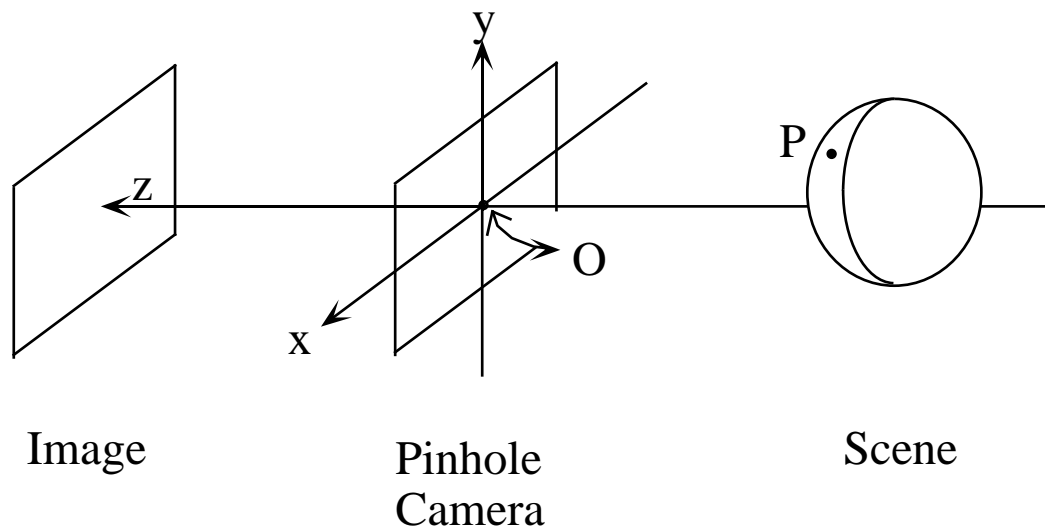


## Projections of 3-D Scenes onto a 2-D Plane

We draw a cube: how do we come up with the projection?

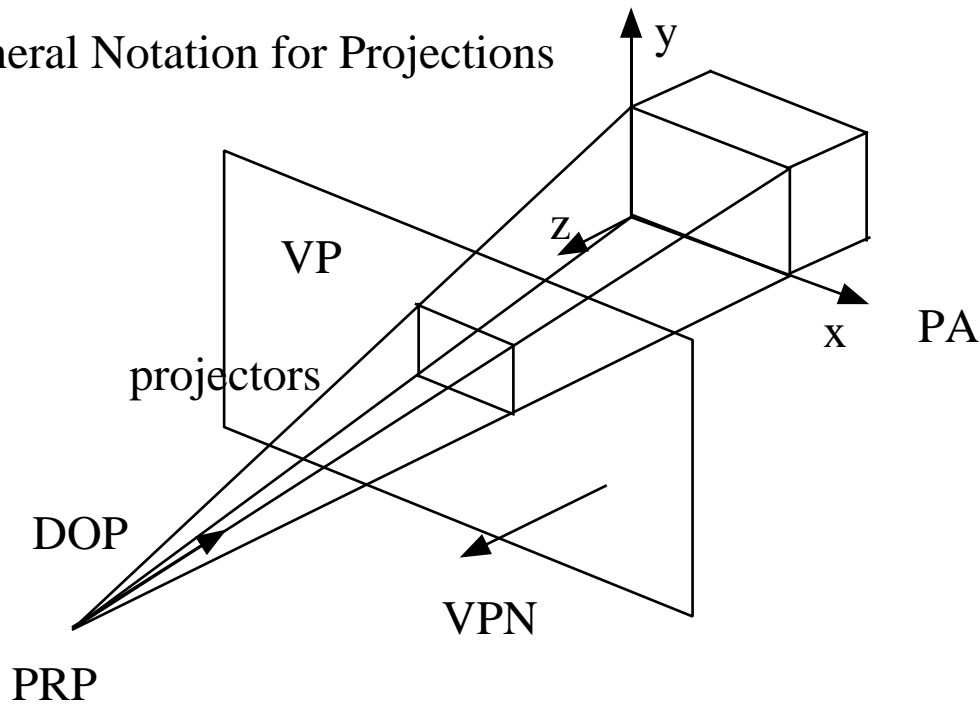
We photograph a scene: how does the light reflected from the scene via the lens form the projection?  
(see figure)



