Ex. 24 a – Instrument Flying

Attitudes & Movements

What you will learn:

- ✓ Human factors in instrument flying, and how to counteract them
- ✓ How to control the plane solely by reference to instruments
  - Attitudes and Movements

Why learn this:

- ✓ You may find yourself in a situation with no good visual horizon:
  - inadvertent flight into cloud
  - dark night
  - haze, other low-visibility conditions
  - contaminated windshield (ice, bird strike)

- ✓ You may want to get an instrument rating
  – this training provides a foundation.

Human Factors

About people-their relationship with equipment, procedures and environment.

On instruments, situational awareness is critical

Just as importantly, relationships with other people-crew, ATC.

Twin objectives can be seen as safety and efficiency.

Human Factors

- Stress
- Fatigue
- Poor eating habits
- Alcohol and Hangover
- Discomfort
  - heat
  - cold
  - posture
- Noise, Vibration, Poor lighting
- Illness
- Medication
- Blood Donation
- Hypoxia – lack of oxygen
  - euphoria, tingling, dizziness, reduced vision, confusion
- Hyperventilation – too much oxygen
  - dizziness, tingling, hot and cold flashes, nausea, sleepiness
- Carbon Monoxide Poisoning
  - sluggishness, warmth, headache, dizziness, dimming of vision.

