What's The Flap All About?

Flaps can be a boon instead of a bother to the lightplane pilot who fully understands their purpose and use. Here is a comprehensive explanation of the three types found on modern-day aircraft

by JERRY MARLETTE / AOPA 25803

■■ During a recent flight instructor critique, several of those present mentioned that a number of their students had a continuing problem: what to do with their wing flaps.

"I've got one chap who wants to use full flaps on every takeoff or landing, whether he needs them or not."

"One of my best students is afraid of flaps, and never uses them unless I insist on it. Fortunately, we've got three 5,000-foot runways, and he can get away with it, but I'm sure leery of signing him off for a cross-country to a small field."

"Huh, that's nothing—I've got a girl who thinks flaps have only two positions, full up and full down. The trouble is, she usually has them down on the ground and up in the air."

So ran the comments. Unusual, don't you think? Could be, except that several of those present queried a number of student and private pilots regarding the purpose and use of flaps during the ensuing weeks. All were flabbergasted at the misconceptions about the subject. Not only did many of those questioned not know how to properly use flaps, most didn't even know their purpose. For example, over half stated that a flap's reason for existence is to decrease the airplane's gliding speed before landing.

Quick now—right or wrong? Have to stop and think a bit? Don't feel bad if you did, but resolve to get better acquainted with them. After all, most modern aircraft have flaps, so we'd best all get familiar with their function and proper operation, and lick "The Great Flap Problem" once and for all.

For a starting point in our review, let's take a look at just what a wing flap is, what it does, and what kinds might be encountered in modern airplanes.

By definition, a wing flap is a large airfoil attached to the trailing edge of an airplane wing, usually immediately outboard of the fuselage.

Its function is to steepen the gliding angle, thereby allowing steeper approaches over obstacles surrounding a landing field without increasing the landing speed. It is *not* intended to decrease the gliding speed.

Seems simple enough, doesn't it? But the question immediately arises, why not just increase the wing size to give a greater area of lift and a consequent lower landing speed? Unfortunately, every airplane design is a compromise. A large wing area would indeed offer a lower landing speed but would also doom the model to a slow cruising speed as well, due to the high overall drag. Thus, modern design envisions a smaller wing area, which decreases the drag, thereby allowing a higher cruising speed, but also requiring a higher landing speed.

Therefore, in order to allow today's high performance planes to get into most existing airports, flaps are necessary. By changing the camber of the wing, the lift and drag components are subsequently increased. The greater lift reduces the stalling speed and allows slower landing speeds, while the increased drag steepens the gliding angle, gives an extra braking effect during landing, and also helps slow the plane during the landing roll.

There are three general types of wing flaps: the conventional, the split trailing edge, and the Fowler.

The conventional, which is also often called the simple or plain flap, is found on most small planes and on a number of large ones, including transport types. It is located in the neutral approach section of the wing, just outboard of the fuselage, and is hinged to travel downward as desired. In many light aircraft, the flap is lowered or raised by means of a mechanical flap handle. Some earlier models employed a crank for raising or lowering, but most modern craft use switches controlling either electrical or hydraulic flap systems.

The split trailing edge, or split flap, is built into the wing. In operation, the hinged lower half of the wing swings downward. In some high performance craft, the upper half is also hinged, allowing raising to increase the drag without increasing the lift. Others, such as those on the famous C-47, are perforated, with evenly spaced holes throughout the flap area. This both increases the drag and allows the tail control surfaces to operate more efficiently at low speeds than they would if they were blanketed by the wake of a solid flap. These flaps, being much larger, are almost always power-operated.

In the Fowler type, the lower part of the wing trailing edge rolls backward and downward on a track, thus lowering the trailing edge to approximately 40° below the retracted position, which in turn increases the effective width of the wing.

Most modern aircraft up through the medium twin class employ electrically operated conventional flaps, with full flap angles of up to 60°. Their travel is generally visible from the cockpit, although several models provide flap position information through mechanical or electrical indicators.

Proper flap procedures envision selective usage. That sounds impressive enough, but what does it mean? Simply that you use your flaps when you need them, in the manner recommended by the aircraft manufacturer.

For a start, examine the flaps carefully during the preflight inspection, checking for holes, dents, and misalignment. Next, check your flap setting when you first climb into your plane. The flaps themselves should be up and the selector switch (handle, or crank) in neutral. If not, position both switch and flap before starting the engine unless, as in some hydraulically operated systems, the flight manual specifies otherwise.

Flap action and travel checking can be done either while the engine is warming up—this will help pass the time during those long winter waits—or during the pretakeoff check at the end of the runway. Either way, taxi with the flaps up to prevent their being damaged by ground obstacles or rocks thrown back by the prop.

