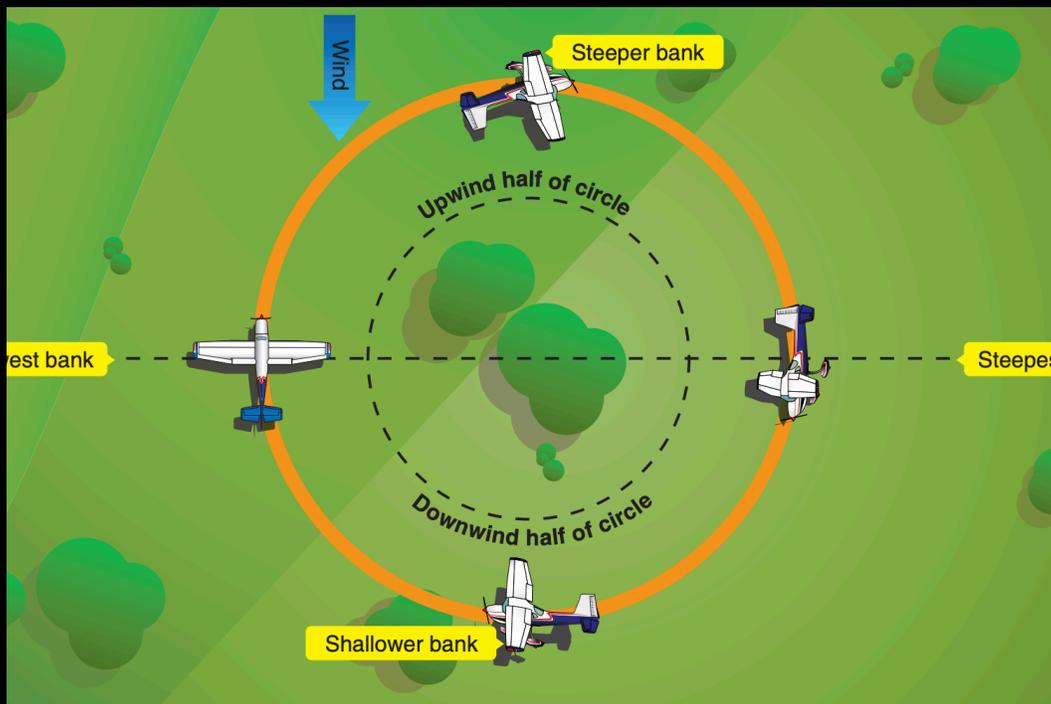


Rich Stowell's

# Learn to Turn



## Flight Simulation Exercises

Ground Reference Maneuvers  
As depicted in the FAA Airplane Flying Handbook  
and Rich Stowell's Learn to Turn Training Exercises.



# A Renewed Appreciation for Ground Reference Maneuvers



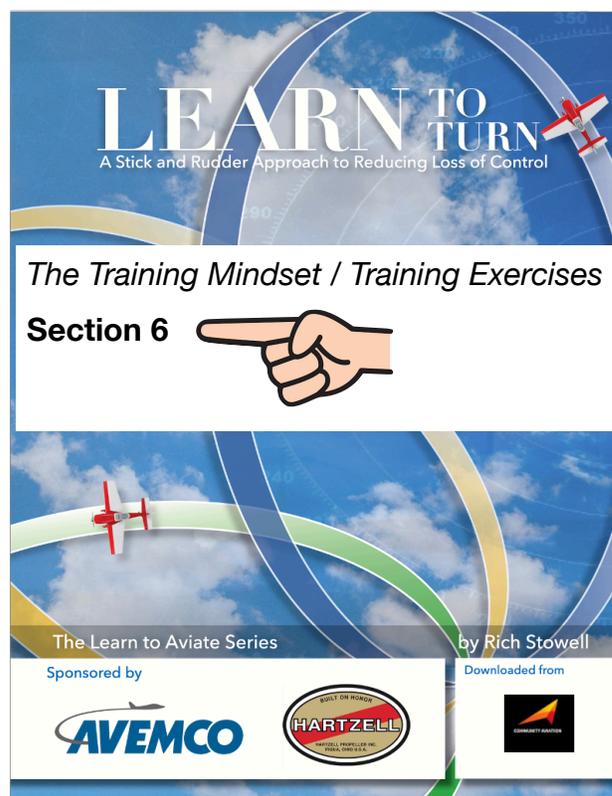
"A pilot must develop the proper coordination, timing, and attention to accurately and safely maneuver the airplane with regard to the required attitudes and ground references. Ground reference maneuvers are the principle flight maneuvers that combine the four fundamentals (straight-and-level, turns, climbs, and descents) into a set of integrated skills that the pilot uses in their everyday flight activity." *The Airplane Flying Handbook / Ground Reference Maneuvers.*

Many of us have not reviewed this book since our last knowledge test but it contains some good exercises that we can practice on a PC flight simulation device.

