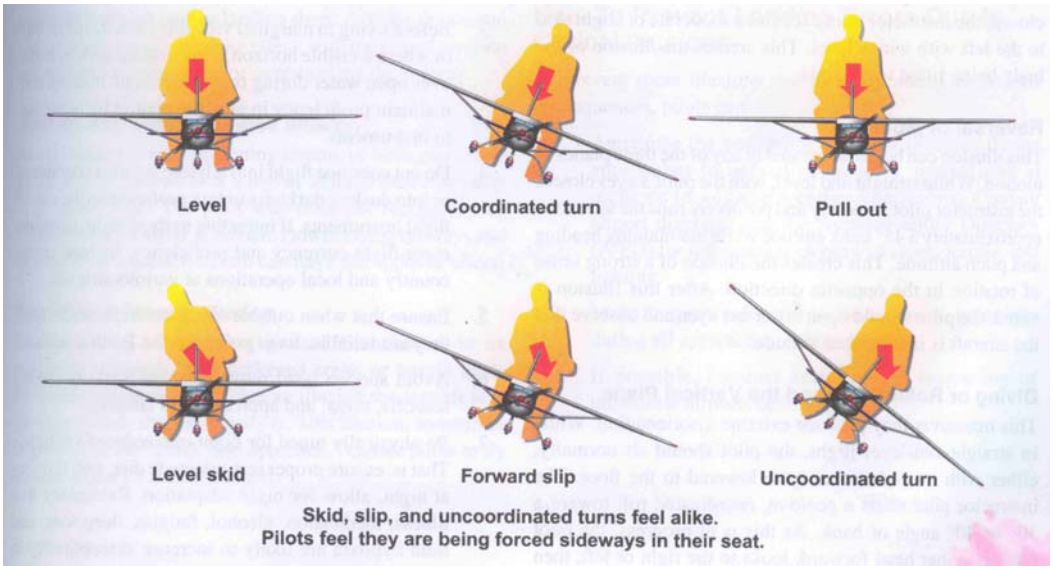
Flight Advisor Corner by Hobie Tomlinson

February 2011 **Human Factors, Part III**

This month we will continue our series on **Human Factors** by looking at some ***demonstrations of spatial disorientation*** as well as ***spatial disorientation coping strategies*** and a more in-depth look at some ***other visual illusions***.

Demonstrations of Spatial Disorientation involve flying defined maneuvers which typically produce specific illusions. The demonstration of any false sensation (or even the absence of any sensations) is an effective way to confer to the aspiring aviator the total inability of the senses to detect bank and roll when all visual clues are absent.



FAA-H-8083-15A ~ Figure 1-8 ~ Sensations from Centrifugal Force

The Objectives in demonstrating these various maneuvers are as follows:

- **Teach pilots** to understand the susceptibility of humans and their spatial orientation systems to spatial disorientation.
- **Demonstrate** that judgments about aircraft attitude based solely on bodily sensations are frequently false.
- **Help lessen** the occurrence (and degree) of disorientation by providing a better understanding of the relationships between aircraft motion, head movements, and the resulting spatial disorientation.
- **Help instill** greater confidence in relying upon the flight instrumentation for assessing the true aircraft attitude.

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Pilots should Not Attempt any of these maneuvers without both sufficient altitude and a competent instructor or safety pilot.

- **Sensation of Climbing during Acceleration** is performed by the instructor pilot while the students keep their eyes closed to eliminate any visual references. The aircraft is placed in straight-and-level flight at the appropriate approach speed for several seconds. It is then rapidly accelerated to cruise speed while continuing to maintaining straight-and-level flight. **The typical illusion experienced during this maneuver is that the aircraft is climbing.** Upon sensing the illusion, have the students open their eyes to observe the true attitude of the aircraft.

- **Sensation of Climbing during a Turn** is performed by the instructor pilot while the students keep their eyes closed to eliminate any visual references. The aircraft is very slowly rolled into a well-coordinated turn of approximately 1.5 positive Gs (about 50 degrees of bank) for 90 degrees of turn. **The typical illusion experienced during this turn is that the aircraft is climbing.** Immediately upon sensing the climb, have the students open their eyes to observe that a slowly established, coordinated turn will produce the same sensations as a climb.

