



Upset Training
and
An Introduction to Aerobatics

A short course in unusual attitudes and enjoying them!

Matt Knapp, CFI
Steve Billester, Acro Aficionado



An introduction to Aerobatics

Some notes on the short course

Aerobatics are a fun and challenging way to explore the true capabilities of an aircraft as a vehicle which maneuvers in all 3 Dimensions. Done properly, aerobatics are quite safe, and a valuable tool to expand any pilot's abilities. This course is designed as a basic introduction to aerobatics, with the most likely training aircraft being a Citabria, Super Decathlon, or perhaps a C-150 Aerobat. The intent of the course is to introduce the student to the concepts of aerobatic flight, how to do aerobatics safely, and to have lots of fun in the process. For many pilots, initial exposure to high g-levels, inverted flight, and extreme attitudes may be uncomfortable at best. The good news is that most people will develop a tolerance to both pulling g's and the amount of maneuvering their stomach can withstand. While the course is laid out as a series of 5 lessons, the actual number of flights will vary by the student's tolerance, or more to the point, to the tolerance of the student's stomach! The course is also structured to provide upset training is so desired. This typically occurs at the end of the course after the student has significantly boosted both their orientation skill, and comfort level with unusual attitudes.

Lesson 1: An introduction to Unusual Attitudes

Objective:

Familiarize the student with what to expect for flying outside of the usual +/- 30 degrees of pitch and +/- 60 degrees of bank. Boost student confidence in the safety and fun of looking at the world from a very different angle. Thorough ground briefing on safety, followed by a flight with “extreme” attitudes in pitch and roll, concluding with an acrobatic maneuver or two.

Pre-Flight Briefing:

1. Safety: Discuss airplane Nzmax limits, minimum altitudes for aerobatics, pertinent FARs (91.303) importance of airspeed control, and proper throttle usage,
2. Aeromedical factors: Most people will experience some levels of gastronomical discomfort when starting aerobatics. A tolerance will be built up over time, and it's important not to push much further once your stomach indicates it is no longer interested in being tossed around. Along with the stomach, the following need to be considered:
 - Eating, or Not Eating: It is advisable for the stomach not to be empty, but also very advisable not to be full! Avoid a big or heavy meal at least 3 hours before aerobatics. Avoid heartburn inducing foods (lots of acid), and definitely avoid flying on nothing but a cup of strong coffee (*lots* of acid).
 - g-factor: Most acrobatic airplanes are rated for +6/-3 g (note: a Citabria is only rated to +5/-2). An unaccustomed body, however, is rated to a good bit less. Tolerance will be built up with repetition of g, but be alert for grey-out, and even black-out. Tighten Stomach muscles and exhale slowly to improve g tolerance
 - General Body Maintenance: Aerobatics are *demanding* on the body. Treat your body well with proper hydration, rest, and physical fitness level, and it will handle the stresses of aerobatics with ease.
3. Pre-Flight Briefing: Emphasize a thorough check of the airplane, with introduction to fabric airplanes if the student is unfamiliar with such. De-FOD the cockpit, and the pilots.
4. Cockpit Briefing: new on the dashboard - the g meter
5. Acrobatic Area Briefing: where the usual practice area is, boundaries, airspace, frequencies, traffic checking, and maintaining good situational awareness.
6. Aircraft Systems: monitoring, and avoiding, throttle over-speed and engine overheat. Discuss inverted fuel & oil systems.
7. Recovery from unusual attitudes: roll preferable to aft-stick, close throttle, avoid over-speed, over-rpm and over-G!
8. Parachutes, and 5-Point Harness Briefing

1. How to don the parachute, where is the “D-Ring” and what to do with it
2. Strapping into a 5-point harness, and then getting out in a hurry
3. Quick-release door (if applicable)

Flight Maneuvers:

1. Getting used to using more controls than your typical Cessna Driver: (near) level flight drills:
 1. Acrobatics uses the Rudder! Dutch rolls, box the point with the nose,
 2. Properly coordinated steep turns at 2g using the g-meter for reference. “Magic spot”
2. Stalls: Flying slowly, big control movements as the controls get sloppy, dealing with adverse yaw, spin awareness, spin entry and spin recovery. Maybe the first spin for the student! Initiate an immediate recovery (multi-turn spins in a later lesson)
3. Larger changes in airspeed and attitude: Pick a good straight ground reference and practice Nose attitude up and down 45 degrees. Note changes in Rudder required to maintain heading, as well as use of the wing tip angle to the horizon to judge angles once the nose is above, or significantly below the horizon. Use of wing-tip levels above both horizons to judge wings-level. Monitor g-meter and increase the briskness of the pull-up and work to 0g on the push-over. Question the student: what is the stall speed at 0g ? Discuss kinematics of large stick movements - the tendency to roll right when pulling back.
4. Wing-Overs: coordinated maneuvers approaching 50 degrees of pitch and 90 degrees of bank
5. First Big Acrobatic Maneuver: offer choice of loop or roll - loop is typically easier on the stomach if queasiness is setting in. Discuss entry speeds for the aircraft, watching for engine over-speed and maintaining orientation during the maneuver. (**Note:** in case of queasiness, all the usual remedies apply; open the vents, have the student fly the airplane and focus on everything but being sick. and keep the sick-sack handy.)

