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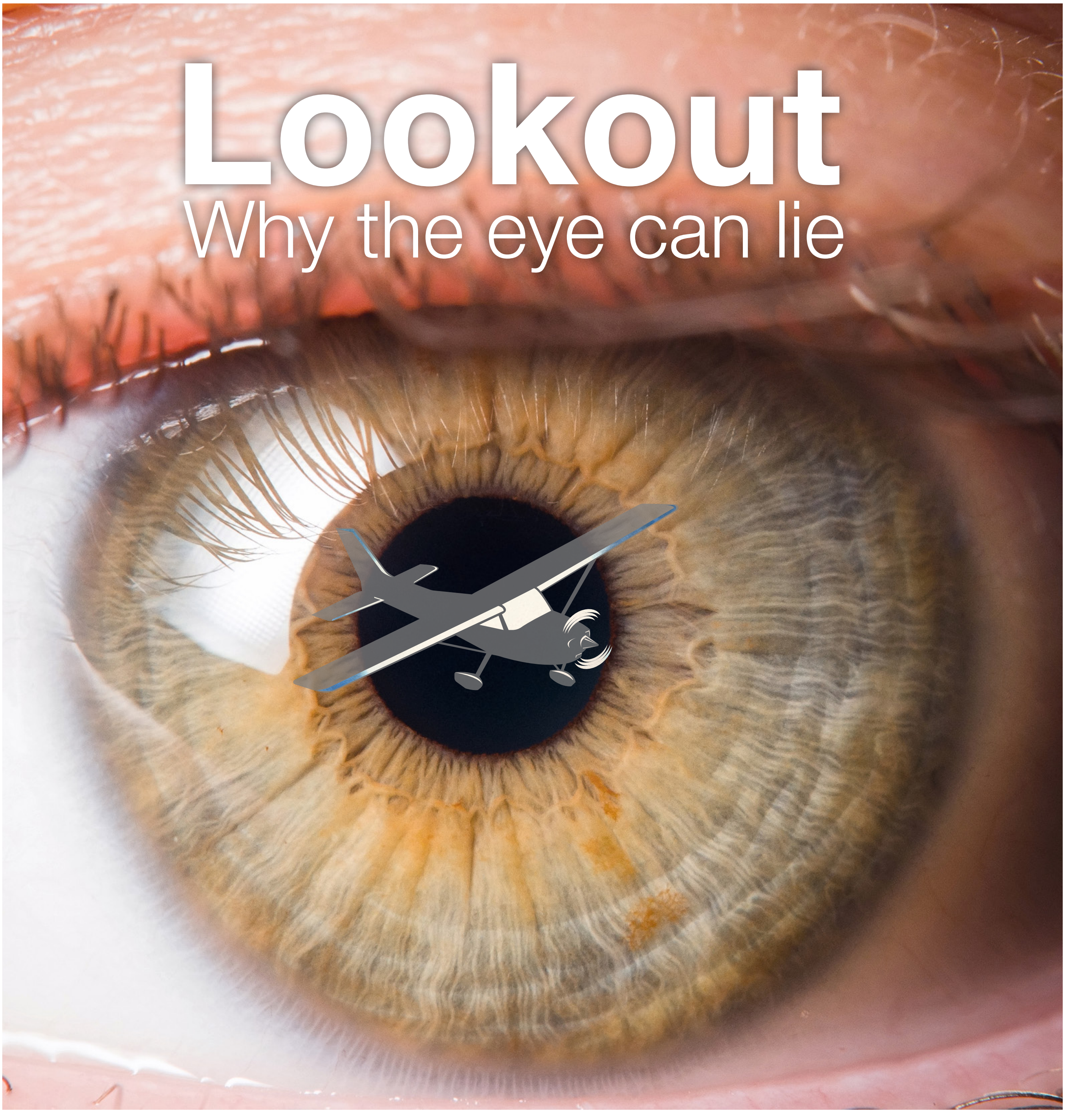
Lookout

Why the eye can lie



PLUS Why are Airprox happening — and what can be done about it?

WELCOME...

to the annual Airprox Magazine 2018

Welcome to the Airprox Magazine for 2018. This, our sixth edition, builds on previous years by focusing on the ins-and-outs of lookout and how the eye works.

Most people know the eye's an imperfect tool in aviation, so we have to work hard to overcome its deficiencies. Although ATC and electronic systems can provide vital situational awareness, in the end the pilot needs to see what he or she is avoiding.

While some material might be familiar, it does no harm to review strategies both for visual scanning and prioritising cockpit activities. If you want to find out more about lookout there's a really good study titled The Limitations of the See-And-Avoid Principle by Alan Hobbs of the Australian Transport Safety Bureau in April 1991 which you can link to by clicking here or simply searching for the title on the internet.

I've also included a section on the Airprox statistics for 2017. Hopefully it will also provide food for thought — how can you maximise the protection offered by mid-air collision safety barriers? The increasingly affordable collision warning systems seem to be a quick-win. The bottom-line is that it's clear that the majority of Airprox could be avoided if only the pilots had known the other aircraft was there.

Suffering an Airprox doesn't make anyone a bad pilot, but failing to report one means that everyone loses the opportunity to learn from the incident. I'm deeply grateful to those who do report, so do follow their example.

As with everything else these days, *'There's an app for that!'*; click on the links here or search for UKAB and you can download our App that has a reporting section, previous reports plus you can learn more about us.

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How the eye CAN LIE

How many times have you said 'I just didn't see it…' Failing to spot something might not be your fault, but down to momentary 'blindness'

By PAUL SHEFFIELD

Most of us probably reckon we carry out a pretty good lookout when flying, but what about the eye — would it surprise you to know that it can lie without you even knowing it? How many times, for example, have you heard people say "I never saw the person, the bike or even the truck", it's not that they weren't looking, but rather that the eye wasn't seeing.

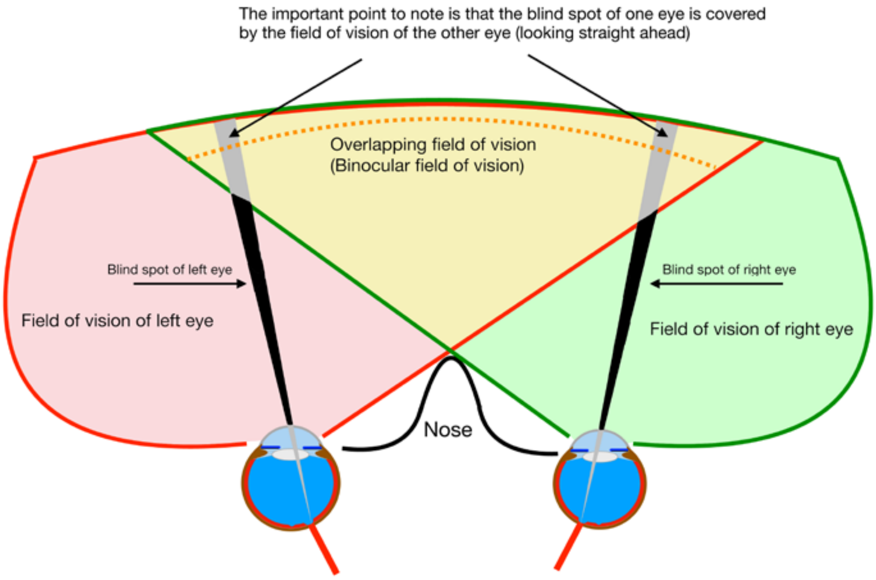
Remember the recently revived adverts from the Seventies fronted by actor Edward Judd that warned drivers to '*Think Once, Think Twice, Think Bike*'? The point wasn't simply about looking and thinking, it was also to give your eyes an opportunity to overcome a physical issue with eyesight — saccades, or momentary blind spots. Here's how it works.

