Spatial Disorientation

Confusion that Kills

Blue Side Up

We humans are VFR-only creatures. The senses we use to maintain our balance and know "which end is up" are completely unreliable when our bodies are in motion without visual reference to the world around us. Pilots deprived of visual references while flying can quickly lose control of the aircraft and succumb to one of general aviation's killers: spatial disorientation.

Spatial Disorientation: What Is It?

Spatial disorientation is the mistaken perception of one's position and motion relative to the earth. Any condition that deprives the pilot of natural, visual references to maintain orientation, such as clouds, fog, haze, darkness, terrain or sky backgrounds with indistinct contrast (such as arctic whiteout or clear, moonless skies over water) can rapidly cause spatial disorientation. Pilots can compensate by learning to fly by reference to their instruments. But a malfunction of flight instruments, such as a vacuum failure, in conditions of reduced visibility can also end in spatial disorientation, with the same lethal results.

While the physiology and dangers of spatial disorientation are taught during primary and instrument flight training, general aviation pilots still have misunderstandings about what it is and how to deal with it. And the accidents it causes continue to claim the lives of too many pilots and passengers every year.

Pilots deprived of visual references while flying can quickly lose control of the aircraft and succumb to one of general aviation's biggest killers.

Maintaining Orientation

Are you sitting up or lying down? Leaning one way or another? Three sensory systems give us the information we use to maintain our equilibrium and determine where we are and how we're oriented:

- **Visual system** – Our eyes, which sense position based on what we see.
- **Vestibular system** – Organs found in the inner ear that sense position by the way we're balanced.
- **Somatosensory system** – Nerves in the skin, muscles, and joints, which, along with hearing, sense position based on gravity, feeling, and sound.

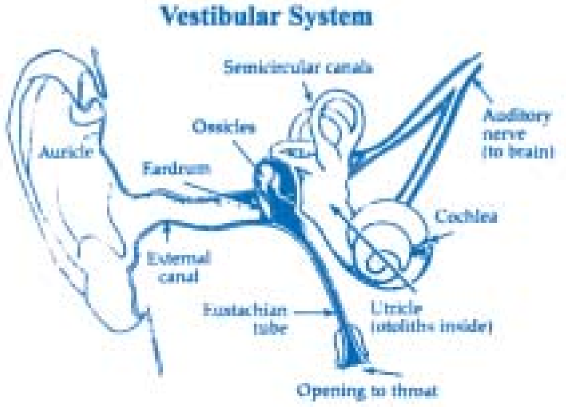
Knowing how each of these systems operates helps explain how spatial disorientation develops, and how to minimize your chances of experiencing it.

Visual System

Ninety percent of the information we use for point of reference comes from our eyes. The most reliable of our senses, vision overrides conflicting sensations from our other systems. When we fly in visual meteorological conditions (VMC), our vision enables us to keep the airplane properly oriented to Earth by reference to the ground, sky, and horizon. Such is its power that we're rarely aware when our brain receives conflicting signals from other systems. Vision is relatively reliable, but it's prone to illusions, mistakes in processing or interpreting what we see, that can result in spatial disorientation.

Vestibular System

The vestibular system, also called the kinesthetic senses, is our secondary positioning system, consisting of motion- and gravity-sensing organs. The system is redundant; there's one in each inner ear, each capable of providing the brain with all the information needed to maintain balance. They can, however, be compromised by several factors: when sick, inebriated, hung over, dizzy, or nauseous, our internal gyros don't function properly. Also, this system can only supplement, not replace, vision for maintaining orientation while airborne. Each vestibular apparatus has two structures: semicircular canals and otolith organs.



Semicircular canals

The semicircular canals each have three perpendicular tubes containing fluid and sensory hairs. As the body moves, the motion of the fluid in the canals provides the brain with roll, pitch, and yaw information. This system can even substitute for sight while on the ground; if you close your eyes, you can still walk, or sense whether you're upright or lying down.

