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Maneuvers

Everything About Eights-on-Pylons

More than Rote Understanding

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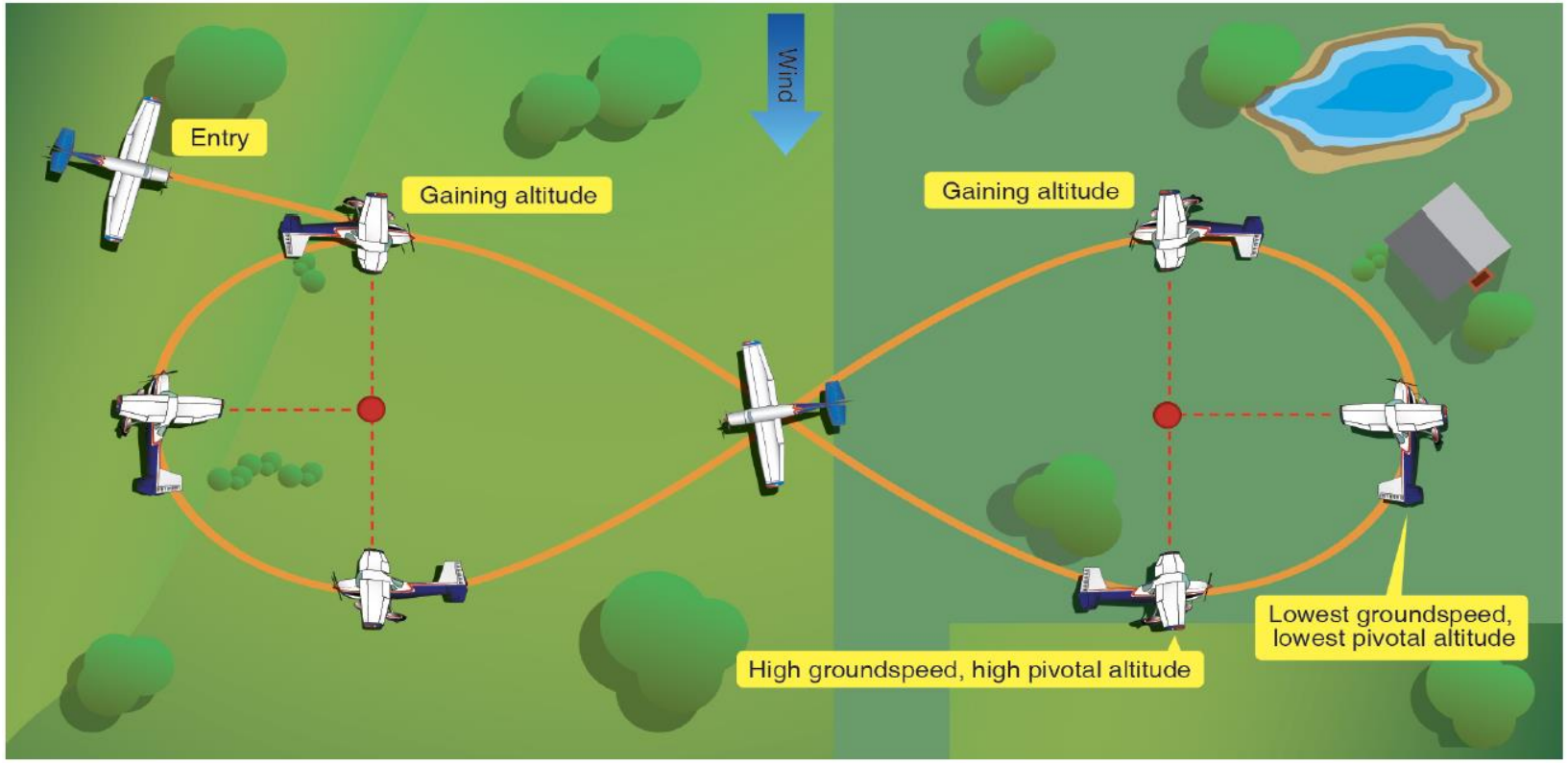
What is the maneuver “Eights-on-Pylons?”



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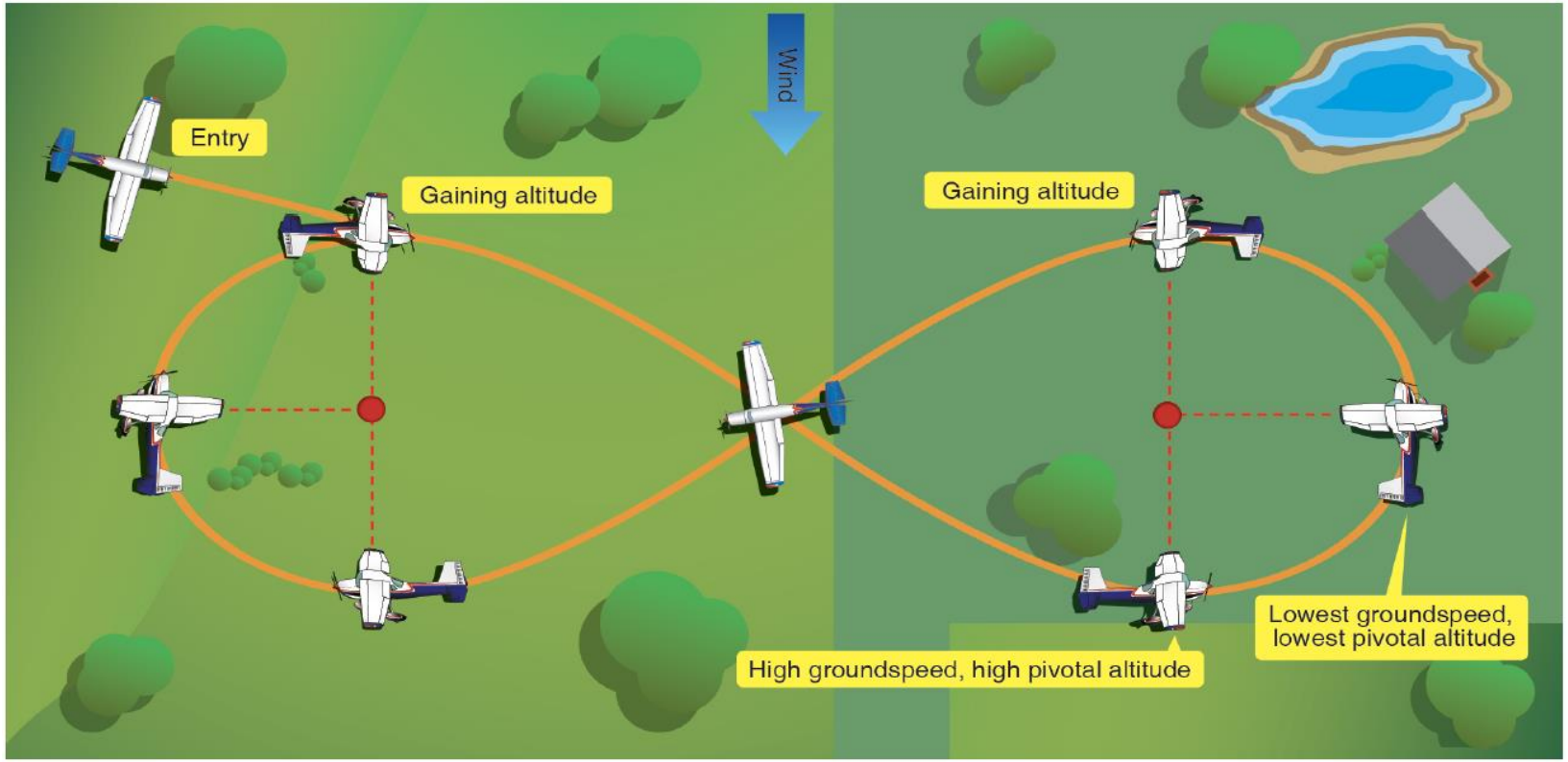
Eights-on-Pylons – A comprehensive analysis

Perform two turns in a figure eight pattern that keeps the pilot's line of sight on the pylon when turning



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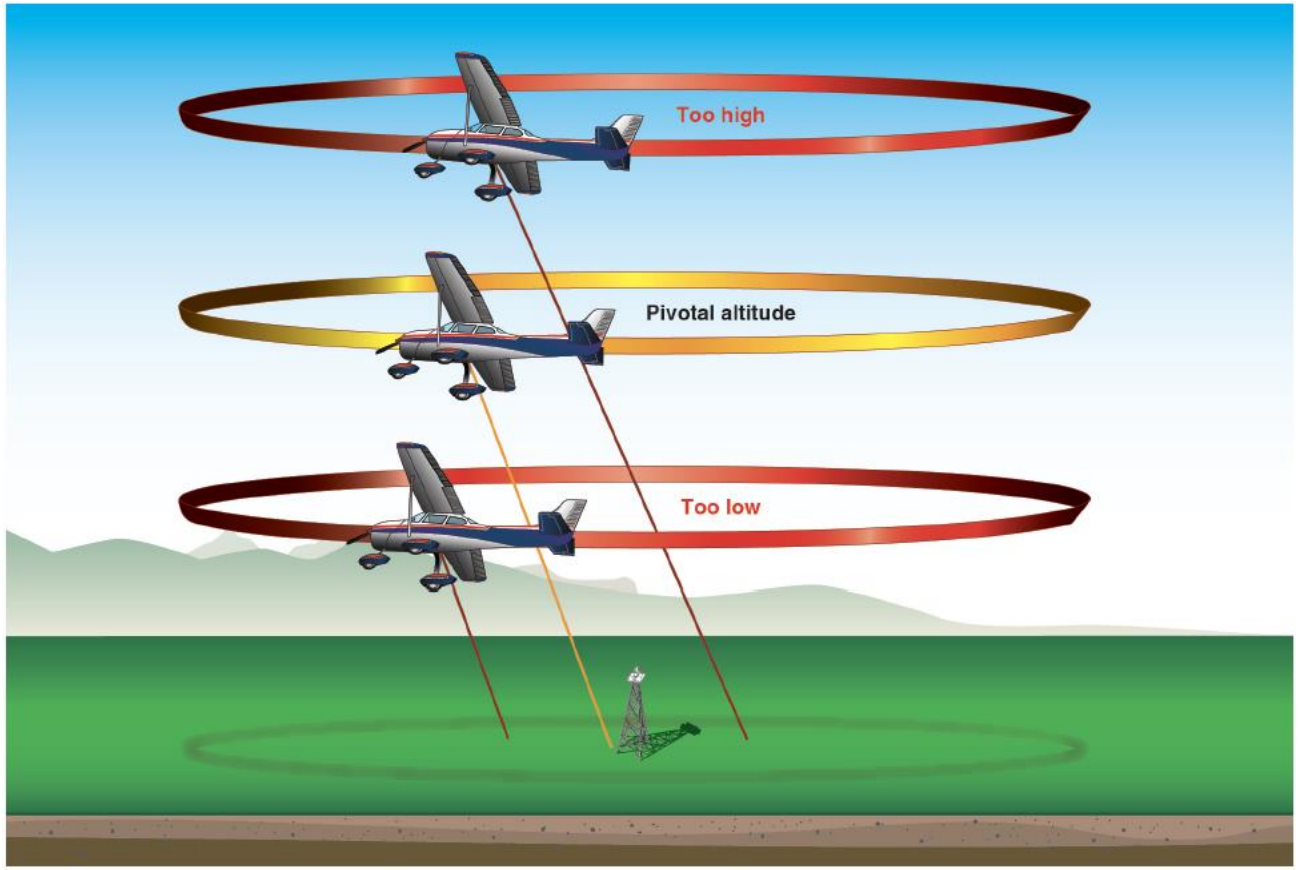
Eights-on-Pylons – A comprehensive analysis