For takeoff, use flap settings as prescribed in the flight manual for your particular aircraft. With hundreds of different planes and flap systems, it is

obviously impossible to specify a setting which will apply to all, so your manual gives the pertinent word for your machine.

Generally speaking, flaps will be used for takeoff from a short or soft field to assist the plane in clearing end-of-field obstacles, in the former case, and to get it out of the mud as quickly as possible in the latter. Normal-sized fields or hard-surfaced runways usually will not require flaps. Keep in mind the fact that while the use of flaps will allow a higher clearance over obstacles, your takeoff run is often increased. So, back to the flight manual and its takeoff charts.

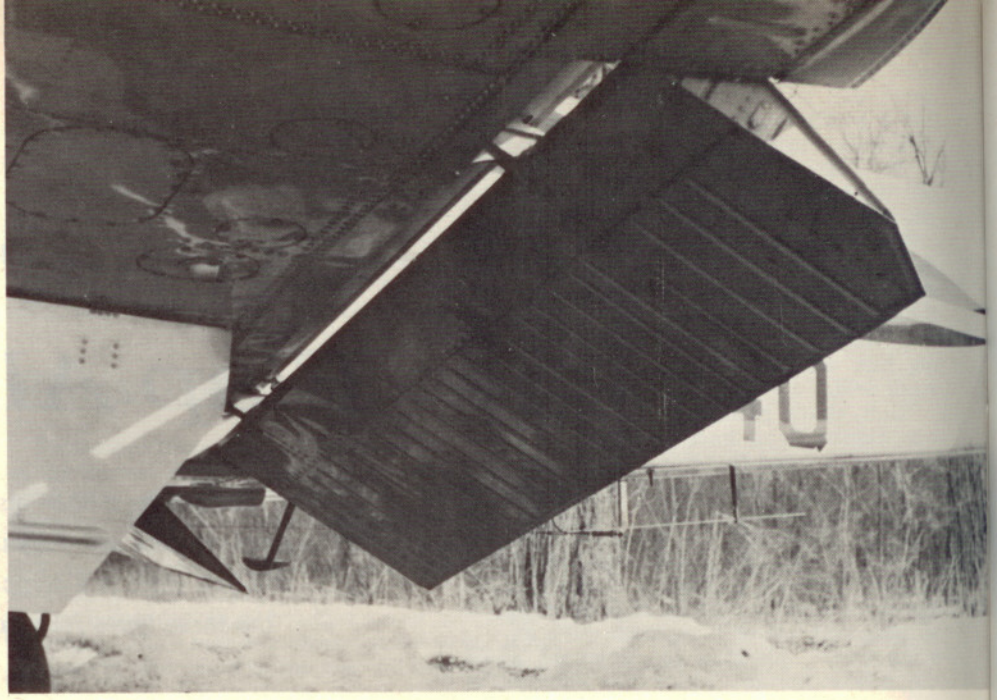
When safely airborne, the flaps may be retracted as soon as the plane's airspeed is higher than the flaps-up stalling speed. Remember to raise the nose to give an increased angle of attack and prevent loss of altitude. However, do not raise the flaps until normal climb airspeed has been obtained. If you are barely over stalling speed, raising the flaps will give a sudden loss of lift, resulting in a stall or immediate loss of altitude, neither of which can you afford.

In some aircraft, standard procedure is to raise the flaps to a lesser down angle once climb speed is attained. Fine—this decreases the drag while still giving increased lift, but don't become so deeply engrossed in properly setting the new flap angle that you forget to watch your altitude and heading. Perhaps the safest way to accomplish this task is to "milk" the flaps up a bit at a time, gauging the new position by watching the changing attitude of the nose and the subsequent increase in airspeed.

Also, some retractable gear craft are restricted in their cleaning-up operations. One model's manual will specify that the gear must be raised before the flaps following takeoff, while another may spell out just the opposite and others may allow raising of both at the same time. A general rule of thumb is to raise the gear after the plane is definitely airborne, with no chance of settling back onto the runway, then raise the flaps slowly as airspeed and altitude are obtained. Again, refer to your craft's flight manual for the manufacturer's recommendations.

