An article by Alan Cassidy on flying high performance taildraggers. A good referesher for those that fly them and a good motivator for those who aspire to fly them.

Many of you, newer pilots are somewhat uncertain of the way in which your aviation ‘career’ is going to progress once you have become a fairly competent PPL flyer. You may just stay as you are, but there is a good chance that the novelty of pottering around for an expensive coffee somewhere else will pale after a while. If you fancy a real, paying career as a pilot, you will have to set off down the PPL, IMC, QFI, CPL, ATPL progression. If you take this route, you need never explore new parts of the flight envelope, nor improve your handling skills beyond the parts of the envelope that you learn in your ab-initio training (even as an airline Captain).
If you want to learn new skills and develop a better understanding of how flying really works, you need to look elsewhere.

Since the 70s and 80s, more and more high performance ‘sport’ planes have been imported into the UK (regrettably few, if any, are built here except for the PFA types). Because of their post-war design they have more consistent airworthiness, and most are still here. This has resulted in ‘trickle-down avianonics’, and the superplanes of that era are now readily available to any new PPL. Pitts Specials, Christen Eagles, Yak-50s and -55s, even Extra 230s and 300s are relatively affordable, especially to small ownership groups.

Yet many pilots are deterred from making the transition to these adventurous aircraft types because current Club training aircraft are so different. The skills required to land a PA28 are very different from those required to land a modern 2-seat aerobatic biplane. But the opportunities are there, the instruction is available and you can make the transition to more rewarding flying if you really want to.

This brings me to the point of this article. Namely to describe and explain some of the techniques used in taking off and landing in modern, high-performance tail draggers. My hope is that this explanation will dispel some myths and some bar talk, that it may motivate you to take that first step on the journey that is truly a major part of your flying education. This in Latin, after all, does mean to lead out.

**The Aeroplanes**
In the short list above, I hope to have given you an idea of the type of aeroplane we are talking about. These are all aircraft that a relatively new PPL can have a real hope to get his or her hands on. I will make occasional reference to Spitfires and other war birds, but these must remain a long way off for most readers.

The modern, high performance sport aeroplanes share a number of common design attributes that dictate, to a large extent, their handling. For example, all the 2-seaters have the tandem seating configuration, and when flown solo it is invariably from the back seat. This is for balance considerations; the pilot and the engine ‘sit’ roughly the same distance away on opposite sides of the Centre of Gravity. The fuel and the optional ‘passenger/instructor’ sit near to the middle of the see-saw.

In the past, this has resulted in some pilots sitting only just in front of the vertical stabiliser. Even though we are not really talking GeeBee racers here, the distance from pilot to engine in a Pitts S2-S of a Sukhoi 29 is certainly more than half the aeroplane’s length. This means there is invariably a lot of ‘nose’ ahead of the driver and this means no forward visibility with all three wheels on the ground.

The main undercarriage tends also to be set further forward than on traditional designs, so that the risk of ‘nosing over, on the ground is reduced. This is good for propeller life expectancy but puts more load on the little wheel at the back, which thus gets more temperamental.

As you will see later, some of these machines also have very large diameter propellers (up to 2.6 metres on a Russian engine), and this also demands some careful thoughts about handling techniques.

## Taking Off

### Classic Method

There is a ‘classic’ technique for take off in tail wheel aircraft, which consists of raising the tail of the aircraft off the ground as soon as elevator authority permits. The pilot holds this fuselage-level, tail-up attitude as the aeroplane accelerates to ‘rotate’ speed, whereupon back stick is used to fly the aircraft off the ground.

There then follows a period of level flight, possibly in ground effect, until a planned speed is attained. Then the pilot sets a climb attitude and continues up at best climb rate, or best climb angle, as appropriate.

This classic method evolved because of wing geometry and low thrust, but it is not always the best in modern light aircraft for two. The first is gyroscopics, while the second relates to the undercarriage, fuselage and propeller geometries.
The classic tail draggers that are widely seen and available to the PPL holder include the Tiger Moth and DHC Chipmunk. In both the power to weight ratio is low relative to newer high-performance machines. But this is not the only difference.

At rest, and indeed at the start of the take-off run, all tail wheel types sit with the fuselage at an angle to the horizontal, typically 8 or 10 degrees. The length of the undercarriage is such that the propeller tips are well clear of the surface. Furthermore, the wing is set at an angle of incidence relative to the fuselage longitudinal datum such that the leading edge is raised. Thus when starting the take off run in the tail down position, the wing may actually be presented to the effectively horizontal airflow at an angle of attack of perhaps 12 or 15 degrees.

