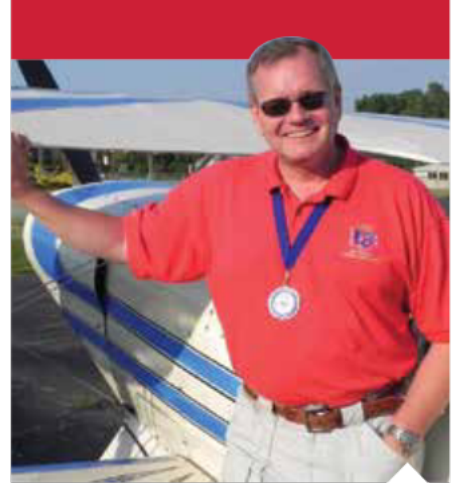


Aerobatic Trim

BY GORDON PENNER, IAC 429704, THREE-TIME MASTER CFI-AEROBATIC, FAA GOLD SEAL CFI



THERE IS A LOT OF DISCUSSION out there about the different ways of setting the elevator trim for aerobatics. This seemingly simple topic brought about an explosion of different opinions and book references as we talked to different people. Also, this seemingly simple topic is not just about setting the trim for aerobatics. It is also a signpost that reveals the ebb and flow of knowledge in our whole aerobatic system in the United States, and in some cases, the world.

There was also a fragmentation of opinions over time, meaning that many were not aware of the other techniques for setting trim that existed. We must also introduce the terms “zero-g trim” and “neutral point.”

I thought I would present a representative sample of what some of the aerobatic books say about this subject and what experienced pilots say. As an aerobatic instructor, I have just about all of them on my shelves. I only do this step to begin the discussion and to show what is already out there for your consideration. The final choice is up to you.

When I was new, learning aerobatics for recreational flying and to compete in Sportsman in a 150-hp Decathlon CS, I was taught to set the trim for 10 mph over book looping speed before beginning the sequence. Looping speed in that model Decathlon is 140 mph. It only does about 125 mph indicated in level flight at full throttle, so I had to dive to get to 150 mph to find that setting. Once set, I was to leave the trim there throughout the sequence. I was also taught to put the trim in that same place even when practicing individual maneuvers. That way, the feel on the elevator would always be the same each time the maneuver was performed.

I was also given two other reasons that such a nose-down/high-speed trim setting was valuable. One was that, on the downlines, the airplane would seek straight down and not try to pitch up on you (nose toward your forehead) until you reached the trim speed.

The other was that the amount of forward stick pressure needed when in the negative-g regime, as in the inverted portion of a slow roll or point roll, would not be near as high.

The above system felt good and got me successfully through many Sportsman category competitions. I had no idea there were so many other ideas on how to do it.

Let's break it all down.

- **Question 1** is the basic overall question about how we should trim for aerobatics: Should we trim for each maneuver to reduce control pressure, as we do for normal flight, or should we set the trim in one place before beginning the sequence and leave it in that position throughout the whole sequence?
- **Question 2** is that if we are only going to set one trim position before the sequence begins and then leave it there throughout, what should that position be? Also, what logical reasoning do we use to determine this setting?
- **Question 3** is an outgrowth of Question 2: If we set the trim in one place for the whole sequence, is that setting different depending on what category of difficulty you are flying, or what maneuvers are inside your sequence?
- **Question 4** is how do we set the trim for training or practice on individual maneuvers, especially if you are new or if you are a recreational-only flyer?

When addressing the fragmentation issue as well as the knowledge issues, one thing all of us in our sport must remember is the continual “forgetting” of common knowledge that seems to happen. The institutional memory or tribal knowledge in our sport always seems to be decaying, and we have to pump it up at regular intervals.



Gordon Penner's 1974 150-hp Decathlon CS.

Rolling inverted to find the best trim position is Ron Schreck, IAC 433751, in his Van's RV-8.



Former IAC Safety Chairman Bruce Johnson said it best, most people remain in a hobby for about five to seven years. People are always cycling in and out. When people cycle out of our sport due to a change of interest or due to life getting in the way, they take their knowledge with them. The passing down of knowledge to new people is not all that systematic.

The IAC-affiliated system is a good central place where tribal knowledge is kept alive, but not everyone comes through the IAC path to become an aerobatic practitioner. Even within the International Aerobatic Club, our knowledge retention is not perfect, which is a good reason to have these discussions. We of the IAC must continually pump that knowledge up, recognizing that the decay is always there.

Questions 1 and 4 go together. Train as you fly, fly as you train, right? A decision must be made on how the trim will be set, and that system must be used throughout all aerobatic flying.

The consensus from all the instructional books for answering questions 1 and 4 seems to be to set the trim in one place and have it there throughout. Setting it in the same place every time any aerobatic maneuvers are flown, whether individually or in a sequence, also builds muscle memory in training and in later experience.

