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Flight instruction is an art practiced by many, but mastered by few. To be a successful flight instructor, requires not only knowledge and skill but also a great amount of passion. To be an effective flight instructor one needs not only a thorough understanding of one’s subject but also true insight in the process of transferring knowledge. As flight instruction is conducted on a moving platform within a constantly changing environment, the instructor needs to master more than just the skill of verbal communication in a noisy and sometimes hostile environment: He should also be able to cope with these changes while constantly ensuring that his student is at ease.

Many instructors believe that the more complex and detailed the information included in the teaching process, the better the end result. My experience in both flight and ground instruction proved to be the opposite. To enable the student to function well in this unusual environment, the preparation before a flight is of the utmost importance. This is where the training skills of the instructor are crucial. There are two very important elements of teaching that need to be considered when preparing a student for flight, the building block principle and the principle of moving from the known to the unknown. By applying the rule of simplicity and association the instructor will not only simplify the teaching process but also change it into a relaxed, enjoyable experience.

Flying and flight procedures are in their essence not very complex, provided the instructor possesses a full understanding of the important basic elements involved. This will make it easy to impart the knowledge. Add to this an effective, simple graphic presentation of the scenarios involved, and the scene is set for the instructor to teach with ease. These principles were followed by the author of this book, resulting in a magnificent publication.

At first glance one might think that it is just another attempt of someone - who knows something about flying and flight instruction - to scribble down a few ideas. However, the author has succeeded to effectively apply the basic principles of teaching to a section of flight training that invariably leads to frustration and confusion. Instrument flying is such an important part of flying as a whole, that one cannot afford to neglect the teaching of any aspect within the scope of instrument and procedural flying. A thorough understanding of the principles involved, will not only have the result of training professional pilots, but will definitely save lives.

This book will lead you step-by-step in discovering all the important elements of instrument flying in an enjoyable fashion.

Francois Naudé
The VHF Radio Communication Stack

Below is a typical Bendix/King Com/Nav Radio arrangement.

- This is the Audio Selector Panel – Here you will select the COM stack to broadcast ON & to select for identification purposes the NAV frequencies selected.
- This is COM/NAV stack ONE. The left hand frequencies are COM frequencies and the Right hand frequencies are NAV frequencies. In each window, the right hand frequency is the STANDBY frequency and it is where you TUNE the frequency required, then activate by pressing the button with the double arrow.
- This is COM/NAV stack TWO. Its operation is as described for COM/NAV 1. When selecting COM 2 on the Selector Panel this will make COM 2 the active stack and the radio broadcast will be made on the frequency in use on COM 2. Selecting NAV 2 will allow the user to IDENT the selected NAVAID.
- This is the ADF box; this is a digital display type. NDB frequencies are tuned using the large round knob. TEST by pressing the ADF button and IDENT by selecting the ADF button on the selector panel then adjust the VOL knob to listen to the Morse code.
- This is the DME box. It displays DME distance to a DME station. The pilot can select a DME station on either NAV 1 or NAV 2, on this DME unit R1 is NAV 1 and R2 is NAV 2. Therefore R2 is picking up a DME on frequency 114.50 and is showing a distance of 13.5 DME.
- This is the Transponder. The required code is selected via the numbers on the bottom of the box. Select SBY after start to “warm up” the unit, then on the Runway prior to departure select the ALT position to commence SQUAWKING. (Selecting ALT sends Altitude information referenced to 1013.2 HPa.)

The understanding of an aircraft’s particular Radio Stack is imperative to successful flight. If you are unfamiliar with the aircraft’s communication and navigation arrangement, read through the operating handbook.

Some useful tips for using the Com/Nav radios:

- Have the next frequency to be used in the Standby “window”.
- Set the squelch on the radio’s after start-up during the radio and instrument checks.
- Always Identify the Navigation facility before you use it.
- If you have two com stacks, make sure that you are transmitting on the desired one.
- With two com radio’s you can monitor another frequency if necessary, however the primary frequency volume must be louder.
STEP 2 – Where am I? Where do I want to be?

Where am I?

- Centre the CDI needle with TO flag indicated
- Note the Course at the TOP of the instrument and note the Radial at the bottom of the instrument.

Where do I want to be?

- Then select the desired RADIAL to be intercepted
- (REMEMBER TO LOOK AT THE BOTTOM!)
- Note the direction that the needle has been deflected, this is very important! In the diagram below the needle is deflected to the left, telling you to fly left.

