



Air Combat

## How to Live and Die in the Virtual Sky

F-16 pilot

by Dan "Crash" Crenshaw

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As Air Combat simulations become more advanced, artificial intelligence improves, flight modeling and flight dynamics become more realistic, the need for real world fighter maneuvers becomes more necessary. Unfortunately, there is a void for the flight simulation enthusiast when it comes to this type of information. There are a few very good books that can help you learn some of this information, unfortunately they are out of print, difficult to find, or difficult to read and understand.

"How to Live and Die in the Virtual Sky" is intended to fill this void. Many years of flight simulation experience, testing of several air combat simulations, and a great deal of research has been compiled here to teach the basics of BFM or Basic Fighter Maneuvers. The only way to understand these lessons will be to practice them. These lessons will center primarily on JET air combat. Many of the maneuvers will apply equally as well to propeller driven aircraft. The fundamentals will apply to both.

This information applies to both computer run opponents as well as Human opponents. Many recent simulations have very good AI (Artificial Intelligence) and can actually perform very close to how a textbook flying human would react. However, when fighting against a human opponent, the element of surprise is highly likely. Human opponents will execute maneuvers and try tricks at all costs in an effort to survive. You must stay on your toes when fighting a human.

I would like to point out, I personally believe that all flightsims should be flown from inside the cockpit, and not outside views. I will grudgingly concede that for TRAINING purposes, outside views will help you understand what the aircraft is doing. But once you have learned the basics, you should practice from the pilots eye view. Many sims are coming out that will allow you to lock out the outside views in a competition, and many competitions have this rule. So I highly recommend you to work at getting these maneuvers down while in the hot seat. There are currently 8 lessons, 2 to be released each week.

Menu:

- \* Chapter One: Basics of Flight Dynamics
- \* Chapter Two: Fundamentals of BFM
- \* Chapter Three: Offensive BFM
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- \* Chapter Five: Head On BFM
- \* Chapter Six: Beyond Visual Range Fight

Questions about these lessons may be sent to CRASH. I intend to publish this information in book form which will also include several appendices which will include a glossary of terminology, brevity code, Air to Air weapons specifications and more. If you would be interested in this book, please e-mail me at [crash@deltahawks.org](mailto:crash@deltahawks.org). All of this material is copyrighted by the author and may not be reproduced or reposted, in it's entirety or in part, in any form without the express written permission of the author. This article was originally published at the Combat Simulations site.

# CHAPTER 1: Basics of Flight Dynamics

Before we can begin to understand Basic Fighter Maneuvers, we need to understand a few basics of flight. Most modern flight simulations are doing a decent job of modeling the different variables that help or hinder the practice of flight.

There are four forces that effect flight; two that help and two that fight against you. Thrust and Lift are essential for flight, but are forced to overcome Drag and Weight.

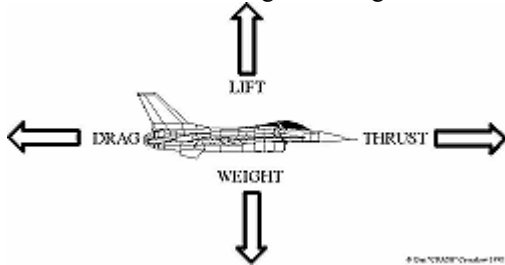


Figure 1-1

## Thrust

Thrust is the force that causes an aircraft to move through the air. This can be produced by anything from a jet engine to a rocket motor to a propeller pulling your aircraft through the air. The measurement of thrust is usually in pounds or newtons. It would seem pretty obvious that the more thrust an aircraft engine produces, the faster an aircraft can travel. The faster an aircraft can travel, the faster the air can be moved across the wings, and thus the more lift that can be generated.

The power of fighter aircraft engines are expressed in a thrust to weight ratio. The ratio compares the thrust of the engine to the weight of the aircraft. The higher the ratio, the more powerful the aircraft. Most combat aircraft have had between 0.7 to 0.9 thrust to weight ratio. The F-15 and F-16 fighter models actually have a thrust to weight ratio of greater than 1.0 which allows them to climb vertically. The Soviet built twin engine MIG-29, with no weapons has a greater than 1.0 thrust to weight ratio ... with one engine turned off.

## Lift

We briefly touched on lift. Lift is the force generated by air moving across the surface of the wing. To be more precise, it is the force generated by the unbalanced movement of air across the top as opposed to across the bottom of the wing. Due to the curvature of the top of the wing being greater than the curvature of the bottom of the wing, air flowing across the top of the wing must move faster, to cover the greater distance, if it is to meet the air moving across the bottom of the wing at the trailing edge of the wing at the same time.

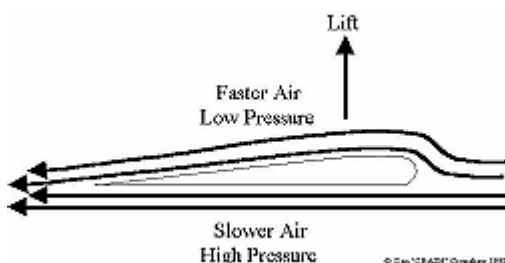


Figure 1-2

The principal at work is known as Bernoulli's Law. Bernoulli, an 18th century Italian scientist, discovered that the faster a gas travels, the lower it's pressure. So if the air moving over the wing is moving faster than the air moving under the wing, there is more pressure below than above. This allows the higher pressure below the wing to "push" up and "lift" the wing.

The faster the aircraft travels, the faster the airflow across the wing. The faster the airflow over the wing, the more pressure differential there is between the top and bottom of the wing. A simplified example: if the pressure at 100 knots is 95 PSI on the top of the wing and 100 PSI on the bottom, there is a 5 PSI pressure differential.

At 200 knots, the pressure would be 200 over 190, for 10 PSI differential, or twice the lifting force. It should be noted that there are those that claim the Bernoulli theory is incorrect and that Newtonian theorems should be used. I have used the current most accepted explanation of Lift.

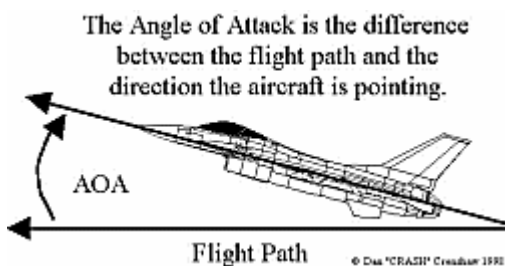


Figure 1-3

We also must take into account the AOA, or Angle of Attack, of the wing. Initially the amount of lift increases with the AOA. But there comes a point when the AOA is too high for the air to flow over the wing. Without airflow, there is no pressure differential. With no pressure differential, there is no lift. When this happens, the aircraft stalls. While AOA can cause a stall, flying too slow can cause a stall as well. When you fly slowly, you decrease the amount of airflow over the wings, which in turn decreases lift. When your lift drops too low to keep

the aircraft aloft, you stall.

## Drag

Drag is the opposite of thrust. Drag is the force that slows the aircraft down. Drag is basically friction, the resistance of the air against the structure of the aircraft. This may be a bit difficult to understand. If you put your hand out the window of a moving car, the wind pushes against it and tries to push it back. This is drag.

Aircraft designers try to eliminate as many drag inducing features as possible. Bumps, rivet heads, paint, antennae, bombs, missiles, drop tanks, even control surfaces (rudders, canards, etc.) all cause drag. The smoother an aircraft's surface is, the less drag will be induced. But you can never completely eliminate drag.

It is very interesting to note the Soviet design concept. The Soviets make the front of the aircraft as aerodynamic, thus less drag inducing, as possible. Nose, wing leading edges, anything that comes into contact with the air first is made as smooth and flawless as possible. The areas behind these parts of the aircraft are not considered as critical. By this time the air is "dirty", or is in a somewhat turbulent state, since the front of the aircraft has already pushed through and disturbed the airflow. Because of this, they feel there is not much purpose to spending the time or money to make these surfaces smooth. The Western countries do not follow this same train of thought and make the entire aircraft as smooth as possible.

## **Weight**

Weight is the opposite of lift. Weight is the effect of the gravitational pull of the earth on the aircraft. We can always add more thrust, or create a more efficient wing, or even reduce drag as far as possible, but we can do nothing to counteract gravity. Gravity will always win in the end (unless you hop on the Space Shuttle and blast yourself out of the reach of the gravitational pull of the earth ... but then, that would not be flying anymore). If thrust or lift become too low, or drag becomes too high, weight and gravity will persevere.

Now that you have a basic understanding of what actually holds your aircraft in the air, we can start learning Basic Fighter Maneuvers. I am sure you have figured out by now that holes in your wing reduce lift and increase drag. So let's learn how to avoid getting hit while making sure you cause some flight dynamics problems for your opponent.

## CHAPTER 2: Fundamentals of BFM (Basic Fighter Maneuvers)

While the basic fundamentals and geometry of BFM are not very exciting to read or learn, it is critical to understand these basics. Without knowledge and understanding of these very basic concepts, the remainder of these lessons will seem like so much jibberish.

### Positional Geometry

"Angle Off", "Range", and "Aspect Angle" are the common terms used when describing the relative positions as well as the advantage or disadvantage of one aircraft vs. another.

#### Angle Off:

Angle Off is the difference between your heading and that of the bandit. This difference is measured in Degrees. If you and your bandit are heading in the same direction, you would be at an Angle Off of  $0^\circ$ . At  $90^\circ$  angle off, you would be perpendicular to the bandit (see Figure 2-1 for details). Angle Off is also known as HCA (Heading Crossing Angle). This is the basic, root form of other, more specific geometry's (Angle Off Tail - AOT, and Angle Off Nose - AON).

Figure 2-1

#### Range:

"Range" is simply the distance between your aircraft and the Bandit. This can be displayed in feet or miles. Most modern western military aircraft HUD systems (Heads Up Display) read in nautical miles and tenths of miles unless you are less than one mile from the target, then the display will read in feet. Some European/Soviet aircraft use the Metric system in a similar fashion. A nautical mile is 6000 feet. A bandit at a 3000 foot range would display as "3000", a bandit at a 6000 foot range would display as "1" mile, a bandit at a 9000 foot range would display "1.5" miles.

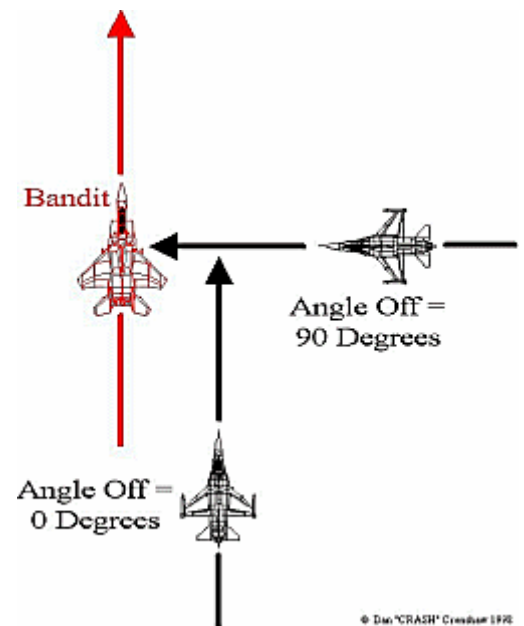


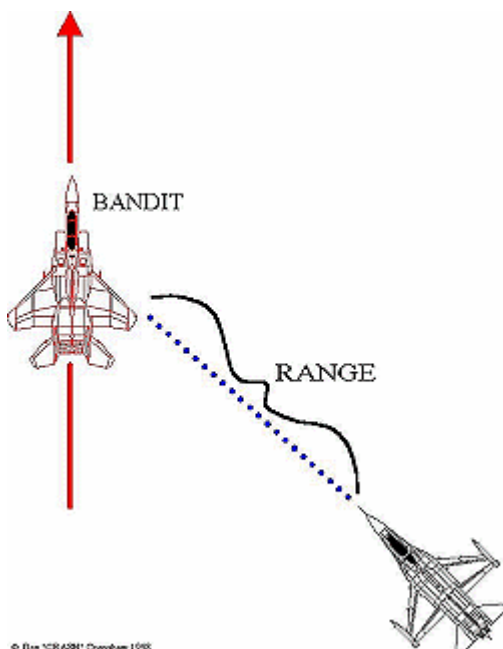
Figure 2-2

#### Aspect Angle:

Aspect Angle is the number of degrees, measured from the tail of the bandit, to your aircraft. Aspect Angle indicates your relative position to the bandits 6 o'clock position. Aspect Angle has absolutely NOTHING to do with the heading of your aircraft. Your aspect angle will remain the same regardless of your Angle Off. Aspect angle is determined from the tail of the opposing aircraft. The tail, 6 o'clock position, is  $0^\circ$ . The nose of the Bandit is  $180^\circ$ . If you are on the right side of the bandit, that is right aspect. If you are on the left side, this is left aspect.

