The Starduster Magazine

July 2000

In This issue –

The Starduster Magazine

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Table of contents

President's message

Les Homan, President, Stolp Starduster Corp.

I want to thank all those who were involved in the Oroville Open House. It was the best gathering ever. We had a total of 84 aircraft on the field at one time. There were some high quality Stardusters present. The open house was a success and we will start planning for next year.

We have just returned from Bartlesville, Oklahoma and the National Biplane Fly-in. It was great. I can highly recommend this fly-in. Biplanes only. All the others park in spam can alley. Weather was hot, cold, rainy and beautiful. Friday afternoon and Saturday the weather was not the best. Gene Hudkins with his beautiful Starduster Too won an award. We talked to all the Starduster people and had a great time.

We will have a booth in Arlington and in Oshkosh. Stop by and see us. We will be looking forward to meeting you.

We will be having our annual gathering at Wautoma, Friday July 28th, Saturday the 29th and Sunday the 30th. We will be presenting the awards on Saturday night at the airport in Wautoma.

Les Homan

Starduster Open House 2000

Katherine Soudan, Starduster Corp.

The first thing I would like to say is thank you all for coming to our 20th Open House. We had an outstanding turnout this year, if not for each and every one of you, this wouldn't have been such a great event.

It was very exciting to meet all of you in person, many of whom I have spoken to on the phone. We had the same agenda as previous years, but from what I understand, the weather was much better this year attracting more people.

We really hope everyone enjoyed themselves on the house boat. That was a lot of fun! Hope next year is the same. I hope everybody had time to meet each other and get a chance to talk. From what I saw you all did !!!

Photo courtesy of Carolina Labby

I wasn't able to go to the fly-in breakfast at Willows on Saturday but from what I heard it was a lot of fun, and everybody enjoyed themselves.

We had over 80 aircraft at the Fly-in. There was not one tie-down left on Saturday morning (that was great to see). We had a lot of enthusiastic people who had a lot of positive things to say about Starduster and the EAA chapter. I would also like to thank the EAA for having us share this with them.

I hope that all of the accommodations were pleasant for everybody. I would like to thank Cornucopia and Karolyn Fairbanks and her group for all their help with the food and drinks. Our guest speaker from the FAA was very informative and had a lot to offer.

Congratulations to everyone who won an award for all their hard work and time that they spent with their aircraft. For those who didn't receive an award, there is always next year, so keep trying.

I would like to acknowledge Ian Castle and Matt Boddington for joining us all the way from England. They are in the process of being licensed by Starduster Corp to market Starduster aircraft and products in the U.K. Ian and Matt recently purchased a Starduster Too and are also building one. To the ones at home we really hope that you make it to the next year's fly-in and see what we are all talking about.

I felt that everybody I had talked to had a wonderful time. The whole weekend was great. I would like to know if there was anything that we could change for next year. Please feel free to e-mail me at Katherine@starduster.com. All suggestions are gladly accepted.

This has been my first year working at Starduster and I feel the people were all so nice. I really have to thank Bob Pisani for giving me and my stepson our very first ride in a Starduster. Also I would like to thank Les Homan for giving my fiance his first ride.

I really hope that each and every one has enjoyed themselves and will be attending our 21st Open House next year. We hope it won't be the same weekend as our local university is having their graduation, allowing for more accommodations.

From all of us at Starduster we would like to thank you greatly. We hope to be able to see you and meet more people in the coming years.

Correspondence

To Starduster Magazine, 29 February, 2000
Re: Fla-bob Fly-in.

Way to go . . . where were all you 'Duster drivers? I mean, what happened to you? That's right, You, the ones that stayed home . . . just couldn't drag it on down to ragged ol' Rubidoux, huh?

Were it not for 'Fighter-Jock John' and his little ol' red single-place (SA100 to you 'Johnnie-Come-Latelies') Starduster would have had no representation at all.

That's not the worst of it. Not having any 'Dusters to drool over, the ever fickle public found a beautiful (how it hurts' to say this) AcroSport II upon which to lavish their warm affection.

Want some more? The guy what owns said AcroSport says he's gonna take 'er to Oshkosh in August and show the judges how the cow ate the cabbage. He's gonna get 'er done if 'Duster drivers stay away like they did at Fla-Bob. Shame on you!

Be it known— I speak only of Saturday the 26th, up to 1500 hours. Not having any TOO's around to ogle really ticked me off. I addled up and finished the other half of the one-hundred and fifty SM round-trip home. When I got there, I kicked the dog!

Gee, you don't suppose the weather had something to do with the absence of 'Dusters, do you? Maybe a tad too cold? Is that why we're starting to see a lot of canopies on the Stardusters? My frail old Aunt Mabel had one on her biplane. All in fun.
Craig M Phillips, Rancho Mirage, CA

Editors, 1 March, 2000
Re: January Issue.

How 'bout that . . now, tell me the squeakin' wheel doesn't get the grease? You ask for 'How we did it photographs' and the Starduster crew delivers the goods! Just don't quit while you're ahead.

There's not a thing wrong with Glen Olsen's leveling device. The concept is worthy of filing away. Lucky for me, forty years of construction work has left me with a slipped disc and a builder's level (kinda like a transit, but doesn't take all those smarts to operate). With a few 'tricks of the trade' it too makes rigging the wings a one-man (sorry, girls) operation.

Now for Oscar Bayer and his seat-situated survival kit. Why not, when space is at a premium? Below the seat of my Single-Place exists a void. I formed an aluminum 'pan' to act as a trap to catch any and all objects that "Phumble Phillips" may accidently drop into that space. I guess I could store some light weight goodies under there.

Speaking of which . . . smartest thing ol' Bayer ever did was to get that survival weapon out from under his behind.

Worst Case Scenario: The last thing ol' Bayer wants is twenty rounds of .455 Nitro Express between his Hanes and the permafrost!
Craig Phillips, Rancho Mirage, CA

Dear Glen, 13 April, 2000

In the summer of 1997, my family and I went to the Wautoma fly-in. We had a wonderful time and you were kind enough to give my son, Justin, a Young Eagle flight in your beautiful Acroduster Too. We have wonderful photographs of our vacation.

My husband, Bill, has been a subscriber to the Starduster magazine for several years and I happened to see a photograph of your airplane in the 1991 issue. I have been teaching myself the art of sketching and I am having a lot of fun with it. I guess I don't do too bad since I have never taken an art class in my life. I wanted to send you this sketch. I hope you enjoy it. Please keep putting the photographs of all the planes in your magazine so I can deep drawing and sketching them. Maybe if you put this one in your magazine someone else might like their plane sketched also.

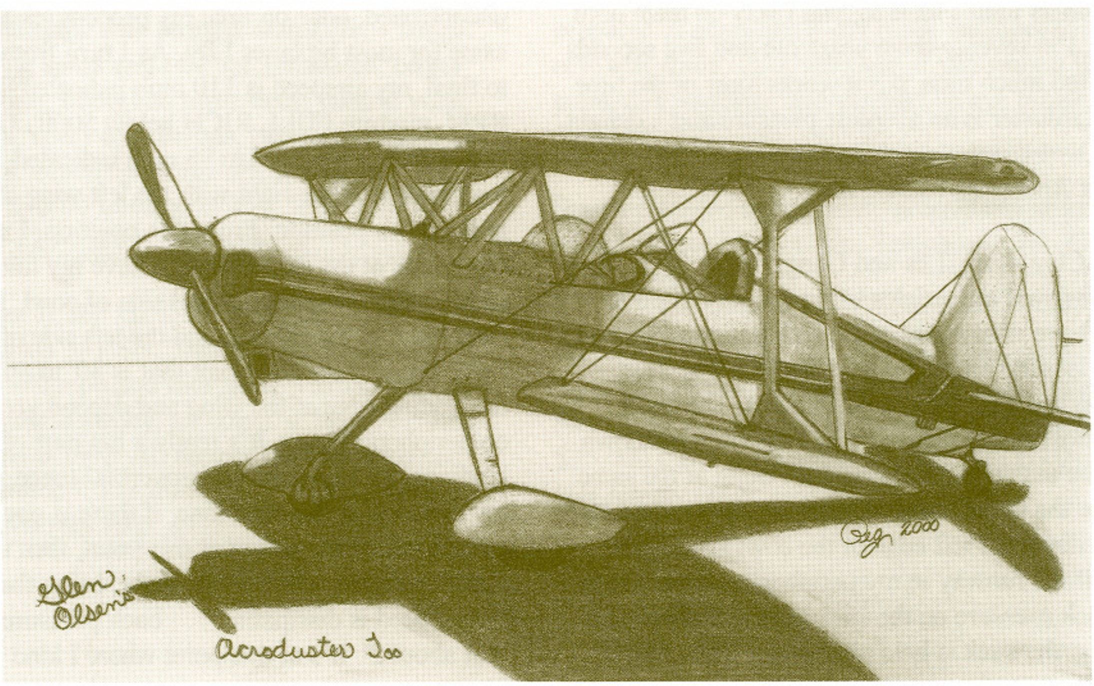
Bill is still working on his Starduster Too. It is slow in coming but that is the fun of it. The articles in the magazine always help to motivate him and keep him going. We would love to come to the open house this May but I am not sure our schedule will permit it this year. The dates are much better than in the past for us though. We were never able to come because we have children still in school the first weekend in May. At least this year you have pushed it back so those of us who do have children can come over and not have to worry about taking the children out of school. Great plan on someone's part! If you have the same dates next year we could surely come. It would be great to see Dave, Les and Bill again.

I must close now but do hope you enjoy the sketch. Sincerely,
Peggy Gauger, Mesa, AZ (See drawing below)

Dear Mr. Olsen 14 September, 1997

Thank you for the Young Eagle flight and certificate. It was fun flying with you, maybe we can go again sometime. I had a fun vacation. I got to ride in an Acroduster, a Starduster, a horse, a four wheeler, a farm tractor, and I got to drive a boat on the lake. It was really fun, I can't wait to go on another vacation.

I hope you had fun in Wautoma too, maybe we will see you at another fly-in soon. You can always stop and visit us when you come to Arizona. Thanks again.
Justin Gauger, Mesa, AZ (See photo, p.10)



Where Do You Put Your Eyes When You Land a Starduster? Cont'.

Hi Glen and Clay,

You asked me to describe how to land my Starduster N8233X, which I built after I retired. Glen taught me how to fly it. He hopped in the front cockpit. I proceeded to stretch the bungees, scrub the tires and wear out the brakes in unusual attitudes on the runway. It was a courageous thing for him to risk his life to teach me. He should have had white knuckles but he didn't show it. I certainly did. Downwind, slow her down and go through my checklist. Turn base and get my composure and wits about me. With my head against the headrest and my eyes glued on the runway, I turn final with a curved approach so I can keep the runway in sight. As I start to parallel the runway, it disappears. With a little right rudder and a little left pressure on the stick, this keeps the runway in sight. Over the fence I recover from the slip. The runway disappears. Only five seconds left to put it all together. Eyes cocked on both sides of the runway, then my eyes zero on the left side to establish my depth so my gear is about two feet off the surface. I have about 2½ seconds left to finish the job. Nose high trim, fingertips on the stick. Now I am really feeling for the seat of my pants! Very gently, back pressure on the stick, she flares and sets on all three, like a duck landing on water. I don't work the rudders until I have to, and I stay on them until I stop. I'm seventy-three years old and five seconds is not too much time, but it works most of the time. My Starduster is an absolute pleasure and a delight to fly.

Bryant Anderson, Heber, Utah

Dear Clay, Glen, Les and Gang,

I enjoyed the articles in the January 2000 issue. I have used many of the techniques mentioned in the landing article (Where Do You Put Your Eyes When You Land a Starduster). The one I used most successfully is a full stall at touchdown with the mains and tail wheel touching at the same time or the mains touching just after the tail wheel. I look down the left edge of the cowl keeping the edge of the runway in my peripheral vision. Keeping back pressure on the stick once the wheels are turning, the stick is held all the way back until the engine is shut off. My approach to landing is usually steep so that I can keep the numbers perched atop the fuel cap between the cabanes until I settle into ground effect over the runway, slowing to settle and flare. It works most of the time, if I don't let my speed build on approach. This turns out to be a matter of feel as I often don't have enough time to check my airspeed indicator once I clear the fence. Oh well, as I said, it works most of the time for me but I am no expert nor am I an instructor.