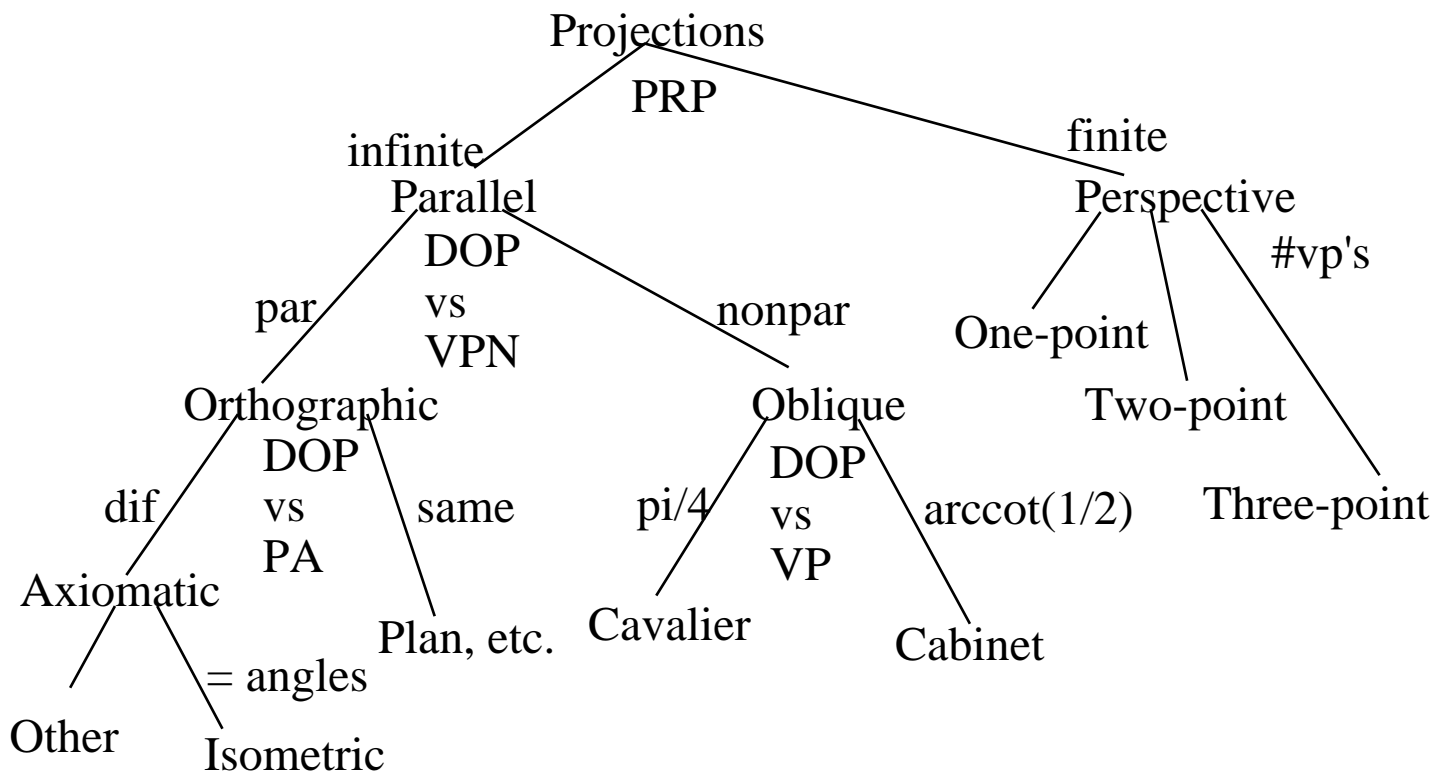
Ideal Camera: Pinhole Camera

Where does point  $P$  in the scene project to in the image?

