

Transcript

2007 Forum - Propeller Loss

As many of you may know, I lost my propeller out in the middle of nowhere back in December and I thought that maybe there was something that people could learn from my stupidity, so I put together this presentation here.

So again, what am I going to talk about? What led up to the incident? What were the early stages of this particular flight? What were we talking about in the cockpit? What happened when the prop disappeared? Then what were we talking about in the cockpit again after the prop disappeared? What decisions and actions and communications did we take? What happened during the landing? Post landing de-brief. Some pictures of the damage. What was the cause of this propeller coming off? The proximal cause was reasonably easy to determine. It took a little while to determine the root cause. And what can we learn from this?

So, before this flight, I had made five other flights of pretty good length as you can see here. I flew up to Beale Air Force Base to do an altitude chamber class, which is wonderful. If anybody gets a chance, they hold it in a couple of places around the country. It's fifty bucks and you get to experience hypoxia in an altitude chamber safely and then you know what your hypoxia symptoms are, which is a very useful thing to know. At any rate, on the way up there and on the way back, I experienced some every slight vibrations, slightly above what the normal background were. I figured: well, maybe one of my wheel pants is a little loose or jiggling around once in a while or something. Didn't pay it a lot of mind. That was 3.7 hours. I went from Tehachapi in Mojave down to Thermal, which is south of Palm Springs, a couple of times. No vibrations on those two flights over 5 hours. Flew down to Bisbee, Arizona to visit some friends. It's about 6 hours round trip. No vibration on that flight. Went to Santa Cruz to go see a concert with a friend. Three hours, no vibration. Went down for a CAD class for work to John Wayne Airport, had the plane parked there for a week, and on the way back experienced the same sort of vibration that I had had on the Marysville flight. But again, it was very intermittent and I stupidly assumed that it was some door flapping or the wheel pants being a little bit loose. I had looked at them after the first time, couldn't find anything that was loose, and I didn't know what was going on.

So, my wife Deanie and I took off to go visit some friends in Phoenix, and that route takes us past Big Bear, 29 Palms over Joshua Tree National Park. And you can see the sort of terrain here that we fly over. There isn't a damn thing there, and it's pretty rough terrain too for a lot of it. In the first 45 minutes going around Edwards, going down past Victorville and Apple Valley, there was some slight vibration, similar in nature to what I had felt previously, on and off. Then when we got near Big Bear it started to build up a little more. And I started playing with the throttle, playing with the mixture, changing attitude, turning a little bit, just trying to figure out if I could affect it and try to figure out where that was coming from.

So for the first 30 minutes, we didn't really talk about it. It was almost nothing. I could notice it because I know the plane really well. I don't know if Deanie even noticed that

anything was going on. Near Big Bear she started saying: "Is there a little... is something buzzing a little bit?" And we knew something was going on. So as we were approaching 29 Palms, there was some more discussion, we were at 9500 feet, and I looked down and I could see 29 Palms below me and I'm going "ah, crap", you know, "it'll take 5 or 10 minutes to get down there, and then I gotta poke around and...". And then we figured: ok, we'll land in Blythe which is another 60 miles up the road. I figured: ok, we'll be there in 15 minutes, I'll get a nice long slow descent into Blythe, Deanie will hit the can and I'll take a look at the plane, and we'll try and figure out what's going on. Now, in my mind, this is where I made the big judgment error. And just to be clear, my wife disagrees. She thinks I did the right thing by staying in the air, and it's a very different position that I take as an Engineer where I know that something's wrong. I know that the plane is not acting the way it normally acts, the way it should be acting, and so what should I do? I should get on the ground and I should figure out what's going on, and I shouldn't keep flying. And I shouldn't fly the plane again until I know what's going on. Well, her position is that we go down, we land at 29 Palms, I take a look at the plane, go over it with a fine tooth comb, I don't find anything wrong, I take off, the prop comes off at 300 feet and now we're really in trouble. I don't know what the right answer is. In my mind, I should have landed, but there is an argument for the other side.

So, again, we thought we'd land at Blythe in 15 minutes. So we get about 7 minutes past 29 Palms, and we're out over the middle of no place. This is a Google Maps picture, but that's pretty much what it looks like out there. And we get out there and it just goes "KA-BOOM!!!" And it was *extremely* loud, and obviously something wrong. Now what was this? Was it all six bolts breaking? The prop hitting the winglet? I have no idea. My guess is it was all six bolts breaking within a couple of milliseconds of each other, because you break six half-inch bolts, there's an awful lot of energy being dissipated, and I'm guessing that's what we heard.

