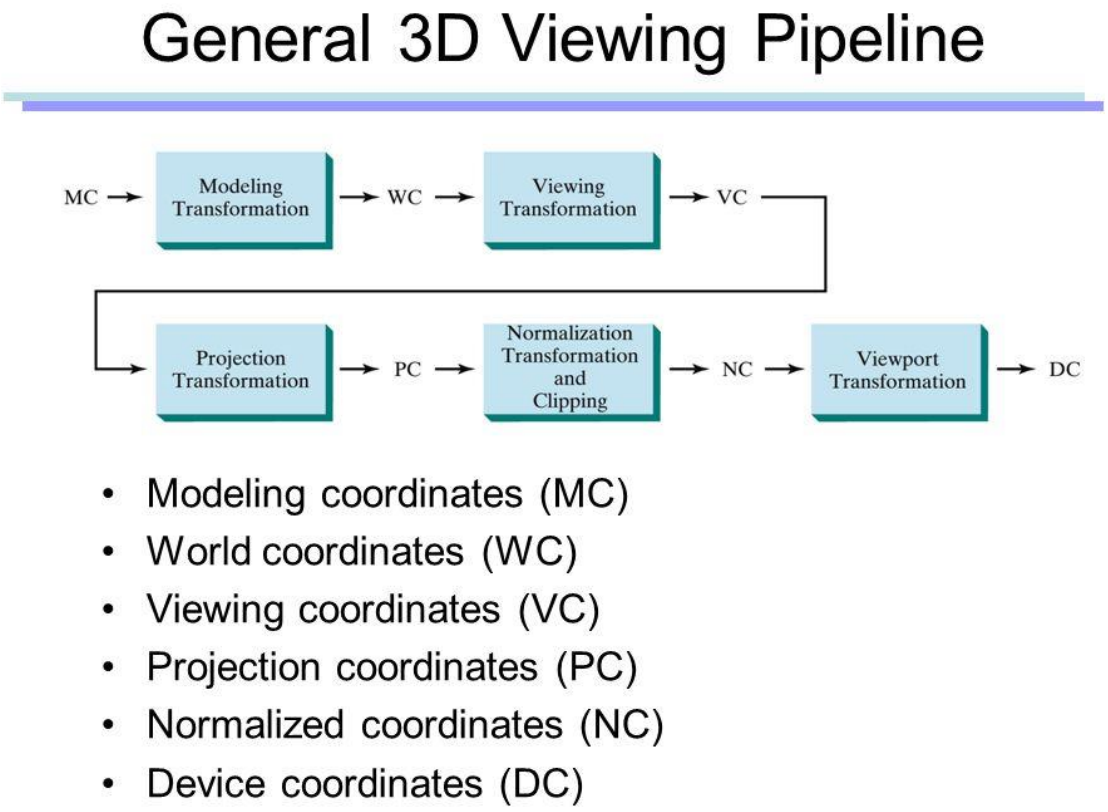
THREE-DIMENSIONAL VIEWING

For three-dimensional applications, first of all, we can view an object from any spatial position: from the front, from above, or from the back. ***Or*** we could generate a view of what we would **see** if we were standing in the middle of a group of objects or inside a single object, such as a building. Additionally, three-dimensional descriptions of objects must be projected onto the flat viewing surface of the output device.



- Modeling coordinates (MC)
- World coordinates (WC)
- Viewing coordinates (VC)
- Projection coordinates (PC)
- Normalized coordinates (NC)
- Device coordinates (DC)

The steps for computer generation of a view of 3D scene are analogous to the process of taking photograph by a camera. For a snapshot, we need to position the camera at a particular point in space and then need to decide camera orientation. Finally, when we snap the shutter, the seen is cropped to the size of window of the camera and the light from the visible surfaces is projected into the camera film.

Projections: Once world co-ordinate description of the objects in a scene are converted to viewing co-ordinates, we can project the three-dimensional objects onto the two-dimensional view plane. There are two basic projection methods:

Parallel projection: In parallel projection, co-ordinates positions are transformed to the view plane along parallel lines.

Prospective projection: In prospective projection, objects positions are transformed to the view plane along lines that converge to a point called projection reference point (centre of projection). The projected view of an object is determined by calculating the intersection of the projection lines with the view plane.

