higher angles of attack the drag coefficient is much greater and small changes in angle of attack cause significant changes in drag. As stall occurs, a large increase in drag takes place.

A factor more important in airplane performance considerations is the lift-drag ratio, L/D. With the lift and drag data available for the airplane, the proportions of C_L and C_D can be calculated for each specific angle of attack. The resulting plot of lift-drag ratio with angle of attack shows that L/D increases to some maximum then decreases at the higher lift coefficients and angles of attack. Note that the maximum lift-drag ratio, $(L/D)_{max}$, occurs at one specific angle of attack and lift coefficient. If the airplane is operated in steady flight at $(L/D)_{max}$, the total drag is at a minimum. Any angle of attack lower or higher than that for $(L/D)_{max}$ reduces the lift-drag ratio and consequently increases the total drag for a given airplane lift.

The airplane depicted by the curves of Figure 1.13 has a maximum lift-drag ratio of 12.5 at an angle of attack of 6°. Suppose this airplane is operated in steady flight at a gross weight of 12,500 lbs. If flown at the airspeed and angle of attack corresponding to $(L/D)_{max}$, the drag would be 1,000 lbs. Any higher or lower airspeed would produce a drag greater than 1,000 lbs. Of course, this same airplane could be operated at higher or lower gross weights and the same maximum lift-drag ratio of 12.5 could be obtained at the same angle of attack of 6°. However, a change in gross weight would require a change in airspeed to support the new weight at the same lift coefficient and angle of attack.

Type airplane:	$(L/D)_{max}$
High performance sailplane	25–40
Typical patrol or transport	12–20
High performance bomber	20–25
Propeller powered trainer	10–15
Jet trainer	14–16
Transonic fighter or attack	10–13
Supersonic fighter or attack	4–9 (subsonic)

The configuration of an airplane has a great effect on the lift-drag ratio. Typical values of $(L/D)_{max}$ are listed for various types of airplanes. While the high performance sailplane may have extremely high lift-drag ratios, such an aircraft has no real economic or tactical purpose. The supersonic fighter may have seemingly low lift-drag ratios in subsonic flight but the airplane configurations required for supersonic flight (and high [L/D]'s at high Mach numbers) precipitate this situation.

Many important items of airplane performance are obtained in flight at $(L/D)_{max}$. Typical performance conditions which occur at $(L/D)_{max}$ are:

- maximum endurance of jet powered airplanes
- maximum range of propeller driven airplanes
- maximum climb *angle* for jet powered airplanes
- maximum power-off glide range, jet or prop

The most immediately interesting of these items is the power-off glide range of an airplane. By examining the forces acting on an airplane during a glide, it can be shown that the glide ratio is numerically equal to the lift-drag ratio. For example, if the airplane in a glide has an (L/D) of 15, each mile of altitude is traded for 15 miles of horizontal distance. Such a fact implies that the airplane should be flown at $(L/D)_{max}$ to obtain the greatest glide distance.

An unbelievable feature of gliding performance is the effect of airplane gross weight. Since the maximum lift-drag ratio of a given airplane is an intrinsic property of the aerodynamic configuration, gross weight will not affect the gliding performance. If a typical jet trainer has an $(L/D)_{max}$ of 15, the aircraft can obtain a maximum of 15 miles horizontal distance for each mile of altitude. This would be true of this particular airplane at any gross