# Tailwheel ground school


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Red Bull


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# Why does loss of control happen?

- Let's talk about
  - Lateral stability
  - Left turning tendencies
  - Stall/spins
  - Aileron reversal
- How to prevent incidents?
  - Procedures
  - Techniques
  - Experience


# First let's look at regulations

**FAR 61.31 — Type rating requirements, additional training, and authorization requirements.**

(i) *Additional training required for operating tailwheel airplanes.* (1) Except as provided in paragraph (i)(2) of this section, no person may act as pilot in command of a tailwheel airplane unless that person has received and logged flight training from an authorized instructor in a tailwheel airplane and received an endorsement in the person's logbook from an authorized instructor who found the person proficient in the operation of a tailwheel airplane. The flight training must include at least the following maneuvers and procedures:

(i) Normal and crosswind takeoffs and landings;

(ii) Wheel landings (unless the manufacturer has recommended against such landings); and

(iii) Go-around procedures.

(2) The training and endorsement required by paragraph (i)(1) of this section is not required if the person logged pilot-in-command time in a tailwheel airplane before April 15, 1991.

**FAR 61.57 — Recent flight experience: Pilot in command.**

(a) *General experience.* (1) Except as provided in paragraph (e) of this section, no person may act as a pilot in command of an aircraft carrying passengers or of an aircraft certificated for more than one pilot flight crewmember unless that person has made at least three takeoffs and three landings within the preceding 90 days, and—

(i) The person acted as the sole manipulator of the flight controls; and

(ii) The required takeoffs and landings were performed in an aircraft of the same category, class, and type (if a type rating is required), and, if the aircraft to be flown is an airplane with a tailwheel, the takeoffs and landings must have been made to a full stop in an airplane with a tailwheel.


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# Leaving our comfort zone

- It’s a fact of life that pilots new to tailwheel will be embarrassed by their aircraft sooner or later
- The purpose of training is to get done with the unavoidable embarrassment without damaging the aircraft
- Show of hands: who has been flying tailwheel aircraft?
- Show of hands: who has already done a groundloop?


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# Are taildraggers more difficult to fly?

Maybe it's nosewheel aircraft that are easier to fly…

Is a tailwheel pilot a better pilot?

•Not necessarily, but a tailwheel pilot has to maintain a level of control of the aircraft that is rarely required from a tricycle gear pilot.

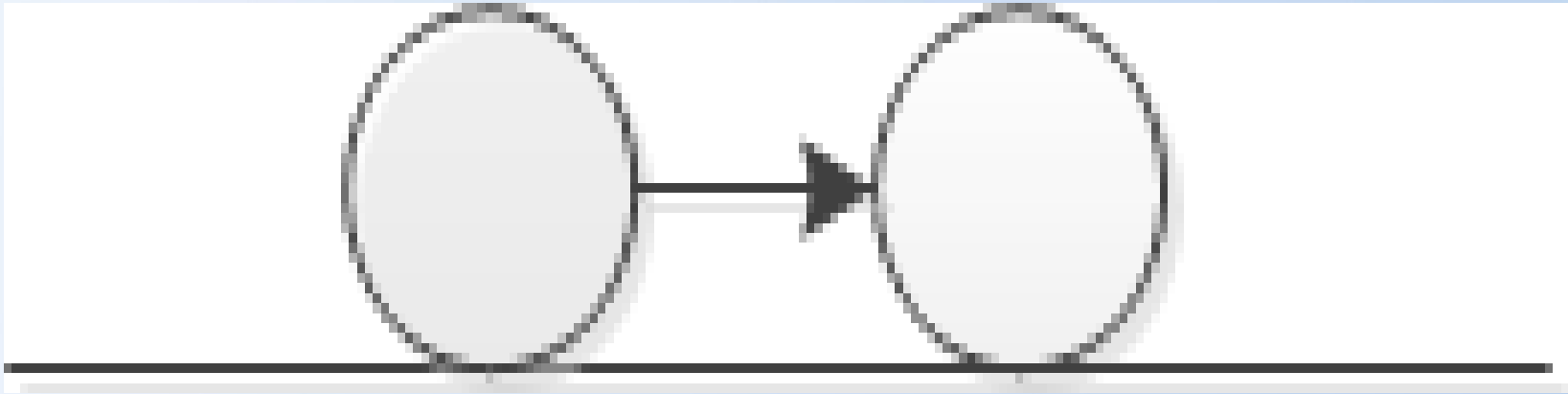
•Those who had never flown a tailwheel airplane may have developed bad habits because of the inherent forgiveness of tricycle aircraft.


# What are the differences?

- After all, an airplane is an airplane, right?
- In flight, there's not much difference except we are usually dealing with older aircraft
- On the ground, however, the aircraft is negatively stable on its lateral axis
- So what is negative stability?

