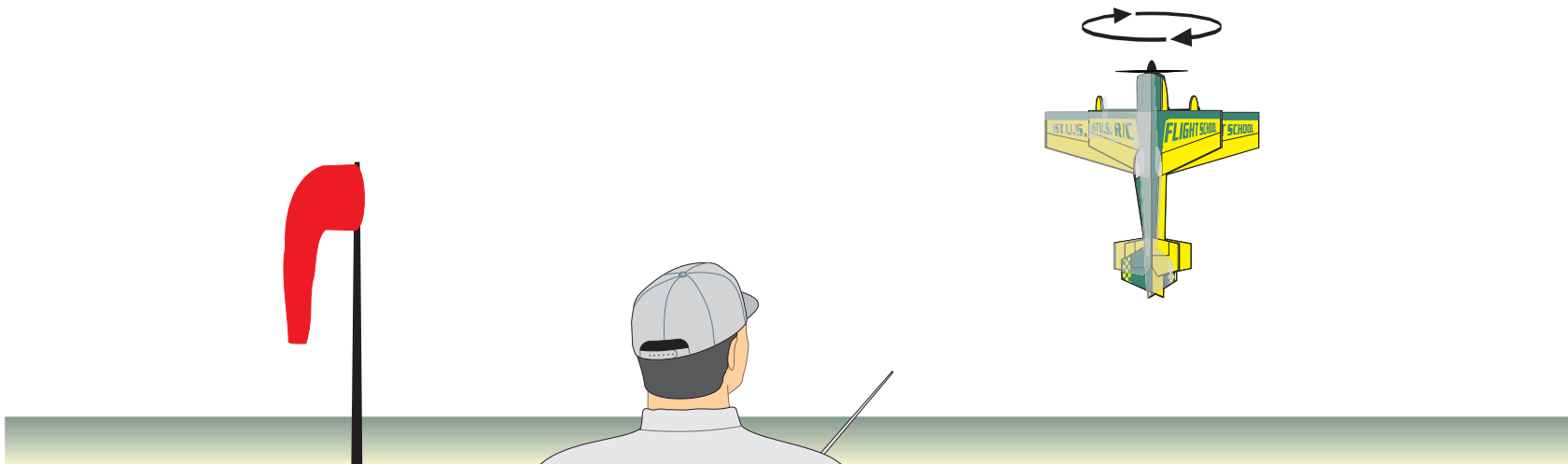


### 3D Torque Roll Introduction

The awe inspiring “torque roll” consists of rolling to the left while hovering. There are two methods pilots use to effect torque rolls. The first is to establish a stable hover and then start rolling with left aileron. The second, more advanced, method is to establish a stable hover and then remove the right aileron and allow engine torque to effect the rolls.

Newcomers to torque rolling usually find that holding in some aileron works best. While the rolls are faster with aileron, the plane tends to “lock into” the rolls with less tail movement. Plus, the confusing segments of the rolls when the bottom of the plane is facing the pilot are much briefer. Holding in aileron also keeps the airplane rolling when the fuselage is not perfectly vertical. The disadvantage of holding in aileron is the faster roll rate allows little time to salvage the maneuver in the event of a gross error. Therefore, you should start at a safe height and remain ready to punch the throttle to recover.

In order to perform a slower torque roll with minimal aileron, the fuselage (thrust line) must be kept perfectly vertical. If the fuselage deviates even a few degrees from vertical, the rolls will slow or stop altogether—at which time the pilot must demonstrate incredible coordination to pump the aileron to keep the plane rolling while at the same time manipulating all the other controls.



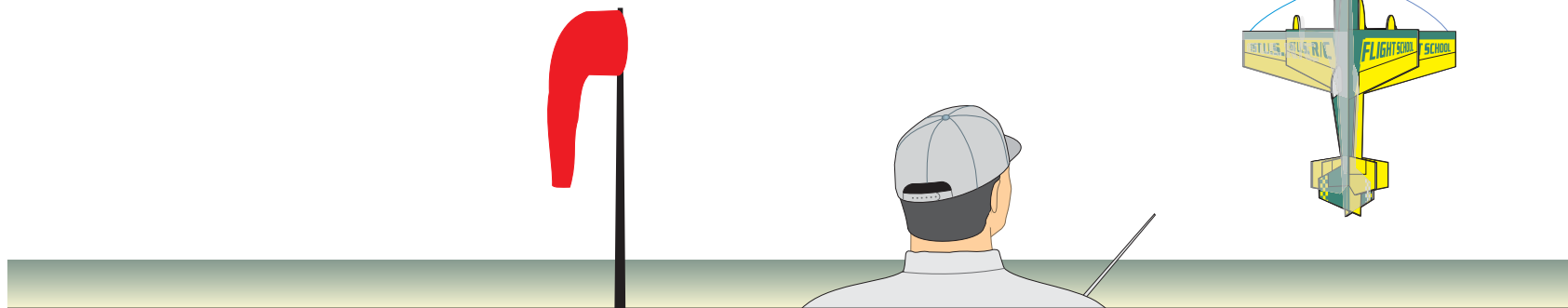
### 3D Torque Roll

Before initiating a torque roll, establish a stable hover with the fuselage perfectly vertical. (If the roll axis is off just a few degrees, this maneuver becomes exponentially more difficult.) Once established in a hover, smoothly apply left aileron to start rolling.

