

THE DEVELOPMENT OF AN EFFECTIVE LOOKOUT

A See and Avoid system

Introduction

The practice of looking out, or scanning, is recognized as the primary method by which a sailplane pilot minimises the risk of collision when flying in visual meteorological conditions [VMC]. Scanning is directly linked to the pilot's skill at looking outside of the cockpit and becoming aware of the surrounding visual environment, termed spatial awareness.

The effectiveness of scanning has to be learned and constantly practiced to compensate for the limitations of the human eye. These skills include the application of an effective visual scan, and the development of a discipline to form and maintain sound habits.

The aim of this presentation is to make pilots aware of the skills required to make look-out more effective and is directed towards glider and soaring pilots who are flying under visual rules [VFR].

A study of over two hundred reports of mid air collisions showed that accidents 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 conditions. While the majority of mid air collisions occurred at lower altitudes where most VFR flying is carried out, collisions can and do occur at higher altitudes. Because of the concentrations of aircraft in the vicinity of airfields, most collisions occurred near airfields when one or both aircraft were descending or climbing.

It is difficult to quantify as to whether it is the experienced or the inexperienced pilot who is more likely to be involved in a mid-air collision. While a novice has much to think about and so may forget to maintain an adequate lookout, the experienced pilot, having flown through many hours of routine flight without spotting any hazardous traffic, may grow complacent and forget to scan.

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 high performance sailplane and a light twin-engine aircraft may have a closing speed of 250 knots. It takes a minimum of 10 seconds for a pilot to spot traffic, and identify it, realise it is a collision threat, react, and have the aircraft respond. Two converging aircraft at 250 knots will be less than 25 seconds apart when the pilots are first able to see each other, so it is obvious that they will need to pay attention.

The reason most often noted in 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 pilot 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% of our total information is through the eyes. In other words, the eye is our **prime means of identifying** what is going on around us.

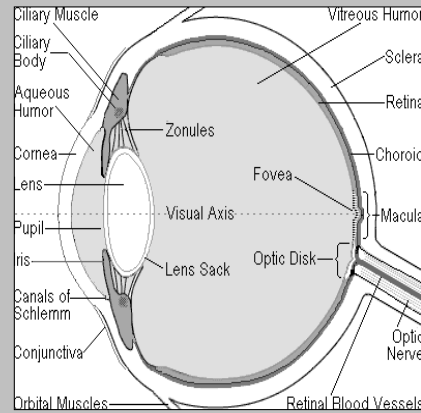
In the air we depend on our eyes to provide most of the basic input necessary for flying the aircraft, e.g. attitude, speed direction, and the proximity of opposing air traffic. As air traffic density and aircraft closing speeds increase the problem of mid –air collision increases considerably, and so does the importance of effective scanning.

Understanding the eyes limitations

A basic understanding of the eye’s limitations in target detection is probably the best insurance a pilot can have against collision.

THE EYE

- We can see and identify only what the mind permits us to see.
- The eye has blind spots.
- To see effectively you must **move your head**



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, atmospheric conditions, glare, lighting, windshield distortion, aircraft design, temperature, depleted oxygen, acceleration forces and so forth influence vision.

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. So conditioning of the mind and what may be expected to happen also plays an important part. A day dreaming pilot staring out into space-myopia, more about this later, is probably a 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 change for something up close, like a dark instrument panel two feet away, to a well-lighted landmark or aircraft target a mile or so away may take one to two seconds. That can be a very long time when it is considered that 10 seconds is needed 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 lower levels on vague, colourless days when no distinct horizon is visible. Pilots experience something known as “empty field myopia”, i.e. staring but seeing nothing, so that not even opposing traffic enters 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 casual 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 canopy frame 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 narrow limited to a relatively 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 corners 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 sailplane or aircraft on a collision course will appear to be motionless. The aircraft will remain in a seemingly stationary position without appearing to move or grow to 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 maybe 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 unavoidable because of the high closing speeds involved.

Light also affects our visual efficiency. Glare, usually worsens 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 the terrain that is varicolored 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 underestimate 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 an 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 runway visually, to ensure that there are no aircraft or objects in the take-off area.

