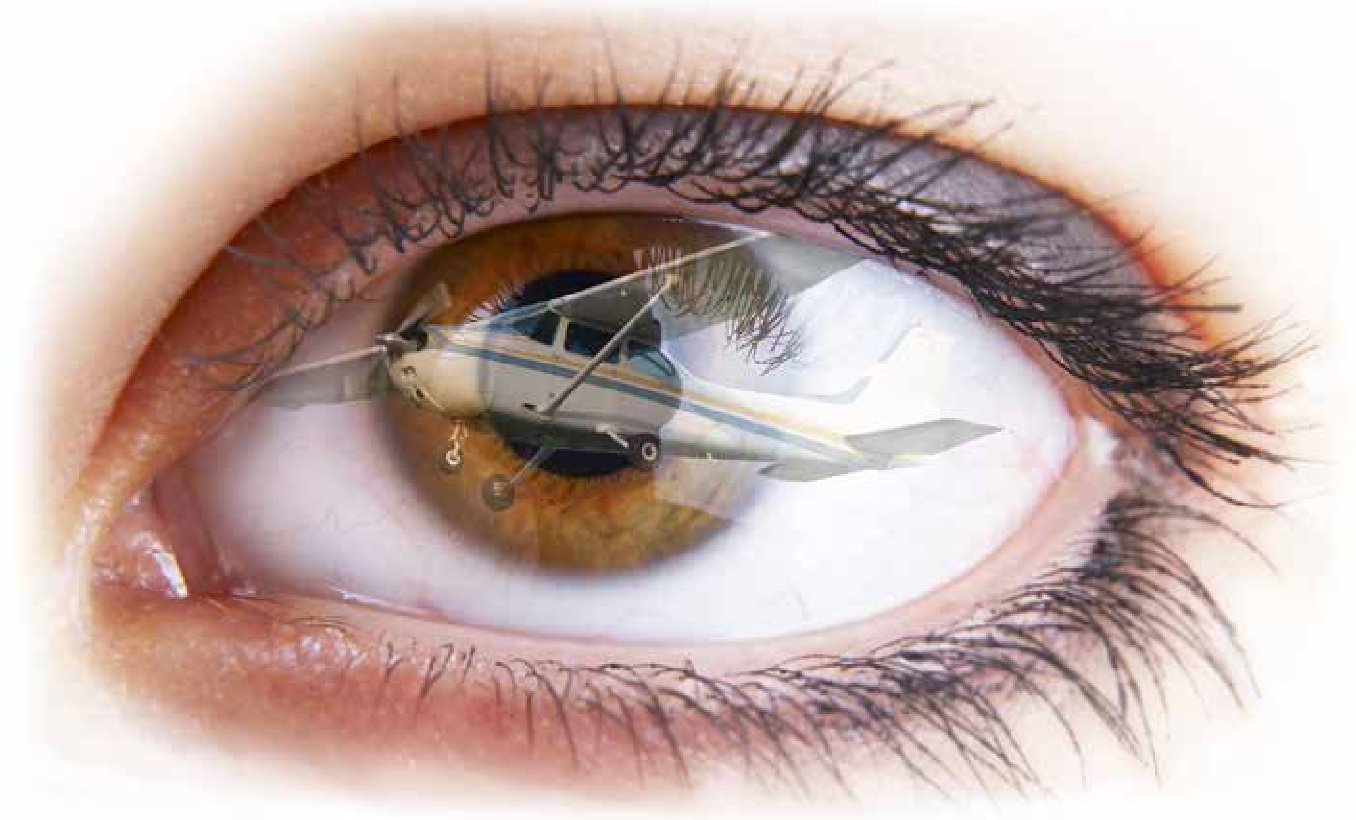
# So You Think You Can **See and Avoid**



For pilots operating under VFR, seeing and avoiding is the final defence against a mid-air collision. But pilots need to be aware of the human factors that affect their ability to scan effectively.

A 2010 investigation studied 12 mid-air collisions that had occurred in New Zealand in the previous 20 years. Seven of the collisions were fatal, with 20 people killed. Interestingly, all of those collisions were during daylight in good weather conditions with the pilots operating under VFR. The principles of see and avoid failed to alert those pilots to conflicting traffic.

So why were those pilots unable to grasp the traffic situation accurately?

## Case Study

On Monday 26 July 2010, two Cessna 152 aeroplanes were being used for training flights near Feilding aerodrome. Cessna A was returning to the aerodrome circuit with an instructor and student pilot on board, and Cessna B was climbing away from the aerodrome, flown by a solo student.

The two aeroplanes collided at 1300 feet – about 1100 feet above the ground.