At this high alpha the wing can produce a lot of lift, but also induces a lot of drag. The wing is well past its most efficient angle, whereat the lift drag ratio is highest. Consequently, a low powered aircraft in this attitude configuration may well not accelerate even to ‘rotate’ speed. Even if it does get airborne in ground effect, it remains very unlikely to ever reach climbing speed and may just fly straight into the hedge at the upwind end of the strip. Not the desired effect. Hence the ‘classic’ technique of raising the tail, so that the aeroplane can accelerate at a very low angle of attack whereat the wing induces much less drag.

This fuselage/wing configuration is also present if most, if not all, classic tail wheel warbirds. While a WWII fighter may have a much superior thrust to weight combination, this cannot be said for a heavily laden bomber, and so the ‘classic’ technique was also prevalent when these types were operational, and remains so to this day.

However, in aerobatic tail draggers of the modern era the situation can be very different. Consequently, there are alternative techniques available which may be more suitable.

### Alternative Technique

Modern aerobatic aeroplanes have to be able to complete the whole repertoire of advanced figures, with equal ease, in both positive and negative G regimes. Hence the development of symmetrical aerofoils, wherein the chord line and the zero lift axis are the same. The gain from this is that symmetrical handling is achieved; the down side is that the wings are relatively inefficient in terms of lift/drag ratios

Additionally, the wings are most often mated to the fuselage with no angle of incidence. Lastly, some aircraft have very large propellers and very little ground clearance, even in the tail-down ground attitude. Associated with these large propellers are commensurately large gyroscopic forces, which facilitate spectacular low-speed tumbling figures in flight but which also increase the hazard associated with directional control on take-off. The last consideration is that the take-off thrust/weight ratio is usually so high that the take-off ground run is literally counted in seconds, usually in single figures.

It is well known that tail wheel aircraft with powerful motors can have major swinging tendencies on the take-off run. Where modern aerobatic aircraft differ from warbirds, such as the P51 Mustang, is in the rudder authority available. Fighters optimised for combat speeds in the 400 knot range necessarily have fairly small rudders or they would be impracticably heavy at high speed. Thus at take-off speeds these machines have poor rudder authority, in many cases insufficient to keep straight if full power were used. Hence reduced-power take-offs are the norm in these old aircraft.

In a Sukhoi or Extra, there is always enough rudder authority to stay straight on take-off, even at full power. However, the rudder is very sensitive and powerful. Inexperienced pilots can have some difficulty adjusting the delicacy required to maintain direction at this critical phase.

Of course, in a tail-down take-off, all three wheels remain in contact with the runway until lift off. Therefore there is no actual ‘rotate’ speed where the pilot can make the aircraft un-stick using aft elevator control. In fact, it is quite feasible to take off without any manipulation of the elevator control by the pilot, subject to having the elevator trim in a suitable position.

A few seconds after opening the throttle fully, the wing will be generating 1G of lift at the ground-attitude angle of attack. At this point the aircraft will effectively ‘fly itself’ off the ground and adopt a climbing attitude controlled solely by the trim setting. All the pilot has to do during this period is to maintain direction, countering the yawing due to ‘p-factor’ or ‘asymmetric blade effect’.

So there are several reasons why it may be wiser not to raise the tail during the take-of run in, say, a Pitts S2B or Sukhoi 29: the propeller will come very close to the ground; raising the tail will cause a precessive gyroscopic force in yaw which will cause a rapid swing needing more very delicate footwork; the thrust/weight ration and lower angle of attack (compared with our Tiger Moth) means that the aircraft will always have excellent climb performance in the regular, three-point attitude.

Of course, in a tail-down take-off you cannot see the runway ahead of you, only the edges to either side. It is thus necessary to look a bit sideways during the take-off run and to learn to determine directional visual cues from this oblique view. Nevertheless, most new Pitts students take more easily to the tail-down technique than to the classic style, especially on uneven grass runways.

Certain modern machines, such as the Extra-300 and CAP-232, tend in Europe to have smaller diameter, 4-bladed propellers to reduce their noise signatures at high rpm. In these types, the classic tail-up take-off can be safely made without fear of a propeller strike, but the pilot must still be very alert to the need to counter gyroscopic yaw as the pitch angle is changed at low speed.

**Approach and Landing**

It is tempting to say that approach and landing are rather like chicken and egg: which comes first? Of course, the approach always has to be flown first, but the wise tail wheel pilot will usually consider the landing options first, choose one and then select a type of approach best suited to that type of landing.