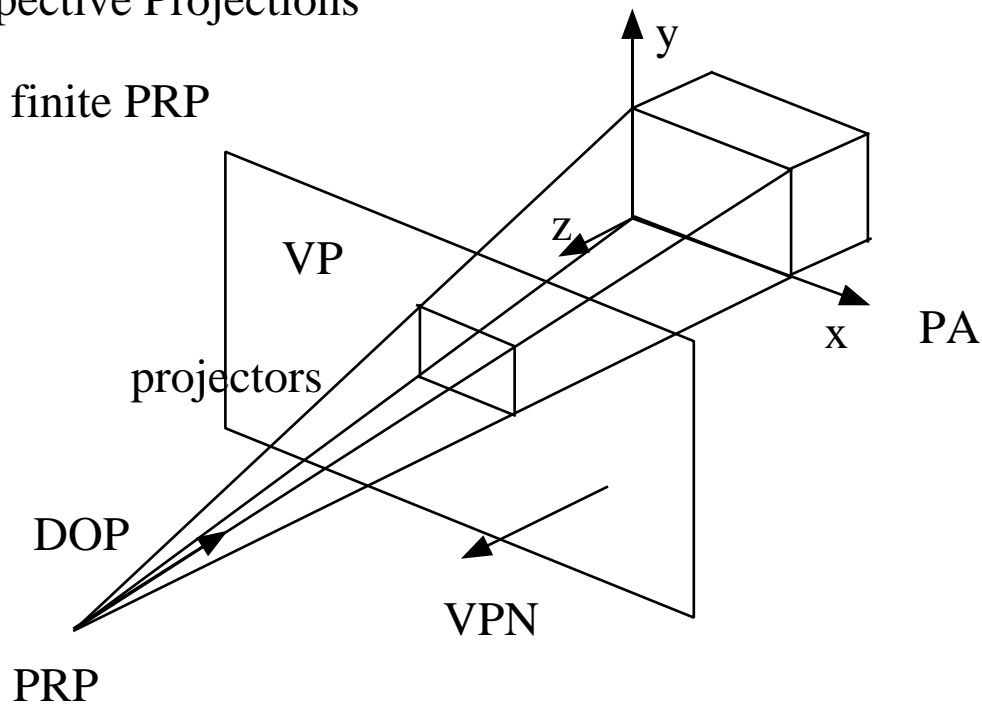
## General Notation for Projections



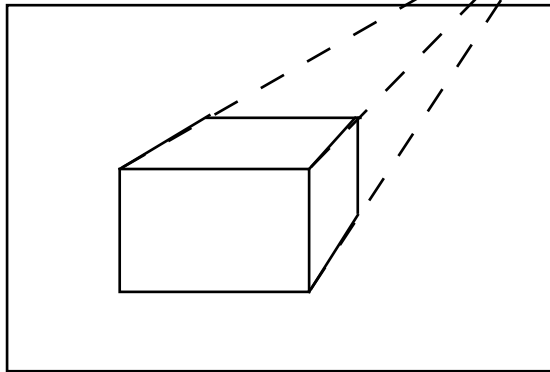
PA	principle axes of the scene
VP	view plane (projection plane)
VPN	view plane normal (projection plane normal)
PRP	projection reference point (center of projection)
DOP	direction of projection



## Perspective Projections



What does projection look like?  vanishing point



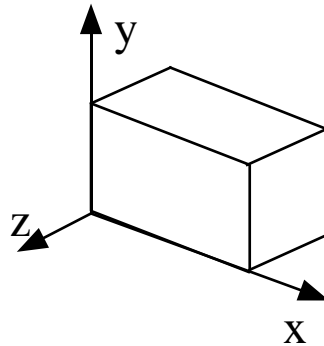
How get more than one vanishing point?

It's a function of the relation between the principle axes and the viewing plane.

Number of vanishing points = number of principle axes cut by viewing plane

How get two-point perspective?

Usually cut x and z axes



Where place view plane?

(see figure for projection)

