



# FIGHTER FORMATION FUNDAMENTALS



I hope everyone had a great summer. It's hard to believe that it's already over. Just a few more shows and back in the hanger they go for the winter. How time flies. The subject of this paper is low altitude awareness. Of everything we do, nothing is more dangerous than high performance maneuvering close to the ground. It's something we do at almost every airshow we attend, but how much about that environment do we really know? There is nothing more demanding of skill, situational awareness and knowledge than the low altitude arena. Most of you have had no formal training in this arena, so I decided to dedicate this article to an environment I spent many years training in. The purpose is to enhance your awareness of the low altitude environment, so the next time you roll in to the strafe at an airshow, you will feel a little more comfortable.

To begin, I ran across an interesting article in the USAF Flight Safety magazine concerning this very topic. It is written by an F-16 Instructor Pilot (IP) engaged in training future F-16 pilots. It reads as follows:

*As an F-16 Instructor Pilot, I've seen my share of student errors over the years, but in the FTU business that sort of thing is expected. I had the opportunity to lead a four-ship low altitude step-down training mission. The flight consisted of myself, another IP, plus two students. The objective was to introduce the students to maneuvering as a formation, performing tactical low-level intercepts in the 500 ft AGL regime. The student wingmen needed to learn to divide their attention between the rocks, keeping the visual with lead, using the radar, getting the bandit tally, employing weapons and maintaining effective communications throughout. My briefing stressed the usual things that can cause problems on missions like this: altitude awareness, prioritization, task saturation, formation considerations, comfort level, etc. The airspace was in a restricted area over flat, featureless desert terrain.*

*The mission went well, with two elements alternating as fighters and bandits. In the debrief, we reviewed all the intercepts, noting the students radar use, communications, formation position (not station keeping) and weapons employment. Overall a solid mission.*

*About an hour after the debrief my student came to me. He looked shaken and asked if he could talk to me privately. We reviewed the tapes together and found the HUD video started towards the end of our first engagement as bandits. The student was a 500 ft AGL on the radar altimeter, 440 KCAS, approximately 2nm from me and swept aft, as briefed – a typical low altitude bearing formation.*

*The featureless terrain had a slight upslope to it. Over the next 30 seconds, the student descended from 550 AGL to 320 AGL. The low altitude warning was flashing in the HUD, but the student was dividing his attention between the radar, watching me off his right and gaining tally on the fighters and he didn't see it. After 15 seconds the student continued the descent to less than 70 ft. He stabilized there for another 15 seconds before beginning a climb to 1500 AGL. Neither he, nor I, had any idea he was well below the 500 ft hard deck for approximately 1 minute.*

*This was a classic case of misprioritization – watching lead, the radar and getting tally at the expense of watching the rocks.*

**Lesson 1:** *I'd broken one of my cardinal rules by not watching him more. I was too busy running the formation, working my own radar and going for the tally. Admittedly, in the fighter business you can't watch your wingman all the time. But in this case, a quick glance back over my shoulder could have alerted me to his situation. I was also irritated that he was the one who caught it on tape and not me in the debrief.*

*"flying fighters is not a matter of life or death - it's much more important than that"*

**Lesson 2:** *Yeah, it's embarrassing, but having the gumption to speak up when you screw up is really called guts. You'll be surprised how many guys will admit having done the same thing. You might prevent a repeat occurrence, and people will respect you for it. Only fools think, "that this could never happen to me".*

**Lesson 3:** *Take heart at the hazards you hear about concerning low-level flying. It's all true and it does happen. In this case, the results were not fatal but could have been catastrophic.*

*Anonymous*

## **THE DEADLIEST ARENA AND HOW TO SURVIVE IT**

Lesson 3 is what the paper is all about. It will be somewhat longer than my usual dissertation, but I felt it was important enough to make it thorough. This has been the worst year I can remember in loss of precious friends and irreplaceable aircraft. We simply owe it to each other to arm ourselves with anything available in an unceasing effort to keep us out of the rocks.

You might be asking why such a statement about low altitude flight. We don't really fly at low altitude. The truth is most of us do, in the worst possible scenario. The airshow low level strafe in fighter trail formation. A combination of changing geometry, airspeeds, attitudes and altitudes make this environment a most hostile one to the unwary.

The most important disadvantage of low altitude flight is the unforgiving nature of making a mistake in close proximity to the ground. An understanding to the physics involved in low altitude flight as well as a command of the control and management of low altitude flight is essential if you are to survive in this environment.

### **Low Altitude Tasking**

Critical tasks are those that require immediate pilot attention. The first and foremost is terrain clearance tasking. Remember the Probability of Kill (PK) of the ground is almost always one! Terrain clearance tasking loads the pilot in basically four modes: Aircraft control, Time control, Vector control and finally Altitude control are descending order tasks the pilot must manage.

The remaining critical tasks are performed in addition to the primary task of terrain clearance. These include situational awareness, command and control (if lead), communications and maintaining position.

