



The Highest Ever Week of Soaring Airbus Perlan Mission II

Jackie Payne

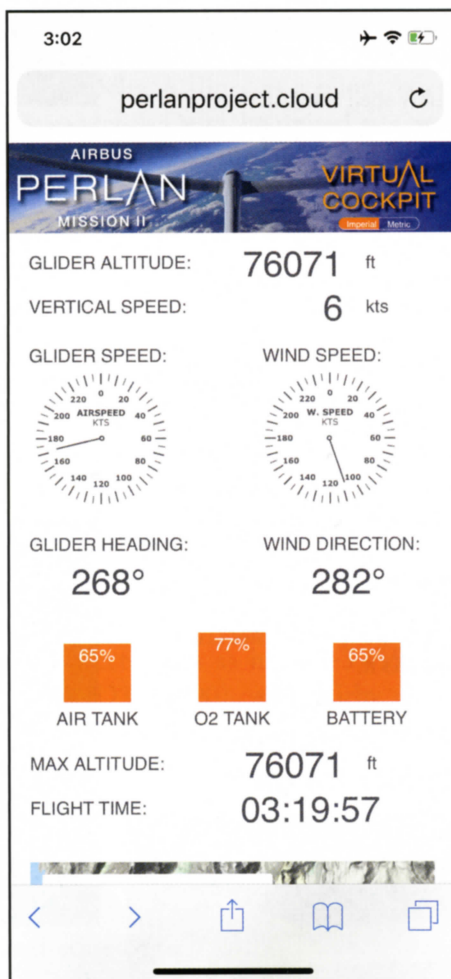
Top: It takes a team to accomplish what the Perlan Project is accomplishing. With Stewart's beard showing the wind. (Photo by Jackie Payne.)



Above: Five pilots toast attaining 76,000 ft. L-R: Tim Gardner, Morgan Sandercock, Ame Vasenden, Jim Payne, Miguel Iturmendi. (Photo by Jackie Payne.)



Above: Front cockpit at 76,000 ft + pressure altitude. (Photo by Jim Payne.)



Virtual cockpit screenshot.

Perlan Project was founded to safely explore stratospheric waves. August 26 through September 2, 2018

was the big payoff with an 8 day validation that the southern Polar Vortex does create soarable lift to above 76,000 ft. It takes specific weather conditions, a pressurized sailplane, and an awesome onsite team of 20 volunteers to make it happen. Here's the story.

Background

Many years ago, Perlan Project's founder, Einar Enevoldson, hypothesized that there was wave lift in the stratosphere above the tropopause. In 2006, Einar and Steve Fossett proved it with the Perlan 1, a modified DG-505, during Perlan Mission I. During descent from their record flight to 50,722 ft, they decided that they should build a pressurized sailplane known as Perlan 2. Perlan is the Scandinavian word for pearl – referencing *pearlescent* high altitude clouds. The building of Perlan 2 was a big effort that was documented in Dr. Dan Johnson's article published in the May 2019 issue of *Soaring* magazine.

The Perlan Project has conducted three campaigns in El Calafate, Argentina. Shipping Perlan 2 to remote Argentine Patagonia with the necessary equipment and required official permissions made my prior experience of logistics for five World Soar-



ing Championships and four scouting trips to Patagonia (before the Perlan 2) look like child's play.

We were helped by many supporters in Argentina. This included shipping companies, soaring and aero clubs, glider pilots, government agencies, and lodging providers. There were many, many more supporters who helped Perlan Project. I tried to include all of them in my blogs from Argentina. See www.PerlanProject.org/blogs.

Team

Airbus Perlan Mission II maintained 20 volunteers to fully staff the complex needs to safely soar in the stratosphere. In 2018, we expanded the onsite team



Perlan CapComm, L-R: Ed Warnock, Lars Besch, Tim Gardner. (Photo by Jackie Payne.)

to include professional weathermen and a medical doctor. Our bilingual government relations coordinator, Sandra Sandercock, and Argentine logistics coordinator, Tago De Pietro, both worked to get us what we needed and to stay out of trouble. Rebreathers needed mounting and testing before each flight and cleaning post flight. Each pilot pulls additional responsibilities. We have professional flight test engineers. Our CapComm (capsule communications) ran the entire time of every flight. They were analyzing the weather real time and analyzing the vibration excitation system to look for signs of flutter. They kept a close watch on all life support telemetry.