So let's see what some of the aerobatic instruction books say about the value of trim forces that result from the large airspeed changes throughout an aerobatic sequence. This discussion also will answer questions 2 and 3. In addition, we will nail down the zero-g trim and neutral point definitions.

In Eric Müller's book *Flight Unlimited 95* (written with aviation author Annette Carson), the Swiss and European aerobatic champion said the following on the trim subject:

"There are different reasons for trimming in different ways, depending on the machine and the purpose of the flight. With an aeroplane approved for aerobatics but without an inverted fuel and oil system, for instance, I trim it to +1g at the maximum horizontal speed before the start of my performance or training, and I do not change this trim until my routine is finished.

"With real aerobatic machines (*appropriate +/-g ratings and inverted fuel and oil systems — Ed.*), normally there is only an elevator trim, which we set for an entire sequence to the zero-g trim.

"To find the best trim position, we must first half-roll inverted, trim the aeroplane so that it flies hands-off horizontally, and note the setting. Then we must trim halfway between hands-off in normal flight and hands-off inverted: we call this the zero-g trim."

In Chapter 5, "The Basic Maneuvers — The Loop," of Neil Williams' 1975 book *Aerobatics*, the British aerobatic champion wrote: "First one sets up the aircraft in a fast cruise condition. Then, the machine is trimmed slightly nose heavy, so that it can be held in level flight with only the pressure of one finger ... the trim is now set for all aerobatic flying, and although many pilots use the trimmer during maneuvers to take the load off the stick, I prefer to accept these loads, because it gives me a feedback of information from the aeroplane, and a datum to work from. If the stick force changes unaccountably, it may mean that something on the aircraft has moved, and I must then land and investigate."

In Chapter 4, "Technique and Feel," of David Robson's book *Skydancing*, the author said on Page 78, subtitled *The Use of Trim*, "The development of this (aerobatic) sensitivity is adversely affected if the aircraft is constantly retrimmed to remove out-of-trim stick forces. As a general rule, most properly designed aerobatic aircraft have only a small trim change with changing airspeed so that the out-of-trim forces are not excessive over the operating envelope of the aircraft. In this case, it is preferable to trim the aircraft at an airspeed corresponding to cruise at maximum continuous power and leave it set.

"Any reduced airspeed (increased angle of attack) will be reflected in the necessary pull-force. Similarly, speeds above this will be indicated by the push-force required. Trim (out-of-trim force) is a very valuable reference for flying by feel and, therefore, for developing a sensitivity for aerobatic maneuvering."

In Alan Cassidy's book *Better Aerobatics*, which I consider to be the top of all the great aerobatic how-to books, the British aerobatic champion and instructor has the most robust and comprehensive treatment on the subject of "The Elevator and Elevator Trimming."

Steve Johnson, IAC 20081, Advanced category competitor, in his MX2.



THE ELEVATOR

Cassidy wrote, “In aerobatics, however, we are striving to fly accurately through constantly changing attitudes. A lot of this maneuvering involves prolific use of the elevator in order to make continuous changes in wing lift. Under these circumstances, accuracy requires a full understanding of the lift-generating system, of which both the elevator and its trim control are essential parts.

“A simple wing moving through the air would always try to take the path of least drag, which would mean zero angle of attack (alpha) and no lift. The wing in flight generates lift only because the elevator produces down force that holds the wing at a non-zero angle of attack. The elevator and the wing together form a lift-generating system that we can vary and control.

“When the pilot moves the elevator control, he/she is actually demanding a change in the angle of attack of the wing. The position of the control column, in the fore/aft sense, is effectively a measure of the angle of attack of the wing.

“There is a very important stick/yoke position in every aircraft where the elevator in fact does nothing, and the wing then has zero alpha and generates no lift. I shall call this position the ‘neutral point’ in reference to the elevator control.

“It also follows that the same stick position will give different load factors at different speeds.

“The amount of lift being generated is proportional to the airspeed squared ... Also, each pilot is feeling something different through the stick, because the stick forces are different (if the trim is the same each time).”

TRIMMING

“In most aircraft, it is possible to set the trim control position sufficiently far nose-down so that when the elevator is released, the aircraft flies a parabolic flight path and the *g*-meter reads zero,” Cassidy wrote. “This is how weightlessness is simulated in astronaut training. With this trim condition set, a fair amount of back pressure is required on the stick to maintain level flight at cruise speed. If the stick is released, it moves forward to the position where the elevator is doing no work.

“This is the ‘neutral point’ referred to above.”

