DIFFERENCES BETWEEN ULTRALIGHTS AND GENERAL AVIATION AIRPLANES

by Jon Thornburgh

As an ultralight instructor who is also an FAA Certified Flight Instructor, I am often asked about the differences between ultralights and general aviation airplanes. An ancillary question is, "How long does it take a general aviation pilot to check, out in an ultralight?"

The answer is that there are several significant differences between the two types of aircraft. The transition time varies from two to ten hours, depending on how experienced the general aviation pilot is with various types of light aircraft.

A general aviation pilot who has also flown a glider and a helicopter would be able to transition to an ultralight more quickly. This is because he is used to landing close to the ground in a glider and making a steep landing approach in a helicopter.

This article is primarily directed toward general aviation pilots who may be thinking about transitioning to an ultralight.

ULTRALIGHTS ARE REGULATED BY FAA REGULATIONS, PART 103

The FAA regulation concerning ultralights is found in FAR Part 103. In Part 103 an "ultralight" is defined as a "single-seat vehicle" with specified fuel, weight, and speed restrictions. The FAA defines an ultralight as a "vehicle" to distinguish it from all other aircraft in the Federal Air Regulations.

Despite what the FAA may think, a fixed-wing ultralight is really an airplane, not an airborne vehicle. Any person who saw an ultralight for the first time would call it an "airplane," if he were unaware of the FAA "vehicle" definition.

As noted in Part 103, an ultralight is a "single-seat" vehicle. There is no such thing as a two-seat ultralight.

However, the FAA has granted a waiver to several ultralight organizations to allow them to provide two-seat ultralight aircraft/vehicles for training purposes only. These flying machines are called "ultralight trainers."

It is in these ultralight trainers that a general aviation pilot will receive his ultralight checkout. When I refer to ultralights in this article, I am mostly referring to these two-seat trainers, although the ultralight characteristics that I will be discussing also apply to the single-seat ultralights.

AN ULTRALIGHT, BY DEFINITION, IS LIGHT IN WEIGHT

The primary difference between an ultralight and a general aviation airplane is, of course, the lightweight of an ultralight. A single seat ultralight must weigh no more than 254 pounds. A two-seat ultralight trainer must weigh 496 pounds or less. This is the so-called "empty weight" of the ultralight, not the "gross weight" commonly used in general aviation.

As a consequence of its light weight, an ultralight can takeoff and land in a very short distance. Many will takeoff and land within a couple of hundred feet. They can get airborne in 5 or 6 seconds.

Ultralights are usually able to climb remarkably well, considering their small engines. They can turn in a small radius; sometimes within 200 feet. They also bounce around more in turbulence, and are more susceptible to upset in wake vortices.

The lightweight does not mean that an ultralight is "flimsy." An ultralight has great strength, despite its lightweight. Most all ultralights are stress tested to four, five, or six "G's" or more. Some, such as the Phantom, are aerobatic. Some will lift a payload equal to their own weight, something that no general aviation airplane can do.

Almost all ultralights are made from aviation quality material, such as 6061 aluminum and AN nuts and bolts. The wings are sophisticated in design and construction. Some wing designs are the result of research by NASA.

The end result is that ultralights are light in weight, but still very strong. The general aviation pilot need not fear that the structure of an ultralight is not safe, as long as it is properly maintained, like any other aircraft.

AN ULTRALIGHT HAS A "HIGH-LIFT/HIGH-DRAG" WING

In addition to lightweight, the ultralight's "high lift/high drag" wing is significantly different from general aviation airplanes. With its "high lift" wing, an ultralight is able to takeoff in a short distance, and at a low airspeed. A typical takeoff distance and airspeed is 300 feet and 40 miles per hour.

The ultralight lifts off the ground in only a few seconds after power is applied, which sometimes startles a general aviation pilot. It's a good idea for an ultralight instructor to brief his new student on how quickly the ultralight will takeoff.