Now, pick a heading to intercept the radial.
As a general rule use a 30° intercept, or use the heading that is double the difference between the actual radial and the desired radial.

The diagram on the left illustrates the 30° intercept method...simply fly the heading 30° left of the course at the top of the instrument.

- In this case, a heading of 180° would be flown using a 30° intercept.

If the needle had deflected to the right, you must fly a heading to the right.
In order to determine what Track or Bearing we are on using a fixed card ADF we use both the RBI and the DI in conjunction:

1. Look at the RBI and check to see what side of the needle is in the top section of the RBI...
2. If it is the Sharp end, we are going to the station; we will assume that it is the sharp end for this example.
3. Now see how many degrees off the North marker the tip of the needle is; in this case it is dead ahead.
4. Transpose this across to the DI and read off the heading where the needle points; this is your track TO the station!

Look at the diagram below to visualise this:

**The RBI shows the Sharp End of the needle dead ahead on the North Reference Marker**

**Now transpose the needle across to the DI to determine the track.**

**The Magnetic Track TO the station is 090°**

**Another way of expressing Magnetic Track is Magnetic Course**

**The Big Picture**

Magnetic Track 090° going directly TO the NDB
Bracketing FROM the station

Again look for the indication from the SHARP end of the needle to determine the direction of the wind.

Once you see the needle move, turn 10° in the direction of the sharp end of the needle.

If the needle gradually moves further away from the North Reference Marker then a further turn in the direction of the sharp end of the needle must be made… again use 5° increments.

If the needle gradually moves back towards the North Reference Marker then you have turned too far when correcting for drift, so adjust your heading by 5° back to your original heading.

It will take some practice before you get the feel for this, again, only practice makes perfect!

Once the drift angle has been determined by bracketing the beacon, you must re-intercept the correct track, this time by allowing for wind.
Obstacle Clearance in the Hold

A Holding Pattern is designed with specific obstacle clearance criteria which can be found in the PANS-OPS 8168 document.

However, a basic holding pattern obstacle clearance in non-mountainous areas is:

**984 feet**

This clearance is provided within the Holding area which makes allowances for speed, effects of wind and timing errors.

Should the Holding pattern be in a mountainous area (3000 ft terrain rise within a 10nm area), the obstacle clearance in the holding area is increased to:

**1968 feet**

This is mainly due to the effects of high terrain such as increased turbulence from up and down drafts.

A “Buffer” area extending 5nm beyond the boundary of the holding area is used when determining the minimum holding level which offers a decreasing obstacle clearance margin from terrain the further you fly from the limits of the holding area.

The Standard Holding Pattern

A Standard holding pattern is flown in a right hand pattern with timing at and below 14,000 feet resulting in a 4 minute hold (see below diagram).

---

*Diagram of Standard Holding Pattern*
Holds on Approach Plates

In the illustrations below; both left and right hand holding patterns can be seen. These are holding patterns as depicted on the CAA type approach charts. It must be noted that on the CAA charts, a descent in the holding pattern is drawn in the profile view of the plate… whereas on other types of approach plates such as Jeppesen this is not included in the profile view and only text will advise the pilot of the initial approach altitude and to descend in the hold.

LANSERIA INTL VOR/DME 06L

Holding using the LIV VOR beacon on frequency 117.40 MHz

The inbound magnetic track is 064°

The outbound magnetic track is 244°

The hold is at an altitude of 8000’

If approaching from a higher altitude, descend in the hold to 8000’ as advised by ATC.

GEORGE VOR/DME 11

Holding using the GGV VOR beacon on frequency 112.50 MHz

The inbound magnetic track is 117°

The outbound magnetic track is 297°

The hold is at an altitude of 8000’

Before commencing the approach, descend to an altitude of 4000’ in the hold.
The best way of doing this is to work out the aircrafts distance in Nautical Miles per Minute... this will allow the pilot to determine how far the aircraft will fly per minute and as such will enable the pilot to work out when to commence the offset turn based on a TIME/DISTANCE.

For example:

If the approach plate stipulates that at 80 Kts groundspeed the aircraft should fly OUTBOUND for a TOTAL of 3 minutes 45 seconds, the pilot should allow for the 1 minute offset and as such fly on the OUTBOUND track for 2 minutes 45 seconds. This leaves 1 minute for the offset making a total time flown of 3 minutes 45 seconds.

**Step 3: Ready for the 45° Offset Turn**

Turn 45° in the correct direction as depicted on the approach plate at the required TIME/DISTANCE.

The turn should be made at Rate 1 or Max 25° Bank Angle (Whichever requires the lesser bank angle).

