Taildragger Training Notes

Rules of Taildragger Flying
Rule 1: When landing a taildragger, all that matters is that you touchdown straight - no drift/crab. You want to make sure your wreckage goes straight down the runway...

Rule 2: Don't stop flying the taildragger until it is in the hangar.

(Note: These notes assume the engine is American and rotating clockwise as seen from the cockpit. Anti-clockwise rotating engines produce opposite yaw)

Taildragger.com

What's Different About Taildraggers?
What makes a taildragger different from an aeroplane with tricycle gear? There really is only one simple difference. The centre of gravity is forward of the main gear on the tricycle gear aeroplane and behind the main gear of the taildragger. This one little difference accounts for some pretty significant differences in the way the aeroplanes behave while on the ground and during takeoff and landing.

Taxiing
The first difference you would notice comes during taxiing. Since the centre of gravity is behind the taildraggers' main landing gear, the aeroplane does not naturally track straight. The tail has a tendency to swap ends with the nose because the centre of gravity is pushing from behind.

A good analogy can be made with a wheelbarrow. If you pull it behind you it tracks straight. This is the principle of the tricycle gear aeroplane at work. If you try to push it out in front of you, the principles of the taildragger are at hand and it's a different machine. You really have to pay attention and be quick to keep it tracking straight. It constantly tends to deviate to either side and swing around behind you. The further off-centre you let it get, the more difficult it is to get it straight again. If you let it get too far off centre it's too late. It's sideways and you cannot get it back in front of you. Try it on your wheelbarrow and you will get an excellent feel of the forces affecting the ground handling of a taildragger.

This is really the exact same physics at work as trying to balance a broom standing straight up on the palm of your hand, with the bristle end up in the air. It's not quite that quick in the aeroplane because most taildraggers have a much wider wheelbase to length ratio than a broom. The taildragger's centre of gravity is much closer to its main gear than the broom's to its tip, but this analogy really brings the point home. As long as you pay attention you can keep that broom balanced up there, but let your attention wander just for a moment and the broom might start to fall. More than likely it will get too far over to save. You will soon run out of arm movement necessary to get back under the balance point, which would be like running out of brake power, rudder, and runway in the taildragger.

Takeoff in a Taildragger

Your first takeoff in a taildragger might seem like some kind of exercise in s-turns on the runway, but with a little understanding of what is happening, learning a few techniques, and a little practice, you'll soon be able to make nice, straight, and clean takeoffs in the taildragger.

Overview

In this overview section, we will explain the basic takeoff procedure in a taildragger. The next section will break down the forces acting on the taildragger in more detail.
Takeoff in a taildragger starts like a takeoff in any aeroplane. You taxi out onto the runway, line up with the centre line, straighten the tailwheel and begin applying power. You will see that right rudder is immediately required to keep the aeroplane rolling straight down the runway. You must look beyond the end of the runway throughout the entire takeoff roll with full attention and use the rudder to keep the aeroplane tracking straight. Don't let anything distract you from paying full attention to maintaining directional control.
Taildraggers are essentially designed to sit at their stall angle of attack on the ground for landing purposes. This is not the ideal situation for takeoff. You need to raise the tail a little during the takeoff roll to achieve something closer to the aeroplane's normal climb angle of attack. You accomplish this by applying forward or neutral stick once full power is achieved. Be prepared for an extra dose of right rudder when the tail comes up. Hold this attitude and allow the aeroplane to fly off the runway. In this way you can concentrate on maintaining directional control, and not be distracted by watching for a certain "rotate speed". Only check the ASI briefly during the takeoff roll to ensure that is indicating.
Some pilots raise the tail too high, then pull back on the stick to "rotate" and lift off. This is not the correct way to make a takeoff in a taildragger except on rough ground or in gusty wind conditions. In climb, the airspeed indicator is used as a reference to make sure you have the correct pitch attitude.
It cannot be emphasised enough that you need to have all eyes looking straight down the runway on takeoff.
Next we'll look at the forces at work acting on the taildragger during takeoff that require you to use rudder to keep the aeroplane going straight down the runway.