With tricycle aircraft, from Cessna 150s to 747s there appear two types of landing: smooth and carrier-deck. However, the pilot’s intended touch-down attitude configuration is always the same.

With tail draggers there are two well-known touch-down alternatives: three-point landings and wheel landings. Some older aircraft are more suited to the former, some to the latter. Others, a Tiger Moth or Piper Cub for example, are equally suitable for either option. Much has been written about the two techniques elsewhere and I don’t have space to write extensively on them here, but I will explain the implications of modern aircraft configuration on these two options.

I explained when describing take-off techniques how the wing section (symmetrical or not) and the angle of incidence between the wing and fuselage (existent or not) affect drag and lift in tail-down and tail-up attitudes. Similar considerations arise on landing except that on departure we had initially almost no airspeed and full thrust, whereas now we have airspeed but almost no thrust. A Tiger Moth flying parallel to the ground in the three point attitude has a very high angle of attack and will land virtually stalled: just about as slow as it will fly. The same aeroplane landing with the fuselage level will have a much lower angle of attack, more or less equal to the angle of incidence. To fly level with the ground and touch down in this attitude you must fly faster, but still not unacceptably so. Now consider a modern aerobatic craft with a symmetrical wing and no incidence and you will appreciate that with the fuselage level the angle of attack will be close to zero and no lift generated at all.

A wheel landing can be flown in one of these advanced types (propeller clearance permitting) but the fuselage must still be slightly nose-up and the touch-down speed will have to be very fast. For example, the touch-down speed of a Pitts S2A in the three-point attitude is roughly 70 mph IAS. To make a wheel landing with the fuselage still not quite level may need a speed of 120 mph. This is faster than the main wheels really want to be turning. As kinetic energy is proportional to the square of the speed, the wheel landing Pitts just mentioned will, on a still air day, have three times the energy on touch-down. This energy is slow to dissipate and a long landing run can be expected.

With a long smooth runway available, however, it is quite possible to fly wheelies with a high performance tail dragger, and they are a very good test of judgement, but they are not for the novice to try and they are certainly not at all suited to short or uneven runways. So lets go back and consider the three-point landing, and then I'll introduce the third option which is, in many cases, by far the best for the machines we are talking about.

**Three Point Landing**

The first thing to realize is that when landing in the three-point attitude a Pitts or Extra is nothing like stalled. The angle of attack is not close to critical. The aeroplane is still flying. For any given weight and density altitude, the touch-down air speed will always be the same, but it will be well above the 1g stalling speed. Consequently, all the flying controls will still be very effective, so the pilot must still have an extremely delicate touch.

Ideally, you will be in the exact three-point attitude, six inches above the ground and flying level (no rate of descent). A fraction of a second later, as you slow down further, the aircraft will sink gently onto all three wheels. But remember you are still flying! If the runway is grass, there will almost certainly be a bump coming up and when you hit it you may well become airborne once again. You must continue to fly the aeroplane now, which means working to retain the three-point attitude, not blindly applying full back stick because this would just get you climbing away from the ground again.

In this way the second and, as there may well be, third touch-down will all be on three points and all will be well. By now the aircraft will have slowed enough for it not to be at risk of flying again and the landing roll-out proper can start.

It would have been unwise, and ineffective, to have started braking when there was still a chance that the main wheels may not be in proper contact with the runway. Once you start using the brakes, you should pay careful attention to how the aircraft responds in the pitching sense. Because most modern aircraft are fairly heavy at the back end, there should be little if any tendency for the tail to lift under moderate braking. It should not, therefore, be necessary to hold the stick hard back as you might on a Chipmunk or CAP-10.

In fact, keeping the elevator neutral will put more weight on the main wheels and so improve braking, as well as avoiding the tendency to 'excite' the tail spring that goes with full aft stick over bumpy ground. Now I have to go back in time a little to talk about how we might have arranged our approach to get us to the six-inches-above-the-ground point.

**Slipping Approaches**

The first key aspect of any visual approach is that the pilot must see the runway. Just as these aircraft have a blind spot straight ahead whilst on the ground, the big-engine/tail-wheel combination leads to similar problems during low speed flight. The Spitfire and other WWII fighters suffered from this problem, despite having asymmetrical wings, incidence and flaps.

