



ILLUSIONS IN FLIGHT

IDENTIFY, MITIGATE, MONITOR

ILLUSIONS IN FLIGHT

Train like you fly, fly like you train.



Goals

- Define “Illusions in Flight”
- Identify Illusions/ causes
- Categories of Illusions
- Risk Mitigation
- Case Study



WHAT IS AN INFLIGHT ILLUSION?

IN GENERAL



**Most flight attitude is done with reference to the natural horizon.
(VFR - Visual Flight Rules)**

When your sensory systems don't agree with where you perceive to be in space, spatial disorientation has occurred. BUMMER.

Occasionally if reference to the horizon is lost, orientation can be maintained with reference to the ground. If neither exists it's time to get creative!

A pilot's sight- supported by other senses such as *otolith* organs and inner ear function- greatly influence your perception in an airplane.

Sometimes with subpar conditions relying heavily on these senses becomes less reliable if not downright dangerous.



OTOLITH ORGANS

Displacements and linear accelerations of the head, such as those induced by tilting or translational movements, are detected by the two otolith organs: the sacculus and the utricle. Both of these organs contain a sensory epithelium, the macula, which consists of hair cells and associated supporting cells.

IN GENERAL



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TYPES OF INFLIGHT ILLUSION



There are many types of illusions- lets break down the different categories.

