Sept. 2, 2003

Year of the Goat

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Presentation for the Sailplane Homebuilders Association Western Workshop 2003.

Given on Aug.30, 2003

For me this has been the year of the Goat.

The Goat is my latest home built glider design, essentially a monoplane version of the Bug4. I've been flying this glider since February, and I've found it to be practical and fun to fly. Like the Bug series, this design is intended to be a recreational glider for soaring or training (the name Goat is an acronym for "glider or airplane trainer").

Here are the Goat basics:

1. Weight is 140 lbs. with parachute, heavier than the Bug4 mainly because of the wing span increase
2. Wingspan is 36 ft., the Bug4 span was 32 ft.
3. Total wing Area is 174 sqft.
4. 3 axis conventional stick and rudder control
5. The Goat was Built in my shed with hand tools, made out of tubes and cables bolted together (The primary structure is hang glider or ultralight airplane technology)
6. The Goat is carried on an unspecialized car top rack and assembled rapidly by one person (I can do it in less than 20 minutes)
6. Big 16" wheelbarrow tire, not a hang glider (no foot launch capability)
7. The Goat has its own page on my Basic Ultralight Glider Internet Site, and the complete technical drawings can be viewed there and can be downloaded from there for whatever purposes may interest the individual. There is no commercial aspect to the Goat or the Bug, they are just homebuilts.

The Goat looks like a classic primary glider, but it has a much lighter wing loading, about 1.7 pounds per square foot, which gives it the airspeed of a hang glider. This means I can fly with the hang gliders, launching and soaring using hang glider sites and hang glider soaring techniques. I could tow the

Goat behind an ultralight airplane, but not behind a certificated tow plane. The nominal redline for me is 45 mph.

So what kind of sailplane is that? It is an ultralight sailplane, it weighs 140 lbs. with the parachute, but I think "ultralight sailplane" is an awkward and misleading description of this kind of glider, so let's use a new word. I remember Bill Spencer calling his Compact 110 a "flying garden chair", and I picked up on that for describing my gliders, and now that has been condensed to "airchair". I call the Goat an "airchair" because the word implies casual flying out in the open; it suggests a simple, light aircraft that consists of the pilot's chair with a wing attached. It suggests flying that is insouciant, not so serious, not centered on aerodynamic performance or any kind of pilot precision.

Flying around in the Goat I recline in a comfortable seat, belted in place with an the old style aircraft four point seat belt. I'm out in the breeze with a nice view, usually wearing an insulated flight suit because above about seven thousand feet it starts to get chilly. It's fun to fly in shorts and a tee shirt on a hot day, but you have to decide ahead of time how high you think you're going to get. I always wear sunglasses, as I would paragliding or hang gliding, because there are bugs in those thermals. I fly with a combination audio variometer and digital altimeter, but I don't use an airspeed indicator, so I don't know how fast I'm flying. I think the Goat thermals at about 23 to 25 mph., depending on pilot weight, and when I fly for headwind penetration I'm going about 30 mph. My basic airspeed reference is glider attitude, which I measure by looking at a mark on the nose tube relative to the horizon.

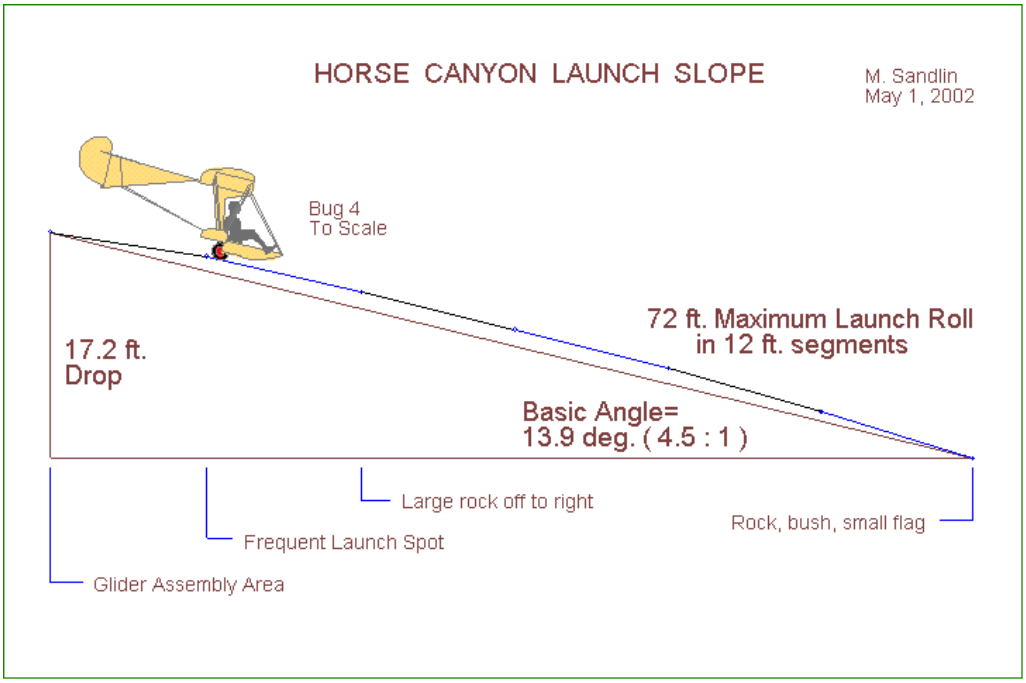
Goat is not "Lighthawk Junior", not a micro lift soaring glider. Performance seems to be about the same as that of that of your average weekend hang glider. The usual comment I get from the hang glider pilots is that I don't seem to have any pronounced sink rate or glide advantage or disadvantage, but it looks like I'm flying slower and turning tighter in the small thermals. I agree with this. I think that relative to the hang gliders the Goat is quicker, easier handling and is a lot more stable in turbulence. The three axis stick and rudder control system of the Goat gives me effective and adequate control in all the flying I've done, although if I'm thermalling real slow I and want to maneuver I usually drop the nose a little for greater control authority. Good stick and rudder coordination is required for an effective turn, which is the big draw back of the traditional sailplane

