Flight Advisor Corner by Hobie Tomlinson

December 2010 **Human Factors, Part I**

As I was contemplating what topic to tackle next in our Flight Advisor Newsletter, I wanted to do something in-sync with the annual, "turning out the lights" ceremony which occurs each fall in Northern New England with the arrival of Eastern Standard Time. Since we suddenly now find ourselves flying "in the dark" (after 6 month of very little – or no – night operations), I thought it logical to look at some night flying issues. In order to preclude repeating information previously discussed, it seemed appropriate to look at "in-flight" illusions. In-Flight Illusions are much more common during Instrument and Night flight operation than during day, VMC (**V**isual **M**eteorological **C**onditions) flight operations. This subject is obviously a subset of "Human Factors," so here we go.

Human Factors is a broad field of research and study which deals with the interaction between humans and machines and how that interaction is affected by the operating environment within which it occurs. Its primary purpose is the recognition of the following:

1) People are error prone,
2) People have "hard-wired" natural tendencies which were included during product design by the OEM (**O**riginal **E**quipment **M**anufacturer). These natural tendencies cause major problems when machine design (or operation) requires a "counter-intuitive" action (I.e. Airplane Stall Recovery).
3) Over 80 percent of all accidents involve some aspect of Human Factors.
4) Implementing Safety Design Initiatives requires consideration of Human Factors.
5) Pilots who have a basic understanding of Human Factors issues are much better equipped to plan and execute safe flight operations.

Persons flying during IMC (**I**nstrument **M**eteorological **C**onditions) or night conditions can experience sensations which are misleading to the individual's sensory system. Safe Flight operations require pilots to understand these false sensations and to develop the knowledge and ability to successfully counteract them. IMC and night flight operations (unlike day, VMC operations) require pilots to adjust their decision-making processes. This, of course, is due to the total absence (or very limited availability) of outside visual clues during these types of flight operations. The ignoring of this very important premise is how two retired airline captains (with over 50,000 hours of combined flight experience) managed to fly a Garmin 1000 equipped CAP CE-182 into the mountain ridge just west of Las Vegas, Nevada on a dark December night. **The *assumption that VFR flight operations during very dark, night conditions are somehow different than straight IMC flight operations has caused many fatal CFIT (Controlled Flight Into Terrain)accidents, including the recent accident occurring during a flight enroute from Schenectady, N.Y. to Malone, N.Y.***

Elements of Human Factors include *Sensory Systems* used for orientation, In- Flight *Illusions*, *Physiological* and *Psychological Factors*, *Medical Factors*, *Aeronautical Decision Making* **(ADM)**, and *Crew Resource Management* **(CRM).**

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Night Currency is the obvious jumping-off point for our discussion and the first consideration before undertaking any night flight operations. As you remember, night currency has a couple of different twists to it than day currency. First of all, you have to maintain night currency in the Category and Class of aircraft you are going to operate (When less than 12,500 pounds MTOGW (**M**aximum **T**ake-**O**ff **G**ross **W**eight) and no type specific rating/training required). This means that AMEL night currency does not maintain your ASEL night currency or vice versa. The same would be true between Aircraft and Helicopter night currency. AMEL aircraft which require a type rating cover those AMEL aircraft which do not, but the reverse is not true. The same would apply to ASEL aircraft which require a type rating and those which do not.

The Second Item regarding night currency is the requirement to make full stop landings. The requirement to make full stop landings to maintain currency only applies to conventional gear (i.e. tailwheel) aircraft during day time, but it applies to all aircraft during night time operations. Currency in tailwheel aircraft will keep you current in tricycle gear aircraft, but not vice versa

The Third (and Last) Item regarding night currency is that all night takeoffs and landings required to obtain/maintain currency have to be flown during a very specific time period. The regulatory, defined time period during which night takeoff and landing currency may be obtained/maintained is from 1 hour after civil sunset until 1 hour before civil sunrise as defined in the American Almanac. One of the easiest places to find this designated time, which is specified in the night currency regulations, is in one of the flight planning web-sites such as FltPlan.com. On that site the times are listed in a little block in the lower right hand corner of the flt log. Remember, *both the takeoff and the landing* must occur between time periods defined by one hour past civil sunset to one hour before civil sunrise. These times define the area during which night currency may be obtained or maintained. *Oddly enough, this time period is never defined by the presence, absence, or degree of darkness.*