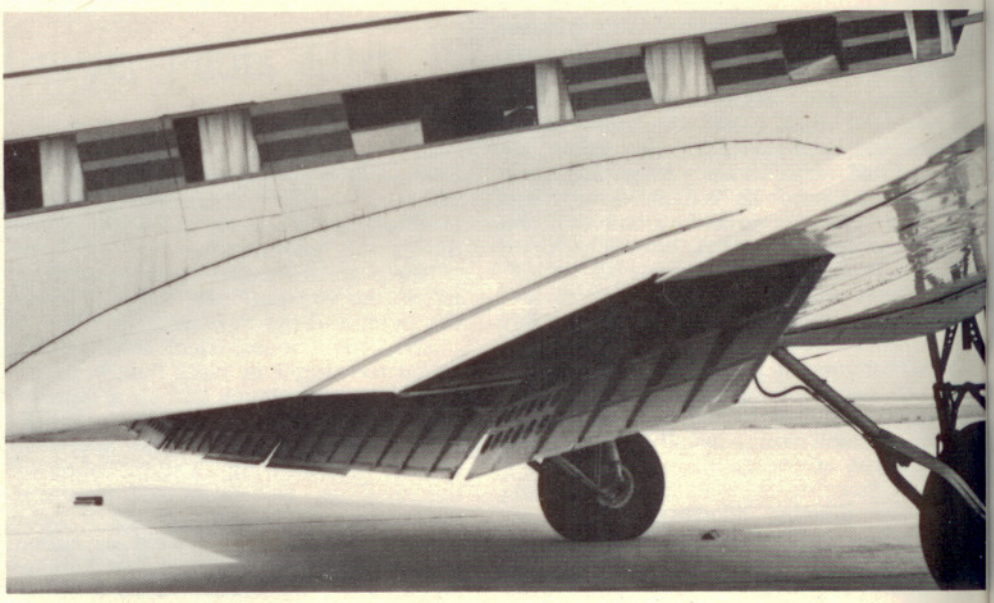
When landing, remember that flaps have definite never-exceed speeds for lowering. If lowered at speeds higher than those in the flap arc, structural failure may result, with the flap being twisted or broken, or even, in exceptional circumstances, ripped from the wing. Thus, should this maximum flap down speed be exceeded, make a full and careful check of the entire flap installation before the plane's next flight.

Flap usage will be determined by the field condition. If the field is short, a power approach with full flaps is indicated. The same will hold for a soft field, with the flaps being raised immediately following touchdown to prevent damage from mud, water, or rocks thrown into them from the wheels.



Conventional flap on Beech Baron, in lowered position. This type runs outboard from the fuselage to the aileron, or about half the distance to the wingtip.

Photos by the author



Split trailing edge flap is the type found on long-lived DC-3, among others. Shown here in lowered position, it folds upward against wing to form a normal tapered trailing edge in cruising flight condition.

Fowler flap on Lockheed Lodestar is shown in "up" or retracted position. The Fowler flap slides rearward and downward on protruding tracks seen along wing's trailing edge.

With full flaps, retain a safe margin of airspeed over your plane's stalling speed and maintain the steepest angle of descent possible without acquiring excess speed. If you're going to be too high, ease off on the power and if too low, add power. In either case, leave the flap setting alone.

Remember that you will have to level off more abruptly with flaps, because you'll have to make a much greater change in the plane's attitude to get into landing position. Hold the nose up until your excess speed is lost and the plane settles down, then let it roll out with the flaps down for extra braking action, raising them when turning off the runway. If the runway is covered with water, snow, ice or slush, retract the flaps as soon as the plane is on the ground, both for more weight on the gear and subsequent better braking, and to protect the flaps from thrown ice and snow.

In turbulent or gusty air, it is a good idea to use half flap or less, thereby giving more effective aileron control. This also allows the pilot to raise the flaps quicker once on the ground, to minimize the aircraft's tendency to float and to put the ship's weight on the wheels for better braking.

In a crosswind, opinion is divided as to whether it is better to leave the flaps up for better control, or to lower them for slower landing speeds and resulting lesser ground speeds and required braking. Looking at both practices, it is generally best to use half flaps for better aileron control and quicker raising once on the ground. This also keeps the plane from drifting on the runway due to being light on the gear, and is particularly true with a conventional tail wheel airplane where the combination of lightness and poor braking can easily lead to a ground loop.

If a go-around becomes necessary, add takeoff power, retract the gear, then raise the flaps to their takeoff position, and trim the plane to climb attitude. Do not raise the flaps fully or too rapidly, since the resulting immediate loss of lift may cause the plane to stall or settle into the ground. Best practice in this situation is to "milk" them up, a bit at a time, to takeoff setting, rolling the elevator trim tab to takeoff position and watching the airspeed the while. As a rule of thumb, raising the flaps to the halfway position gives a maximum decrease in drag with a minimum decrease in lift.

Going back a step, if during your approach it appears that a go-around may be imminent, due to traffic still on the runway, shifting winds or other problems, lower the flaps just halfway, thus lessening the amount of changes necessary if you have to pull up and go around.

In many planes, it is impossible to retract gear and flaps at the same time, and the combination of extended gear and full-down flaps just might be the difference between a successful go-around and an embarrassing settling into the ground. If you have to make a choice, get the gear up first, since its drag will be much greater than the flaps. In any event, use the procedures recommended in your particular aircraft's flight manual.

