The Perlan 2 Glider

Dr. Daniel Johnson

Perlan 2 on the ramp in El Calafate, ready to tow out, worshipper genuflecting. (Photo by Daniel Johnson.)

The design goal of Perlan 2 is to soar at 90,000 ft above sea level. This is probably as high as any manned aircraft has ever flown, the actual record not documented. An SR-71 pilot named Darrell Greenamyer is quoted as once having achieved level flight at 90,000 ft.

Let's just hypothetically suppose that you are an engineer and test pilot with extensive experience in flying stratospheric aircraft, and understand the aerodynamics there.

Let's just hypothetically suppose that you are a very experienced mountain wave glider pilot.

And let's hypothetically suppose that nearly everyone believes that mountain wave, like thunderstorms, is blocked by the tropopause from affecting the stratosphere.

And then, one day, on a job as the test pilot of yet another stratospheric aircraft, you walk past a bulletin board on which is a lidar image showing atmospheric wave over the mountains of Sweden extending above 80,000 ft altitude.

What do you do? Of course, you walk into the office belonging to the bulletin board and have a detailed conversation with the physicist inside about these findings.

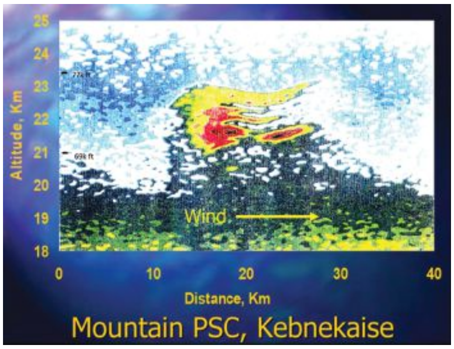


Figure 1: The Bulletin Board image that showed stratospheric wave over Sweden and captured Einar Enevoldson's imagination.

Your knowledge of aerodynamics and soaring lets you instantly realize it should be feasible to design a sailplane capable of climbing in that stratospheric wave. If it is there, and it is possible to reach it, it must be explored. This is a presupposition of the human condition.

Einar Enevoldson is a non-hypothetical engineer, test pilot, and glider pilot who was in exactly these circumstances and had exactly this epiphany more than 25 years ago. But being a retired NASA test pilot, he did not have multiple millions of dollars to bring this vision into reality.

On September 2, 2018, the Perlan 2 glider achieved a pressure altitude of 76,100 ft (that's the altitude that matters aerodynamically, though the lower GPS altitudes are used for records nowadays).

Why can't you fly a Schweizer 1-26 or a Ventus 3 to that altitude? Why build a bespoke glider for the task? The best answer is that if you want to succeed at any flying challenge, you're best off flying an aircraft that is optimized for the task. Why?

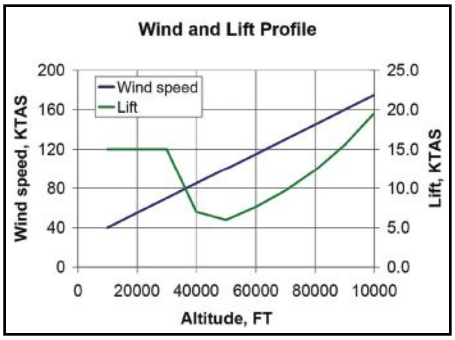
1. The air is really wispy up there. The "Reynolds number" varies with the density (and viscosity) of the air being flown through. At 100,000 ft, the Reynolds numbers are bird-like rather than airplane-like. As you climb, the true airspeed begins to approach the speed of sound, and the air wafting over the wings might exceed it – what are you going to do about that?

2. It's severely cold up there. How will the materials of the glider, the control mechanisms, the avionics, the tire, the sealants, and the windows change their properties at -50° to -85 °C? How can you find out? Very few materials or completed equipment are tested at such temperatures and pressures.

3. It's really high. How are you going to get there? What is the most common form of lift at each of the altitudes that you must transition? The stratospheric mountain wave must be connected to the tropospheric mountain wave that we're used to in order to climb in a glider into the stratosphere. Do such connections exist? How are they found?

4. What's the meteorology? When does stratospheric mountain wave develop? Where in the world do you find it? How can you predict it, so as not to waste effort and money?

5. How do you keep the pilot safe? The Armstrong limit is about 63,000 ft, above which water turns to warm steam at body temperature, so a pressure suit or pressurized cockpit is essential.



