



# FANTASTIC FOUR



## FUNDAMENTALS

BY TOM HOFFMANN

### Unlocking the "Superpowers" of Basic Airmanship

I was never much into comic books as a kid. My older brother, on the other hand, was an avid collector of what I assumed were rare, early-edition comics since they were strictly off limits. But not all of his comics were sentenced to a life of being hermetically sealed in a plastic sleeve. Among the few issues that piqued my interest, and that I was also allowed to touch, were Marvel Comics' *Fantastic Four* series. Notwithstanding my comic book snobbery, I found this team of mismatched heroes oddly curious and I was fascinated by their unique and complementary superpowers. Incidentally, this was creator Stan Lee's first stab at using a superhero team, a concept that would later thrive in future series he and other writers would develop. As is the case for many teams, power struggles and family squabbles ensued. Despite some inner strife, this team of super-stretchy, disappearing, flame-throwing, and fist-pounding heroes worked harmoniously and ultimately knew what it took to save the day.

So what do superhero superpowers have to do with aviation? A lot! While we may not initially regard them as having superpowers, you might say there is a Fantastic Four team hard at work during every flight. I'm referring, of course, to the four

fundamental flight maneuvers: *straight-and-level flight, turns, climbs, and descents*. These four basic skills, first presented on every aviator's first few flight lessons, are the building blocks for all flying tasks. Student pilots soon learn that a healthy respect and mastery of these basic skills can unlock all kinds of superpower potential.

Of course that doesn't mean you'll fly as fast as a speeding bullet or be more powerful than a locomotive. But it does mean you'll be equipped to "save the day" by capably handling any situation that comes your way. So let's have a look at each of these skills, explore some common execution errors, and review ways you can fine tune your basic airmanship superpowers.

#### In the Beginning ...

As noted earlier, it is imperative for new pilots to understand and execute the four fundamental flight maneuvers. Primary training sets the tone for how well successive flight training and future aviation endeavors will go. If these critical skills are not taught properly in the first 10 to 20 hours of instruction, it is possible pilots may never fully master them.

Experienced pilots have a different issue.



Some veteran pilots mistakenly liken flying an airplane to riding a bike. Consequently, they give short shrift to the notion of practicing these basic skills, an omission that can allow shortcuts, sloppy habits, or a period of inactivity to bite them in the you-know-what. Those “permanently ingrained” skills are actually quite perishable. NTSB aviation accident reports are replete with instances where incorrect control inputs, or a failure to recognize an airspeed reduction or an encroaching stall had deadly results.

The common denominator here for *all* pilots — novice to expert — is practice, practice, and more practice.

### Feel the Power

In my early flight training days, my instructor would routinely admonish my death-grip on the controls and rap my hands with a sectional chart. “No ‘white-knuckling,’” he would say. Even though it robbed me of the ability to more accurately “feel” the airplane — not to mention the sheer physical exhaustion it caused — this habit was hard to break. Using fingertip control and mastering the trim made all the difference in the world.

In addition to feeling the flight controls, pilots can gather important sensory perception clues from hearing and sensing aircraft reactions during flight (e.g., the varying sound of wind against the windshield, engine sounds in different attitude configurations, or the G-force loading sensed during turns or climbs.) Being aware of these seat-of-your-pants flying sensations is an important element of under-

standing and interpreting what is actually happening during various conditions of flight.

The use of visual cue techniques is another important part of early training. When combined with snap-shot reference to cockpit instruments, this type of integrated instruction can be very effective in helping pilots maintain desired attitudes and aircraft control. There are several tips and tricks that can help pilots to master this technique — many of which offer the ability to have some fun at the same time.

One such tip is from FAA Aviation Safety Inspector and National FAAS Team member Fred Kaiser.

Kaiser has his beginning flight students visualize key reference points before ever leaving the ground.