VESTIBULAR SYSTEM ILLUSIONS

VISUAL / NIGHT ILLUSIONS

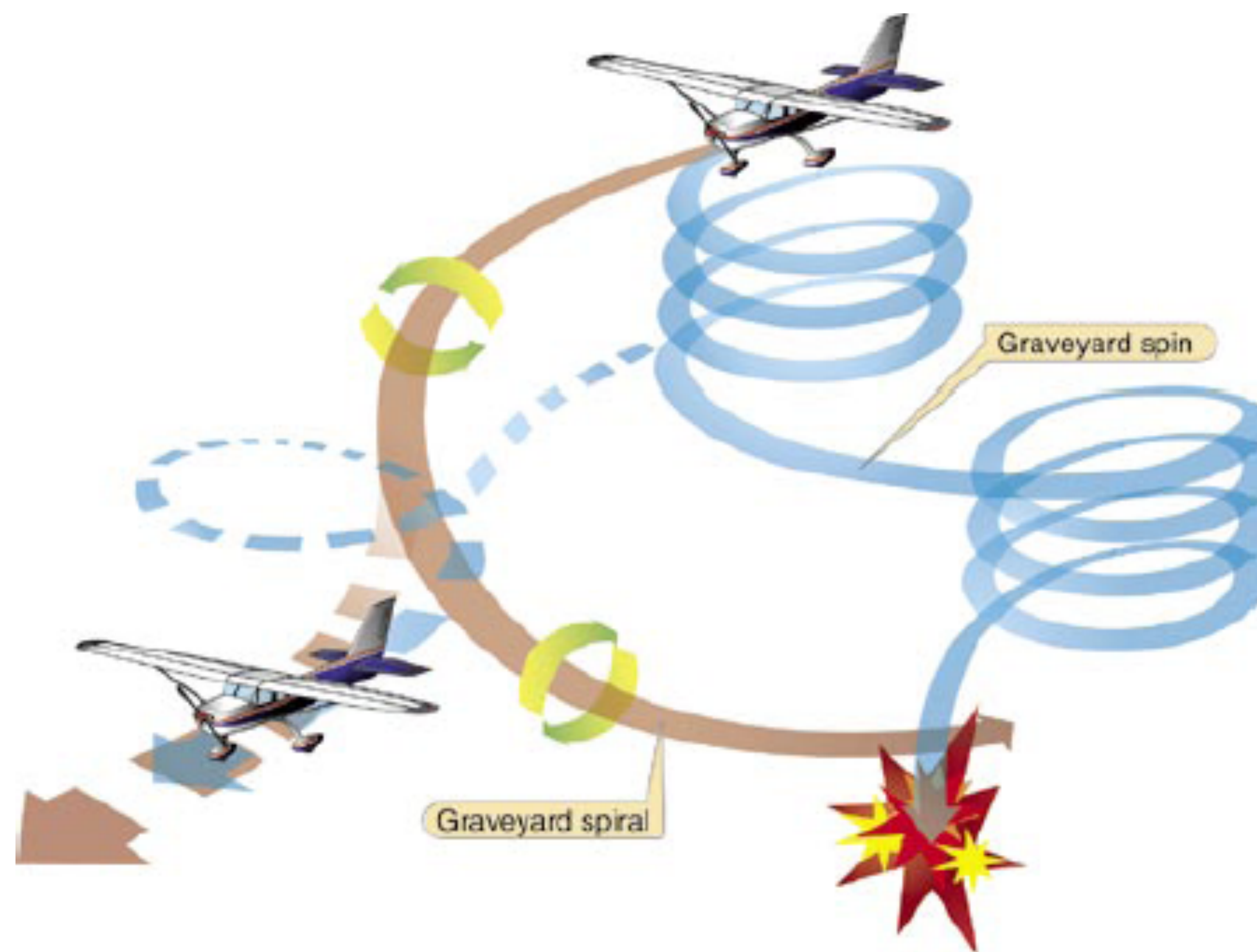
LANDING

ATMOSPHERIC

VESTIBULAR SYSTEM ILLUSIONS

“... ILLUSIONS INVOLVING THE SEMICIRCULAR CANALS OF THE VESTIBULAR SYSTEM ...”

- The Leans
- Coriolis Illusion
- Graveyard Spins
- Graveyard Spiral
- Somatogravic Illusion
- Inversion Illusion
- Elevator Illusion



THE LEANS



CAUSES

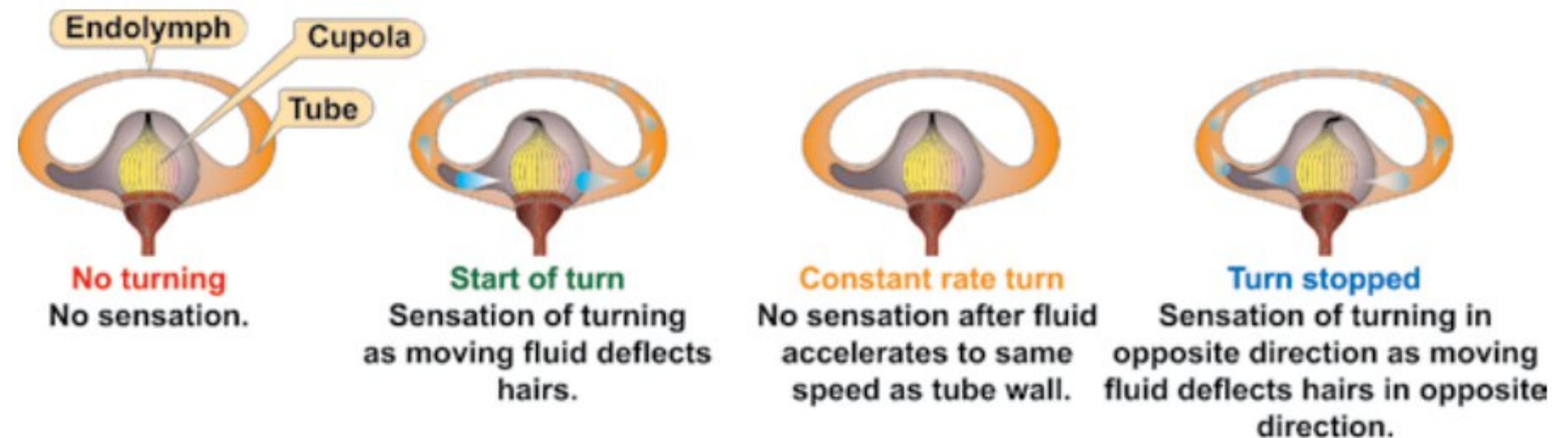
Usually occurs with an abrupt change in banked attitude when the initial turn was started too slowly to stimulate the motion sensing system in the inner ear. The result is that the inner ear fluid keeps moving the direction of the corrective turn.

When the plane is returned to level flight the sensation of a continued turn remains. This can be a result in a breakdown of an instrument scan with limited/ no horizon.

CORRECTIONS

Look at your instruments.

Don't trust your body.



CORIOLIS ILLUSION



**...IN A TURN LONG ENOUGH FOR THE FLUID IN THE EAR CANAL
TO MOVE AT THE SAME SPEED AS THE CANAL..."**

Prolonged turns in a consistent direction followed an abrupt head movement can cause this unsettling illusion.