However, there are some limitations, such as when a turn commences in the air, the inertia of the fluid moves in the opposite direction relative to the sensory hairs, and we correctly interpret the turn and its direction. But if the turn continues, the fluid catches up, creating the sensation that the turn has ceased. Therefore, a prolonged constant rate turn results in the false sensation of not turning at all. When the turn finally does stop, due to inertia the fluid continues moving, creating the sensation of a turn in the opposite direction. Additionally, any bank rate of less than two degrees per second is insufficient to stimulate the fluid in the canals, and will not be felt. Considering that a standard rate turn is three degrees per second, you can understand how, without visual reference, it's possible to enter a bank that becomes progressively steeper while feeling that the aircraft is flying straight and level.

Otolith organs

The otolith organs are small sacs at the base of the semicircular canals. They are embedded with sensory hairs and contain a gelatinous membrane with chalk-like crystals – called otoliths. As the head or body moves, the movement of the membrane against the sensory hairs registers gravity.

The forces of acceleration and deceleration also stimulate the otoliths and, without visual reference, the body can't tell the difference between the inertial forces resulting from acceleration and the force of gravity. Thus, acceleration may give the sensation of tilting backwards. Deceleration may give the perception of pitching forward.

Somatosensory System

Also called the proprioceptive system, this system is comprised of nerves in the skin, muscles, joints, and internal organs, along with hearing. The nerves sense pressure differentials. This system remains relatively unnoticed on the ground. But while flying, pilots can feel changes in G-forces and pressure as the inertia of their bodies reacts to the motion of the airplane. These sensations are most acutely felt where the body and the airplane meet, namely on the seat, and the ability to correctly interpret these sensations is the source of the term "seat-of-the-pants" flying.

Our binaural hearing can determine our position relative to a sound source. In the air our hearing can also identify conditions such as an overspeeding propeller, air rushing against the airframe, or an engine suddenly going quiet.

Sensory Illusions

All three sensory systems are prone to errors. In some cases we may have the illusion of being straight and level when we're almost inverted. Or we may be convinced we're tumbling end over end when we're straight and level. The following are some of the most common illusions affecting pilots of fixed-wing aircraft that can result in spatial disorientation.

Visual Illusions

False Horizon – When the only or most distinct visual reference is a cloud formation, it can be confused with the horizon or the ground. A sloping cloud deck that extends into a pilot's peripheral vision will appear to be horizontal. Likewise, a cloud bank below the aircraft that is not horizontal to the ground may appear to be horizontal. These illusions cause the pilot to fly the aircraft in a banked attitude.

Confusing Ground and Star Light – At night, ground lights can be confused with stars. This can lead pilots to maneuver the aircraft into an unusual attitude in an effort to put the ground lights "above" them. In areas with sparse ground lighting, isolated lights can also be mistaken for stars, which can make the aircraft appear to be in a nose-high attitude or have one wing low. When overcast conditions block any view of stars, unlighted areas of the terrain can appear to be part of the sky.

Autokinesis – At night, a stationary dim light against a dark background will appear to move if a pilot visually fixates on the light for about six to 12 seconds. This can lead pilots to mistake the light for another aircraft, and to attempt to maneuver the aircraft to compensate for the perceived movement of the light.

Vestibular Illusions

In the absence of visual reference, we rely on our vestibular system to keep us oriented. But as previously explained, this system is unreliable when in motion. Therefore, these illusions create the greatest danger of spatial disorientation.

The Leans – This is the most common form of spatial disorientation. It results from a pilot's failure to detect angular, or banking, motion. If a bank is entered slowly, or is maintained long enough for fluid in the semicircular canals to stabilize, and the aircraft is quickly returned to straight and level, the motion of the fluid in the canal will give the sensation that the aircraft is banking in the opposite direction, and the pilot will have a tendency to bank the aircraft into an attitude erroneously perceived to be straight and level.

The Graveyard Spiral – This is a high speed, tight descending turn (not a spin, because the wing never stalls) entered as a result of a failure to detect rolling motion. Since any bank rate of less than two degrees per second is not felt, the wing may drop and the plane may begin a turn without the pilot realizing it. As the plane spirals downward and its descent accelerates, the pilot senses the descent but not the turn. The natural tendency is for the pilot to pull back on the yoke to arrest the altitude loss. But with the bank angle having gradually increased, this control input only tightens the turn and increases the descent rate.

