The CIX VFR Club	Flight Training Notes	Exercise 12
For Simulation Purposes only. Not to be used for real World flight	THE STANDARD TAKE OFF & CLIMB TO DOWNWIND	Issue 1.5 29/08/12

1 INTRODUCTION

This series of tutorials for the CIX VFR Club are based on real world flight training. Each document focuses on a small part only of the necessary skills required to fly a light aircraft, and by echoing real world training, you will be a better Flight Simulator pilot and get more enjoyment out of the hobby as a result.

For this exercise, it is assumed that you are familiar with the Cessna 172SP on which this tutorial is based, that you can fly straight and level (without using the auto pilot), and can perform level turns, climbing turns, and descending turns. If not, or if you feel the need for practice, I recommend that you spend some time on the Flying Lessons provided with Flight Simulator. The Club will be publishing tutorials on those topics in due course.

It is also assumed that you have a yoke or joystick, and rudder pedals. If not, you will have to make the equivalent moves using the mouse or appropriate keys. In the early 1990s, Flight Simulator was much less sophisticated than today (as were the computers on which it ran), and it was possible to fly quite well by means of the keyboard. Today, to fly well in all the conditions which Flight Simulator can throw at you, it is next to impossible to do so with keyboard and mouse alone.

For example, when there is little or no wind, you can manage using auto-coordination, and rudder pedals are not really necessary, but with a strong and turbulent crosswind to deal with on final approach, rapid and precise control inputs are necessary, making a yoke and rudder pedals essential just to stay on the runway centreline in the air and to steer down it on the ground. It is also very important to keep the aircraft properly trimmed for each stage of the flight – see Exercise 4c in this series. It should be possible to release the controls without any serious effect on the flight path.

2 ALTIMETER SETTING

In the real world, in the UK, most flying in the vicinity of an airfield is done at heights based on QFE. When an Air Traffic Controller gives you QFE, this means that the altimeter displays the aircraft's height above the runway.

In this tutorial therefore, all heights are given relative using QFE. If you use QNH you will have to make an adjustment and add the airfield's height above sea level to the heights given in the text. For example, Gloucestershire Airport is 100 feet above sea level and Biggin Hill, 600 feet above sea level (not for nothing was it known by World War II pilots as "Biggin on the Bump". So with QNH set on the altimeter, you would fly the circuit at Gloucestershire at 1100 feet (1000 + 100), and at Biggin Hill, 1600 feet (1000+600).

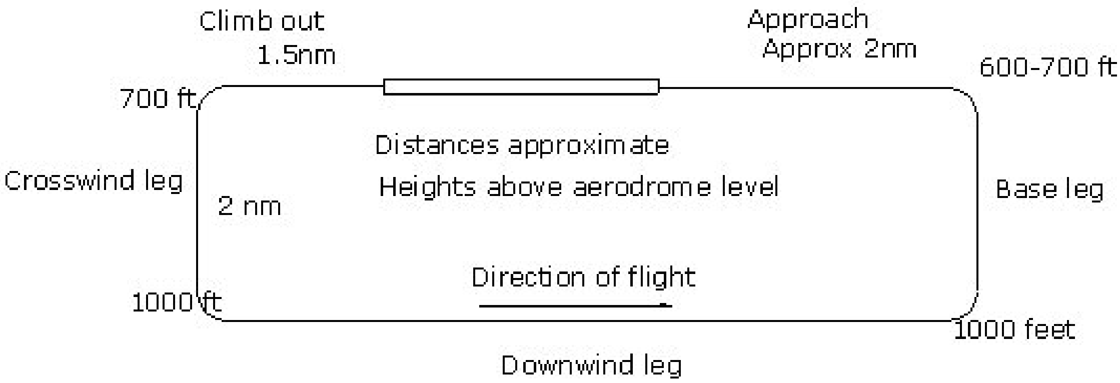
See Exercise 2 for more detail on setting the altimeter, and Exercise 16 for a full description of Altimetry (the measurement of height).