After take-off, scan to ensure that no aerodrome traffic will be an obstacle to your safe departure. In the circuit area beware of conflicting traffic after take-off and on the downwind leg..

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

Remain constantly alert to all traffic in 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 develop scanning is by developing good habits and avoiding bad habits. Naturally, not looking out at all is the poorest scanning technique. Glancing out at intervals of five minutes or so is also poor when considering that it takes only seconds for 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, fixation, 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 is not 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 when making an unusual entry into the circuit. During aero- tow decent and climb-out, tug pilots must make gentle turns to see if anyone is in the way.

During the very critical approach stage, do not forget to scan all-round 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 threshold at that time.

In normal flight, you can generally avoid the threat of mid-air collision by scanning an area at least 60 degrees left and right of your flight path. Be aware that constant angle collisions happen when the other aircraft initially appears motionless at about you 10 o'clock or 2 o'clock positions. This does

not mean that 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 area. 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 might 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 shows no horizontal or vertical motion on the windscreen, but is increasing in size, take immediate evasive action.

Scan patterns

Two scanning patterns described here have proven to be 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 different 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 your 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 methods

Starting at the center block of your visual field, the center of the canopy or wind screen; move to the left focusing very briefly in each block, then swing quickly back to the center 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 visual work. To achieve maximum efficiency in flight, a pilot has to establish a good external 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 workload 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 whose 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 scan and 19 to 20 seconds for the outside scan. Glider pilots now need even less time on instruments, as nearly all sailplanes are equipped 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 sailplane, 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; in other words the second pilot must scan ahead and to both sides of the aircraft.

Collision avoidance check list

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 per-takeoff and landing checklists. Such a checklist might include the following items:

- Start with a check of your own conditions. Your eyesight, and consequently your safety, depends 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.
- To minimize the time spent “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, and distances, etc. ahead of time so that you spend minimum time with your head down in maps, logger and electronic gadgetry.
- 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
- During the pre-flight, make sure that your canopy is clean.

Adhere to procedures

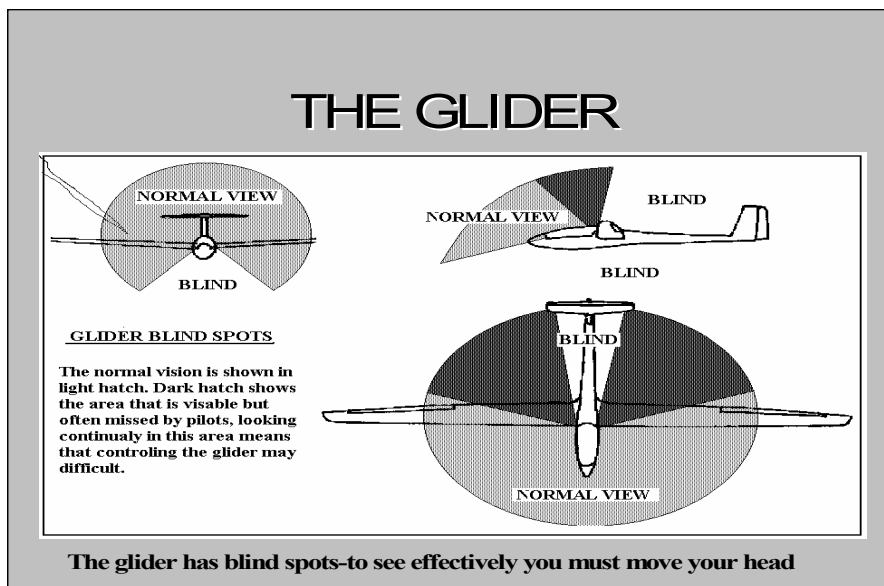
Follow the established operating procedures and regulations, such as proper circuit practices. You can get into trouble, for instance, by skimming along the bottom of clouds without observing proper cloud clearance. In most in-flight collisions at least one of the pilots involved was not where he was supposed to be.

Avoid crowded airspace

If you cannot avoid aerodromes en-route, fly over them well above circuit eight. 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 also apply to the instructor's rear cockpit in most two-seat gliders.