“I taxi the aircraft to a location where I can put it on the centerline of a long, straight taxiway. Students can see the centerline and get a good view of the horizon,” he explains. “After shutting down, I place a piece of mask-

ing tape down the cowlings that lines up with the taxiway centerline from the pilot’s per-

spective in the left seat.” Kaiser also marks the spot on the tape where the horizon crosses through the windshield just above the tape.

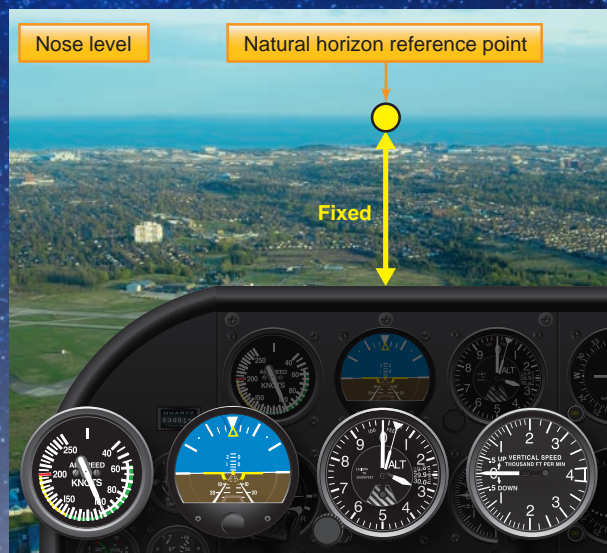
This exercise gives the pilot a solid reference for where the center of the airplane is, and a reference to where the horizon should be in straight-and-level flight. Though designed for a beginner, this technique could also aid an experienced pilot’s transition to a new type of aircraft.

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**The four fundamental flight maneuvers, straight-and-level flight, turns, climbs, and descents, are the building blocks for all flying tasks.**

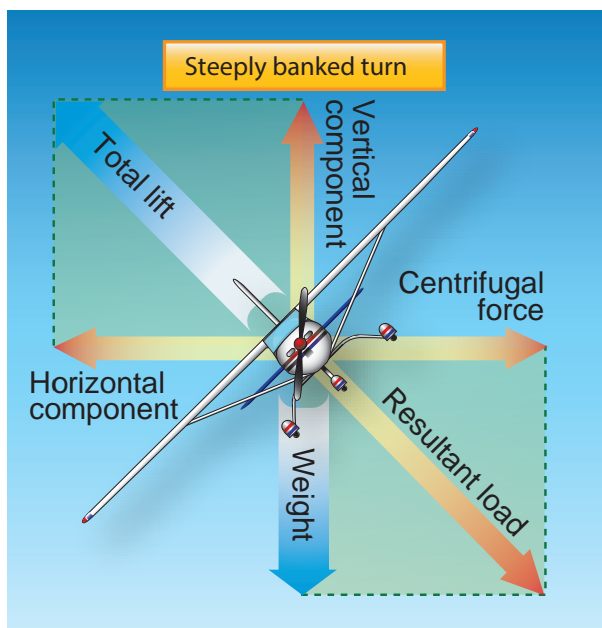
### On the Straight and Level

The first of the four fundamental flight maneuvers, straight-and-level flight, is a condition in which you are essentially preventing the other three basics (turns, climbs, and descents) from happening. It requires you to detect deviations in direction and altitude as soon as they occur and apply flight control corrections precisely, smoothly, and accurately. This further reinforces the benefit of a light touch, with just enough of an input to correct the deviation, and not overcontrol the aircraft. With proper trim and smooth air, control inputs may not even be necessary. The altimeter and attitude indicator can help with maintaining a straight-and-level condition, but your primary source should be the natural horizon in relation to a reference point on the nose



*Nose reference for straight-and-level flight*





**An illustration of the vector-based lift forces in a turn.**

of the aircraft, as well as off each wingtip. This last bit is an important point, since a common error is to try holding the aircraft straight and level by using the nose alone as a reference. This practice can result in dragging one wing low while using rudder pressure to compensate. Scanning both wingtip reference points also has the benefit of helping you scan for traffic, terrain, weather, and improving your overall situational awareness.

