The CIX VFR Club	Flight Training Notes	Exercise 13
For Simulation Purposes only. Not to be used for real World flight	CIRCUIT, APPROACH & LANDING	Issue 1.1 04/08/12

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.

These tutorials are written specifically for the Flight Simulator Default Cessna 172. Some details will be different for other aircraft.

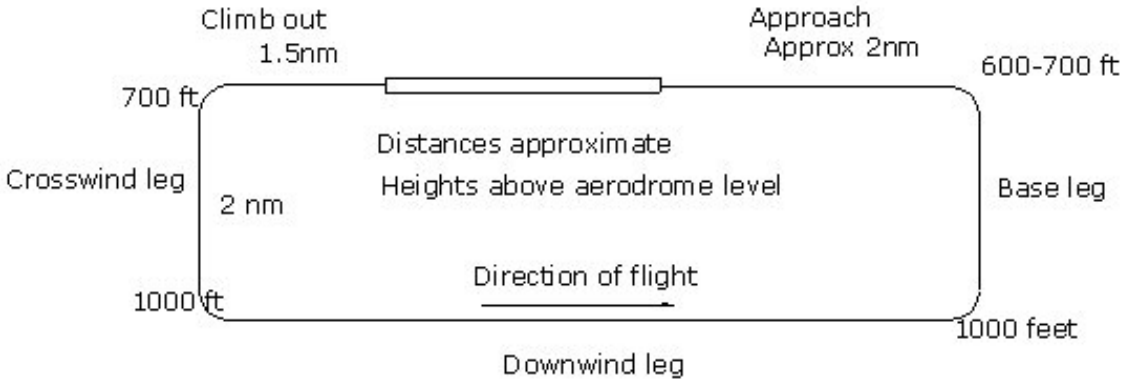
You should read Exercise 12 before continuing with this tutorial.

2 THE BASIC VFR CIRCUIT

This exercise covers the second part of flying "the circuit" ("the pattern" in the USA). See also Exercise 12 "The Standard Take Off & Climb to Downwind". 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

3 THE BASE LEG

Because you are flying at cruise speed, then the turn onto base leg is a standard medium turn, maintaining height, and using 30° angle of bank. The turn is made when the downwind runway threshold is 45° behind you. 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.

Immediately the turn is complete the aircraft is slowed to descent speed. To slow the aircraft down quickly, close the throttle completely, and maintain the nose attitude, gradually increasing backpressure on the yoke to prevent the nose dropping. When the speed falls to 70 knots, apply 2 stages of flap, and release the back pressure slowly, allowing the nose to maintain the airspeed at 70 knots, but taking care not to allow the lowering of flaps to actually raise the nose. (This effect is less marked in Flight Simulator than in a real Cessna 172). Trim to maintain 70 knots and increase power to around 1600-1700 r.p.m. If you have got it right, this will result in a descent rate of about 450 feet per minute at a steady 70 knots.

Why 70 knots? The normal rule for a safe approach speed is 1.3 x the stall speed in the landing configuration. In the Cessna 172SP, this is 47 knots with full flap, and with the usual 2 stages of flap, perhaps 49 knots.

1.3 x 49 = 64 knots

It is common for real world light aircraft training schools to add a margin for safety – hence the 70 knot figure which is widely adopted and maintained by pilots once they have completed their training.

Note: The white arc on the altimeter is the range of airspeeds in which it is safe to lower flaps. Do not start to lower flaps until the airspeed has fallen within this range (less than 95 knots in the Cessna 172).

Look for the runway threshold frequently, using the view selection hat switch or buttons on the yoke, first in 'ahead and sideways' view and the in 'sideways view' to judge when to make the final turn to bring the aircraft in line with the runway. When it appears in sideways view, wait until it appears about halfway between the leading edge of the wing and the wing strut, then make the final 90° turn.

4 THE TURN ONTO FINAL APPROACH

The turn onto final approach is an important manoeuvre. Firstly it should be a 'rate one' turn - made at a maximum angle of bank of 15° in the Cessna 172. Secondly, this turn is used to make adjustments to the flight path so that your final approaches, from this point on, flight after flight, are as similar as possible..