Use all available eyes

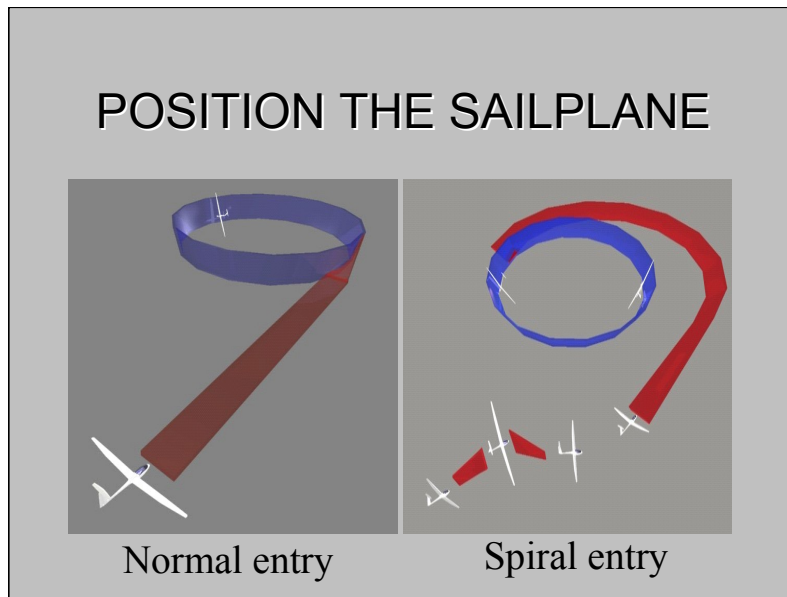
The command pilot of a two-seater should establish crew procedures which ensure that an effective scan is maintained at all times. Obtain the assistance of the other pilot to look out for traffic, which you have been made aware and monitor the movement of other aircraft, which you have already sighted.

Remember, however, that the responsibility for avoiding collision is yours and you must maintain your vigilance at all times. Although the eye is regarded as the leading contributor to mid air collision knowing what to look for is just as important. Particularly whilst turning, the right picture is safe the wrong picture with taking action maybe a collision.

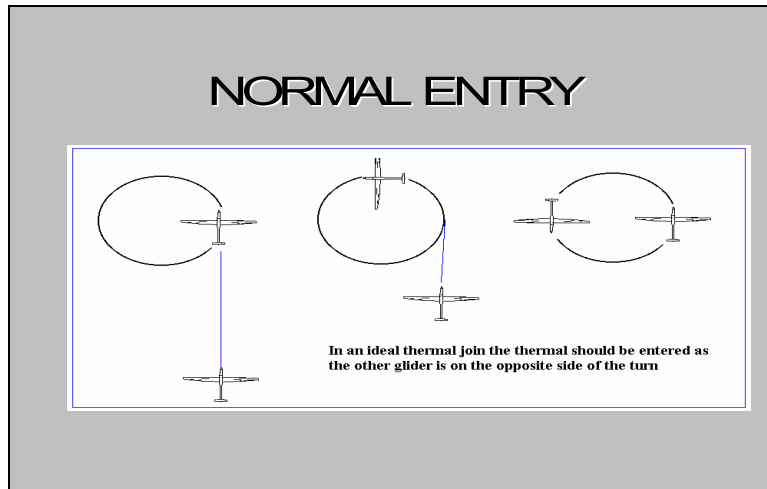
The following sequence of pictures produced by our British friends summarises what too look for and what to avoid. Take mental note of what the right picture looks like.