The performance design goal of Perlan 2. (Reproduced courtesy Greg Cole.)

This graph was given to Greg Cole by Einar Enevoldson at the beginning of the design-build process for Perlan 2, as a depiction of the best expected atmospheric environment. The green line shows expected best lift at altitudes. The dip at 35,000 to 50,000 shows the loss of lift through the tropopause. The blue line shows typical wind speeds at altitudes that would be encountered in the jet stream or polar night jet. It was anticipated that Perlan 2 would release from tow in mountain wave at mountaintop height, and would have to climb through the tropopause to the stratosphere. This was the case until 2018, when the Grob Egrett was first used as a towplane so that release could occur above 40,000 ft, in the lower part of the stratosphere.

Airframe and airfoil design

Obviously, the first step is to try to design a glider that can climb to and be flown in the stratospheric atmosphere. After Einar discovered stratospheric wave, he began a design study, what aeronautical engineers call a "preliminary sizing exercise."

This study concluded that the glider needed to have a wingspan of about 100 ft, aspect ratio of about 30:1, and best glide about 30:1. When Greg Cole was chosen to build the airplane, he was also given the design task. As he refined the design, he evolved to a shorter wing with a lower aspect ratio than the NASA-Perlan sizing study.

Einar judged that it should be a two-seat aircraft due to the expected high workload, the safety of the redundant pilot, and the need for support systems. Having spent much of his professional flying life in pressure suits, he understood their expense, complexity, and limitations, so judged that having a pressurized cockpit would be necessary.

He had only recently retired from NASA, and was able to persuade someone to write a simulation, which refined the aerodynamics. NASA engineers seized the opportunity to explore this unusual design challenge.

A test pilot named Helvey happened to have flown a U-2 from Fresno, California, into Nevada and back across the Sierra at 60,000 ft in mountain wave conditions. He got the hell beat out of him but lots of data. A brilliant graduate student named Daniel Landau created a model of the turbulence field that had been encountered. Using the fastest computer then available at UCLA, computation took about a month.

They took the most "interesting" 15 miles of this flight and ran this in the simulator that had been designed. Einar flew it often, and, as he recalls, he invited a fellow test pilot named Jim Payne to fly it, too.

This data indicated that +/- 3 g would likely be the maximum experienced, so an airframe designed for +/- 8 g seemed sufficient.

In the quarter-century since then, atmospheric modeling has advanced greatly. The Perlan meteorologist, Dr. Elizabeth Austin, notes, "[Landau's] is an older model and the newer ones have many more parameters and are more realistic in terms of their equations, etc. We also have much better analysis input data and much better computing power to get to much higher resolutions. This is not to say that his model results don't have merit and I do believe the +/-3 g for sure."

In about 1999, he pitched the construct to a fellow glider pilot who had a bankroll, Steve Fossett. Steve preferred that they first obtain and modify a commercial glider (a DG) and fly in pressure suits to assess the feasibility of stratospheric flights before building a bespoke glider.

The next step was to determine where in the world they might most likely find stratospheric wave. This requires finding a location where the polar night jet crosses mountains at a favorable angle.

The first three seasons, they flew from New Zealand and mainly found that the conditions did not quite meet their need. "Looking back," Einar notes, "it seems likely that we missed at least one chance in NZ, because we didn't understand the configuration of the stratospheric wave."

They then changed to the Andes, and flew from El Calafate, the southernmost reasonable airport. The first season there, they failed to reach the stratosphere, but in the second season, in 2006, they reached 51,500 ft.

This proved the concept, and demonstrated no loss of climb with increasing altitude, an important requirement to be able to go higher. Steve Fossett then agreed to build Perlan 2, on which Einar had been working for at least a decade.

Airfoil design

Prof. Dr. Richard Eppler, of Universität Stuttgart, decades ago developed computer code that directly connects the boundary-layer development and the pressure distribution. NASA adopted his philosophy that a reliable theoretical airfoil design method is preferable to catalogs of experimental sections.

Dan Somers, a student of Eppler and founder of Airfoils, Inc., was engaged to begin airfoil design studies.

In about 2001, Einar discovered the Sparrowhawk glider at the Tehachapi annual soaring meeting and inspected it very carefully. He then knew he'd found the guy who could build this dreamed-of glider – Greg Cole. But it was years before that could begin.