A point on the ground will appear to pivot



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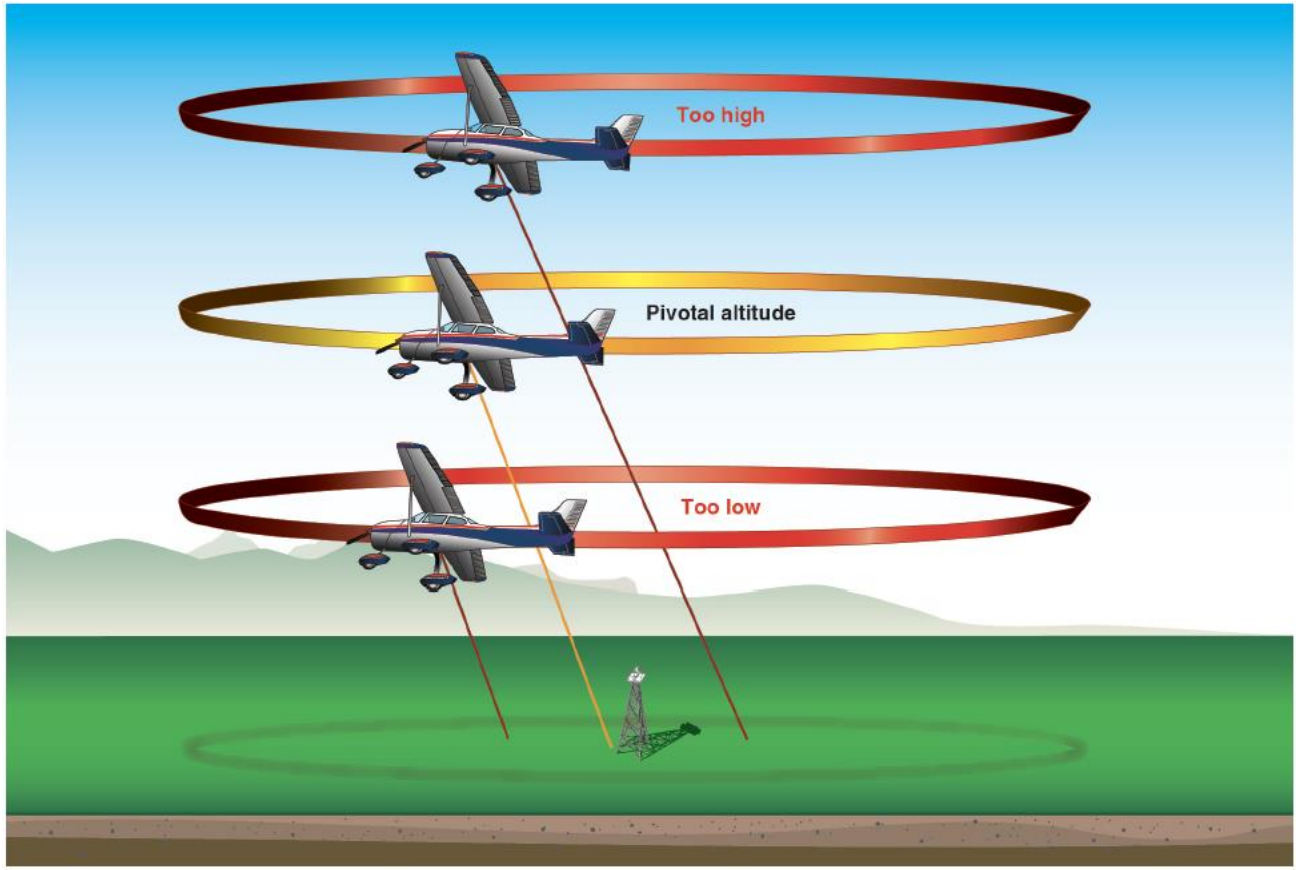
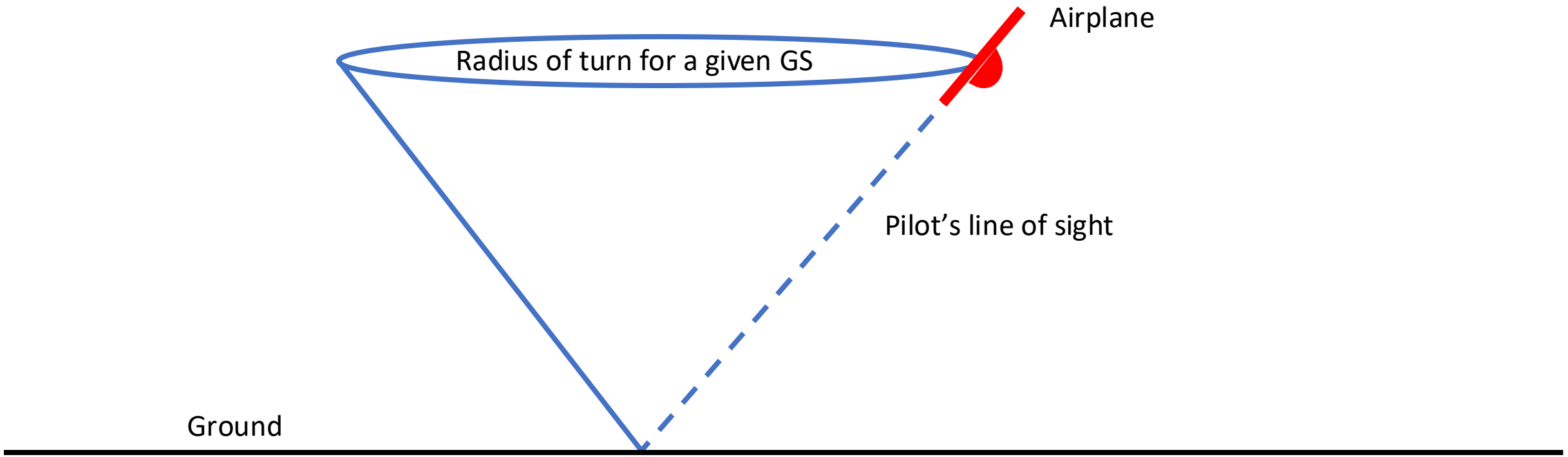
Line of sight – 90° to the longitudinal axis at the bank angle



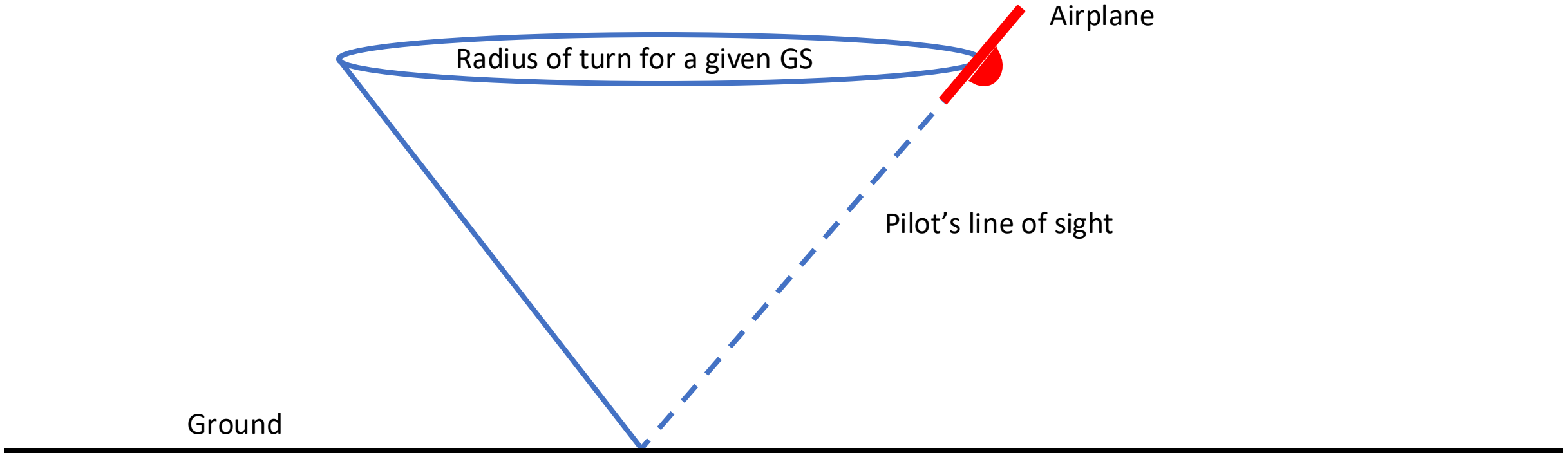
What does a pilot observe during this maneuver?

Eights on pylons demonstration

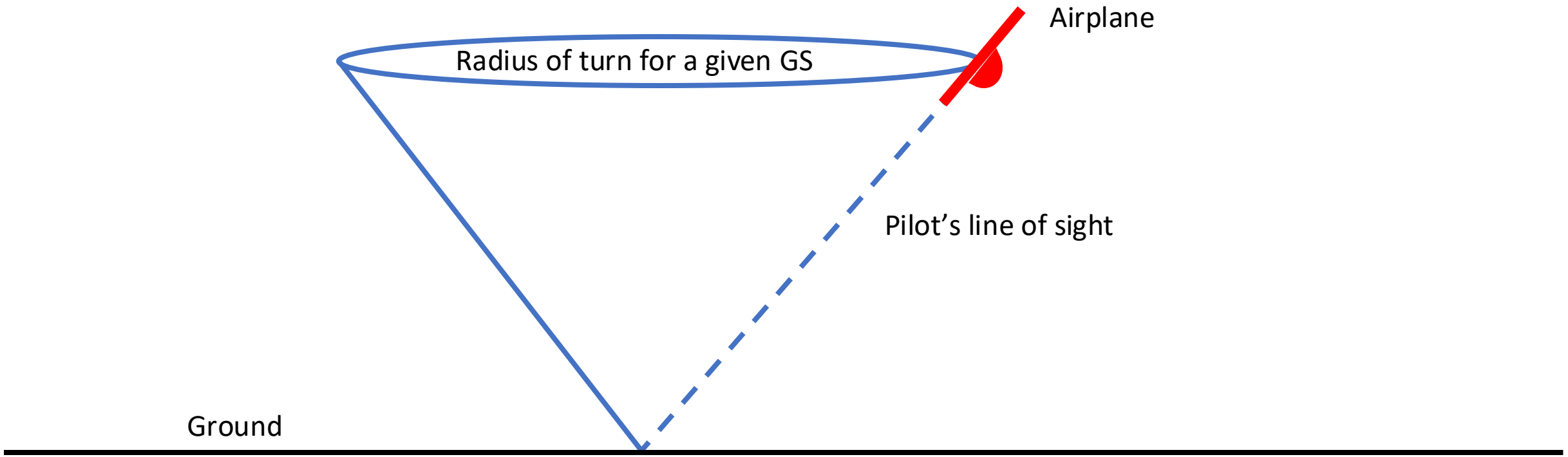
What is pivotal altitude?



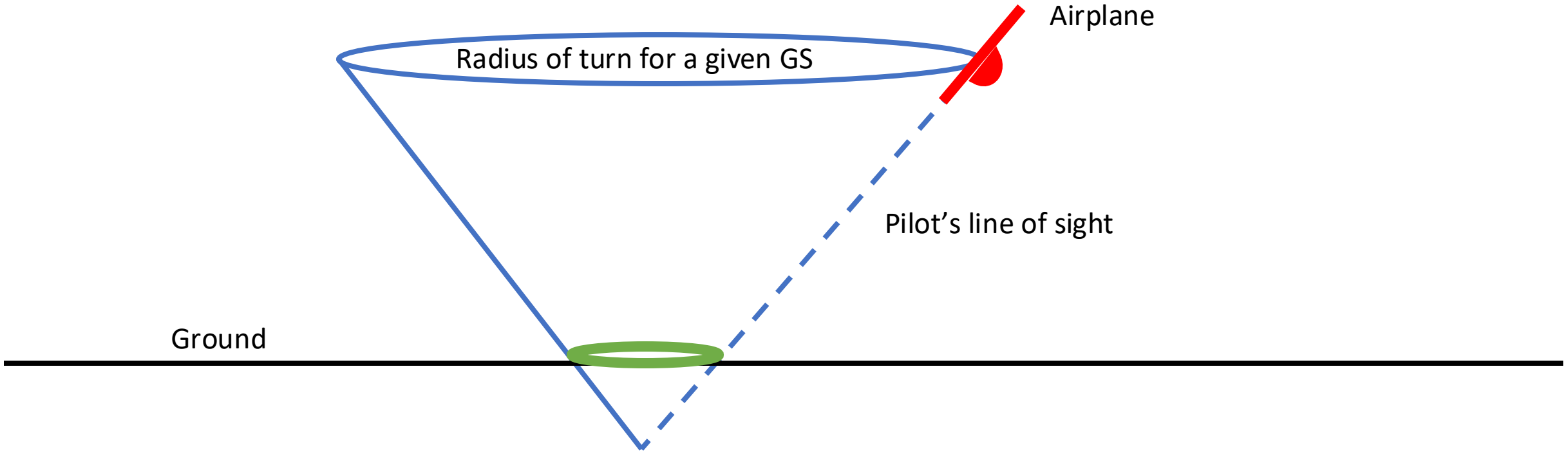
Why does the point appear to pivot?



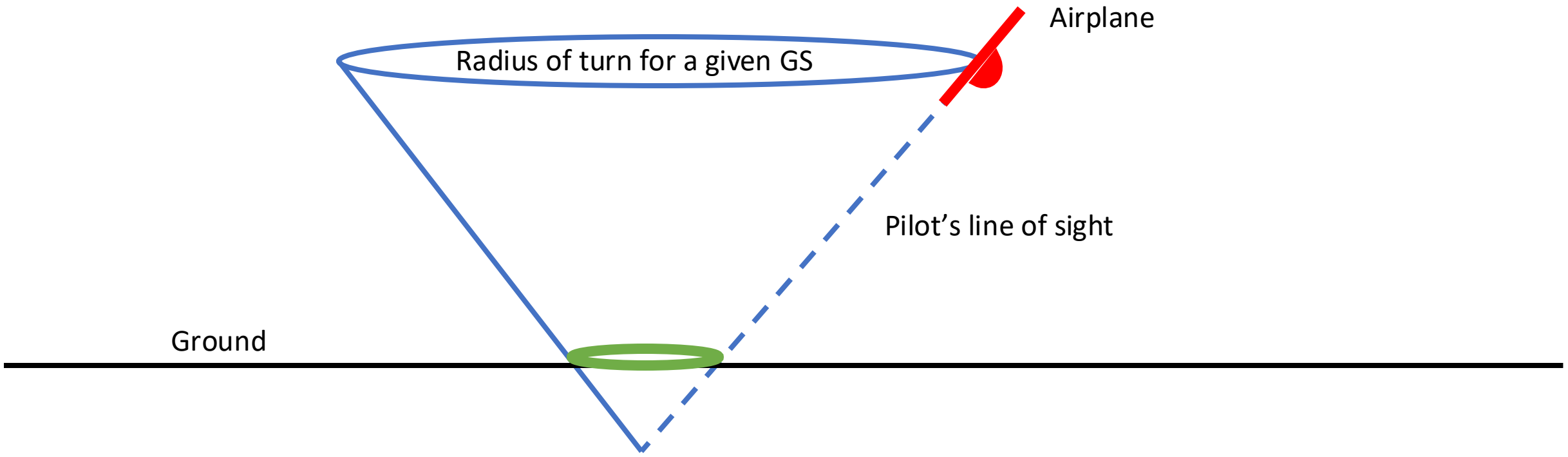
The line of sight is on the apex of the cone