Figure 2-3

In figure 2-3 the two F-16's in the lower right corner are both at 45 Right Aspect. The two F-16's in the upper left are at 135 Left Aspect.

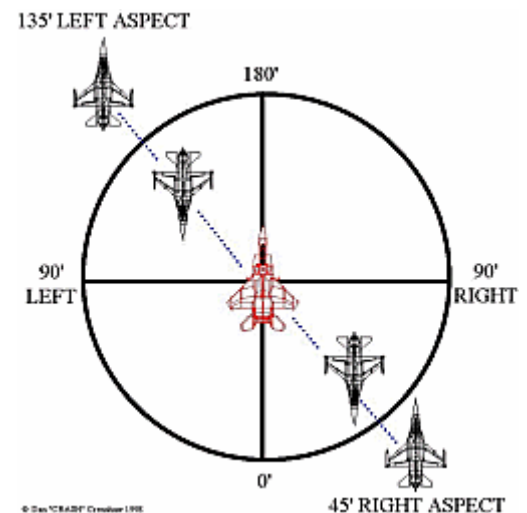


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Aspect Angle is very important in assisting in determining your position from the bandit. By using Aspect Angle and Range, you can determine the "lateral displacement", or turning room available.

### ATTACK GEOMETRY

Attack Geometry describes your Offensive aircraft's flight path to its target. Very simply, if you are pointing behind your target aircraft, you are in "Lag Pursuit". If you are "Nose On" the target, you are in "Pure Pursuit". And if your nose is pointing in front of the target, you are in "Lead Pursuit".



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## Lag Pursuit:

Lag Pursuit is primarily used for approaching the target. It can also be used when a bandit pulls out of plane; that is, when the bandit pulls out of the same plane of flight, or motion, as the attacking aircraft (See Figure 2-4). To fly Lag Pursuit for any extended length of time, you must be able to out turn the target. In a 1V1 fight with like aircraft, you would not want to maintain a Lag Pursuit for very long. You must be able to out turn the target in order to pull your nose out of lag to shoot guns or a missile. If the target is able to out turn you, or at least match your turn rate, he will be able to keep you in lag and prevent you from getting a shot.

## Pure Pursuit:

Pure Pursuit is exactly what it sounds like. You keep your nose on the target and fly straight at him. A Pure Pursuit path all the way to the bandit will lead to an overshoot. This is reason enough not to fly in Pure Pursuit and put your nose on the target until you are ready to shoot him. Use Pure Pursuit for missile shots.

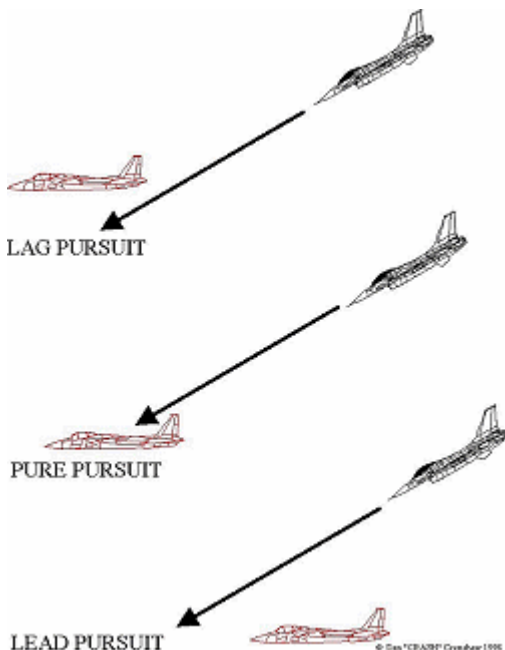


Figure 2-4

## Lead Pursuit:

Lead Pursuit is the "short cut" to the target. You fly Lead Pursuit to close on the target and get into weapons parameters. This is also the most commonly used pursuit for Guns shots. You must be careful not too establish Lead Pursuit too early or you will overshoot the bandit when you get in close, unless you have a much higher turn rate than the bandit. When flying against an aircraft with similar abilities (F-16 vs. MIG-29 etc.), you will not be able to maintain a Lead Pursuit for very long, and may be forced into an overshoot situation. It is critical to pick when you go into Lead Pursuit to close the gap to set up in Guns parameters.

I have been forced to go Lag to Lead to Lag to Lead, several times over in some dogfights. This is not desirable. You want to pull your nose on the bandit and shoot him, get it over and done with. This sort of maneuvering also bleeds speed at a higher rate, which is just not a good idea. If you find yourself very evenly matched, you may have no choice but to "dance" for a while to line up a good kill shot.

## Determining the Pursuit Course:

There are two positions that the bandit can be in, "In Plane" and "Out of Plane". Figure 2-5 shows both "In Plane" and "Out of Plane" examples.

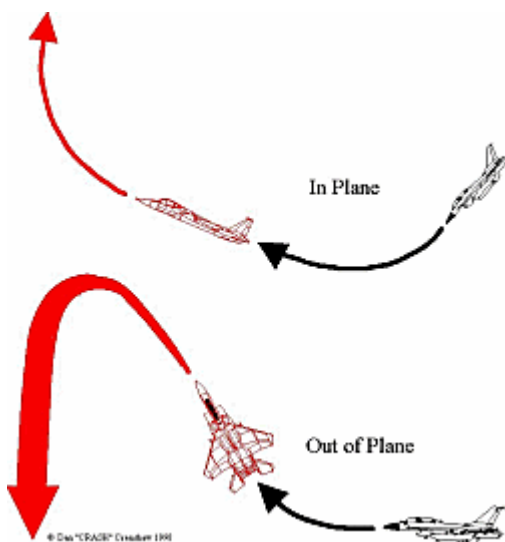
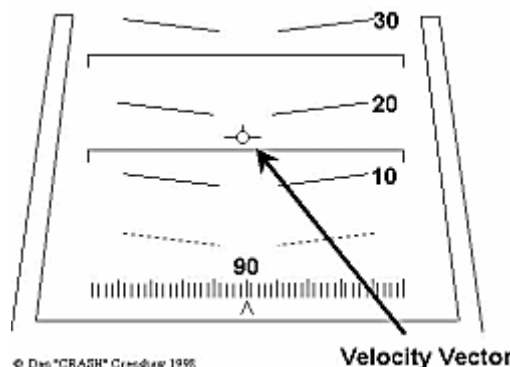


Figure 2-5

"In Plane" is where the attacker and the defender are both in the same plane of motion. If the bandit is "In Plane" with your aircraft, the HUD Velocity Vector will determine the pursuit course you are taking. See figure 2-6 for an example of a Flight Path Marker in a HUD displaying Velocity Vector.

Figure 2-6

The Velocity Vector is the direction your aircraft is traveling. For the sake of explanation, this can be determined by the nose of the aircraft. It represents the direction of travel of your aircraft. The Flight Path Marker on your HUD will indicate your Velocity



Vector. If the defender and attacker are not in the same plane of motion, then you are "Out of Plane". To determine the pursuit course during "Out of Plane" maneuvers, use your "Lift Vector". Figure 2-7 demonstrates "Lift Vector".

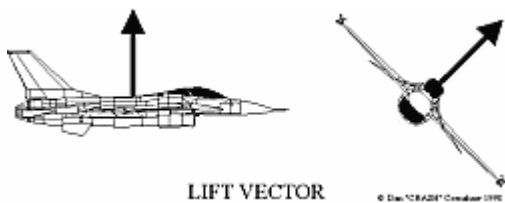


Figure 2-7

"Lift Vector" is simply a vector pointing out of the top of the aircraft. This is the direction the aircraft moves at high G's. You position your Lift Vector by rolling the jet so that the Lift Vector points in the direction you want to go. The nose of the aircraft will track towards the Lift Vector.

When an attacker pulls "Out Of Plane", he is technically flying "Lag Pursuit". As he pulls back into the bandit, he may be flying Lead, Pure or Lag pursuit, depending on the maneuver. Remember, when you are attacking, where you position the nose of your aircraft is VERY important.

## The Weapons Envelope:

The Weapons Envelope is often overlooked as a fundamental and listed in other areas of BFM instruction. But if you do not know and understand the Weapons Envelope and how it affects your choice of maneuvers, you will not be able to make good choices for the next move you should make.

The Weapons Envelope is the area in which a particular weapon is effective. It takes into account the weapons maximum and minimum range, weapons capabilities, Aspect Angle, Speed, Angle Off, Relative Headings ... what I am I missing? Basically, the Weapons Envelope is determined by every possible variable imaginable.

The basic shape of a Weapons Envelope is that of an egg shaped doughnut that you impose over the BANDIT. See Figure 2-8.

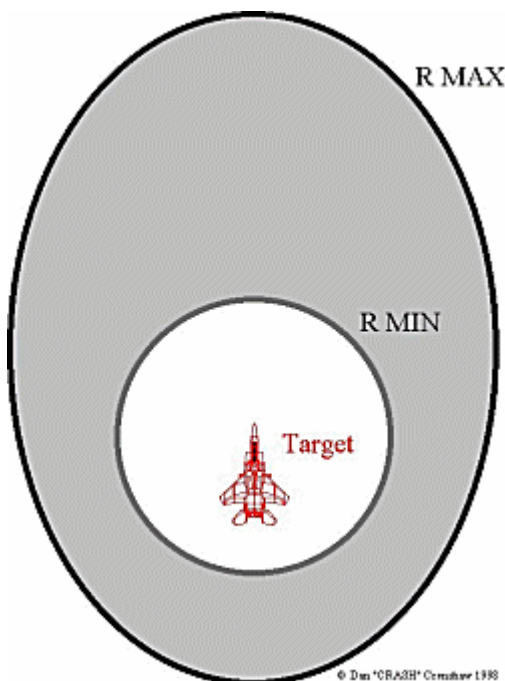


Figure 2-8

RMAX is the maximum effective range and RMIN is the minimum effective range of a particular weapon. Figure 2-8 is an example of a weapons envelope of an All Aspect missile. A Rear Aspect missile would not have the front lobe of the "egg". As you can see, the effective operating range to the front of the bandit is much larger than the rear area. Obviously, if you are shooting the bandit in the face, he is moving towards you as your weapon moves towards him ... he is doing half the work for you. While a rear aspect shot forces the weapon to "chase down" the target. If you shoot too soon, the missile will burn out it's motor before even coming close to the target Remember this when we get to Chapter 4: Defensive BFM.

Figure 2-8 is a "perfect world" example of a Weapons Envelope, the bandit flying straight and level. The shape of the Weapons Envelope will change as the target starts to maneuver and pull G's. The Weapons Envelope will deform and may grow in one area while almost completely disappearing in another. It should go without saying, the target will attempt to put the less effective portion of the Weapons Envelope towards you. Remember this as well for the Defensive BFM chapter, what works for them will work for you too.

Most missiles will have similar Weapons Envelopes, RMIN and RMAX figures being the primary difference. As I said before, Rear Aspect Only missiles would not have the forward portion of this diagram. Guns are the other exception. You are close enough to minimize the effect of the bandits movement for RMAX range, so the "egg" becomes more rounded. There is no minimum range on a bullet. You can have your nose half way up the targets tailpipe and still shoot guns. The problem here is that you may end up killing yourself as pieces of your opponent start coming off and smacking your aircraft. Most recently released sims as well as some on the way have begun to model this aspect of air combat. So beware just how close you get before you take the shot.



## CHAPTER 3: OFFENSIVE BFM

This is the lesson that most of you really want and think will give you the edge. I should have made this the last lesson to keep you from stopping your training here ... too early. But, in order to understand the defensive maneuvers that we will discuss next lesson, you need to know what the offensive maneuvers look like first.

Offensive BFM is, in a nutshell, what you need to do to kill your opponent. You need to keep your maneuvers smooth and graceful. Sudden jerks, quick directional changes, and basic rough handling of the aircraft will cause loss of energy, speed and attitude (both of the aircraft and your mental attitude when all your fancy moves makes you a wallowing, low speed pig, ripe for the kill by your opponent).

The basic objective of Offensive BFM is to put you in control of the fight, and in position for the killing shot. If your opponent has no idea that you are there and maintains a straight and level flight path, no BFM is needed. You just drive up behind the bandit and shoot him. Offensive BFM is needed when the bandit is aware of you as a threat and attempts to maneuver away from you.

Once your opponent has begun Defensive BFM maneuvers, you need to employ Offensive BFM maneuvers. To maintain control of the encounter, you must maintain a position in the "6 o'clock" area of the bandit. This is the position where you will get the most effective, likely and controlled shot. This is also known as "flying to the elbow".