So of course, the first question is "What was that?", and not quite in those words. I said "I think we lost the prop." And I thought that because (a) it got really smooth really fast. Now remember I mentioned that I had been rolling the throttle and mixture back and forth to try and figure out what was going on. Luckily, I was only running at about 1800 RPM when the prop disappeared, so I was not at full throttle. My guess is the air was actually back-driving the prop so it didn't over-speed. It didn't go up to 3500 or 4000 RPM. So the engine's just sitting there running at 2000, 2200 RPM being very happy. So I said "well, I think we lost the propeller", and she said "What does that mean? What do you mean *lose* the propeller?" I said "Well, I don't think the propeller is on the plane any more." And then, of course, ok, as many people, especially people who have never flown gliders, or haven't take flight training, what's going to happen? You know, can an airplane fly without a propeller? Well if you've ever flown a glider, obviously an airplane can fly without a propeller. And so I said "well, the plane is flying, we're doing 150-something knots, we seem ok". Now while I'm talking to her and telling her this, I'm in the process of slowing down the getting the best L/D speed. I said "the plane seems to be ok, flying fine, we're going to find the closest airport, we're going to land, and everything's going to be alright".

Now, before I actually did all the work, I didn't really know of that was true. I knew I could fly the plane, but I didn't know whether I could find an airport. So within 5

seconds after the noise, I hit the "nearest" button on the GPS. There were 3 airports within about 17 to 20 miles, and I slowed down to best glide, trimmed it to hold that. I tried some turns, just to make sure there wasn't something really bizarre going on. I wanted to know that I could fly the plane in the pattern and I reached wherever I was going to land. The closes airport was Desert Center, L64, you can take a look on Maps. It's in the middle of no place. Well, it's 3 miles off of I-10, but I-10 goes through the middle of no place out there. So it's 17 miles straight ahead, we've got about 10 knot tail wind, I changed heading 5 degrees to point straight at it. I asked Deanie to find the airport info on the map. Now, of course, I've got that on the GPS as well but I needed to give her something to do. I did need the info and I just wanted to verify that the chart and the GPS were going to tell me the same thing. We found that the airport is at 550ft. We started out at 9500, I've got 9000 feet to lose. I figure a conservative glide ratio in a Cozy of about 13 to 1, and I said "ok". Especially with a 10 knot tail wind, and no propeller for drag, I can get there, and I estimated that I would get there about 1000 feet above the pattern altitude. So I figured we'd get there somewhere between two and three thousand feet.

At that point, I knew we could get there. I knew we could get to this airport, and there its just a question of only getting one shot at landing. I'm a glider pilot, and I've got a couple of hundred glider landings and I figured ok, I try to do all my landings dead stick anyway. We should be ok.

At that point, so this is probably now three of four minutes. Well, maybe two or three minutes after the prop came off. That's when I dialed in 121.5 and called a mayday. We were not on flight following at the time. They had refused us because they were busy. It's amazing how un-busy they get when you declare a mayday. And while they can't fly the plane for you and they can't do anything, what they can do is make sure there's nobody around you, make sure you're not screwing up airspace, and just keep track of what's going on. This is something that Deanie was very concerned with. "When are you going to call in? When are you going to call ATC?" And I said "They can't fly this plane. They can't keep the plane in the air, they can't get me to a runway. The only thing they can do is keep track on info".

They were good about it. Once we started gliding, you've got to realize, from 9500 feet, we're losing 500 maybe 600 feet per minute, we were in the air for 11 or 12 minutes before we touched down. That's a long time when you're just sitting there, looking out the window going "Oh look, there's the airport, 15 miles ahead". We know we're going to get there, but you've just got to wait. Especially since you're only going 100 miles an hour. Aviate, navigate, then communicate. You've got to fly the plane.

So after eleven minutes of gliding, we got to Desert Center. You can see the path here. Checked the wind sock, picked the landing direction. I was way high on crosswind, but I was able to bleed off the altitude, and told Deanie we're going to make a normal landing. Dropped the gear, played with the landing brake a bit. Wanted to stay high the whole time, obviously because I can't get any energy back. Touched down about 1000 feet down the runway, rolled to an end and stopped on the taxiway, and we shut down and opened up the canopy.

Obviously, there was a pretty big emotional release after landing. We're both safe, we're alive, the plane is seemingly intact, and we're ok and that's obviously the important thing. So we got out, called ATC on the telephone. Since we're only three miles off I-10, there's cell towers. Told them everybody was safe, there's no damage to us, no major damage to the plane, no injuries. Spent a lot of time talking to Deanie about what happened. Got out and took a look at the prop extension and cowl area and at that point is when I noticed that part of the lower winglet is missing as is part of the trailing edge. Discussed the damage, called Bill Seibold, sitting in the back here, and asked if he could come get us in his Cozy. He was one of the people we were going to go visit in Phoenix. And then sat down and ate and drank something because there wasn't anything else to do.

