CHAPTER 4 - THE DEVELOPMENT OF EFFECTIVE LOOKOUT

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INTRODUCTION

The practice of "see-and-avoid" is recognised as the primary method that a pilot uses to minimise the risk of collision when flying as an uncontrolled flight in visual meteorological conditions. "See-and-avoid" is directly linked with a pilot's skill at looking about outside the cockpit or flight deck and becoming aware of the surrounding visual environment. Its effectiveness can be greatly improved if the pilot can acquire skills to compensate for the limitations of the human eye. These skills include the application of effective visual scanning, and the development of habit patterns that can be described as "good airmanship".

This chapter aims to make pilots aware of the skills required to make look-out more effective and is directed towards those pilots who do their flying under visual flight rules (VFR).

A study of over two hundred reports of mid-air collisions showed that they can occur in all phases of flight and at all altitudes. It may be surprising that nearly all mid-air collisions occur during daylight hours and in excellent visual meteorological conditions. While the majority of mid-air collisions occurred at lower altitudes where most VFR flying is carried out, collisions can and did occur at higher altitudes. Because of the concentration of aircraft in the vicinity of aerodromes, most collisions occurred near aerodromes when one or both aircraft were descending or climbing. Although some aircraft were operating as instrument flight rules (IFR) flights, most were VFR and uncontrolled.

There is no way to say whether it is the experienced or the inexperienced pilot who is more likely to be involved in a mid-air collision. While a novice pilot has much to think about and so may forget to maintain an adequate look-out, the experienced pilot, having flown through many hours of routine flight without spotting any hazardous traffic, may grow complacent and forget to scan.

If you learn to use your eyes and maintain vigilance through proper awareness, it will not be difficult for you to avoid mid-air collisions. The results of studies of the mid-air collision problem show that there are certain definite warning patterns.

Causes of mid-air collisions

What contributes to mid-air collisions? Undoubtedly, traffic congestion and aircraft speeds are part of the problem. In the head-on situation, for instance, a glider and a light twin-engine aircraft may have a closing speed of about 250 kts. It takes a minimum of 10 seconds for a pilot to spot traffic, identify it, realise it is a collision threat, react, and have the aircraft respond. Two aircraft converging at 250 kts will be less than 25 seconds apart when the pilots are first able to see each other, so it is obvious that they both need to pay attention.

The reason most often noted in the mid-air collision statistics reads "failure of pilot to see other aircraft" - in other words, failure of the see-and-avoid system. In most cases at least one of the pilots involved could have seen the other in time to avoid the collision if that pilot had been watching properly. Therefore, it could be said that it is really the eye which is the leading contributor to mid-air collisions. Take a look at how its limitations affect your flight.

Limitations of the eye

The human eye is a very complex system. Its function is to receive images and transmit them to the brain for recognition and storage. It has been estimated that 80 per cent of our total information intake is through the eyes. In other words, the eye is our prime means of identifying what is going on around us.

In the air we depend on our eyes to provide most of the basic input necessary for flying the aircraft, e.g. attitude, speed, direction and proximity to opposing air traffic. As air traffic density and aircraft closing speeds increase, the problem of mid-air collision increases considerably, and so does the importance of effective scanning. A basic understanding of the eyes' limitations in target detection is probably the best insurance a pilot can have against collision.

The eye, and consequently vision, is vulnerable to many things including dust, fatigue, emotion, germs, fallen eyelashes, age, optical illusions, and the effect of alcohol and certain medications. In flight, vision is influenced by atmospheric conditions, glare, lighting, windshield distortion, aircraft design, cabin temperature, oxygen supply, acceleration forces and so forth.

Most importantly, the eye is vulnerable to the vagaries of the mind. We can "see" and identify only what the mind permits us to see. A daydreaming pilot staring out into space is probably the prime candidate for a mid-air collision.