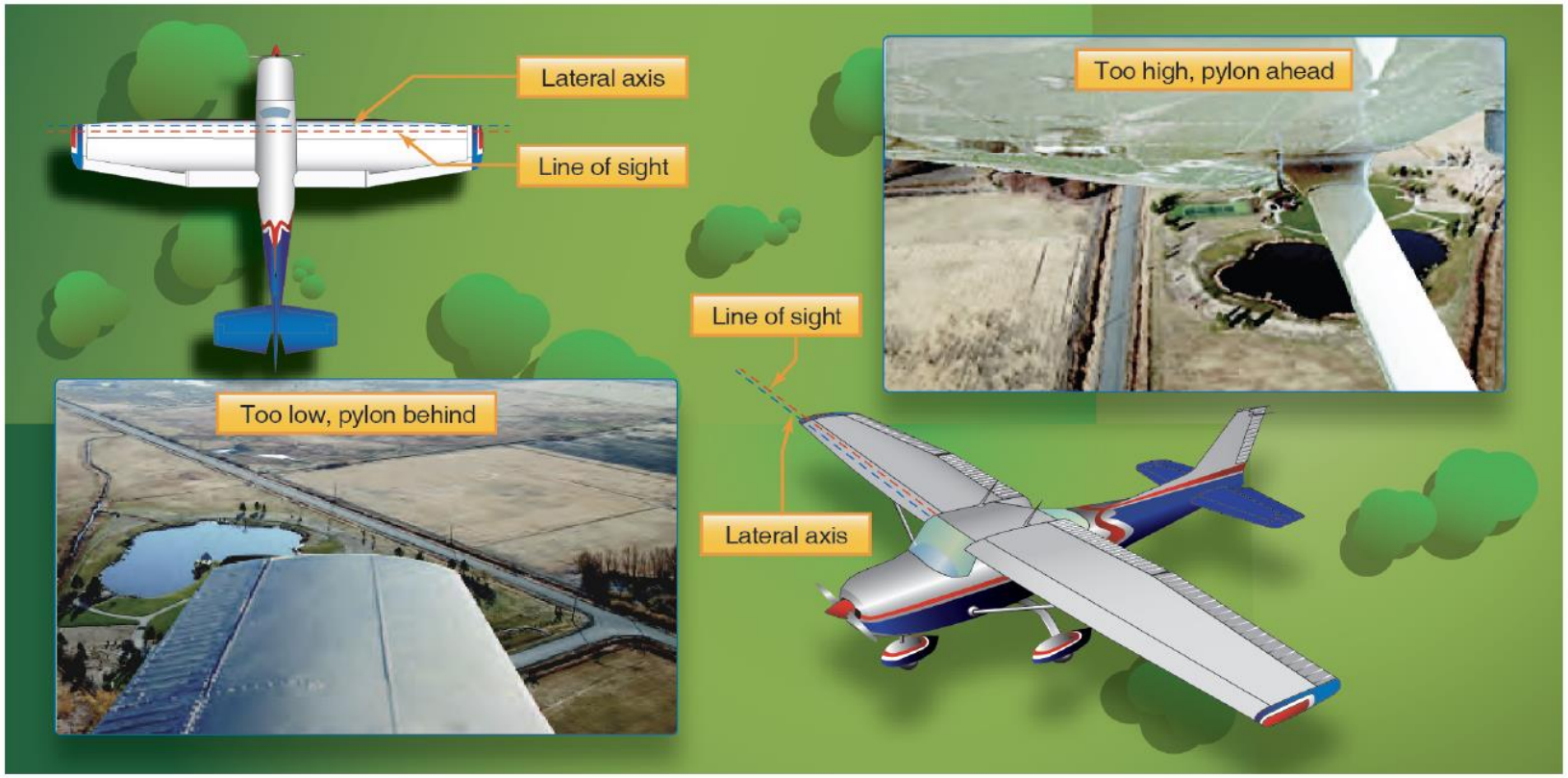
What happens if you are too low?



The line of sight makes a circle – Wing appears to go forward



Eights-on-Pylons – A comprehensive analysis



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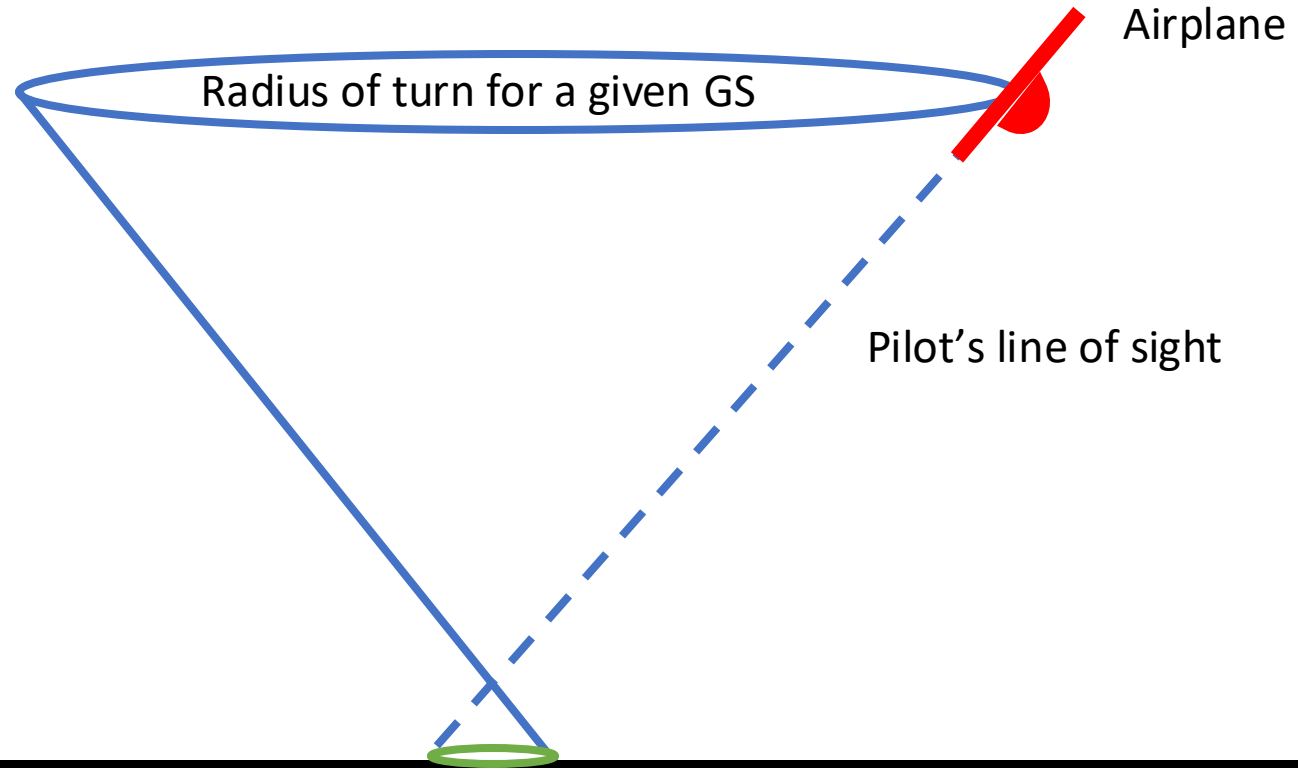
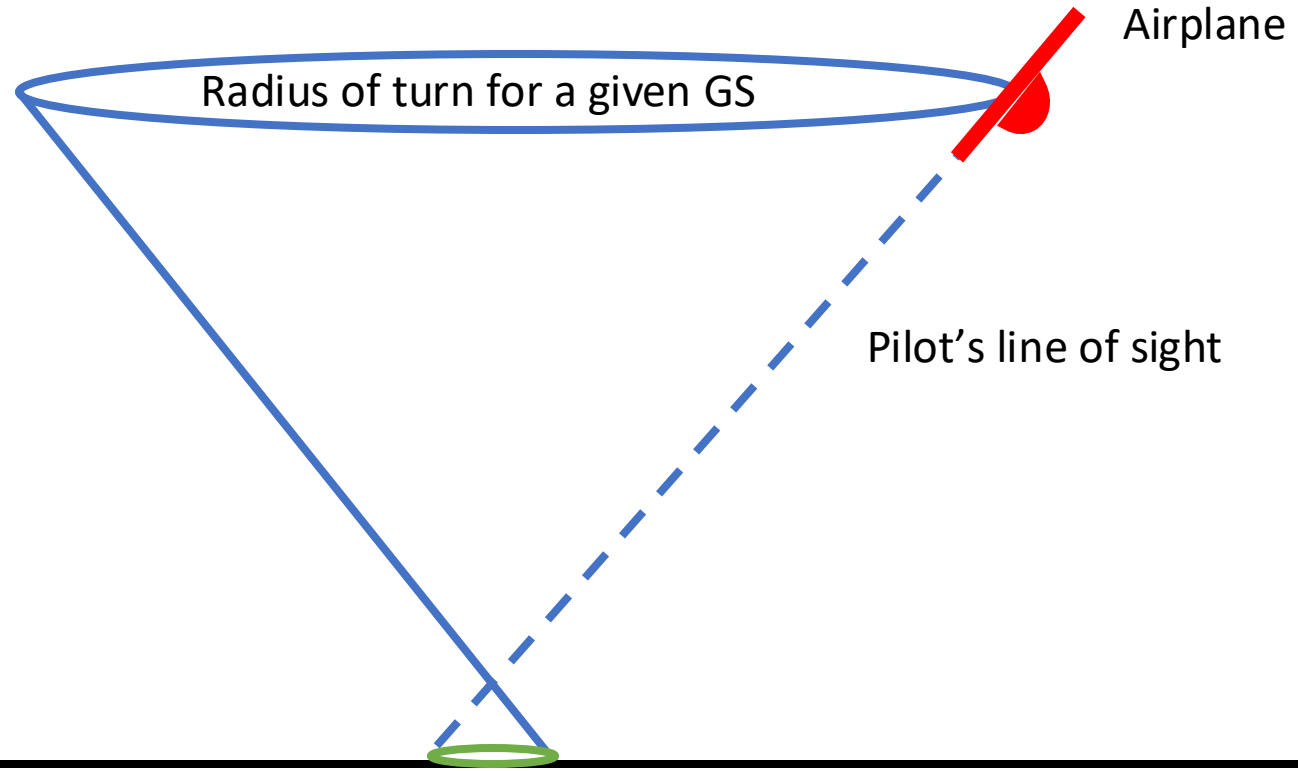
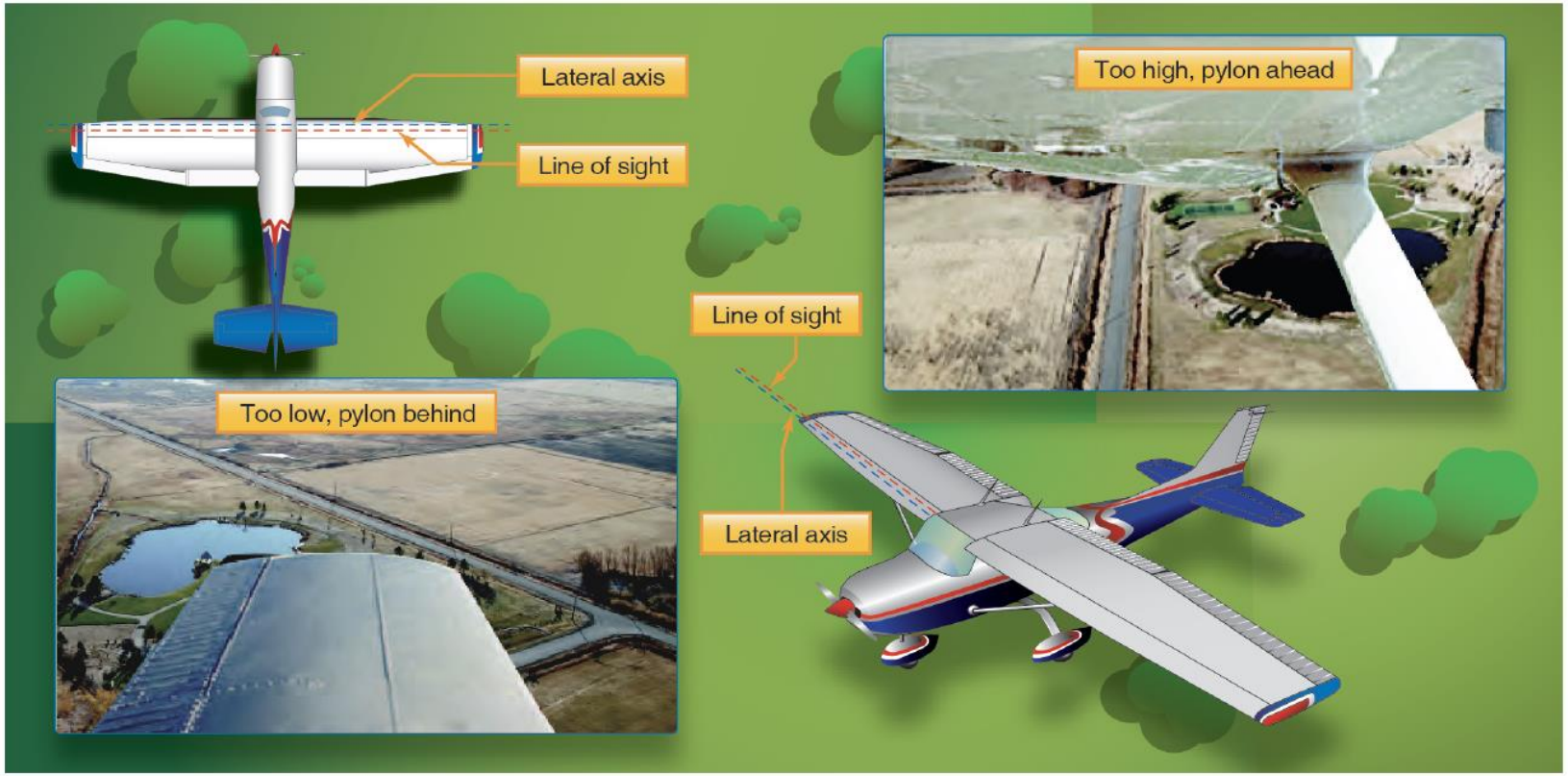
What happens if you are too high?