Forces at Work

Torque
Torque is a major factor acting on the aeroplane at all times when the engine is running. During takeoff is one of the times it's most noticeable. In the average taildragger most of us fly, it is most noticeable early in the takeoff roll. Essentially, torque is the tendency for the propeller to stop and the aeroplane to rotate in the opposite direction. This in turn creates more drag on the left wheel, so yaw to the left. The more horsepower an aeroplane has, the stronger the effect of torque on that aeroplane. A 65 HP J-3 Cub does not have a lot of torque, but it is noticeable and cannot be ignored. A 300 HP Cessna 195 has very noticeable torque and must be countered properly during takeoff or you'll end up in the weeds for sure. Imagine what torque must be like in a P-51 Mustang! In these really powerful aeroplanes, you have to bring in the power incrementally as you pick up speed so you don't introduce more torque than you have available rudder with which to counteract the torque.
The bottom line is that when you add power for takeoff, you must use right rudder to counteract torque. Torque is trying to yaw the aeroplane to the left.

Slipstream Effect
Slipstream Effect is caused when the rotation of the propellor causes the air to rotate as it moves aft. This can be visualised as the slipstream moving in a helical or corkscrew motion, striking the left side of the rudder, at an angle. This causes yaw to the left, which decreases as the airspeed increases as the corkscrew 'unwinds'. Manufacturers may design in a certain amount of offset in the fin and rudder and/or offset the engine thrust line to neutralise slipstream effect at cruise speed, but at speeds away from cruise, any such compensation is not correct.

P-Factor
P-Factor (or Assymetric Blade Effect) is caused when the plane of the propeller is moving through the air at an angle to the direction of travel. With the aeroplane in a nose-high attitude in relation to the path of the aeroplane, as is the case in a taildragger starting its takeoff roll, the plane of the propeller is not moving perpendicular through the air. It can be at an angle of about 10^{o} to the flight path. The air is coming at the propeller at an angle from below. This means that the propeller blade moving downward has a higher angle of attack than the blade moving upward. Since the blade on the aeroplane's right hand side is moving downward it is realising a higher angle of attack, therefore producing a little more "lift" (thrust). Since the blade on the aeroplane's left hand side is moving up, it realises the slightly lower angle of attack and produces a little less "lift" (thrust). So, the right hand side of the propeller has a little more thrust than the left hand side. This tends to yaw the aeroplane to the left. As the aeroplane begins to roll down the runway, P-Factor decreases.
The bottom line is that this force also requires right rudder to counteract. This force gets stronger as the aeroplane picks up speed, but the rudder also becomes more effective as you pick up speed. This force is reduced once you have the tail raised, but may still there as in a normal takeoff you do not raise the tail high enough to completely reduce the angle.

Gyroscope Effect
This force only acts on the aeroplane during the moments the tail is moving up (or down). The propeller acts as a gyro. When you apply a force to a gyro, it reacts 90 degrees in the direction of rotation. When you are raising the tail, you are essentially changing the plane of the propeller "gyro" as if you were pushing on the top of the propeller arc from behind. Since the propeller is turning clockwise when viewed from behind, and since a "gyro" reacts with a force 90^{o} in the direction of rotation, the reaction comes as if you were pushing from behind on the right side of the propeller arc. This tends to yaw the aeroplane to the left. The more horsepower the engine has, therefore the larger and heavier the prop, the stronger this gyroscope reaction will be. In aeroplanes with a lot of power, you will need to be careful not to bring the tail up too soon, before you have enough speed and therefore rudder effectiveness to counteract this force.
The bottom line is that while the tail is coming up, an extra dose of right rudder is required to keep the aeroplane straight. A good taildragger pilot will anticipate the tail coming up and apply right rudder so that the nose doesn't yaw, rather than waiting to see the nose to start to yaw then reacting. Once the tail stops raising, you relax pressure on the right rudder because the gyroscope effect stops.