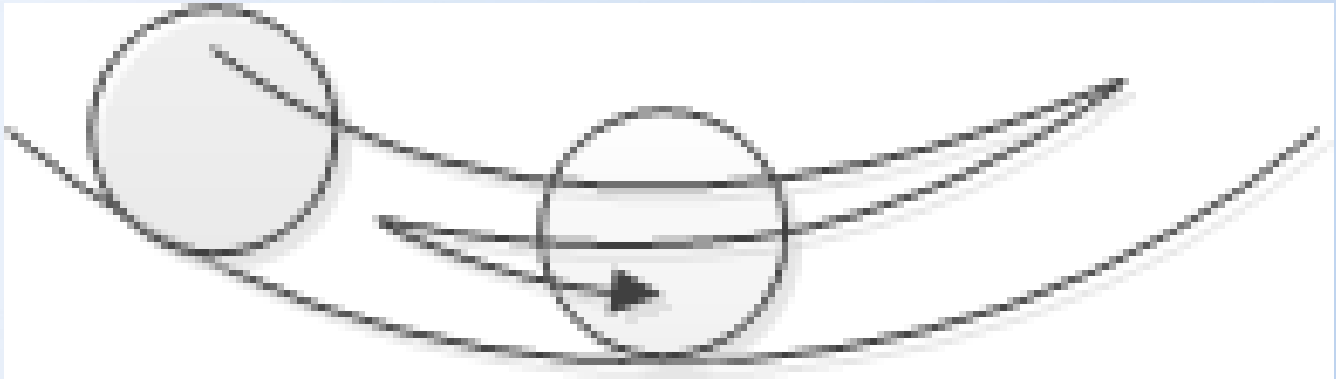
# Neutral stability

- Definition: object stays in its new position after a disturbance



# Positive stability

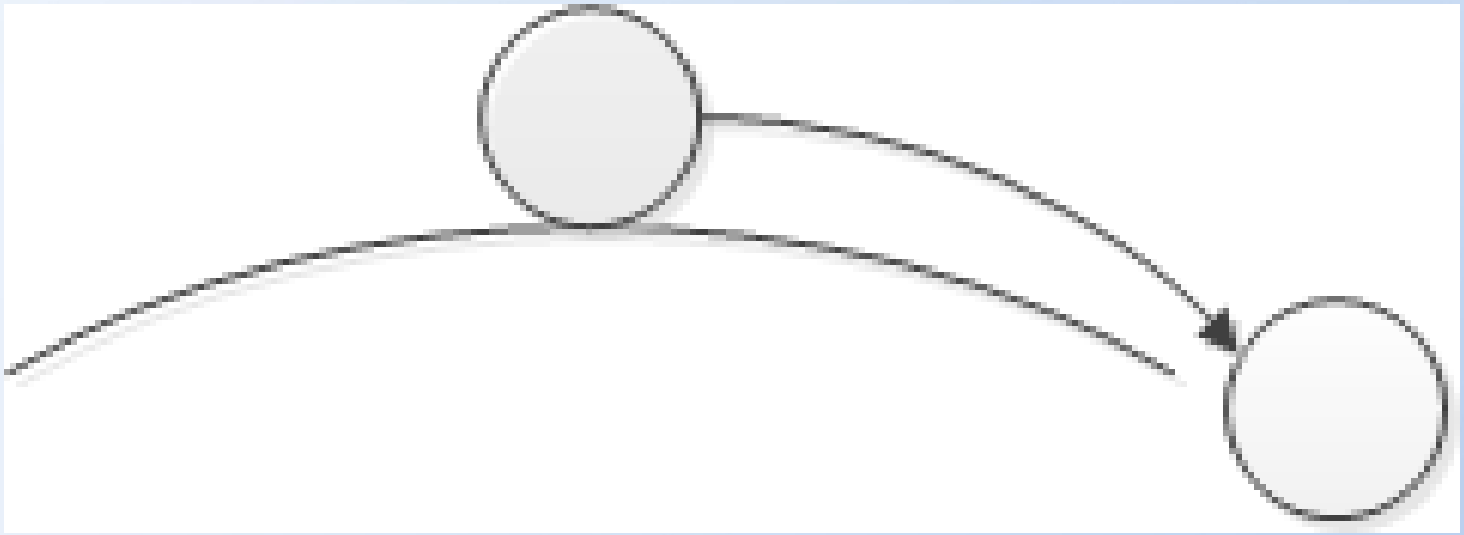
Definition: object returns to its original position after a disturbance → equilibrium



A tricycle gear aircraft has positive lateral stability on the ground (inherently stable)

# Negative stability

Definition: Object diverges from its equilibrium after any disturbance, even a small one



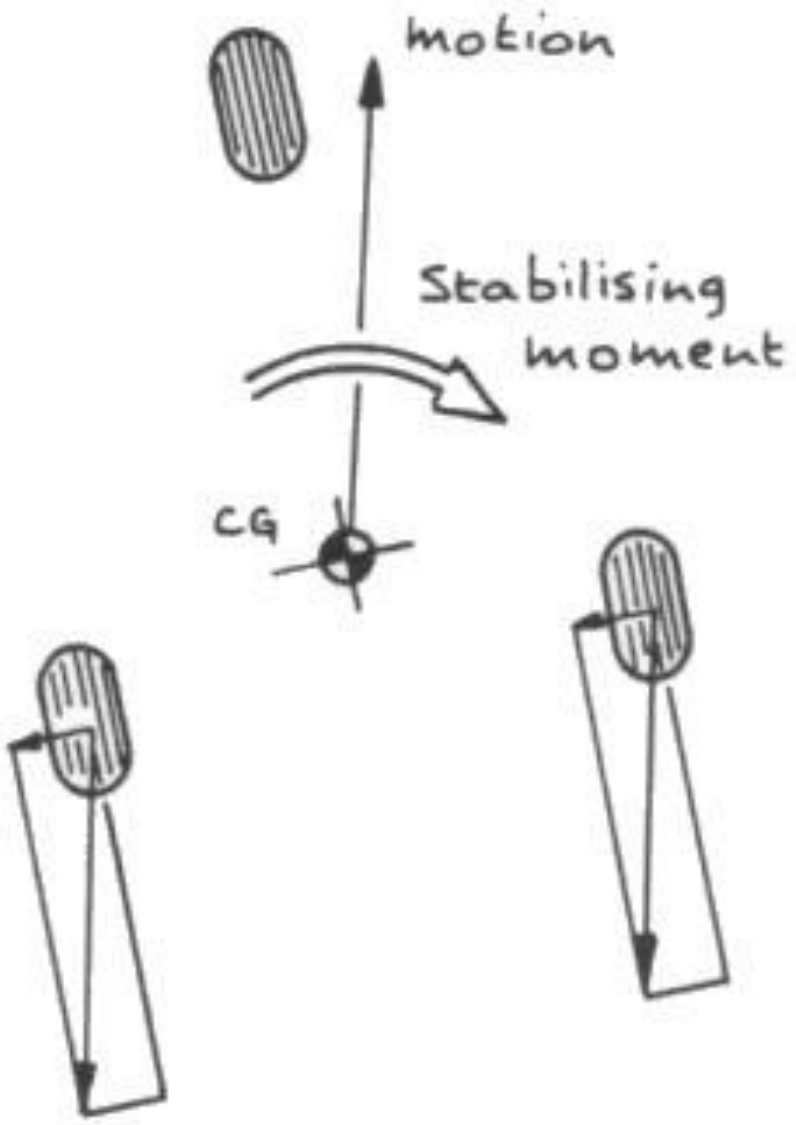
A tailwheel aircraft has negative lateral stability on the ground


