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FORUM

COLLISION AVOIDANCE IN TRAFFIC PATTERNS – TIME, FLYING TASKS AND VISUAL SCANNING

Thomas Kirton

INTRODUCTION

Conducting traffic pattern and landing training at non-towered airports presents an instructor and student a challenging environment. The training must be effective in all aspects of the maneuvering and landing and at the same time safety is an overriding concern. Some flight training organizations conduct training in "traffic saturated" environments. The potential for mid-air collisions at these airports is a major concern.

The Aircraft Owners and Pilots Association (AOPA) Air Safety Foundation publishes an accident summary each year in the Nall Report. This report discusses mid air collisions and notes that "78% of the midair collisions that occurred around the traffic pattern happened at nontowered airports." This report does not address how many near mid-air collisions happen. Further, most discussions about mid-air collisions focus on the pilot's failure to "see and avoid" other traffic. Some questions need to be discussed. Are there a large number of "unreported" situations at nontowered airports in which airplanes get close enough to each other to cause either pilot to maneuver to avoid the other airplane? Where in the traffic pattern do the conflicts happen? Why do pilots not see each other soon enough so that a collision avoidance maneuver becomes necessary? And, most important, is there a safety hazard that needs to be corrected

A questionnaire was prepared and presented to the flight instructors at Embry-Riddle Aeronautical University (ERAU) in Daytona Beach. One hundred and fifty current and active instructors responded to the questionnaire. Two questions were asked. The first question was "Have you ever been involved in a traffic conflict in flight at an airport without a control tower and if so how many times?" The second question was "Where did the last three traffic conflicts occur in the pattern?" "Traffic conflict" was defined as any situation involving another aircraft in the pattern that required either pilot to maneuver to avoid a mid-air collision. A diagram of the Aeronautical Information Manual (AIM) recommended traffic pattern was shown on the questionnaire with pattern positions indicated by letters of the alphabet (Figure 1). The instructors were asked to indicate on the diagram where the conflicts occurred and to indicate the kind of flight (dual training or any other kind of flight). The results discussed in this paper reflect only dual training flights.

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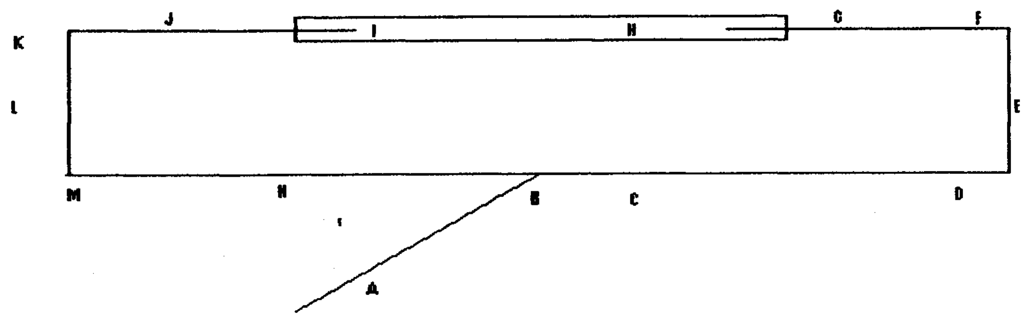

Figure 1. Recommended traffic pattern positions

ERAU FLIGHT DEPARTMENT TRAINING PROCEDURES

ERAU Flight Department standardized procedures require instructors and students to fly the traffic pattern as recommended in various publications. Those procedures are published in the Aeronautical Information Manual (AIM), The Airplane Flying Handbook (FAA-H-8083-3), On Landings part I (FAA Accident Prevention Program pamphlet), Recommended Standard Traffic Patterns for Aeronautical Operations at Airports Without Operating Control Towers (AC 90-66A), Pilots' Role in Collision Avoidance (AC 90-48C, and Traffic Advisory Practices at Airports without Operating Control Towers (AC 90-42F). Here is a summary of these procedures: Enter the traffic pattern at the published traffic pattern altitude by flying a ground track that is 45 degrees to the midpoint of the downwind leg. Establish traffic pattern altitude on this leg at a distance from the downwind that allows sufficient time to scan the pattern for other traffic. Fly the downwind leg a distance of ½ to one mile from the landing runway. Make all turns in the pattern in the published or indicated direction for that runway. Slow to a speed no higher than the top of the white arc on the airspeed indicator and no slower than 1.4 Vso until turning final. On final fly a speed of 1.3 Vso or as recommended by the airplane manufacturer. Make all turns no steeper than a medium bank turn and fly the legs and turns in the pattern as they would be flown while doing the rectangular pattern ground reference maneuver. Turn onto the final approach leg at a safe altitude considering terrain and obstacles. Other specific guidance recommends the pilot to limit the bank angle on turns to no more than 30 degrees and that the base leg distance from the end of the runway should be positioned with reference to wind conditions on final. The base leg should be positioned closer if the wind speed is higher and farther out if the wind speed is lower. The descent for landing from pattern altitude is begun after passing abeam the runway touchdown point on downwind. The diagram in Figure 2 is a copy of the traffic pattern diagram shown in the Airplane Flying Handbook (FAA-H-8083-3) and the Aeronautical Information Manual.