Nolan Getsinger, Idaho Falls, Idaho

Dear Glen,

Having received your letter requesting my technique for landing a Starduster caught me by surprise. As the January 2000 issue already had ten respondents, which were quite interesting, I could see some resemblance in style and a slight difference in application and "numbers."

My first flight in a Starduster product was an Acroduster being built for Aldo Locatelli, a competition pilot for an Italian team. I was just hired by Bill Clouse, in the fall of 1981, after finishing my air shows for the season. This was quite an interesting flight, which I would like to save for another article.

It doesn't matter if the airport is controlled or uncontrolled, once on final my procedures are the same for most biplanes I fly. As I turn from base to final, my airspeed is 110 mph indicated, high RPM, mixture FULL RICH below 5000'. Once on final I reduce airspeed to 95 mph indicated, moving the nose to the right with the left wing slightly in the down position. From this point on, I usually don't look at the instruments, I have my line of sight just off the cabanes and side of cowl. I have a clear view of the runway and the left side of the field. I'm looking at a point that is 30' to 40' from the leading edge of the wing and depend very much on peripheral vision, it's really a big part of my landings. As I go over the proverbial fence, I get my last look at the centerline, if there is one. I come back on the power at this point, then using rudder pressure to keep it straight, bring the wings level, speed is dissipating . . . back pressure to hold it at about 2'. It's at this point where I kind of step it down, you're coming off back pressure then on and off and on . . . so it goes and you're on the ground. By the way, I three point 95% of the time. High crosswinds, of course, call for French wheel landings. So now I have three wheels on and for many pilots, new to biplanes, this is where the fun can start. I know the rudder is going to steer the plane until the speed is bled off. I use light tapping pressure at this point. When the speed is low I know my Scott tailwheel will get me to the hangar.

On crosswind landings you have got to know what the heck you're doing. Flabob is a great training center for X-wind landings. We have what is called Santa Ana winds. They come in from 05° at 20 mph as an average. They can be very gusty. Your final is to the East. It's a real challenge but it can be done safely. I come down final at 110 mph, following the same procedure for line of sight as above. I carry much more of a crab and usually don't worry about traffic. Not too many will brave the winds. When I'm about 3 ft. from touchdown still carrying a little power, I do a kick-out just before touching the runway. My stick is usually full to the left to hold the wing down on the windward side. All this stuff comes from experience and that's called practice. THANKS GLEN, for the opportunity.

Hank Schmel, Riverside, Ca.

Dear Glen,

Until I read Max Bennett's letter in the last issue of Starduster Magazine I thought I was the only guy still struggling to make consistently good landings in my SA300. How true that every landing is an adventure. Believe me, they become even more exciting when operating out of high elevation airports with density altitudes that easily and routinely hit 8,000' to 9,000' in the summer months. TAS (True Air Speed) goes out of sight!

Let me say that after 16+ years and over 1,000 hours I still consider my Starduster a real handful on the ground. It's not through flying until it's parked in its hangar. May I offer my experience via the following comments.

1. Contrary to the exuberant claims of a few builders, they don't fly "hands off" on the first flight, or on all subsequent flights, nor do they "practically land themselves" unless you're operating in a one mile square black-top surface and the bird is weathervaning into a steady 30 knot wind.

2. I never flight plan on X-C to any airport with less than a 60' wide runway. I learned early on that your peripheral vision on narrow runways is zilch and you can take out a few runway lights without a crosswind. Then again, perhaps I'm not trusting my vision the way I did when I began flying 57 years ago!

3. My bird was built heavy (1420 lbs. empty) so it does not land at 55 MPH . . . 70 to 75 MPH is more like it. It will full stall (which I cannot attain in landing attitude) at 63-65 MPH. My 240 lbs. doesn't help matters a bit.

4. I try to make a descending 180° turn from downwind abeam the numbers to final, leveling briefly to check the final for someone on a long, unannounced straight in. The 180° close-in turn works best—when you can use it. However, the airports I fly into around Central Arizona are frequently very busy, with the pattern stretched out to a 2 mile or so base leg turn. If I'm coming in high I use a forward slip while trying to keep the airspeed targeted at 80 MPH. If I find myself both high and hot I usually go around and try again. Power is carried to the flair. In common with many other SA-300's my Starduster tends to fly with an aft CG—this by design, my weight and limited down elevator travel. With reduced forward visibility I keep my head and eyes at 12 o'clock while monitoring runway expanse on both sides. Any X-wind drift is corrected with control inputs before touchdown. On contact with the runway, sometimes tailwheel first, I keep the stick full back and feet off the brakes. Releasing stick back-pressure can lead to a porpoising motion that is not pretty to watch. On X-wind landings, I use a combination of crab and wing down into the wind, It's more feel and instinct than anything else. If my upwind ailerons are deflected to compensate for a X-wind, this can get hairy real fast if the winds gust or shift direction rapidly, as they are

prone to do here in mountainous Arizona where we land on runways atop mesas. One side of the bird can be flying again and you become a mere passenger waiting for things to settle down.

These are my thoughts about a nice biplane—one I dearly love. The Starduster teaches me something every time I strap in and go flying.

In conclusion, I learned to fly in tailwheel planes like the PT-19, BT-13, and AT-17 as an Aviation Cadet during WWII. My first nosewheel bird was the B-24 Liberator. This was followed by many years in fighters until my retirement as a USAF Command Pilot in 1970. So after 57 years I tell my old flying pals to sell their Cessnas, Beeches, or Pipers and build or buy a Starduster and go have some fun!

Dick Lucas, Cottonwood, Arizona

Ed. Note: Dear Dick, It was a real pleasure for Loretta and me to meet your daughter again at the Moab, UT Airshow last May 6. Glen

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The Starduster Too

by Ángel Jiménez, Madrid, Spain
Extracted from *VOLAR, Aviación Deportiva*
Translated by Clay Gorton

To fly an open-cockpit biplane is a completely different experience than flying in the usual enclosed-cabin monoplane. It's not that it is only much more fun, but it is a unique sensation of flight—a completely different experience.

The Starduster Too was created by the North American, Lou Stolp, who also designed the Starlet, a delightful monoplane with an elliptical parasol wing and a fuselage very similar to that of the Starduster. Both airplanes are exceptionally beautiful. For me, the Starduster is one of the most beautiful biplanes that I have ever seen. (And I don't say that just because I have one.)

The Starduster was not conceived primarily as a competition aerobatic airplane, but rather as an open-cockpit biplane in which to enjoy the type of flight that this concept represents. Nevertheless, since the construction is sufficiently robust, many pilots use it for aerobatics. As I had occasion to read in an old copy of the magazine *Homebuilt Aircraft*, this airplane "is capable of beautiful aerobatics when in the hands of a competent pilot."

Construction

The Starduster is an airplane of classic biplane structure. That is to say, the fuselage and empennage are of chrome-moly steel tubing, with some parts of aluminum (cowling and the cockpit-forward fuselage), and others of fiberglass (the turtledeck and the wheel pants). The wings are constructed with spruce spars and plywood ribs. The skin of the airplane, both fuselage and flying surfaces, is of fabric. The airplane is designed for power plants ranging from 160 to 300 HP, and the Starduster Corporation provides kits in various stages of prefabrication, from a simple set of plans to a welded fuselage and fully constructed wings ready for assembly. The company also has available various sets of exhaust pipes, depending on which engine is to be used, and different fuel tanks, one of some 30 gallons capacity for installation in the fuselage forward of the cockpit, and one of 15 gallons located in the center section of the upper wing.

My Starduster is fitted with a Lycoming O540, with a 234 c.c. displacement, a variable pitch prop and an inverted oil system. The Dacron fabric skin is painted with Dupont Delux. Instrumentation in the rear cockpit includes airspeed indicator, altimeter, compass, G meter, tachometer, oil temperature and pressure gauges, fuel pressure, cylinder head and exhaust temperature gauges and ammeter. The NAV/COM system is a VOR-COM with transponder. Instrumentation in the front cockpit includes only an altimeter, tachometer and airspeed indicator.

Time required for construction of the Starduster , according to the manufacturer, is approximately 1,500 hours, depending on the kit that is purchased. In any case, construction of the

Starduster is a major project, and I would not recommend it to someone who is not endowed with considerable patience.

Test Flight

While taxiing, it will be necessary to do the classical S-turns to see where you are going, which requires your full attention, although it's not difficult, since the tail wheel has a good response, and one can taxi the entire distance without using the brakes. However, when running the engine at 1000 rpm (with an O540 engine) the airplane tends to accelerate, so from time to time it will be necessary to apply the brakes.

At the end of the runway, I do the engine run-up. Advancing the throttle to verify maximum power, I have to hold the brakes with all my strength to keep the plane from moving forward; even so, it will slide forward somewhat. In addition it is necessary to hold the stick in one's lap to keep the tail from rising. After completing the pre-flight check, I ask permission from the tower to take off and begin "the moment of truth."

I apply full throttle and the airplane jumps forward with a force that pins you to the back of the seat. The engine develops considerable torque, but due to the effectiveness of the rudder impacted by the airstream from the propeller, it is easy to maintain direction on the runway. Within a few meters the tail comes up, and in a little more than 200 meters, as the speed reaches 70 MPH, I pull back gently on the stick and climb out at 80 MPH. At this point, unless you want a steep climb-out, we can reduce the rpms to 2500 and lower the manifold pressure to 21 inches. Even so the climb-out is rather steep maintaining 90 MPH indicated air speed.

The sensation at this point is incredible, I don't want to overdo it, but it really is fantastic. The climb rate is excellent and the airplane is very responsive to the stick. I make tight banks to the left and to the right, and without realizing it, I end up practically at a knife-edge. In this position the nose tends to fall somewhat and increase the speed and it is necessary to apply the corrections with the rudder.

Having arrived at altitude and on course, with 20 inches and 2300 RPM, the plane cruises straight and level at 120 MPH. I begin pulling back on the throttle maintaining altitude to see at what speed the plane begins to fall off. I see 50 IAS without producing the stall. At this point I lower the nose try it again, pulling the stick back more abruptly. This initiates the stall at about 50 IAS and the plane stalls without falling off on either side.

I am at a high enough altitude to initiate a spin to the left. The Starduster winds up like the devil. At two turns I release the stick and center the pedals. The plane makes a perfect pull-out, although it has picked up considerable speed. I perform aileron rolls to the left and right without any difficulty. To start the roll one raises the nose about 40^0, places the stick all the way to one side and the airplane completes the role "by itself." I center the stick when the wings are level with the horizon and finish the roll with the nose level. Slow rolls are more involved, especially as the airplane approaches inverted, and again in the fourth quadrant where in order to complete the roll without yaw, it is necessary to use top rudder.

Loops are easy to perform. I begin by diving to pick up speed to 150 IAS, then pull the stick back firmly and the plane responds eagerly. I let up on the stick a little when I am inverted so that when I am in the down position I bring the power off and begin to recover immediately, because if one "goes to sleep" the airplane picks up so much speed that the pull-out will exceed 150 IAS and 4 Gs.

I have no problem performing the rest of the classical aerobatic maneuvers, such as wing-overs, Cuban eights and snap rolls. So far I have not done any negative G maneuvers, but I have verified that the inverted oil system works well in sustained inverted flight.

Landing requires full attention although it is not too difficult. One must come in on final at 70/80 IAS, and once lined up with the runway, I keeping pulling back on the stick little by little. As the nose begins to rise you can't see straight ahead, so you must judge where the runway is using peripheral vision. I pull back until the plane starts to stall and make a three-point landing, and although I may be a little too far above the runway, very little correction is needed. Nevertheless, if we touch down while the airplane is still flying it is very difficult to keep the airplane from bouncing. In any case, you can't disregard the pedals, even when you have quit guiding the plane down the runway, because at any moment you may veer off to one side, especially if there is a cross wind. But if you are alert there is no problem.