# How does lateral stability affect us?

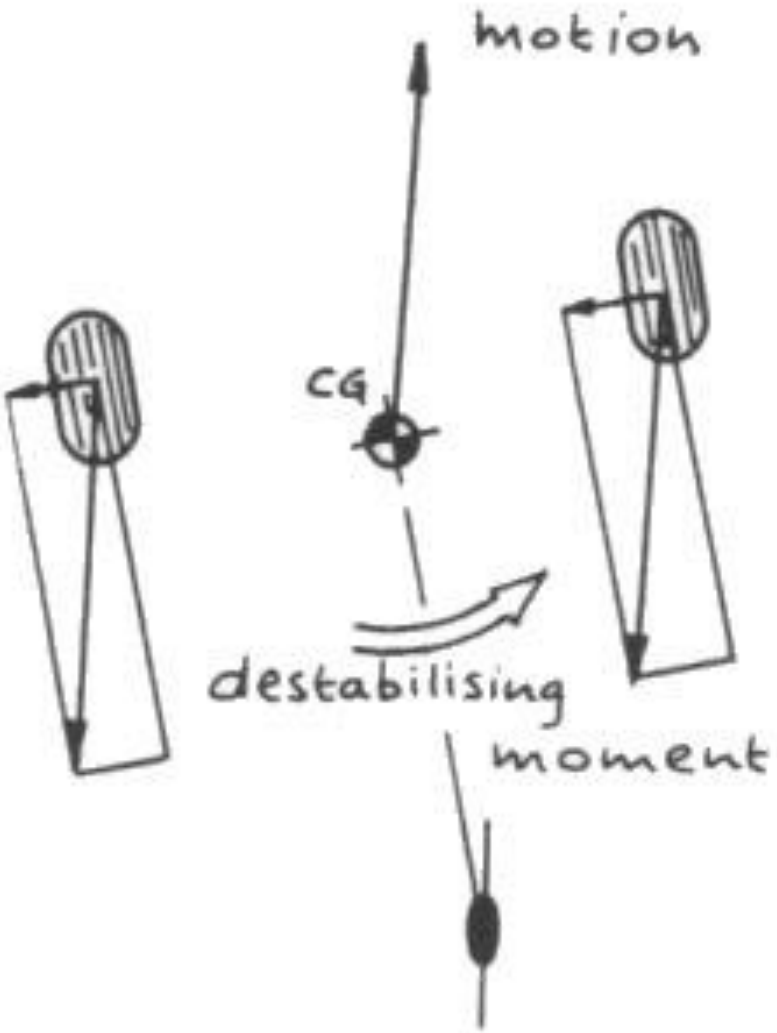
Visualize the aircraft momentum (energy) applied to the CG

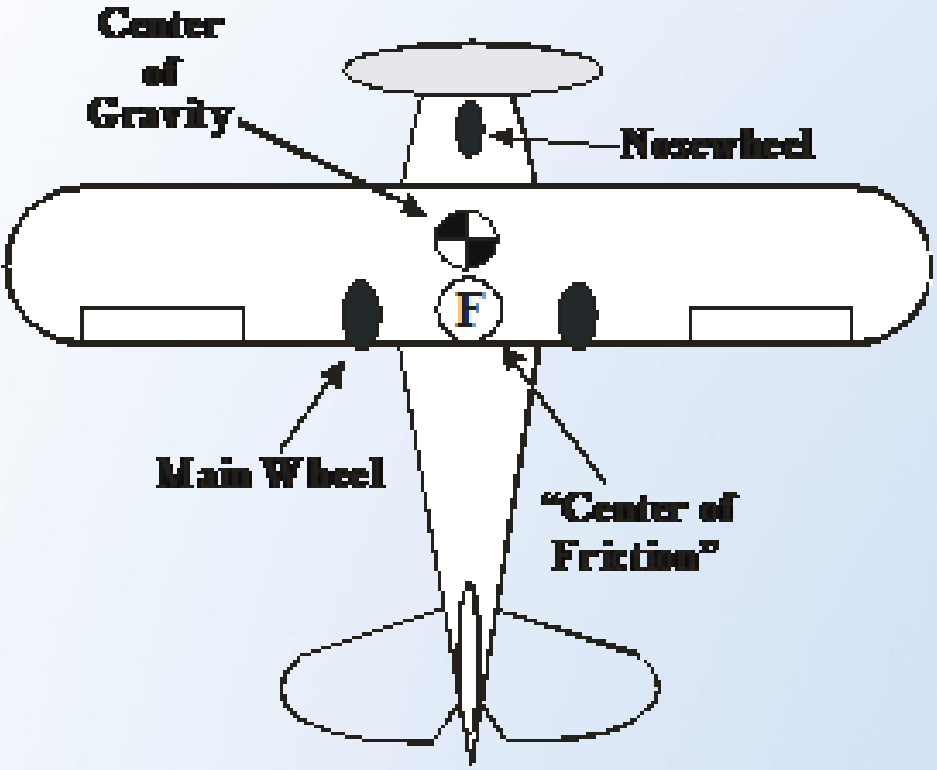
Picture a string pulling the aircraft from its CG