Let's review the Learn-Do-Fly method referred to in Section 6 of the Learn to Turn e-booklet. Now that we've completed some learning we can "Do" more in a flight sim. While we won't have true seat-of-the-pants G-cueing capability there are opportunities to rehearse exercises before we get in the airplane.

Follow these rules to practice deeply:

- CHUNK IT - Absorb the whole but then break it down into its component parts.
- REPEAT IT - Repetition is essential. Perishable skills need to be practiced.
- FEEL IT - Learn to know when it feels right and when it feels wrong.



## A Renewed Appreciation for Flight Simulation



Patented in 1929, the **Link trainer** permitted pilots to practice more deeply, to stop, struggle, make errors, and learn from them. During a few hours in a Link trainer, a pilot could “take off” and “land” a dozen times on instruments. He could dive, stall, and recover, spending hours inhabiting the sweet spot at the edge of his capabilities in ways he could never risk in an actual plane.

Daniel Coyle, *The Talent Code*

General aviation pilots today can practice deeply on a home PC, or in a more sophisticated motion simulator at a flight training center.



# Training Exercises with your PC Flight Sim

## SIM SETUP

Think of this process analogously, as any athlete would. You go to the tennis court with a basket of balls and start hitting against the backboard. You work your forehand stroke over and over. Then switch to your backhand and try that. Work on your serve, hit volleys. Repetition is good.

The key is to follow the three rules we referred to above: chunk it, repeat it, feel it. And even if you can't really "feel it" with a desktop PC and a simple joystick you can begin to imbed the procedures that you will use in the airplane when you transition from Do, to Fly.

It does not make a difference whether you use X-Plane, MSFT Flight Simulator 2020, FSX, Lockheed Prepar3D, etc., or even what type of airplane you choose. Joystick, rudder pedals, yoke; it doesn't really matter what equipment you have as long as you have the right mindset. See "The Training Mindset" in Section 6 of the Learn-to-Turn e-booklet.

These are ground reference maneuvers so position your sim in a location that gives you a clear picture of your position relative to roads, terrain, and other visual cues. If you don't have a particular place in mind try Santa Paula, California.

Rich Stowell began his teaching career at CP Aviation located at KSZP. He frequently used the valley area between the airport and the town of Fillmore to the east for a practice area. It's replete with fields, roads, and terrain that make great ground references.