Three-point perspective

Cut all three principle axes

Not used much, as doesn't increase realism

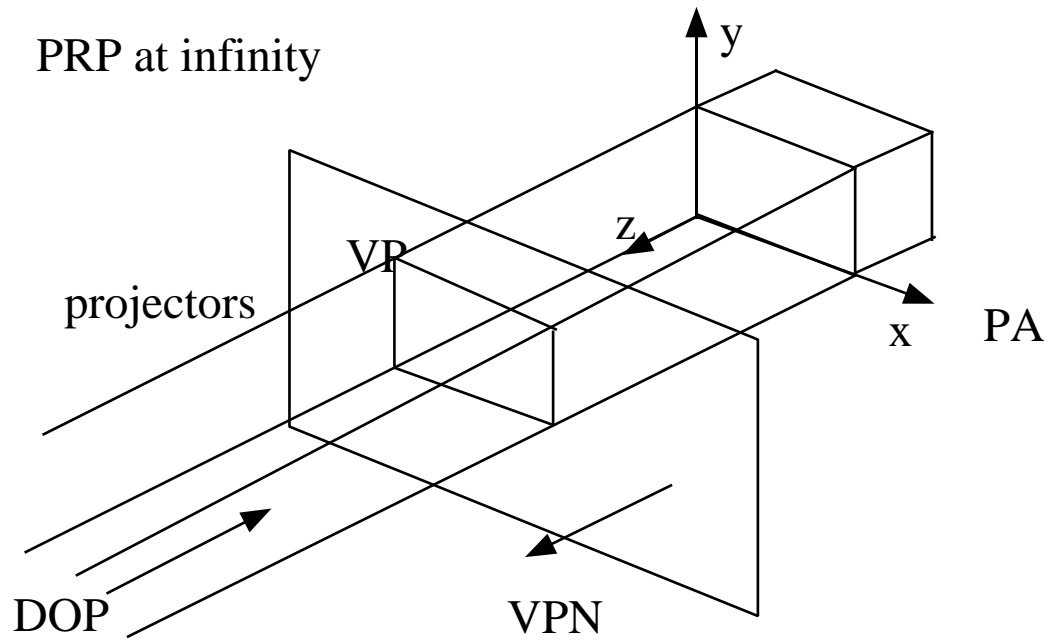
Relation between SLR cameras and perspective projections

How does photographer determine which projection?

How to get one-point perspective image of class?  
two-point?  
three-point?

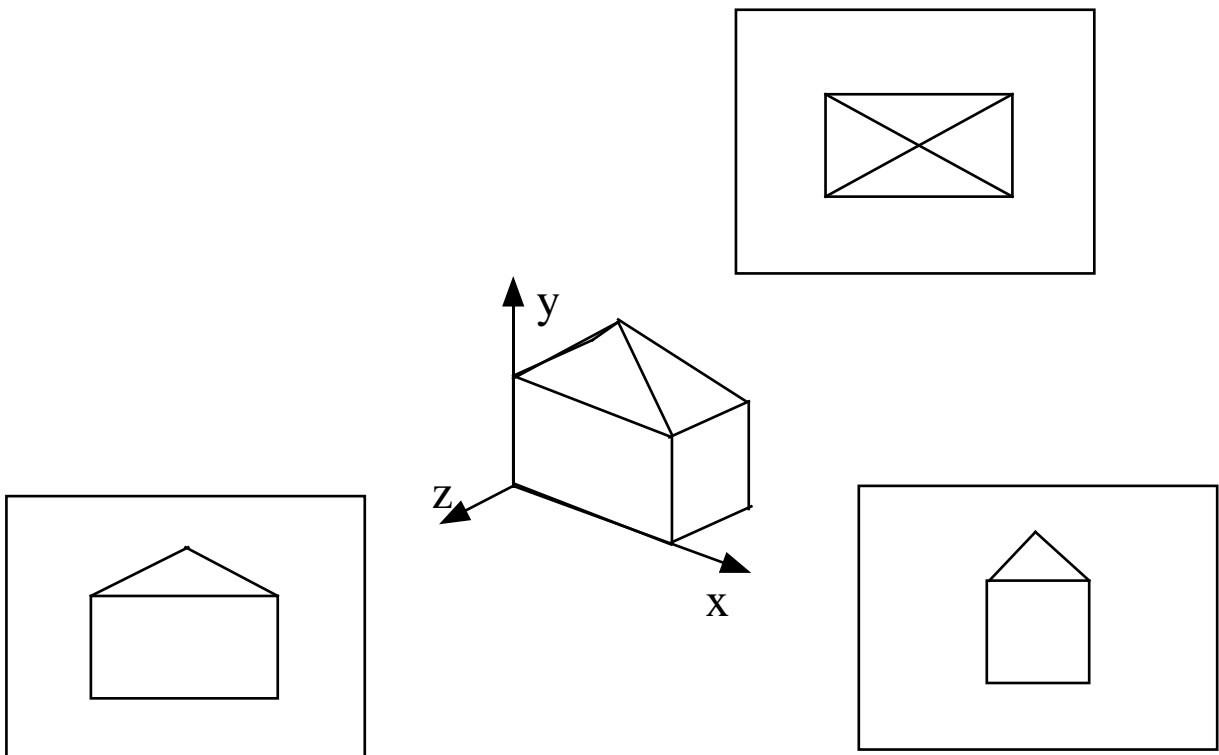
We view (our visual systems) with perspective projections  
distant objects smaller  
perspective foreshortening

# Parallel Projections



Which parallel projection does this depict?