## Nosewheel Gear




## Tailwheel Gear




Center
of
Gravity
Nosewheel
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Main Wheel
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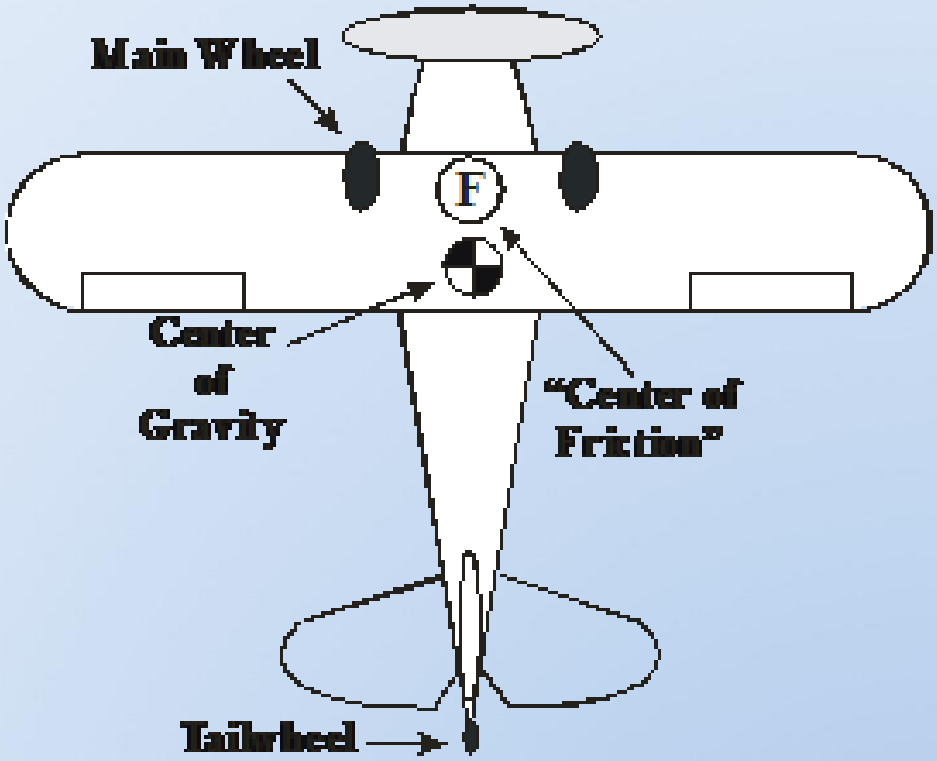
Main Wheel
F
Center
of
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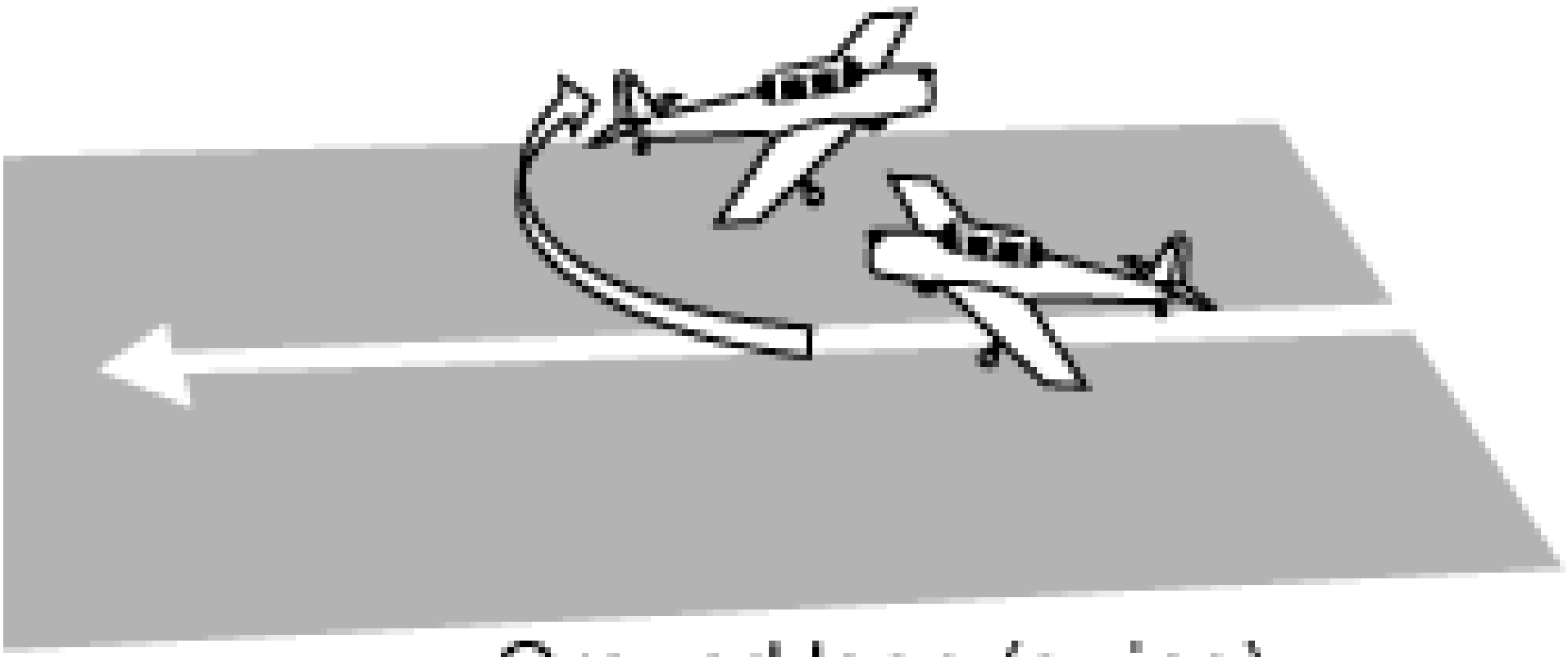
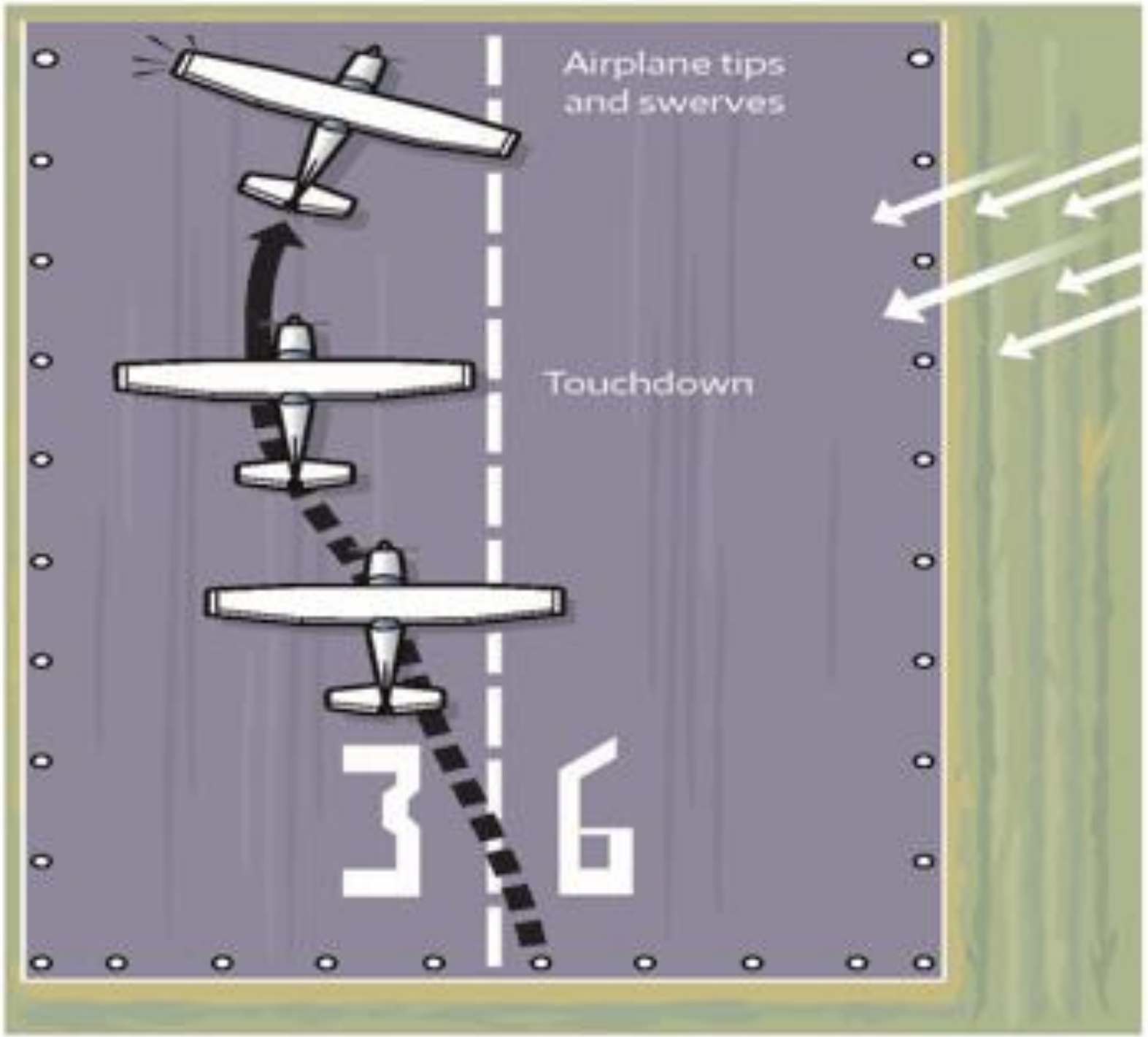
Tailwheel



Ground loop (swing)


Airplane tips
and swerves
Touchdown
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# How does lateral stability affect us?