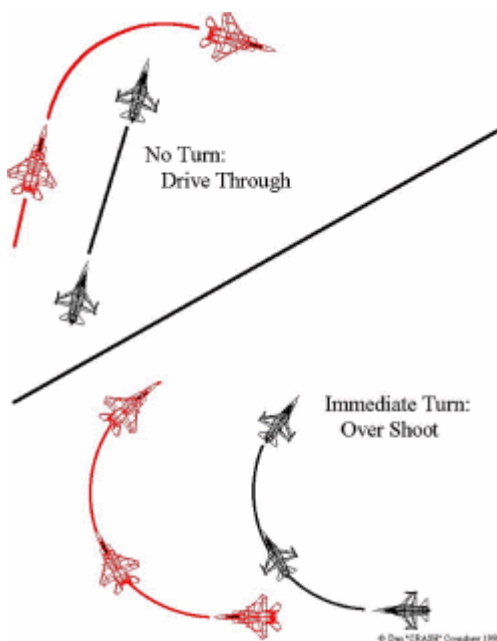


Figure 3-1

Figure 3-1 shows two different scenarios of not using Offensive BFM once a bandit starts to break. If you do nothing, you will drive straight ahead, lose the Angle advantage and will most likely put you at the disadvantage in a hurry. If you turn immediately with the bandit, you will probably end up in front of the bandit and at an obvious disadvantage.

What we need here is a hybrid of these two maneuvers to resolve the Angle Problem created by the bandit's turn. We need to decide how and when to turn based on what the bandit is doing.

### Turns

One of the most encompassing and important parts of BFM, of any type, is the turn. To be able to develop competency and skill in BFM, you must understand some basic concepts of turns. We will discuss positional energy, turn radius and rate, corner velocity, and turns in the vertical.

### Energy:

There are two types of energy in air combat maneuvering: kinetic and potential. Kinetic energy is directly related to the speed or velocity that the aircraft is traveling. Potential energy is "stored" energy available for use. This does not mean stored like in batteries. Potential energy is directly proportional to the altitude of the aircraft. At high altitude, the aircraft has a HIGH potential energy, while at low altitude, the potential energy is LOW.

The easiest way to explain this is to visualize a jet at 30,000 feet. This pilot has the option to put the jet into a dive, thus increasing his airspeed. The higher he is flying, the more speed he can generate in a dive. An aircraft at low altitude of 5,000 feet has much less room to increase speed in a dive.

Always remember: you can trade altitude (potential energy) for speed. Likewise you can trade speed for potential energy. If you have one, you have the ability to have the other when you want or need it.

You can also trade energy for nose position. As I mentioned in lesson one, maneuvering costs energy, and any "dancing" you do will cause your aircraft to slow down and lose energy. The higher the G pull in a maneuver, the more "costly" to your energy level it is. The only consolation to this is that the bandit is working under the same laws of physics and has the same problems to overcome.

### Turn Radius and Rate:

Turn radius and rate are the two primary characteristics of turns. Radius is just the "tightness" of the turn circle. If you were to look down from a Gods Eye View (see Figure 3-2), the radius is the distance from the center of the turn to the turn circle, or plane, of your aircraft in feet. While the actual math for calculation of turn radius is not important ( $TR = V^2/gG$  where TR is Turn Radius,  $V^2$  is Velocity squared,  $g$  is gravity and  $G$  is G force. Got that?), it is critical to understand that Turn Radius increases exponentially with velocity, or speed. A 500 knot turn at 9 G's will not be twice the size of a 250 knot turn at 9 G's, but roughly 4 times the size.

Just remember that airspeed has a much greater effect on turn radius than does G force effect.

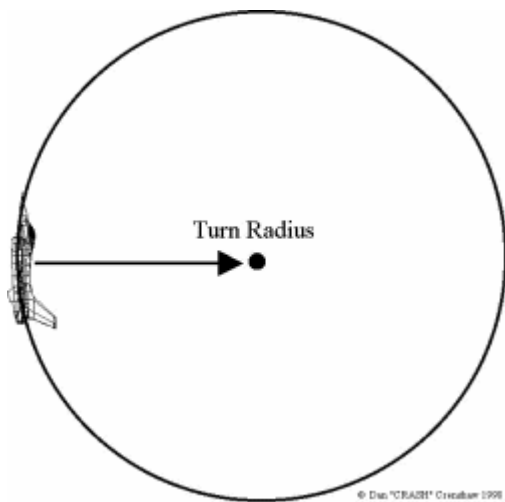


Figure 3-2

Turn Rate is how fast your aircraft can get around the Turn Radius. It also indicates the speed of which you can change the nose position of the aircraft. Turn rate is dependant upon G's and Velocity (Turn rate =  $KG/V$ , where K is a constant and G and V are the same as in the turn radius calculation. The constant is based upon several factors including altitude, humidity, temperature etc.). Turn rate is measured in degrees per second.

To really over simplify this, if the velocity remains constant the higher the G's the faster the turn rate. And inversely, if the G's remains at a constant, the lower the velocity, the faster the turn rate.

### **CORNER VELOCITY:**

Corner Velocity is the airspeed at which your aircraft has the fastest turn rate and tightest Turn Radius. This is not the slowest you can fly while pulling back on the stick as hard as you can. You can not pull higher G's at slower speeds. Less lift is available, therefore there is less force available to work with.

Also, at high air speeds, you are unable to pull high G's. So somewhere in between really fast and really slow is your Corner Velocity. In most modern jet fighters simulated, this is between 400 to 500 KCAS (knots, computer airspeed). There are exceptions of course: EF2000 has a corner velocity of about 350 KCAS. If there is no documented speed in the manual, you will need to play with the handling to figure it out. It also needs to be noted that altitude can affect this figure as well.

There are 4 basic means by which you can adjust your airspeed, up or down, to reach Corner Velocity.

### **Throttle position:**

Pretty simply here, more throttle to increase your speed, less throttle to slow down.

### **Drag Devices:**

So you are going too fast and chopping the throttle won't slow you down fast enough to get to Corner Velocity as soon as you need to. Your main device here is your speed brake. You can also use flaps and as a last resort (not recommended), you could use your landing gear. Be careful with this last one. Many simulations are modeling gear damage due to lowering at excessive speed. You may end up with your gear in a permanently down and damaged position, making maneuvering, and ultimately landing, rather difficult.

### **Nose Position:**

Nose Position refers to the nose of your aircraft in relationship to the ground. Point down and you can increase your speed, point up, and you bleed off speed.

### **Aircraft G's:**

The higher G force you exert on the aircraft, the faster you will bleed off energy (speed).

These methods can be used singularly or combined, depending on how much speed you need to increase or decrease. I have often found myself with a chopped throttle, speed brakes out, pulling into a high G slow banking climb in an effort to slow down in a hurry.

Point to remember: your first turn is the most important turn in the fight. Blow it and allow the bandit on your 6, the fight could end very fast and with an outcome you would rather not talk about. Use all your tools to achieve corner velocity, and you could be on the bandits 6, in control of the fight, and in a very good position to add a tally to your kill sheet.

"Rate Kills" is a common fighter saying. Simply put, a fighter with a higher turn rate can out maneuver a fighter with a tighter Turn Radius. The ability to put your nose on the bandit to allow a shot is more important than being able to fly in a tighter circle. Get to your Corner Velocity, pull your nose on him, shoot him ... the party is over, you win. You no longer have to worry about him.



## VERTICAL TURNS:

There are two key factors for you to consider in a dogfight; the bandit and the ground. Both can kill you. However, the ground can also help you. The gravitational pull of the earth can actually allow you to pull a faster turn rate and tighter Turn Radius than a turn that has you parallel to the ground.

The earth's gravitational pull causes the actual G force to be different from the G meter reading in your HUD. This is also known as Cockpit G OR "Gods G". The actual G force affecting the fighter is known as "Radial" G's. Figure 3-3 shows an example of Radial G force vs. Cockpit G force.

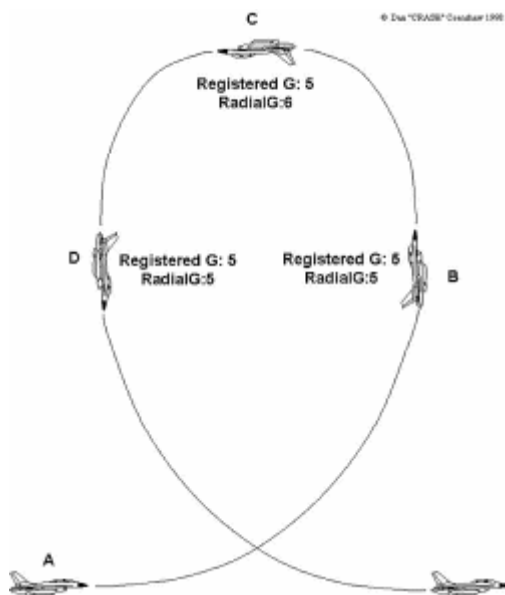


Figure 3-3

At point A, the fighter begins a high G vertical turn. The HUD is reading 5 G's. At point B, in the pure vertical, the HUD and actual G force are the same. HUD G registry is the actual G force applied if you are in a full vertical climb or dive. Gravity has no affect on Cockpit G in this position.

At this point, your Lift Vector is parallel with the ground. The less parallel the Lift Vector is with the ground, the more effect G force will have on your maneuver, up to a maximum of 1 G. If the Lift Vector is pointing up, you would subtract the G force from your HUD reading. If the Lift vector is pointing towards the ground, you would add to the G force registered. Radial G is merely the effect of gravity on cockpit G. At Point C, completely inverted, the HUD reads 5 G's, but Radial G's are actually 6 G's. As the jet continues down the backside of the vertical turn, at point D, the G force and actual G force is identical again at 5 G's.

Radial G describes the effect of the gravitational pull of the earth on the aircraft, which could be positive or negative, depending on the attitude, position and maneuver of the aircraft. Radial G is also the determining force for Turn Rate. Each Radial G could be worth up to 4° of Turn Rate per second!

## CHAPTER 3: OFFENSIVE BFM, Part 2

Figure 3-4 shows the difference in Turn Radius with all factors being equal (speed, Cockpit G, etc) except the direction of the vertical turn. It should also be noted that aircraft in the downhill turn has a higher Turn Rate as well.

Figure 3-4

### TURN CIRCLE

Turn Circle has two basic definitions: "The path a fighter flies through the sky when it turns" and "The area you must position yourself for Offensive BFM to be effective."

When a bandit starts to evade and turns, he creates a Turn Circle. To effectively attack him without becoming the prey yourself, you must get "inside" his Turn Circle. The reason for this is, if you begin your attack outside this circle, the bandit has enough "Turning Room" (Turning Room is the offset and distance between you and the bandit) to get back around on you and possibly take control of the fight. Turning Room can be Vertical, Horizontal or a combination of the two.

Starting Offensive BFM maneuvers outside of the Turning Circle allows the bandit to continue his turn and cut off any Turning Room you may have been able to get. The up side to this is that you probably have more energy than the bandit. The down side is now you are in a turning fight. Going Vertical while outside the Turning Circle to acquire Turning Room will usually put you into a very compromising position and should be avoided.

Any maneuvers you make outside of the Turn Circle will delay you from entering the Turn Circle. You want to get into the Turn Circle as fast as possible with no delay.

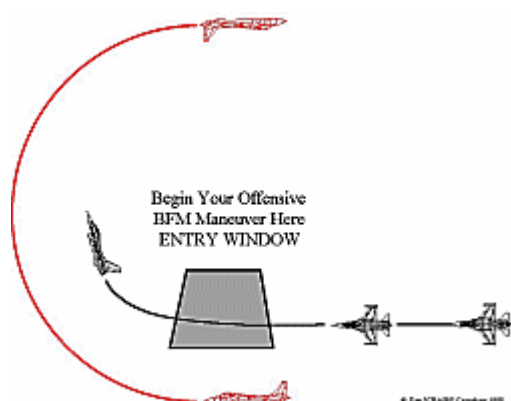
How do you know when you are in or out of the Turn Circle? To make your decisions on when to turn and what type of turn to do, you really need to know this. Watch the bandits turn rate. Will it allow him to turn fast enough to put his nose on you? If so, you are outside the Turn Circle. This will lead to a Head On BFM situation which we will cover in detail in Chapter 5. If he can not get his nose around and point it at you, you are inside the Turn Circle. You must watch your opponent and compensate for his maneuvers. Based on the jetfighters modeled today in simulations, 2nm is a decent rule of thumb for range to the bandit for estimating basic Turn Circle.

### GOING OFFENSIVE

The entire reason we are doing this is to get the bandit into your "Kill Zone" and end the fight as fast as possible. The longer the fight goes on, the better the odds are that the bandit will get into a position to take a shot at you.