We had several glider knowledgeable ground crew for oxygen, pressurization, launch, and recovery. There were two interns who assisted with pre-flight responsibilities like cameras and cockpit computers, science equipment, cubesats, Virtual Cockpit, launch, and recovery. The Perlan Project CEO Ed Warnock and purser Linda Warnock kept everything flowing smoothly and paid for. And I managed logistics and ground ops, and wrote blogs.

2018 Upgrades

The team made two huge improvements before the 2018 campaign. The pilots did not like the way the

hatches fit the cockpit openings. So a recent Lockheed retiree, Greg Scates, a composites guru, built a pair of new hatches. Mike Malis supported with the engineering calculations. Those hatches were textbook perfect for all the high altitude 2018 flights.

The second gamechanger was getting a Grob G-520 Egrett for a towplane. Normal glider towplanes could only get to about 12,000 ft in an hour of fighting headwinds and rotor. After discussion amongst the team considering several more powerful options, Jim said in January 2018, "What we really need is Einar's Egrett." (Our founder Einar was a test pilot for the Egrett in Europe.) As Miguel Iturmendi commented, "You must be very careful what you ask for in Perlan. Someone is likely to make it happen." By May of 2018, Mike Malis had helped the Egrett owner install a tow reel system and get it signed off. Jim and Miguel, with Tim Gardner and Mike Malis' support, did some test tows in a Grob 103 to verify the suitability and procedures for launching behind the Egrett. With the high tow line tension, flying tow was relatively easy as the sailplane wanted to follow the Egrett, and it was difficult to induce slack line.

The Egrett is a towplane on steroids. In El Calafate (cold, 665 ft MSL), the Perlan 2 was 1,200 ft AGL by the end

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of the 8,400 ft runway. That climb rate meant the Perlan 2 was quickly above the rotor turbulence. With a flat rated engine, the Egrett had a steady 1,000+ ft per minute climb to 28,000 ft, and then kept climbing until well over 40,000 ft.

On August 10, the team made a tow to 12,000 ft to check the Egrett and Perlan 2. All went well and the next tow was to 40,000 ft MSL. There was no wave forecast in mid-August which was perfect for these test flights. The first time above 25,000 ft, Jim said on the radio, "The towplane is conning." He meant the towplane had a contrail. Jim anticipated window frosting before the first high tow. He asked Mike Malis to make a clear plenum to 1) capture the air near the eyeball window for better solar heating and 2) restrict access of the moisture from pilot bodies to those super cold windows. Jim's idea and Mike's fabrication was eminently successful.

August 26 - 60,705 Feet GPS

From the first Egrett tow until August 26, the team was incredibly busy implementing all the upgrades and getting experience with high altitude tows. Dan Gudgel analyzed the stratospheric weather, and we sent multiple weather balloons up to verify forecasts. We were watching for the right conditions to develop. We needed enough open sky to stay clear of clouds from the surface to the tropopause. Then we needed wave to develop from the energy of the Polar Night (winter) Jet, aka Polar Vortex. On August 24 and 25, we almost had the weather we wanted, but not quite. The team had early group breakfasts but the weather just didn't break in our favor. On Sunday, August 26, Jim said, "It's a go!" and we continued the preflight regimen. Jim and Morgan Sandercock were ready to make this happen! The launch was flawless, but the stratospheric wave was weak. It was not where the forecasts said it would be. The 5.6 hr flight proved that high tows allowed time to explore and search for stratospheric

wave. The plenums helped prevent icing. The tire was flat upon landing, but Jim expected that after our 2017 experience. It was very windy on the ground upon landing. We brought a second truck with people to the runway to walk the wing during the long trip back to the hangar. El Calafate Tower and the Bomberos (fire department) provided lights and sirens to punctuate a new world record! The high point was 60,705 ft GPS altitude (62,600 ft pressure altitude) for a new world record. More details are at <http://perlanproject.org/blog/world-record-claim-above-60000-feet-august-26-2018>.