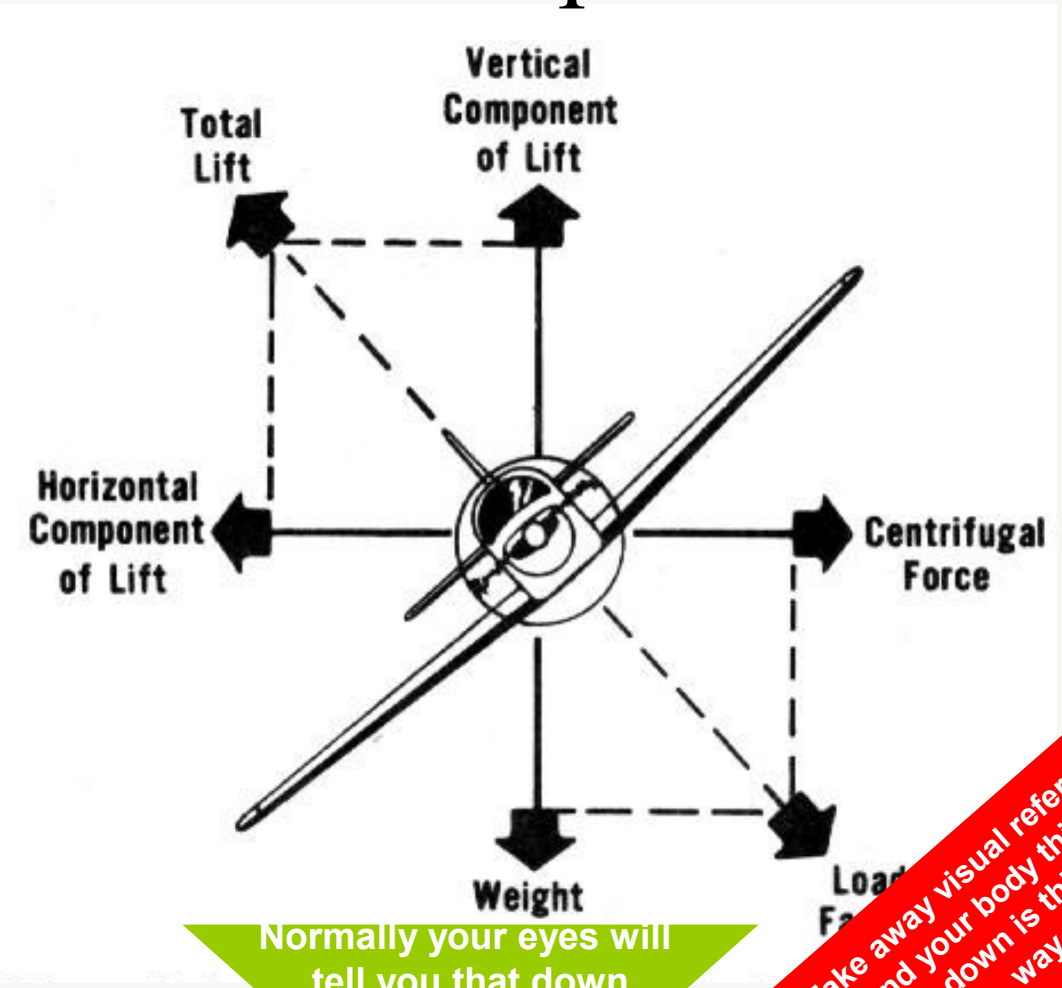
Human Factors
The "I'm Safe" Checklist

Illness	Am I coughing up huge amounts of blood & pus?
Medication	How many medical drugs am I currently on?
Stress	Is psychological pressure from bankruptcy, divorce & own children rejection taking attention from flying?
Alcohol	Do I drink alcohol? Am I an alcoholic? Do I have a hangover? Am I drunk right now?
Fatigue	How much over maximum duty today? Is sleeping in the car considered rest in suitable accommodation?
Eating	Do coffee, cigarettes and potato chips provide enough nutrition for the entire flight?

Illusions

- We use our senses to orient ourselves in space:
  - eyes
  - vestibular apparatus – inner ear
  - kinesthetically (“seat of your pants”)
- Normally visual inputs have priority
- In the absence of visual clues, the other two senses take over – and FAIL!

Illusions: One Example



Illusions

YOUR INSTRUMENTS WILL TELL YOU.

HELP!

WHICH

WAY

IS

UP?