three axis system. Novices have to learn three axis coordination to fly the Goat or the Bug, and this is the big barrier to sailplane flying, as opposed to hang gliding or paragliding where a simple two axis system is all you need.

With the stick in the full back position, the flying is balky and rough, sometimes the nose will drop and sometimes it won't. The nose drop is gentle and the wings don't roll, and the recovery is conventional: stick forward, apply opposite rudder, return to normal airspeed. No spin entries have been attempted. Like the Bug, there is a low speed range where flight is stable, descent rate is high, and control is poor. If you come down too slow through the wind gradient just before touch down you will have no elevator control, and you will bounce on the big pneumatic tire.

The great novelty of the lightly loaded airchairs, such as the Goat, is their ability to self launch by rolling down hillsides. Floyd Fronius and I have been launching this way at the San Diego hang gliding sites on a regular basis this season. and this has become our normal method of launch. I don't know anywhere else in the world where this is being done yet, but I think others will do it too, eventually.

My favorite rolling launch is Horse Canyon, in San Diego (see diagram below). Rolling friction used to be a big factor here, but the slope has been manicured and is now smooth instead of rough, so I don't have to bounce into the air anymore.



So, I arrive in my truck at the setup area behind launch, unload and setup the glider, do the preflight check, stow my water bottle in the day pack attached to the back of the seat, put the flight suit on, and recruit a helper to

hold my wing tip while we maneuver the Goat through the crowd of hang gliders up to the start, at the high point of the ramp. Now I scramble into the seat, get the nose down onto the ground, get the seat belts on, and check out the situation. I judge the wind strength by requiring enough wind to hold the wings level without movement (with a long open slope you could start with less). A really good condition would be strong enough to raise the nose also. I haven't had excessive wind, so I don't have any rule for that.

If I'm waiting for a the best take off wind, I just sit there on launch with the wings level, fighting off the wing helpers. Hang glider helpers are accustomed to holding on to the glider during gusts, and sometimes that's just when I want to go, so I have to keep telling them that I don't have a roll control problem on launch, the windier the better, this situation is the opposite of a hang glider on launch, so please let go and back off.

When the wind is right and there's no conflict with the ridge traffic, I can start the launch by raising the nose off the ground and letting the glider begin a slow roll down the hill. As the speed picks up, I'll hold the glider down on the ramp and use it all to get as much extra airspeed as possible. When the glider flies, I pull up and fly straight out a couple of wing spans to get clear of the terrain, then I'm off down the ridge, looking for my first thermal.

I haven't done any towing with the Goat, yet, but I expect it to behave just like the Bug4, where the tows are easy and stable. Ground towing involves a simple hook up using a safety weak loop that should break at about 110% gross weight. Unlike a hang glider, there should be no problems with lockouts or tumbles, and no launch dolly is needed.

Airchairs like the Goat will launch with the hang gliders and the paragliders, not here at the glider port. If airchairs are to have ratings, liability insurance, or a political/public relations organization, I expect it to be affiliated with the hang gliders and paragliders more that the sailplanes because those are the people we will be sharing the flying sites with.

