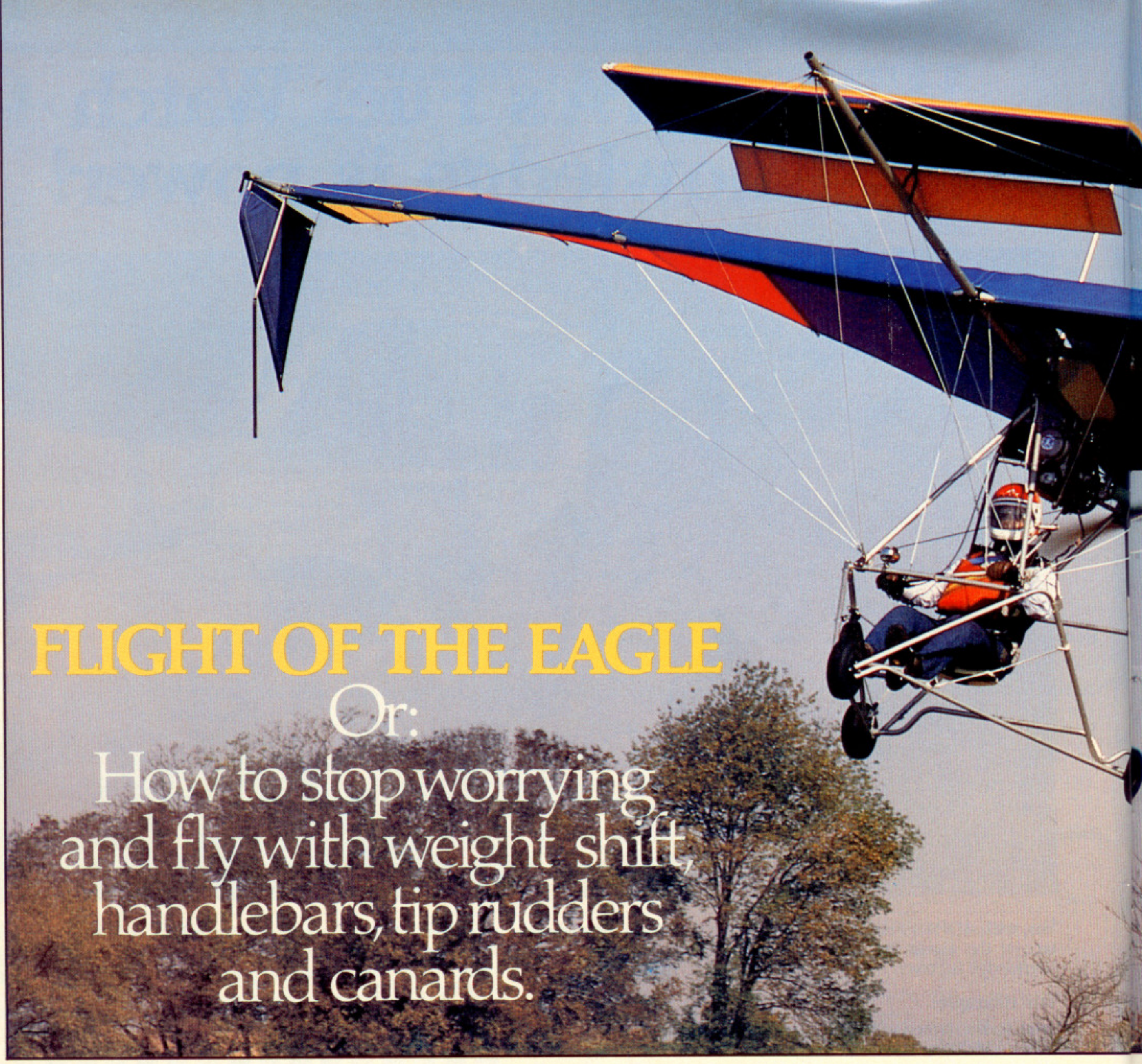
# FLIGHT OF THE EAGLE

## Or: How to stop worrying and fly with weight shift, handlebars, tip rudders and canards.



# FLIGHT OF THE EAGLE

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*It's all in the stall.*

BY THOMAS A. HORNE

Suspended by a strap from an aluminum tube, free to swing here and there according to the whims of nature, the pilot of an American Aerolights Eagle is in for a special flying experience.

