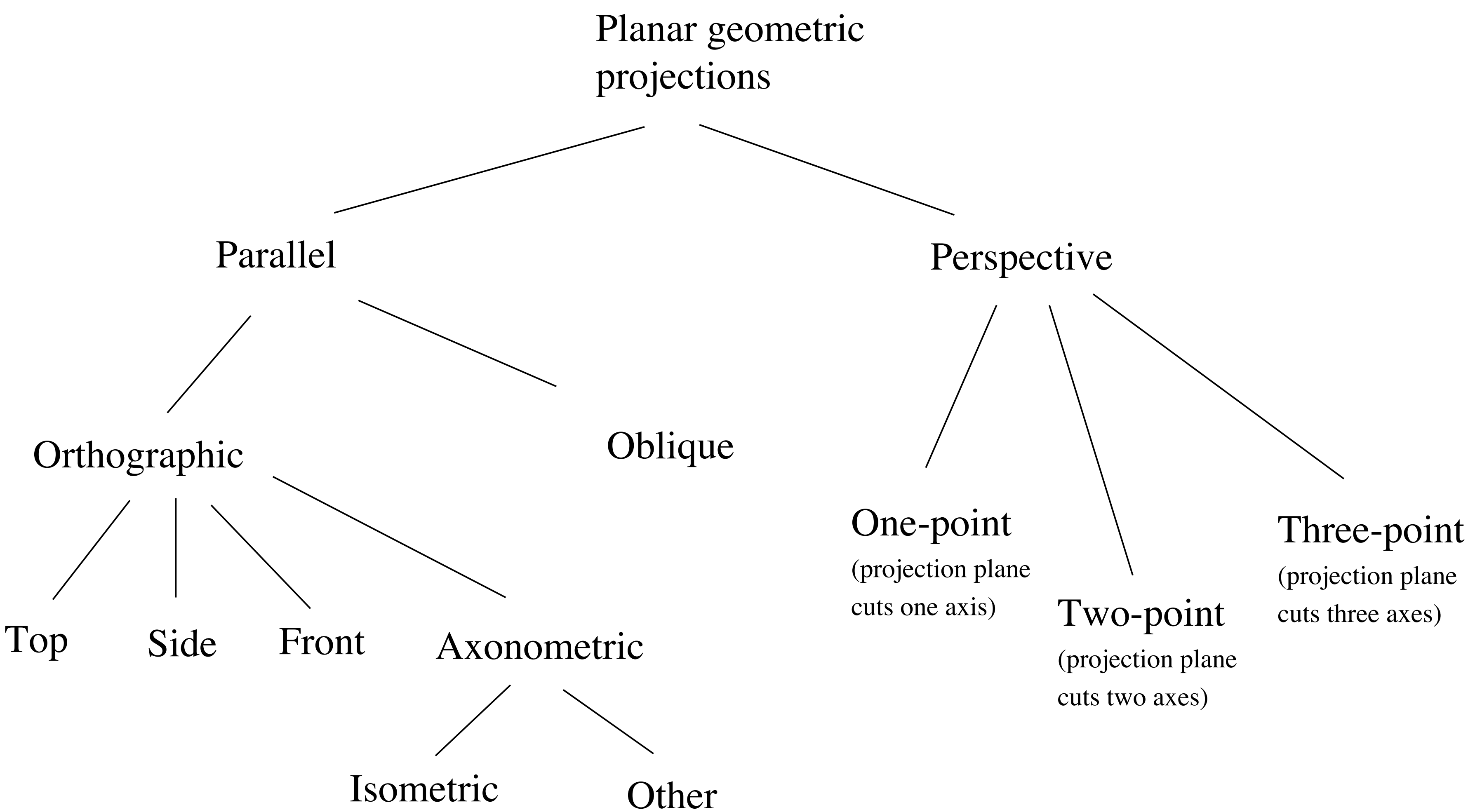
Projection Taxonomy

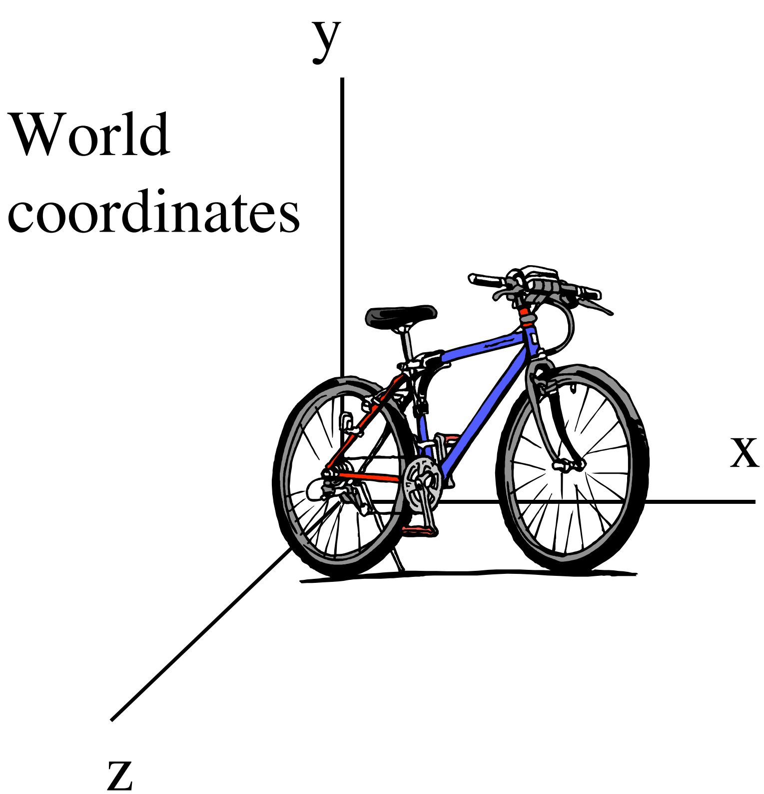


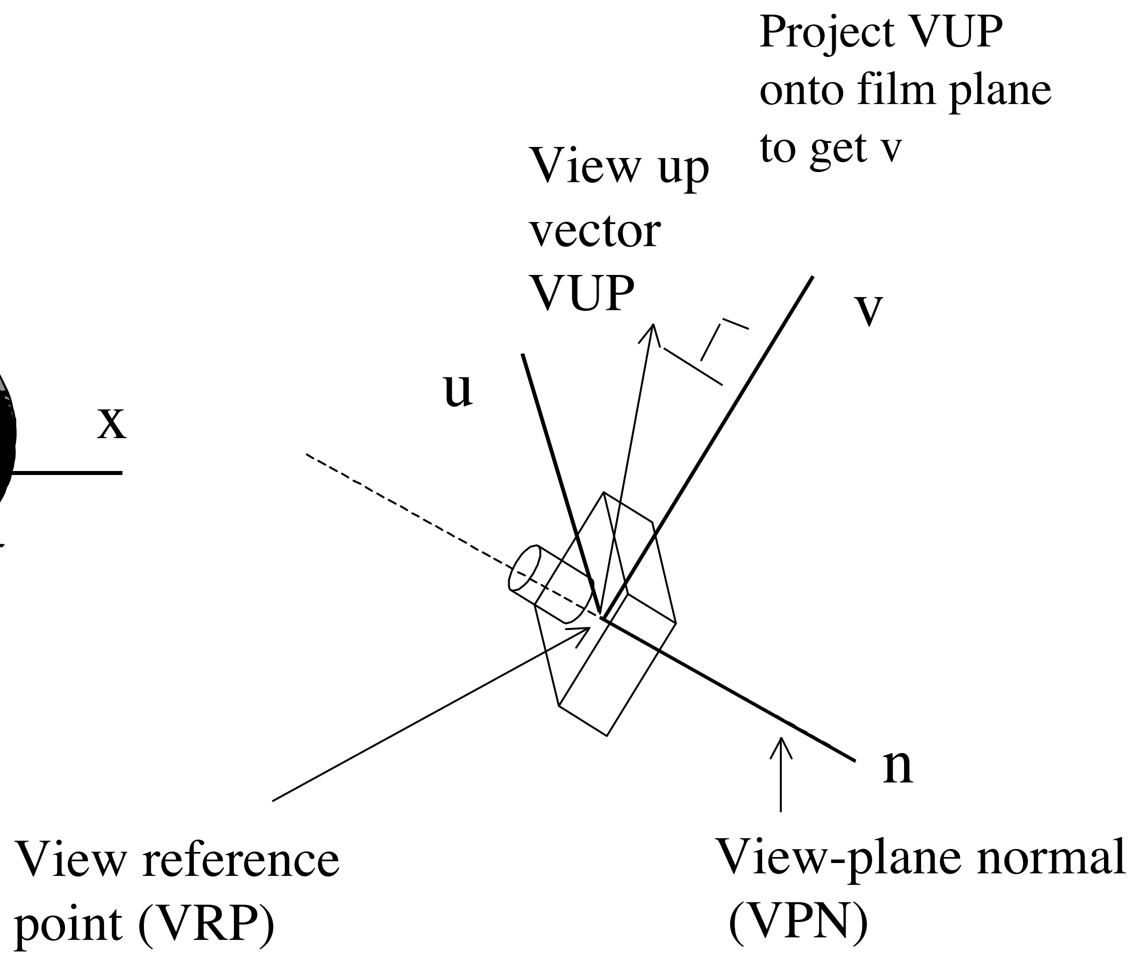
Specifying a camera

- Camera
  - Tell rendering system where camera is in world coordinates
  - Need to specify focal point and film plane.