### To Everything — Turn, Turn, Turn

I recall learning the definition of a turn as one of those memorable “say what?” moments in my fledgling flying days. “Horizontal component of lift overcoming centrifugal force” seemed like a mouthful for a 16-year-old to recite, let alone comprehend. Some good ground instruction, along with a few crude drawings quickly cleared up my understanding of the vector-based lift forces and how the four primary controls (ailerons, elevator, rudder, and throttle) all play a role in executing a coordinated turn. Ailerons bank the wings and determine the rate of turn; the

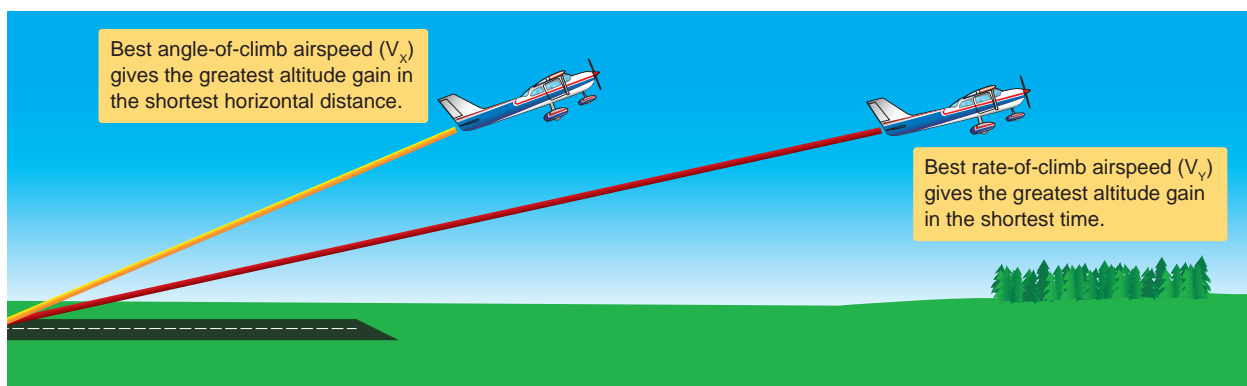
elevator increases the vertical component of lift needed to maintain level flight; the rudder coordinates the turn by counteracting adverse yaw; and the throttle provides thrust which may be used for airspeed to tighten the turn. Integrating these inputs is important because uncoordinated turns can lead to loss of control incidents, especially during low altitude maneuvers. Good turn coordination also goes back to being able to “feel” the airplane, and recognize slips and skids without having to rely on instruments.

As with other maneuvers, always make turns with smooth, precise, and accurate flight control inputs along with outside visual reference points when able. Depending on the bank angle, the degree and type of control input will vary. Shallow turns require a bit more aileron input during the turn to overcome the aircraft’s natural stability, whereas with steep turns, the tendency of the aircraft to overbank must be countered with aileron input opposite the turn.

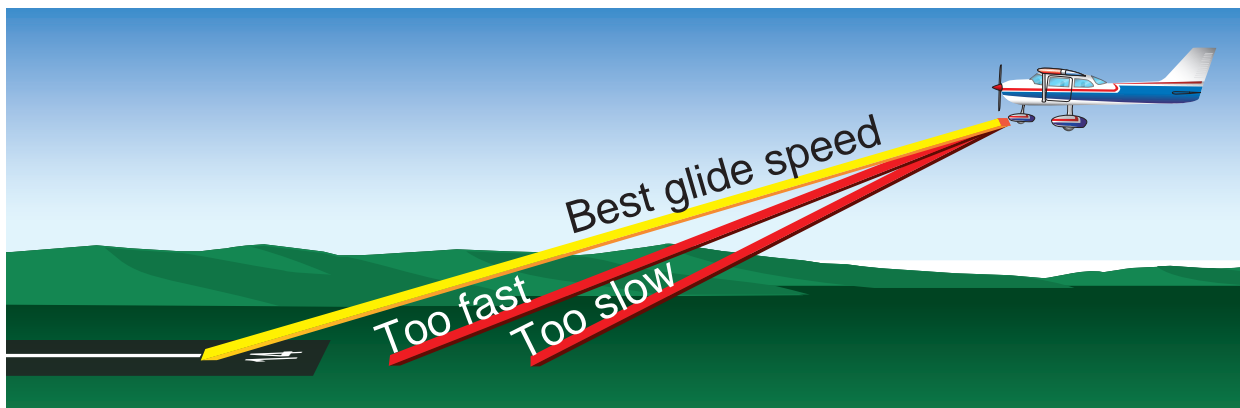
### What Goes Up ...