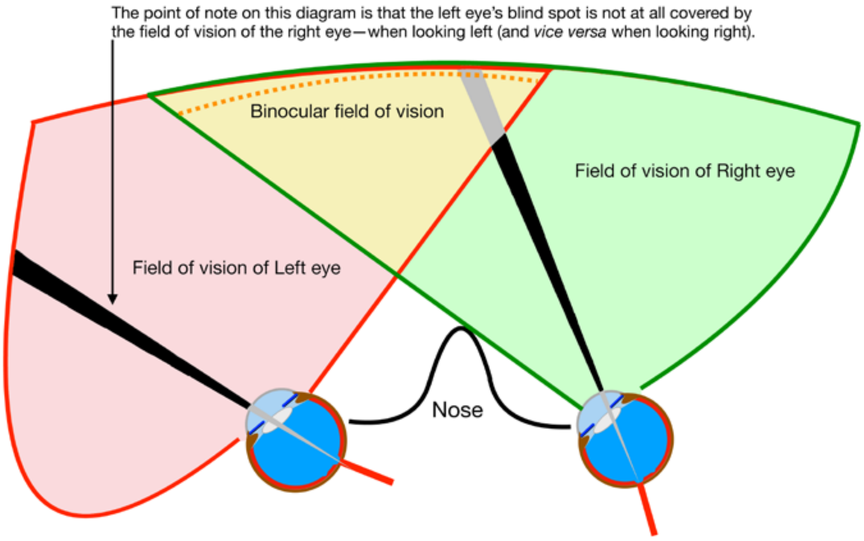
Just imagine for a moment you're sitting in a car at a 'T' junction as a cyclist rides past on a main road in front. You'll follow their path smoothly from right to left and see everything along that path, but try moving your eyes just as smoothly when there's no bike to follow, you can't it's impossible. You won't be aware of it, but without something to track your eyes will be moving in sudden jerks, or saccades, then pausing for a moment (fixating), before another saccade and so on.

During this very rapid and short — around 20–200 milliseconds — saccadic eye movement you are effectively blind. This is because the brain suspends vision during the saccade and nothing new is seen for that small duration. If that wasn't the case the world would whizz past in a very blurred and disconcerting fashion.

There is, of course, a related process that causes the same suspension of vision — blinking.

During normal subconscious blinking the world doesn't go dark (or pink if it's a sunny day) as the light is cut off or filtered by the closed eyelids. Vision is momentarily suspended during a blink until the image can be updated. The same is true with a saccade, in fact a more complete cut-off occurs, vision is only updated when our eyes have come to rest and had a moment to interpret the image.





As a collision threat approaches, its size on the retina roughly doubles with each halving of the separation distance, so colliding aircraft stay relatively small until shortly before impact when it all happens rather quickly

The consequence of this is that with large saccadic eye movements we could easily jump over any number of aircraft while we are 'blind' and if there are none where our eyes come to rest, or fixate, we will assume there are none anywhere. Even a bright flash of light would not be seen during a saccadic eye movement — you are effectively totally blind for that short moment.

If an aircraft is moving relative to us in that jumped over part of the visual scene, we might see it after the saccade ceases if our peripheral vision detects movement, but if it's on a constant relative bearing (collision course) it's very probable we wouldn't see it until it's alarmingly large in the field of view.

In addition to saccades, understanding how the visual system works explains why you so often hear "I just didn't see it…".

Light enters the eye through the cornea, continues through the pupil and adjustable crystalline lens and finally falls into focus in the form of an image on the retina. This retinal image is analysed by more than 100 million light sensitive cells, and a huge number of additional cells that convert the light (i.e. image) to nerve impulses.

The result is only superficially analysed in the retina and so is compressed and sent to the brain for further interpretation. Note that compression of the data means assumptions have to be made by the retina. The main thing it does is to break down the image into edges and contours — a contour map of edges.

One of the biggest assumptions is that anything within a given contour is assumed to be uniform, in other words nothing else exists within that particular boundary. There are roughly one million nerve fibres leaving the retina (the optic nerve) so clearly there has been at least a 100:1 data compression of the 100 million light sensitive cells. It's also worth looking at the retina's two types of light sensitive cells in more detail: rods and cones.

Cones require a lot more input energy (brightness) to work and therefore generally only function in daylight conditions (photopic conditions). Cone cells peak in number in the centre of your retina—the macula (and the macula therefore gives rise to the centre of your field of vision and its peak resolution), and rapidly decrease in number more peripherally.

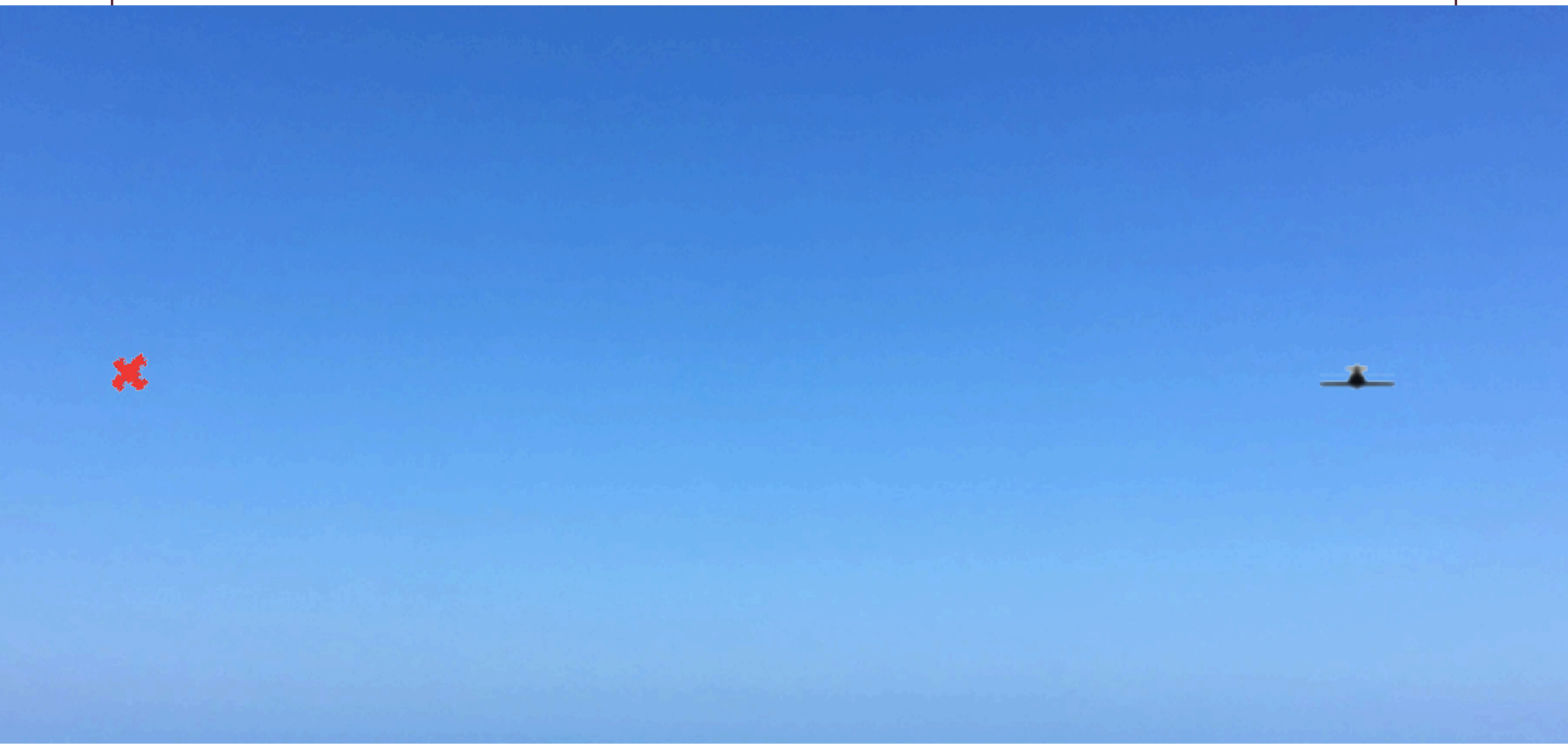
Rod cells only work in low light (scotopic conditions) and are completely bleached out and functionless in daylight conditions. Rod cells are much less numerous in the very centre of the retina (which is why a faint star appears to fade if directly looked at, and brighter if looking just to one side of it at night-time). Rod cells cannot detect colour, and so the colour of navigation

DEMONSTRATION OF THE NATURAL BLIND SPOT

Cover your left eye and look at the red cross with your right eye only. The aircraft will disappear, if it doesn't, move your head slightly closer, or further away from the page until it does. The aircraft is now in the blind spot of your right eye. Now open your left eye (while still looking at the red cross). The aircraft will re-appear, but not that obviously. The left eye's field of vision is now making up for the blind spot in the right.

