SOARING Rx

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Secret Betrayal: Ourselves, the Air

We call it an 'accident' because we weren't planning to have one.

Josh sat in his shattered glider, and moved his legs, his arms. They worked. The pain had not yet begun, he felt uninjured. He was stunned: but emotionally, not physically. What happened? He wasn't sure. He'd been low over the rocks, sure enough. But it had felt high enough and fast enough. Then a giant hand pushed a wing down; it hit a branch. Now, here he was in the mountain wilderness surrounded by broken composite trash that once was a beautiful glider.

He activated his emergency rescue devices, and eased himself out from beneath the fractured canopy. He picked up his water and his snack bars, tied his jacket around his belt, and began to walk down toward a road in the distance. Or, more precisely, he walked, clambered, climbed, and descended.

The next morning he was sore in some places that surprised him, but the most intense pains were the humiliation and the grief of having wrecked his ship.

Why a good pilot might have an accident.

Josh was a skilled soaring pilot of long experience, an instructor and sometime racer. He'd flown in the mountains before, though this area was new to him, he felt prepared.

Why do bad accidents happen to good pilots?

Because they're human. Our perceptions are approximate and prone to distortions. We believe we understand the weather and wind, but the fact that the air is either invisible or opaque means that we can rarely see what it is actually doing.

Spatial Disorientation: *An incorrect perception of linear/angular position, or of motion, relative to the Earth's surface or another aircraft, **sufficient to affect performance, situational awareness or workload** – however slight that effec*t may be. (USAF definition.) We'll call this SDO, to save typing.

By such a definition, Josh obviously crashed due to SDO. How do we know this? Because he was not incapacitated, and was a skilled pilot who would have controlled his aircraft properly if he'd perceived its dynamic 3-D situation accurately.

Frank Caron's 1999 study of French glider accidents found that half of accidents and injuries and 70% of fatalities were due to SDO!

Wait. There's another, non-obvious cause: atmospheric betrayal. Shall we call this Atmospheric Disorientation, ADO? After all, it's due to our misunderstanding of what the invisible air around the glider is doing. This is not a miss-perception because we can't perceive the air! However, because it's invisible, we are always flying on the presumption that we have a good-enough idea of the winds and the thermals. Many pilots have died upon the mountains after entering airflow that was totally not what they presumed, perhaps most famously Steve Fossett.

Perceptual factors.

The illusions that trick pilots are not conjured by magicians. They are built in, ready for use. We defeat these illusions – automatically, most of the time – by repeatedly cross-checking what we see and feel.

Our perception does have limits, and when we operate outside these limits accuracy is degraded, though our brain is pretty confident that what's perceived is factual.

What perceptual factors might put a skilled pilot into the rocks? Scientists have nicely categorized individual factors and given them names. What we have to realize is that in the real world, the distortions these represent do not come singly, but in combinations that may make our error harder to recognize. I will list a brief catalog of relevant standard illusions; you can use your experience to remember (or imagine) the effect of combinations.

Depth perception. Depth perception depends, beyond about a dozen feet, on perspective. Unless there are objects of known size in our field of view, we easily misinterpret distance. From a low-flying airplane, trees, telephone and electrical poles, houses and cars may let us judge distance. Of these, trees are the least reliable in mountains, because their size varies so much, especially with altitude.

Motion parallax (or its absence) is an adjunct to accurate depth perception, especially in circling flight. When we're high above a surface, it moves little when we circle; it shifts dramatically when we're low. This is also useful when flying straight, as distant object creep past, near ones zoom along quickly.

Oh, maybe we should define this: Motion parallax is a depth cue that results from motion of our head or body (to which it's normally attached). As we move, objects that are closer to us move farther across our field of view than those at a distance. Objects that move a lot as we circle are close.

Aerial perspective is another adjunct to depth perception, though less useful because there are so few straight lines in nature, and those created by man are not measured precisely, except in Iowa, where town roads are straight, perpendicular and precisely one statute mile apart.

We also use *texture gradient*, *overlapping* of objects, and *shadows* or shading to judge relative distance. There are two aspects to using such cues to judge distance. First, they are pretty good indications of *relative* distance. Second, they are all wretched measures of *actual* distance.

Constancy. We are structured to assume that things which look alike are the same size, that things which are nearly the same shape are possibly identical, and things move past at about the same speed. This is a help to accurate perception in familiar surroundings, where the things nearby have not changed. However, as soon as we climb that ladder in a thermal, nothing is constant anymore, and our instincts become liability.

Mountains and hills are notorious for being impossible to gauge accurately. This is a reason that photographers like to put objects of known size (spouses, children) in travel-landscape photos. We understand more clearly the monstrosity of Niagara when we see the tiny figure of 6'5" Brett wrapped in mist near its base.

Inconveniently, when we're running the ridge in Utah, we can't toss Brett out and see how he stacks up against the rocks. First, we're past and gone by the time he gets there, and besides, we'd miss him. Instead, we use experience, motion parallax, and healthy self-doubt about our own perceptual accuracy to keep a big margin.

The illusion of *autokinesis* was established by understanding that stationary lights seen isolated against the night may seem falsely to move. Nevertheless, this is simply one type of illusory movement (or immobility) that may occur with reduced visibility. Fog, mist, cloud, and dark obviously reduce visibility; if we lock our attention onto a single spot, such as the point on the ground around which we're turning, we become blind to all else, and the spot may continue to seem still even as we spiral toward it.

The *vection illusion* is familiar in city traffic: our car is felt to creep backwards; suddenly, we realize that it's the car beside us that is creeping forwards. Once, at a stoplight on a steep uphill in Duluth, my brother honked a warning as the car ahead drifted backwards down toward us. A second later, he hit us, and the driver was irate that we had impatiently struck him while the light was still red.