- **Sensation of Diving during a Turn** is performed by the instructor pilot while the students keep their eyes closed to eliminate any visual references. The aircraft is rolled into a well-coordinated turn of approximately 1.5 positive Gs (about 50 degrees of bank) for 90 degrees of turn and then returned to level flight using a normal roll rate. **The typical illusion experienced about half-way through the recovery from this turn is that the aircraft is diving.** Upon sensing the illusion, have the students open their eyes to observe the true attitude of the aircraft.

- **Sensation of Tilting (Leans) Right or Left** is performed by the instructor pilot while the students keep their eyes closed to eliminate any visual references. The aircraft is stabilized in straight-and-level flight and then the instructor pilot performs a moderate skid to the right (or left) while keeping the wings level. **The typical illusion experienced during this maneuver is that their body is being tilted to the right (or left) – i.e. "The Leans."**

- **Sensation of Reversal of Motion** is performed by the instructor pilot while the students keep their eyes closed to eliminate any visual references. This illusion can be demonstrated in any of the three planes of motion, but it is typically flown in the horizontal rolling plane. The aircraft is first stabilized in straight-and-level flight. The instructor pilot then smoothly and positively rolls the aircraft into a 45 degree banked attitude while maintaining a constant heading and pitch attitude. **The typical illusion experienced during this rolling maneuver is a strong sense of rotation in the opposite direction to the actual roll.** When this illusion is noted the students should open their eyes and note the actual banked attitude of the aircraft.

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- **Sensation of Diving (or Rolling) Beyond the Vertical Plane** is a maneuver which may produce extreme spatial disorientation. This maneuver is again performed by the instructor pilot while the students keep their eyes closed to eliminate any visual references. The aircraft is allowed to stabilize in straight-and-level flight while the students sit normally with their eyes closed. The instructor pilot initiates a positive coordinated roll toward 45 degrees of bank while the students tilt their head forward, turns it to the right (or left), and then immediately return their head to the original upright position. The maneuver should be timed by the instructor pilot so that the roll stops as the students return their head to the upright position. **The typical illusion experienced during this maneuver is one of falling downward into the direction of roll and it usually produces an intense spatial disorientation.**

Having the Students do the Flying can also produce very effective demonstrations of spatial disorientation. For this technique, the instructor pilot informs the students what control inputs to make while the students fly with their eyes closed (to eliminate any visual references) and keep their head tiled to one side. It will quickly become clear that the students have no idea of the actual attitude as they react to the sensations produced by their senses. Once the students have become thoroughly disorientated, have them open their eyes, look up and recover. This maneuver probably produces the most realistic training because the students perform the recovery maneuver while actually experiencing spatial disorientation.

Coping Strategies for Spatial Disorientation are as follows:

- **Understand** the causes for these illusions and constantly remain alert for them. Take the time to understand and experience spatial disorientation by using devices such as a Barany chair, Vertigon, or Virtual Reality Spatial Disorientation Demonstrator at aviation safety functions.

- **Always** obtain and understand preflight weather briefings.

- **Before** flight in marginal VFR (weather less than a 3000 foot ceiling and 5 sm visibility) or where a visible horizon is not evident (i.e. flight over open water or sparsely lighted areas during dark, moonless night conditions) obtain training to achieve proficiency in controlling the aircraft solely by reference to the flight instruments.

- **Do Not** continue flight into adverse weather conditions or darkness unless proficient in controlling the aircraft solely by reference to the flight instruments. Before flying at night, obtain night-flight currency and proficiency, including cross-country and local operations at different airfields.

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- **Ensure** that any outside visual references used are reliable, fixed points on the Earth's surface.

- **Avoid** sudden head movements, particularly during takeoffs, turns, and approach to landing.
- **Be Physically** tuned for flight into reduced visibility by having adequate rest and proper nutrition. When planning night operations, allow time for night adaptation of the eyes. ***Illness, medication, alcohol, fatigue, sleep deprivation, and mild hypoxia all increase susceptibility to spatial disorientation***

- **Most Importantly**, become and remain proficient in the use of flight instruments for aircraft control and learn to rely on them. Learn to trust the flight instruments and disregard your sensory perceptions.