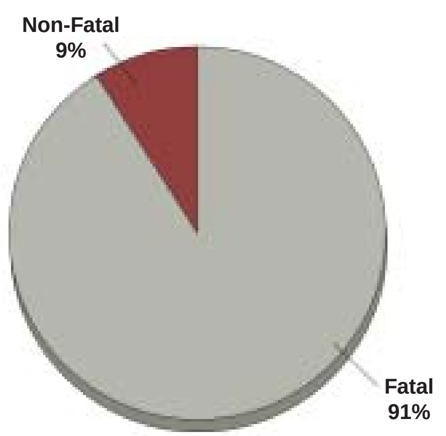
Vertigo/Coriolis Illusion – Abrupt movements of the head can set the fluid in the semicircular canals moving in such a way as to create an overwhelming sensation of tumbling head over heels. The sensation can be so strong as to lead pilots to lose control of the aircraft. Looking down, as you might when searching for a chart in the cockpit, and then looking up can cause vertigo.

Inversion Illusion – An abrupt change from climb to straight-and-level flight can excessively stimulate the sensory organs for gravity and linear acceleration, creating the illusion of tumbling backwards.

Spatial Disorientation Accidents

Figure 1

Number of Spatial Disorientation Accidents Resulting in Fatalities



Source: ASF Accident Database

The Aeronautical Information Manual ranks spatial disorientation among the most cited contributing factors to fatal aircraft accidents. From 1994 through 2003 it caused at least 202 accidents. One hundred eighty-four of them involved fatalities (see Figure 1). Thus, while spatial disorientation makes only a modest contribution to the overall accident rate in GA, it is responsible for a high percentage of its fatalities. Spacial disorientation accidents fall into three categories:

- **Attempted VFR flight in IMC.**
- **Night VFR flight in VMC.**
- **Instrument flight in IMC.**

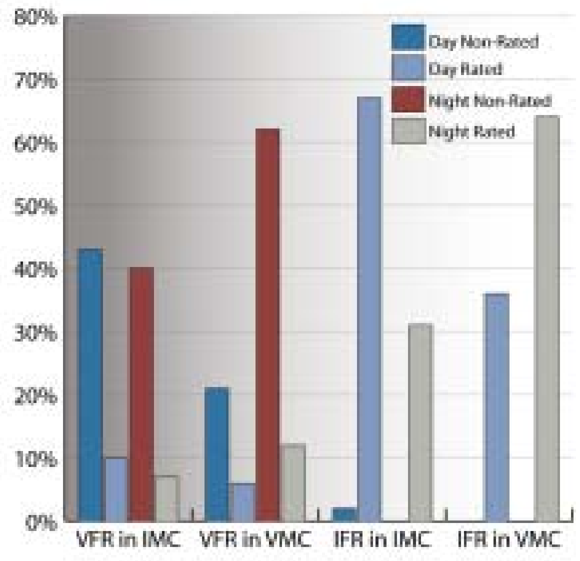
Attempted VFR Flight in IMC

VFR flight into IMC (Instrument Meteorological Conditions) is the number one cause of spatial disorientation. This category accounted for at least 83 accidents (see Figure 2). VFR-rated pilots were responsible for most of these identified by the NTSB (69 accidents or 83%), but instrument-rated pilots were involved in fourteen such accidents (17%).

Figure 2

Spatial Disorientation Accidents by Pilot Certificate and Weather Conditions

1994 thru 2003



Type of Flight

Source: ASF Accident Database

The Last Leg

Following a fuel stop in Indiana, the VFR-rated pilot of a Cessna 210 on a cross-country from Amarillo, Texas, to Washington, DC, contacted Washington ARTCC and said, "…I seem to be lost…I was heading east into Manassas showing ah sixty miles out and all of a sudden these clouds just fogged in front of me on the mountains so I just turned around and just kind of circling right here above two pretty good sized towns." The aircraft was given a transponder code and identified at 1511, and proceeded toward Manassas. At 1517 the pilot radioed ATC and said, "…I'm in clouds right now, you need to get me out…" Asked if he was capable of IFR flight, the pilot answered, "No, I'm not." The controller attempted to vector the aircraft north to VMC, but communication with the plane was lost at approximately 1525. Witnesses saw the aircraft descend from an overcast sky at a steep angle and burst into flames upon contact with the ground. The pilot and his passenger were killed. Radar data from the last ten minutes of the flight indicate that it climbed from 5,200 feet to 7,300 feet before entering a descending right turn.