  - Convenient to construct a coordinate system for the camera with origin on film plane

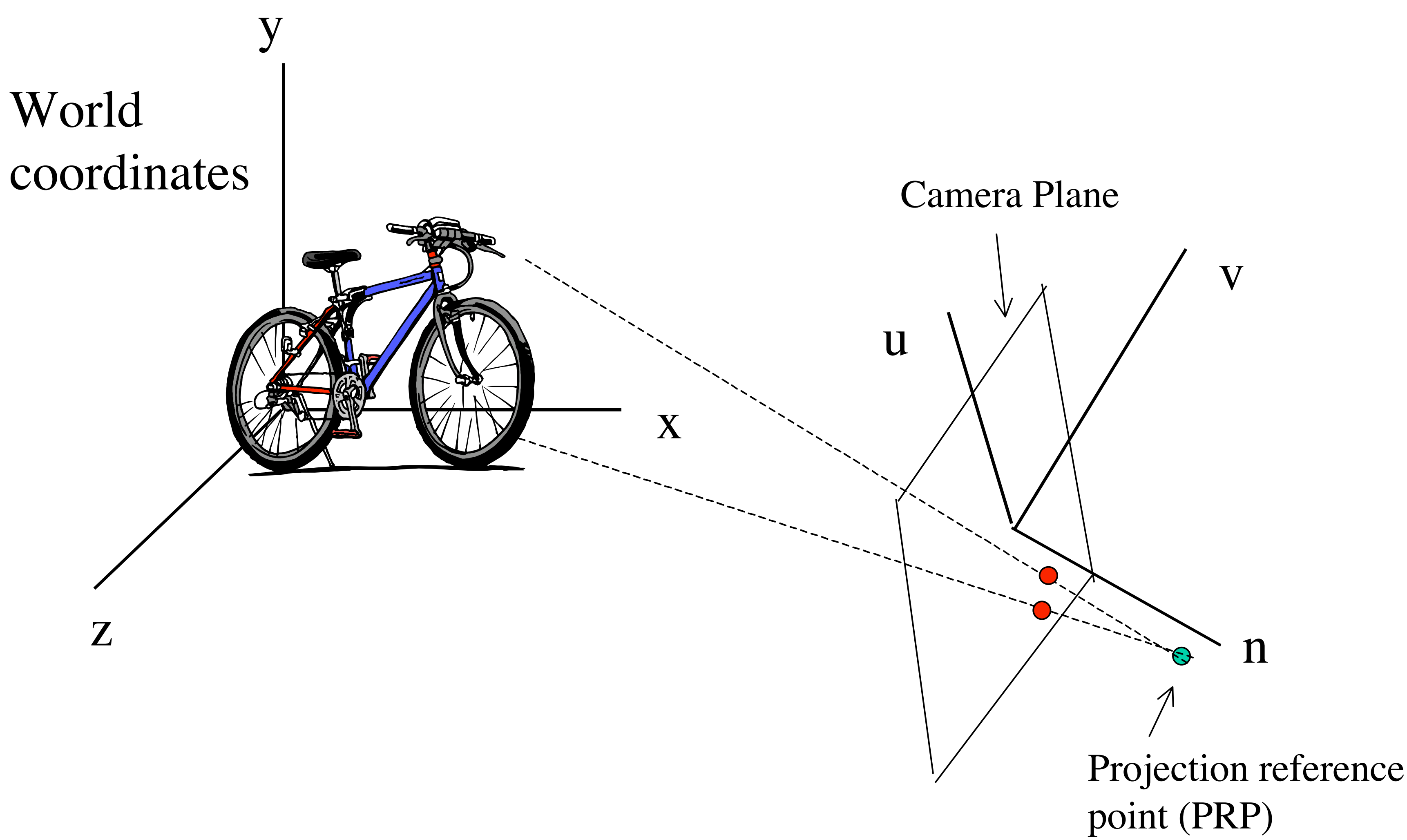
- Clipping volume
  - we render only a window in the film plane
  - Things beyond any of four sides don’t get rendered
  - Things that are too far away don’t get rendered
  - Things that are too near don’t get rendered.