Now, keep looking at the red cross with both eyes open and slowly turn your head to the left (which is in effect the same as glancing to your right without a head movement), the aircraft will disappear again as your nose cuts off the overlapping field of vision from your left eye. This could be quite a small movement if your nose is larger, or your head held slightly chin high.

This latter demonstration shows that when looking to your right, without moving your head, it is possible that an aircraft further to the right is lost in your blind spot even though your field of vision extends well beyond that point. Moving your head, ideally roughly pointing your nose in the direction you wish to scan, will allow the fellow eye to cover the other's blind spot. The same is true for the other eye if looking the other way — close your right eye, look at the aircraft with your left and the red cross will disappear.



lights are only seen by the cone cells, and they only function when there is sufficient focused light energy at night to stimulate them. Fortunately, rod cells at night are extremely sensitive and excellent at detecting flashes.

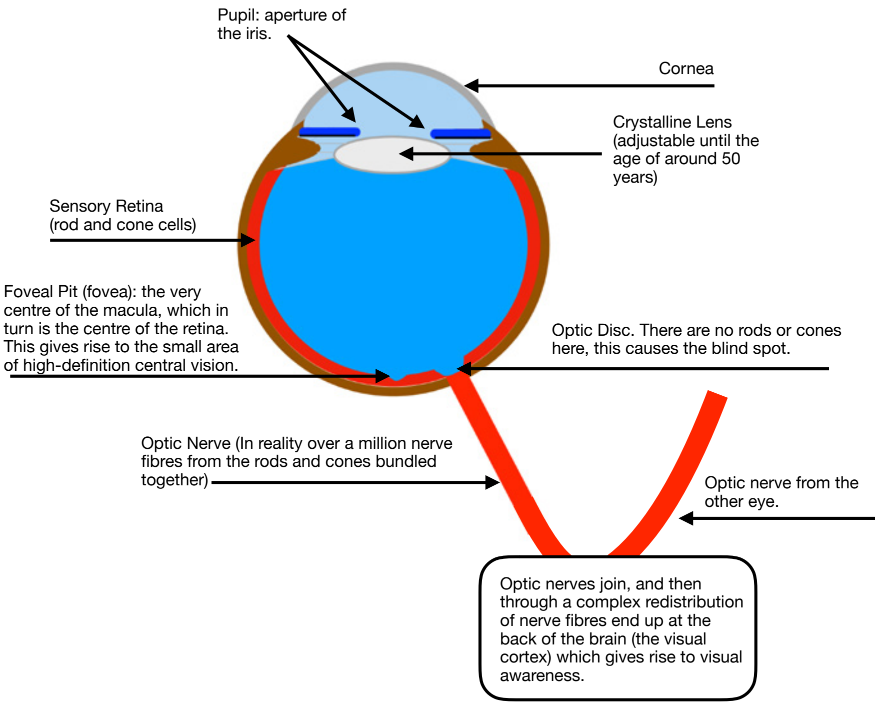
In daylight conditions then, what you might think of as one big clear, detailed picture is far from it; detail is only seen very centrally, an area roughly that of a thumbnail held at arm's length. Not only is this area small, but also an image falling on it has to be stable for a moment for retinal processing, and the higher brain centres (the pilot's attention) to be directed towards it for active interpretation. The more peripheral your field of vision the less resolution. Try reading a car number plate by moving your eyes (your point of fixation) just one car width to the side.

Meanwhile, the cones in the periphery of the retina are responsible for the peripheral visual field in daytime, and it's now motion detection that comes to dominate. You may have noticed a flickering fluorescent light bulb in your peripheral vision which appears less flickery when looked at directly. Peripheral vision is especially good at detecting motion and flicker. Movement of an object is a very important attention-grabber. This is fine if an object isn't on a constant relative bearing — a collision course.

On top of all this, the nerves from the rods and cones pass through a hole in the retina, the optic disc, which has no rods or cones so there's a small, circular area about 12.5 degrees from your absolute central vision (your fixation point), about the size of a fingernail at a hand-span's distance, where there is no vision whatsoever.

This area of blindness is to the right in the right eye, and to the left in the left eye on the horizontal plane (see images on page 4). Each eye simply fills in the blind area with whatever it sees around the edge of the blind spot, so in a blue sky it will be filled in with blue — the retinal data compression assumption. Thankfully, one eye tends to cover for the other blind spot with its visual field when looking ahead. It is possible when just moving your eyes to the left that the right eye doesn't cover the blind area in the left eye, and vice versa when looking to the right, so it's critical to move one's head when looking around to maintain a full field of vision. Just glancing to one side with little head movement may well cut off the one eye's overlapping field of vision of the other's blind spot.

So how do we lookout properly? I'm a glider pilot and I don't have my own glider, so I have to wait for a club single-seater to land. On an excellent day, when the thermals are so strong that even dustbin lids are going up and not coming down, I



search the bit of sky 'my' glider was last seen in to see where it's got to, and whether it's coming back.

I make lots of small eye movements in the area it's most likely to be, pause, look intently and examine that small bit of sky before moving a little further to the adjacent piece of sky. If on a non-flying day someone had asked me to look for an aircraft in the sky, I would probably make large saccadic eye movements, pausing for as short a time as possible so as to cover as much of the sky as possible. In reality I'd almost certainly not see an aircraft if one was there. Here lies the clue on how to lookout for other aircraft.

The first step is attitude of mind. If I think it's unlikely there's an aircraft there then the temptation is not to expect to find one and therefore not to look properly. So when looking out, absolutely assume there's someone out there. Next, look in the area of sky the threat is most likely to be.

In normal flight, most of the risk of a mid-air collision can generally be reduced by scanning an area at least 60° left and right of the intended flight path (although it's important to acknowledge this doesn't mean the rest of the sky should be forgotten).

At least 10° above and below should also be searched. Simply, the more, smaller saccades and attentive fixations the better. Move your head, too, as you look along your zone of horizon to ensure no blind spots.

Quite apart from the physiological limitations, the eyes are vulnerable to other visual distractions; lighting, foreign objects, illness, fatigue, emotion, the after-effects of alcohol, certain medications, dehydration and age all play their part. There are also additional challenges, such as atmospheric conditions, glare, deterioration of transparencies, aircraft design and cabin temperature, which all take their toll on your eyes and what you can see.

You'll probably be familiar with the problem of 'constant relative bearing', or 'stationary in the field of view', mentioned earlier where colliding aircraft have a relative bearing constant to each other until impact. The subjective effect of this is that the collision threat remains in the same place (stationary) on the canopy, so looking intently is key.

An unfortunate consequence of 'constant relative bearing' is that pilots are most likely to see aircraft that are moving in the field of view and therefore not on a collision course; frustratingly, it's the very ones on a collision course that are so hard to see because they don't move in your field of view. So moving your head, relative to the canopy or windscreen is an important aid to lookout, and helps take out the blind spots such as canopy furniture, pillars, high/low wings etc.

A quick bit more science shows that as a collision threat approaches, its size on the retina roughly doubles with each halving of the separation distance, so colliding aircraft stay relatively small until shortly before impact when it all happens rather quickly. This presents a bit of a challenge even if you do perform a good 'lookout', but it underlines the importance of apportioning the correct amount of time for a systematic and repetitious scan pattern to spot aircraft early.

It's a curious thing about flying that many pilots believe they keep a good lookout when, in reality, it's less-than-effective; glancing out and scanning with continuous eye or head movements is unproductive because for the pilot to perceive another aircraft, time is needed for a stable image of it to fall on the centre of the retina, at least about one second in fact.