**CRASH'S RULE NUMBER 1:** If you have a shot take it NOW! Do not wait for a better chance, or until you can get close enough to use guns instead of missiles. To die with a full wing of missiles because you thought, "I might need them later in the mission" is, well ... it is just "plane" silly.

As you approach the rear of a bandit, you have a very short period of time before his Defensive BFM will put your missiles out of parameters. As soon as you have a shot, TAKE IT! The harder the defending target turns, the less time you will have before you are forced into a decision on your next move ... and then it may be too late.



So, your missile shot has missed (or you missed the chance before the bandit saw you). You pull into an attacking rear aspect position. The bandit sees you and starts Defensive BFM ... your move. At this point, you are committing the next stage of the fight to guns (or a rear quarter HEATER shot if you're lucky). When do you start your turn to maintain your advantage – to "Stay in Control" of the fight? The point you want to begin your turn will be approximately the same place the bandit started his: this is known as the "Entry Window". This window will be to the inside of the bandits turn circle (remember you do not want to start an Offensive BFM maneuver outside of the bandits turn circle). Figure 3-5 shows the Entry Window. Once you enter the window, begin your high G pull into the bandit.

Figure 3-5

Other ways to estimate the Entry Window would be Chaff and Flare possibly dropped by the bandit as he started his turn, or when the bandit is about 30° off of your nose. Or maybe a bit of debris from your near miss missile shot. Watch for any signs that may help you, but do not focus on where you should turn at the expense of not paying attention to what the bandit is doing.

Next consideration as you approach the Entry Window is Corner Velocity. You want to be at Corner Velocity. If you enter too fast or too slow, you will be forced into a Lag Pursuit where you will probably not be able to pull your nose into Lead Pursuit for a gun shot. You must be at your best turn rate, which is Corner Velocity, to have the control and the option to pull your nose around fast enough to take a shot when you want to.

O'okay, are you still with me? You have determined the Entry Window, and you have gotten to it at Corner Velocity ... everything is going great so far. Now you want to pull your high G turn into the bandit. The idea now is to keep in Lag Pursuit (by choice) until you have pulled into guns range, somewhere between 2,000 and 3,000 feet. If you find yourself creeping up on Pure Pursuit, back off the stick a little and maintain Lag Pursuit ... and watch your speed during this period so you do not bleed off or pick up too much speed so you keep at Corner Velocity. Once you are in guns range, you must maintain your overtake speed with the throttle. When you take the guns shot, you want to be as close to the same speed as possible. As soon as you go to Lead or Pure Pursuit, the throttle is the key to not over shooting the bandit. You will work the throttle back and forth a lot during this time.

(A friend asked me just the other day why all the texture is worn off my TQS throttle in the palm area ... I mean this baby shines. I like to fly in close BFM and usually close to the ground as well which adds a whole new dimension to the arena). You may have the throttle from full idle to full burner during this section and everywhere else in between. You may even need to pull "out of plane", into a High or Low Yo-Yo type maneuver, to keep your position. (These maneuvers will be described in detail in Chapter 8: ACM). Figure 3-6 shows a High Yo-Yo maneuver. In the case in this picture, the F-16 is using a High Yo-Yo to bleed speed to keep behind the F-15.

Figure 3-6

You've worked it, you've jockeyed, you have gotten yourself lined up to take a guns shot. There are 3 things that you must now do to get a successful shot.

1. Be in range. Rear (Low) Aspect shots should be taken no more than 2500 to 3000 feet away. Front (High) Aspect shots may be as far as 4000 feet out.

2. You must be in Lead Pursuit when you pull the trigger. Bullets are unguided projectiles. Most gun shots TOF (Time of Flight) is .5 to 1.5 seconds. You must compensate for this by pulling a Lead Pursuit. This is not STAR WARS, these aren't lasers ... they will not fly straight. If you put your nose on the bandit, your shots will pass behind him. Note that the closer you are, the less pronounced the Lead Pursuit will be.

3. You must be in the same plane of motion as the target. Before anyone tells me you can pull a little high and have your bullets drop due to gravity; If this works, you are taking your shot way too far away (and if you consistently hit like this, you have one heck of an eye!). Lets just make it simple: Be in the same plane of motion when you take your shot.

There is one more thing that is critical for survival during this phase. Think about what you are going to do if you carve off a piece of his wing, tail, etc., and it comes flipping towards your plane (actually, you will be hurtling yourself towards it much faster). If you get too close, this could kill you (most new sims are modeling this now. It has changed the way many computer jocks fly and makes real BFM that much more important).

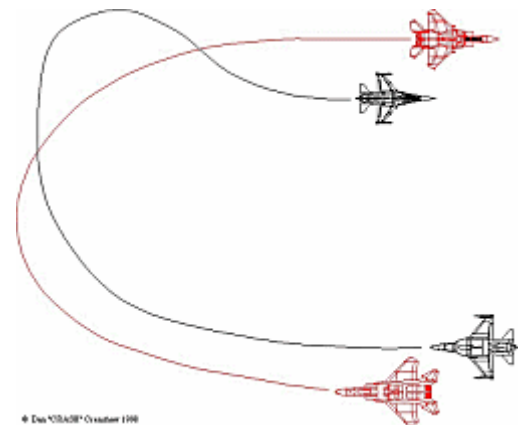
## **LINING UP YOUR SHOT**

How do I know when my target is in my sights? This is going to change from sim to sim and from plane to plane. These days, most sims come with a pretty good section on how to line up your target in the modeled gunsight. I could do a few lessons just on this, so I will defer this to the individual manuals. I will however give you a look at a few variations of gunsights in current sims. The Gun Snake from the EF2000 family of sims by DiD. The bullets will follow the line, "snake" to impact at the circled end of the snake. The circle on the end will creep around to the right as you close in range.

The gun pippet in GSC's F/A-18 HORENT KOREA. Similar in idea to the gun snake in EF2000, but without the snake. The circle will count down range. Also, this one will give you a shoot designation when you are in parameters (and is pretty accurate too.). SSI's SU-27 and the tried and true Gun Funnel. Basically, if the funnel's lines both touch a wing, you should hit the target (very basic and simplistic explanation). For anyone looking for a sim to practice your "close in" combat skills, this is a really good choice. Never mind the graphics, it does everything else very well.

For equal time, since we shot down an F-15 in SU-27, here is the gun funnel depicted in JANES latest release, F-15E. This is probably one of the smoothest working funnels I have seen. This includes little range markers as well.

One of the several gun sighting modes in MicroProse's FALCON 4. Works sort of like a gun snake, sort of like a pippet. Not my favorite choice in sights, but I wanted to show you this one. FALCON 4 has a few other sight options including the gun funnel.



## CHAPTER 4: DEFENSIVE BFM

The call comes over the virtual radio, "I've been hit!". You execute a Wingman Padlock only to see "2" rolling into a spiraling dive, flames and smoke belching from the aircraft. You think to yourself, "Where did that come from" as you frantically do a search for bandits ... you spot him. The MIG that just took out "2" is moving into position on your "6" to take his next ATOLL shot ... at you.

Welcome to Defensive BFM. You are in the worst position a fighter pilot can be in ... on the defensive. In Chapter 3 we learned the basic Offensive maneuvers to get into and stay in control long enough to take a "Killing" shot. In this lesson, we will learn what to do to keep the bandit out of the "Kill Zone". If that fails, what to do to avoid getting hit by the "Killing" shot. When you think of Defensive BFM, think of High G, difficult maneuvers that are executed while straining your neck to watch what the bandit behind you is doing. There is no magic move ... no, you can not "Just hit the brakes and he will fly right by" like Tom Cruise did (Unless you are flying the Pre-TACTCOM or Pre-Version 2.0 versions of EF2000 ... then it works like a charm). To avoid getting killed by the bandit, you're going to have to work pretty darn hard. As in Offensive BFM, you want to keep your movements smooth and fluid, no sudden maneuvers.

Keep in mind, if you fly perfect Defensive BFM and the bandit flies perfect Offensive BFM ... "your gonna die". What you want to do is cause BFM problems for the bandit and force him to make a mistake. If he does not, all you can do is make him work for the kill and force him to close to gun parameters, then you must work to defeat his gun shot.

### Detection

Most kills are on a target that had no idea he was about to get hit. Before you can execute Defensive BFM, you need to know there is a threat. There are 3 basic ways to detect a threat.



#### RADAR:

RADAR is probably the best way for detection. It has good range (usually 60 or more miles), allows you to lock weapons onto your target, can allow you to track his movements ... pretty much, if you get a bandit on RADAR, you can keep him there and know what he is doing.

The problem is, RADAR is limited in scan area. You can not always pick up a bandit and you have a rather large blind area to deal with. You may need to use one of the other resources to get a general bearing on the bandit in order to use RADAR. You can also do frequent "sweeps" to search you area.

The 209th usually uses a leapfrog method for sweeping, one aircraft will perform a sweep while the rest of the flight moves along the flight path. If the sweep is negative, he moves back towards the flight. About the time he rejoins the flight, it is time for another sweep. The job gets handed off to the next plane in the wing.



#### TWS:

TWS (Threat Warning System, DASS also falls into this category, sort of.) will react if RADAR is looking at you. It will pick up airborne as well as ground threats. It does not pickup Electro-Optical targeting devices or threats not using RADAR. So, again we have some limitations.

I am going to lump JSTARS and AWACS into this category as well. Some of the newer sims are modeling these systems. Most JSTAR type systems will give you a gods eye view of EVERYTHING in the air. This is regardless of whether or not they are a threat, emitting RADAR, 300+ miles away, etc. They tend to work a bit too well in the gaming environment. But if the game has it as a resource ... use it. AWACS has been modeled in various forms, some similar to a JSTARS type system while others just offer up digital heading calls. SU-27 has an AWACS view that lends itself extremely well to multi-player use. This system allows a person to actually perform the AWACS function and give out calls for bearing and prioritization. There are several examples of this on the 209th VFS Delta Hawks web site at <http://www.deltahawks.org> on the RADIO COMMS page.

#### VISUAL:

Your eyeballs ... probably the best detection device ever. Regardless of how you first detect the bandit, when you get into a furball ... you are going to have to rely on the old glassies to keep tabs on him.

### THREAT IDENTIFICATION

We know how to find the threat ... now how do we identify the threat? I do not mean, is it a MIG-29 or and SU-27, I mean which item in the air RIGHT NOW should you be most concerned with. Probably the most common mistake I see anyone make, and even veterans will get caught in this trap now and again, is not defending against the most immediate threat. The missile lock klaxon is going off in your cockpit ... you KNOW you have a missile inbound, but if you hold this line just a couple more seconds, you can kill this bandit you are tracking. STOP! If you are certain a missile is tracking you, do nothing else but GET OUT OF ITS WAY! As soon as you know you have a missile tracking you, find it using your aircraft's sensors and your eyes and begin evasive tactics.

**CRASH'S RULE NUMBER 2:** If you have someone or something shooting at you, get out of it's way before you even think about attacking a target.

How do you evade a missile? There are several techniques, some of which are better and more reliable than others are. They all use the same basic root principal ... "Fight Missiles with Aspect". What this means is you want to give the missile the most difficult guidance solutions possible by making it maneuver. The first thing you want to do is put the missile on your 3/9 line and "Beam" it.

Your 3/9 line is the imaginary line that goes across your aircraft from left to right. If you look down at the top of your aircraft, and imagine it sitting on a clock face nose pointing to 12 o'clock, you will be able to visualize the "3/9" line. Missiles fly in Lead Pursuit to increase their range, so by putting the missile on your 3/9 line you will cause it to pull maximum lead. As you do this, drop chaff and flares. This may confuse the missile as it tries to create guidance calculations. Do not try and let the missile close in and expect to pull a high G turn to force the missile to over shoot you.

Missiles are designed to explode if they over shoot, (Now you know why you keep getting hit even though the missile went past you) your attempt to pull around the missile will bring you close enough to it that on explosion, you will take damage. (Note: missile damage is frequently collateral damage, direct hits are not required to kill you. A common missile design throws steel bars in a wide ball shaped area when it explodes). You need to judge timing for a break away from the missile as you drop chaff and flares. Near the end of the missile's flight (after the motor has burned out) you want to pull a high G turn causing the missile to try and pull a turn with you. The chaff and flares may confuse the missile as it tries to track you and it may lock onto that leaving you a get away. Don't wait too long or, once again, you will be in the blast radius of the missile.

I mentioned motor burn out, once a missile motor is burned out, it loses maneuvering and any high G turn it is forced to make becomes unrecoverable energy that causes it to slow down. Most simulators do not do a very good job of this, but these types of maneuvers will still work.

