Aircraft Safety

Accident Investigations, Analyses, and Applications

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moving at up to 20 degrees per second in one or many directions. When flying, a pilot could lose control of the airplane in attempting to align it with the false movements of the light. Military pilots have been known to attempt to rejoin in formation flying toward Venus or a star, and civilian pilots have done evasive maneuvers to avoid stars. The autokinetic effect helped convince them that stars were moving aircraft lights. Radars, radios, and collision avoidance systems help provide cues to avoid taking incorrect actions in flight due to the autokinetic effect.

BLACK HOLE

When in a situation without peripheral cues, such as landing on a very dark runway or in a snow or sand storm, pilots must rely on focal vision when a combination of focal and ambient vision would be preferable. In a black-hole situation over water, when there is no visible horizon or only the runway lights are visible, or a black-hole situation complicated by landing on a dark night with a distant town on a hill rising beyond a runway, a pilot may feel that the aircraft is stable but the runway is moving or is in an incorrect position. Landing short is the common fatal mistake from failing to recognize and correct the aircraft's position in time.

WHITEOUT APPROACHES

Like the black-hole approach, the whiteout approach causes disorientation and incorrect pilot responses due to the lack of peripheral or ambient cues. An atmospheric whiteout occurs when there is no visible horizon because the white snow-covered terrain blends in with the overcast or solid white sky. In this case, visibility might be "unrestricted," but visual cues are lacking. Similarly, blowing snow or sand may create a whiteout (or gray-out), but this is due to poor visibility causing lack of peripheral cues. Helicopters hovering low or attempting to land may cause a whiteout through rotor wash.

SIZE CONSISTENCE

Commonly a depth-perception issue, size consistence is particularly a factor in landing, when a pilot perceives her distance from a runway

based on the width and distance from a runway. For example, when accustomed to a certain size runway, a pilot approaching a narrow runway may perceive that the aircraft is higher than it actually is. This results in a low approach and a late flare, and usually a hard landing. Conversely, a wide runway can lead a pilot to perceive that he is too close to the runway, causing him to make a high approach and early flare, resulting in a dropped-in landing or excessive floating and a long landing (see Fig. 4-2).

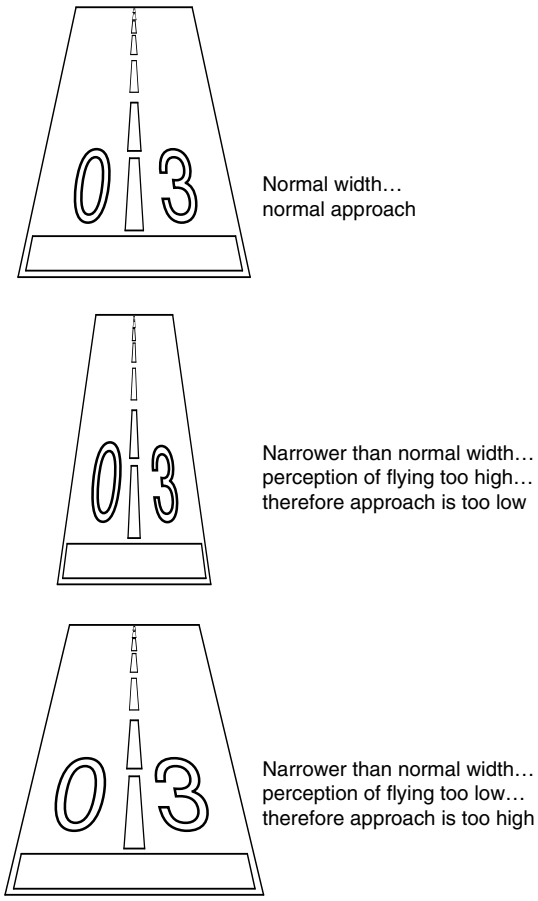

Fig. 4-2. Size consistence example.

SHAPE CONSISTENCE

An example of this visual illusion is when a runway is not level and either slopes up or down from the approach end. When the runway slopes up from the approach end, the pilot perceives that the approach is too high and, therefore, flies too low of an approach. The opposite is true of a runway that slopes down from the approach end (see Fig. 4-3).