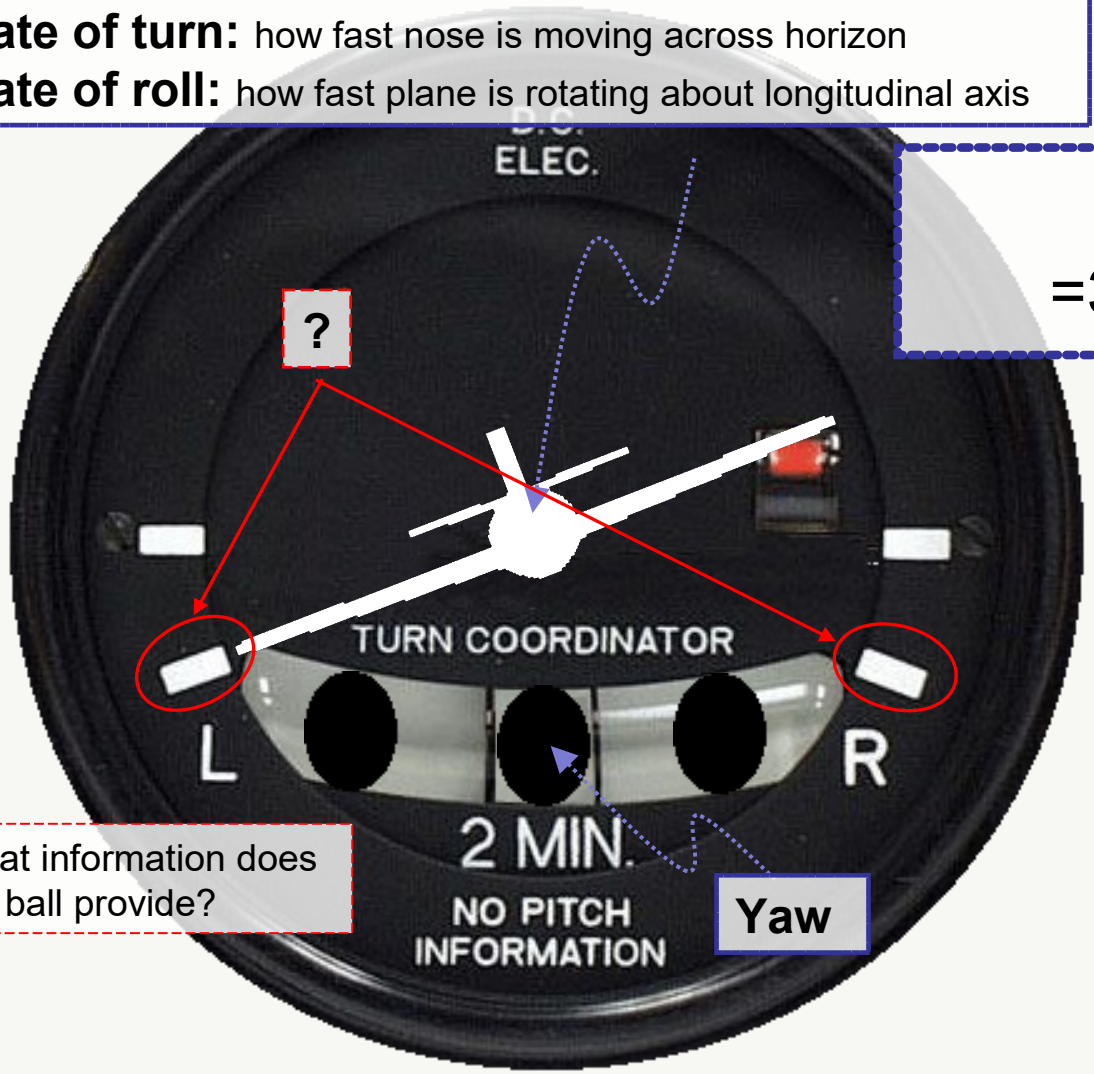
1) Air Speed Indicator

2) Attitude Indicator

3) Altimeter

4) Turn Coordinator

Rate of turn: how fast nose is moving across horizon
Rate of roll: how fast plane is rotating about longitudinal axis



Rate One Turn
=3 degrees per second

What information does the miniature airplane provide?

What kind of turn the plane is in? (Left, right? Coordinated, slipping, skidding?)

How long will it take to turn from heading 210 to heading 150 at rate one turn?

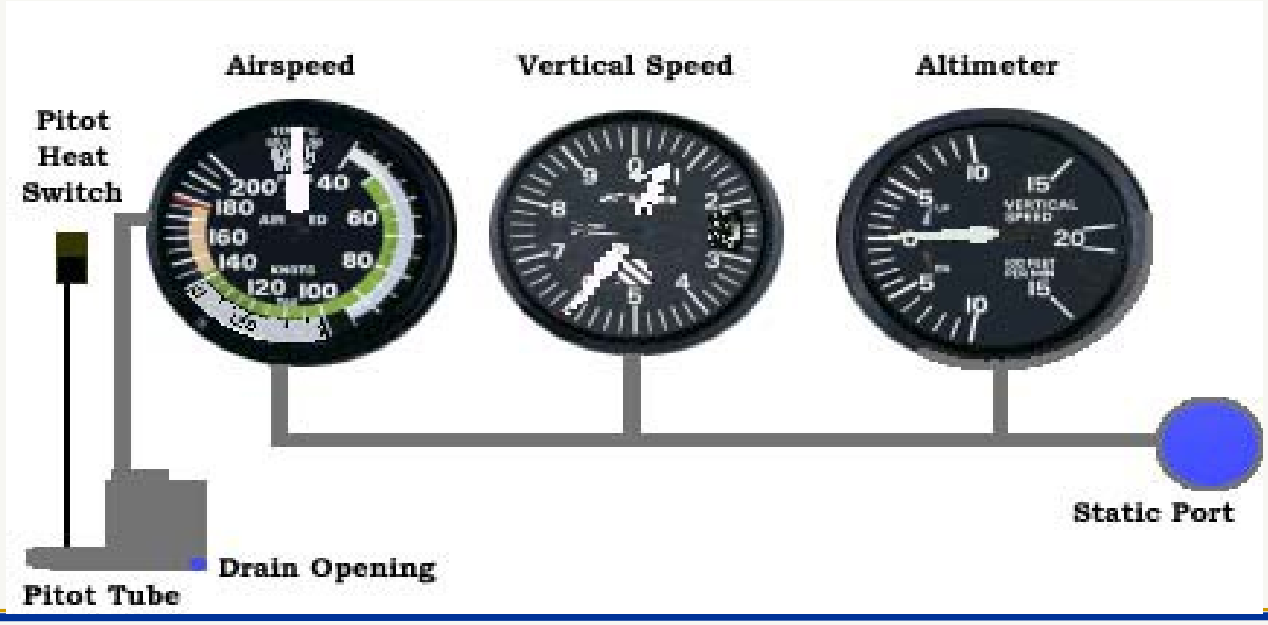
What information does the ball provide?