- If there is a crosswind for landing, then it will either be a headwind or a tailwind on base leg. If a headwind, then delay the turn until the runway threshold is almost on the wing strut. If a tailwind, start the final turn early – as the runway threshold appears near the wing leading edge.
- If you turned base leg too late, or making a low approach likely (not good) then ensure that the turn is made without any loss of height. You can delay lowering flaps until after the turn, and maintain level flight at cruise speed until you are closer to the runway (but if you add power, check that the nose does not lift and airspeed reduce below 70 knots).
- If you have had to extend the downwind leg as a result of other traffic ahead, then both the base leg and final turn should be flown at circuit height - do not start the descent until after the final turn.
- If you turned base leg too soon, and you are 'too high' - closer to the runway than you think you ought to be to achieve a normal descent to land, then use the final turn to lose height, by reducing power *a little* and allowing the nose to drop, as it will want to anyway. Immediately the turn is complete, check your airspeed, and adjust power as necessary for the final approach.
- If you find yourself turning final too soon, reduce the bank angle to widen the turn.
- If you turn final too late or overshoot the runway centreline, then bring the aircraft back onto the final approach track gently. Do not sharpen the turn by increasing bank angle beyond 20°. A steep turn with flaps out at low altitude and low airspeed is a recipe for a disastrous spin in a real aircraft, although Flight Simulator is much more tolerant in this configuration.

5 THE POWERED APPROACH

This is the busiest time in the circuit. There are many things to think about and do on the descent. Action is required to maintain the correct rate of descent at the correct airspeed, whilst staying on the extended runway centreline. Fly with one hand on the throttle, and the other on the yoke or joystick all the way down, as small adjustments to direction, airspeed and rate of descent will be required frequently. Your eyes should mainly concentrate on the runway ahead. Aim for a point about 1/3rd of the way along the runway and, most importantly, **keep this aiming point in a fixed position in the windscreen**.

As soon as you are established on the extended runway centre line, report "Final" to the controller. If the runway is quite short, lower the final stage of flaps to full down, and add a little power to overcome the added drag so that you continue to descend at around 450 feet per minute and 70 knots. When landing on long runways (greater than about 800 metres) full flaps are not required, and in the event of a go around, the aircraft will climb better on part flaps. The more flap deployed, the steeper will be the approach path at the same power setting.

Control the rate of descent with power. If the runway appears to be moving down the windscreen, your rate of descent must be increased, and if it appears to move up the windscreen, your rate of descent must be decreased. Add power to reduce the rate of descent, and reduce power to increase the rate of descent. It is particularly important not to get too low.

Control airspeed by adjusting the pitch attitude with elevators, maintaining 70 knots as accurately as possible. If you are too fast, ease back on the yoke to raise the nose. If you are too slow, ease forward on the yoke to lower the nose.

Remember the PAT – (Power Attitude Trim) mantra and if you add power, ease the yoke forward a little to lower the nose a fraction and maintain the correct airspeed. Similarly, if you reduce power, you will need to raise the nose a fraction to maintain the correct airspeed.

All of these control actions need to be gentle - just enough to give the desired effect. Constant adjustments to direction, airspeed and height using aileron, elevator and throttle will be required to maintain the correct approach path.

You may also refer to the VASI/PAPI lights. These are set to show two red and two white when an aircraft is on the correct 'glideslope' – the angle of approach – normally 3o. If you can see more white than red you are too high; more red than white you are too low. As a general rule, it is better airmanship when flying a light aircraft, to make the final approach above the glideslope, with 4 whites showing, because if the engine fails when you are flying the PAPI glideslope, you are unlikely to reach the runway at the end of the subsequent glide. It is surprising how high a light aircraft can be above

the glideslope, and still be landed successfully by using techniques to lose height quickly if required. These will be described in future tutorials.

A good landing is most likely if you have made a good approach, so aim to fly the approach as accurately as possible.

6 THE LANDING

Landing cannot be taught like a science, factually and precisely, for although one can quote numbers, judgement and experience, and even an innate ability, play a large part. No two landings are ever the same, and the pilot who learns something from the less than perfect touchdowns will improve and achieve a consistently satisfactory standard in most conditions.

