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Crew's Eyes Remain the Key to Midair Collision Avoidance

See-and-avoid techniques continue to be the best prevention against a midair collision, in spite of advanced technology.

by
Doug Crockett
Aviation Safety Consultant

A number of aviation dreams have become realities in recent years through such concepts as the head-up display (HUD), electronic flight instrumentation system (EFIS) and flight management control systems (FMCS) and satellite navigation. Although the aviation industry has achieved new heights in technology, the midair collision continues to be a threat. Even with the availability of space-age, computer-assisted air traffic control systems and navigation equipment, the see-and-avoid technique remains the most reliable method for collision avoidance. The potential for a midair collision is genuine; consider the following occurrence from an accident report:

It was a beautiful day for flying — a Cessna aircraft with instructor and student pilot was climbing under air traffic control (ATC) radar control. A Boeing 727, operating on an instrument flight rules (IFR) flight plan to San Diego, Calif., U.S., had a flight crew of three, and a deadheading pilot, in the cockpit. As the 727 descended through 9,500 feet, the crew reported the airfield in sight and the aircraft was cleared for a visual approach to runway 27. Shortly thereafter, 144 people died as a result of the midair collision that occurred at approximately 2,600 feet above ground when the 727 descended into the climbing Cessna.

In spite of numerous traffic advisories from ATC to the airline crew about the Cessna, the 727 crew members apparently never saw the single-engine aircraft clearly; and, of equal importance, they never informed the controller they had lost sight of the Cessna. At approximately 19 seconds before the collision, the approach controller received a "conflict alert" warning on his radar system. He radioed the 727 and again notified the crew about the Cessna. The crew advised visual contact with the Cessna. No further warning was required unless the 727 pilot reported losing sight of the Cessna. It was a case in which professional crews, flying in visual flight rules (VFR) conditions and in radar contact failed to see and avoid.

See-and-avoid rules have not changed. According to U.S. federal aviation regulations (FARs), the *FAA Pilot/Controller Glossary* and common sense, when flying in visual conditions — regardless of the flight plan type — pilots must continually watch for other aircraft and act positively to avoid a collision.

Midair Profile Reveals Danger Signals

In order to guard against the threat of a midair collision, it is important to identify the conditions under which the majority of midair collisions occur. A review of literature published by the U.S. National Transportation Safety Board (NTSB), Flight Safety Foundation and related military reports indicates that most midair collisions occur:

- During daylight hours,
- Under VFR conditions,
- Below 5,000 feet msl and
- Near an airport.

However, midair collisions occur in other conditions, such as the following example:

At approximately 1015 hours GMT on September 10, 1976, a midair collision occurred in clear skies between a Hawker Siddeley Trident Three and a McDonnell Douglas DC-9. The collision took place at approximately 33,000 feet msl and approximately 30 kilometers (19 miles) northeast of the Zagreb very high frequency omnidirectional radio range (VOR) navigational transmitter in Yugoslavia.

The government of Yugoslavia attributed the cause of the accident to air traffic control. The senior controller was arrested and sentenced to seven years in jail. Air traffic control problems *and* failure by flight crews to see and avoid resulted in the total destruction of both aircraft and the deaths of 176 passengers and crew members. As with many other midair collisions, this one occurred during daylight hours and under VFR conditions.

The fact that most midair collisions occur in ideal weather conditions further illustrates the importance of practicing see-and-avoid techniques. The NTSB has found that the probable cause of numerous midair collisions is: "Pilot in command failed to see and avoid other aircraft."

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In addition to occurring during ideal weather conditions, a number of midair collisions have involved two pilots who were on the same route and each was aware of the other's presence.

Two aircraft departed an airport at approximately the same time, en route to the same destination. They collided five miles short of the intended destination at 500 feet above the ground in VFR conditions. One aircraft was destroyed in flight and the pilot suffered fatal injuries. The other aircraft landed without further incident.

This accident highlights two points to remember. First, midair collisions are unforgiving, with the majority resulting in fatalities. Second, when a midair collision occurs during ceiling and visibility unlimited (CAVU) weather conditions, contributing factors other than prevailing weather must be considered.

Contributing Factors Create Trouble

One of the factors that can contribute to a midair collision is visibility, and it is affected by numerous parameters. One parameter involves the limitations of the human eye, i.e., a built-in blind spot all our eyes have at the point where light entering the eye strikes the optic nerve. With the field of view of both eyes unobstructed, the blind spots of each eye are cancelled out by the peripheral vision of the other eye. However, if a windscreen center post or door frame is between the eyes and an approaching aircraft, it is not possible for the eyes to fill such a void. This combination of the natural blind spot and aircraft design can greatly restrict visibility.

Space myopia is another parameter that can restrict the pilot's visibility. Space myopia is a condition that reduces the ability of the eyes to focus due to a lack of objects to focus on. This condition frequently prevails during hazy and cloudy days where there are no mountains, buildings or other objects in view. Under such conditions, a pilot will tend to focus on a section of his aircraft instead of scanning for other aircraft.