### **Extra Added Bonus:**

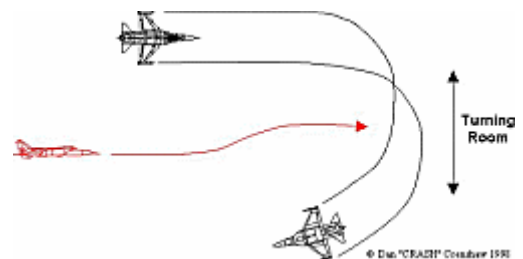
In the EF2000 family of games you can put a missile at your 12 o'clock and do wide barrel rolls. This will spoof a missile just about every time. Problem is in EF, you usually have more than one coming at you at a time.

## **DEFENSIVE BFM**

Remember I told you that the first turn, BFM maneuver, in a fight is the most important? There are a couple of reasons I say that. Pete Bonanni makes an excellent point in "Art of the Kill", when you pull that first high G maneuver, not only are you creating BFM problems for the bandit to resolve, you are making a clear statement that "I am going to stay alive. If you are going to kill me ... your gonna have to work hard for it." (Pete said it with a little more flamboyance ... "It's you and me for all the wine and women in the world".) A mid or low level G turn is almost a surrender ... at this point you might as well just fly straight and level and let him shoot you.

The other reason, as we mentioned, is to create BFM problems for your new friend back there. We know we want to get to corner velocity. If you are not there yet, start your maneuver anyway and try to get there. Slowing down is easy, cut the throttle – pull your G's and make your speed. Speeding up is not so easy ... good argument for cruising at or above corner velocity. (I know of no one that flies slower on purpose, but you should pay attention). Pull your turn, put your velocity vector ON THE BANDIT. If you do not, you will create additional turning room for the bandit when you are trying to take it away. Figure 4-1 shows a defending aircraft creating turning room for his attacker.

Figure 4-1



## **OUTSIDE THE TURN CIRCLE**

You want to begin your BFM turn as soon as possible. If you spot the bandit early enough and can begin your BFM while he is still out side of your Turn Circle, you can turn a defensive position into at least a Head On Pass, or even an offensive position.

So there is no missile and you have a bandit on your six, you begin Defensive BFM. How do you know what to do next? How do you know what you are doing is working? If your turn is moving the bandit away from your 6 o'clock position and up towards your 3/9 line, it is working. You want to get the bandit forward of your 3/9 line. If you start your turn while the bandit is outside your turn circle, and you put your lift vector on him and execute the turn correctly, you should force the bandit in front of your 3/9 line. Here is where it gets a little tricky.

If the bandit pulls a Lead Pursuit while you are executing the turn that is forcing him in front of your 3/9 line, he will get the opportunity for a gun shot as he over shoots. Watch out for this. If he starts to pull Lead Pursuit the best way to defend for this is to quickly pull out of plane. At this point, you have to judge when to make your "jink" out of plane. Don't wait too long, if you're too late ... your dead, if your too early, you just need to "jink" again. Better too early that too late.



## CHAPTER 4: DEFENSIVE BFM, Part 2

If the bandit is inside your turn circle when you begin BFM, there is a much different scenario that plays out. First you need to determine how serious the pilot behind you is. If he intends to get in on your 6 and take a shot at you, he will have to fly Lag Pursuit to get to your entry window. If he pulls into a Lag Pursuit, he wants to party and you better be ready.

Your best shot here is to pull a high G turn at Corner Velocity. At this point it is imperative you are at Corner Velocity. You want to keep his nose in Lag. Your best chance for survival is to keep turning hard and see if he can get around on you for a shot. If he can, get ready for Guns Defense. There is also the school of thought that you should unload and extend (release the G and accelerate for distance). The problem here is that the bandit will quickly get deep into your 6 o'clock and probably take a missile shot at you. Figure 4-2 shows a well executed Lag Pursuit entry.

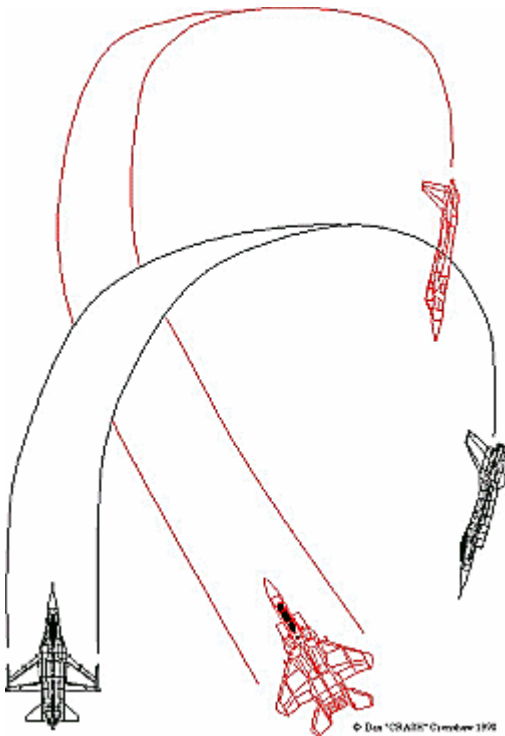


Figure 4-2

Now you can not count on the bandit to do everything you want him to. And he may try to trick you into making a mistake as well. He may try to go vertical. Keep pulling hard and put your Lift Vector on him. As you start to climb, watch him. If he pulls down, back into a Lag Pursuit as you climb, you got a hot shot on your hands and he will quickly move in for a gun shot. But if he continues going up, keep your pull and follow him. You should be able to hang onto enough speed to be able to pull your nose around on him and take a shot (most likely a snapshot, but a shot never the less). See Figure 4-3.



Figure 4-3

Now you have probably gotten into a "Scissors" fight. Better than having him on your 6, now the odds are much more even. A "Scissors" is when you and the

bandit are in a Line Abreast or side by side situation. Both planes pull towards each other as they try to bleed speed and thus, get behind the opponent. The fighter that can slow his aircraft the fastest usually wins this one. Use every trick you know to do this, airbrakes, flaps, barrel rolls. I know I don't recommend it, but if the fight gets slow enough, throw out your gear ... just get behind him! Figure 4-4 is a Scissors.



Figure 4-4

Then again, the bandit may try a Lead Pursuit immediately. He may overshoot you, but still get a snapshot. The trick here is to pull for all that you are worth. Be at Corner Velocity ... any faster or slower and he will be able to keep behind you.

And pull G's till it hurts (or in this case, until the screen goes black).

A quick side note about how many G's to pull. When the 209th went into the first FALCON 4 test session, we all immediately turned on the blackout. This surprised some of the unseasoned folks there. But what really confused them is how we managed to maintain awareness while looking through a little circle in the middle of a black screen. It isn't a matter of maintaining awareness at this point, it is about survival. Situational awareness is important, but if you unload G's to lessen the blackout effect, the other guy is gonna pull his nose on you and shoot. When I say HIGH G anywhere in these lessons, I really mean HIGH G's.

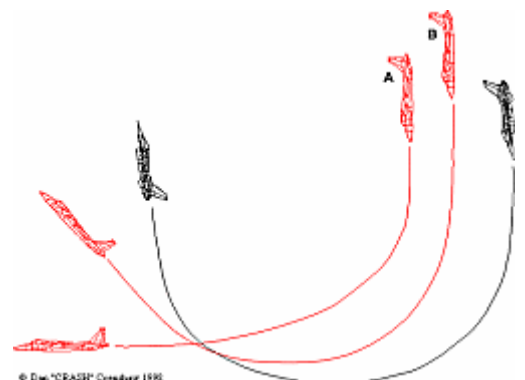
O'kay, the last thing that the bandit may try this close is a Pure Pursuit. If the bandit has his nose on you and has not launched a missile, you have just met your next Kill Tally. He is maneuvering in HUD BFM ... he is always looking through the HUD. This is VERY common in sims when you are flying H2H (since this is usually the primary view used by most people). At close range, it will lead to an overshoot and suddenly you will find yourself on his 6 ... now you can go back and try stuff you learned in Chapter 3. You are in control and on his 6.

### OVERSHOOTS

We have talked about overshoots in several places now. Lets describe what an overshoot is and why it is important to you as a defensive aircraft.

There are two basic types of overshoot, the Flight Path Overshoot and the 3/9 Line overshoot. Figure 4-5 shows a Flight Path Overshoot.

Figure 4-5





A Flight path overshoot can be a minor error for the attacker, or a fatal error. If the path causes a minor overshoot as aircraft A in the figure, this will usually mean very little to you as a defender, and very little stress to the attacker. However an excessive overshoot, like aircraft B, could easily give the defender the opportunity to reverse his turn and cause a line abreast situation (which would result in a Scissors) or even on the attackers 6, turning the tables.

A 3/9 Line over shoot, as shown in Figure 4-6 puts the attacker in front of the defending aircraft. A quick reversal by the defender and the hunter becomes the hunted.

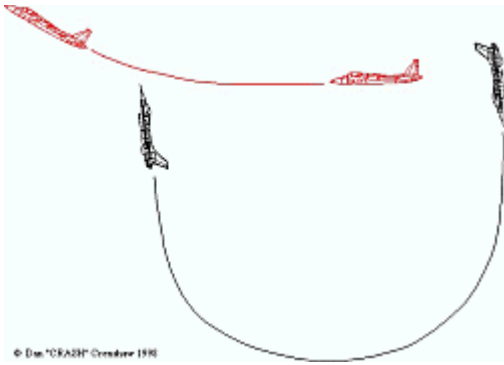


Figure 4-6

When the bandit over shoots, you have 2 basic ways to reverse your turn. If the bandit is going to overshoot with a high line of sight rate (he is going to pass you very quickly), you will probably want to do an "Unloaded Reversal". You need to release the G load on your aircraft (ease off on the stick), roll your aircraft so that your lift vector is on the bandit and then pull maximum G at him. Only use this method if you are sure he will over shoot. This move will not force an over shoot, but it will get your nose on the bandit quickly when he does.

The other type of reversal is the "Loaded Reversal". Use this move to force an impending over shoot into an over shoot. This is simply maintaining the G's on your aircraft as you roll your lift vector onto him. Pull for all your worth at maximum G. Figure 4-7 shows a Loaded Reversal.

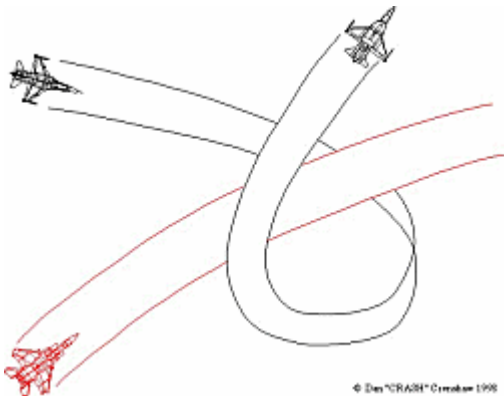


Figure 4-7

There is one little issue you must consider in a Loaded Reversal. If the bandit doesn't over shoot, you will have him clawing at your underwear, do a quick check to make sure you know where the EJECTION strap is. You will have almost no airspeed after this maneuver, so if he stays behind you, you will have no maneuvering ability.

This brings us to the Rules for Reversal. 3 quick thoughts to consider before you decide to reverse on this guy as he over shoots.

1. When in doubt if the bandit will over shoot, don't reverse.
2. Best results are when you reverse when the bandit is within your turn circle with a high line of sight.
3. Do not reverse if the bandit is outside your turn circle. He has way to much room and time to correct.

## GUNS GUNS GUNS

Now your down to the wire. He has closed in range for a gun shot. You need to know the two types of gun shots and what to do.

### Snapshot

Snapshot is when a bandit is passing you at a high line of site rate. To defend against this type of attack you need to break out of plane. The tough part is to decide when to make the break. Early is better than late ... so watch him close.

### Tracking Shot

This is where the bandit has maintained control, is on your 6 and tracking you for the kill. This will require multiple "jinks" out of plane. These "jinks" must be rather severe, a 70° or more break is what we are talking about here. Do not lose sight of the bandit, once he begins to line up again, and trust me – he will, you need to "jink" again. Make the "jinks" random in direction, sudden, and severe.

This concludes the basics of Defensive BFM. In a nutshell, you need to pull hard with your lift vector on the bandit. Watch him to see if he makes any errors, if he does, jump on the opportunity to turn the tables. If you fly perfect BFM, and the bandit does as well, you will end up defending against his guns attack (not really a consolation prize, but better than already being shot down).

Above all, if you are in a defensive mode, never give up. Do whatever it takes to cause as many problems or the attacker as you can. If he is going to kill you, make him work harder than he ever has before for a kill. Of course, the best Defensive BFM is not to let him on your 6 in the first place.