August 28 - 63,809 Feet GPS

Only 2 days later, the weather again lined up with our desires. This time Miguel Iturmendi would be flying with Jim. Tim and Darlene Gann from Airbus America (our biggest sponsors) had just arrived to watch how Airbus Perlan Mission II operated from remote Patagonia. Again we had an early team breakfast, but to our dismay when we arrived at dawn at the hangar there was no electricity! The entire airport was "dark." The decision was if we could get a generator to power our essential equipment in CapComm, we could still launch. So Tago De Pietro worked yet another miracle when he got a generator loaned to us. It was a bit of a scramble, but I kept running the checklist.

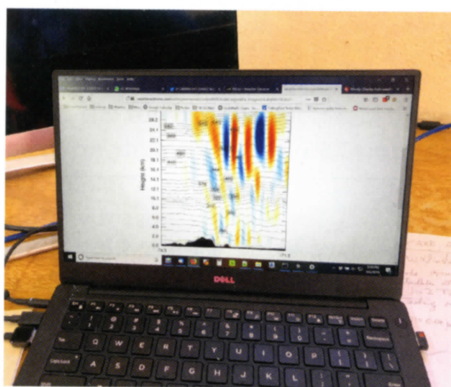
As we pushed out of the ramp, I asked for the team to stand down while I ran the checklist again Where was the backup iPad which runs the artificial horizon (Garmin GDL-39 3D)? It was still on the dead charger The front cockpit was already sealed after the pressurization test. We quickly inserted it into the rear cockpit and Miguel handed it to Jim in the front. Safety backup was restored. The iPad is only used if the glider loses battery and all other instrumentation. But it's the "get home" backup. By the way, ground power was restored sometime while on tow. CapComm had to go back to 220 V configurations.

This time the forecast position of the wave lift was closer to reality. Lift was barely there from surface to 30,000 ft, extremely weak at the tropopause, and improving at 55,000 ft. Perlan 2 was designed to explore the stratospheric waves. Our wing is optimized for 60,000 ft. No other normal sailplane with a wing that performs well from 0 to 20,000 ft would be able to climb off tow that day. And as altitude increases, so does true airspeed. Correspondingly, the true sink rate increases in the same ratio. At FL600, the true airspeed is 3.3 times indicated and minimum sink is 330 ft per minute. So lift of 400 ft per minute meant even Perlan could barely hang on at 60,000 ft. We needed a lot more lift, and on that day the stratospheric wave delivered exactly that.

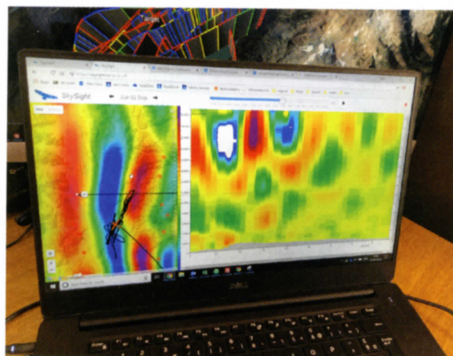
Altitudes can be a bit confusing with Perlan 2. Pressure altitude (setting the altimeter to 29.92) is used globally in Class A airspace so all aircraft are using the same reference for height measurement. So Perlan needs standard pressure altitude on its instruments. The "standard" day was created for operations at the latitude of Edwards Air Force Base. El Calafate is a loooooong way from that "standard." The International Gliding Commission and the Federation Aeronautique Internationale a few years ago required GPS altitude to be used for soaring records above 15,000 m (about 49,000 ft). We have consistently found with our weather balloons and flights that GPS altitude in the vicinity of El Calafate is about 2,000 ft lower than pressure altitude. That's why you may see photos of cockpit pressure altimeters (65,600+ ft) that differ from the official record of 63,809 ft GPS altitude. <http://perlanproject.org/blog/second-world-record-claim-2-days>

Sept 2 - 74,334 Feet GPS

The team was energized with two high altitude soaring flights in the bag. But the weather kept cranking. Both September 1 and 2 looked very promising. But the surface conditions of



WeatherExtreme wave forecast during FL760 flight.