Uncorrected nearsightedness (not wearing required glasses to improve distance vision) can also impair a pilot's ability to see and avoid. If a pilot is nearsighted (myopic) he will not be able to see an oncoming aircraft as quickly as he would with his vision corrected to 20/20. How close an aircraft must get before it becomes visible depends on how nearsighted the pilot is. If glasses are prescribed, they must be worn for safety.

Glare also interferes with visibility. It overstimulates the eyes and causes a reduction in sensitivity, thereby decreasing the ability of the eyes to see objects under normal light conditions. Glare may be produced by the angle at which sunlight strikes the windscreen or instrument panel, or when the pilot inadvertently looks directly at the sun. An alert pilot must guard against glare and its effects.

The absence of motion in an observed object is an indication of a potential collision. If a pilot is on a head-on collision course with another aircraft, the other aircraft will appear motionless. Also, if the pilot is directly overtaking another aircraft, the other aircraft will appear motionless. An object that is obviously in motion will be detected much more rapidly than one with no apparent motion. Once an oncoming aircraft appears through the windscreen in a non-moving state, the pilot will have to initiate evasive action in order to avoid a potential collision.

Contrast between objects is very important in avoiding another aircraft. An aircraft that contrasts with its background is much easier to detect than one that blends in with its surroundings. Many major airports have become surrounded by buildings of various sizes, shapes and colors. Pilots in aircraft descending over a city environment can experience great difficulty identifying converging aircraft against a background of multicolored buildings or city lights.

Pilot workload or division of attention can also greatly hamper an individual's ability to see another aircraft.

A combination of many factors contributed to the following:

A light helicopter was monitoring holiday traffic for a local radio station when it collided with a Cessna 172 that was performing the same type mission. Both pilots had received automatic terminal information service (ATIS) briefings, but neither had filed a flight plan nor was participating in flight following service with an ATC facility. The aircraft collided at a height of 1,000 feet. The pilots were able to make successful landings even with substantial damage to both aircraft. No one was injured.

The requirement to closely monitor location over the ground, observe surface traffic flow, coordinate with an on board observer, compensate for glare, and the basic requirement to fly the aircraft could have easily placed either pilot in a position where his workload completely voided his ability to see and avoid other aircraft.

Pilot workload or division of attention can greatly hamper an individual's ability to see another aircraft.

Uncontrolled Airports Breed Midairs

Consider the following situation. A pilot is cleared by ATC for a published straight-in IFR approach to an uncontrolled airport. When the aircraft breaks out of the overcast at 1,000 feet agl and one mile visibility, it is nose-to-nose with another aircraft — and both are legal. At this point both aircraft are in visual meteorological conditions (VMC) where all pilots are responsible to see and avoid whether on an IFR or VFR flight plan; and VFR aircraft in the United States can legally operate with only one statute mile visibility and clear of clouds 1,200 feet or less agl.

A common practice, when landing at an uncontrolled airport, is to cancel an IFR flight plan when the airport is sighted. If a pilot elects to cancel IFR at this time, he should be aware of the following:

- Separation protection from other IFR traffic has been lost.
- VFR rules for uncontrolled airports must now be followed.
- The level of assumed risk has been increased.

Midair Collisions Can Be Prevented

The following checklist was developed from a compilation of NTSB safety recommendations; a special report, "How to Avoid a Midair Collision;" and pilot reports of lessons learned.

1. **Man**. Insure that you, the pilot-in-command, are totally prepared for the flight, both mentally and physically. If required to wear glasses to correct vision, wear them. Practice cockpit resource management (CRM). Keep all crew members informed and actively involved in collision avoidance. Brief other crew members and jump seat passengers on proper scanning procedures and how to report other aircraft observed in flight. Most important, scan all the time. All crew members and jump seat passengers should continuously incorporate the maximum limits of their field of view into a scanning pattern. Identify blind spots in your aircraft and, whenever possible, utilize another person on board to help observe around such spots. Perform a detailed study of each intended flight to include familiarization with weather and intended landing areas to minimize the time required for your eyes to be busy inside the aircraft as you approach the airport.

2. **Machine**. Insure that your aircraft is ready for the mission. Distractions such as red lights on the warning panel have a tendency to detract from a pilot's ability to totally concentrate on looking outside the aircraft. The windscreen is of prime importance for collision avoidance. Something as small as bug residue on the windshield or accumulated scratches could greatly impair your ability to see and avoid another aircraft. The aircraft should be as visible as possible — if you have strobe lights, use them.

3. **Environment**. Be an active part of the environment in which you fly. Maintain a listening watch on the radio

to monitor the movement and location of traffic in and around your flight route. Make maximum use of any available radar service and always insure that ATC knows in advance when you are approaching a high density traffic area. Adhere to all regulations and procedures. Review your guide to the aviation environment — the *Airman's Information Manual* or equivalent rules and procedures guides — to insure that you follow proper procedures. Midair collisions have resulted from entering a traffic pattern incorrectly or unannounced.

4. **You**. It is your responsibility to see and avoid. Be prepared. Use all the tools you have available.

The pilot and his crew remain the critical elements in collision avoidance … .

What About Electronic Collision Aids?

