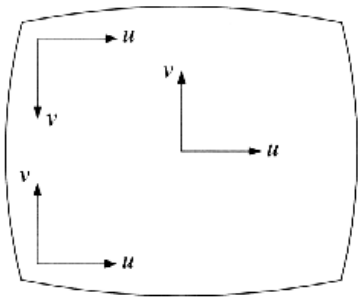
Visualization

Understanding what you are seeing.

Device Coordinate Systems

- Ultimately all geometric models must be displayed on a 2D display device.
- Various “device display coordinate” conventions are used:



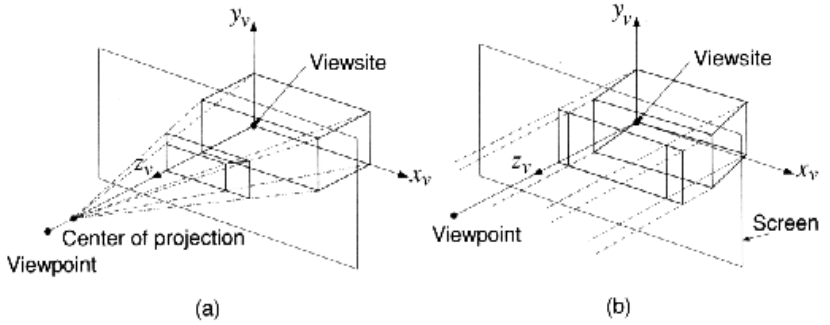
(K.W. Lee, *Principles of CAD/CAM/CAE System*, 1999)

Viewing Coordinate System

- Points in the **viewing coordinate system** (x_v, y_v, z_v) are projected onto the screen in **virtual device coordinates** (x_s, y_s).
- "Viewsite" gives the Viewing CS origin.
- The "Viewpoint" is the eye or camera position (pointed at the Viewsite).
- An "up" direction is chosen arbitrarily.
- The screen is located somewhere between the Viewsite and Viewpoint.

Viewing Coordinate System

- Two types of projections are possible:
  (a) perspective projection and
  (b) parallel projection.



(K.W. Lee, *Principles of CAD/CAM/CAE System*, 1999)

Viewing Projections

In the parallel projection:

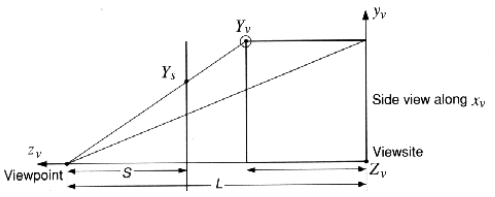
$$x_s = x_v$$

$$y_s = y_v$$

In the perspective projection:

$$X_s = \frac{S}{L - Z_v} X_v$$

$$Y_s = \frac{S}{L - Z_v} Y_v$$

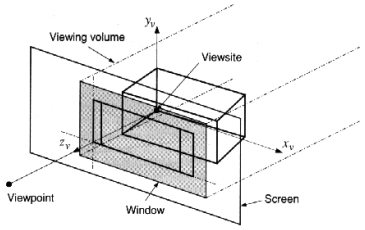


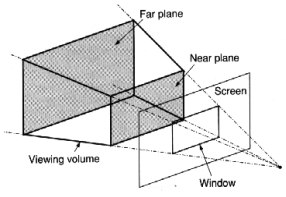
The device coordinates u and v are determined from x_s and y_s by appropriate translation and scaling.

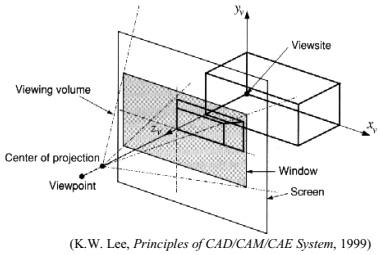
(K.W. Lee, *Principles of CAD/CAM/CAE System*, 1999)

Viewing Window and Viewing Volume

- Elements that would appear outside the "Viewing Window" and are outside of the "Viewing Volume" are not processed.
- The Viewing Window, "Near plane" and "Far plane" determine the Viewing volume.



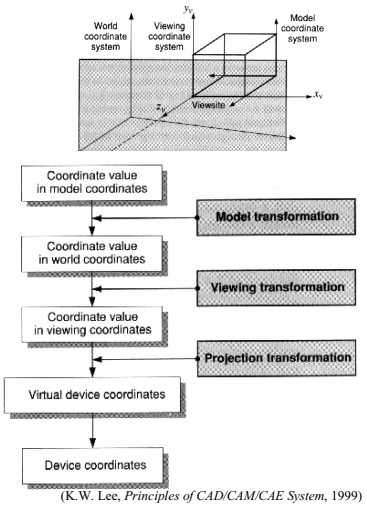




(K.W. Lee, *Principles of CAD/CAM/CAE System*, 1999)

Viewing Transformations

- The positions of shapes, lighting, the viewsite, viewpoint and up direction are given in a "World coordinate system".
- Individual shapes are given in terms of their own "Model coordinate systems".
- It is therefore necessary to perform a series of transformations between coordinate systems.



(K.W. Lee, *Principles of CAD/CAM/CAE System*, 1999)

Types of Display Elements

- **Lines** and **polylines** – with various colors, styles and thicknesses,
- **Polygons** – with various colors, textures and shading options,
- **NURB** freeform surfaces – with various colors, textures and shading options,
- **Markers** (to mark points) – with different symbols (E.g. '+', 'x"), and
- **Text** (2D – in plane of screen, or 3D – on some plane in World Coordinate system and various font sizes and styles).