“Say... What's a mountain goat doing way up here in a cloud bank?”
NTSB Report: NYC99MA178

- VFR Conditions at night
- Descent of 400 – 800 fpm
- Entered a right turn, stopped at 2,200 feet
- Climbed to 2,600 feet, Entered a left turn
  - Descending 900 fpm
- Rate of descent increased to ~4,700 fpm
- Airplane struck the water in a nose-down attitude

Can you identify the cause?
Spatial Disorientation, A Definition

“[A failure] to sense correctly the position, motion, or attitude of the aircraft or of him/herself within the fixed coordinate system provided by the surface of the earth and the gravitational vertical.” (Benson, 1998)
Lost Resources, An Issue

- Military
  - 1980 – 89, $500M in USAF resources lost
  - Currently, $100M per year

- General Aviation
  - 1976 – 92, ~10% of fatalities resulted from SD
  - Numbers have declined

Types of Spatial Disorientation

- **Type I**
  - Unrecognized (most common)

- **Type II**
  - Recognized (more traditional)

- **Type III**
  - Incapacitating (least known and understood)
Physiological Mechanisms

- Visual Orientation
  - Object Recognition, Spatial Orientation
- Vestibular Function
  - Stabilize Vision, Orientational Information, Percept of Motion and Position
- Auditory
  - Location of Sound Source
Dynamics

- Visual Dominance
- Vestibular Suppression
- Opportunism
- Giant Hand
- Disintegration of Flying Skill

http://www.wpafb.af.mil/
Research and Technology Development

Human Systems IAC Gateway (Vol. XII, No.3 (2001))
- Measuring the Head Tilt Illusion During Sustained Acceleration
- Canadian Approach to Spatial Disorientation Training
- SD, GD, LSA, and CFIT
- Advanced Display Technologies
- Desdemona: Advanced Disorientation Trainer
Measuring the Head Tilt Illusion

- Coriolis and G-excess Illusions

Objective
- Determine the effect of head tilt in > 1G environment on perception of attitude
Measuring the Head Tilt Illusion
Conclusions

- Pitching and yawing in > 1G acceleration can lead to a misperception of attitude
- Magnitudes of illusions were greater for larger head movements and accelerations
Canadian Approach to SD Training

- Demonstration of other illusions after basic jet training
- Complement ground training with in-flight training
- Provide trainee with procedures to cope with illusions
SD, GD, LSA, and CFIT

- Spatial Orientation
  - Control and Performance Instruments
- Geographic Orientation
  - Navigational Instruments
- Loss of Situational Awareness
- Controlled Flight into Terrain
SD, GD, LSA, and CFIT

Figure 1. An illustration of the relationship between spatial orientation and situation awareness. In this scheme, spatial orientation is a subset of situation awareness. (Adapted from Previc et al., 1995).
Advanced Display Technologies

- Advanced displays may overload operator
- Loss of confidence in “fused data”
- Attentional Capture
Advanced Disorientation Trainer

Figure 1. The Desdemona concept: Basic vestibular and visual disorienting illusions to be demonstrated with the pilot in control.
SURE IS A EASY CLIMB.

CRASH

WHEN YOU GET YOUR DESCEND
MIXED UP WITH YOUR ASCEND, YOU
SOON RUN OUTTA SPACE TO DO
EITHER.

SAY WHAT?
Illusions in Flight

- Autokinesis
- Blackhole Approach
- False Horizon
- Leans
- Coriolis
- Somatogyral
Autokinesis
Blackhole Approach
Coriolis Illusion
Somatogyral Illusion
Back to the NTSB Report

- FAA AC: VFR Minimums
- No pre-impact mechanical malfunction
- Probable cause:
  - “The pilot’s failure to maintain control of the airplane during a descent over water at night, which was a result of spatial disorientation.”
  - Graveyard spin?
Contributing Factors

- Fatigue
- Weather*
- Personal Time Pressures*
- Unexpected Flight Plan Changes
- Personal Attitude (self-confidence)
Reduction in SD Mishaps

- Improving training materials and techniques
- Development of technologies to
  - Minimize occurrence of SD
  - Assist in the recovery from SD
- Research in psychological mechanisms leading to SD
- Cockpit Layout and Flight Instruments
A Few Last Words

“Aviation in itself is not inherently dangerous. But to an even greater degree than the sea, it is *Unforgiving* of any carelessness, incapacity, or neglect.”

-- *Anonymous*
Questions / Discussion

- Personal Experiences with SD?
  - (Doesn’t have to be related to flight)
- Should the FAA impose stricter minimums for VFR flight?