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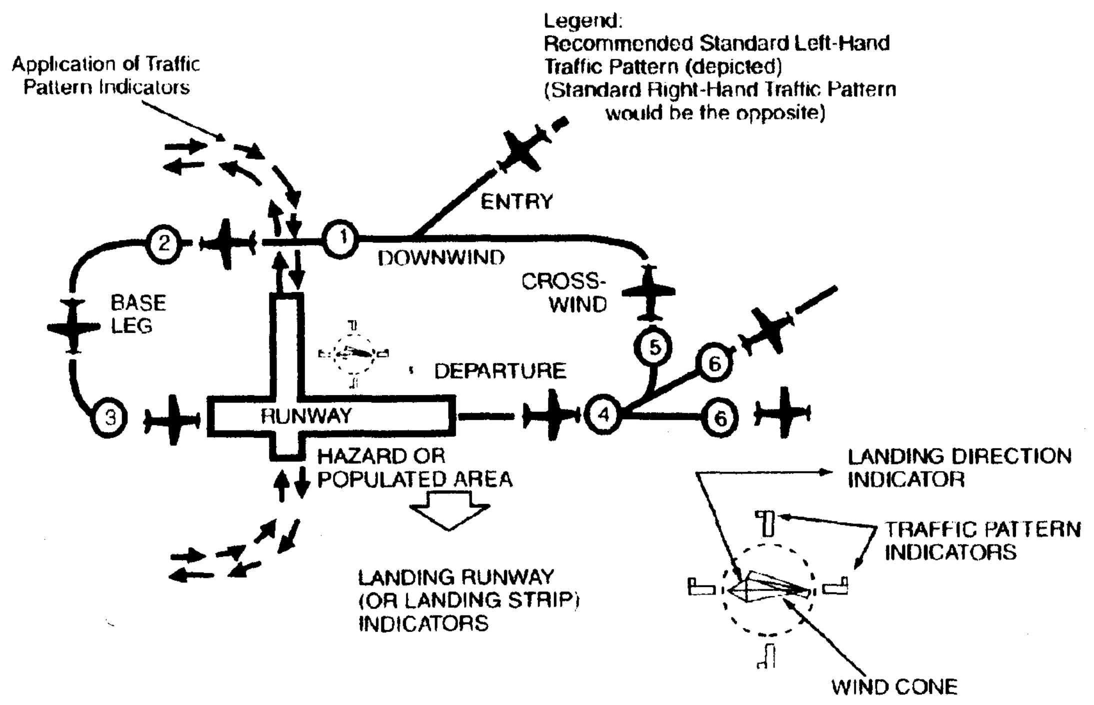

Figure 2. Traffic pattern diagram shown in the Airplane Flying Handbook (FAA-H-8083-3) and the Aeronautical Information Manual

RESULTS OF THE SURVEY

Twenty-nine of the responses were not completed according to directions and were not used in putting together the survey results. Most of the instructors were airplane and instrument instructors and about half of them were multiengine instructor rated. The average flight time for each was 1500 hours. Of the 121 instructors completing the survey the average number of total conflicts reported was 5.5. This indicates one traffic conflict occurred approximately every 300 hours of flight time.

The total number of traffic conflicts reported for each place in the traffic pattern is shown in by each of the pattern locations (Figure 3). The two places in the traffic pattern with the highest number of conflicts are the vicinity of the entry leg (A, B, N) and the vicinity of base and final leg (F and G).