As early as 1955, the Air Transport Association (ATA) in the United States made a formal request that the aviation industry develop a collision avoidance system. Since the 1978 midair collision between a Boeing 727 and a Cessna 172 over San Diego, Calif., U.S., in 1978, there has been extensive research into the development of a collision avoidance system that will function in a high density traffic environment. Progress continues on the development of a totally reliable traffic alert and collision avoidance system (TCAS). A number of air carrier and corporate aircraft are currently equipped with TCAS equipment, and numerous reports of near-miss avoidance have resulted from use of these systems. (TCAS and TCAS I refer to a proximity warning indicator [PWI] function and is designed for use by small, slow aircraft such as those used in general aviation operations; TCAS II provides intruder warning and prescribes vertical-only evasive maneuvers in heavy and jet aircraft; and, TCAS III adds turning evasive directions to the capabilities of TCAS II equipment.)

A number of limitations still exist in TCAS equipment. In July 1991, a joint U.S. Federal Aviation Administration (FAA)/industry working group, the TCAS Event Analysis Team, issued a newsletter regarding resolution advisories (RAs, or recommended evasive maneuvers generated by the TCAS) for non-existent intruders. A non-existent intruder problem has occurred with all TCAS II equipment now in production, and is caused by the TCAS tracking its own transponder.

When this type of false RA occurs, the traffic advisory display of the TCAS II system shows an intruder nearly superimposed on the "own-aircraft" symbol at the same altitude. Also, the intruder remains at the same displayed position relative to the own-aircraft symbol regardless of the evasive action taken by the pilot.

Although greatly improved compared to earlier systems, TCAS II systems are limited to providing only vertical RAs. For this reason, evasive action turns based solely on TCAS II indications are not authorized. It is acceptable to climb or descend to evade an intruder, but due to TCAS system limitation, visual contact with the intruding aircraft must be made before evasive turns can be executed. Specifically, guidance from the event analysis team newsletter indicates:

"… crews should ensure that, if they initiate a turn on the basis of visual acquisition, their radio report to ATC should state that the turn was based on visual acquisition, not on TCAS."

Electronic collision avoidance systems have become more sophisticated, but are not the total solution to the midair collision problem. The cockpit crew members remain the critical elements in collision avoidance, and the regulatory requirement to see and avoid is as binding as ever. ♦

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About the Author

Doug Crockett is a Boeing 727 flight engineer for a major U.S. airline and actively participates in his company's pilot organization training, safety and accident investigation committees at domestic and international levels. He is also a free-lance safety consultant. He has extensive training and experience as a safety specialist and aviation accident investigator.

Crockett retired from the U.S. Army where he organized and commanded that service's first jet aircraft unit. He holds an airline transport pilot certificate with helicopter and seaplane ratings. He is also a certificated flight instructor.

Crockett has received aviation safety awards from the U.S. Army, the Association of Flight Attendants (AFA) and the National Business Aircraft Association (NBAA).

Blue Ice Is a Continuing Threat to Safety

Blocks of ice that form on the outside of an aircraft fuselage from lavatory plumbing leaks can result in severe engine ingestion problems.

(Adapted from the Boeing Flight Operations Review, *published by the Boeing Commercial Airplane Group)*

There have been 33 infight "blue ice" incidents involving Boeing commercial air carrier aircraft — 21 on Boeing 727s and 12 on 737s — where significant airplane or engine damage occurred due to dislodged frozen forward lavatory fluids that leaked out during flight. Fourteen of the 33 events have occurred in the past three years.

This significant rate of increase is of concern. Three cases of number three engine separation of Boeing 727 aircraft have been reported. During one of the events, the airplane was cruising at 35,000 feet when a loud bang occurred, accompanied by a severe jolt and slight yaw. All number three engine instrument parameters froze or went to zero. The number three engine had separated cleanly at the attachment bolts with only minor fuselage damage.

The cause was traced to "blue ice" that had formed on the outside of the fuselage from a service valve leak at the forward lavatory servicing point. A chunk of this ice had separated and entered the engine inlet, causing the engine to seize, following which it separated from the aircraft. Prior to this event there had been numerous write-ups about the forward lavatory on the affected aircraft, including loss of fluid. Blue streaks were also evident along the side of the airplane.

Typical reports of airplane and engine damage caused by blue ice include right-hand landing light lens broken, wing leading edge damaged, engine strut damaged, horizontal stabilizer and vertical fin damaged, engine fan blades damaged and engine separation.

The leaking blue-tinted water freezes at typical cruise altitude where the outside air temperature is significantly below freezing. The resulting chunks of ice may become large enough to break off while still at cruise altitude. During descent into warm air, the airplane fuselage skin temperature increases rapidly to above freezing, dislodging remaining chunks of blue ice.

In order to prevent possible serious airplane or engine damage from blue ice accumulation, Boeing recommends that flight crews check the forward lavatory servicing and drain points of aircraft for evidence of blue-tinted water leaks during preflight inspections. The side of the fuselage should also be checked for telltale blue streaks which may indicate leaks that occurred during previous flights. ♦

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