Lookout should be performed using a series of small eye and head movements with intervening fixations, the latter being the only time when the outside world is really being interrogated. Carrying out regulated scans may sound a bit formulaic and, let's be honest, boring, but they do work. That said, there is no one technique that suits all situations or all pilots, so it is important to develop your own comfortable and workable scan. ■

Paul Sheffield is a glider pilot and has been an Optometrist for 35 years

IN SHORT

Ensure your eyesight is properly focused in the first place with clean spectacles and canopies, and your eyes focused in the distance.

Only a small, central area of your vision is high definition.

The peripheral retina is good at detecting movement, but an aircraft on a collision course, a constant relative bearing, has virtually no movement until the last few seconds.

You must move your head as well as your eyes for an effective lookout.

Develop a methodical scan routine, the 'rule of threes' (see next page) is a good starting point, but the more, smaller saccadic eye movements with moments of pause along your zone of interest the better.

SECONDS COUNT

How long do you reckon it takes from spotting another aircraft to hitting it – 30 seconds to a minute, maybe? You'd be wrong

If you're unlucky enough to have a very close encounter you'll have nowhere near as long as even 30 seconds to take action; a bit like a slow motion train crash everything seems to take a long time until the last few moments when it all happens in split seconds.

Apart from split-second survival instinct push or pull moments, research suggests that in normal circumstances the average pilot and aircraft needs anything up to 10-12.5 seconds (about as long as it's taken you to read to here…) from spotting another aircraft to processing the closure geometry and avoiding a potential collision in a controlled manner.

Take two PA-28s meeting head-on at around 90kt each – at the eye's maximum acuity, there's around ten seconds from the most eagle-eyed pilot seeing the other aircraft before they impact. In the first 5 seconds there's not much change in the size or motion of the oncoming PA-28, it's only in the last five seconds that it suddenly blooms in size; the mind then takes a couple of seconds to recognise it as a threat, leaving just three seconds to take action.

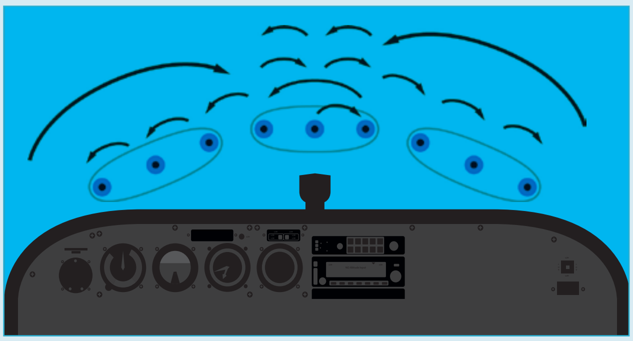
Naturally, the likelihood of spotting a potential collision increases in relation to the time spent looking out, and the best rule of thumb is the 80:20 rule – 80 percent of the time looking out and just 20 percent inside the cockpit. But just 'looking' for other aircraft isn't enough.

Glancing out and scanning with smooth and continuous eye movements is less-than-effective because, as discussed in the main article, time is needed for a stable image to fall on the centre of the retina and the pilot's attention be directed towards it.

An effective scan of the sky in front (and to the side) needs to be in a systematic and repetitious pattern. It should be performed by using a series of small eye and head movements with intervening rests, the latter being the only time when the outside world is really being interrogated.

That said; there's no one technique that suits all pilots; although horizontal back-and-forth eye movements seem preferred by most. It's important to develop a comfortable and workable scan. First, know where and how to concentrate 'lookout' on the most critical areas at any given time. In normal flight, most of the risk of a mid-air collision can generally be avoided by scanning an area at least 60° left and right of the intended flight path. This doesn't mean the rest of the area to be scanned should be forgotten. At least 10° above and below the projected flight path should also be searched.

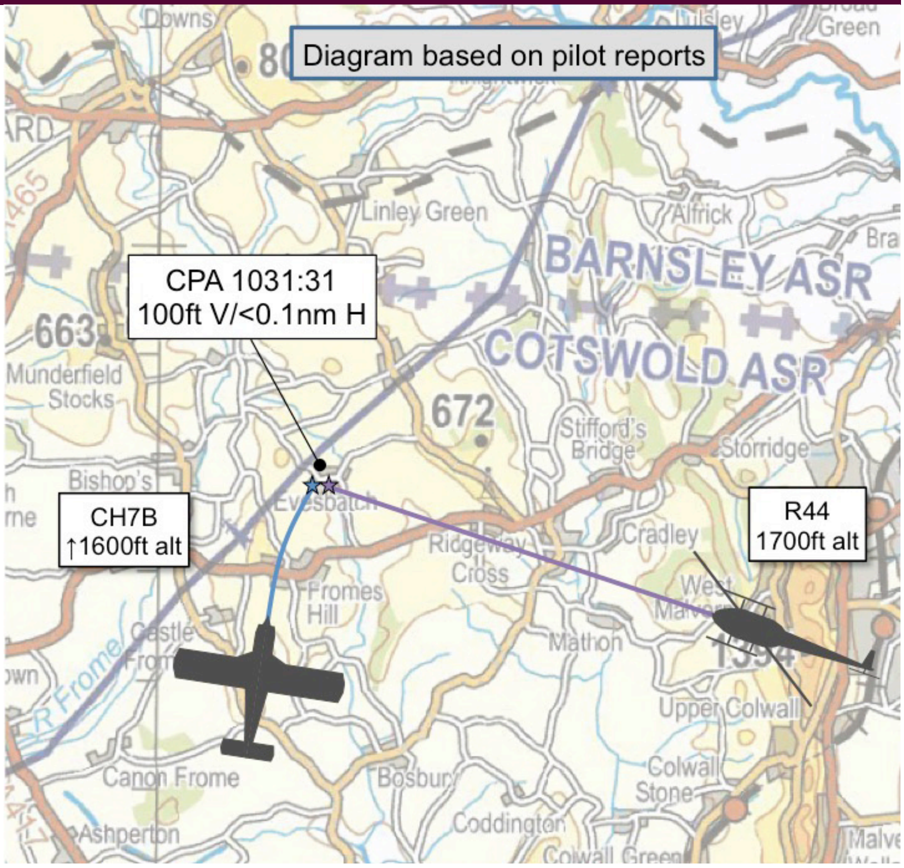
One of the simplest and effective is the 'rule of threes' as detailed in the graphic below:



RULE OF 3s: 3 zones, 3 areas in each. Allow eyes 1 second per pause. Start scan on centreline (greatest threat); return scan to centreline (greatest threat). First look at centre 3, then 3 hops left; back to centre, 3 hops right; back to centre, look inside.

Clash in the climb-out

However hard you look, it can still be a tricky time to spot what might be coming your way



A Citabria pilot was getting into the air from a private strip near Bromyard, not far from Worcester, and trying to ensure a good lookout by lowering the nose regularly as he climbed. But, despite this, he still didn't see an R44, which was probably a small stationary target in his peripheral field of view, approaching on the beam.

For his part, the R44's pilot would probably have been looking down onto a dark background and didn't see the Citabria climbing up until they were very close. Both saw each other at the last moment and had to take emergency evasive action.

Neither aircraft in the incident (Airprox 2018036) was fitted with a collision warning system and, because both were using transponders, the Board felt it worth emphasising that the increasingly affordable systems now available could have helped.

It's not for me to promote any particular system, but they're becoming increasingly affordable and interoperable so, for the price of a couple of tanks of fuel, it'd be well worth thinking about investing for just such eventualities when circumstances conspire to render see-and-avoid a fairly poor barrier to collisions – an alert in either aircraft here would have helped immensely by allowing at least one of the pilots to take earlier action.

Full details of the incident can be found at airproxboard.org.uk in the 'Airprox Reports and Analysis' section within the appropriate year and then in the 'Individual Airprox reports' tab.

During its May meeting, the Board assessed 26 incidents of which16 were aircraft-to-aircraft, with five having a definite risk of collision (two were Category A where providence played a major part, and three were Category B where safety was much reduced through to serendipity, misjudgement, inaction, or late sighting).