## Chapter Five: Head on BFM

Head On BFM, the most dreaded and difficult of BFM situations. Your aircraft is "nose on" to the bandit, and he is "nose on" to you. When used as a Competition set up, you are generally required to make a clean first pass, no shots fired and once the 3/9 line is cleared, "FIGHTS ON!"

For this purpose, a lead turn is excellent. Both combatants are at an equal advantage/disadvantage and this sort of fight requires more maneuvering, tactics, skill and luck than any other BFM.

But in a WAR (campaign, custom mission, any actual game situation) chivalry is dead. There will be no clean first pass. Odds are, the yokel heading at you will start spraying you with bullets the second you are in range. Of course, the exceptions here are in games that have realistic load outs. I do not think anyone in their right mind would start spraying bullets in SU-27. With only 150 bullets, they all need to count. But in many other sims, with over zealous bullet loads, expect the "curtain of tracers".

You have many decisions to make rather early on in Head On BFM. Do you commit to a Turning Fight? Do you opt for a "blow through" and extension and run away? If you commit to the Turn Fight, do you go for a two circle fight or a single circle fight? All of this must be decided before you even enter the fight. And in a Head On fight, closure speeds can easily exceed 1000 KIAS, so you don't have a lot of time to decide.

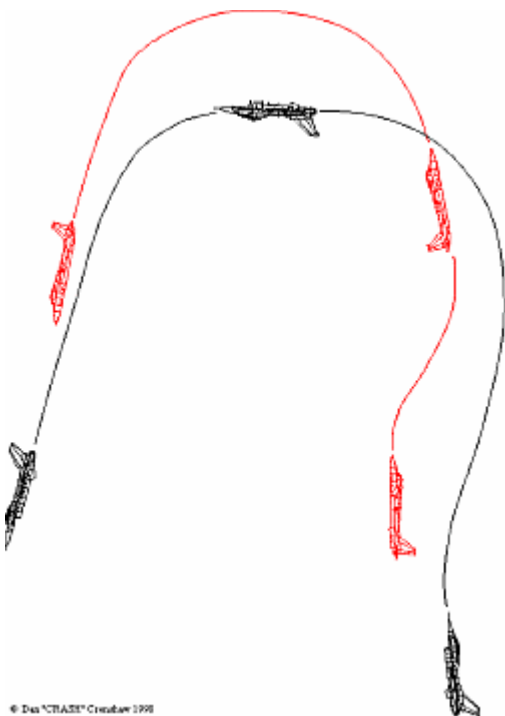
There are several factors that can help you make this decision. We need to remember that a Turn Fight, or Knife Fight, eats up time and energy. Time is critical, since if you get tied up in a fight, the longer you are in the fight, the more time there is for one of your playmate's friends to show up and sucker punch you. Energy is obviously needed for maneuvering.

There are many reasons to "blow through" and leave a fight. There are also as many reasons to stay and fight. This lesson will give you some basic guidelines to help you lay out a strategy for a fight. The first thing you will need to know and remember is the "Escape Window"

### ESCAPE WINDOW

A fighter pilots job is to enter a fight, shoot down the enemy and live to be able to do it again. A priority when entering a fight is to be aware of your position in relationship to your "escape window". What is an escape window? An escape window is a loose representation of your ability to extract yourself from an engagement. It is called a window because it can open or close in varying degrees depending on the current situation, position and energy level of your aircraft.

If you sneak up on a bandit that has no clue you are there, your escape window is enormous. You have the ability to leave the fight at anytime you want, you have complete control. The window is wide open. But if the tables are turned and a bandit sneaks up on you, the window is closed. Any attempt you make to leave the fight will most likely end in you getting shot down. In between these two extremes the window can fluctuate in size. The smaller the window, the less your chance of getting out of a fight alive. In any maneuvering fight, the window will close completely at some point. You are then committed to stay in the fight to the conclusion.



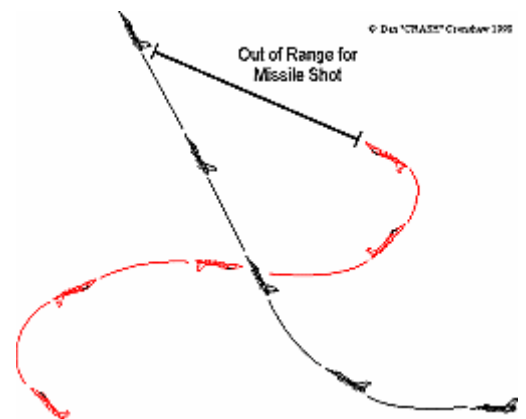
In figure 5-1, the attackers escape window is open. The bandit can not turn and get a shot on the attacker as he passes through the fight.

### Pen Window

Figure 5-1

If the attacker turns to roll out of the fight, the bandit can not reverse his turn fast enough to engage. If the attacker "Blows Through" and extends, by the time the bandit can come around to engage, the attacker is out of range.

In figure 5-2, the window is closed. An attempt to leave the fight will give the bandit the opportunity to turn and engage the attacker. The attacker has tried to leave the fight, and the bandit has reversed his turn and lined up on the attackers 6.



## Closed Window

Figure 5-2

If the attacker reverses to leave the fight, the bandit has plenty of time to turn and engage from a 6 o'clock position. Any attempt to "Blow Through" will probably cause an overshoot, or allow the bandit ample time to reverse and engage.

Figure 5-3 shows a classic "Lufbery". In this fight neither aircraft can leave, both windows are closed. The first one to try and leave will get shot.

## Lufbery

Figure 5-3



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While it is important to know where your escape window is, if you intend to be successful and shoot down bandits, you will have close your escape window. Knowing where your escape window is will prevent you from trying to leave a fight that has a closed escape window.

Should I stay, or should I go? Providing you both see each other, there are three main factors that effect an escape window. Range: The range between you and the bandit. The greater the range, the more open the window Energy: Energy relative to your opponent. The greater your energy in relationship to the bandit, the more open your window.

Angle-Off: The greater your angle-off, the more open your window. (A head on pass is the best advantage here). Click to continue.

## BFM

All of these factors combine or cancel each other out to figure the size of your escape window.

Should you decide to stay, you need to decide when to make your move. Remember, you have decided to stay and fight, so FIGHT TO WIN! To go aggressive, you have really only one option before the merge. Lead Turn. Any other maneuver is not going to put you on the offensive and will probably put you on the defensive pretty quick.

## Lead Turn

A Lead Turn is when you try to decrease the angle-off prior to the merge, or passing the bandits 3/9 line. Lead TurnS are a critical and highly important part of BFM and can be used almost anywhere. They is most frequently used in a HEAD ON Pass. Lead TurnS are the most efficient way to BFM and are so potent that, if you Lead Turn and your opponent does not, you will win.

How exactly do you execute a Lead Turn? I will look at this from a HEAD ON aspect. As you approach your opponent, you will have a relatively low line of site rate on your bandit. Remember line of site rate is how fast the bandit is moving across your field of view.

In a HEAD ON, the bandit is almost stationary, almost no line of site rate at all. However as you close with the bandit, he will start to slowly move towards the rear of your aircraft. You will be able to watch him move from the center or near center of your HUD to the edge and then out of it and aft on your canopy. As this happens the line of site rate increase.

In a HEAD ON Pass, closure speeds can easily meet or exceed 1000 knots. Your closure speed, velocity of closure, is VC. This is the sum of your speed and that of your opponent. In a HEAD ON Pass, it is pure addition. If you are going 500 knots and your opponent is going 500 knots, your VC is 1000 knots. When your 3/9 line is even with his 3/9 line, your VC will rapidly change from 1000 knots to negative 1000 knots. It is at this point, when your 3/9 lines are even, that you want to start your Lead Turn.

You can not wait until this point is reached to begin your turn. If you do, you are too late in executing your turn. You must remember, the further back the bandit moves on your canopy, the faster his line of site rate will increase. Before you know it, he will be blasting past you, and if he is smart, will be making his own Lead Turn. You need to anticipate when to begin your turn.

The best place to begin your turn is where the line of site rate begins to increase very rapidly. This happens usually around 30° off of your nose in a good turning aircraft (some slower turning aircraft may have to start sooner than this). As you practice this, you will begin to notice when this happens and can then pick a reference point in your cockpit to use as a "start your Lead Turn here" indicator.

Figure 5-4 shows a Lead Turn.

## Lead Turn



Figure 5-4

Figure 5-5 shows from a cockpit view approximately where you would begin a Lead Turn.

Begin Lead Turn

Figure 5-5

Now we have a pretty good idea when to begin the turn, what about the turn? Well, we are back

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to the CRASH SCHOOL of BFM ... Pull as many G's as you can. Pull for all your worth. When you make a Lead Turn, you are committing yourself to the fight. You have closed your escape window and the only way to open it again is kill your opponent (O'kay, there may be a few other ways if the bandit really makes a mistake, but odds are you will not get that lucky).

Lead Turns do not have to be executed in HEAD ON. They can be used from any aspect and angle-off. You must be able to predict the bandits flight path and take great care not to fly out in front of the bandit when you pull your turn.



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As I said before, a Lead Turn is an incredibly powerful BFM tool. And you can bet, your bandit will know this as well. I also told you that if you Lead Turn and your opponent does not, you will win. Likewise, if he Lead Turns and you do not, he will win. In similar aircraft fights, a Lead Turn will not give you the advantage if you both execute them, but if you both do a Lead Turn, he will not get the advantage either.

In aircraft with distinctive handling differences, a Lead Turn vs. Lead Turn will gain you the advantage if your aircraft is the better of the two. If you are in an F-16 and entering a fight with a MIG-29, you will more than likely gain an advantage in the Lead Turn fight. If you are in an F-14 and fighting the same MIG-29 ... I truly hope you have planned a high speed "blow through" and acceleration, or have your hand poised on the "seat popper".

If you ever find yourself "Nose High" while the bandit is closing "Nose Low", you're either very lucky or very good. (Remember, Nose High and Nose Low refer to aircraft nose position relative to the horizon). You are in a prime spot to pull a high G Lead Turn going high and getting help from the Radial G effect discussed in previous lessons. If you pull a Lead Turn here, you can quickly gain the 3/9 line advantage, get behind your bandit and score a kill.

Figure 5-6 shows a Nose High/Low Pass Lead Turn and a subsequent Vertical Lead Turn.

Nose High/Low Pass Lead Turn

Figure 5-6



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## Chapter Five: Head on BFM

### VARIATIONS ON A THEME

As much fun as it is to dogfight in a simulation, in virtual reality - and real life - the longer you are in a fight, the more the chances are that you will make a mistake and end up losing (or get jumped by your playmates friends). So the idea here is to maneuver into a position to get a good kill shot. First thought is All Aspect Missiles. There are a few different variations modeled, most common are All Aspect Heat Seekers (AIM-9M) and the ASRAAM, All Aspect Short Range Air to Air Missile.

Thought number 2 ... guns. Problem here is you need to maneuver to aim your guns and sacrifice setting up for good BFM. And remember, if your bullets can hit him in a HEAD ON Pass ... his can hit you too. Personally, I NEVER fly HEAD ON into a bandit. I always break to one side or the other to get some separation to set up for BFM. I see tracers trying to track me which would be hitting me if I were going H2H with him. Even if I intend to extend and run, I try to keep off center to avoid giving him an easy shot.

You may even get a "Face Shot" with an All Aspect missile as you close with the bandit. But again, he may have this same opportunity. If you have the chance, and the equipment to take a HEAD ON Missile shot, do it. It should put your opponent on the defensive, take you out of a HEAD ON fight as he evades pending doom, and give you the advantage.

Based on all of this, if we are going to stay and fight, we probably are not going to go for a Head On guns shot. So we need to decide exactly what type of turn we will execute with our Lead Turn. There are 3 basic options we can use:

- \* Turn Nose Low
- \* Turn Level
- \* Go up into the Vertical

These are not the only types of turns you can use. There are other maneuvers that can be done, but anything other the three listed will probably result in you getting shot down.

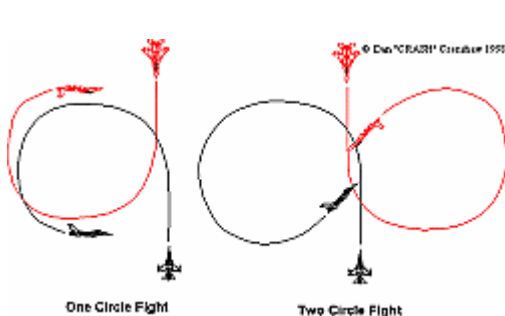
HEAD ON BFM is the most maneuver intensive type of fight you can get into. And as a result, you will not win this fight. Maneuver intensive fights are lost because of mistakes. The more maneuvering required in a fight, the higher the chances of a mistake. You must make deliberate and calculated moves. Watch your opponent and work to counter his moves while putting yourself in a position that puts and/or keeps him on the defensive. Obviously to do this, you must keep him in site. "Lose Sight, Lose Fight" is not just a cute cliché, it is very real.