### **Physics**

The application of physics to the low altitude environment is always a factor. The time to ground impact varies significantly, with bank being the most important factor. Bank will alter the physics much more quickly than a change in altitude because an increase in altitude hardly affects time to impact in a turn. As an example, impact from 200 ft only take 1.2 seconds longer than in a turn. **Proper control of bank saves the pilot faster than anything else.**

Turning and looking away from the aircraft vector in a turn off target can be dangerous. Most accidents do not occur with the pilot looking out the front windshield. Instead, a turn is started and the attention is diverted somewhere else. The answer is to keep the crosscheck time short. If the pilot wants to look and turn, he should do it climbing and looking only for short intervals. **This is a must for low altitude survival.**

There is also dive recovery altitude; another fundamental to consider anytime the nose is pointed at the ground, such as in the roll-in to a strafe demonstration. The altitude loss of the aircraft is a function of flight path angle and airspeed. The best dive recovery is not necessarily the tightest and best turn, unless the pilot instantaneously has the required G and is established at corner speed (refer to the turn performance paper previously). If there is any delay in G onset, slow airspeed is always better than fast, because the airplane ends up descending at a slower rate and thus loses less altitude. Simply do not bury the nose in the roll-in to the strafe. Leave yourself and out. Stop the roll and then let down to a comfortable altitude.

## Visual Perceptions

This area is probably what has contributed to more fatal low altitude accidents than any other. Visual misperceptions and failure to focus attention may lure an unwary pilot closer to the ground than intended or perceived, he is a prime candidate for a ground kill. All it takes is a moments inattention. Vision is the most important sensory input and yet, in the low altitude arena, cannot be completely trusted. Survival in the low altitude arena depends upon several human factors:

**Attention:** The amount of time the pilot permits away from monitoring his flight path depends upon perceived height above terrain and obstructions. If a pilot perceives himself high he may drop his guard and may become a victim of Canalized Attention.

**Canalized Attention:** Focusing of conscious attention on a limited number of environmental cues to the exclusion of others of a higher or more immediate priority. An example is target fixation in which a pilot is so intent on driving toward a specific airshow reference that he flies into it or loses visual contact with the other members in the trail formation and thus becomes a liability to the formation.

**Distraction:** Interruption of conscious attention to a task by the introduction of a nontask related environmental cue or mental process. Examples of these may be a sloppy rejoin, dropped object in the cockpit, bird near miss, etc.

**Task Saturation: This is the big one!** Demands exceed the attention capacity of the pilot either because of increased demands or lack of experience in the environment. This single anomaly has killed more fighter pilots over the years than anything other than combat! We'll examine some airshow examples later.

Other contributors to low altitude survival are **judgment** and **experience**.

**Judgment:** It should be noted that man is basically a poor monitor. He does not pay attention well. He gets distracted easily and tends to fixate excessively. A pilot may take pride in his mastery of these faults, but he must also be aware of how fragile that mastery may be. Judgment therefore is the mechanism that must control these faults. Judgment is the mental attribute of common sense based on a healthy survival instinct that keeps pilots from doing the dumb things that have a high potential for injury or death. Good judgment is the capacity to think through a situation, determine what's important and make accurate timely decisions. **Good judgment is always having an out and never letting pride get in the way of what is safe even if embarrassment is the end result. Embarrassment in the fighter arena is for fools. Do what is safe and honor your capabilities. If you do not feel comfortable with the game, do not play. Risking your life or the life of a teammate cannot be accepted.** Judgment therefore, should not be confused with ultra-cautiousness or timidity; this is where the fine line is drawn. You must be comfortable and competent in the low altitude airshow arena.

**Experience:** The more you fly in this arena the more comfortable you will become. Realize the inexperienced pilot is just as responsible for his performance as the experienced pilot, but may have to work harder at it. It's all our responsibility to nurture and critique the inexperienced fighter pilot. Tidbits you offer may save his life.

Now lets examine a real world scenario and talk about some priorities and responsibilities. We are flying in a 6 ship fighter trail formation strafe fire-power demonstration. Everyone in this formation is responsible for a multitude of details. First and foremost, do not hit the ground. We accomplish this task armed with all the information we have just discussed. Then being aware of the attention anomalies we have other tasks. We absolutely must maintain sight of the fighter in front of us and also the lead fighter. That's situational awareness. We must maintain spacing as briefed either by geometry using cutoff or the vertical. And finally we must use judgment: each of us know our individual capabilities. If we lose our ability to master the tasks we discussed we absolutely must confess and remove ourselves from the flight. The smart fighter pilot will disengage and live to fight another day. These items may include loss of sight of the other members of the formation or the onset of task saturation in the low altitude airshow environment, If these things happen, announce your situation to lead and pitch out of the flight. Don't stay and hope for the best. The results could be tragic.

I could write for pages on the importance of what we have just discussed. It all boils down to professionalism and a heightened attention for all the "gotchas" involved in the low altitude environment. I spent most of my Air Force career in this arena. It is challenging, demanding and totally unforgiving. I hope some of this may help you the next time you find yourself hurling and the ground at close to 300 knots.

The airshow season is winding down for the season and I hope everyone has had a safe one. To those dear friends we've all lost this year, our world is a lesser place. They will be deeply missed!

Check Six,

A handwritten signature in black ink, appearing to read 'BC Hood', written in a cursive style.

Bradley C. Hood  
Fighter Formation Qualification Program