Our familiarity with the Eagle goes back to early 1981, when we flew one of the ancient Twin-Chrysler-powered models. Our first impressions of the Eagle were negative. It seemed very sluggish about the roll axis. Landings nearly always involved the threat of a ground loop, owing to the free-swinging seat and an unfamiliarity with the sled-style steering. And then there was the Eagle's control system. And the canard. And the unreliable Chrysler engines.

Now that two years have passed, and the Eagle, two engine changes and more than 3,000 sales later, is one of the biggest-selling ultralights, the time is right for a reacquaintance.

The decision was made to attend American Aerolights' dealer training program in Albuquerque and return home with an Eagle of our own. The training would provide a better understanding of the machine and allow a look at the quality of the dealer training program as well.

The airplane we chose to evaluate was a Double Eagle, the hot rod of the line with a two-cylinder, 35-hp Cuyuna 430 engine.

**Dealer Training**

There are approximately 140 Eagle dealers; all must attend the dealer training program and meet certain qualifications. The training program consists of two main areas of concentration: assembly and tow training.

The five-day program began by taking care of the most important business—signing waivers and submitting orders for the dealers' first shipment of Eagle ultralights.

Taxi training took place in the late afternoon. My classmate, Don Weeks, AOPA 326971, of Lubbock, Texas, and I took turns taxiing an Eagle and getting the feel of the steering. There was concern that Weeks, whose legs had been weakened by a bout with poliomyelitis, would not be able to control the airplane on the ground. Accustomed to working around his disability, Weeks adapted to the task with little problem.

On the second day, we received our tow training. This was done in two stages. First, using a car, we were towed aloft in a two-place tow trainer.



PHOTOGRAPHY BY ART DAVIS

This is a standard Eagle, *sans* engine and with a second seat. The student sits behind the instructor, who does the flying. The instructor is able to discuss the fine points of taking off and landing while it takes place, and the student gains an awareness of what it is like to be towed. You need that.

Most dealers do not use the two-place tow trainer, but they should. American Aerolights maintains that the two-place tow is a good teaching tool, but its use is not mandatory.

Another helpful training option is the Eagle simulator. This device looks like a miniature flat-bed trailer and carries a full-size Eagle tethered to fittings. The apparatus is designed to be hitched to the front bumper of a car. Prior to the solo towing phase of training, the simulator can be used to give a student a glimpse of the Eagle's control feel. Usually, the tethered Eagle slams up against its restraints just after lift-off; it is a skillful pilot who can hover the Eagle within its 18-inch vertical limit of travel.

After the two-place tow training comes the solo tow. The ultralight's engine and drive system are reinstalled for this step of the training, and a two-way communications system is used. The instructor, using a hand-held transceiver, coaches the student, who wears a helmet with a headset and microphone.

Towing starts out at a low speed, then the car is accelerated slightly. Weeks and I alternated between driving the tow car and flying the Eagle. The initial target speed is one that will raise the nosewheel. This speed can be anywhere from 22 to 28 mph (19 to 24 kt), depending on the weight of the pilot.

That speed established, the driver increases the tow speed in two, two-mph increments. This should provide the airspeeds needed for short hops at two feet agl and higher work at the 15- to 20-foot level.

The last phase of tow training is really a controlled dead-stick landing. After towing the student to 20 feet, the instructor disengages the tow line's quick-release and the student glides in for a landing.

Solo flight is anticlimactic after enduring the tow sessions. After a warning about the tendency to over-rotate on lift-off, and a reminder to land from an idle-power glide with weight full forward, we were set free.

This training program is one of—if not *the*—most thorough of its kind. In fact, American Aerolights was one of the first companies to mandate training programs

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*continued*

for its dealers and customers. If the progam has its deficiencies, at least it ensures a uniformity of training standards throughout the Eagle network and gives the Eagle dealer an intimacy with the ultralight that many other manufacturers' dealers do not share.

**Pilot Training**

Customers are taught the same way the dealers are. The cost for Eagle pilot training is $400, and purchasers of new airplanes must take the course. Buyers of secondhand Eagles are foolish if they do not take the training; there are too many different ways a neophyte can go wrong.