Specifying a camera

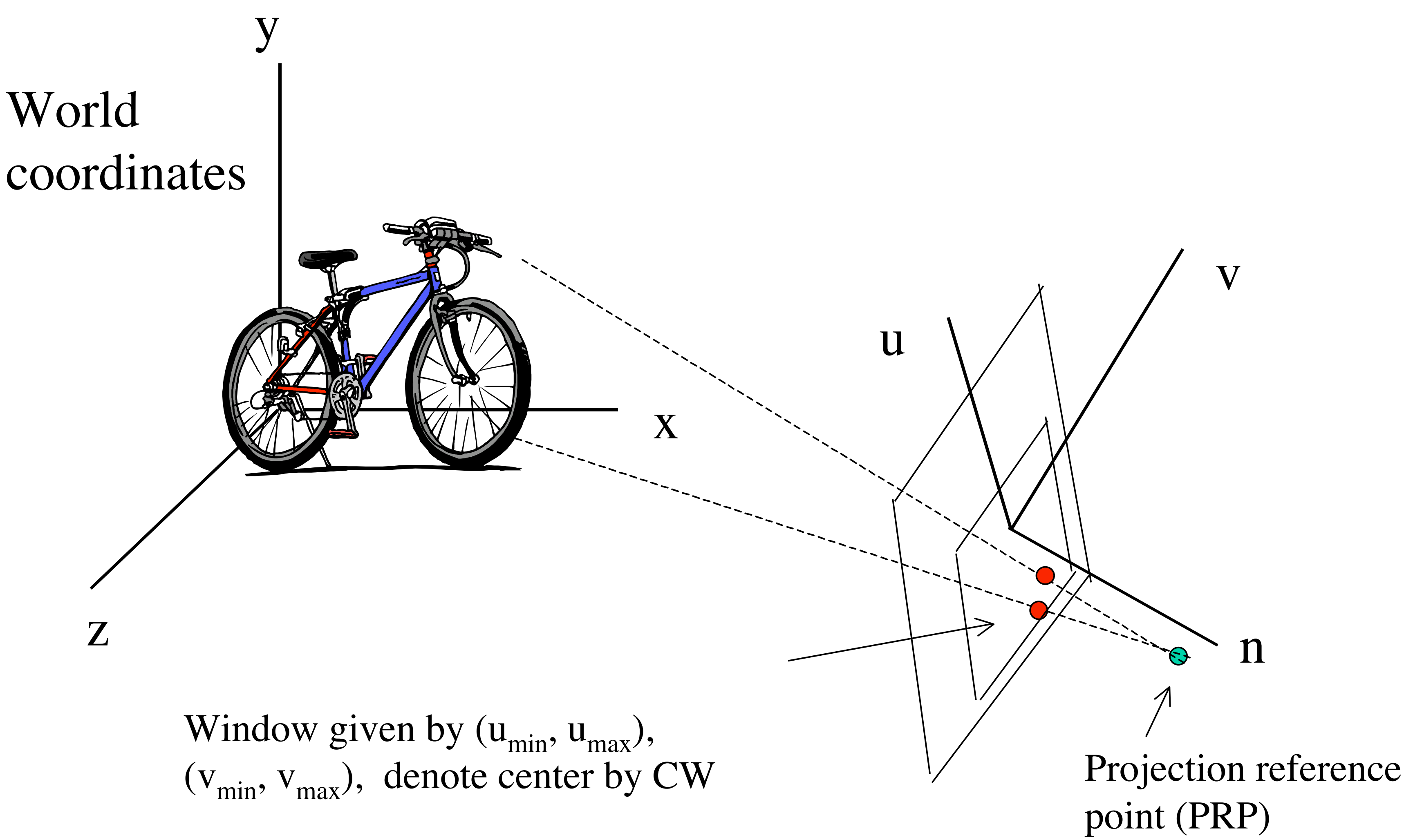




Specifying a camera



Specifying a camera

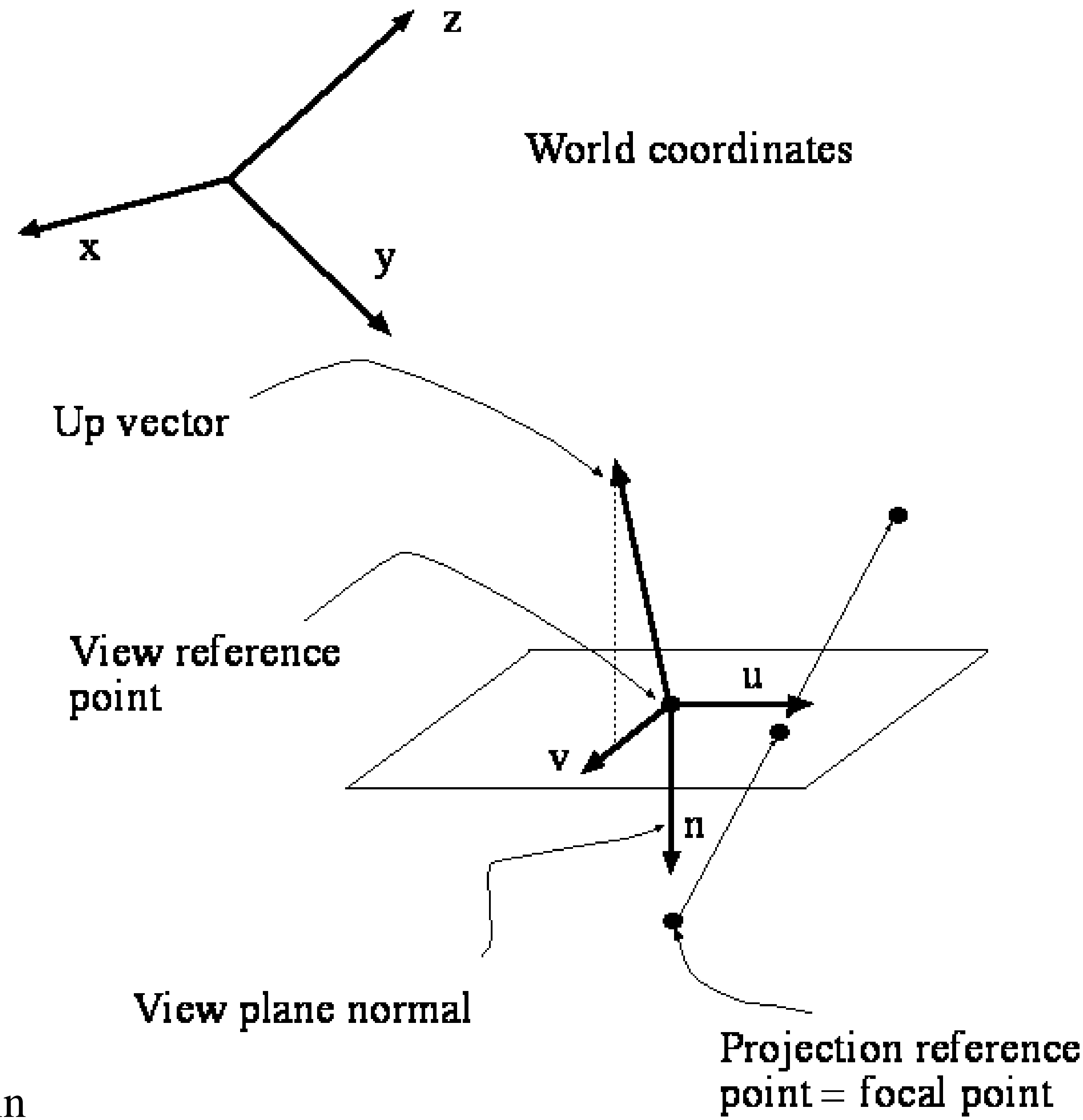


View reference point
and view plane normal
specify film plane.

Up vector gives an “up”
direction in the film plane.
vector v is projection of
up vector into film plane
(= **n** ⎣VUP ⎕ **n**).

u is chosen so that (u, v, n)
is a right handed coordinate
system; i.e. it is possible to
rotate (x->u, y->v, z->n)
(and we’ll do this shortly).

VRP, VPN, VUP must be in
world coords; PRP could be in
world coords or in camera coords