VFR Not Recommended

At 1044 a noninstrument-rated pilot called the Flight Service Station in McAlester, Oklahoma and requested a weather briefing for an afternoon VFR flight to Muscle Shoals, Alabama. During the briefing the pilot was told VFR was not recommended. At 1349 the pilot called for another briefing and was again told VFR was not recommended. At 1645 the pilot, now airborne in his Bellanca 17-30A, contacted Memphis Flight Watch and reported he was in deteriorating conditions. He asked for an update on the weather at his destination and was told VFR was not recommended. The pilot landed in Corinth, Mississippi, purchased fuel, and drove into town for food. At 2108 the pilot telephoned for a weather briefing for a flight to Muscle Shoals and was told VFR was not recommended, and that more fog was forming along the intended route. During the briefing, an FBO employee recommended a good local hotel and offered the pilot use of the courtesy car, but the pilot declined the offer. Witnesses reported ceilings of 1,000 feet and visibility of three miles, with visibility decreasing, at the time. A search was initiated after the pilot failed to arrive at his destination, and the fatally injured pilot, the sole occupant, and the wreckage of the aircraft were found in Corinth. The engine exhibited no pre-impact failures or malfunctions. Control cables and control surface attachments exhibited failures consistent with overload forces.

The Expectation of Success

Many pilots who succumb to spatial disorientation have plenty of time to get themselves out of trouble, but they continue on as if the deteriorating conditions blind them to their options. The pilot in the first accident, at left, could have made a 180-degree turn and headed back toward VMC when first identified by radar. The pilot had six minutes after that to turn around before making the desperate call to ATC asking for help getting out of the clouds. In the second accident, the pilot had hours of warning, and refused to consider any alternative up to the moment when time ran out.

Why do pilots flying VFR plunge ahead into IMC despite the dangers they've been warned about? An expectation of success appears to play a significant role in these accidents. Such pilots take off without a back-up plan, automatically assuming they'll successfully complete the flight. Without a Plan B, they have no other course, literally, other than to continue on, developing a kind of tunnel vision that seems to lock up the brain as conditions deteriorate. These habits are reinforced when pilots do successfully complete flights in adverse conditions, leading them to push the envelope more and more relative to the risks they take. But if you keep sticking your hand in the cookie jar, eventually you'll get caught.

Avoid Deadly Expectations:

- Consider options before the flight.
- Evaluate options while en route.
- Be committed to maintaining flexibility.
- Give yourself room to change your mind.
- As soon as you start to feel uncomfortable, go to Plan B.

Spatial Disorientation in VMC Conditions

Risks vary with the environment we fly in. In many parts of the country, if you stayed on the ground every time marginal conditions or the possibility of thunderstorms were forecast, you wouldn't fly very often. That's where experience comes in. As we gain more experience and knowledge, we gain more confidence and expand our horizons. But this confidence also leads us into flight environments where the odds against us can rise, such as marginal VFR, night, and IMC. Add these factors to the flight environment, and the potential for spatial disorientation accidents increases. As the PIC, it's your duty to manage that risk responsibly.

Lost Horizon

During a night flight in VMC from Orlando Executive Airport to Craig Municipal Airport in Jacksonville, Florida, the pilot of a Cessna 172 contacted Jacksonville Approach and requested VFR flight following. At 2142, the aircraft was identified and observed on radar at 2,600 feet, three miles south of St. Augustine, on a heading of 019 degrees, a course that would take it over the ocean. At 2145 the target was observed at 2,000 feet on a heading of 013 degrees. Thirty seconds later the aircraft was observed at 1,200 feet on a heading of 051 degrees, and its speed had increased from 104 knots to 126 knots. One second later the pilot radioed, "I haven't any direction finder, I don't see anything, one five six ro-." After trying to reach the pilot, at 2146 the controller radioed, "November one five six romeo alpha, radar contact is lost two and a half miles northeast of St. Augustine, ah, if you can hear me, ident." The controller was unable to establish further contact with the pilot. The aircraft crashed into the Atlantic about 4.1 miles east of St. Augustine Airport. Weather at the time was reported as 3,500 scattered, visibility 10 miles. The night was moonless. The VFR-rated pilot, with about 100 hours of flight time, had received his license less than a week before the accident. The pilot's body was recovered the following day, but the aircraft's engine, wings, fuselage, and tail section were not located. A 100-hour inspection on the airplane, which had accumulated 151.9 hours total time before the flight, had been conducted about two weeks before the accident.