The 1930s solution was to fly a curved approach down to the flare, judging descent rate and position using a constant relative sight line from the pilot to the touch-down point. Inevitably, there remains a short period of ‘blind’ descent once the aeroplane is lined up with the runway and straightened for landing. It is during this ‘blind’ period, albeit on a few seconds, that the aircraft has to be very accurately flown to the three-point position that ensures a good landing.

Curved approaches like this will also work with our modern aerobatic aircraft, but are not readily compatible with circuit flying amongst mixed GA types at typical recreational airfields. So, the modern sporting pilot has to have some other approach alternatives up his sleeve to cope with other environments.

To be sure you understand the source of the visibility problem, consider the configuration of the symmetrical aeroplane in low speed descending flight. (Figure 9). With no flaps to enable lowering of the nose, the flight path is invariably towards a point on the ground hidden behind the engine. Of course, it is possible to fly the approach much faster, so that some forward visibility is available, and I will talk about this last. But first I will describe the low speed option.

When you are approaching at low speed in a straight line, you must find some way of moving the nose out of the way, sideways, in order to be able to see the touch-down point. Hence a side-slipping approach becomes the norm.

In a slipping approach, the you apply rudder to move the nose out of the line of sight between yourself and the runway. The right amount of rudder to apply is that which just gives the visibility needed. Then you apply aileron in the opposite direction so that the aeroplane’s track maintains the runway centre line. These are the key things to remember: rudder for visibility, aileron for direction. Now we must also consider the operation of the straight symmetrical wing in low speed flight.

You should recall from PPL ground school that there is a minimum power setting at which you can maintain straight and level flight. At any power setting higher than this, there are two speeds at which you can fly level, one faster and one slower. If you are flying at the lower speed you are operating on the ‘back’ of the drag curve. You are pushing the wing through the air at an un-necessarily high angle. You are also being quite inefficient in burning more fuel than you need, as you are balancing power against high-alpha drag to control rate of descent.

For a powered approach in our chosen aircraft we are going to fly in this exact regime, just as you did in the ‘slow flight/stall avoidance’ part of the PPL syllabus.

While turning onto final approach, then, you must reduce speed to the chosen value. This will naturally vary between types, but in each case it is a speed that puts you on the back of the drag curve. The further back on the curve you are, the greater will be your rate of descent (sink) without power. The best speed is one that gives a slow rate of descent with just a little power applied.
On reaching the centre-line, the nose of the aircraft will start to block your view of the runway, so this is the time to apply the rudder to initiate the slip that will ensure a continued view of the touch-down point. At the same time apply opposite aileron to get the right track over the ground and apply a little more power to counter the drag induced by the sideslip.

Now make small changes of attitude or power to ensure that the aircraft continues towards the best spot on the ground at an acceptably low rate of descent. You must have got this sorted by 300 feet so that this last bit of the approach is truly stable.

You now have two sources of drag – the ‘drag curve’ drag and the ‘sideslip’ drag. The two are opposed by a smallish amount power. If you get slower, or apply more sideslip, then the drag will increase and so more power will be required to keep the optimum rate of descent. After a short while in this stable situation the ground will be getting quite close. At maybe 10 feet or so you must quickly take off the slip by moving rudder and aileron simultaneously to bring the nose in line with the runway. Now you are blind ahead so must turn your gaze to the side to judge direction by looking at the side of the runway or some other convenient markers in the middle distance. It is no good continuing to look over the nose, because your peripheral vision is insufficient for accurate height assessment.

Removing the side slip has taken away one of the two sources of drag. But please note that I have said nothing yet about closing the throttle. The power which was previously countering both drag elements now has only one to contend with. Consequently, the very act of 'straightening up' the aeroplane will also reduce its rate of descent. If you had the ideal approach speed for the type, this power will just make the aircraft fly parallel to the ground while you hold the three-point attitude. Then, immediately on closing the throttle the aeroplane will touch down perfectly.

If the approach speed was a bit high, you might find that the aeroplane climbs a bit after straightening up, so you must reduce power a little and fly it gently down again. If your approach speed was too slow and your power setting a bit less than required, the aircraft will continue to descend after straightening up and will land before you expect it to. If you attitude is not the perfect three-points, then a bounce will ensue that is probably best cured by a go-around.

Mastering this rather complicated technique will allow you to land the aircraft very precisely on your chosen spot in any wind speed, as long as the cross wind component is small or non-existent. If there is a significant cross wind then you make sure of two things. First, you must select your sideslip direction by applying rudder that puts the nose into the cross-wind component. If the wind is from the right, use right rudder, and vice versa. You will then use left aileron to raise the right wing to maintain track. Second, after removing the slip you must maintain some crab, with the nose into wind, until the precise moment of sinking onto the wheels. At this last instant you must yaw the aircraft straight using the rudder again.