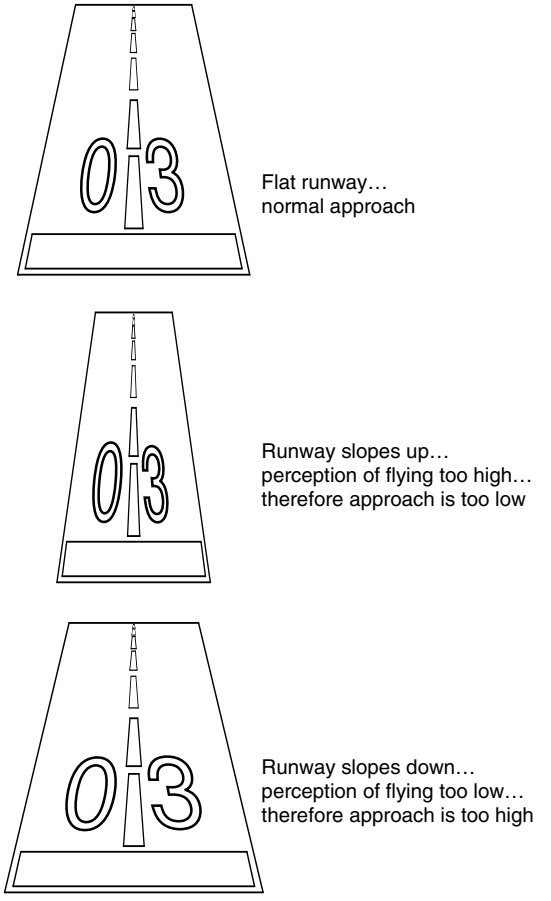

Fig. 4-3. Shape consistence example.

FALSE HORIZON

A sloping cloud deck, or the lights of a town lying on a slope viewed at night, can create the perception of appropriate visual cues resulting in inappropriate control inputs. When correcting the aircraft's flight to match the misperception of a false horizon, slow corrections may result in equilibrium in the vestibular system. This creates a sensation of straight-and-level flight that matches the visual perception, when the aircraft is actually in a bank. These illusions may create significant confusion when the brain is sure that a horizon is real but the flight instruments, in contrast, show a bank (see Fig. 4-4).

HEIGHT PERCEPTION ILLUSION

When flying over terrain with poor visual cues or references, such as the sea or a barren desert, or when flying over repetitive terrain such as a forest, in the dark, a pilot may perceive the attitude of the aircraft to be much higher than it actually is.

Fig. 4-4. False horizon—sloping cloud deck. Microsoft Clipart.

Somatosensory Illusions

GIANT HAND

In some spatial disorientation situations, the pilot may want to initiate a control input to correct her condition, but feels as if a hand is pushing against her in the opposite direction. This "giant hand" phenomenon is a subconscious result of cognitive dissonance; the mind and trained reflex pattern are fighting one another in an extremely disorientating situation.

Types of Spatial Disorientation

Spatial disorientation cases are frequently divided into three types based on the pilot's awareness and reaction.

Type I

This is a condition where the pilot does not recognize the spatial disorientation. It is the most deadly type because, since the disorientation is unrecognized, the pilot takes incorrect actions or makes inappropriate control inputs. Flying in what appears to be a wings-level attitude above a gently sloping cloud deck but without noticing the frequent input of trim to maintain the apparent wings attitude is an example. Upon looking back inside the cockpit, the pilot may find that he had trimmed in 5 degrees of right turn to maintain wings-level with the cloud deck beneath the aircraft. This Type I spatial disorientation situation was caused by a false horizon.

Type II

In this case, a pilot recognizes that something is wrong but has not recognized that the problem is caused by spatial disorientation. For example, a pilot increases speed to one assigned by the controller to maintain good separation from another aircraft. After setting the new speed, the pilot then notices that he has descended several hundred feet and is still descending. He climbs and rechecks his instruments. The pilot may have experienced an oculoagravic illusion.