During our Human Factors Series, we will discuss the following subjects:

- ***Sensory Systems for Orientation***
  - *Eyes*
  - *Ears*
  - *Nerves (Postural)*
- ***In-Flight Illusions***
  - *Visual*
  - *Optical*
  - *Vestibular*
  - *Flight Demonstrations*
- ***Physiological and Psychological Factors***
  - *Stress*
  - *Fatigue*

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- ***Medical Factors***

- ***Aeronautical Decision Making (ADM)***
  - *Risk Management*
  - *Task Management*
  - *Flight Deck Resource Management*
  - *Single-Pilot Resource Management (SRM)- if a crew (CRM)*
  - *Situational Awareness*

Sensory Systems for Orientation includes the eyes (visual), the ears (vestibular) and the nerves (postural). *Orientation* is an individual's awareness of the position of the aircraft and oneself in relation to a specific reference point (usually the surface of the earth or the natural horizon). *Disorientation* is the opposite or a total lack of orientation. *Spatial Disorientation* specifically refers to the individual's loss (or lack) of orientation with regard to ones position in space with reference to other objects (i.e. the surface of the earth or natural horizon).

Orientation is maintained through the body's three sensory organs which are visual, vestibular, and postural. The eyes maintain visual orientation, the sensing system in the inner ear maintains vestibular orientation and the nerves in the skin, joints, and muscles of the body maintain postural orientation. When healthy human beings are in their natural environment these three systems work well. However, when the human body is subjected to the forces of flight, misleading information can be provided to the brain by these systems. It is this misleading information which causes pilots to become disoriented.

The Eyes are the most important in maintaining safe flight. This was dramatically demonstrated by a recent fatal B747-400 freighter crash when an onboard fire produced such intense smoke in the cockpit that the pilots were unable to see any of the flight displays or cockpit controls.

The eyes are optimized for day vision, however; they are also capable of vision in very low light environments. During the daytime (ample light) the eyes use light receptors called cones, while at night (low light) the eyes use receptors called rods. Both the cone and rod sensors provide a level of vision optimized for the lighting conditions for which they were intended.

Objects are seen with the sharpest focus when their images fall on the fovea (occurs when one looks directly at an object). The field of vision with which one best sees a stationary object is only 3 degrees. Because an aircraft, which is a collision threat, will not display any relative motion, it must be seen within this 3 degree field of vision which detects stationary objects. This is why it is so important to "block scan" the airspace when looking for traffic.

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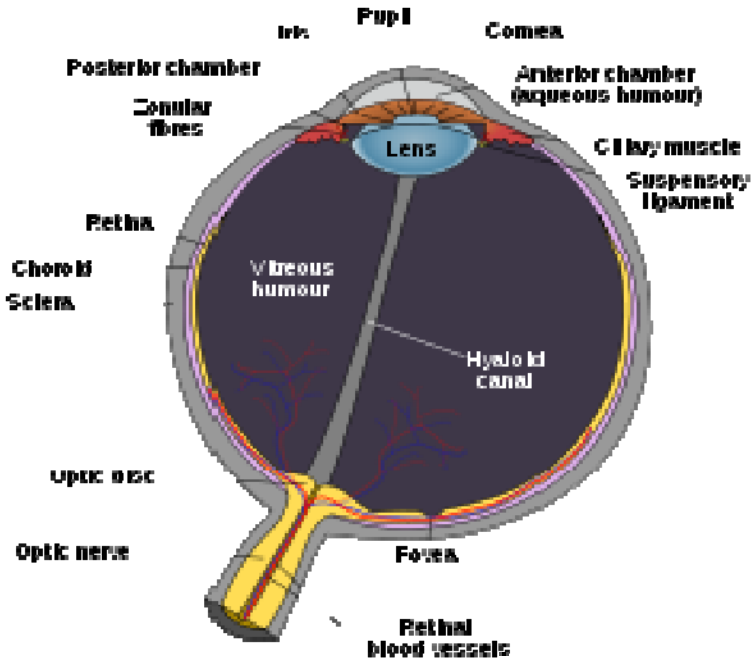