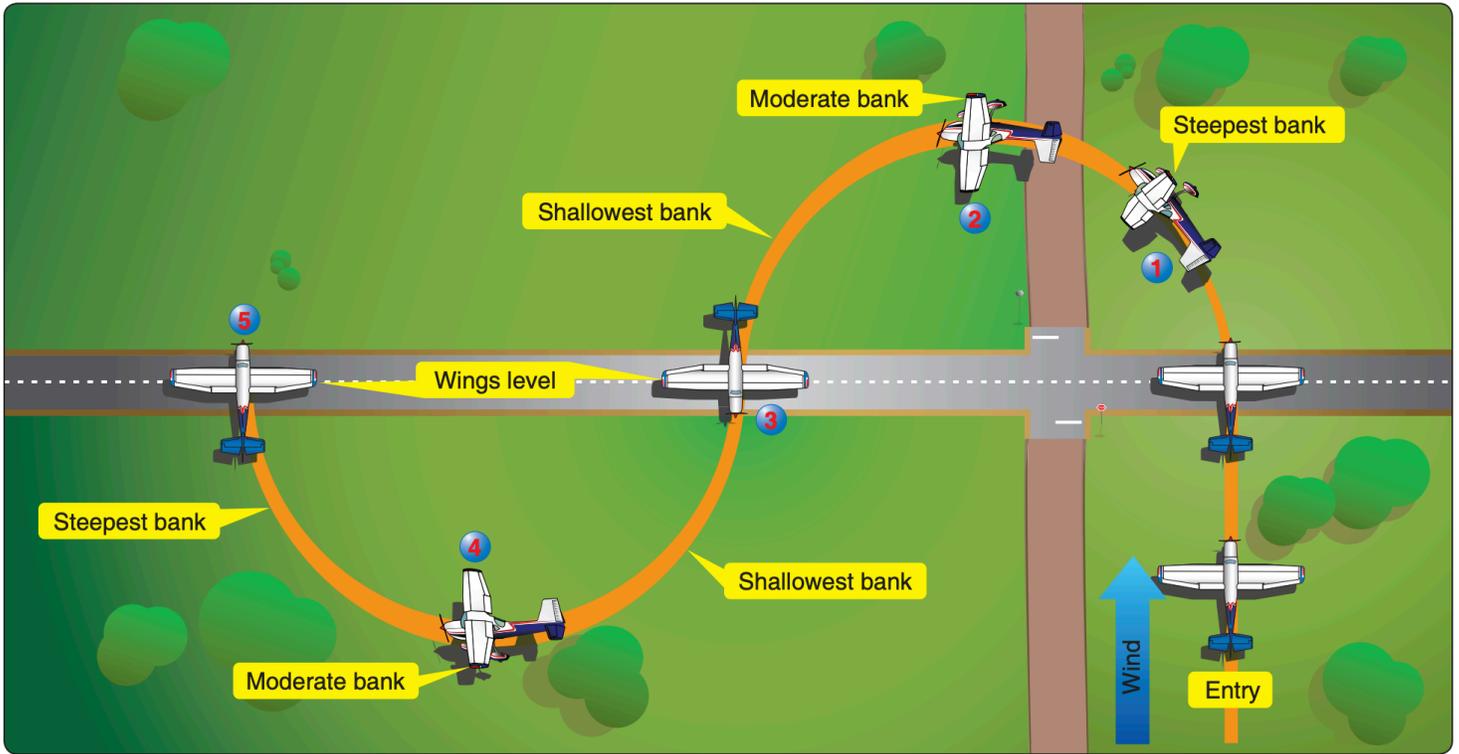
Select an altitude of at least 3,000' AGL and line up your "airplane" with a road or other landmark as a reference. Make sure you save your flight, or situation, once your position is good. You may find that it makes sense to save more than one flight location based on the maneuvers you want to perform.

For more advanced practice dial in some wind, from various directions. You can save these flights too. Before long you'll have your own customized exercise bundle.

Refer to the FAA Airplane Flying Book, specifically Chapter 6, Ground Reference Maneuvers. We'll follow with more advanced exercises from the Learn to Turn e-booklet.

Need help with your PC sim setup? Check out expert [Kevin Myers](#). He can help.