At this time, you have also reduced the angle at which the plane of the propeller is moving through the air, so P-Factor has also been reduced. Also, when the tail comes up, you lose the traction provided by the tailwheel, so this too causes a little more rudder to be required. Once the tail is up, the aeroplane is picking up speed, so the rudder is becoming more effective. As the rudder becomes more effective, less rudder is required to do the same job. The typical taildragger takeoff may require a lot of right rudder during the initial moments of takeoff, maybe even sustained doses of full right rudder. During the end of the takeoff, you have pretty much reduced right rudder usage to that normal during a climb. When the aeroplane flies off the runway, you are essentially in a normal climb, and we all know that a little right rudder is required in the climb, whether in a taildragger or a nose wheel aeroplane, to counteract slipstream and P-Factor.

Techniques to Learn and Use

Look straight down the runway

During a taildragger takeoff, you should look beyond the end of the runway at all times and keep pressure on the rudders to keep the aeroplane straight. Apply power with the stick fully aft, then once you have full power set relax the stick to neutral. The aircraft will naturally raise the tail to a tail low attitude. Maintain direction, countering the yaw from torgque, slipstream, assymetric blade effect and gyroscopic force. The aircraft will lift off in the climb attitude when it has enough airspeed. Once airbourne check climb speed and keep the wings level to maintain direction.

However, when the wind is gusty, or the runway is rough, you do not want the aircraft to get airbourne prematurely, and then sink again. In this case raise the tail a little more than normal (approximately to the wheeler attitude), to stick the aircraft to the runway until a higher speed (no more than 5-10 mph, otherwise you could strain the undercarriage during the bumps) then slightly rotate and climb away cleanly. So you need to know what speed the aircraft normally lifts off by quickly glancing at the ASI sometime early in the training. Also you will be able to feel when the aircraft is ready to fly as you gain experience.

Hopefully you're flying a taildragger in the first place because you like to fly, not watch gauges and push buttons on fancy radios and other equipment. You're a pilot when you fly a taildragger, not a cockpit resource manager!

Anticipate

Learn to anticipate right rudder when needed. When you start applying takeoff power, apply right rudder at the same time. Don't wait for the nose to yaw then reacting. Keep ahead of the aeroplane. The same holds true when the tail comes up, as mentioned above in the gyroscope discussion. Anticipate that tail coming up. Be ready to lead that with right rudder so that when the tail comes up the nose doesn't yaw.

Use your feet

Use you feet aggressively at first. A good technique is to use full rudder, then once the nose starts yawing, centralise it, and be ready to apply a little more or less rudder as required. If you need right rudder for example, use full right rudder until it starts yawing right, then centralise. Hopefully it will stop in the centre, but may still swing further right, requiring left rudder. Or it may stop early and require a little more right rudder. This way you can stay ahead to rudder requirements, and avoid overcontrolling.

Takeoff Summary Outline

- Line the aeroplane up with the runway centre line
- Straighten the tailwheel
- Look at a point beyond the end of the runway
- Apply power gently
- Keep looking straight down the runway and keep the aeroplane straight with the rudder
- Once full power is applied, neutralise the stick, then apply a little forward stick to raise the tail as necessary
- Anticipate the tail coming up and be ready with more right rudder at that time
- Keep looking straight down the runway and keep the aeroplane straight with the rudder
- Hold your climb angle of attack until the aeroplane flies off the runway
- Begin your climb out holding that same angle of attack
- Now check your airspeed and make minor pitch adjustments as necessary