Another circle – Wing appears to go backwards across the ground



Eights-on-Pylons – A comprehensive analysis



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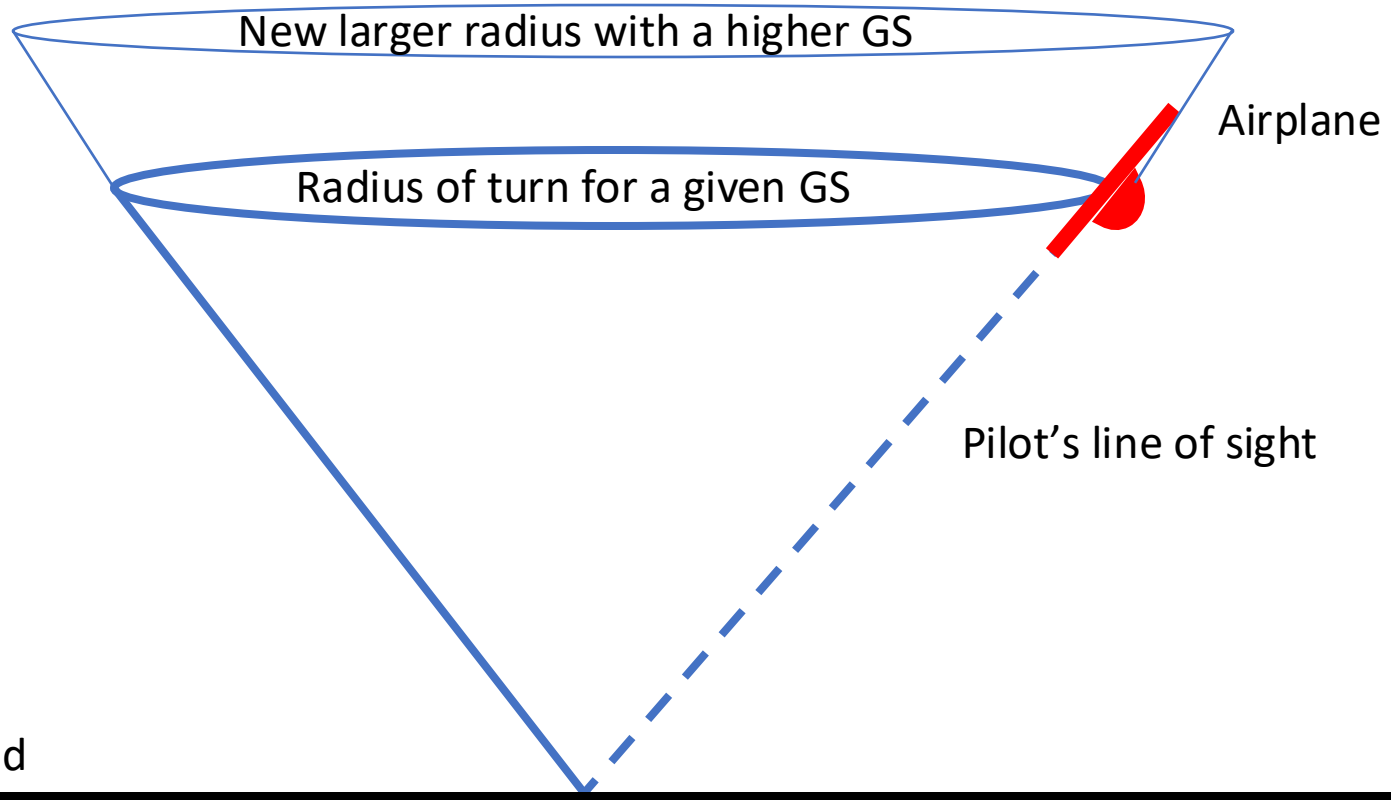
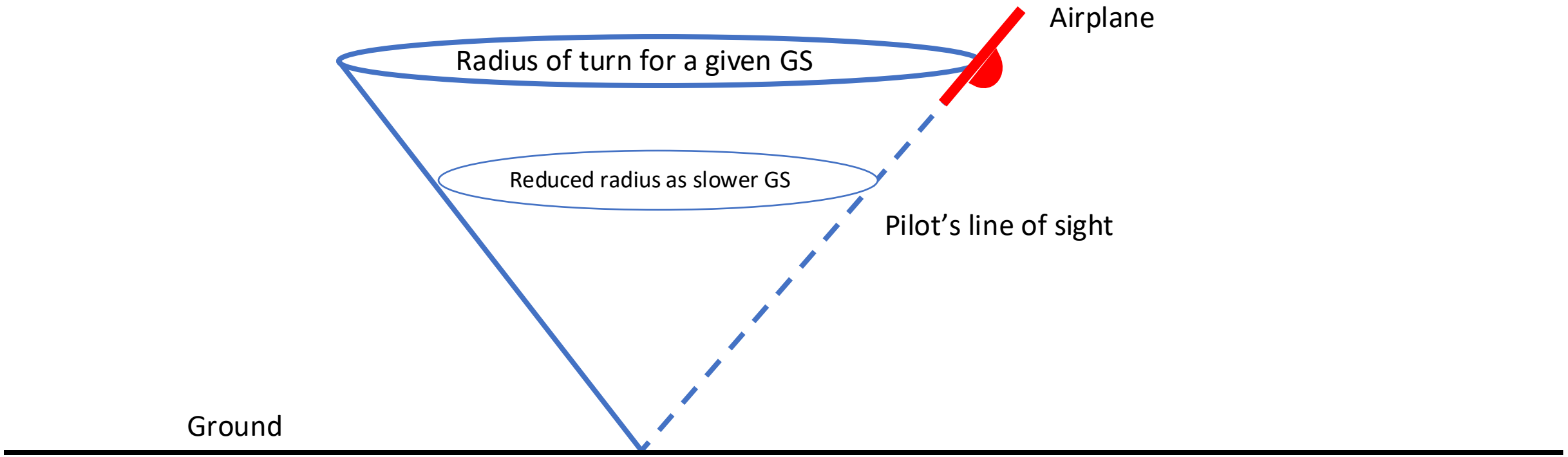
Why does pivotal altitude change?



Why does pivotal altitude change?



Pivotal altitude changes with Ground Speed

Groundspeed		Approximate Pivotal Altitude
Knots	MPH	
87	100	670
91	105	735
96	110	810
100	115	885
104	120	960
109	125	1050
113	130	1130

You need to calculate the PA from your Groundspeed

Groundspeed		Approximate Pivotal Altitude
Knots	MPH	
87	100	670
91	105	735
96	110	810
100	115	885
104	120	960
109	125	1050
113	130	1130

Eights-on-Pylons – A comprehensive analysis

Does this mean you do it for the headwind and tailwind?

Groundspeed		Approximate Pivotal Altitude
Knots	MPH	
87	100	670
91	105	735
96	110	810
100	115	885
104	120	960
109	125	1050
113	130	1130

Eights-on-Pylons – A comprehensive analysis

Will the airplane end up flying between those two altitudes?

Groundspeed		Approximate Pivotal Altitude
Knots	MPH	
87	100	670
91	105	735
96	110	810
100	115	885
104	120	960
109	125	1050
113	130	1130

From here to here?

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Only the highest PA needs to be calculated

Groundspeed		Approximate Pivotal Altitude
Knots	MPH	
87	100	670
91	105	735
96	110	810
100	115	885
104	120	960
109	125	1050
113	130	1130

Eights-on-Pylons – A comprehensive analysis

The airplane will not need to descend to the lowest calculated

Groundspeed		Approximate Pivotal Altitude
Knots	MPH	
87	100	670
91	105	735
96	110	810
100	115	885
104	120	960
109	125	1050
113	130	1130

Eights-on-Pylons – A comprehensive analysis

Why?

No attempt is made to keep the indicated airspeed the same

It is allowed to vary – fixed power maneuver – varying airspeed

Creates a “doubling effect”

Eights-on-Pylons – A comprehensive analysis

If the PA is too high a descent will

1. Cause the airplane to descend back to the Pivotal altitude
2. Increase the pivotal altitude at the same time because the groundspeed is increasing in the descent.

Eights-on-Pylons – A comprehensive analysis

If the PA is too low a climb will

1. Cause the airplane to get back to the Pivotal Altitude.
2. Decrease the pivotal altitude at the same time because the groundspeed is decreasing in the climb.

If the airspeed we kept constant during the maneuver:

The airplane would need to maneuver through the calculated headwind and tailwind Pivotal Altitudes.

What was the maneuver used for, practically?

Eights-on-Pylons – A comprehensive analysis

It can be used to deliver and retrieve objects from a confined area where a landing isn’t possible

Patented as a long line loiter and used by the US Air force

The Declassified Document is in the email we send you after the show!

Long Line Loiter Declassified Document

Used by Missionaries in Equator – Bucket drop technique

Bucket Drop Technique

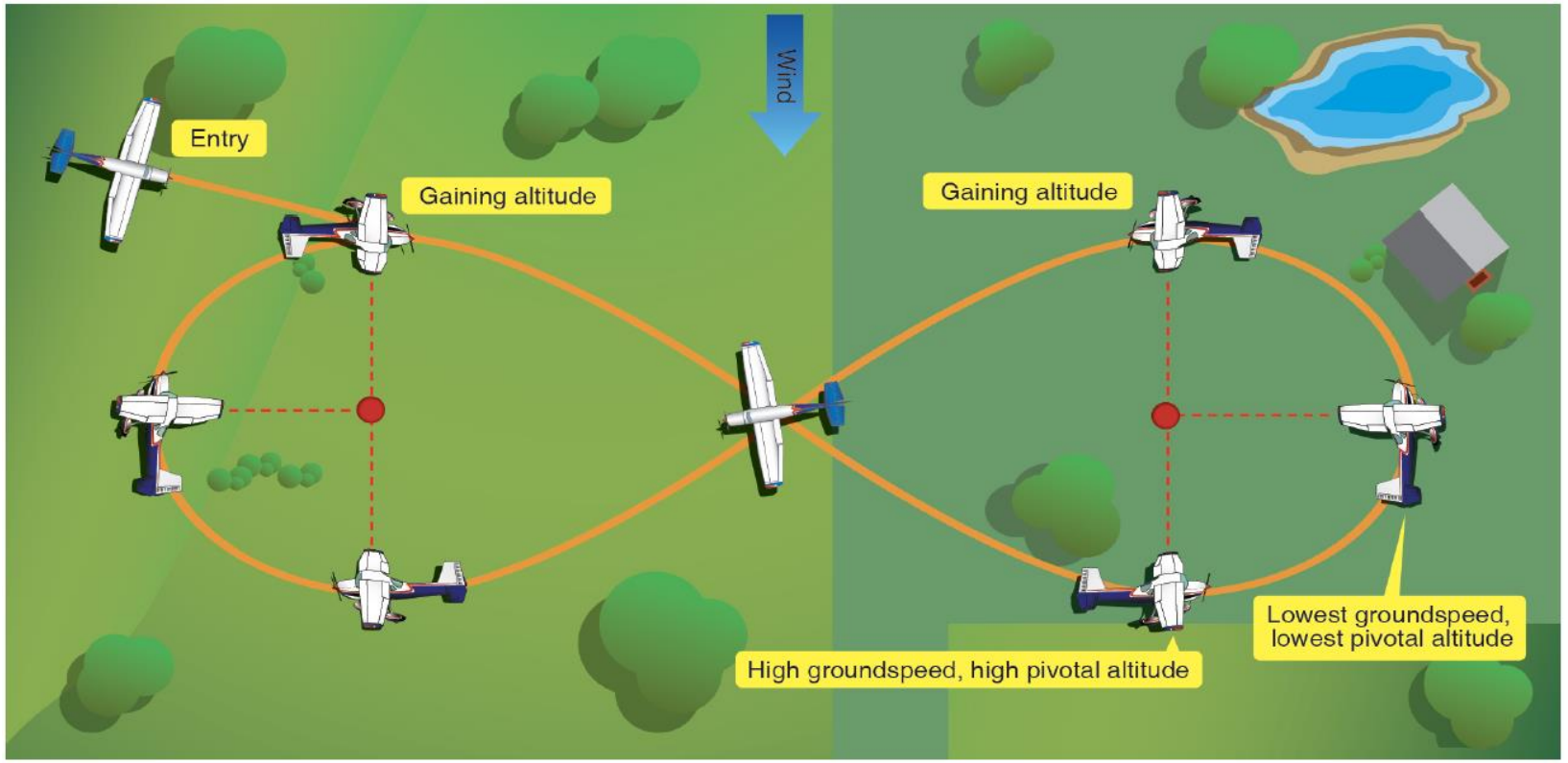
Featured in the movie “The End of the Spear"

Popular Mechanics Article

Used today to develops the ability to subconsciously fly by looking outside

Eights-on-Pylons – A comprehensive analysis

Why you can’t maintain a constant radius
The AFH illustration is wrong



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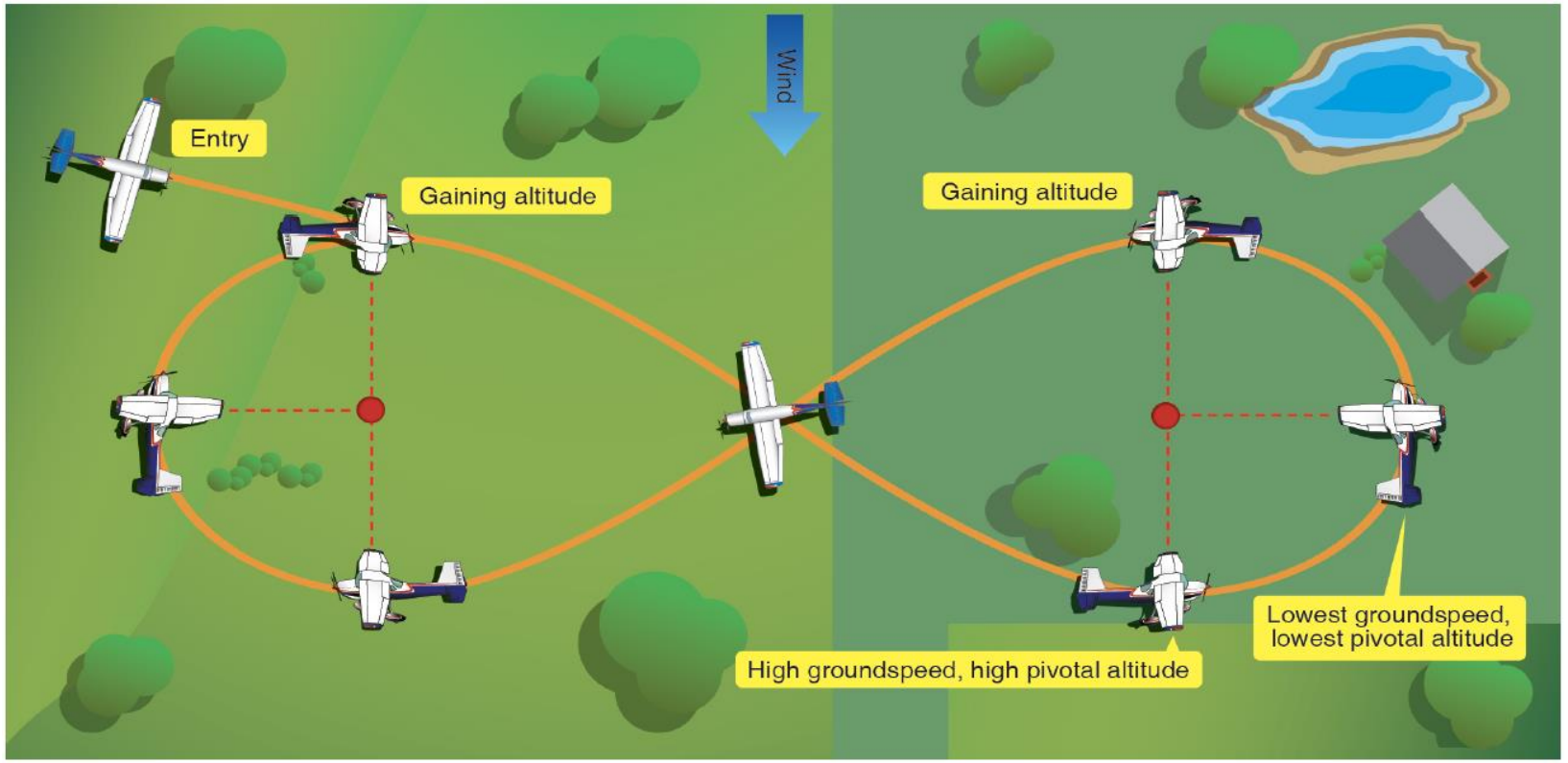
Eights-on-Pylons – A comprehensive analysis