The dominant theme concerned nine cases of poor choice of airspace or poor integration with others, including a couple where pilots flew over promulgated and active glider/microlight sites.

Poor choice of airspace is an emotive topic, although all the cases involved pilots flying in airspace in which they were entitled to operate, a little more thought for how their activities may have impacted on others might have avoided the conflicts.

Poor communication in the air, or less-than-good liaison between neighbouring units, featured in six incidents; non/late-sightings accounted for six others and inaction or flying too close to other aircraft was seen in five. Three incidents involved TCAS resolution advisory events caused by flight vectors impinging on the TCAS envelopes of larger aircraft.

Of the six non/late-sightings, three were associated with a lack of transponder transmissions from one or both aircraft which, if selected on, might have assisted ATC in providing Traffic Information, or allowed other collision warning-equipped aircraft to detect the other aircraft well before they came into proximity.

SERA 13001 came into force in UK in October 2017 mandating that, if fitted and serviceable, transponders must be switched on with all modes selected. A straw-poll of GA Board members revealed that in their experience two-thirds of pilots they either instructed or interacted with, including other instructors, did not know that transponder selection was now mandatory.

Although this requirement was highlighted in SkyWise by the CAA when it came into force, it seems that much of the GA community is still not aware of the change, hence an associated Board recommendation that the CAA consider further publication and education efforts about it.

The Board also recommended that RAF Benson and local airfields engage in liaison to improve co-ordination of activities. This resulted from a CAP231 pilot from White Waltham conducting aerobatics in one of their 'aeros boxes' that happens to be about 10nm on the extended centre-line to RAF Benson's runway 01.

Normally it's not an issue with prevailing south-westerly winds, however on this day the easterly wind meant that the Puma pilot was conducting a TACAN hold and approach to 01. Although both pilots saw each other, it seems that neither really knew of the other's operating intentions and so they ended up in proximity.

Both pilots were entitled to operate where they did, but a bit more co-ordination would have eased the problem, especially if the CAP231 pilot had been able to make a call to Benson ATC to let them know his intentions.

The Regional Airspace User Working Groups (RAUWG) run by the military units are a brilliant way for pilots and clubs to engage with each other and the military to exchange information about such things as aeros boxes etc, so I highly recommend asking your local military ATC when they are holding the next one and going along to participate (and also enjoy the usual free lunch that's included!).


PHOTO BY TERRY JOYCE

Over the **top**

So, you're flying above the top of an ATZ no problem — not necessarily…

A PA-28 was joining overhead at Earls Colne (above) when a Robin DR400 appeared flying in the opposite direction just at the top-height of the ATZ. Although the DR400 pilot was nominally 75ft above the ATZ, this didn't give much of a margin against other airspace users who might have been operating at Earls Colne.

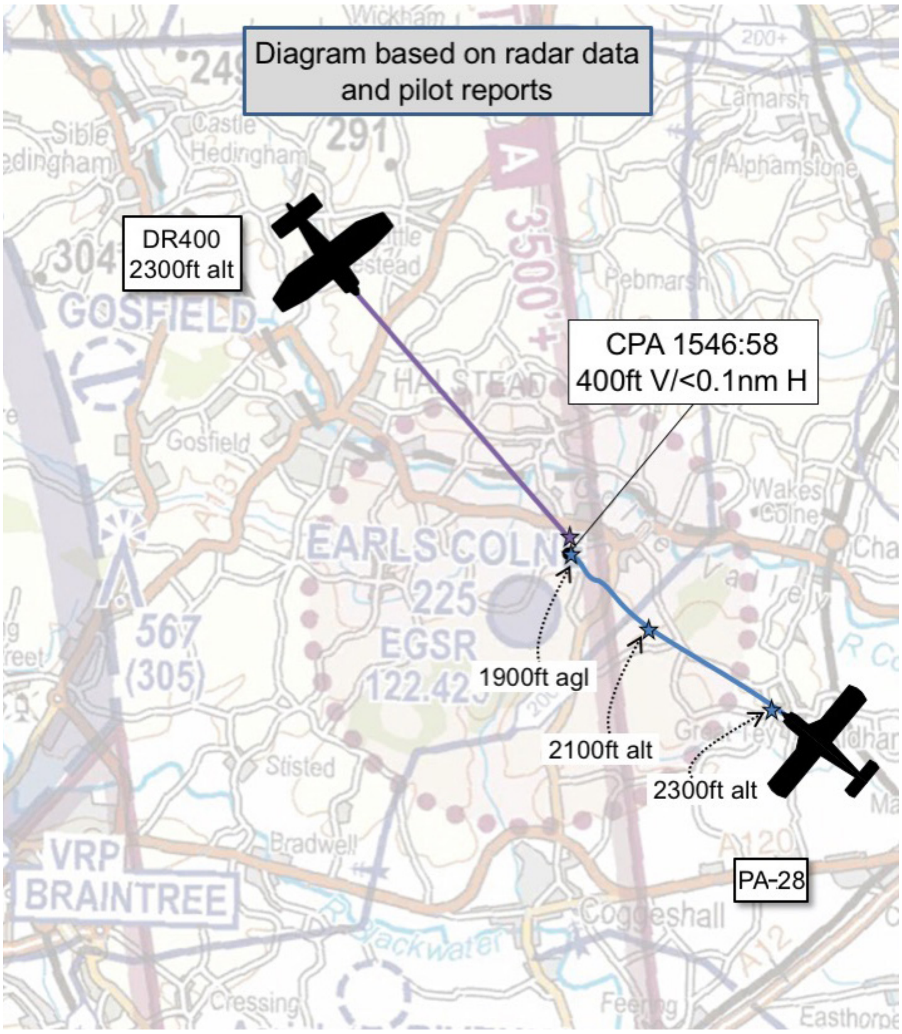
Furthermore, in consideration of others who might be operating at the airfield, the Board felt that the Robin pilot would have been much better served by monitoring the Earls Colne frequency as he flew over the top rather than opting for a Basic Service with Farnborough.

It's even better to fly with a height margin of 500ft or so above any ATZ, even if you are talking to the airfield – you never know who might be conducting a radio-out overhead join that you might not be aware of. The Robin pilot's expectations of the level of service he might receive under a Basic Service also seemed to be overly optimistic. Remember that a Basic Service does not guarantee any form of traffic information, and neither will you be able to assimilate any information yourself from the radio calls of other pilots unless they happen to be using the same frequency.

Clearly, those operating at Earls Colne in this case would not be on Farnborough's frequency, and so the Robin pilot would not be likely to get any useful situational awareness of what they were doing. More specifically, if you want traffic information then ask for a Traffic Service, otherwise the controller you're talking to may not even be monitoring your aircraft track on the radar if they are busy. This prompted a recommendation for the CAA to re-emphasise what pilots will and won't get in terms of service under a Basic Service – but don't wait for them to do so, have a look at CAP 774 or the shorter CAP 1434 and refresh yourself! There's a short version of the details in the box on the far right.

Finally, the Robin pilot also seemed to be operating on the assumption that other aircraft he saw would give way if he was on their right. Although this is of course technically the case, always assume the other pilot hasn't seen you even if they are notionally required to give way – they won't give way to something they haven't seen, and we all know that even those with the sharpest lookout can miss things if they aren't looking in the right place at the right time.

Full details of this incident (**Airprox 2018064)** can be found at airproxboard.org.uk in the 'Airprox Reports and Analysis' section within the appropriate year and then in the 'Individual Airprox reports' tab.



During its July meeting the Airprox Board assessed 29 incidents, of which16 were aircraft-to-aircraft, with six having a definite risk of collision (two were Category A where providence played a major part, and four were Category B where safety was much reduced as a result of serendipity, misjudgement, inaction, or late sighting).

The dominant themes concerned inaction or poor integration/turning towards a threat in six incidents; poor tactical planning and/or awareness of NOTAM/weather in another five, while lack of communication with ATC or sub-optimal controller liaison were responsible for five more.