The nose wheel of Cessna B struck and severed part of Cessna A's wing, rendering Cessna A uncontrollable.

Cessna A was seen to enter a steep descending spiral dive before striking the ground, destroying the aeroplane and killing the two occupants. The other pilot involved was able to glide Cessna B back to the aerodrome without injury.

The Transport Accident Investigation Commission (TAIC) safety investigation report stated the pilots of both aircraft should have been able to see each other but failed to do so.

The report also provided some key lessons and recommendations.

## Workload

The sighting of other aircraft requires an effective scan outside the cockpit, supported by good radio use. During periods of high workload, a pilot's systematic scan can be disrupted by essential tasks inside the aircraft. For example, checking engine gauges, or making a switch selection. Cockpit workload is likely to be higher near airports where traffic is most dense, but where scanning is all the more crucial.

Remember to maintain visual contact after sighting an aircraft. If you do lose sight, let other aircraft in the vicinity know and state your intentions.

***Feilding Mid-air Case Study – Finding***

"The first priority of a pilot-in-command must be to ensure the safety of their aircraft, before engaging in other tasks."

Photos: istockphoto.com/sandsun and istockphoto.com/sambrogio

An instructor has the role of balancing aircraft safety with enabling their student to learn effectively. When flying with a student, you need to get a feel for their capacity and then compensate accordingly. Students who are in the early stages of training will be completely focused on flying the aircraft, so their ability to direct their attention to other tasks will be limited.

### Limitations of the Visual Scan

'Accommodation' is the process of focussing on an object. Visual scanning involves moving the eyes to bring successive areas of the visual field onto the small area of sharp vision in the centre of the eye.

Pilot scans are often unsystematic. Areas of sky near the edges of windscreens are generally scanned less than the sky in the centre, and the scan may be in chunks that are too large.

FAA Advisory Circular AC 90-48C, recommends scanning the entire visual field with eye movements of 10 degrees or less. It estimates that around one second is required at each fixation. So to scan an area 180 degrees horizontal, and 30 degrees vertical, could take 54 fixations, so 54 seconds. But only a young person can accommodate to a stimulus in one second. The average pilot probably takes several seconds to accommodate to a distant object.

A big part of the answer is using a practical scanning technique. By fixating every 20 degrees, it should be possible to detect any contrasting or moving object in each visual block. Across the total scan area, that involves 9 to 12 blocks, each requiring one to two seconds for accommodation – see the two diagrams.

### Aircraft Design Limitations

When flying, you need to compensate for the design limitations of the aircraft. All aircraft have blind spots that you need to keep in mind when scanning for traffic.

***Feilding Mid-air Case Study – Key Lesson***

"Pilots need to … ensure that their scans cater for any blind spots in the cockpit, either by moving their heads to look around any obstructions or by manoeuvring their aircraft."

Before turning, start scanning by looking in the direction opposite to the turn as far as the cockpit vision allows. Then move your eyes to scan in the direction of the intended turn, finally raising/lowering the wing to give you a view above and below. Once this scan is complete, a turn can be initiated.

In high-wing aircraft, there is a considerable blind spot created by the lower wing during a turn. To partially overcome this problem, you should lean forward to look through the side of the windscreen, moving both your head and body for a better view.

When descending in low-wing aircraft, make shallow turns to compensate for your blind spots so that lower flying traffic can be seen.

On descent and climb-out, make gentle 'S' turns to ensure no-one is in the way. On final, do not fixate on the touchdown point. Look in front and behind that point for other traffic.

Also, be aware of how your seating position affects your line-of-sight. Your visibility is most restricted on the side of the aircraft furthest away from the pilot. If you're short, or the aircraft combing is high enough to significantly restrict vision, it may pay to use a cushion.

Window-posts, bug splatter, sun visors, hats and caps, wings, and front seat occupants all have the potential to hide an approaching aircraft from view. An obstruction wider than the distance between the eyes will not only mask some of

the view completely, but will also make other areas visible to only one eye. Obstructions can also act as focal traps for the eyes, making it difficult to see distant objects.

## Limitations of Vision

As well as the aircraft blind spots, the eye itself has a built-in blind spot at the point where the optic nerve exits the eyeball. If the view from one eye is obstructed, then objects in the blind spot of the remaining eye will be invisible. You can compensate for that by moving your head and upper body during your lookout. Use the blind spot test on page 14 to check your blind spot.

Acuity, or sharpness of vision, varies across the visual field. In daylight, acuity is greatest at the centre (fovea), in low light it is fairly equal across the whole retina, and at night it is greatest in the periphery. There are times when an approaching aircraft will be too small to be seen because it is below the eye's threshold of acuity. Acuity can be reduced by factors such as vibration, fatigue, and hypoxia.