I’m sure the *Fantastic Four’s* Human Torch goes by a different set of rules when blazing through the skies, but for us pilots, the ability to climb is limited by the thrust available. It is therefore important to know the appropriate power settings and pitch attitudes that will give you the climb performance you need.

For example, to achieve the best rate of climb ( $V_y$ ), use the airspeed where the most excess power is available over what’s required for level flight.  $V_y$  provides the greatest gain in altitude in the least amount of time. Resist the notion that increasing pitch attitude here will give additional altitude gain. Although pulling up for a faster climb might seem intuitive, especially in a high stress situation, it will in fact decrease the rate of altitude gain.



**Best angle of climb versus best rate of climb.**



**Best glide speed provides the greatest forward distance for a given loss of altitude.**

To achieve the best angle of climb ( $V_x$ ), which is a considerably lower airspeed than  $V_y$ , use the airspeed where the most excessive thrust is available over what's required for level flight. This steeper climb configuration will get you greater altitude over a given distance and help you clear those trees looming upwind after takeoff.

Remember too that with adequate right rudder during a climb, you have the power to ward off those left-turning tendencies conspiring to steer you off course.

### ... Must Come Down

As with climbs, pilots should be familiar with the appropriate pitch and power settings required to execute different types of descents. The key to maintaining balance and order during descent is recognizing the need to offset surplus thrust — caused by the reduction in lift and induced drag — by decreasing power.

However, it's often the strictly gravity-powered descents that require the most attention. During a glide, lift and gravity tend to have a bit of a tug-of-war struggle. Gravity inevitably wins, but the key is trying to gain as much forward motion as possible before reaching terra firma. Without power, pitch control is your biggest ally in maintaining a best glide speed, the speed that strikes a delicate “Goldilocks-like” balance between induced and parasite drag. In other words, maintaining anything other than best glide speed will cause your rate of descent to increase.

This cardinal rule gets many pilots in trouble, especially when faced with an inflight engine failure at low altitude. Sadly, there have been far too many failed attempts to “stretch” a glide by pulling back and decreasing airspeed. The physics never favor the pilot, and will invariably lead to an increased descent rate and sometimes an inadvertent stall.

When maintaining best glide speed, use outside visual references to aid in your pitch control and make the trim your new best friend. Note how everything looks, feels, and sounds in this configuration as well,

so that you will be quickly and intuitively aware of variations that require an adjustment.

### Use Your Power Wisely

Much has changed in aviation in the last 100 years, but the importance of learning and mastering the four fundamental flight maneuvers is a constant. These “fantastic four” skills comprise the very core of basic airmanship and provide critical insight into the aerodynamic laws that govern our ability to fly. They're also key components in defeating the archenemy of pilots — loss of control.

Whether you're a fledgling flyer or a practiced pilot, avoid the “one and done” mentality when it comes to learning the four fundamentals. Instead, make sharpening these skills a regular part of your everyday flight plans. Honing these skills may not help you save the universe, but they most certainly can help you live to fly another day ... which is always a feat worthy of superhero status. ✈️

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**A healthy respect and mastery of basic skills can unlock all kinds of superpower potential.**

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### Learn More

**FAA Airplane Flying Handbook (FAA-H-8083-3B), Chapter 3, Basic Flight Maneuvers**  
<https://go.usa.gov/xnNKZ>