THE OFFICIAL EF 2000 Strategy

Guide

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SIM TECH
Simulation Technologies

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EF 2000™

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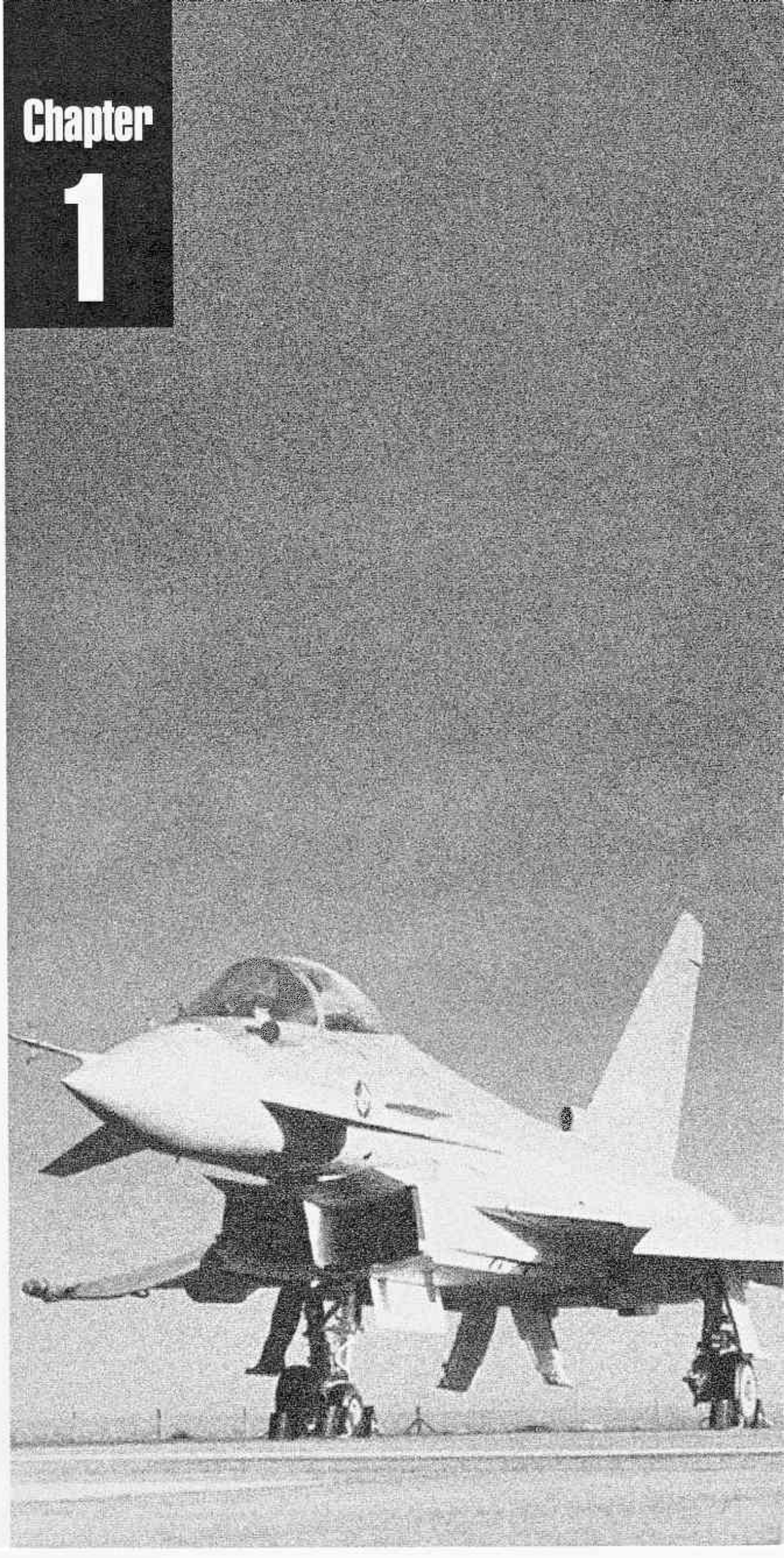
Chapter 1



INTRODUCTION

CHAPTER 1

Chapter 1

Introduction

'When Digital Image Design (DID) conceived EF2000, the company wanted to make a product that would win the dedication of new and hardened flight simulation fans alike. Since its release just over a year ago, the product has sold more than 300,000 copies world-wide and won numerous awards, including Computer Gaming World's Simulation of the Year. It is therefore fair to say that it has become one of the benchmarks in PC combat simulation history.

This book is testimony to the fact that DID has reached its goal of providing the player with a simulation that has the fun, feel and depth that fans of the genre demand. EF2000 was created by people passionate about the product; equally, this book has been written by a group of individuals who are passionate about their flightsims, and who are highly representative of our very special audience. They have injected the one vital element we could not possibly include in the original manual, the distillation of many thousands of hours of intense flying experience, in both single-player mode and in networked battles.

As a companion to the game, you could not wish for better. It is a must for all fans of EF2000.'

Don Whiteford, EF2000 Producer.

In addition to covering the original release of EF2000, this book also deals with the series of mid-life upgrades, the TactCom add-on and the Windows '95 version - Super EF2000. Since its original release EF2000 has been improved and adjusted to meet the demands of the hardened user as well as incorporating the facility for the less experienced to tailor the simulation to their ability. New communications options have been added to give network, modem and internet users even more play options. The most interesting addition is the mission editing and planning facility that allows players to adjust their waypoints or plan multi-plane strikes against targets of their choosing.

Now that you have that power, you need to know how and where to apply it and that is what you will learn from this book. It provides the information you need to enable you to turn the tide of the war. Most importantly, it will help all players to get the utmost enjoyment from EF2000.

Due to the dynamic nature of EF2000 you will find that no mission is ever the same and that whilst the initial disposition of forces may be similar from one campaign to the next, they will always remain different. The very fluid nature of EF2000 means that you need to learn to adapt and improvise if you wish to triumph. With this in mind, we set about creating a Strategy Guide that offers you not only the simplicity of considered suggestions and tips but also, more importantly, depth and a comprehensive analysis of the simulation.

The hints, tips and techniques found in this book are specific to EF2000. What you will find here are the exact tactics that work in the simulation - after all, what is the point of learning how to perfect a manoeuvre if it gets you killed? Therefore all the strategies and tactics in this book are 'combat proven', not fancy rhetoric.

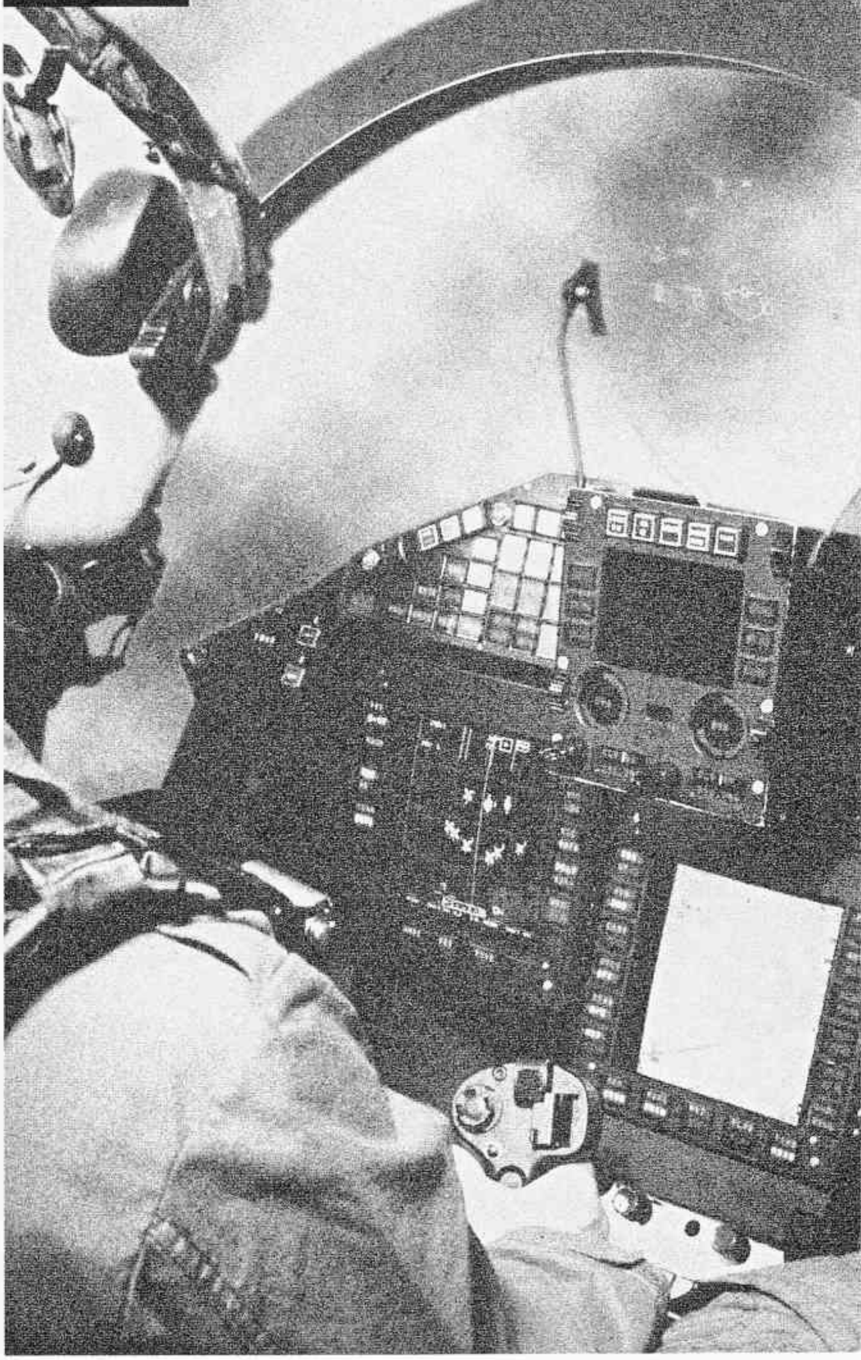
To be able to cover the simulation in such depth required not only time, but also a fundamental understanding of what flightsim enthusiasts want and need from a Strategy Guide. Since all the writers involved in this project are first and foremost dedicated flightsim enthusiasts, we have written a book that answers the kind of questions we ourselves would have posed.

Therefore, this book is a step beyond the manual, not merely a replacement. Hence we expect you to have at least a basic understanding of the systems, keys and procedures of EF2000. With that in mind we have written The Official EF2000 Strategy Guide in a way that enables you, the reader, to access and extract the information that is important to you. Whether you are a flightsim novice or consider yourself a veteran you will find that every section of this book contains information that will prove invaluable in your efforts to defeat the enemy.

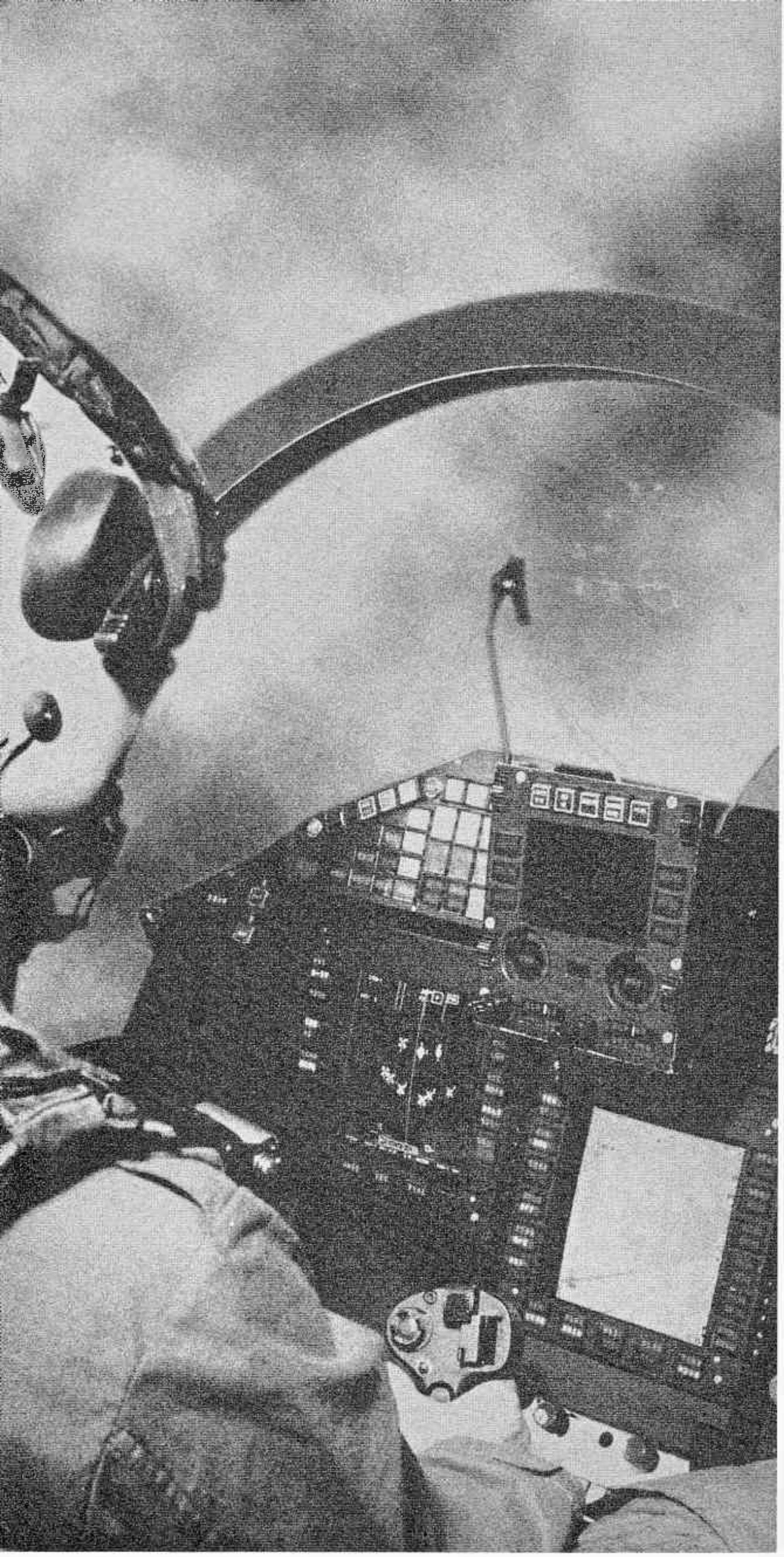
Finally, we expect that after reading this book you will have a thorough understanding of every aspect of the simulation and will be able to get more enjoyment and success through a combination of our advice and your skill.

Dominic Silk

Chapter 2



INSTRUMENTS AND AVIONICS



CHAPTER 2

Avionics

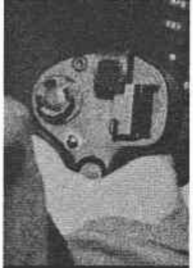
Modern air combat is increasingly a challenge of technology as well as a challenge of piloting skills. As technology pushes the capabilities of offensive and defensive systems further, the problems of pilot overload and reduced combat effectiveness become more severe. The avionics systems in today's sophisticated combat aircraft must provide information crucial to mission success in a way that minimises pilot overload.

The Eurofighter is equipped with an avionics suite that represents the state of the art for single seat, multi-role combat aircraft. Many functions that previously required pilot intervention have been automated to allow you to concentrate more on mission objectives and less on 'pushing the buttons' or 'busy work'. Onboard computers deliver information that allows you to identify threats sooner and to convert them into targets with deadly effect. In addition, automated defensive systems help keep the Eurofighter from becoming a target itself.

The information is presented to you primarily through three large Multi-Function Display (MFD) units as well as the Heads Up Display (HUD) and Helmet Mounted Display (HMD). A smaller Video Display Unit (VDU) is used for the Infra-Red Search and Tracking (IRST) and Forward-Looking Infra-Red (FLIR) functions. Indicator lamps provide additional information about the status of aircraft systems and battle damage. Finally, backup analog instruments provide redundancy for key functions such as navigation and flight attitude.

In combination, these displays provide access to: target acquisition and identification, weapons deployment, defence, engines and stores management, damage assessment, autopilot and terrain following systems, tactical and navigational mapping functions.

Let us look at the main components of the Eurofighter's avionics suite and see how they work together to consolidate battlefield information into an easily digested whole, giving you unprecedented situational awareness.



Part I Radar

Overview of the ECR-90 radar

The ECR-90 is an extremely versatile, third generation multi-mode radar unit capable of presenting information about the complex three dimensional world in front of the aircraft in a simplified and coherent manner. By applying sophisticated analysis on the signals received, the ECR-90 can identify and prioritise targets, as well as direct you as to the best conditions for weapons release.

Located on the left MFD, the ECR-90 is a highly capable, Track-While-Scan (TWS) radar unit that can process a large number of targets and provide prioritised information on up to six targets simultaneously (Figure 1). TWS capability means that you can concentrate your weapons and your attention on one target without giving up the ability to keep an eye on what other enemy aircraft are doing.

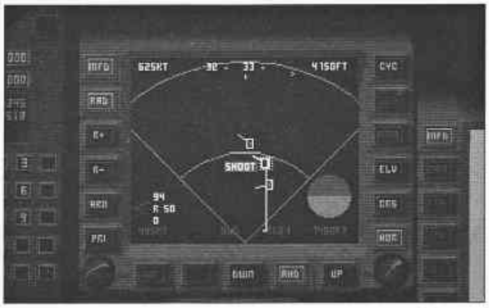


Figure 1

Target Detection and Acquisition

The scan range of the ECR-90 extends out to a maximum of 200 miles or can be adjusted to focus attention on as short a range as 5 miles. The ECR-90 will automatically adjust scan range up or down to provide the fullest coverage of prioritised targets. Autoranging mode is the default mode of operation and the ARN button will be illuminated while in this mode. Manual control of the scan range is available should you wish to override the autoranging function.

There is a direct relationship between scan range and the width of the region being scanned. As scanning range is increased, the radar cone becomes narrower. As a result, targets at the edge of the radar cone may no longer be visible if scan range is increased even though they are well within scan range. You should be aware of the blind spots in coverage and perform 360 degrees sweeps periodically to ensure that they are not caught by enemy interceptors unaware.

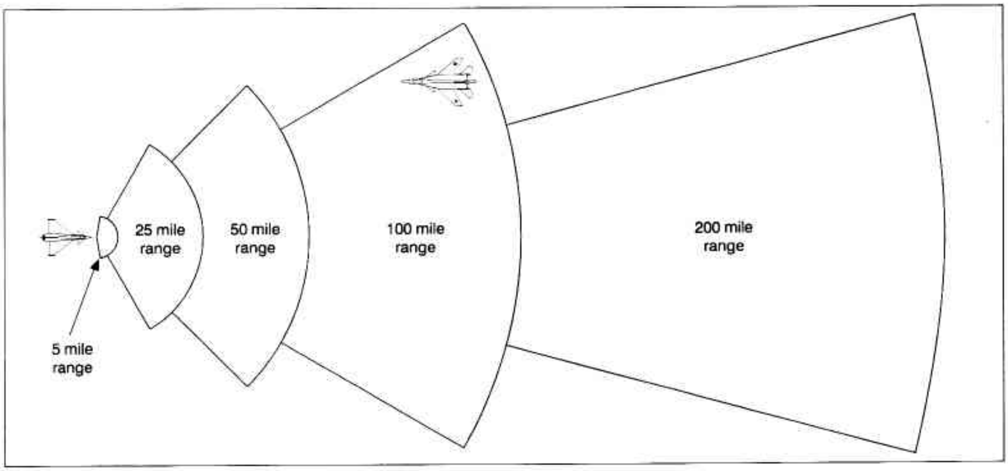


Figure 2: Scan range and coverage

Figure 2 shows the scan widths at different scan ranges. As you can see, the target aircraft is well within the 100 mile scan range. However, it would be invisible at a 200 mile range setting because it is beyond the limits of the scan cone. The radar scan cone is 160 degrees wide at 5 mile range, but only 30 degrees wide when operating at the maximum 200 mile range. For intermediate settings, the width of the scan cone is: 60 degrees at 100 miles, 90 degrees at 50 miles and 120 degrees at 25 miles. In practice, the useful range of the ECR-90 is about 65 miles.

Since the ECR-90 is a phased-array system and processes signals digitally, complete coverage of sky within the radar cone is nearly instantaneous. Unlike older, scanning radar systems, you do not have to remain exposed to enemy radar receivers for long periods while building up a picture of the sky ahead. This is of great help in keeping your position hidden from the enemy until you have entered into weapons range.

Identify Friend or Foe (IFF) functions are fully automatic and relieve you of the need to query targets individually. Enemy aircraft are indicated with red squares, as are neutrals. Friendly aircraft are indicated as green squares . The ECR-90 can also identify which enemy aircraft have already been targeted and fired upon by your wingmen or other friendly aircraft in the area. Enemy aircraft that have already been engaged will have an 'X' drawn through their target markers. All fixed-wing targets, friendly or enemy, sport a short tail that points away from their direction of movement. This allows you to quickly ascertain whether targets are approaching or receding.

To further simplify the task of threat assessment, the ECR-90 is capable of assigning a threat level to enemy targets. Threats are prioritised on the basis of which target is expected to intercept your aircraft soonest. The target with the shortest Time-To-Go (TTG) is assigned the greatest threat level. The six most threatening targets are automatically ranked with the letters 'A' through 'F'. The rankings appear as small letters inside each target square. Threat level rankings change dynamically as the targets move relative to the Eurofighter. The threat rankings are duplicated in the HUD target boxes with much greater clarity than on the radar display itself.

The ECR-90 can be programmed to arrange target priorities in two ways allowing greater flexibility in how the radar information is delivered to you. Targets can be prioritised strictly on the basis of their TTG, or filtered to assign priorities to strike aircraft first by activating the PRI button. When strike priority is selected, the ECR-90 will rank up to six strike aircraft based on their TTG. If fewer than six strike aircraft are in radar range, interceptors or escorts will be assigned the remaining rankings. By allowing easy identification of strike aircraft, you are more readily able to separate out those targets of greatest value for your current mission in a multiple target environment.

You should be careful when using the PRI function since the rankings are not necessarily a measure of the degree of threat faced by the Eurofighter. The PRI function should only be used for quick target identification when the mission calls for strike interdiction and then disengaged.

Missiles are also tracked by the ECR-90 and appear as small dots on the radar screen. Radar missiles are colour coded in yellow and Infra-Red (IR) missiles are colour coded in orange. There are no distinctions made between allied or enemy missiles and both will appear on the radar screen simultaneously. You can only determine whether a tracked missile is incoming or headed out to a target by observing its motion across the radar screen. When several missiles are in the air at once, it can become difficult to make the distinction and care should be exercised if you are relying on this information for evasive purposes.

Using the Radar Views

You can command the ECR-90 to focus the radar scan forward along the flight path, downwards toward the ground or upwards toward the sky. These changes in the azimuth setting of the radar antenna are under your control at all times. While you will generally keep the radar pointed forwards, there may be times when you may wish to focus the scan in another direction. For example, you can focus the scan downwards in order to detect low-level intruders or upwards to detect high altitude reconnaissance flights. The DWN, AHD and UP buttons illuminate when selected to indicate the current azimuth setting. In addition, a small symbol in the lower left hand corner of the radar display graphically depicts the current radar azimuth as well as

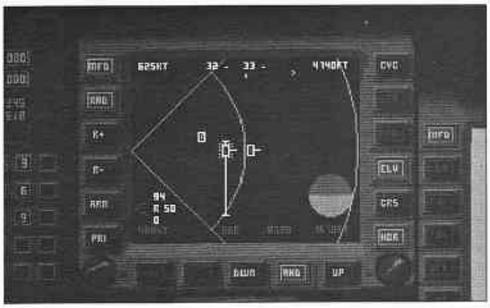


Figure 3

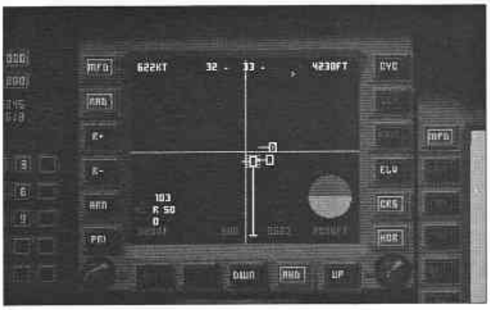


Figure 4

minimum/maximum scan altitudes and radar range. The ECR-90 can display the data collected through three different views: a conventional plan view, an elevation view (Figure 3) and a boresight view (Figure 4). The views share many common features, but there are significant differences. We shall briefly examine these views and compare the strengths and weaknesses of each.

The plan view is the most commonly used mode. It is typical of radar displays that you may have encountered in other combat aircraft. Figure 1 is an example of the ECR-90 in plan view. Plan view presents a top down picture of the sky in front of the aircraft. The scan coverage is indicated by the triangular pie section with the Eurofighter facing up from the point of the triangle at the bottom of the screen. The arc mid-way up the triangle represents the halfway mark of the current scan range. The plan view gives you an overview of where enemy aircraft are with respect to himself as if they were projected down on to a two dimensional map. You can quickly ascertain which targets are closest as well as how they are arrayed with respect to the Eurofighter's current flight path. Targets centred in the display are directly in the line of flight. Targets to the right or left of centre are, predictably, to the right or left of the current flight path.

The elevation view (Figure 3) displays information as if the viewpoint is located off to the side of the action. The ELV button will be illuminated when the radar is in this mode. The pie section is now turned on its side so that the Eurofighter is located at the point of the triangle to the left. Distance to the targets is represented by how far to the right they appear from the point of the triangle. Once again, the centre arc divides the range in half. This time the targets are shown relative to the Eurofighter's altitude rather than its flight path. Targets in line with the centre of the display are at the same altitude as the Eurofighter. Targets higher or lower on the display are at a greater or lesser altitude when the ECR 90 is in 'look ahead' mode. If the ECR-90 is looking up, all targets will be shifted downwards. Conversely, if the ECR-90 is looking down, all targets will be shifted upwards.

The boresight, or cross-section view (Figure 4) displays the radar returns as if they were painted on to a screen in the distance. The CRS button will be illuminated when the radar is in this mode. The radar information displayed on the MFD is divided into quadrants, and the centre of the MFD represents where the nose of the Eurofighter is pointed. Targets are shown with respect to the flight path. If they are up and to the right, that means the targets are to the right of and above the current flight path. Likewise, if a target is directly below the centre point, that target is directly ahead but at a lower altitude. Once again, if the ECR-90 is looking up or down, the targets will be shifted accordingly. Unlike the plan or elevation views, there are no distance cues based on the position of the radar blips.

Each view has its strengths and weaknesses. The plan view provides an easy way to visualise range and bearing to target but leaves you blind to altitude differences between targets. The elevation view can show comparative altitude in addition to range, but it cannot show whether targets are to the right or left of the flight path. Finally, the boresight view gives the most complete view of where a target is relative to the current flight path. However, it cannot display the relative distances nor does it show the direction of movement of each target. Between all three views presented by the ECR-90, it is possible to create a complete three dimensional image of where each target is within the space in front of the Eurofighter.

The views presented by the ECR-90 are always keyed to the Eurofighter's current attitude. The plan view always shows a top down view relative to the Eurofighter and the elevation view is always presented from the side. This means that if the Eurofighter is rolled 90 degrees to the horizon, the plan view becomes the elevation view and vice versa. Likewise, the targets in boresight view will rotate around the screen when the aircraft is rolled. As a consequence, it is possible to determine relative altitude from a plan view and angle off the nose from an elevation view simply by rolling the aircraft. This trick is particularly handy when you wish to obtain a 'quick and dirty' look at a different view but do not have time to change the radar settings.

Radar azimuth is affected in the same manner. The look up setting, for example, looks 'up' only if the Eurofighter is flying straight and level. This too has utility if, for example, you wish to keep the radar pointed at a target but have the nose of the aircraft pointed elsewhere. If the aircraft is rolled 90 degrees to the horizon, you can pull the nose away from the target to reduce closure rate yet maintain radar surveillance by switching the radar into look up or look down mode. Or you may change the azimuth and roll the aircraft through 360 degrees in order to obtain a wider radar coverage without changing your heading.

Target Tracking and Weapons Deployment

When you choose to track an individual target, several changes occur on the ECR-90 display. The tracked target becomes bracketed by dashed lines (captain's bars) on either side of the radar blip. A line of data on the bottom of the ECR-90 screen displays (from left to right) the selected target's speed, compass heading, range and altitude. A vertical bar will also appear which provides a visual cue for the minimum and maximum range of the currently selected weapon. The ECR-90 constantly computes weapons range based on the Eurofighter's current airspeed and altitude as well as that of the target and the vertical bar will lengthen or shorten correspondingly. If the selected target is within firing range of the current weapon, a 'SHOOT' cue will appear next to the target's radar blip. Targets are cycled with the CYC button which toggles through all the aircraft in the scan cone, (or by using the C and X keys just for allied and enemy aircraft respectively) and weapons are selected with the AAM button.

The ECR-90 is capable of both Air-to-Air (A2A) as well as Air-to-Ground (A2G) operation although A2G use is strictly limited to the targeting and delivery of the Sea Eagle Anti-Ship missile. The range of the radar in ground attack mode is limited to a maximum of 100 miles. The SEA button is used to select this mode and will be illuminated when active.

As powerful as the capabilities of the ECR-90 are, there are several problems and deficiencies associated with its use that you should be aware of. Since the ECR-90 is a Pulse Doppler unit, a target has to show movement against the background in order to be seen. It is difficult if not impossible to detect enemy aircraft flying at right angles, 'beaming', your radar. Small targets may not be detected at maximum range, and targets at low altitude may disappear due to ground clutter or masking by terrain obstructions. Adjusting the azimuth to scan downwards can assist in spotting enemies who are hiding in the weeds. Likewise, altering the Eurofighter's flight path can help to spot targets that are beaming your radar. However, these solutions are far from perfect.

The biggest problem associated with using the ECR-90 is visibility; not that of the enemy to you, but rather that of you to the enemy. Flying along with your radar turned on is the equivalent of walking about with a flashlight on a dark night. You can see reasonably well where your light is pointed, however you can BE seen from quite a long way away. The ideal for a combat pilot is to announce his presence with the explosion of ordnance, not to broadcast a challenge to every enemy interceptor in the sky. For this reason, you may choose to keep the radar off to maximise stealth until it is time to deploy weapons. Rely on passive systems such as the Joint Tactical Information Distribution System (JTIDS) or the Infra-Red Search & Track (IRST) system during combat operations in enemy territory.

Part II JTIDS

Overview of the Joint Tactical Information Distribution System (JTIDS)

Combat pilots have almost always relied solely on the sensors in their own aircraft, their radar and their eyes, to obtain information about the disposition of threats around their aircraft. Additional information regarding the disposition of allied and enemy aircraft within the larger theatre of operations, incursions by strike and interceptors as well as the location of ground based threats would only be available if provided by other sources. These sources include ground based radar operators, field spotters, forward air controllers and others. The information would then be transmitted to the pilots via radio messages. This situation creates several problems. First, the information is difficult to integrate into a working mental picture of the combat environment. Secondly, the information is static and sporadic. Finally, as we have already noted, active sensors put the aircraft and pilots at greater risk of detection and interception.

As a result, it has become increasingly important to provide pilots with a broader and more dynamic picture of the strategic situation. Doing so allows pilots to avoid threats where possible, remain hidden longer and attack targets with greater efficiency. In the modern combat environment, where the situation can change rapidly and weaponry has grown more complex, the need for accurate and timely information becomes crucial. After all, in the simulated world of EF2000, as in the real world, you cannot win the war if you are unable to consistently reach your targets, fulfil your mission objectives and get home safely.

Tactical Information Display

The JTIDS implemented in the Eurofighter represents the pinnacle of development efforts to provide combat pilots with the information they need to maintain a high degree of situational awareness.

Combining information from Airborne Warning and Control System (AWACS) aircraft, Joint Surveillance Target Attack Radar System (JSTARS) aircraft and Global Positioning Satellite (GPS) systems, we get the Joint Tactical Information Distribution System (JTIDS) allowing you to 'see' where enemy aircraft and Surface to Air Missile (SAM) sites are at ranges far beyond those possible with onboard sensors (Figure 5).

Figure 5

The middle MFD is used to display JTIDS and mapping data. Overlays are available that can display the disposition of airborne and ground targets as well as navigational information. The format for all display modes is identical and depicts the Eurofighter in the centre of the screen with the current flight path aligned towards the top of the MFD.

Range is adjustable in all modes and can be zoomed to focus more closely on the region surrounding the Eurofighter. The maximum range is 360 nautical miles and the display can be zoomed by halving the range in increments all the way down to a focus of just 5 nautical miles. When the Moving Map Display (MMD) is overlaid on the display, only two range increments are available: 80 or 40 nautical mile range maximums. Range circles are drawn on the display and denote the current maximum and one-half the maximum range.

Airborne target symbology is similar to the ECR-90. Enemy aircraft are indicated by red squares, allied aircraft indicated by green squares and neutral aircraft by blue squares. Fixed wing targets have tails which point away from the direction of flight, helicopters are depicted without tails. In addition, the colour coded dots in the centre of target markers identify the mission role of that aircraft. This includes all enemy aircraft but only extends to allied aircraft that are part of your strike package see Table 1.

Table 1: Aircraft Dot Colour Coding

	Strike	Escort	Wild weasel	CAP	Tankers	AWACS	SAM Sites
Your mission package	blue	orange	red	green	white	yellow	green cross
Enemy	red	orange	orange	orange	white	yellow	red cross
Neutral	blue	blue	blue	blue	blue	blue	blue cross

By checking the colour coding and flight path information, you can assess which aircraft in the immediate area pose the greatest threat to your mission objectives. Once identified, you can adjust your route to avoid detection or attack. Likewise with ground based threats, you can veer off your programmed waypoint route if SAM activity is particularly high in one area as compared to another.

Tactical information is not always available depending on whether the appropriate sensor aircraft are airborne. Indicators in the upper left-hand corner of the JTIDS screen display the words AWACS and JSTARS in green or red to indicate whether down-link data is or is not available from the given sensor aircraft. The information can also be filtered to display only airborne targets, SAM sites or both. The AIR and GND buttons will illuminate when the selected information is being displayed.

Navigational Display

The middle MFD also serves to display the Moving Map Display (MMD) which shows the location of the Eurofighter on a map of the surrounding terrain (Figure 6). The MAP button selects this function and will be illuminated when active.

Figure 6

A white bar with tick marks extends upwards from the centre of the display and indicates where the Eurofighter will be based on current speed. The tick marks represent the time of flight in two minute intervals. Waypoint information can be overlaid showing the route and waypoint numbers as blue boxes connected by white lines. The WAY button is used to select this information. If the mission parameters call for a ground strike, a large red triangle will be presented over the target area which can be toggled with the TAR button.

Mapping information allows you to plot the most advantageous route through enemy territory. You can use the information to take advantage of natural terrain to mask your ingress and egress to the target area from enemy airborne and ground based radar.

JTIDS data can either be overlaid on the MMD or displayed by itself. Likewise, waypoint and target data can be displayed independent of whether the map is active or not. The variety of combinations available gives you a wide choice of what information is presented and allows for enormous flexibility. The information can thus be focused to provide the clearest picture of the combat environment as it applies to the task at hand.

If available, you should always use JTIDS in preference to your own radar equipment. Not only will it provide a more complete picture of the surrounding battlefield, but it will allow the flight to proceed with a greater degree of stealth.

Part III IRST

Overview of the Infra-red Search & Track (IRST) System

Located on a small MFD under the HUD, the IRST system provides you with limited search and track capabilities. The IRST system allows you to track airborne targets without the need to activate radar and hence alert enemy aircraft. Developed originally by the Eastern Bloc, IRST systems have recently begun to appear in Western fighter aircraft.

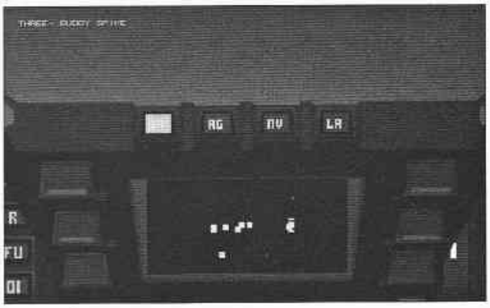


Figure 7

At moderate ranges, the IRST can be compared to a crude version of the ECR-90 in boresight mode. Operating out to a maximum range of just under 30 miles and covering a scan width of approximately 120 degrees, the IRST displays airborne targets by detecting temperature differentials and displaying small, bright green squares (Figure 7). Targets can be tracked in the IRST display and a pair of 'captain's bars' (small lines above and below the target blip) will bracket the current target of interest. The IRST, unlike active radar, provides no details on target range, speed or heading. Only the relative angle off the Eurofighter's nose is available.

