of such a device. To illustrate a few principles of flap management, figure 1.19 presents the lift and drag curves of a typical airplane in the clean and flap down configurations.

In order to appreciate some of the factors involved in flap management, assume that the airplane has just taken off and the flaps are extended. The pilot should not completely retract the flaps until the airplane has sufficient speed. If the flaps are retracted prematurely at insufficient airspeed, maximum lift coefficient of the clean configuration may not be able to support the airplane and the airplane will sink or stall. Of course, this same factor must be considered for intermediate flap positions between fully retracted and fully extended. Assume that the airplane is allowed to gain speed and reduce the flight lift coefficient to the point of flap retraction indicated on figure 1.19. As the configuration is altered from the "cluttered" to the clean configuration, three important changes take place:

(1) The reduction in camber by flap retraction changes the wing pitching moment and—for the majority of airplanes—requires retrimming to balance the nose up moment change. Some airplanes feature an automatic retrimming which is programmed with flap deflection.

(2) The retraction of flaps shown on figure 1.19 causes a reduction of drag coefficient at that lift coefficient. This drag reduction improves the acceleration of the airplane.

(3) The retraction of flaps requires an increase in angle of attack to maintain the same lift coefficient. Thus, if airplane acceleration is low through the flap retraction speed range, angle of attack must be increased to prevent the airplane from sinking. This situation is typical after takeoff when gross weight, density altitude, and temperature are high. However, some aircraft have such high acceleration through the flap retraction speed that the rapid gain in airspeed requires much less noticeable attitude change.

When the flaps are lowered for landing essentially the same items must be considered. Extending the flaps will cause these changes to take place:

(1) Lowering the flaps requires retrimming to balance the nose down moment change.

(2) The increase in drag requires a higher power setting to maintain airspeed and altitude.

(3) The angle of attack required to produce the same lift coefficient is less, e.g., flap extension tends to cause the airplane to "balloon."

An additional factor which must be considered when rapidly accelerating after takeoff, or when lowering the flaps for landing, is the limit airspeed for flap extension. Excessive airspeeds in the flap down configuration may cause structural damage.

In many aircraft the effect of intermediate flap deflection is of primary importance in certain critical operating conditions. Small initial deflections of the flap cause noticeable changes in $C_{L_{max}}$ without large changes in drag coefficient. This feature is especially true of the airplane equipped with slotted or Fowler flaps (refer to fig. 1.17). Large flap deflections past 30° to 35° do not create the same rate of change of $C_{L_{max}}$ but do cause greater changes in C_D. A fact true of most airplanes is that the first 50 percent of flap deflection causes *more* than half of the total change in $C_{L_{max}}$ and the last 50 percent of flap deflection causes *more* than half of the total change in C_D.

The effect of power on the stall speed of an airplane is determined by many factors. The most important factors affecting this relationship are powerplant type (prop or jet), thrust-to-weight ratio, and inclination of the thrust vector at maximum lift. The effect of the propeller is illustrated in figure 1.20. The slipstream velocity behind the propeller is different from the free stream velocity depending on the thrust developed. Thus, when the propeller driven airplane is at low airspeeds