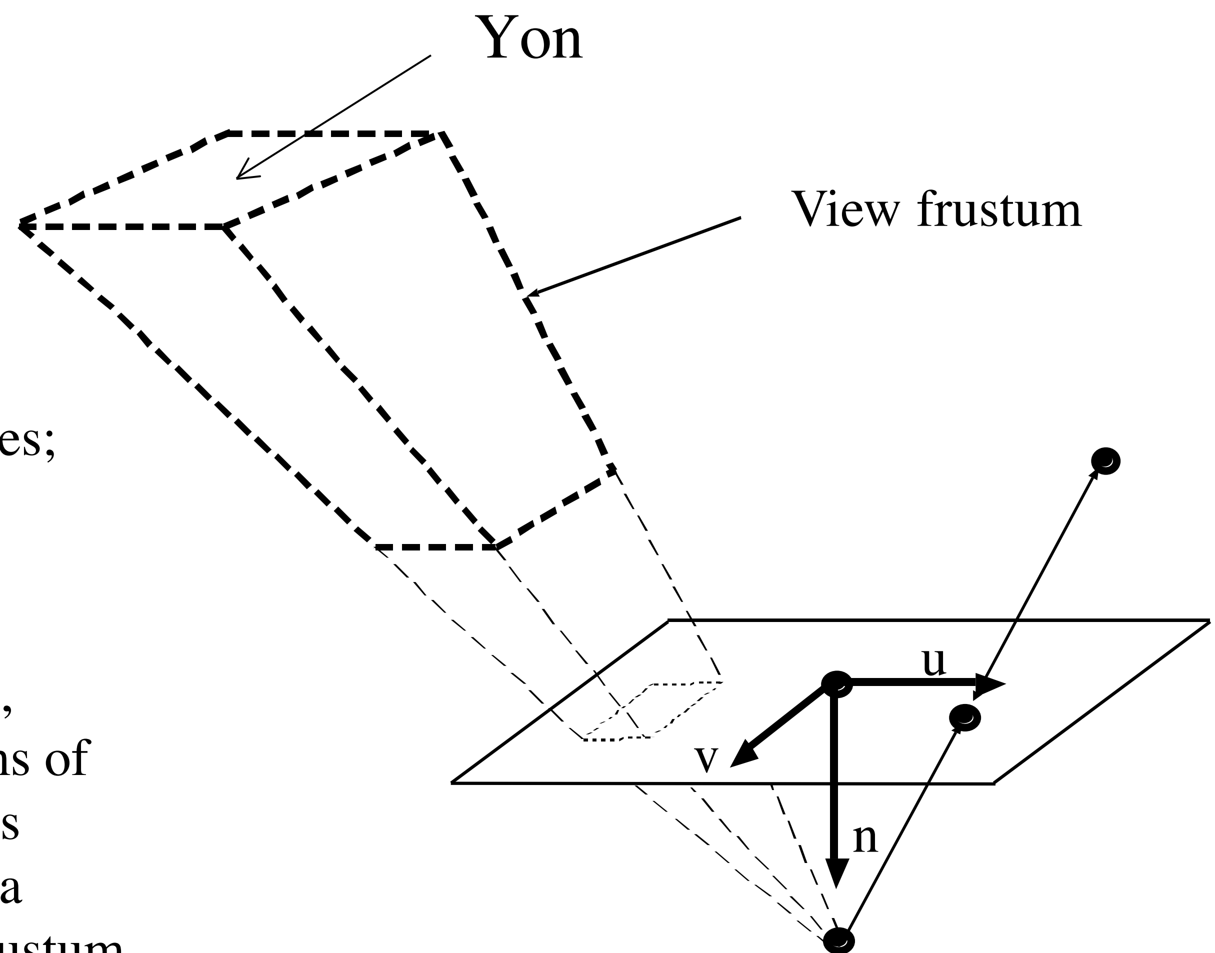


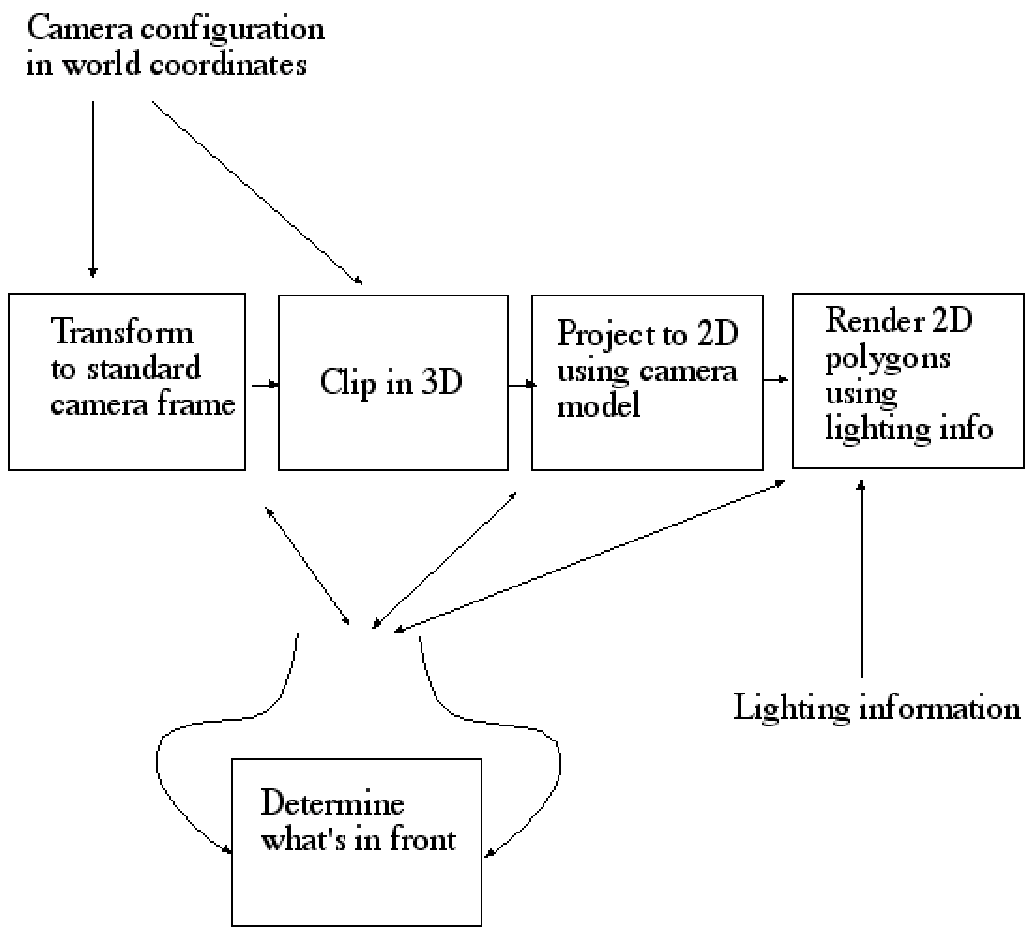
U, V can be used to specify a window in the film plane; only this section of film ends up on the screen.