Landing the Goat is pretty easy, the pattern speed is slow, there are no air brakes but slipping is effective. I use a hang glider type landing procedure where the pattern is flexible, allowing for maneuvering inside or outside as required for the lift conditions. On one landing this summer I flew into so much lift in the pattern I had to repeat fly base leg about four times, doing figure eights until I stopped going up, then waiting for a chance to come down. (I did this with the drogue chute out). I think this is the most practical kind of landing procedure for ultralight sailplanes, considering the effect that lift can have on our landing pattern. Trying to land like a heavy sailplane,

flying on rails at constant speed and using an air brake for glide path control, is not going to be workable in small landing zones in lifty conditions.

I use a side mounted, five foot diameter drogue chute for every landing. It's mounted 27 inches off centerline, and when inflated is stable low and off to the side. One time recently I was short on final approach so I had top reach back, grab some lines, and pull them forward to deflate the drogue so I could float over the last bush tops before the landing zone.

The wheel is at the center of lift, so the Goat, like the Bug4, is a nose dragger or tail dragger at the momentary whim of the pilot. Most takeoffs and landings are nose down for gust safety. Tail down landings are done for style.

Because the wheel is at the center of lift, the static margin check does not require any placards or pilot weight estimates, just level the nose while fully loaded and assure that it drops to the ground when released. If the tail goes down instead, the weight is too far back and will have to be put forward.

The Goat is transported on a padded rack on top of my truck. The main Goat problem is big, heavy wing panels, weighing 42 lbs. each. These are at the limit of what I can carry and load by myself.

The quick assembly assembly pins (main structural fasteners) have been improved, and are more durable and more reliable. New pins are held in place with three elastic bands each, and now have, in addition, a steel cable locking loop for strength, durability, and redundancy in retention of the pin. As always, shear pins should be quick to use, reliable in flight, and stay attached to the aircraft.

Building the Goat took five months, and was another exercise in what I call "garage technology". This means using mostly hand tools, readily available materials, and proven methods to make the glider, not using any welding, machining, nor molding.

The structure is mostly aluminum tubing and fittings held together with aircraft bolts. Cables are stainless steel swaged with Nicopress fittings.

Fabric covering is polyester (Dacron) cemented on and shrunk tight with an iron, the conventional covering process (Polyfiber), but without the ultraviolet protective coating. Zippers can be installed for access through the fabric using contact cement (no sewing at all).

Control lines are Armstrong "Spectron 12" (special kind of Polyethylene) 1/8" braided line, routed through sailboat pulleys. Steel cable is better (more durable) but requires a lot of custom pulley mount fabrication (availability wins over fabrication when possible).

Off the shelf items: The seat is a folding boat seat, the wheel is a 16" wheelbarrow wheel, the seat belts are from an off road automotive item, and the drogue chute is made from a Rite Aid drug store beach umbrella.

The main panel ribs are small aluminum tubes bent to the upper surface airfoil contour, using my stomach or a convenient tree. Smaller ribs are laid up with epoxy, fiberglass tape, and graphite composite rods on Styrofoam.

The main wing has a nonstructural leading edge shell on the upper surface. This is made from Styrofoam blocks glued between the ribs and then

shaved down to the rib contour. The shell is filled with light construction

spackle, sanded smooth, then smeared with epoxy resin to seal the Styrofoam,

preventing it from being dissolved by the fabric dope. The shell is flexible

and causes no problems.

The Goat is a collection of conventional ideas put together in a time

tested manner, not much development or original thought required.

The airfoil is an airfoil of convenience, all the fabric surfaces are flat except the upper

surface of the main wing panel. The Goat has a lot more tip clearance than the Bug. This contributes to pilot confidence but we don't know yet if this is any real advantage.

For crash safety, the pilot is strapped in by a 4 point belt in the center of a deep, frangible structure, flying at low speeds.

There is a hand deployed emergency parachute which is intended to bring down the glider and pilot together in a tail down attitude. This backwards landing should provide protection for the pilot by collapsing the wing or tail when the terrain is impacted.

No load tests have been performed. I do a basic stress analysis, requiring an ultimate load of 9gs positive, 4.5gs negative, with a 200 lb. pilot, neglecting half the weight of the aircraft (see DHV formula). I am not a stress engineer and don't know how strong my airframe actually is.

I would like to see airchair development continue in the direction of the 4S glider (slow, simple, soarable, safe). Controls can be simpler with fewer connections. Can we achieve a two axis airchair, as simple to fly as a paraglider, perhaps? Airchairs have a long way to go.

The Goat launches from a rolling takeoff at Horse Canyon, San Diego, California.

The author in the Goat at the Horse Canyon takeoff.

The Goat on (and in) the truck, on arrival at the Horse Canyon setup area.

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