# S-Turns



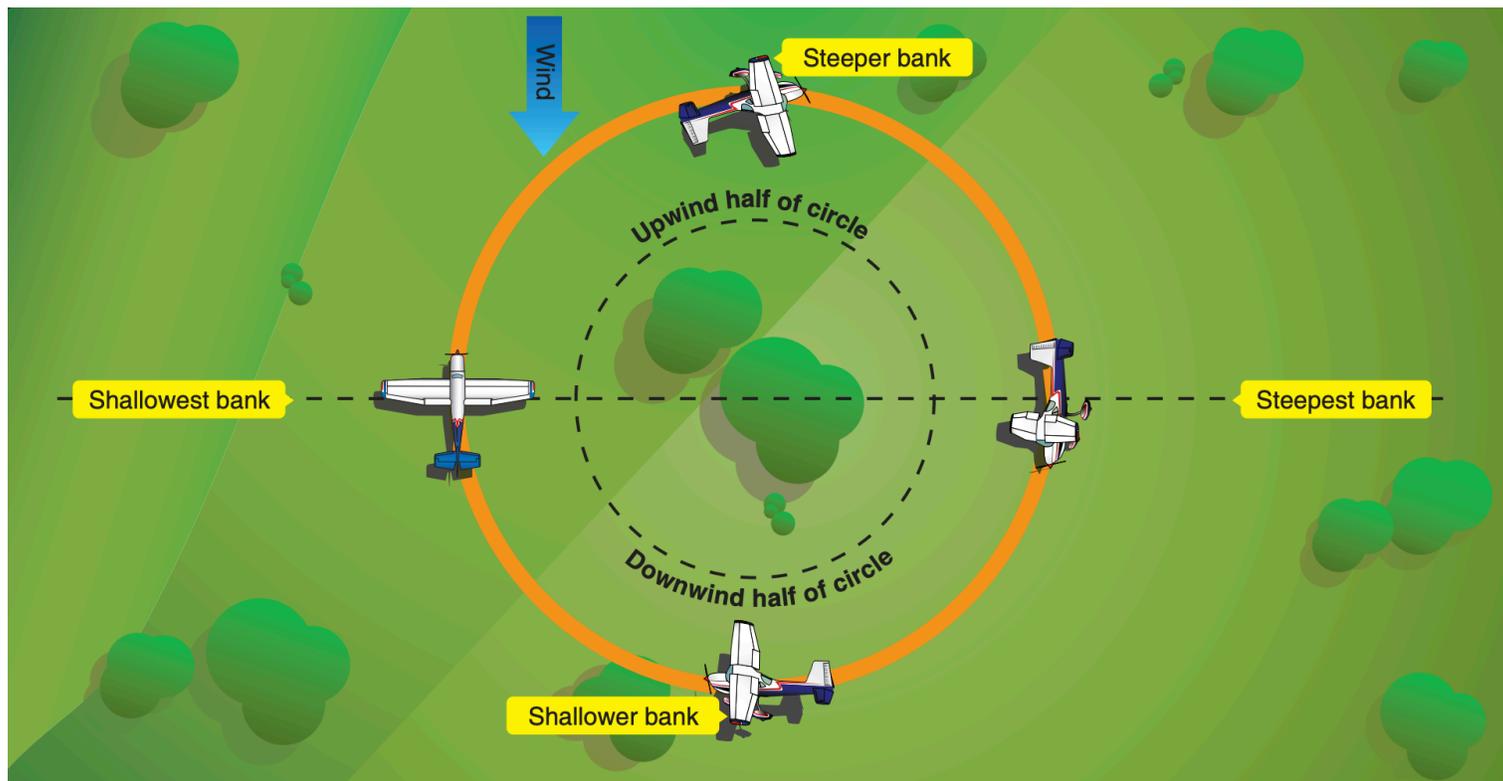
*From the FAA's Airplane Flying Handbook, Chapter 6, Ground Reference Maneuvers*

S-turns is a ground reference maneuver in which the airplane's ground track resembles two opposite but equal half-circles on each side of a selected ground-based straight-line reference. This ground reference maneuver presents a practical application for the correction of wind during a turn.

The objectives of S-turns across a road are as follows:

- Maintaining a specific relationship between the airplane and the ground.
- Dividing attention between the flightpath, ground-based references, manipulating the flight controls, and scanning for outside hazards and instrument indications.
- Adjusting the bank angle and amount of pull (i.e., G) during turns to correct for groundspeed changes in order to maintain a constant radius turn—steeper bank angles and higher Gs for higher ground speeds, shallow bank angles and lower Gs for slower groundspeeds.
- Rolling out from a turn with the required wind correction angle to compensate for any drift cause by the wind.
- Establishing and correcting the wind correction angle in order to maintain the track over the ground.
- Developing the ability to compensate for drift in quickly changing orientations.
- Arriving at specific points on required headings.