Plan, front elevation, side elevation

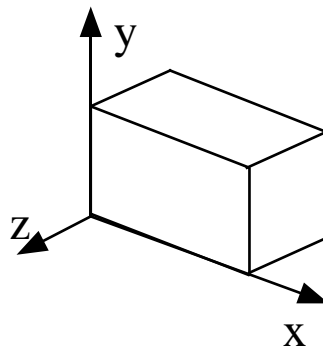


## Axiomatic Projections

DOP not aligned with a principle axis

## Isometric Projection

DOP makes equal angles with each principle axis

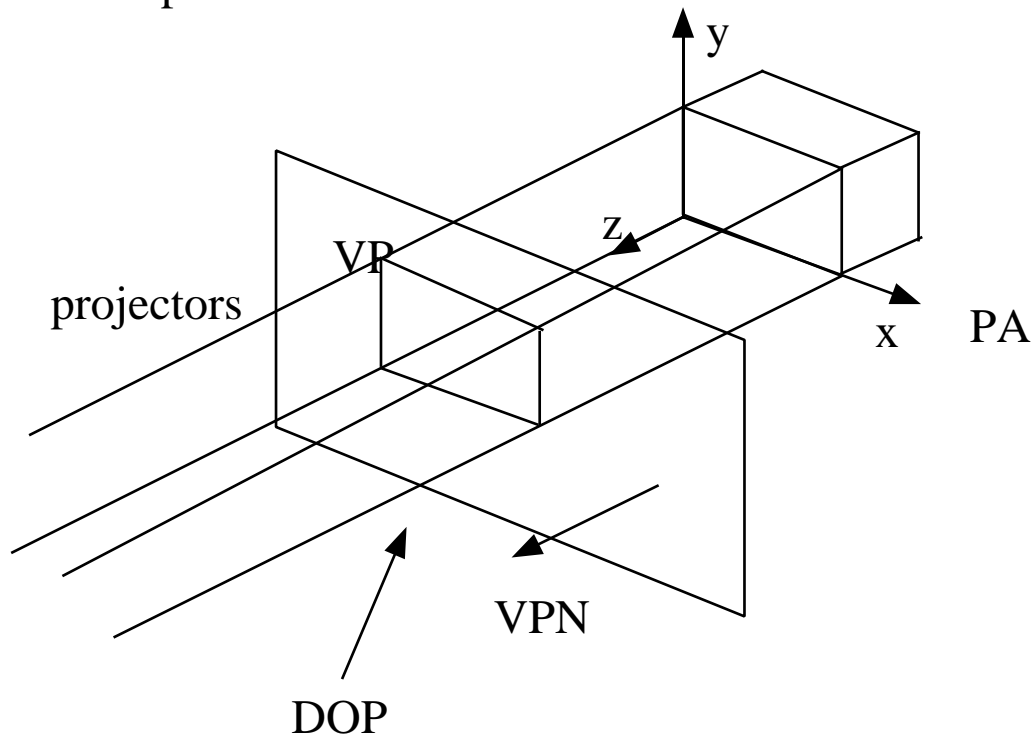


What would DOP be here?

What would the projection look like?

## Oblique Projections

DOP is not parallel to VPN

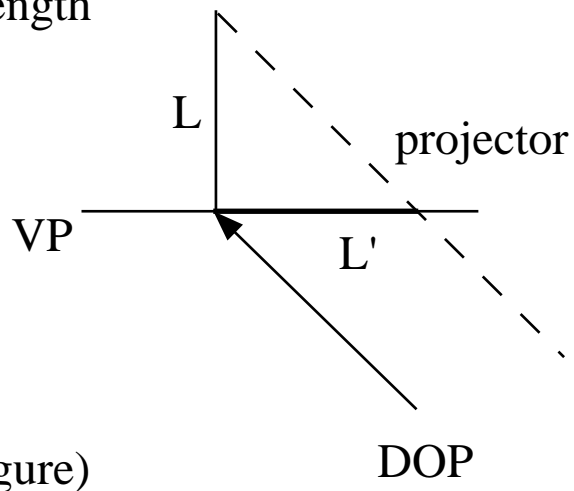


## Cavalier Projection

DOP forms 45 degree angle with VP

Does this fully specify DOP?