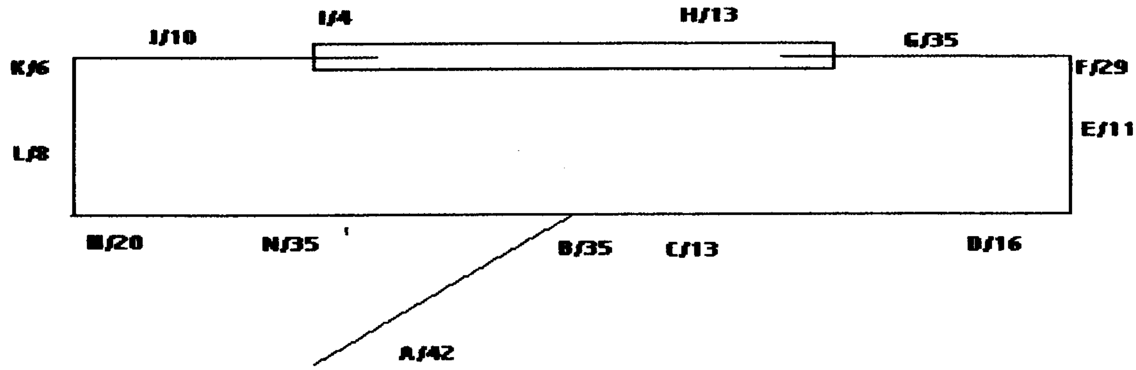

Figure 3. Pattern Locations

DISCUSSION

Why are these two places reporting the highest number of conflicts? One obvious reason is that all traffic gets channeled here sooner or later for landing and that attention begins to get focused on the landing spot on the runway. The other observation that could be made is that the pilots of each airplane do not see each other until a conflict is imminent. What is going on that allows so many of these conflicts to happen in a training environment? Are a lot of pilots flying the pattern in other than recommended ways or are there other reasons such as task saturation or distraction caused by dual instruction? Whatever the reason it looks like it all begins with the pilots not seeing each other until a collision avoidance maneuver becomes necessary.

Task saturation and time available may provide clues to this problem The traffic pattern at a non-towered airport can be an extremely busy place for any pilot regardless of experience and flight time logged. How much time is available on each leg of the pattern to fly the airplane, communicate, accomplish checklists, scan for other traffic, make adjustments as needed, and evaluate the accuracy of the flight path? Also, if an instructor is added to the situation, how much more time is available to accomplish instructing tasks and student responses to those tasks?

The analysis was presented to the attendees at a safety conference and generated interest. The results of the analysis show the amount of time available during the straight-and-level portions of base leg and final approach based on the following conditions. The pattern flown by all aircraft is assumed to be the same size and the only variable is the speed flown by each aircraft. The pattern size is ¾ mile (nautical mile) wide with the turn to base leg begun when the end of the runway appears 45 degrees behind the airplane wing. The bank angle used is averaged at 25 degrees for each turn. The final approach leg is ¾ mile long. The groundspeeds used are based on a no-wind situation at a sea level density altitude airport.

The time available on the base leg may be determined by calculating the distance for wings level flight on base and then calculating the time to fly this leg based on groundspeed. The distance needed for the turns from downwind to base and from base to final can be determined by using the turn radius chart published in the Jeppesen Sandersen, Inc. Instrument Commercial Manual. For example, this chart shows that an airplane flying a downwind leg ¾ miles wide and starting a turn with an average bank of 25 degrees will require a turn radius of 1000 feet. The total distance including both the turns to base leg and final approach is 4500 feet. If we subtract the two

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turns (base and final) the distance remaining will be 2500 feet of wings level flight for base leg. The wings level final approach leg will be the same distance. The results of the calculation follow:

> An airplane flying base leg at 70 knots will have 2500 feet of wings level flight and take **21** seconds to fly base leg.
>
> An airplane flying base leg at 80 knots will have 1800 feet of wings level flight and take **13** seconds to fly base leg.
>
> An airplane flying base leg at 90 knots will have 1000 feet of wings level flight and take **7** seconds to fly base leg.
>
> An airplane flying base leg at 100 knots will have 500 feet of wings level flight and take **3** seconds to fly base leg.
>
> An airplane flying base leg at 120 knots will have to be in a **constant bank on base leg** to avoid overshooting the turn to final.

How much time should a good visual scan outside the aircraft take and how many degrees left and right should the scan area include? Techniques are presented by the Federal Aviation Administration (FAA) in Advisory Circular 90-48C and in the AOPA Safety Advisor pamphlet "Collision Avoidance Strategies and Tactics". All of the techniques recommend visual scanning in a series of short, evenly spaced, ten to fifteen degree blocks. The scan should be paused one to two seconds in the middle of each block to allow time for the eye to focus.