5) Heading Indicator

6) Vertical Speed Indicator

Pitot Static System

- ✓ The pitot-static system utilizes static and dynamic air pressure.
- ✓ Airspeed indicator (ASI) displays the pressure differential between the dynamic and static pressure. Altimeter and vertical speed indicator (VSI) use Static Pressure only.



Vacuum-Driven Gyro Instruments

ATITUDE INDICATOR

HEADING INDICATOR

- ✓ Gyroscopes have rigidity in space – want to continue to spin in the same plane it started out in
- ✓ You can think of the plane as flying “around” the gyros
- ✓ Due to friction, the heading indicator gyro precesses (drifts) about 3° per 15 minutes
- ✓ Earth rotation underneath the gyro causes apparent precession (rate varies depending on how far from the equator you are)
- ✓ Aggressive manoeuvres involving extreme unusual attitudes, gyros will “tumble”

Electrically-Driven Gyro Instruments

What is the advantage of having different gyro power sources for different instruments?

TURN COORDINATOR (TC)

- ✓ TC gyro is typically electrically-driven
- ✓ Ball is controlled by gravity and centrifugal force – does not need any power to operate
- ✓ The gyro design/alignment is drastically different from HI and AI: Turn Coordinator will not tumble.

Direct and Indirect Information

Direct Info: Heading

Indirect Info: (pitch or bank) Bank Attitude

CONTROL INSTRUMENTS

POWER

What instrument provides direct POWER information?