You also need to make sure you keep your air speed up in the area of corner velocity, pull high G's (not wimpy little mid-level G's), keep your Lift Vector on the bandit, Lead Turn ... you must do all of these things CORRECTLY to have a chance to win.

The most important decision you must make in HEAD ON BFM is whether or not to stay and fight. If your opponent is in a superior handling aircraft, extend! Keep your Escape Window open. Run away! Our F-14 vs. MIG-29 example from earlier is a prime example for "putting the hammer down" and "blowing through" the fight ... hit that MACH 2 and run like hell.

### FIGHT GEOMETREY: ONE & TWO CIRCLE FIGHTS

Figure 5-7 shows the difference between a one circle and a two circle fight. By looking at the figure, you can easily see why they are called what they are. If you and your opponent both use a Lead Turn, you are going to end up in a two circle fight.



Circle Fights  
Figure 5-7

If one of the fighters turns away from the other, you will be in a one circle fight. Most fighters will turn into each other to get the most use of their available turning room. If a fighter turns AWAY from the Lead Turning bandit, he has given himself less turning room to work with while actually GIVING his opponent more turning room. Thus handing

him the advantage.

What is the worst that can happen if you turn away from the bandit? You can GIVE your opponent the advantage and get yourself shot down. Figure 5-8 demonstrates one way this can happen. Fighter A turns away from fighter B.



So why would you turn away from the bandit? There is a reason you may attempt this. In a two circle fight, a fighter may get the opportunity to fire an All Aspect Short Range RADAR or IR Missile if he can get his nose around fast enough. In a One Circle fight, you are most likely too tight for an accurate missile shot (missiles take a little bit of time to lock and start their tracking). So if you do not have All Aspect capability and you think your opponent does, this may be an option to stay alive.

The last rule of the circle fight ...once you have started your turn, DO NOT REVERSE IT! If you want a two circle fight, but the bandit turns away, do not try to reverse. Continue with your turn. If you try a reverse, you will give away energy, time, and angles while you reverse your turn. You will also more than likely lose sight of the bandit during this move.

## THE FIGHT

You have decided to stay and fight. You are confident you can out turn and get parameters for a shot quickly. You are setting up for your Lead Turn. Which turn do you choose?

### Nose-Low:

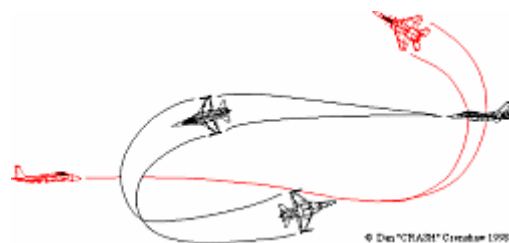
When you pull a Nose Low Lead Turn, or Slice, you are using Gravity to help you turn faster. The RADIAL G effect will pull your nose around faster than the other Lead Turn options here. When you do a Nose Low Slice, you pull High G's with your nose pointing 10 to 15 degrees down to take advantage of the RADIAL G. Figure 5-9 shows a Nose Low Slice.

### Nose Low Slice

Figure 5-9

### BFM

There is a qualifier here. This maneuver will more than likely, if executed correctly, put the bandit out of sight for a very short period of time. Now we talked about "Lose Sight, Lose Fight" a while ago, so you are thinking this is probably not the best maneuver to initiate. Well, from a technical standpoint and from what I have told you - yes. However ... you should only lose sight for a VERY brief time. The bandit should reappear quickly approaching your 12 o'clock, a bit above the horizon, as you come around a full 180°.



If you are attempting to execute this maneuver, you are in a fast turning aircraft that can pull High G's. If this is not the case, you have already made your first mistake by staying in the fight. Maintaining a Tally in flight simulations is usually pretty easy since many of them model PADLOCK views that can "see through" the airframe. So the disadvantage you would normally deal with here does not exist in many simulations.

At this writing, SU-27 Versions 1, 1.2 and 1.5 are probably the best example of an exception. It has a PADLOCK view that requires you to first see your desired target to PADLOCK and will then lose PADLOCK once the bandit has past beyond your airframe or to a position that you would not be able to physically see in the aircraft. In this situation, you are dealing what real fighter pilots have to deal with. In my opinion, the best example of a PADLOCK view in any simulation to date.

### Level Turn:

Basically the same maneuver as the Nose Low Slice with it's own pros and cons. In a Level Lead Turn, you should be able to maintain a visual on the bandit, but will slow your airspeed down much more than a Nose Low Slice.

### Vertical:

Going Vertical is not usually your best option. A few cases do exist where it may be a good idea. If the sun is overhead, you may be able to lose yourself in it. The bandit may lose sight of you, "Lose Sight, Lose Fight" works both ways. This may also help in the event of a Heat Seeker Missile shot. Many new sims are modeling the confusion caused when a IR missile is looking at your exhaust and the sun at the same time.

If the sun is NOT above you ... you are a marked man. Hot afterburner against a cold blue or gray sky, makes a nice signature for an IR missile. If the bandit does lose sight of you, you can then set yourself up for a better shot while he flounders around looking for you. (If you see S-turns and rocking wings, he is trying to look behind himself to find out where you are. He will more than likely not be pulling towards you either.)

You will also have a lot of plane form to look at of your bandit while you do this. Problem you will have is speed loss is HIGH! As you begin your Vertical move, you will be at a disadvantage since you must fight gravity to pull up (RADIAL G again), remember



that you will gain the advantage of the RADIAL G as you come over the top. If the bandit manages to get a tally on you while you are doing this, you can bet he will be making moves on you. Best bet is that unless you are positive you can get lost in the sun, going vertical is a big gamble at best.

A rule of thumb here is if you plan to go vertical, get some speed built up. Not corner velocity. Once you pull up, you will bleed speed so fast, that you will hit CV pretty quick anyway. Start wings level for maximum lift, get some high speed and pull hard.

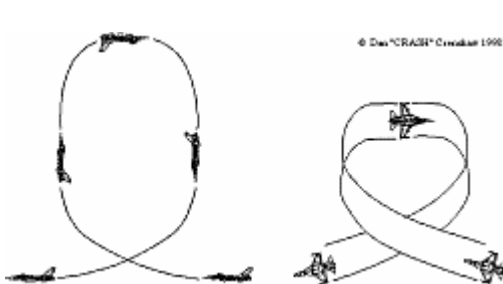
As you get to the pure vertical, find your little pal and put your lift vector on him and pull into him. You may have to pivot or rotate your aircraft to do this (if not, he really is daft and deserves to be shot down). The odds are the bandit has had a tally on you for a little while and has made moves of his own.

What this means is the YOU are the wrong end of a Nose Low/Nose High merge like we discussed earlier. (See why I said you should not go vertical unless you are SURE you can get lost in the sun?) He will probably start a Lead Turn into you. You need to counter this with a Lead Turn of your own. Once you are able to continue around in the level, put your lift vector on him and pull into him.

Your other option here would be to continue the vertical fight. If you pull over the top and realize you have been spotted, go vertical again. You will not have the luxury of getting a lot of speed built up again. Accelerate until you are passing the bandit and pull up again. As you get to the pure vertical, look for your playmate and rotate and put your lift vector on him again and pull into him.

Do not hesitate on this vertical pull, if you do the bandit will be able to convert and get on your 6. Watch your opponent. You may have to try this vertical move again. When he is no longer pulling his nose up into you, you have the advantage. Then you have altitude that you can trade for speed and your opponent is out of energy. You now have the turning room and the energy advantage.

I am only talking about a full vertical climb and turn here. An oblique vertical turn will not give you enough turning room. See figure 5-10 for the difference in turning room offered between a full vertical turn and an oblique vertical turn. The full vertical turn is on the left, while the oblique vertical turn is on the right.



Lufbery  
Figure 5-10

These are the basic maneuvers you can use to get behind your opponent. Depending on how successful you have been, you can go back to the chapter on Offensive BFM or if you weren't so smooth, Defensive BFM. The main thing you need to remember is to make your decision and stick with it. Do not wait and decide at the last minute you will stay and fight, or after you have started a Lead Turn that you may want to extend and run instead.

## Chapter Six: Beyond Visual Range Fight

So far we have looked at close up and personal air combat. Those techniques and practices are the fundamental roots of air combat. All air combat is based on BFM, the modern day "joust" between knights of the sky in visual range.

Once a pilot is trained how to handle a dogfight where the aircraft are in visual range, he must be taught how to avoid getting this close in the first place. He must learn how to maneuver against an aircraft that is BVR (beyond visual range).

The amount of information in this area is vast. The next chapter (Wingman Tactics) will go into a great deal more detail on how to set up for a BVR missile shot. In this chapter I will go into the basic steps of BVR combat and how to prep for a shot.

Modern simulations present different levels of realism in the RADAR avionics. As a result of developers desire to present balanced game play, many of these RADAR models are overly powerful and extra accurate in order to compensate for the lack of real world situational awareness you would have if you were actually in the aircraft.

Because of this, they are rarely realistic and give away entirely too much information. There are a handful of simulations out, or due out, that have incredibly well modeled avionics packages that actually act as a real aircraft avionics package would. The key here is to also have the enemy AI RADAR function in a similar fashion. It is not a lot of fun to go up against an enemy fitted with KLINGON technology in a fighter of the late 20th century, especially when your own radar functions in a realistic manner.

Based on all of this, you have probably figured out that the RADAR is the primary sensor for detecting bogeys BVR. It may also be possible to get data from air borne sensor platforms such as an AWACS. Regardless of where this data comes from initially, you must act upon the information and begin to take measures to put yourself at a tactical advantage. To accomplish this, there are 6 basic steps that must be set into motion:

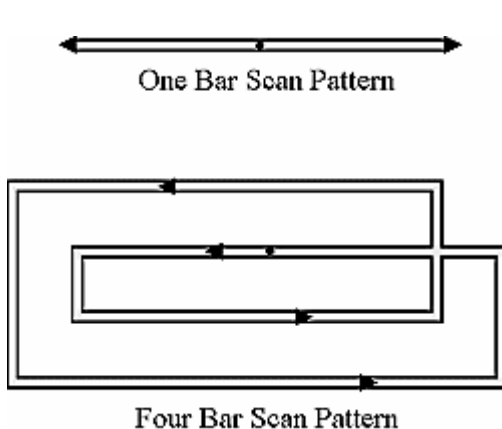
- \* 1. Detection
- \* 2. Sorting
- \* 3. Targeting
- \* 4. Intercept
- \* 5. Engage
- \* 6. Separate

These are not different items you can execute; they are steps that must all be executed in this order to avoid a breakdown of the tactical plan. You must understand and be familiar with each step.

### Detection

Until you know the bandit is there, you can do anything. It is quite possible, and does happen, that flights of opposing sides may fly right by each other. "But I have my RADAR on," you are thinking. Well, that is great, but real RADAR, and thus a well-modeled RADAR package, is not the all seeing "RADAR of GOD". There are parameters you must meet to be able to even get another aircraft to show up on your scope.

RADARS have what are called "search volumes", or "areas of scan". Modern fighters have a "sweep" or side to side scan of 120°. This single sweep is called a bar. There are normally between 4 to 6 bars that you have the ability to adjust. Figure 6-1 shows a 1 bar scan and a 4 bar scan pattern.



Scan Pattern  
Figure 6-1

So if one bar is so limited, why not always use 4 bar scans? A one bar scan allows the RADAR to get back to a detected object 4 times faster than a 4 bar scan, thus updating your screen that much faster. In the period of time RADAR scans 4 bars, a bandit could easily move out of the RADAR scan area. Remember, most modern aircraft have on board sensors to alert them if they are "pinged" or "painted" by RADAR. ("ping" and "paint" are terms used to denote being scanned and/or detected by RADAR.)

As a result, once you detect a bandit, he may have enough time to move out of scan range. Also, a smaller scan elevation (number of bars), thus more frequent updates, usually increase the odds that you will be able to "Lock" onto the bandit.

A 4 bar scan is useful when you are "sweeping" (generally scanning) an area for unknown aircraft. Once you have a general fix on the bearing and altitude of the bogeys, you would want to go to a smaller scan. In addition to the selection of number of scan bars, you are generally able to point the RADAR cone up or down as well.

If you are searching for bogeys you believe or close to the ground, you can crank down the RADAR scan cone and use 1 bar, giving you faster and more accurate updates. Figure 6-2 shows the difference in scan areas of a RADAR cone depending on where it is pointed.

