BASIC INSTRUMENT FLYING - (LONG BRIEF)

Aim:

To understand the major principles, considerations and application of the techniques required to fly solely by reference to the instruments.

Objectives: by the completion of this brief you will be able to recite the 6 primary flight instruments, the basic "T scan and what to do should you inadvertently enter Cloud (IMC conditions).

Definitions:

Instrument flying - to control the aircraft by sole reference to the instrument panel
VMC - visual meteorological conditions - conditions in which we can operate under the visual flight rules (VFR). We can fly and navigate by outside visual reference. The criteria by which VMC is defined can be found in the General Operations section of the VFRG.
IMC - instrument meteorological conditions - conditions whereby visual reference has been lost and aircraft control can only be maintained through reference to instruments.
Rate one turn - a standard rate turn and is defined as a 3°per second turn, which completes 360° in 2 minutes.

Applications:

A basic introduction to instrument flying, and to be able to execute a 180 degree turn if cloud is inadvertently entered.

Principles:

Instrument scanning:
Instrument flying substitutes the visual horizon for an “artificial horizon” displayed on the attitude indicator (AKA Artificial Horizon). Little changes with respect to the physical aspect of flying the aircraft, although there is a need to develop a more systematic approach to instrument scanning.

The diagram below depicts what is known as the Primary or “T” scan which runs as follows:

Our attention is first directed on the attitude indicator (AI) and moves to the airspeed indicator (ASI). It then returns to the AI and moves to the altimeter. From the altimeter it once again returns to the AI and moves to the directional indicator (DI), and then back to the attitude indicator to repeat the process. Note that we are always returning to the attitude indicator before we progress to another instrument. This is where the majority of our attention should lie, and is analogous to our practice of spending most of our time looking outside at the visual horizon in VMC.

Every few primary scans we will conduct a scan of the turn-coordinator (TC) and vertical speed indicator (VSI).

The Basic Instrument Flying lesson is not intended to provide the skills to fly in instrument conditions on a regular basis. Its purpose is to help the pilot learn to control the aircraft and remove themselves from a situation in which they have inadvertently entered IMC. Judicious preflight planning will mitigate against this risk.

Once the aircraft is under positive control, the safest way to escape IMC conditions is to conduct a 180° rate one turn for one minute and then maintain our altitude and heading in straight and level until we regain visual reference to the horizon and ground.

A rule of thumb for calculating the angle of bank required for a rate one turn is:

AOB (Rate one turn) = (IAS/10) + 7

Alternatively, a rate one turn will be achieved by putting the wing on the TC onto the first notch in the direction of your desired turn, as shown below:

Control and Performance instruments:

You will have already been introduced to the concept of:

POWER + ATTITUDE = PERFORMANCE

What our aircraft does and how it *performs* is a function of both the power we have set, and the attitude we are holding.

We set our attitude using our AI and power using the tachometer. These are known as ***control instruments.***

The ***performance instruments*** directly reflect the performance the aircraft is achieving. These are the altimeter, ASI, VSI and TC.

Considerations:

Instrument power sources:

It is important to consider what systems "power" the various instruments in the cockpit. This allows us to anticipate which instruments will become unreliable for a given system malfunction, and which instruments can still be referenced. Instruments can be electrically powered, powered by a vacuum (or even a simple venturi) system, or rely on pitot/static pressure readings. These system, their possible malfunctions and effects will be covered in more detail in the RPL theory class or in the Bob Tait book if you are opting to self study.

Instrument lag:

All instruments suffer from lag, some to a greater extent than others. All instruments can be considered to be responsive enough for light aeroplane use. The VSI, however, suffers from significant lag, and must be cross-referenced with other instruments to check its indications.

Human Sensations:

We receive 80% of our positional information from our eyes, 10% from our vestibular system and 10% from our somatosensory systems. It is important that we understand that the most likely cause for disorientation in IMC is a mismatch of inputs from each of these systems.

Vestibular System:

The vestibular system is located in the inner ear and consists of the Otolith organ and vestibular apparatus. The vestibular apparatus consists of three fluid filled semicircular canals. Each has a cluster of small hairs at the base. The interaction of the fluid in the canals and the hairs provides sensations of movement in the three axes of flight.

In the same region is the Otolith organ, another fluid filled device which detects linear acceleration and deceleration. It is co-located with but separate from the semicircular canals.

Somatosensory system:

The muscular pressure sensors of the nervous system are affected by gravity and allow us to detect, for example, whether we are standing or sitting when our eyes are closed.

Crucially, this system cannot differentiate between the various causes of increased G – for example, as the result of pulling out of a dive or of entering a steep turn.

Sight:

In instrument flight conditions, the visual references used to resolve ambiguous or conflicting orientation information are not available. Until considerable practice has been carried out to replace the normal visual cues with instrument readings, orientation conflicts may occur, causing various sensory illusions. These three systems that give us positional information and their limitations will be covered in detail in the RPPL class

Because the limitations of the human orientation system are considerable, and instrument failure is rare, **trust the instruments**.

Unusual attitudes:
Basically there are two types of unusual attitudes, nose-high or nose-low. The most dangerous of the nose-low attitudes is the spiral dive, because it's difficult to identify.

The spiral dive produces positive G, which feels like a dive pull-out when, in fact, the aeroplane is being pulled tighter into the spiral dive.

A Dangerous nose high attitude can lead to inadvertent stall spin situation.

Unusual attitudes may come about as a result of disorientation, turbulence (which may be quite pronounced in cloud), or a distraction that breaks down the instrument scan.

Recovery:

The first step in recognising an unusual attitude, is to maintain faith in the instrument indications. This can be difficult when your body senses are screaming at you that the instruments must be wrong.

The unusual attitude recovery is always carried out to regain straight and level. Then a *gradual return to the reference altitude and heading* is made. No attempt to return *directly* to the reference should be made, as this may increase disorientation or lead to another unusual attitude.

Recovery from unusual attitudes uses the same 'change – check – hold – adjust – trim' sequence as all flight. However, the initial movements are more pronounced, and trim should not be required.

Airmanship:

- Remember to perform the relevant checks before flight - including the taxi checks - to ensure that each instrument is functioning correctly and would be reliable if we were to inadvertently enter IMC.
- Remember the scanning technique. Remember to cycle our attention through all the instruments and to not become fixated.
- Your instructor becomes your Lookout for other traffic and you will both continue to and listen out.
- Keep head movements slow and gentle to avoid vestibular disorientation.
- Handover / Takeover.
- Engine management.
- Situational awareness - the best defence against inadvertently entering IMC is to not operate in conditions where it is likely to occur in the first place. Maintain good situational awareness of your surroundings and changing weather conditions along your flight path. Always seek to remain ahead of your aircraft and anticipate further threats.