Landing a Taildragger

Overview

If there is really one word that sums up all you need to know about landing a taildragger, that would world be "**straight**". You must touchdown with the aeroplane absolutely straight with no drift. Since the centre of gravity (CG) is behind the main wheels of the taildragger, if you are not straight when you touch down, that CG will be offset and will try to swing the tail around. If the drift is slight, you can fight it back with the rudder. If the drift is significant, or if you have a crosswind, you may not have enough rudder or brake available to straighten the aircraft, in which case you may find yourself upside down the weeds along the side of the runway faster than you can say "groundloop". *The bottom line is you want your wreckage to go straight down the runway!*

The other big issue with landing a taildragger is that given the CG being rear of the main wheels, when the main wheels touchdown, the CG will want to continue its downward momentum, thus pulling the tail down, which increases the angle of attack, thereby increasing lift and causing the aeroplane to fly again, or appear to "bounce". This kind of bounce in a taildragger is different than that in a nose wheel aeroplane. Usually a bounce in a nose wheel aeroplane is caused by landing too hard and the spring in the gear pushes the aeroplane back into the air. There is no increase in lift so the aeroplane settles back down. In a taildragger, the lift increases due to increased angle of attack, yet airspeed is low, so a stall at 20 feet or so is possible. Sometimes you may have been carrying a little too much speed and the bounce leaves you 20' or more up in the air, and slow! This bounce may require some quick work to keep the aeroplane flying and get it setup for another touchown attempt, *or to make a go around*.

There are basically two types of taildragger landing. They are the Stall or Three-Point and the Wheel Landing

Basically, with a stall landing, you stall the aeroplane just a few inches off the runway. The taildragger is designed to sit on all three wheels at about the stall attitude, so when you actually stall it, the aeroplane will touchdown almost on all three wheels, probably a little tailwheel first. Since the tailwheel is down now, the CG cannot bring the tail down any more, so your angle of attack will not increase, and the aeroplane will not lift off the ground again. Even if the angle of attack could increase, it's already at or exceeding the stalled angle of attack because you did just stall it, so it would be impossible for it to gain any lift and fly off again. For the Piper Cub the normal landing is a 3 point, but the disadvantage with the 3 point or stall landing in gusty conditions is that you are vulnerable to those gusts with reduced controllability (especially rudder due to blanking of the rudder by the fuselage) during the flare for landing. So if there are any issues that you cannot afford to be vulnerable, do a wheeler landing as below, or go to another airfield without the issues.

The three-point landing is actually very similar to the stall landing. Most taildraggers will sit at their three-point attitude just slightly shy of the stall. When you really get familiar with a particular aeroplane, you can learn that exact attitude and touchdown so that all three wheels roll on at the same time. Usually it's just shy of a full stall (1 or 2 mph faster). It requires a little finesse to do this nicely.

The wheel landing is actually pretty easy to make once you get the hang of it. This landing simply requires that you make easy contact with the runway on the main wheels first, with the shallowest rate of descent possible so the downward momentum of the CG is slight. At the moment of touchdown on the main wheels, *almost* with a slight anticipation, you apply forward stick to prevent the downward momentum of the CG from lowering the tail. You actually want to raise the tail at that instance, decreasing the angle of attack, maybe even to zero or slightly negative, so you really stick the aeroplane onto the runway. As the aeroplane

slows down and the elevator runs out of airspeed, the tail will drop and you end the landing rollout by keeping straight until you are at taxi speed.
Is either the three-point/stall or wheel landing any better than the other? This is a good topic of debate among taildragger pilots, but the answer is simply *no*. Of course there are exceptions to both ways for particular aeroplanes, as specific aeroplanes have to be approached differently for all kinds of reasons, including how you might land it. Overall, either type of landing is fine if executed properly. What really matters either way is that you touchdown straight with no drift. If you can't get it straight, you must go around and try again, or go find another runway. The bottom line is that for the typical taildragger you should remain proficient in both types of landings and make whichever one you feel most comfortable with in any given condition as that's going to be the safest type for you.