Something as simple as grabbing a chart, looking down to check fore flight can trigger this spatially disorienting illusion.

CAP pilot have a higher possibility of being exposed to this illusion due the nature of our mission.

The healthiest habit to get into for night flying is developing a instrument cross check procedure that requires minimal head movement.

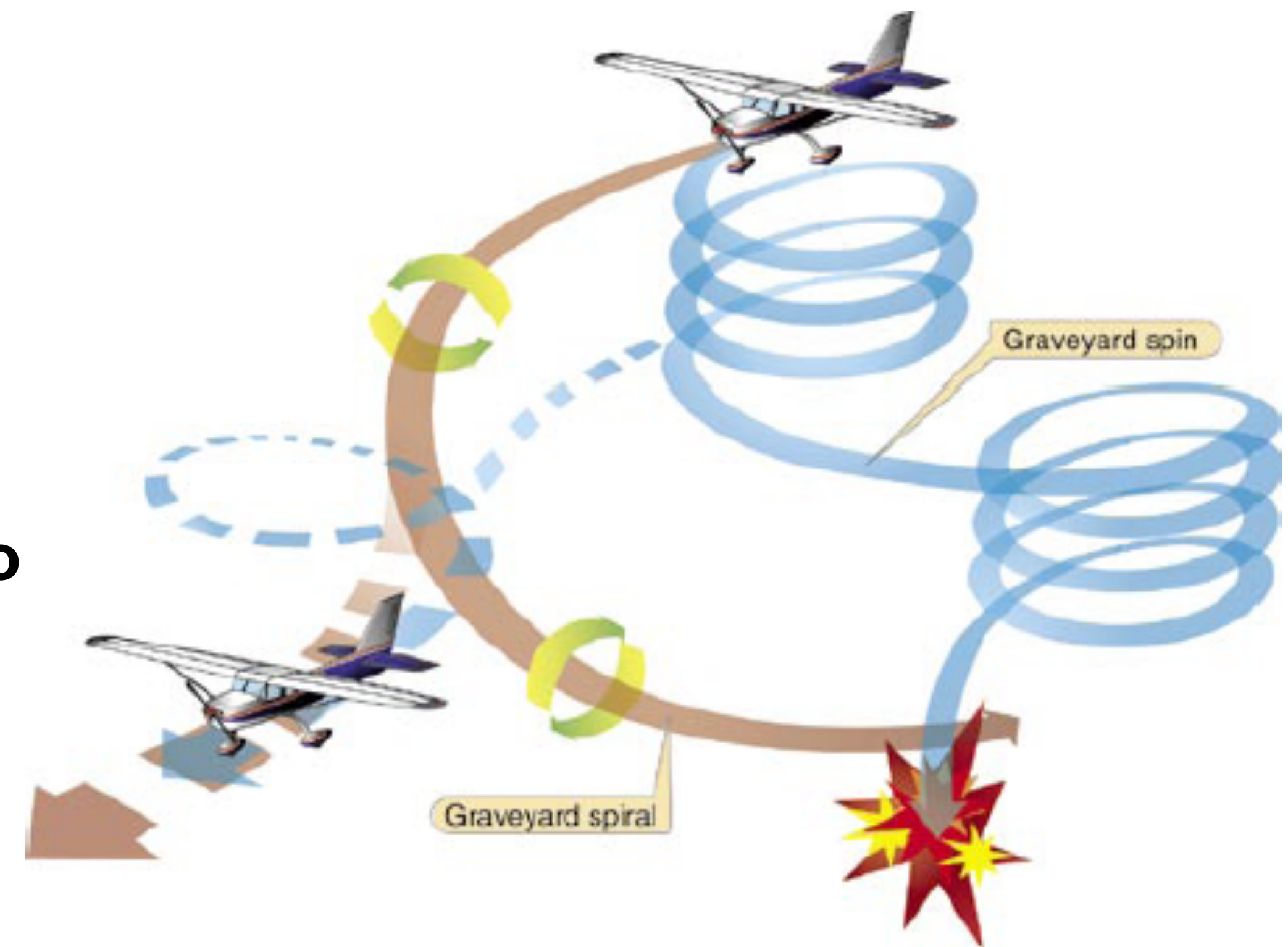
GRAVEYARD SPIN

SCARY NAME, SCARY ILLUSION.

Graveyard Spins are different from Graveyard Spirals.