Wikipedia image

Cones are ineffective at night and rods are ineffective during daytime. Cones compromise a rather narrow visual angle (the part of your vision within which you can read) and are the sensors which are responsible for color vision. There are three types of cones, each with a maximum sensitivity to one of the three primary colors (red, green and blue). The color which the brain sees is the combined effect of the stimuli to, and responses from, these three types of cone cells. (Just the same way colors are generated on a visual monitor). Cones are concentrated in and near the center of the eye (fovea), with only a few present on the sides of the retina

Rods cannot distinguish colors but provide low-light, monochrome (black and white) vision. Rods contain the pigment rhodopsin (visual purple) which is sensitive to low light intensity, but saturates and washes out during high light intensities. Hence when a bright light is momentarily introduced at night (i.e. automobile headlight glare) night vision may become totally ineffective, as the rods take time to again regain their sensitivity to low light conditions (regaining night vision can take up to 20 minutes). Smoking (carbon monoxide), alcohol consumption, density altitude, and age all affect vision, especially night vision. Night vision starts to significantly deteriorate above density altitudes which can be as low as 5,000 feet.

Two Blind Spots (day and night) exist in the eye. The day blind spot is located on the light sensitive retina where the optic nerve fiber bundle (which carries the optic data to the brain) passes through. This location has no light receptors and no optic data for the brain can be created from any part of an image which falls there. The night blind spot is

caused by the concentration of cones in the area surrounding the fovea on the retina. Because this area lacks rods, looking directly at an object at night will cause it to disappear from view (autokinesis). This results in a requirement to use off-center viewing and scanning for best obstacle avoidance and maintaining maximum situational awareness at night.

Color, the relationship of colors, and vision from objects around us affects the way the brain processes information. The brain assigns color based on many items which includes the objects surroundings. This is why the same color can have a different appearance in different lighting or surroundings. (Metallic paints are known for this quality.) The aviation application of this principle is evident when processing visual information that is influenced by its surroundings. This has the affect of decreasing our ability to pick out an airport in varied terrain or another aircraft in light haze. This color interpretation problem makes increased vigilance all the more necessary

Dim Illumination makes aeronautical charts and aircraft instruments unreadable unless adequate supplemental flight deck illumination is available. Because red lighting distorts colors, alternate (dim) white flight deck lighting should be used for chart and instrument reading, especially under IMC conditions. *Dark adaptation* is the process by which vision becomes more sensitive to light. Full dark adaptation takes 30 minutes of total darkness while a moderate dark adaptation can be achieved in about 20 minutes under dim red flight deck lighting. The problem is that dark adaptation can be lost in a few seconds when exposed to a bright light and will take another 20 minutes to regain. If it is necessary to momentarily turn on a bright light, one eye should be kept closed to preserve some night vision. To prevent flash blindness, the cockpit lighting should be kept in a bright setting when flying in the vicinity of lightning at night. *Dark Adaptation* is impaired by exposure to carbon monoxide (smoking), Vitamin A deficiency, cabin pressure altitudes above 5,000 feet, and prolonged exposure to bright sunlight.

Bright Illumination provides the best environment for the eyes to function in. During flight in VMC (***V***isual ***M***eteorological ***C***onditions) the eyes are the major orientation source and usually provide accurate and reliable information. Visual clues typically prevail over false sensations from the other sensory systems. It is when these visual clues are taken away by night or IMC operations that false sensations can cause a pilot to quickly become disorientated.

False Sensations can most effectively be countered by the recognition of the problem and then intentionally disregarding it by using the process of substituting of a trained response (i.e. relying on the flight instruments as the proper source of valid flight information). The eyes thus become the primary sensory source for determining the actual aircraft attitude, either using an adequate visual horizon or the flight instruments. The pilot must have the required skill set to manually control the aircraft using either the visual horizon or (in the case of dark-night or IMC operations) only the flight instruments. Instrument operations also require the skill set to adequately control the aircraft manually while using only the standby instrument indications.

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This looks like a good place to break for this month. After the first of the year we will continue with our discussion with the ears and nerves as sensory systems.

The thought for this month is **"It was the best of times and it was the worst of times." *~ Charles Dickens, English Author in "A Tale of Two Cities."*** So until next month, be sure to ***Think Right to FliRite!***

Merry Christmas! ***~ Hobie***

2009 Christmas Tree in Rockefeller Plaza, NYC ~ Image by Hobie Tomlinson

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