

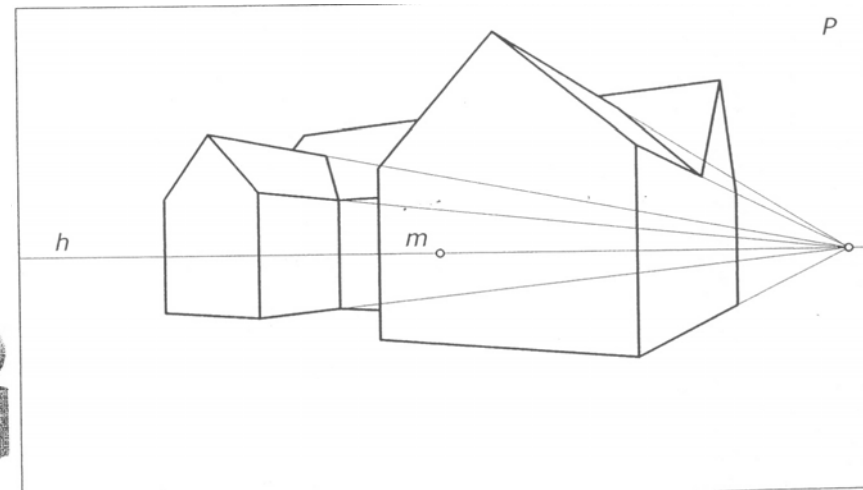
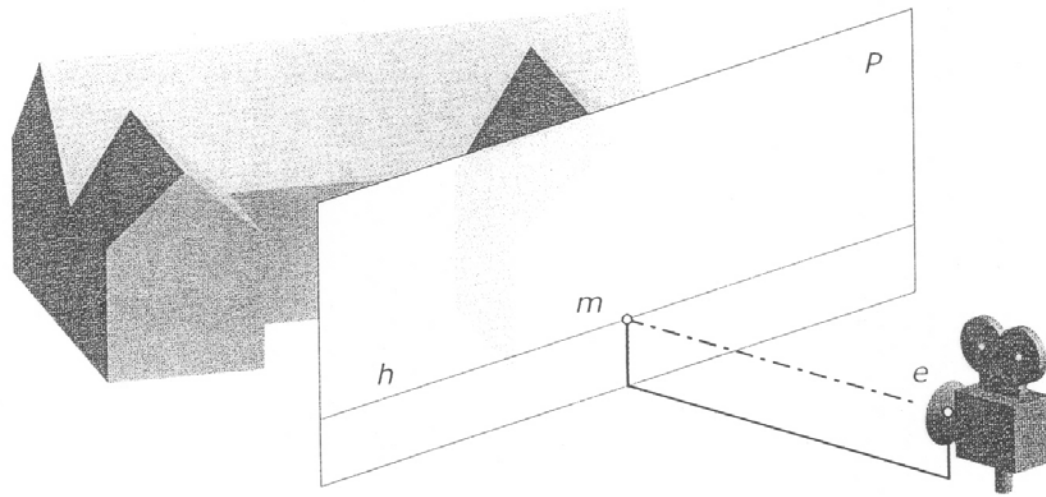
- Center of projection at fixed point
 - Shadows generated by light emanating from a single point source