It is harder to land well in Flight Simulator than in the real world because of the lack of proper visual cues as a result of not having binocular and peripheral vision in the Flight Simulator screen. This can be overcome with multiple screens, but that luxury is not covered in this tutorial.

As you reach a point about 200 feet above the runway, return Carburettor heat, if fitted, to COLD, so that you will have full power available in the event of a go-around.

6.1 The Round-out or Flare

You should arrive at the runway threshold at around 40 to 50 feet above it. At this point, reduce power by around 200 r.p.m. and raise the nose a little to reduce speed to 60 knots and check the descent. Hold this attitude until the aircraft again begins to descend. At about 20 feet above the runway, slowly reduce power to idle and simultaneously raise the nose to check the descent. The greater the rate of sink induced by power reduction, the greater the back pressure that is required on the yoke to slow the descent. Do not allow the aircraft to climb.

6.2 The Hold Off and Touchdown

Continue to ease back on the yoke as the airspeed drops off to hold the aircraft level just above ground. Keep holding off, as if trying to stop the aircraft actually landing. Look well ahead at the runway at this stage, not at the instruments. What is important now is to maintain directional control down the center of the runway, because you will lose sight of it beneath the coaming as the nose continues to be raised. This is one of the things which makes flight simulator more difficult than real world flying, for the real world pilot can still see the runway sides in his peripheral vision.

As you continue to hold off, the stall warner eventually sounds and the aircraft finally stops flying. At this point, the yoke should be back in your chest, and you will be unable to stop further descent. The aircraft will then descend the last foot or so and touch down gently, in a nose high attitude, main wheels first.

This method results in a gentle touchdown at minimum speed – considerably slower than the approach speed – but with the pilot retaining full control all the way.

6.3 Landing Roll

The final phase of landing is the landing roll. Slowly release the back pressure to lower the nose wheel to the ground before elevator authority is lost, and maintain directional control with the rudder. Once the nose wheel is on the ground, brakes may be applied as necessary to slow the Aircraft to taxi speed.

After taxying clear of the runway, stop and carry out the after landing checks. Return power to 1200 r.pm., raise the flaps (and if flying an eroplane with retractable undercarriage taking care not to retract the undercarriage instead – it has been done – many times), check carburetor heat COLD (if fitted).

7 THE GLIDE APPROACH

The earliest powered aircraft always either made a glide approach – the engine developing minimum power, or, in aircraft with early rotary engines, but shutting down the engine altogether. So early pilots were able to routinely turn their aircraft into gliders and make a safe landing.

7.1 The Optimum Approach Position

Today, most light aircraft have a glide ratio of about 9 : 1. This means that without power, and without flaps, if an aircraft is set to fly at the “best glide speed” (68 knots in the C172SP) it will fly 9000 feet horizontally and descend 1000ft vertically. It follows that if you are at 1000ft, then the optimum approach position is 9000 feet, (1.5 nautical miles) from the touchdown point. This is much closer to the airfield at that 1000 feet height than you will be accustomed to when making a powered approach. Powered approaches typically start at about 3nm from the touchdown point at 1000 feet.

In practical flight training, aircraft are positioned from a rectangular circuit at the “Low Key” position prior to commencing a glide approach. This is abeam the runway downwind threshold at 1000ft above the airfield on the downwind leg. The aeroplane is flown on the downwind leg at approximately the same distance from the runway as in a normal circuit.

7.2 Setting up the Approach

When throttle is closed you must IMMEDIATELY reduce the aircraft speed to best glide speed, and trim, before carrying out any other action. The aircraft is then turned towards the airfield onto a base leg. You must then judge where your landing point will be. If you feel you are too high, turn away from the field (a maximum of 45^{o}), or if you feel you are too low, turn

towards it. Bear in mind that what initially appears too high for a powered approach can be good, even be too low for a glide approach. That is why the three observations below using visual cues are important.

1) Positions on the ground that appear to move down from a fixed point on the windshield are ground positions that you can reach and fly over, with height to spare.
2) The position on the ground that remains stationary in relation to the fixed point on the windshield is the ground position that your aircraft should reach.
3) Positions on the ground that move up from a fixed point on the windshield are ground positions that your aircraft cannot reach.