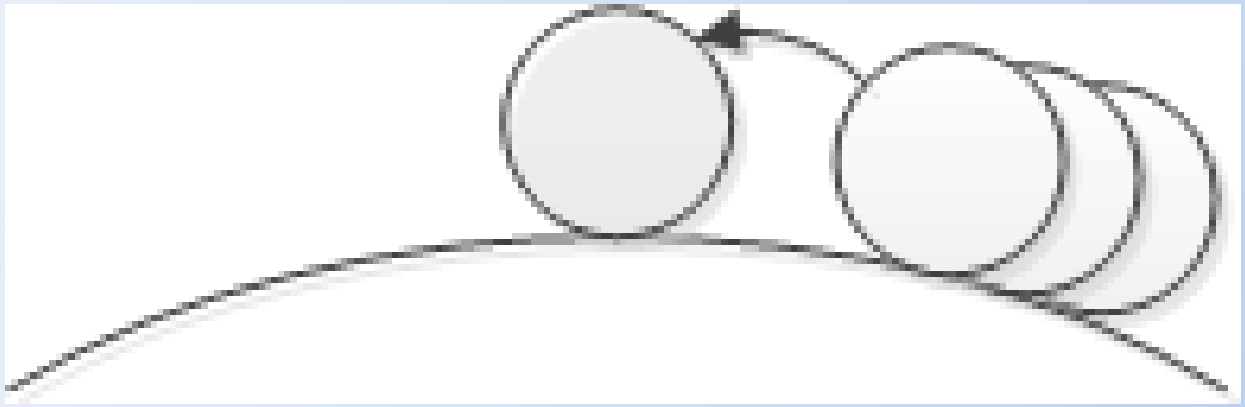
In a tricycle gear aircraft, any lateral deviation will self-correct

In a conventional gear aircraft, any lateral deviation will self-amplify

→ If the pilot does not fix it fast enough, it may be too late (that's what a groundloop is)

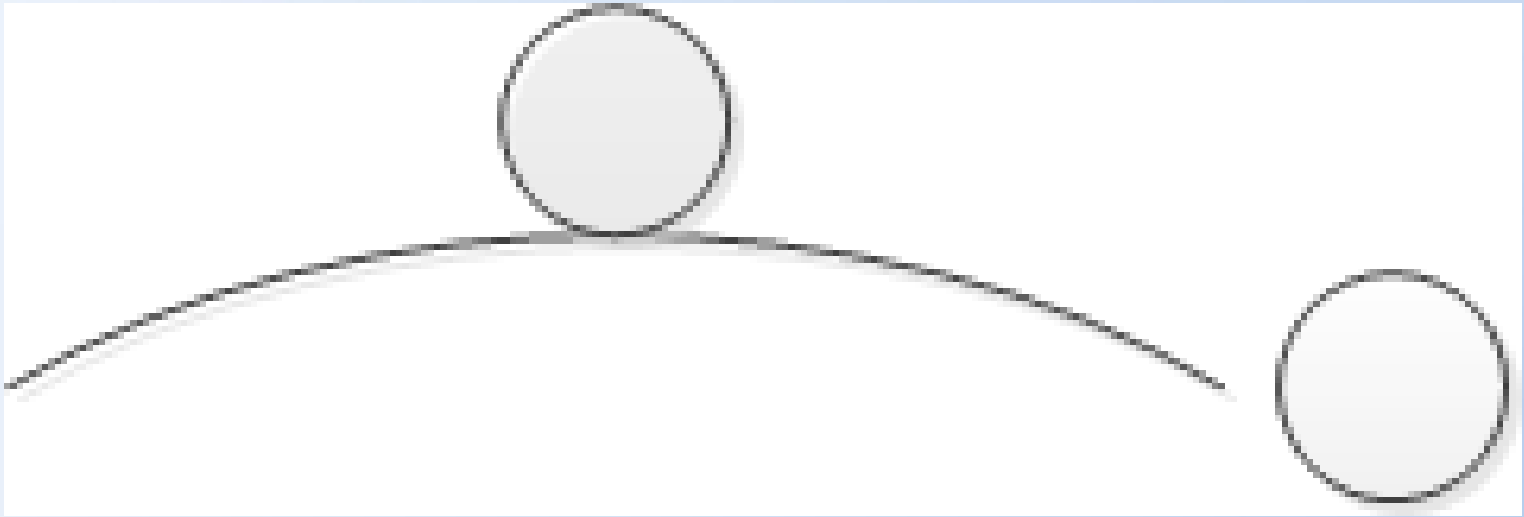
# Detect early and correct quickly

Imagine that the marble represents the momentum of the aircraft and that you control it with your rudders.



Detect any deviation early and correct quickly, before you run out of rudders!

Correct lateral deviations before running out of rudder effectiveness




# Stabilizing forces

- Vertical stabilizer/rudder
  - Only with positive airflow – best when relative wind is perpendicular to it
  - Least when tail low, slow airspeed, no propwash
- Tailwheel
  - Only when on the ground with weight on it – friction resists lateral deviations
  - Least when tailwheel is light or off the ground
- Power/propwash
  - Momentum pulling the aircraft straight ahead
  - Propwash blowing the control surfaces
- Ultimately: the pilot (rudders)
  - Reaction time is key

**Increase your clock speed**

# Most/least lateral instability

- Most unstable
  - Power off – momentum is pushing the aircraft
  - Tail low but tailwheel off the ground – no friction and airflow not perpendicular
  - Low airspeed – low control effectiveness

- Least unstable:
  - Power pulling the aircraft - propwash blowing the empennage
  - Tailwheel on the ground, stick back
  - Or tail up with weight on the mains and airflow perpendicular to vertical stab/rudder (best rudder effectiveness)

- The faster you go, the faster things happen

**<u>Increase your clock speed</u>**


# Develop aggressive finesse

- Detect deviations early
  - Increase your clock speed
- Correct aggressively
  - Use full control deflection if needed
- Control the aircraft with finesse
  - Do not overcontrol


# How can we practice aggressive finesse?

- Repeated landings
- Delayed recovery stalls (falling leaf)
  - This maneuver allows us to practice the exact same sensations and rudder inputs used for lateral control during landing while we are at a safe altitude


# Delayed recovery stalls

Deep stall at a safe altitude

- Power off
- Stick back
- Do not recover from the stall right away
- Keep wings level (more on this shortly)


# First, let's review spin recovery

- Power OFF
- FULL opposite rudder
- Stick forward (to neutral)
- Neutralize rudder when rotation stops
- Recover to level flight before speed builds up
  - But avoid secondary stalls !