Airfoil design challenges

There are several special challenges to airfoil design for even slow flight in the stratosphere.

A special challenge is that it must climb well from the traditional maximum towplane altitude – 10,000 ft or so – through the troposphere in mountain wave, then traverse the weak lift of the tropopause in order to connect to stratospheric wave, and then climb in progressively less dense air until the increasing true airspeed begins to converge with the decreasing speed of sound.

(Why not try higher? It isn't clear that it is feasible to build a wing that will climb well at lower altitude, fly well when airflow over the wing is transonic, and also fly safely and effectively when that flow is supersonic, above the transonic altitude. A supersonic wing should be thin and flat; a high-lift, slow-speed wing should be curved and have some thickness.)

The design of Perlan 2 was somewhat simplified by designing the airfoil to fly at the same indicated airspeed at all altitudes (Perlan 2 is flown at 48 kt) – there was no reason to create a compromise that would also fly well at high indicated airspeeds, if only because those airspeeds are supersonic well below the goal altitude. In any case, cross-country performance was not relevant.

The *indicated* airspeed is a *pressure* reading, with dial markings of speed. This is very important because lift is determined by pressure, and the most important speed instrument is therefore indicated airspeed, which is kept constant.

True airspeed increases with altitude related mainly to the drop in static pressure. The formula in the inset shows that there is a small decrease with cold temperatures (about 50% from 0 to -70 °C), but a large increase as static pressure, P, decreases (about an 8-fold decrease from sea level to 90,000 ft).

Mach tuck

As the curved airfoil ascends and the true airspeed increases, transonic flow begins to develop over the top of the airfoil. An angle in the airflow develops – a shock wave – which inconveniently moves the center of lift aft. This causes the nose to dip, which increases airspeed. This can develop very quickly, and the nose-dip irrecoverable, especially if the lift under the horizontal tail has become transonic and shifted strength and location.

The shockwave over the airfoil and Mach tuck develop earlier with increased wing loading. The Perlan 2 airfoil will develop transonic flow above 90,000 ft if the wing loading is more than 1 g – which means that straight and level flight is best above 90,000 ft. About 96,000 ft, the flow will be transonic at 1 g, which forms the "coffin corner" for Perlan 2. (It's useful to remember that these are theoretical and design considerations – the actual aircraft and the actual conditions have not been tested, and will be somewhat different from theory.)

Pressurized cockpit

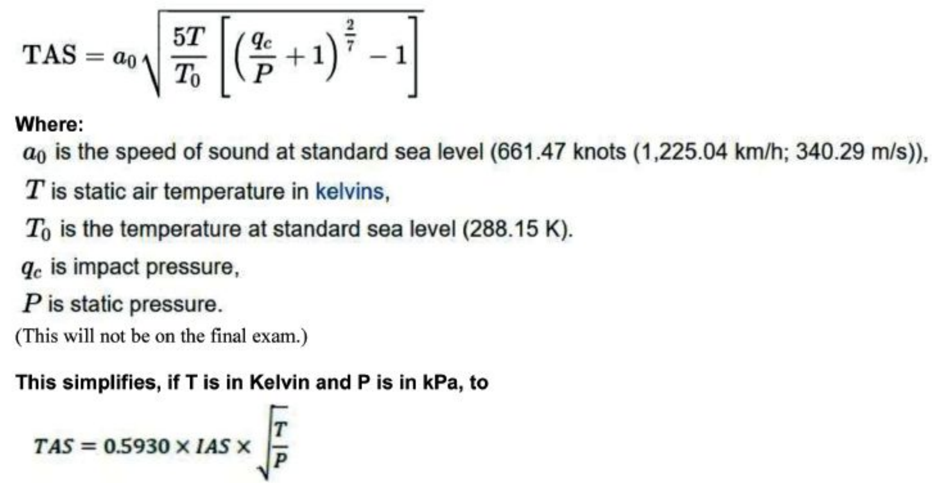
Steve Fossett, not at first convinced of the need for a pressurized cockpit, asked Einar to borrow pressure suits from NASA. To Einar's total surprise, NASA agreed, seeing a research benefit. At 50,000 ft in Perlan 1, the suits were so stiff that moving the controls was fatiguing, and it was not clear that full control movements would be possible if necessary. For example, above 50,000, Steve's pressure suit pushed him forward such that the stick could not be pulled fully back. This emphasized that a pressurized cockpit was necessary.