In addition to scanning outside the aircraft for traffic a pilot must scan the instruments in order to fly the traffic pattern with precision. One study showed the average time needed to scan the instruments was 3 seconds for every 17 seconds of outside visual scanning. At least one scan of the instruments should be done on base leg and possibly more on final approach.

An example of one technique is the "side-to-side" scan. It is begun by starting at the left side of the pilot's visual area and scanning in ten to fifteen degree blocks with a pause for focusing of one to two seconds in the center of each block. Scanning 60 degrees to each side of the nose of the aircraft is recommended for a total scan of 120 degrees. Every few scans the area in the nine and three o'clock position should be scanned. The scan should include the area above and below the aircraft at regular intervals. This technique will require a minimum time of 8 seconds if only 120 degrees is scanned in 15 degree blocks with one second of pause in each block. Allowing time to check for the nine and three o'clock positions will add at least 1 second in each of these two blocks and about 2 seconds to move the head from full left to full right. Including time for one scan of the instruments will increase the time another 3 seconds. This is a **total of 15 seconds** to accomplish a minimum scan. This does not include looking above or below the aircraft. If the scan is done in 10 degree blocks with a 2 second pause in each block there will be a total required scan time of **33 seconds** (12 ten degree blocks = 24 seconds + 3 and 9 o'clock + instrument scan = 33 seconds).

The following compares the time required to complete a visual scan to the time available at various airspeeds. Flying a ¾ mile wide traffic pattern at 70 knots on base leg allows 21 seconds of wings level. This shows that time remaining for other tasks is 6 seconds with a one second pause in each block. If the pilot pauses for two seconds in each block there will not be enough time available to complete the scan and accomplish the other tasks. The time available on base leg in this example is the most time that a lot of training aircraft will have. Consider a traffic pattern populated with faster aircraft all trying to fly the ¾ mile wide pattern. As the speed increases the time for visual scanning decreases.

Other factors that affect visual scanning time must be considered in this discussion. Additional time may be required on base leg to assure that there is no potential traffic conflict from an aircraft "hidden" in the blind spots of a particular make and model airplane. An example is the location of the post on each side of the windscreen of a Cessna 172 hides a portion of the area to scan. Extra time must be spent looking on each side of the post. Another factor to consider is the sun angle. If the runway alignment is east or west the sun angle early or late in the day will affect how well aircraft can be seen on final approach and will probably require more time looking. Additional time may also be required if the scan is interrupted by a need to adjust the flight path or correct a deviation in airspeed.

Conclusions

To accomplish a complete and effective visual scan for traffic on base leg and final approach leg will take time. How much time available for the visual scanning task depends on the amount of time left over after aircraft control is accomplished. Traffic pattern size and the speed flown will determine the amount of time available to complete all

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required tasks. In a training environment the traffic pattern may have numerous aircraft flying different speeds each piloted by pilots and instructors of varying skill levels. Some pilots may be able to effectively scan and control the aircraft in a shorter amount of time than others. An awareness of the risks involved in flying a minimum size pattern and shortening the time available to visually scan should be part of each pilot's decision-making process. Operations in the traffic pattern should be conducted considering this risk factor especially during student pilot solo operations and dual training flights in the traffic pattern.

Student pilots should be taught early in their training the physical dimensions of traffic patterns. These dimensions should then be related to time, speed and distance awareness. Increasing a student pilot's knowledge about the physical aspects of traffic patterns will enable the student to predict accurately the outcome of decisions and actions.

Student pilots should also be required before starting landing practice to master all of the mechanics of flying traffic patterns including descending with precision on the various legs of the pattern and the actions required to correct deviations from the planned flight path. The traffic pattern should be completely mastered before beginning the training in actual landings.

Training for pattern operations should be conducted away from other traffic so that a student is able to use a part task approach to mastering the various elements of traffic pattern maneuvers. The minimum standard for being allowed to get into the pattern should be mastery of ground track maneuvering at various airspeeds while descending. The scanning tasks should also be included in this as part of the observed performance of a student before being allowed in the pattern.

The guidelines presented by the FAA and AOPA for flying traffic patterns should be reviewed and possibly modified considering the information presented in this paper. A meeting should be accomplished with all interested safety, flight training, and FAA persons with an interest in this area. ✈

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