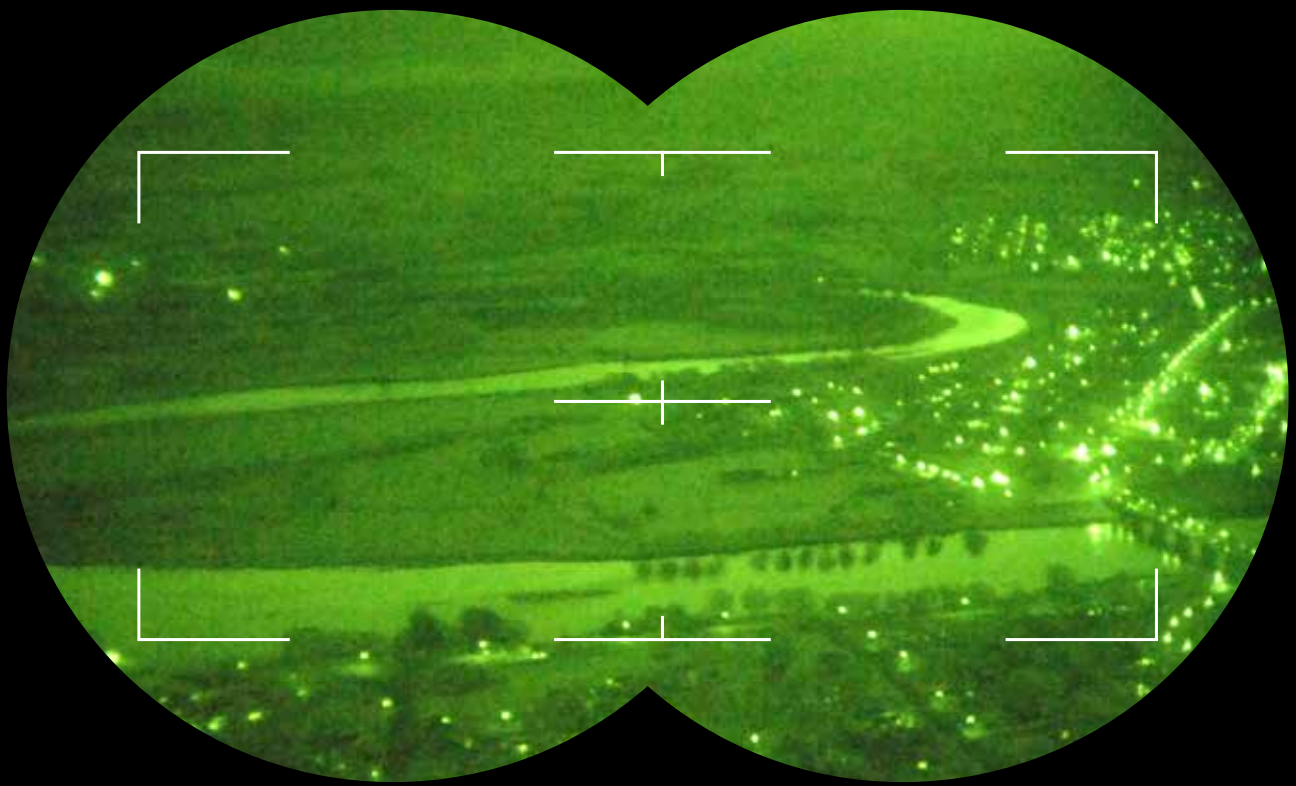

NIGHT-INDUCED SPATIAL DISORIENTATION

A fatal accident in Canterbury and a close call near Murchison illustrate how a straightforward night flight can descend into killer spatial disorientation.

Photo supplied.

About 2045 hours on a mid-December 2020 night, a BK117 B-2 helicopter lifted off from Nelson Airport to uplift a patient from Murchison and fly them back to Nelson.

On board were the 9200-hours pilot, a 2000-hours crewman, and an intensive care paramedic.

Picking up the patient after a non-eventful outward flight, the crew began the homeward journey to Nelson Hospital.

The weather was clear and calm and the pilot and crewman were wearing night vision goggles (NVG).

During the 120-kilometre journey north, the pilot's attention was partially diverted by a persistent band of light reflecting on his side of the windscreen. All three crew tried to identify the source of this light because it was degrading the pilot's visual picture[1].

As he flew on, the pilot's attention was further divided. He was trying different ways to improve the visual picture of his surroundings, diminished by that band of light. He was still trying to identify what it was. And he was also navigating towards a narrowing valley near Kawatiri Junction, which was further reducing the quality of visual conditions, due to the lack of ambient light.

The pilot slowed the aircraft, and descended from approximately 1000 feet AGL to 500 feet. But then he had another problem. Both he and the crewman noted their NVG visual picture seemed to 'darken off', and it further deteriorated due to oncoming headlights along State Highway 6.