Scan, Scan

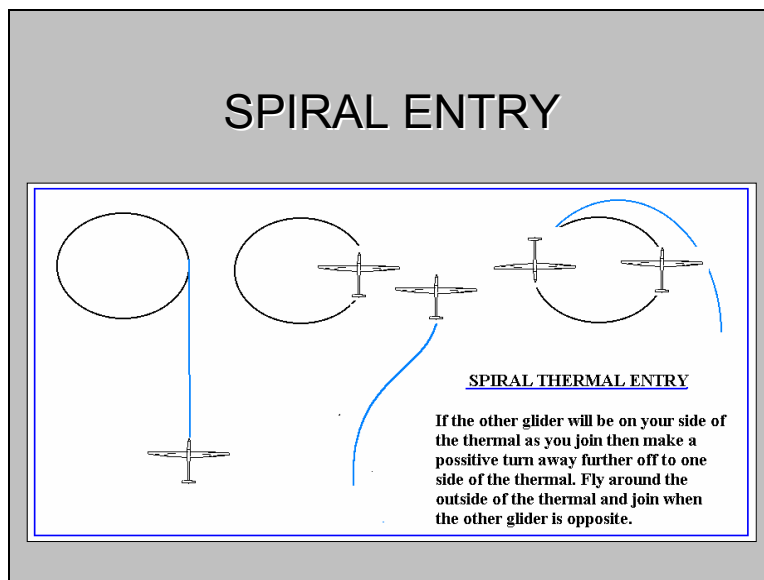
Keep looking out at where you are going and watch for other traffic. The entry of a sailplane into a thermal is a high risk maneuver, the risk is high because other sailplanes, may also be attracted the marked thermal.



Scan constantly looking from the nose the outer wing, avoiding any abrupt pull up as a target may be hidden in the sailplane's blind spot.



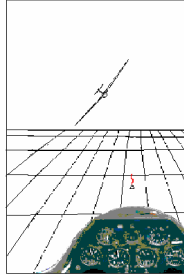
The positioning of the sailplane is critical requiring considerable skill.



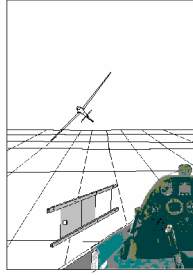
As you learn to use your eyes properly, and train them to spot miniscule targets in the sky, you will also learn to see many other important little things you may now be missing, both on the ground and in the air. When you approach another sailplane note its trajectory, anticipate and don't fixate on the target as there maybe other traffic lurking in your peripheral vision. Remember to move your head.

POSITIONING

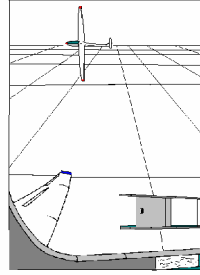
VIEWS OF A CORRECT THERMAL JOIN



As you approach the thermal the other glider is viewed end on



The other glider starts to take on more of a planform and move towards the left.



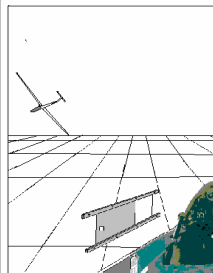
Once you get a planform view of the glider and is on your left, match your angle of bank with it, it should remain in the same relative position.

The rules associated with looking out are:

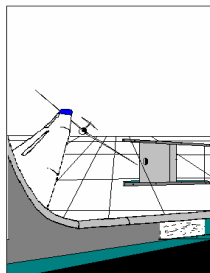
- Assume that all other aircraft have not seen you.
- Always be aware of what is happening around you.
- Always keep other sailplanes in sight and ensure that you can be seen.