Empty field myopia occurs in the absence of visual cues, causing the eye to focus at a relatively short distance. In an empty field, such as blue sky, the eyes will tend to focus at two to three metres, or onto a nearby object, such as a dirty windshield. It therefore requires an effort to focus at greater distances. To combat this, look for a cloud or distant terrain to focus on.

The average person has a field of vision of around 190 degrees, although it varies from person to person, and is generally greater for females than males. The field of vision begins to contract after age 35. In males, this reduction accelerates after 55.

A comfortable and alert pilot may be able to easily detect objects in the corner of the eye, but the imposition of a moderate workload, fatigue, or stress, may induce tunnel vision. This has also been observed under conditions of hypoxia and adverse thermal conditions.

The limited mental processing capacity of the human can present problems when they need to do two things at once. Experiments conducted by NASA indicated that a concurrent task could reduce pilot eye movement by up to 60 per cent. The key is to carefully prioritise your tasks.

Direct glare from the sun, and veiling glare reflected from windscreens, can effectively mask some areas of view. Direct glare is a particular problem when it occurs close to the target object. When the glare source is five degrees from the line of sight, visual effectiveness is reduced by 84 per cent. A good pair of non-polarised sunglasses will help combat this.

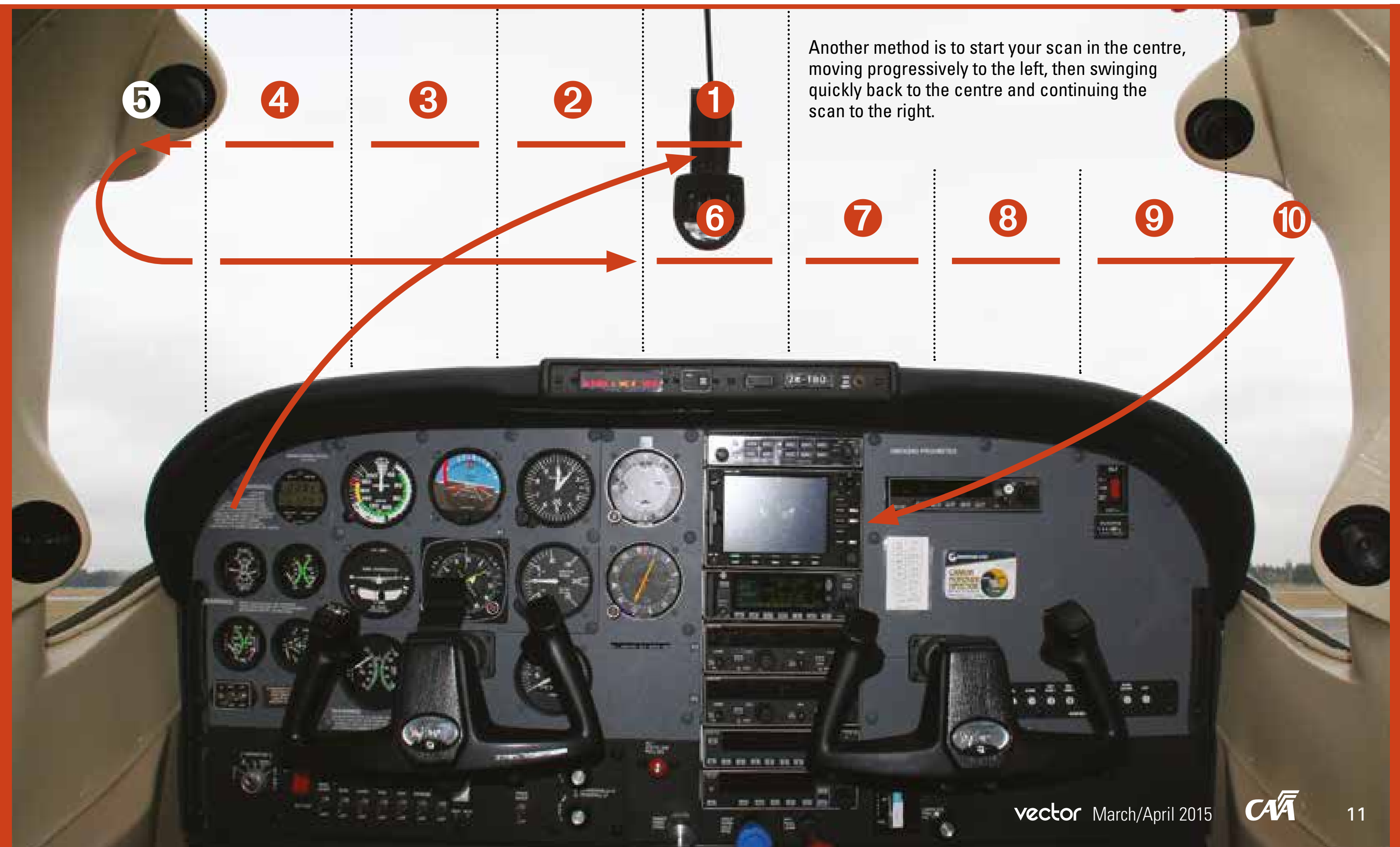
## Hear and Avoid

***Feilding Mid-air Case Study – Key Lesson***

"Pilots must make clear, concise, accurate and timely radio transmissions, and they need to listen actively to the transmissions of others to help build accurate pictures of what is occurring around them."

Without detracting from the need for effective lookout, it's clear that relying purely on see and avoid won't guarantee you'll avoid a collision. Engaging in good radio use helps pilots build a mental understanding of where other aircraft are and the risk they pose.

In the Feilding collision, the solo student should have heard, but did not recall hearing, the joining call made from the other Cessna just before the accident occurred.



*Here's a simple test to reveal your blind spot:*

Close your left eye and stare at the plane on the left with your right eye. Now slowly move your head towards the diagram while focusing on the plane on the left. At a particular distance the plane on the right will disappear.

He was aware it was in the vicinity performing overhead joins, but had he heard the specific joining call, he would have had between 35 and 95 seconds to respond and look for that aircraft.

When making transmissions, remember to follow the four Cs: clear, concise, consistent, correct. It's just as important, however, to actively listen to the transmissions from other aircraft and understand their implications. This will allow you to focus your efforts on locating and avoiding other aircraft. If there is any doubt or confusion, don't hesitate to ask the other pilot for clarification.

Don't favour 'hear and avoid' over 'see and avoid' though, warns Carlton Campbell, CAA Aviation Safety Adviser.