SkySite wave forecast.

September 1 were less desirable. There is no crosswind runway at El Calafate and strong surface winds 60° off centerline are a real challenge for long winged ships. I loved the Egrett (108 ft wingspan) tow pilot's response to Jim. Arne said, "I can handle anything you can handle." Jim opted to wait for September 2.

During the night, we had hard rain and even small hail. We didn't want a wet runway, and we saw rooster tails of water as the early commercial traffic took off. Miguel checked the actual runway conditions and said it was almost dry. So we restarted the preflight regimen. Again the forecast tropopause lift band was weak, but at least it was forecast to exist according to Walt Rogers. But as Jim and Tim Gardner towed behind the Egrett, they reported no lift through 35,000 ft.

They finally got a "nibble" above 40,000 ft. Then the lift improved nicely. The Perlan 2 got off tow at about 42,000 ft and quickly climbed to 65,000 ft and performed more flutter

excitation tests. We want the dampening (reduction of vibrations) to match the models produced at our 2015 ground vibration testing made in San Diego at ATA.

We record the test results in the cockpit and then download them via telemetry to CapComm. The file is then emailed to ATA with a 5 minute analysis time. We also have Lars Bensch, a Flight Test Engineer, in CapComm who can immediately look at the data for any anomalies. If flutter ever were to develop at these altitudes and true airspeeds, it would not be good.

Jim and Tim surpassed the previous high point and kept climbing. They stopped at 74,334 ft GPS altitude (76,124 ft pressure altitude). That was higher than the U-2 spy plane's max record altitude while using a big engine. So the pressurized sailplane Perlan 2 has the record of the highest level flight (not zoom) of a subsonic, manned aircraft. Jim calculated the max speed on this flight was Mach 0.46 with a true airspeed of 4.5 times indicated. This was a 5.1 hr flight – an hour on tow, 3 hours climbing, and an hour to get down. <http://perlanproject.org/blog/perlan-2-soars-above-76000-ft>

Post Record Flights

After these flights, we needed to test faster speeds to prepare for the 2019 assault on 90,000 ft. On September 12, 2018, Jim and Miguel towed to 45,000 ft to make the highest ever tow (unofficial record). The design limit for airspeed on Perlan 2 is M 0.62. Our flight envelope stops at 90,000 ft. There is a point (called "coffin corner") where stall speed and V_{NE} meet. That altitude is about 96,000 ft for Perlan 2 – straight and level. In wave flying, there are always gentle maneuvers to stay in the line of lift. We don't do straight and level like a jet with an



Egrett contrail from Perlan tail camera.

engine. That's why we plan to "only" climb to 90,000 ft if stratospheric wave permits. Yes, we have two aircraft-sized parachutes for emergencies, but we would rather not use them. <http://perlanproject.org/blog/final-flight-argentina-2018-highest-ever-tow>

The Future

Airbus Perlan Mission II will be in El Calafate from the end of July until late September 2019. If you want to "ride along," there are several ways to be notified. You can follow our Twitter account to be notified when we are flying, then watch the Perlan Virtual Cockpit with nearly real time data like altitude, moving map, climb rate, winds, heading, remaining battery, oxygen, and air percentage. We use tweets for live commentary from CapComm. Over 12,000 folks watched the highest glider flight ever on September 2, Labor Day Sunday. You can enter your (USA) phone number for a text message to check the Virtual Cockpit. Or you can enter your email address on our website to be notified of flight. We also have active Facebook and Instagram accounts. Perlan Soars High! ✈



76,000 ft, tail camera.