How Flaps Work

The effect of Flaps on stall speed, pitch moments and angle of descent. From the [Flight Instructors Training Manual.](#) At RealCFI.com

How flaps work: Lowering of flaps increases the CAMBER and AOA of the wing which increases the coefficient of lift (greater acceleration of airmass and thus more lift for the same airspeed). The coefficient of lift may increase 30 to 70% depending on wing and flap design. Consequently, less air speed is required to generate the same amount of lift at the critical AOA, thus stall speed is decreased. Flaps also reduce the critical AOA. The aircraft will *stall at a lower air speed and lower AOA* . Increased lift also means increased drag, which can be useful.

Energizing the boundary layer. Vortex generators, leading edge slats and slots energize the boundary layer which delays airflow separation to a higher AOA. Thus, the airfoil has a higher critical AOA and lowers the stall speed. Fowler flaps also energize the boundary layer and increase wing area. Combining these devices with flaps is additive.

The effect of flap deployment. How the average GA aircraft behaves with flap deployment is complex and depends on aircraft design, type of flaps, CG location, air speed and other factors. In general, the following considerations for effect of flap employment could include:

- **In high wing aircraft**, as we add flaps:
  - Lift increases AFT of CG and creates a *down pitching moment*.
  - Increased wing down wash increases the AOA on the horizontal stabilizer and increases the tail down force causing an up-pitching moment.
  - Increased *AOA drag is above CG* and results in *up-pitching moment*.
  - The net effect is an *up-pitching moment*
  - The pilot may need to reduce power or respond with initial forward yoke pressure till the aircraft slows.
  - As the aircraft slows, the tail does not get the same benefit of increased lift as the wings for a given airspeed, more up trim will then be required.
- **In low wing aircraft,** adding flaps:
  - Lift increases AFT of the CG and creates a *down pitching moment*.
  - the accelerated down flow does not affect the horizontal stabilizer.
  - Increased *AOA drag is below the CG* causing a *down pitching moment*.
  - The net effect is a *down pitching moment*.
  - The pilot will need to respond with up trim for both the down pitching moment and decreased elevator effectiveness as aircraft slows.

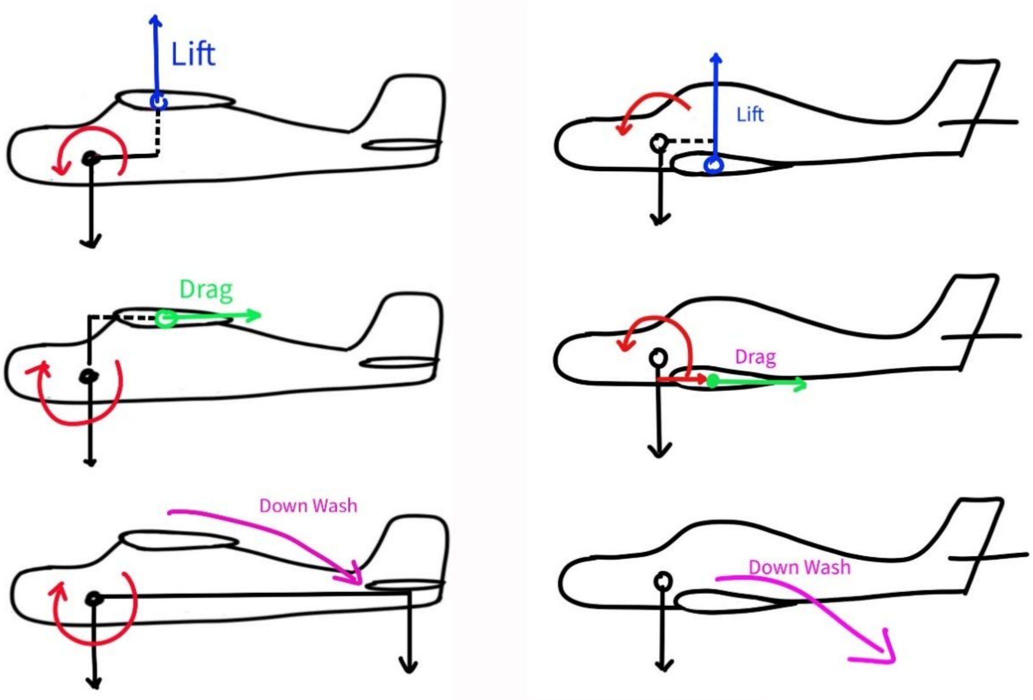

Figure 34.