This direction of sideslip is the opposite to that used for the 'wing down' method of cross wind landing in, for example, a Cessna 150. Don't be concerned at the difference, however, because the reason is very logical and both are correct in their own way. In the Cessna, your purpose for slipping is to ensure that the fuselage stays aligned with the centre-line of the runway. The aircraft/wing configuration, flaps etc will ensure you can still see ahead. In a Pitts or Sukhoi, however, the sole purpose of the slip is to get the fuselage misaligned with the runway so that you can see ahead round the cowlings. Hence the two apparently contradictory methods are both sensible for their respective situations.

You can rest assured that mastery of this technique on the ubiquitous, and relatively cheap, Pitts or Eagle biplanes will perfectly equip you to land a Spitfire which has, with flaps down, a 70 knot approach speed which is actually slightly slower than the modern bi-planes.

**Fast Approaches**
The difficulty of a low-speed slipping approach is the workload as the aeroplane is straightened up. Precise inputs are required for all three primary flying controls and for power. If you are approaching a runway that is long enough for the actual touch-down point to be less important, then this workload can be reduced by using a high-speed approach technique.

In this case, visibility of the runway ahead is maintained by keeping the nose low and looking straight ahead. As an example of speed difference, the normal 75 knot slipping approach in a Giles G202 might turn into a 110 knot straight in approach. The pitch attitude you select should just low enough so that you can see the centre-line at the far end of the runway. It would be much too fast, or result in a dramatic undershoot, if you could see the numbers at the near end of the strip.

In this attitude, and with a trickle of power applied, you can fly a stable approach, occasionally looking either side of the nose at the airfield perimeter to determine correct descent path. During this phase you should maintain constant attitude and make subtle power changes to maintain the correct descent rate. When you are sure you will make the runway threshold, you can convert this to a glide.

As you near the ground, you must start to raise the nose to reduce speed and rate of descent. As you do this you will lose forward visibility, so you must not do it too early. During the flare you must be able to look obliquely out of the cockpit and monitor direction by looking at the runway edge. The speed of the approach will mean that flare will be gradual, and that the aeroplane will cover quite some distance before the key three-point attitude is reached. During all this time, continue very slowly raising the nose to ensure level flight close to the runway surface.

Once you reach the three-point attitude, you must maintain it. Do not continue to bring the elevator control aft – just sit still. Then you will lose a little more speed and the aeroplane will settle onto its wheels perfectly. In this approach, once you close the throttle, you use only the elevator in any significant way. Hence the lower work load.

This method is not really very suitable for cross wind conditions, because during the ‘float’ period immediately prior to touch-down there will be a tendency to drift. You could use a ‘wing-down’ cross wind correction, as long as you are not in a bi-plane with minimum ground clearance on the lower wing, or a crab correction, but then you would be defeating the object of the reduced work load. But it is very useful when visiting controlled airfields, like Bournemouth, where you invariably get vectored onto a 4 mile final behind an Aztec on an Instrument Rating test.

**Wheel Landing**
An alternative, at the point of closing the throttle would be to maintain power, and gradually bring the aeroplane to an almost level attitude, only very slightly tail down. This means you can now aim for a wheel landing by flying the aeroplane onto the runway with absolutely minimum rate of descent. As soon as the main wheels touch (and before they can bounce up again!), you must raise the tail a little to reduce the angle of attack and spill all lift. Then you can close the throttle and continue to slow down.
Maintain the level attitude with progressively more forward stick and keep directional control with the rudder. Once you have the control column fully forward, the continued slowing of the aircraft will lower the tail wheel gently to the ground whereupon normal braking and taxiing can continue.

**Tail Wheel Protection**
Because high performance aerobatic aeroplanes are ‘flown’ onto the ground, not ‘stalled’ on, touch-down speeds can be relatively high. In nil wind conditions, with a CAP-232 or Pitts S2B this may be as high as 85 or 90 mph. This is a lot faster than the speed for which the widely-available Scott or Maule tail wheels were actually designed. Rotation under load at such speeds will inevitably lead to early bearing failure.

One solution to this problem for more experienced tail dragging pilots is the tail-down wheel landing. From either a slipping or a fast approach, you can hold the aircraft off the ground until you reach the three-point attitude. A very low rate of descent and a height of just a few inches are both critical at this stage. As the wheels start to brush the ground, you can use a rapid and substantial forward stick input to bring the aircraft up to the level attitude, killing lift and keeping the delicate tail wheel off the ground.