(In any case, a specially designed glider was necessary because aerodynamically, the DG was not expected to be able to surpass 70,000 ft.)

Pilots do not wear backup pressure suits in Perlan 2 because they are prohibitively expensive when not on loan from a generous government – they must be custom built for each pilot, and require their own maintenance crew on the ground. If I recall correctly, they cost more than $100,000 to build and more than that annually for handling and maintenance.

The cockpit is double-walled carbon fiber with a foam core. It's a space capsule: The prototype cockpit was tested to failure, at 23.5 psi. Sea-level pressure is 14.7 psi, so Perlan could be maintained at sea level cockpit pressure safely. This is not done because it is unnecessary physiologically, and the inevitable air leakage at seals would shorten endurance. It is pressurized to 8.5 psi – about 18,000 ft altitude, which provides a large safety margin and leakage is small, about 7 liters/

True airspeed calculation



$$TAS = a_0\sqrt{\frac{5T}{T_0}\left[\left(\frac{q_c}{P}+1\right)^{\frac{2}{7}}-1\right]}$$

Where:

a_0 is the speed of sound at standard sea level (661.47 knots (1,225.04 km/h; 340.29 m/s)),

T is static air temperature in kelvins,

T_0 is the temperature at standard sea level (288.15 K).

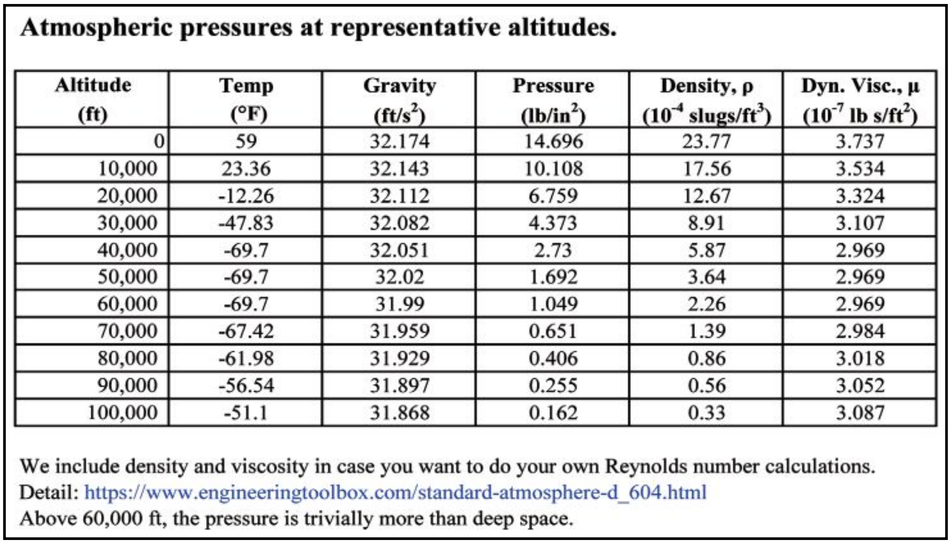
q_c is impact pressure,

P is static pressure.

(This will not be on the final exam.)

This simplifies, if T is in Kelvin and P is in kPa, to

$$TAS = 0.5930 \times IAS \times \sqrt{\frac{T}{P}}$$



Atmospheric pressures at representative altitudes.

Altitude (ft)	Temp (°F)	Gravity (ft/s^2)	Pressure (lb/in^2)	Density, ρ (10^{-4} slugs/ft^3)	Dyn. Visc., μ (10^{-7} lb s/ft^2)
0	59	32.174	14.696	23.77	3.737
10,000	23.36	32.143	10.108	17.56	3.534
20,000	-12.26	32.112	6.759	12.67	3.324
30,000	-47.83	32.082	4.373	8.91	3.107
40,000	-69.7	32.051	2.73	5.87	2.969
50,000	-69.7	32.02	1.692	3.64	2.969
60,000	-69.7	31.99	1.049	2.26	2.969
70,000	-67.42	31.959	0.651	1.39	2.984
80,000	-61.98	31.929	0.406	0.86	3.018
90,000	-56.54	31.897	0.255	0.56	3.052
100,000	-51.1	31.868	0.162	0.33	3.087

We include density and viscosity in case you want to do your own Reynolds number calculations.
Detail: https://www.engineeringtoolbox.com/standard-atmosphere-d_604.html
Above 60,000 ft, the pressure is trivially more than deep space.

minute, well within the capacity of the air tanks.