The wing achieves it's high lift quality due to the pronounced curvature on top of the wing. As pilots learn early in their instruction, a wing creates lift due to the difference in distance (and therefore the difference in velocity) in which air molecules travel over the top surface of a wing compared to the bottom surface.

This difference in velocity creates a lower pressure on the upper surface of the wing, which "lifts" the airplane into the air. The greater the curvature of the wing, the greater the wing's lifting force.

However, there are a couple of penalties associated with the high-lift wing. (If there weren't penalties, then all airplane wings, including general aviation, would be high-lift.)

Although the wing will generate great lift at low speeds, the shape of the wing prevents the airplane from flying at a very high speed. That's one of the reasons why ultralights are so slow. (The other reason for the slow airspeed is the limited horsepower of the engines.)

A "HIGH/LIFT" WING ALSO PRODUCES HIGH AERODYNAMIC DRAG

The other penalty associated with the high-lift wing is the high drag created by the wing as a by-product of the creation of lift. If you look closely at an ultralight wing, you will notice that there is a pronounced curve at the leading edge. This is known as a "thick" leading edge.

Starting a few inches back from the leading edge, the top of the wing slopes downward to the training edge at a gradual angle. Lift is produced perpendicular to the surface of the wing. Therefore, the lift produced on the aft three-quarters of the wing is directed slightly rearward.

This slightly rearward-directed lift produces drag, (as well as creating upward lift.) This drag is called "induced drag."

A full explanation of the aerodynamics associated with the creation of lift and induced drag would include a discussion of Bernoulli's Theorem, relative wind, angle of attack, "vectors" and "resultant force." An explanation of these phenomena can be found in any chapter on aerodynamics in a pilot's flight instruction textbook.

The result of the induced drag, in conjunction with the Low Mass of an ultralight, is this: when the engine is reduced to idle, or if the engine fails, the airplane descends at a steep angle. An ultralight will glide about half the distance that a general aviation airplane will glide.

The glide angle of an airplane is referred to as a ratio, such as "10 to 1." This means that an airplane without engine power will travel ten feet forward for each foot of altitude that it descends. In this instance, if an airplane were one mile above the ground, it would glide ten miles forward before reaching the earth.

The nominal glide slope for a general aviation airplane is about 9 to 1 or 10 to one. A low-performance glider will glide at a ratio of 20 to 1; a high performance glider, 50 to 1.

The typical glide ratio of an ultralight is 5 to 1.

DUE TO ITS HIGH DRAG WING, AN ULTRALIGHT WILL NOT GLIDE WELL

An ultralight descends very steeply compared to a general aviation airplane. Therefore, an ultralight pilot must be especially careful not to fly over an area where he cannot glide to a safe landing spot in case of an engine failure.

This is one of the reasons that FAR Part 103 prohibits ultralights from being flown over congested areas. Ultralight flying is relegated to rural areas, where it's more likely that there will be open fields to accommodate a forced landing.

However, even in rural areas there are places where it would not be suitable for an ultralight to land. When an ultralight pilot is flying over such terrain, it is imperative that he climb to a higher altitude to allow the ultralight to remain within gliding range of a more distant suitable field.

DUE TO AN ULTRALIGHT'S STEEP DESCENT, AN ULTRALIGHT PILOT MUST CONSTANTLY FLY HIGH ENOUGH TO GLIDE TO A SUITABLE LANDING FIELD IN CASE OF AN ENGINE FAILURE

An ultralight pilot must constantly be on the alert for suitable landing areas below him. He must be aware of his steep angle of descent in the event of an engine failure, and discipline himself to climb to a higher altitude when he flies over areas of unsuitable terrain.

General aviation pilots are also taught to keep an emergency landing spot in mind when they fly. But this habit is not stressed nearly as much in general aviation as it is in ultralight flying.