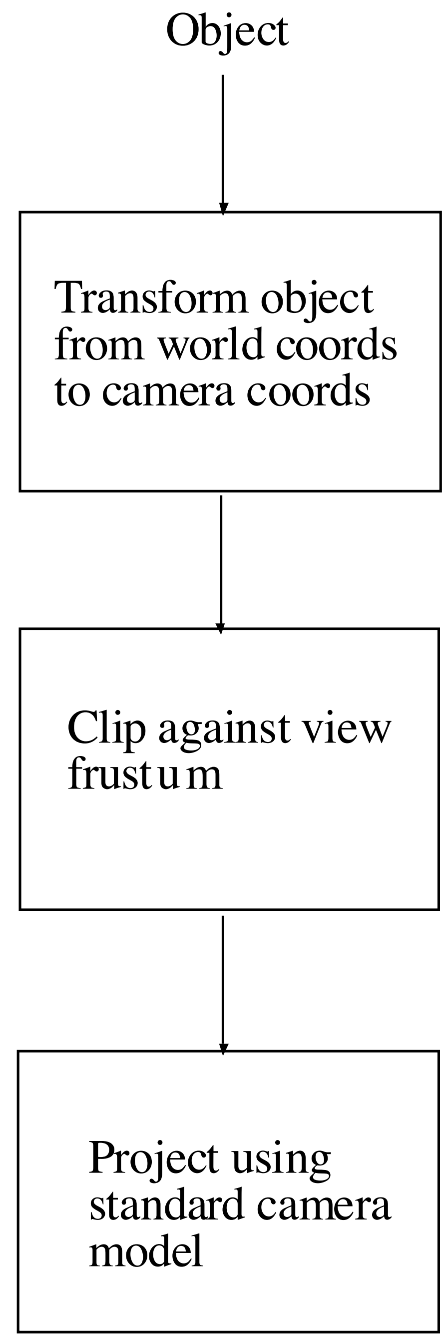
This window defines four planes; points outside these planes are not rendered.

Hither and yon clipping planes, which are always given in terms of camera coordinates, and always parallel to the film plane, give a volume - known as the view frustum.

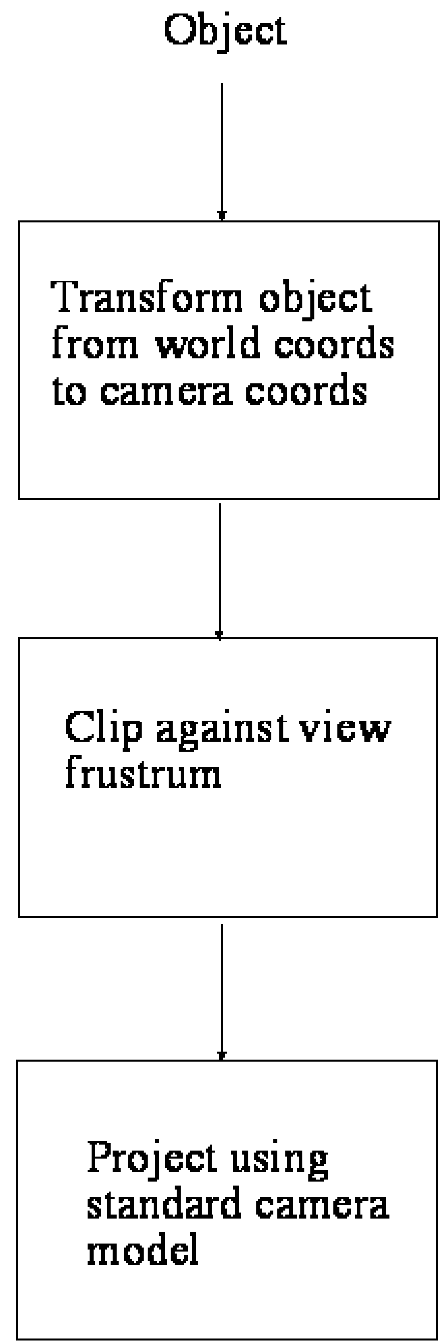
Orthographic case: - view frustum is cuboid (i.e. all angles right angles, but edges not necessarily of equal length).