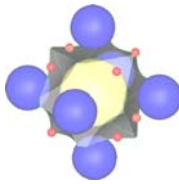




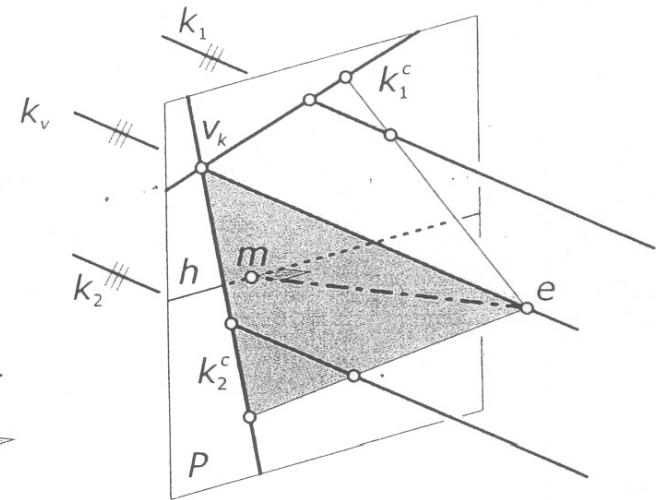
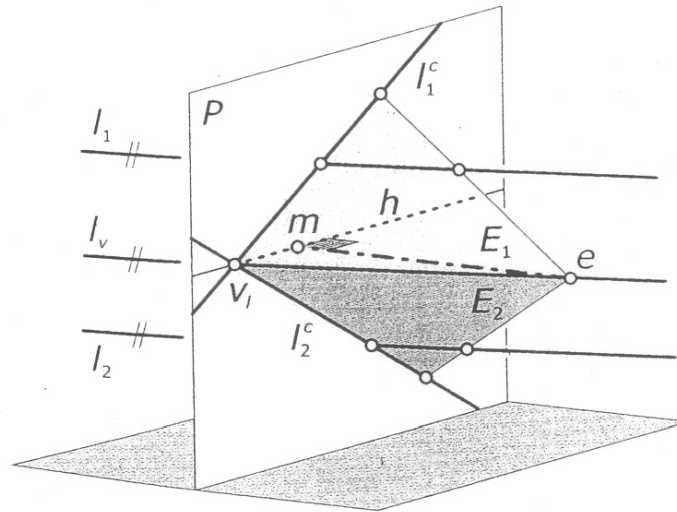
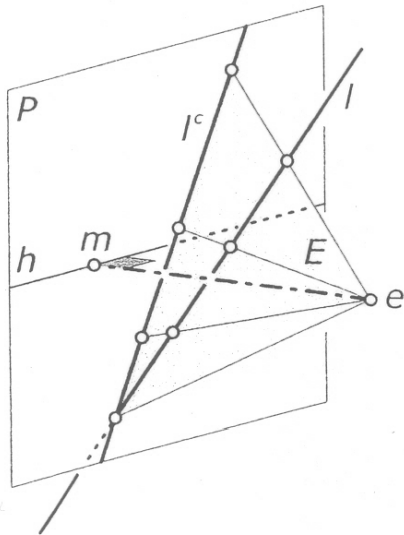
Perspective projection

- Eye point (camera), optical axis, horizontal line
- Do not preserve **parallelism** and **ratios**

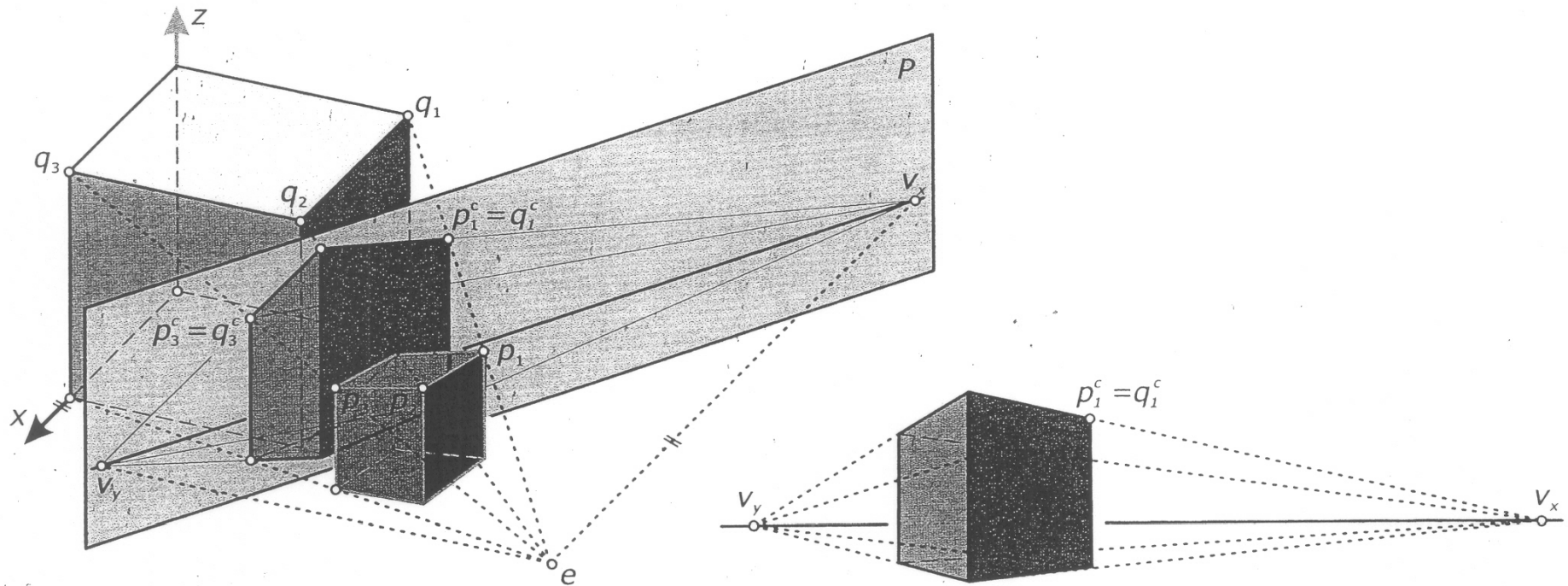
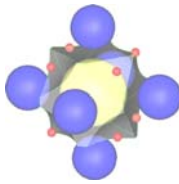


