A GOOD LOOKOUT

Most mid-air collisions occur in close manoeuvring situations. The BGA safety team looks at the shortcomings of the human visual system

■ Clubs can obtain printed copies of Safety Briefings from the BGA Office.

IF YOU have 20/20 vision, you can read a letter of the alphabet the size of a pound coin at the distance of a Standard Class wingspan. A light aeroplane would subtend the same angle several miles away; and with good eyesight and perfect conditions, you should be able to spot an object that's quite a bit smaller. At first sight, visual lookout would seem capable of giving enough notice of approaching aircraft for us to manoeuvre and avoid them.

Although remarkably powerful, the human visual system unfortunately has a number of well-known shortcomings. It is most sensitive to changes – either from time to time or place to place – so is not good at spotting low-contrast objects, particularly if they are stationary against the horizon as, in straight flight, objects on a collision course are wont to be. Against an unstructured background the eye relaxes its focus to the middle distance, leaving distant objects somewhat blurred. And, whenever we

STRAIGHTEN UP & FLY RIGHT

shift our gaze ('saccade'), the brain blanks visual information without telling us, so we mistakenly think that we are looking when we are not. Furthermore, the 20/20 acuity only holds for a small angular range of a degree or two around our gaze direction, which is why we need to move our eyes when reading: beyond a word or so, the letters will be blurred.

The lookout scan

We're therefore taught to carry out a disciplined lookout, scanning the field of view in discrete steps, looking above and below the horizon as well as along it, pausing at each step to focus on the horizon and fixate upon each point for half a second or so. The 'straight glide and scan cycle' exercise covers this in detail when we're learning to fly, and an abbreviated version is the very first airborne exercise in a glider [1]. And it was during this introduction to visual lookout at a popular UK gliding site a decade ago that a K-13 collided with a K-21. Happily, despite major damage to the aircraft, both gliders landed safely [2].

Two Air Cadet training aircraft, a couple of years earlier, were less fortunate. Both aircraft were critically damaged, and all four pilots were killed. The subsequent Service Inquiry examined, amongst other factors, a scan cycle popularly taught for VFR aviation, calculating that this would take nearly a minute to complete, and concluding "Not only is this an impracticable task but the scene would have changed before the scan was finished." [3]

The scan cycle, which is recommended by the FAA, CAA, AOPA and other bodies, is slightly more prescriptive than is taught in gliding: "Effective scanning is accomplished by a series of short, regularly-spaced eye movements that bring successive areas of the sky into the central visual field. Each movement should not exceed 10°, and each area should be observed for about one second." [4]

Vision research

The origins of this widely-recommended scan pattern are unclear, but probably stem from a burst of research carried out during and in the years after WW2. Computers and image processing had yet to be invented, radar and sonar were still in their relative infancy, and human eyes were the principal means of detecting enemy aircraft, hostile ships, battlefield targets, and life-rafts at sea. Speed and efficiency were crucial.

Civilian and military scientists across the world undertook a vast range of careful, methodical experiments that were mostly compelling and occasionally comical. One institute built a special observation room with featureless walls and a screen onto which objects varying in size and contrast could be projected, while at the other end 10 "young women, aged 19-26" spent hours each day seated in banks, clocking up tens of thousands of test observations over months on end. Another study using a planetarium found that, with its reclined seating, student volunteers would sometimes nod off.

This often fascinating research explored the time taken to locate an object of a given size, contrast and shape within a defined size and type of background. One interesting finding was that the acuity, while best at the centre of the gaze, does not drop abruptly but falls progressively as the object is further from the centre of attention. The figure below allows a practical demonstration: if you fixate upon the centre, all the letters should be equally readable [5]. In a search context, this means that for the same detection probability, objects must be larger the further they are from the gaze direction.

Equally readable letters; after Anstis [5]

Search patterns

The results of these studies allow search patterns to be designed for operational use. For a given object and search field, determine the size of region in which the object would be detectable from a single glance, divide the search field into regions of that size and, to avoid duplication or omission, conduct a systematic scan, pausing to fixate at each region in turn. It's probably a great way to search a reconnaissance photo for camouflaged tanks, or to scan the horizon from a lookout post on Beachy Head – and it's the Nautical Institute's recommendation for watch-keepers on the bridge of a ship – but it's not obvious that it's the best way to spot collision threats while flying a glider.

Lookout strategies often aim to detect threats at the greatest range, but this requires the slowest scan and, though good, isn't necessary as an aircraft must be nearby to hit you. Accident reports show that most mid-air collisions occur in close manoeuvring situations, where the colliding aircraft were never far apart but the pilots failed to spot each other – or lost sight at some point – because their attention was elsewhere, the aircraft were masked by their surroundings, or the view was blocked by the airframe.

Particularly in dynamic situations, a swifter scan is required, sampling a wide field of view to ensure that immediate threats will be seen. If the detection regions do not overlap for more distant aircraft, a regular scan will be no more effective than random sampling, and is in any case hard to achieve.

It makes sense to direct your attention deliberately, emphasising the direction of turn and areas previously obscured by the airframe. Paul Sheffield's articles [6] give good suggestions. Build a glance at FLARM into your scan routine. There may be busy directions, with circuit traffic, thermals or final glides, but don't let them monopolise your lookout. In straight flight, when a longer, more systematic scan might be appropriate, it's good to turn or lift a wing occasionally to check blind spots.

Summarising a symposium on visual search in 1959 [7], the editor concluded that optimum visual search techniques could not be specified without knowing details of the target, its environment, and the time available, and offered the following advice: 'When searching: scan as fast as possible, providing brief, rapid fixations which cover greatest area in shortest time.' The step size and regularity of the search pattern matter little.

Tim Freegarde and the BGA safety team

DURING THE LOOKOUT EXERCISE THE K-13 COLLIDED WITH A K-21

■ For more information on lookout and the human visual system, see sections 5 and 9 of the BGA Instructor Manual [1] and recent *S&G* articles by Paul Sheffield [6].

[1] BGA Instructor Manual, sections 5 & 9 *https://tinyurl.com/flyright2114*
[2] BGA Investigation Summary (2011) *https://tinyurl.com/flyright2115*
[3] Service Inquiry G-BYUT & G-BYVN (2009) *https://tinyurl.com/flyright2116*
[4] CAA Safety Sense Leaflet 13 *https://tinyurl.com/flyright2117*
[5] S M Anstis, Vision Res. 14, 589 (1974) *https://tinyurl.com/flyright2118*
[6] P Sheffield, *S&G* Feb/Mar p10, Apr/May p14 (2020) *https://tinyurl.com/flyright2119*
[7] Visual Search Techniques, eds A Morris, E P Horne (1959) *https://tinyurl.com/flyright2120*

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