Timing of the 45° offset commences at the start of the turn on the OUTBOUND track.

The 45° offset heading should be flown for 45 seconds making a total time of 1 minute (15seconds for 45° Turn).
The Missed Approach Procedure While Circling

If visual reference is lost while circling to land from an instrument approach, the missed approach specified for that procedure must be followed.

It is expected that the pilot will make an initial climbing turn toward the landing runway and overhead the aerodrome where the pilot will establish the aircraft climbing on the missed approach track.

Note that different patterns will be required to establish the aircraft on the prescribed missed approach course, depending on its position at the time visual reference is lost.

An example of the missed approach from circling is illustrated below:

- **At MDA/H pilot commences Circling for opposite end of runway**
- **Action: Turn towards airfield and establish MAP track**
- **Missed Approach Track**
- **Visual Reference Lost at this point**

The procedure that is to be followed should the pilot lose visual contact with the runway *after* turning final approach can be found in the Jeppesen Airway Manual under the Air Traffic Control Section in the South African Rules and Procedures section.

The procedure states that if visual contact is lost after turning final approach whilst conducting a circling approach, the action is for the pilot to initiate an immediate climb towards the Initial Approach Fix on which the instrument approach is based on, unless otherwise instructed by Air Traffic Control.

Some airfields may have a prescribed track for the circle to land procedure – check the plate carefully for this information

Note that the procedure may differ in other countries therefore if a circle to land procedure is to be flown, check the Jeppesen/Aerad for local rules RE: Circle to land procedures.

<table>
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<th>Aircraft Category</th>
<th>Max Speed for visual manoeuvring (circling) Kts</th>
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</thead>
<tbody>
<tr>
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<tr>
<td>B</td>
<td>135</td>
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<tr>
<td>C</td>
<td>180</td>
</tr>
<tr>
<td>D</td>
<td>205</td>
</tr>
<tr>
<td>E</td>
<td>240</td>
</tr>
</tbody>
</table>
Approach Tolerances on the ILS Instrument

The ILS approach should be flown as accurately as possible in order to maintain a stable approach. However, should the pilot deviate from HALF FULL SCALE DEFLECTION on either GS or LOC once established, then a missed approach should be commenced immediately.

Time to go missed...

What happens if the Glideslope fails during the approach?

Then you can fly a LLZ approach if one is prescribed for the ILS approach you are flying. The LLZ approach is a localizer only approach.

If you are using a Jeppesen approach plate the LLZ approach, if applicable, is illustrated on the ILS approach, but the South African AIP publishes a separate plate for the LLZ approach.

The significance of the LLZ approach in comparison to the ILS is that it is a non-precision approach, therefore non-precision approach minima’s apply.

ILS Monitoring

The localizer and glideslope transmissions are monitored automatically by equipment placed in the normal service area, if an error is detected then a warning can be sent to a designated point such as the Control Tower.
Now the picture looks something like this…

The CDI is our indication of when we must commence the next turn, therefore we simply maintain 360° until the CDI shows half full scale deflection…

As half full scale deflection is reached it is time to turn. The DME may show 10.1 or even 10.2, however at this stage you need not worry as this is normal… remember we are flying a ‘faceted’ arc.
Chapter 11 - IFR Flight Planning and Routes

In this chapter IFR flight planning and routes will be discussed. It is extremely important that the IFR pilot is familiar with IFR planning requirements and the use of en-route charts.

IFR Planning...

The importance of thorough pre-flight IFR planning cannot be over-emphasized. The IFR pilot must consider a number of factors when planning an IFR flight, a list of suggested factors to consider follows:

Personal Planning:
- IFR Currency
- Personal Minimums
- IM-SAFE

Weather Information: - *Current and Forecasted*
- Cloud Base
- Cloud types... i.e. Cumulonimbus etc.
- Freezing Levels
- Precipitation
- Visibility
- Wind

Aircraft Planning: 
- Part 135 requirements
  - Fuel Planning
  - Aircraft Weight and Balance
  - IFR Equipment Serviceable
  - Take-Off Performance
  - Landing Performance
  - Single Engine Performance – *if Multi Engine Aircraft*

Route Planning:
- NOTAMS
- Current Charts
- Airspace
- Direct Routing; or
- Routing via Airways and Navaids
- Restricted/Prohibited/Danger areas
- Minimum & Maximum Flight Levels
- Route MORA’s and Grid MORA’s.
- Flight Information Regions (FIR’s) – Estimates to Boundaries
- Communication Regions – Frequency Boundaries
- Flight Log
- Flight Plan - *incl. Search and Rescue Required*
Multi Engine Charter Scenario

Your charter company has asked you to fly a charter for its clients. There are three passengers, two male, one female and a total of 33 kg of baggage. The flight details are as follows:

- ZS-IFR – A Turbine Engine Twin Aircraft – It can comply with Table 1 and is Approach CAT B.
- Cruise TAS 250 Kts
- SE Cruise Speed 190 Kts
- The Fuel on board is equivalent to an endurance of 5 hours.