Although the Starduster was not designed primarily as a cross-country airplane, nevertheless, it completely changes the concept of local flights that are flown more often, because, from the time you step in the plane until you get out of it, there is not one moment of boredom, and I'm not talking about aerobatic flight. My Starduster flights tend to be 20 to 30 minutes long, and I get much more enjoyment from them than from much longer flights in other types of airplanes.

In conclusion, the Starduster is an airplane, with its open-cockpit and high performance capability, that no matter where you go, one thing is certain, you will not go by unnoticed.

Young Eagle Justin Gauger, with Glen Olsen

Depending On How You Look At It—

Someone, remarked, "If you don't care about seeing anything above you, fly a high wing airplane. If you don't care to see anything below you, fly a low wing airplane. If you don't care to see anything above or below you then fly a biplane, and if you don't care about seeing anything at all put a round engine on a biplane.

First Flight—1

by Bob Scarlett, Bismark, North Dakota

Enclosed is a picture of N62DS taxiing up after it's maiden flight. (See inside back cover). My good friend and "pilot extra ordinaire" Bob Simmers was at the controls, and reported that the engine ran well, it tracked straight down the runway, and flew straight and "ball centered" through the air. I seem to have lucked out and got the rigging almost perfect! Engine is a Continental IO470 with a McCauley constant speed prop. The final FAA inspection was April 29. A few minor things were noted by the inspector (for example, would you believe I totally forgot to safety wire the rudder turnbuckles, and cotter key a few bolts)? so he came back April 30, checked everything again, then signed it off. For a few moments, at least, I had the newest airplane in the world! Several of my "EAA Buddies" were present at the inaugural flight and a lot of smiles erupted when Bob did a perfect three-point on the grass. With my relative inexperience with tail draggers, the insurance company wants 5 hours in a similar aircraft, then I can fly off the 25 hours test flight time, then point the nose 095 to Wautoma and Oshkosh. It's been fun, fascinating, educational, and sometimes frustrating—building N62DS.

I'd like to thank all the builders on the Starduster web site who answered many questions and solved many problems for me. Really appreciate it! I'd also like to thank Ken and Les, (neither of whom I have had the pleasure to meet) for excellent factory support and the many bits of advice and information obtained while ordering parts, etc. Also thanks to Bill Clouse for all his help before Les took over. I couldn't have done it without the physical and moral support of my wonderful wife, Kathy. She put up with me summoning her at all hours of the day and night to hold bolts, turn wings, lift "stuff," etc. and put up with my coming in at all hours, smelling like Epoxy, NIF-K, 100LL and other toxic junk, not to mention the many evenings and weekends that we could have spent doing more interesting things. The rest of you guys out there may think your wives are great, but I've definitely got the best one in the world. (She's a great co-pilot, too). If any prospective builders need a demonstration ride in this part of the country or a recommendation, don't hesitate to send them my way. See you at Wautoma/Oshkosh!

First Flight—2

By Chris DeBaun (C5Babe), Lakeview, Minnesota

The Acroduster is done! Finished! Complete! Out the door! Unfortunately, I'm in California, doing my Air Force duty for the next 12 days, so Gary will have to wait until I get home to fly it. We are planning on going out to the airport early on the 27^{th} or 28^{th} and seeing if it will really fly. It looks like it might. In the meantime, Gary will be puttering with it. We'll let you know what happens when it happens.

Smooth Landings

There are three simple rules for making a smooth landing in a Starduster.
Unfortunately, no one knows what they are.

Stardusters At Sun'N Fun

By Oscar Bayer, Arroyo Grande, California

The call of the road (and other family considerations) led me to hook up the old 5th wheel and motor from Arroyo Grande, CA all the way to Lakeland, FL for the 2000 Aviation Convention. We left on the 1st of April and arrived at the convention campground on the 8th in time for the first days' activities on the 9th. Not the speediest of trips, but there were necessary deviations to visit New Orleans and a date with Crawfish and Oysters!

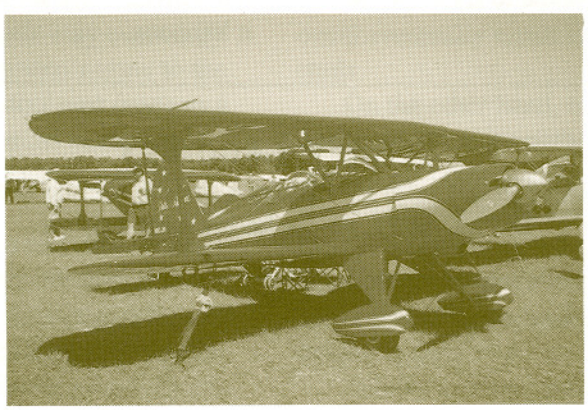
The show was pretty standard, lots of War Birds, but kind of short on home-builts and Antique/Classic machines. The daily air show was a bit different in that the folks from Old Rhineback Aerodrome in New York brought in a couple of World War 1 fighters to open the show with a traditional "dog fight." All in all it was a fine put-together, and although we only stayed three days, we were impressed. One thing Oshkosh (AirVenture) could learn from the Florida folks is to increase the frequency and number of people movers (Trams)—no long waits and almost always a seat available.

As for Stardusters: I counted three while we were there, Gene Hudkins was there with his N88H, an all silver "TOO" with an IO540 power plant. Gene was a pervious "Grand Champion" winner at Sun'N Fun and I could see why! Roland "Buck" Rado flew his Starduster Too into the show, N88HH, a beautiful red and white machine powered by an IO360. Both Gene and Buck are from Navarre, FL. Jim Hayden flew his TOO in from Covey Trails, TX and had N10JH, powered by a Continental O470J, parked next to the other two 'Dusters. His machine is also red and white.

I did meet a yound lady who is the proud owner of a Starduster TOO who had driven in from Murrya, KN. Nancy and H.C. Farrell own N1145P, and are not yet ready to venture into a big venue like Sun'N Fun or Oshkosh, but I encouraged them to come to Wautoma in July and join the rest of us —believe they will.

N88H

N88HH



N10JH

A Round Engine & Two Wings—What More Do You Need?

By Steve Whitson, reprinted from *Custom Planes*, 1, 3, Oct. 1998

There are many adjectives that describe the builder of custom planes: resourceful, intelligent, industrious. But of all the traits one can ascribe to the successful, probably the one, above any other that is a must-have, is perseverance. To spend the thousands of hours and years of work with only minuscule signs of progress requires a dedication unknown to most.

David Allen has been laboring on his dream plane for 19 years and for so many hours that he can't add them up. His Stolp Starduster Too, with a Continental W670-6N 220-hp, seven-cylinder radial engine, is rapidly approaching the finish line. But the start was actually long before he bought the plans in 1979. The start was, like most avid builders, in his childhood. It began with the simplest plastic model airplanes. By the time he was 8, he and his brother took the oak leaves from his mother's dining room table and constructed a fuselage. Two-by-fours were drafted for the gears—two up front and one in the rear—and with a Briggs and Stratton engine up front, they were in business, albeit not too successfully.

Two other highlights are worth repeating. In 1956, when he was about 9 years old, he was given a U-controlled model, a plastic Wen-Mack with an O-49 engine. Nothing exceptional there, but this was winter in Michigan and his mother would let him start the engine in the kitchen, filling it with exhaust smoke of course, and then the two of them would race outside in the snow; she holding the roaring plane and he the control lines. Once outside, she would toss the model up and it would crash. The second event was in 1959. Dad was an electrical engineer. Using one of the first transistors, a CK722, and a Raytheon RK61 gas tube (which glowed a beautiful blue,) he made a single-channel radio control for the plane Dave built, a Babcock. Two pulses would input right rudder, while one pulse was for left.

The Inspiration— Continuing his love of airplanes and seizing every moment to read about them, Dave remembers being in his dental school human anatomy dissection class in 1969. While his fellow students carved on a cadaver, he read a magazine that featured the Starduster Too on the cover. He thought this was the most beautiful biplane he had ever seen. Remembering the last line of the article, "Wouldn't it look great with a round engine?" he said this was when he resolved to build the plane. Of course, the realities of life, work, family, etc., got in the way and it wasn't until 1974, at Oshkosh, that the bug bit again. Will Neubert was there with a Starduster Too that had a Continental W-670 hanging on the front. As if that weren't enough, Bud Geffen's white Starduster Too was the Oshkosh grand champion. That was also the year Dave got his private license. He bought a Citabria in 1977, but he wanted a round-engine Starduster. (By the way, Veronica, his wife, who accompanied him to Oshkosh, is still his supporter after 30 years)!

Beginning— A year of studying plans and gathering equipment passed, and, in February 1980, he made a fuselage jig and started tack-welding the fuselage. The know-how came from reading all the Tony Bingelis articles in *Sport Aviation Magazine.* (Dave's daughter has all the articles cataloged by topic so he can find what he needs without effort). Prior to starting the actual welding, Dave took a welding course at Golden West College (in Southern California) under Dan German, instructor and master welder. It turns out that Dan was also building a Starduster Too. An immediate bond developed and Dan taught Dave gas, MIG and TIG welding. Dave did the entire fuselage with gas, but saw in TIG a better way. He bought a used machine, taught himself how to finesse it and did everything from there on with TIG.

The fuselage was done one side at a time. Once all the longerons, diagonals and intercostals were tacked together, the final welds were started. Beginning at the firewall, each cluster would be skip-welded (a short span is welded on one side, then on the other and so on, until the cluster is finished. This is done to minimize warping from the heat). The welds were done in a circle around the fuselage to the rear of the plane, all the while clamping and jigging to prevent twisting. Using the TIG required the welded joints be normalized with gas using a neutral flame and reheating the joint to a dull, cherry red color and slowly backing the flame away, letting the joint cool slowly. Of course, when you do this, the doors and windows must be closed to prevent drafts shocking the weld. Once the metal work was done and Dave put on the gear, it was time to start the wings.

The Wings— The wings are wood with chrome-moly drag and anti-drag rods. In 1985, Dave bought a wing kit from Stolp. This "kit" contained only the raw materials, although the ribs, which

are routed plywood, were ready for installation. The spruce spars had to be cut and shaped and everything put together. There were two wing modifications Dave performed. First, he bolted and glued to the spars the metal plates used to mount the wings to the fuselage. This increases their strength a great deal. Second, he put plywood on the leading edge, instead of the aluminum called for in the plans. This was an esthetic option, since the fabric can buckle where the aluminum overlaps. The aluminum can't be butted together because of heat expansion. Not satisfied with simply replacing the aluminum, he cut into the nose caps an amount equal to the plywood's thickness so there would be no step where the plywood terminated at the rear. While the process was easy to write down and read, the wings took many years to finish.

The Engine— How do you go about putting a round engine on a plane not designed for one? Dave started with a trip to Chino Airport to consult with John Travis, who had a Starduster Too with a round engine. This was about 1982. John, with the generosity we've come to expect from fellow aviators, gave Dave a copy of all the modifications, as well as the dimensions. But, best of all, he gave Dave a ride. Thrilled and rejuvenated, Dave went back to work. On the copies were the items Dave needed the most: the dimensions for the engine mount. Using an engine mount from a Stearman, Dave cut off the tubes and run from the ring to the firewall and then cut them to the correct length.

Dave related a funny story about this phase in the project. At that point, he had been working with Norm Eaves at Stolp. Norm told him to cut the tubes at the ring and grind the old welds to the parent metal. Dave left about 3/8 inch of stub and proceeded to grind them with a small Moto-tool. Weeks into the grinding, breathing and choking on the dust, he told Norm, who laughed until he cried. Norm told him, "get a big grinder and you'll be done in minutes!" The lesson learned and the tubes shortened by half of their original length, he took the assemply back to Norm for welding. (For those of you interested, there are 15 inches from the fire-wall to the ring, and there is a 1½-degree down-thrust angle. To get this angle, Dave made a jig out of two pieces of plywood, which were askew from parallel by this amount).