Leakage is minimized by rotary control transfers, which are easier to seal than push-pull tubes. Pressure is stored in large air tanks – SCUBA tanks.

Why not a canopy?

As you've probably noticed, glider canopies are pretty flexible. This deformability is not suitable for a pressure cooker. A conventional canopy would require latches to resist a very large pressure load. It is likely that a sufficient latching mechanism would be too heavy for the light structure that it served. Einar's preferred solution was plug hatches, which are sealed and kept in place by the pressure itself.

One winter in New Zealand, while waiting for wave, Einar got a NZ wooden-glider repair expert to build a mockup of the pressure cabin. They built side hatches and then top hatches in turn, and decided the top entry would work better, to avoid control passes and avoid pilot contortion during entry and exit. They are sized to permit wearing a parachute. In Perlan 2, pilots do not wear parachutes, mostly because actually bailing out above 20,000 ft is more harmful than staying in the cockpit, partly because it's very difficult to exit Perlan 2 actually wearing a parachute, as was discovered in the first mockup.

Perlan has 2 rescue chutes, a drogue tail chute to be deployed at high altitudes, and a BRS ballistic chute to be deployed below about 12,000 ft. This is expected to result in a nose-first landing at about 15 mph if the glider is uncontrollable. A bonus advantage of the BRS system is that it's lighter than 2 parachutes and harnesses.

Perlan overhead. (Photo by James Darcey, Airbus.)

The round windows date from flights in an ASK-21, in which the canopy was masked and holes cut, with different window arrangements until satisfactory visibility with sturdy structure was feasible.

Einar notes, "The windows are not the finest achievement of this design. In the ASK-21, the pilot sits further forward than in Perlan 2, and the pressurized cockpit walls are much thicker. The angle of view and the actual aperture is smaller, so the view is not as nice as intended."

The view is further degraded by frost even though the windows are double glazed. During the 2018 season, engineer Mike Malis devised a removable plastic third pane that was very helpful. At one time, early in the project, a cockpit dehumidifier was constructed, but the fans were much too noisy.

The visual backup is the tail cameras, with the image displayed on an iPad in each cockpit. In 2018, the forward-looking tail camera consistently failed, but the 360° VIRB was reliable.

The cabin is designed as a two-gas system – a normal atmosphere in the cabin, and closed-loop pure oxygen for the pilots to prevent decompression sickness if cabin pressure is lost.

This arrangement conserves oxygen and keeps exhaled moisture out of the cabin. More important, there would be a fire risk as the cabin oxygen ratio rises progressively above 25%. (It's the ratio, not the partial pressure of oxygen that's key. This was carefully studied after the Apollo 1 catastrophe occurred.)

Aerodynamic challenges

After Steve Fossett's death in September 2007, Einar said to Greg Cole, "Let's build the glider we really ought to have." Greg really grabbed onto Einar's dream, and for years worked all his spare time on the nuances of its design. *Everything* has to work. Meanwhile, they wrote one proposal after another for financing with little result. Money was difficult to raise.

The mission and the materials drive design.

The requirement to be able to climb through the tropopause was the most difficult challenge, because a design for high altitude has decreased climb performance at low altitude. If tow could have been planned to above the tropopause, it would have been possible to use wing profiles that permit higher Mach numbers.

Designing a subsonic aircraft able to fly to 90,000 ft was *comparatively* straightforward (though very complex). Going to 100,000 ft is a very difficult design challenge because of the expected transonic flows. The pressure at 90,000 ft is 0.25 psi, at

100,000 ft it's 0.16 psi – this is trivially different from space.

As transonic flows develop, shock separation produces loss of control. Perlan was designed to be capable of Mach 0.6-0.65, to create some margin and ensure that the altitude goal of 90,000 ft was feasible. Ultimately, the wing was a blended transitional design with a series of airfoils. Sharp breaks were avoided, as these have a drag penalty. Greg Cole states:

Each part of the wing talks to every other part of the wing. The wing design is intended to minimize induced drag and parasitic drag at its operating point (relatively slow or high coefficient of lift). The planform (chord distribution) combined with twist, geometric, and aerodynamic, are selected to accomplish this. The loop is getting airfoils to work at this design point consistent with structures. As we have pointed out, the Reynolds number (small and ever worse with the small tip chords) and Mach number are not helping us on this plane. So the wing outer area is driven by these factors and a very important additional one. The low speed behavior of the aircraft (from near stall to stall) is strongly affected by the behavior of the outer wing. The lateral control devices are also located in this outer wing area.