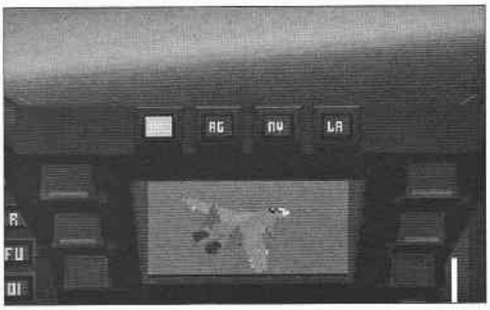
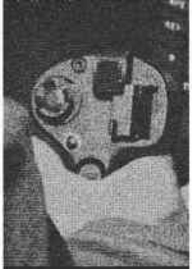


Figure 8

As the range to the target decreases, the IRST is capable of displaying a high-resolution image to allow target identification prior to weapons release and will track the target through nearly 360 degrees of viewing angle (Figure 8). The maximum range at which a target image becomes available is approximately 15 miles. There are flaws in the implementation of this system that you need to be aware of. The range at which a high resolution image becomes available is tied to the effective range of the selected weapon, therefore, maximum range capability is only present if the currently selected weapon is a long-range radar missile. If IR missiles are selected, the range decreases to approximately half this distance, or 8 miles. If the cannon is the selected weapon, the range decreases even further to approximately 2 miles.

The IRST display also doubles as a Forward Looking Infra Red (FLIR) for target identification when Maverick Air To Ground missiles are selected.



Part IV DASS

Overview of the Defensive Aids Sub-System (DASS)

'A good offense is the best defence.' There is a lot of truth in this statement. There is no doubt however, that you will appreciate the defensive capabilities built into the Eurofighter with the DASS when the enemy has applied this maxim against you and missiles are in the air aimed at your Eurofighter.

The DASS combines a Radar Warning Receiver (RWR) that detects and identifies airborne and ground based radar threats with a system for dispensing countermeasures to thwart inbound missile threats. Chaff packets are dispensed in order to confuse radar guided missiles and flares to distract Infra-Red (IR) homing missiles. Capable of performing several defensive tasks at once, the DASS reduces your workload considerably by timing the release of countermeasure packages in order to achieve the greatest effectiveness against inbound threats.

Figure 9

Located on the right MFD, the DASS displays information collected by passive receivers as well as the ECR-90 radar system (Figure 9). The display is a top-down view with the Eurofighter at the centre of a pair of concentric circles designating ranges of up to 80 nautical miles. The display is aligned with the direction of flight at the top of the circle. A 120 degree pie section represents the portion of the sky visible to both the ECR-90 and IRST systems. This area of the DASS delivers information in a much higher resolution than the remaining 240 degrees.

Threats are represented by colour coded symbols according to type. Airborne radar transmitters appear as red squares with numeric codes to identify the source of the emissions. Interceptor target tracking radar appears as either numerals '1' or '2' (the less sophisticated aircraft having the higher designation). Strike aircraft search radar appears as a numeral '2'. Airborne Warning and Control System (AWACS) aircraft search radar appears as a numeral '6'. Ground radar transmitters appear as red crosses and also display numeric codes to distinguish the source. Surface to Air Missile (SAM) sites appear as a numeral '3'. Ship based radar systems appear as a numeral '4' and long range Early Warning (EW) sites appear as a numeral '5'. Allied radar sources are coded similarly but are shown as green symbols rather than red one.

Radar missiles appear as small yellow squares and IR missiles appear as small orange squares. Both allied and enemy missiles are displayed on the DASS and no differentiation is provided. You must observe the course of the missiles to determine if they are inbound or outbound. If a radar missile is being jammed by your Electronic Countermeasures (ECM) or chaff packets, its symbol will flash on and off. This does not, however, mean they have been spoofed and you should continue to observe flashing missiles until you are sure they are no longer a threat.

You may select the range at which the DASS displays active radar sources or disable the system entirely if no automated release of countermeasures is desired. If active, the DASS will automatically begin dispensing countermeasures when an inbound missile threat is approximately 5 nautical miles from the Eurofighter. The DASS will continue to dispense chaff and/or flares until the threat is defeated, the countermeasures are exhausted or the Eurofighter is destroyed, whichever comes first.

Part V HUD & HMD Systems

Overview of the Heads Up Display (HUD) and Helmet Mounted Display (HMD) Systems

The final major components of the Eurofighter avionics suite are the HUD and HMD display systems. HUD technology has been a part of all combat aircraft since World War II. It was first introduced to provide a predictor gunsight that allowed pilots to more accurately target enemy aircraft with their guns. These early implementations projected an image of the gunsight on to a plate of glass mounted above the instrument panel between the pilot and the aircraft canopy. Modern HUD systems have not radically changed the method of providing information. However, with the introduction of computer technology, the amount and the quality of the information available to the pilot has increased and improved dramatically (Figure 10).

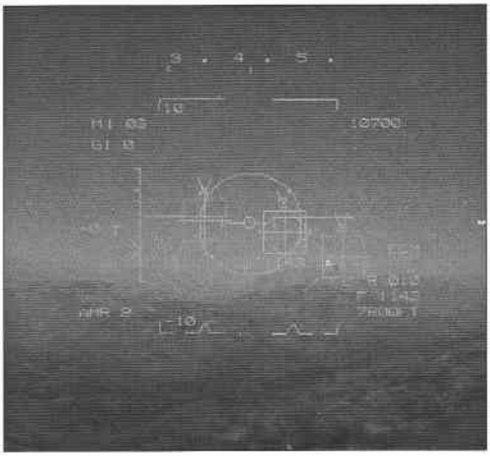


Figure 10

The HMD is a more recent advancement in technology and is geared towards integrating information and targeting systems directly into the pilot's helmet. The system is essentially a 'look and shoot' technology allowing the pilot to focus the aircraft's weapons systems on a target simply by pointing his head at it. This keys in with developments in weapons technology that allow for 'off-boresight' delivery, or in other words, the ability to fire on targets that are not in front of the aircraft. In addition, vital flight data can be presented to the pilot even if he is not looking at the HUD or instrumentation. There are enormous tactical advantages to having such a system. With it, the pilot can engage targets over a broader section of the sky with far less manoeuvring and can enable the pilot to effectively track and destroy multiple targets in a close combat environment.

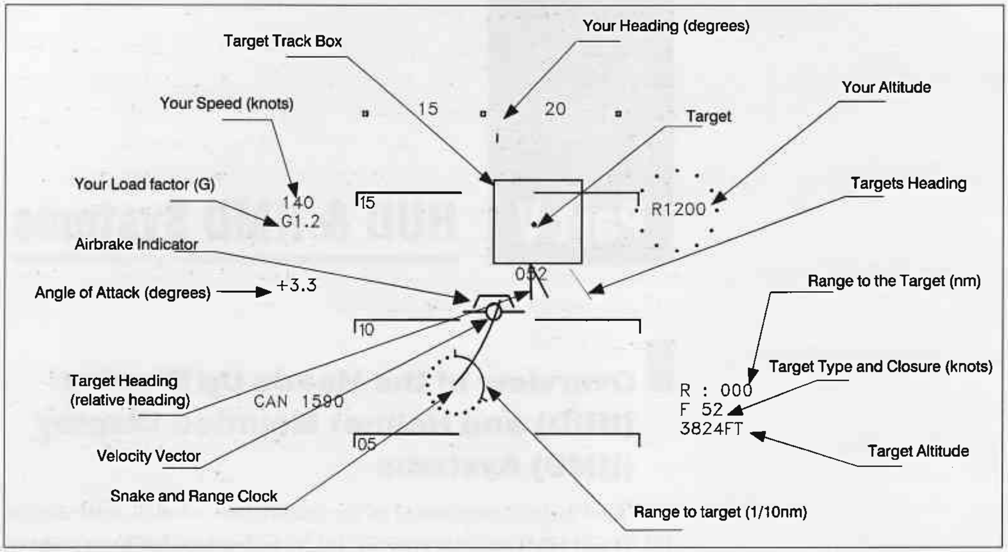


Figure 11

The HMD is active whenever you are using one of the padlock views or scrolling the full cockpit view.

The HUD operates in four modes: Air-to-Air (A2A) mode, Air-to-Ground (A2G) mode, refuelling mode and instrument landing mode. A2G mode doubles as a navigational mode that is tied to the programmed waypoint route. The information presented to you in each mode is tailored to the task at hand. However, many items are common to all modes. We will look at the common features first (Figure 11) and then take note of the more specific features of the different modes.

Common HUD and HMD Symbology

Airbrake

A small flashing symbol will appear above the velocity vector whenever the airbrake is extended.

Airspeed

Aircraft velocity is indicated in knots up to the speed of sound, which varies depending on altitude. Supersonic velocity is indicated by Mach number.

Altimeter

Altitude is indicated as feet above ground level up to an altitude of 5,000 feet above the surrounding terrain. Standard barometric (above sea level) altitudes are shown for flight levels of over 5,000 feet above the current terrain. Altitude is shown in hundreds of feet. A series of dots arrayed around the altimeter readout resembling a clock face tick off altitude in hundreds of feet.

Angle of Attack (AoA)

AoA is the angle of the wing surfaces relative to the wind or airflow across the wings. This is of particular importance when the Eurofighter is in landing configuration in order to have the main gear touch down before the nose gear. The Eurofighter is capable of extreme AoA manoeuvres and this is of tactical significance in a dogfighting environment as it is possible to quickly bring weapons to bear on a manoeuvring target. Care should be exercised at high AoA however, since the large wing surfaces act as a very effective airbrake and airspeed can be depleted extremely rapidly.

Compass Tape

The compass tape scrolls above a vertical 'tick mark' which corresponds to the aircraft's current compass heading expressed in 10 degrees increments. The compass tape also displays a small inverted 'U' shaped indicator under the correct heading to your currently selected waypoint. When the waypoint indicator is aligned over the tick mark, the aircraft is flying directly towards the next waypoint. Small arrows appear on either side of the compass tape if the aircraft is not headed towards the waypoint. These act as steering cues to indicate the direction of turn required to bring the aircraft on course.

ECM Indicator

Displayed to inform you that the ECM is activated.

Master Arm Indicator

Provides information as to the type of weapon (A2A or A2G) currently selected and the quantity of ordnance of that type remaining. In refuelling and landing modes, this indicator switches to show the currently selected mode. Contrary to the published manual, weapons are NOT disabled in landing mode although they are in refuelling mode. Care should be exercised when landing that you do not pull the trigger as the currently active weapon will be fired. Once the Eurofighter is on the ground, all weapons are disabled.

Pitch Ladder

These lines across the HUD are aligned to the horizon and represent the aircraft's orientation to the ground. A wide, flat line represents the horizon itself, lines above the horizon are solid and lines below the horizon are broken with jagged markings. Small bars at the ends of the lines point towards the horizon. The pitch ladder is represented in 5 degrees increments in A2G, landing and refuelling modes. 10 degrees increments are used in A2A mode to reduce clutter in the HUD. The pitch ladder is not available in the HMD.

Terrain Following Box

Combining data from digital terrain maps, GPS and the radar altimeter, this indicator allows you to fly a low level profile and be assured of a minimum 200 foot clearance over ground obstacles in the flight path. Projected as a small rectangle on the HUD, you need only to keep the velocity vector within the 'box' in order to maintain a safe low level flight. The terrain following box is not available in the HMD.

Velocity Vector

A small symbol in the shape of an airplane that indicates the current flight path of the Eurofighter.

Air to Air HUD Symbology

When A2A weapons are selected, the HUD symbology changes to reflect the priorities at hand. In addition to the standard items noted above, several new items appear in the HUD as indicated below.

Aiming Reticle

When missiles are selected, this circular symbol represents the 'kill circle' for missile deployment. Except for the ASRAAM, missiles must be fired at targets in front of the Eurofighter in order to have a reasonable chance of striking the targets. The size of the kill circle is dependent on the missile selected and is smaller for long range missiles than it is for medium or short range missiles. When firing a missile, the target tracking box should be within the kill circle in order to give the missile the best possible chance of scoring a hit.

An aiming reticle will also appear in the HMD when missiles are selected. This is of importance only when using the padlock views. Since the padlock view centres on the currently tracked target, the reticle is of no particular use or interest. However, care should be taken if you do not have ASRAAM missiles selected since the reticle has no relationship to the true kill circle. For this reason, you should not use the HMD when firing any missile other than the ASRAAM.

Break X

When a tracked target has flown inside the minimum range (Rmin) for the selected missile, a large 'X' is drawn across the HUD. Either switch to a shorter range missile or if none are available, switch to cannon.

Diamond X

This cross-hatched diamond symbol is seen when the selected target is not currently visible in the HUD but is still being tracked by the Eurofighter's sensors. Flying the aircraft in the direction of the Diamond X will bring the target into view. If the target flies beyond the view of the sensors, the Diamond X will not be visible. The Diamond X is not visible in the HMD.

G-Force

G-Force is the amount of centripetal acceleration acting on the aircraft, and consequently the pilot, when the aircraft is manoeuvring.

The number is a measure of how many times the force of gravity is currently being experienced. The force acting on the aircraft when it is flying straight and level is equivalent to 1 G, or the same as that created by gravity alone. When the aircraft is in a hard turn, the G-Force can rise to several times the force of gravity. Conversely, if the stick is pushed forward forcing the plane into a dive, the G force will drop to zero, indicating a free fall, or even negative values. The Eurofighter is capable of withstanding positive G-Forces of up to slightly more than nine times the force of gravity, or 9 G.

Pilots of high performance aircraft wear G-suits that are designed to constrict the legs and force blood to the head to help counteract the effects of high G manoeuvres. Nonetheless, sustained exposure to high G forces will cause the pilot to 'black out' and leave him incapable of controlling the aircraft. Negative G forces cause blood to rush to the head resulting in 'red out' with much the same consequences. The ability of a pilot to tolerate negative G forces is significantly less than for positive G forces. Flying a high-performance combat aircraft means subjecting yourself to G forces as a matter of course. Nonetheless, care should be taken to avoid doing so to the extent that performing the task at hand becomes impossible.

Predictor Gunsight

A circular gunsight pipper appears when the cannon is selected. The outer ring of the gunsight serves as a range indicator and appears solid when the target is at a range of three miles or more. As the range falls under three miles, the solid ring will start to shrink in a counter-clockwise fashion leaving a dotted outline behind. A dot in the centre of the ring is connected by a line to the centre of the HUD. This line, or 'the snake' as pilots refer to it because of its often convoluted appearance, represents the predicted path of the cannon shells projected on the HUD as the aircraft manoeuvres. The 'head' of the snake is connected to the centre of the HUD and represents the nearest point where the shells would hit, right in front of the nose. The pipper is the 'tail' of the snake and by placing it directly over the selected target you can be reasonably certain of scoring a hit. Detailed information on using the predictor gunsight is provided in Chapter 5.

Target Data Block

Three lines of data about the current target are projected on to the lower right hand corner of the HUD. The first line represents the range to the target in miles. The second line indicates target type and closure rate. The closure rate is a measure of the relative speed along a direct line between the Eurofighter and the target and is expressed in knots. A positive number indicates that the two aircraft are moving closer, a negative number indicates that the two aircraft are moving apart. The last line displays the target altitude. Target types are indicated as: F for fighter aircraft, B for bombers, A for AWACS aircraft, R for refuelling aircraft and U for helicopters and other, utility or unidentified targets.

Target Track Box

When a target is being tracked by either the ECR-90 or the IRST, it is designated in the HUD by a solid square box. If the ECR-90 radar is active, multiple target boxes are presented with threat priority cues above each box. All targets within the current radar range are shown. In the case of multiple targets, the currently selected target is surrounded by a solid box. All other targets are surrounded by dashed boxes. Allied aircraft appear as boxes with a dashed 'X' through the middle. Targets already fired upon have a solid '+' symbol drawn through them. Closure rate is indicated in knots under each box when the target is within a 15 mile range.

A small caret symbol around the outside of the target track box corresponds to the relative heading angle, or the difference between the target's heading and that of the Eurofighter. The direction that the caret is pointing corresponds to the direction that the target's nose is pointing. If the Eurofighter can be thought of as pointing straight up through the HUD, the point of the relative heading caret corresponds to the direction the target is facing. A caret pointing down indicates that the nose of the target is pointed directly opposite that of the Eurofighter, a caret pointing up indicates that the target's nose is pointed in the same direction. A straight line projecting from the box represents the target's current compass heading as if projected on to a standard compass rose with north at the top. (See the section on interpreting the target track box symbology below for examples.)

Missile Seeker Diamond

When the missile seeker head is tracking the selected target, a diamond symbol will overlay the target track box. You should wait until you receive a shoot cue or the Weapon Range Bar indicates the target is within range before firing.

Weapon Range Bar

A vertical line along the left side of the HUD indicates the maximum and minimum range in relation to the current target. Two small lines project to the left from the top of the bar. When missiles are the selected weapon, the uppermost marker indicates the maximum tracking range for the missile. The lower line indicates the maximum firing range for the missile under the current conditions. The firing range line will move up and down depending on aircraft speed, target speed and aspect angle. A small caret symbol will move up and down the bar as actual range to the target increases and decreases. If no caret symbol is visible, the target is beyond maximum tracking range for the missile.

HMD Symbology

The HMD becomes visible whenever you are not looking through the standard HUD (Figure 12). This occurs in padlock view, wide-angle tracking view or in the scrollable full cockpit view. The HMD shares the same symbology as the A2A HUD with only a few exceptions. Pitch ladder information is absent in the HMD. The Diamond X is also absent in the HMD since it is assumed that you have the target in sight. When missiles are selected, shoot cues are available however, only the ASRAAM missile which is capable of off-boresight targeting should be fired from this view. Despite the appearance of an aiming reticle, all other missiles should be fired from the A2A HUD so as to place the target within the kill circle before launch.

Figure 12

The HMD displays all cues from the A2G, Refuelling and Landing HUD modes except the A2G targeting sights.

Air to Ground HUD Symbology

When Air to Ground weapons have been selected, the HUD symbology changes to reflect navigational and weapons release information. Three different targeting sight modes are available and are automatically selected depending on the currently active weapon as indicated by the Master Arm display. Waypoint navigation cues are provided in all Air to Ground HUD modes. Detailed information on weapons selection, delivery and targeting will be provided in Chapter 7, 'Air to Ground Combat'.

This section is intended only as a brief overview of the HUD terminology. We will first look at the changes reflected in the HUD as they apply to navigation, and then examine the individual targeting sights.

Waypoint Data Block

Three lines of data about the current waypoint are projected on to the lower right-hand corner of the HUD. The first line represents the currently selected waypoint number as well as the type of upcoming waypoint where applicable. The second line indicates the distance and compass heading to the waypoint. The final line shows a countdown timer representing the Time on Target (TOT) and indicates the time required to reach the selected waypoint based on current speed of the aircraft. Waypoint types are indicated as: R for refuel, I for Initial Point (IP) which signifies the running in point for striking a ground target, T for the target waypoint itself and L for landing at home base.

Waypoint and Target X Marker

A small 'X' will appear in the HUD marking the point on the ground directly beneath the current waypoint. When the target waypoint is selected, the 'X' will be placed directly on the assigned target.

A2G Targeting Sights

Freefall Bomb Sight

When a freefall bomb is selected, a fall line is drawn on the HUD to indicate the path of the weapon across the ground after it is released (Figure 13). In addition, a Time to Release (TTR) countdown clock will appear as a large circle when you are approximately one minute away from the target and shrinks counter-clockwise as you approach. If you place the fall line directly over the Target 'X' marker and flies perfectly straight and level, releasing the bomb when the countdown clock reaches zero will result in a hit. While it is possible to strike a target in this fashion, the more common scenario is to make use of the Continuously Calculated Impact Point (CCIP) marker. The CCIP is indicated as a small horizontal line crossing the fall line and indicates the projected point of impact if the bomb is released 'at that moment.' Since the impact point is always under the nose, unless you are flying fast and low, it will often be necessary to dive towards the target in order to see it. Release the bomb when the CCIP marker is over the Target 'X'.

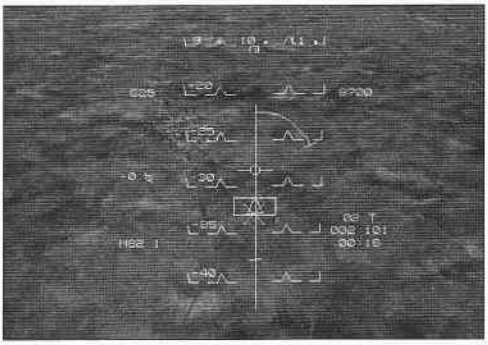


Figure 13

Unguided Rockets and Cannon Strafing Sight

When CRV-7 rockets or the cannon are selected, an A2G predictor sight with a range circle similar to the A2A gunsight minus the 'snake' appears. The predictor sight indicates the point of impact for the weapons as shown in Figure 14.

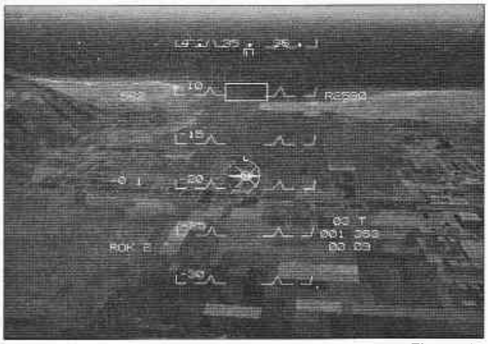


Figure 14

Alarm Anti-Radiation Missile Sight

When the seeker detects an active ground radar emission a box will appear on the ground over the target site. When the ALARM missile is within firing parameters, the box will be marked with a cross '+' and the weapon can be released. (Figure 15).

Figure 15

Landing HUD Symbology

When the Landing HUD is activated (Figure 16), the waypoint steering cues on the compass tape will direct the Eurofighter to the nearest allied base. The Master Arm indicator will switch to indicate LANDING. Once again, contrary to the manual, weapons ARE live in landing mode and care should be exercised not to release weapons over your home airfield.

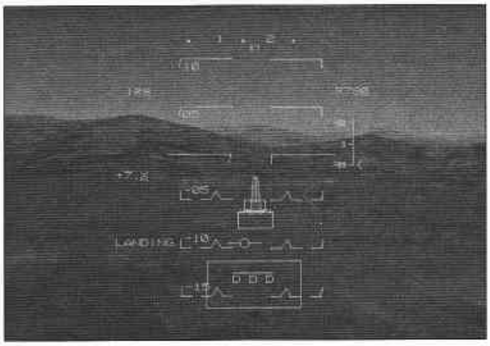


Figure 16

Command Flight Path Display (CFPD)

If an Instrument Landing System (ILS) is active at the air base, selecting Landing Mode will activate the CFPD if you are within 30 miles of the runway. CFPD displays a 'corridor of boxes' that provide a visual cue for the landing glide path. Simply guide your velocity vector through the boxes much as you would use the Terrain Following Box and you will be guided along a perfect approach path.

Landing Gear Indicator

The landing gear on the Eurofighter is automatically retracted at speeds above 300 knots. When the aircraft's speed is below 300 knots the landing gear may be extended. A small horizontal line appears below the velocity vector with three 'D' symbols beneath it if the landing gear are down and locked. If the landing gear is moving or not locked, three 'X' symbols appear.

Vertical Speed Indicator (VSI)

The VSI appears as a small vertical scale with an indicator caret on the right side of the HUD. The VSI displays the rate of climb or descent in Feet per Second (FPS) and is calibrated to show vertical changes from -20 to +20 FPS. Changes in altitude at greater FPS rates simply peg the meter. In order to execute a smooth landing, the VSI should indicate a descent rate of approximately -10 FPS.

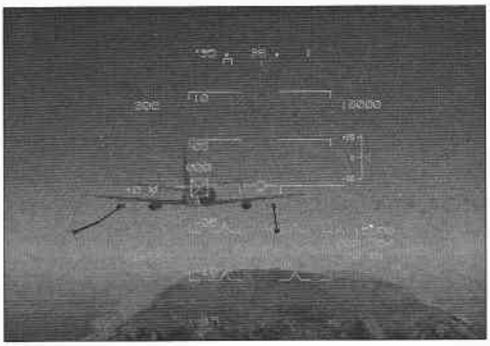


Figure 17

Refuelling HUD Symbology

When the Refuelling HUD is selected, the waypoint steering cues on the compass tape will direct the Eurofighter to the nearest refuelling tanker aircraft. The Master Arm indicator will switch to indicate REFUEL. The data block in the lower right-hand corner of the HUD displays information relative to the refuelling aircraft (Figure 17). The altitude of the refuelling aircraft is presented on the first line. The distance and compass heading appear on the second line. The third line displays a countdown timer that represents the time to intercept the refuelling tanker based on the Eurofighter's current speed.

A small target box with an 'X' drawn through it represents the location of the refuelling tanker and displays the same relative heading caret as other A2A target boxes. No compass heading marker is displayed for the refuelling tanker. Closure rate is indicated in knots above the target box. In addition, a VSI indicator is provided to assist in maintaining altitude with the refuelling tanker.

Interpreting the Target Track Box Symbology

Understanding the Target Track Box symbology is crucial to proper weapons deployment. We will look at a simple example now to illustrate this very important part of the A2A HUD.

In Figure 18, we will assume that north is up as if we were looking at aircraft symbols projected on to a map. The Eurofighter on the right, facing West, is pointing at an Su-35 facing Northwest. Notice that the heading marker on target track box points in the direction of the Su-35's flight as if the marker itself was a compass rose. The relative heading caret points up and to the right to indicate that the Su-35 has its nose pointed ahead and to the right of the Eurofighter's flight path. The number below the Target Track Box displays the closure rate in knots.

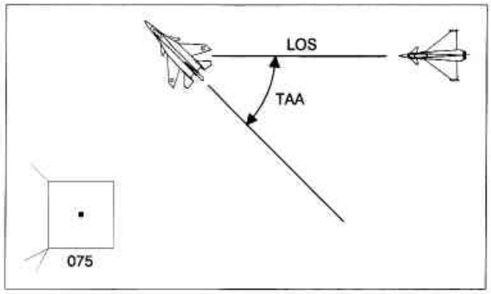


Figure 18 Target Track Box and Target Aspect Angle

Target Aspect Angle (TAA) is the angle between the Line of Sight (LOS) and the target's velocity vector. If the target is out in front and you are looking at the target's six, the aspect angle is 0 degrees. If the target is turned around however, so that it is out in front but facing directly at you, the aspect angle is 180 degrees. Aspect angle is often expressed as an angular degree and a direction that indicates the side to which the target's nose is pointed. In the example above, the aspect angle is 45 degrees Right. If, however, the Su-35 were turned so as to be flying directly down the page, the aspect angle would be 90 degrees Left. Target aspect angle is an extremely important consideration for missile deployment.

When viewed through the HUD, the relative heading marker is a reasonable indicator of TAA. In Figure 18 the aspect angle is 45 degrees Right, you will notice that the caret is pointing up at 45 degrees and to the right.

The important thing to remember is that in versions of EF2000 prior to the release of TactCom the relative heading marker is NOT necessarily related to the aspect angle, it is only a reflection of where the target's nose is pointed. If you are viewing the target through the main HUD display, the relative heading marker corresponds accurately to the aspect angle. However, although the target track box in the HMD is identical to the one in the HUD, the relative heading marker is NOT a correct indicator of the target's aspect angle in this situation. This is because you are not necessarily facing in the same direction as the aircraft,

The symbology of the target track box shown in Figure 18 would look the same regardless of where the Su-35 was in relation to the Eurofighter. The symbols are the same as long as the Su-35 is flying Northwest while the Eurofighter heads west.

Pilots not accustomed to using Helmet Mounted Displays may find the situation confusing at first but once you understand this important difference it will become clear. This deficiency has been corrected in the TactCom release of EF2000. The relative heading marker now behaves like a true aspect angle indicator. If, for example, the Su-35 in Figure 18 were positioned behind, rather than in front, of the Eurofighter, the relative heading marker would appear to be pointing down and to the left. In other words, the relative heading marker now shows where the target's nose is pointed in relation to the Eurofighter itself, rather than the Eurofighter's nose. This makes determining the heading of the target much easier and less confusing, since the player no longer has to take the Eurofighter's heading into account. Regardless of whether you are looking through the HUD or the HMD, or which direction you are facing to view the target, if you see that the relative heading marker is at the top and pointed down, the target is facing you. Conversely, if the relative heading marker is at the bottom, pointed up, the target is facing away from you.

Overview of Precision Air to Ground Targeting Systems

To provide multi-role capabilities, the Eurofighter is equipped with systems for delivering precision air to ground weapons: Laser Guided bombs and Maverick Air to Ground missiles. The Chapter on Air to Ground Combat will cover the use of these in detail with respect to targeting and delivery. This discussion is intended to provide an introduction to these components with respect to the avionics suite.

Thermal Imaging and LASER Designation (TIALD) System

The Thermal Imaging and Laser Designation (TIALD) system is used to provide target designation for the delivery of laser guided bombs.

The TIALD appears on the centre MFD (Figure 19). When active, the TLD button will be illuminated and a video image of the target area will appear in the MFD. The default image is produced with a thermal imaging system that displays a false colour infra-red view of the target area. A low light television image can be used if thermal contrast is poor. The TV button will illuminate when the low light camera is in use. The view can be zoomed in two stages for either sensor. When a zoomed view is active, the FOV (field of view) button will be illuminated. A target track box and laser cross hair can be slewed independently to provide flexibility in designating the impact point. A countdown timer along the right side of the MFD directs you as to the appropriate time of release.

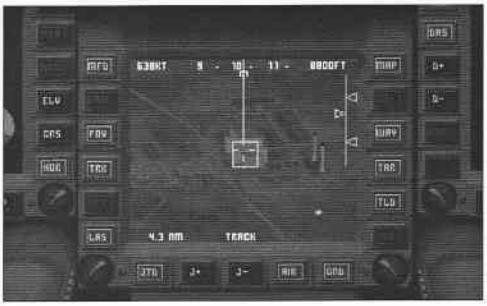


Figure 19

Maverick Missile Aiming System

Maverick missiles are equipped with Infra-Red optical recognition systems which identify and track targets based on heat signatures. The Maverick missile aiming system utilises two of the Eurofighter's display units, the left MFD and the IRST display (Figure 20). When Maverick missiles are selected, the left MFD will display an image of the target area which can be slewed to focus the missiles sensors in the direction of interest. The image can be zoomed and is indicated when the 2X is illuminated. A detailed image of the target is generated on the IRST display to confirm target identification.

Figure 20

Part VI MFD's

Overview of the Flight Assistance and Management Systems

Several additional displays pertinent to the operation of the Eurofighter are presented on the right MFD. These include the autopilot, system status displays for engines, fuel, expendable stores and damage warning displays. In addition, warning and status indicator lamps are located along the left side of the glareshield.

Figure 21

Engine Management Display

The Engine Management Display (Figure 21) provides information on throttle settings, fuel flow and fuel load. Throttle settings are in percentage of full military thrust. When the afterburner is engaged, the thrust setting will display 110 percent. Fuel load is in kilograms, and fuel flow rate is in Kg/min. You should check this display if you experience an engine fire and need to shut off an engine in order to verify that the engine has indeed been shut down.

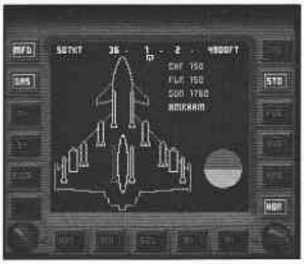


Figure 22

Expendable Stores Management Display

The Expendable Stores Management Display (Figure 22) displays a graphic representation of your available weapons and external fuel tanks. The currently selected weapon is shown in red; other stores are shown in green. This display also indicates how many countermeasure (chaff and flares) packets remain available on board the Eurofighter. You should check this display to verify that external fuel tanks have been dropped if the jettison command has been issued.

Figure 23

Fuel Management Display

The Fuel Management Display (Figure 23) depicts three bar graphs which represent (from top to bottom): your total current fuel load in kilograms, the amount of fuel required to reach the indicated waypoint, and the amount of fuel required to reach your base from your current location. The bar graphs are colour coded in red, yellow and green. The 'Fuel Left' bar will turn yellow when 3,000 kilograms of fuel remain, and red when you are down to 1,200 kilograms. The distance to the currently selected waypoint, as well as to your base, is shown in nautical miles at the bottom of the display. The display changes dynamically according to your current fuel flow and distance to destination. If you are carrying external fuel tanks, you can jettison them when the fuel level reaches 4,000 kilograms because this means they are empty. You should check this display periodically to ensure that you have sufficient fuel reserves to reach your target and return to base safely.

System Status and Warning Display

The System Status and Warning Display (Figure 24) will provide information on what procedures to follow if you suffer a malfunction due to combat damage. If you hear Nora say 'System failure', you should immediately check this display, as well as the Warning Annunciation Panel, to assess what type of damage you have incurred. Procedures that should be followed to mitigate the damage and avoid additional failures are displayed for each system malfunction. This display will also provide a mission briefing with information about your current mission objectives (Keypad INS).

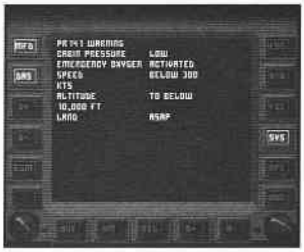


Figure 24

Autopilot System Display

The Eurofighter is equipped with a highly advanced autopilot system (Figure 25). Four different modes of operation are available: Waypoint, Heading, Tracking, and Throttle. Depending on the selected mode, you may set the altitude, airspeed, heading or waypoint number. A complete description of each mode and its operation is provided in Chapter 3.

Figure 25

Warning Annunciation and Status Panel

Located along the left side of the glareshield, the Warning Annunciation and Status Panel consist of several rows of indicator lamps that display the status of all the myriad systems in the Eurofighter (Figure 26). Lamps will illuminate in blue when a system is active. If a system is damaged, the indicator for that system will change to orange. A red lamp indicates failure of the system in question. If you

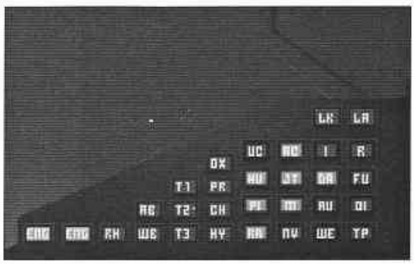


Figure 26

sustain battle damage, you should check this panel, as well as the Systems Management Display, to assess the extent of the damage.

BACKUP SYSTEMS AND REDUNDANT DISPLAYS

Figure 27

In extreme cases of damage, it is possible for the Eurofighter to lose some or all of the HUD and MFD functions. A set of analogue backup instruments will provide you with the essentials for navigation and maintaining level flight (Figure 27).

Located along the right side of the glareshield are a magnetic compass, artificial horizon and Vertical Speed Indicator (VSI). The compass also functions as a simple Horizontal Situation Indicator (HSI) which can tell you whether are following the waypoint course or not. A red marker will indicate the heading to the next waypoint and a green marker will display the Eurofighter's current heading. When these indicators overlap, the aircraft is on course. The artificial horizon provides a means for maintaining level flight. Finally, the VSI displays a white line that extends up or down from a central tick mark to roughly indicate the Eurofighter's climb or descent rate.

Several items are available on all the multi-function displays in order to provide you with basic flight information during periods when you are 'heads down' in the cockpit. Along the top of each MFD are duplicates of information that is normally visible in the HUD. In the upper left hand corner of each display is an indication of the current speed. Along the top of the displays is a duplicate of the compass tape along with waypoint marker and steering cues. In the upper right hand corner is an indication of the current altitude. Finally, an artificial horizon ball can be displayed in the lower right hand corner by selecting the HDR button.

The Radar and DASS displays are duplicated in the full screen HUD view, so you do not have to be 'heads down' in order to see these important items. In addition, the JTIDS can be displayed in this view as well by pressing SHIFT M. When the HMD display is visible, this information can also be made visible by pressing SHIFT M. however it will toggle all the features on or off at once. The current speed, time of day and engine throttle settings can be displayed along the bottom of any display by pressing SHIFT A .

Part VII Putting it to work – Using the ECR-90, JTIDS & DASS

Now that you have an overview of what the avionics can do, we shall run through a simple intercept mission to demonstrate some of the basic principles of navigating through enemy territory and reaching your objective.

We will use the AWACS mission in the simulator since it is an easy one and there is not a lot of enemy activity. The objective is to kill the AWACS. Anything beyond that is extra.

The mission parameters call for a flight of four EF2000s divided into two sections. The second section is slow to get off the ground - maybe as long as 5 minutes after your flight is cleared for takeoff. For this exercise we will assume that they are not available and takeoff without them. In any case, we are only interested in using the mission to illustrate how the avionics function together and how to use that information to make tactical decisions.

The default weapons loadout is perfectly adequate so simply hop in the cockpit, SHIFT S to get on the runway at Trondheim and get airborne (Figure 28).

Figure 28 Starting positions

When you get airborne, order your wingman into echelon formation and have him deactivate his radar. Even though we are going to attack an Early Warning Aircraft and it does not appear that stealth is an option much less an issue, it is a good habit to get into. There is no need to create an overly large radar signature and echelon keeps your wingman tucked in tight.

You will notice that our waypoint route takes us roughly Northeast and that the AWACS, the aircraft symbol with the yellow dot in the centre, is orbiting near waypoint 5. It is just possible to make out an escort (orange dotted aircraft symbol) near the AWACS, and we expect there will be at least two or more fighters there protecting the AWACS.

There is a small Combat Air Patrol (CAP) flight operating approximately 120 miles East of the air base and currently flying away from your position. In addition, there is an enemy strike mission with an escort in the air approximately 100 miles North of the air base and about 60 miles west of the programmed waypoint route.

The strike flight and its escorts are your immediate concern. The computer AI will almost always ignore allied flights that are beyond 70-80 miles, even if you are pointed at them. When you start to come inside that range, there is a chance that they will feel threatened and hence attack. Get within 35-40 miles and the AI will almost always attack.