# Falling leaf: how to keep the wings level in a stall?

Rudders!

But why?

# Why not use ailerons in a stall?

- How is lift created? How to increase lift?
  - Parasite drag vs. induced drag - Induced drag is a byproduct of lift

- Stall happens when critical angle of attack is reached
  - Drop of lift - Increase of induced drag

- What happens when we deflect the ailerons in a stall?

  - Aileron deflection: increases angle of attack on the low wing
  - But the wing is already stalled

  → Deeper stall on the wing with the down aileron

  → No increase in lift, but increase in induced drag (adverse yaw)

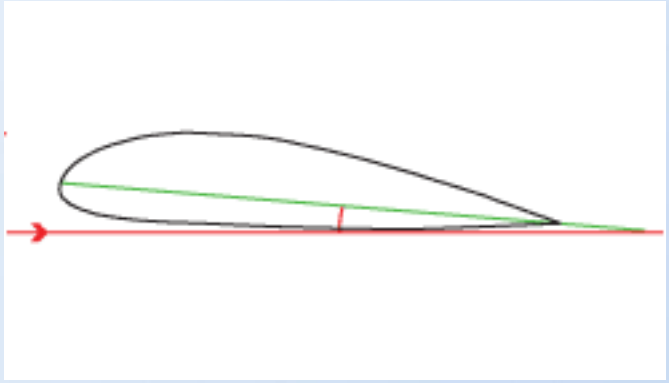
  → Roll in the direction of the down aileron – opposite the stick deflection

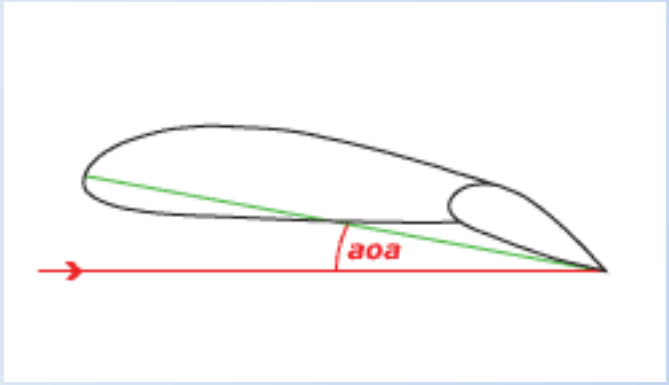
  → Aileron reversal!

  → Potential SPIN !!

On newer aircraft: wing warping, differential aileron deflection

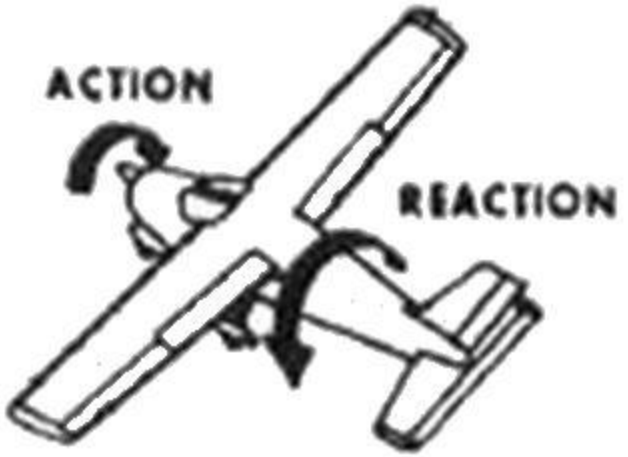
# Why not use ailerons in a stall?



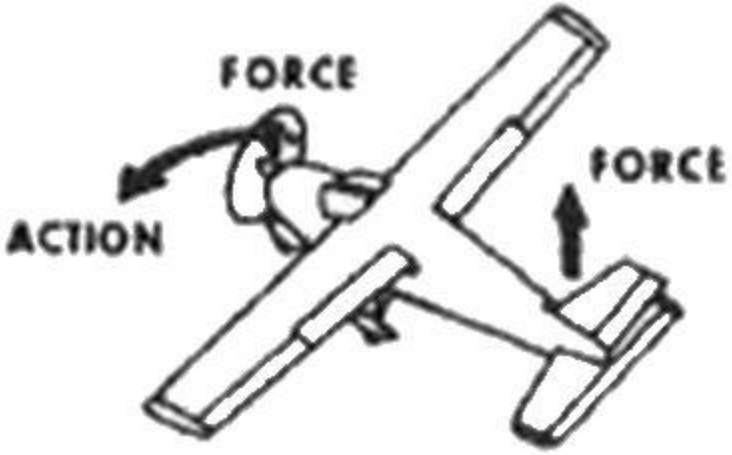



# Left-turning tendencies review

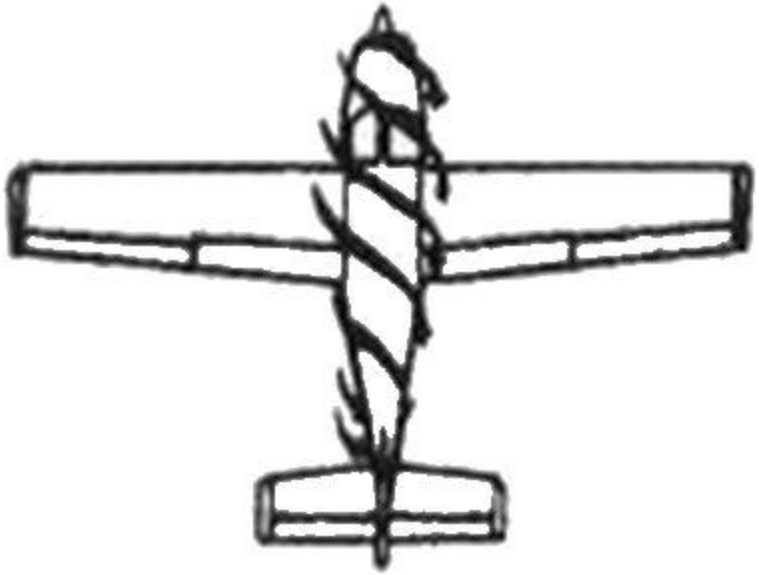
- Slipstream
- P-factor
- Torque
- Gyroscopic precession
  - When the tail comes up