There were five instances of late- or non-sightings, and four where a more appropriate air traffic service would have been advantageous or where the Board suspected that the pilot had false expectations as to the level of service he was receiving.

There was also a mixed bag of other factors including a level bust, a read-back failure, pilot distraction, poor interpretation of TCAS, lack of courtesy to others and lack of traffic information under a Traffic Service.

The Board made four recommendations: the first stemmed from an incident where the Red Arrows spilled out of their restricted airspace (R313) at Scampton at an early stage in their work-up and came across a Cessna 152 flying close to the airspace but not talking to Waddington LARS.

Because Waddington radar was under maintenance, the controller was operating at Cranwell with associated degraded base-height coverage and so the Cessna only appeared as intermittent pop-up traffic at the last moment.

Although it was entitled to operate there without calling ATC, a simple call when flying in busy airspace or close to potential threat areas would at least give ATC some situational awareness that they could then pass on to others, even if you don't want any help yourself.

Two recommendations came out of one incident involving a commercial drone operator flying his craft close to Top Farm strip near Royston. He wasn't aware of the strip and was concerned when a landing aircraft came close by — another timely reminder about drones and their integration with other aircraft, especially now that drone regulations and rules have recently changed. ■

Airprox Recommendations

2018020 A NOTAM is issued to remind airspace users of the advantage of contacting Waddington LARS when operating in the vicinity of EG R313.

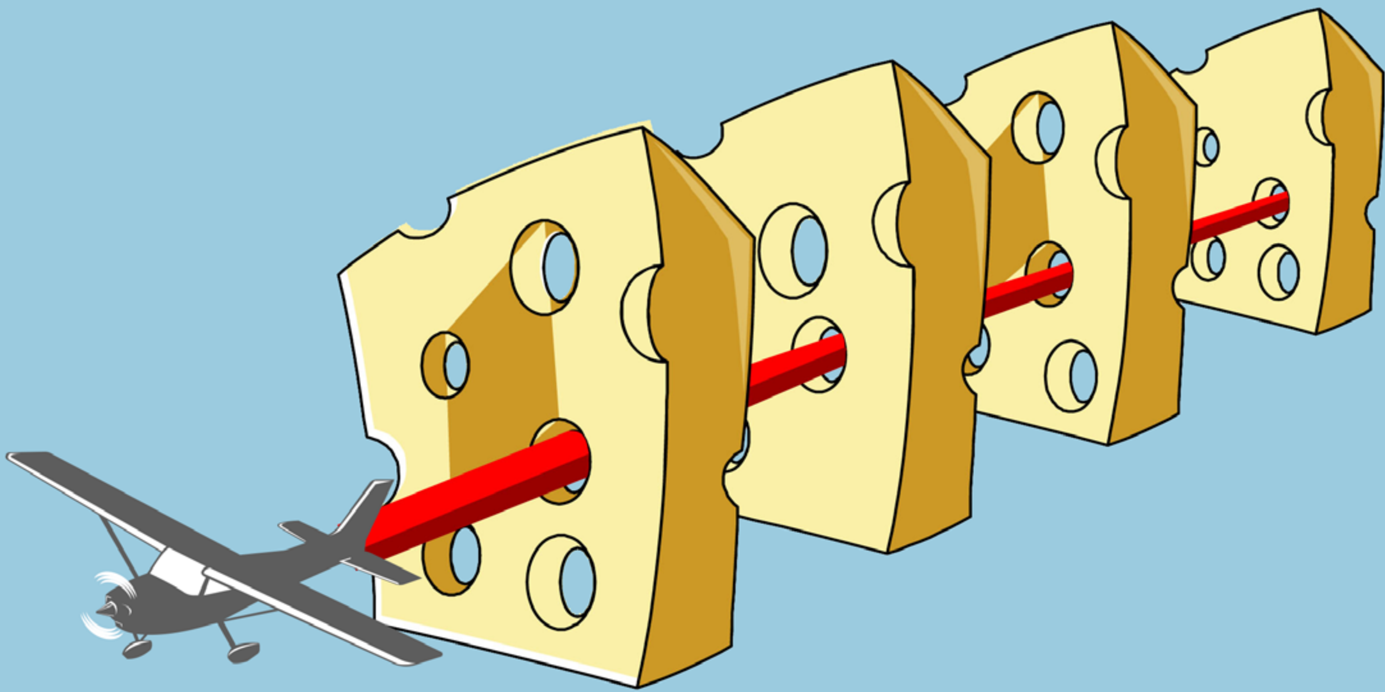
2018064 The CAA re-emphasise the provisions of a Basic Service.

2018069 Drone Assist should display all minor airfields more obviously.

2018069 The CAA re-emphasise that commercial drone operators are required to have access to a current VFR chart before commencing operations.

BASIC SERVICE
This is intended to offer the pilot maximum autonomy and is available to IFR flights in Class G airspace, or VFR flights in Class E and Class G airspace. If the ATCO or FISO are aware of airspace activity that may affect your flight they will tell you; however, this is subject to their workload and the avoidance of other traffic is solely the pilot's responsibility. Maintain a good lookout.

TRAFFIC SERVICE
Under a Traffic Service, an ATCO will use radar to provide you with detailed traffic information on specific conflicting aircraft; they will not provide you with deconfliction advice, regardless of your meteorological conditions and the avoidance of any other traffic, whether called to you or not, still remains solely the pilot's responsibility.



The hole story

You'll know the 'Swiss Cheese theory' about accidents or incidents, and now in-depth research is exposing any 'safety barriers' issues in Airprox

You might think the term 'safety barriers' sounds like something that gets in the way of safety, and while it's perhaps understandable to think that, nothing could be further from the truth – 'safety barriers' are in fact quite the reverse.

Look at it this way; you probably know the Swiss cheese theory that when all the holes in a series of cheese slices line up an incident can happen, but if something stops the holes lining up you then have a 'safety barrier' that prevents the incident.

Back in 2017 we started to look at Airprox from the perspective of 'safety barriers' in addition to the traditional cause and risk assessment. This was to try to move away from a simple review of 'what' happened in individual cases, to a more informative and systemic assessment of

One of the best sources of situational awareness about other aircraft is ATC – if you talk to them

See-and-avoid remains the mainstay of preventing collisions

'why' the incident happened and where the safety barriers might be improved. So Airprox Board reports now include an assessment of the barriers for each incident, together with short statements for why we graded the key barriers as we did. Although it's still early days at present, this process is rapidly maturing to the extent that we can now see useful results from the aggregate of these assessments that give an indication of the strongest and weakest barriers in Airprox terms.

There are nine recognised barriers to mid-air-collisions (MAC) grouped into four ATC (ground) barriers and five Flight Crew (airborne) ones as follows:

ATC/ANSP

- *Regulations, Processes, Procedures and Compliance*
- *Manning & Equipment*
- *Situational Awareness & Action*
- *Warning System Operation and Compliance*

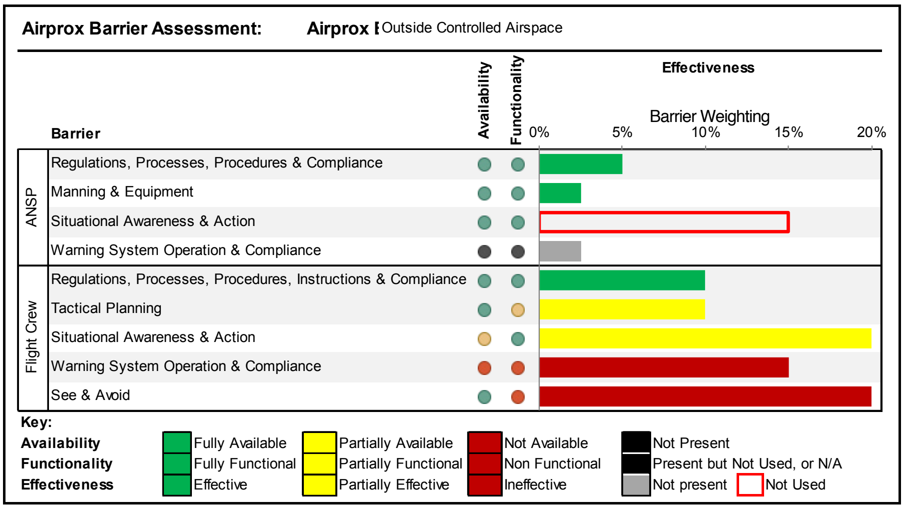
Flight Crew

- *Regulations, Processes, Procedures and Compliance*
- *Tactical Planning and Execution*
- *Situational Awareness of the Conflicting Aircraft & Action*
- *Warning System Operation and Compliance*
- *See & Avoid*

Although they all have relevance to a greater or lesser extent, some are more relevant than others and so we apply a weighting to each barrier to reflect that.