You will see that there is an allied flight about to engage the escorts although you cannot count on them to clear out the threat. There is also the possibility that the allied flight could drag the escorts towards the allied base or the waypoint route if they get into trouble. In any case, getting to your target safely is the first order of business.

The best way to ensure the success of any mission in EF2000 is to avoid detection and confrontation until you achieve the objectives. If it is available, you should ALWAYS use JTIDS in preference to your radar. In addition, the JTIDS provides a continuous, broad range coverage that radar cannot provide. Whenever you activate your radar, you broadcast your position to every enemy for miles around. Wait until you are committed to a fight or within weapons parameters before you light up the sky.

Fly East in trail of that small CAP for a little while. Climb to a good cruising altitude, and set the throttle for a relatively quick pace, just over supersonic speed is good and at 40,000 feet that works out to about 90 percent of dry thrust. Altitude will give your missiles a better shot at hitting the AWACS from beyond the range of it's escorts.

You need to get some separation between yourself and the strike flight before turning North. So fly East until you are south of the objective and the strike flight is roughly off to your left and slightly behind in your seven o'clock position. Once you reach that point, you can turn North, maintaining your distance from the strike flight.

Figure 29 Heading out

Based on the positions in Figure 29 it looks like you need to go about another twenty miles or so unless the CAP flight ahead decides to turn around and take a look at you. Keep an eye on that flight, if it starts to manoeuvre, you will have to start the turn North a bit sooner.

The allied flight engaging the strike group has been downed. Your companion flight is in the air and you can see them following the original waypoint route. You have already turned to the North and are flying between the two enemy flights operating in the area, but with enough separation that neither is likely to bother you. The AWACS and its escorts continue to orbit near waypoint 5 and the coast continues to look clear (Figure 30).

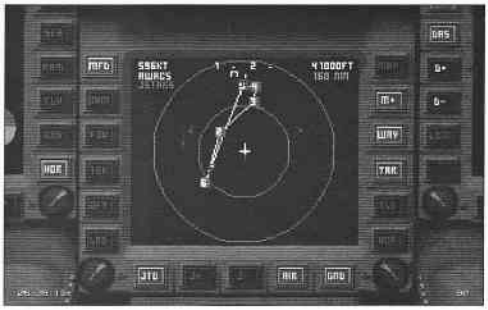


Figure 30 Heading towards the target

You will notice that the range on the JTIDS has been set to 160 nautical miles, half the maximum distance. This is mainly for clarity of illustration and also because there are few if any threats outside that distance in this scenario.

The 160 nautical mile range is, however, an excellent range for monitoring your passage around enemy formations. The inner circle, positioned at 80 miles, serves as a guide to warn you that getting any closer may get you in trouble. At the widest zoom level it is difficult to discern where the danger point is, and at narrower zoom levels you may not be aware of the danger until you blunder into a conflict.

Figure 31 Closing in

Nonetheless, you should make it a habit to expand the range periodically in order to check on the situation farther out. If other flights were en-route to rendezvous with the AWACS for example, you need to know about it.

You are closing in on our objective. In another couple of minutes you will to ruin someone's day. The AWACS is just about at the maximum range of our long range missiles and as luck would have it, the escort is on the far side. However, luck is always fickle, and notice that the AWACS is currently flying AWAY from you which reduces the effective range of the missiles dramatically. Having observed the enemy during our approach however, you know that the AWACS has been following a clockwise orbit so it should be turning right at any moment which will improve the missile range and give us a shot.

You will notice that the JTIDS has now been zoomed in to 80 miles and that the waypoint information has been removed (Figure 31). Zooming in allows you to see what the enemy is doing with greater clarity. We know we are in the right place so waypoint information is unnecessary as well as distracting. As the intercept progresses, you will want to zoom in more and more to monitor the location of the enemy fighters and ensure that none sneak around behind you.

Be careful though, reinforcements can arrive at any time and if possible you will want to check the long range view from time to time and avoid nasty surprises.

Time to take the shot (Figure 32). As the AWACS turned to the right, there are several things you should do: order your wingman into battle spread formation (in anticipation of attack), push the throttle forward to full military power (boosting your speed to give your missiles maximum inertia at launch) and finally, engage the radar to locate and lock the targets.

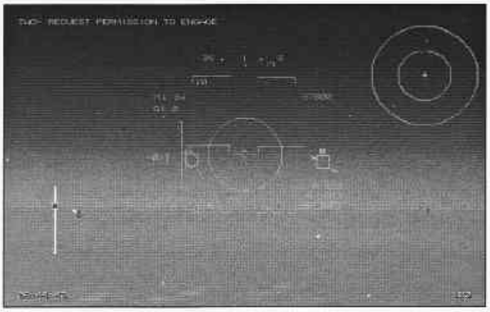


Figure 32 Taking the shot

The AWACS is on the left and the escorts are off to the right side. Of course, your wingman wants all the glory but fire at the AWACS before letting him engage the escorts.

In the full HUD view you can see the radar, DASS and JTIDS displays in the corners. Examine the aspect carets on the targets. They are all pointing to the lower right which correspond to the tails pointing to the upper left on the radar display. The white line on the radar display, as well as the range indicator on the HUD, show that the missile is well within range. The missile seeker head is locked on the selected target as indicated by the diamond in the track box, and the target data block confirms that it is type 'A', the AWACS. The priority letters above the escorts are a bit of a garble since they are so close together, but the 'E' above the locked target is clearly visible. The AWACS is farthest away and so gets the lowest priority, but the letter 'E' tells you that it is the fifth target which means there are four escorts.

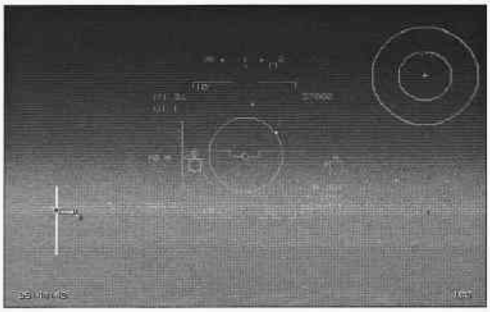


Figure 33 Missiles away

You have good speed and altitude for a successful missile shot, time to start shooting, Fox Two.(Figure 33).

A missile is on the way towards the AWACS as well as the four escorts. You can see the yellow tracks of the missiles outbound towards the escorts at the bottom of the radar screen as well as the track of the missile headed slightly to the left where the AWACS is.

The escorts are returning the favour, and their missiles are now visible as well. Notice how the missiles can be seen both on the radar screen as well as the DASS. There is a numeral 1 alongside the threat indicator on the DASS which identifies these fighters as front line interceptors.

The target boxes in the HUD now have crosses '+' and the tracks on the radar have an 'X' drawn through them indicating that they have been fired upon. There are four enemies, and four X's on the radar screen, so it appears as if everyone is accounted for.

Rather than continue to charge in and possibly end up too close to fire more long range missiles if the first volley misses, order the wingman to disengage and steer away from the incoming threats for a moment while your missiles close in on their targets.

Step the radar down manually to the 25 mile range. Although this puts the AWACS out of range (notice that its target box disappears from the HUD), the shorter range provides a wider coverage. This will allow your flight to turn away approximately 50 degrees from the incoming missiles and fighters, yet maintain radar contact.

Make sure that the ECM has been turned on in order to break the enemy's target lock and hinder incoming missiles.

Splash one. The AWACS is down and this mission is effectively over (Figure 34). You should be holding off with the escorts just inside radar coverage in order to keep an eye on them as our missiles approach. If the yellow dots representing your missiles continue past the escorts, then it is time to either break away from the bandits and make your escape or turn back in to the fight with medium range missiles and mop up. The missiles are seconds away from impact and the escorts must be working to evade them by now.

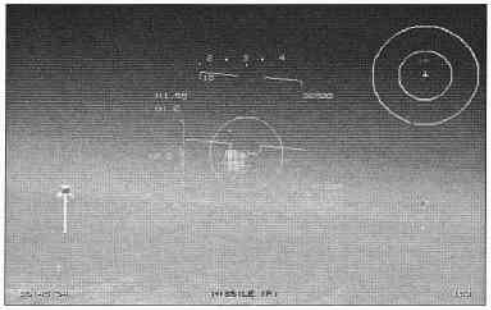


Figure 34 Splash One!

Your DASS will have been periodically pumping out chaff and along with the ECM, the first salvo of enemy missiles should have already passed harmlessly by. The remaining incoming missiles will be flashing to indicate that the DASS is actively jamming them. Nonetheless, if you have kept your speed up and are approximately beaming the incoming missiles you will present the missiles with difficult target solutions.

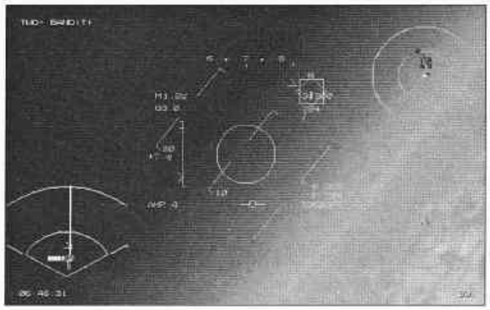


Figure 35 Three bandits down, one to go.

The escorts, on the other hand, are continuing to charge head on into your missiles. With a little luck, two or three of them will go down on this shot.

In this example, three of the escorts went down in the first volley and now it is time to turn back to clean up (Figure 35). The wingman calls one bandit left and fires a medium range missile at him. Verify the kill and prepare to head for home.

Figure 36 Targets of opportunity

Zoom the JTIDS back out to check the area, you can see that the strike flight is still airborne. The bombers are well out in front of their escorts and we have plenty of missiles left, a perfect opportunity (Figure 36). Order the wingman to shut off his radar and ECM, tuck into a tight formation and head for

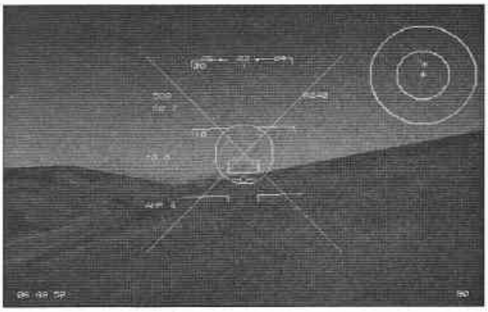


Figure 37 On the deck

Figure 38 At the fjord

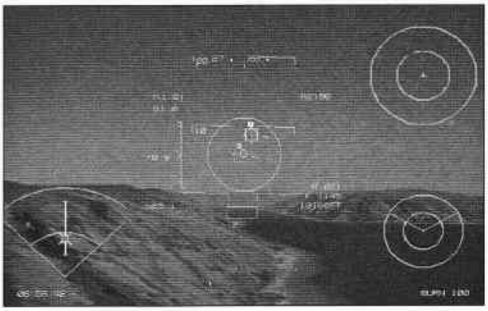


Figure 39 Nothing's perfect

the deck. See if it is possible to sneak up on the strike flight now that they are without AWACS cover.

The MMD showed a valley running back to the south, intersecting an east-west fjord that leads to where the strike flight appears to be lingering.

Hug the deck as in Figure 37 to mask your flight from the strike flights' radars. Your DASS will flash on and off periodically indicating that the strike flight is out there searching for you.

By following the terrain box, you can keep under their radar coverage and be masked by the mountains. The large 'X' on the screen accompanies 'Nagging Nora's' complaints to 'pull up' - 'if Nora isn't nagging you, you're NOT low enough' is a useful motto.

Once you reach the fjord, check the MMD (Figure 38). According to the timing markers on your projected flight line, it will take about four minutes at your current speed to intercept the bombers. It is unlikely that you will have that long before being picked up, but you should be able to get in close enough to take good shots. Hopefully the escorts will remain on the far side until it is too late.

It is probable that the bombers and their escorts will exchange places in the last couple minutes and what is worse, you may get spotted (Figure 39). Time to fire the last of the long range missiles before you reach minimum range then wait and see if more clean up is required.

The final outcome? Well the story is one for you to finish another day. See you back at Trondheim.

Chapter

3

LEARNING TO FLY

TAKING OFF

AUTOPILOT

FLIGHT PRINCIPLES

REFUELLING

BASIC LANDING

ADVANCED LANDING

DAMAGE

CHAPTER 3

Chapter 3

Learning to Fly

This chapter is all about learning to walk before you can run. Knowing the full limitations of your aircraft cannot only save you in life-or-death situations, it can help you achieve maximum performance in every aspect of flying that is addressed in this book. The standard elementary topics have been expanded upon to give you the information you need to learn how to perform tasks such as landing and refuelling in a variety of adverse and challenging circumstances. Advanced landing in particular is an important aspect given that you may frequently wish to rearm and refuel at a friendly airfield during missions.

Part I Taking Off

Pre-Flight Settings

Once you have entered the cockpit, the first order of business is to get your 'office' in order. Those of you with a Thrustmaster set up should start with a customary 'wake up' call via the relevant button. It is also prudent for users of all types of joystick to perform a quick ALT C with the controls set at neutral, then bring the throttle back to idle. This will centre your controls ready for taxiing - you do not want to start your engines and go speeding in circles around the pan because you had your throttle advanced and your rudder calibration was way off centre - it is pretty embarrassing to have to eject as you are about to plant your ECR-90 set-up into the tower before you have even left the ground.

The next order of business is to set up any navigational preferences. Start with your autopilot settings on the right MFD. Assuming you have already decided on your chosen altitude and speeds, punch them in now while you do not have to worry about flying the plane at the same time. If you selected and planned the mission yourself they should already be downloaded, although this should be checked anyway. When flying with human wingmen over a network you will probably use the autopilot waypoint mode as this is the best way to bring all the elements of the flight together. Now is also a good time for you to select what you consider to be your first waypoint rather than the one the autopilot has defaulted to.

When you are flying a networked mission, it is useful to set the autopilot heading mode to the same altitude and speed settings as the waypoint mode. That way if you all decide to divert from the waypoint heading en-route, it helps you keep in formation. Before leaving this MFD, switch it back to DASS mode and set the range to your preference. In general the lowest range is usually the most useful since it will display the most important threats, although setting it to the next step up will help you identify where long range missiles or SAMs are being fired from.

Now change to the centre MFD and set up the JTIDS. Personal preference is the rule here, followed by common sense dictating that you only attempt to display pertinent information. For example, if you are on a CAP mission there is little benefit in having SAM and AAA sites displayed as it will only increase clutter. The main benefit of the JTIDS overlay is its ability to display and update the positions of enemy planes all around your position. This removes the need for you to look for threats with your radar which would broadcast your presence and position to the enemy sensors. To this end, it is recommended that you consider the following standard settings as your defaults.

First turn off the map; this will give you a wider selection of range options and is only necessary should you need to fix your position. Select waypoints to off as you can use the bug that is displayed on the HUD compass tape to ensure you are going the right way. Now set the range to your preference. If you plan to time skip the first parts of a mission 80 miles is a good starting point, this way if you do get dumped close to bandits you will be able to discern their position and heading much easier and react faster rather than having to change views and fiddle with the mouse or trackball. If you intend to hand fly the mission 160 miles will be more appropriate.

To further reduce clutter in this display you should consider turning off ground site reporting. If you are on a Wild Weasel mission you will obviously not want to do this, but it is unnecessary for other mission types as the ground sites will not be moving around. Ideally you will have modified your waypoints to keep you away from ground fire until you hit your target, in which case you should already know where the sites are without needing the JTIDS to remind you.

The next task is to set up your radar. This can be done from the left MFD or from the main cockpit. You will find it much easier to range down the radar by at least one step. By switching the radar to manual ranging in this way you will find that the display will not jitter around - a symptom of locking on to a target that is using ECM. In practice this presents minimal disadvantage since your radar can acquire targets inside maximum range that are still beyond the capabilities of your missiles. Depending on your chosen altitude en route and your mission profile, you may want to consider changing the default 'look ahead' setting to look up or look down. Once you have set the range and mode, turn your radar off unless you wish to broadcast your position in advance to the enemy once airborne.

Return to the cockpit view and choose your preferred cockpit display. The fixed forward view brings a frame rate advantage and makes precision flying much easier. Finally, it is worth the extra clutter of adding the JTIDS overlay by pressing SHIFT M bearing in mind the range you have set it to on the central MFD.

Taxiing

Do not bother to start your engines until you get clearance to taxi. The radio message will tell you which runway you should be using. If you find it difficult to decide where to go from your heading and the given runway heading, look around you to see if there are any computer controlled pilots (CCP's) moving in a particular direction and follow them.

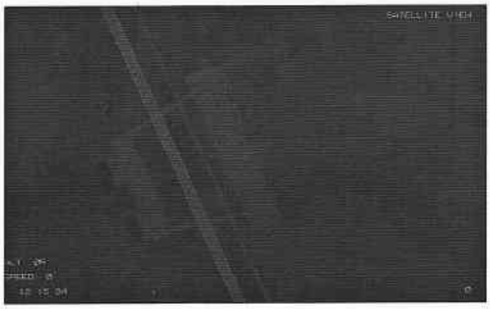


Figure 1

When you are playing multi-player network play, it does not matter too much which runway you use but it helps formation if you all depart from the same one. This will help you keep your flight together once you have departed as you will all be within visual range of one another. As a general rule try to congregate at the runway which has the windsock at the end. Real world conditions play no part in runway selection as wind effects are not modelled in EF2000. You can always look at the satellite view Shift [illegible] to get a better view of the layout of the airfield in relation to where you are (Figure 1). Once in satellite view, you can zoom in and out by using Shift Keypad 1 or 7.

Once you have your engines started, advance the throttle to around 72%, this will provide you with enough push to get moving. Taxiing is relatively safe at speeds of up to 20 knots, beyond this you will find control of the plane becomes more difficult especially when trying to negotiate turns. Think of it like driving a car: the faster you go the greater your turn radius will be. Bear this in mind when approaching any bends in the taxi way and do not try to imitate your computer wingmen who have the advantage of an invisible central pivot wheel! The wheelbrakes on the EF2000 are of the kind that would stop a herd of charging elephants in their tracks so use them sparingly. One excellent tip here for owners of programmable joysticks is to set your wheelbrake button with a press/release modifier. This will allow your braking to be much more controlled as it will only activate them for as long as you hold the button, making it far easier to trim your ground speed slightly.

Assuming you have a general idea of which direction you should be taxiing in, your next achievement will be getting to the runway without getting lost. There is usually a taxi way parallel to the runway, although you may need to cross the runway itself to get to it. Before you cross any runway, check both directions first for any sign of a refueller taking off - this is the only plane that will kill you if it collides with you. Likewise, crashing into a building will also result in a return to the game interface, so do not get careless. A particular example here is thinking you can takeoff over the grass. It is recommend that you

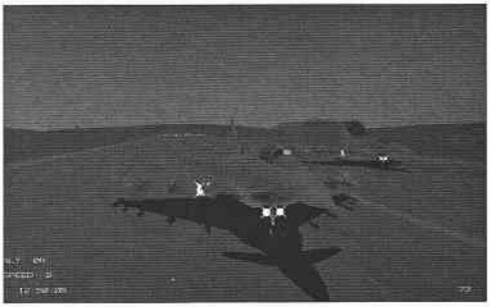


Figure 2

attempt this at least once - you will soon find out that it stretches your takeoff run considerably. Taxi way takeoffs are a little easier in terms of rolling resistance but still no substitute for the real thing. The only exception is with the King of the Skies options in which you can (and should) just kick in the afterburner and go for it (assuming there are no buildings directly in your path).

Once you have the feeling of taxiing, experiment with adjusting your speed by the use of throttle and wheelbrakes along the straight. When you approach the end of the runway, pick a place to line up and await your remaining wingmen, or slot in behind or to the side of them as shown in Figure 2. Fine tune your heading so that you are lined up perfectly with the opposite end of the runway. If you are displaced from the centreline, make sure that you are pointed at the same place on the opposite end of the runway to ensure a straight takeoff roll. Bring the throttle back to idle and apply the wheelbrakes while you wait to takeoff.

Taking-off

Once you are ready for takeoff, release your wheelbrakes and bring the throttle up to 100 percent power. There is no need to use afterburner for takeoff in most cases - it just uses up lots of valuable fuel. The only exceptions would be if you were scrambling or short of runway due to an intersection takeoff. You can use rudders on the takeoff roll to fine tune your heading but it is not recommended unless you really have to as it causes some instability and will affect your takeoff distance. Watch your speed until it reaches around 170 knots and then gently pull back on the stick until the nose wheel lifts off the tarmac. The main wheels will follow a second afterwards. If you are fully laden, you may need a few extra knots to get airborne.

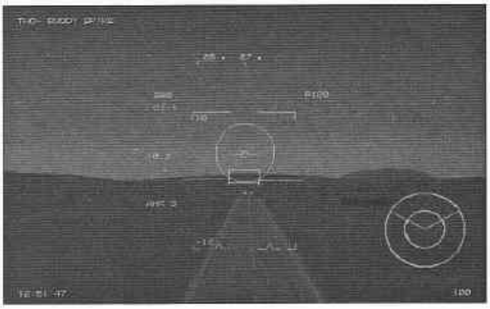


Figure 3

Do not pull up hard when you depart the runway - it is better that you stay in ground effect for a while as this will help you build up speed quicker. Ground effect is the cushion of air that forms between the plane's wings and the ground, causing extra lift. In this instance the extra lift is translated into forward speed by keeping the nose no higher than ten degrees up as shown in Figure 3. Do not forget to raise your gear once the main wheels have lifted off. Although the plane will do this automatically at 300 knots if you happen to forget, there is a large drag penalty for leaving them down, so do not get lazy.

After you have raised the gear and accelerated to around 250 knots, start a gentle turn (thirty degrees bank) on to your selected waypoint, maintaining between five and ten degrees nose up attitude (Figure 4). Bring the wings level on the waypoint and continue to accelerate until you get to around 400 knots at which point you can increase the pitch up attitude to between ten and thirty degrees depending on your ordnance and assuming you are not intending to fly nap of the earth.

Figure 4

Scramble takeoffs

If you need to takeoff in a hurry get to the runway as soon as possible - it does not have to be the end of the runway, but make sure you point yourself towards the end that is furthest away when you reach it. If you decide it will take too long to get to the runway (as is often the case) try lining yourself up with a lengthy piece of taxi way. Once lined up, increase to full afterburner and immediately apply full aft stick deflection. The nose will eventually raise (although for taxi way takeoffs it will bounce a fair bit) at which point you should bring the gear up immediately and level off at ten degrees nose up until you have reached a safe manoeuvring speed for whatever your next action will be.

Part II Autopilot

The autopilot as an aid is becoming more and more commonplace in aircraft nowadays. In a military jet like the EF2000, it gives the pilot the chance to forget about needing to fly the plane and concentrate on other vital tasks. It also relieves the physical effort that can wear you down on a long flight. The autopilot fitted to the EF2000 is particularly advanced in its various modes of operation. Most planes can fly to a set altitude and heading but, waypoint modes are a little less commonplace as are auto throttle features. To have the system linked into the targeting computer for the tracking mode is extremely rare. You will utilise the autopilot frequently during your missions in EF2000 so absolute mastery of its modes and operation is essential.

Autopilot Waypoint Mode

As an example, get the plane flying straight and level at 500 knots, then look at the right MFD and select the autopilot display. Ensure that waypoint mode is set and then alter the settings to reflect your current speed and altitude (these will be displayed at the top of the MFD). Engage the autopilot and return to the forward view. It is now possible to change your altitude and speed by the use of the keyboard without returning to the MFD. Just use the cursor up/down keys for height adjustments and the keys for speed adjustments. When making changes, try to do them a little at a time so as not to invoke the afterburner and waste valuable fuel. This is even more applicable when reducing your altitude as the autopilot will just nose over - as a pilot, you cannot take many negative G's and will soon start to red out if you are too aggressive.

Select Air to Ground weapons mode on the HUD and look at the distance to the next waypoint. Watch the autopilot very carefully as you approach a waypoint. Sometimes, when a new waypoint is selected by the computer it will have a different pre-set altitude. This tends to happen on player designed missions, usually when you hit the IP. If you have been cruising to the IP at 43,000 feet when the waypoint changes you can find the autopilot putting the plane into a steep dive down to the deck. To avoid this it is safer to turn the autopilot off when approaching the waypoint, manually change the waypoint, then check the settings before turning the autopilot back on.

Autopilot Heading Mode

This mode is very similar to the waypoint mode except that it will not follow the pre-planned route when waypoints are reached and the heading to the next waypoint changes. This is useful if you feel you are likely to deviate from the route but wish to remain on autopilot. When this mode is engaged you can use the cursor left/right keys to adjust your heading along with the up/down keys to change your altitude.

Autopilot Tracking Mode

This mode requires you to select an airborne target in your HUD through the Air to Air or refuelling modes. When this is done, simply select the speed and engage the autopilot. As before, you can adjust speed with the [+] [-] keys. The autopilot will manoeuvre the plane to the targets six o'clock position and will maintain that position if you have selected the correct speed. This mode is useful for lining up or holding station with the refueller.

This mode comes into its own in multi-player missions, where you can track your wing leader and follow him wherever he decides to go within the limits of the autopilot. You should not however use the tracking mode to follow the leader while he is terrain following - it is possible that the autopilot will fly you into a hill if the leader pulls a tight turn around a peak or the like. Instead, use either heading or waypoint mode if you have to.

Auto Throttle

The auto throttle has limited uses. The only two times you might want to use it is when on the approach to land or when refuelling. It is useless in dogfights as it does not have any ability to predict which manoeuvre you will perform next and therefore lags behind what you want it to do. Again, once engaged you can adjust the speed using the keyboard as before.

Part III Flight Principles

Principles and advantages of Fly By Wire

Fly by wire systems operate by taking the pilot's control inputs and interpreting them via a series of redundant computer systems before translating them into the control surface output. Current fighter aerodynamic technology utilises designs which make the plane inherently unstable in flight. The benefit of this is that it extends the plane's manoeuvring capabilities. As the plane is unstable, a fly by wire system is necessary to make the plane flyable. It is argued that fly by wire 'makes an average pilot good, but it also makes a great pilot good'. Nonetheless, the Russians are switching to fly by wire systems for their new combat aircraft despite the fact that their planes were typically more manoeuvrable than the Western equivalents.

Fly by wire will also stop pilots from performing dangerous manoeuvres in some situations, wherein lies the disadvantage - sometimes that little extra pull might make the difference between life and death. In EF2000 you have no G or AoA limiters which removes the majority of the limitations inherent in early designs. Regardless of the implementation, fly by wire still gives massive advantages to the pilot and is here to stay.

You can watch fly by wire in action on your EF2000 by switching to an external view of the front three quarter of the plane. Once you have the view lined up, pull back hard on the stick for a few seconds and then abruptly release the controls. You will see the canards move towards the neutral position and then flutter in both directions for a second or so as it brings the plane into the desired attitude.

Control co-ordination

Whenever you perform a manoeuvre in the EF2000, you will need to co-ordinate the pitch and roll inputs simultaneously. To demonstrate this, put the plane into a shallow turn - the nose will gradually begin to drift downwards. The main aid that you have for control co-ordination is the flight path marker. As long as you keep the flight path marker on the same level as the zero degree pitch bar, you will maintain your altitude regardless of bank angle. This principle also applies if you wish to maintain a set rate of climb or descent while in the turn. (Figure 5) shows the ILS HUD view with the plane performing a standard rate turn with the flight path marker at the same level as the zero degree pitch bar. Cross referring to the Climb/Descent indicator proves that the plane is remaining at the same altitude while performing this manoeuvre.

Figure 5

Standard rate turns

A standard rate turn is defined as 45 degrees angle of bank. Put the plane into a turn and maintain your current altitude and speed. You will notice that you need to increase the throttle slightly to compensate for the loss of speed caused by the turn. If you perform the same turn while at a climb angle of twenty degrees for example, you will need to increase your pull back on the stick to maintain the same angle of climb. Note that this also increases the rate of turn due to the extra aft stick pressure you are applying. The reverse of this is true for descending turns. When entering a turn, think of the equation simply as how quickly you want to turn being directly affected by the angle of bank.

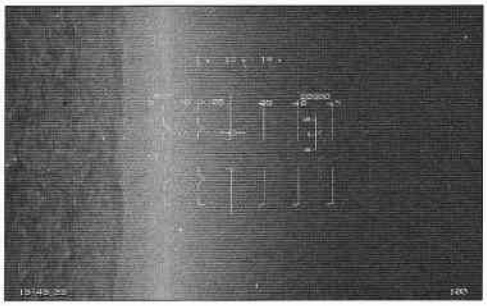


Figure 6

Hard turns

As a demonstration, try the following manoeuvre. Put the plane into a 90 degree bank (Figures 6 and 7) and just leave it there. Notice that the heading does not change at all and the nose gently slides towards the ground. To perform a hard turn you will also need to apply a large amount of aft stick deflection (pull hard back on the stick). Put the plane back into straight and level flight, bring the throttle up to maximum and light the afterburner. Once you have hit Mach 1, roll over to 90 degrees bank again and pull back hard while maintaining the same altitude. You will notice that as your speed decreases you will be forced to dial out some of the bank to be able to maintain your altitude. You will also find that this becomes more and more difficult to maintain as the planes speed decreases. Further,

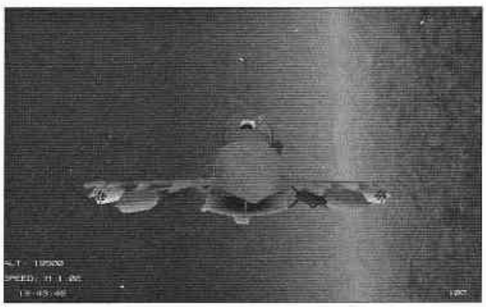


Figure 7

the rate of turn will begin to increase drastically as your airspeed decays. Try the same manoeuvre at 10,000 and 40,000 feet. You will now notice the effect that altitude has on your speed - the higher you are the faster you will need to be going to maintain effective control. When you are feeling particularly brave, take the plane down to the mountains and maintain the maximum rate of turn you can at the lowest altitude you feel safe at with your speed at around 130 knots.

Recovering from hard turns

When you are in a hard turn, try to picture the flight path marker as being where the main body of the plane is flying. Due to the canard design of the EF2000, the cockpit is in this situation a fair way ahead of the rest of the plane - the canards are effectively leading where the rest of it will follow. To demonstrate this, pull a hard turn until the speed has decayed to around 300 knots, then abruptly level the wings - notice how the HUD snaps back in the direction of the flight path marker. This is because the plane did not have time to catch up with where the canards were when you levelled the wings, so the main bulk of the plane dragged the canards back to the direction they were heading in. To stop from this happening, either roll out of the turn at a gradual rate or just stop pulling back for a second and then snap the wings back to level. At low speeds this violent sliding back and forth has been referred to as 'pitch bobbling', and can make accurate gunfire almost impossible. In these situations, you should use smooth and gradual movements at all times to improve your accuracy. Learn to master this particular aspect thoroughly and you will find your air to air gunnery success will be of a much higher standard.

Use of the airbrake

The exercise above showed how plane's airspeed will affect the rate of turn that it can perform. The airbrake is particularly useful for bringing your speed down quickly when performing hard turns at above 500 knots where it will take longer to bleed off the speed to give a high turn rate. Be careful not to leave it on by mistake as this will have you wallowing around as an easy kill for the enemy in a dogfight. You will also make use of the airbrake at times such as landing and refuelling so it is worth practising with its effectiveness until you are familiar with it.

Hard Descents

Take the plane to 40,000 feet and accelerate to a speed of Mach 1 or higher. Now push the nose over hard until you reach a pitch angle of minus 45 degrees. Assuming you have red out/black out turned on, you will now experience what the former looks like. Whenever you need to perform this kind of manoeuvre, it is always better to roll the plane inverted and pull back on the stick (Figure 8). Once you reach your required descent angle just roll around again so that you are the right way up. As you will see, this is a much faster way of getting to the required pitch down angle - it is also a whole lot more comfortable.

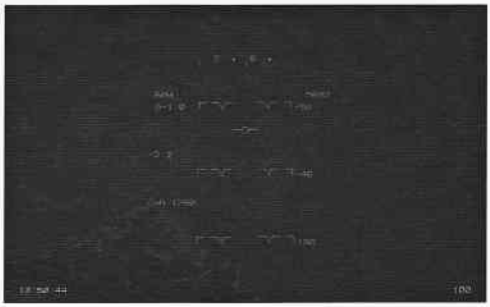


Figure 8

Effects of ordnance

The effect of ordnance on your plane is quite simple - the more you carry in terms of weight, the more thrust you will need to have to perform a particular manoeuvre. If you have been performing the above manoeuvres with a default load out from one of the free flight missions, you will have been flying with a fairly hefty load of ordnance. For the purposes of comparison, fire off all of your missiles, bombs and rockets, then drop the external fuel tanks SHIFT J. If you now repeat some of the exercises above you will notice a marked difference in how much easier it is to control the plane as well as its abilities to compensate for the manoeuvres at maximum throttle settings. It is worth repeating and practising these handling lessons with a variety of weapon load outs so that when you get in a tough situation during a mission you know what items you will be happy to retain in order to survive. In those situations, the first things to go should be the external fuel tanks, followed by ground ordnance. Missiles will not disadvantage you very much and are worth the weight and drag penalty due to their value in air to air combat. If you have not hit your target at the time its also worth trying to retain at least one large bomb (assuming you are on ground attack) for the possibility that you might break through. That said, one bomb is useless on a plane that is heading to the ground in a fireball so your judgement of the situation at hand is critical in this respect. It is better to survive and keep the plane than risk its loss in a futile attempt to reach the target.

Proper use of the afterburner

If you select the engine display on the right MFD you will see a depiction of fuel flow rate. This display will show you how much extra fuel the afterburner uses - it is four times that of 100 percent throttle. Judicious use of afterburner can be vital to a mission's success. In general, never use the afterburner unless you absolutely have to or do not need the fuel. Cases where you absolutely have to can be generally categorised as life threatening situations where extra thrust is vital such as dogfighting (prolonged use here is common), extending from an engagement or needing to climb rapidly to avoid terrain (although in some cases they can make the situation worse - see below). Situations where you do not need the extra fuel might be when you are about to drop your external fuel tanks even though they are not empty or at any time prior to docking with a refueller. You do not need the afterburner for routine takeoffs, even at maximum weight unless you are performing an intersection takeoff and are very close to the end of the runway.

Nap of the Earth flying

The easy way to fly nap of the earth is to use the autopilot at minimum altitude (200 feet). In general this presents only a couple of disadvantages. If you select the waypoint mode, the plane will fly to the waypoint directly as expected; if the waypoint route happens to have the highest mountain peak in the region along it, then the plane will fly at 200 feet above that peak. This really defeats the object of nap of the earth flying, which is to avoid radar detection. One way around this is to use the heading mode instead and manually adjust your route as you progress. The other disadvantage is that if you route over a sheer cliff face, the autopilot will nose over causing a temporary red out.

Manual nap of the earth flying carries only the disadvantage of possible pilot error causing you to hit the ground. This does add an aura of excitement, however, as you speed along the earth weaving your way down the valleys and in between the mountains. If you are trying to run in to a target undetected, this is the best way to do it, and an excellent opportunity to enjoy the scenery as well.

Running in to a target is a typical example of when you would use nap of the earth flying. To best accomplish this, use the waypoint heading as a general guide only. The intent here is to avoid detection by staying as low as possible. Pick your way through the valleys and mountains (Figure 9) along whatever seems to provide the lowest ground level possible along your general route of flight, cross referencing your JTIDS overlay to avoid any potential trouble spots that may have shown up. It is also worth noting that the enemy can sometimes slip in close to you undetected, so the occasional scan in padlock view is very wise.

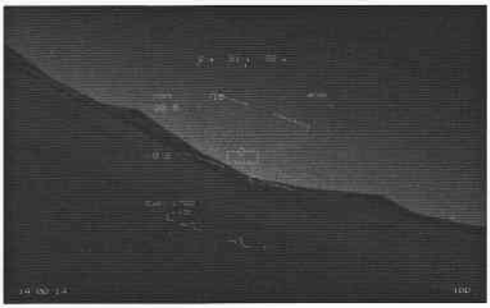


Figure 9

Throttle setting can be anything up to 100 percent without giving any difficulties - there should be no need for afterburner. Try to move the controls fluidly rather than yanking the stick as this will cause excessive drag and slow your progress. When coming over a ridge or cliff face, roll inverted and pull down to the ground before rolling the right way up again as this will avoid those wearing negative G's. Fly as low as you feel comfortable with - this could be anything from 200 - 1,000 feet on average but in some places will vary considerably. You may even see 0 feet briefly on some occasions as you get between the 10 and 0 feet level! It is wise to ensure that detail is set at least to medium to help with your depth perception.

Low level abort

If you do unexpectedly get in to a position where you need to do a low level abort, carefully consider your current flight dynamics. If you have pulled down hard into a fjord and find that the other side is coming at you at around 600 knots for example, it is better to pull the throttle back to idle and pull back hard on the stick with the airbrake out as this will reduce your radius around the turn axis and pull you clear in a shorter distance. The only time to increase throttle and perhaps use the afterburner is when you have insufficient speed to clear the obstacle in question. Do not get too fixated on the threatening object ahead as it may be that you will have a better chance of avoidance by dialling in some bank as well as positive pitch to go around it. For the first situation, this tactic will also bleed off some speed as well and could prove particularly effective.