APPLICATION

“There are many occasions in aerobatic flight where it is necessary to have the wings generating no lift, in other words to fly at zero alpha,” Cassidy wrote. “These occasions include all vertical lines and both of the occasions in a straight line roll (*slow roll – Ed.*) when the wings are vertical with respect to the horizon (*what we Americans call knife-edge flight – Ed.*)”



Tony Wood, IAC 20897, entering knife-edge flight in his Sukhoi.

An advertisement for the Extra NG aerobatic aircraft. The main image shows a red and white Extra 300 in flight, banking sharply to the left. The aircraft is viewed from a low angle, showing its underside and the cockpit. The background is a scenic landscape with a river and hills under a blue sky. In the top right corner, there is a logo for "EXTRA AEROBATIC PLANS" featuring a stylized aircraft. Below that, the text "EXTRA NG" is written in large, bold, red letters. Underneath, it says "The Next Generation of Aerobatic Aircraft". In the bottom right corner, there is a logo for "SOUTHEAST AERO" featuring a stylized aircraft. In the bottom left corner, there is a block of text: "The Extra NG is flying in the USA and available for immediate delivery from Southeast Aero. Experience a leap forward in performance and design. Demo flights available for qualified pilots." In the bottom center, there is contact information: "Contact: Doug Vayda dvayda@southeastaero.com 904-568-9410".

TRIMMING FOR AEROBATIC SEQUENCE FLYING

“It is not practical, nor is it wise, to try to change the elevator trim setting after the start of a sequence of linked aerobatic figures,” Cassidy wrote. “So it is necessary to consider what you want and set the trim control before starting the sequence.

“Where you set the trimmer is a matter for your own preference, and may vary depending on the complexity of the sequence you are going to fly. Whatever position you decide, you should make this decision based on a sound logical basis, so here are some thoughts worthy of consideration ... the purpose of an adjustable trimmer is to reduce workload for the pilot. Remember that at any time when you are flying level, however briefly, at other than the trimmed speed, some stick force will be required on the elevator control to maintain the flight path. The question to ask yourself is: ‘When is it most critical that the elevator looks after itself, so that I can concentrate my mind on other things?’”



Alan Cassidy's book *Better Aerobatics* has a robust and comprehensive treatment on the subject of elevator trimming. The book is available at EAA.org/shop.



2020 IAC CONTEST SEASON CALENDAR



DATES	HOST CHAPTER	NAME	REGION	LOCATION	AIRPORT
Oct. 9, 2020	36	Akrofest	Southwest	California	LO8
Oct. 9, 2020	52/58	Kathy Jaffe Challenge/Wildwood Acroblast	Northeast	New Jersey	KWWD
Oct. 10, 2020	5	Clyde Cable Rocky Mountain Aerobatic Contest	South-Central	Colorado	KLAA
Oct. 16, 2020	34	Ohio Aerobatic Open	Mid-America	Ohio	KEDJ
Oct. 16, 2020	107	Texas Hill Country Hammerfest	South-Central	Texas	KAQO
Oct. 16, 2020	3	Mark Fullerton Memorial Bear Creek Bash	Southeast	Georgia	KRMG
Oct. 24, 2020	61	Giles Henderson Memorial Challenge	Mid-America	Illinois	KSLO
Nov. 21, 2020	23	Sebring 81	Southeast	Florida	KSEF

SIMPLE SEQUENCES

Cassidy wrote, “If the sequence to be flown is all positive, with no vertical rolling, as you find in the Basic (Primary) or Sportsman categories, then the answer is probably ‘When I am flying very fast through the box between figures and need to think about positioning and what comes next.’”

“The ability to fly without having to make an elevator input will only occur when you are level at trimmed speed, so it is best to arrange this happy state for when your brain has to be quickly making other decisions ... So consider the highest speed at which you are going to be flying level during the sequence and trim for hands off at this speed.”

ADVANCED SEQUENCES

“If the sequence to be flown includes a lot of vertical rolling, then this is the time when you need the finest elevator control,” Cassidy wrote. “Such sequences also probably include a balance of positive and negative loops and lines. In these cases, it is my strong recommendation that the trim is set to give zero g: elevator neutral point. Then vertical lines will stand a much better chance of remaining vertical when you quickly apply

aileron to roll ... This is my recommendation for the Advanced and Unlimited categories.

“My preferred method of trimming for neutral point is simply to start a climb, about 45 degrees nose up, from a relatively high speed, fast cruise say, then let go of the stick and look at the accelerometer. ...

“Now move the trim control nose down until the g-meter reads zero and you are effectively weightless.

“Now if you fly in Intermediate, you are on the cusp between these two recommended solutions. So you can decide for yourself which is most important to you.”

There you have it. Here are some techniques for your consideration and for the “energetic” conversations that are to follow. At least now we know a lot of the opinions — and the reasons behind them — that are out there from those who have been there before us. A later article will present opinions of current competitors and instructors.

Enjoy! **IAC**