Keep the Stick Back!
With all landings, you must **keep that stick back** when the tailwheel is on the runway! Keep it all the way back during landing rollout, without exception. If making a full-stall landing, you want to work the stick all the way back so that it hits the stop the moment the aeroplane stalls and touches down, then hold it there until you shut the engine down and get out. With the three-point landing, you want to do the same if possible, or immediately get it back at the moment of touchdown (it will be almost there if not already). After making a wheel landing, as soon as you get the tail down, immediately get that stick back and keep it back.
We have an entire page devoted to keeping the stick back.
In the following sections, we will break out into more detail each type of landing.

Stall Landing

Stall Landing Outline

- Make normal approach to the runway.
- By short final, eliminate any drift by lowering the upwind wing and keep the aeroplane straight with opposite rudder as necessary
- Make a normal flare to level flight just inches off the runway
- Keep working the stick back so as to not let the aeroplane land and keep it a few inches off the runway
- Strive to get the stick all the way back to its stop
- Allow the aeroplane to stall just inches off the runway
- Keep the stick back!!!
- Keep looking straight down the runway and steer the aeroplane with the rudders
- DO NOT let your attention drop one instant from maintaining directional control
- Keep the ailerons turned into the wind as necessary
- Keep the stick ALL THE WAY back!

Three-Point Landing

Three-Point Landing Outline

- Make normal approach to runway.
- By short final, eliminate any drift by lowering the upwind wing and keep the aeroplane straight with opposite rudder as necessary
- Make a normal flare to level flight just inches off the runway
- Keep working the stick back so as to not let the aeroplane land and keep it a few inches off the runway

- Strive to attain the exact attitude at which all three wheels will touch at the same time. This attitude will probably be a little shy of the full stall attitude.
- Try to hold that attitude with the wheels just inches off the runway until the aeroplane settles onto the runway.
- Once the aeroplane is solidly one the runway, get and keep the stick back!!!
- Keep looking straight down the runway and steer the aeroplane with the rudders
- DO NOT let your attention drop one instant from maintaining directional control
- Keep the ailerons turned into the wind as necessary
- Keep the stick ALL THE WAY back!

Wheel Landing

The wheel landing is very easy to make once you get the hang of it. You are basically just flying it onto the ground, touching on the main wheels as gently as possible. Once the main wheels touch, you apply a little forward pressure to the stick to stop the downward momentum of the CG so the tail does not come down, which would increase your angle of attack and cause the aeroplane to fly again. You can even apply enough forward stick so as to reach a zero or even slightly negative angle of attack to really stick it on the runway. This technique might be useful in gusty conditions, as you have more airflow over the controls (especially rudder) to counter changing wind.
Don't worry too much about the touchdown attitude as it will vary depending upon your speed. Depending on your aircraft type approach a little faster for a wheel landing, maybe 5 knots/mph, with a trickle of power on. You will need more runway for a wheeler landing.

Wheel Landing Outline

- Make normal approach to runway with normal final approach power but 5 mph faster, and holding about 1300 RPM (Cub).
- By short final, eliminate any drift by lowering the upwind wing and keep the aeroplane straight with opposite rudder as necessary
- Make a slight flare to near-level flight attitude just inches off the runway, but keep the nose down a little. Control any sink with use of power, not raising the nose.
- Let the main wheels settle onto the runway - be patient. Use the elevator control to achieve this
- Once the main wheels are one the runway stick it on with a little forward stick.
- Keep looking straight down the runway and steer the aeroplane with the rudders
- If you are not happy with the landing or conditions, open the power and go around for another try or another runway/airfield.
- Once you commit to the landing, reduce power to idle.
- Hold the tail up with more and more forward stick until it settles on its own.
- DO NOT let your attention drop one instant from maintaining directional control
- Keep the ailerons turned into the wind as necessary
- Once the tail comes down, immediately bring the stick all the way back into your gut and keep it there
- Keep the stick ALL THE WAY back!