3 THE BASIC VFR CIRCUIT

This exercise covers the first part of flying “the circuit” (“the pattern” in the USA). The idea of the circuit is to provide a standard method of arriving at an airfield and positioning to land, so that some of the many variables in the process are eliminated or their effect minimised. If you always turn onto final approach at 70 knots and 700 feet above the runway, then you have a better chance of making a standard descent and a good landing. The lengths of each leg and the aircraft’s distance from the runway at any one time are designed in such a way that if the engine stops, you can land on the runway. This was a much more important consideration in the early days of flying than it is today, thankfully. Of course in Flight Simulator, you have to set reliability to less than 100% otherwise your engine will never fail!

Circuits may be right hand (clockwise) or left hand (anticlockwise). It follows that, in a right hand circuit, all turns are to the right, and in a left hand circuit, all turns are to the left. With side-by-side seating in modern aircraft, left hand circuits are the standard, because the pilot, who normally sits in the left hand seat, has a better view of the airfield at all times during the circuit. Both left hand and right hand circuits are used at Gloucestershire and Biggin Hill, depending on which runway is in use.

The VFR circuit forms a rectangle with rounded corners. It consists of the take off and initial climb along the line of the runway, a 90° climbing turn onto the crosswind leg, then completing the climb to circuit height followed by a further 90° turn onto the downwind leg, parallel with the runway. The downwind leg is flown straight and level at cruise speed. Next comes another 90° turn onto the base leg, slowing down and commencing the descent, followed by a descending 90° turn back onto the runway extended centreline and completing the descent to land.



The VFR Circuit

The theoretically ideal circuit takes 6 minutes from lift off to touch down, comprising the initial climb to crosswind turn, 1 minute, the crosswind leg, 1 minute, the downwind leg, 2 minutes, base leg, 1 minute and final approach and touchdown, 1 minute. Many factors affect circuit times, but a good tight circuit in reasonably favourable weather and wind should be close to that figure. The commonest mistake made, particularly by inexperienced pilots, is to extend the downwind leg too far and as a result find themselves low on final approach and have to "drag her in" to use the jargon – a low descent rate and low airspeed coupled with high power setting. In this configuration, an engine failure will always result in the aircraft failing to reach the runway.

4 BEFORE TAKE OFF

4.1 Weather

The first requirement is to check the weather, in particular the wind. The wind direction will indicate the expected runway in use – "expected" because sometimes VATSIM ATC will have designated a different runway for operational reasons. As a principle, the runway in use will be the runway which is most into-wind, so that the effect of the wind blowing towards the aircraft as it starts to take off, will enable the aircraft to reach flying speed in a shorter distance than otherwise, because when heading into wind

Airspeed = ground speed plus wind speed down the runway

4.2 Crosswinds

In the early days of flight, aircraft took off directly into wind from large fields. They were no constrained by runways. As soon as runways were laid down, the aircraft could only take of directly into wind if the wind happened to be blowing in the same direction as the runway was built. There were careful attempts to lay out runways in the direction of the prevailing winds, but winds aren't always prevailing! So quite often the wind is blowing across the runway to a greater or lesser degree. At its worst, a stiff breeze across the runway – 15 knots or so, can be enough to make it dangerous for a light aircraft to take off. What's more, landing in such a wind will be even more dicey!

So before take off, the pilot must calculate the crosswind component of the wind, and compare that with the crosswind limit of the aircraft. Mathematically, the crosswind component is

The full wind x SIN(angle between the runway and the wind)

If a wind is blowing at 16 knots at 310^{o} and the runway direction is 270^{o} (i.e. Runway 27) then the crosswind component is

16 x (SIN(310^{o}-270^{o}) i.e. *16 x (SIN(40^{o}) = 11.17 knots*

In practice, rather than get the calculator out, pilots use an approximation called "The Rule of Six".

10° = 1 = 1/6

20° = 2 = 2/6

30° = 3 = 3/6

40° = 4 = 4/6

50° = 5 = 5/6

60° = 6 = 6/6

So for a 16 knot wind offset from the runway heading by 40°, the crosswind component is 4/6ths of the full wind velocity. 4/6ths of 16 is (16 x 4)/6 or 10.6 knots. That is close enough to the mathematically precise value of 11.17 knots for practical purposes..

4.3 Aircraft Performance Limits

The pilot also needs to ensure that

- the runway is long enough to take off on,
- the aircraft is not too heavy (passengers and fuel)
- any crosswind component of the full wind is within limits for the aircraft.

