## SOARING Rx

BY DR. DANIEL L. JOHNSON

# Mindset

*Expectation Governs Action*

**Flying the invisible air.**

The day was blue. The forecast estimated 3-5 kt thermals as high as 5k agl, yet the winds in the boundary layer were to be southwesterly at about 25 kt. In the central plains, a doubtful situation for soaring success, yet Dan felt compelled to find out for himself.

At takeoff, the wind was 190 degrees, 0 kt gusting to 20 kt. He took off on runway 18, and was a little surprised a 20-degree right crab was needed to stay over the centerline.

He took a high tow, 3000 ft, expecting to have trouble contacting usable lift. Indeed, he did – there was some turbulence, but no organized, workable thermals. There was nothing to climb in. His flight computer estimated the wind aloft to be 230 degrees at 24 kt. He worked his way back to the field.

While he flew, he thought about this wind direction. The choice was runway 27 or 18. He knew, from his sailing days, that gusts were the gradient wind brought down from aloft, so the lulls now would be more southerly and the gusts more westerly.

He considered the fact that runway 27 was flanked on the south by a smooth, mown 100 ft x 2500 ft grass margin, an unofficial parallel runway he'd used many times. Landing on this would ensure that there would be no side loads on the gear if a crosswind gust required a lot of crab. It was an easy decision.

He joined the pattern, flew rapidly downwind. Gear down and locked, landing flaps set, 55 kt approach speed. AWOS reported the wind being 210 at 12 kt gusting to 18. Six knot gust factor – not too bad.

He flew a high approach to accommodate to a headwind on final. After turning final, his apparent landing point – his aim point – was at the far end of the grass strip, so when sure of making the field, he deployed full spoiler until the aim point was just past the PAPI lights that he had to pass over. He kept the airspeed 55-60 kt because of the wind and gustiness, and because he'd long ago learned that the round-out to stall from a rapid full-spoiler descent required about 15 kt of airspeed.

The ground speed seemed as slow as expected with a 25-kt headwind. Little crab was needed. The wind must have shifted, he thought. The air was bumpy. At about 50 ft agl, the airspeed abruptly dropped below 50 kt and the air felt soft. Into the friction layer, he thought. There was no crosswind at all here.

The glider dropped a bit as he stowed the spoilers to nearly closed and lowered the nose to get back to 55 kt. The ground speed picked up. Hardly any crab was needed. He crossed low over the PAPI lights. The dry, brown grass looked inviting.

The situation felt calm and comfortable. His mindset unconsciously shifted from a wheel landing in turbulence to a low-energy landing on the grass. He let the glider descend to about 5 ft agl, then leveled to slow the descent to permit a soft touchdown. He watched the grass to the left, looking past the airspeed indicator at the ground.

As he leveled, suddenly the controls went slack. The needle of the airspeed indicator swung swiftly past 40 kt, from about 50 to about 30. Stall speed is 38 kt. The glider simply dropped. As it dropped, he pulled full spoiler to limit any aerodynamic bounce in case the back side of this lull had a gust. The glider hit hard, in landing configuration, simultaneously on the tail wheel and main. It bounced a bit, and Dan bounced in the cockpit with it. His knees lifted the panel, and he saw the panel-mounted wet compass punch through the canopy.

The glider stopped too quickly. He felt sad. He looked down, and saw the gear lever unlocked. For a moment, he felt stupid, then remembered locking it on final. It's not an over-center design.

He got out and walked back. The wheel made a long mark where he'd landed, then no mark for a few feet where it bounced, afterwards another wheel-mark. There the gear doors were knifed vertically into the ground. Well, that proved they'd been open...

He fetched a couple of friends. They took photos, then raised the glider. The gear lowered and locked securely. He put on the tail and wing dollies and towed it back to the hangar. He disassembled it, inspecting it as he did so. No other damage was apparent. The season had ended.

**What happened?**

*He probably flew into the back side of a dust-free dust devil.* There seems no other good explanation for a 20-kt drop in airspeed with a 6-kt gust factor.

Should Dan have flown differently? How would he know he needed to? He was planning a wheel landing, yet within a few feet of the ground felt secure to stop the descent. A stall landing is not as safe as a higher-speed wheel landing in stronger winds, which are always gusty. ("Gusty" means "big, unpredictable airspeed variations" and this is not a good thing near stall speed).

Perhaps most important, his mindset – his expectation – did not include the possibility of a 20-kt lull. It certainly will in the future! And he'll be practicing wheel landings more often. However, my point is that he did have a mindset, and we always do – our mindset both helps us land adroitly in normal conditions and hinders adaptation to the unexpected.

**The Mistimed Tailwind**

In a distant part of the soaring universe, the mountain West, at another time, Dave was returning to the home field. The sky wasn't threatening. The cloud above the field dropped no rain – but the cloud was apparently coughing hard, as in the pattern Dave had to make rapid full aileron deflections from one side to the other from turbulence to stay upright.