You may have seen videos or displays where pilots actually apply brakes the moment both mains are planted. They don't nose over like you might think, (unless there is some other drag on the main gear, such as soft ground, long grass etc) but these are pilots who fly taildraggers for a living, every day, and they rebuild their aircraft every winter. DO NOT TRY THIS ON YOUR OWN!

Keep the Stick Back!

The stick should be kept all the way back in your gut all the time the taildragger is on the ground except during takeoff, rollout from a wheel landing until the tail comes down, or when taxiing with a significant wind on your tail. If you see a taildragger taxing by on a relatively calm day or rolling out of a landing and the elevator is neutral or down, or flopping around, that's the sign of a poor taildragger pilot and ***an accident waiting to happen***.
The idea is that you want to keep the tail planted firmly on the ground. This improves directional control if you have a steerable tailwheel, and you don't want an application of power to raise the tail unexpectedly and possibly drive the nose into the ground.
With all landings, you should **keep that stick back** when the tailwheel is down on the runway, and you want to keep it all the way back, without exception. If making a full-stall landing, you want to work the stick all the way back so it hits the stop when the aeroplane stalls, and then hold it there during the entire rollout. With the three-point landing, you want to do the same if possible, or get it back the moment of touchdown. After making a wheel landing, as soon as the tail is down, immediately come back with the stick and keep it back. Many folks just don't keep the stick back out of bad habits, lack of technique, or just plain not paying attention. Some folks have made a conscious decision that it doesn't matter, and say it's not necessary, but this is not true. You want keep that tail firmly down on the ground for stability and so the tailwheel gets maximum traction. For the folks that just refuse to believe it's necessary, try to think of one good reason for not keeping the stick back. What could possibly be a good reason for keeping it forward or letting it do what it wants to do? Why take the chance?

Tailwind Taxiing
When taxiing with the wind on your tail, that wind has to be awfully strong to exceed any taxi speed plus propwash speed, so don't blindly use forward stick just because you have a tailwind. You need to learn to detect when the use of forward stick is applicable. Some can feel it, others can hear it. Sometimes you have to make a judgement call when conditions dictate, and just be extra careful anytime you're taxiing with a tailwind.
Even with a 65 HP Champ or Cub, the propwash over the tail is equivalent to a respectable breeze. Stand back there sometime (or put your hand out the window) and feel it for yourself to get a feel for what you're up against. If the wind is on your tail, your propwash may cancel it out unless it's a pretty strong or gusty wind. You should have some understanding of where this threshold is for your aeroplane. If you are moving at all, then you also have to take that into account. If you have a 10 MPH wind on your tail, but are taxing at 10 MPH, they absolutely cancel one another out. Just keep all this in mind and apply forward stick only when you think it is really warranted, and again, either way, always be very alert and careful when holding or taxing with a tailwind.

Aileron Application
It is very important to always apply proper aileron inputs when holding and taxiing. It's easy to do: turn into headwind components and turn away from tailwind components. So, if the wind is from your front and right side, turn into it by applying right aileron. If the wind is

from your front and left side, turn into it by applying left aileron. If the wind is from behind you and from your right, turn away from it by applying left aileron (this puts the aileron on the right wing down), and if the wind is from behind you and from your left, turn away from it by applying right aileron. Be aware of wind direction at all times and smoothly change aileron application as appropriate while turning the aircraft.

Summary

Many folks are seen rolling out of a landing with that elevator neutral, down, or even flopping around. No wonder they think these aeroplanes are squirrelly during a stall or three-point landing rollout. They aren't properly following through with those landings, so they really aren't making an accurate or fair observation. It's amazing how much more directionally stable the average taildragger becomes when you pull that stick back into your gut. If you're a new taildragger pilot and you find the aeroplane getting loose during landing rollout, or other things are happening after touchdown, such as purposing, just hold the stick back and everything should settle down.

Old habits are just hard to break, but if you have a habit of relaxing the stick, this is one bad habit you need to break in a hurry!

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