Direct Info: Airspeed

Indirect Info: (pitch or bank) Pitch Attitude

PITCH and BANK ATTITUDE

Direct Info: Altitude

Indirect Info: (pitch or bank) Pitch Attitude

Direct Info: Yaw, roll, coordination

Heading

Climb/descent rate

Indirect Info: (pitch or bank) Bank Attitude

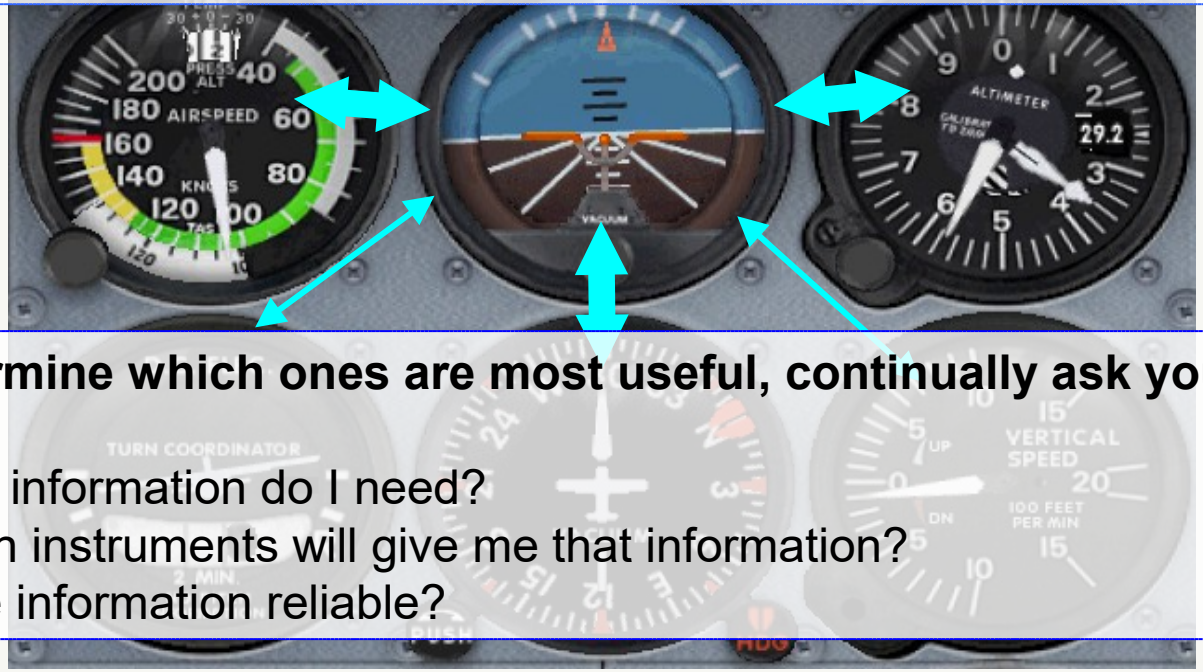
Bank Attitude

Pitch Attitude

PERFORMANCE INSTRUMENTS

Radial Scan Technique

Look more frequently at instruments that provide most useful info at the time



To determine which ones are most useful, continually ask yourself:

1. What information do I need?
2. Which instruments will give me that information?
3. Is the information reliable?

Selective Radial Scan:

Procedures

- Pitch Up
  - Entry
  - During
  - Recovery
- Pitch Down
  - Entry
  - During
  - Recovery
- Roll
  - Entry
  - During
  - Recovery
- Straight and Level Flight
  - During
  - Increasing Power
  - Decreasing Power.

Pitch Up: Entry

- ✓ Enter from Cruise
  - AI: level, at the horizon
  - TC: wings level, ball centre
  - ASI, HI, ALT: steady
- ✓ Ask instructor: “All clear above?” Wait for a positive answer
- ✓ Gently pull back on the control column to place miniature airplane slightly above the horizon
- ✓ Use radial scan to control roll, pitch and yaw.

Pitch Up: During

Pitch Up: Recovery

- ✓ Ask instructor: “All clear?” Wait for a positive answer
- ✓ Release back pressure on the control column to place miniature airplane at the horizon
- ✓ Use radial scan to control roll, pitch and yaw.

Pitch Down: Entry

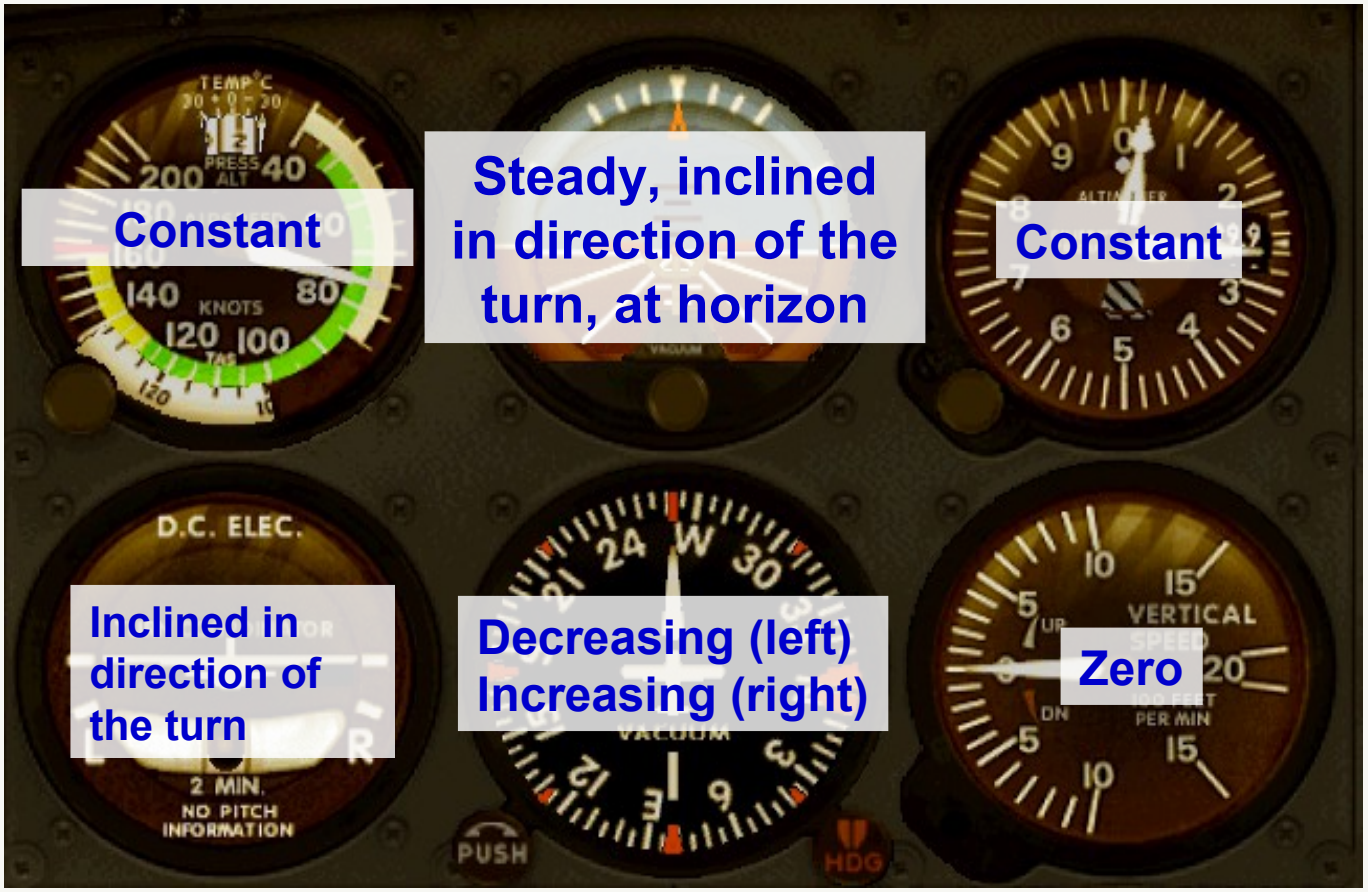
- Enter from Cruise
  - AI: level, at the horizon
  - TC: wings level, ball centre
  - ASI, HI, ALT: steady
- Ask instructor: “All clear below?” Wait for a positive answer
- Gently push forward on the yoke to place miniature airplane slightly below the horizon
- Use radial scan to control roll, pitch and yaw.