This is some pictures of the damage. You can see the missing lower winglet here. And the missing trailing edge of the wing. This is about the tip of the aileron right there. The whole rudder is still attached, and we missed cutting the rudder cable by about a quarter of an inch.

This is what the wing looked like after I cleaned it up a little bit in the dust booth at work. Took the rudder off and started the repairs. This is what it looked like from the outside. You can actually see the cut line where one of the blades went through, and another blade went through right there. There was about six inches of the prop tip stuck up into the structural layup in between the winglet and the wing on the outside. I still have six inches of the propeller.

This is what the prop extension looks like and you can see the surface is fretted and beat up from all the vibration and heat of what happened, and one of the lugs is bent.

So what happened? The torque on the prop bolts was wrong. So then I didn't have the right compression on the wooden prop, you get motion between the prop and the extension, possible contribution from the spinner back plate getting hot, and the epoxy and the carbon spinner back plate getting squeezed. Fretting there. Fatigue of the bolts. As soon as a wooden prop starts moving against the back plate, you get heat and you get fatigue of the bolts because they are now bending. The bolts on a wooden prop do not take any bending loads when they are working correctly. They only take tensile loads and they put friction force onto the propeller to keep the propeller onto the back plate. Once they start to move, you get heat buildup, and you get bending of the bolts, they fatigue, and as I said, within a couple of milliseconds, all six of them broke. They all broke right about at the end of the lug.

So what's the root cause of this? Well, with current technology, you use a wooden prop, you need to check your bolt torque constantly. Every 25 hours, 50 hours at the most, is what the wooden prop manufacturers recommend. If you've got a spinner on you plane, as I did, it's a pain in the neck. You've got to take the spinner off, you've got to chah-blah-blah-blah, take out the torque wrench, take all your safety wire off, and it's annoying and in my case at any rate, easy to ignore. I wasn't checking it often enough. I was only checking them on my conditional inspection once a year. I fly about 120 hours a year. I had also moved from the east coast, where it's soggy and wet like here so the wood is expanded, to the Tehachapi/Mojave area where it's bone dry. Over the course of a year, the prop had dried out and shrunk. I wasn't checking the bolt torque often enough and I

wasn't checking it correctly either. And so the torque wasn't enough, and the force between the prop and the prop extension wasn't enough.

So we need a new design for wood prop hubs or a new method of tensioning the prop bolts, and in my view people have live with this. I view this as a design defect. This is not a robust engineering solution where somebody needs to check something and be vigilant rather than having the system be robust enough to deal with people not being vigilant. You may think that's an excuse on my part, but I'm in the process of coming up with a solution for this, so I'm not just waving my hands in the air.

So this is the repaired winglet. The amazing thing about these composite planes is you can fix anything and you end up with something that weighs about a half a pound to a pound more than it did before.

This is what the wing looks like after repairs. If you didn't know that a prop had gone through it, there's no way to tell.

And that's about it. So, I might have time for one or two questions. If you're going to be at the Cozy dinner, I will be giving a presentation tomorrow night on the solution to this which is a series of Bellville washers.

Q: How many hours of operation had it been since you last broke a prop? (???)

It was about a hundred.

Q: Marc, I'm interested to know why you actually shut down the engine and what your thinking was when you shut down the power plant. (???)

I left the engine on for the whole rest of the flight since it hadn't over-speeded and it was running fine and my alternator's on and everything was ok, I figured I don't want to change anything. So I just let the engine run until we got on the ground and then I turned it off.

Last question.

Q: How'd you get the airplane home?

How did I get the airplane home? We parked the plane. Bill Seibold flew us back. That was either a Thursday night or Friday when this happened. I drove down, borrowed a prop extension, a propeller and some bolts from Thomas Kennedy who's building a Mark IV. Went to work and then on Monday, Mike Melvill flew me down to desert center in the company Duchess and helped me wrap up the trailing edge of the wing with duct tape and put the prop on and I kept my indicated airspeed below 120 miles an hour and he flew wing and just stayed what seemed to me about four feet away from me, looking at

the winglet and making sure that nothing was buzzing or flapping or falling off, which nothing did, and we flew back to Tehachapi and landed. Then I took the wing off and brought it down to work to repair it.

Well thank you very much for coming. I really appreciate it. It was a great turnout, and I hope you all can make the Cozy forum tomorrow because Chris Esselstyn is going to be doing a really nice presentation on his stretched O-540 retract Mark IV.

Thank you.