Swiss Cheese. Aligning holes.

The pilot slowed again and descended. The crewman noticed this and also that the pilot's demeanour had altered. They'd flown together for years and the crewman was able to identify the pilot "just wasn't himself".

"His physical posture was altered; he was turned and had his head lowered, attempting to look under the reflected light. He was quieter and preoccupied.

"His brain was having to interpret the images he was 'seeing' through the goggles, and he was having to deal with the mystery band of light. There were differences in switch operations between this machine and our regular aircraft, and on top of it all, a shiny dash-mounted vinyl map pocket was reflecting light on to the pilot side of the windscreen. It all came together in the worst possible Swiss Cheese moment[2]."

Recognising that the pilot was probably suffering from task saturation[3], the crewman began to talk to him about whether to land or turn around.

"I have been taught some important aviation skills by pilots over the years, so I was trying to relieve some of his mental workload, and trying to gauge his level of overload as well as getting him focussed."

A subsequent safety investigation into what happened next, says, "It's likely, based on the indicators identified, that the pilot had lost situational awareness at this point".

As the crewman attempted to engage the pilot in a discussion of options, headlights from an oncoming vehicle on State Highway 6 threw the pilot into full spatial disorientation.

"I realised what was happening and just became his 'eyes and brain' as we fought to regain control of the aircraft.

"I was reading data off the gauges and instructing him as to what control movements to make. I was making urgent 'positive voice commands' for him to climb – to counteract the aircraft's rearwards and sideways movements."

It took nearly 90 frightening seconds to regain control.

"We landed as soon as safely possible and called for a road ambulance to pick up the patient and medic.

"The pilot had the presence of mind to immediately take photos of the conditions through his NVG to show it wasn't a weather/IMC event.

"The event had a big effect on all of us for some time, but it's made us more risk-averse in our night flying decision-making. We're more conscious of verbalising our situation and we do it more readily. We're talking more about the flight, the conditions, our options, how we're feeling, and we regularly fact-check each other."

The role of fatigue

In late November 2019, a visual flight rules CPL student was 25 minutes into a solo night flight, when inexplicably, his Cessna 172 entered a high-speed spiral dive, impacting a Lake Ellesmere sandspit, and killing the 23-year old.

A CAA safety investigation concluded the 206-hours student was fatigued, and was also likely experiencing visual and sensory illusions. »

1 This was eventually identified as the reflection of the rear tailight, the assembly of which was incompatible with a certain class of NVG.
2 The Swiss Cheese Model of Accident Causation. skybrary.aero > articles > james reason-hf-model.
3 'Task saturation', according to the US-based National Business Aviation Association, is "having too much to do without enough time, tools, or resources to do it."

He'd completed a successful cross-country flight test that morning, and returned to the organisation's base about 1630 hrs to prepare for a solo night flight in the aerodrome circuit later that evening. He was unable, however, to obtain a solo circuit training slot so he was authorised by his training school to fly in a local training area instead.

About 2140 hrs, he took off from Christchurch aerodrome. The night was clear with unlimited visibility.

The subsequent safety investigation found that, after a series of turns, "The aircraft started losing height as soon as the [final] right turn was begun. During the last 30 seconds, the height loss and change of direction both increased exponentially until the aircraft impacted the sandspit in a steep nose-down spiral turn. The average rate of descent over this time was calculated to be approximately 4500 feet per minute".

Such were the impact forces, some parts of the aircraft were found almost 60 metres away from the main fuselage.

Physically and mentally overwhelmed

There was no failure found with the aircraft. The pilot was competent and current. The post-mortem had no adverse pathological or toxicological findings. The pilot had no pre-existing medical condition that may have contributed to the accident. He'd formally declared himself fit to fly, using his provider's preflight checklist.

The safety investigation concluded that in fact, the student had likely been affected by visual and sensory illusions.

The subsequent report noted that, "Many types of visual and sensory illusions can affect a pilot, particularly if flying visual flight rules at night, with reduced external visual references".

The Good Aviation Practice booklet, *Night VFR*, also describes environmental features that can lead to pilot disorientation. "Large areas of water can be hazardous because of loss of horizon, lack of landmarks for situational awareness, and reflections of stars can contribute to disorientation."

As the safety report notes, "All these features were present during the final right turn leading to the departure from controlled flight".

The safety investigator, Peter Stevenson-Wright, says, "The final turn was conducted away from the bright lights of Christchurch city, towards the relative darkness of the Akaroa Peninsular and Pacific Ocean in the east. There would have been very few significant visual lighting clues for the student to reference during the latter stages of this turn.

"Absence of visual references can contribute to the onset of visual and sensory illusions. Sensory illusions caused by fluid movement in the ear's vestibular canal can be overwhelming."