Norm welded the tubes to the ring and told Dave that, while he had taken great care, it was posssible the mounting bolts might have to be tapped in. Dave was subsequently amazed when the bolts slid in with perfect alignment. These dimensions have subsequently proven correct, as far as weight and balance are concerned, and the only fit problem is the starter, which is from a military tank. Once Dave changes the starter to the E-80, designed for aircraft, there will be no tight fits anywhere. Plus, there should be about a 10-pound reduction in weight.

Incidentally, the engine is at zero time and was built by Al Ball, of Antique Aero Engines, in Santa Paula, California. Everything in the engine is new, except the crank. Al did the job in 1981 and, when finished, asked Dave if he should pickle it. Dave of course, like all of us with unfinished projects, said he'd be flying in another year or so. Al (a veteran) said, "Sure" and pickled it, using his own concoction of WD-40 and Cosmoline. Dave occasionally puts WD-40 in the intake ports with the common collector off and pulls the prop through two or three times every other day. Covered with oil, there is no rust showing anywhere.

The Engine Cowling— With an engine, there should be a cowl. With an engine that doesn't belong on the plane, you have to make the cowl. First you manufacture a wooden form, called a "buck," which is used as a model. Then take a flat piece of aluminum and beat it into shape until it fits the buck. Having been shown the technique by Steve Davis, Dave used a Yoder power hammer to pound out the basic shape, doing a hit-and-fit operation. Once the cowl fit the buck, it was time to fit it to the plane. This involved driving to his house, marking where and how much to form, driving to the shop, using the power hammer, driving to the house, etc., etc. The final minuscule amounts were hand-done using a sand bag, sheet metal hammer and pieces of leather-covered wood. All the fasteners are cam locks for easy access. Louvers are cut into the cowl to assist in cooling the accessories.

Closing in on the End— With a trip to Flabob Airport and the Stolp factory, now located in Oroville, California, and the help of Bill Clouse, the wings were mounted. The angle of incidence is 1½ degrees on the lower wing and 0 degrees on the upper. Likewise, the dihedral is also 1½ degrees on the lower and 0 degrees on the top. Mounting holes drilled, the fuselage, gear, etc. were sand blasted and powder coated. A small hole was drilled in each longeron and, using a large syringe, oil was injected into the fuselage tubes.

Covering was next and Dave said this was fun. It's when a see-through item becomes solid and the "ghost ship" becomes a real thing. Dave did all the rib-stitching and, for coating, used the Stits process from start to finish. Using an iron to take the wrinkles out was, in Dave's words, "cathartic." (He is a dentist, you know). The paint and silver were applied, using an HVLP (high-volume/low-pressure) paint system. The Croix brand that he purchased uses a turbine and very large hoses about 2 inches in diameter, as well as a large spray head. In addition to eliminating over-spray—an important consideration in the homemade plastic spray booth—the unit heats the air so no water collects in the line. The final colors were too important for Dave to attempt so he enlisted Ed McKay's company, the Paint Booth, of Corona, California.

Wiring, instrument installation and sheet metal were next. Actually, the sheet metal was done awhile ago and, as usual, in the most difficult way possible. Not wanting any overlapping joints, Dave opted to hand-form, using a shrinker, an extruded aluminum "T" channel, to run over the top of the panels. A shrinker is a tool that grasps the aluminum and pushed it together, a small amount at a time, bending it into a curve). This allowed him to make butt joints where the sheets came together. As long as he went to this much trouble, he figured he should dimple the top sheets, countersink the "T" and install nut plates. This brings us up to what you see now. The battle cry is "Oshkosh in 1999."

Tech Tips

Comments on "*An Inexpensive, Positive Pressure Breathing System*," Jan. 2000, p. 29

By Nolan Getsinger, Idaho Falls, Idaho

In the Jan. 2000 issue of the Starduster Magazine is an article with the hook, "Breathing Easy" or "An Inexpensive, Positive Pressure Breathing System." I wish I had the pictures of an old friend building his Very Eze. This was the first composite aircraft in our EAA chapter and after many hours of work on the structure he started getting very sick. He had been using gloves and a dust mask so he did not know that his illness was related to his project (this was in the mid 70s). He would be sick for several days thinking that he may die. He would start feeling better and then try to get some work done on the plane. Boom, he was down again and each time worse than before. Soon he and his MD figured the problem out. The project was put on hold and he was feeling so poorly that he did not care if he completed the plane or not. As his health improved so did his attitude. His engineering background started to nag at him to not drop the project but find a way to build the plane without exposure to the toxic resins, fumes and dust. He bought a pair of surplus rubberized coveralls meant for work around acid, rubber boots and lots of duct tape. He already had a couple of boxes of rubber gloves. He bought a large sheet of plexiglas plastic and cut it into squares about 14 inches each. He glued them togeather in a cube and cut a hole large enough to get his head into. He would wear this cube like a space helmet along with the rubber suit. A new 25-foot vacuum cleaner hose was attached to the helmet and a new ten gallon shop vacuum was placed in an upstairs room (he was building in his basement) and the hose ran through a tightly tailored hole in the floor of the upper level and plugged into the exhaust port of the shop vac. He wore this space suit for nearly 3000 hrs of construction time with no more problems. I used this same idea (the Shop Vac) to supply clean air for sandblasting and painting small parts. I use the cheap sump pump hose of about 1½ inches for the long run and attach a smaller 1 inch sump hose of about 3 feet to a breather mask. I get the smaller hose at a builder's warehouse store like Home Depot and use it because it is lighter and more flexible. I made a clip to attach the hose to my clothing so that it does not pull at the mask. I can also attach the hose to a canvas sandblasting hood with a large sight window if I need more protection than just goggles and mask. I place the shop vac a safe distance away and in another room or outside if possible to keep contamination from entering the inlet side and to keep the noise from the work area. The advantages of the shop vac for air supply is that first it has a built-in filter and most of them can be rigged with a double filter as well. Second, most of them put out pretty good pressure and volume for this purpose. Third, they are already set up for a hose-type connector. Fourth, they are less expensive by hundreds or sometimes thousands of dollars for air separators, coolers and filters for air compressors. When it is hot weather I can place ice in the vacuum canister to cool the air that is coming through the mask or hood if needed. And lastly, the unit can be used to clean up the work area once you are sure that you will no longer need the fresh air supply. On this I would like to suggest that a new shop vac be used for the air supply as some things that may have been deposited in a used shop vac could be a hazard or even deadly to your health—things you may not think about such as mouse droppings and residue from toxic dusts and chemicals. Don't screw with it!! Use a new machine and recycle later. Don't recycle an old machine for breathing air, it could be your life. Also don't hook your supply line to the wrong connection—it sucks!!
Nolan Getsinger, Idaho Falls, Idaho

Blast It All

By John Huie, Desoto, Texas

I wanted to write a piece for the magazine while the memory was still fresh and I was still picking sand out of every nook and cranny. When it came time to sandblast my fuselage, I couldn't find much info on the subject. I have a fairly good library of reference material, but sandblasting seemed to be some dark secret. I went to the Starduster online bulletin board and got some good info to start from Joe Fisher and Gary DeBaun (thanks!).

Equipment— I don't have a compressor so I decided to rent one. Based on online advice, I got one about 5 hp that would keep around 80 - 100 psi. A couple of times the pressure dropped to 50 - 60 psi and the sand cutting performance dropped off significantly. The blasting equipment itself that came with this compressor was a vertical steel cylinder that held about 10 lbs of sand and weighed around 50 lbs. It was heavy, bulky and a pain to constantly refill. It had a hose slightly smaller than a fire hose and a nozzle that looked like surplus from a space shuttle booster. This was not what you want, unless you are sandblasting a bridge. I did the tail feathers (very carefully!) and landing gear with this thing and decided there had to be a better way. I looked at the balusters that have the hopper attached to the nozzle but quickly figured it would be hard to use inside the fuselage. I finally stumbled across a unit made by Devilbiss Model ATI 90 for about $30 at the local home supply store (Lowes). It has a hose that is inserted into a supply of sand—I used a metal 5 gallon bucket. The hose supplies sand to a small gun that has a trigger which allows you to stop/start sand and airflow at any time. This thing worked perfectly and I used it on the main fuselage. One hint—the sand hose is about 8 ft long and any bends between the sand bucket and gun will restrict sand flow. Cut the hose down to about 5 feet. I used a sand graded "fine" from one of the same type building supply stores. The Devilbiss blasting gun is also economical with the sand. The main fuselage took about 250 lbs.

You can put down some sheet plastic under the blasting job and sweep up sand for reuse as you go. I did this for the bridge blaster but not for its successor. The stuff is cheap enough, about $4 for 50 lbs. You will need a set of goggles, the kind that have a tight fit all around—simple safety glasses will not work, the sand will come around the sides and you'll blink sand out of your eyes for a week. In fact, get two pair of goggles—after a day, they will be somewhat opaque from being blasted themselves. I tried a nose/mouth filter to keep out the sand dust but it was always fogging up the goggles. What finally worked was a simple bandana, a la "this is a holdup!" and ear plugs to keep the noise and sand out. I have seen the full head covers that sandblasters use—don't know the pros/cons of that.

As far as technique goes, you will figure it out quickly with trial and error. One thing that will be very helpful is some way to turn the fuselage while blasting it. I constructed a contraption out of surplus square tube that bolts to the holes for the engine mount and provides a shaft that rests on a support so the fuselage can be rotated. Since the fiberglass turtle back is not attached yet, the back end of the fuselage can rest on a sawhorse. If I had to do it over (hopefully not soon) I would buy a used compressor. The job took 3 days and at $35 a day for the rental, I could have bought a used one. I highly recommend the type of nozzle I finally used. If there is a better one, I would like to know about it myself.

Painting— It took two full days to blast the fuselage and I didn't want to leave half of it unprotected at the end of the first day, so I went ahead and primed the first half. This was no problem at all and worked pretty well. I used Stits epoxy primer. When you are through blasting the part you want to prime, use the air hose to blow off residual dust, especially out of the numerous crevices. Stits recommends wiping down the bare steel with their metal cleaning solvent—a little goes a long way and really does a great job in final cleaning the steel before priming. The epoxy primer goes a long way also—I only used about 2/3 of a quart kit. Only mix enough to fill the cup at one time. I have a HVLP spray unit and adjusted the spray pattern to about an inch diameter at 6 inches distance from the gun and then reduced the paint flow to about half of full flow. The Stits book says put down a light mist first, then follow with regular coverage. I tried that on a couple of fuselage tubes and said to heck with that. I sprayed it right on, full coverage, and did not get any runs or drips. I wanted to paint the fuselage forward of the rear seat with a finish coat of paint (the part of the frame that would show when the plane was complete). I had some Aerothane, but after reading all the cautions about health protection (read cyanide) and the way it had to be applied in several light coats, I decided to look for something else. Rustoleum (don't laugh) makes an enamel paint sold under something called "Professional" grade. I thinned it enough for the spray gun and it went on in a single pass, dried quickly and seems to be wearing like iron. Best yet, if it needs touch up, I can use a spray can of the stuff. Just be careful to mask off the longerons, etc. where you will later be attaching fabric.

Conclusion— This was definitely the least enjoyable part of the project to date. I was once quoted $300 for a sandblasting shop to do the work. In retrospect, it was a reasonable price, but like everything else, I learned a new "skill" so it was worth doing it myself. Besides, if you turn over your fuselage to somebody who blasts bridges all day, who knows what you'll get back.

P.S. Hello to Bill Clouse - Bill, I'm still working on it!

Safety

To Go Or Not To Go

by Tom Krashen

Michigan Department of Transportation, Bureau of Aeronautics

Before you launch off into the clag, take a moment to review your decision-making process. Did you make your go/no-go decision for the right reasons? How well has your training and experience taught you that crucial skill: how not to go. A little introspection might just enhance your life expectancy. This article was originally published in "Michigan Aviation", a bimonthly publication by the Michigan Department of Transportation, Bureau of Aeronautics, and is reproduced here by permission.

Every flight consists of countless decisions, which for the most part are made as a matter of routine. We decide on routing and altitudes based on weather forecasts, we decide on fuel loads based on weight and balance factors. The results of these decisions are *almost* always predictable. People (especially pilots) are reluctant to admit limitations and shortcomings; we like to think each decision is a result of exceptional skill, careful reflection, and thorough knowledge of all variables involved. Perhaps other factors affect the decision making process? After all, to err is human, to admit it impossible.

