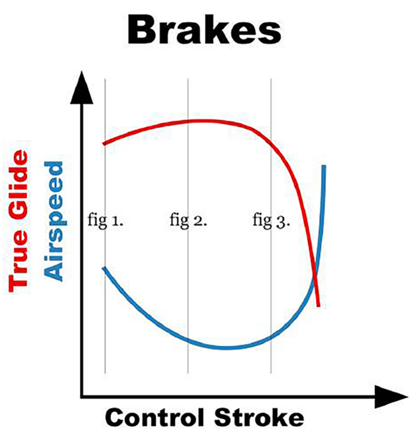
FOUNDATIONS OF FLIGHT
GLIDE, PART 2 – LIFT-TO-DRAG RATIO

AXIS Flight School®

Brought to you by Niklas Daniel and Brianne Thompson of AXIS Flight School at Skydive Arizona in Eloy. Images by Niklas Daniel. More skydiving educationVal content and professional coaching services are available at axisflightschool.com.

"Foundations of Flight: Glide, Part 1" (September *Parachutist*) defined a canopy's trim angle and glide. This installment takes a closer look at how a canopy pilot can alter the system's glide using brakes. The following image highlights the changes that occur when a canopy pilot gently and continuously applies brakes while in level flight.



The graph above corresponds to the images to the right and is an over-generalization that does not apply to all parachute designs.

The point of origin at the bottom left side of the graph represents full flight at trim speed. The control stroke refers to the location of the canopy pilot's hands; the farther to the right of the graph, the more brake application. Jumpers experience an increase in glide during the first stage of a landing flare, provided they transition from full flight. This is because lift momentarily increases due to an increased angle of attack (pitching the nose up) and increased camber (wing curvature). This combination produces a fleeting increase of lift and drag. Therefore, it is important to properly time your landing flare.

Through the steady application of brakes, the system loses airspeed and in turn experiences a decreased true glide. As a result, the system progressively descends at a slower rate until it reaches the "max-float" configuration. With continued application of brakes, the system reaches a critical configuration and angle of attack, causing the wing to stall. That is why at the far right of the graph, the airspeed abruptly increases and the true glide reaches close to zero.

Lift to Drag Ratio (L/D)

The relationship between lift and drag greatly affects flight performance. Altering the relationship between these two forces allows us to access different flight configurations. To explain the graph in more depth, let's take a closer look at how brake input changes the relationship between the lift and drag forces. Using letters to abbreviate the various forces in the free body diagrams: G = Gravity, L = Lift, D = Drag, R = Reaction Force.

We can affect a wing's relationship with lift and drag with inputs. Notice that in the three images below, the magnitude of the reaction force remains the same, while lift and drag change. When drag is increased, the system's true-glide distance decreases. While lift is perpendicular to the relative wind and drag is parallel, the two forces create a resultant force that works against gravity. If we let the canopy fly at trim-speed, lift prevails over drag (fig. 1). By applying brakes, we make the system experience more drag and less lift. The direction of the relative wind can be inferred because it is in direct opposition to drag. This highlights the flight path or trajectory of the system.

Fig 1. Full flight – Breaks are unstowed and hands are all the way up. The canopy is flying at full flight or trim speed.

Fig 2. Half brakes – Brakes are pulled down to around rib-cage height (The arm placement in fig. 2 is not accurate). Lift has decreased and drag increased. The system slows down significantly in both forward speed and descent rate. The system is now on a steeper glide path than before and descending more slowly.

Fig 3. Toggle stall – Brakes engaged beyond the maximum float configuration. Lift has all but disappeared and the system is experiencing predominantly drag.

The effects of brake input on a system's true glide are most noticeable when flying side by side with someone on a similarly loaded canopy. If one person applies the brakes, they immediately float and fall behind the other. By changing which force is more dominant (lift or drag), we can exert precise control over our flying experience. One force is not better than the other. It simply comes down to what outcome you desire and how you want to optimize the system. Want to fly as far as possible? Then you need more lift and should minimize drag. Want to stay aloft for a long time? Then you need more drag, but avoid exceeding the maximum float configuration (i.e., stalling).

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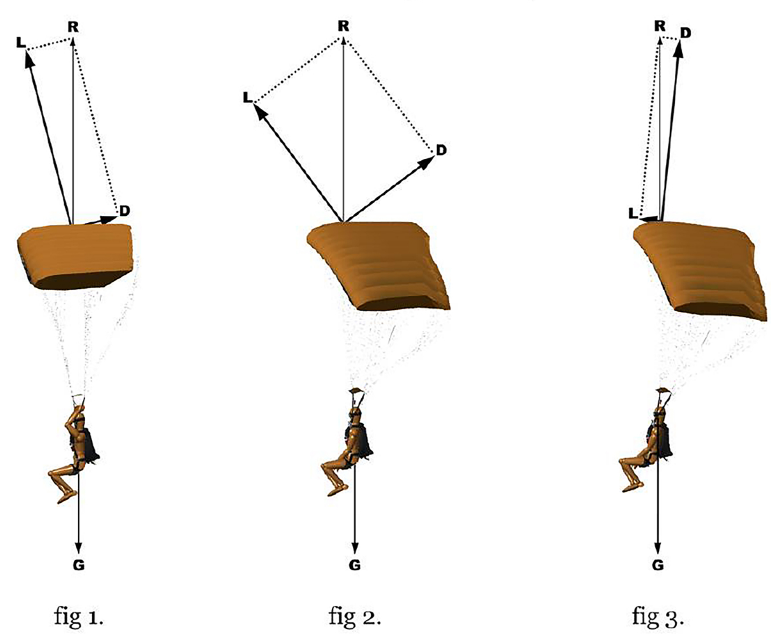
Effects of braking on L/D Ratio



Lift and drag vectors are exaggerated for contrast.