The objective during the initial phase of learning to torque roll is to practice correcting deviations from vertical using only the elevator. (No matter which way the tail moves, a fraction of a second later the plane will have rotated to where a pull or a push will correct it.) At the same time, pump the throttle to maintain the same height and positive control. After awhile, you'll start detecting instances where rudder would be an appropriate correction, and eventually you will bump the rudder as much as the elevator during torque rolls.

Barring over-controlling or wind, the majority of your corrections during a torque roll will entail right rudder and up elevator. This understanding will be a significant help when the bottom of the plane is facing you and the controls are reversed: Odds are a bump of right rudder or up elevator will correct most deviations. If the torque roll is slow enough, some people deal with the control reversal problem when the bottom of the plane is facing them by applying the rudder to the "low wing", and you may want to try that also.

The most common mistakes during torque rolls are forgetting to pump the throttle and thus losing control authority, and, applying the rudder in the wrong direction. So, remember to keep pumping the throttle during torque rolls, and if you're not sure which way to apply the rudder, don't apply the rudder at all.

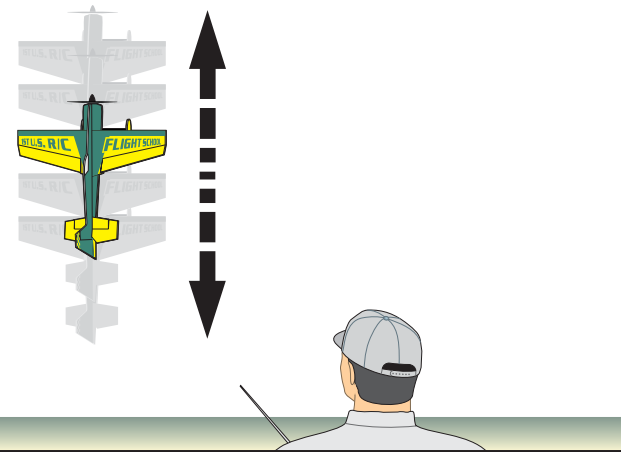


Punching the throttle to full and rolling skyward is a very exciting way to exit a torque roll....

### 3D Pogo

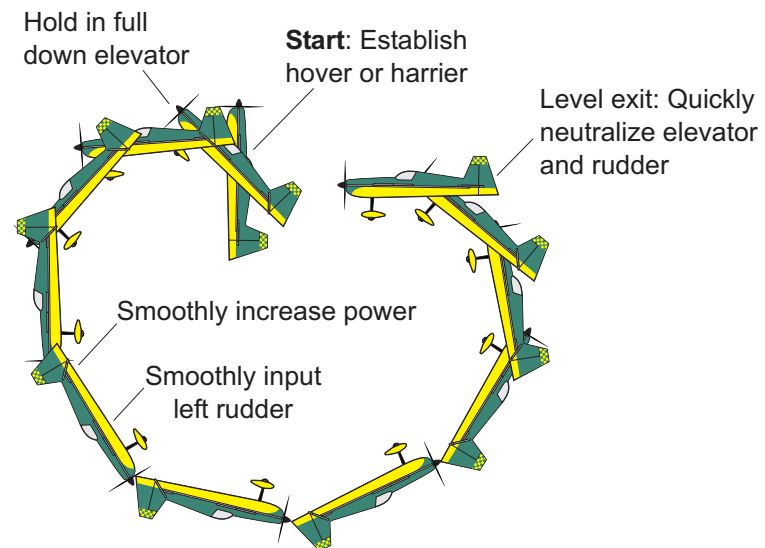
A variation on the hover is the “pogo”. A pogo consists of establishing a stable hover, then increasing the throttle to effect a short climb, then pumping the throttle in such a way to allow the airplane to enter a backwards descent. And repeat.

Don’t forget, the only way to maintain control while descending backwards is to pump the throttle to generate propwash over the control surfaces.



### 3D Waterfall

A “waterfall” is a tight forward flip using full down elevator. Waterfalls are typically performed out of a hover or upright harrier, and usually finish in a hover or level flight: Start by pushing full down elevator. When the nose points straight down, increase the throttle to approx. 3/4 to increase elevator authority. Then, quickly neutralize the elevator when you want to stop. Note: There will be considerable *negative* P-factor after you increase the throttle, therefore you will very likely need large amounts of left rudder to track straight. The keys to this stunt are initiating the push with the wings level or square, and figuring out exactly how much left rudder to apply and when.