SITUATIONAL AWARENESS

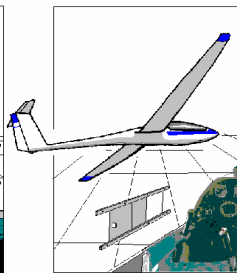
WHAT IT LOOKS LIKE IF YOU GET IT WRONG



As you approach the thermal the other glider is already on the opposite side



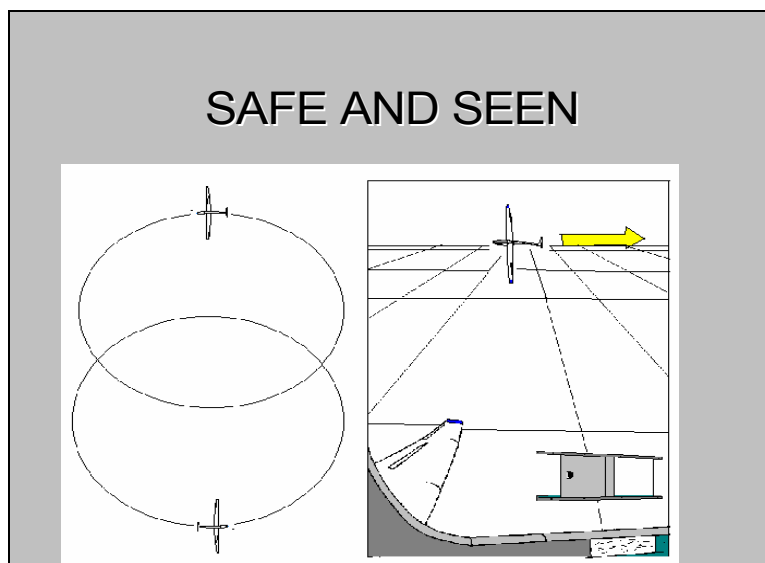
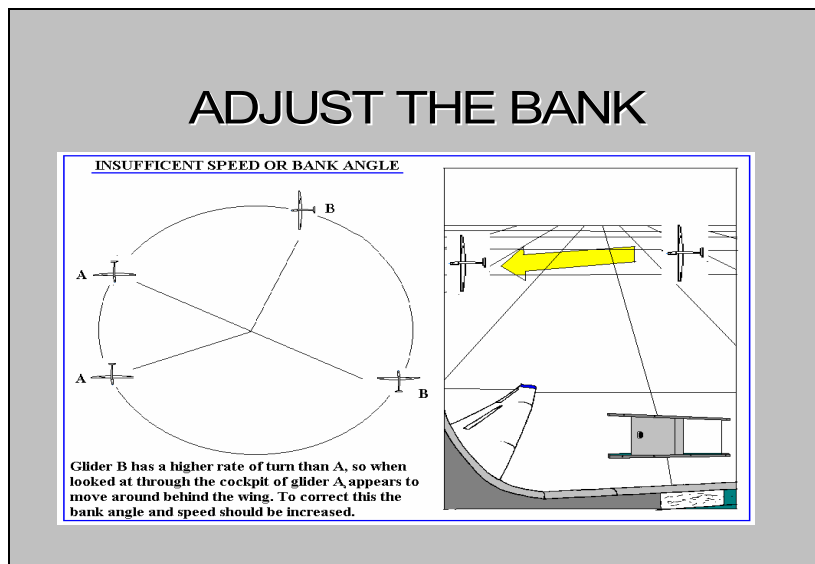
When the glider is on your wing tip you see a head on view as it flies towards you.



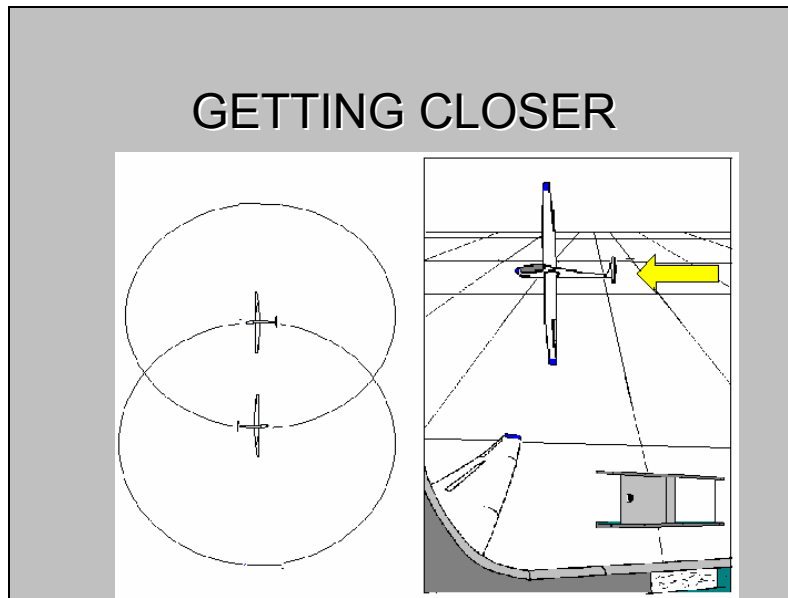
You end up joining the thermal on the same side as the other glider, this may be the last thing you see.

An aircraft that is growing larger is going hit you unless you take avoiding action.