This illusion - unfortunately - is usually caused by proper recovery from a spin. That's to say that regardless day or night an improper spin recovery can prove fatal. However with little to no reference to the horizon proper spin can recovery can prove as deadly for different reasons.

Proper recovery from spin stops stimulating motion system and can stimulate spin in opposite direction.



GRAVEYARD SPIRAL



**SUICIDE SPIRAL, DEADLY SPIRAL, DEATH SPIRAL,
CALL IT WHAT YOU WANT- IT'S ALL BAD**

Graveyard Spirals can be one of the most vicious of Vestibular System Illusions. Prolonged exposure to a coordinated constant rate turn gives the sensation of not turning.

An observed loss of altitude during a coordinated constant-rate turn that has ceased stimulating the motion sensing system can create the illusion of being in a descent with the wings level.

During the recovery to true level flight, the pilot will experience the sensation of turning in the opposite direction (The Leans) and return the AC to its original turn and due to the turn probably lose altitude (trading vertical for horizontal lift) the pilot will now be in the original turn and pulling back on the yoke trying to arrest the descent when in actuality it's only tightening the turn resulting in a Graveyard Spiral.

Unfortunately this usually results in component/ airframe failure- hence the "graveyard."

VISUAL / NIGHT ILLUSIONS

...THESE ILLUSIONS ARE PRIMARILY ASSOCIATED WITH LANDING...

Visual Illusions

- False Horizon
- Autokinesis
- Vertigo
- Black Hole Approach

Landing Illusions

- Runway Width/ Slope
- Featureless Terrain
- Ground Lighting

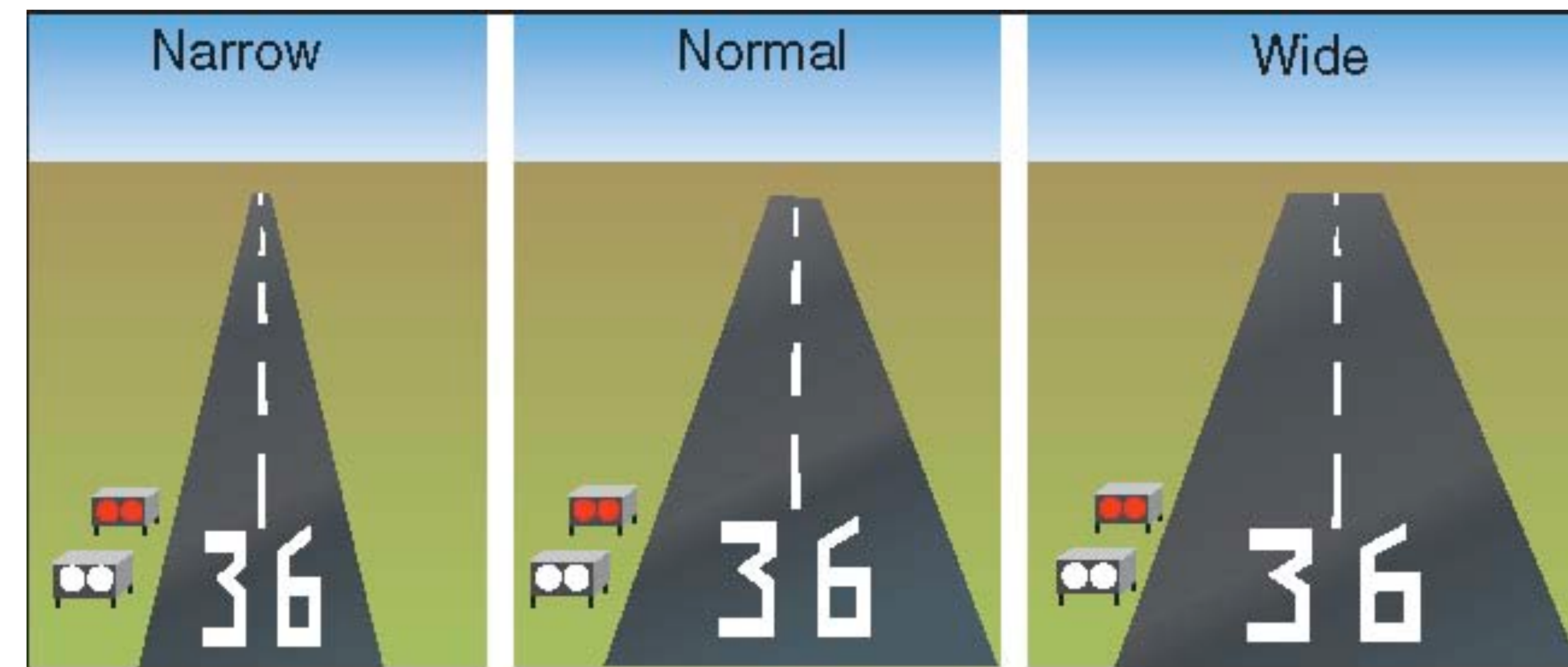


Figure 15-4. Runway Illusions.