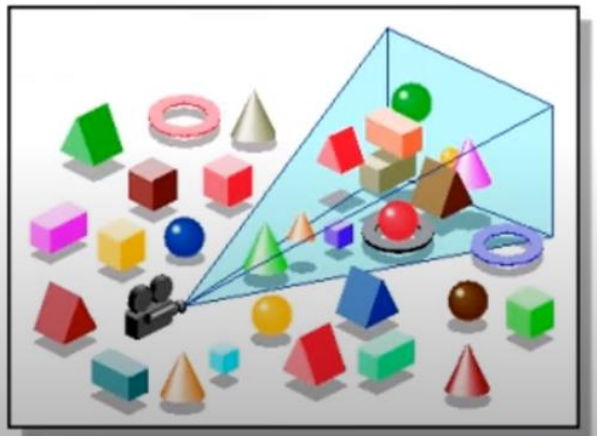
Processing Steps

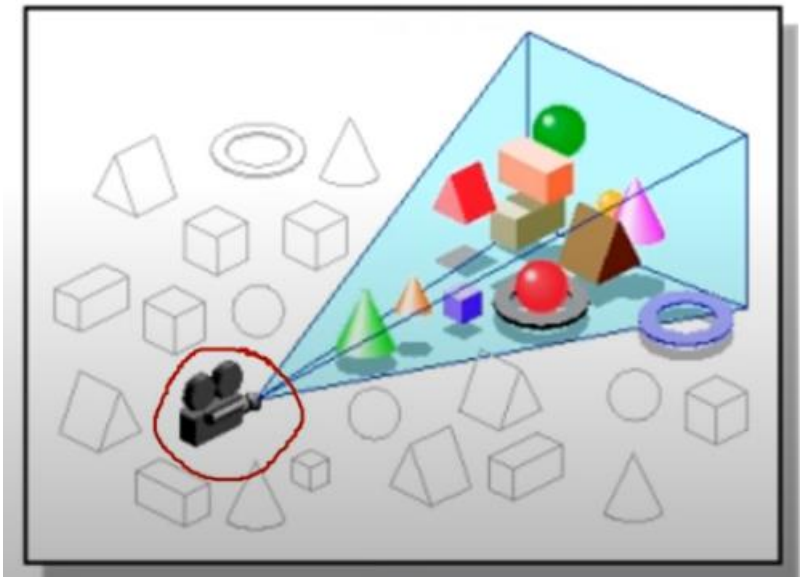
- Once the scene has been model, world coordinates position is converted to viewing coordinates.
- The viewing coordinates system is used in graphics packages as a reference for specifying the observer viewing position and the position of the projection plane.
- Projection operations are performed to convert the viewing coordinate description of the scene to coordinate positions on the projection plane, which will then be mapped to the output device.
- Objects outside the viewing limits are clipped from further consideration, and the remaining objects are processed through visible surface identification and surface rendering procedures to produce the display within the device viewport.