Turns not constant radius with wind and the roll on points are incorrect – bottom one sooner – top later



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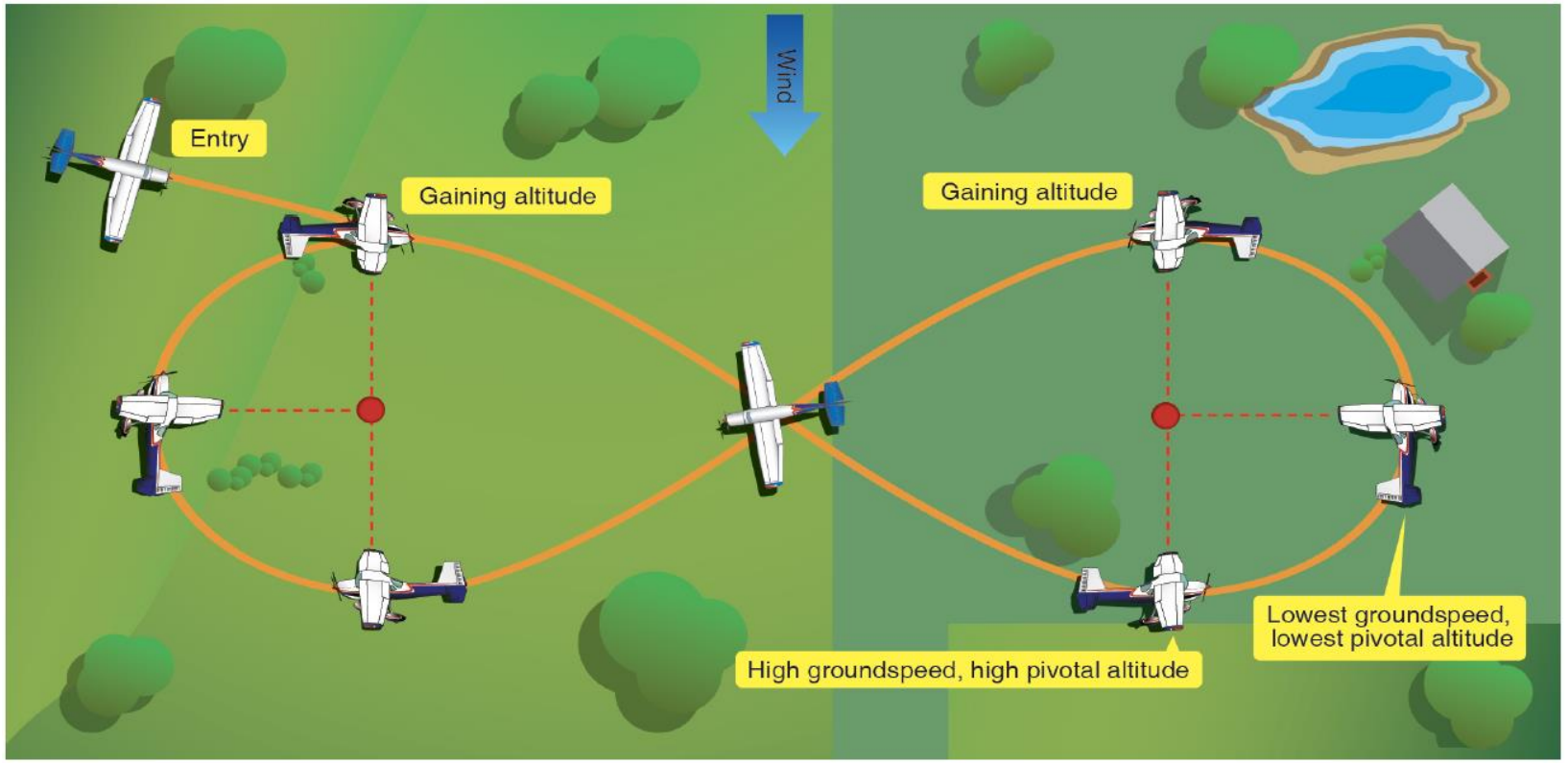
Eights-on-Pylons – A comprehensive analysis

Roll on/off points are incorrect – bottom sooner – top later



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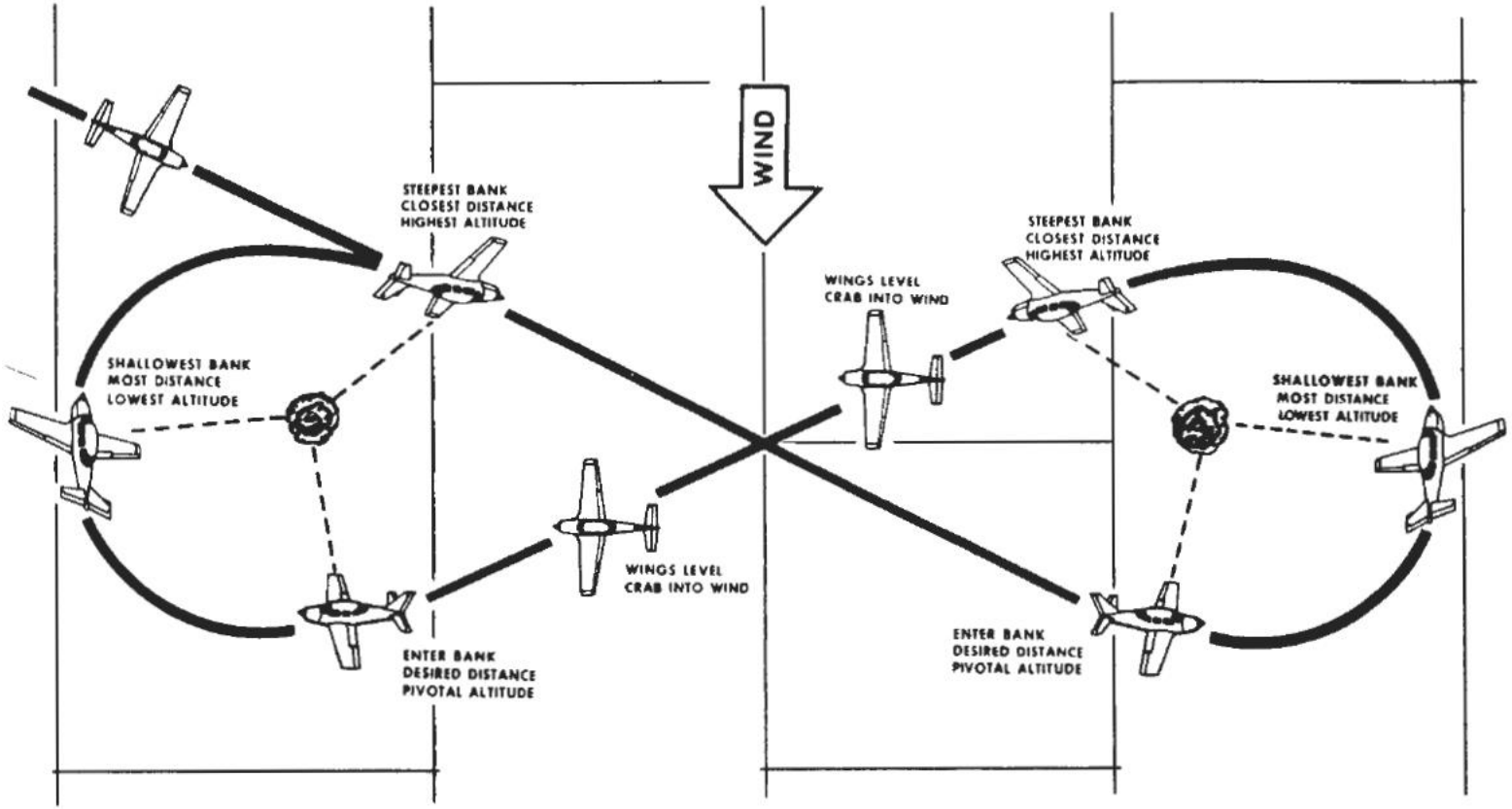
Eights-on-Pylons – A comprehensive analysis

This is better – shows changing radius and different roll on/out points



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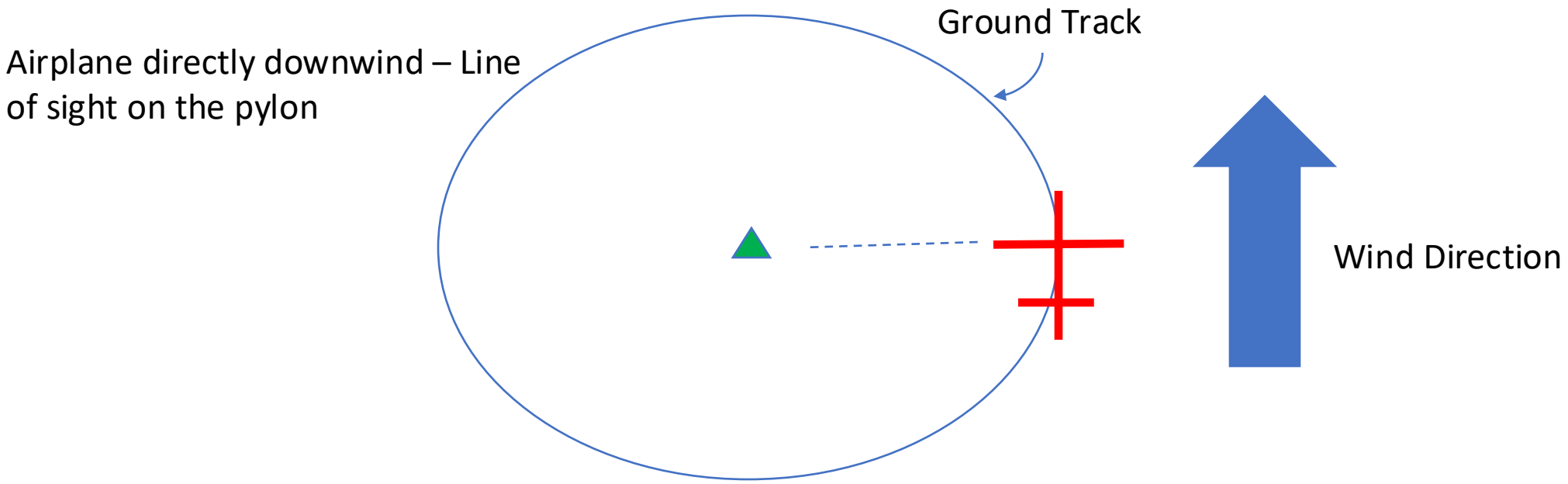
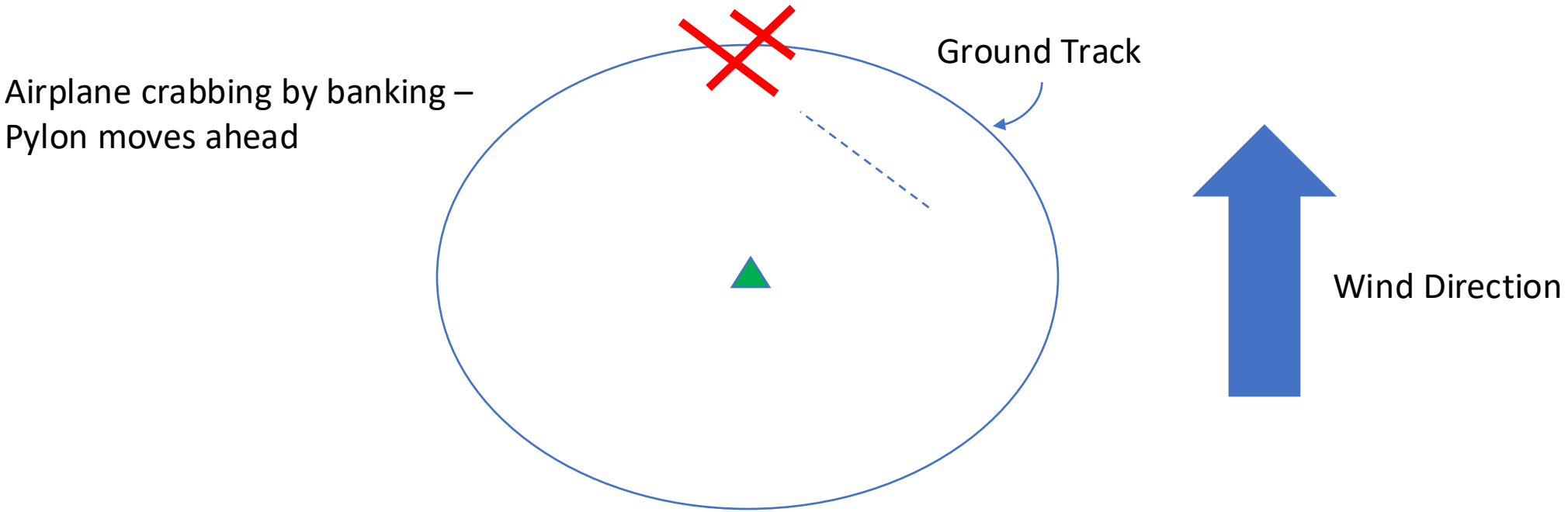
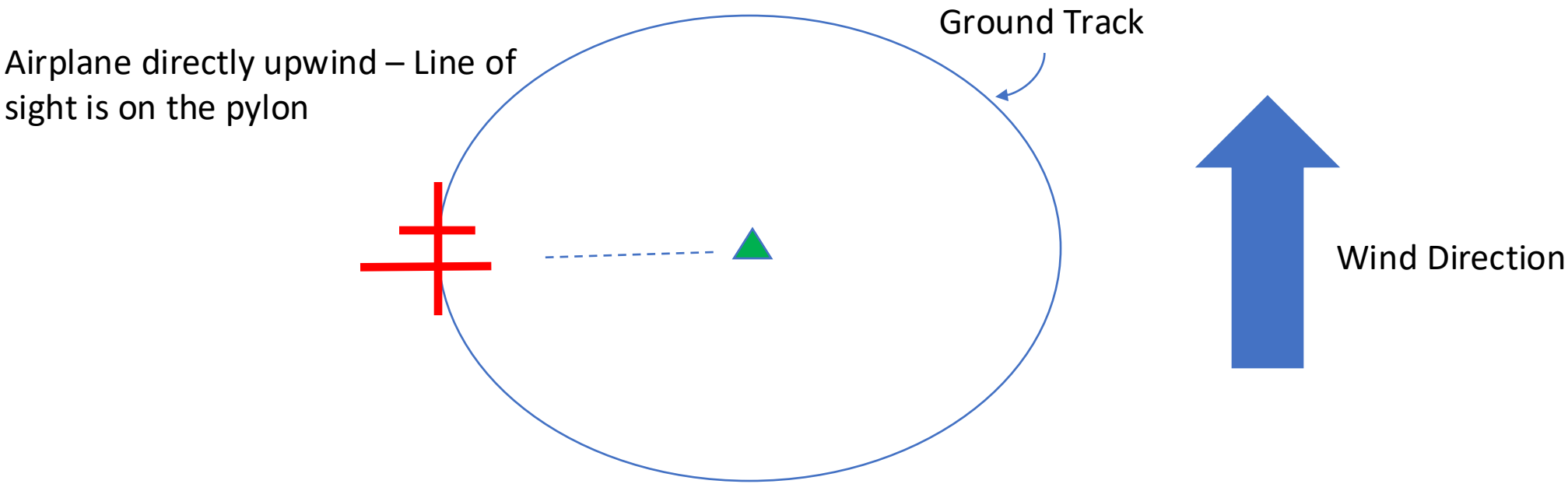
To maintain a constant radius – The line of sight will change