# Turns Around a Point



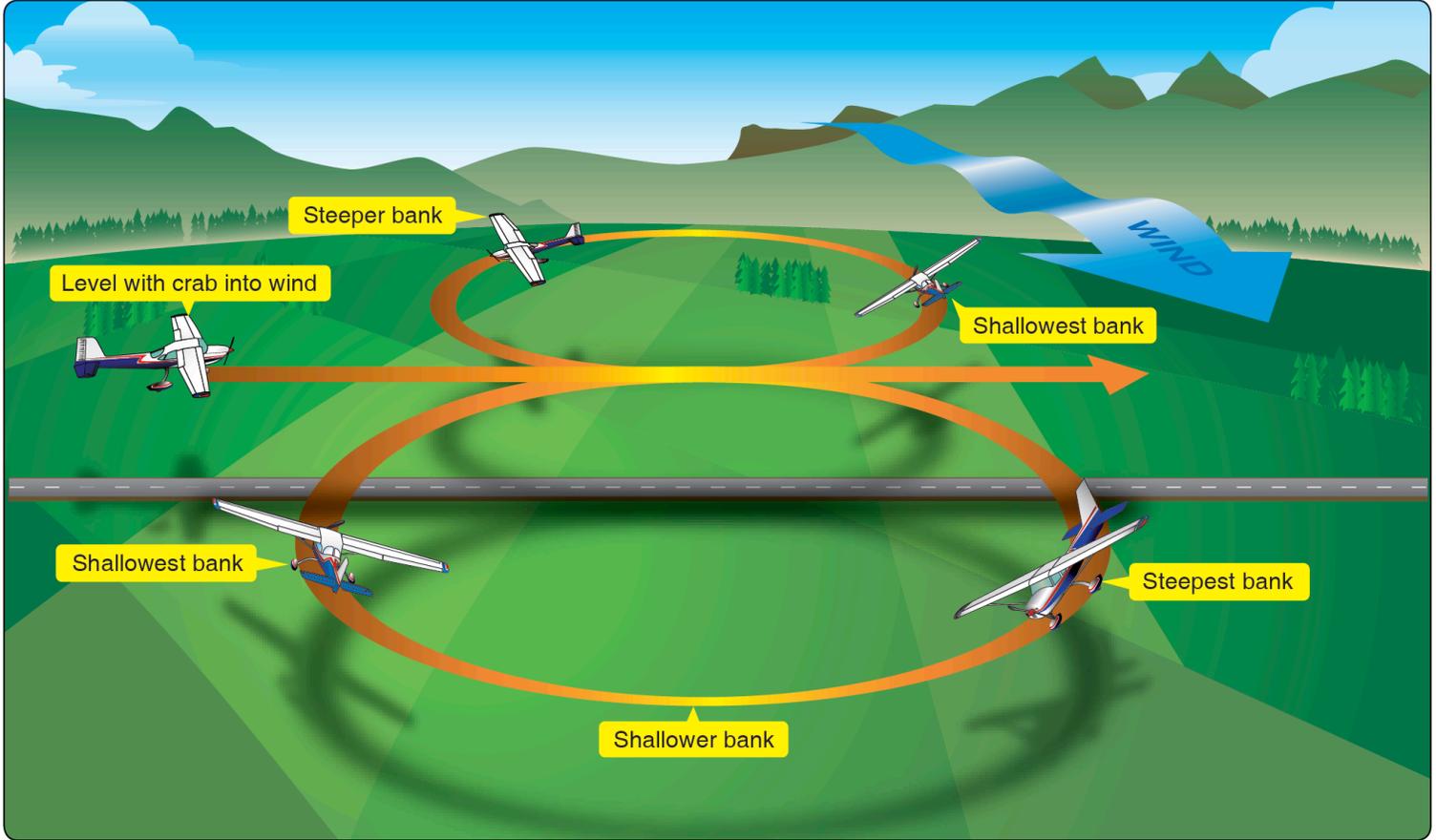
*From the FAA's Airplane Flying Handbook, Chapter 6, Ground Reference Maneuvers*

Turns around a point are a logical extension of both the rectangular course and S-turns across a road. The maneuver is a 360° constant radius turn around a single ground-based reference point. The principles are the same in any turning ground reference maneuver—higher groundspeeds require steeper banks and higher Gs, and slower ground speeds require shallower banks and lower Gs.

The objectives of turns around a point are as follows:

- Maintaining a specific relationship between the airplane and the ground.
- Dividing attention between the flightpath, ground-based references, manipulating of the flight controls, and scanning for outside hazards and instrument indications.
- Adjusting the bank angle and amount of pull (i.e., G) during turns to correct for groundspeed changes in order to maintain a constant radius turn - steeper bank angles and higher Gs for higher ground speeds, shallower bank angles and lower Gs for slower groundspeeds.
- Improving competency in managing the constantly changing bank angles and Gs.
- Establishing and adjusting the wind correction angle in order to maintain the track over the ground.
- Developing the ability to compensate for drift in quickly changing orientations.
- Developing further awareness that the radius of a level turn is correlated to the bank angle and required G.