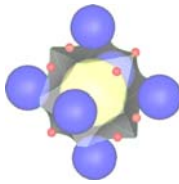


Vanishing point



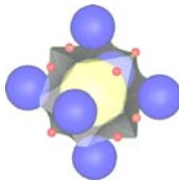
Optical illusion





Realistic rendering

- **Lighting (illumination) model**
 - Procedure for computing the **intensity of lights**
- **Surface rendering algorithm**
 - Procedure for **applying lighting model** to obtain the **pixel intensities** of all projected surface positions



Light sources

■ Point light

- Emanate in all directions

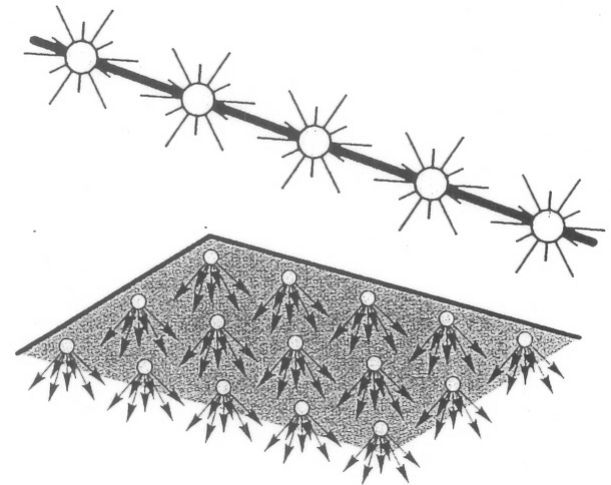
$$I \propto \frac{1}{dist^2}$$

■ Distant light

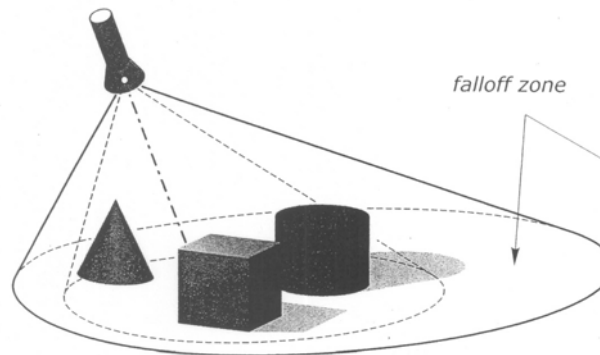
- Constant intensity

■ Area light

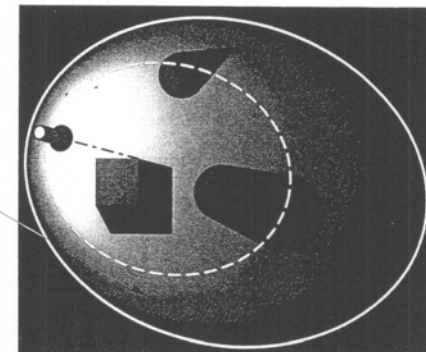
■ Spot light



Spotlight.