In the same way as for a powered approach, aim for a point about 1/3rd of the way along the runway and, most importantly, **keep this aiming point in a fixed position in the windscreen**. If the fixed point turns out not to be on the runway, but before or after the runway, then action is needed as described below.

7.3 Below or further away than the optimum approach position.

Without the engine you have no throttle, so the only control you have is the joystick (and pedals) so how do you reach the runway?

Pull back on the stick? – WRONG!!! This increases the angle of attack, so yes it does initially increase the lift and you climb slightly, BUT it also increases the drag, so you will soon slow down and the lift will then be reduced. So even though you may stay airborne for a bit longer, the rate of descent will increase, and you probably won't reach the runway.

Deploy the Flaps? – WRONG!!! Again, although this increases the lift a little, the main effect is to reduce the stalling speed, and greatly increase the drag. The glide angle becomes very much steeper, and there is no chance of getting to the runway!

Push forward on the stick? – WRONG!!! This reduces the drag, makes the airframe more "slippery" through the air – you're moving faster, so the lift is increased. But having lowered the nose, the rate of descent will increase.

Maintain the Best Glide Speed and prepare to land in the undershoot. CORRECT!!! Although you have estimated that at Best Glide Speed you will not reach the runway, there is NOTHING you can do to stretch the glide. Many have tried and all have failed because without power you cannot add any energy which the aircraft does not have. You only have the energy available due to your height. How to make a successful off-field landing is covered in Exercise 16.

That is why it is vital, for a successful glide approach, to commence from a higher position closer to the field, than for a powered approach.

7.4 Above or closer in than the optimum approach height.

So if you are high, how do you avoid overshooting the runway?

Push forward on the stick? – WRONG!!! This decreases the angle of attack, so yes it does decrease the lift and you initially dive slightly, BUT it also decreases the drag and makes the airframe more "slippery" through the air. Your airspeed will increase significantly above best landing speed, and you will at best land long, or may even overshoot whilst trying to shed that excess speed in the flare!

Pull back on the stick? – MAYBE! This increases the angle of attack and it also increases the drag which slows the aeroplane down. This reduces lift and increases the rate of descent. Perhaps you will make it! BUT, if you slow the aircraft down too much, you will stall, and if you stall at a low height, you will be unable to recover before the aircraft crashes.

7.5 You do have Control!

So - it isn't a case of "aim at the runway and hope". You do have control to a degree. If you deploy the flaps, again these increase the drag, and thus increase the descent rate. Flaps are in fact the best control available in an engine-out or "deadstick" landing, because they are a graduated response. Bit too high? Lower 1st stage of flap. Still a bit too high? Lower the next stage – and so on.

However, once lowered NEVER raise them again. If you lowered too much flap too soon – tough! Get ready to land in that field a mile short! If you raise the flaps in a deadstick approach, the loss of lift cannot be regained quickly enough (by lowering the nose – it's all you can do) to prevent a high rate of sink, and you will land in that field even more than a mile short!

The final thing you can do if you are still far enough from the threshold, is to make some "S" turns. This has two effects. The loss of height in a turn is greater than when flying straight, so you can lose excess height that way, and because the distance covered will be a little greater than when flying straight, you will descend further before reaching the runway.

7.6 The Flare

You will have a steeper nose down attitude in a glide approach with flaps, then the equivalent configuration with power. So be prepared for a greater round out, but do not be tempted to start earlier. If you do, your airspeed will decay more rapidly than even with idle power and a hard landing will result. Your airspeed should ideally be similar to a powered approach in the last 50 feet, so start at about 10-15 feet above the runway but bring the stick back a little more quickly.

8 CROSSWIND LANDINGS

8.1 Limits

Flying a landing in a crosswind is a skill which takes a while to master. Not only are there limits for the aircraft's performance, but pilots should give themselves limits too. A new Cessna 172 pilot should avoid landing with a crosswind of more than 5 knots. An old hand will pull off a successful landing with a crosswind of more than 25 knots.

The accident statistics of real world flying are peppered with cases where the pilot has exceeded his personal crosswind limit and found himself blown off the runway or worse.

Firstly, what is the crosswind limit of the aircraft? The Pilot's Operating Handbook (POH) will commonly include the phrase "demonstrated crosswind limit". What this means is that during its airworthiness certification a test pilot successfully landed with a crosswind of – whatever the "demonstrated" value is. This does not mean that it is not permitted to land in a higher crosswind. It is quite legally acceptable for an experienced pilot to land with a higher crosswind than the demonstrated value.