One inherent problem with the eye is the time required for accommodation or refocusing. Our eyes automatically accommodate for near and far objects, but the change from something up close, like a dark instrument panel two feet away, to a well lighted landmark or aircraft target a mile or so away, takes one to two seconds. That can be a long time when you consider that you need 10 seconds to process the necessary information to avoid a mid-air collision.

Another focusing problem usually occurs when there is nothing to specifically focus on, which usually happens at very high altitudes, as well as at lower levels on vague, colourless days above a haze or cloud layer when no distinct horizon is visible. Pilots experience something known as "empty-field myopia", i.e. staring but seeing nothing, not even opposing traffic entering their visual field.

The effects of what is called "binocular vision" have been studied during investigations of mid-air collisions, with the conclusion that this is also a causal factor. To actually accept what we see, we need to receive cues from both eyes. If an object is visible to only one eye, but hidden from the other by a windshield post or other obstruction, the total image is blurred and not always acceptable to the mind. Therefore, it is essential that pilots move their head when scanning around obstructions.

Another inherent eye problem is the narrow field of vision. Although our eyes accept light rays from an arc of nearly 200 degrees, they are limited to a relatively narrow area (approximately 10-15 degrees) in which they can actually focus on and classify an object. Although movement on the periphery can be perceived, we cannot identify what is happening there, and we tend not to believe what we see out of the corner of our eyes. This, aided by the brain, often leads to "tunnel vision".

Motion or contrast is needed to attract the eyes' attention, and tunnel vision limitation can be compounded by the fact that at a distance an aircraft on a collision course will appear to be motionless. The aircraft will remain in a seemingly stationary position, without appearing to move or to grow in size, for a relatively long time, and then suddenly bloom into a huge mass, almost filling up the canopy. This is known as the "blossom effect". It is frightening that a large insect smear or dirty spot on the canopy can hide a converging aircraft until it is too close to be avoided.

In addition to its inherent problems, the eye is also severely limited by environment. Optical properties of the atmosphere alter the appearance of aircraft, particularly on hazy days. "Limited visibility" actually means "limited vision". You may be legally VFR when you have the specific visibility, but at that distance on a hazy day you may have difficulty in detecting opposing traffic; at that range, even though another aircraft may be visible, a collision may be unavoidable because of the high closing speeds involved.

Light also affects our visual efficiency. Glare, usually worse on a sunny day over a cloud layer or during flight directly into the sun, makes objects hard to see and scanning uncomfortable. An aircraft that has a high degree of contrast against the background will be easy to see, while one with low contrast at the same distance may be impossible to see. In addition, when the sun is behind you, an opposing aircraft will stand out clearly, but if you are looking into the sun, the glare of the sun will usually prevent you from seeing the other aircraft. Another problem with contrast occurs when trying to sight an aircraft against a cluttered background. If the aircraft is between you and terrain that is varicoloured or heavily dotted with buildings, it will blend into the background until the aircraft is quite close.

And, of course, there is the mind, which can distract the pilot to the point of not seeing anything at all, or cause cockpit myopia - staring at one instrument without even "seeing" it.

As can be seen, visual perception is affected by many factors. Pilots, like others, tend to overestimate their visual abilities and to misunderstand their eyes' limitations. Since a major cause of mid-air collisions is the failure to adhere to the practice of see-and-avoid, it can be concluded that the best way to avoid collisions is to learn how to use your eyes for an efficient scan.

Visual scanning technique

To avoid collisions you must scan effectively from the moment the aircraft moves until it comes to a stop at the end of the flight. Collision threats are present on the surface, at low altitudes in the vicinity of aerodromes, and at cruising levels.

Before take-off, scan the airspace and the runway visually, to ensure that there are no aircraft or other objects in the take-off area.

After take-off, scan to ensure that no aerodrome traffic will be an obstacle to your safe departure.

Before and during any turn, focus particular attention in the direction of the turn.