3D clipping

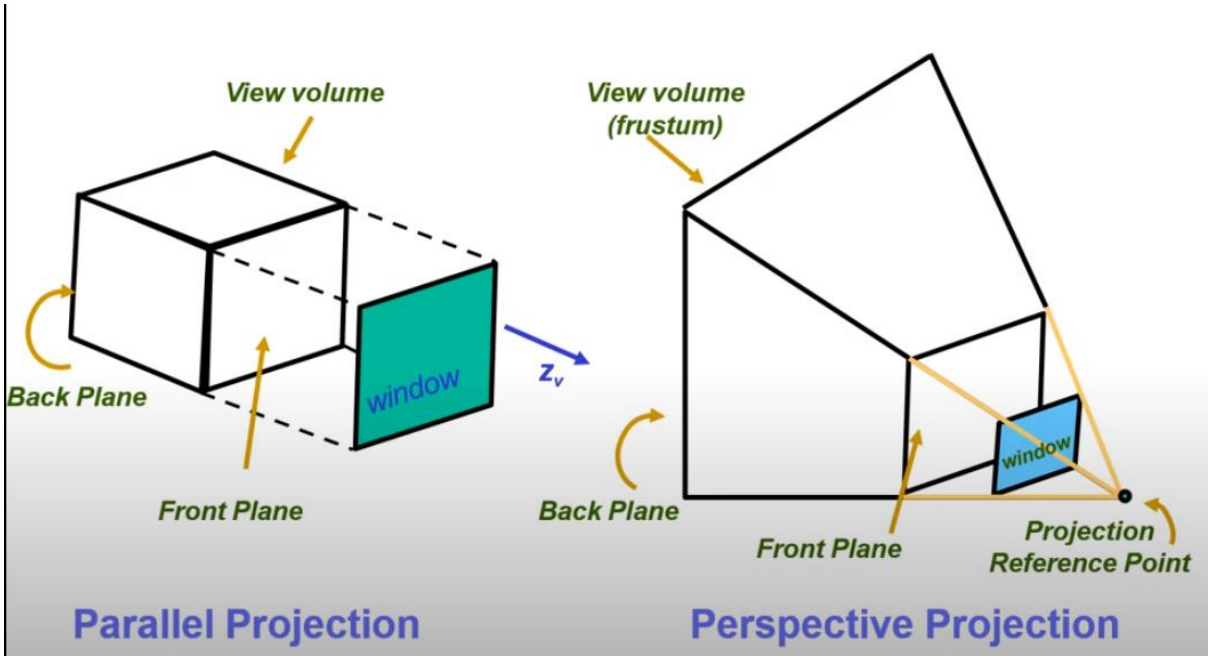
- Just like the case in two dimensions, clipping removes objects that will not be visible from the scene
- The point of this is to remove computational effort
- 3-D clipping is achieved in two basic steps
  - Discard objects that can't be viewed
    - i.e. objects that are behind the camera, outside the field of view, or too far away
  - Clip objects that intersect with any clipping plane

- Discarding objects that cannot possibly be seen involves comparing an objects bounding box/sphere against the dimensions of the view volume
  - Can be done before or after projection