Post stall flight

Although it is possible to stall the EF2000, it is actually far more difficult to achieve than the recovery itself. If you do manage to stall, the fly by wire will lend a hand to getting you back underway by limiting the effectiveness of your control inputs until such time as a reasonable flying speed has been built up. You will still be able to make inputs but their effectiveness is mostly limited by the fact that the control surfaces will have little effective ability to change the planes direction until they have sufficient airflow over them. Playing around with post stall flight is relatively easy, just take a heavy ordnance load out and head up to around 40,000 feet. Once there, try some hard turns or loops at minimum throttle with the airbrake out. When you feel the need to recover, just roll the wings level and ensure the nose is pointing downwards. As speed builds to a safe level, you will feel control effectiveness returning.

Another exercise worth performing is to fly over the sea at around 4,000 feet with your gear down. Try to maintain a steady and slow rate of descent while gradually reducing the airspeed. Keep a very close eye on the flight path marker as it starts to drop off the HUD and just play with the throttle while holding the plane in a fixed attitude - try flying with wings level and five degrees nose up. Once you have established your profile, make minor adjustments to the throttle to give alternating slow rates of descent and climb. Use the angle of attack indicator and flight path marker (which are displayed in the ILS HUD mode) as your cues for this. This is very useful practice for when you need to land and anyone having trouble maintaining steady approaches should perfect this technique first.

Formation flying

Formation flying is almost exclusively the domain of the network player. Again, the simplest way to fly a tight formation is with the use of the autopilot in any mode except auto throttle. The procedures for this in network play are for the flight leader (usually the server, as he has control of the waypoints) to decide the flight profile in terms of altitude, speed and heading then relay this to his wingmen. Speed settings can be a particular throttle setting, although it will be difficult for the wingmen to maintain position if they have a different weapons load. Once he is established in this profile, his sole responsibilities are to maintain his stated settings and inform his wingmen in advance of any changes to it he is about to make.

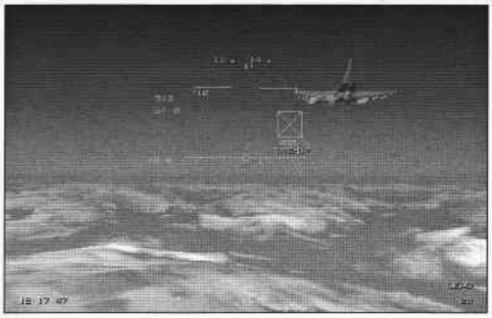


Figure 10

The wingmen can then form up on the leader in any fashion that they desire or agree, although it is suggested that for large groups you maintain visual contact with your wing leader or pairing by being behind and to one side of him in your chosen formation. It is useful here to padlock the leader to get your relevant closure rate with his aircraft (Figure 10). It is not possible to get destroyed by a collision with any aircraft other than refuellers, so do not panic if you find yourself flying up the leaders jet pipe! Typically, the leader will have engaged his autopilot once in the agreed profile and it is sensible for the wingmen to do the same, particularly if you want to accelerate time during the mission. When forming on the wing leader, slow your closure rate as you approach until you get into the desired position before engaging the autopilot. This way you will not suffer from the autopilot throwing you around the cockpit as it tries to match the desired parameters. One way to avoid this is to use the tracking autopilot from the outset and adjust the speed setting with the keys to get into position. This also has the benefit of safeguarding you against the leader shirking his responsibilities by not informing you of a change in flight profile, albeit somewhat less satisfying in terms of attaining your initial formation were you to perform a manual approach.

To avoid having a problem locating the wing leader once you are airborne, keep visual contact with him when you takeoff and follow him at the same power settings. You should also select him in your air to air HUD mode (but keep your finger off the trigger). Use the wingman padlock key F11 if you begin to have difficulty following him or if you get separated.

Part IV Refuelling

The refuellers in EF2000 tend to be located near to friendly air bases, so you may think 'why bother refuelling, my tanks are almost full anyway?' In the real world, taking off with a heavy weapons load uses a lot of fuel, plus it also makes sense to have the refueller well away from the front line where the enemy could potentially shoot it down with long range missiles.

In the simulation, the answer as to whether or not you should refuel is dependant on the likely mission length, and how much you tend to use your afterburner. If you do refuel, you may find that the tanker puts you closer to your target, but you will have gained about 25,000 feet in altitude anyway. If you are on a CAP mission then refuelling is a strong probability, as these missions are intended to keep you aloft for about four hours.

Finding the refueller

When you are in the mission selection screen, take a close look at the map to see where your refuellers are located. Although it will almost certainly be waypoint 2 that is assigned for you to refuel, there is nothing to stop you from hooking up with any tanker you like. Finding the nearest tanker while in the air is simplicity itself. Looking at your JTIDS is the most reliable method to locate a refueller in the region - they show up as green squares with a white dot in the centre. Head in the general direction indicated by the JTIDS and turn on your refuelling HUD mode. The HUD waypoint heading indicator will now have shifted to the direction of the nearest tanker (this can also be the only way you will find it if your JTIDS is down). A quick look in padlock view will help in determining their location (refueller's are identified by the letter 'R' on the HUD's bottom right target information area). This should also help you line up with greater efficiency since you can actually see the pattern the refueller is flying and can choose where you want to intersect him. Tankers will fly at either 20,000 or 25,000 feet in almost all instances, except when climbing to their assigned altitude (not a good time to try and dock).

Calling for clearance

You can call for clearance ('To Join' from the 'Flight Comms' menu) as soon as you get within 30 miles of the tanker (check the range readout on the HUD). The initial reply from the tanker will be 'Clear to Join' - this means you can form up with the tanker to await a free hose to refuel with. You are not cleared to dock with the hose until you hear 'Move astern the (left/right) hose'. it is important that you remember this as you must dock with the assigned hose. Clearance to dock with the hose may be some time coming - fuel is served on a first come first serve basis as you will see by the queue in (Figure 11).

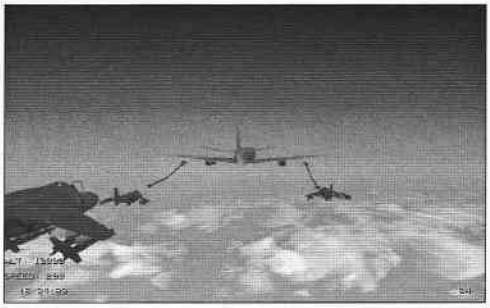


Figure 11

Approaching the tanker

Get your EF2000 into a position to the rear of the tanker, flying on the same heading. Aim to have your speed no higher than 350 knots when you are two miles from the tanker, reducing to no more than 320 knots at one mile. For the docking itself, speed can be anywhere between 300-320 knots. Steer the plane in the direction of the outer part of the wing you have been assigned to refuel from until you see the basket on the end of the refuelling hose. The basket is quite easy to see from a distance as it has a series of green lights around its edge. Put your flight path marker over the basket and hold it there as you approach (Figure 12). Now would be the time to engage the auto throttle if you so desire, although with a little practice you will find its use unnecessary.

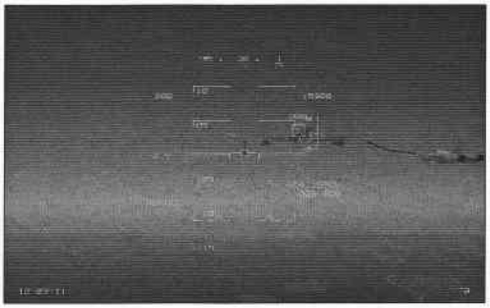


Figure 12

Docking procedures

The first principle to remember here is that you can fly all the way to the basket and dock successfully by keeping the flight path marker over the basket while being inside the speed parameters. Try to use small movements when lining up and just abort your approach if you are oscillating too much - better to try again than lose your plane, the tanker and hence deprive other flights of the fuel they may need to complete their respective missions. If you find this a little tricky, you might want to adjust the joystick sensitivity in the options menu. Some joysticks tend to provide little movement along the majority of their travel followed by severe movement towards their axis limits, so for some users this will be essential. Another important consideration is which forward view you use. The fixed forward view will give you the best amount of feedback for you to be able to make precise control inputs.

If you are off the line of the basket, bear in mind that when you put in some bank to compensate this will put you on a different heading to the tanker. If you try to change back to the same heading as the basket comes in line with the flight path marker you are too late. By the time you have the correct heading, the basket will have drifted off in the other direction and you are back to square one. Anticipation here is vital for success or you will end up with too much oscillation and have to abort the approach.

If the tanker begins to turn when you are approaching, back off and follow it around until it has levelled off, then begin another approach in the same manner. Although it is possible to dock while the tanker is banking it is extremely difficult and carries a much greater risk of collision. Once you have docked, sit back and enjoy the ride. The computer takes over for this part, so just leave everything as it is until you get the message 'Indicating full, clear to break'. Pull the throttle back to idle and retract the refuelling probe. Once you have fallen back to a safe distance from the tanker, you are clear to continue with your flight path (do not forget your wingmen though).


Figure 13

Sometimes, the tanker will continue to fly its pattern and bank away while you are still hooked up. Do not be too concerned by this as your plane will automatically bank with it as seen in Figure 13. Although it has been known for both planes to explode when this happens, the occurrence is quite rare.

High Speed Refuelling

If you are in a hurry to get to the refueller, the following parameters will get you to the doorstep as quickly as possible while still allowing you to line up in time. These parameters assume that you have a typical air to ground weapons load and that the tanker itself is cruising at 25,000 feet.

Ensure that you have permission to dock with the tanker while you are approaching it. Continue to fly on maximum afterburner until the range to the tanker is about to reach two miles. When the range clocks down to two miles you will need to perform all of the following immediately: afterburner off, throttle to idle, airbrake out and begin to barrel roll hard. This should result in you being a few hundred feet below the tanker as you hit a speed in the region of 550 knots (Figure 14). Now stop the barrel roll and pull back hard on the stick to trade the excess speed for the difference in height between you and the tanker. This should place you very close to the tanker yet still allow you enough room to comfortably line up for a smooth docking procedure.

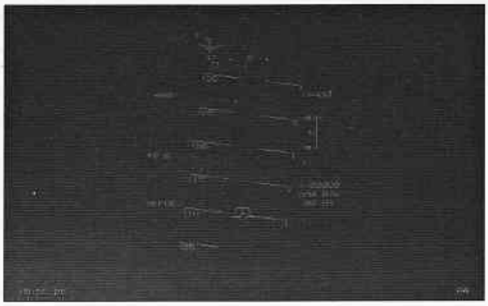


Figure 14

Network Refuelling

Network players can refuel in exactly the same manner except that only the server (or flight leader if there are multiple flights) may request fuel. All pilots in the flight will get the 'Clear to Join' message at the same time. Each individual player will then in turn get assigned a hose as they become free starting with the server and continuing in the order in which players were connected to the network. If you are the first player(s) in, care with docking is especially important. If you hit the tanker you not only take out your own aircraft but deny the rest of your flight (and others) precious fuel. As a result of this potential situation, other planes should remain a safe distance (three hundred feet recommended) from the refueller to ensure that if it does happen, they do not take damage or go down with them.

Part V Basic Landing

Landing a plane is one of the most difficult actions a pilot will ever be called upon to perform during the course of his flight. Imagine all that space that you fly through during the course of a mission and then contrast it to the small area of tarmac that you have to bring your tyres into contact with at a certain speed and attitude. As a result, it is also one of the most satisfying aspects of any flight when performed especially well. The lessons below will help you ensure that you consistently achieve uneventful and even perfect landings every time in a variety of challenging circumstances.

Finding the airfield

The first thing that you will need to be able to do in order to land is locate your airfield and get there.

It is prudent when planning a mission to set up your waypoints in such a manner that the next marker after the target is your diversion airfield. This way, you will automatically be heading for home once you have cleared the target zone. Alternatively, if you need to find an airfield immediately as a result of damage or aborting the mission, switch on your ILS mode. The waypoint heading bug will now switch to the direction of the nearest field. As soon as you get within thirty miles of the field, you will see the text 'LANDING' illuminate on the lower left portion of the HUD display. You will also now be able to see the Command Flight Path Display (CFPD) 'boxes in the sky' shown in Figure 15 which depict the glide slope approach to the runway (depending on altitude, weather, and terrain plus of course looking in the right direction...).

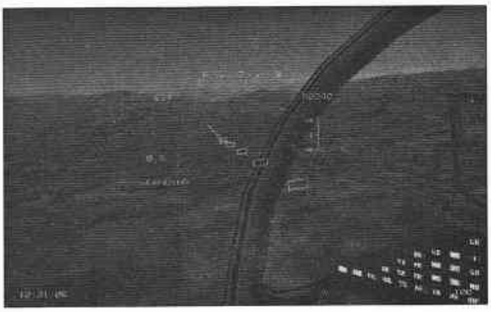


Figure 15

Calling for clearance

When you get within thirty miles of the airfield, select 'Flight Comms' from the radio menu followed by the 'For recovery' option. The airfield in question will now identify itself and give you the details of the active runway for example 'Orland, using runway 15' - the 15 referring to the runway which is heading 150 degrees. You may be told 'Negative, hold off airfield busy' usually when another flight has received clearance but not actually landed, or there are other flights waiting to depart. If you are damaged, you will obviously want to ignore this message and land anyway (although you should still keep an eye out for refuellers). Do not worry if when you get to the airfield you can see that the runway has been bombed, it makes no difference to the simulation as far as your ability to land is concerned.

Approach Aids

One very useful landing aid for the EF2000 is the CFPD which draws three dimensional boxes in your helmet mounted display which depict the glide slope for the runway. The glide slope is the optimum path though the air for the specific runway it is assigned to. The CFPD boxes can be viewed as 'hoops for you to fly through' and regardless of your position they appear fixed in space.

There is sometimes a VASI (visual approach slope indicator) on the airfields as shown in Figure 16 but it tends to suggest that you are a little high compared to the CFPD images so ignore it unless it shows red over red - now you are so low that you will be filling up your air intakes with undergrowth any second now. VASI lights are two rows of lights that are placed either side of the approach end of the runway. The lights are either red or white depending on your current position relative to the glide slope. White over white indicates you are too high, red over white 'you're all right' and red over red 'you're dead'! The VASI is actually a better guide for getting a touch down on the 'numbers' (the very first section of the runway that has its two digit direction identifier painted on it) but it is best ignored for the purposes of basic landing.

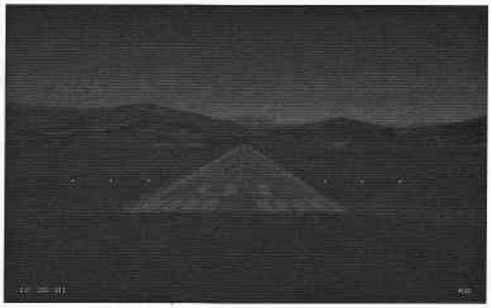


Figure 16

Lining up

Once you have found the CFPD boxes, lining up on the glide slope is a simple case of flying through them. Give yourself plenty of room for the approach by flying with the CFPD boxes out to one side until they are pointing almost straight at your plane before turning in towards them. When the ILS HUD mode is selected and you have called for clearance, the padlock view will lock on to the airfield if you are within a few miles of it. This is particularly useful to get a better idea of where the glide slope is in relation to your current flight path.

The Approach

You need to be a lot slower than you might think when you are approaching the first boxes. Get your speed down to under 200 knots before flying through the first box if possible, and get the gear down as well. If you are well above the boxes, leave your airbrake on and perform a rapid descent at minimum throttle. It is important to get the speed slowed early, as this will mean you have more time to make corrections and will allow you to get your approach stabilised sooner. The landing speed of your aircraft will depend on how heavy your plane is - dumping your stores on the approach to come in clean every time will not gain you any friends in the WarGen Supply section either. Although most of the time you are likely to be landing with minimal ordnance at somewhere in the region of 120 knots, once or twice there may be a reason for you to come back fully kitted out and this kind of fixed speed approach will catch you out - if you are not convinced about this fact then try landing with all the fuel, sea eagles and anything else you can manage.

The procedure we are going to use below will help you make a good landing every time at just the right speed for the weight of the aircraft. It is prudent to point out now however, that landing is nonetheless extremely challenging - probably the most difficult piece of precision flying you will ever need to accomplish in EF2000. This method has been designed for use with the fixed forward view once again. Although it will work in the jelly-neck normal cockpit view, it will bring you in about 10 knots faster due to the displacement of the symbology on the HUD.

The first thing you need to do is get the flight path marker heading through the middle of the boxes and keep it there (Figure 17). That will get you pointing at the runway and on the glide slope. Next we need to establish the correct angle of attack (AoA) for landing. Angle of attack is the angle between the wing and the oncoming air. At a fixed AoA the EF2000 will maintain a constant rate of descent at the correct speed for the weight of the aircraft. Put simply, establishing the right AoA will automatically give you the correct landing speed for your aircraft.

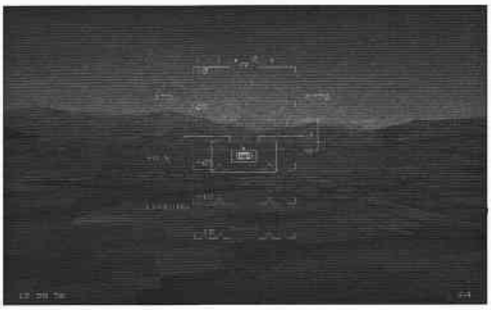


Figure 17

The best visual reference for establishing and maintaining the correct AoA is the 'Gear Down' indicator that can be seen in the ILS HUD mode. In the ILS mode you will see a bar above three letter D's (indicating '3 greens' or gear down). What you need to do is position this indicator so that it appears in the centre of the boxes as you fly through them. The ideal position is for the bar along the top to intersect the flight path marker while aimed and flying through the centre of the CFPD boxes (Figure 18). If you can achieve this all along the glide slope, you will be able to achieve an uneventful landing every time.

Control over your altitude and rate of descent will be achieved using the throttle. Once you have established the flight path marker on the glide slope, bring your speed down slowly while raising the nose to keep it in the same place. Anticipate the arrival of the gear down indicator at the centre of the CFPD boxes by bringing the throttle up to hold its position there with the flight path marker. The earlier lesson in slow flight at 4,000 feet will be invaluable experience here, so if you have trouble with your approaches it would be worthwhile going back and repeating that lesson a few more times.

Finals

Once the gear down indicator is in the middle of the CFPDs fix it in place with the stick and watch the flight path marker. If you have too much throttle the flight path marker will rise, too little and it will sink. Hold the flight path marker in position by trying to anticipate where it is going and use small corrections if possible, as there will be some lag in its movement.

You will not need to worry about how fast you are going - really, it does not matter. The movement of the flight path marker will give you all the indication you need as to whether you have the correct speed. Maintaining the correct glide slope positioning of the gear down indicators is relatively easy, leaving you to concentrate almost entirely on throttle inputs to keep the flight path marker in the right place.

As you get over the runway threshold, hold the plane in the same attitude and the ground effect will settle you down on to the runway (Figure 19). It does not matter that you do not land on the numbers - indeed this procedure will put you a couple of hundred feet past them. Better that than landing on the grass.

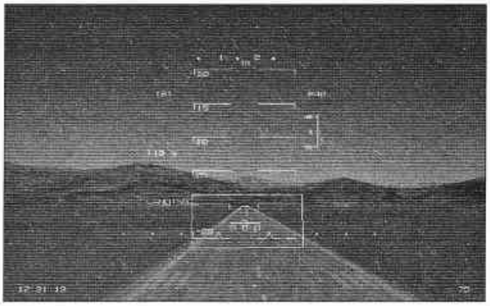


Figure 18

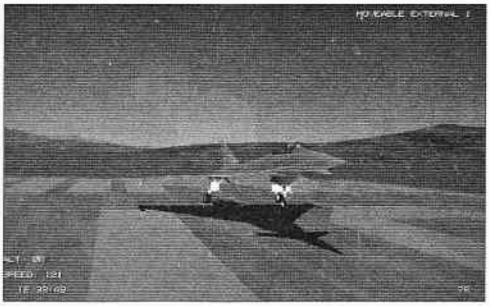


Figure 19

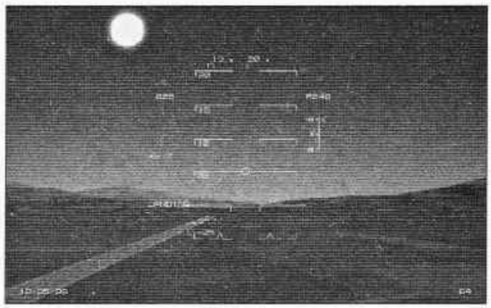


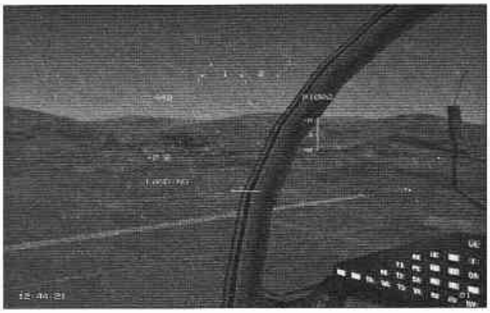
Figure 20

Figure 21

Aborting the approach – 'go around' procedures

If it all starts to go wrong, bring the throttle up to maximum while holding the attitude you should have already established - the nose should be pointing upwards if you have got this part right, if not bring it up to around five degrees up. As your speed increases you will establish a positive rate of climb. Afterburner should only be used if you are going down really fast. Once you have established a positive rate of climb, raise the landing gear and turn slightly to the right of the runway (Figure 20) so that you are flying out almost parallel to it but to the side - this in theory will help avoiding collisions although again it is only the refuellers that you need to worry about.

Once you are about a quarter of a mile past the far end of the runway, make a left turn across the approach path while maintaining the climb until you are ninety degrees from the runway heading (Figure 21). The go around procedure being described here involves flying a rectangle around to finals again. This part of the pattern is called the 'cross wind leg'. During the procedure you should continue climbing and accelerating until you reach 450 knots and 1,000 feet. After another quarter of a mile on cross wind, make another turn through ninety degrees which will put you on to the downwind leg (Figure 22). Fly downwind until you have put a couple of miles between yourself and the runway before turning again on to what is known as 'base leg' (Figure 23). When you are about to turn 'base' you should bring the throttle back to idle before making the turn as this will help bleed off your speed. You will only be on base leg for a short while before needing to start a smooth turn on to the approach (Figure 24). A smooth turn is necessary here as you will be at minimum throttle and bleeding off speed. It is important not to make any drastic manoeuvres that will put you at the low end of the speed scale where the plane will wallow and plummet as it approaches a stall (stall speeds for a given configuration are higher when turning due to the increased drag caused by the turn). Once lined up you are ready to begin the approach as before, better luck this time.



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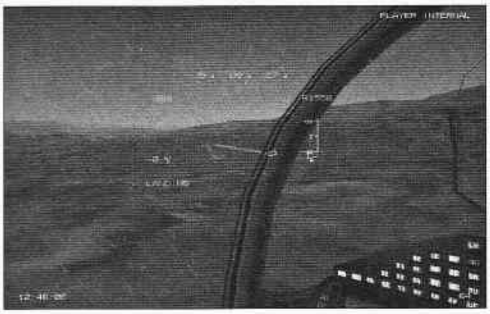

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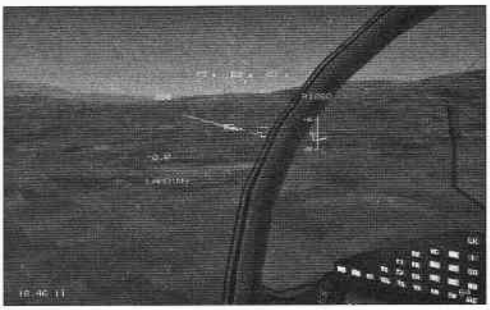


Figure 24

Touchdown

When you are about to touch down, get ready to let the brake parachute out. If your landing is less than perfect, you will begin to feel the full effects of the six degrees of freedom flight model contained within the EF2000 simulation. Landing too fast or slightly off balance is a potentially dangerous situation that could have you cart wheeling into oblivion down the runway (Figure 25). Whether this is likely to be the case or not, get the drogue chute out as soon as the wheels hit the tarmac, then put on the wheelbrakes. If you are off the parameters, this is the only thing that will save you now, short of ejecting.

Figure 25

Post landing taxi and shutdown procedures

Your brake parachute will automatically detach itself at around 40 knots. Look for the first taxi way exit from the runway and steer yourself on to it once you reach it. Taxi to the front of the nearest hangar and turn off your engines. Congratulations, you made it.

Part VI Advanced Landing

If you hear the squeal of the tyres as your wheels touch the tarmac, your landing was slightly heavier than it could have been. If you want to achieve a 'greaser', you will also need to arrest the rate of descent slightly as you are about to touch down. This mainly comes down to judgement and finesse with the throttle, although you can also refer to the rate of descent indicator on the right hand side of the HUD (if using this aid, aim for no greater than 5 feet per second descent). Fix your eyes on the far end of the runway as this will be the best way to gauge your rate of descent. Slowly bring in a little throttle as the plane gets down towards the runway (30 feet or less) to arrest the rate of descent while being conscious that ground effect down low will give you some extra buoyancy. Be careful not to overdo it or the ground effect will have you kangarooing along the centreline.

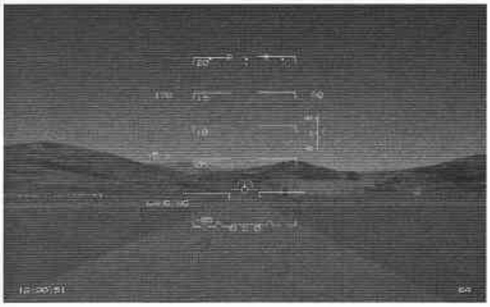


Figure 26

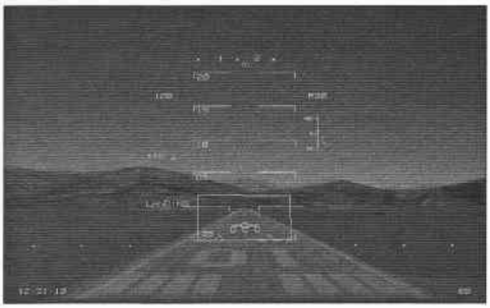


Figure 27

If you do start to kangaroo, just keep the plane in the same attitude as you had it in for finals and reduce the throttle while jabbing on the airbrake for a second or two. Bring the throttle back slightly as you start to settle. Watch the flight path marker like a hawk and bring in some more throttle if it starts dropping down too quickly.

If you settle down without any tyre squeal, you have achieved a 'greaser'. If you want a bigger challenge, try landing on a taxi way - here you will have no visual approach aids plus the smaller width will require better placement and an appreciation of the subtle difference in perceived depth (Figure 26).

How to hit the numbers

If you want to land on the numbers, you can initially use the above CFPD method to establish your approximate landing speed, but then use the VASI indicators to follow the perfect glide slope all the way down to the numbers (Figure 27). Be very careful here not to get too low or slow as there is only a very small margin for error at the bottom of the flight envelope a few knots slower and you will start to fall like a brick.

Speed Landings

If you need to land fast to rearm, the following parameters will be of use to you. These statistics are for a clean aircraft with no structural damage and hence no control instability.

When lining up with the CFPD boxes, you should aim to pass just over the top of the first box at a nose up pitch of no more than five degrees (Figure 28). As you do, you should set the throttle to idle, ensure the afterburner is off and extend the airbrake while simultaneously entering a violent barrel roll. If at any time you hear the voice annunciator warning you to pull up, you should stop rotation and switch to a series of hard 'S' turns instead. This will usually happen as you are approaching the runway threshold, although it will be dependant on how accurate you were on setting the nose attitude when passing over the first CFPD box. Use the 'S' turns to line yourself up over the runway while also dropping your gear down as soon as possible (Figure 29) - the extra drag from them once extended will help to slow you even faster. Try to hold off from the runway until you are below 150 knots, then put it down as soon as you have levelled off completely. If you are not level at this kind of speed, you should hold off some more while attempting to correct as setting down that fast will almost certainly result in your destruction. If you cannot level off sufficiently then holding off will nonetheless bring your speed to a safe level for a less than perfect touchdown. As soon as the wheels touch the tarmac, get the brake chute out and slam on the wheelbrakes (Figure 30).

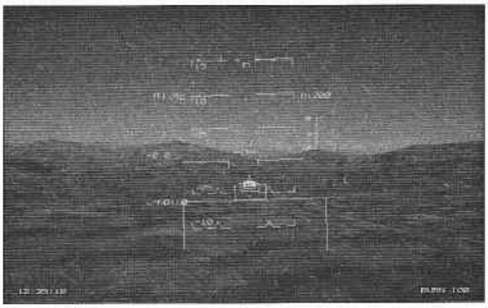


Figure 28

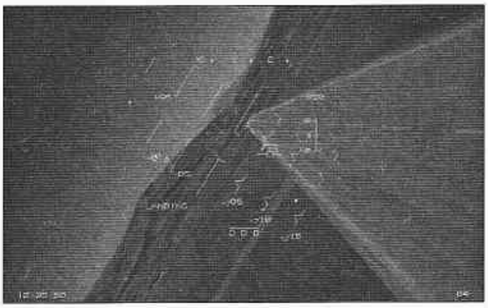


Figure 29

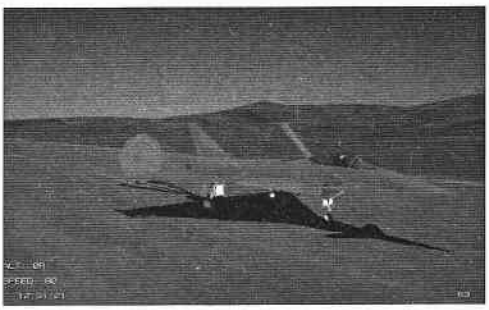


Figure 30

The speed of your plane as you pass over the first CFPD box will depend on why you want to land and how comfortable to feel with this procedure. Treat these figures as an absolute safety limit: Mach 1.35 if you want to have enough runway to takeoff again after rearming or Mach 1.40 if you just want to land before you run out of runway. If you are rearming, you should follow the procedures for a scramble takeoff detailed earlier once you are ready to go.

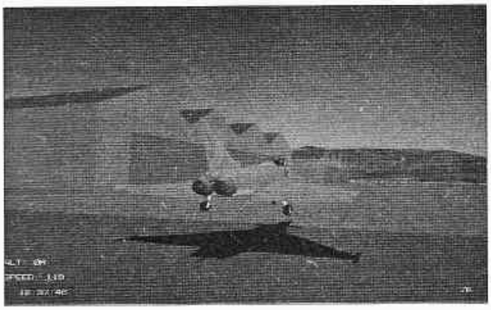
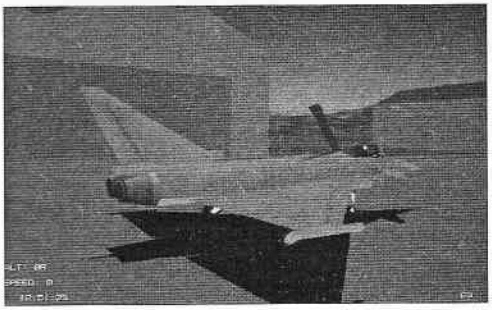


Figure 31



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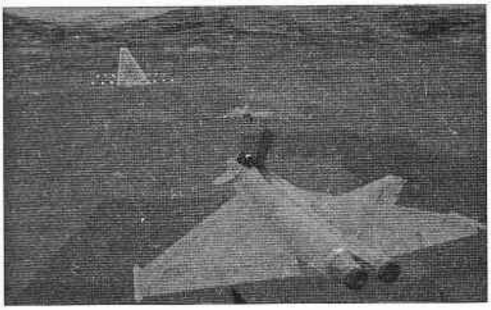


Figure 33

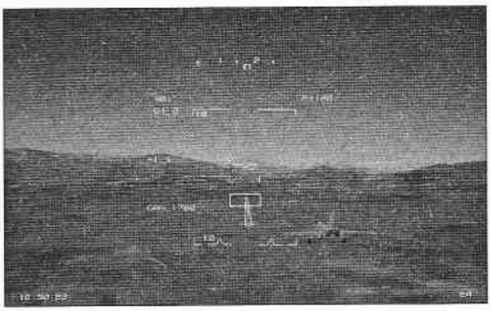


Figure 34

How to show off!

If you really think you are flash, try this for a challenge. Select the landing mission from the free flight menu and accept the default weapons load (no weapons). When you enter the cockpit, look ahead and to the left of the runway (its probably worth making a low level pass to identify the area in question). You will see the control tower and behind it two four plane hangars (Figure 31). In front of these hangars is a small tarmac area - you are going to land on this! If you can touch down consistently on the tarmac and come to a halt (using wheelbrakes and airbrake only) before passing the end of the first hangar as shown in (Figure 32) then there is nothing else you need to know about landing on good surfaces in an undamaged plane (if you are a real masochist, try it with engines out).

Formation Landings

This section will be more relevant to network missions as it is not as satisfying to perform with a computer wingman who will fly his own approach regardless of your intentions. In general, both (all) pilots should follow the procedures above, although it is recommended that you stick with the CFPD method and not get any more advanced than using the 'greaser' trick of bringing in some extra power at the very last stage of finals. As a general guide to formation, try to fly as though the wingman is on a half second delay behind the leader's approach path while displaced to the left as shown in (Figure 33). Form up on an extended three mile final and establish your positioning and approach as early as possible. If you choose to use tracking autopilot in this procedure, you should turn it off as soon as you are formed up.

The wing leader should aim to land on the right hand side of the runway, with the wingman having free reign over the left. This helps the wingman as the leader's plane will be easier to monitor on the right side where it will be strategically placed in between the instruments and aids that are most important to him (Figure 34). The leader's vital responsibility is to constantly call out the status of his approach regarding altitude, speed and throttle setting, plus to fly his own approach as accurately as possible (it does not matter to him how the wingman is doing). The wingman should be cautious when gauging the leader's throttle setting as he could have a different weight which would therefore give different results were the same settings maintained. Finally, the leader should also try to give his wingman a good estimate as to which part of the runway he intends to touch down on, preferably while on short finals.

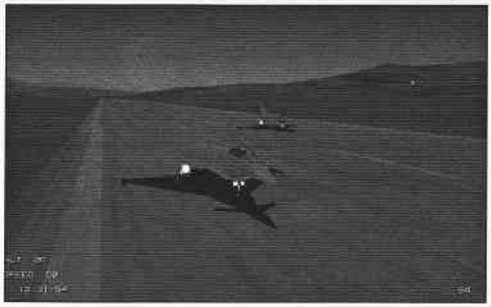


Figure 35

The wingman has the most difficult task here. Not only does he have to fly his own approach but he must try to remain in a constant position relative to the wing leader. The important thing here is to fly your own approach and make sure you are completely comfortable with it. Assuming you are, then you can worry about fine tuning your adjustments to follow the position of the wing leader. A major factor in your performance here will be how well the leader flies the approach. If he is rock solid all the way down the line it will make your task a lot easier. Assuming this is the case, bear in mind that the leader is slightly ahead so this should compensate for your reaction time. Formation landings are particularly difficult to achieve but can be a very satisfying and thrilling end to a successful networked mission (Figure 35).

Engine flame out procedures

Attempting to land on one engine makes little difference except that you do not have as much thrust and therefore will need higher throttle settings to achieve the same approach. Landing with no engines is a different matter altogether as you will find out.

A likely scenario for this occurrence might be where you have incurred a systems failure that has led to both engines being on fire and therefore needing to be shut down. As if this was not hard enough as it is, once you have shut down both engines you will find that after a couple of seconds the plane will develop a roll to the right. Those of you with trim wheels may find them useful now although for the moment you should concentrate on establishing your best glide speed and angle (see below) before fiddling with them. Those of you without will have to use a constant pressure on the stick to hold a wings level attitude and train yourself to compensate with the same extra pressure should you need to bank on the way down. The first order of business in this situation (aside from shutting the engines down) is to drop all of your stores immediately and start heading for the deck. With a fire on board you will need to put the plane on the

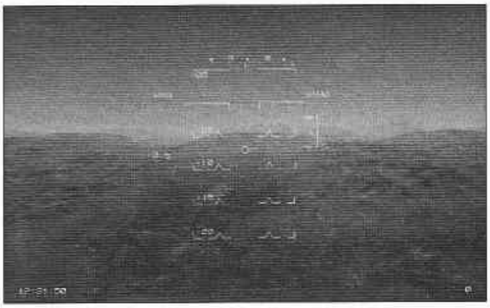


Figure 36

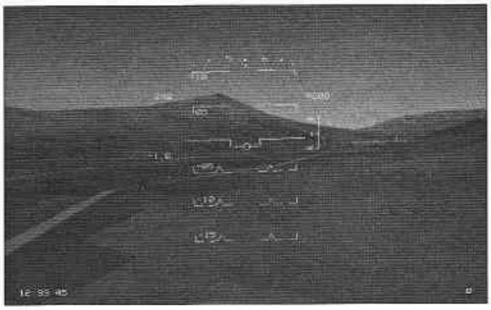


Figure 37

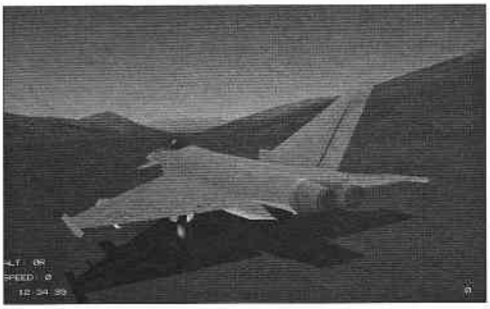


Figure 38

ground as soon as possible. Altitude plays a major part in how you conduct this approach, but the following guidelines are very good to achieve the end result.