Sensory Illusions are normal for pilots to experience. While these undesirable sensations cannot be prevented, pilots learn to suppress and ignore them by developing an absolute reliance in the flight instruments through training and awareness. Pilots become less susceptible to these illusions (and their effects) as they gain proficiency in instrument flying.

Optical Illusions, which are created by various terrain features and atmospheric conditions, can interfere with a pilot's interpretation of visual clues. These visual clues are the most important sensory data input for maintaining safe flight. Visual illusions are primarily associated with landing; however, some (i.e. "False Horizon" and "Autokinesis") are associated with enroute flight and were discussed in last month's article. Since most instrument approaches eventually transition to a visual segment for landing, it is imperative that pilots be aware of these potential optical illusions and take appropriate corrective action.

Major Visual Illusions leading to landing errors are as follows:

- **Runway Width** illusion occurs when a narrower than standard runway (i.e. KFSO @ 60 feet wide – a standard runway is 150 feet wide) creates the false illusion of being higher than normal during approach. When this is not recognized, the pilot inadvertently flies a lower than normal approach path with the attendant risk of hitting obstructions or landing short. This is especially critical at night. A wider than standard runway (i.e. KPBG @ 200 feet wide) will cause the opposite effect (a high, fast approach) with the risk of a high flare and hard landing or even overshooting the runway. The mitigating item for wide runways is that they were typically created for military operations and are usually quite long.

- **Runway or Terrain Slope** illusion is caused by a sloping runway or terrain features. Upslope runways will produce low approaches with their attendant

risks, while downslope runways will produce high, fast approaches with their attendant runway overrun risks. KMVL is down-sloping (0.5%) when landing south and (obviously) up-sloping (0.5%) when landing north. Because the KMVL runway is only 75 feet wide, it also has Runway Width Illusion, producing a double visual illusion.

- **Featureless Terrain** illusion is caused by the absence of ground features, such as an approach over water, approach over dark areas ("black hole") or approach over terrain rendered featureless by snow ("whiteout"). These all produce the false illusion of being higher than normal, thus leading to a low actual approach path.