# Eights Along a Road



*From the FAA's Airplane Flying Handbook, Chapter 6, Ground Reference Maneuvers*

Eights along a road is a ground reference maneuver in which the ground track consists of two opposite  $360^\circ$  adjacent turns with the center of each  $360^\circ$  turn and the adjacent turn point perpendicular or parallel to the straight-line ground reference (road, railroad tracks, fence line, pipeline right-of-way, etc.).

Like the other ground reference maneuvers, its objective is to further develop division of attention while compensating for drift, maintaining orientation with ground references, and maintaining a constant altitude. Although eights along a road may be performed with the wind blowing parallel or perpendicular to the straight-line ground reference, only the perpendicular wind situation is explained since the principles involved are common to each.

The pilot should select a straight-line ground reference that is perpendicular to the wind and position the airplane parallel to and directly above the straight-line ground reference. Since this places the airplane in a crosswind position, the pilot must compensate for the wind drift with an appropriate wind correction angle. Remember: steeper banks require higher Gs; shallower banks require lower Gs.

*The following exercises are from the Learn to Turn e-booklet, section 6, Training Exercises. See the booklet for additional details such as common errors, tips and variations.*

## Dutch Rolls

**Essence:** Rock the wings left and right while on a constant heading

Plane: Horizontal

Objectives:

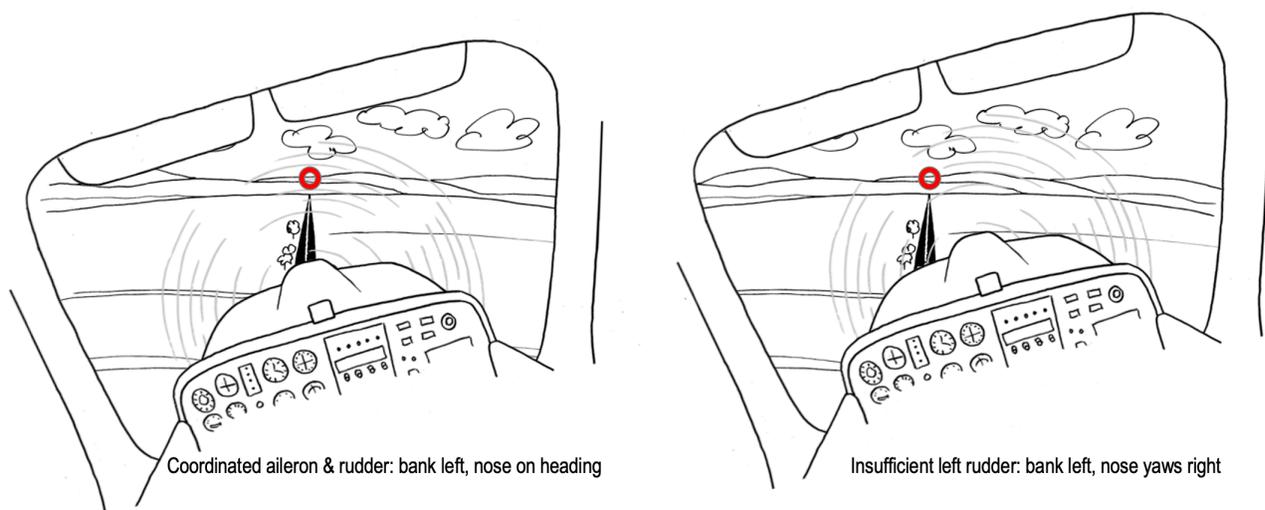
- Experience banking without turning
- Learn to coordinate aileron and rudder inputs
- Develop visual and kinesthetic cues for roll and yaw
  - See head-to-hip movements relative to the pilot.
  - Feel not only the differences between aileron and rudder control pressures, but also their displacements (i.e., how far you are moving them).
  - See and feel the difference between coordinated and uncoordinated flight

Applicability:

- Banking into and out of turns in horizontal and oblique planes
- Recovering from spirals and other overbanked attitudes
- Correcting deviations in bank caused by turbulent air

Actions and consequences: The pilot applies the ailerons; the airplane rolls. The airplane also yaws, requiring corrective action with the rudder.