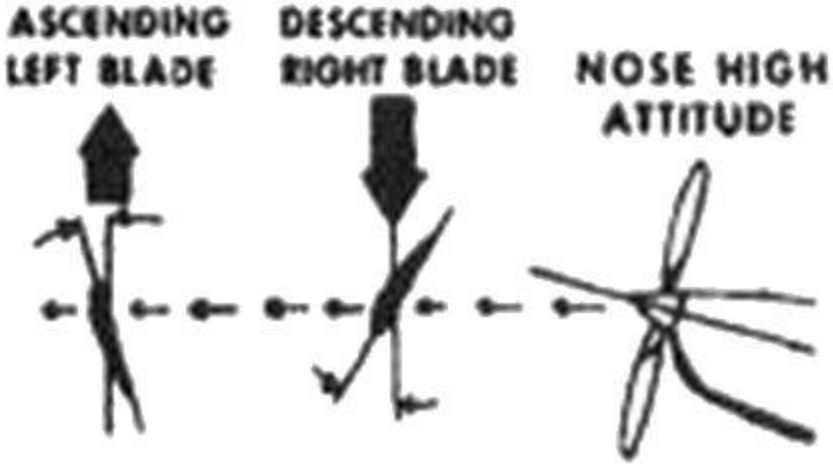

TORQUE REACTION




PRECESSION



SLIPSTREAM




P-FACTOR


# Questions?

- Reviewed:
  - –Negative stability
  - –Stalls/spins – aileron reversal
  - –Left turning tendencies

- Now: what can we do to prevent incidents?


# How to prevent incidents?

Let’s talk about

- Starting
- Taxiing
- Run-up
- Taking off
- Landing


# Starting a tailwheel aircraft

- What can go wrong?
  - Risk of nosing over
- Brakes ON
- Stick back
- Watch the throttle


# Taxiing

- Stick back - position with wind
- S-turns for visibility
- School zone speed

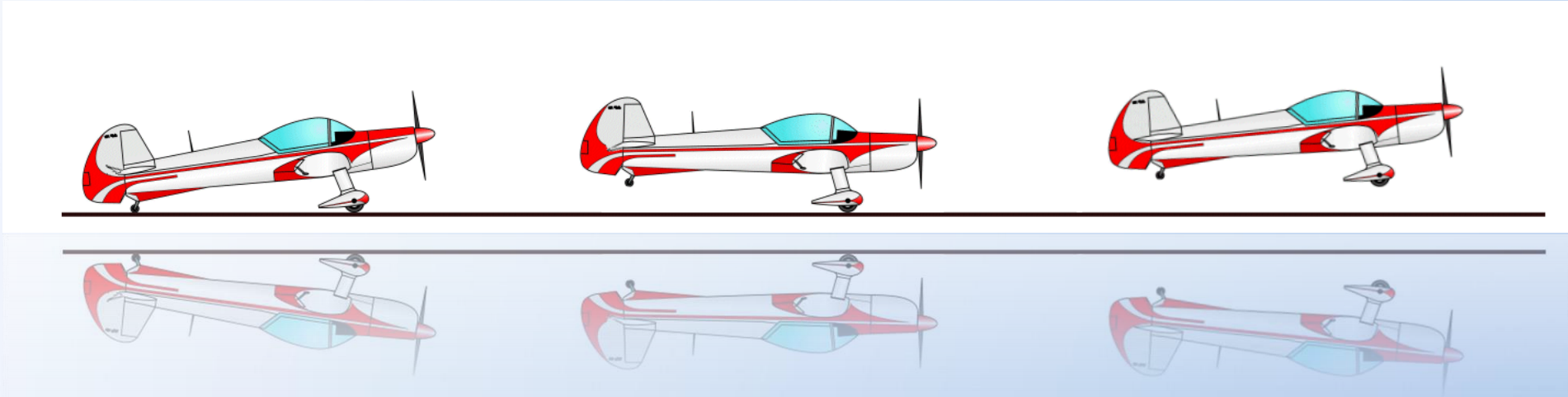

# Runup

- Face the wind
- Lock the tailwheel
- Hold the brakes
- Stick back!


# Takeoff sequence

- Lining up
  - Make your life easier – let it roll straight – make sure the tailwheel is locked
- Stick back, apply power progressively
  - Peripheral vision
  - P-factor, Slipstream
  - No brakes!
- Lift the tail – why?
  - Reduce tailwheel friction and aerodynamic drag
  - Watch for gyroscopic precession
  - Do not let the airplane skip on the runway

# Takeoff sequence




# How high should the tail be?

- High enough reduce aerodynamic drag, low enough so it stays comfortable
  - Depends on aircraft type and personal preference

- Tail low
  - Still subject to P-factor
  - Less rudder effectiveness (not parallel to airflow)
  - Risk of lifting off at slow airspeed in ground effect
  - Risk of skipping the main tires

- Level attitude (positively lifting the tail)
  - More stable
  - Less drag
  - Weight on the mains (to be progressively relieved when speed builds up)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# In flight

- Tailwheel aircraft are usually more demonstrative
  - P-factor in climb
    - Do not compensate with ailerons!
  - Adverse yaw while banking
    - Perform Dutch rolls to get acquainted
- Positive control at all time
- Watch for stalls, spins, aileron reversal
  (already covered)


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# Landing

- Detect early and fix quickly any deviation
  - Increase your Clock speed
  - Aggressive finesse

- Stay off the brakes as much as possible.  That's when bad things usually happen…
- ie
  - Risk of nosing over


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# When is a tailwheel aircraft stable on the ground?