Post-Flight Debrief:

Discuss student levels of comfort / discomfort with g's, and high angles of bank and pitch. Discuss the rapid changes in control stroke with the correspondingly rapid changes in airspeed, and maintaining orientation at extreme attitudes.

Recommended Reading:

“Basic Aerobatic”, Geza Szurovy, Mike Goulian, TAB Books, 1994

“The Basic Aerobatic Manual”, William K. Kershner, 1987

For Next Lesson: read up on loops and aileron rolls.

Lesson 2: Loops, Aileron Rolls and Inverted Flight

Objective:

Continue to develop orientation in unusual attitudes, tolerance to g and stomach queasiness. Emphasis on safety, fun, and recovery from botched maneuvers.

Pre-Flight Briefing:

1. Q&A with student on safety procedures:

- Aircraft limits (Nz min/max, airspeed limits, engine limits)
- Altitudes & Regulations for Acrobatics
- Parachute procedures
- Pre-Flight things to pay extra attention to
- Physiology: how well the student handled the g's and queasiness last flight, and planning the current flight accordingly (i.e. don't start with rolls if they're going to get sick on the first one)

2. Lesson Plan: Discuss the maneuvers for the flight:

- Loops: Entry speed, Keeping wings level, brisk, but not too abrupt pull-up, transition in looking to wing-tips, easing off at the key point, float over the top, power management on the back-side, avoiding too many g. Think round, not egg. What happens if too slow? falling out of the maneuver, inverted stall potential.
- Aileron Rolls: Entry Speeds, starting attitude, What can go wrong - *keep rolling!* never “pull” to escape an inverted situation!

Flight Maneuvers:

- Warm-Ups: review from first lesson, wing-overs and steep climb / steep descent maneuvers. Discuss orientation, where to look, rudder coordination
- Loops: Demonstrate / follow through with entry speed, noting any power reduction to keep from red-lining the engine. Note starting altitude when attitude goes neutral, Initial pull, not too hard to avoid excessive energy loss. continued pull until the key point (noted from wingtip), re-acquire horizon while easing off on the stick and floating over the top. Partial, but not complete power reduction down the back side, and increasing g with airspeed. Maximum g is 3-4 depending on briskness of the maneuver.
- Aileron Roll: In the case of the Citabria, this is combined aileron + rudder, but is still the “simple roll”. Demonstrate maneuver pointing out entry speed and attitude. Relatively low-g maneuver.

- Loop too slow. Demonstrate a loop from a slower starting speed, or with too abrupt a pull which bleeds off energy too fast. Attempt to complete, and/or fall out of the maneuver as as demonstration of “when things go wrong” with the loop.
- Bonus Maneuver: Roll with a pause for short segment of inverted flight. Demonstrate entry speed and attitude, and then the nose-high attitude required for sustained inverted flight in the Citabria. Point out the g meter, which should read -1 for level, inverted flight.

Post-Flight Debrief:

Constructive-Critique: discuss maneuvers and any helpful tip for students on orientation, keeping wings level through a loop, etc.

Recommended Reading:

“Basic Aerobatic”, Geza Szurovy, Mike Goulian, TAB Books, 1994

“The Basic Aerobatic Manual”, William K. Kershner, 1987

For Next Lesson: read about inverted flight, the “slow roll” and the Cuban-8

Lesson 3: Slow Rolls, Cuban-8s, Inverted Flight

Objective:

student gains comfort and proficiency in the basic maneuvers (aileron roll and loop), and improves orientation allowing combination of maneuvers (Cuban-8) and cross-coordinated maneuvers (slow rolls)

Pre-Flight Briefing:

- Elements of a Cuban 8; where the key point is, identifying when to stop the loop, holding the line (briefly) before rolling, and recovery
- Elements of a “Slow Roll” including entry speeds, initial attitude, use of rudder, forward stick pressure when inverted, and how to blend the controls together.
- Inverted flight - orientation, nose-high attitude for lift, *reversed P-factor*, which means a quick pop of *right* rudder to roll *left*. Recovery: *always roll!*
- Spins: Altitude loss per turn, recovery procedure: full opposite rudder, forward stick, wait for rotation to stop, recover, avoiding secondary stall.

Flight Maneuvers:

- Warm-Ups / Review; At discretion of student, start with basic rolls and or loops to get the feet working and the head spinning
- Cuban 8: Finding a good reference line, entry speeds, demonstrate the maneuver (with student follow-through). Stick with a half-Cuban for this lesson!
- Slow Roll: Demonstrate a roll, talking through the maneuver, and then a follow-through with same discussion, then student tries.
- Inverted flight: Short segments, keep the nose up! Watch for nose drop on roll-out.
 - Bonus Maneuver #1: Inverted stall.
 - Bonus Maneuver #2: Split-S
- Spins: Check altitude, and for traffic crossing underneath. Spin either direction, recover after 2-4 turns.