- A pilot departs in a four place single into low instrument meteorological conditions, with reports and forecasts of moderate to severe ice. Shortly after takeoff the aircraft goes down. All five people on board are killed.
- The pilot of a popular low wing single engine airplane made several attempts to land on a runway with a crosswind component in excess of twenty-five knots. On the final attempt, he lost control and was killed in the ensuing crash and fire.
- After completing a night, non-precision approach, the pilot of a corporate jet elected to land downwind. Touchdown occurred approximately two-thirds down the runway. The airplane continued at high speed across a road, through a fence and came to rest in a field. There were no injuries, but the aircraft was substantially damaged.

(*Cont. Page 23*)

GRAND CHAMPION
Maynard Ingalls
Dayton, NV
SA300 N38PM

FIRST PRIZE
Wayne Ensey
Albany, OR
SA750 N94WE
Photo courtesy Carolina Labby

SECOND PRIZE
Ron Monson
La Verne, CA
SA300 N5317Q
Photo Courtesy Carolina Labby

Godfrey Amacher
Woodland, CA
SA100 N112WD

THIRD PRIZE
Bob Caravas
Grants Pass, OR
SA300 N49BC
Photo courtesy
Carolina Labby

Ken Calander
& Steve Zangar
Sacramento, CA
SA300 N411TM

Oscar Bayer, w/
Matt Boddington
& Ian Castle
Arroyo Grande, CA
SA300 N49OB

Mike Gustafson
Menlo Park, CA
SA300 N32142

Jeff Chambliss
Livermore, CA
SA300 N80MM

Glen Olsen
Salt Lake City, UT
SA750 N34LG

Bill Hartman
Yuba City, CA
SA100 N26EB

Bob Pisani
& Matt Boddington
Livermore, CA
SA300 N7989
Photo courtesy Carolina Labby

Gerhard Paasche
Scappoose, OR
Smith Miniplane
N47032

Ray Siefker
Albany, OR
SA300 N14W

Hap Schnase
w/Bob Wampler
Scappoose, OR
SA300 N26AH
Photo courtesy Carolina Labby

In each of these examples there is a common thread. All three accidents were the result of a poor decision, or decisions. Federal Aviation Administration statistics for 1990 indicate 69.7 percent of all general aviation accidents are related to human factors. 11.4 percent were mechanically related and the remaining 18.9 percent were unknown or undetermined. The implications here are clear. More than two-thirds of all accidents could be prevented by analyzing human performance and decision making.

Hazardous Thought Patterns

What makes an otherwise rational person load five people into a four place airplane and venture into weather which grounds airliners? Why did an experienced pilot make continued attempts to land with very strong, direct crosswinds when there were at least seven airports with runways aligned into the wind within twenty-five miles. A discussion of human personality traits and attitudes may help clarify how such obviously poor (at least in hindsight) decisions are made.

Researchers have identified five patterns of hazardous thought which may contribute to accidents.

- **ANTI-AUTHORITY:** This type of individual is apt to act in a way contrary to safety simply in an attempt to defy authority. This person thinks regulations are simply "a bureaucratic waste of time," "checklists are for the other guy," and "aircraft manufacturer's limitations are to be ignored."
- **IMPULSIVITY:** This pilot is likely to do anything, as long as it's quick. "I'm sure the weather's ok, besides I'm late."
- **INVULNERABILITY:** This thought pattern is perhaps the most dangerous. This individual thinks "It won't happen to me." After encountering unexpected head winds this pilot flies past a good fuel stop "because things always work out."
- **MACHO:** Also a very dangerous thought pattern. A Macho individual believes "I can do it." For this person canceling (or even delaying) a flight is a sign of weakness and executing go-around is admitting defeat.
- **RESIGNATION:** This person, when faced with a challenge, thinks "what's the use." This pilot might continue flight into deteriorating weather because "it's too late to turn back, the decision's already been made."

Almost every pilot has experienced each of these thought patterns at one time or another. Additionally, each of us can probably identify friends or acquaintances who fit one of the categories.

The Bad Decision Chain

Accidents are seldom caused by a single bad judgment. They are usually the result of a chain of bad decisions. The key to accident prevention lies in recognizing, and breaking, that chain.

- **Step one, evaluate.** When faced with a decision, check to see if it is being made as a result of a hazardous thought pattern. Remember, everyone is subject to each of the thought patterns. Have all options been considered?
- **Step two, stop!** If the decision is a result of a hazardous thought pattern, break the chain early! Accidents are almost always the result of a series of events and bad decisions.
- **Step three, verify.** Before committing to a course of action always check to see if there is a way out if things don't turn out as expected. Never leave yourself with only one alternative.

Learn How Not To Go

In the course of flight training we spend significant effort on learning how to complete a procedure. Once certified, even more value is placed on "completing the mission." Most cross countries are flown to the planned destination, most landings to touchdown, and most instrument approaches to completion. The go-no-go process shouldn't stop after take-off, it must be continuous. The "no-go" decision may take the form of a diversion to an alternate, a detour around weather, landing short of the destination, or a go-around or missed approach.

For many of us this requires a change in thought process. We must redefine in-flight diversions, go-arounds, and missed approaches as normal procedures. The most important skill a pilot can learn is when and how "not to go."

One footnote: recent statistics are encouraging. Previously mentioned 1990 figures indicate a 9.4 percent decrease in accidents caused by human factors when compared with averages for the preceding six years.

Mag Check

by Mike Busch

This article originally appeared in the May 1999 issue of *Cessna Pilots Association Magazine.*

Magnetos are frequently-neglected items, probably because they're so reliable and our engines have an "extra" one. But mags need regular maintenance, and the consequences of neglect can be devastating. AVweb's Mike Busch explains how mags work, what preventive maintenance they require, what can go wrong with them, and what to do about it.

Mag Tune-Up

Tuning up the magnetos for optimum performance involves two sets of adjustments: internal timing (point gap and E-gap) and external timing (timing the mag to the engine). The internal adjustments require that the mags be removed from the engine and opened up, and should be performed at least every 500 hours of operation. External timing is performed with the mags mounted to the engine, and should be checked every 100 hours or at annual inspection.

Internal Mag Timing

There are two internal adjustments that must be set correctly for a magneto to operate properly: point gap and "E-gap."

The point gap should be set first. To do this, the drive shaft of the magneto is rotated to the position at which the cam has opened the breaker points to the maximum extent. Then the point gap is measured with an ordinary wire-type feeler gauge. The points are then adjusted for the specified gap (normally about .018 inch for Bendix mags).

Once the point gap is correct, the "E-gap" can be set. First, rotate the rotor slowly until you can feel a "magnetic detent." This is known as the "neutral position" of the rotor. Now, with a timing light (buzz box) attached across the breaker points, rotate the magneto until the points just start to open. The number of degrees of rotation from neutral to point opening is called the "E-gap" and needs to be set to a specified value (e.g., 10 degrees +/- 2) so that the points open exactly when magnetic field induced in the coil by the rotor is at its maximum. On the big Bendix S-1200 and dual Bendix D-2000/3000 mags, this adjustment is made by loosening the screw that attaches the cam to the rotor shaft, and rotating the cam until the "E-gap" is correct. Other magneto models have non-adjustable cams, so the "E-gap" adjustment is made by adjusting the breaker points.

These adjustments are essential to ensure that the magneto is able to generate enough energy to produce a hot spark. If the "E-gap" drifts out of limits, the mag will continue to work but the spark it produces will be weak.

External Mag Timing

Checking external mag timing with a timing light.

Once these internal adjustments have been made, the magnetoes must be mounted on the engine and ignition timing set correctly. To do this, one of the spark plugs in the #1 cylinder is removed and the crankshaft rotated until the #1 piston is at top-dead-center position. Once this TDC position is established, the crankshaft is rotated to the specified firing position (typically 20° before TDC).

Using an ignition timing light (buzz box), each magneto is adjusted so that its breaker points open precisely at this desired firing position. The adjustment is made by loosening the two magneto base clamps and rotating the entire magneto on the engine mounting pad until the points just start to open (as shown by the timing light connected to the mag's P-lead terminal). The base clamps are tightened and the timing is re-checked.

External timing is critical to proper engine operation. It should be within a degree or so of spec, and should be re-checked every 100 hours.

Bumping The Mag

When ignition timing is checked routinely at 100-hour or annual inspection, it's not unusual to find that it has drifted off-spec by a degree or two. The drift can be in either direction. Wear on the rubbing block causes the points to open later, retarding ignition timing. Erosion of the breaker points themselves (due to arcing, etc.) causes the points to open earlier, advancing the timing.

The usual procedure is to loosen the magneto hold-down clamps and to "bump" the mag a little bit to bring the timing back to specifications. This procedure is fine so far as it goes. The problem comes when mechanics fail to keep track of how far the magneto timing has been "bumped" in the course of successive inspection intervals. You see, the same factors that cause the external timing to drift (rubbing block wear and point erosion) also cause the magneto's internal timing to drift away from the correct E-gap, which degrades the quality of the spark that the mag produces.

So, while it's certainly okay to bump the mag timing by one or two or even three degrees to correct timing drift, drift beyond that should be considered a "red flag" that it's time to pull the mag and re-adjust the internal timing. Naturally, unless you keep track of each time you bump the mag timing, you have no way of knowing the cumulative amount of timing drift that has occurred since the E-gap was last set. (One more reason for including more detail in your maintenance log entries).

Getting Started

Once the engine is running, a properly adjusted magneto does a fine job of providing the required ignition. Starting the engine is another matter altogether.

There are two major obstacles to starting a magneto-ignition engine. For one thing, our electric starters crank the engine at very low speed—typically 10 to 20 RPM. But, a magneto is not capable of generating enough energy to fire a spark plug at less than, say, 150 RPM (referred to as the mag's "coming in speed"), and even at that speed, the spark would be marginal at best.

Then there's the problem of timing. Magneto-ignition aircraft engines have fixed ignition timing, typically at something like 20° BTDC (before top-dead-center). This setting is a compromise between takeoff and cruise (where we'd really like the ignition timing to be advanced even more) and idle (which would be a lot smoother if the timing was retarded). But there's no way that an engine is going to start with ignition timing like this. If you crank an engine at 20 RPM and a spark plug fires 20° before the corresponding piston reaches the top of its compression stroke, the engine will backfire—guaranteed.

So, to have a prayer of getting our engine started, we need to do two things: (1) figure out a way to coax the magneto into generating enough energy to fire the spark plugs at slow cranking speeds, and (2) figure out a way to retard the spark enough to ensure that the engine won't backfire during cranking.

Two rather different methods are commonly used to accomplish these things—one mechanical, and the other electrical. Which you use depends on what kind of airplane you fly. Most Cessna singles use the mechanical method (impulse coupling), while most Cessna twins and many Beech Bonanzas use the electrical method (retard breaker).

Impulse Coupling

The impulse coupling is an extraordinarily clever mechanical solution to the starting problem. It's a mechanism that's contained within a hub that attaches to the magneto's drive shaft and is driven in turn by the engine. Here's how it works.

When the starter cranks the engine, a spring-loaded flyweight in the magneto drive hub catches on a stationary stop pin mounted on the magneto case. This stops the magneto shaft from turning further. As the engine continues to turn, an impulse spring in the hub is wound up for 25° to 35° of engine rotation (the "lag angle") until a drive lug on the coupling body trips the flyweight, disengaging it from the stop pin. At this point, the wound-up impulse spring "snaps" the magneto through its firing position at a speed much faster than cranking speed.

This has precisely the two effects desired: the ignition timing is retarded (by the lag angle of the coupling), and the magneto rotor is turned fast enough to generate a decent spark. Neat trick, eh? Once the engine starts, centrifugal force causes the spring-loaded flyweights in the impulse coupling to retract so that they no longer catch on the stop pin. When this happens, the engine drives the magneto directly and timing returns to its normal setting of

20° BTDC or whatever.

