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FORUM

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A primary lesson that I was taught aircraft life sciences mishap investigation training was to resist jumping to a solution until the evidence took me to a solution. Several plausible scenarios could explain JFK Jr.'s mishap. This writing should not be construed in any way to suggest a solution to this mishap; the solution will only be possible after the physical evidence (wreckage) is collected and analyzed by trained mishap investigators. Rather, this is a technical explanation of how Spatial Disorientation, as one possible cause of this mishap, can occur.

Spatial disorientation and loss of situational awareness cause up to 15% - 17% of general aviation crashes annually. More significantly, 90% of these mishaps result in a fatality. Most of these mishaps occur when pilots are flying at night and/or intentionally or inadvertently flying in the weather (Instrument Meteorological Conditions). For example, Last Sunday's Philadelphia Inquirer ran a front page article entitled: *After the crash: 'What is to be learned?'* In this article, the writer, Mr. Joseph Gambardello reported that 30 other small plane crashes were reported to federal authorities on the same weekend as JFK Jr.'s mishap. Applying the FAA statistics for general aviation Spatial Disorientation mishaps yields that 5 (15 – 17% of those 30 mishaps) probably involved Spatial Disorientation and 4 (90% of those 5 mishaps) were fatal mishaps.

Night VFR is an oxymoron and the FAA should consider regulating (to some degree) such flying for pilot's who do not possess an instrument rating. A pilot cannot perceive as much visual information at night as he does during day VFR conditions. Most of the information that is not perceived at night is peripheral visual information (or ambient vision). Ambient vision is sensitive to flat planes (i.e. the horizon) and motion cues, and is processed by the preconscious brain. Under day Visual Meteorological Conditions (VMC), the pilot specifically uses ambient visual information (whether he realizes it or not) to judge and maintain proper aircraft attitude. Since this information is processed by the preconscious brain, and the task of wings level flying is a learned skill that can be executed by the preconscious brain, this activity does not result in a load on the limited capacity, conscious brain.

At night, much of the ambient visual information is absent. Also, the potential for other visual illusions (false horizon or indistinct horizon) is much higher. Since focal vision must be used to maintain aircraft attitude and focal vision is processed by the conscious brain; a slow and serial processor. The conscious brain can quickly become overwhelmed (task saturation) and important situational awareness cues (i.e., altitude, descent rate, etc.) can be missed. The most susceptible pilots are those who are not trained to operate in these (limited visibility) conditions trained or a pilot who has been trained, but is not current.

Cockpit tasks are more difficult at night since the night cockpit is a somewhat foreign environment to a day, VFR pilot. Switches are harder to find and placards are harder to read under low cockpit lighting conditions. Again, this puts an increased load on the conscious brain and this, in turn, raises the potential for unrecognized Spatial Disorientation and/or loss of situational awareness.

Several factors can predispose a pilot to Spatial Disorientation. These factors can be classified into three categories: Environmental, Psychological, and Physiological. Many of these factors may be present during night flying.

Environmental factors include those factors that reduce the amount of information (usually visual information) that is normally available to the pilot during day, VMC flying conditions. These include: night, IMC, blending of the surface of the water with an overcast sky (for over water flights), fog, and haze. These factors tend to make the horizon difficult or impossible to distinguish, thus requiring the pilot to revert to the flight instruments in order to maintain level flight.

Psychological factors are those factors that impose an additional processing load in the conscious brain. When these factors are present, the pilot may experience Task Saturation; a condition where there is more information that must be processed than the conscious brain can handle. The result is that important information may not be attended to and processed. This may allow dangerous flight conditions to persist until time to successfully recover is no longer available. Psychological factors may include instrument/navigation flying, low level flying, a contingency situation (such as an in flight emergency), or visual navigation under degraded visual conditions. (Note: Basic VFR cloud clearance and visibility requirements are 500' below the clouds, 1000' above the clouds, 2000' horizontal distance from the clouds, and 3 miles visibility. Visual navigation at VFR minimums can be a challenging task, especially if the pilot is not completely familiar with the area landmarks.)

Physiological factors are those that degrade the pilot's ability to perform. Unlike the Environmental factors and the Psychological factors, the pilot can directly influence whether Physiological factors are or are not present during flight. By far the most common physiological factor is fatigue. Fatigue impairs concentration, degrades communication skills, causes the pilot to be irritable and impatient, and degrades the pilot's conscious attention management capability. Simple tasks become difficult and difficult tasks may become impossible when the pilot is fatigued. Other Physiological factors may include hypoglycemia (low blood sugar from not eating recently), dehydration, illness, the effects of alcohol and/or tobacco, and flying while taking prescription or nonprescription drugs.

Pilots must constantly evaluate the potential for environmental factors, psychological factors, and physiological factors when they plan their flights. Admittedly, one single factor is not likely to cause a mishap. However, when several factors are present, their adverse effects on the pilot's ability to safely and effectively fly the aircraft are much greater than just a simple sum of the individual factors effects. Stress management training can help pilots to recognize these factors and avoid their effects when they fly.

Instrument training disciplines the pilot in conscious attention management and helps him avoid attention management problems like channelized attention, distraction, and task saturation. Additionally, instrument training disciplines the pilot to ignore false sensory perceptions and believe the instruments. However, instrument training is not enough to prepare the pilot to operate efficiently and safely at night or in poor weather conditions.

Spatial Disorientation training (both class room and hands-on training in an interactive spatial disorientation trainer) prepares the pilot to recognize conditions that can make him susceptible to Spatial Disorientation. If the pilot can recognize these conditions, he can proact instead of react and make proper recovery actions while there is still time for successful recovery. A pilot who has had proper training is recognizing and recovering from Spatial Disorientation has a much better chance of taking timely actions to successfully manage a potentially dangerous Spatial Disorientation episode; thereby turning a potentially fatal situation into a successfully recovered incident.

Situational Awareness training prepares the pilot to maintain constant awareness of all aspects of the dynamic flight environment in order to fly safely and effectively. During this training, pilots learn how they execute learned skills. They learn how perceptions are interpreted and how decisions are made based on those perceptions. Pilots can be taught the necessity of proper conscious attention management and the problems that disrupt attention management and, in so doing, cause loss of Situational Awareness. Last and very importantly, pilots can be taught how to recognize the indications that they have lost Situational Awareness and, most importantly, the actions to take to regain Situational Awareness before an accident occurs.

The Air Force Research Laboratory, Human Effectiveness Directorate worked with Environmental Tectonics Corporation (ETC) to develop a machine to train pilots to avoid or recover from Spatial Disorientation. ETC now offers state-of-the-art curriculum produced and taught by our AeroMedical Training Institute (AMTI) and has built more than 22 interactive Spatial Disorientation trainers. High quality training in these machines has dramatically improved aviation safety worldwide.

It all adds up to a properly trained pilot who knows his limitations and can operate safely and effectively within those limitations. This pilot can perform an effective and efficient instrument cross check and he also has the discipline to believe the flight instruments and (in the words of Dr. Kent Gillingham) "Make the instruments read right."

As I have often said (and it is the opening line of my book), "It is a great misfortune when an aircraft mishap occurs...it is a tragedy if nothing is learned and then passed on to prevent that type of mishap from recurring."□

What is to be learned?

1. Serious consideration should be given to regulating Night VFR flying by pilots not possessing an instrument rating. The FAA should sponsor and enact this regulation.

2. Spatial Disorientation and Situational Awareness training, both academic training and hands-on training in an interactive training device should be a required part of pilot training.

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