Remain constantly alert to all traffic within your normal field of vision, as well as periodically scanning the entire visual field outside the aircraft to ensure detection of conflicting traffic. Remember that the performance capabilities of many aircraft, in both speed and rates of climb/descent, result in high closure rates, limiting the time available for detection, decision, and evasive action.

How to scan

The best way to start good scanning is by eliminating bad habits. Naturally, not looking out at all is the poorest scan technique. Glancing out at intervals of five minutes or so is also poor when considering that it takes only seconds for a disaster to happen.

Glancing out and "giving the old once-around" without stopping to focus on anything is practically useless; so is staring out into one spot for long periods of time.

There is no one technique that is best for all pilots. The most important thing is for each pilot to develop a scan that is both comfortable and workable.

Learn how to scan properly by knowing where and how to concentrate your search. It would be desirable, naturally, to be able to look everywhere at once but, that not being possible, concentrate on the areas most critical to you at any given time.

Always look out before you turn and make sure your path is clear. Look out for traffic making an unusual entry into the circuit. During aerotow descent and climb-out, tug pilots must make gentle clearing turns to see if anyone is in the way.

During that very critical final approach stage, do not forget to scan all around to avoid tunnel vision. Pilots often fix their eyes on the point of touchdown. You may never arrive at the runway if another pilot is also aiming for the same runway threshold at that time.

In normal flight, you can generally avoid the threat of a mid-air collision by scanning an area at least 60 degrees left and right of your flight path. Be aware that constant angle collisions often occur when the other aircraft initially appears motionless at about your 10 o'clock or 2 o'clock positions. This does not mean you should forget the rest of the area you can see. You should also scan at least 10 degrees above and below the projected flight path of your aircraft. This will allow you to spot any aircraft that is at an altitude that might prove hazardous to you, whether it is level with you, climbing from below or descending from above.

The probability of spotting a potential collision threat increases with the time spent looking outside. To be most effective, the gaze should be shifted and refocused at regular intervals. Most pilots do this in the process of scanning the instrument panel but it is also important to focus outside the cockpit to set up the visual system for effective target acquisition. Pilots should also realise that their eyes may require several seconds to refocus when switching views between items in the cockpit and distant objects. Proper scanning requires the constant sharing of attention with other piloting tasks, thus it is easily degraded by such conditions as fatigue, boredom, illness, anxiety or preoccupation.

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 degrees and each area should be observed for at least one second to enable detection. Although horizontal back-and-forth eye movements seem preferred by most pilots, each pilot should develop the scanning pattern that is most comfortable and then adhere to it to assure optimum scanning. Peripheral vision can be most useful in spotting collision threats from other aircraft. Each time a scan is stopped and the eyes are refocused, peripheral vision takes on more importance because it is through this element that the presence of other aircraft is often detected. Remember that if another aircraft appears to have no relative motion, it is likely to be on a collision course with you. If that aircraft shows no horizontal or vertical motion on the windshield, but is increasing in size, take immediate evasive action.

Scan patterns

Two scanning patterns described here have proved to be very effective for pilots and involve the "block" system of scanning. This system is based on the premise that traffic detection can be made only through a series of eye fixations at difference points in space. The viewing area is divided into segments, and the pilot methodically scans for traffic in each block of airspace in sequential order.

Side-to-side scanning method

Start at the far left of your visual area and make a methodical sweep to the right, pausing very briefly in each block of the viewing area to focus your eyes. At the end of the scan, return to and scan the instrument panel and then repeat the external scan.

Front to side scanning method

Start in the centre block of your visual field (centre of front windshield); move to the left, focusing very briefly in each block, then swing quickly back to the centre block after reaching the last block on the left and repeat the performance to the right. Then after scanning the instrument panel, repeat the external scan.

The time-sharing plan

External scanning is just part of the pilot's total visual work. To achieve maximum efficiency in flight, a pilot also has to establish a good internal scan and learn to give each scan its proper share of time. The amount of time spent scanning outside the cockpit in relation to what is spent inside depends, to some extent, on the work-load inside the cockpit and the density of traffic outside. Generally, the external scan will take about ten times as long as the look at the instrument panel.