falloff zone



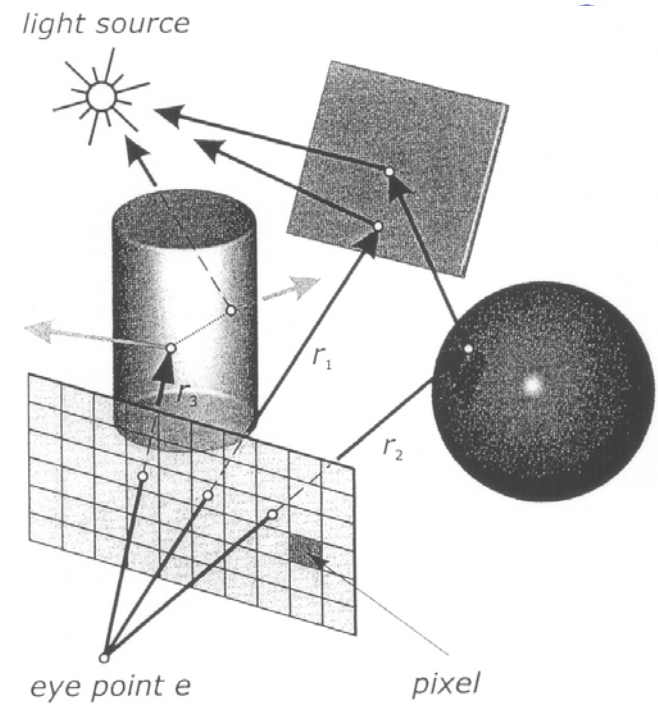
Rendering method

Local methods

- Flat shading
- Gouraud shading
- Phong shading

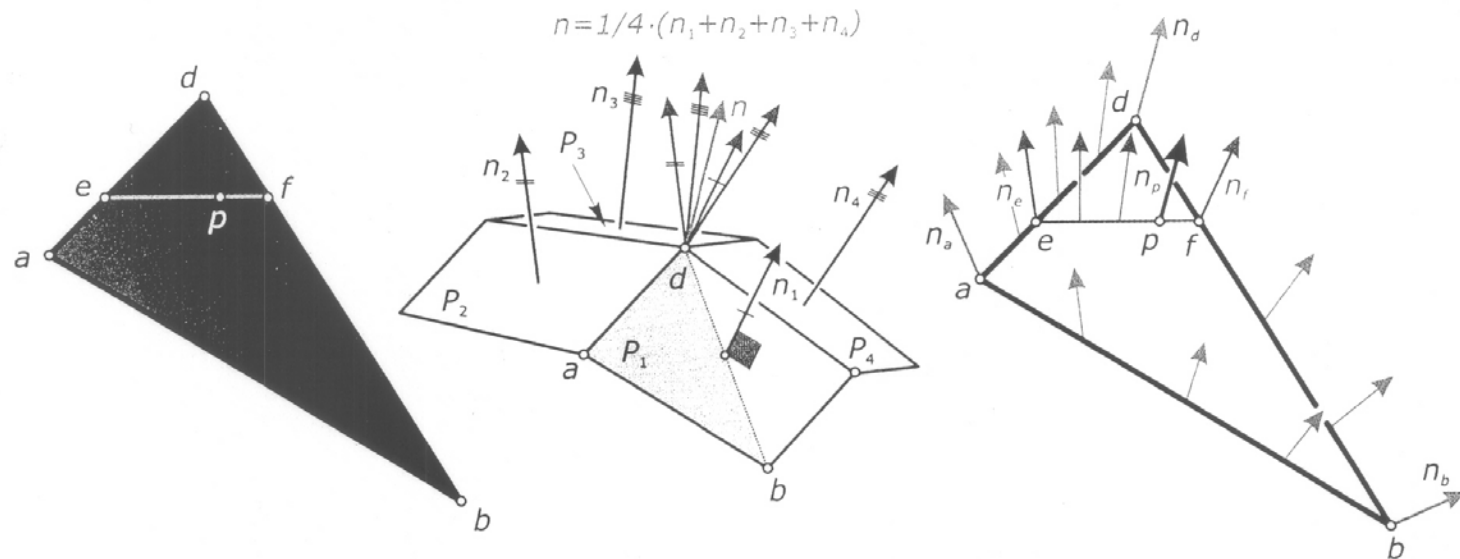
Global methods

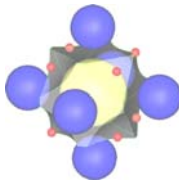
- Ray tracing
- Radiosity



Phong shading principle

Gouraud shading principle





Nonlinear projections

- **Perspective projection** with the projection plane replaced by projection **cylinder** or **sphere**