- When it's stopped!
- When is not too unstable?
  - Slow: tailwheel on the ground, weight on the tailwheel (stick back)
  - Fast: tailwheel up, weight on the mains, airflow perpendicular to the rudder


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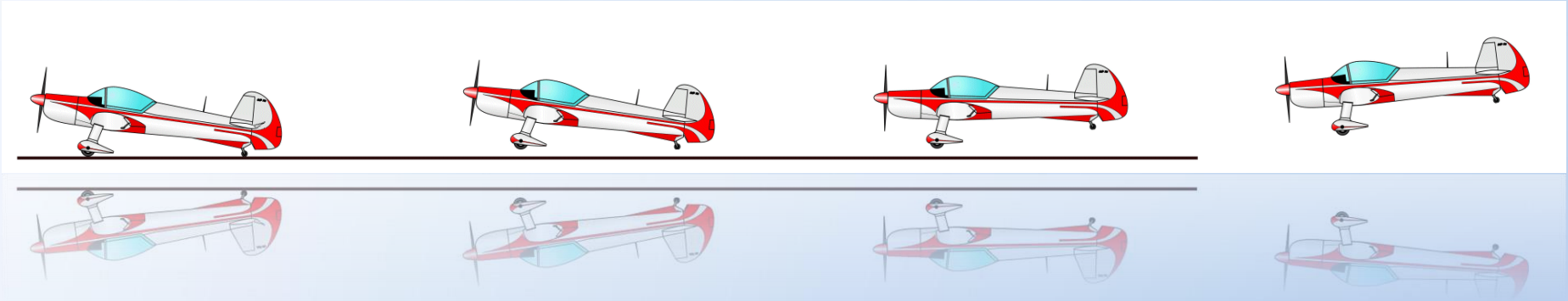
# Three-point Landing

- Heels on the floor
- Kill any drift before touchdown
- Full stall
  - Memorize and reproduce 3-point taxi attitude
- Use peripheral vision
  - Look straight ahead
  - Keep both triangles of asphalt/grass equal
- Power off & stick back when on the ground

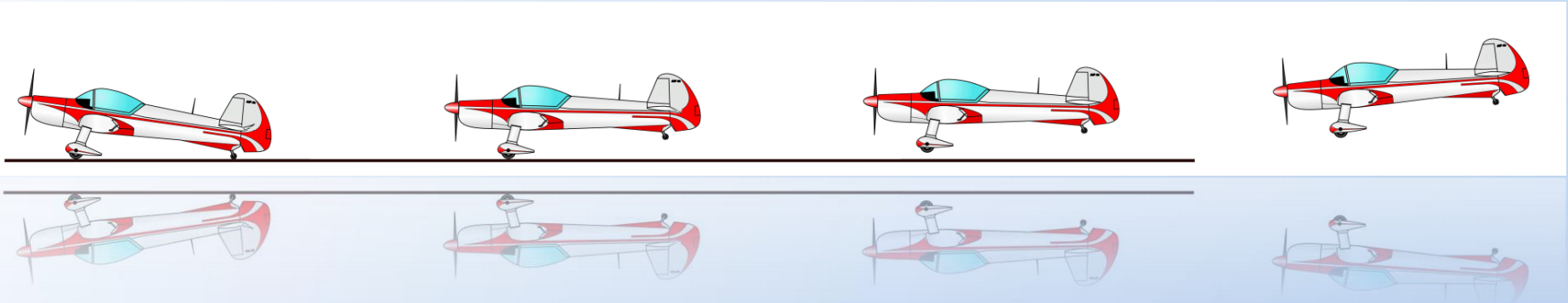
# 3-point landing




# Wheel Landing

- Touchdown close to a level flight attitude
  - Not a stall landing
  - Stay on the front side of the power curve
- When the mains touch
  - Nudge the stick forward to prevent aerodynamic bounce
  - Avoid PIO
- How high to keep the tail up?
  - Same as takeoff
  - Weight on the mains to help with stability

# Wheel landing




# Lowering the tail

- When/how to put the tailwheel down?
  - Fly the tailwheel down – do not let it fall
  - Risk of running out of rudder before running out of elevator
- Gyroscopic precession when tail comes down
- Rudder effectiveness at low speed
  - Stick back as soon as the tailwheel touches down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# Pros and cons

- Is a wheel landing more dangerous than a three-point?
  - Not unless you keep the tail high too long and run out of rudder!
- Be proficient in both 3-point and wheel landings (FAR 61.31)
  - Unless SOP in the aircraft is only wheel landings (B-17, C-45, C-47, etc)

# Training exercise

On a long runway:

- Perform a wheel landing
  - Keep the tail up
  - Add some power
  - High speed taxi
- Good for takeoff & wheel landing practice
  - Memorize sight picture
  - Optional: lift one wheel, then the other… Do not try this without an instructor on board!


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# Crosswing landing

As usual:

- Aileron into the wind
- Rudder to keep it straight
  - Kill any drift before touchdown
  - Keep the stick into the wind
- Is a wheel landing better in crosswinds?
  - Better control effectiveness – higher speed
  - Landing on the upwind wheel…
  - But the tailwheel needs to come down eventually… some prefer to do a 3-point


# Quartering tailwind

- Reduced rudder/aileron effectiveness
  - Risk of control reversal at slow speed
- Avoid quartering tailwind
  - Ask for a runway change!


# Landing roll

- That's when bad things usually happen
  - Momentum pushes the aircraft
  - Rudder less effective
- Detect early, correct quickly
  - Aggressive finesse
- Use peripheral vision in a 3-point attitude
  - Look straight ahead
  - Stay on the centerline
- Stick back when tailwheel is on the ground
- Use brakes sparingly

# Landing roll

It’s not over until the airplane is fully stopped

- Many accidents happen at the end of the landing roll, when the pilot relaxes

•Do not hesitate to apply power/go around if things start to get out of hand

- Power blows propwash on the controls and pulls the aircraft straight


# What can go wrong in a tailwheel aircraft?

Plenty…

- In the air:
  - Older aircraft, more demonstrative
  - Adverse yaw, P-factor, torque, gyroscopic precession
  - Stalls, accelerated stalls, spins
- On the ground:
  - Loss of control – negative stability
  - Nosing over – beware of brakes!
  - Hitting something – S-turns (zigzag)


# Loss of control / Groundloop

- Detect small deviation quickly and fix immediately
  - Precise, aggressive correction
  - Use finesse - do not overcontrol!
  - Most groundloops happen in the opposite direction of the initial deviation
- Use brakes only in last resort
  - Risk nosing over
- Keep the stick back
- Add some power to blow the rudder if needed

# Do not put yourself in a potential groundloop situation

- You need speed for a wheel landing
  - If too slow, do a 3 point instead
  - If a 3-point does not look good, go around!
- Avoid any quartering tailwind and watch for wake turbulence on the runway
- Detect small lateral deviations early
  - Stay focused – increase your clock speed on final
- Use peripheral vision
- Fly the aircraft all the way to the chocks


# No one is immune to a loss of control

- Develop a healthy respect for your aircraft and its traits.
- Nobody has immunity from embarrassment in a taildragger
  - The aircraft does not know how many hours the pilot has (nor does it care).
- Never let your guard down, it can happen to anyone!


# What is the most likely cause of a groundloop?

**Learn to respect the aircraft and expect its unstability**

Proof by contradiction : 100% of pilots who groundlooped never thought the day would end that way.

Therefore, if you believe it could happen to you, maybe it won't…


# Could this happen to you?