The main wheels must be in contact with the ground during this attitude change, or a big bounce is likely to ensue. Hence the technique is only really viable on smooth hard runways or the very best billiard-table grass strips (there are some, but not my home base!).

Of course the risk is that in trying to protect the tail wheel, you are putting the much more expensive propeller at risk if your actions are over-cooked or the ground is insufficiently level. Hence my description of this technique as an advanced one for more experienced pilots to try only when they are sure they can react quickly to whatever might happen. Once mastered, however, it is extremely satisfying to know that you can fly well and treat your machine with the consideration it deserves.

**The New ‘Golden Age’**

We, the passionate aviator fraternity (including sisters in that term, of course) – and I assume that is a description that fits you as you are actually reading this magazine – are constantly told in books, articles and films that the ‘Golden Age’ of aviation was during the 1920s and 1930s. Hendon Air Displays featuring Harts all tied together with string, the design of the Spitfire, the beginnings of inter-continental jaunts my Amy Johnson, Francis Chichester and the like… the list of romanticisms is almost endless.

I think that is actually a load of equine faecal matter! Understandable, but missing the point about living in the 21st Century. I contend that the golden age of aviation is now, and I will explain why.

In the 20s and 30s you had to be seriously inheritanced to be able to fly at all. Certainly no boy (or girl) from a relatively humble background could actually become a civilian or military pilot. The aeroplanes were labour-intensive and unreliable. They were also of varying airworthiness – which is another way of saying they quite often broke. All things navigational were amazingly complicated, involving sextants if you were flying over the sea.

Currently we have more aircraft, with more performance, greater reliability and lower running costs than at any time in history. Great Feats of Aviation, as Spike Milligan may have called them, are now open to almost anyone who has the desire. Today, you can make any flying dream you have come true without being the son of the Duke of Wherever. Now we can all be ‘fighter pilots’, looping and swooping in the most romantic fashion. You can do all these things

The route to this privileged position is through flying ever higher performance, tail dragging aeroplanes with the primary purpose of striving always to improve your own level of piloting skill.

**P-Factor or Asymmetric Blade Effect**

When an aircraft flies with a very low angle of attack, the disc of the propeller is virtually symmetrical with respect to the relative air flow. The lift forces generated by each blade of the propeller are more or less the same. When it has a significant angle of attack, however, the situation changes dramatically.

Say an aircraft is flying (or travelling along the ground) with an angle of attack of 15°. Also assume that it has a 2-bladed propeller, but the situation remains the same with more blades. In the time it takes the propeller to make half a revolution, the aircraft will move forward a small distance. The blade that is moving down will actually have to travel further through the air than the blade that is going up. So the down-going blade has effectively more airspeed than the up-going one and will develop more lift.

Thus, with an angle of attack the propeller blades a asymmetric in terms of the lift they generate. This means that the thrust from the propeller is greater on one side of the disc and so it tends to yaw the aeroplane towards the side that has the up-going blade. In Lycoming-engined aircraft this means the aeroplane will turn to the left, while in Russian-engined planes, the direction of yaw will be to the right.

**Gyroscopic Precession**

You should remember from the PPL ground school that any rapidly spinning mass acts as a gyroscope, and that this tries to maintain its existing plane of rotation. Hence gyro-stabilisation. If you try to change the plane of rotation of the gyroscope, a strange thing happens, called precession.

This means that if you yaw the nose of the aeroplane sideways, the propeller generates a precessed force that, in turn, makes the nose go down or up. Similarly if you pitch up or down rapidly, the gyroscopic force tends to make the aeroplane yaw in response.

When you raise the tail on take off, you are effectively making the nose pitch down. In a

Lycoming-engined aeroplane, with the propeller turning clockwise as viewed from the cockpit, there will be a resultant yaw to the left. If you have a propeller that goes the other way, as in a Yak or a Chipmunk, then the yaw will be to the right.

**Different Side-Slipping Methods**

With the wind from the right, the way you apply side slip will depend on the principal reason for actually slipping. In the Pitts, you are trying to move the nose to one side, so you can see the runway ahead. So you would use right rudder and left aileron. In the Cessna, you are trying to keep the nose aligned with the runway so that you eliminate drift on finals and on touch-down. So you would use left rudder and right aileron. Both methods are correct, because the problems and hence solutions are mutually contrary.