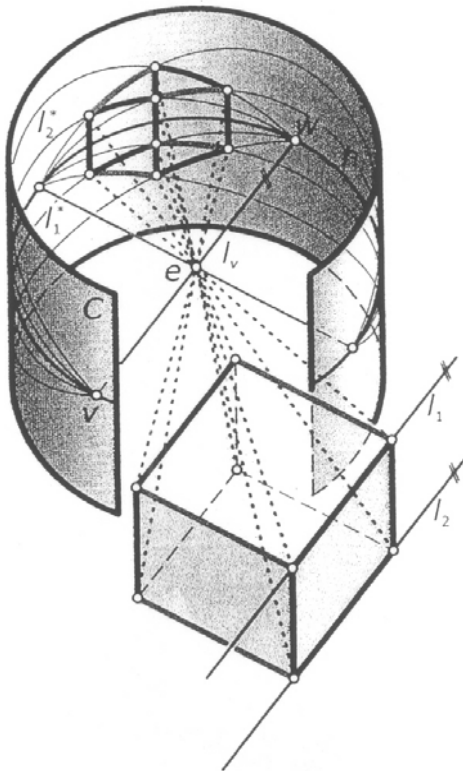
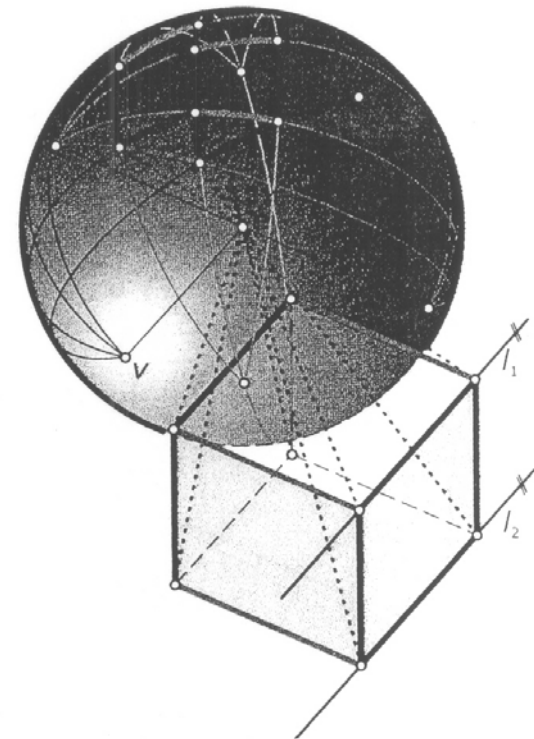
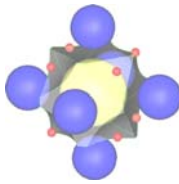


Fig. 2.50
Cylindrical projection of a cube.