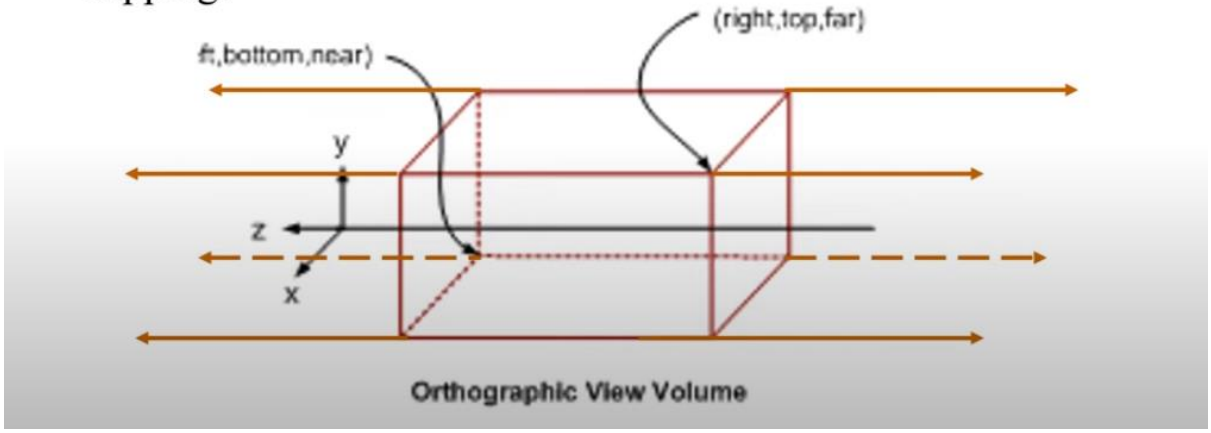




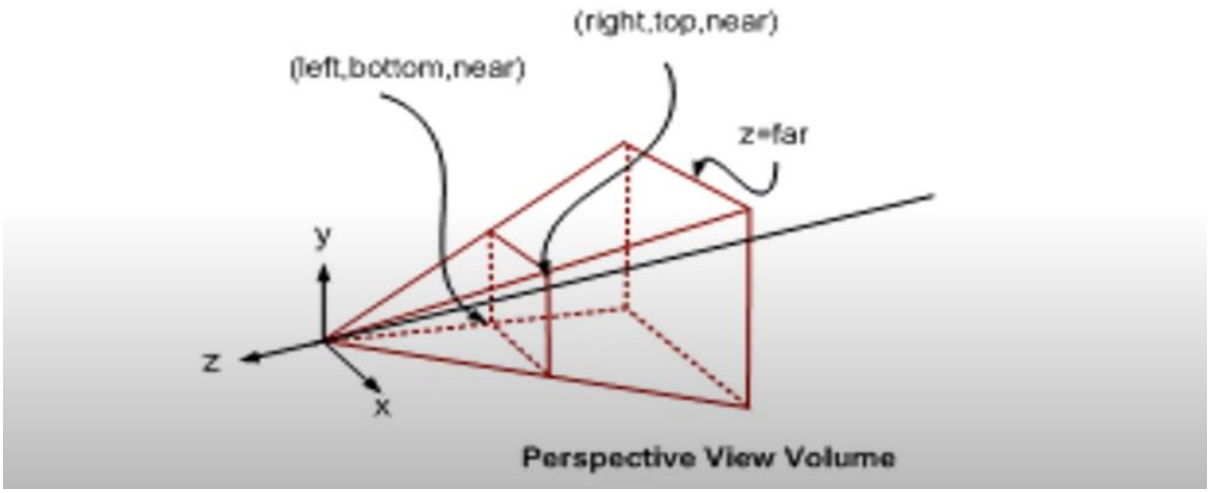
- When a camera used to take a picture, the type of lens used determines how much of the scene is caught on the film.
- In 3D viewing, a rectangular view window in the view plane is used to the same effect. Edges of the view window are parallel to the x_v-y_v axis and window boundary positions are specified in viewing coordinates.



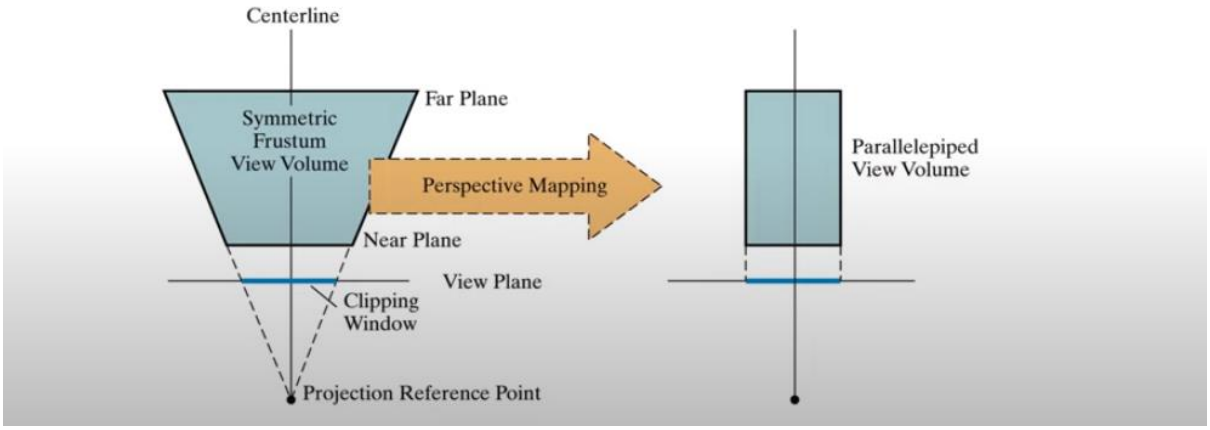
- In case of Parallel projections the infinite Parallelepiped is bounded by Near/front/hither and far/back/yon planes for clipping.



- In case of Perspective projections the semi Infinite Pyramid is also bounded by Near/front/hither and far/back/yon planes for clipping



- After the perspective transformation is complete the frustum shaped viewing volume has been converted to a parallelepiped - remember we preserved all z coordinate depth information



- Because of the extraordinary computational effort required, two types of clipping strategies are followed:
  - **Direct Clipping:** The clipping is done directly against the view volume.
  - **Canonical Clipping:** Normalization transformations are applied which transform the original view volume into normalized (canonical) view volume. Clipping is then performed against canonical view volume.

3D clipping algorithms are direct adaptation of 2D clipping algorithms with following modifications:

1. ***For Cohen Sutherland*:** Assignment of out codes
2. ***For Liang-Barsky:*** Introduction of new equations
3. ***For Sutherland Hodgeman:*** Inside/Out side Test
4. ***In general:*** Finding the intersection of Line with plane.