VISUAL / NIGHT ILLUSIONS



Illusions associated with night flying are most greatly influenced by vision.

Transitioning from instrument flying to visual flight reference can present a number of challenging illusions.

Preparation, proper mitigation, and appropriate corrective action are the best methods for ensuring safety and maintaining proper situational awareness.

BLACK HOLE APPROACH

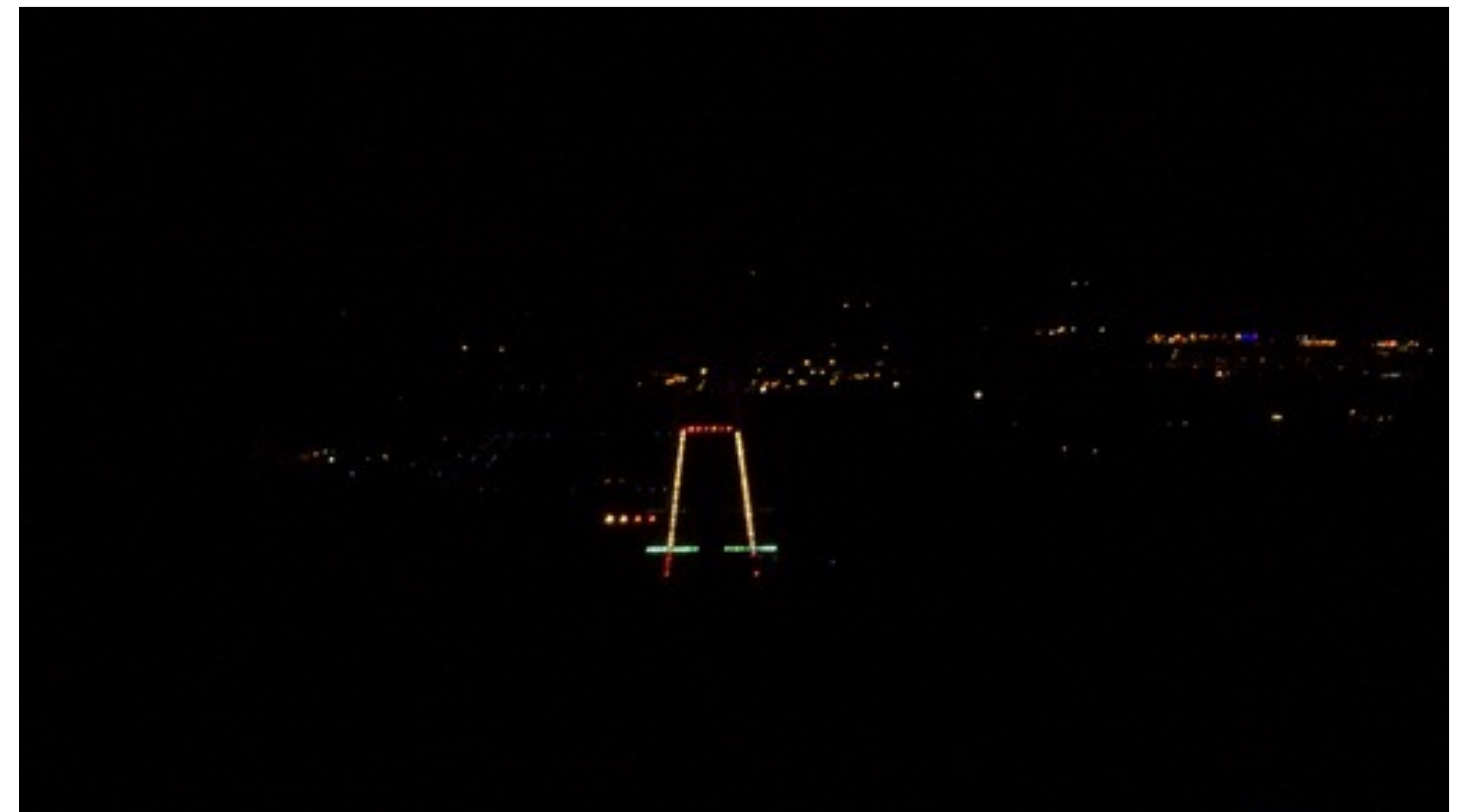
...AT NIGHT FROM OVER WATER OR NON-LIGHTED TERRAIN...