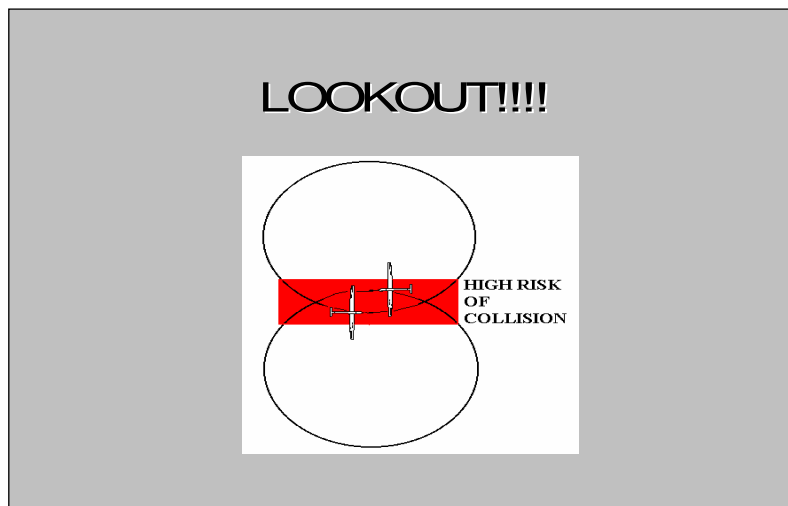
Never forget that an aircraft that is growing larger is going hit you unless you take avoiding action. Adjust the bank angle and reposition whilst monitoring the outer turn.



Remember that the first sailplane in the thermal has the right of way and must join the other sailplane in the same direction.

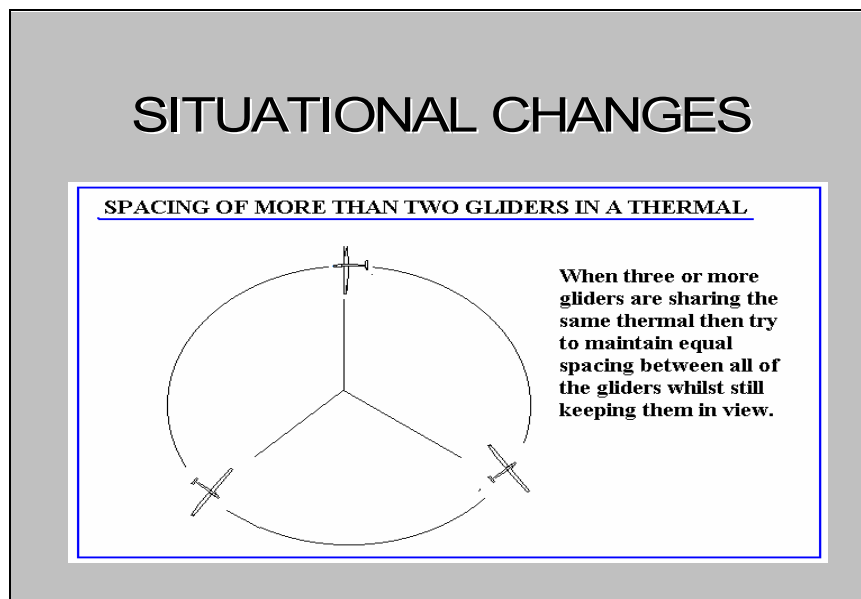
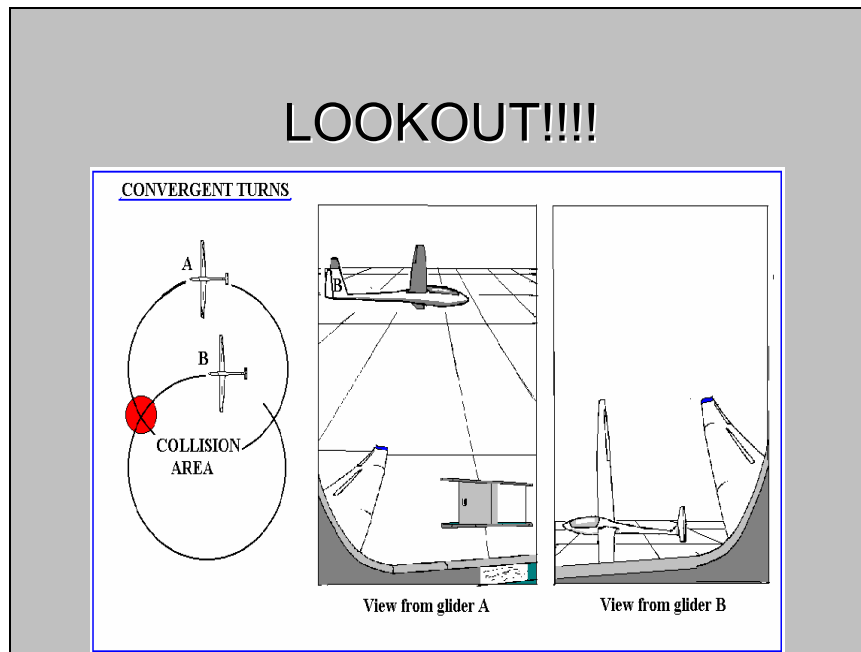