During an experimental scan training course, using military pilots who experience ranged from 350 hours to over 4000 hours of flight time, it was discovered that the average time needed to maintain a steady state of flight was three seconds for the instrument panel scan and 18 to 20 seconds for the outside scan. Glider pilots need even less time on the instruments, especially with audio variometers.

An efficient instrument scan is good practice, even when flying VFR. The ability to scan the panel quickly permits more time to be allotted to exterior scanning, thus improving collision avoidance.

Developing an efficient time-sharing plan takes a lot of work and practice, but it is just as important as developing good landing techniques. The best way is to start on the ground, in your own aeroplane or the one you usually fly, and then use your scans in actual practice at every opportunity.

In two-seaters, if one pilot is occupied with essential work inside the cockpit, (e.g. map reading), the other pilot must expand his scan to include both his own sector of observation and that of the other pilot; in other words the second pilot must scan ahead and to both sides of the aircraft.

Collision avoidance checklist

Collision avoidance involves much more than proper scanning techniques. You can be the most conscientious scanner in the world and still have an in-flight collision if you neglect other important factors in the "see-and-avoid" technique. It might be helpful to use a collision avoidance checklist as routinely as you do the pre-take off and landing lists. Such a checklist might include the following items:

Check yourself

Start with a check of your own conditions. Your eyesight, and consequently your safety, depend in your mental and physical conditions. If you are distracted before a flight, you should think twice about flying under such circumstances. Absentmindedness and distraction are the main enemies of concentrated attention during flight.

Plan ahead

To minimise the time spend "head down" in the cockpit, plan your flight ahead of time. Have maps folded in proper sequence and within handy reach. Keep your cockpit free of clutter. Be familiar with headings, distances, etc. ahead of time so that you spend minimum time with your head down in your maps.

Check your maps, NOTAM, etc. in advance for such potential hazards as restricted areas, military low-level routes, intensive training areas and other high-density areas.

Clean canopy

During the pre-flight, make sure your canopy is clean.

Adhere to procedures

Follow established operating procedures and regulations, such as proper circuit practices. You can get into trouble, for instance, by skimming along the bottoms of clouds without observing proper cloud clearance.

In most in-flight collisions at least one of the pilots involved was not where he was supposed to be.

Avoid crowded airspace

If you cannot avoid aerodromes en route, fly over them well above circuit height. Military aerodromes, in particular, should be avoided as they usually have a very high concentration of fast-moving jet traffic operating in the vicinity.

Compensate for blind spots

Compensate for your aircraft's design limitations. All aircraft have blind spots; know where they are in yours. For example, a high-wing aircraft that has a wing down in a turn blocks the view of the area you are turning into. A mid wing blocks the area beneath you.

One or other of these limitations apply to the instructor's cockpit of most two-seat gliders.

Use all available eyes

The command pilot of a two-seater will have established crew procedures which ensure that an effective scan is maintained at all times. Obtain the assistance of the other pilot to look out for traffic of which you have been made aware and monitor the movement of other aircraft which you have already sighted. Remember, however, that the responsibility for avoiding collision is yours and you must maintain your vigilance at all times.

Scan

The most important part of your checklist is, of course, to keep looking out at where you are going and to watch for other traffic. Make use of your scan constantly.

If you adhere to good airmanship, keep yourself and your aircraft in good condition, and develop an effective scan time-sharing system, you will have the basic tools for avoiding a mid-air collision. And as you learn to use your eyes properly, you will benefit in other ways. Remember, despite their limitations, your eyes provide you with colour, beauty, shape, motion and excitement. As you train them to spot miniscule targets in the sky, you will also learn to see many other important "little" things you may now be missing, both on the ground and in the air. If you use the brain behind the eyes, you will be around to enjoy these benefits of vision for a long time.

TYPICAL GLIDER BLIND SPOTS