The need for altitude awareness versus suitable emergency landing areas stems from two reasons: (1) the steep angle of de- scent caused by the high lift/high drag wing, and (2) the propensity for ultralight two-cycle engines to fail more often than general aviation four-cycle engines.

AN ULTRALIGHT PILOT MUST ALWAYS BE ON GUARD FOR AN ENGINE FAILURE

Although there are no readily available statistics to prove that two-cycle engines are inherently less reliable than four-cycle engines, the general consensus of opinion in the ultralight community is that two-cycle engines are not as trustworthy. This is evidenced by the fact that Rotax, for example, recommends a 300 hour overhaul time for its two-cycle engines, compared with up to 2,000 hours for a Lycoming four-cycle general aviation engine.

There are several reasons proposed for the two-cycle failure rate. First, the engines are not built under FAA mandated manufacturing standards (these standards can be found in FAR Part 33.)

Second, general aviation four-cycle engines operate in the 2500 rpm range, while ultralight two-cycle engines operate closer to 6500 revolutions per minute. This high rpm causes more wear on the pistons, cylinders, and other engine components, and causes increased vibration throughout the airframe.

Third, ultralight engines are operated by unlicensed pilots and maintained by unlicensed mechanics. The likelihood of error in operation or maintenance is therefore greater than in rigidly controlled general aviation.

Lastly, ultralights are often flown in dusty, windy areas where dirt can get into the cooling fans and air filters, causing damage to the engine.

If the engines are maintained properly and operated with care, there is no reason that the two-cycle engine would not be as reliable as a four-cycle engine. This is evidenced by the fact that the FAA has certified the Quicksilver GT-500 ultralight in the new "Primary" category. The certified GT-500 is allowed to fly over congested areas, and it is powered by the same Rotax 582 engine that is used by hundreds of uncertified ultralights.

Why is the GT-500 allowed to fly over congested areas, while uncertified ultralights are not? Because the FAA mandated a strict engine maintenance schedule for the GT-500, and the maintenance must be done by certified FAA A&P mechanics.

Despite the fact that two-cycle ultralight engines may or may not be as reliable as four-cycle engines, it is prudent for an ultralight pilot to fly his airplane as if the engine would fail at any time. Therefore, he must fly high when over hostile terrain, and constantly be on the lookout for a suitable landing area.

There is a saying in the ultralight community that there is "safety in altitude." If so, why do we so often see ultralights flying at low altitude, skimming across the ground?

Low altitude flight, called "flathatting," is one of the thrills of ultralight flying. In the El Mirage desert area north of Los Angeles, trikes, gyroplanes, gliders and ultralights of all types skim across the desert for miles.

The answer is that the low-flying ultralights are flying over terrain where they could immediately land in case of an engine failure. The ultralights at El Mirage have 20 square miles of desert available for an emergency landing; all directly beneath their wheels.

It's O.K. to fly low; if there is a suitable landing area directly below you.

However, in less suitable areas (perhaps New Hampshire, for example), ultralights must fly high over hilly terrain or fields covered with trees. This higher altitude will allow the ultralight to glide to an open field that does not have trees, power lines, houses, or fences.

A quick illustration will show the mathematical advantage to flying at a higher altitude over unsuitable terrain. We'll assume that the wind is calm for this illustration.

Let's say that you are flying at a thousand feet above the ground. If your ultralight has a five to one glide ratio, you could glide 5,000 feet forward as you descend a thousand feet.

If you climb up to 2,000 feet you could glide twice as far; you could glide to a landing spot 10,000 feet away (approximately two miles). It's obvious that your potential gliding distance has doubled when you climb from 1,000 feet to 2,000 feet.

But what is not quite as obvious is that, while your gliding distance has doubled, your gliding area has quadrupled. This is because at 2,000 feet you can glide twice the distance in radius than at 1,000 feet. From basic geometry we know that a circle with twice the radius will have four times the area.