Note that there is now a very high risk of collision.



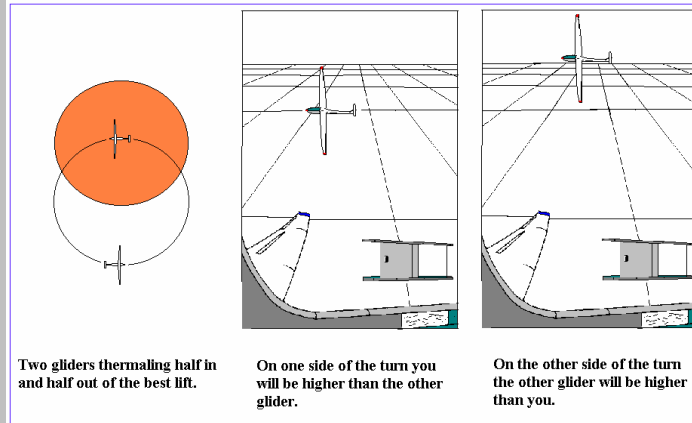
and as the turns converge.....

ensure that other sailplanes do not have to manoeuvre to avoid you.



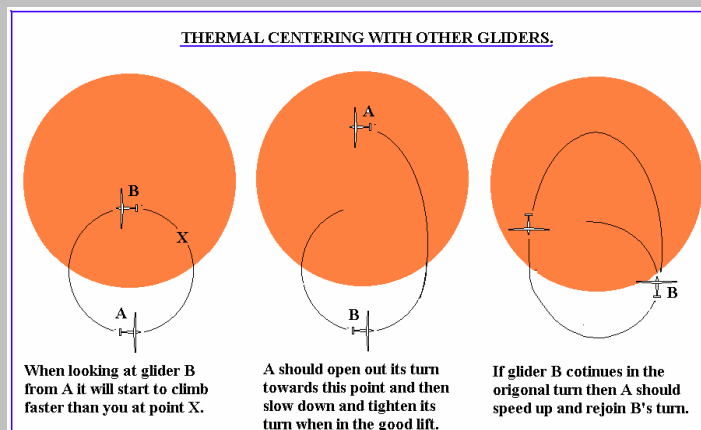
The situation may change if more sailplanes join the thermal, this will require adjustments. If uncomfortable leave the thermal..

MONITOR



Don't allow your concentration to lapse, and keep adequate speed above the stall consistent with around 40-45 degrees of bank.

MORE MANOUVRING



Finally, make sure that you can see other sailplanes and that they can see you, and anticipate that other sailplanes may join or fly through the thermal. Do not turn inside another sailplane unless you can maintain adequate separation even if they tighten their turn. Leave the thermal if other

sailplanes are getting too close or too much of your attention is given to watching other sailplanes.

If you use the brain behind the eyes, you will be around to enjoy the benefits of “See and avoid”

The foregoing is edited, with added copy, from a series of papers gathered over a number of years towards the prevention of mid air collisions. Sadly I have been unable to locate the source of most of the material. However, recognition is made to the Gliding Federation of Australia and the British Gliding Association and its members with a particular interest in flight safety.

Graham Garlick
April 2009