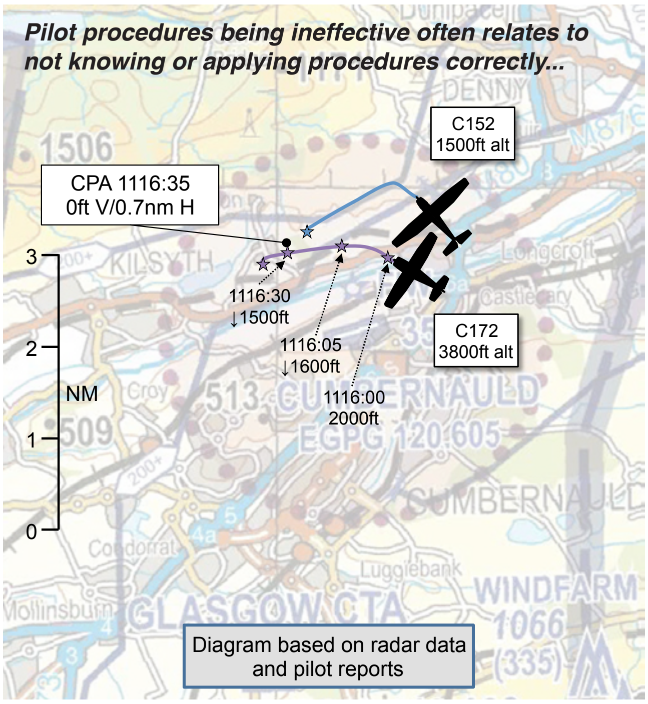
For a typical Airprox in uncontrolled Class G airspace, the chart shows how the barriers are weighted for importance (their length represents their part of a theoretical100% for all the barriers added up).

For example, Flight Crew see-and-avoid and situational awareness are both seen as being 20% of the solution in Class G, while ATC regulations are only seen as being 5%. There's no mathematical formula behind these weightings, it was purely the output from a panel of pilots and controllers who were asked to grade the relative importance of each barrier for us. But they do give an idea of what's important and what's not so important. These percentages don't change from Airprox to Airprox in Class G, they simply allow us to quickly identify which are the most important barriers. That being said,



Barrier Assessment:	Effectiveness Percentage Count					Effectiveness Numerical Count					Check Sum Total Incidents
	Absent	Ineff	Partly Eff	Fully Eff	Not Used	Absent	Ineff	Partly Eff	Fully Eff	Not Used	
ATC Regs, Processes, Procedures & Compliance	17%	6%	11%	66%	0%	27	10	18	107	0	162
ATC Manning & Equipment	22%	2%	5%	72%	0%	35	3	8	116	0	162
ATC Situational Awareness & Action	26%	21%	17%	25%	12%	42	34	27	40	19	162
ATC Warning System & Compliance	90%	3%	1%	5%	1%	146	5	1	8	2	162
Pilot Regs, Processes, Procedures & Compliance	1%	19%	17%	64%	0%	1	30	27	104	0	162
Pilot Tactical Planning	0%	12%	35%	52%	0%	0	20	57	85	0	162
Pilot Situational Awareness & Action	0%	41%	38%	21%	0%	0	66	62	34	0	162
Warning System Operation & Compliance	33%	28%	12%	25%	2%	53	45	20	41	3	162
See & Avoid	0%	14%	42%	39%	6%	0	22	68	63	9	162

effectiveness of traffic warning systems



Pilot procedures being ineffective often relates to not knowing or applying procedures correctly...

...Such as joins not conducted correctly

the percentages are different for incidents in controlled airspace where we apply different weightings to take more account of the importance of ATC versus see-and-avoid.

What does change from Airprox to Airprox is how each barrier performed during different incidents. We colour-code each barrier according to how we assessed its effectiveness for each incident (colour-coded as: Red – barrier ineffective; Yellow – barrier partially effective; Green – barrier fully effective; Grey – barrier absent; and Open Red – barrier not used).

The first three colours are self-explanatory. 'Absent' refers to incidents where the barrier wasn't present (for example, ATC is not present in much of UK airspace), and 'Not used' applies to incidents where the barrier was present but was not employed (for example, ATC may have been available but the pilot chose not to talk to them).

So, for the fictional example shown, see-and-avoid and warning systems were both ineffective, thereby removing 35% of barrier protection, but ATC procedures, ATC manning and Flight Crew procedures were fully effective (giving 17.5% of full protection) and Flight Crew tactical planning and situational awareness were both partially effective (giving another 30% of partial protection).

So in other words, 17.5% of the total protection that might have been available was fully effective, 30% was partially effective and another 15% of protection might have been available if ATC had been used but it wasn't (as indicated by the ATC situational awareness being an open red box).

While all of that is interesting for each Airprox, it's when the aggregate analysis is done that real value can be gained. The next chart shows the combined outcomes for the 162 incidents assessed in 2017, and the pie charts show the key outcomes for the six highest weighted barriers. So, here are some things to think about.