Pitch Down: During

Roll: Entry

- ✓ Ask instructor: “All clear?”
- ✓ Gently turn yoke to tilt miniature airplane with respect to horizon (refer to TC – no more than Rate One turn!)
- ✓ Return yoke to neutral once the desired rate of turn is established
- ✓ Use radial scan to control pitch and yaw.

Roll: During


Constant
Steady, inclined in direction of the turn, at horizon
Constant
Inclined in direction of the turn
Decreasing (left) Increasing (right)
Zero
TEMP °C
PRESS ALT
KNOTS
TAS
D.C. ELEC.
2 MIN.
NO PITCH INFORMATION
VACUUM
PUSH
HDG
VERTICAL SPEED
PER MIN

Roll: Recovery

Turn yoke in opposite direction to level the plane (refer to AI and TC)

- ✓ Return yoke to neutral once wings are level
- ✓ Use radial scan to control roll, pitch and yaw.

Straight & Level Flight: During

Selective Radial Scan: Straight & Level Flight

Considerations

- ✓ Light touch on the control column and smooth control movements
  - plane flies exactly the same as before, but it may feel to you that your actions are producing no effect
- ✓ No chasing needles!
  - Set attitude, give plane time to settle, use small corrections and let indications settle before correcting again
- ✓ Importance of proper scan
  - don't fixate on one instrument
  - scan purposefully, not randomly
  - include all instruments and cross-check them against one another
  - always come back to attitude indicator – this is your horizon now.

SAFETY

- Remember taxiing instrument checks: your chance to notice malfunctioning instruments on the ground
- Get adequate rest, nutrition and ensure you're in good health and state of mind (important for all flights, doubly so for instrument flights)
- During practice, ask your instructor "All clear?" before initiating a climb, descent or turn
- No solo practice of instrument flight
- When instruments and your feelings disagree: TRUST THE INSTRUMENTS!!!
- Avoid brisk, rapid head movements.

Conclusion

- ✓ Ready to start practicing instrument flying
- ✓ Precision is required to control the plane by reference to instruments: mastering it will make you a better VFR pilot
- ✓ Solid instrument skills are useful in an emergency (flight into cloud, windshield icing up) as well as low visibility conditions
- ✓ Instrument flying practice prepares you for night rating and instrument rating
- ✓ Read for next lesson: Ex. 24, Climbing, Descending, Turns

QUESTIONS?