It's easy to tell whether or not your engine uses impulse couplings. If you hear a loud "snap" when you pull the prop through by hand, and if you hear "snap snap snap" just before your engine stops at shutdown, then you have impulse couplings.

Some installations provide an impulse coupling on both magnetos. Others use an impulse coupling on only one mag, and employ an ignition switch that grounds out the P-lead of the non-impulse mag during the start.

Because impulse couplings have moving parts, they need to be disassembled and inspected carefully during each 500-hour magneto maintenance cycle. In addition, there have been a lot of Airworthiness Directives against impulse couplings in recent years—both Bendix and Slick—and these have to be taken very seriously. An impulse coupling failure in-flight can result in total engine failure, and some failure modes can cause parts of the impulse coupling to drop into the engine gearbox, causing catastrophic destruction of the engine. So be sure your impulse couplings are not worn excessively and that all applicable ADs are complied with.

Retard Breaker

An alternative solution to the starting problem is the retard-breaker magneto. This was first pioneered by Bendix in its "Shower Of Sparks" system, but nowadays both Bendix and Slick make retard-breaker mags.

As the name implies, the retard-breaker mag makes use of a second set of breaker points to generate a spark at retarded ignition timing during engine start. Generally, only the left mag has the extra breaker points, and starting is done with the right mag disabled in this scheme.

While the extra set of points solves the problem of retarding the spark for starting, the fact remains that the magneto is still turning too slowly to generate the energy required to fire a spark plug. To deal with this problem, aircraft battery power is converted into pulses by a starting vibrator—basically, a little electric buzzer—and those pulses are fed to the magneto coil's primary winding via the P-lead, inducing high-voltage pulses in the secondary winding that do contain sufficient energy to fire the spark plug.

This scheme has some advantages. It eliminates the mechanical risks associated with worn impulse couplings. It also produces easier starting because the spark plug fires a dozen times or so during each ignition event, rather than just once. (Hence, the "Shower Of Sparks" trademark that Bendix uses for this system). Finally, it saves a little weight.

There is one big disadvantage of the retard-breaker ignition system, however: You can't start the engine with a dead battery. Don't bother trying to hand-prop a twin Cessna unless you're simply looking for a new and different kind of aerobic workout.

SlickSTART

In 1997, Unison Industries introduced a product called SlickSTART, which is really a solid-state replacement for the old starting vibrator used in the retard-breaker system. Interestingly enough, however, Unison got the SlickSTART approved for use with both TCM/Bendix mags as well as their own Slick mags, and also got approval for use with impulse-coupling-equipped mags as well as the retard-breaker kind. In fact, just about the only engines that the SlickSTART is not approved for are those that use the Bendix D-2000 or D-3000 dual magneto.

The SlickSTART produces a much hotter spark for starting than either a starting vibrator or impulse coupling, and is far better at firing carbon-fouled plugs. (Note that nothing can help if the plugs are lead-fouled, other than removing and cleaning the plugs.)

Is it worth retrofitting your engine with the new SlickSTART system? If your engine is hard to start or you operate in frigid temperatures, it's an excellent idea. On the other hand, if you're not having any problems with starting, there's probably no reason to make the change.

Putting It All Together

Every 100 hours or annual, check ignition timing (i.e., external timing) with a magneto timing light. If the timing has drifted off by more than a degree, "bump" the mag to return the timing to specifications. Keep track of how far the timing has been "bumped" at each inspection, and in which direction. Cumulative "bumping" of more than about three degrees is good reason to remove the mags from the engine and readjust the internal timing, even if the normal 500-hour maintenance interval hasn't yet arrived.

Every 500 hours, remove the mags from the engine for major maintenance. For TCM/Bendix mags, it's easy enough to perform the 500-hour inspection and adjustment procedure locally, and replace the wear-prone parts (points, carbon brush, and distributor block). For Slick mags, consider simply exchanging the mags at 500 hours for reconditioned units from Unison. (Slick tends to discourage field maintenance of their mags by setting parts prices high and offering very reasonable prices for overhauled-exchange units). If your engine uses impulse couplings, be sure to inspect them very carefully for excessive wear, and make sure all ADs have been complied with.

If hard-starting is a problem, consider installing the SlickSTART solid-state unit, which will work with almost any installation except for the TCM/Bendix dual-mag.

If you fly at high altitudes (especially if turbocharged), you need to take extra precautions to prevent high-altitude misfire. Clean and gap your plugs frequently (every 50 to 100 hours) and keep the gaps at the low end of the allowable range. Consider using fine-wire spark plugs. For high-altitude operations, you should be using either the big TCM/Bendix S-1200 mags, or pressurized Slicks with the big green TCM or RAM line filters to keep moisture out of the mags.

For even more information about magnetos, I recommend John Schwaner's book "The Magneto Ignition System."

When Metal Lets Us Down

by Mike Busch (mbusch@avweb.com)

(This article originally appeared in the June 1999 issue of *Cessna Pilots Association Magazine.*)

It's rare for an engine, propeller or airframe to fail catastrophically in flight. But when one does, more often than not, the culprit is metal fatigue. To make intelligent maintenance decisions, every aircraft owner needs a basic understanding of how metal behaves ... and why it fails. AVweb's Mike Busch offers a primer on the subject.

Metal fatigue isn't a subject that usually keeps me awake at night. For most of the 30-odd years during which I've been an aircraft owner, I figured it was a subject of interest mainly to metallurgists and aeronautical engineers and other Ph.D. types, not to mere mortal aircraft owners like me. However, my interest in the subject was rekindled recently by a rash of maintenance problems I encountered with my 1979 T310R. The problems started showing up during my annual inspection last March. I did a compression check on my two 1000-hours-SMOH engines, came up with mid-to-high 70s on all twelve cylinders, and figured my jugs were doing just fine. But within an hour of starting the inspection, Phil Kirkham—my IA for this year's ordeal—called me over and pointed to a nearly imperceptible blue stain in the vicinity of the upper spark plug boss on the #5 cylinder of the right engine.

"Looks like we might have a cracked head," Phil told me. "Boy, your eyes are sure better than mine," I replied. "I can just barely see what you're talking about." "One way to know for sure," Phil said, reaching for an aerosol can of dye penetrant.

Within a few minutes, there was no question that Phil was right. The head was definitely cracked, and the cylinder was trash. This was something of a watershed event for me, since the twelve cylinders on my engines were the original twelve that rolled out of the Cessna Wallace Plant in 1979. They'd survived 20 years, 3,000 hours, and one major overhaul. But now, one of them had let me down. Could the other eleven be far behind? Given that the engines were only 400 hours from published TBO, I decided the appropriate course of action was to find a decent serviceable cylinder that would get me to major overhaul, at which time it was pretty clear that all twelve jugs would have to be replaced with new ones. I phoned Ken Tunnell at Ly-Con Aircraft Engines in Visalia, Calif., explained my situation, and he fixed me up with a nice-looking reconditioned jug for about half the cost of a new one. Ken runs a great engine shop.

I figured that the worst was over. But later in the annual, I discovered another serious problem. I'd removed my 310's retractable cabin step from the airframe in order to replace its worn pivot bushings. With the step removed, I got a good look at the big magnesium step support casting, and didn't like what I saw one bit. The casting had a serious fatigue crack that had grown to the point that the part was on the verge of fracturing in two. This one didn't require dye penetrant—it was painfully obvious, even to my untrained eye. Cessna wanted $900 for a new one, but I managed to get mine weld-repaired (which is tricky business with magnesium, as you might imagine).

It Ain't Over Yet

The prop shop suspected a fatigue crack in the blade retention nut. After a month of wrench swinging that seemed like it would never end, I finally got the airplane back together. Phil signed off the annual and returned the plane to service, and I looked forward to 11 months of hassle-free flying. But it was not to be.

In late April, I was flying up to Bend, Ore., to visit the Lancair Columbia 300 factory and have a close look at the newly certificated 300-hp composite speedster. About an hour into the three-hour flight, I noticed a thin reddish streak starting to develop on the top of the right engine nacelle. Unless it was bug blood, red fluid in that location could only come from one place: my red-dyed-oil-filled propeller hub. Sure enough, upon landing at Bend, I verified that the red liquid was indeed coming from the right prop hub. As I write this, the prop is at the prop shop being torn apart. The verdict isn't yet in, but one theory is that the source of the leak may turn out to be a tiny fatigue crack in the retention nut that secures the #2 blade to the hub.

While all this was happening, I was deeply immersed in the ongoing TCM CSB 99-3 crankshaft debacle. Early in 1999, TCM became aware of seven crankshaft fatigue failures in factory reman 520- and 550-series engines. These failures were extraordinary for several reasons: they all occurred in new Vacuum Arc Remelt (VAR) cranks with very low time, and they all occurred in virtually identical locations in relatively low-stress areas of the crankshaft. Forensic investigation revealed that the failures had been caused by a stress riser created by a faulty tool used to press counterweight hangar bushings into the crankshaft during manufacture. The result was a massive inspection program affecting the entire 1998 production of new and reconditioned 470/520/550 crankshafts, and the scrapping of nearly 15% of those crankshafts.

So, with my airplane AOG and propless, and my e-mailbox full of messages from disgruntled TCM engine owners, I decided to do some reading on the subject of metal fatigue. It turned out to be a pretty interesting subject.

One of the best write-ups on this subject to be found anywhere appears in John Schwaner's "Sky Ranch Engineering Manual," available from Sacramento Sky Ranch Inc. ($19.95, 1-916-421-7672). Much of the following discussion is derived from material in Chapters 1 and 7 of this excellent book.

Stress and Strain

Consider what happens when you apply force to a piece of metal: It deforms. The force you apply is called stress, and the amount of resultant deformation is called strain. The relationship between stress and strain is what defines the structural properties of the metal.

The deformation of a metal part in response to stress may be either elastic or plastic. Elastic deformation is temporary—when the stress is removed, the metal returns to its original shape. The flexing of an airliner wing or the spring steel main landing gear on a single-engine Cessna are examples of elastic response to stress. The slope of the stress/strain curve determines the elasticity (stiffness) of the metal.

When metal is stressed beyond its elastic limit or yield point, the result is permanent (or plastic) deformation—when the stress is removed, the metal does not return to its original shape. The ability of metal to be bent, stamped, forged or extruded into a desired shape—as well as its ability to bend before it breaks—are the result of its plastic properties. On the other hand, once a metal part is placed in service, it's obviously important that it not be subject to stress in excess of its yield point.

When you think about it, this combination of elastic and plastic properties is what makes metal behave like . . . well . . . metal. Many other familiar materials—whether flexible like rubber or brittle like glass—are almost entirely elastic at ordinary temperatures, and become plastic only when heated. Other materials like clay or putty have little or no elasticity, and deform permanently with the slightest force.

Tension and Compression

When we think about applying stress to a metal part, we usually think in terms of tension—in other words, applying a load that tries to pull the metal apart. Cylinder studs and crankcase through-bolts are examples of metal parts that are loaded in tension. Aluminum alloys may have tensile strengths between 20,000 and 80,000 PSI, while high-tensile-strength steel can withstand 200,000 to 400,000 PSI or more.

If a metal part is subject to tensile stress in excess of its elastic limit, it may start to crack. Over time, the crack may grow to the point that the part fractures in two.

Tension isn't the only kind of stress, however. We may load a metal part in compression. Sufficient compression stress may exceed the elastic limit and result in permanent deformation of the part. However, metal normally doesn't have a well-defined yield point in compression, so compression doesn't normally cause cracking or fracture. (Extremely hard and brittle metals may shatter under excessive compression, however.)

In real life, metal parts are often subject to complex combinations of tension and compression stresses. When a part such as a wing spar or spring steel landing gear leg is subjected to bending loads, for example, certain areas are stressed in tension while other areas are stressed in compression. The same is true of parts subjected to torsion or shear loads. In such cases, we tend to be more concerned with the areas of the part subjected to tension, because those are the areas that are most likely to crack and fail.

Stress Concentration

Stress concentrations also occur at geometric discontinuities—so-called "stress risers"—such as corners, holes, notches, threads, scratches, nicks, and pits.