Once the plane is clean of all the external stores and you are heading for the deck, you can also consider firing off your remaining cannon rounds - although they only weigh 0.5kg each, this soon adds up to some fairly substantial ballast if you have a sizeable quantity left. Next, switch to ILS HUD mode (it gives a better HUD depiction even though you unlikely to be near a runway) and establish a seven degrees dive (Figure 36) as soon as your speed hits 300 knots. Start looking around from the cockpit for a suitable place to land - roads are your best bet, followed by flat ground. Hills are practically impossible and the sea definitely is, so if these are your only choices it is time to eject. Once you have identified a suitable area, begin a gentle turn to line up for your chosen approach. Drop the nose slightly at the same time to compensate, coming back to seven degrees nose down after you have levelled the wings. When you reach 300 feet above ground level, drop your gear while bringing the nose up to one degree nose down pitch (Figure 37). Holding this attitude will trade off the remaining height while slowing you to a safe landing speed, but you should check that it is no higher than 140 knots before touching down. If it is just raise the nose slightly to let the extra speed bleed off. As soon as you touch down, get the brake parachute out and stand on the wheelbrakes. If you have chosen a good area to land and have conducted a good approach, you should survive this one (Figure 38).

Low fuel and glide procedures

If you find that you are low on fuel while returning to base, you will have a number of options depending on how much you have left. If you have a few hundred pounds or so but still have some way to go before reaching a friendly base and there are no refuellers closer to you the best course of action would be climbing to a more economical cruising altitude. You have the best chance of maximising your fuel by getting up to 43,500 feet (the most efficient altitude for the EF2000). On your way up, fly at 100 percent throttle and do not use the afterburner. Aim for an angle of 25 degrees nose up, trying not to let the speed drop below 450 knots. Once there, if you think you can make it back to base at a lower throttle setting (check the fuel status display in the right MFD) without getting caught up by any bandits, then do it.

If you get close to base and your fuel is almost empty, bear in mind that you now have a lot of altitude which can be used to gain some extra miles. On one occasion during network testing while flying back from a particularly intense dogfight, which required plentiful use of the afterburner, the engines were switched off with 72lbs of fuel left in the tanks. The rest of the approach was conducted at a glide, turning on one engine on finals to regain full control of the FBW system. The fuel ran out at a height of 20 feet above the deck, needing a swift input to hold it steady and settle down graciously on to the runway. This procedure can work very well assuming you are happy to deal with the control input problems caused when you turn your engines off. You might even want to consider turning them off with more fuel than in the above case to give you some extra reserve on finals should you need it. If you do go 'down to the wire' on remaining capacity, you only need to turn one engine back on to regain the control effectiveness.

As for how far you will be able to glide, Table 1 below shows the approximate glide ranges you should be able to achieve from different altitudes. All results are for a clean aircraft with bingo fuel and assume engines off at 500 knots. The range given is that which can be obtained from the specified altitude down to 1,000 feet. Basically, when the fuel runs out hold the plane straight and level until the speed bleeds to 300 knots. Now lower the nose to between five and eight degrees nose down pitch with the aim of maintaining between 250 and 300 knots. If your speed goes below 250, lower the nose further until you hit around 290 knots before bringing it back to around five to seven degrees nose down. If you are below 15,000 feet, do not worry about the speed so much but do not let the nose go any further than seven degrees nose down. When you start to get low, follow the procedures listed under the engine flame out section for touchdown.

Table 1

Height	Range to 1,000 feet	Miles per 1000 feet
40,000 feet	68 miles	1.7
30,000 feet	55 miles	1.8
20,000 feet	38 miles	1.9
10,000 feet	21 miles	2.1

Table 1 shows the best average figures achieved after trying a number of techniques involving constant speed, constant angle and combinations of both. For comparison, Table 2 shows some of the other results obtained, again all with a starting speed of 500 knots.

Table 2

Height	Dive Angle	Dive Speed	Glide Range	Miles per 1,000 feet
40,000	7.5 degrees	variable	55	1.4
30,000	7.5 degrees	variable	39	1.3
20,000	7.5 degrees	variable	26	1.3
10,000	7.5 degrees	variable	13	1.3
40,000	5 degrees*	variable	72	1.8
40,000	variable	200 knots	61	1.5
40,000	variable	250 knots	68	1.7
40,000	variable	300 knots	68	1.7
40,000	variable	350 knots	68	1.7

*it is not possible to maintain a five degrees nose down pitch initially as the speed at altitude drops off too quickly.

The conclusions that can be drawn from these results are that closer to five degrees is the best angle of glide, but not below 250 knots. You can see from the data that you will get around 1.7 miles of glide for every 1,000 feet you have. It is important to note that this data is for flying in a straight line - if you start turning it will obviously reduce your range considerably due to the increase in drag caused by the turn. This aspect should be taken carefully into consideration when attempting to reach a runway on the limit of your glide range. In this case you should be considering alternative set down points all along your approach.

Part VII Damage

Damage types and effects

Damage in EF2000 is implemented by way of a points system. Your plane can take up to 100 points of damage before being completely destroyed. The table below lists the amount of damage caused by the different weapons that will be employed against you.

Weapon	Minimum Damage	Maximum Damage
Cannon (per burst)	3	18
Air to Air Missiles (all variants)	80	100
Anti Aircraft Fire	8	14
Surface to Air Missile	90	100

Damage to the aircraft will be in the form of either structural damage (for example losing part of a wing as shown in Figure 39), systems damage or both. Hits from the weapons listed above will cause random damage of any combination. Once systems have been damaged beyond a certain point they will get progressively worse until ultimately, they fail completely. An indicator of this is the respective light on the damage warning panel (Keypad 4) turning orange. Once you have taken damage there is also the possibility that additional 'knock on' failures can occur even though you may be flying straight and level miles from any enemy threats. The 'knock on' damage is completely random in both its timing and effects. The items listed below can cause additional secondary problems when damaged (orange colour on warning panel) or serious problems when destroyed (red on warning panel).

Figure 39

Reheat (Afterburner)

When reheat has failed, you should discontinue its use immediately and refrain from using it further throughout the remainder of the flight. Continued use of reheat can cause engine fires.

Engines

If an engine has failed, it is important to shut it down immediately. Failure to do so could cause a fire which would ultimately result in the destruction of the aircraft.

Hydraulics

Once you have a hydraulics leak, things will get steadily worse as you lose hydraulic pressure. Eventually, once you lose all pressure, you will no longer have control of the aircraft.

Oxygen & Pressure

Flying at altitude causes more loss of pressure and oxygen.

Fuel

A fuel leak will inevitably cause the loss of fuel

Damage Procedures

Figure 40

When you hear an audible 'systems failure' warning, you should check the right MFD to see which system(s) have been affected. Most of the recommended procedures which will be displayed as shown in (Figure 40) are not strictly necessary, however, a cross check to the damage warning panel is strongly recommended whenever you take any damage so that you can assess the status of your aircraft before deciding on your next course of action.

The procedures which should be considered mandatory are those which specify shutting down an engine or cancelling reheat. The only other failure which will inevitably cause your destruction is loss of hydraulics. Once it has failed the plane's hydraulic systems (control surfaces, brakes, refuelling probe and landing gear) will get steadily less effective until they ultimately become inoperable.

Damage considerations for assessing mission continuance

Whether you decide to continue your mission with structural damage is entirely down to personal preference. When a wing does take damage, you will experience a turning force on the plane which will require a constant control input to counter its effects. It is possible to take away this burden by flying on autopilot but this will not help you when landing or during combat situations. Depending on the type of joystick you are using it may be possible for you to tune a trim wheel to compensate for the effects, although the plane will obviously still not fly as normal due to the large amounts of drag being caused by the vacant space where the wing used to be, along with the dramatic reduction in the square footage of your control surfaces.

If you have total hydraulics failure, you will basically be flying a time bomb. This occurrence should dictate an immediate diversion to the nearest friendly field for an emergency landing. It is recommended that while heading towards the diversion airfield that you fly the plane manually if possible. This way you should be able to feel the progress of your loss of control effectiveness. If the controls begin to feel particularly sluggish, you should start looking for somewhere to put down immediately.

When an engine has failed, shutting it down will prevent it from catching fire - an event which will definitely result in your destruction after a very short time period. This will not however prevent other systems which are already malfunctioning from continuing to get worse.

The knock on damage effects make judgement extremely important in making your decision for continuing a mission. You should first check how far you have to get to your target and how far you will then have to fly to get to the nearest diversion field. If you are badly damaged or have a partial or total hydraulics failure then it is better to save the plane by aborting the mission immediately. If you are relatively close to your target and it is particularly important to destroy it then it may be worth pressing on.

During testing, the best case of damage survivability attained involved flying a round trip of some 200 miles to the target before heading to the diversion airfield. The go/no go decision was taken with a partial failure to one engine and the hydraulics. At the end of the mission the plane was set down safely on the runway with only one engine running (albeit badly damaged also) having had the total hydraulics failure warning some fifty miles earlier. Use of the airbrake on finals was limited to one cycle only to preserve hydraulic pressure as the controls were already very sluggish. The route back was flown at high altitude to ensure the best possible speed was made back to the airfield. This case should probably be considered as the limit of both survivability and good fortune.

In some situations it is necessary to ignore the recommended damage procedures. If you have received a cabin pressure failure for example, you may well need to completely ignore the suggested 300 knots maximum speed/10,000 feet maximum altitude limitations for two reasons. Firstly, you will be easy prey for any enemy interceptors who decide they want to catch you and second you will dramatically increase the time to landing at the nearest field therefore exposing yourself further to additional systems failures which will inevitably be more deadly. In these situations do not be afraid to light the afterburner (assuming they have not failed) and get yourself high and fast on the way back. The importance of bringing a plane back should never be underestimated, particularly in campaigns where mounting losses will severely affect both your personal player rating and how much Wargen can accomplish with the computer controlled pilots.

Damage considerations for assessing a decision to eject

Once your hydraulics have totally failed and pressure has run out, you will have no other option but to eject so do not hesitate in this situation. The only other circumstance which should require an ejection is where you must land but for some reason cannot. This may be because both engines have failed and you cannot find a safe landing spot or the structural damage you have incurred is sufficient to make the plane uncontrollable to the extent that you do not feel you will be able to make a safe landing. If you are going to lose the plane, it is better to eject to try to save the pilot at least.

Landing on the sea or with the undercarriage up will mean instant death, so only alternative in these cases will be to bail out.

Flying with severe damage

When you have incurred structural damage to a significant level and the plane becomes difficult to control you can try the following procedure to alleviate the effects. First, climb to a safe altitude (recommended above 10,000 feet). If you have a joystick that is equipped with trim wheels you can now adjust them until you attain level flight. If not, the only procedure that may help involves re-calibrating your joystick which unfortunately does not work for all controllers. As an example we will assume the plane is rolling to the right. Imagine the position you would have to put your joystick in to create the amount of roll that is currently being generated by the structural damage. Now put the joystick into that position and hold it there while simultaneously pressing ALT C to recalibrate. Effectively you are turning further into the existing roll before recalibrating. Bring the plane level and see how it has effected the roll rate. Repeat this procedure until the plane will fly straight and level without requiring additional control input. This will probably take a number of attempts to get even roughly correct, hence the suggestion for safe altitude before commencement.

If you do perform this procedure during a mission you must remember to recalibrate your controls before starting your engines in the next mission as your PC will remember the off-centre settings you have just given it.

Chapter 4

PERFORMANCE

CHAPTER 4

Chapter 4

Performance

Taking your Eurofighter into combat presents you with a unique challenge. During every stage of an engagement you will need to stay on top of the avionics and weapons deployment systems. You will need to master the views in order to achieve a high level of situational awareness and you will need to do all of this while flying the aircraft. There is so much 'busy work' to do during combat that the only way you can avoid cognitive overload is to make many of your essential tasks become second nature. The views must become so familiar that you can scroll through them and use padlock with as little thought as turning your head. You must learn to cycle and deploy the weapons without any conscious effort, much as a boxer might throw a punch. Of course those things will take time and you will develop that ability the more you fly. The challenge of learning and mastering each new system is all part of the fun. By practising until those things become second nature you will be less conscious that you are doing them. You will be able to concentrate on the really important things, like flying your aircraft.

Flying your aircraft into a position where you can remain safe while you kill your opponent is the greatest challenge of all. To do so, you will need to be able to fly your aircraft to the limits.

Pilots should go into battle armed with information on aircraft performance. Things we need to know about our aircraft include its top speeds, its turning ability, its corner velocity and many other characteristics that will depend upon altitude and fuel or weapon load outs. Before we can successfully take our Eurofighter into combat, we need to discover what it is really capable of.

Energy

Energy can be defined as the 'capacity for action.' For an aircraft that action can mean several things, among which is the ability to climb to a higher altitude, to extend from a fight, to avoid missiles or to do many of the things that a pilot needs to do during the course of an engagement.

When we talk about energy, we are talking about two things, Kinetic and Potential energy. Kinetic energy is the energy possessed by an object in motion. An aircraft that has some speed is said to possess some Kinetic energy. Potential energy is a way of describing stored energy. An aircraft that has altitude is said to possess potential energy.

For the fighter pilot kinetic and potential energy are useful ways of describing speed and altitude. When you fly your Eurofighter it has kinetic energy due to its speed and potential energy due to its altitude. The overall energy status for the Eurofighter is the sum of its kinetic and potential energy and that will depend upon its speed and altitude. An aircraft can trade altitude for speed by diving. The higher it is, the more potential energy it can convert to kinetic energy and the more speed it can gain. If the pilot climbs he will lose speed but gain altitude, which can be converted back to speed by diving once again.

The way in which speed and altitude are converted back and forth in this way is called 'Energy Management'. The combination of an aircraft's speed and altitude is referred to as its 'Energy Status'. It is possible for two aircraft to have the same energy status even though their speed and altitude may be different. (Figure 1.)

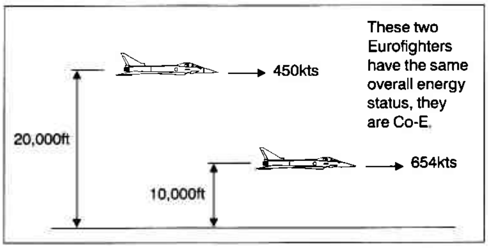


Figure 1

These two aircraft are at different altitudes and speeds but their total energy status is the same. These aircraft are said to be Co-E. Being Co-E means that if in this example the low fighter climbed to 20,000 feet his speed would bleed to 450 knots or that if the high fighter dived to 10,000 feet his speed would increase to 654 knots. That means that they have the same amount of total energy.

However, things get slightly more interesting because we now know what energy is and how it can be combined but where does it come from, and where does it go? In the example above for instance the discussion ignored drag, thrust and atmospheric changes. The aircraft's energy is provided by the engines as thrust. When the thrust is greater than the drag, the aircraft accelerates and gains kinetic energy that can be converted to potential energy at the pilot's discretion. Drag is the name given to air resistance. The aircraft's energy is dissipated by drag. During normal flight the Eurofighter's engines can overcome the drag with relative ease and energy is not a huge concern to the pilot who can increase his speed and gain energy even while climbing. When an aircraft manoeuvres however, the drag is increased to the point where the engines cannot overcome the energy loss produced by drag. During combat, fighter aircraft execute hard turns and because hard turns produce large amounts of drag, they lose energy. Since low energy states are less desirable it is of vital importance to the combat pilot that energy is not wasted.

A slow fighter with height may have the same energy status as a faster opponent at low altitude. However, speed and altitude are not equally desirable. Given the choice between speed and altitude when entering an engagement, choose speed every time. The reason for this is that with speed you have many more options. You will be able to avoid enemy missiles or leave the engagement altogether if you choose. However if a turning fight is inevitable you will need to lose energy in order to fly at the speed that maximises your aircrafts manoevrability and it is always easier to lose energy than it is to gain it.

As aircraft have developed in power and performance it might be thought that energy would become less of a worry to fighter pilots. During the second World War altitude and speed were everything. As engines became more powerful, lost energy could be recovered more quickly. However, as fighter aircraft have evolved, so have the weapons. In the arena of modern air combat, a low energy status quickly converts a state of the art fighter worth millions into missile bait. A low energy status can reduce your escape options to the point where you may become trapped in a fight that you cannot win. In order to avoid that situation you must employ methods that conserve energy and you must remain aware of your own and your opponent's energy state during combat. Keep these considerations in mind because surviving your missions may depend on them.

Eurofighter Flight Performance

The characteristics of aircraft performance of concern to a flightsim pilot will depend upon what stage of an engagement he is in. Beyond visual range a pilot is interested in stealth, avionics, being able to perform an intercept or the ability to leave the fight. Beyond visual range, therefore, the performance related issue we are most concerned with is speed.

Speed Performance

The Eurofighter can outrun every other aircraft in the simulation. If you want to gain speed, drop your excess baggage, climb to 40,000 feet, light the burner and watch every other aircraft disappear in your vapour trail. There is just one snag. You cannot stay at full AB for very long. At 40,000 feet you will be burning fuel at 4.8kg per second. At full AB you will only get 3.5 minutes of flight for every 1,000kg of fuel. Your 'Fuel Low' warning will sound when you have only 1,000kg of fuel remaining so at that point you will have only 3.5 minutes to either land or bail out. For this reason, running at full AB is not the best thing to do. Instead, you should extend with full AB until you are beyond enemy weapons range, then reduce throttle from a high negative closure to zero closure. This will allow you to maintain a safe distance and maximise your fuel consumption.

Table 1 shows the top speeds for the Eurofighter compared to the four top ranked Russian fighters (Table 1). The speeds given are for level flight with zero stores and can be exceeded in every case if the aircraft is diving from a higher altitude.

Table 1: Top speeds for selected aircraft (zero stores)

Aircraft	Top Speed at Sea Level (knots)	Top Speed at 20,000ft (knots)	Top Speed at 40,000ft (knots)
Eurofighter	680	1080	1430
MiG-29	740	1000	1320
Su-27	710	965	1260
Su-35	690	925	1250
Su-33	670	900	1190

From the table it can be noted that all of the enemy aircraft except for the Su-33 can catch the Eurofighter at sea level. The most difficult enemy aircraft to extend from at any altitude is the MiG-29. The most formidable opponent in a turning fight, the Su-35, is one of the easiest to extend away from.

If you get into a bad situation against an Su-35 and need to get out of the fight, the top speed of the Eurofighter is an advantage that you can exploit. Of course, you will need some altitude in order to make this work. Any attempt to break away from a fight that is already at sea level will be difficult if not impossible. In such a situation you will need to take the fight up a few thousand feet so that when the time comes you can dive away from the fight at zero G. Wait until you do the nearest thing to a head on merge, then unload to zero G. Timing your escape in this way will force the bandit to do a full 180 degree turn before coming nose on and the zero G extension is the optimum way to exit a fight. By extending in free fall you add the acceleration of gravity to that of your engines and will be able to exceed the top speeds given above. Of course, extending at ground level will be difficult since the Eurofighter is still at a speed disadvantage. You may initially want to use the terrain to assist in evasion followed by a gentle climb to altitudes where you will perform better. If you can reach 20,000 feet you will have a small speed advantage over all of the other aircraft. These speed considerations may seem mundane, but they may well make the difference between ending your mission in the officers' club or a smoking hole. Remember, 'Speed is life.'

Turn Performance & Power

Within visual range, you are primarily concerned with turning ability and power - turning ability because you want to be able to out turn your opponents and power so that you can sustain your turn performance.

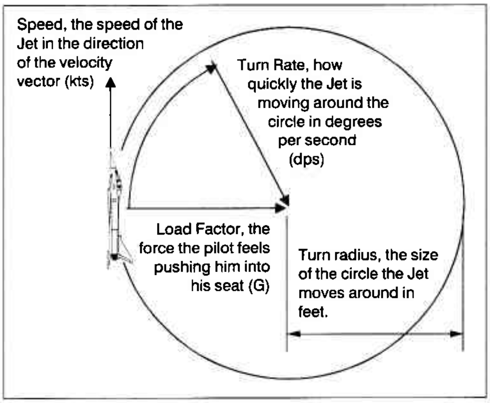


Figure 2

We will begin by considering an aircraft's turning ability. The main factors affecting an aircraft during a turn are shown in Figure 2. For any given speed and load factor, there will be a specific turn rate and turn radius. However, in a dogfight you are not interested in the specific values for turn rate and turn radius, your goal is to achieve the highest turn rate and smallest turn radius.

The relationship between speed and load factor dictates that slower speeds and higher load factors produce higher turn rates and smaller turn radii. The simple answer would appear to be for you to pull as much G as possible and go as slow as possible.

That is fine in theory, but there is a slight problem. You can go as slow as you like, but you can never pull as much G as you like. When you have the speed to generate as much lift as you want, you are bound by the structural limits of the aircraft and the physical limits of the pilot. This is referred to as being G limited. Structurally, most high performance aircraft are designed to sustain a maximum of 9G. Loads significantly above that will cause damage to the airframe and may result in the destruction of the aircraft.

Why not go as slow as possible, yet continue to pull 9G thus getting the highest turn rate and the smallest turn radius? Unfortunately, here too there is a catch. As your speed decreases, the wings will generate less lift and reduce the load factor that the aircraft can attain. Ultimately, you will slow down to where the lift you can generate is less than the G limit. That is a very important speed. Flying below that speed means your turning performance will be lift limited. Flying at speeds where you are lift limited will reduce your turning ability because you will be generating less and less G as you get slower.

The speed at which you can no longer generate your 9G limit is so important that it has a name, 'Corner Velocity' or sometimes simply 'Corner'. Corner is the slowest speed at which you can achieve maximum load and consequently the best turn rate. Any speed faster or slower than that will reduce your turning ability, so ideally you will want to maintain a speed at corner velocity in a fight.

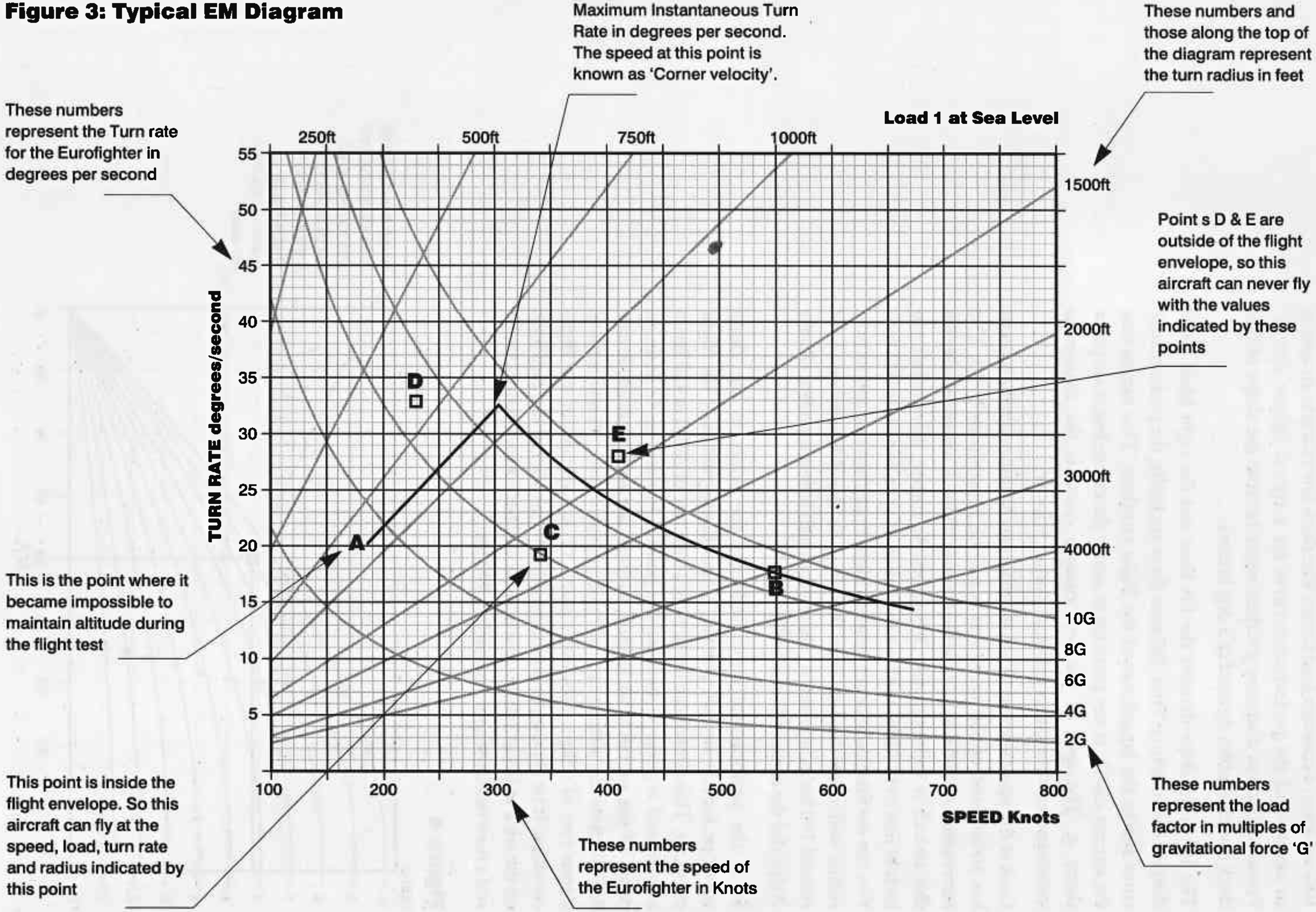
In order to maximise your turning performance, you need to know what corner velocity is for your aircraft and once you know the speed, you need to be able to sustain it. Some simulated aircraft have the power to sustain corner velocity and some do not. If you can sustain corner velocity, your problems go away. You can fly at corner velocity and maximum G for the entire fight. If on the other hand you cannot sustain corner velocity, it is of less value to you. It becomes a speed that you can only maintain for an instant as your energy bleeds down to a point that you can sustain. In that case you would be much more interested in your turn performance at the speed you can sustain. Since the Eurofighter is unable to maintain corner velocity, the distinction between sustained corner velocity and instantaneous corner velocity is therefore important to us.

Using Energy Manoeuvrability Diagrams

At this point we could simply hit you with the facts. We could state the corner velocity for the Eurofighter and its maximum instantaneous and sustained turn rates, but we will not because there are far better ways to represent that data. In the real world, pilots use a graphical method to represent aircraft performance known as the Energy Manoeuvrability, or EM Diagram. EM Diagrams provide a wealth of information on the performance attributes we have been discussing and are known as 'Doghouse Plots' among real fighter pilots. These diagrams are valuable because they allow us to see in which part of the flight envelope our aircraft will perform best. Furthermore if the diagrams for different aircraft are overlaid, they will allow comparisons between turn rate, load factor and turn radius to be made at a glance for any speed. Such comparisons are invaluable in any dissimilar aircraft engagement. We can see exactly how aircraft will perform against each other and determine whether we need to take the fight high, low, fast or slow in order to win.

We will take a look at a typical EM Diagram and consider the main features (Figure 3). Turn rate is noted in degrees per second along the left hand vertical axis. Airspeed is noted in knots along the lower horizontal axis. The diagonal lines marked 250 feet, 500 feet, 750 feet, 1,000 feet, 1,500 feet, 2,000 feet, 3,000 feet and 4,000 feet are lines of constant turn radius. The curved lines marked 2G, 4G, 6G, 8G and

Figure 3: Typical EM Diagram



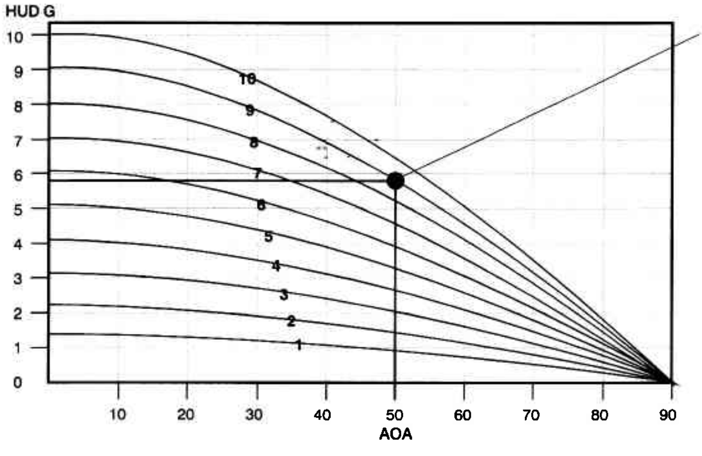
10G are lines of constant load factor. The thick line rising to an apex is an example of the performance curve for a typical fighter aircraft. Presumably these diagrams got their name because the shape of this thick line resembles the roof of a dog kennel.

The left hand slope denotes the lift limit and the right hand slope denotes the structural limit. Because these are limits, the performance curve marks the boundaries of the flight envelope. This means that the aircraft can fly at any point on or under the curve, but at no point above it. The apex of the performance curve is the maximum instantaneous turn rate possible, or corner velocity.

Look at the point marked 'B' on the diagram. At this point the aircraft has an airspeed of 550 knots and is pulling approximately 9G. The turn radius is 3000 feet and the turn rate is 18dps. Corner velocity for this aircraft is approximately 303 knots. At corner, this aircraft can turn at just over 32dps with a turn radius of approximately 900 feet. You can see that it will never turn at a higher rate than that and its turn radius will never be less than 900 feet. As speed bleeds down to around 190 knots at point 'A', this aircraft will have a turn rate of only 20dps and the same radius as before.

Since the performance curve indicates the limits to the flight envelope for this aircraft, points 'D' and 'E' are outside of the flight envelope. This aircraft can never have a turn rate of 28dps at 410 knots as indicated at point 'E' because this point is beyond the G limit. At point 'D' the aircraft is lift limited, so it can not pull 7G at 230 knots. At 230 knots this aircraft can only pull approximately 5G and achieve a turn rate of 25dps. However, point 'C' is well within the flight envelope. If he chooses to do so, the pilot of this aircraft can pull back on the stick to 6G at 340 knots where he will have a turn rate of 19dps and a turn radius of approximately 1,700 feet.

Figure 4



With these examples you should now feel confident in your ability to read these Doghouse plots. The speeds on the following plots are True Air Speed (TAS) as indicated in the HUD in EF2000, but the lines of constant load factor represent the G actually turning the aircraft and not the G indicated in the HUD.

If you wish to compare the Doghouse plots presented here with your own HUD readings, you will need to be able to convert the G shown in the HUD to the amount of G doing the turning. This can be done using the chart shown in Figure 4.

On this chart it it easy to see that if you have a HUD indicating 5.8G at 50 degrees Angle of Attack you are actually turning at 9G. We are now in a position to present the EM Diagrams for the Eurofighter as modelled in EF2000.

Figure 5 shows the EM Diagram for the Eurofighter at Sea Level with a clean configuration at full throttle with AB.

The key features of this diagram are the Corner Velocity at 190 knots and the maximum instantaneous turn rate of just over 51dps. The

Figure 5: Eurofighter 2000 at Sea Level

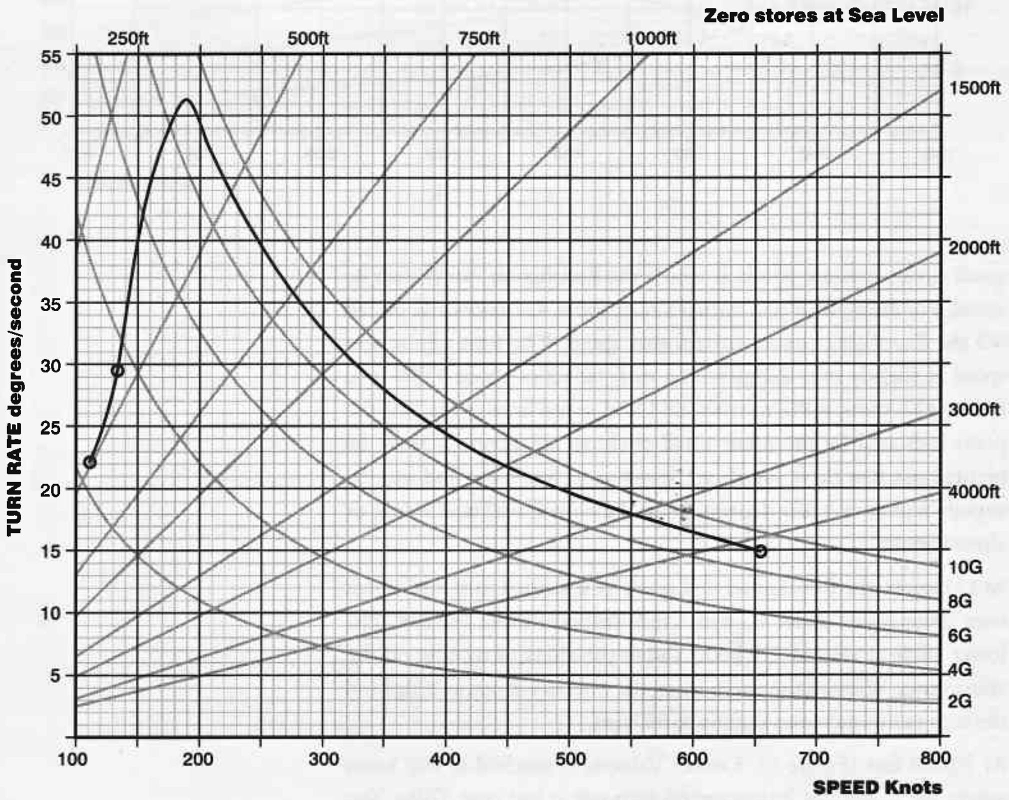
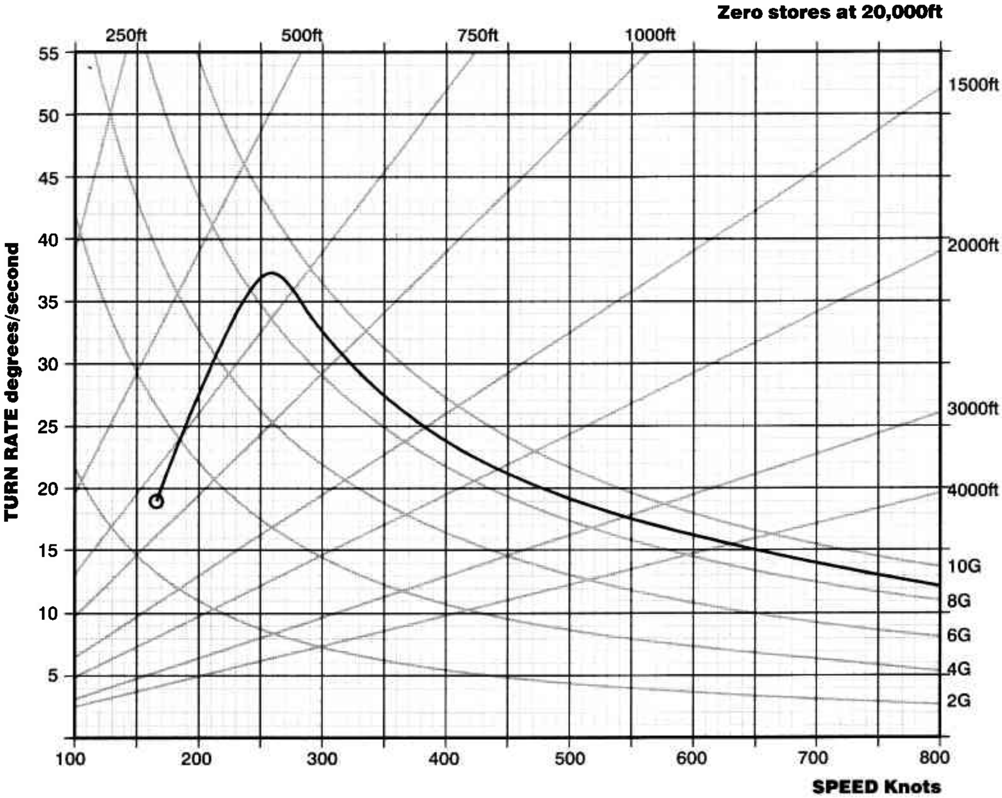


Figure 6: Eurofighter 2000 at 20,000 feet

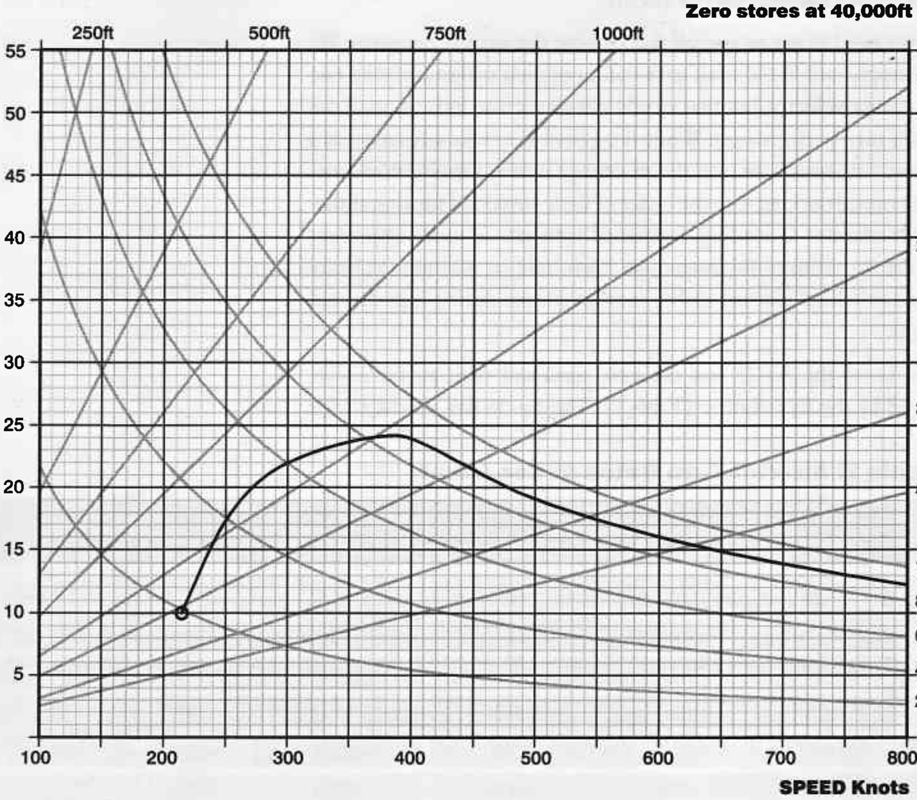


small circles indicate points at which the Eurofighter can sustain its speed. For example, if you started a turn above 437 knots and pulled 9G the Eurofighter could sustain that speed. The turn rate at this speed is slightly over 22dps with a turn radius of about 1,900 feet. Below 437 knots, a 9G turn would bleed speed until it reached the point indicated by the other small circle at 133 knots. It must be pointed out that these speeds are sensitive to fuel loads and may be slightly higher or lower depending on if the main fuel tank is full, or almost empty.