In addition to the measured wind, it is necessary to take account of gusts, and the resultant effect, called windshear. Windshear occurs when the wind suddenly drops, which results in an immediate loss of airspeed (though not ground speed) and therefore lift. The aircraft will experience significant sink when this happens, so if gusty conditions exist, the approach speed is increased to minimise the effect of gusts. With the higher approach speed, the difference between the airspeed and the gusting wind speed is less, so the sink is less.

8.2 Estimate or Calculate?

Flying an approach in a stiff crosswind is not the time to get the calculator out! Instead, a table of crosswind factors, which can be memorised, is much more valuable. The table below gives the commonly used factors.

Wind Direction	Headwind	Crosswind
Up to 30 degrees off the runway direction	Full	Zero
From 30 degrees to 45 degrees off runway direction	50%	50%
45 degrees to 60 degrees off runway direction	30%	70%
More than 60 degrees off runway direction	Zero	Full

Note that if the crosswind is 60 degrees off the nose or more, then the full wind value is used. These value provide significant safety margins, but that is a good thing is it not? Even in the risk-free environment of Flight Simulator.

A worked example should help consolidate the meaning of this table.

The reported wind on final approach to runway 16 is 190º at 18 knots. What is the crosswind component? The landing direction is 160º and 190º is 30º off 160º. So the crosswind factor is 50% and the crosswind is therefore assumed to be 18 x 50% = 9 knots.

The rule for dealing with gusts is to increase the approach speed by one half of the gust factor, or one half of the reported airspeed loss due to wind shear. If the wind is 10 knots gusting 24 knots, the gust factor is 24 – 10 = 14 knots, and you should add half the gust factor – 7 knots – to your normal approach speed. Alternatively. if other pilots are reporting a 12-knot loss of airspeed on final approach due to wind shear, add half that loss – 6 knots – to your approach speed.

8.3 Crosswind Landing Techniques

The landing technique most favoured by flying schools in the UK is the "crabbing" method. This is because it requires no abnormal control inputs until the flare. You simply fly the approach crabwise down the centreline, the nose of the aircraft pointing into wind just as you would flying en route to maintain a given track. As a general rule, a 10º into wind heading or less is sufficient. In the flare, as the nose comes up and just before touchdown, you kick the aircraft straight with rudder. You need to judge with some care when to kick straight – do it too soon, and the wind will start to move the aircraft sideways; too late and you will land slightly sideways anyway. You aren't going to damage the landing gear in Flight Simulator, but your "arrival" in this manner would be untidy!

Another crosswind landing technique is the crossed-controls, or wing-low landing. The pilot adds aileron input to fly the final approach with the into wind wing low. To prevent the aircraft turning towards the lowered wing, opposite rudder is applied to keep the aircraft pointing straight down the runway. This is known as a "forward slip" and is a safe manoeuvre, even at low airspeeds. The flare can be held slightly wing low and either a quick levelling of the wings made to land on the two main wheels, or touchdown on the into wind main wheel can be made first. This is mainly a function of the pilot's skill and experience.

8.4 Other factors

Wind direction and speed change with altitude, and the aileron and rudder deflection required to keep the aircraft on the runway centreline will increase as the aircraft's speed decreases. Maintain appropriate control inputs during taxying to avoid weathercocking or at worst, tipping over onto one wingtip – yes it can happen in Flight Simulator.

It is usually advisable to use less than full flap when landing in a gusty crosswind.

If you are experienced Flight Simulator pilot, you could consider reducing the crosswind component a few degrees by landing slightly acroos the runway.

8.5 VATSIM Requirements

The demonstrated crosswind limit is not an absolute or legal limit in the real world, nor, therefore, on VATSIM. The VATSIM Code of Conduct states:

Rule 1: Members should, at all times, be courteous and respectful to one another.

and: *The primary goals of VATSIM are to educate, to provide a realistic simulation of flying and air traffic control and, most importantly, to provide a fun environment for everyone to enjoy our hobby*

So if you are connected to VATSIM,;

- consider if the crosswind exceeds your personal or the aircraft limit,
- consider whether, if you fail to control the aircraft in the crosswind, are you going to spoil the enjoyment of other VATSIM members
- Will you learn anything about yourself, the aircraft or your skill level if you crash.
- consider diverting to an aerodrome where the runway is more into-wind.