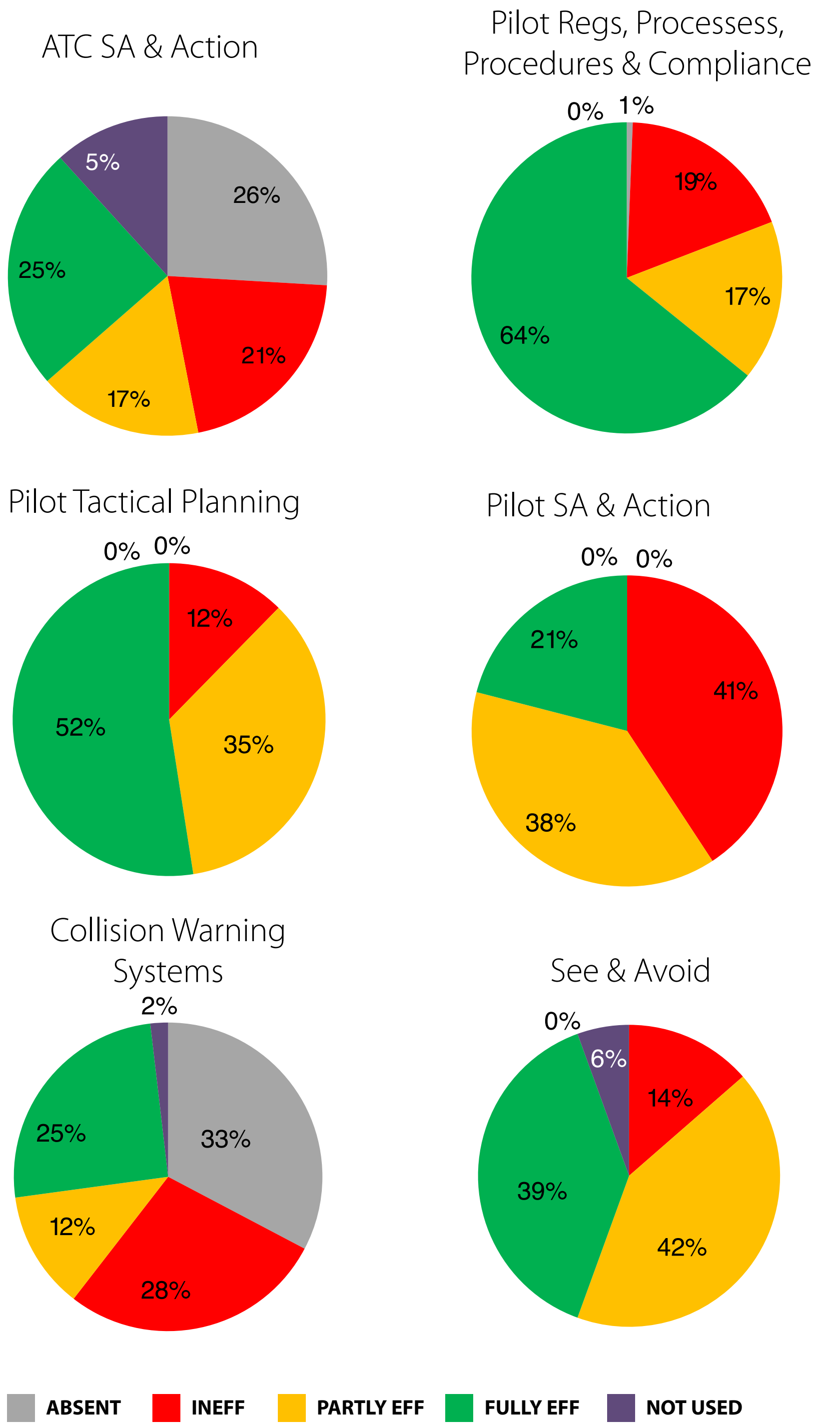
- *ATC was not present for 26% of Airprox in 2017. Not much that can be done about that other than to think about it in another way: ATC was present for 74% of Airprox but was not always fully effective. ATC situational awareness and action being 'ineffective' often derives from Airprox where the other aircraft was not displayed on radar at all (due to terrain, radar coverage, or lack of radar cross-section, perhaps) or lack of secondary surveillance radar meaning that the controller did not know the height of the aircraft. This was in the days before it was mandatory to switch on transponders with all modes showing and so reflects that factor. But it also reflects situations where one of the pilots might not have been talking to ATC and so they had limited or no situational awareness with which to give traffic information to the other pilot. ATC situational awareness 'partially-effective' derives from Airprox where a controller might not have provided timely traffic information due to other priorities, had only generic information about the other aircraft (probably a primary return only), or ATC only partially resolved the conflict (often due to late 'pop-up' traffic on their radar display). The deduction is clear – if ATC is present then talk to them for both your benefit and to increase their situational awareness to the benefit of others.*
- *Pilot procedures being 'Ineffective' or 'Partially-Effective' often relates to pilots not knowing or applying procedures appropriately (for example, overhead joins not conducted correctly, or other examples of failing to integrate in the visual circuit), or not avoiding ATZs and glider sites sufficiently, or not calling ATC as they transit through an airfield's feathers for example. A figure of 64% fully effective compliance with procedures is good to see, but we can work on those 36% of incidents where pilots didn't perform so well due to lack of knowledge.*

> 'See-and-avoid is the mainstay of collision avoidance in Class G but it was only fully effective in 39% of Airprox incidents in 2017'

- *Forty-seven percent of incidents saw ineffective or only partially effective pilot tactical planning. This includes pre-flight planning, in-flight re-planning, and execution of the plan. 'Ineffective'* *tactical planning often concerns a lack of any proper planning (not reviewing NOTAM, weather, airfield details etc), while 'Partially-effective' often concerns a failure to modify the plan when confronted with changed circumstances in the air (no 'plan B' when things go wrong, for example).*

- *Pilot situational awareness was fully effective for only a disappointing 21% of incidents. Pilot Situational Awareness 'Ineffective' (41%) generally applies to situations where the pilots had no knowledge that the other aircraft was present. 'Partially-effective' (38%) often applies to situations where pilots did not act sufficiently on information they had, or situations where they had only generic information that there might be other aircraft in their vicinity (e.g. knowing that there was a gliding site nearby and therefore expecting that there might be gliders around, for example). The best sources of situational awareness about other aircraft for a pilot are: ATC (did I mention that it's a good idea to talk to ATC if you can?); on-board collision warning systems (see the next bullet); and thorough pre-flight planning (as mentioned in the previous bullet).*

- *Collison warning systems are becoming increasingly affordable and available. It's not for me to promote any system in particular, but there are several available and system-to-system compatibility is key. In the pie charts, 'absent' refers to situations where neither aircraft was fitted with such a system; 'ineffective' refers to situations where one aircraft was fitted with a system, but the other aircraft did not have compatible equipment; and 'partially-effective' refers to situations where the aircraft did have compatible systems but the warnings were late or only partially acted upon. It's not just a matter of buying such a system though, think carefully about how it is mounted in the cockpit (especially the aerial). Antenna performance is greatly affected by masking and orientation of the antenna so don't expect it all to work if the antenna is pointing at an odd angle or buried beneath a metal computer tablet that's also resting on the coaming. There's a really good article about this from the LAA which is reproduced on our website airproxboard.org.uk under Topical Articles of Interest.*



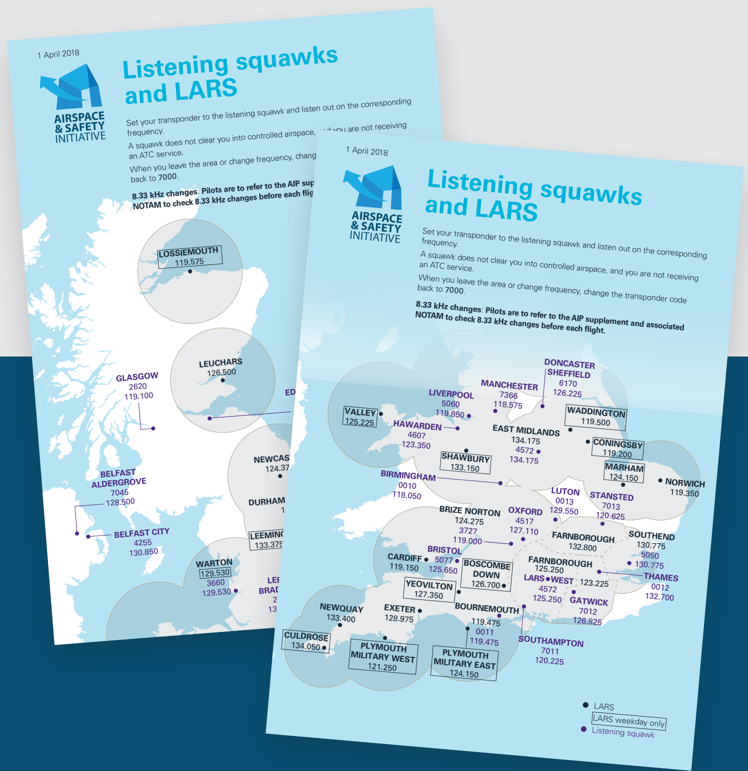
- *See-and-avoid is the mainstay of collision avoidance in Class G airspace but it was only fully effective in 39% of Airprox incidents in 2017. 'Ineffective' (14%) refers to situations where neither pilot saw each other (non-sightings), while 'partially-effective' (42%) refers to situations where late sightings meant that often only one of the pilots was able to take emergency avoiding action. So that's why we talk a lot about lookout 'effectiveness' and scan patterns. As pointed out in the magazine's article on Lookout, it's very important to try to spend 80% of your time looking out and only 20% looking in – and that 20% should be done in small bursts of activity for two to three seconds interspersed with lots of looking out again. Lookout is probably one of the most important parts of 'Aviate' in the 'Aviate-Navigate-Communicate' mantra.* ■

Where are you flying today?

Who will you be listening to?

A listening squawk enables an air traffic controller to alert a pilot if their aircraft looks likely to infringe. Check which listening squawks and frequencies you will need before your next flight.

- Select the listening squawk, using ALT (Mode C) if you have it
- Tune in to the appropriate frequency without transmitting
- Listen out for your call sign or position
- Change to code 7000 when you leave the area or change frequency



8.33 kHz changes – use the AIP Supplement to check for 8.33 kHz changes before each flight.

Download squawks from:
airspacesafety.com/listen