No peripheral clues makes orienting to the horizon difficult.

Runway perception can seem to slope up or down. A worst case scenario could result in landing short of the runway.

Any Vertical Guide Slope Indicators should be used if available. (VASI, PAPI)

Proper and conscious use of flight instruments should be used to maintain SA when approaching these types of runways.



BLACK HOLE APPROACH

...AT NIGHT FROM OVER WATER OR NON-LIGHTED TERRAIN...

Human have relatively poor night vision so judging distances is more difficult.

Runways with cities in the distance at a higher elevation tends to cause a lower-than-normal approach.

Approach lighting that is too bright may cause a higher-than-normal approach.

Properly briefing approaches into dimly lit airports and studying it's boundaries can help mitigate these risks and make landing less challenging.



**Above all, if it doesn't feel
safe- GO AROUND**

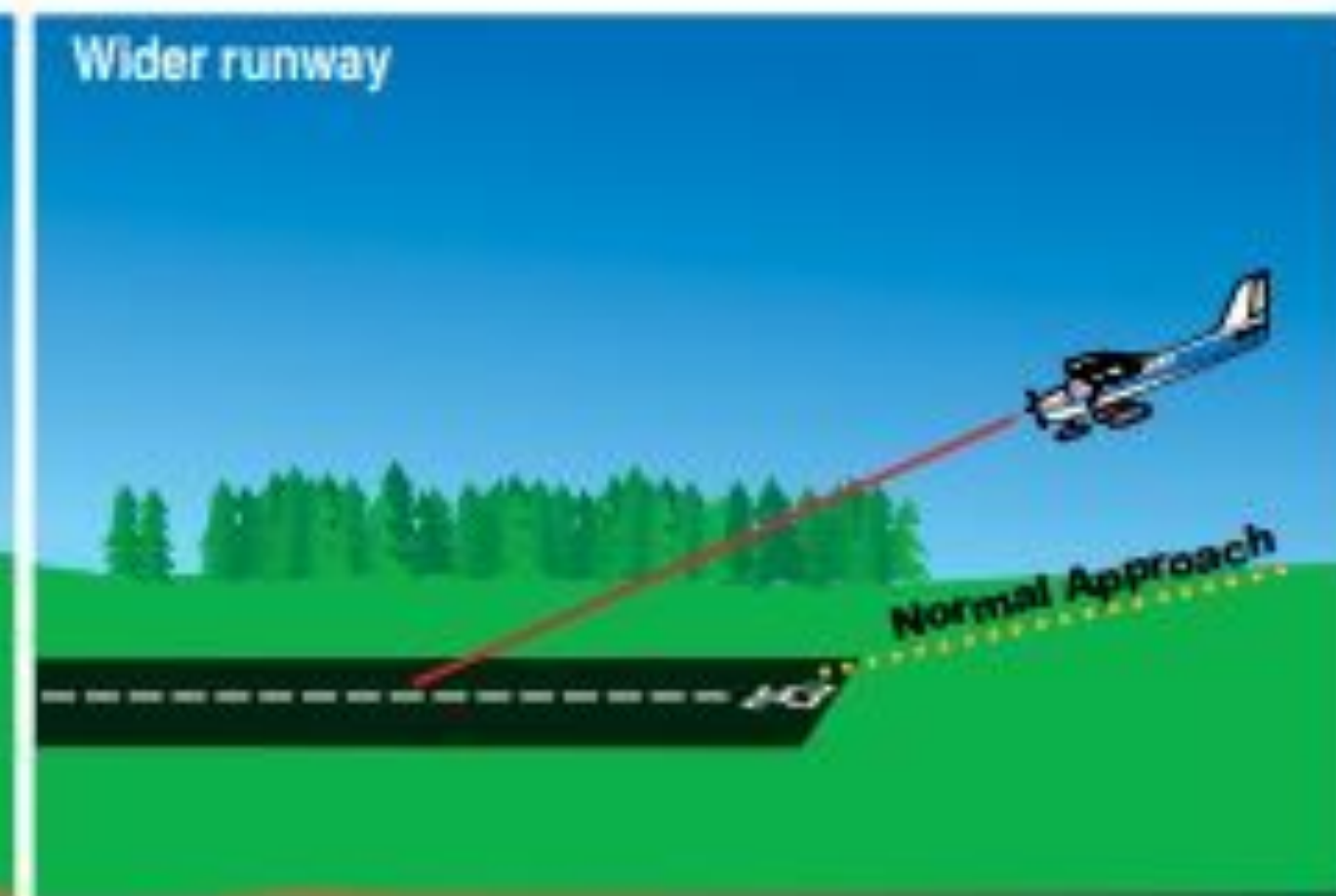
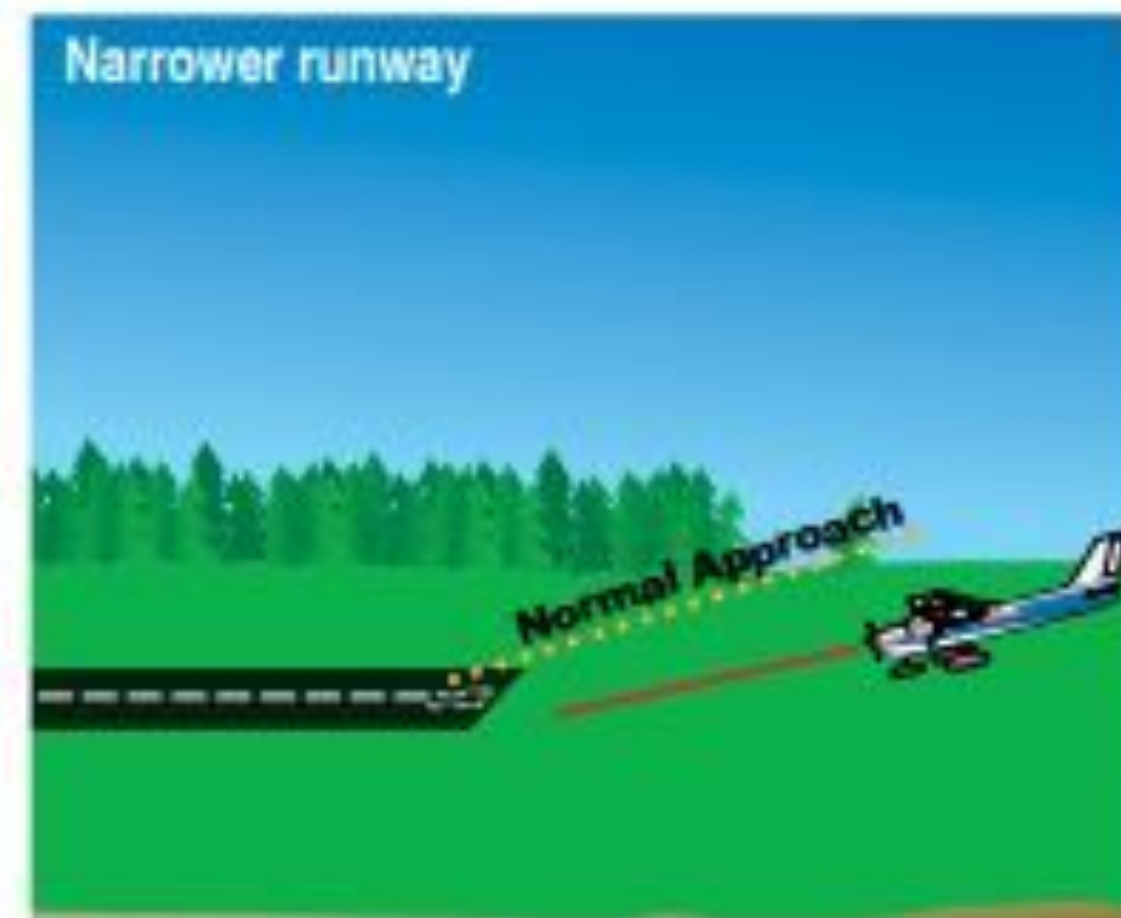
LANDING ILLUSIONS



A narrower-than-usual runway can create an illusion that the AC is higher than it actually is, leading to a lower approach.

