

by Dale Wilson

I enjoy flying at night. Evening cooling normally results in less turbulence, reduced traffic means less radio frequency congestion, and it's often easier to spot other aircraft—providing they have their lights on. And the sparkling ground lights at night, well, they're just plain pretty.

There are hazards that lurk in the dark however, just waiting to trap an unsuspecting pilot. For example, pilots can be tricked into flying too low at night when approaching upslope runways or runways with greater length-to-width ratios than they are accustomed to. The most deadly of these hazards, however, is the “black hole approach.” Black hole conditions exist on dark nights (usually with no moon or starlight), when there are no ground lights between your aircraft and the runway threshold. The black hole illusion, sometimes called the featureless terrain illusion, fools pilots into thinking they are higher than they actually are, causing them to fly dangerously low approaches.

Such were the conditions for an instructor and his student on a night training flight when they struck the trees on final approach. The instructor knew all about the black hole phenomenon—that's why he elected to conduct the approach himself—but he ended up flying too low nonetheless. Unfortunately, unlike this incident where both pilots were able to walk away, most black hole approach accidents involve fatalities. And even though the hazards of black hole approaches have been publicized in the aviation community for decades, pilots are still falling prey to this illusion.

So what causes this visual illusion? Perception scientists don't exactly know for sure. There is disagreement as to the exact cause and probably no one theory alone fully explains the phenomenon;



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## Avoiding Black Holes

there are likely many factors involved. The most extensive study was conducted by Boeing scientists Conrad Kraft and Charles Elworth after a series of airline black hole accidents in the 1960's. Using a flight simulator, experienced Boeing instructor pilots (with more than 10,000 hours each) conducted entirely visual approaches to runways in black hole conditions. The result was that without the aid of altimeter or glide slope information, most pilots flew excessively low approaches and crashed into terrain short of the runway.

Kraft and Elworth explained that, in the absence of lighted terrain between the aircraft and runway, pilots attempted to maintain a constant visual angle between the runway threshold and runway end lights (or the ground lights beyond). Contrary to what you might think, a constant *visual* angle does not equal a constant *approach* angle. In fact, a constant approach angle results in an ever-increasing visual angle as one gets closer to the runway (Fig.1). When pilots attempt to maintain a constant visual angle the result is a curved flight path, which extends below a safe approach angle (Fig. 2).

Some researchers claim the original Boeing conclusions are contradictory and that the mechanisms involved in visually landing an aircraft are still not fully understood by scientists. Others believe pilots get suckered into flying low approaches because a visual expansion of the runway environment occurs when their vision transitions from *near* focus (the cockpit instruments) to *far* focus (the runway environment). This in turn causes a height illusion, which results in a lower approach. Of course, a critical visual cue pilots rely on for height perception during daylight approaches, optic flow, is completely absent in black hole conditions. Without this relative movement of outside terrain in our peripheral vision, it is virtually impossible to judge our height above the ground. It is likely that any or all of these factors play a role in deceiving pilots into thinking they are too high when conducting approaches in black hole conditions.

One final warning: upslope runways intensify this illusion. In fact, the experienced crew of a Boeing 767 recently landed short, damaging the aircraft's tail, while

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### NORMAL APPROACH TO LANDING ON THE NUMBERS

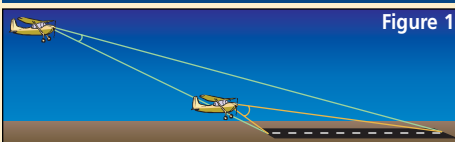
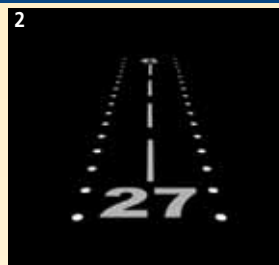
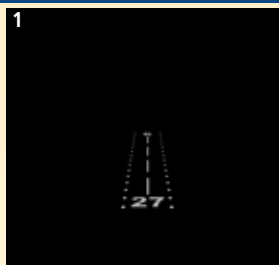


Figure 1

On a normal approach (sequence at right), the touchdown spot remains fixed in the windscreen and the apparent height (visual angle) of the runway increases as the aircraft descends. Just before touchdown, the runway nearly fills the windscreen.



### BLACK HOLE APPROACH TO A LANDING SHORT OF THE RUNWAY

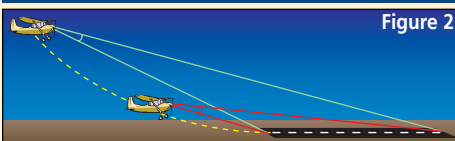
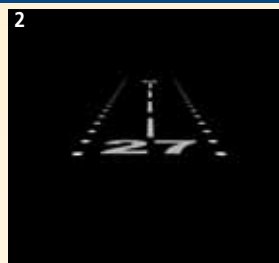
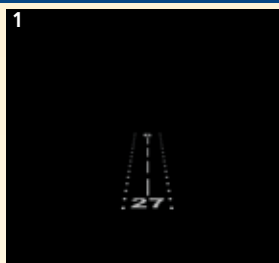


Figure 2

On a “black hole” approach, pilots tend to maintain a constant visual angle (apparent height) of the runway. They descend below glidepath to achieve this. A pilot who sees the far right image is dangerously close to the ground.



## FLYING TIPS

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conducting an approach to an upslope runway at Halifax International Airport. Even though the Precision Approach Path Indicator (PAPI) lights indicated a "too low" approach, the dark night combined with the upslope runway created a strong height illusion for the crew. In the original Boeing black hole studies, 11 out of 12 pilots who conducted visual approaches to a simulated upslope runway crashed short of it!

So what can you do to avoid falling prey to this trap? First, recognize that when it comes to the black hole illusion *seeing is deceiving*. Just because the approach angle looks safe doesn't mean it is. We're all subject to this illusion and even the most experienced pilots have been deceived by it.

Before you venture into an unfamiliar airport, determine if it is conducive to black hole conditions, has upslope runways, or has high terrain under the approach path. If you can't get that information from other pilots, the Airport/Facility Directory, or other publications, then avoid making your first flight to that airport at night, especially if it is located in a remote or unlighted area. If you can't avoid flying into an unknown airport at night then overfly it to get more familiar with the local terrain. You should also avoid long straight-in visual approaches, since even in daylight conditions with plenty of optic flow to provide altitude feedback, most pilots end up flying too low.

Even though your senses can fool you, you can use both airport and cockpit aids to help guide you to a safe landing. Using airport visual approach slope indicators (VASI, PAPI, PVASI, etc.) can help keep you from getting too low on the approach. Some of these can be seen from 20 or more miles away at night, but keep in mind that safe obstruction clearance is usually guaranteed only within a few miles and a few degrees of the extended runway centerline. Cockpit aids that provide altitude and glide path information can also protect you. For example, choose a runway with an ILS and follow the glide slope. You can also use DME readouts and altimeter information to secure a safe approach angle. For example, a 3°, 4°, or 5° glide slope can be flown by maintaining 300, 400, or 500 feet AGL per NM respectively from the runway threshold. A 300, 400, or 500-fpm descent rate at a 60-knot groundspeed also yields a 3°, 4°, or 5° glide slope.

The black hole approach has fooled many pilots. Following these strategies can help you from becoming one of them. ■

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