In this example, a simple climb of a thousand feet resulted in four times as many potential landing spots. The higher altitude allows you to glide twice as far in all directions: ahead of you, behind you, and to your side.

Similarly, if you climbed to 3,000 feet, you would have eight times the potential landing area that you would have at 1,000 feet.

Considering the potential for engine failure, an ultralight pilot might examine the surrounding terrain before taking off, and decide it would be prudent to climb in a box pattern overhead the runway. That way he could gain altitude before departing the safety of the airport environment.

Likewise, since it's very difficult to find an emergency landing spot at night or above a cloud layer, the ultralight pilot should be aware that FAR Part 103 prohibits ultralight flight at night or without visual reference to the ground.

For additional safety, the ultralight pilot could also carry a minimum of survival equipment, such as dried food and water, a signal mirror, and a thermal blanket. As an extra precaution he could even carry an ELT, a handheld aircraft radio, and possibly even a cellular telephone. All of these safety items could be put into a small knapsack and carried behind his seat, or even strapped to his body.

A SAFETY FEATURE OF ULTRALIGHTS IS THEIR ABILITY TO LAND IN A SMALL AREA AND AT A LOW AIRSPEED

At first blush, it seems as if the ultralight's high descent angle would be detrimental to safety. But the high sink angle can have the advantage of allowing the ultralight to make a steep descent over an obstacle and then touchdown and come to a safe stop in a very small area.

The ability of an ultralight to make a steep descent and land in a short distance can be a great safety feature. In fact, it's probably the biggest safety feature that an ultralight has. (Another safety feature is the emergency parachute, which many ultralights carry.)

After an engine failure, an ultralight could easily glide right over the goal posts of a football field and come to a stop before hitting a fence at the other end. This is not something that many general aviation airplanes can do.

AN ULTRALIGHT PILOT MUST BE PROFICIENT AT ENGINE-OUT PRECISION LANDINGS

The capability of ultralights to land in a football field raises another factor of the difference between ultralight flying and general aviation flying. Like a glider pilot, an ultralight pilot must be skillful enough to guide his craft to an exact landing spot without engine power. This is called a "dead stick" landing.

Ultralight pilots must be much more proficient than general aviation pilots when it comes to dead stick landings. That's why spot landing contests are standard fare at ultralight airshows. It encourages the contestants to practice their engine-out skills.

A majority of the checkout time in ultralights is spot landing practice. A general aviation pilot could very possibly learn to get an ultralight on and off the ground in only an hour of flight instruction. But precision landings takes a lot of practice. Even ultralight flight instructors must constantly practice to stay proficient.

The dynamics of gliding to a precision landing vary with each attempt. A moderate headwind can significantly change the glide angle of an ultralight; a change in airspeed will also do so. If a turn is required toward the landing spot, the angle of descent will increase considerably. All of these changing, dynamic factors must be taken into account when executing a dead stick landing.

Therefore, a thorough checkout in a ultralight should emphasize engine-out landings much more than a check-out in a general aviation airplane.

AN ULTRALIGHT PILOT SHOULD BEGIN HIS LANDING FLARE VERY CLOSE TO THE GROUND

Another difference between ultralights and general aviation airplanes is the low level at which the ultralight is flared for landing.

Because ultralights do not stand as high as general aviation airplanes, the pilot is sitting closer to the ground than he is used to. When he approaches the runway for landing, he senses that he is much closer to the ground than he actually is. The difference can be compared to sitting in a go-cart versus an automobile.

The tendency, therefore, is for the pilot to initiate the landing flare much too high. This is probably the biggest problem that general aviation pilots have when transitioning to ultralights.

When the flare is initiated, the ultralight will rapidly lose flying speed because of the high-drag wing and the low inertia of the airplane. It can easily stall before touchdown, resulting in a hard landing likely to damage the ultralight.

