Visual illusions at night

Following on from last month's article, which focused on some of the rules for night flying, here's a refresher on some of the human factors, in particular visual illusions, that you ought to be aware of if you're venturing into the wide black yonder.

Night vision

Your eyes take about 30 minutes to adjust fully to darkness, so if possible you want to avoid looking at bright lights just before you go flying. And while it takes half an hour to gain it, it only takes a flash of bright light to lose your night vision.

Your retina is made up of rods and cones. The cones are the ones you use by day. They're in the centre of your retina, which means if you look straight at something by day the image will fall on your cones and you'll see it well. But the rods are towards the edge of your retina, so the best way to see something at night is to look slightly to one side of it.

Visual illusions

The balance organs in your body are:

- Eyes: these tell you which way is up because you know the floor is horizontal, the walls are vertical, the sky is up, and so forth.
- Vestibular (ears): the fluid in your semicircular canals tells you if your head is rotating, in roll, pitch or yaw. This information can be wrong, such as when you get the leans.
- Proprioceptive: muscles, or "seat of the pants", which sense gravity and other pressures. This one tells you which way is down because you can feel your backside on your chair, for instance. This one can be wrong as well, such as in a balanced turn, when your backside tells you that your seat is "down" and it's only your eyes that tell you the truth.

The most important balance organ is your eyes. That means at night the only way to be absolutely sure about which way is up is to use the visible information, starting and finishing with the attitude indicator. Trust your instruments, and only use external visual reference for navigation and traffic avoidance, and in the circuit.

The leans

The most common source of spatial disorientation for pilots, "the leans" is a result of the fluid in your ears giving you the wrong information. There are a couple of ways it can happen. One is where a balance turn has been sustained for a while, and the fluid in your ears "settles down" and stops moving, which makes your ears think your wings are level. When you roll wings level, your ears then tell you that you've rolled into a turn. Another way it can happen is for you to not be paying attention to your AI, a wing drop starts (which is not hard because most aeroplanes are unstable in roll), the wing drop is below the threshold of stimulation for your ears so your ears still think your wings are level, then when you look at the AI, realise what's happening and correct it, at a rate that your ears can sense, your ears tell you you've rolled into a turn. It can be quite a strong illusion, and if your AI says your wings are level, you need to believe it no matter how strongly your ears are telling you otherwise.

Coriolis illusion

This one is caused by excessive head movement, which can give you a sensation of tumbling. A good way to get it is to move your head too much while you're rolling into or out of a turn, because then

your head is pitching, rolling and yawing all at once. The way to minimise it is to minimise head movements. As Test cricketer and WW2 fighter pilot Keith Miller said when asked about the pressure of Test cricket, “Pressure is a Messerschmitt up your arse. Playing cricket is not.” Coriolis illusion, from manoeuvring to avoid the Messerschmitts and turning your head to look for them, must have only added to that pressure!

Somatogravic illusion

This is a “seat of the pants” illusion, which has killed people at night. When you accelerate fast, you get pushed back into your seat. When you pitch up, you feel the same thing, which is why all-singing all-dancing airline flight simulators tilt back on take-off to give you the feeling of accelerating. So if you accelerate on the runway in a relatively high-performance aircraft, you know it’s an acceleration and not a pitch up because your eyes can see the runway lights whizzing past faster and faster. The problem arises when you rotate and lose the visual reference, and the feeling of the real pitch up can be heightened by the imaginary pitch up due to the acceleration. If you’re not paying proper attention to the AI, you may feel you’re pitching up too much, you push forward, and you make a smoking hole in the ground a couple of hundred metres upwind of the runway. The simple mantra “Rotate, onto the clocks” helps to avoid this. (Flying PGL also helps because acceleration is not a term commonly associated with a 172.)

Autokinesis

If you look at a single stationary light source against a dark background for long enough, the light may appear to move. If you scan constantly you should avoid this problem.

Empty field myopia

If there’s nothing to look at outside, and you’re just looking at your instruments, your focus will “default” to your normal resting focal length, the same as when your eyes glaze over when you’re listening to a boring talk. That resting focal length is 1 – 2 metres, which means you’ll see your instruments but not the traffic. To eliminate the problem, shift your focus beyond 1 – 2 metres often, even if it just means looking at your wingtip lights.

Black hole effect

This can happen at aerodromes with little or no ground lighting in the vicinity. The lack of lights means you don’t have any visual cues other than the runway to estimate height and distance. Also, the runway lights can look brighter than they actually are because of the contrast with the surrounding darkness, which can make the runway look closer than it actually is, so you think you’re too high, and you descend into the black hole.

As with most illusions, the way to not get bitten by it is to rely on your instruments.

A few tips, not just for minimising black hole effect, but for circuits in general:

- Plan the circuit, including heading for each leg and height for rolling out on finals. Use the heading bug to help you.
- Avoid long straight-in approaches if there is no glideslope guidance available, such as PAPI.
- Fly by reference to instruments, especially in turns (except for turning final, when you should roll in on instruments and roll out on runway centreline).
- Don’t rely solely on visual estimates to judge height and distance.
- Fly downwind until you’re abeam the point where you should be at 500 ft AGL on final. I do this by imagining a line from the landing threshold, at 45° to the runway, to a point on downwind which is the base turn point. If you turn base and fly at right angles to the runway

(unlike some of the trapezoidal circuits I see sometimes), and roll out on final at 500 ft AGL, you will be on the right glidepath, even if it looks high due to black hole effect, or low at Northam because the runway lights are so dim.

- Pick an aiming point beyond the landing threshold, such as the second set of lights.

If you want to practice dealing with black hole effect, and the other challenges of landing on a runway with no other lighting close by, Narrogin is a very good option as it's about 5nm from the town. Wyalkatchem is not a bad option either.

Happy flying, and enjoy that cold winter night climb performance!