Nonlinear projections

- Spherical projection
- Stereographic projection

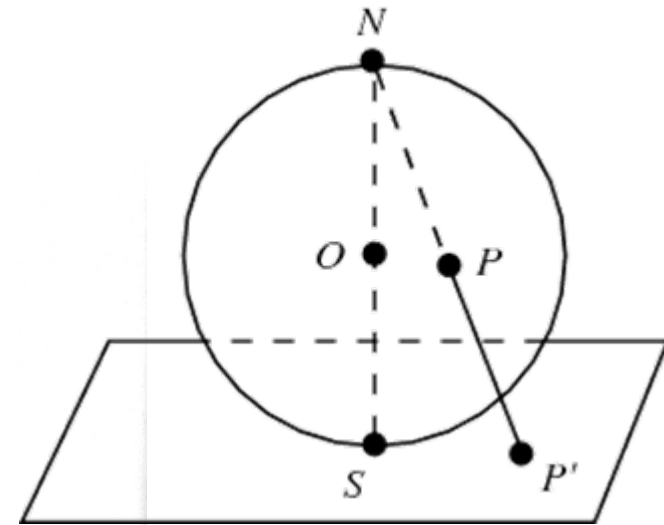
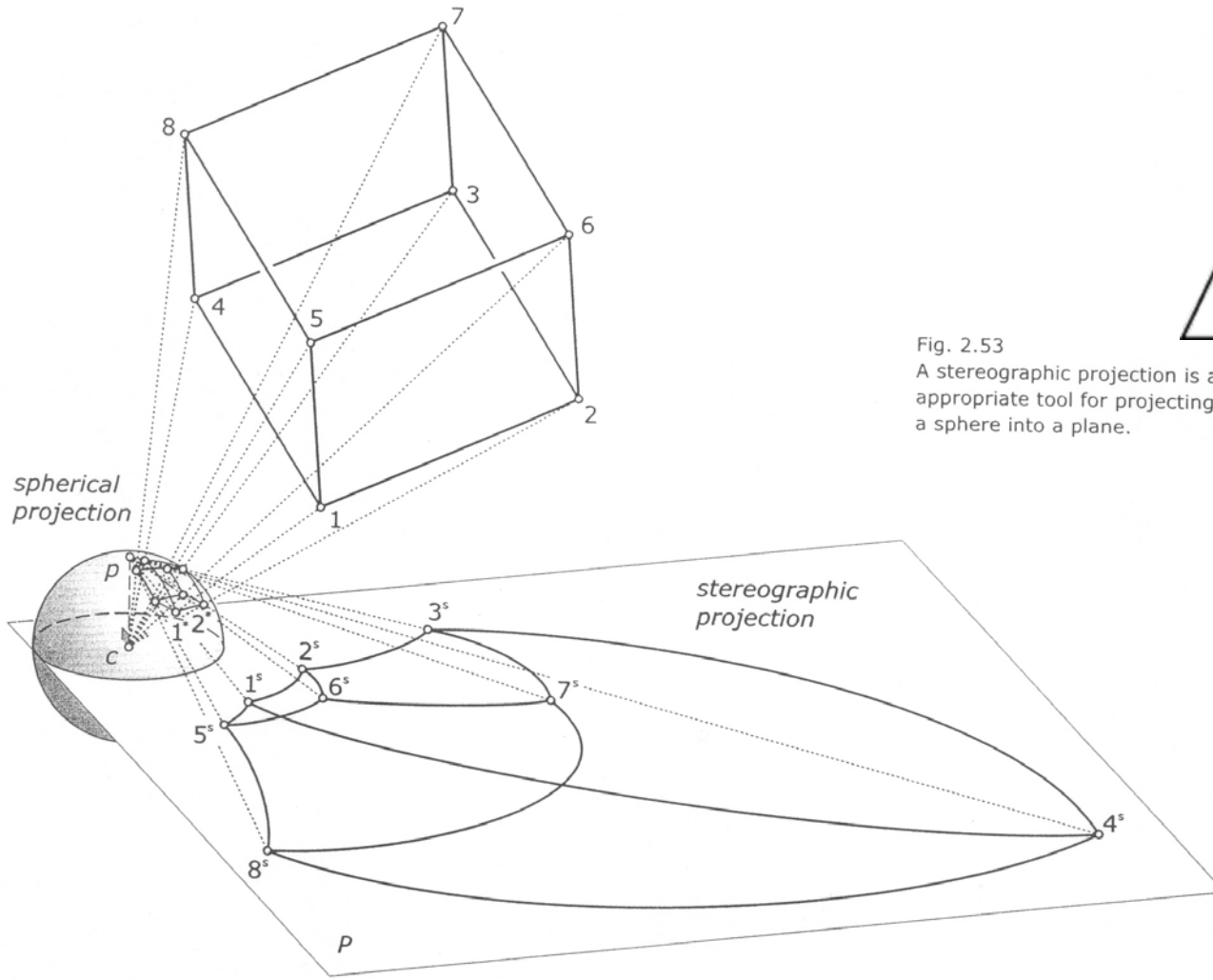


Fig. 2.53

A stereographic projection is an appropriate tool for projecting points of a sphere into a plane.