4.4 Taxi

After starting the engine, and before moving off, carry out the after start checks, and set the radio frequencies required. Then call Air Traffic Control for permission to taxi and taxi instructions. On VATSIM, it may be "Tower" or "Approach", and occasionally both might be available. When on the ground you first call Tower, if available. In the real world there are normally always both at a full ATC airfield such as Gloucestershire or Biggin Hill. For Air Traffic Control procedures and standard dialogue, see the ATC tutorial ATC_for_Pilots_1.2.pdf available for download on the Club web site.

Having taxied to the active runway, report at the hold and wait for clearance to line up or take off. Before calling "Ready for Departure", carry out the pre-take off "vital actions" (see Exercise 2 again).

It is mandatory, even on VATSIM, that you do not enter the active runway without ATC permission.

The required radio frequencies should have been set already, but check again that you have set them correctly. Most "dead radios" are actually an incorrectly dialled digit.

The checks and vital actions mentioned above are fully described in Exercise 2, and it is assumed that you are familiar with them.

5 THE TAKE OFF

When all checks are complete and you are ready to continue, you call ATC "Ready for Departure" (Note – **not** 'ready for take off'). You will then be told either "line up and wait" or "cleared take off". If told to "line up and wait", do just that. You do not need to say anything else to ATC. He/she will come back to you with a "cleared take off" instruction. If you receive a "cleared immediate take off" instruction, then carry out the following actions as quickly as possible, but calmly. It usually means there is someone on final approach, and the ATCO is trying to get you away without undue delay.

Once cleared for take off, move onto the runway at taxi speed and line up with the centre line. Push the throttle forward slowly to its full setting. Use the rudder to stay on the centre line as you accelerate along the runway, glancing down occasionally to check the indicated airspeed. As you approach your takeoff speed of 65kts, begin to ease back on the yoke.

Because aircraft in Flight Simulator tend to stick to the ground a little unrealistically, you may have to hold the yoke back some way to achieve lift off. If this back pressure is sustained once airborne, the aircraft will assume a nose attitude which is much too high; airspeed will decay and the aircraft may stall. Therefore, once off the ground, immediately but gently ease the back pressure on the yoke until the pitch attitude is about 10° nose high, as indicated on the Attitude Indicator (artificial horizon). However. You must keep the climb going. Do not let the aircraft sink again.

Provided you have set the elevator trim correctly the aircraft will settle into a climb at 75 knots, with a nose attitude about 10° above the horizontal, and you should find that as this is achieved, the yoke will return to its neutral position. If it doesn't, then while maintaining the approximately 10° nose high attitude required to achieve 75 knots, ease the yoke pressure until it returns to the neutral position whilst simultaneously adjusting the elevator trim. A fuller description of the theory and practice of the climb are contained in Exercise 7 – The Climb, in this series.

6 THE CROSSWIND LEG

Maintain the runway heading until you reach 700ft, then perform a climbing 90° rate one turn (maximum angle of bank 17°) to the crosswind leg. In the Cessna 172, a 90° climbing turn should increase the aircraft height by 300 feet. The reason why this is so is explained in Exercise 9b – The Climbing Turn, in this series. Therefore, as you roll wings level from the climbing turn, you should be close to the normal 1000 feet circuit height. If the circuit height is lower, commence the climbing turn sooner. If the circuit height is higher, commence the climbing turn later.

As you reach circuit height, and not before, lower the nose to the cruise attitude and allow airspeed to build up to cruise speed of 105 knots before reducing power to the cruise power setting of 2300 r.p.m. Ease off any pressure on the yoke and trim to maintain level flight without any forward or back pressure and adjust the throttle setting as required to maintain cruise speed.

7 THE DOWNWIND LEG

Approximately one minute after ***commencing*** the previous turn, commence a 90° standard level turn (30° of bank) onto the downwind leg, adding a little back pressure to prevent any loss of height. Flight Simulator exaggerates the back pressure required to prevent loss of height in a level turn, so be prepared for a significant yoke back pressure requirement, followed, as you roll out of the turn, with the corresponding easing off of that pressure. Adjust the heading to precisely 180° opposed to the active runway heading – e.g. if take off was on runway 21, on a heading of 210°, then the downwind leg is flown on a heading of 030° – parallel to the active runway. If you made your downwind turn at the right time, you should be about 2 miles distant from it, but preferably not more. Wide circuits are the hallmark of the student; good pilots keep their circuits tight. A neat way of checking that you are the right distance from the runway in the Cessna 172, is that the runway should appear to be about half to two-thirds of the way up the wing strut. It should also appear to be level, indicating that you are neither climbing nor descending.