The horizontal tail is very thin in order to be effective at the low Reynolds numbers at 90,000 ft. (At that altitude Perlan is operating with the Reynolds numbers of a bird.) There is a little sweep on the tail surfaces because this reduces the effective Mach number, delaying onset of Mach tuck and making less of a cliff.

A T-tail would be unsatisfactory because of the torsional load this puts on the tail boom, increasing the airframe-flutter risk.

Flutter risk

The entire aircraft is involved in flutter, with elasticity in all three dimensions, with both bending and twisting motions simultaneously. The control surfaces cannot be fixed, so their mass balance is critical to flutter response.

Flutter is *related* to the true airspeed – the speed of the molecules of air passing across the surfaces (remember, this varies with both temperature and pressure – density). Flutter occurs when at some point the elastic resonance of the airframe is matched by the harmonics of the turbulence in the flowing air. Because at that point, the turbulence is synchronous with the airframe response, very little force is required to trigger it. And flutter tends to develop abruptly. The flutter true airspeed in Perlan 2 is much higher at high altitude than at lower altitudes, so flutter testing is necessary at each high altitude. As Einar says, "There are no safe rules of thumb."

Perlan has two measures to decrease this risk.

One is massive control surface balance weights. The elevator horns are tungsten, a heavy metal. These actually tend to reduce the stick force, because they are forward of the hinges. The aileron mass balance is increased with small lead torpedoes attached at the hinge points, positioned in front of the hinges.

The other is resonance detection. There is a collection of tiny accelerometers in the control surfaces that are monitored for vibration, and a test protocol is flown every few thousand feet in which wing vibrations are introduced briefly and resonant response can be detected.

Meteorological danger

At these high altitudes, the thin air can result in odd loss-of-control modes. Stratospheric wave is known to break just as ocean waves do; this is a concern because the vertical velocities are very high and there are no wave-marking clouds there (and air is invisible, so you discover lift or turbulence only by entering it).

Wave-marking stratospheric clouds are known to exist – mother-of-pearl or "Perlan" clouds – but these are rare and have not been seen during Perlan flights, either from the glider or from the ground.

The g-stresses at these car-crash velocities are not as great as if the air were dense, but Perlan would get severely banged around, though it's designed to withstand this extreme turbulence. Yes, the pilots wear crash helmets. No, they have not encountered breaking wave. At altitude, the lift is broad and smooth. Downwind excursions have not been undertaken because of the limited airspace permitted in Argentina, and this helps avoid breaking wave.

One of the purposes of having installed a tail-drogue chute is in case a breaking wave creates loss of control, it can be deployed to prevent a damaging high-speed excursion and keep the nose pointed forward.

Handling

At low altitude, the lateral stick forces are high. On tow at 70 kt, the controls are heavy. If you find a cockpit video of a takeoff, you may notice that the pilot then usually has both hands on the stick. The roll rate is slow and the ship feels somewhat sluggish.

In general, Jim Payne says, the handling is like an open-class ship. He mentions the Nimbus 3D as being most like it. The wing loading is pretty light, close to 8.2 (lb/sqft), so the feel even down low is pretty good.

Stall characteristics are totally benign – we haven't stalled it above 20,000 ft, but at low altitude, it's just like an ASK-21, a slight break. Or with forward CG, you may end up with the stick full back and mushing.

It's very stable in a steep bank, no different from an open-class ship. Thermaling has been done only in rotor, which is always less pretty than in a standard smooth-ish thermal.

At high altitudes, the controls get light and the roll rate increases. "Up and away, you're making small inputs, and Perlan 2 isn't much different from the ASH-25. Control feel – this year in Argentina, we never saw any turbulence off tow, and up that high, the areas of lift are fairly big, so you don't have any sharp transitions, so it's pretty straightforward."

He observes that during the hands-off portion of flight testing there has been some gentle Dutch roll (yaw) with a period of about 4 seconds with a "snaky" motion involving small bank angle changes of < 10° that has been easily controlled and not evident if either pilot is hands-on.