He looked at the ground. All seemed calm there. People were walking around, handling gliders normally. It seemed incongruous to him, but he had his mind fully occupied with flying a safe pattern through this upheaval.

After he established on final, the air was much smoother. A relief.

He touched down normally, at a higher speed than usual because of the turbulence he'd gone through. Suddenly, he was overtaken by a huge wind shift. All control effectiveness vanished; all he had was the wheel brake. As he slowed, the glider was all over the runway, but it managed not to hit anything. His friend Rob ran up to catch a wingtip.

When Dave felt brave enough to lift the rear-opening canopy in the unknown tailwind, Rob said, "Pretty spectacular." (smirk)

"Yeah," said Dave. "You have no idea. Better to be lucky than good. Hope that's once in a lifetime!"

**What happened?**

He had been overtaken by an (invisible) rain-free down burst, creating a strong tailwind during rollout that took effective airspeed to about zero, removing directional control. In the desert West, cumulus bases may be very high. They may have only a wisp of virga to signal a down burst, but this is invisible from below. The only sign of the down burst may be an inverted mushroom cloud of dust where it hits dry dirt far below cloud base.

**Virga is dangerous.**

On another flight, in Utah, Dave had completed the day's task, but a pitot-static system malfunction had left him with only altimeter (hopefully not too far off) and no airspeed or Vario, so he stayed high and fast. He was about 4000 ft agl southbound just 3 miles from home. The sky didn't look threatening; there was a friendly cloud a little ahead dangling a virga beard.

He flew through it. Suddenly, the controls got squishy (a technical term meaning "loss of aerodynamic effectiveness due to slow air flow"). He put the nose down, watched the buildings get bigger while he waited for the glider to gain enough airspeed to get control effectiveness. At about 1000 agl he could level off, moving fast. He arrived over the airfield southbound, about 500 ft agl. The midfield wind sock was limp. The north-south runway was long. The gliders were staged at its south end, so landing to the south seemed convenient.

For a pattern, he simply made a big, left 360 around the wind sock. In the westbound arc of the turn, he noticed that he was drifting rapidly sideways to the left. A couple hundred feet below, the windsock was still limp.

Now he was too low to do a 270 to land northbound, so he put out full flaps and spoilers, dove for the ground, and leveled out going fast in what was now a strong tailwind. Déjà vu, the controls went squishy long before it was convenient. Brake squealing, he stopped just five feet from the end of the runway. He didn't dare to lift the canopy, for fear the tailwind would tear it off. ☛

**What happened?**

The down burst that had dumped him 3000 ft had arrived at the field just after he did, creating a very nonstandard situation. Three other pilots met with the same down burst; one made it back to the field; two were forced to the ground with damage to their ships, and psychological rather than physical damage to the pilots.

These pilots all flew through the invisible air that turned out not to be doing what their mindset was ready for. Virga is visible, but is only a warning of dense cold air plunging invisibly beyond and below it, accelerating downward through the warm surrounding air. Similarly, there is not always dust in a dust devil, and when it is present, it marks only the center.

As you may recall, my thesis underlying these columns are that accidents are inevitable because of the operating characteristics – the built-in functions, limitations, and structure – of our perceptual systems. Today's particular limitation is the invisibility of air. Conversely, with similar risk, its opacity in a cloud. In either case, the air's next surprise is invisible and unknowable.

We fly as if the air is relatively uniform; as if the air is the way we expect it to be; as if it will continue to be as it is at least for the next few moments. And were because it usually is consistent (if not uniform), we smugly, complacently, think that we're successful because we right. The truth is, what we didn't see, didn't worry us.

**Truth v. Fact**

To put it bluntly, we commonly confuse truth and fact in all facets of life, not just flying aircraft. Truth is a rational construction based on presuppositions, bolstered by observations. Fact is what is really out there. It may or may not be verifiable, but it's what hits us in the face. (Note to attorneys: I know you define these differently, but I need this distinction to make the pedagogical point here.)

Truth is what guides decision and judgment; fact corrects or enlarges truth. Meteorology is "truth," today's weather is fact. Aerodynamics is truth, the oil streaks on the winglet are fact.

The important point here is that truth is not always correct! It may involve unrealistic assumptions, inadequate theory, or poor observations. Nevertheless, we need "truth," for it provides a framework with which we can organize facts. Though the truth is inadequate, we can't understand the significance of facts without it. Those that don't fit well should cause us to modify the truths that seem so self-evident.

We call scientific truth "theory" to emphasize that, no matter how good it seems, it's open to revision. We call religious truth "faith" to emphasize that, no matter how convinced we may be of its veracity, it's unverifiable.