**Takeaway:** Coordinated banking requires linking our aileron and rudder inputs together—same time, same direction.



**See also the Learn to Turn video at 03:22**

# Undulating Turns

**Essence: Play with the elevator to see its effect on turning flight while holding a constant bank angle**

Plane: Horizontal with minor excursions into the oblique

Objectives:

- Experience the effect elevator has on flight path
- Find the right match between pitch and bank vis-à-vis the  $\emptyset$ -G curve for horizontal turns
- Develop visual and kinesthetic cues for pitch
  - See head-to-feet movements relative to the pilot
  - Feel not only the subtle changes in control pressures, but also their displacements
  - Possibly feel changes in G-load (depends on Just Noticeable Difference)

Applicability: Performing normal level turns

Actions and consequences: The pilot varies elevator inputs while turning; the plane of the turn changes. Secondary effects may be evident, requiring corrective aileron and rudder actions.

**Takeaway: Use the elevator to manage the shape, type, and quality of turning flight**

*See also the Learn to Turn video at 05:36*

# Sine Waves

**Essence: Pull into a climb, then push into a descent**

Plane: Vertical

Objectives:

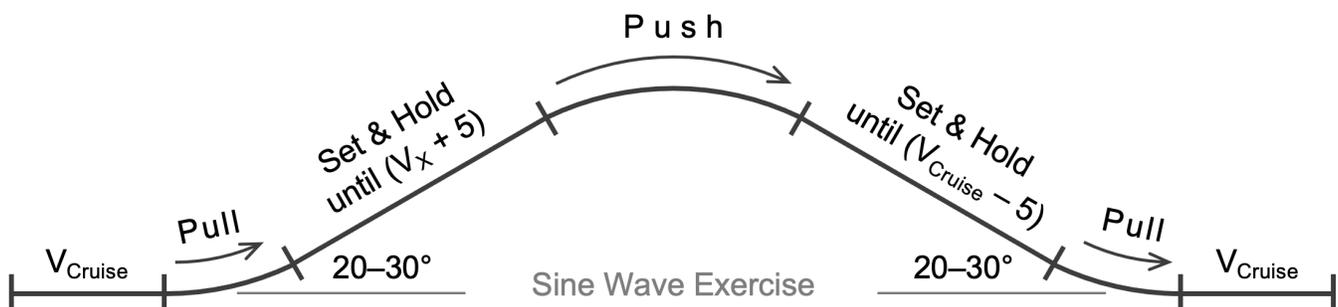
- Experience turns in the vertical plane
- Learn to coordinate elevator and rudder inputs
- Manage G-load, speed, and proximity to the stall
- Develop visual and kinesthetic cues for pitch
  - See head-to-feet movements relative to the pilot
  - Feel not only the differences in control pressures, but also their displacements
  - Feel changes in G-load
  - See and feel the difference between coordinated and uncoordinated flight

Applicability:

- Performing normal climbs and descents
- Reacting to an engine failure during climbout
- Recovering from stalls
- Rounding out for landing

Actions and consequences: The pilot makes pitch inputs in wings-level flight; the flight path curves in the vertical plane. The airplane also yaws, requiring corrective action with the rudder.

**Takeaway: Use the elevator to bend or straighten your flight path**



# Acro-Style Turns

**Essence: Separate the banking piece from the turning piece during level turns**

Plane: Horizontal

Objectives:

- Experience the effect elevator has on flight path
- Learn to separate roll inputs from pitch inputs
- Find the proper match between G and bank vis-à-vis the  $\phi$ -G curve for horizontal turns
- Improve precision and discipline with your control movements
- Develop visual and kinesthetic cues
  - See head-to-hip motion while rolling; head-to-feet motion while pitching
  - Feel not only the changes in control pressures, but also their displacements
  - Feel changes in G-load and correlate the required G with the sight picture for level turning at the given bank angle

Applicability:

- Performing normal level turns
- Learning steep turns
- Recovering from spirals and other overbanked attitudes

Actions and consequences: The pilot applies coordinated aileron and rudder inputs; the airplane Dutch rolls. The pilot neutralizes aileron and rudder inputs; the airplane instantly stops rolling. The pilot pulls the elevator control aft; the airplane turns. Provided the G-load equals the inverse of the cosine of the bank angle, the turn occurs in the horizontal plane. The pilot unloads the added G; the airplane instantly stops turning.

**Takeaways:**

- **Ailerons roll the airplane**
- **Elevator bends or straightens the flight path**
- **Rudder maintains coordinated flight**

# Acro-Style Turns (cont'd)