A moment's reflection will let us realize that this is simply a variation on the *constancy* illusions, only this constancy is of speed. We encounter this on every flight, for the ground hardly moves past, in turns or straight-ahead flight, when we're high; and at the same airspeed races past when we're low. I'm confident that this difference has deluded many pilots into making the ground slow down without attending to airspeed, leading to a stall or stall-spin.

This is important when turning close to the ridge: we feel a lot faster (ground speed) than we are (airspeed), especially downwind.

False horizon. In mountains below the peaks, there is often no true horizon, only a collection of false horizons. I think this is generally not so important in soaring because we normally don't fixate on the horizon for orientation the way an instrument airplane pilot might, but can easily cause us to incorrectly estimate the bank angle.

Gravitation and g-force illusions.

There is a nice collection of illusions that exist because the proper sensations of 3-dimensional orientation (tilt, bank, rotation, and acceleration) all assume a normal gravitational force is operating on the head. These illusions may cause us to misinterpret our bank angle, and may cause a spiral, spin, or stall when turning near the ridge or in mountains.

The *G-excess illusion* occurs when the

glider is in a steep turn, and the pilot looks into the turn and "up" (that is above the plane of the wings), for example, to look at the base of the cloud above or at another ship in the gaggle. This movement makes you feel as though you've lost the bank. The reflexive "correction" then produces an overbank, which can lead to a spiral and will at least reduce climb performance.

The *somatogyral* illusion may, I think, sometimes cause sloppy thermaling in rough air. It takes only about ten seconds of smooth air in a turn to "settle down" the fluids of the inner ear. Then, when we enter a part of the thermal that unbanks the glider, it *feels* as if we have begun a turn in the opposite direction.

The *Coriolis illusion* can have a similar effect without being recognized. If the glider is in a stable turn to the right, and we tip our head down to check a chart – excuse me, our PDA – our semicircular canals are now lined up differently with the rotation, and there will be a sudden sense that we have *turned* and rolled left. The reflex will be to step on the right rudder and steepen the bank.

I really don't think these illusions likely cause accidents, but I'm confident they often cause reflexive control movements which turn out not to fit the situation and are awkward; and I'm pretty sure that it gets blamed on turbulence, not on our perceptual limitations.

There are a number of other interesting illusions that I judge not to be likely to affect coordination and control in VMC (visual meteorological conditions), but if we enter cloud, it's been shown that even experienced pilots lose control in about 15 seconds.

(If you're ever caught in cloud, don't try to control the aircraft. Hold the controls in the center and manage airspeed with pitch and spoiler. Or just give up: let go of everything, pull spoiler, and hold both knees with your arms. This isn't "safe," but is better than trying to control the ship. If your glider has a benign spiral mode, this may be safe, but when I'm trying that out in my own glider, I am always suspicious about how well it's going to work inside a violent thunderstorm. I've read of pilots safely spinning out of cloud, but in low-performance ships, not in modern glass.)

Normally, we are saved from disastrous illusion by the fact that in VMC, our vision is used to build perception (*visual dominance)* and the sensations from the inner ear are made secondary, modifying influenced (*vestibular suppression).*

In VMC, the *Giant Hand* is not an illusion: it is due to the control forces being overwhelmed by large-scale turbulence, shear, lift, or sink. If the rotor is faster than your maximum roll rate, there is indeed a Giant Hand in command, and it's no illusion. This is what likely caused Josh's sense of being brought down by a giant hand.

I hope that you can see from this long list of built-in tendencies to perceptual error that there are many human reasons why Josh may have ended up on the rocks in a broken ship. However, there is another reason, as well:

Wind, thermals, and turbulence are invisible.

I don't know about you, but as long as the glider behaves as expected, I don't spend a lot of time worrying about whether my opinions on the behavior of wind and thermals are correct. I'm grateful for the wind calculation of my flight computer, and actually tend to believe it, for even if it's wrong, I can't know in which direction the error lies.

But "local wind" (as induced by thermal effects) may be vastly different from the gradient wind. The greatest risk of a crosswind landing, even on the prairie, is that the invisible turbulence in the friction layer near the ground may cause a stall, wingtip strike, or flip.

A few years ago, a pilot with three teens was landing in a crosswind at the prairie airport in Faribault, Minnesota. As he flared, he was observed to roll inverted, land on his canopy, and burn. Everyone died. Most of us were trained to worry about loss of directional control in a crosswind landing. That is the least of the risks.

Last September, I was landing my own glider in a crosswind at my home prairie airport. The only surprise was that no crab was needed on short final. As I leveled to flare, the ASI dropped from 55 to 35 knots smacking the ship down hard, damaging the ship but not me.

In the mountains, there are many more possibilities for invisible wrinkles and potholes and inversion-inducing turbulence. Henry Coombs nearly lost a friend in May, 1984, who was climbing along the face of a mountain in the late morning in lift of only 200 fpm when he was thrown into the rocks by something that Henry christened "The Sinister Trap" in a *Soaring* article published in September, 1984.

I was at a soaring XC camp at Air Sailing in 1995. A delightful professional pilot named Joe Finley gave a lecture on the invisible dangers of mountain thermals, especially outlining the powers of The Sinister Trap. Ironically, Joe died in the Sierras in such a trap in 2002.

So we see that Josh may have flown awkwardly, perhaps been even "illusioned" into a stall which put him into the rocks – or he may have flown into air which was flowing entirely the wrong way at the moment he entered it. I don't know what to recommend, except, *don't go close to the rocks*. Henry Coombs and JJ Sinclair have detailed advice in their articles cited below, which are worth downloading, saving, and studying.

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