What we call "sanity" requires something that the psychiatrists call "reality-testing:" continually noticing the facts that strike us, always asking whether they clash with our truths, and changing assumptions, rationales, priorities, or protocols to better fit the facts we meet.

In aviation "truth" produces mindset; "fact" blows it up. We must train to achieve safe and effective mindsets. At the same time, it's a challenge to train pilots to be always ready to modify the procedures when some event clashes with our expectations. Careful protocols combined with a readiness to be found wrong is the key to excellence and safety.

**The importance of mindset.**

We cannot live effectively without making realistic assumptions about what is significant, how the world around us is organized, how human and mechanical systems function; in short, what will occur in the future. This is mindset.

When our mindset matches reality, we can do amazing things with great skill and rapidity, intellectually or in sports.

When reality deviates from normal – betrays us – our mindset creates unfortunate decisions. Sometimes bad luck is truly the cause: reality changes too abruptly to perceive it, or to react. Or reality might ooze off in a curve too subtly to notice while we continue as usual.

However, sometimes we are oblivious to changes, because we don't expect them, that are glaringly obvious to others. Mindset can prevent us from perceiving the unexpected; in fact, mindset can cause us to perceive falsely that conditions are the way we expect them to be, and this happens at the subconscious level.

Some mindset phenomena are built into our perceptual system. For example, in a glide, we are gradually descending; the world is progressively moving up to meet us. If we gently, swiftly apply back pressure to arrest the descent, we perceive what we expect. Ingenious testing can show that our eyes automatically move as if we have gone halfway even before we get there, and if nothing else interferes to correct this, after actually leveling, we automatically resume the descent at about half the previous rate – all the while believing that we're level.

Other mindsets are built on habit – not merely habits of action, but habitual perception: we sense what we expect to. This is why the less-experienced pilot, though not as adept, is to a lesser degree prone to inflexibility and to a lesser degree likely to make presumptuous errors: he has neither habit nor expectations yet built in.

So – though maladroit awkwardness belongs to the neophyte, his blessing is that with naivete, there are no expectations. This may permit remarkable responsiveness to change. Complementing this, skilled flight into catastrophe may afflict the experienced pilot who has years of routine firmly lodged in long-term memory.

**The Brain is Built for Mindset.**

The brain is, essentially, a powerful pattern-recognition engine, as has been recognized for over 40 years. We perceive patterns; we store patterns in memory; we compare patterns during reasoning and recall. There are patterns of perception, of thought, and of action. Musicians don't play note by note; they play patterns: scales, arpeggios, chords, etc., that they perceive in toto, and memorize or play in segments.

These patterns mold expectation, for we live in the flow of time. One of the most important functions of the brain is thus to recognize and predict patterns. The brain is very good at this. This is what allows elite athletes to anticipate accurately the movement of the ball, an opponent, or a teammate in a complex game situation.

Our own collection of patterns – including patterns of change over time – form our mindset. Mindset describes both a static recognition of what is and a dynamic recognition what's happening as time flows along.

Air carrier operations involve massive expense and major tragedy when a flight goes wrong. One of the newer ways to view the approach to this is TEM, threat and error management. It is organized around some straightforward principles:

**Threat and Error Management**

1: Human error is inevitable.

2: Unpredictable adverse events do occur.

Based on analysis, history, training and experience:

- What is the situation?
- What are the likely hazards?
- What are my likely errors?

Form a plan (predictive pattern)

- Consider options:
- Rule-based decisions (standard procedures)
- Knowledge-based decisions (recognize uniqueness)
- Flexibility

Still: Even with the best training, the most accurate perception and analysis, great skill –

- The future is unknowable,
- The air is invisible (or opaque, in a cloud), and;
- Unforeseen bad things do happen.

We can reduce but never eliminate catastrophe.

***Interesting Reading:***

**On Intelligence**. Jeff Hawkins and Sandra Blakeslee, Times Books, Henry Holt and Co: 2004, ISBN 0-8050-7456-2. Mr. Hawkins invented the Graffiti handwriting recognition system and the Palm Pilot. In this non-technical book, a biography of ideas, he describes the brain as a time-dynamic, memory-dependent pattern-recognition engine. It's short and readable. It raises the interesting questions. His ideas, that the brain is a pattern-recognition engine with computational dynamics, are not new, yet he pulls them together freshly.

If you want technical stuff, go to http://redwood.berkeley.edu/seminars.php, list of online seminars for the research center he founded, the Redwood Center for Theoretical Neuroscience.

**Defensive Flying for Pilots**: An Introduction to Threat and Error Management. Ashleigh Merritt, Ph.D. James Klinect, Ph.D. The University of Texas Human Factors Research Project; The LOSA Collaborative; December 12, 2006. (Google site:utexas.edu "TEM. paper") http://homepage.psy.utexas.edu/homepage/group/helmreichlab/publications/pubfiles/TEM.Paper.12.6.06.pdf One of the first papers on TEM.

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