9 COMMON LANDING ERRORS

9.1 The "Balloon"

Ballooning is where the aircraft stops descending and starts to climb again when near the ground. It may be caused by: -

- Airspeed too high
- Too much back pressure on the yoke, or or too quickly applied
- Power not reduced sufficiently during the flare or hold off
- A sudden increase in windspeed (a gust).

To correct for a small balloon, relax the yoke pressure (just a little) momentarily, until the aircraft starts to sink again, then continue the landing.

If the balloon is large, or if you are in any doubt about you ability to recover the correct control, go around and try again. With experience, quite large balloons can be recovered, provided there is enough runway left for a second attempt.

9.2 The "Bounce"

If the aircraft touches down: -

- Whilst the airspeed is still above stalling speed, i.e. before it has finished flying, or
- If the landing is a hard one, because the flare was not sufficient, or
- You flare too high and cannot check the subsequent rfapid sink rate,

the aircraft will bounce back into the air again on the undercarriage springs.

To correct for a small bounce, the procedure is similar to that for recovery from a small balloon. Relax the yoke pressure (just a little) momentarily, until the aircraft starts to sink again, then continue the landing. If the sink rate is high or the airspeed very near the stall on this second attempt, adding a little power – possibly to 1100 or 1200 r.p.m. may reduce the sink rate. Leave the power on until the main wheels touch down, then immediately reduce power to idle to prevent a second bounce.

If the bounce is large, or you bounce twice, or if you are in any doubt about you ability to recover the correct control, go around and try again. With experience, quite large bounces can be recovered, provided there is enough runway left for a second attempt.

9.3 Rounding Out Too High

Rounding out too high is often the result of not looking far enough ahead along the runway when commencing the flare. By not looking far enough ahead, the pilot can be unnerved by the "ground rush" effect as the runway begins to approach very quickly, with the result that he over-controls.

Ideally, when the flare is completed, the aircraft will be flying a foot or so above the runway. This takes practice to achieve consistently. If you flare too high, the sink rate as the aircraft approaches stalling speed may be greater than you have elevator authority to check, and a heavy landing results.

If you recognise this high sink rate, then adding a little power – possibly to 1100 or 1200 r.p.m. may reduce the sink rate. Leave the power on until the main wheels touch down, then immediately reduce power to idle to prevent a second bounce, or an unwanted acceleration along the runway.

10 THE GO-AROUND OR MISSED APPROACH

The first rule student pilots are taught when approaching first solo stage is "if in any doubt at all about your landing, go around". This remains true throughout a pilot's career, the only thing which changes with experience is the point at which the pilot has "doubts". Very experienced pilots may only have such doubts if something dramatic happens like a bird strike, or burst

tyre on touchdown. These things of course are not part of the Simulator pilot's life!

To initiate a go around, apply full power, check that the nose attitude remains correct for a the required climb speed and flap configuration, (a climb speed of 70 knots is better than 75 knots if flap is deployed). When 300 feet above the ground or more, "clean up" the aircraft (raise flaps in stages, and undercarriage if fitted) and climb back into the circuit for a second approach.

Note: If flaps have been deployed, then the nose attitude to achieve 70 knots will be considerably lower than if the aircraft is "clean", and the climb rate will be reduced significantly. The Flight Simulator Cessna 172 has more power than a real world one, so even with full flaps deployed, climb rate is reasonable, whereas a real world C172 will scarcely climb at 200 feet per minute with full flaps.

11 TOUCH AND GO LANDINGS

Flying circuits is excellent practice, even for very experienced pilots, as it brings into play in a concentrated manner, most of the skills required to fly an aircraft. When flying circuits for practice, immediately the aircraft touches down

- Retract all flaps
- Apply full power
- Hold forward pressure on the yoke if necessary

Holding forward pressure on the yoke may be required because the elevator trim is set for landing, not take off, and this can result in the nose being too high with the consequent loss of airspeed, possibly critically.