At 133 knots, the Eurofighter will reach its sustained turn rate of just over 29dps at just under 4G with a turn radius of about 450 feet. The lower circle at around 110 knots shows the effect of turning off the afterburner. Without the afterburner, the turn rate drops to 22dps and the turn radius increases slightly to 500 feet.

At 20,000 feet (Figure 6), Corner Velocity is reached at 260 knots where the maximum instantaneous turn rate is just over 37dps. You

Figure 7: Eurofighter 2000 at 40,000 feet



can see that as you get higher, you need to maintain a higher true airspeed to stay at corner velocity. The sustained turn rate is reached at 165 knots where the Eurofighter can maintain a 3G turn at 19dps with a turn radius of 842 feet.

At 40,000 feet (Figure 7), Corner Velocity is now at 383 knots with a turn rate just over 24dps and a turn radius of 1,540 feet. You will also notice that the minimum turn radius now occurs somewhat below corner. At 300 knots and 6G, the turn radius is approximately 1,350 feet, nearly 200 feet less than at corner. The sustained turn rate is reached at 215 knots with a turn rate of slightly less than 10dps and a turn radius slightly greater than 2,100 feet.

General observations are that your turning ability drops dramatically as you gain altitude. However, do not jump to conclusions. You may be tempted to believe that this infers that you will do better against the enemy aircraft (in terms of turn performance) at low altitude. However we as yet only have half of the picture. The best altitude for an engagement will depend on performance of the Eurofighter relative to the enemy aircraft at each altitude. In other words, we also need the EM Diagrams for our enemy.

First, we need to get an overall feel of how the aircraft compare. We could simply rank the aircraft in the order of their maximum turn rate at the corner velocity, but that would not give a true indication of the aircraft's turn performance. While it is possible to take advantage of a high instantaneous turn rate, the advantage is only a momentary one. A more useful ranking is in the order of their sustained turning ability under maximum G loading. Sustained turn rate is more important than the maximum instantaneous turn rate at Corner Velocity because sustained turning ability is what counts during a protracted dogfight.

At Sea Level the Su-35 has the best sustained turn performance, followed by the Eurofighter (Table 2). The Su-35 has almost a 3dps

Table 2: Aircraft Turn Rates at Sea Level

Rank	Aircraft Type	Sustained Speed (knots)	Sustained Turn Rate (dps)	Sustained Turn Radius (feet)	Corner Velocity	Instantaneous Turn Rate (dps)
1	Su-35	225	32.2	678	261	37.4
2	Eurofighter	133	29.4	437	190	51
3	Su-27	342	28.5	1160	342	28.5
4	Su-33	326	26.5	1192	326	26.5
5	MiG-29	407	22.2	1776	423	23.1
6	MiG-31	359	15.8	2201	468	20.8
7	MiG-27	325	15.2	2066	399	18.9
8	MiG-21	298	15	1919	383	19.7

Table 3: Aircraft Turn Rates at 20,000 feet

	Aircraft Type	Sustained Speed (knots)	Sustained Turn Rate (dps)	Sustained Turn Radius (feet)	Corner Velocity	Instantaneous Turn Rate (dps)
1	Eurofighter	165	19	842	260	37
2	Su-27	395	17.5	2189	468	20.8
3	Su-35	225	16.7	1309	357	27.3
4	Su-33	360	15.4	2261	447	19.4
5	MiG-29	407	11.6	3395	579	16.8
6	MiG-31	359	8	4337	641	15.2
7	MiG-27	325	7.6	4139	546	13.8
8	MiG-21	298	7.4	3902	525	14.4

Table 4: Aircraft Turn Rates at 40,000 feet

Rank	Aircraft Type	Sustained Speed (knots)	Sustained Turn Rate (dps)	Sustained Turn Radius (feet)	Corner Velocity	Instantaneous Turn Rate (dps)
1	Eurofighter	215	9.8	2116	383	24
2	Su-27	289	4.6	6070	690	14.1
3	Su-33	263	3.3	7791	659	13.1
4	MiG-29	297	1.6	17932		11.4
5	Su-35	None			526	18.6
6	MiG-31	None			944	10.3
7	MiG-27	None			805	9.4
8	MiG-21	None			774	9.8

advantage at Sea Level. However the Eurofighter has the advantage of a smaller turn radius and the computer pilots definitely run low on ideas near the deck.

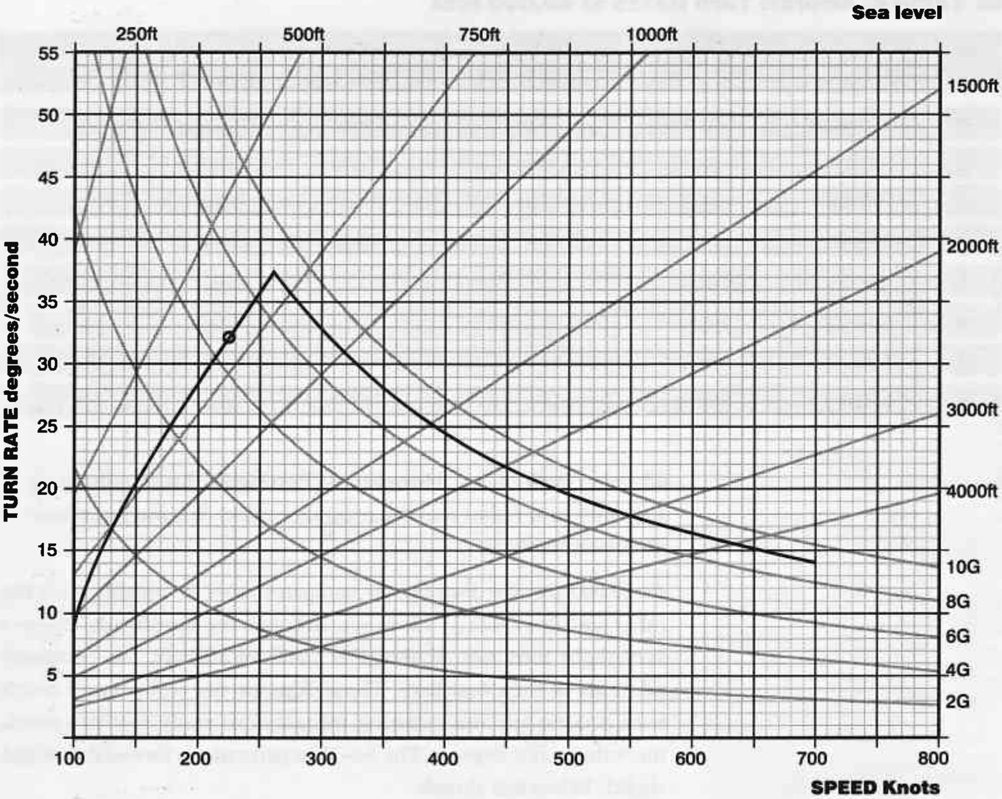
At 20,000 feet the Eurofighter compares more favourably with the other aircraft (Table 3). However, although the Eurofighter enjoys a very slight turn rate advantage at medium altitude, the computer pilots are at their best here. Those 2dps are not really worth much here because any manoeuvring mistakes can easily cost you much more than a few degrees. The Su-35 in particular is formidable at and slightly below this altitude.

Table 4 highlights some of the problems in making comparisons in this way. The bottom 4 aircraft can not sustain speed at 40,000 feet, they will simply lose energy until they stall and begin to lose altitude. However that does not mean they can not fight at 40,000 feet. They can come up to that altitude fast and fight while bleeding speed. Speed bleeds slowly at this altitude so they will have ample time to stay and fight. As they lose speed, they will attempt to take the fight to lower altitudes by looping downwards in the hope of dragging you down with them.

These tables give us the impression that dogfighting at 40,000 feet is the way to gain the greatest turn rate advantage against most of the enemy fighters. However, you should not jump to conclusions here either. The tables omit a lot of other valuable information. As noted earlier, what we really need to do is to compare the EM Diagrams for the Eurofighter and the enemy aircraft to arrive at the most informed conclusions.

Therefore, we need the EM diagram for an enemy aircraft, in EF2000 the primary air threat is the Su-35 Super Flanker and we will examine

Figure 8: Su-35 at Sea Level



the performance of this aircraft in detail (Figure 8). The main features of this diagram are a Corner Velocity of 261 knots giving an instantaneous turn rate of 37.4dps with a turn radius of 674 feet. You will also note that the Su-35 has a sustained turn rate of 32.2dps at 225 knots as marked by the circle.

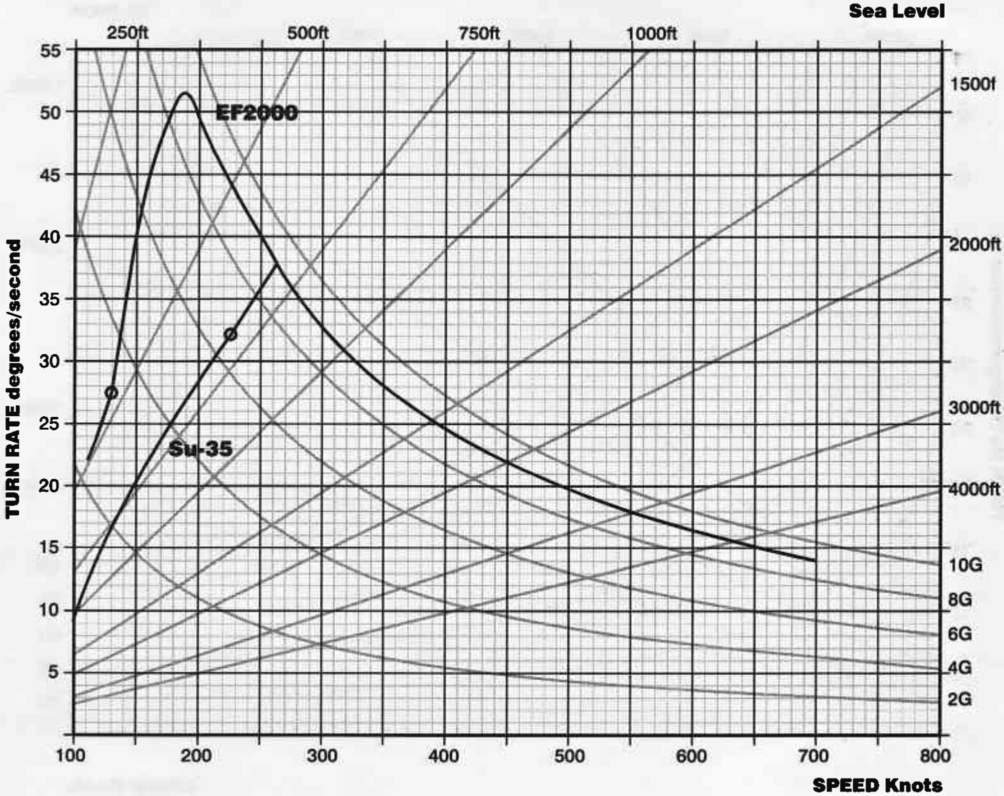
Before we look at the diagrams for the Su-35 at other altitudes, we need to look at an example of what these diagrams are really meant for: comparison.

Look at the overlay for the Eurofighter and the Su-35 at Sea Level (Figure 9). This is where the EM Diagrams really excel. You can see at a glance how these aircraft compare.

First, you can see that both aircraft have identical performance at all speeds above 260 knots. Below 260 knots the turn rate of the Eurofighter exceeds that of the Su-35 significantly, however you can see the problem here.

With the stick full back, the Eurofighter will bleed speed very rapidly at speeds below 260 knots so that it will reach its sustained value in

Figure 9: Su-35 v Eurofighter at Sea Level



only a few seconds. That means that it does not enjoy those high turn rates long enough to win any real advantage. Once the Eurofighter's speed has reached its sustained value of 133 knots, it will be in a fight in which the Su-35 will have a 4.5dps advantage.

However, you will notice that the Eurofighter has a turn radius almost 250 feet smaller than the Su-35. Although the Su-35 will be able to out turn the Eurofighter, it will not be able to get in behind it. The Eurofighter can turn inside the Su-35 indefinitely.

This explains a common situation. The Eurofighter ends up in deep lag pursuit unable to catch up with the Su-35. The Su-35 turns slightly faster but with a larger radius and is unable to turn tightly enough to get behind the Eurofighter. The Eurofighter is flying around inside the Su-35's turn circle in a stalemate situation. By overlaying the EM Diagrams, you can predict this outcome. However, such a situation is short lived. It is relatively simple to create a suitable turn circle misalignment (as explained in Chapter 6) for a shot. This technique works extremely well against the computer pilots.

Figure 10: Su-35 at 20,000 feet

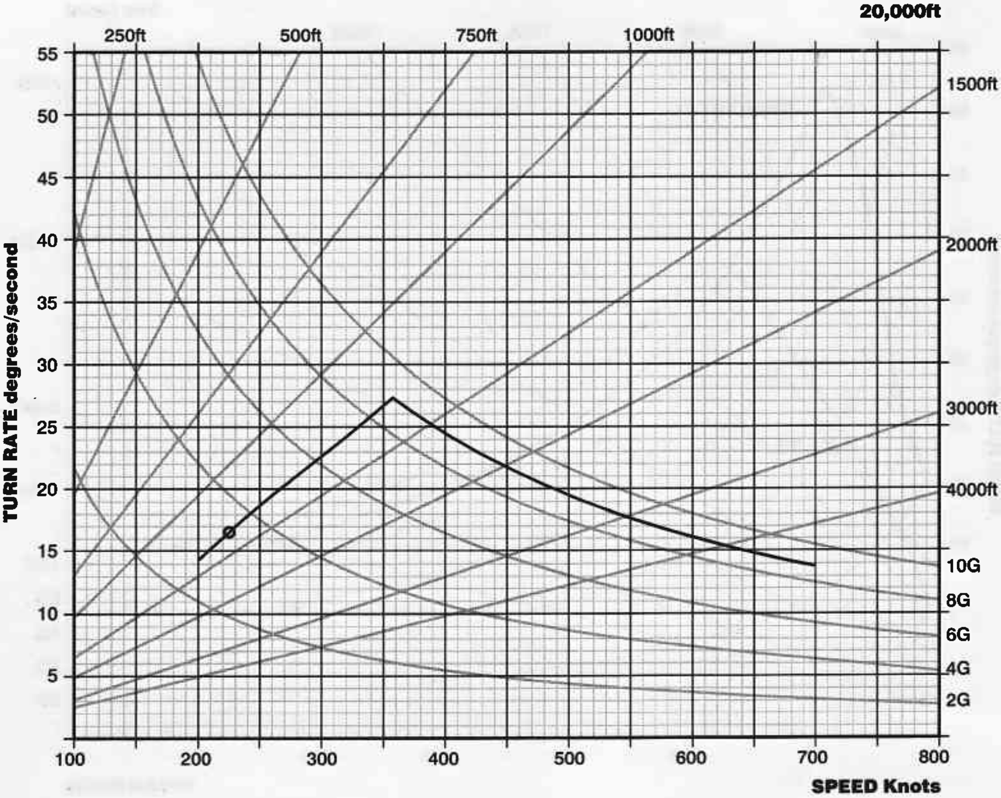
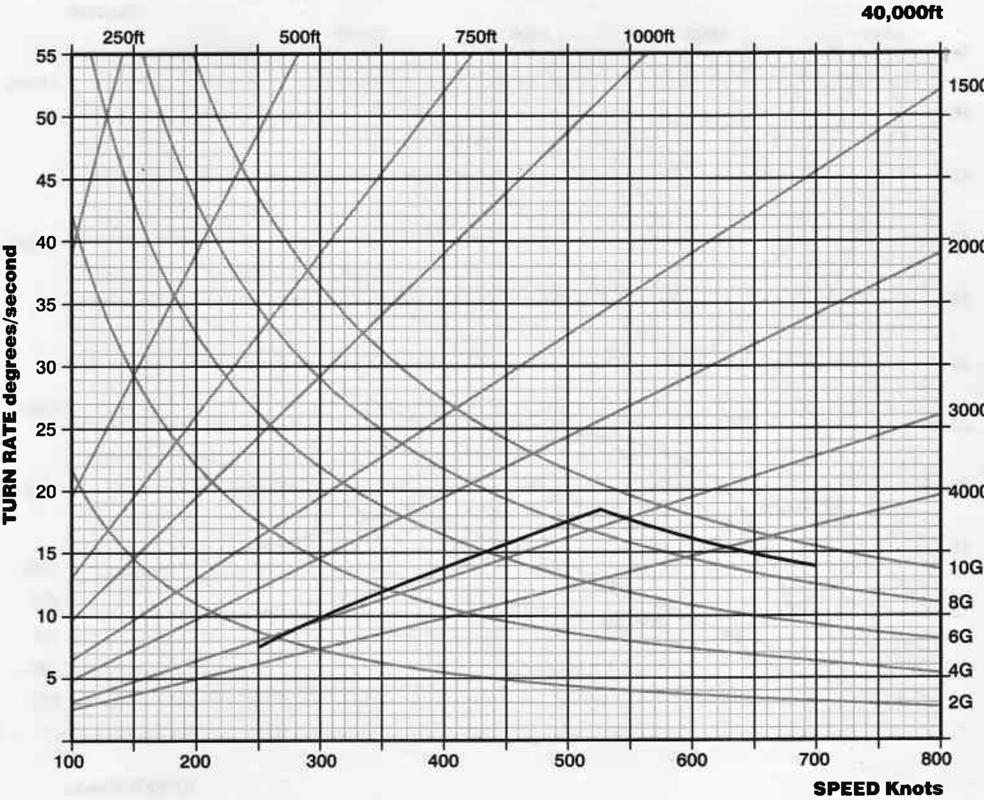


Figure 10 shows the Su-35 at 20,000 feet. Here you will notice that corner velocity is at 357 knots with a turn rate of 27.3dps. The sustained turn rate is much lower, 16.7dps at 225 knots, or about half the turn rate enjoyed by the Su-35 at Sea Level.

At 40,000 feet the performance of the Su-35 drops off sharply, (Figure 11) you can see that Corner Velocity is now 526 knots with a turn rate of 18.6dps. At this altitude the Su-35 cannot sustain any particular speed, but will eventually stall. Of course, the Su-35 pilots will not just keep turning into a stall, they will manage their energy, converting potential energy to kinetic energy in order to stay in the fight, albeit at a lower altitude.

Now that we have seen how the Su-35 performs at 40,000 feet, we will overlay the EM Diagram for the Eurofighter and make comparisons (Figure 12). One very striking feature is that the Eurofighter is clearly going to dominate any fight that takes place below 526 knots. You will recall that at Sea Level the maximum instantaneous turn rate was of no real advantage. Speed bled off so

Figure 11: Su-35 at 40,000 feet

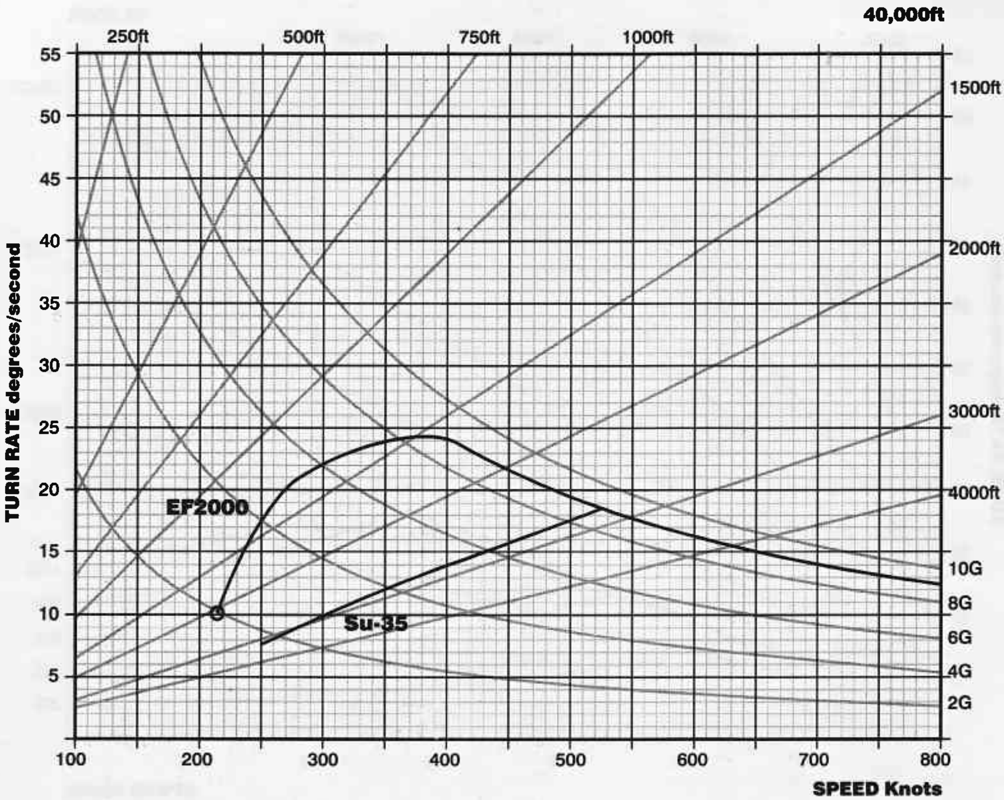


quickly that we hit the sustained turn rate before getting any real benefit from the higher peak value. The bad news was that the Su-35 could then sustain a higher turn rate than the Eurofighter. The only consolation is that the Su-35's turn radius was larger which made it very difficult for him to take advantage of the extra performance. The key point however was that the high instantaneous turn rate was of little use to us.

At 40,000 feet the situation is slightly different. You will bleed off speed much more slowly, so you can sustain higher turn rates for longer. You will gain more of an advantage from your maximum instantaneous turn rate. Even when you do bleed down to your sustained turn rate, albeit only 10dps, none of the other aircraft will be able to match it at this altitude.

You have probably realised by now that how an aircraft bleeds speed is very important. In what part of the flight envelope an aircraft will be able to sustain speed depends on something called Excess Power. If you have Excess Power, your aircraft has the ability to accelerate. Excess Power can be measured quantitatively and fighter pilots call it

Figure 12: Su-35 vs.Eurofighter at 40,000 feet



Ps (pronounced 'peas'). If you have positive Ps you can accelerate. If you have negative Ps you will bleed speed. How quickly you will accelerate or bleed speed will depend on the magnitude of the Ps.

By superimposing Ps information on the EM diagrams we can determine in which parts of the flight envelope the fighter can sustain its performance. On real EM diagrams there will be a whole series of these extra lines from high negative to high positive values. However, for our purposes one extra line will do very nicely, the line representing Zero Ps. The Ps=0 line joins all the points in the envelope where we can just sustain energy, points where thrust exactly equals drag. Superimposing this information upon our existing EM Diagrams can tell us a lot.

In Figure 13 a Ps=0 line has been superimposed on a typical EM diagram. The area above the Ps=0 line represents negative excess power. Flying at any point above the Ps=0 line will cause you to bleed speed. The area below the Ps=0 line represents positive excess power. Flying at any point in the envelope below the Ps=0 line means you can accelerate.

Figure 13: Typical EM Diagram with Ps=0 Line

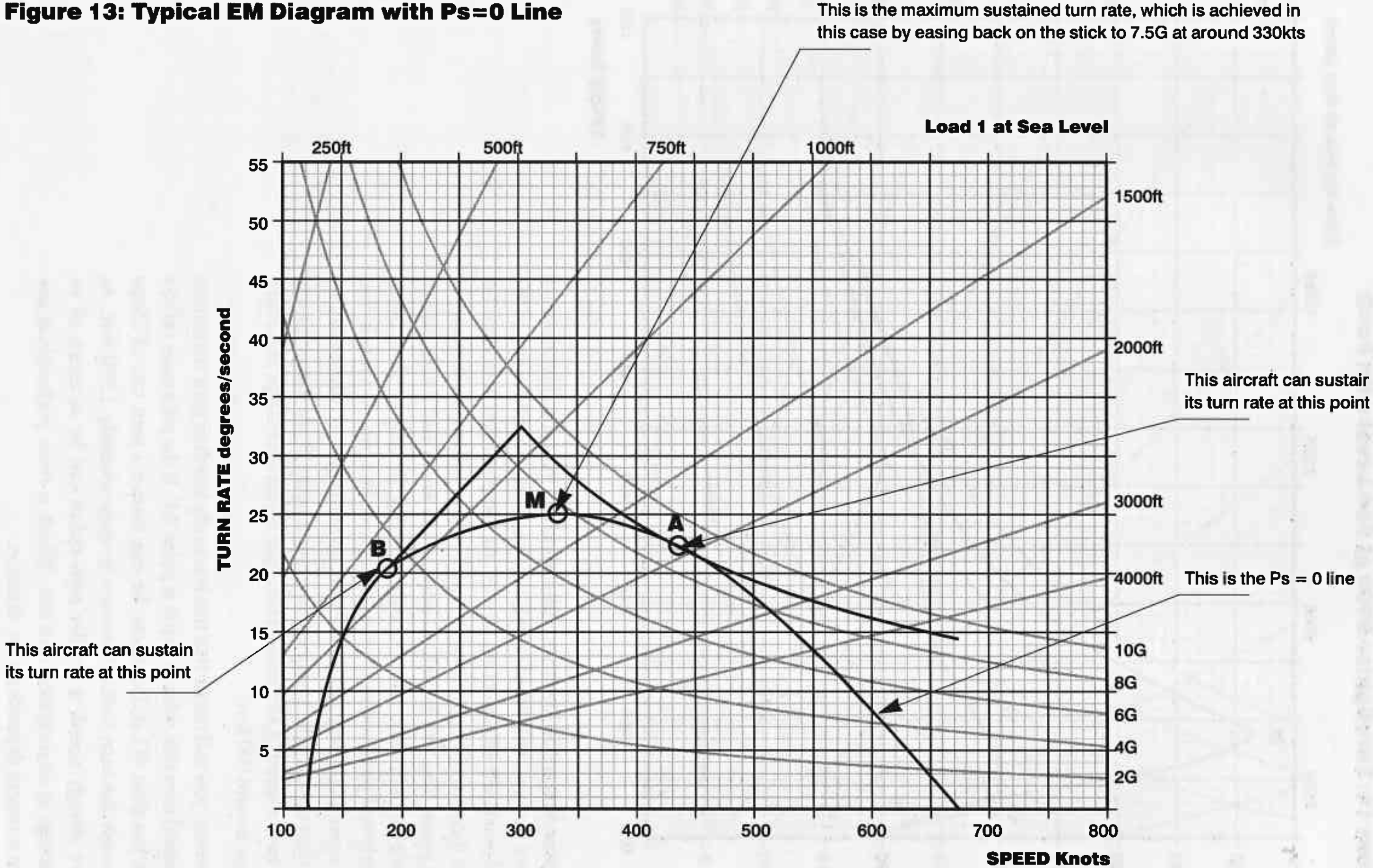
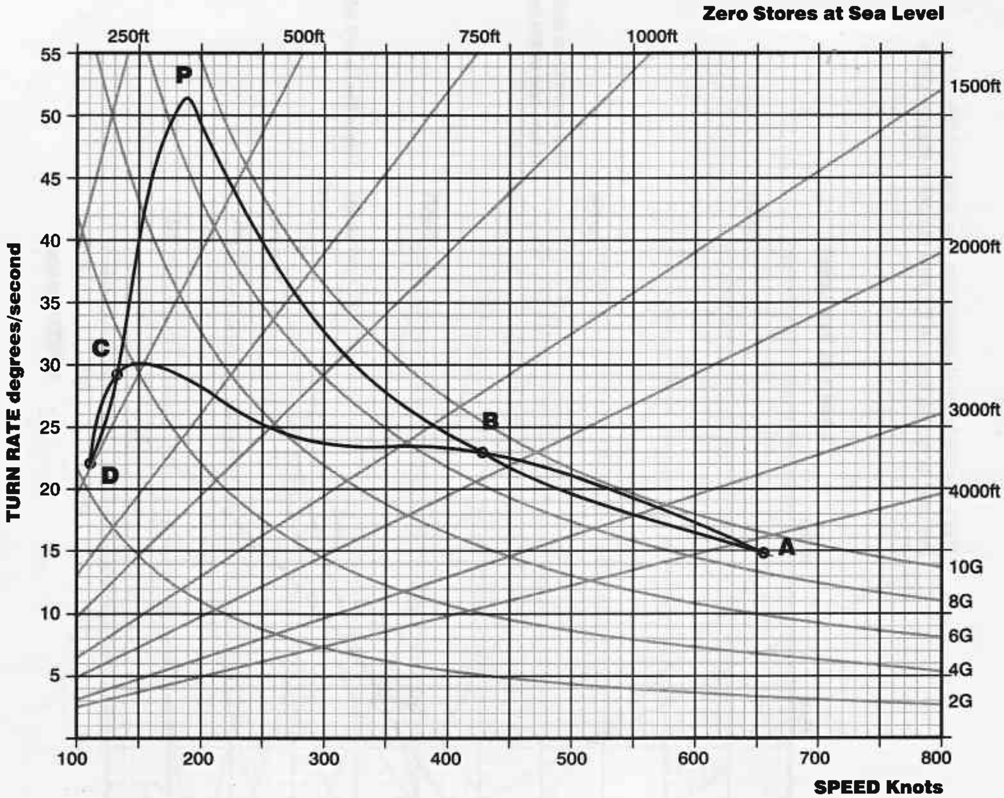


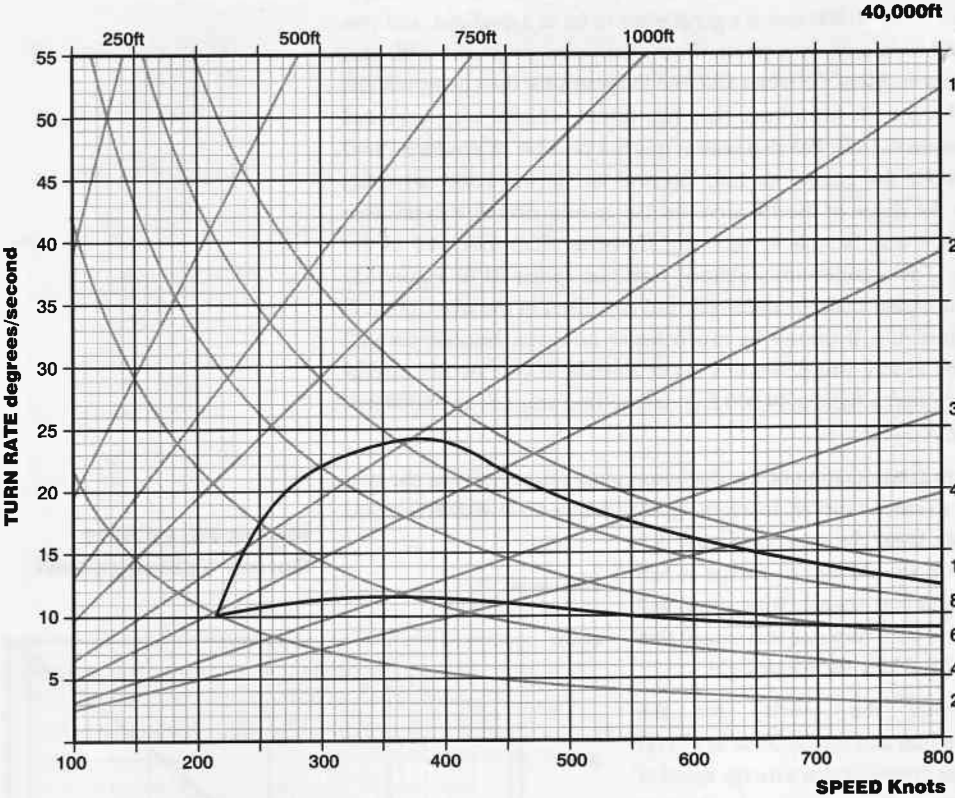
Figure 14: Eurofighter 2000 at Sea Level with Ps=0



Suppose that at 650 knots you roll into a hard 9G turn. This diagram shows that you will bleed speed, moving along the EM curve at 9G until you reach 435 knots at point 'A'. At that point you have Zero Ps. Your thrust and drag are exactly equal, so you will maintain energy at that point. You will be able to sustain 435 knots and a turn rate of 22.5dps indefinitely. Momentarily reducing throttle to slow down slightly will place you in a region of negative Ps again. As a result, you will move all the way along the curve, up to the peak at corner velocity and then down to the sustained turn rate at point 'B'. At this point you will have a speed of 185 knots, a turn rate of just over 20dps and a turn radius around 900 feet.

However, you will notice that this is actually less than your maximum sustained turn rate, which occurs at point 'M'. If the pilot eases off to a little less than 8G at 330 knots, he can sustain a turn rate of 25dps although the turn radius increases to approximately 1,300 feet. As we've already noted, a smaller turn radius can be as much of an advantage as an increased turn rate. Which is more preferable at any given moment depends on the situation.

Figure 15: Eurofighter 2000 at 40,000 feet with Ps=0



Another important observation is that if you are holding the stick back and thus bleeding speed back along the main EM curve. The higher above the Ps=0 curve you are, the faster your speed will bleed off. You can see that speed will bleed off much more rapidly at your corner velocity and at high speeds than anywhere else.

The effect of adding a Ps=0 curve to the EM diagram for the Eurofighter is shown in Figure 14. You will notice that the Eurofighter has a positive excess power between points 'A' and 'B'. This means that the Eurofighter has the power to accelerate at speeds above 430 knots at Sea Level. Between points 'B' and 'C' you have large negative excess power which explains why your speed bleeds off so rapidly here. You can sustain energy again at point 'C'. Point 'D' is the sustained energy with the afterburner turned off. Lighting it again creates a positive excess power that will allow you to accelerate up to point 'C' once again. The effect of adding a Ps=0 curve to the EM diagram for 40,000 feet is shown in Figure 15 and reveals that your sustained turn performance is almost constant (changing by less than 3dps) over the whole flight envelope.

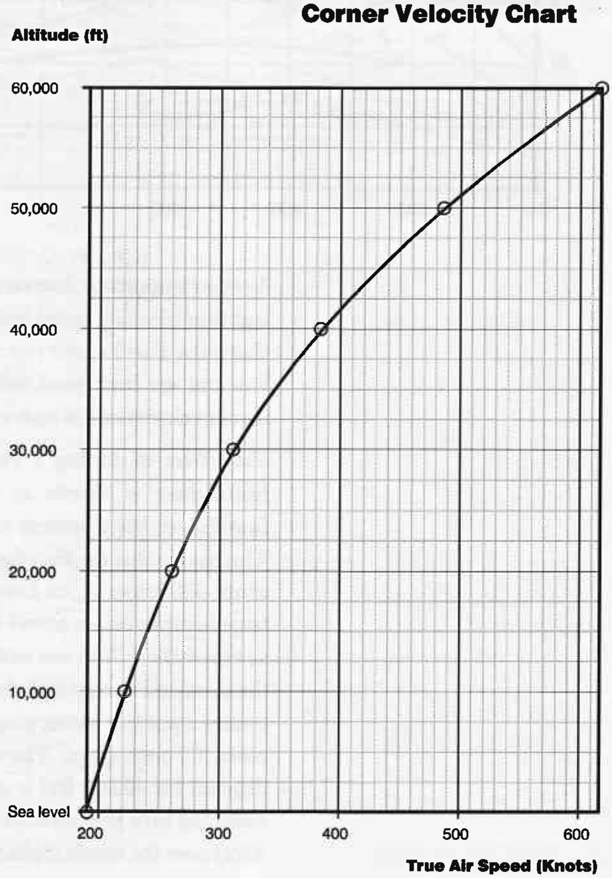
What conclusions can we draw from these diagrams? You might consider that 40,000 feet is a good place to be in a dogfight, and you would be correct, to a point. There are some problems with this conclusion. All of the tables and EM Diagrams for the enemy aircraft have been built from basic data like thrust, weight, wing area and maximum G load. For that reason it is not possible to produce Ps=0 curves for the enemy aircraft. Because we do not know anything about the shape of the Ps curve for the enemy aircraft it is possible that they may be able to turn slightly better than indicated in the tables. Their maximum sustained turn rate (point M in Figure 13) may be higher than the sustained turn rate given in the table (point B in Figure 13). It cannot be much better however, because they all attempt to lure you down to a lower altitude. If you are not careful you can start a fight at 40,000 feet only to find yourself at 20,000 feet before you realise it.