The student can expect to spend about four hours in ground school training, and he must pass two multiple-choice examinations. The flight training can be accomplished in two days, provided weather conditions remain favorable.

**Design**

The Eagle is a portable, high-wing, cable-braced ultralight with a pusher propeller, wing-tip rudders and a canard.

The Eagle's control system is unique. The pilot sits in a seat suspended beneath the root tube. Fore and aft movements of the pilot's body cause changes in the center of gravity and also raise and lower the canard's elevator. This is how the pilot controls movement in the pitch axis.

For turns, the pilot deploys the tip rudders. These are connected to a set of handlebars, which are equipped with a twist-grip throttle.

Another interesting feature is the billow-equalizing system. The Eagle is a flexible-wing ultralight. The wing inflates with air loads, causing the sails to billow. The cable that stretches from one wing tip to the other is designed to keep the same amount of billow in each wing. This is essential during turns and in turbulence, when an uneven billow in the wings can cause instability and control problems.

An analysis of the Eagle's load paths, design and structure conducted by the AOPA Air Safety Foundation revealed areas of concern that dealers, owners and prospective owners should be aware of, including:

- *The bowing of the wing spars.* The wings are held semirigid by opposing forces. The tension exerted by the wings' fabric works in one direction, and the cables connecting the leading edges to the bowsprit and triangle bar work in the other. When these forces work against each other, the spars bow under compression.

This means that the fabric itself is a structural component. If it deteriorates or tears—especially at or near the center aft wing panels—there will be nothing to oppose the pull of the cables, and the wings will be drawn forward. Airfoil shape and rigidity will be lost in this structural failure.

Eagle operators must maintain their aircraft's wings and inspect them often for signs of wear. The sleeve joining the two spar sections should be inspected before each flight for wear and security.

The Eagle owner's manual recommends replacing the main wing after 400 hours in service and cautions that they must be protected. An Eagle left outdoors will be unairworthy after six months because the Dacron will deteriorate from exposure.

• *The loads imposed on the spar attach points.* Because the spars are in compression, the spar roots exert constant stresses in their attach fittings. It follows that the spar's bolt holes will elongate in time. This is another structural wear point that can cause an inflight airframe failure.

Eagle pilots should observe the gap between the root tube and the spar root for signs of narrowing. The spar's attach bolt should be checked before each flight to see if it is aligned through the center of the spar. A narrowed gap, or a misaligned attach bolt, means that the spar's bolt holes have elongated.

• *The rear drive-shaft bearing mount pad.* At this writing, the hole locations for this mounting pad had not yet been standardized. The owner must drill them as part of the assembly. Our Eagle went through its first drive shaft because a nut was situated so close to the shaft that it was scored. For our second shaft, we shimmed the two bottom mounting bolts; this gave the shaft adequate clearance.

Though we have not heard of any propeller mounting nuts contacting the root tube, the clearance is so close that one wonders when the first incident will be reported. In theory, contact between the Eagle's propeller mounting hardware and the root tube is not possible because of a retaining sleeve.

• *The elevator up-limit cable.* Though unlikely, it is nonetheless possible for the elevator up-limit cable to hook itself under the left elevator pulley. In such a case, the canard's elevator would be held in the nose-up position. We used a rubber band to take up the slack in the up-limit cable. We still have nose-down authority, but with this arrangement it is impossible for the Eagle's up-limit cable to snag on the pulley.

• *The outboard sweep wire canard support attach point.* The trailing edge of the canard's wing tip is secured to a small section of bare cable on the outboard sweep wire. This area is subject to numerous stresses that cause fraying of the cable. The owner's manual recommends inspecting and replacing, if necessary, the sweep wires at 50-hour intervals. Since this cable prevents the canard from slewing about, we suggest checking it before each flight. After two hours of flying, our sweep wires were starting to fray.

• *General wear and tear.* There is no other way to put it. An airplane that is meant to be assembled and disassembled repeatedly will have wear associated with the act for which it was de-

signed. Holes will show the effects of repeated assemblies, as will the aluminum tubes. Particularly if you transport it by car top.