An ultralight is not as susceptible to ground effect as general aviation airplanes, and ground effect will not "cushion" the landing as much as general aviation pilots are used to. Instead of beginning the flare at 20 to 30 feet like a general aviation airplane, the ultralight pilot should flare at 4 or 5 feet.

The best way for a general aviation pilot to transition to an ultralight is to carry partial power on the engine (approximately 3500 rpm) all the way to touchdown. This will reduce the steep angle of descent and cushion the landing if the transitioning pilot flares too high.

THE ULTRALIGHT WILL "YAW" WHEN A TURN IS INITIATED

Another difference between an ultralight and a general aviation airplane is the greater "adverse yaw" exhibited by an ultralight when a turn is initiated.

"Adverse yaw" is the tendency of the nose of an airplane to yaw in the direction opposite to roll when banking into a turn. This is due to the increased drag created by the down aileron when a turn is initiated.

For example, when a pilot initiates a turn to the left, the right aileron drops down. This increases lift on the right wing, and causes it to rise, resulting in a bank to the left. But the down aileron also creates more drag on the right wing. Therefore, the body of the airplane will yaw to the right, opposite to the direction of the left turn.

The way to counter the yaw is to push on the left rudder, as is done in all airplanes. However, a much greater push on the rudder is required by ultralight pilots. The are two reasons for this: (1) The ailerons are much larger on ultralights, creating more drag than the ailerons on general aviation airplanes, and (2) the rudder on most ultralights is smaller then general aviation airplanes, requiring a greater deflection to counter the yaw.

The secret to a coordinated turn on most ultralights is to initiate the turn with the rudder slightly before applying the ailerons.

Due to the pronounced dihedral on the wings, many ultra-lights can be turned quite effectively by using only the rudder. In fact, some of the earliest ultra lights, such as the Eipper MX did not even have ailerons.

Speaking of the rudder, another difference between many ultralights and general aviation airplanes is that the pilot must use left rudder instead of right rudder to counter the propeller torque on takeoff and in a climb. This is true when the propeller is facing aft, as is often the case with ultralights.

AN ULTRALIGHT'S PERFORMANCE WILL SIGNIFICANTLY DETERIORATE AT HIGHER GROSS WEIGHTS

Another difference between general aviation airplanes and ultralights is that a two-seat ultralight trainer will perform much more poorly with two people on board than one person.

For example, the Quicksilver GT-500 will climb at 1,000 feet per minute with a 160-pound instructor flying alone. When a 200-pound student joins the instructor, the climb rate decreases to 400 feet per minute, and the takeoff distance increases.

The reason for the marked reduction in performance with the increase in weight is that a 200-pound person can add up to 30% more weight to the airplane. Regarding the GT-500, the airplane weighs 700 pounds with the fuel and instructor. The addition of the 200-pound student is a 29% increase in weight.

The gross weight on a six-seat general aviation Bonanza is 3600 pounds. A 200 pound increase or decrease in weight on a Bonanza is only 6% of the gross weight. The 200 pound, 29% change in weight on the ultralight is much more noticeable than the 200 pound, 6% change on the Bonanza.

What all this means to the ultralight instructor is that his ultralight will have a significant decrease in performance with a heavy student on board.

ULTRALIGHT FLYING IS "SEAT OF THE PANTS" FLYING

Many ultralights have very little instrumentation. Some ultralights have no instrumentation whatsoever. Others have only an airspeed indicator, and maybe an altimeter. Most ultralights do not even have a compass, and virtually no ultralights have gyroscopic instruments.

With some ultralights, like the famous Quicksilver Sport, you sit in a "lawn chair," open to the elements. The engine is mounted in the rear. Because there is no fuselage in front, there is no attitude reference. You can imagine how difficult it is to teach a new student what "level attitude" is, when there is no fuselage reference.

THE TWO-CYCLE ENGINE HAS MANY CHARACTERISTICS THAT ARE DIFFERENT FROM A GENERAL AVIATION FOUR-CYCLE ENGINE

The maximum two-cycle rpm is two and a half times greater than a four-cycle engine's. Since propellers are not proficient at high rpm, ultralight engines have a gear reduction system to turn the propeller at a slower speed.