All lines perpendicular to the VP are projected with no change in length

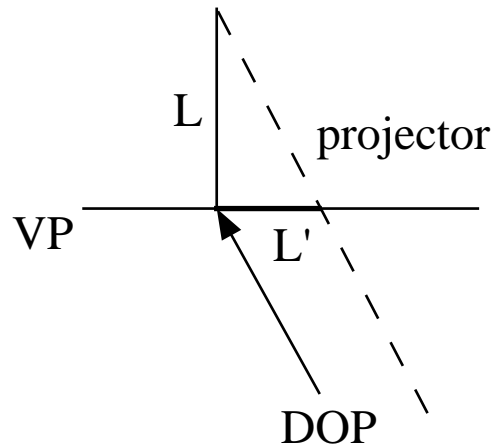


(see figure)

## Cabinet Projections

DOP makes an angle of  $\text{arccot}(1/2)$  with VP

Lines perpendicular to the VP are projected at half length



angle  $\approx 63.4$  degrees

(see figure)

## Specification of an Arbitrary 3-D View

Need not only projection, but also the view volume

(see figure)

Must specify window on the VP

Must specify front and back (hither and yon) planes

Commonly use a rectangular window

What window shape used by SLR camera?

What shape view volume?

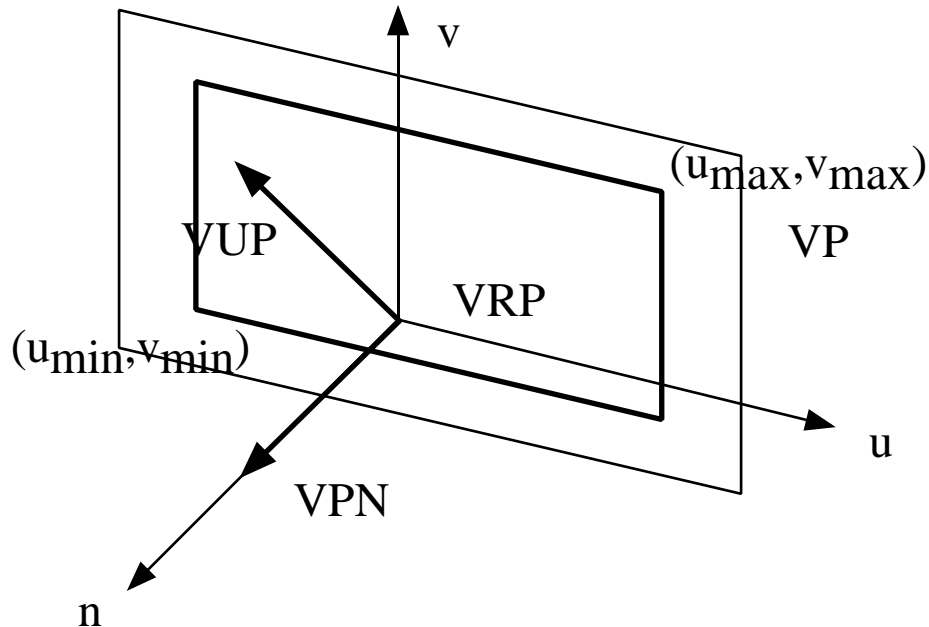
What window shape used by eye?

What shape view volume?



Assume rectangular window

What do we need to specify for rectangular window?



First form viewing reference coordinate (VRC) system

Assign some point in the plane to be its origin

Call it the viewing reference point (VRP)

VPN and origin specify the  $n$  axis

VUP (view-up vector) defines  $v$  axis, as the projection of VUP onto VP

(projection in VPN-VUP plane)

$u$  axis is perpendicular to  $v$  and  $n$  axes

Now can specify window

$v$  and  $u$  axes are the principle axes of the window

define window by  $(u_{\max}, v_{\max})$  and  $(u_{\min}, v_{\min})$

How get a rotated window?

Note center of window (CW) not necessarily at VRP