Most of these design peculiarities are the direct result of a portable airframe. It appears that one of the Eagle's strong points may be its weak point, too. A heavy, well-braced airframe with structural redundancy is not compatible with a take-it-anywhere, "set it up in 45 minutes" mentality.

**Aerodynamics**

The Eagle's two most recognizable features—the canard and the tip rudders—contribute to this airplane's unconventional aerodynamics. The canard and the variable center of gravity help the Eagle achieve its own brand of pitch stability.

A canard, like a wing, is a lifting surface. It generates lift in an upward direction, unlike a conventional rearmounted horizontal stabilizer that produces negative lift—lift in a downward direction.

The canard is mounted on the fuselage at a higher angle of incidence than the wing. This makes the canard reach its stall angle of attack before the main wing does. Theoretically, the main wing never can stall, because as soon as the canard stalls the nose drops and flying speed quickly is restored.

The canard can help protect against an overspeed condition. As speed builds, the canard generates more lift, and the nose rises.

So much for stability at each end of the flight envelope. In normal flight, the closely coupled Eagle, in turbulent conditions or with an inexperienced pilot at the controls, tends to wander in pitch. You become accustomed to this.

The tip rudders, sometimes called vortex gates by the manufacturer, cause turns by two aerodynamic effects. When deployed, they cause drag. This slows the wing on the inside of the turn while the wing on the outside of the turn speeds up. At this point, the sweep of the wings fights the turn.

In a turn to the left, for example, the left tip rudder is deflected, creating large amounts of form drag. The left wing slows down and the right wing begins to come around. Because the wings are swept, more right than left wing frontal area is presented to the relative wind. After a period of sluggishness as the sweep attempts to return the airplane to its original heading, the turn is completed.

Another theoretical model for the dynamics of the tip rudders involves a visualization of induced drag. With the tip rudders in trail, the wing-tip vortexes created by induced drag are minimized. These devices reduce induced drag and create effects similar to those associated with a higher aspect ratio.

When a tip rudder is deployed, induced drag rises abruptly. Thus the reason for their being called vortex gates. The tip rudders can be used together to produce steep descent angles. To do this, the pilot must grasp both rudder cables above the handlebars and pull them simultaneously.

**Engines**

The Eagle has had three different engines in its production history. The first 900 Eagles were equipped with two Chrysler West Bend nine-horsepower engines. It did not take very long to realize that these engines failed often and required a lot of maintenance. They were dropped from the Eagle line in August 1981.

The 250-cc, 20-hp Xenoah engine was used in the next 1,400 Eagles, to much greater satisfaction. A switch was made to Cuyuna engines in April 1982. First the 20-hp, single-cylinder Cuyuna 215RR engines were offered, followed in June 1982 by the two-cylinder, 35-hp Cuyuna 430RR engine. Those airplanes with the Cuyuna 430 engines are called Double Eagles.

Of the 700 Cuyuna Eagles built to date, approximately 500 have been shipped with the 35-hp engine.

### Instructions

There are two sets of assembly instructions. One is a detailed, 20-page, 35-step set of instructions in the owner's manual, and the other is an abbreviated series of steps printed on a small plastic card.

After a dealer walks you through the assembly a few times, you can use the abbreviated procedures and be reasonably certain that the process will go smoothly.

### Assembly

Eagle dealers perform the airplane's first assembly, then test fly it and give assembly guidance to purchasers. Our Eagle went together in four hours the first time it was assembled. This was because of the preassembly procedures. The landing gear had to be assembled, and we had to join the spar sections.

We also ran into a few problems. We fell into a common trap when we assembled the spars. The billow-equalizer cable had wrapped itself around the spar, and we did not realize it until later in the assembly process. Also, one of the tip-rudder cables became wedged between the spar and the fabric. If you plan to transport an Eagle ultralight in its 11-foot bag, look out for these problems. You will have to disassemble the Eagle's spars in order for them to fit into the bag, and it is easy for these cables to become wrapped around the spars accidently.

The company's literature claims that one person can assemble an Eagle. That may be so, but two people make the task breezier.

It takes practice to assemble the Eagle in the company's advertised 45-minutes but it is possible. Generally, our assemblies took an hour and a half, but then again we were not trying to set a world speed record for assembly.