The two-cycle engine is susceptible to failure unless operated properly. Unlike four-cycle engines, oil is mixed (and consumed) with the gasoline in two-cycle engines. The pilot must be careful the oil and gasoline are mixed in the proper ratio (usually 50 to one.)

Some two-cycle engines are cooled by free air. Some are cooled by a fan, and some are water-cooled, like a car. The engine must be properly warmed up before takeoff. Care must be taken not to over cool the engine on descent.

It is not a good idea to make a prolonged descent at idle power. The pistons will cool at a different rate than the cylinders, and may seize up. It's best to maintain partial power on the engine throughout the descent.

The maximum CHT and EGT temperatures are different from the four-cycle engines. Ultralights are not required to have engine instrumentation, but many do. On the popular Rotax two-cycle engine, the maximum cylinder head temperature (CHT) is 300 degrees F. The maximum exhaust gas temperature (ECT) is 1200 degrees.

If the engine is water cooled, it will have a water temperature gauge. The water temperature is normally between 140 and 180 degrees. The two-cycle Rotax engine does not have a mixture control, carburetor heat, or an oil pressure gauge.

Many two-cycle engines have only one spark plug per cylinder, without the dual magneto redundancy that general aviation pilots are used to.

Is a pilot is not mechanically inclined, he may want to think twice before buying an ultralight. Most of the engine maintenance is done by the pilot himself. This includes changing spark plugs, fuel filters, air filters, and the reduction gear oil. He must also maintain the cooling fan, the carburetors, the ignition timing, and "de-carbon" the pistons".

Maintenance courses are offered by some engine manufacturers, and by some catalog supply companies. The schedule of the courses are often printed in ultralight magazines. It is very beneficial if the pilot/owner can attend one of these courses, or at least seek help from an ultralight dealer or a friend who is experienced in maintenance procedures.

A SUMMARY OF THE DIFFERENCES BETWEEN FLYING AN ULTRALIGHT AND A GENERAL AVIATION AIRPLANE

1. An ultralight will takeoff much more quickly and in a much shorter distance than a general aviation airplane.

2. The glide ratio of an ultralight is half the distance of a general aviation airplane.

3. Without power, an ultralight will descent very steeply.

4. The ultralight can land in a very short distance.

5. An ultralight should always be flown high enough to glide to a suitable landing field.

6. The ultralight should be flared for landing very close to the runway. Due to its low mass, an ultralight will lose airspeed quickly during the flare. It is not as susceptible to "ground effect" as general aviation airplanes.

7. An ultralight pilot should constantly have a suitable landing field in mind in case of an engine failure.

8. An ultralight pilot must be proficient at engine-out precision approach and landings.

9. When a turn is initiated, an ultralight will exhibit more adverse yaw than a general aviation airplane. Due to the adverse yaw, the pilot uses more rudder input when flying an ultralight.

10. If an ultralight has a rear-mounted, aft-facing engine, left rudder is needed to counter yaw during takeoff and climb due to engine torque. (This statement does not apply if the engine has a gear reduction system which reverses the direction in which the propeller turns.)

11. Ultralight performance is significantly reduced at higher gross weights.

12. The two-cycle engine used on must ultralights is considered to be more prone to engine failure than the FAA certified four-cycle engines used on general aviation airplanes.

13. Ultralights are flown by the "seat of the pants," with little reference to flight instruments.

14. Most of the ultralight two-cycle engines do not have mixture control, carburetor heat, or an oil pressure gauge. The engine oil is mixed with the gasoline. The pilot must be careful not to takeoff before the engine is adequately warmed up. Care must be taken not to over cool the engine on descent.

For re-prints, comments, or suggestions, please call Jon's toll-free voice mail at 888-600-0054.

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