Dutch roll is generally a problem with highly swept wings or high dihedral. As Perlan 2 goes higher, we expect the Dutch roll to have a lower damping ratio and maybe even become unstable. A yaw damper will be added, which would make the oscillations damp out sooner.

To point out the obvious, this ship has never been above 76,100 ft, so we really don't yet know what its aerodynamic and handling qualities are above that.

Jim says Perlan 2 is *satisfying* to fly rather than "fun" because it's a challenge – like the F-104, it takes pilot compensation to fly it well.

Why not just go to 90,000 ft?

People have asked, "Why did they stop climbing? They were still in good lift." Greg Cole said, "Why don't they just take it up to 90,000 ft? It's designed to go there."

There are two uncertainties. One is that the design is a *model*, based on assumptions and known aerodynamics. No matter how careful the design, the fact remains that no aircraft has ever flown in these extreme conditions of cold, rarefied air, and (potential) turbulence. There is no track record of prior successes or known problems.

The Perlan test flight program is very carefully laid out to demonstrate that it handles safely at all design airspeeds and configurations – "expanding the [demonstrated] flight envelope."

The other uncertainty is how well the constructed, real-life glider conforms to the design. This is not merely a matter of measurement and precise mold cutting. It is also related to the behavior of hinges, control rod connections, the elasticity of the soles of the pilots' boots, the change of structural resonance frequency when the temperature decreases from +5 °C to -90 °C, and other physical factors. All these factors can change the handling qualities and stability.

Einar has a great deal of experience in high-altitude test flight. He points out that there are always surprises, and these surprises can develop quickly. The flight characteristics of the aircraft are also interdependent with piloting style, though we seldom think about this.

For example, in 2006, Einar and Steve Fossett flew together in a modified DG to over 50,000 MSL in a modified DG-1000. This altitude range was not part of the design specification for this aircraft and every high flight in it was a first-experience test flight.

Dutch roll, as you know, is the tendency of an aircraft to wag its own tail. This is less well damped in a rarified atmosphere. Einar recalls that during the record flight, at one point, Fossett asked to fly. As soon as he took it, the airplane started sashaying around like a tugboat in high seas; Einar then realized that he had been subconsciously compensating without realizing that the phenomenon was occurring.

Perlan 2 is predicted to have an increasing Dutch roll tendency above 70,000 ft MSL. It is impossible to know until it's flown just how that will change as they go higher. It is known that the damping is negligible; aerodynamic models have indicated that at some altitude it may become dynamically unstable. The concern for possibly uncontrollable Dutch roll is one reason for having a tail drogue chute that can be deployed to keep the glider's nose pointed forward.

Einar recalls that NASA created a *simulator* of the Apex unpowered remotely piloted stratospheric sailplane and of his Perlan-concept design. Both showed Dutch roll divergence above about 75,000 ft and that it was marginally controllable.

But Perlan 2 is different from each of these – yet how different? Only careful and incremental testing can reveal whether its Dutch roll characteristic is divergent. Should a yaw-damper be added as insurance? This is a point of debate: It is added complexity, time, and cost. We can't know whether it's *necessary* without flying high.

Aerodynamic stability analyses have never been done, so it's possible there are some surprises ahead.

Flight testing protocol

For these and other reasons, the Perlan 2 team has followed a meticulous, incremental, disciplined, and detailed test-flight protocol.

There are two key features of this testing:

One is flutter evaluation. There are 3 asymmetric small gyros in the junction between the wingtip extension and the main wing, one for each geometric axis. In a 15 second span, these are run from 1 Hz to 20 Hz, during which time accelerometers in the ailerons send data to a cockpit recorder and telemetered to ground. The analysis evaluates whether resonance has occurred in any axis, at any frequency.

The other is for handling and stability. For each flight, test points are set, with the glider being flown at selected speeds and altitudes during the flight. These tests of course include spoiler deployments. By this means, the known flight envelope is steadily expanded.

This is tedious work, and "success" for the glider is to have delivered no surprises. But it's important work, for it defines limits within which the glider's behavior is known.

Acknowledgements

This essay was made possible by long discussions with Einar Enevoldson, whose idea this program was; Greg Cole, the designer of the Perlan 2 glider; Morgan Sandercock, the engineer who ensured it endured and its systems functioned; and Jim Payne, Chief Pilot, a career test pilot who knows a great deal more than he lets on. Also, Jackie Payne and Dr. Elizabeth Austin have reviewed the manuscript helpfully. All errors are the author's.