Note: Change in the center of pressure (CP). Many texts describe the center of pressure on the wing moving forward with increasing AOA and aft with decreases in AOA as cause for pitching moments. While the CP does move, this does not contribute significantly to pitching moments as much as the change in total lift. As the CP moves with the angle of attack, so does the length of the arm that it acts upon the aircraft. With increase in AOA, the magnitude of the CP increases but also moves forward, the arm decreases. With decreases in AOA, the CP decreases in magnitude but moves aft increasing its arm. The net effect is _all changes_ in CP act through the "Aerodynamic Center" (AC), typically 25% of the cord length aft of the leading edge. For stability, nearly all aircraft are designed with the CG forward of the AC. Increases in lift produce a down pitching moment. The sum of all moments determines the net effect.

Pitch attitude: Flap deployment requires a lower AOA to generate required lift at a given speed and pitch attitude will be lower. No flap landings require a higher pitch attitude***. NOTE**: pitch attitude does not equal steeper descent angle. See discussion below.*

- **Descent angle:** Flaps, *by themselves* DO NOT cause a steeper approach path to clear an obstacle. The descent angle depends on both *ground speed AND rate of descent*. Low ground speeds and higher rates of descent increase the descent angle. See figure below.
  - Flaps lower the stall speed which allows a *slower approach speed which steepens the approach angle*. However, if the approach speed is not reduced, neither will the descent angle.

- Flaps add drag which increases the descent rate for a given power setting and given air speed. The *increased descent rate will increase the descent angle for a particular airspeed*. However, if too much power or air speed is carried in the approach, there will not be an increase in descent angle.

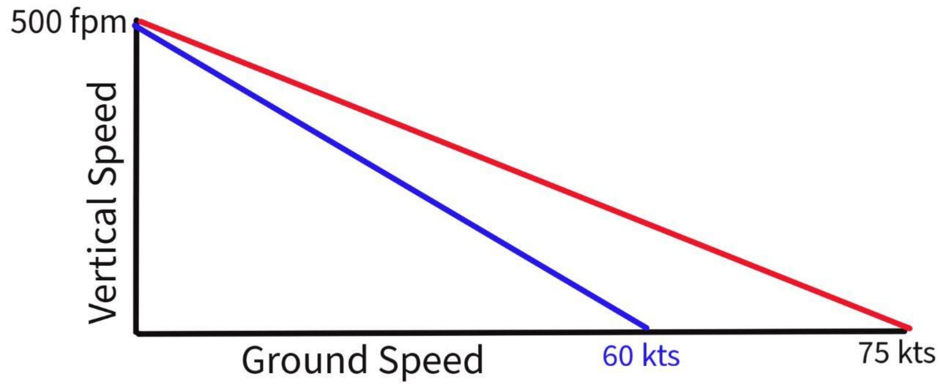

Figure 35.

Note: Steeping the approach is accomplished by lowering ground speed. This can be done by slowing the approach or in the case of strong headwinds. This is why more power is required to maintain glide path on an approach into a strong headwind.

- Landing with flaps allows a ***slower touch down speed*** which decreases landing roll out. The practical application is to approach at the slowest SAFE air speed for the greatest angle of descent and shortest landing roll out.
- Another benefit of flying a slow approach with full flaps is the requirement to carry power all the way to touch down. This allows the pilot to make more accurate and precise landings by the adjustment of power.
- Flap deployment typically reduces the structural G load limitations of the airframe. *Most GA aircraft are limited to ZERO negative Gs with flaps deployed*. Consequently, aggressive forward yoke control movements (which can produce negative G loads) should be avoided with flaps deployed (such as stall recovery).