Crosswind – The airplane is banked steeper

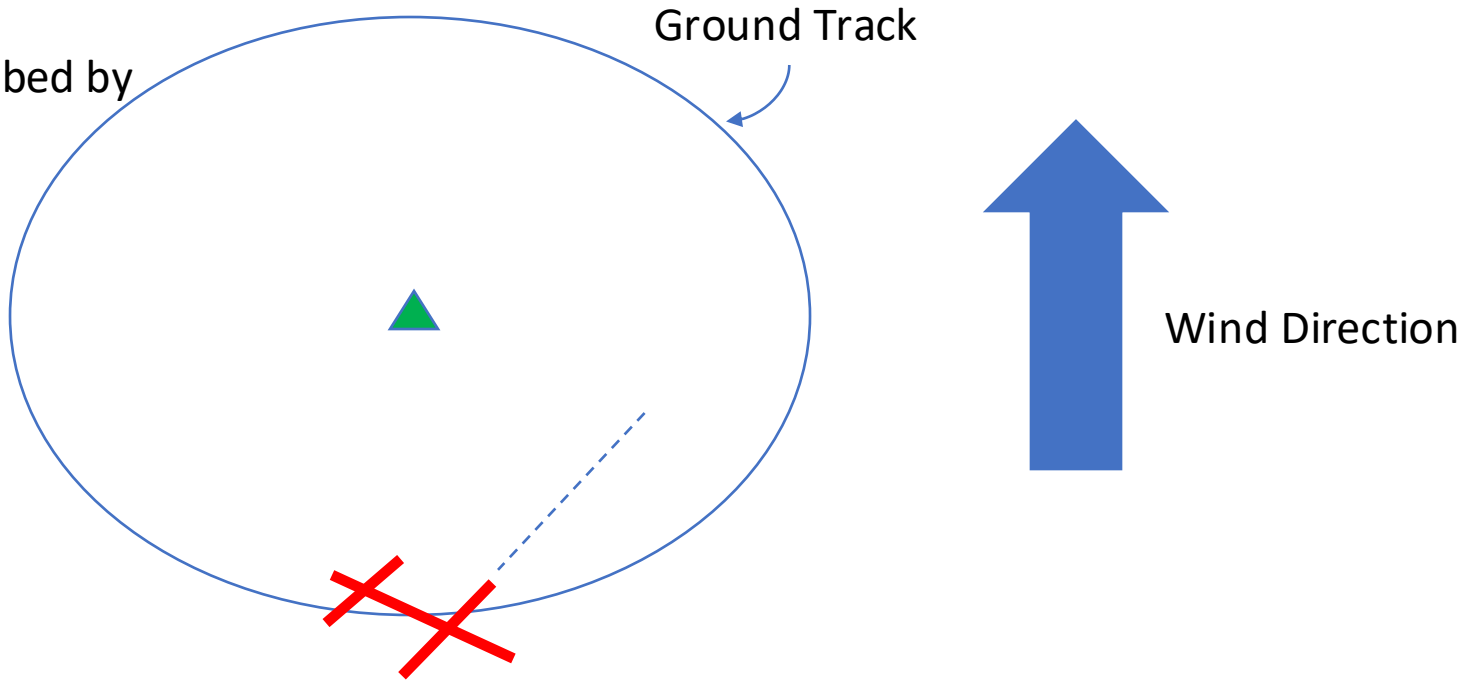


Upwind – The pylon is directly on the line of sight



Crosswind again – Line of sight changes

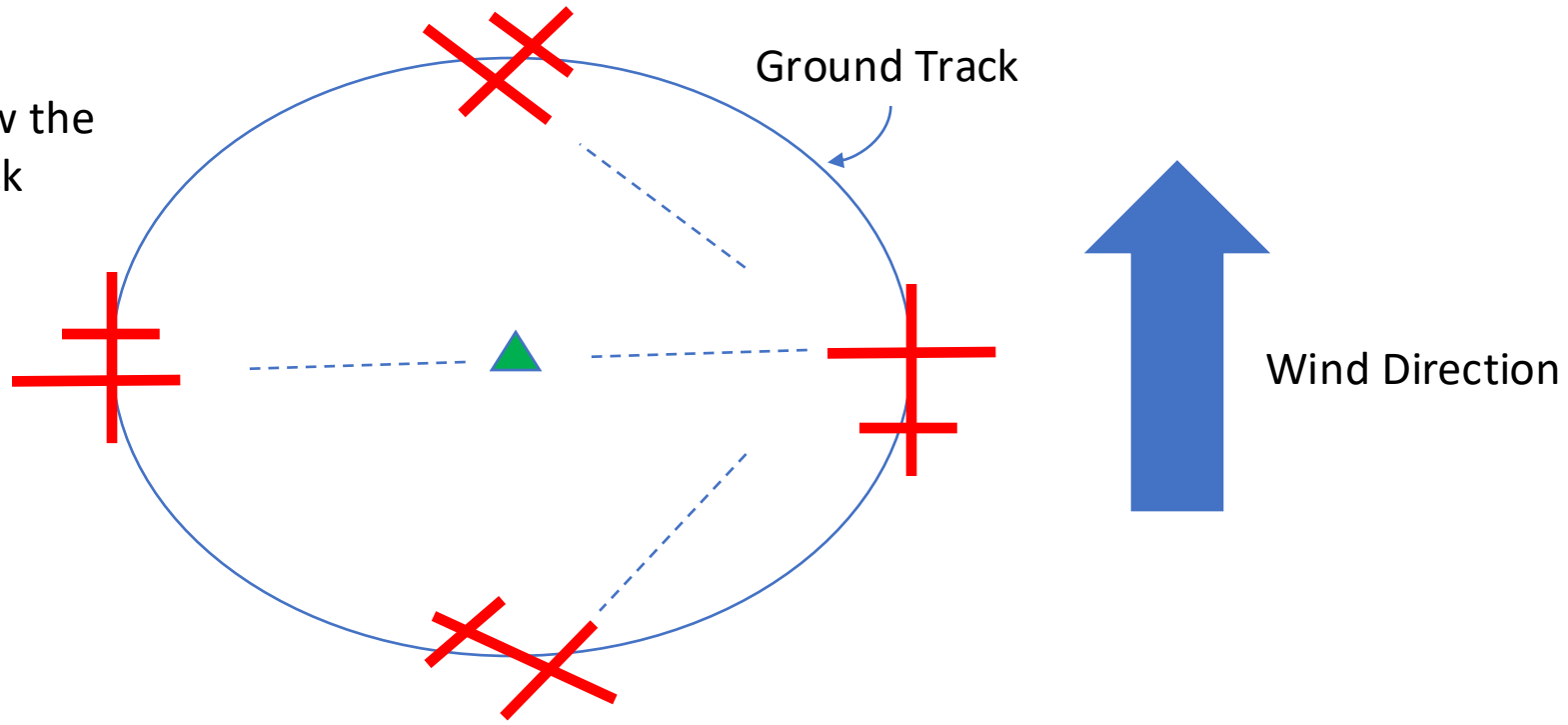
Crosswind – Airplane is crabbed by banking – Pylon behind



Eights-on-Pylons – A comprehensive analysis

You can’t maintain a constant radius and keep the line of sight on the pylon

The Red airplanes show the heading vs ground track



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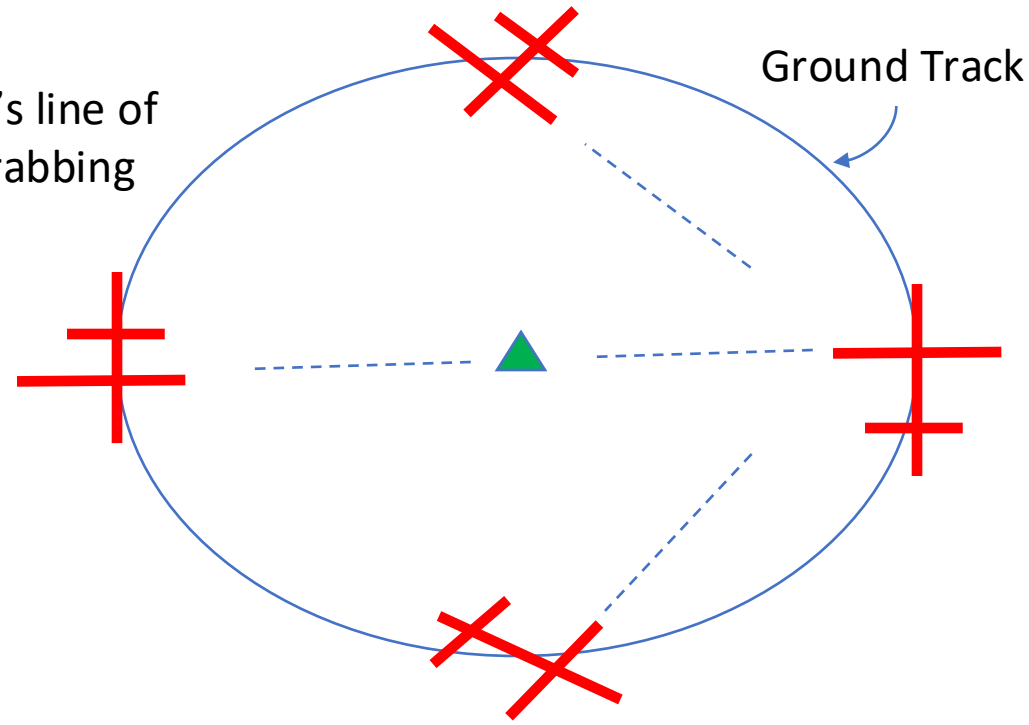
Eights-on-Pylons – A comprehensive analysis

Dashed lines are the pilot's line of sight – Changing due to crabbing



Wind Direction

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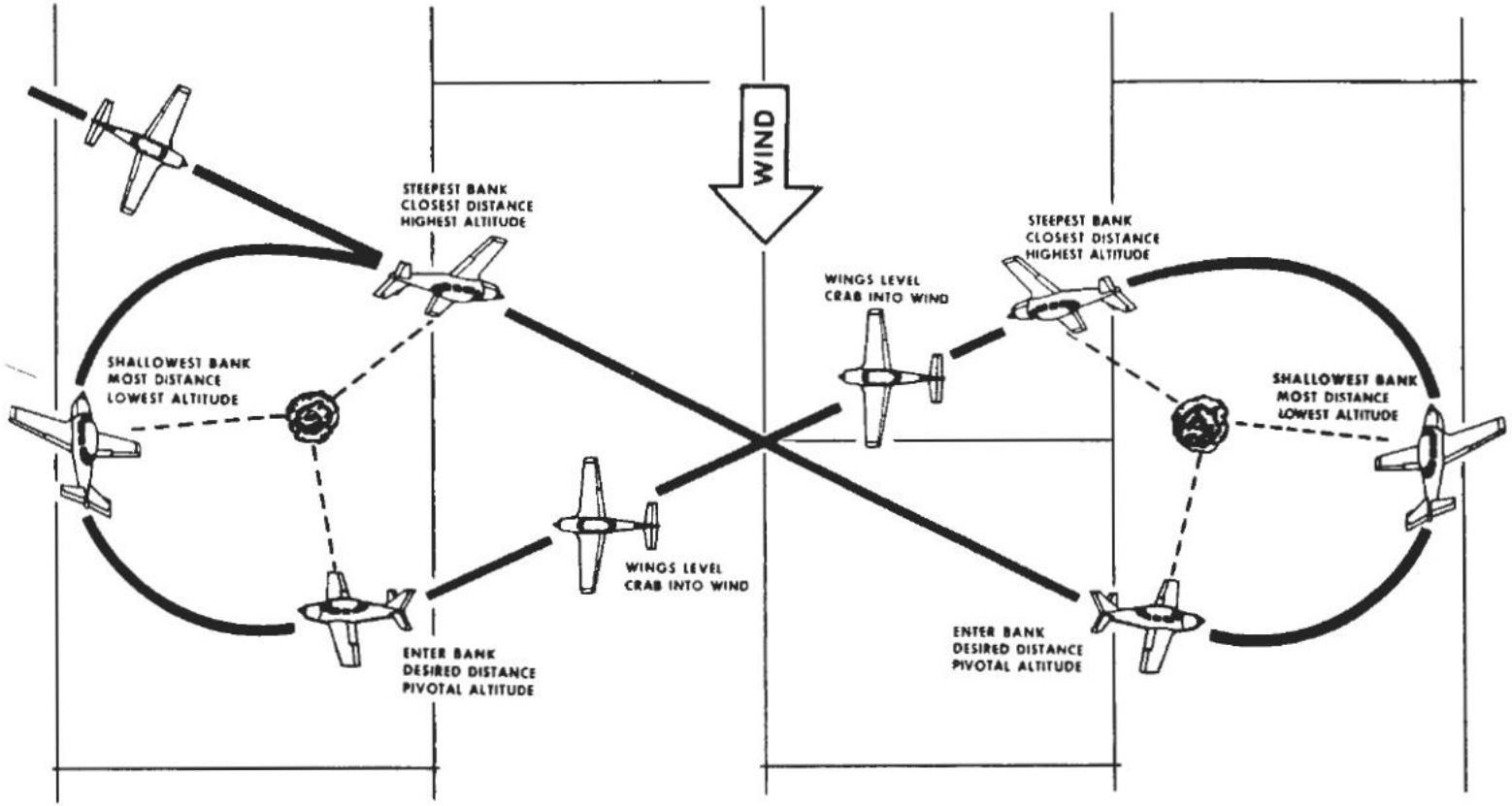
Eights-on-Pylons – Allow the airplane to drift while turning