Marginally Qualified

On descent toward Martha's Vineyard Airport (MVY) in night VMC, a Piper Saratoga crashed into the ocean, killing the noninstrument-rated pilot and two passengers. The area forecast called for visibility of three to five miles in haze. No adverse conditions were reported. Visibility at MVY at the time was reported as eight miles. Visibility on the mainland at the point where the aircraft turned toward the island was reported as three miles in haze. The accident sequence was reconstructed from radar tapes. The flight had originated at Essex County Airport (CDW) in New Jersey at about 2049 local time. After departure, the aircraft reached a cruising altitude of 5,500 feet and flew along the Connecticut shoreline until turning directly toward the island. At 2133, while over water about 34 miles west of MVY, the aircraft began a descent. Radar data showed the descent rate initially varied from 400 to 600 feet per minute (fpm). At about 2138, the aircraft began a bank in a right wing down direction. Thirty seconds later, the descent stopped at 2,200 feet and the aircraft began a climb that lasted another 30 seconds, stopping at 2,500 feet with wings level by 2138:50. At 2139 the plane entered a left climbing turn to 2,600 feet, then began a descent that reached a rate of about 900 fpm. At 2140 the wings were leveled. Eight seconds later, the plane banked in a right wing down direction and the bank angle, descent rate, and airspeed began to increase, with the descent reaching as high as 4,700 fpm. The last radar return, at 2140:34, showed the plane at 1,100 feet. The wreckage of the aircraft was recovered about 1/4 mile north of the last radar return, in 120 feet of water. The pilot had a total of about 310 hours of flight time, including 29 hours in simulated IMC and 9 hours in actual IMC, and about 36 hours in the accident airplane. Pilots flying in the vicinity at the time of the accident reported that no visible horizon existed over the water. Accident investigators also noted that the pilot was recovering from a fractured ankle, which may have affected his ability to use the rudders and thus control the aircraft. Spatial disorientation was ruled the most likely cause of the accident.

Marginal Conditions

These accidents in VMC prove pilots don't have to lose all outside visual reference to become disoriented. Spatial disorientation can and does occur in VFR conditions. Haze, darkness, or flying over water can also contribute to a loss of visual reference. In fact, flying over water on a moonless night is tantamount to flying in IMC. At least 66 spatial disorientation accidents occurred in VFR weather during the last decade; the great majority of them – 45 – occurred at night. Twelve IFR-rated pilots were among those who lost their lives due to spatial disorientation in VMC at night. Even in daylight, pilots need to remember that marginal VFR, while legal to fly in, isn't necessarily safe. Three miles of visibility doesn't guarantee a visible horizon. Remember, marginal could refer to the forecast for your chances of survival, as well as the visibility.

IFR in IMC

An instrument rating is no guarantee of survival when instrument conditions prevail. Spatial disorientation claimed the lives of 113 pilots and passengers in IMC during the last decade. Investigators found evidence of vacuum system and/or instrument failures in at least 24 of these accidents. It's important to remember spatial disorientation can overcome the most experienced pilots even in the absence of malfunctioning equipment. However, the high percentage of accidents caused by mechanical failures indicates a widespread inability to fly the aircraft by partial panel. Instrument-rated pilots are required to be proficient in partial panel flying, and these statistics indicate why.

No-gyro Approach

During an IFR cross-country flight from Pontiac, Michigan, to Providence, Rhode Island, in VMC, the pilot of a Mooney M20J was contacted by controllers and told he was "going the wrong way." The pilot reported he had lost his vacuum system. ATC notified the pilot he would encounter IMC en route, but the pilot elected to continue to his destination, about 180 miles away. During a no-gyro approach to the localizer in IMC, the pilot became spatially disoriented and reported to controllers, "We just lost it." That was the last transmission from the aircraft. The resulting crash killed the pilot and his passenger. The dry air vacuum pump had been replaced about two years before and accumulated approximately 570 hours of use, under the manufacturer's recommended replacement time of 700 hours or three years of service, whichever came first.