### Flight Characteristics

It is no wonder that pilots of conventional airplanes often have difficulty transitioning to Eagle flight. Desperate for a secure feeling during anxious moments, the pilot is denied it by the Eagle's swinging seat. Everything moves —you, the airplane, the center of gravity, the center of lift, the horizon—everything. Especially when flying in turbulent conditions.

Most pilots are not familiar with canard airplanes, and adapting to canard flight also involves a learning curve. As if this were not enough, the Eagle is short-coupled. This means that there is not much distance between the two primary flight surfaces—the wing and the canard. Also, any pilot movement fore or aft causes a change in the Eagle's centers of gravity and lift. This all adds up to an airplane that is very sensitive in pitch.

The roll axis has its idiosyncrasies, too. Because of the large amount of drag created by the interaction of the tip rudders and the sweep of the wings, the airplane will dive slightly during turns. To prevent this, the pilot has to shift his weight back while turning. This increases the canard's lift and keeps the nose from dropping.

The Double Eagle has yet another complication—an abundance of power.

On a full-power takeoff, the Double Eagle will accelerate smoothly up to 5,000 rpm, then surge abruptly to its 6,000 rpm redline. This thrust can make the ultralight leap into the air in an extreme (45 to 50 degrees) nose-high attitude.

The Double Eagle carries a placard warning pilots weighing less than 200 pounds that flight can be hazardous, so hazardous that it should not be attempted. According to a company spokesman, weight and balance is not the problem. Those weighing less than 200 pounds can safely fly the Double Eagle, we are told, but they must be right on top of the airplane at all times.

It has been our experience that partial-power takeoffs produce satisfactory performance without the threat of a severe pitch up. We would advise Double Eagle pilots to avoid full power on takeoff. Most of us do not weigh 200, and unless you are trying for a climb-out record, the skyrocketing, 1,000-fpm climb is as unnecessary as it is unsafe.

In turbulence, the Eagle's canard configuration produces an unacceptable ride. The canard, set at a higher angle of incidence than the wing, is very sensitive to gusts. When the air is rowdy, the canard hunts up and down.

Landings are not particularly troublesome. Just remember to approach at a low power setting and push back before touchdown so that the airplane will flare.

So much for the scary talk. Yes, the Eagle is touchy in pitch and slow to roll, and yes, it bobs around in turbulence. With experience you become accustomed to this and learn the skills and patience you need to deal with these quirks; then you can concentrate on the Eagle's pleasant aspects.

One of the Eagle series' strong suits is their ability to soar. Thanks to the Eagle's light weight and large wing area, it is able to manage a glide ratio of eight to one, in spite of its considerable drag. This glide ratio puts the Eagle near the top of the heap among the

## FLIGHT OF THE EAGLE

**American Aerolights Double Eagle 430B**

Price: $5,095

Assembly time: 45 minutes

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|---|---|
| **Specifications** | |
| Powerplant | Cuyuna 430RR, 35 hp @ 6,000 rpm |
| Propeller | 2 blade, 54-in dia, wood, 12 laminations |
| Length | 15 ft 3.6 in |
| Height | 9 ft 9.6 in |
| Wingspan | 35 feet |
| Wing area | 180 sq ft |
| Wing loading | 2.27 lb/sq ft (200-lb pilot) |
| Power loading | 11.7 lb/hp (200-lb pilot) |
| Seats | 1 |
| Empty weight | 210 lb |
| Max gross weight | 510 lb |
| Useful load w/full fuel | 276 lb |
| Max pilot weight | 300 lb |
| Fuel capacity | 4 gals, 3.7 usable (24 lb, 22.2 usable) |
| Max calculated stress | +6Gs, −2Gs |
| **Performance** | |
| Takeoff distance | 125 ft |
| Rate of climb | 700 fpm |
| Cruise speed @ 60% power | 38 mph/33 kt |
| Fuel consumption | 1.5 gph/9 pph |
| Max endurance | 2.5 hr |
| Max range | 95 sm/83 nm |
| Service ceiling | 17,500 ft |
| Power-off glide ratio | 7:1 |
| Sink rate | 400 fpm @ 26 mph/21 kt |
| **Limiting and Recommended Airspeeds** | |
| Vs (Stall speed) | 24 mph/21 KIAS |
| Vy (Best rate of climb) | 30 mph/26 KIAS |
| Vx (Best angle of climb) | 28 mph/24 KIAS |
| Va (Design maneuvering/rough-air penetration) | 40 mph/35 KIAS max 28 mph/24 KIAS min |
| Vne (Never exceed) | 55 mph/48 KIAS |

*All specifications and performance figures are based on manufacturer's calculations and, unless otherwise noted, observed on a standard day at sea level with a 250-lb pilot.*

*American Aerolights, 700 Comanche, N.E., Albuquerque, N.M. 87107; 505/344-6366.*

other cable-braced ultralights available.