Further consideration of the doghouse plots can reveal that the best speed to enter a merge. In a fight against the Su-35 at 40,000 feet you will see from the overlay (Figure 12) that you should aim to merge at 526 knots. As you engage, your speed will drop but your turn rate will exceed that of the Su-35 for the whole fight.

Inspecting the overlay for the Eurofighter and the Su-35 at Sea Level (Figure 9) reveals that a merge speed of 261 knots allows you to take the best advantage of your own peak turn capability. Of course you still have a lower sustained turn rate than the Su-35 at this altitude so only flying skill will save you.

Similar reasoning suggests that the best speed for the merge is the corner velocity of the bandit for that altitude. Using data from tables 2-4 shows that at 40,000 feet you should fly at 659 knots when you merge against the Su-33. A merge at 20,000 feet against the Su-27 should be made at 468 knots. This information must be tempered with your ability to avoid the bandit's head on gun shot. You may choose to come into the merge with more smash in order to be able to barrel roll

Figure 16: EF2000 Corner Velocity Chart



through unscathed. You can then use your air brake and throttle to reduce speed as you pass the bandit's 3-9 line.

You will recall that the HUD in EF2000 displays True Air Speed, which means we have a different Corner Velocity at every altitude. So far, we only have those values at the altitudes for which we have Doghouse plots. However, Corner Velocity is such an important number we would like to know what it is for every altitude. After all, suppose you are in a dogfight at an altitude somewhere between those given in the Doghouse plots. Corner Velocity for the Eurofighter at every altitude is shown in Figure 16. For example, you can see from this that at 30,000 feet the Eurofighter has a corner velocity of 310 knots and at 15,000 feet it has a corner velocity of 240 knots.

The Effects of Weight and Drag

Using Doghouse plots provides us with a wealth of information. However, each diagram is only valid for a specific configuration.

Table 5: Weight of Stores

ITEM	MASS (kg)
EF2000	10,000
BL-755	277
DURANDAL	185
IRON Mk-83	447
IRON Mk-82	241
GBU-16	454
GBU-12	225
CRV-7	220
SEA EAGLE	600
MAVERICK	220
ALARM	175
S-225	200
AMRAAM	157
ASRAAM	100
AIM 9M	100
CANNON (1760)	880 (0.5kg each)
INTERNAL FUEL	4000
CL DROP TANK	3500 + 400 (tank)
WING DROP TANKS	3500 + 400 (tanks)

Other altitudes, fuel and ordnance load outs require Doghouse plots of their own. So you will appreciate that even these methods have their limitations. There are far too many consumable armament configurations to produce Doghouse plots for each one. However, we can still consider the effects of our fuel and ordnance load out on performance in general.The difference that these load outs make is simply to increase the mass and thus the weight of the aircraft. This in turn has an effect on both speed and turning ability. Before we investigate the effects of weight on our aircraft's performance, we need to know the weight of the various stores (Table 5).

Taking off with nothing but internal fuel and a full magazine for the cannon will give you 10,000kg + 4,000kg + 880kg = 14,880kg or nearly 15 metric tonnes. Adding a centre line fuel tank, two Mk-83s, four S225s and two ASRAAMs would add 9,282kg giving a total of 24,162kg, just over 24 tonnes.

These increases in mass produce two main considerations in EF2000, the first of which is drag. Everything you have hanging off the rails will increase the drag on your aircraft and will consequently reduce your top speed. For instance, you will recall from the Top Speed table (Table 1) that at 40,000 feet your top speed was 1,430 knots. With a mass of 22 tonnes, this drops to 1,090 knots, a loss of almost 340 knots. At this new speed you will notice by looking back to the top speed table that now all of the enemy aircraft listed can catch you.

When you are heavily loaded for ground attack or long missions, you are vulnerable to interception. The only sure way to avoid being intercepted is to reduce your weight and that means dropping stores. In a fight or flight situation, you either lose the excess baggage or die.

At this point, you are probably thinking that if the Eurofighter can turn so well, why bother running? Unfortunately, top speed is not the only issue here. The heavier your fighter becomes the less effective it will be in a turning fight. One of the reasons for this is shown in Figure 17.

In the diagram a Eurofighter is frozen at an instant in time during a hard and level turn. In order to stay level, the aircraft cannot be banked at 90 degrees. It needs to maintain a vertical component of its lift exactly equal to its weight in order to maintain altitude. In Figure 17, the vertical component is marked 'y'. The amount of lift available for turning the aircraft is shown at 'x'.

If the aircraft is made heavier by adding stores the pilot will need more vertical lift in order to maintain level flight. he will need to increase the size of the force marked 'y'. However the pilot can only pull

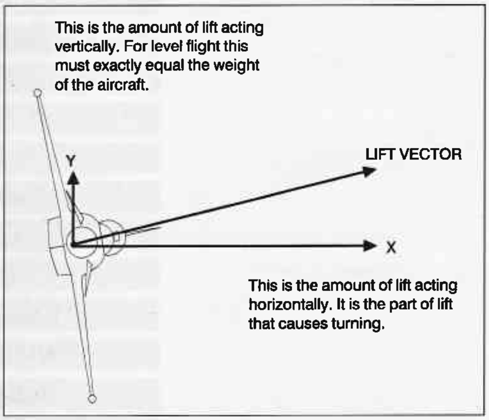


Figure 17

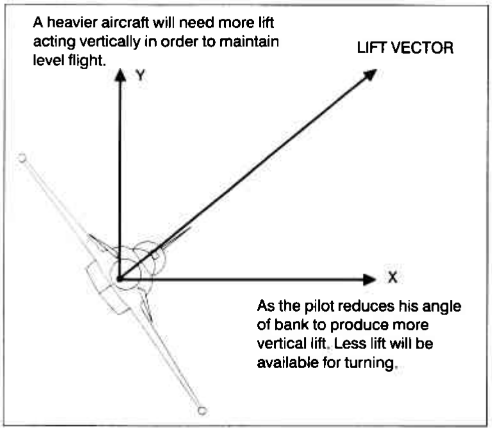


Figure 18

the same amount of G so in Figure 18, the lift vector has exactly the same magnitude as Figure 17. Now the bank angle must be reduced in order to provide more vertical lift and counterbalance the additional weight. It is easy to see that increasing the vertical component of lift also reduces the horizontal component. Less lift is available for turning. The result is that a heavier aircraft does not turn as well as a lighter one. A fact that has long been known by competitive flightsim pilots, who when entering a fight that was certain to be concluded with guns, could be observed almost ritualistically firing their missiles into oblivion in order to gain a slight turning advantage. Of course, if they had anything as effective as the ASRAAM they would not have dumped them.

How badly will your turning ability be affected by your weight? The equations of motion for the Eurofighter were used in order to experiment with various load outs and determine the resulting reduction in instantaneous and sustained turn rates. While there are too many configuration permutations to include here, one very useful rule of thumb emerged. While turn rate varied between 1.5dps and 0.8dps per 1,000kg of fuel or stores, 1dps per 1,000kg turns out to be very close to the average. This gives you an easy and reasonably accurate method for calculating the effect of weight on turning ability.

Dropping your centre line tank (3,900kg) will increase your turn rate by approximately 4dps. Firing away four S-225s and an ASRAMM will shed 900kg and therefore gain you approximately 1dps. During the course of a fight, firing off 1,000 rounds of your 27mm cannon will gain you a further 0.5dps.

How do you know if dropping stores is necessary in the first place? The answer is simply feel. When you are watching the bandit in padlock, you can see if he is moving forward (in the same direction that the canopy markers are pointing) or moving backwards relative to your aircraft. This will tell you if you are gaining angles or losing them.

However, the reason may be due to your speed, or to turn circle misalignment rather than a deficiency in your turn rate. Knowing which one is true at any moment can be determined from experience. You will simply have to acquire a feel for these things. Too many pilots fly by the numbers. You just cannot rely too heavily upon good old fashioned instinct.

If you feel that none of the above reasons are responsible for you losing angles then dump the stores. Whatever you decide, you will never have long to make a decision and it is always better to be safe rather than sorry. Exactly which stores to drop and when to drop them will be dictated by the circumstances at the time. Without doubt, external fuel tanks should be the first to go in an emergency. Ground ordnance not critical to mission success should be next. After that, what else you drop depends on how desperate you become. However, never, ever drop your ASRAAMS, given a good rear aspect they are a one shot one kill missile and worth every bit of their 100kg each.

In the past, the sort of knowledge presented in this chapter would only come from long, hard experience. Many hours of training flights against the artificial intelligence and many more hours spent flying against real opponents. Many smoking holes in terra firma and a long slow learning curve has always been the only way from novice to ACE. This is all part of the fun. However, no one enjoys getting their tail feathers singed, so we hope that this information has shortened the learning process. Fewer smoking holes, and fewer dents in your pride.

The next time you load EF2000 you will be able to enter a dogfight with the sort of knowledge that might have otherwise taken many months of dedicated flying to ascertain, even then without any real certainty. From here on in, you will be able to fly every engagement in a way that will make best use of your aircraft's strengths while taking advantage of your opponent's weaknesses. You will be able to fly your Basic Flight Manoeuvres (BFM) confident in the knowledge that you are not only out manoeuvring your opponent, but that you are also out turning him. This combination will make you an extremely formidable adversary.

Chapter 5

A2A Weapons

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Air-to-Air (A2A) weapons fall into three general categories: stand-off missiles intended to strike targets from Beyond Visual Range (BVR), short range missiles intended for use in close quarter dogfights and cannons, also intended for close quarter dogfighting.

The longer a pilot has to engage in A2A combat with an enemy, the more chance there is of the enemy prevailing. Mistakes can happen to the best of pilots. In A2A combat, mistakes get you killed. Eliminating the enemy threat from BVR is by far the most preferable method as it exposes the aircraft and the mission to the least amount of danger. If an enemy successfully penetrates to a point inside the minimum range of BVR missiles, short range missiles may allow a pilot to achieve a kill quickly and end the fight. If all else fails, the pilot must be able to bring his cannon to bear on the enemy with accuracy and expedience.

Brief Introduction to Missile Propulsion, Guidance and Fusing

The majority of modern A2A missiles utilise solid fuel rocket propulsion and the missiles carried by the EF2000 are no exception. Rocket engines provide several advantages for A2A missile use. First, they have a very high thrust-to-weight ratio and allow for a smaller, lighter weapon. Total missile weight affects the quantity that can be carried by an aircraft and smaller sizes reduce drag and allow for higher aircraft speeds and improved fuel efficiency. Second, rocket motors generate extremely rapid acceleration and high terminal velocities that translate into longer range capabilities than might be achieved by other means.

The EF2000 is capable of carrying four different A2A missiles: the AIM-9M Sidewinder, the AIM-132 Advanced Short Range Air-to-Air missile (ASRAAM), the AIM-120 Advanced Medium Range Air-to-Air missile (AMRAAM) and the new S-225 Long Range Air-to-Air Missile (LRAAM).

Of these four missiles, all but the LRAAM use solid fuel rocket motors exclusively. There are advantages and disadvantages to solid fuel propulsion. On the plus side, they allow for a smaller missile body and are very reliable. On the negative side, solid fuel rockets offer no throttling ability. They burn at full thrust until the fuel is exhausted. Solid fuel rockets also produce a fair amount of smoke which makes both the missile and the aircraft that shoots it easier to spot in flight.

The LRAAM uses a dual rocket motor that offers the advantages of throttling and reduced smoke output. Throttling allows the missile to accelerate under full power and then coast at a lower, thrust maintaining level of propulsion. This greatly extends the missile's effective range without excessively increasing size and weight. Reduced smoke output translates into a stealthier missile that is both harder to spot, and consequently harder to spoof. It also decreases the ability of enemies to determine where the missile came from. The LRAAM motor maintains a reserve boost capability to give it excellent terminal velocity at the target.

A2A Missile guidance systems can be categorised as active, semi-active and passive. Passive guidance is typical of short range missiles and generally uses the hot, Infra-Red (IR) emissions from the target exhaust to effect seeker tracking and lock. Semi-active and active guidance systems are more typical of medium and long range missiles and generally use radar as the basis for targeting and tracking. Semi-active guided missiles require that the firing aircraft maintain radar contact with the target for the missile to track. Active guided missiles can generate their own radar picture of the target and are largely 'fire and forget' weapons.

The IR missiles carried by the EF2000 are passively guided while the radar missiles utilise advanced active radar guidance systems.

A2A missiles generally employ one or more of several different fuze types that can be categorised as contact, proximity, time delayed or command operated fuzes. By far, proximity fuzes are the most commonly seen type. As with guidance systems, there are active, semi-active and passive variants of proximity fuzes and the operational characteristics are similar as well. Passive fuzes rely on some emission from the target: heat, radar, radio. Semi-active fuzes work in conjunction with emissions from the firing aircraft. Finally, active fuzes generate their own signals upon which to determine the optimum time for detonation.

Fuzing mechanisms are often tailored to the types of intercept conditions they will likely encounter and are designed to detonate the missile at or near the point of greatest potential damage to the target. As a result, missile effectiveness can be severely diminished if these conditions are not met at the time of intercept. For example, a missile designed for rear-aspect intercepts may detonate beyond the target if it approaches from the front or side since the fuze timing was intended to account for a much slower closure rate. Because intercept conditions may vary widely, especially for all-aspect missiles, designing an effective fusing mechanism can be a serious challenge.

All missiles carried by the EF2000 employ active laser fuzes which can adapt to a wide range of intercept aspect conditions.

Maximising the Probability of Kill (PK)

A number of factors come into play when determining the most effective firing conditions in order to ensure the greatest PK. These include the speed and altitude of the launching and target aircraft at the time of weapons release, aspect angle and the effective range, speed, guidance system and fusing characteristics of the missile.

Target Aspect Angle (TAA)

All other factors being equal, aspect angle is perhaps the single most important factor in achieving favourable release conditions.

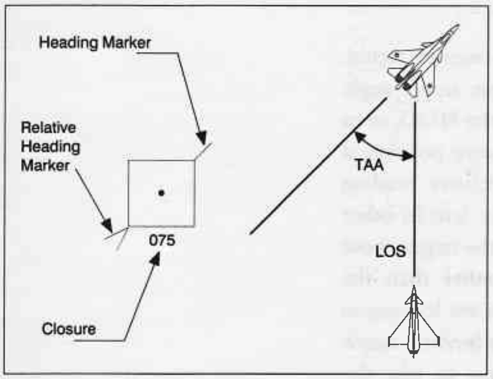


Figure 1: Target Aspect Angle and the Target Track Box

Target Aspect Angle (TAA) can be described simply as the difference between the line of sight (LOS) and the direction of the velocity vector of the target aircraft. A target in front of your aircraft and flying directly towards you has an aspect angle of 180 degrees. If you are chasing a target flying directly away from you, the aspect angle is 0 degrees. Aspect angle is often expressed as an angular degree and a direction that indicates the side to which the target's nose is pointed. In Figure 1, the aspect angle is 45 degrees right (45°R). If, however, the Su-35 were turned so as to be flying directly to the left, the aspect angle would be 90 degrees left (90°L).

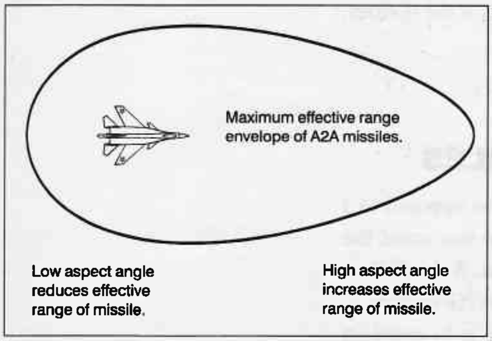


Figure 2: Effects of aspect angle on missile range

In general, a low aspect angle is desirable for short range IR missiles as that exposes the seeker head to the hot exhaust of the target. A high aspect angle is desirable for long range missiles because of the greatly extended range obtained (Figure 2). Aspect angles near 90 degrees are usually avoided because a short range all-aspect missile must make the most radical course changes in order to reach the target . In addition, a long range radar missile is more likely to lose target lock because of the low Doppler shift presented by a target flying at right angles to the launching aircraft.

When viewed through the Heads Up Display (HUD), the relative heading marker on the target track box is a reasonable indicator of aspect angle. In the example above where the aspect angle is 45 degrees right, the relative heading marker points up at 45 degrees and to the right.

The target track box in the Helmet Mounted Display (HMD) is identical to the one in the HUD. However, the pilot must bear in mind that the relative heading marker, as viewed in the HMD, is NOT always a correct indicator of the target's aspect angle. This is especially important when firing off-boresight with the ASRAAM missiles.

The important thing to remember is that in versions of EF2000 prior to the release of TactCom, the relative heading marker is NOT necessarily related to the aspect angle, it is only an indication of where the target's nose is pointed. The symbology does not change as the relative positions of the aircraft change unless the relative headings change. Pilots who are used to watching the aspect caret in other HUD implementations may end up wasting missiles on a poor shot. Pay close attention to not only where the target's nose is pointed, but also to where your head is pointed to get a more accurate reading on the true target angle.

In the TactCom release of EF2000, this deficiency has been corrected. The relative heading marker now behaves like a true aspect angle indicator, regardless of whether you are viewing it in the HUD, or in the HMD. If, for example, the Su-35 in Figure 1 were positioned below, rather than above, of the Eurofighter, the relative heading marker would appear to be pointing down and to the left. In other words, the relative heading marker now shows where the target's nose is pointed in relation to the Eurofighter itself, rather than the Eurofighter's nose, regardless of which direction you are looking to view the target. This makes determining the target's heading much easier and less confusing, since you no longer have to take the Eurofighter's heading into account. If you see that the relative heading marker is at the top and pointed down, that indicates that the target is facing you. Conversely, if the relative heading marker is at the bottom, pointed up, the target is facing away from you.

USING THE AIR TO AIR MISSILES

It is always preferable to engage in a BVR encounter as opposed to a dogfight. If you can defeat the enemy from a distance you stand the greatest chance of success in completing your mission. A dogfight is no place to be when you are weighed down with A2G ordnance; manoeuvrability is not on your side. The best policy is to avoid an engagement in the first place. Unfortunately, the enemy is rarely inclined to think the same way. You will need to make decisions before you take off as to which weapons to carry and this section is intended to provide you with some guidance to help make those choices. We will examine the different A2A missiles that are available, what they are capable of and how to get the maximum effectiveness from each. We will run down from BVR weapons to short range missiles as this is the order in which you would employ them in practice.

THE S-225 LONG RANGE AIR TO AIR MISSILE (LRAAM)

The S-225 LRAAM is an advanced, dual rocket propelled, active radar guided missile capable of extremely long range delivery. It is a formidable weapon due to excellent jamming resistance, a large warhead (30kg) and high terminal velocity at impact. The dual propulsion system utilises a smokeless rocket motor during much of the flight to the target decreasing the likelihood of detection and making evasion much more difficult.

The missile utilises a 'boost and coast' strategy to extend range and as such its average speed is somewhat less than the published maximum speed of 0.9 miles/second at Sea Level. It will, however, reserve power in order to allow for a final rocket boost to give it a high terminal velocity as it approaches the target.

The S-225 has a quoted maximum effective range of 50 miles when fired under high aspect angle conditions against a target with a high closure rate. You will notice that at 40,000 feet a launch cue can be obtained at a range of approximately 55 miles. Firing from this extreme range is not recommended as it is quite possible for the missile to burn out before hitting the target. The S-225 has a maximum flight time of 90 seconds before burn out.

Maximum range is dependent on both the altitude and the speed of the launching aircraft as well as the closure rate as noted in Table 1 below.

Table 1: S-225 LRAAM Maximum Range Head On Launch Performance

Launch Speed	Launch Altitude	Closure Rate	Max Range
Mach 1 (650 knots)	5,000 feet	1135 knots	40 miles
500 knots	5,000 feet	800 knots	36 miles
Mach 1 (620 knots)	20,000 feet	1105 knots	48 miles
500 knots	20,000 feet	800 knots	43 miles
Mach 1 (580 knots)	40,000 feet	1065 knots	55 miles (approx)

The ECR-90 radar will determine maximum missile range based on the current firing conditions so it is not necessary to do the calculations for any given launch situation. It is clear, however, that the best conditions for firing the LRAAM are when the Eurofighter is flying high and fast so as to impart the greatest initial boost to the missile.

Minimum range for the S-225 LRAAM missile is approximately 11 miles regardless of speed, altitude or target aspect.

The S-225 LRAAM is a 'fire and forget' weapon utilising active radar guidance to locate and track targets. This allows the launching aircraft to either select another target or 'get out of Dodge' if it so chooses. In addition, it is also capable of receiving in-flight data from the launching aircraft to update target position which can increase the likelihood of a kill.

The missile should only be launched if the following conditions are met: a radar lock is established on the target, a steady 'shoot' cue is either visible on the radar or audible as a lock tone, the missile seeker head diamond is on the target track box and the track box itself is within the aiming reticle, or 'kill circle' in the HUD. Use of the HMD for aiming and firing the missile is highly discouraged since the reticle visible in the HMD is not aligned with the HUD reticle. As noted earlier, the initial boost phase is ballistic. If the target is not located within the HUD reticle at the time of launch, the missile may not be able to acquire and track the target.

If the audible 'shoot' cues are unsteady or the radar image is jumpy, this indicates that the enemy has activated his ECM jamming equipment. You should decrease the range to the target in order to allow the ECR-90 to 'burn through' the jamming prior to launch. Turning away from the enemy for a moment or temporarily switching your radar off are other techniques you can apply, they will sometimes cause the enemy to turn their ECM equipment off.

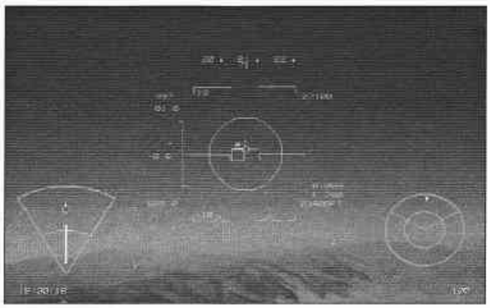


Figure 3 Approaching the target with LRAAM

From the Simulator menu, choose Weapon Training and select the S-225 mission. You will start in the air at 27,000 feet and there will be a MiG-21 positioned in a head on aspect 70 miles ahead, (Figure 3).

Light the afterburner and accelerate above Mach 1. Watch as the range bar on the radar lengthens as your speed increases.

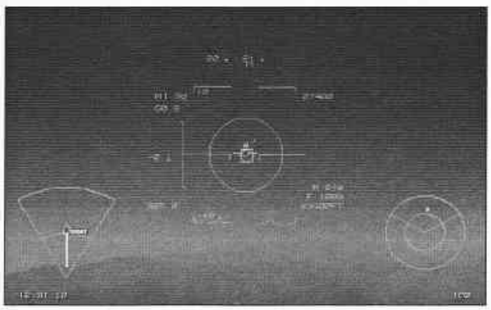


Figure 4 Shoot cue for LRAAM

The MiG will come into range somewhere around 50 miles out. Notice the 'shoot' cue (Figure 4) visible on the radar screen. At this point you can fire and forget. Launching an LRAAM at a MiG 21 is like shooting fish in a barrel.

Using the LRAAM against this type of target would not be recommended in a mission setting as the MiG-21 is quite easy to defeat with guns alone. Save the LRAAM missiles for bigger fish such as the Su-35 Super Flankers.

The Aim-120 Advanced Medium Range Air to Air Missile (AMRAAM)

Based on initial design specifications proposed nearly twenty years ago, the AMRAAM project grew out of the troubled AIM-7 Sparrow project. The AIM-7 Sparrow missile was designed as a semi-active radar homing missile intended to provide BVR launch capability that the smaller AIM-9 heat seeking missiles could not provide. However, unlike the highly successful AIM-9, the Sparrow was plagued with enormous technical difficulties. Guidance technology of the mid-1950s simply was not up to the task required to track and hit targets effectively at stand off ranges. Despite repeated attempts to upgrade and improve the Sparrow, its performance during the Vietnam War was a dismal failure. The Sparrow hit less than 10% of the targets it was fired at.

After Vietnam, a new design was mandated, one that called for a 'fire and forget' missile capable of higher speeds, greater manoeuvrability and a significantly higher success rate. Enter the Advanced Medium Range Air-to-Air missile, or AMRAAM. Hughes Missile Systems was awarded the contract in 1981 and after nearly ten years of development and testing, the first AMRAAMs, designated the AIM-120, became fully operational in 1991 just in time for the end of the Gulf War. The first combat firing of the AIM-120 would not occur until late in December of 1992 when a single missile was fired at an Iraqi MiG-25 in a high aspect BVR encounter over the No-Fly zone. The shot resulted in the first AMRAAM kill. Several weeks later, in mid January of 1993, another AIM-120 brought down an Iraqi MiG-23 from rear aspect and extreme range. Another AIM-120 was used to bring down a low flying Serbian attack aircraft over Bosnia. Three for three, the AIM-120 AMRAAM has, so far, proved itself worthy of fear and respect.

The AIM-120 is the missile of choice for most of the engagements in which you will find yourself in EF2000. This is due to its extremely wide range of launch parameters, high speed and excellent resistance to jamming.

Maximum range for the AIM-120 is affected by the same factors as the S-225: launch speed and altitude as well as target closure and aspect. Maximum flight time for the AIM-120 is 55 seconds before burn out.

The published speed of the AIM-120 is listed as 0.6 miles/sec at sea level. However, due to the fact that the AIM-120 utilises a single stage rocket motor and maintains full thrust during the entire flight, this missile is actually faster than the S-225 in practical use.

Table 2: AIM-120 AMRAAM Maximum Range Head On Launch Performance

Launch Speed	Launch Altitude	Closure Rate	Max Range
Mach 1 (650 knots)	5,000 feet	1135 knots	28 miles
500 knots	5,000 feet	800 knots	25 miles
Mach 1 (620 knots)	20,000 feet	1105 knots	34 miles
500 knots	20,000 feet	800 knots	30 miles
Mach 1 (580 knots)	40,000 feet	1065 knots	42 miles

The published maximum range for the AIM-120 AMRAAM is given as 30 miles. However you will note from Table 2 above that shoot cues and effective kills can be obtained at significantly longer ranges in the simulation. As with the S-225, the ECR-90 radar will calculate maximum range for you based on the current launch conditions and the disposition of the target.

Minimum range for the AIM-120 AMRAAM missile is approximately 4 miles regardless of speed, altitude or target aspect, although kills have been achieved at as little as a mile in 'panic fire' situations.

Like the S-225, the AIM-120 is an active radar guided missile. The missile follows a ballistic trajectory for a short period after launch and is then capable of identifying and tracking its target independently. Update information from the launching aircraft can be received during flight but is not required for the missile to strike its target.

Although it carries a smaller warhead (22kg) than the S-225, the AIM-120 still packs an impressive punch and will bring down virtually any aircraft in the EF2000 theatre.

Launch procedures are exactly like those for the LRAAM. The launching aircraft needs only establish a radar lock, bring the target track box into the HUD aiming reticle, wait for a steady 'shoot cue' and release. Once again, high speed and altitude impart the largest boost to the missile resulting in the longest possible range, highest terminal velocities and the greatest likelihood of a kill.

From the Simulator menu, choose Weapon Training and select the AMRAAM mission. You will start in the air at 16,000 feet and there will be a MiG-21 positioned in a rear aspect 40 miles ahead (Figure 5).

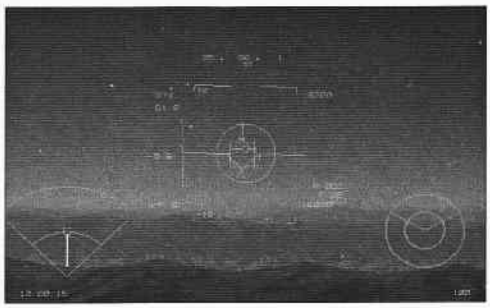


Figure 5 Approaching the target with AMRAAM

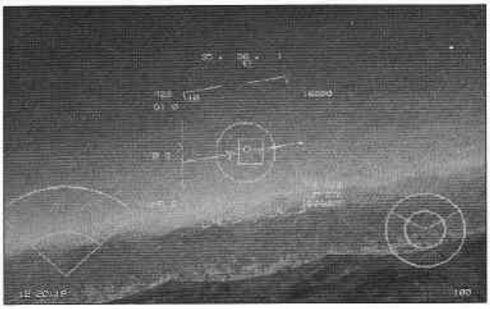


Figure 6 Target turning towards Eurofighter

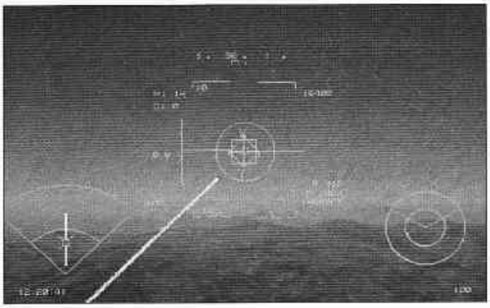


Figure 7 Firing AMRAAM

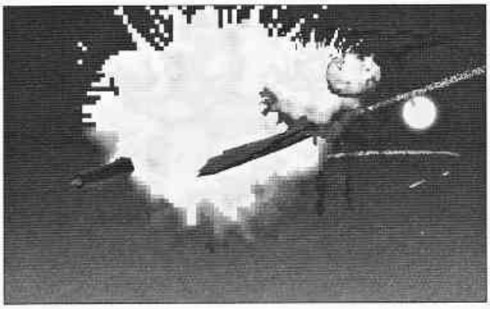


Figure 8 Splash one MiG

Light the afterburner and accelerate above Mach 1. As you approach, notice that the range bar on the radar reflects a lowered maximum range as a result of the rear aspect presented by the target. You are at 22 miles and have still not received the 'shoot' cue.

The MiG is reversing to face you head on (Figure 6). Notice how your radar and missile lock disappear when the MiG is midway through his turn and is beaming your radar.

As the MiG turns to a head on aspect, you may experience jamming which will cause the radar to oscillate and the 'shoot' cue to wink on and off. Simply press on until the radar can burn through the jamming. Once you have a steady 'shoot' cue, go ahead and take the shot (Figure 7). Here we can see the AMRAAM leaving the rails as we reach 15 miles to the target. Notice also that the range bar has lengthened considerably compared to what it was while the target presented a rear aspect.

The MiG is going down in flames (Figure 8).

The Aim-132 Advanced Short Range Air to Air Missile (ASRAAM)

The ASRAAM program was undertaken in the early 1980s to provide an eventual replacement to the venerable AIM-9 Sidewinder. As originally conceived, the AIM-132 was to be built jointly in Europe by British Aerospace (BAe) and the German contractor, Bodenseewerk Technik Geraete (BGT) for NATO. However, the United States and Germany have dropped out of the program and transferred all interests to BAe which continues development of the AIM-132 for the Eurofighter and other NATO aircraft.

The ASRAAM represents this next generation of all-aspect, short range air-to-air missiles and incorporates a number of exciting developments. These include: an advanced Infra-red seeker head coupled with high-speed computerised image processing software, giving the missile the capability of recognising and distinguishing targets with a high degree of accuracy. The ability to be launched using a HMD, allowing the pilot to designate targets simply by looking at them. Active thrust vectored propulsion that allows the missile to execute radical manoeuvres.

The seeker head on the AIM-132 is capable of tracking a target through an extremely wide field of view. Combined with HMD targeting and thrust vectoring, these advancements give the AIM-132 'off-boresight' launch capability, or in other words, the ability to be launched at targets well off the centreline of the launching aircraft. Successful launches are possible at any aspect and angles as high as 90 degrees off the nose. Theoretically, you can fire at a target completely across your turning circle. However, the probability of scoring a hit under such conditions is very low. The best firing solutions are achieved at angles under 60 degrees and aspects more closely approximating a rear quarter shot.

Maximum range is achieved from a head on position and is approximately 9 miles. Minimum range is approximately one mile or less under low closure and rear aspect conditions.

The ASRAAM missiles are worth their weight in gold in a dogfight. When fired from within reasonable parameters, these missiles will hit their targets nearly 100 per cent of the time. The missile seeker head diamond will appear over the target track box when the missile has the target in view. An audible 'shoot cue' will be heard if the radar is active (although the ASRAAM is equally effective when used in conjunction with the passive IRST) and conditions are favourable for a shot. As long as you hear the tone and the target is not in a high aspect orientation, you can pull the trigger and break away to pursue another bandit. The likelihood of a successful evasion is so small as to be of little concern.

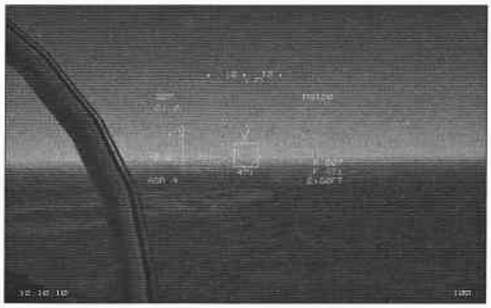


Figure 9 Target in Padlock view

Forward quarter shots at high aspect targets are possible, but only shots taken from about 2 miles will strike their targets with any regularity. You will have far greater success if you forego forward quarter shots and manoeuvre for a better position from which to fire.

Since the Eurofighter can only carry short range missiles on the outer pylons, you definitely want to load a pair of these on board. Carrying four ASRAAMs will allow you to survive engagements even if you are badly outnumbered.

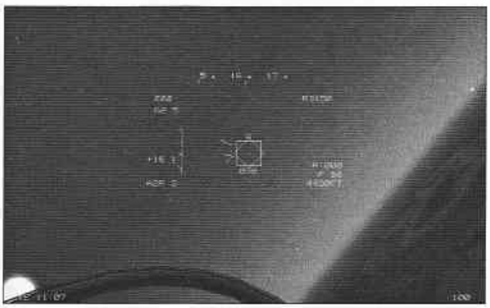


Figure 10 Target in poor firing parameters

From the Simulator menu, choose Weapon Training and select the ASRAAM mission. You will start in the air at 3,100 feet with a MiG-21 positioned 10 miles and about 45 degrees off to your right. Switch to the HMD in padlock view (Figure 9). The ASRAAM can be fired from this view unlike the other missiles in the simulation.

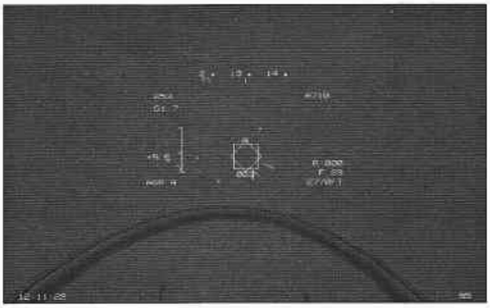


Figure11 Target in good firing parameters

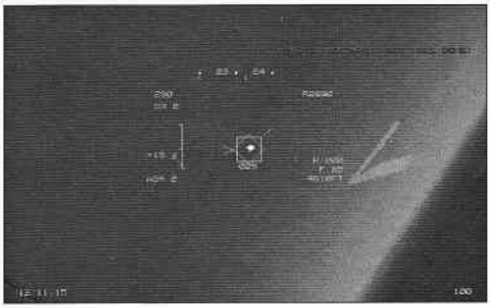


Figure 12 Dead Bandit

You will notice that the seeker diamond is on the target track box in this view, indicating that a launch is possible (Figure 10). However, the aspect angle is relatively high and a kill in this case is far from certain. You will want to manoeuvre into a position with a lower aspect angle.

Here the bandit is about 40 degrees off the nose, the aspect is nearly a pure rear aspect and the closure is relatively low (Figure 11). This is a perfect opportunity to fire. You could pull up into a position more directly off his tail, but there is no point in doing so. Pull the trigger and consider this bandit dead.

In this screen shot, the bandit is manoeuvring in a one circle fight. He is about 45 degrees off the nose, slightly high and to our right. The aspect is nearly side on, but the range and closure is very low. Once again, this is a great opportunity to use the ASRAAM. Despite the bandit's attempts to spoof the missile, this is an easy kill (Figure 12).

THE AIM-9M SIDEWINDER

The AIM-9 missile has been around in one variant or another for nearly fifty years. This workhorse missile has been used in every major conflict and continues to be used today. The newest variants are planned to include thrust vectoring, much like the ASRAAM missile. The AIM-9M is still one of the most widely used A2A missiles due to its low cost and availability.

The AIM-9M is a heat-seeking, all-aspect missile. It can be fired at the target from any angle. In practice, the best results are achieved if the missile is fired from a low aspect angle so that the seeker head can lock on to the hot exhaust of the target.