Inoperative Backup

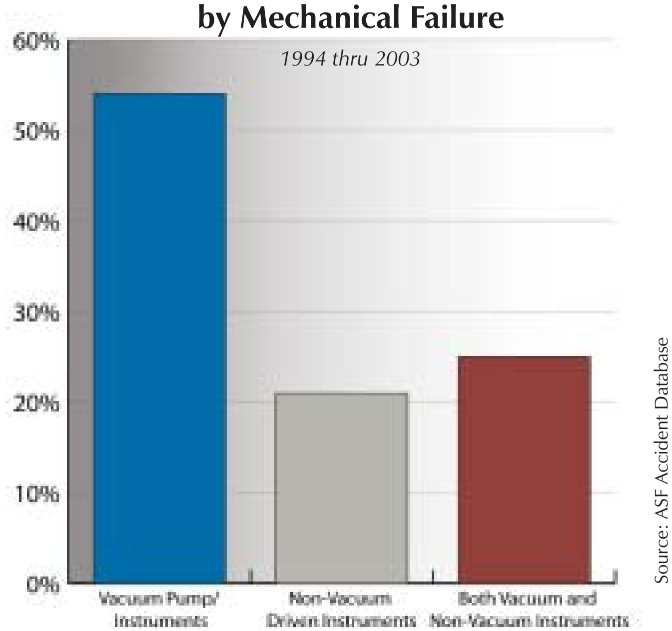
After a late day business meeting, a pilot called Flight Service and requested an abbreviated briefing for a trip back to Oklahoma City from Duncan, Oklahoma. The weather briefer asked the pilot if he could go IFR. "I don't want to but I guess I can if I have to," the pilot responded. The briefer informed the pilot that IMC was moving toward the destination from the west. After the call, the pilot stated he and his colleagues needed to go directly to the airport, and skip dinner. At 2017, the pilot contacted ATC and reported he'd just left Duncan and was trying to maintain visual conditions. At 2019 he requested an IFR clearance. The instrument clearance was issued at 2020. At 2024, the pilot radioed ATC and said, "I have uh, a vacuum problem and uh panel situation here so I, I'm going to be a little limited on being able to talk to you." Soon after, radio contact was lost. The C-182 crashed in an uncontrolled descent, killing the pilot and two passengers. Examination of the flight instruments found the gyro bearings for the turn and bank gyro were "heavily corroded and bore no evidence of recent rotation."

Vacuum Failures

Instruments themselves can fail or the vacuum pump that powers them can fail. Indeed, vacuum pump failures are one of the most common squawks in general aviation aircraft. But pilots don't train enough for this possibility, and the training they get is often inadequate. An instructor slaps a suction blinder on the AI and DG,

Figure 3

Spatial Disorientation Accidents Caused by Mechanical Failure



and says, "You just had a vacuum failure." But in the real world, though the pump fails quickly, vacuum instruments themselves usually die slow deaths. The attitude indicator and directional gyro – the two vacuum driven instruments – become more and more erroneous as the gyros slow their spinning and coast to a stop. The first accident cited on the previous page illustrates that fact. The reason the plane was "going the wrong way" as reported by ATC, was because the pilot or autopilot was following the directional gyro (DG). The pilot had ample time to divert, but chose to continue on. Even if you *are* skilled in partial panel flying, you won't survive if your secondary flight instruments don't work. In the second accident cited, evidence strongly suggests the turn and bank indicator was inoperative, as upon examination its gyro was heavily corroded and showed no signs of having worked recently. In other words, the instrument that would have been primary for maintaining directional control after a vacuum failure didn't work. This put the pilot in a virtually unsurvivable situation.

Vacuum failures are hardest to notice in high workload environments, such as in IMC or immediately after takeoff. When the pilot finally realizes that various instruments aren't in agreement, he or she must determine which ones are reading correctly and which aren't. And once the problem is diagnosed, the pilot must be able to fly the aircraft without the instruments that are normally relied on most. That makes a vacuum failure in IMC, without a backup system, an emergency. Pilots should include the vacuum gauge in their instrument scan for early warning of a problem.