There is no mistaking a thermal in an Eagle, so do not worry about that. Once established in a steep turn, the airplane will bank quite smoothly, making it easy to stay in the core of the thermal. Because it can fly so slowly, the Eagle can out-turn many other ultralights, another feature that can help in competition or when just trying to make the most out of a day with marginal thermal activity.

The Eagle's most important advantage is its stall-resistance. We tried a number of different stalls—power on, power off, with and without turns, and some turning departure stalls—and all produced the same results. The nose dips, and airspeed is automatically restored, even if the pilot does nothing. All ultralights should have manners like the Eagle's when placed in such aggravated situations.

This is not to say that an Eagle cannot be made to stall fully. It can. But it takes violent aerobatic maneuvering. For all its weird looks, its odd behavior and its structural flaws, the Eagle possesses a significant saving grace in its stall-resistance.

**Accidents**

So far there have been 10 Eagle fatalities. One accident was the result of towing at too high a speed. The tow rope broke, and the Eagle entered a loop. At the top of the maneuver, the pilot, who did not have his lap belt fastened, fell out.

Another fatal tow accident involved high winds and an elderly trainee. The flight instructor decided to tow the student even though the wind was blowing 15 to 20 mph. The instructor drove the tow vehicle with no one attending the tow rope. The rope was tied to the rear bumper with no means of quick release. On tow, the student overcontrolled the ultralight and crashed. The instructor, oblivious to what had happened, dragged his student for some distance before stopping.

An Eagle dealer's father was killed when he made a hurried takeoff after a quick assembly and an incomplete preflight inspection. The billow-equalizer cable was wrapped around the spar, and the airplane crashed shortly after takeoff.

One Eagle pilot failed to notice that his front canard bracket pin was missing its safety clip. He went flying, the pin fell out, and he crashed.

Two pilot fatalities were caused by aerobatics. One pilot was performing wingovers with 120 degrees of bank until the airframe failed, and another was observed making a series of whip stalls.

A passenger was killed when an Eagle broke up at the completion of a loop. This was a tandem flight; the pilot survived.

In a floatplane accident, a pilot with no training attempted to fly an Eagle in 10- to 15-mph winds. Caught by a crosswind, the Eagle tipped over. The pilot, unable to free himself, drowned.

One pilot flew into trees on final approach, and another fatality occurred when an Eagle penetrated a dust devil.

The most recent fatality apparently was caused by a heart attack. After two months of training, the student, a diabetic, was allowed to solo. Once aloft, the pilot became disoriented and flew several 360-degree turns. During the last turn, the airplane struck a power line. An autopsy revealed evidence of heart failure.

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American Aerolights' conservative approach to training indicates the company's awareness of the Eagle's handling peculiarities. Its insistence on a standardized training curriculum shows a level of responsibility that is missing among most other manufacturers. The training syllabus is the most structured in the industry.

Most of the criticism directed at the Eagle has come from pilots of conventional aircraft. More specifically, those with fixed ideas of what an airplane's handling should be and who accept no deviations from conventional design concepts.

Those with no prior flying experience typically have no trouble adapting to the Eagle. They relate well to the handlebars and motorcycle-style twist grip and think of weight shift as going uphill or downhill.

The truth is that the Eagle offers one of the simplest ways for a beginner to become involved in ultralight flying. Prebuilt, there is less opportunity to botch up the assembly. It steers like a bicycle in the air and like a sled on the ground. And it resists a complete stall. The Eagle may not be a certificated pilot's cup of tea, but it has a strong endorsement from the rest of the pilot population. If it serves the function of safely bringing more people to the field of aviation, then the Eagle cannot be all bad. □