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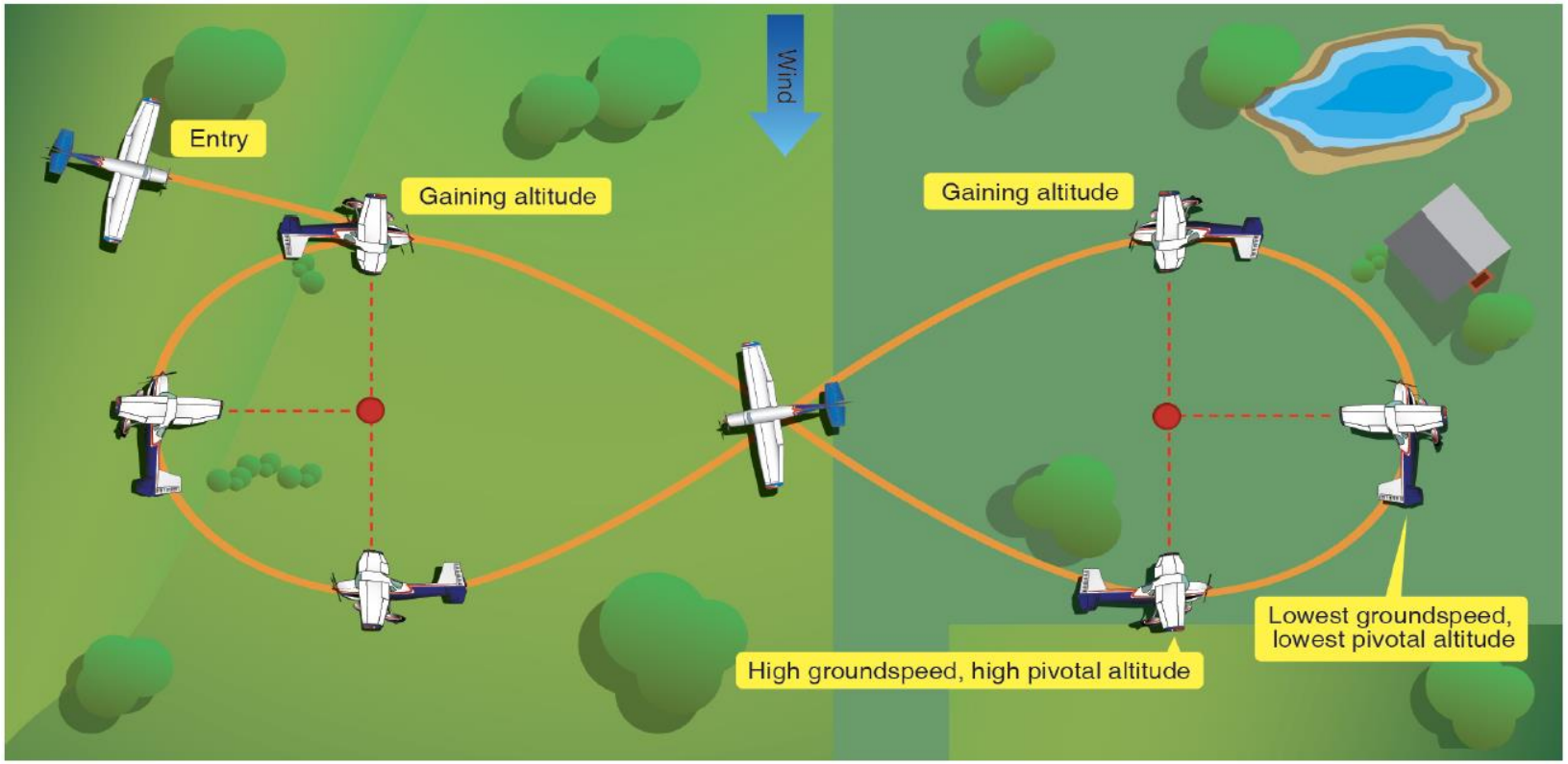
Eights-on-Pylons – A comprehensive analysis

The image in the AFH – 3C version is incorrect



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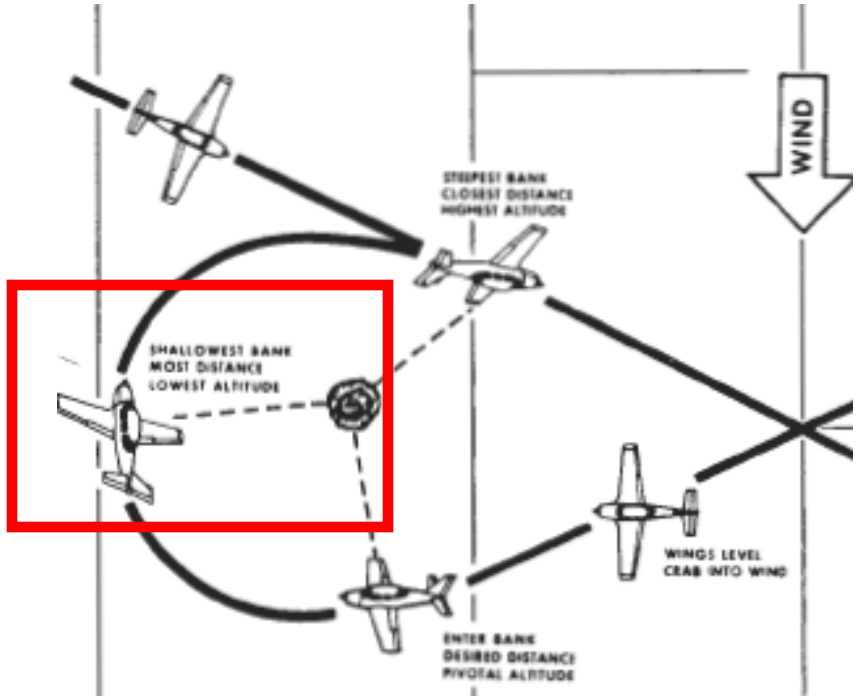
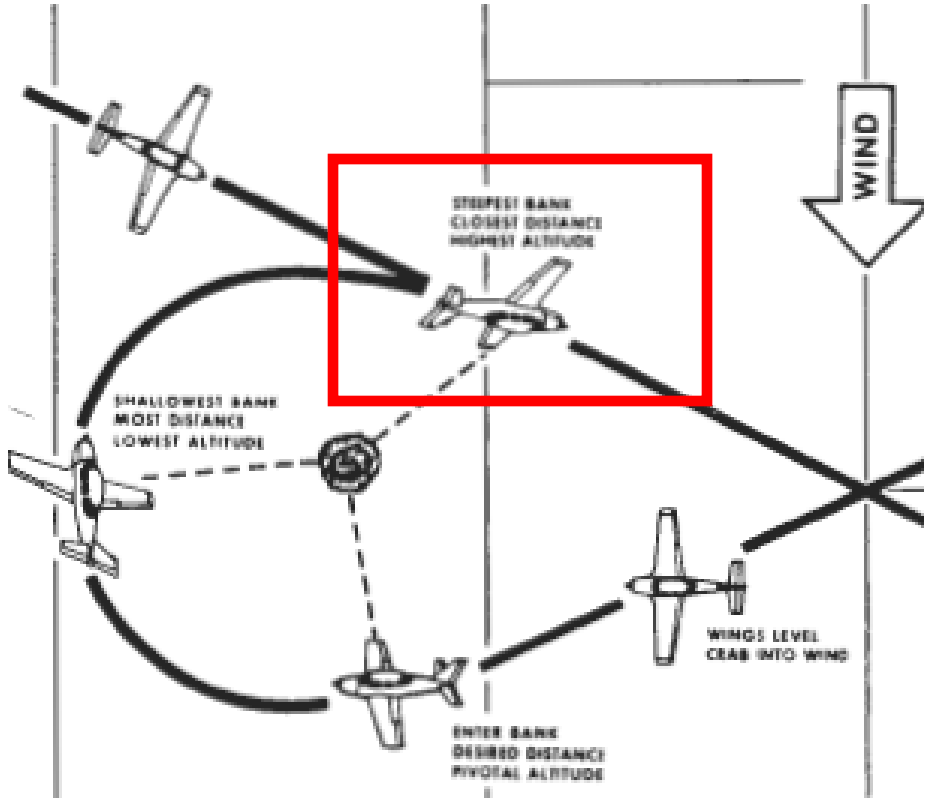
Where is the point you'll be farthest from the pylon?



The airplane stops drifting when directly upwind

Eights-on-Pylons – A comprehensive analysis

What point requires the steepest turn?



No correction for wind drift -
The airplane will be close to the pylon –
If the turn isn't steep the plane will fly over the pylon

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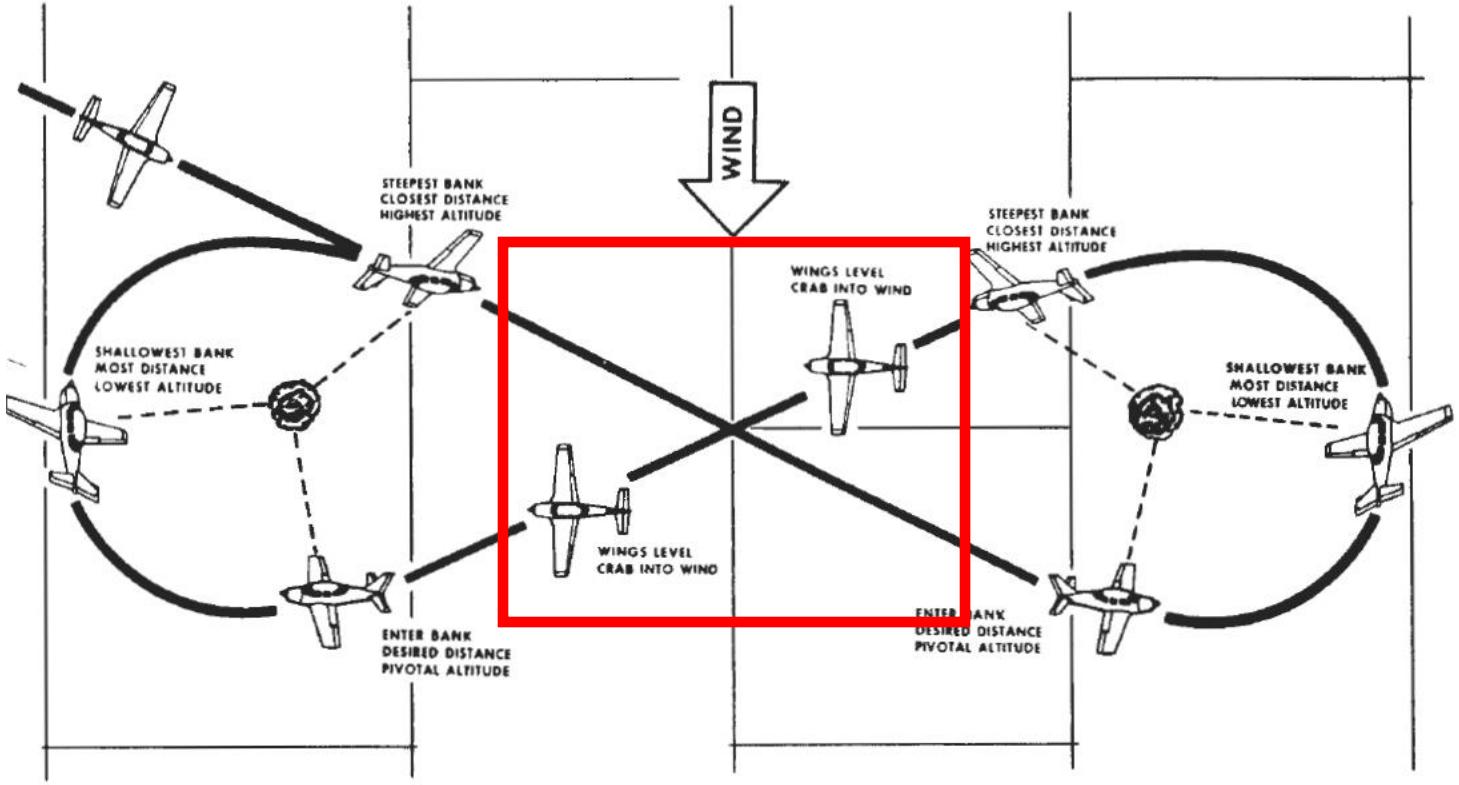
Eights-on-Pylons – A comprehensive analysis

How can you keep from drifting farther away if doing this multiple times?