The Australian Transport Safety Bureau describes three types of spatial disorientation (SD), with Type III being the most extreme.

"The pilot may be aware of the disorientation, but is mentally and physically overwhelmed to the point where they are unable to successfully recover from the situation. They may freeze at the controls, or make control inputs that tend to exacerbate the situation rather than effect recovery from it. The pilot may fight the aircraft all the way to ground impact, never once achieving controlled flight.

"Such forms of disorientation are a result of breakdowns in the normal cognitive processes, possibly due to the overwhelming nature of the situation, especially if other factors such as fatigue and high workload are also present."

"[This form of SD] closely resembles the scenario that available evidence suggests may have contributed to this accident," the Lake Ellesmere safety investigation report notes.

As to fatigue, the report notes that flying exams are generally quite stressful, placing more mental burden on the pilot than a training flight.

"It's likely that by the time of the night flight," it concludes, "the student was suffering a level of fatigue from the long duty day and the earlier flight test."

CAA Chief Advisor of Human Factors, Alaska White, says the effects of fatigue are a well-known threat to aviation safety.

"Fatigue can lead to the failure of pilots to recognise a rapidly changing environment, and it can slow and degrade a pilot's decision-making response times. Fatigue causes them to be more prone to making errors and even worse at detecting them, once they've happened."

It can happen to any pilot

Peter Stevenson-Wright says such illusions can occur, regardless of a pilot's experience or the aircraft's instrument panel design.

The safety investigator who reviewed the Nelson to Reefton occurrence, Siobhan Mandich, agrees.

"The ATSB research shows that experience does not protect a pilot from spatial disorientation. It's not always the junior pilot who gets disorientated – some studies show the more at-risk pilot is the highly proficient one.

"Disorientation can affect any pilot, any time, anywhere, in any aircraft, on any flight, depending on the prevailing circumstances.

"And a pilot's experience of disorientation does not mean it will never happen again to them. It does, however, allow the disorientation phenomenon to be recognised more readily in the future. Awareness and preparedness are key elements in preventing a spatial disorientation accident."

According to the ATSB, there are many steps pilots can take to minimise their risk of experiencing spatial disorientation.

"Many of those involve preflight planning and adequate preparation," says Siobhan. "Being aware of the risk of spatial disorientation is one of the key elements in preventing an SD accident. Increasing awareness of spatial disorientation illusions is essential. In the preflight planning process, plan for their possible appearance at different stages of flight.

"It's getting the crew to talk about what scenarios they may experience on a particular night, based on various factors – moonlight, geographical location, weather, for instance – and discussing what cues to look for to identify the onset of the loss of situational awareness that could lead to SD – as mentioned in the first story.

"That means the crew have that fresh in their minds during that flight, making it easier to pick up on."

There are very few loss of situational awareness or spatial disorientation incidents reported to the CAA.

These incidents highlight valuable information on how loss of situational awareness can lead to spatial disorientation, and what the indicators are that can be detected and ultimately recovered from.
The CAA encourages participants to report any loss of situational awareness, or spatial disorientation events, to enable accurate guidance material to be provided.

// MORE INFORMATION

For your free copy of the *Night VFR* Good Aviation Practice booklet, complete the order form at aviation.govt.nz > order publications.

Comments or queries?
Email **education@caa.govt.nz**

YEAR-END LICENSING REMINDER

The last day for issuing licences in 2022 will be 23 December. Licences will again be issued from 9 January 2023.

Licence applications are dealt with on a first-in, first-processed basis. Calling the licensing unit doesn't give your application greater priority, and only takes staff away from processing applications.

If you're applying for a new licence, you'll need to satisfy the Director of Civil Aviation that you meet the 'fit and proper person' (FPP) requirements of the Civil Aviation Act 1990. Obtaining the necessary information can take several weeks. As a rough guide, allow up to six weeks before your flight test to complete the FPP process.

If you need to renew your medical certificate, take into account the time that may take, particularly if you require a specialist examination.

AVIATION SAFETY ADVISORS

Contact our aviation safety advisors for information and advice. They regularly travel around the country to keep in touch with the aviation community.

John Keyzer – Maintenance, North Island
027 213 0507 / john.keyzer@caa.govt.nz

Mark Houston – Operations, North Island
027 221 3357 / mark.houston@caa.govt.nz

Carlton Campbell – Operations, South Island
027 242 9673 / carlton.campbell@caa.govt.nz

NEW GAP BOOKLET: *MEDICAL MATTERS*

Safe flying starts with you.

This new Good Aviation Practice booklet explains all things medical – from types of medical certificates and the application process, through to how endorsements work and how to renew your medical. There's also information and advice about human factors, and where to look for more information.

Go to **aviation.govt.nz/education** to download a digital copy or to order a printed copy.