HG401
Advanced Techniques & Concepts
Pushing OUT

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It's easy to define the (only) two times when less experienced pilots should push out—when they want to land (flare) and when they want to crash. Pushing out reduces airspeed by raising the angle of attack of our wing, which drastically impacts the roll response of our glider and hinders in-flight lateral control. New and low-airtime pilots should be flying forgiving single-surface wings, which do a great job of finding the appropriate "trim" position and speed for nearly every situation.

However, some advanced techniques involve pushing out. I will describe a few, but first, I would like to identify some risks involved. The first and most obvious is the greatly reduced lateral control that accompanies pushing out. The cause of this is two-fold: The more air we have flowing over our wings, the more force the same amount of "deflection" is created in the sail. (Easy example: sticking your hand out the car window at 20 mph compared to 80 mph: more airflow, more force.) The less recognized factor comes from flying tail-less aircraft and having swept wings with washout, where the tips are at a much lower angle of attack than the center of the wing. When we push out and fly very slowly, more of the wing is at a positive angle of attack, making the effective wingspan of the glider larger. As we decrease our angle of attack and fly faster, more of the wing actually sees a negative angle of attack, shortening the effective wingspan of a glider. This is pretty complex and something fairly unique to hang gliders. But changes in effective wingspan can have a HUGE impact on handling. In simple terms, shorter wings roll easier.

Loss of lateral control isn't even the biggest risk in pushing out. The more you push out, the easier it is for your glider to tumble. Again, the cause is two-fold. First, pushing out changes the center of mass of the wing. There is a direct relationship between center of mass and pitch stability. A simple example is a dart (heavy at one end, very light with lots of drag at the other). No matter how you throw a dart, it will eventually stabilize in a "nose down" orientation. The opposite example is a sheet of paper; each side is balanced, with equal weight and equal drag. Hold up a sheet of paper and drop it, and it will not stabilize in any particular orientation at all. Pulling in, in a hang glider, drastically increases pitch stability, while pushing out reduces it considerably. It does not matter if a glider is certified to be "pitch stable"; when you push out, you alter the stability.

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The other factor that increases the risk of tumble comes from the very low airspeed associated with pushing out and how our pitch-stability systems work. Pitch-stability systems

OPPOSITE Pushing out on a high-performance glider, especially with a lot of VG on, can easily result in a tip stall and even a spin entry. Spins are THE most dangerous aerobatic maneuver because of their unpredictability and the minimal airspeed, which can keep the pitch-stability systems from being effective in preventing a tumble.

create a nose-up restorative force, which we experience as bar pressure. When you pull in to lower the nose, the wing "fights" that input. With limited airflow over the wing, the twist of the wing and the low angle of attack of the tips produce minimal nose-up force. Worse still, without airflow over the wing, there is very little resistance to a nose-down "tuck" rotation. The problem can arise because we hang well below the wing and weigh much more than our wings. In a low-airspeed, nose-up stall, or when falling out of a thermal while pushing out, the pitching-forward rotation can happen so quickly that the inertia of that rotation can continue past vertical and carry you into a tumble. The glider's swept wings and pitch systems work against this by damping—not preventing—that pitching rotation. The more airflow over the wing, the more those systems can slow that nose-down rotation, limiting the amount of inertia that builds up.

These days, a hang glider tumble is very, very rare. Most of today's gliders are designed, tested, and certified for strength and stability. Today, there is no reason to risk flying a wing that hasn't been tested and certified. In smooth air, a pilot would have to do everything *just right* (or is that *just wrong*?) to cause a tumble. But when we start flying in soarable conditions, we need to be very careful not to unwittingly facilitate a tumble. The more soarable (read: turbulent) it gets, the more careful we need to be. The key here is to fully understand that pushing out and flying slowly comes with significant risk.

After reading all of this, why would *anyone* want to push out other than when they are landing? Well, when doing 360s, flying slower reduces the diameter of our 360s for a given bank angle. In small and light lift, the art of staying up is keeping the glider in that lift. Flying too fast can make your 360s too big. If your glider is trimmed correctly, trim speed should be right about where you get your best sink rate, so pushing out will actually increase your sink rate. Sinking a bit faster in rising air can be better than sinking slower in still air, or, worse still, sinking slower in the sink surrounding the thermal. In this situation, pushing out is both a managed risk AND a compromise. How much pushing out is relatively safe, or even beneficial, is highly dependent on the situation—which only veteran pilots have the experience to evaluate accurately.

What's a bit safer than flying around pushed out and slow is using short pitch inputs as a tool, when trying to position your glider in a thermal. In a bank, a quick-but-smooth push out can help tighten that side of your 360. If you are in a thermal and you recognize that the strongest part is behind you, speeding up your direction-change can make the difference between turning in light lift at the edge of the thermal or turning in the big sink just outside of the thermal. Of course, the risk, if you time it wrong, is that you'll be exiting the thermal pushed out with low airspeed/energy, which is, again, why this is something only advanced pilots should even

consider. It takes an advanced pilot's expertise to know when it's an acceptable risk and when it's a really, really bad idea. It's important to note that this technique is NOT pushing out and holding it; it is just a quick pitch input to change direction faster and then return to the speed at which you were originally climbing.

Another time when an advanced pilot might choose to push out is when a very quick roll input is needed. Pushing out momentarily increases our G-loading, essentially making one's body weigh more. Because we fly weight-shift wings, weighing more means more control. The catch with this technique is that in smooth air we already have plenty of roll control, so this technique gets used more in strong thermals or rougher air. In rough air, you don't want to get caught pushed out and slow, so this technique works best if you're flying a little fast to begin with (which we usually are in rough air) and are using a quick stab in pitch combined with roll inputs, only when needed. Again, this is a risk-management scenario, where pushing out can be pretty risky when timed wrong—but if a thermal turns you toward the hill, this technique can save your bacon. Back in the day when gliders were much harder to turn, this was commonly called a "J turn," where you pull in first to gain speed, shift your weight to the side, and then push out to load up the wing, moving your body in the shape of the letter J. Modern wings don't need this excessive input on a regular basis, only in crucial or dire situations.

There are more scenarios where pushing out might have some benefit, but they always comes with risks, as described above. Expert pilots can draw from their experience to evaluate each situation's risks and potential rewards and then decide if pushing out not only suits the situation but also is worth the additional risks. I, once again, urge newer pilots to keep it simple and only push out when they want to land or want to crash.

My final request regarding this topic: If you see someone pushing out and feel they are not being wise about it—since many don't grasp the risks associated with pushing out—please, please educate them. We're all in this together, and keeping each other safe and flying well benefits all! Variable center-of-mass and pitch stability is a topic every tail-less aircraft (hang glider) pilot needs to understand.

OPPOSITE Flying slowly with the bar out past your face, especially in big mountain air, is most often a big risk not worth the minimal reward. **ABOVE** Pushing out—when you want to land, or when you want to crash?