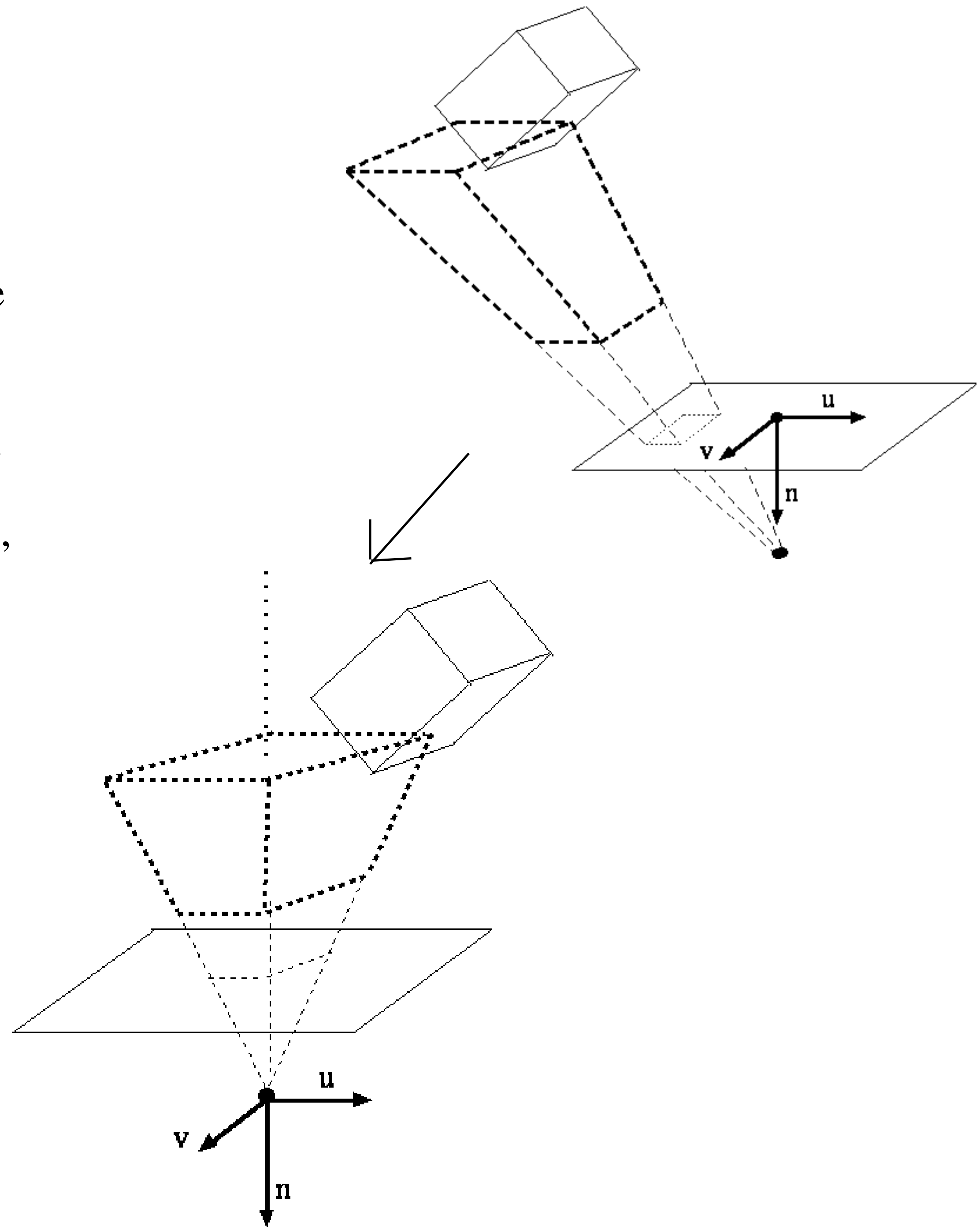

Camera configuration
in world coordinates
Transform
to standard
camera frame
Clip in 3D
Project to 2D
using camera
model
Render 2D
polygons
using
lighting info
Lighting information
Determine
what's in front


Object
Transform object
from world coords
to camera coords
Clip against view
frustum
Project using
standard camera
model

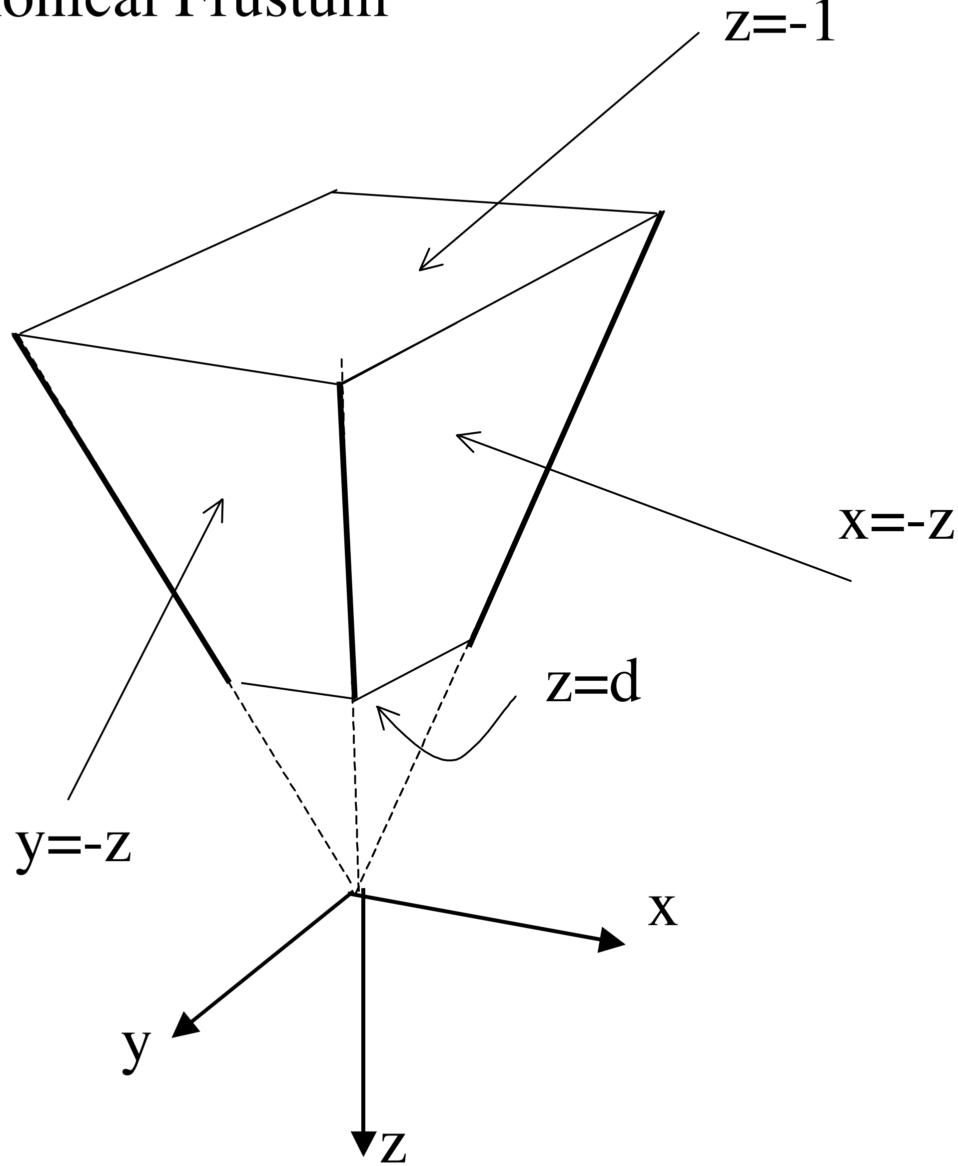
- Advantages of clipping against view frustrum:
  - Don't project objects that aren't drawn
  - cf. clip against hither/yon, project, clip against window in film plane
  - hence slightly less work.
- Advantage of clipping in camera frame (rather than in world frame):
  - Better supports transform to standard view frustrum, where clipping is easiest.
- Advantage of transforming to camera frame:
  - Easiest to compute the effects of the camera in this frame.