As soon as possible after the turn, when trimmed for level flight, report 'downwind' with your intentions on landing, e.g. "GBNOZ downwind, touch and go", or "GBNOZ downwind to land" or if you have previously been flying touch-and-go circuits, the clearer "GBNOZ downwind to full stop landing." In response the controller should instruction you to "Report final" (in the USA "finals") and inform you of your position with respect to any other aircraft that are ahead. If there is one other aircraft ahead of you, or on final approach from a different direction, you would be No. 2 and so on. The ATCO will then normally request that you "report final, No. 2".

The downwind leg should take approximately 2 minutes, and take you not much more than a mile downwind of the landing runway threshold. (You may be asked to extend the downwind leg if there is a danger of conflict with another aircraft. In this case continue straight ahead, and make the turn to base as directed. It may then be necessary to delay the start of your descent until after the next turn from base to final approach.) During this leg, you must carry out the downwind, or pre-landing checks as follows.

- Brakes off – including parking brake
- Undercarriage down and locked *Still say the check, even if flying a fixed undercarriage aircraft, because one day you might not be, and many an aircraft has accidentally been landed on its belly.*
- Mixture full rich (Red knob IN)
- Fuel – select both tanks for landing

- Flaps – decide how much flap you are going to use in consideration of the runway length, wind speed and direction.
- Carburettor heat ON (only in the Club C172N)
- Hatches (Doors closed and locked)
- Harnesses (if you have unstrapped yourself from your desk, then strap yourself to it again!)

Pilots usually commit this check to memory, using the mnemonic BUMFFCHH to help.

The descent and final approach to land is dealt with in Exercise 13a.

8 THE EFFECT OF WIND

In nil wind conditions, the headings flown will be related directly to the runway direction. If the runway direction is 270° for example, then the heading during the climb will be 270°, and changes of heading will be precisely 90° and in a left hand circuit, the crosswind leg will be flown at 180° and the downwind leg at 090°.

With any significant wind, the headings have to be adjusted for drift to maintain the required track. (For definitions of "heading" and "track" see Exercise 16 – Navigation). Because of the short distances involved in flying a circuit, these adjustments do not necessarily need to be as carefully calculated as they would for a significant cross country flight.

8.1 Calculated Drift Correction

The following table gives precise drift corrections for different winds, at climb speed and at cruise speed for the Cessna 172. From this you can derive approximate headings for a range of wind speeds and directions. The wind direction shown is the direction relative to the required track, i.e. 0° would be a headwind, 90° a crosswind with the wind directly abeam.

Wind Direction	Wind Speed Knots	Airspeed Knots	Into wind Heading correction
30°	5	75	2°
30°	10	75	4°
30°	15	75	6°
60°	5	75	3°
60°	10	75	7°
60°	15	75	10°
90°	5	75	4°
90°	10	75	8°
90°	15	75	11°

30°	5	105	1°
30°	10	105	3°
30°	15	105	4°
60°	5	105	2°
60°	10	105	5°
60°	15	105	7°
90°	5	105	3°
90°	10	105	5°
90°	15	105	8°

Drift Corrections at Cessna 172 Climb and Cruise Speeds

A very useful formula for calculating drift is shown below. The maximum drift angle, with the wind directly abeam, is given by: -

$$Drift = Windspeed \times \frac{60}{TAS}$$

where TAS is True Airspeed. At the speeds and heights flown in the circuit TAS can be taken as the same as the Indicated Airspeed.

Consideration should also be given to the fact the wind speed at 1000 feet is usually about 1.5 times stronger than at the surface, and from a direction 10° or so anticlockwise from the surface direction, although it isn't certain that Flight Simulator simulates this.

8.2 Practical Drift Correction

Taking all the above into consideration, no-one is going to complain if you allow an into wind heading adjustment of 5° in winds of 10 knots or less, and 10° into wind for wind speeds greater than 10 knots.