Scan Pattern

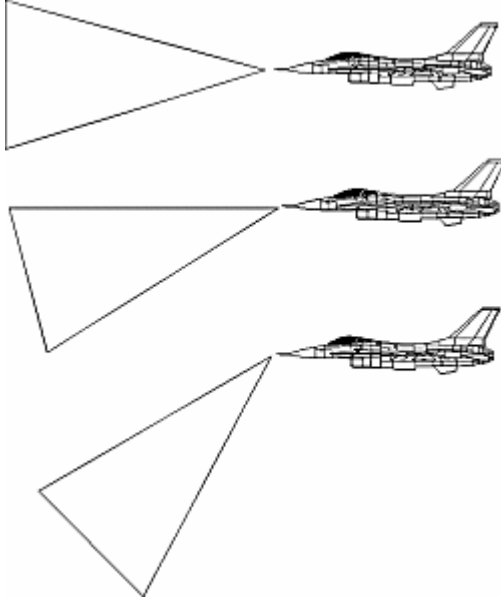


Figure 6-2.

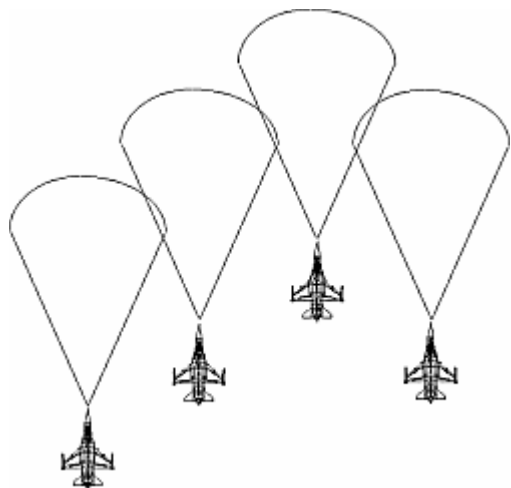
You do not want all aircraft in your flight to search the same area with RADAR. AWACS or GCI may vector you towards a group of bogeys. If you have their bearing and altitude, you can use a small RADAR search pattern. Otherwise, you generally want to search the greatest volume of air space possible. You should work out search patterns with your flight so that you cover the widest area with as little overlap as possible.

Figures 6-3 and 6-4 show examples of search patterns for flights. Figure 6-3 shows a flight of 4 using the "Finger Four" formation which allows each aircraft to search a different area of airspace and also allows good visual coverage of the other aircraft in the flight's "6" position. Figure 6-4 shows a 2-ship flight flying "Line Abreast" and the area they would sweep their RADAR cones in to get maximum coverage.

The difference in scan areas of a RADAR cone depending on where it is pointed.

Scan Area

Figure 6-3

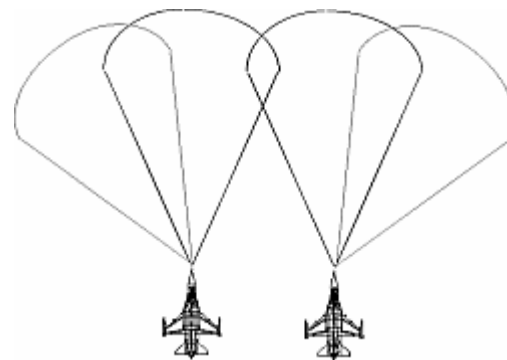


in?

\* 4. What are they doing?

Scan Pattern

Figure 6-4



Sorting

Once you have detected bogeys, you need to sort them. To sort them is to answer 4 primary questions:

- \* 1. Are they Friend or Foe?
- \* 2. How many are there?
- \* 3. What formation are they

The first thing you must do when you detect a bogey is to alert the other aircraft in your flight. This is first, foremost, and paramount. You want to let everyone with you know what you see, where you see it, and make sure they all see it too. You can then confirm or deny each other's findings and insure you really know what is out there.

"Hawk11, Hawk12 ...2 bogeys at 10 o'clock, low aspect, line astern, range 23 miles, angels' 20"

"Hawk12, Hawk11 confirming 2 bogeys, 10 O'clock, low aspect, line astern, 23 miles, angles 20"

Hawk 11, lead, has just confirmed he sees the same aircraft on his RADAR scope as you do. Now you both know where the bogeys are, how many there are, and what they are doing (heading straight for you). While you are doing this, you can be checking them with IFF or NCTR (devices to identify if an aircraft is friendly or not).

"Hawk11, Hawk12 ...2 bogeys at 10 o'clock, nose on, line astern, range 23 miles, angles 20"

"Hawk12, Hawk11 confirming 2 bogeys, 10 O'clock, nose on, line astern, 23 miles, angles 20"

"Hawk11, Hawk12, bogeys are not responding to NCTR"

"Hawk12, Hawk11 confirms bogeys are probably hostile"

Hawk11 is checking IFF/NCTR as well. The odds that these are bandits has just increased since you both got negative readings. This last line would probably be followed by an order for a maneuver to align the newly determined bandits up for a shot. See Chapter 7 for more detail.

## Chapter Six: Beyond Visual Range Fight

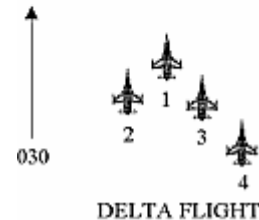


Targeting Now you must target your bandits. Generally, a targeting plan is briefed before take off. You could call your targets in the air, or more realistically, take your target orders from your wing leader. Most flight sim pilots will probably call targets on the fly.

"Hawk12, Hawk11, take the bandit high and to your right. I have the bandit low and to the left."

"Hawk11, Hawk12, copy, engaging bandit high and to the right."

The next chapter on Wingman Tactics will go in to more detail on targeting, tactics and maneuvers.



### **Intercept**

This is where you will close in and engage the bandits. At this time, you would drive to the weapons envelope, lock and launch your missile. If you are fortunate, and did everything right, you will get a BVR kill. Remember that, while you are setting up to shoot, when you detected the bandit, he probably detected you. He is more than likely doing the same thing to you; you are doing to him. So as you approach the bandit, keep him out of weapons parameters.

### **Engagement**

So your BVR shot missed. Now you are entering the world of BFM. This is where you get to try all the fancy stuff we already discussed. As you merge together you need to start using all the other lessons we have gone through so far. Start from the beginning and work your way through the lessons.

### **Separate**

No matter how sure you are of your eminent success, always be prepared to separate and leave a fight. Watch your Escape Window and know where it is. You also need to know where you plan to go after the fight. Enemy pilots calling for help and brilliant balls of fire, followed by trailing smoke from a rapidly descending chunk of aircraft tends to attract just a wee bit of attention. Know what heading you plan to egress on and be prepared to do it.

### **The Encounter**

I am going to take a tried and true approach from most every reference I used and give an example here of what an encounter may sound like. Since all aircraft are in formation together, I will use BRA calls instead of BULLSEYE calls. This will also make it easier for you to follow along. It is critical to let the other pilots know, what you see, where it is, and what they are doing. It is also imperative you tell them who you are talking to and who you are.

Flight of 4: DELTA Lead is Delta 11 (one one) His wingman is Delta 12 (one two) Element 2 Lead is Delta 13 (one three) Element 2 wingman is Delta 14 (one four) BULLDOG is AWACS

### **Situation:**

Delta Flight is performing a SWEEP. They are currently heading at 030 in a finger four formation when they pick up contacts.

Sweep

Figure 6-5

Delta 11: "Delta, Delta 11, . . . two hits, close-abreast at 045 . . . for 40 . . . angles 20 . . . hot. Confirm?"

Delta 12: "Delta 11, Delta 12, negative."

Delta 13: "Delta 11, Delta 13, confirm hits."

Delta 14: "Delta 11, Delta 14, confirm hits."

Delta 11: "Delta, Delta 11, negative prints, confirm?"

Delta 12: "Delta 11, Delta 12, no joy on bogeys."

Delta 13: "Delta 11, Delta 13, confirm, Negative print."

Delta 14: "Delta 11, Delta 14 confirm, Negative print on bogeys."

The flight has 3 readings that all agree at this point. The odds are very high these are not friendly aircraft. Delta 12 has been unable to pick up the bogies, but is aware of where they are and knows where to look. The communication in the flight has everyone up to

speed on all the data available at this time, whether they can see the bandits or not. They know where the bandits are, that there are 2, and that they are not responding as friendly on NCTR or IFF.

Delta 11: "BULLDOG, Delta 11, declare bogies, two hits, line abreast, from our location, BRAA 045, for 40, medium, hot. negative prints, request permission to engage."

BULLDOG: "Delta 11, BULLDOG, bogies declared as bandits, commit."

Delta 11: "BULLDOG, Delta 11, copy, permission to engage bandits at BRA 045, 40 miles, nose on, line abreast, Angels 20, granted."

Delta 11: "Delta meld"

Frequently, VID (Visual Identification) is required. For our little scenario, AWACS has decided that these guys are not good guys and allowed Delta Flight to engage BVR. Maybe the bandits are bit to close to the AWACS for them to feel warm and fuzzy.

Engage

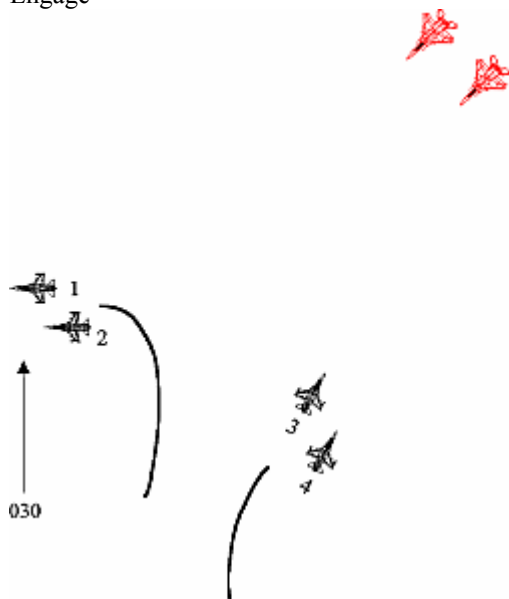


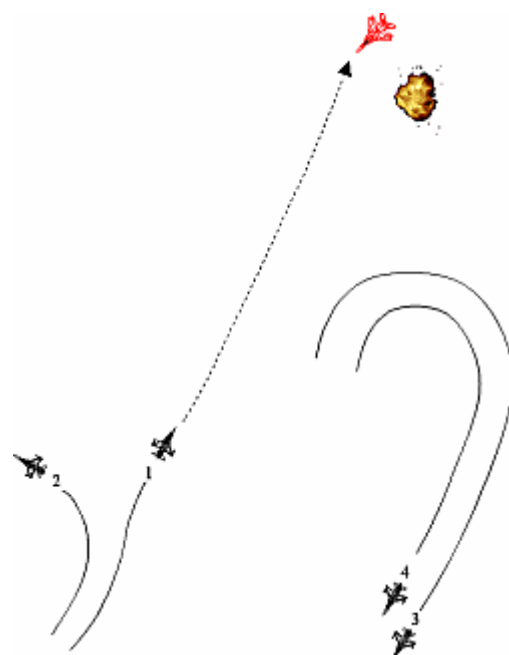
Figure 6-6

Delta 11: "Bracket On mark." "Mark."  
Delta 13: "Sorting western bandit."  
Delta 14: "Sanitizing."  
Delta 13: "Good track on eastern bandit, naked."  
Delta 13: "FOX 3"  
Delta 14: "Re-setting"  
Delta 13: "Re-setting."  
Delta 11: "Delta 13, Delta 11, good kill on eastern bandit, continue reset."  
Delta 13: "Roger Delta 11, resetting."

At this point, the first element is pitching into the fight and coming in behind Delta 13 and 14. Delta 11 and 12 are now in position to engage any bandits that avoid the first volley and Delta 13 and 14 are getting out of harms way if the bandits fire back. Delta 13 has killed the eastern most bandit and is now rejoining his leads formation.

Enter the Fight  
Figure 6-7

Delta 11: "Western bandit at 010, for 40, medium, hot."  
Delta 12: "Roger."  
Delta 12: "Spike . . . notching west."



The bandit is locking up Delta 12 on RADAR. Delta 12 is turning to the west to "beam" the bandit. "Beaming" is putting the bandit on your 3/9 line which causes problems for many types of RADAR and may cause the lock to break.

Figure 6-8

Delta 11: "Copy notch Delta 12."  
Delta 11: "Fox 3."  
Delta 11: "Good kill on eastern bandit."  
Delta 12: "Roger lead, good kill, scope clean . . . naked."  
Delta 11: "Delta flight, say status and resume formation."

All the bandits have been eliminated. Lead is requesting status of all aircraft and ordering them to reform .