When a metal part is placed under load, stress is almost never uniformly distributed through the part. Instead, it concentrates in certain areas. Naturally, those areas of stress concentration are where the part is most likely to crack or fracture. When a part is subject to bending or torsion loads, almost all of the stress (tension and compression) occurs at the surface of the part. That's why many airplane parts are hollow rather than solid. A hollow tube is very nearly as strong as a solid rod of similar size, but the hollow tube is much lighter in weight. The principal disadvantage of a hollow part is that, if stressed beyond its elastic limit, it tends to fail much more suddenly and catastrophically than a solid part.

The same principle explains why I-beam and C-beam structures (commonly used for wing spars) carry virtually all their load in the top and bottom "caps," and very little in the "web" area that connects the two. It also explains why it's possible to put "lightening holes" in parts without weakening them significantly.

Stress is also concentrated at—and magnified by—any geometric discontinuities in the part, such as corners, holes, notches, threads, scratches, nicks and pits. Such discontinuities are commonly referred to as "stress risers" and are almost invariably where fatigue cracks begin.

Think about the last time you struggled to rip open a bag of potato chips or peanuts, for example. The thin plastic or cellophane material of the bag is nearly impossible to tear unless you're fortunate enough to locate the tiny "open here" nick—or to create such a nick yourself with a pocket knife or your teeth. The nick concentrates the stress enormously, and makes the bag easy to open.

So it is with metal: A tiny and seemingly innocuous nick, scratch or pit may act as a stress riser that concentrates the surface stress enough to cause the part to crack and ultimately fracture. Simple surface roughness may be enough to weaken a part significantly, which is why highly stressed parts are usually machined or polished to a smooth finish. In time, corrosion pits may mar this smooth surface enough to permit fatigue cracking to begin.

Metal Fatigue

No matter how low the stress level, they will eventually suffer fatigue failure. Take an ordinary paper clip, straighten, and then bend it back and forth repeatedly until it breaks in two. What happened? You just demonstrated metal fatigue. If you'd examined the bend point of the paper clip under a microscope as you bent it back and forth, you'd have seen one or more microscopic fatigue cracks develop on the outside radius of the bend—the portion subject to tension stress. As you repeated the bending cycle over and over, you'd see the crack grow with each cycle until the paper clip finally fractured.

Surprisingly, it is not necessary to stress a metal part beyond the yield point in order to generate a fatigue failure. Fatigue cracks can develop even when stresses remain well within the elastic limit of the metal, given enough cycles. The lower the stress level, the more cycles it takes before a fatigue fracture will occur. This can be plotted in the form of what engineers call an "S/N curve."

A heavily loaded steel part can be expected to endure ten million cycles or so before failing from metal fatigue. That might sound like a lot, but a connecting rod, crankshaft throw or cylinder hold-down stud gets that many cycles in about 140 hours of flight time.

With steel, there is a stress level below which fatigue failures do not occur: the *fatigue limit.* A part loaded below the fatigue limit may eventually develop fatigue cracks, but they won't grow to the point of fracture. Therefore, a steel part (such as a crankshaft) can theoretically remain in service forever, provided it doesn't corrode or wear beyond service limits.

In sharp contrast, aluminum and other nonferrous metals have no fatigue limit. No matter how low the stress level, eventually the metal will suffer a fatigue failure if it is subjected to enough cycles. This means that aluminum parts are inherently life-limited. For some parts, such as wing spars, the frequency of stress cycles may be so low that the predicted life is ridiculously long. But for high-cycle parts, such as cylinder heads, crankcase halves and propeller blades, the fatigue life is very significant, as my cracked #5 cylinder head demonstrated.

Torque and Preload

Fasteners which undergo cyclic tension loads must be torqued to establish a "preload" that exceeds the maximum operating load. If this is done, the fastener will not "see" the cyclic loads and will not be vulnerable to fatigue, nor will the fastened parts be vulnerable to fretting. It is crucial for fasteners that undergo cyclic tension loads—such as crankcase bolts and cylinder hold-down studs—be torqued properly to ensure that they don't fatigue and fail. Here's why. Consider the cylinder whose flange is attached to the crankcase by studs and nuts. Each time the cylinder goes through its compression and power strokes, the cylinder tries to pull away from the crankcase. At a peak cylinder pressure of 1,000 PSI, each firing load on a 5.25-inch bore is over 20,000 pounds. Since there are eight hold-down studs for each cylinder, each sees a peak load of around 2,500 pounds. At cruise RPM, this happens 1,200 times a minute. Imagine that the cylinder hold-down nuts were torqued to establish a "preload" of only 2,000 pounds. During each combustion cycle, at the moment of peak stress, the stud would be subject to cyclic stress of an additional 500 pounds, which might cause the stud to elongate slightly (in accordance with the stress/strain curve). This is a bad thing for two reasons: The cylinder base flange and crankcase mounting pad will be subject to fretting, and the hold-down studs will experience stress cycles that could eventually result in fatigue failure of the studs.

On the other hand, suppose the cylinder hold-down nuts were properly torqued to establish a preload of 3,000 pounds. Now, even under peak stress conditions, the cylinder base flange remains firmly in contact with the crankcase mounting pad. The hold-down studs remain under a constant 3,000 pound stress, and are not subject to cyclic fatigue cycles.

Believe it or not, broken cylinder hold-down studs may be caused by something as innocuous as *paint*! It is essential that no paint be applied to the cylinder-to-crankcase mating surfaces, or to the cylinder mounting flange where the hold-down nuts attach. If any paint is present when the hold-down nuts are torqued in place, the paint film will eventually wear away, relieving some of the initial fastener preload. If the preload decreases to less than the peak cyclic stress, then fatigue cycles and fretting damage may occur.

Propeller spinners and spinner bulkheads are also places where inadequate preload is often responsible for fatigue failures. These parts are subject to extreme vibration, and require sufficient preload to overcome cyclic stress that can result in fatigue failure. In most McCauley constant-speed prop installations, spinner preload is adjusted with fiberglass shims inserted between the propeller dome and the forward spinner bulkhead. When fatigue cracks occur at the spinner or aft bulkhead, it's almost always because there are not enough shims installed to provide the necessary preload.

Internal Stress

Another way to help protect parts from fatigue is to build them with built-in stress that counteracts some of the externally applied stress that results from loading. Since fatigue is always caused by tensile stress, generally at the surface of a part, fatigue resistance can be increased by inducing internal compressive stress at the surface.

One way of accomplishing this is to compress the surface material of the part by subjecting it to high-pressure rollers or shot peening. Rolling is commonly used to increase the strength of propeller blades and to create high-strength threads, while shot peening is used on high-stress engine parts such as connecting rods.

Another technique is called "nitriding," and used to case-harden crankshafts, camshafts, cylinder barrels, gears, and other highly stressed steel parts. The parts are baked in an oven in an atmosphere of ammonia gas. The heat releases atomic nitrogen from the ammonia, and the nitrogen combines with the metal at the surface and to a depth of .020 inch or so. Since the nitrogen atoms occupy normally vacuous space in the crystalline structure of the steel, they produce compressive internal stress that increases strength, hardness, and resistance to wear and fatigue.

A nitrided part such as a crankshaft is best thought of as being like an egg: a relatively elastic core surrounded by a very thin, very hard, very brittle case. The outer nitrided layer gives the crankshaft greatly improved wear-resistance. However, just like an eggshell, the brittle "nitride case" can crack easily if subjected to excessive pressure (which is exactly what caused the recent massive TCM CSB 99-3 crankshaft recall).

Furthermore, while fatigue cracks normally occur at the surface of a metal part where they can readily be detected, a nitrided or shot-peened part may develop subsurface fatigue cracks that cannot be detected during visual or dye penetrant inspections. This is why sophisticated non-destructive testing (NDT) techniques such as ultrasound and X-ray must often be used to inspect these parts for fatigue.

What's It All Mean?

Our metal airframes, engines and propellers are made from an eclectic combination of materials with widely varying characteristics. Steel parts—like crankshafts and accessory gears and tubular engine mounts—should theoretically be able to remain in service forever, provided they are loaded below their fatigue limits, and protected from excessive wear, damage and corrosion. Aluminum parts, on the other hand, have no fatigue limit. If they are subject to cyclical stress (as most are), they have a finite service life and must be inspected regularly for fatigue cracking.

Cylinder heads are particularly vulnerable to fatigue failure, as I found out firsthand. If you think about it, cylinder heads have just about everything going against them, fatigue-wise. They're subject to an extraordinary amount of cyclic stress. They're made of aluminum alloy so they're inherently life-limited. They operate at high temperatures, which lowers the yield point of the metal and accelerates the effects of fatigue. (The fatigue strength drops rapidly with increasing temperature, particularly as CHTs rise above 400° F.) They're manufactured with rough surfaces and machined with cooling fins and threaded areas and all sorts of holes, all of which provide stress risers where fatigue cracks can originate. And, they're constantly bathed with hot and highly corrosive exhaust gas which further weakens and pits the surface of the head, particularly in the exhaust port area where many head cracks start. Frankly, it's amazing that they last as long as they do.

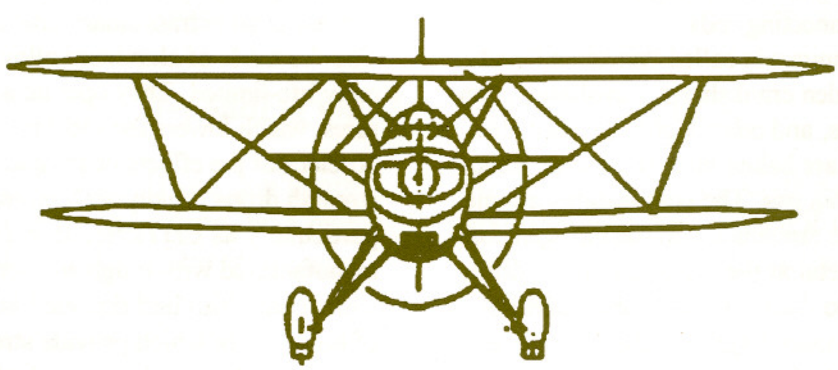
An old rule of thumb states that once a cylinder has made it through two TBOs, the likelihood of fatigue cracking increases significantly. The published TBO for my TSIO-520-BB engines is 1,400 hours, which puts my 3,000-hour jugs a bit beyond twice TBO. So you could say that my cracked #5 cylinder head occurred right on schedule, so to speak.

The question is: Was this a fluke, or are the other 11 cylinders going to follow suit before long? It's not worth trying to get heroic with weld repairs to a cylinder head of the vintage that mine are. Best to accept the fact that they're long in the tooth and bound to give up the ghost sooner or later—probably sooner. Between now and major overhaul time, I'll have to watch my jugs like a hawk for the tell-tale signs of fatigue cracking—mainly subtle fuel and oil stains where there shouldn't be any, and cooling fins that go "plunk" instead of "ping!" With luck, I'll nurse 'em along 'til overhaul time, at which point they will wind up as scrap metal to come back as somebody's Coca-Cola can.

What about my cabin step support casting that nearly fractured from fatigue? There are some lessons learned there, too. Although this part is buried under the floorboards and very difficult to inspect, it is subject to extreme cyclical stress every time someone enters or leaves the cabin. The casting is made of magnesium, a material that is more granular and brittle and prone to rapid cracking than aluminum. The crack originated at a sharp corner of the casting that was not properly radiused during manufacture to minimize the stress concentration at that point... but it is now, after I spent an hour filing and polishing it before reinstallation! Most importantly, this casting was out of sight and out of mind. It wasn't on any Cessna 310 annual inspection checklist, and none of the experienced twin Cessna mechanics I talked to remember ever making a practice of trying to inspect it. That's going to change, at least on my airplane.

Postscript

As for my propeller hub that started throwing red-dyed oil, the problem turned out <u>not</u> to be fatigue-related after all. Instead, it turned out to be caused by loss of torque on the #2 blade retention nut, caused by—can you guess?—the presence of *paint* on the threaded area of the hub when the prop was assembled during the previous overhaul. Turns out that the prop shop had hired a new fellow in its paint shop, and apparently he didn't realize that it was a no-no to paint the hub threads. The paint film gradually wore down, causing a loss of preload, and could have developed into a life-threatening situation if not detected early. The problem didn't show up until three years after the overhaul, in the form of a tiny leak of the red-dyed oil that's there specifically to make hub cracks detectable. Much to its credit, the prop shop re-overhauled both of my props at its expense.