Soaring

Perlan 2 soars above
the Andes in Argentine Patagonia.
(Airbus photo by James Darcy.)

US Hall of Fame Biographies

Collected, Compiled, Adapted, or Written by Bertha Ryan

This month we continue the biographical articles, thanks to the efforts of Bertha Ryan. She has compiled, adapted, and written brief biographies of the Soaring Hall of Fame inductees up through 2013. Since there are many, it will take several issues to present them all, so we will be looking at groupings by year – this issue presents the 2010 inductee. (NOTE: there was no inductee in 2009.) The full set will be on the National Soaring Museum website. —*Editor*

21st Century – 2010

EINAR K. ENEVOLDSON (2010)
(1932-)

Source: Soaring Beyond the Clouds – Einar Enevoldson Reaches for 100,000 Feet, Bertha M. Ryan, 2010, published by SSA.

Engineer, Pilot, Explorer – Einar Enevoldson, like so many others of his age group during that time, built models as a young boy. He soon learned that, to be successful, it was necessary to do careful planning with a depth of understanding of the situation. While in high school, through friends in the model club, he discovered something else to test his curiosity and quest for understanding – sailplanes. He spent some time at the well-known gliderport of El Mirage – which he called the University of El Mirage, not only because of the people and the sailplanes, but also the sport which challenged him.

He joined the Air Force in 1954, where he stayed until 1967, and had several interesting experiences, including flying the F-104 to several time-to-climb records, instructing Chinese pilots in Taiwan, and, perhaps best of all, being selected for the prestigious Empire Test Pilot School in England. He joined NASA at Edwards AFB in 1968 and stayed there until 1986, when he started working for Grob until 1995. While at Grob, he set more time-to-climb records – this time in the Grob Egrett.

Einar loves competition as he believes it is the best way to become a better soaring pilot. Setting of tasks by the Competition Director challenges the pilot to try tasks he might not otherwise have considered – thus stretching the boundaries of his skills. He flew his first contest while stationed in England. When he returned to the States, he flew a regional at California City and then Nationals, first at Marfa, Texas, in 1969, then the U.S. Open at El Mirage in 1970, the U.S. Standard Class at Ephrata, Washington in 1971, and the U.S. Standard Class at Hobbs, NM in 1974. In 1972, he was selected to fly the Smirnoff Sailplane Derby, a cross-country race with a series of goal flights from the West Coast to the East Coast. Einar enjoyed this type of competition because, even though the goal was selected for him, he had to determine his own course in a geographical location that changed every day.

With all the various kinds of flying experiences described above, you might guess that Einar has flown many different aircraft, and you would be correct. As a minimum, he has flown 80 types of NASA and military aircraft, 97 various gliders, and 62 other types of aircraft (General Aviation).

L to R: Dr. Paul MacCready, Dr. Joachim Kuettner, Einar.

Ever since Einar participated briefly in the Sierra Wave project in the early 1950s, he dreamed of exploring the stratosphere in a sailplane. In 1992, he saw a photo of a 75,000 ft high wave cloud over northern Scandinavia. His curiosity and imagination were sparked. What caused these stratospheric wave clouds? Might that meteorological condition carry him far into the stratosphere in a sailplane? He consulted with atmospheric scientists and others and soon learned about the Polar Vortex, the Stratospheric Polar Night Jet, and, most importantly, that these conditions sometimes coincided with the traditional mountain wave. There were indications that this phenomenon reached 100,000 ft. Einar wanted to find out. Project Perlan was formed.

Einar had a plan and went about implementing it. Not surprisingly, the plan required money. Einar managed to interest millionaire adventurer Steve Fossett, and together they went to Argentina and set a new world absolute altitude record of approximately 51,000 ft – more importantly, they had reached the stratosphere and proven it was possible to reach and utilize the high altitude wave.

Mission II of the Perlan Project is to soar to 90,000 ft. The project is now fully funded by Airbus, and Einar has the title of Founder and Chairman of the Board.

Artist rendition of Perlan 2 sailplane.

Einar earned Silver #193 in 1953, Gold #629 in 1971, and Diamond #207 (Intl #1009) in 1971. He gave the Barnaby Lecture in 2007.

Einar, in his own words, has spent a lifetime learning to fly. More than that, he has lived his dreams.