### Route Information

<table>
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<th>Destination Airport</th>
<th>Time</th>
<th>Passengers</th>
<th>Baggage</th>
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### Weather Information

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</table>

### Step 1: Determine if you can legally take off from Lanseria

Looking at the weather at Lanseria at our departure time of 06:00Z, according to the METAR the weather is 800m visibility in Fog with a ceiling on the ground. The visibility is sufficient for take-off according to AWOPS Table 1. However, we cannot return to land at Lanseria as the Visibility is too low to
IFR Emergencies
Inadvertent Flight into Icing Conditions

As with thunderstorm avoidance, continuous flight in icing is not recommended. As part of the pre-flight planning the pilot should check on icing levels given on significant weather charts. If there is a cloud layer that penetrates the icing level, then expect icing.

Severe icing is generally found in the clear icing range, between temperatures of 0°C and -20°C. This is the range where large supercooled water droplets exist in the cloud. Typically, the clouds that contain the larger supercooled water droplets are convective type clouds, such as cumulus, large cumulus, towering cumulus and cumulonimbus.

The pilot should be especially alert when flying through clouds at temperatures at or below 5°C and should activate pitot heat/stall warning heat/prop/windshield/airframe anti ice prior to entering the visible moisture. DE-ICING equipment should be used once the recommended build up of ice has accumulated as per the specific aircraft Pilots Operating Manual. As a general rule of thumb, a build up of 10-15mm is advisable prior to activating pneumatic boots in order to ‘pop’ off the ice.

Even if the aircraft is certified to operate in icing conditions, be vigilant, as icing equipment is not designed to allow aircraft to operate indefinitely in icing conditions. Ice accretion can overwhelm icing equipment’s capabilities and immediate action is required to safely continue the flight.

Some possible actions when flight into continuous icing conditions prevails:

1. Move to an altitude with significantly colder temperatures – severe icing is less likely at temperatures below -20°C.
2. Move to an altitude with temperatures that are above freezing – this generally means you must descend… check MORA, MOCA!!
3. Fly into an area clear of visible moisture – i.e. out of cloud
4. Change heading and fly to an area known to have non-icing conditions.

Remember, icing increases the weight of the aircraft, changes the wing shape and causes a reduction in lift and increases stall speed.

The engine air intakes can be blocked rapidly and engine failure is a possibility… also use of ice vanes reduce engine performance and increase fuel flow.
4. Loss of Situational Awareness

What is Situational Awareness?

Situational Awareness could be described as one’s mental picture of where you are and the overall assessment of how the various factors in the flight environment can affect your flight.

With proactive decision making the pilot with good situational awareness has the ability to make decisions earlier and have various options considered. This type of pilot is knowledgeable in all aspects of the flight.

The pilot with poor situational awareness may on the other hand have a reactive approach to situational awareness; this put simply describes a pilot who does not have the vision to foresee future events and will be forced to make “reactive” decisions when faced with unforeseen events, however as it will be a “reactive” decision, few options may have been considered.

How can I improve my situational awareness?

Improving situational awareness is achieved by improving your knowledge base… this may be technical knowledge, meteorological knowledge or knowledge of instrument flight procedures for example.

The proper planning of each and every flight and ensuring that the aircraft is 100% serviceable and loaded correctly is one step towards an improved situational awareness.

Loss of Situational Awareness…

Throughout an IFR Flight the pilot may be confronted by many factors that will have to be managed, a simple change to the expected may cause a pilot to operate with reduced situational awareness… for example an unexpected or unfamiliar approach being received by ATC may reduce the pilots situational awareness, but once the approach is briefed and familiarized the situational awareness returns to a higher level.

Factors that can reduce a pilot’s situational awareness are:

- Distractions
- Unusual or Unexpected Events
- High Workload
- Unfamiliar Situations
- Systems/ Instrument Failure
- Complacency

A vacuum system failure if not correctly identified can cause a loss of situational awareness as an unusual attitude may be entered… this calls for
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