Should you suffer engine failure immediately after takeoff, there are two entirely different procedures to follow. In a single engine plane, drop the nose at once, but leave the flaps in their existing position. If you raise them at that point, you will have an immediate loss of lift, with a consequent critical loss of altitude.

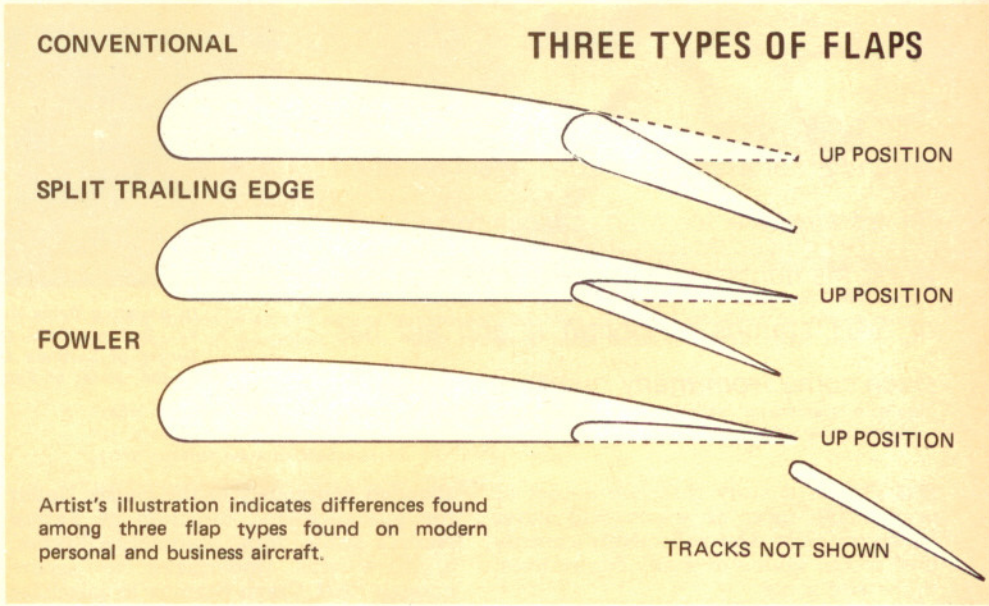
In a multi-engine plane, on the other hand, lower the nose to increase the airspeed, and "milk" the flaps up slowly. This will reduce the chance of inadvertent stall and will improve the ship's directional and longitudinal control. Once the flaps are up, follow your normal single-engine procedures. Here again, check your manual. Some recommend full-up flaps as soon as possible, while others call for half flaps until a certain speed is reached, then full retraction (we are assuming here that the plane is already out of the airport, with its gear retracted).

Once you are safely in the air and the plane is cleaned up to maintain altitude and airspeed, plan your landing as soon as possible. Generally, this will be no real problem (disregarding the occasional terror session if the just-departed field is below landing minimums) if you use a higher pattern speed, with extra altitude, and fly a wide enough pattern to allow gentle turns throughout. Once squared away on final, with the gear down and the field "made," start the flaps down slowly, going to full down position only when you know you can glide to a landing without further complications.

Except in an extreme emergency, do not attempt a single-engine go-around, since the plane will not fly on one engine with both gear and flaps down. However, if this may be the only way you can escape an even worse situation, rapidly go to full power, suck up the gear, raise the flaps to half-down position, and trim for single-engine climb. Be alert for sudden changes in heading, attitude, and altitude.

As you have noticed, reference is made several times above to the aircraft flight manual. Too much emphasis cannot be placed upon knowing this book (and another called "Owner's Handbook" or some similar title) backwards and forwards. You'll not only feel more at home in your plane, you'll be 100% safer as well. Once you've digested the words of wisdom in the book, take your plane out and test-fly it. Take it up to a safe altitude and try every combination of gear and flaps you can think of. See just how it reacts in each case, how it feels with the gear and flaps at the various settings, how much altitude it loses in the different stalls, and so on. Then make several landings, at different flap settings (use just one gear setting—down!), in varying wind and field conditions, until you have a reasonably good idea of how the plane feels and what it will do in each case.

Then—and only then—will you understand "The Great Flap Problem," and just how it pertains to you. Take it as gospel: the feeling will be well worth the effort. □



Artist's illustration indicates differences found among three flap types found on modern personal and business aircraft.

THE AUTHOR

A pilot since 1942, author Jerry Marlette has been flying professionally for most of his occupational life and is a frequent contributor of semi-technical articles to The PILOT. He is president and chief pilot of International Aviation Corporation in Indianapolis, Ind., which offers both helicopter and fixed-wing charter services throughout the eastern third of the nation. An AOPA member since 1946, Mr. Marlette holds commercial, instrument and instructor tickets for both airplanes and rotorcraft. He has accumulated some 6,500 hours during his lengthy flying career.