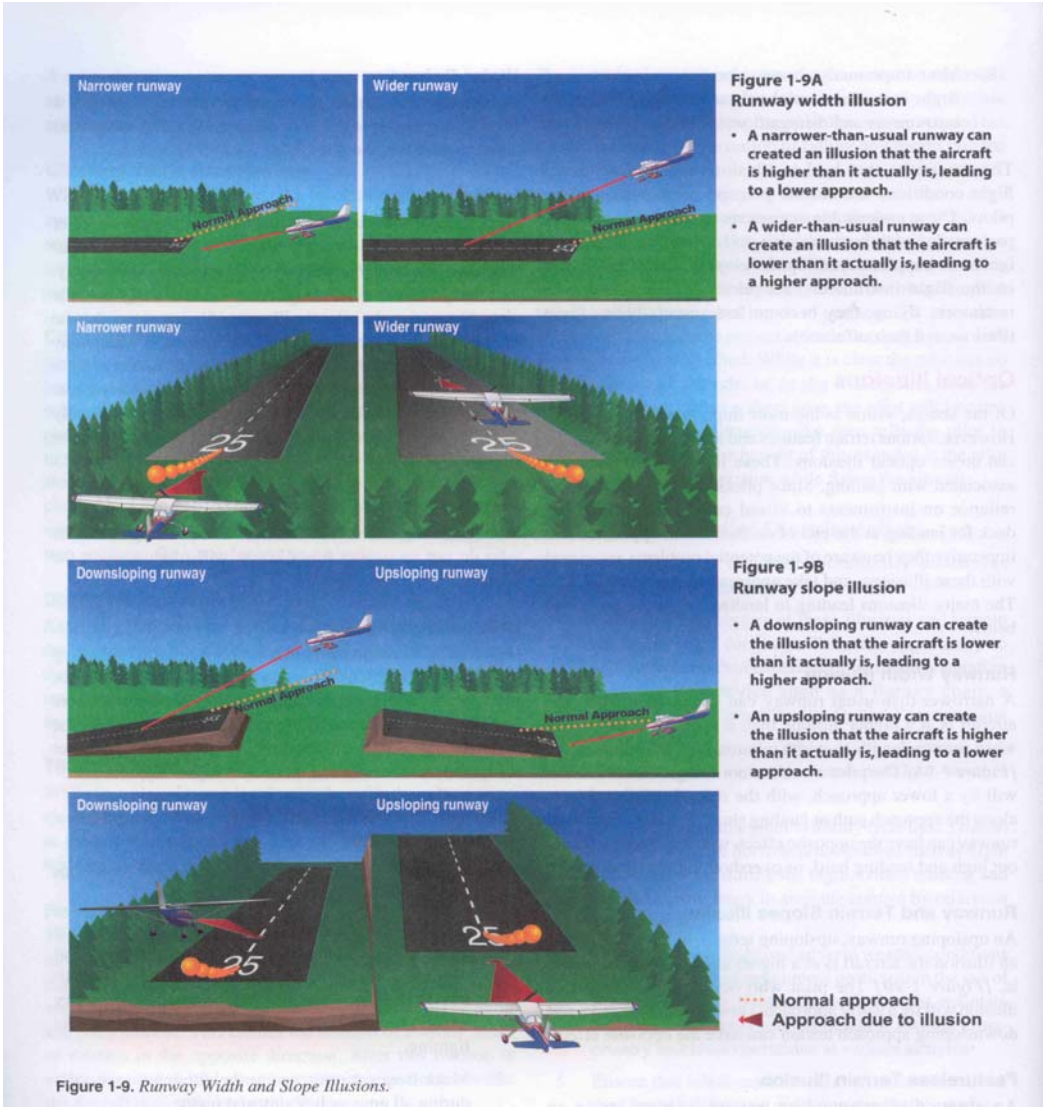

Figure 1-9. *Runway Width and Slope Illusions.*

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- **Water Refraction** illusion is caused by rain on the windshield creating the erroneous perception that the horizon is lower than it actually is. This causes

pilots to think they are high, again resulting in a lower-than-desired approach path.

- **Haze** illusion creates the false perception of being higher and further away from the runway, again resulting in a low approach path. Conversely, the extremely bright and clear conditions produced by sunny winter days (especially at high altitude mountain airports) cause the illusion of being lower and closer to the runway, thus resulting in high and fast approaches. Additionally, the diffusion of light caused by water particles on the windshield will adversely affect depth perception, causing lights and terrain features to be less effective in judging height during the landing flair.

- **Fog** illusion creates the false perception of pitching up, leading to "tuck-under" error. Pilots who do not recognize this illusion often abruptly steepen the last segment of a low visibility approach, thus creating a dangerously low approach path and possibly even impacting short of the runway.

- **Ground Lighting** illusions are created when lights in a straight row (such as roadway lights) are mistaken for approach or runway lights. Runway and approach lights which are set too brightly on clear nights will produce the false illusion that the distance to the runway is less than it actually is.

Strategies to Prevent Landing Errors due to Optical Illusions are as follows:

- **Anticipate** the possibility of optical illusions during approaches to unfamiliar airports, especially at night or during adverse weather conditions. Consult the A/FD (Airport/ Facility Directory for information on runway width, slope, terrain and lighting.

- **Make Frequent Reference to the Altimeter** during all approaches, but especially at night and during adverse weather conditions.

- **When Possible**, overfly unfamiliar airports for visual inspection before landing.

- **Use** electronic glide slope (ILS or WAAS) or visual approach path indicator (VASI of PAPI) for all approaches whenever they are available.

- **Utilize** the visual descent point (VDP) found on many non-precision instrument approach charts.

- **Recognize** the chances of being involved in an approach accident dramatically increase when an emergency or some other activity distracts you from your usual procedures.

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- **Maintain** optimum proficiency in landing procedures.

That completes this month's topics. Next month we will look at some ***Physiological and Psychological Factors.***
The thought for this month is **"A man begins cutting his wisdom teeth the first time he bites off more than he can chew!" ~ *Herb Caen, American Columnist.*** So, until next month, be sure to **Think Right to FliRite!**

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