"There is a tendency to think if you don't hear any traffic, then there isn't any. Also, some pilots tend to treat 119.1 MHz as a de facto enroute instead of FISCOM. There could be traffic on FISCOM or NORDO (no radio) aircraft. See and avoid is your fundamental collision prevention.

"Additionally, with the increase in handheld GPS, EFBs (mostly iPads) and glass cockpit technology replacing analogue instruments, a reliance on, or placing too much confidence in, this technology, also contributes to a degradation of the see and avoid principles," adds Carlton.

## Traffic Characteristics

### Background Interaction

Contrast is the difference between the brightness of a target and its background. Complex backgrounds such as ground features, or clouds, hamper the identification of aircraft due to contour interaction. That happens when background contours interact with the outline of the aircraft, producing a less distinct image.

Small particles of haze or fog scatter light. That may give some light from the aircraft the appearance that it originates from behind the aircraft, and vice versa.

### Lack of Relative Motion

***Feilding Mid-air Case Study – Analysis***

"With a closing speed calculated to be between 130 and 145 knots … the constant bearing and the lack of relative movement meant that there was little to attract the pilots' attention towards the other aeroplane."

The human visual system is tuned to detect movement firstly, then to focus on an object to identify it. When two aircraft approach each other on steady headings, they maintain a constant relative bearing to each other. From each pilot's point of view, the converging aircraft will grow in size, but remain fixed at a particular point on the windscreen. That can be particularly dangerous, as the perceived size of an approaching object changes little until it gets much closer.

### Equip and Be Seen

***Feilding Mid-air Case Study – Recommendation***

"Various aircraft paint schemes have been shown to have little benefit in improving the conspicuity of aircraft for the wide range of weather, environmental and geographical conditions likely to be encountered … however, more modern, high-intensity strobe lighting and new high-visibility paints may increase the ability of see and avoid as a primary means of preventing mid-air collisions."

The visibility of a light largely depends on the luminance of the background. While strobes are not likely to be helpful against bright sky backgrounds, they may make aircraft more visible against terrain or in conditions of low light. In addition, it's wise to using landing lights while in the circuit or on hazy days.

## Evasive Action

Seeing and avoiding other aircraft, even when you know their general location, isn't always a quick and easy process. Once an object of interest has been detected, a pilot still needs to identify it, determine if it's a potential threat, and if required, make the necessary control movements and allow the aircraft to respond.

Research has estimated that the time from recognition to evasive action is around 12.5 seconds.

That may increase for less experienced pilots, older pilots, and those with less than optimal vision. ■