A wider-than-usual runway can create an illusion that the aircraft is lower than it actually is, leading to a higher approach.

A proper briefing prior to flying at night can make you aware of these anomalies before you ever take off.



ATMOSPHERIC ILLUSIONS



...ILLUSIONS CONCERNING WEATHER AND THE APPEARANCE IT CREATES REGARDING TERRAIN...

Anytime the horizon is lost due to atmospheric anomalies spatial disorientation has occurred. These are not limited to IFR conditions.

Spatial Disorientation does not care what the METAR says.

Pilots could be above VFR minimums and still experiences any number of atmospheric illusions. Thick haze, smoke, dust, ice particles, smog, etc. are all contenders for meeting and staying above VFR weather minimums.

Something as simple as rain on the windscreen causing pinpoints of refracted light can cause spatial disorientation.

The best mitigation as a VFR pilot is a proper and thorough weather briefing prior to every flight.

ILLUSION PREVENTION



- Trust your instruments
- Preflight **briefing**, **brief** the flight, also **brief** the flight.
- When's the last time you went under the hood and did unusual attitude recovery?
- Consult the US Chart Supplement for better SA before making your flight.
(Sounds like part of a good briefing?)
- Know how distractions and emergencies could influence your likelihood of becoming spatially disoriented.
- Prepare for the worst, expect the best. Are you current or proficient?
- Fly at night with someone who has experience flying into a more challenging airport and check yourself.

COPING WITH ILLUSIONS



NOT IF, BUT WHEN

It's inevitable, so with that knowledge do everything you can to mitigate the risk that comes with inflight illusions.

With proper training pilots can learn to recognize and suppress the natural sensations their body presents. Being able to identify the issue, accept it, and then take the steps to maintain positive control over the AC at all times is imperative to coping with illusions.

Get your IFR rating. This should not lull you into a false sense of security but rather give you more confidence in your instruments and how to fly strictly using them should you need to.

No one is immune. Trust your instruments. Brief your flight. **Don't be a statistic.**

CASE STUDY





NTSB Identification: CEN13FA135

Nonscheduled 14 CFR Part 135: Air Taxi & Commuter
Accident occurred Tuesday, January 15, 2013 in Pellston, MI
Probable Cause Approval Date: 02/10/2014
Aircraft: CESSNA 208B, registration: N1120N
Injuries: 1 Fatal.



NTSB investigators either traveled in support of this investigation or conducted a significant amount of investigative work without any travel, and used data obtained from various sources to prepare this aircraft accident report.

The pilot landed at the airport to refuel the airplane and pick up cargo. The pilot spoke with three employees of the fixed base operator who stated that he seemed alert and awake but wanted to make a "quick turn." After the airplane was fueled and the cargo was loaded, the pilot departed; the airplane crashed 1 minute later. Night visual meteorological conditions prevailed at the time. An aircraft performance GPS and simulation study indicated that the airplane entered a right bank almost immediately after takeoff and then made a 42 degree right turn and that it was accelerating throughout the flight, from about 75 knots groundspeed shortly after liftoff to about 145 knots groundspeed at impact. The airplane was climbing about 500 to 700 feet per minute to a peak altitude of about 260 feet above the ground before descending. The simulation showed a gas generator speed of about 93 percent throughout the flight. The study indicated that the load factor vectors, which were the forces felt by the pilot, could have produced a somatogravic illusion of a climb, even while the airplane was descending. The postaccident examination of the airframe and engine revealed no evidence of mechanical malfunctions or failures that would have precluded normal operation. Based on the findings from the aircraft performance GPS and simulation study, the degraded visual reference conditions present about the time of the accident, and the forces felt by the pilot, it is likely that he experienced spatial disorientation, which led to his inadvertent controlled descent into terrain.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows:

- The pilot's inadvertent controlled descent into terrain due to spatial disorientation. Contributing to the accident was lack of visual reference due to night conditions.

A circular logo with a purple outer ring. The word "HAWKER" is written in white, uppercase letters along the top arc, and "VAN NUYS" is written along the bottom arc. In the center of the logo is a stylized white and purple swirl. The number "128" is written in a light red color over the center of the swirl.

**TRAIN LIKE YOU FLY,
FLY LIKE YOU TRAIN.**