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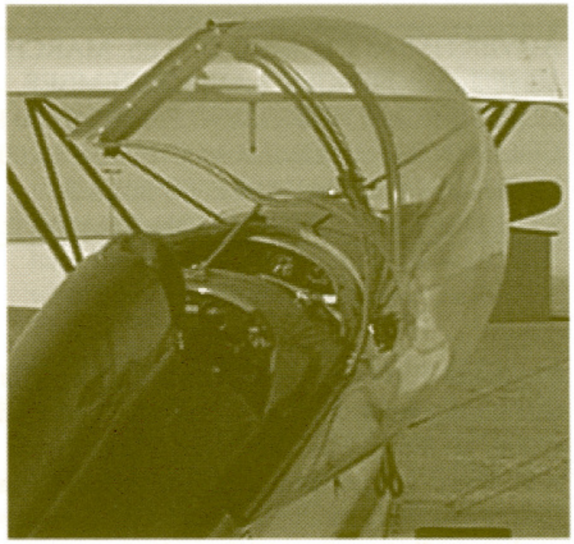

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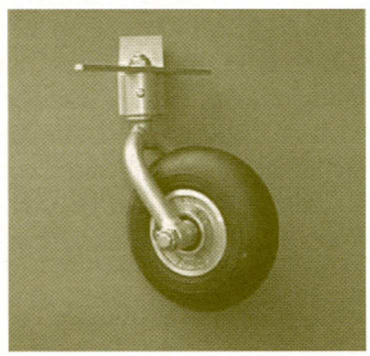

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Looking for a nice, well-built Starduster II for sale in the Southeastern U.S. Prefer 180 hp or more.- Bob Pfister, rtaildragr@aol.com 4/1/00

FOR SALE

STARDUSTER TOO, 1984, IO-320, inverted systems, oil filter, 550 TTAF & SMOH, B&C starter, KY97A, AT50A w/ Mode C, intercom, ELT, G-meter, CHT, volts, amps, safety cables, removable canopy rear cockpit, always hangared, 1/00 annual, Asking $27,000. Located Nor Cal, Email clarkaw@syix.com or cmueller@csuchico.-edu 6/15/00

1997 Starduster too N6191A for sale. 145 hrs TT A&E eng. Franklin Sport 6 225 hp. With Hartzel prop. Nice clean aircraft, partners asking for sale. Must go $38000.00. Apollo SL-40, King X-ponder with encoder, and intercom. Built with 8 inch landing gear aft of firewall, jig welded at Stolp. Flies like a Citabria and no tail wheel problems with this one. 8 plus in and out!! Call Ken in N.J. 609-927-2071 Mon thru Fri 9-5 Est. Aircraft located at 1n4 Woodbine, N.J. e-mail pixs avail. 6/10/00

Welded fuselage with stringer standoffs, 3 wings, fourth wing spars and ribs not assembled, center wing section, fiberglass turtle deck, control yoke, two sticks, spars for ailerons, two sets of plans and a fuel tank which needs rework, not on gear and no cabanes. $3,800 Located in VA. 540-228-5565 days 540-228-8308 nights. 6/8/00

Acroduster II 260 hp 351 TT engine, 1000 SMOH, prop 351 SN. This is a super plane, it's fast 165-170 mph and flies great. Partner wants S2B. Engine is strong, all comp. in high 70s. Just had annual 6-1-00. All factory built covered and paint. It's nice!!! For info call 901-753-7940 after 6pm MEMPHIS time. 6/4/00

1984 Starduster Too for sale. Cont. IO470F 260 hp, 1600 TT, King KY97A w/PTT intercom, King KY 76A Trans, Scott 3200, Morrow 604 Loran, Reliable one piece sping gear, March annual and flying. A bargain for real summer fun at $24,950. Call Bill at 310-822-2442 or email: flier11@mail.-earthlink.net 6/2/00

1971 SA-300 Starduster Too. 300 TTSN. AF&E. Lyc. O360A2A 180 hp. Hartzell C/S Prop. TX-720 Com. Intercom. Loran. Aux fuel tank. Scott T/W. Open cockpit. Bendix mags (O/H 5/97) carb O/H 5/98. Hooker harnesses. Price: 38.5K. Phone: 262-652-7043. Email: STRDSTR@pitnet.net Will consider trade toward DHC-1 Chipmunk. 6/1/00

Starduster II For Sale, TTAF&E 750 Hrs, O-360-A1A, 180 hp, Metal FP Prop, Com,Transponder Mode C, Intercom (really works), Annual Sept 99, Built in 1971, always hangered, flown regularly and is in excellent condition, located in TX at TX05, $25,500. 972-490-7346. 4/1/00

Located in Culpeper, Virginia, a wonderful example of very clean Starduster One. I just installed an O-320-150 hp engine with just 30 SMOH by reputable shop. Aircraft in excellent condition and I am prepared to negociate a fair price. Includes like new seat chute. Give me a call if you want a fun plane that performs and is really an eye turner. 540-349-1507 4/1/00

Starlet SA500 Fuselage. If you have one or know of one, please contact Ben. Telephone: 208-375-1813. 10/15/99

Starduster For Sale. 160 hp Lycoming engine, less than 200 hours on engine. Constant speed Hartzell, New King 97, Apollo Loran, Heated, Ready to Go. $35,000 CDN (approximately $21,000 USD) Contact Jeremy Dann. 10/15/99

News From The Net (Avflash@a1.ipcc.com)

AIR-21 FLYING HIGH,
GOOD NEWS FOR GA. March 13, 2000

In what will be a huge victory for the aviation industry, Congress is very close to approving an FAA reauthorization bill that is extremely beneficial. House and Senate negotiators finally reached an agreement on AIR-21 last week after being unable to reach a consensus for three years. By "unlocking" the trust fund with the guarantee that all aviation tax revenues and interest will be fully spent, enactment of AIR-21 would mean more than $40 billion for the FAA over the next three years. Included in the bill are: a 64% increase in money for airports, a doubling of the Airport Improvement Program state entitlement that funds GA airports and more money for ATC modernization and navigation technology. AIR-21 hasn't made it off the ground quite yet, though—it still must be approved by the House, and signed by the president. Keep your eyes on Washington, as early this week your House representatives are due to vote on this agreement.

AOPA EXUBERANT OVER AIR-21 March 23, 2000

"The new millennium for aviation is about to begin," is how Phil Boyer, president of AOPA, described the success of the AIR-21 legislation that promises to free money from the Airport and Airways Trust Fund for aviation uses. Citing billions to be spent on airport development, provisions to protect pilot rights, and improved weather services for GA, Boyer praised the bill, saying: "No longer will it be possible to block critical aviation projects, piling up a trust fund surplus for other political ends." President Clinton is expected to sign the bill to law early next month.

NEW STUDY FINDS GA HELD IN
"HIGH REGARD" May 8, 2000

If you're an AVweb regular, you've read the many harrowing tales of general aviation under siege. In Chicago, in Austin, Texas, and in many other parts of the country and the world, pilots are fighting not to expand their airports but to simply keep them open ... and many are failing. That's why a just-released poll conducted by the National Air Transportation Association (NATA) comes as a breath of badly needed fresh air. According to the poll, part of a project called the American Aviation Access Initiative, two-thirds of all Americans hold the aviation industry in high regard, 68% have trust and confidence in the FAA, and 46% favor improving or expanding general aviation airports. 46% isn't a majority, true, but according to the poll it would be relatively easy to forge one.

BUT HERE'S WHY THEY
DON'T LIKE US May 8, 2000

As you might have guessed, the biggest rap against GA airports was noise, which was followed by concerns over declining property values, a crash, or the possibility that expansion would lead to much noisier commercial service. There was also a nationwide lack of understanding about the economic benefits of GA and how airports are funded, as well as a general belief that longer runways mean heavier, noisier, planes. The telephone poll numbers were supplemented by nine focus groups of more than 100 people who were neighbors of GA airports in Illinois, Minnesota, New Jersey and California.

"BETTER" GPS SIGNAL CAUSES WARNINGS
IN GARMIN GPS UNITS. May 15, 2000

It's strange that the deletion of Selective Availability (SA) from the GPS satellite signals earlier this month could have adverse effects, but owners of some Garmin panel-mounted GPS units seem to be having problems. AVweb has heard reports of sporadic, multiple RAIM (receiver autonomous integrity monitoring) warnings with some of these units, including the Garmin 430, that were not present before the military stopped degrading the accuracy of the navigation signal. The RAIM integrity monitoring function is used in IFR-certified GPS units to determine if satellite geometry is adequate to allow a GPS-guided IFR approach.

AOPA SUES FEDERAL GOVERNMENT..May 22, 2000

Most organizations shy away from confrontations with the federal government, but AOPA is initiating one in the hopes of proving an important point.

AOPA challenged the FAA to a duel to prove the agency does NOT have the authority to "release" an airport sponsor from federal grant assurances and property deed restrictions, which then allows the sponsor to close the airport.

..TO KEEP GA AIRPORTS OPEN May 22, 2000

At the heart of the federal court challenge is the Kansas City, MO. closing of Richards-Gebaur Memorial Airport. To get the $8 million in taxpayer-funded grants, the city eagerly signed a contract promising to keep the airport open and available to all classes of users for 20 years. There are other problems too, like alleged violations of the Surplus Property Act. AOPA wants the government to put the kibosh on the whole sordid deal. Their big day in court is June 13.

GA HAS LITTLE TO CELEBRATE ON FIRST BIRTHDAY OF NEW AUSTIN AIRPORT. May 22, 2000

Austin (Texas) Bergstrom International Airport will celebrate its first birthday next Tuesday and has a few things to be proud of, but support for general aviation is not one of them. When Bergstrom opened on May 23, 1999, Robert Mueller Municipal closed, followed two weeks later by Austin Executive. The closure of these two GA-friendly airports and the lack of affordable and accessible facilities at Bergstrom left Austin-area pilots fighting an increasingly intransigent City Hall for the most basic of GA services.

...AS LOCAL PILOTS CLAIM CITY OF AUSTIN DISCRIMINATES AGAINST GA May 22, 2000

Recently, local pilots filed a petition requesting that the Southwest Regional FAA investigate alleged violations of law by the City of Austin in its management of Bergstrom, stating that, "the city has engaged in these violations knowingly and willfully and out of gross negligence and open disregard for the law and has substantially discriminated against categories and classes of aircraft in the establishment of Bergstrom." Representative Lloyd Doggett (D-TX) is expected to issue a letter this week requesting that the FAA follow up on the petition.

...AS Y2K+1 LOOKS BRIGHT May 22, 2000

Additionally, the budget bill includes significantly increased funding for aviation fuel research to find a suitable replacement for leaded aviation gasoline and a 64% increase for the Airport Improvement Program with more money specifically earmarked for GA airports. Other FAA budget items were increased as well. Though the House hurdle is cleared, the Senate has yet to vote. AOPA president Phil Boyer believes that with approval of the budget "2001 may become the year of aviation."

BROWN FIELD PRIVATIZATION QUESTIONED May 22, 2000

AOPA is asking the San Diego (Calif.) Planning Commission to withhold approval on a plan to turn Brown Field Municipal Airport into an air cargo facility. Brown Field is one of two city-owned reliever airports and one of five nationwide to be privatized under a congressionally ordered demonstration program. The private developers are planning some big changes but General Aviation has apparently gotten lost somewhere in a cargo hold.

HOUSE COMMITTEE TO VOTE ON GA BACK-COUNTRY BILL June 5, 2000

The House of Representatives' Resources Committee will take up a bill this week to allow general aviation pilots continued access to federal land. H.R.3661 is called the "General Aviation Access Act" and that is exactly what it gives. Included is language to keep back country airstrips open and a two-year timetable for a nationwide policy dealing with GA/federal land issues.


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