### 3D Inverted Harrier Technique

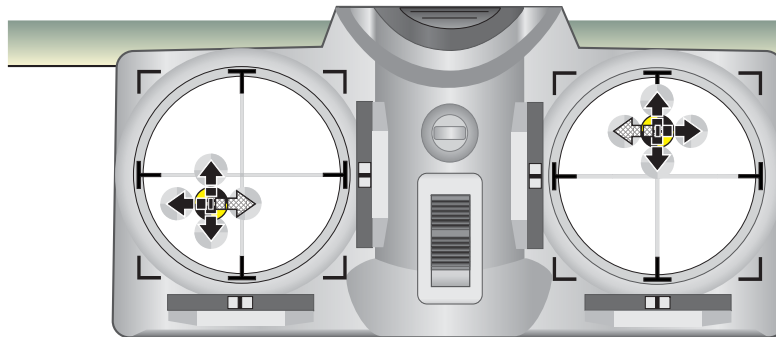


Inverted harriers represent the pinnacle of 3D flying skill: After rolling inverted, down elevator is used to maintain a high negative angle of attack while the throttle is used to control altitude. There will be considerable negative P-factor in this position, therefore, you'll have to hold in left rudder to track straight. In fact, steering will consist mostly of increasing and decreasing the amount of left rudder you're holding in. (You might think that this maneuver would be easier if you could mix out the right turning tendency of negative P-factor. Actually, compared to rolling inverted without any idea what rudder inputs you'll need, knowing that you will need left rudder reduces confusion.) Of course, the rudder/steering will be reversed from your perspective when the plane is inverted. Working through that challenge will take considerable practice, although it helps when the airplane is low and close enough to be able to see which way the rudder is moving.

The wings are kept level during an inverted harrier with brief coordinated aileron and rudder inputs. However, since the rudder is reversed when inverted, you will need to cross-control the rudder with the aileron to prevent adverse yaw when correcting the wings back to level.

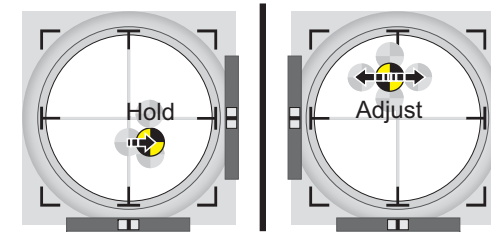


Be ready to push out and punch the throttle when the maneuver unravels!



Inverted harrier pass: Hold in left rudder to track straight. Vary the rudder to steer. Cross-control the rudder and aileron to prevent adverse yaw when leveling the wings.

Unlike an upright harrier, turns are performed by locking-in a small rudder input and then controlling the rate of the turn by maintaining a slight bank angle with the aileron. The plane will likely be so unstable in this attitude that you will need to make both left and right aileron inputs to maintain the same bank angle throughout the turn.



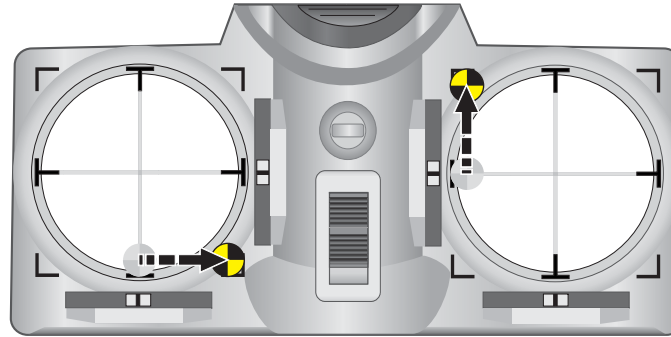
Inverted harrier turn: Lock in a small amount of rudder to turn, then focus on controlling the bank and rate of turn with the aileron.

KPTR: Vary the left rudder you're holding in to steer. Briefly cross-control aileron and rudder to level the wings.

## 3D Blender

In contrast to the inverted harrier, the “blender” is one of the simplest 3D maneuvers, yet because it is so dramatic, it is also one of the most popular.

A blender is performed by cutting the power and quickly pushing the airplane into a vertical dive. As soon as the dive is established, start rolling to the left. After a roll or two, quickly put the sticks into the inside corners (full left aileron and down elevator, right rudder and idle). The plane will then suddenly and violently decelerate and enter an inverted spin. The spin will tend to be flat initially, and then transition into a normal inverted spin. If you take out most or all of the aileron and add some power immediately after the spin starts, it will remain flat longer. Neutralize the controls to recover.



The blender personifies the excitement and exhibitionism that 3D flying is all about, and now you know what it takes to experience those thrills for yourself. Have fun 😊

*David A. Scott*

Instructor

KPTR: Regardless of the maneuver, taking a few minute to rehearse the stick positions beforehand can prove more valuable than hours of trying to figure them out in the air.