Managing a Vacuum Failure:

- Most importantly, be proficient at partial panel flying. The time to practice is on a training flight or with a check pilot while you're on your way somewhere, not when you've just had a vacuum failure.
- Make sure the vacuum gauge is part of your scan, providing you with an early indication of a vacuum failure.
- Have something available to cover inoperative instruments in the event of a failure. If you don't have the covers used for partial panel flight training, keep some Post-it® notes in your flight bag.
- Make timed turns instead of using the magnetic compass to change headings.
- Notify ATC of the situation.
- Confirm the location of the nearest VFR weather.
- Find out the conditions at the nearest airport with a precision approach.
- Ask controllers for a "no-gyro approach," so they can provide lateral guidance.
- If available, select an airport with an Airport Surveillance Radar (ASR) approach.

Vacuum Pump Maintenance and Backup Systems

Maintain your instruments and the systems that power them. That means, among other things, replacing vacuum pumps in accordance with manufacturer's recommendations – before they go bad. The useful life of vacuum pumps is determined by many factors including the type of pump, the aircraft, engine, and installation. Pump manufacturers develop suggested replacement intervals that are available to aircraft owners and mechanics. Your mechanic will know the replacement interval for your airplane.

We recommend redundant gyro instrument power – dual vacuum pumps or a standby for the primary pump. Installing a backup system is the surest way to enhance your safety. A number of affordable backup and standby vacuum systems are available. Another option is installing a rate-based autopilot that gets roll information from an electrically driven turn coordinator, or a standby electrically driven attitude gyro. Renters flying IFR should check with their FBOs to ensure the rental aircraft are properly maintained. That includes adhering to vacuum pump replacement schedules.

Pilots should also know where to find backup heading information when all else fails. Many handheld and panel mount GPS units display heading and track information that can be used during a vacuum failure. An ADF with a manually rotating compass card or a Remote Magnetic Indicator (RMI) may also help with directional guidance.

Encountering IMC

Should you stumble into instrument weather conditions, follow these steps:

- ***Don't panic.*** Stay calm and remember you've trained for this.
- ***Scan your instruments.*** The attitude indicator (AI)

is the primary flight instrument to reference when flying in IMC.

- ***Turn around***. Make a standard-rate 180-degree turn.
- ***Be alert for altitude changes.*** If a high rate of descent or ascent is observed on the VSI or altimeter, ascertain the aircraft's attitude before applying correctional controls.
- ***Trust your instruments.*** Don't trust what your body tells you.
- ***Use an autopilot if so equipped.*** Autopilots have helped many a pilot out of a nasty situation. They've also gone unused as PICs have lost control of aircraft. Be familiar with and maintain your autopilot system. Understand the different modes of operation and how to engage and disengage them.

Recovery from Spatial Disorientation

If you experience confusing sensations after unexpectedly encountering IMC, scan all relevant instruments before making control inputs. Start with the AI. The AI provides the main picture of what your airplane is doing. See where the nose is and where the wings are

in relation to the horizon. Note the airspeed, vertical speed, and altitude. Should they indicate improper control of the aircraft, follow these steps:

- Level the wings.
- If losing or gaining altitude quickly, check to assure you're not reaching critical airspeeds.
- Adjust power if necessary for airspeed, then smoothly apply back or forward pressure to stop vertical deviation, putting the nose of the aircraft on the AI's horizon.
- When the VSI reads zero, the aircraft is in the proper attitude for level flight.
- Maintain current altitude and reverse course to return to VFR conditions.

Simulating Spatial Disorientation

The best way to appreciate the power of spatial disorientation and the speed at which it can develop is by experiencing it yourself. Fortunately, this can be done without ever leaving the ground. Several training devices can induce spatial disorientation in a supervised setting, providing a vivid demonstration of its effects. We recommend pilots seek out training in a simulator such as the ones listed below:

- ***A Barany chair.*** This is a simple rotating chair designed to induce spatial disorientation. Even a swiveling office chair can be used. When slowly spun and then brought to a smooth stop, a seated subject whose eyes are closed and whose head is tilted down will quickly become disoriented when his head is raised.

- ***The GAT II trainer.*** This is a computerized, three-axis simulator used primarily for instrument flight training. GAT II trainers have more than a dozen programs that demonstrate various forms of spatial disorientation, from a graveyard spiral in a cloud, to disorienting visual cues.

