Half Cubans, Accurate 45 Downlines

BY GILES HENDERSON IAC #159

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During the Lakeside Park cookout at Fond du Lac 86, I was asked how I would manage to draw reliable 45-degree downlines without the use of reference gauges or window lines. After describing the techniques, it was suggested that the method be written up as a 'how to' article for *Sport Aerobatics*.

Since every ACA Primary and every IAC Sportsman category known sequence in the history of competition aerobatics has included the half Cuban eight and because it is a relatively high (K=16) value, it probably deserves a critical review.

We will first examine the more general problem of establishing the 45-degree down and then consider the specific maneuver.

Since the accuracy of the 45-degree angle/line is such a cardinal point in the judges' scoring, many pilots have constructed and installed some kind of sighting device. Although many find this approach very effective, let me identify some disadvantages of these devices:

They require several hours to construct and install followed by several hours of adjustment per the critique of a qualified ground observer.

These devices seem to have powerful 'diamagnetic attraction' for people. Regardless how bright you paint these devices, or how many day-glo orange ribbons you attach, someone gets pulled into them at least once a week, even when the plane is locked up in your own hangar. Their lifetime seems to be limited to how many successive bends you can make before the onset of crystallization and fatigue failure.

If the canopy/window reference lines are used as an alternative to the hardware version, we soon discover there is a problem with our eyes trying to focus a horizon at optical infinity concurrent with a reference line eight inches from our face.

Some pilots find it difficult to overcome the disorientation caused by the rotation of the inner ear as we turn our head from forward to sideways during the *g* load of the push or pull to 45-degrees.

Most pilots find it difficult to avoid getting a 'wing down' as they push or pull to the line if they are not looking straight ahead.

Small 'bobbles' or changes in pitch attitude are more likely as we rotate our head and move our field of vision from forward to sideways.

As an alternative to the sighting device, let's consider other existing references, i.e. the aircraft altimeter and the box markers on the ground. In any given sequence the entry altitude on the half Cuban will be approximately constant from one flight to the next; and will depend mostly on the altitude we initiate the sequence, and what specific maneuvers precede the half Cuban.

After rehearsing the sequence several times, we note the entry altitude is fixed within + 100 feet for the 1986 Sportsman Known. Moreover, the approximate position of this maneuver along the X-axis is also fixed from one flight to the next. However, there will be considerable variation along the Y-axis due to different wind conditions, judges' location and the pilot's 'box strategy.'

Now that we have characterized the x-coordinate and the entry altitude, we can exploit the properties of the 45-degree right triangle to our advantage. If we sketch a scale drawing of a 3300 foot box and locate the x-coordinate of the entry position, it is easy to then locate the aiming point that our nose should point at during the 45-degree downline (Fig. 1).

Recall that the height of the 45-degree triangle and the base are equal in length (Fig. 2). Therefore, the altimeter reading above ground level (AGL) is also the distance in feet from the entry point to the aiming point. Fortunately the contest officials have surveyed our box and have actually placed markers on the ground to assist us in locating our down 45 aiming point. The spacing of the box markers provide us with a reliable 'ruler' to measure the base leg of our 45-degree triangle.

Note in our example the aiming point is conveniently on the north boundary of the box. Although this won't always be the case, depending on your entry altitude, this point

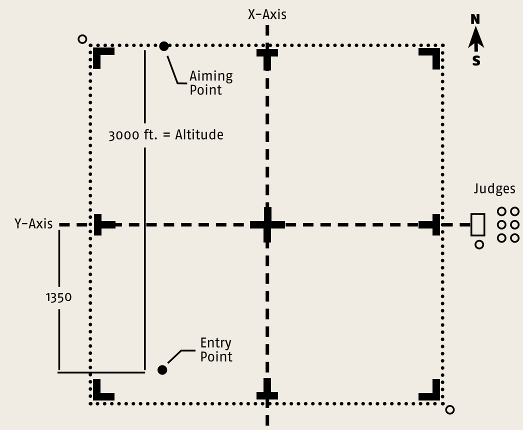

Fig 1 The southbound pilot enters the half Cuban eight 300 feet north of the south boundary at an altitude of 3,000 feet AGL. His 45-degree downline aiming point is then the north boundary. If his entry altitude had been 1350, his aiming point would be on the Y-axis.

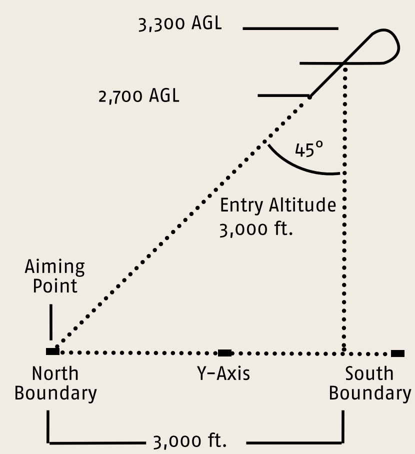

Fig. 2 The aiming point for the 45-degree downline is determined from the altimeter reading at the entry point.