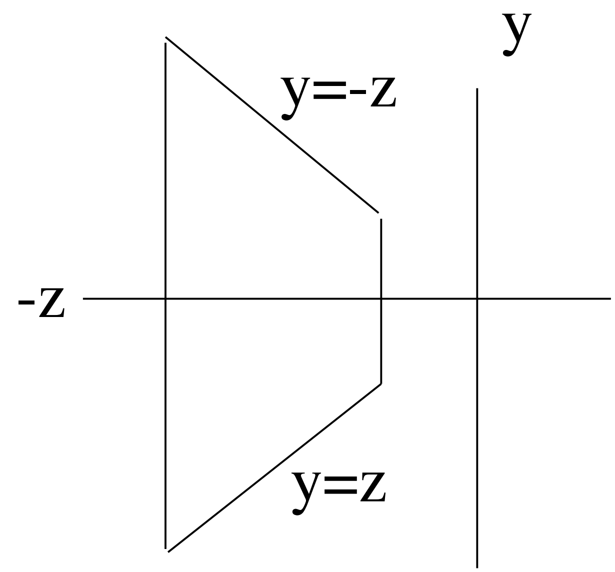


- If we clip against the frustum blindly, clipping is hard - this is because planes bounding the frustum have a complex form
- Thus, to test in/out, must test the sign of a x + b y + c z +d for some a, b, c, d - much worse than a simple compare.
- Solution: transform view frustrum into a canonical form, where clip planes have easy form - e.g. z=x, z=-x, z=y, z=-y, z=-1, z=d



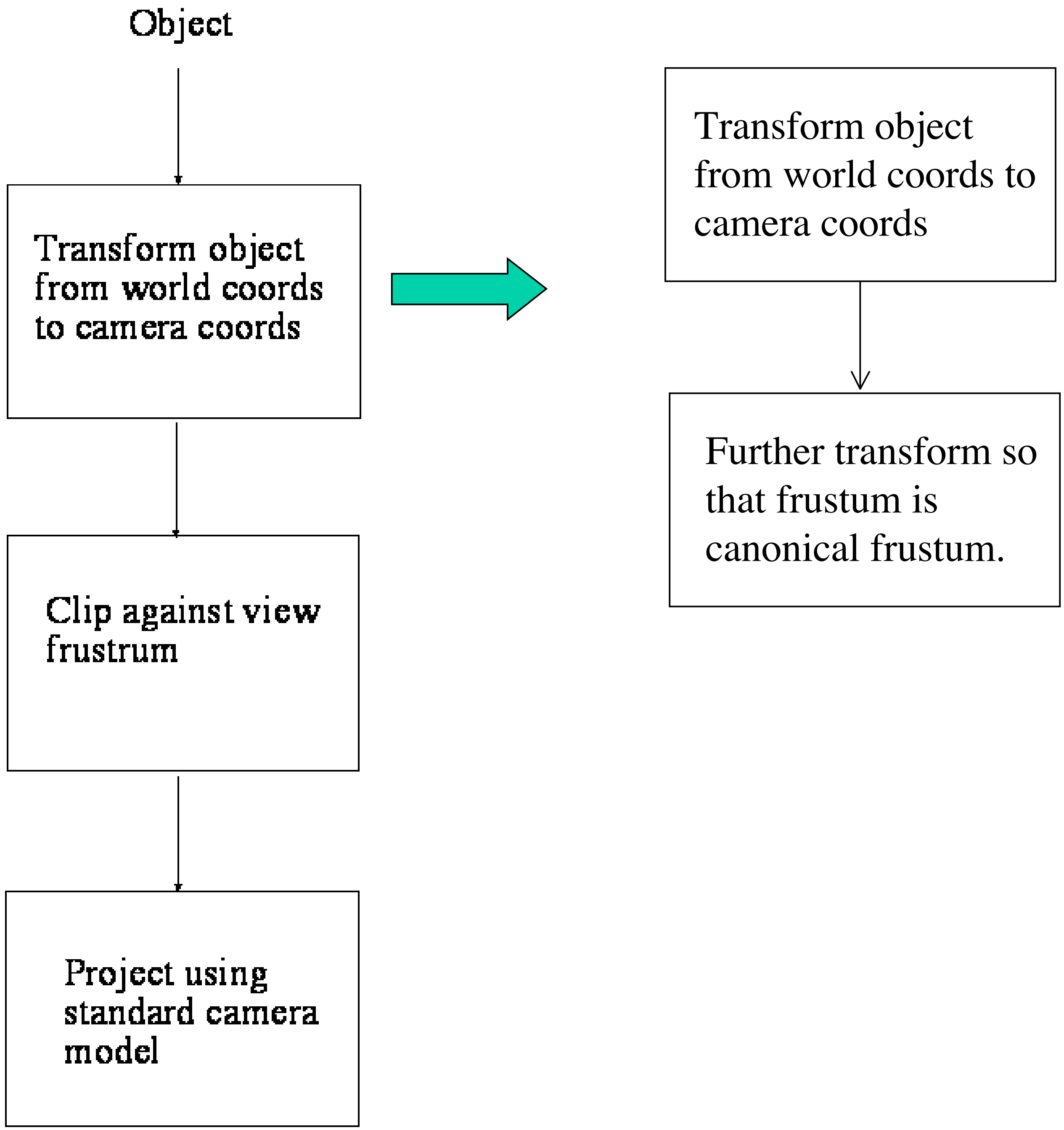
Canonical Frustum





If image plane transforms to z=m then in new frame, projection is easy:

(x, y, z) -> (m x /z, m y/z)


Object
Transform object from world coords to camera coords
Clip against view frustrum
Project using standard camera model
Transform object from world coords to camera coords
Further transform so that frustum is canonical frustum.

Transform object from world coords to camera coords

Step 1. Translate VRP to world origin. Call this T_1. T_1 maps world points (note opposite transformations for object and coordinate frame).

Transform object from world coords to camera coords

Step 2. Rotate camera coordinate frame so that u is x, v is y, and n is z. The matrix is ?

Transform object
from world coords to
camera coords

Step 2. Rotate camera coordinate frame so that u is x, v is y, and n is z. The matrix is:

$$\begin{vmatrix} u^T & 0 \\ v^T & 0 \\ n^T & 0 \\ 0\ 0\ 0 & 1 \end{vmatrix}$$

(why?)