Post-Flight Debrief:

Constructive-Critique: Discuss some of the more difficult coordination aspects of the slow roll, and stopping the aircraft at the desired point in the (half) Cuban-8. Discuss the spin - most students who have never spun before are surprised and impressed how far the nose drops during the rotation, and how fast the rotation rate picks up.

Recommended Reading:

“Basic Aerobatic”, Geza Szurovy, Mike Goulian, TAB Books, 1994

“The Basic Aerobatic Manual”, William K. Kershner, 1987

For Next Lesson: Review slow-rolls with a new eye from experience. Review also “inverted flight” and the reversed P-factor phenomenon. New Reading: reverse-Cuban 8's and snap rolls.

Lesson 4: Snap Rolls, Reverse-Cubans, Upset Recovery, and Review

Objective:

Continue development of coordination with increasingly precise control of the aircraft in basic maneuvers. Apply increased orientation and control capabilities to upset-recovery situations.

Pre-Flight Briefing:

- Snap rolls - entry speeds (low), maneuver description: basically a spin in the forward direction. *Hard on the airplane!* Release of some back pressure after the snap starts to aid recovery.
- Reverse Cubans: Entry speeds (quite high), establishing the line, count to 3, roll, count to five, roll, power back, pull (well, ease) back stick, check altitude and airspeed for doing the 2nd half of the maneuver if desired.
- Upset recovery; 3 categories
 1. stall/spin
 2. Nose (very) high, incipient stall, for example, a failed loop
 3. Nose low, rapid increase in energy; recovery without over-stress, over-rpm or over-g on the airframe.
- Discuss the reactions to the various nose high and low conditions. When to roll upright, when to pull to the nearest horizon. Spin awareness / prevention; you can't stall at 0g!

Flight Maneuvers:

- Warm-Ups: basic maneuver review at the discretion of the student
- Reverse-Cubans: Instructor demonstrates a half reverse Cuban, then student practices maneuver with instructor prompting.
- Snap Rolls (these can be hard on the stomach): Slow to entry speed, emphasize speed control, and the briskness of control inputs for initiation and recovery
- Upset-Recovery: (this can also be rather hard on the stomach). Extensive slow-flight on the verge of a spin. Quarter turn spins and prompt recoveries, paying attention to altitude loss and avoiding a secondary stall.
- Advanced Upset-recovery, nose high: Start a loop from too slow an airspeed. *avoid tail slide*, keep oriented, get the nose down and get the airplane flying again. Point out that if this weren't an acrobatic aircraft, the engine might quit to add to the thrill.
- Advanced Upset - nose very low, and rolling.

- If inverted, *keep rolling* until upright, reduce power, stop roll when upright, and recover.
- If less than inverted, reduce power, recover, Note: when given the choice, it is better to (slightly) exceed red-line airspeed than to exceed the load limit of the airplane, especially if loaded near maximum weight!
- Bonus points: student is looking down, eyes closed while the instructor puts the aircraft into an extreme attitude. **Note:** this is a really good way to get the student to throw up! Don't even start if the student is already queasy.

Post-Flight Debrief:

Constructive-Critique: discuss the unusual attitudes and how well the student did recovering with minimal altitude loss, or tendency to exceed aircraft operating limits.

Recommended Reading:

“Basic Aerobatic”, Geza Szurovy, Mike Goulian, TAB Books, 1994

“The Basic Aerobatic Manual”, William K. Kershner, 1987

For Next Lesson: read up on Hammerheads

Lesson 5: Hammerheads, Cubans (both types)

Objective:

Fun! Final introduction of a basic maneuver (the hammerhead), followed by student's choice of more aggressive acrobatic maneuvers (Cuban-8's both forward and reverse) or, more upset recovery type scenarios.

Pre-Flight Briefing:

- Hammerhead Maneuver; control movements, and noting the relationship of the controls to those for an inverted spin.

Flight Maneuvers:

- Warm-Ups: Student's request
- Hammerhead - high entry speed, vertical or near vertical line, and kicking before too slow. Note loss of energy in the pull-up depends on aggressiveness
- Choice for student: Cuban 8's (also high entry speeds), or upset recovery

Post-Flight Debrief:

Constructive-Critique: discuss maneuvers and any helpful tip for students on orientation, keeping wings level through a loop, etc.

Moving On From Here

Acrobatics is an exciting, challenging and fun way to play in 3 Dimensions. It is relatively easy to bungle through a Cuban-8 or slow roll; it takes much more time to learn to do these maneuvers well. As the student improves, they will transition from a mechanical approach to maneuvers (push stick to stop, wait, recover, etc.) to attaining the orientation and feel for the maneuvers which allows them to respond to, and correct for, the reaction of the aircraft. This takes time - more than the 5 lessons given here. Once the student is safe to practice on their own, if they wish to continue with aerobatic flying, it is recommended that several hours of solo practice be put in, followed by another flight or two with the instructor. Thanks to the practice, and improved orientation, the instructor comments will make a lot more sense at this point! Developing a g and stomach tolerance will also help the student in pursuing more aggressive maneuvers.

Good Luck, have Fun!

And keep the spinning end pointing the way you were meaning to when you started the maneuver.....