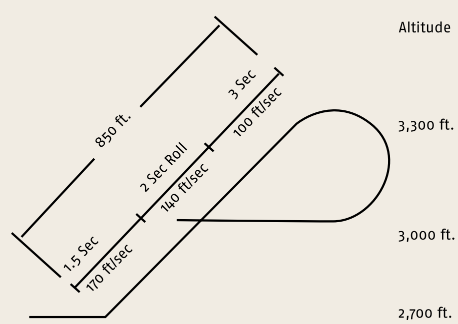

Fig. 3 To locate the half roll symmetrically on the 45-degree downline, we must compensate for acceleration; each segment of the line must be progressively shorter in duration to keep equal distance.

will always be along a line parallel to the Y-axis and can be predetermined for your particular sequence. You know where this line is in relation to the boundary markers before you ever strap on your parachute. In our example, we simply point at the north boundary before, during and after the roll on the 45-down.

Now that I have disclosed the key element of this technique, let's review the entire maneuver. We should actually use a ruler to plot the entry and aiming points on our scale drawing of the box (or aerial photo of the actual box in Fond du Lac).

During our 'hand-flying' rehearsal on the ground we should select some grooves in the ramp or whatever, to simulate the box boundaries. We should mentally locate the judges and the wind direction to formulate our box strategy. We should visualize the location of our entry and aiming points during this rehearsal using the same proportional relationships as specified in our box drawing. Once we strap in and take off, our climb to the holding pattern is our last opportunity to select the actual ground references for the aiming point for this flight, in addition to checking the wind drift and finalizing our box strategy.

Now let's suppose we have just completed the preceding (most likely center-box) maneuver and are now drawing the line between maneuvers. At this moment we want to verify our altitude and airspeed. This scan will provide the basis for any deviations required to compensate the non ideal.

We now look outside at the ground. Our objective is to simply drive the airplane upbox to the rehearsed entry point. Since every box is the same size, there are no surprises here—say 300 feet short of the south boundary.

As our reference slides directly under the plane our vision returns to upfront and we initiate our pull just as if we were doing a loop. As we relax back pressure and float over the top our vision has moved to look out the skylight. As the horizon comes into view we make any small aileron and rudder corrections needed to maintain the exact maneuver and more important, we locate our aiming point (north boundary of the box).

Our vision remains fixed on this point as the nose continues its arc. We stop the pitch change with the nose dead on our aiming point with such authority that the aircraft almost quivers on the 45-line.

It is instructive to realize that the precision in locating the aiming point is quite liberal. In the above example we could point at the target 400 feet (1/8th of the box length) beyond the correct aiming point and our down angle would only be affected by 3.5 degrees (ARCTAN [3400]/[3000] – 45). If you now carefully maintain this angle/line, you are in fact flying with very good precision, but not with exact accuracy. However, it now becomes the burden of the judge to distinguish precision from accuracy and to distinguish 48.5 degrees from 45 degrees.

If after setting the line you recognize an error in the location of the aiming point, you DO NOT want to correct the pitch angle—not even during the roll where you can sometimes hide the correction, since this gesture is a sure confession of your sin.

The remaining elements of symmetry are to place the roll at the midpoint of the downline. Although the following detail is tailored to a 90 horsepower Clipped Wing Cub, the method may be readily adapted to any aircraft. Since the J-3 draws a loop approximately 300 feet tall, we obtain a nicely balanced maneuver if we exit the half Cuban 300 feet below our entry altitude (2700 feet).

The hypotenuse of a 45-degree right triangle with a 600-foot base is approximately 850 feet. As the aircraft comes down this line it will accelerate from approximately 65 MPH to 125 MPH (Fig. 3). It we divide the downline into three equal segments of approximately 280 feet, we should ideally traverse the first segment inverted, complete the half roll in the second segment, traverse the third segment upright and then promptly pull the nose up to the horizon.

To accomplish this we must compensate the fact that we are accelerating from about 100 feet/sec. (approximately 70 MPH) in the first segment to 170 feet/sec. (115 MPH) during the final segment. Therefore a count: a thousand one, a thousand two, a thousand three; "roll around the point" and count: a thousand one, a thousand...; pull will be about right.

So there we have it. If we have already mastered the loops and slow rolls, the half Cuban can be a fun maneuver executed with a lot of confidence. In essence, as in emergency procedures, we have worked out all of the critical elements of the maneuver before we get into the aircraft, leaving us with a very simple prescription to follow during the execution. Moreover, the method assures us of the desired quality in our lines and symmetry while eliminating the need of diverting our attention to a side view of a gauge device or worse yet, to leave the outcome to a guess and a chance. IAC