- ***The Vertigon.*** This device, displayed and demonstrated at many airshows, consists of a rotating seat on gimbals allowing the plane of the seat to be changed as it turns. It quickly proves to pilots that their senses can't be trusted. Caution: Don't try this on a full stomach. Disorientation can have profound physiological effects.

Training requirements for a private pilot certificate mandate instruction in instrument flying, to teach pilots how to get out safely if they stray into IMC. You likely received this training in VFR weather conditions. If you're not instrument-rated, go up with an instructor at night, in conditions of marginal visibility. This can also go a long way toward proving how confusing it can be telling which end is up when visibility starts to go down.

SkySpotter®

Accurate, timely weather reports could go a long way toward reducing spatial disorientation and other weather-related accidents. Inaccurate reports can lure pilots into conditions they're not prepared for, or qualified to fly in. Conversely, erroneous weather information can keep us on the ground if the forecast is worse than the actual conditions that develop. But acquiring accurate weather information is difficult. Conditions between reporting points can vary significantly. And forecasts are often wrong. This latter fact may lead some pilots to discount adverse weather forecasts, again putting them at greater risk.

If every pilot on a cross-country flight submitted just one pilot report (pirep), we'd all have a much easier time making a go/no-go decision. Pireps are among the most reliable and accurate weather data, because they're real time snapshots of actual conditions in the air. AOPA and the Air Safety Foundation, along with the FAA and the National Weather Service Aviation Weather Center, have launched a program called "SkySpotter" to encourage more pilots to file pireps, and get more accurate weather information into the system. SkySpotters are pilots who commit to providing pireps during each cross-country flight, and we encourage all pilots to participate in this valuable program. You can sign up to be part of it and take the training course to qualify online. Access SkySpotter through the Air Safety Foundation website, **www.aopa.org/asf/skyspotter/.**

Spatial Disorientation Avoidance Checklist

Maintaining control of your aircraft can be reduced to three simple rules. Observe them and you can immunize yourself against spatial disorientation:

1. Maintain VFR
2. Fly within your capabilities
3. Get an instrument rating

1. Maintain VFR
If you're not instrument-rated, do not enter IMC conditions. If you enter these conditions inadvertently make a 180-degree turn and exit these conditions as soon as possible.

2. Fly Within Your Capabilities
Make a commitment to fly within your capabilities. As we've shown, maintaining VFR isn't always enough to avoid spatial disorientation. This is where judgment and discipline come in.

- Establish sensible personal minimums, and resist the temptation and pressures to exceed them.
- Be familiar with the aircraft you're flying. Make sure you're familiar with the panel and the instruments, the flight-handling characteristics, and the aircraft's speed. This becomes more critical at night, when visibility inside the cockpit as well as outside is reduced.
- If flying in marginal conditions or at night, pick a route that provides the best outside visual reference, even if it lengthens the flight; over land rather than over water, for example, or over areas with ground lighting instead of undeveloped countryside. Keep terrain in mind. Use the Maximum Elevation Figure (MEF) on VFR sectional charts to determine the highest terrain and obstacle along your route of flight. On IFR enroute low altitude charts use the Minimum Enroute Altitude (MEA) or Off Route Obstruction Clearance Altitude (OROCA) to ensure obstacle and terrain clearance.

3. Get an Instrument Rating
There is nothing you can do, no piece of equipment you can put in the panel, that will do more to protect you from the confusion that kills than the ability to correctly interpret flight instruments and control the aircraft accordingly. Once you earn the rating, or if you already have the rating, here are three additional steps to assure you can use it safely:

- ***Maintain pilot proficiency*** – Keep your instrument rating current, and keep your partial panel skills polished.
- ***Maintain your aircraft*** – Maintain your aircraft to manufacturer's recommended IFR standards to minimize any chance that systems won't work when you need them most.
- ***Redundant power source*** – Install a redundant power source for your gyro instruments.

Following the rules on this checklist will help keep you safe from the confusion that kills – spatial disorientation.

AOPA AIR SAFETY FOUNDATION

maintains a highly active Website, filled with GA Safety topics.

www.asf.org

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- IFR Adventure: Rules to Live By
- Runway Safety Program
- Know Before You Go
- Say Intentions
- SkySpotter®
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421 Aviation Way
Frederick, Maryland 21701
Phone: (800) 638-3101 • Internet: www.asf.org • Email: asf@aopa.org
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