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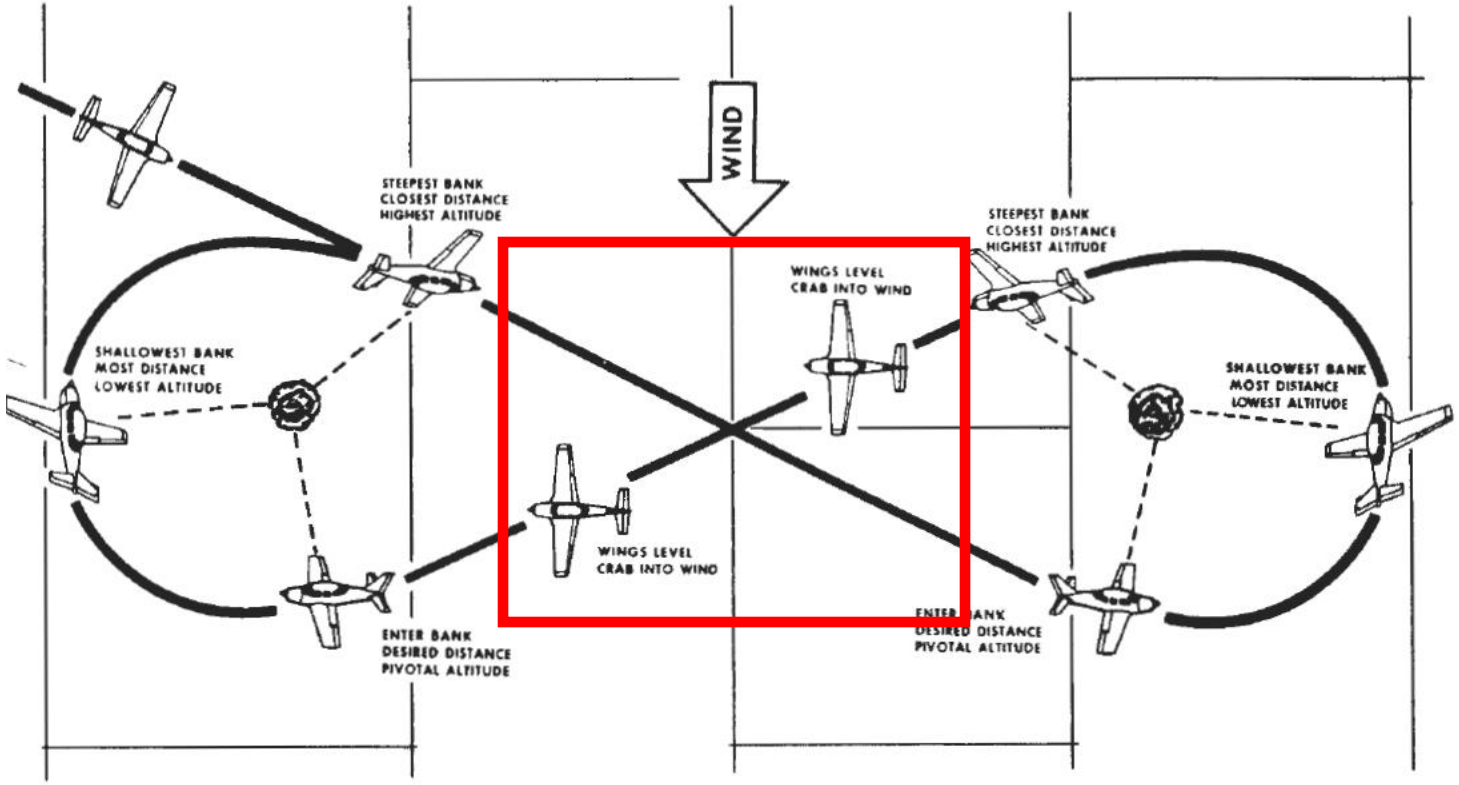
By correcting drift between pylons - Crabbing



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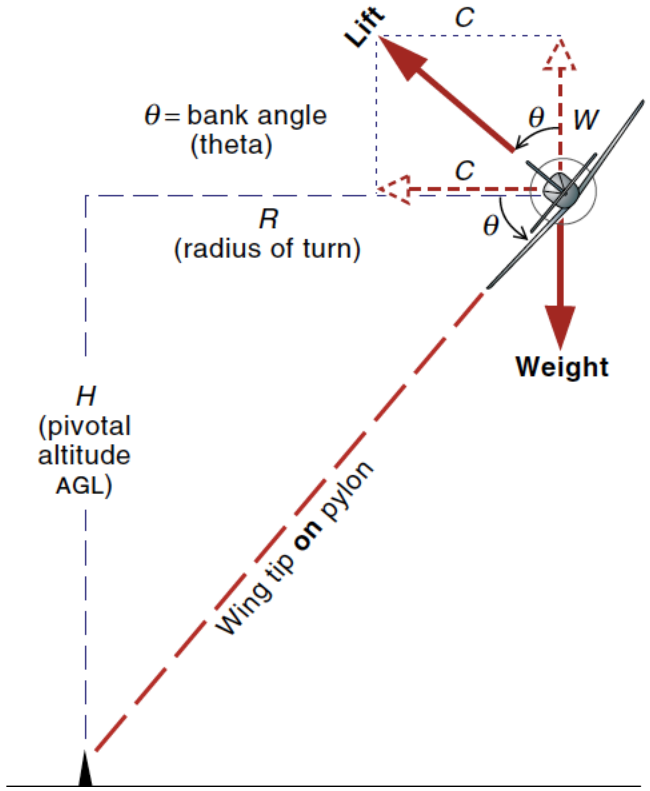
How is the pivotal altitude equation derived – $GS^2/11.3$?

Eights-on-Pylons – A comprehensive analysis

Deriving Pivotal Altitude from Physics and Mathematics



For the Large Triangle:

Tan $\theta = \frac{H}{R}$

Forces Acting on the Airplane are:

1. Vertical component of lift that counteracts weight.
   Where W=mg
   m = mass in pounds
   g = Acceleration due to gravity – 32.2ft/sec.
2. Horizontal component of lift – same as Centripetal force = $\frac{mV^2}{R}$

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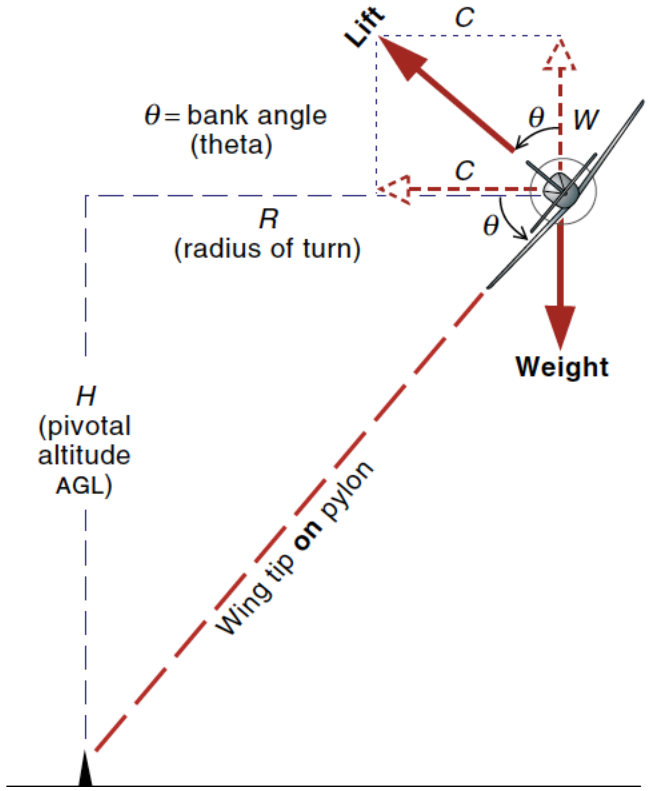
Eights-on-Pylons – A comprehensive analysis

Deriving Pivotal Altitude from Physics and Mathematics



For the Small Triangle:

Tan $\theta = \frac{C}{W}$

Both relationships for the Tan θ must be equal.

$\frac{H}{R} = \frac{C}{W}$ Therefore:

$\frac{H}{R} = \frac{mV^2}{R} \times \frac{1}{mg}$ – The m′s and R′s cancel leaving:

$$H = \frac{V^2}{g}$$

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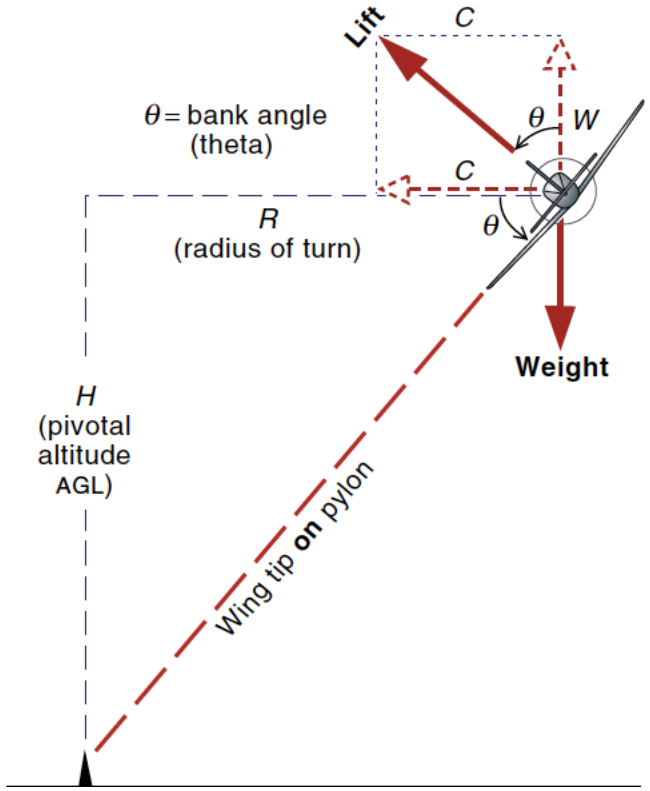
Eights-on-Pylons – A comprehensive analysis

Deriving Pivotal Altitude from Physics and Mathematics



$$H = \frac{V^2}{g}$$

V = Velocity in ft/sec = groundspeed of the airplane

1 knot – 1 nautical mile per hour =
6080 feet per hour =

$$\frac{6080}{60} = Feet\ per\ minute$$

$$\frac{6080}{60 \times 60} = Feet\ per\ second$$

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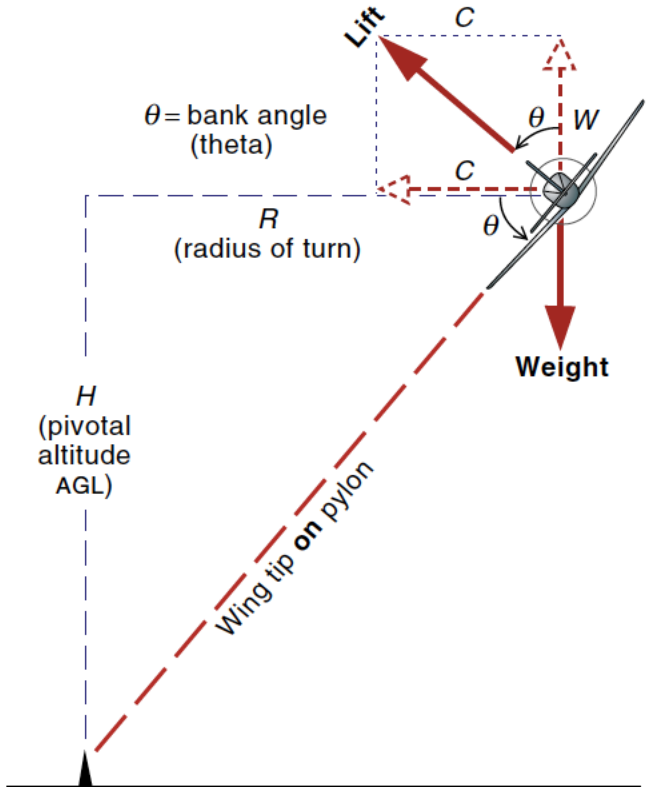
Eights-on-Pylons – A comprehensive analysis

Deriving Pivotal Altitude from Physics and Mathematics



$$H = \frac{V^2}{g}$$

V = Velocity in ft/sec = groundspeed of the airplane

1 knot – 1 nautical mile per hour =
6080 feet per hour =

$$\frac{6080}{60} = Feet\ per\ minute$$

$$\frac{6080}{60 \times 60} = 1.69\ Feet\ per\ second$$

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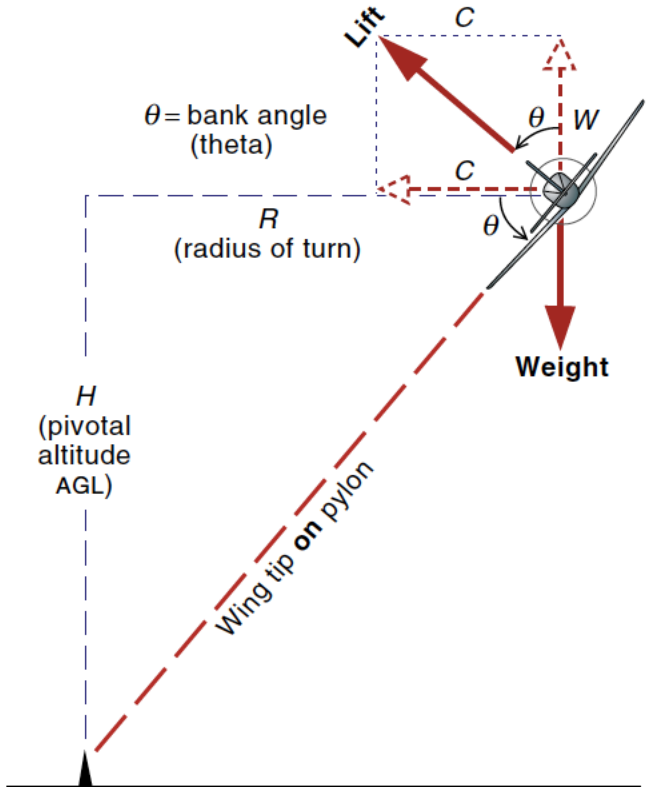
Eights-on-Pylons – A comprehensive analysis

Deriving Pivotal Altitude from Physics and Mathematics



So therefore:

$$H = \frac{V^2}{g}$$

$$H = \frac{(groundspeed\ in\ knots)x1.692}{32.2} =$$

$$H = \frac{(groundspeed\ in\ knots)x2.86^2}{32.2} =$$

$$H = \frac{(groundspeed\ in\ knots)^2}{11.3}$$

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