The maximum range of the AIM-9M is 5 miles when fired from a head on position, though the missile is unlikely to score a hit at this range and aspect combination. If firing from the front, the best tactic is to wait until the target is approximately 2 miles away and saddling up for a head on guns shot. The AIM-9M's rapid acceleration to over 1,000 mph will give the bandit no time to evade.

Minimum range is under a mile in a low closure, rear aspect situation which also happens to be the best place from which to employ the AIM-9M. When fired from a good tracking position the missile performs reasonably well, however this is definitely a weapon you want to leave on the tarmac if you have a choice of using the ASRAAM instead.

From the Simulator menu, choose Weapon Training and select the AIM9 mission. You will start in the air at 8,100 feet with a MiG-21 positioned 10 miles, head on, in front of you.

Apparently, this MiG pilot is still learning the ropes because he will run into the mountain on his right half the time. You can help him out by banking right and he will follow to his left. The MiG will fire a radar missile at you. Simply turn on your ECM, drop some chaff and watch as it sails harmlessly by. The semi-active missiles carried on the aging MiG-21 are no match for the DASS and ECM.

If you like, try your hand at a forward quarter shot, be careful because although this MiG pilot cannot fly very well, his gunnery is very precise indeed.

You will hear the low growl of the missile seeker as the target approaches. If you have chosen to bypass the forward quarter shot, either turn sharply out of his guns or barrel roll around his shots as he passes by. (A complete description of the barrel roll technique appears in the defensive procedures section of Chapter 6) An alternative is to accelerate and climb as he nears since the MiG-21's low speed and power will not allow him to get much of a shot off at you.

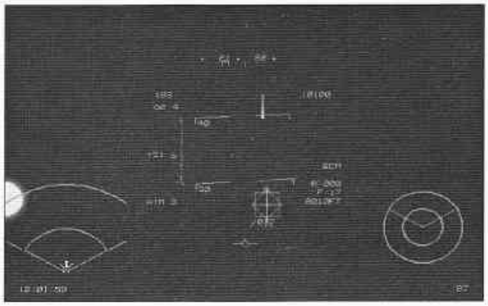


Figure 13 Taking the Shot

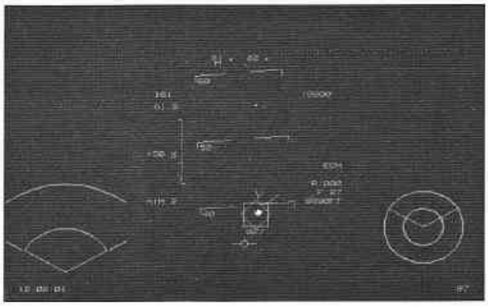


Figure 14 Splash one

Once he passes, reacquire the MiG in padlock view, roll your lift vector on him and pull him into the HUD. The missile growl will rise in pitch and intensity as the lock becomes increasingly firm. When you have a clear view of the MiG's six, fire the Sidewinder (Figure 13) and watch as it streaks in for the kill (Figure 14). The MiG will drop flares in an attempt to spoof the missile; if he succeeds, just set up another shot.

THE MAUSER BK-27mm CANNON

The Mauser cannon carried by the Eurofighter is a single barrel system that employs a compressed gas driven gun feed and electrical firing mechanisms. Capable of delivering a high rate of fire for the 27mm high explosive rounds, the Mauser is a very deadly weapon.

The cannon is mounted in the starboard wing root of the Eurofighter while the ammunition is cross fed from the magazine in the port wing root capable of holding 1,760 rounds. The cannon is linked to the radar and IRST systems to provide auto firing capabilities when the system determines that the target is within firing parameters.

The published rate of fire for the Mauser is 1,700 rounds per minute, although the cannon in the simulated Eurofighter appears capable of a somewhat higher rate of fire, (see Chapter 14 for methods of increasing the Mauser's rate of fire).

Both Air-to-Air and Air-to-Ground operations are supported and aiming modes appropriate to each task are provided in the HUD and HMD. However, since we are primarily concerned with aerial gunnery in this section, we will focus on the Air-to-Air operation only.

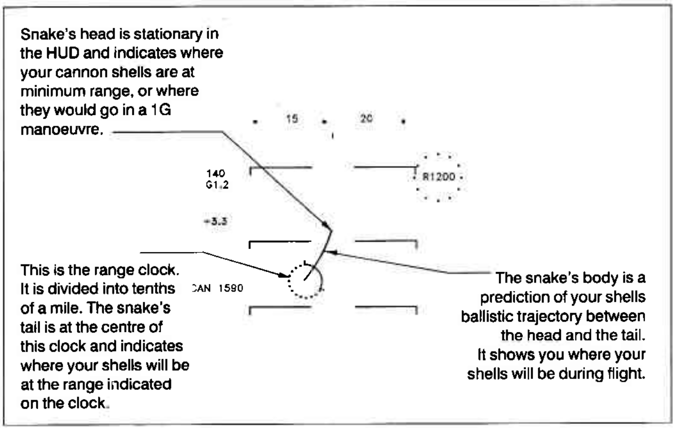


Figure 15

The gunsight in the Eurofighter is a predictor gunsight consisting of an aiming reticle that functions as a 'range clock' to provide easy determination of the distance to the target. The reticle is connected to the velocity vector by a line that indicates the predicted path of the cannon rounds, Figure 15.

The way to use the predictor sight is to drag the body of the snake through the targeted aircraft until the centre of the range clock or the gun reticle is leading the target slightly.

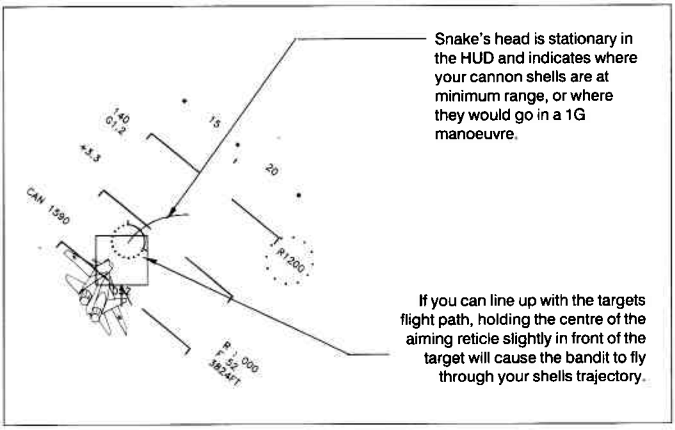


Figure 16

By watching how the body of the snake moves, you can predict the position of the tail and adjust where your nose is pointed accordingly. When you are working the body of the snake through the target, use gentle movements of the stick to avoid whipping the snake off the target. Figure 16 shows an example of what would be considered a good firing solution.

You can see that the centre of the aiming reticle is positioned slightly ahead of the bandit's nose. The body of the snake is in line with the anticipated flight path of the bandit. This will cause the bandit to fly an intercept with every one of your shells.

A series of 'Gun-Camera' shots (Figure 17 overleaf), shows how this sequence appears in the simulation.

Gun Camera Sequences

1. Here you can see that the aiming reticle is being held in lead, ready for a shot. Note the position of the aiming reticle with respect to the bandit and how the bandit is flying into the path of the oncoming shells.
2. With the aiming reticle in lead, you can see the first hits being scored on the bandit
3. Same amount of lead, more hits being landed.
4. Slightly less lead here, but the hits are still coming.
5. Seventy rounds of 27mm cannon shells later, this fight is over.

This example utilised the full screen HUD view. It is also possible to use the padlock view when employing the cannon against the enemy aircraft. Figures 18-20 are a 'gun camera' sequence taken from the wide angle track view.

Once again, the aiming reticle is held in lead anticipating the bandit's flight path (Figure 18). Taking the shots (Figure 19).... and scoring a kill (Figure 20).

As you can see these shots were taken within 3 seconds of each other and only 80 rounds were required to destroy the bandit.

There are pros and cons to both methods and you should practice your gunnery with each one. Use the wide angle track view for your snap shots. Switch to the full screen HUD view when you are in a position for a prolonged guns opportunity or if you become disorientated. The snake re-centres itself each time you switch views. If you switch views prior to taking a shot, you may waste as much as half a second while the snake stabilises again. View switching should be timed to occur just as the bandit comes into the padlock HUD. This will ensure you have the time to allow the snake to settle before you need to shoot. By developing your skills in both methods and learning to use each at the appropriate moment, you will become a very deadly flightsim pilot indeed.

One important point here is that it is better to shoot manually than to rely on the auto cannon. The auto cannon is very sensitive to the position of the aiming reticle and needs an almost perfect alignment with the centre of the target. In addition, the auto cannon requires you to maintain that alignment for longer than you would need to take the shots manually. The reaction time for a flightsim pilot might be anything up to one third of a second, whereas the auto cannon will take as much as twice that time to shoot. Waiting for the auto cannon to fire can seem like an eternity, when it does fire, it is usually after you have already concluded the encounter hence wasting precious ammunition. To avoid such unwarranted interruptions turn the auto

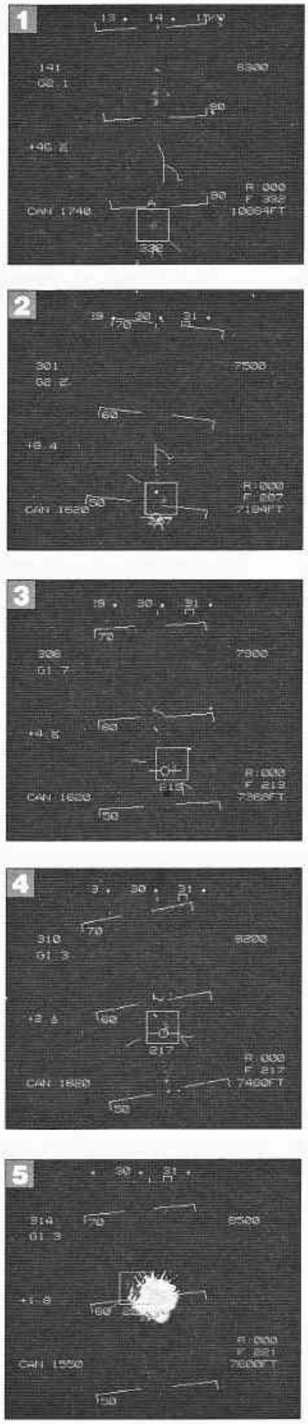


Figure 17

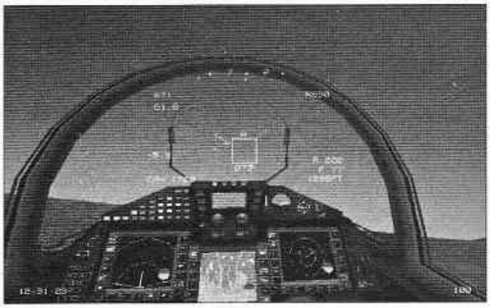


Figure18


Figure 19


Figure 20

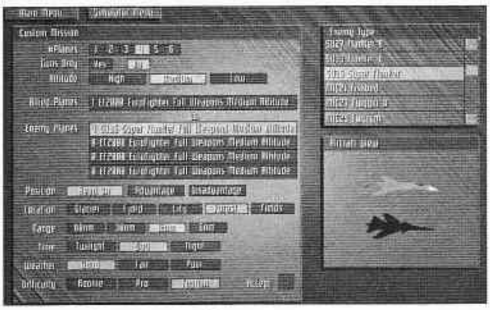


Figure 21 Custom Air to Air selection screen

cannon off, SHIFT G. Practice your manual gunnery and do not be tempted to use 'Spray and Pray' tactics. With a good tracking solution you should be able to achieve a kill in less than 100 rounds. Excellent marksmanship has always been the mark of every great ACE, the time you spend honing your gunnery will be well rewarded.

Practicing Air Combat with the Custom Air to Air Mission Generator

The Custom Air to Air mission generator provides an excellent tool for refining your gunnery and other air to air combat skills. It is especially valuable to network players since it provides a somewhat controlled environment in which to practice wingman communication and co-ordination techniques. You can set up scenarios with a variety of enemy aircraft, weapon load outs and starting positions. There are 36 different types of aircraft you can test your skills against. From the formidable Su-35s to cargo planes. You can choose to fly against up to 4 different aircraft types at once and up to 6 of each type.

From the Simulator menu, select Custom Air to Air and you will be presented with the selection screen shown in Figure 21. You can choose enemies, time of day, altitude, weather, skill levels and other items by clicking on the appropriate boxes.

The 'Head On' selection will position you facing north and the bandits facing south at the selected distance. The 'Advantage' selection places the aircraft in the same locations, but starts you off with a rear aspect rather than head on. The 'Disadvantage' selection will place you facing west with the bandits facing you from behind and to the right. If you select multiple bandits, they will all be grouped together at the chosen distance and location.

The 'Guns Only' option can be assigned to either yourself or the bandits and will affect all of them equally. Setting up a 'Guns Only' scenario against a group of Top Gun Su-35s can be a tremendous challenge to your flying and fighting skills.

Custom Air to Air Combat missions are also a great place to practice your dogfighting skills under conditions where you have your Eurofighter loaded down with Air to Ground ordnance. Becoming comfortable with 'heavy' aircraft handling conditions here will allow you to make informed choices as to when you can, and cannot fight.

Experiment with different scenarios and get proficient with the various A2A weapons systems. The time you spend practicing here will pay large dividends when you find yourself in a furball during a campaign mission.

Chapter 6

A2A COMBAT

LEARNING THE BASICS

GEOMETRY AND BFM

DEFENSIVE

FIGHT OR FLIGHT

CHAPTER 6

A2A Combat

The war in EF2000 is computer generated and your opponents are computer controlled but your objectives are the same as they would be in the real world. Winning the war in EF2000 will require you to succeed in the delivery of Air to Ground ordnance. However, the enemy will rarely allow you to accomplish this task unmolested. Air to Air combat is an inevitable consequence of flying into enemy territory. Survival in the hostile Norwegian theatre will mean knowing how to pick your fights, knowing how to win them once you are engaged and knowing how and when to get out.

As you have seen from the chapter on aircraft performance, an aircraft loaded with bombs is at a distinct disadvantage compared to enemy interceptors armed with missiles alone. Using the JTIDS information to remain stealthy and avoid an Air to Air engagement is a far better strategy than challenging enemy interceptors along your path.

However, if engagement appears unavoidable, you should strive to initiate the fight from as far beyond visual range as your weapons will allow, where your manoeuvrability is not as critical. Use the techniques learned in Chapter 5 (air-to-air weapons) to make your shots count, then continue your flight to the mission objective.

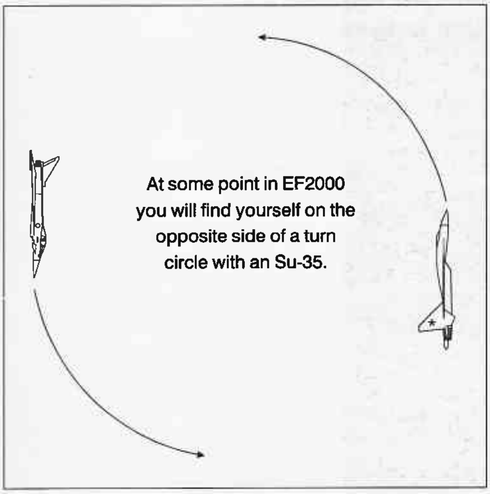


Figure 1

Despite your best efforts to avoid an engagement, there will come a moment when you find yourself in a situation that places you on the opposite side of a turn circle with one of the enemy aircraft. If you are unlucky, it will be one of the dreaded Su-35s (Figure 1).

In order to survive in this scenario, you will need to understand and excel at the skills combat pilots refer to as Basic Flight Manoeuvring (BFM) and Air Combat Manoeuvring (ACM).

Air combat consists of a complicated set of interlocking skills that you will have to grasp in order to come out of a fight alive. You will need to understand the forces that direct where your aircraft is going and how to employ those forces to bring your weapons to bear. You must master the ability to maintain visual contact with the bandit through the use of the Padlock views and be able to determine the spatial relationships between yourself and the bandit. You will need to be able to visualise the geometry in these changing spatial relationships and determine both whether it is possible as well as how best to place yourself in a firing position. You will need to be able to manage your energy and employ the correct manoeuvres in order to bring the bandit into weapons parameters. You will have precious few moments in which to do all this. Indeed, you may only have seconds to make decisions that will determine your success or failure.

This may appear to be a daunting agenda, but you already have many of the skills required. You know how to use the avionics and weapons at your disposal. You have an understanding of what the Eurofighter is capable of and how to make sure you are fighting at your peak performance and under the conditions most favourable to the moment. You need only gain a few new skills and then mould everything into a unified plan of action.

Any attempt to learn BFM and ACM in a set piece fashion will only lead to a rigid and inflexible approach to your engagements. Your reactions will be slower and more predictable. If you react tentatively, you will be killed. A superior aircraft is not a guarantee of success against an opponent who applies the lessons of air combat to his best advantage.

In this chapter we will build upon the skills you already have. First, you must master the basics of applying Lift Vector and utilising Padlock. Next, you will need an understanding of the basic geometry of air combat manoeuvres. Finally, you will apply what you have learned to specific situations in order to make intelligent decisions about when to fight and how.

Part I Learning the Basics

Lift Vectoring

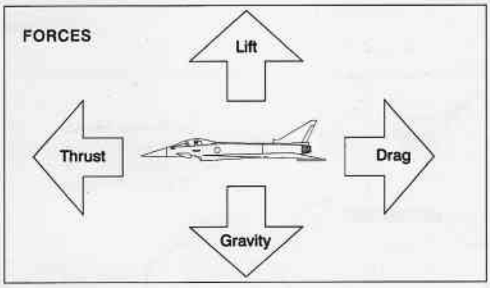


Figure 2

There are four main forces acting in opposition on an aircraft in flight: Thrust versus Drag, and Lift versus Gravity, Figure 2.

Thrust is generated by the engines and drives the aircraft forward against the drag created by moving an object through the air. When thrust overcomes drag, the aircraft moves and causes airflow around the wings. This movement of air around the wings generates lift that keeps the aircraft in flight against the force of gravity. Thrust, lift and drag are forces that all have a specific direction. When forces are associated with a direction they can be represented by something called a 'Vector'. A vector is simply a line pointing in the direction of the force and extending in proportion to the magnitude of that force. The term 'Lift Vector' is thus the name used to describe a line representing the force of lift acting on the aircraft in a direction perpendicular to the airflow.

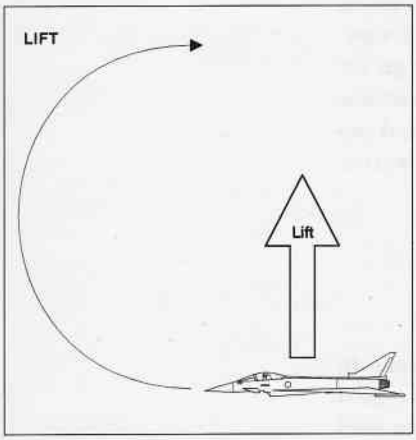


Figure 3

When lift cancels out the force of gravity the aircraft will fly in a straight line. When lift is greater than the force of gravity the aircraft will begin to accelerate along its lift vector. In other words, it will begin to fly in a curved path in the same plane as the lift vector and thus begin to turn see Figure 3. You can modify the airflow over the wings in order to roll your aircraft. As the aircraft rolls the lift vector will roll with it allowing you to turn in any plane you desire.

By rolling until your lift vector is pointing towards a bandit, or is at least in the same plane of motion as the bandit, you are forcing your aircraft to accelerate towards it. Greater lift will produce a larger lift vector, which in turn will produce greater acceleration towards the bandit. This acceleration will cause you to move in a curved path that will bring the nose of your aircraft on to the bandit by the most direct means possible. How quickly it does so, is fully described in Chapter 4 'Performance'.

Lift Vectoring is a term used to describe aligning your lift vector so that it points at the bandit and using lift to bring your weapons to bear. Since the lift vector is approximately perpendicular to the wings, we can imagine that it is an arrow stuck to the outside of the canopy pointing directly upwards. As we roll the aircraft, the lift vector will roll along with it. The idea is to roll until your lift vector is aligned with a bandit, then pull hard back on the stick. This will bring your nose on to the bandit in the most direct manner possible. Your objective now is simply to achieve the best turn rate possible in order to out turn the bandit until you get a firing solution.

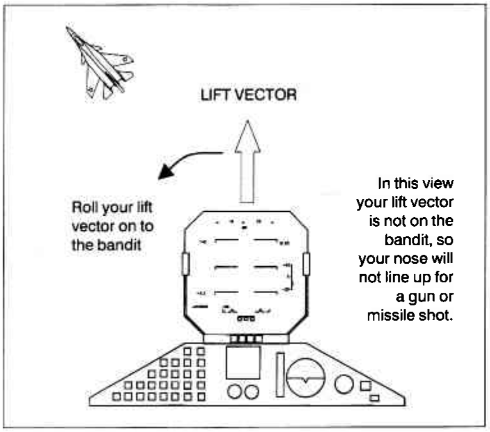


Figure 4

Consider the following example. In Figure 4, you will see that your lift vector is not on the bandit. In that case you are said to be out of plane, because you are not turning in the same plane of motion as the bandit.

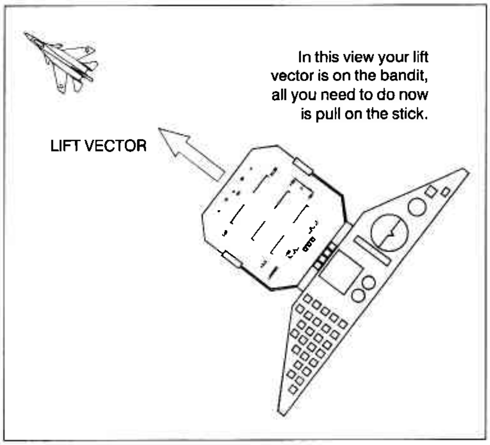


Figure 5

In Figure 5 you can see that you now have your lift vector firmly on the bandit, all you now need to do now is out turn him to get enough lead for a shot.

That sounds easy enough, but there are two major problems you will have to solve before you can put this into practice. First, you need to be able to determine where the bandit is in order to align your lift vector on him. You cannot fly towards the bandit when you do not know where he is and this involves learning how to use and interpret the information from the padlock view. Second, you need to know how to out turn him in order to get the shot. There are other problems to be sure, most notably the fact that lift vectoring alone will not solve every engagement situation and you will need to apply more advanced manoeuvring techniques to win the battle. However, we shall look at padlock first.

Understanding and Using the Padlock Views

Air combat is a complex set of movements in three dimensions. In order to prevail, you need to be able to create and maintain a mental picture of the world around your aircraft. In other words, you need situational awareness. The fighter pilot's maxim 'lose sight, lose the fight' holds equally true not only in the real world, but also in the simulated world of EF2000. Without good situational awareness, you will almost certainly make what could turn out to be a deadly mistake. Padlock view allows you to have that awareness. If you expect to survive air combat encounters in EF2000, you must make learning how to use this invaluable tool your first priority.

In close quarter combat the padlock views allow you to keep your eyes on your target, as if you were swivelling your head around the cockpit. You are thus able to keep track of what your opponent is doing while you manoeuvre your aircraft and have a better chance of winning dogfights. However, becoming proficient in padlock view takes time and effort.

Many players find padlock view extremely disorienting at first. It is very easy to lose track of where your aircraft is with respect to the world around you while you try to chase down that elusive bandit. At first, you will often find yourself climbing into a stall or chasing rabbits down their holes in a desperate attempt to bring your weapons to bear. Once mastered however, the padlock views will provide you with a level of situational awareness that will place you in command.

There are several variants of padlock view available in EF2000. They are:

F10 This is the main padlock view and will track targets depending on which HUD mode you are in. The field of view is equivalent to that in the standard HUD view. You will find this view useful for lining up Air to Ground attacks and for landing because it will track ground targets and the runway when you are in the appropriate HUD mode. However the limited field of view makes this padlock view less useful for air to air combat than the wide angled track view.

F11 This view is very useful for engagements where you have a wingman, either a computerised wingman if you are playing alone, or a human wingman if playing via modem or network. This view allows you to toggle between your wingman, your wingman's target or the bandit currently threatening your wingman.

F12 This is the missile padlock view and is used to determine the direction of an incoming missile so that you can set up the best evasion parameters.

F2 This is the wide angled track view. It provides a much wider field of view than the main padlock view and allows for an enhanced sense of spatial orientation compared to the others. This view provides the best overall situational awareness during close in dogfights.

Mastering Padlock

First, you must be aware of your own relationship to the world. This means interpreting external cues like the orientation of the horizon or the colour of the sky so that you remain constantly aware of your altitude and attitude. Forget about shooting bandits if you do not even know where you are.

Second, you need an awareness of the relationship of the bandit to you and the world. By observing the bandit's movements relative to external and internal positional cues like the canopy markers and the horizon, you will still know where the bandit is 'right this instant' even if at this instant there are no visible clues. By watching the changing condition of these indicators you will know where the bandit is and where he is going even during extended periods of blank sky where you might otherwise become disorientated.

Finally, you will need to put the two together into a three dimensional whole. You know where you are, you know where the bandit is, all that is left is to formulate a plan of how to get there from here.

Simple? Not on your life. However, you certainly will not be able to 'get there from here' unless you have got the first two pieces of the puzzle well in hand. Remember, you cannot always just roll the lift vector on to the target and pull as hard as you can. Sometimes, the shortest route to your target is either through a rabbit hole or by means of a manoeuvre you do not have the energy to perform. You cannot recognise this and react properly unless you can visualise and understand the changing relationship between the two aircraft with the world as the fixed frame reference.

Some important information is provided in the HMD and remains the same regardless of which padlock view you are in so a quick review is in order.

Most of the information should already be familiar from the HUD view. Among the important items you will need to focus on are your speed, altitude and target information such as altitude, range and closure (Figure 6). However, the target tracking box along with the target heading marker and relative heading caret can easily cause confusion due to the way this information is presented in the Eurofighter.

The heading and relative heading markers move around the target box and provide an indication of the bandit's current compass heading and the direction that his nose is pointing relative to the Eurofighter.

The way to read the Heading Marker is to assume that it is a compass needle and that the target track box is a compass with North at the top. The Heading Marker in this example is then pointing to 325 degrees which means that the bandit is heading Northwest (Figure 7). This

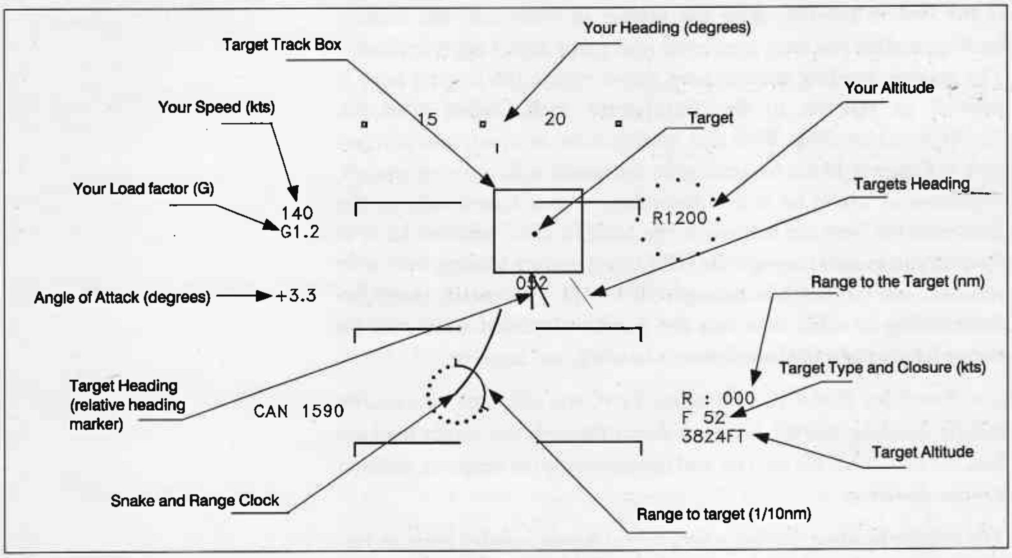


Figure 6

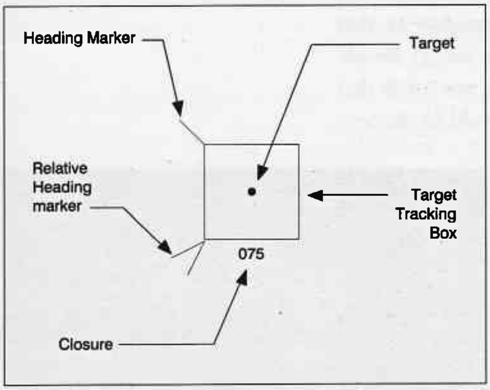


Figure 7

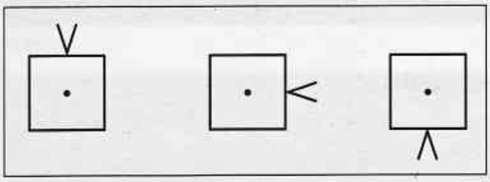


Figure 8

information is of limited use, especially in a close quarter dogfight since we are not interested in what his compass heading is. What we want to know is where his nose is pointed so that we can employ the appropriate manoeuvres.

The Relative Heading Marker provides this crucial information. The following examples explain how to correctly interpret what you see. For clarity, the heading marker and closure information have been left out, (Figure 8).

The apex of the relative heading marker corresponds to the direction in which the target's nose is pointing. It is important to remember that this marker is relative to the direction of your aircraft, it tells you nothing about the position of the bandit. So in the first case, if the bandit is in front of you it will be pointing right at you. If the bandit is behind you it will be pointing away from you. The marker will not move even though the position of the aircraft is very different.

In the second example the marker indicates that the bandit is pointing from right to left, relative to your aircraft. So if the bandit is on your right, it will be pointing at you (shooting no doubt) and if the bandit is on your left, it will be facing away from you.

In the final case, the bandit is facing in the same direction as you. If he is on your tail, you are in deep trouble. If the bandit is out in front of you the relative heading marker will be in the same place, but now he is the one in trouble. With the release of TactCom, the relative heading marker has been converted into a true aspect angle indicator. The relative heading marker now shows where the target's nose is pointed in relation to the Eurofighter itself, rather than the Eurofighter's heading. With this modification in mind, take another look at Figure 8. In the first example, the bandit is facing your aircraft, regardless of where he is in relationship to you. Conversely, in the final example, you are looking at the bandit's tail - whether he is in front of you as seen through the HUD, or if you are looking over your shoulder and viewing him through the HMD. This greatly simplifies determining in what direction the bandit is headed since you no longer have to take the Eurofighter's heading into account.

Just remember that if you are using TactCom, any time you see the relative heading marker pointing down through the target tracking box, the bandit has his aircraft, and consequently his weapons, pointed in your direction.

The relative heading marker is very useful during combat because you can use it to judge when the bandit is coming nose on for a shot. You can judge who is going to come nose on first and if necessary, break to avoid being gunned. The important thing to remember is that (depending upon which version of EF2000 you are using) simply because the relative heading caret is pointing up does not mean that you are on the bandit's six, in fact, quite the opposite could be the case. When in padlock view, pay close attention to the spatial relationship between the bandit and your own aircraft in order to correctly interpret the relative heading.

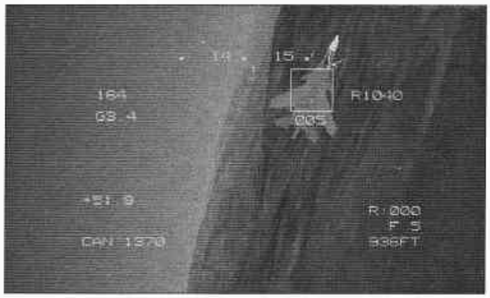


Figure 9

Now that you can read the HMD, you need to become more comfortable with the wide angled track view. One important thing to bear in mind is that what you see of the world while in padlock, has the correct relationship to your orientation. So for example, if you are in padlock view and you see the ground at the top of the screen and the sky at the bottom, your aircraft is flying inverted. If you become disorientated and can see the horizon, simply roll and pull until the ground is at the bottom of the screen without any inclination and you will be right side up again.

In Figure 9 it can be seen that you are turning in an almost horizontal plane with maybe 80 degree bank angle, or pulling slightly away from the ground.

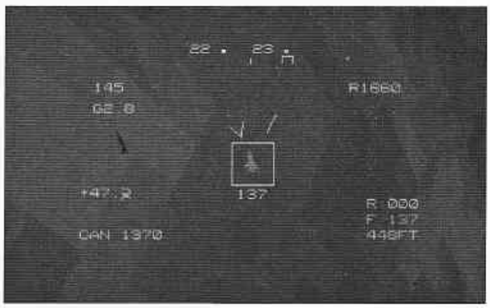


Figure 10

In Figure 10 it is clear that you have rolled over and are pulling down towards both the bandit and the

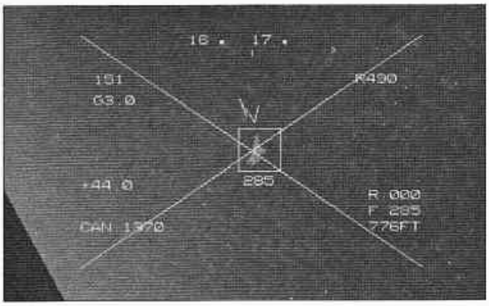


Figure 11

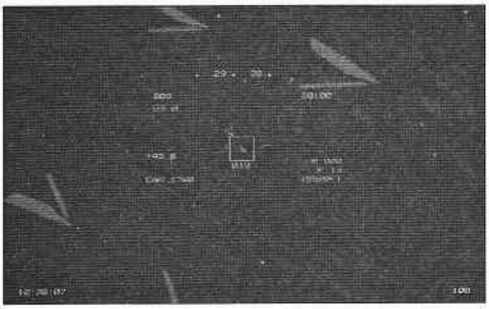


Figure 12

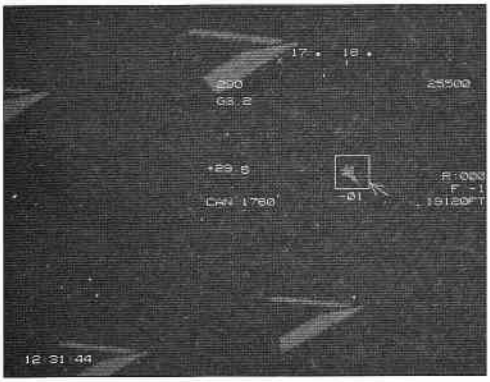


Figure 13

ground. Being able to see the horizon is a big help and gives you all the information you need regarding your orientation to the world.

In Figure 11 the fight is taking place at low altitude. You can see that the pilot is holding the nose slightly above the horizon to prevent losing any more altitude. At low speeds and low altitudes you will need to maintain a fairly steep nose up attitude in order to avoid hitting the ground. Remember to keep a very close eye on the altitude readout when you are near the ground.

Now we consider how you keep your lift vector on the bandit in padlock view. Take a look at the two shots below in Figures 12 and 13, in one of them the player has the bandit lift vectored and in the other he does not. Can you tell which one is which? Can you spot the important difference between these screen shots?

The difference lies in the canopy markers. The canopy markers are the four rows of translucent arrows on the canopy itself that point towards the HUD. They help you to maintain a sense of where your aircraft is pointing in relation to the bandit. The arrows have one thin leg and one thick leg and are spaced closer together towards the rear of the canopy.

The thin legs of these markers are closer to your lift vector while the thick legs are closer to the sides of the cockpit. In Figure 12 the bandit is between two thin legs of the canopy markers. Since the thin lines are closest to your lift vector and the bandit is between two thin lines, he is exactly where you want him. Pulling into the bandit will bring your nose on to him providing you can out turn him. In Figure 13 the bandit is between one thin and one thick leg which means that the bandit is not on the lift vector. Rolling the aircraft towards the nearest thick leg will create the situation in Figure 12.

As you manoeuvre, an easy way to determine if you are gaining position on the bandit is to observe its motion relative to the canopy markers. Since the arrows point forward, if the bandit is drifting in the direction of the arrows you are getting closer to having your nose pointed at him. If, however, the bandit is drifting in the opposite direction, he is gaining position on you and you should consider altering your current plan of action accordingly.

Figure 14 is another example where the bandit is between a thick leg and a thin one. A roll to the left is required to bring the lift vector in line with the bandit. However, you will also note that the canopy markers are very close together which indicates that the bandit is behind your aircraft. In fact, if this pilot was looking any farther back his seat would be in view. The bandit's nose appears to be only very slightly in lag pursuit and he needs just a few more degrees to get a shot. However, note the high closure rate. The bandit has a closure rate nearly double the current speed of the Eurofighter and will almost certainly overshoot before he can line up a shot. What this means and how to capitalise on it will be covered shortly.

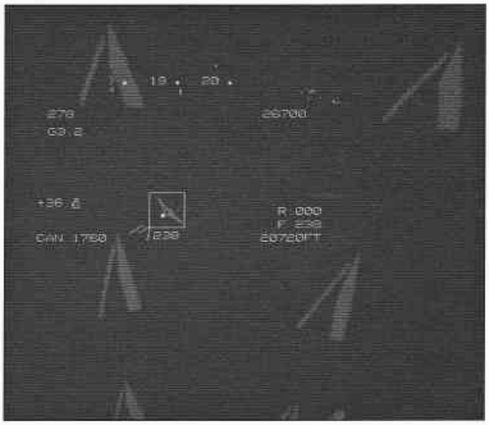


Figure 14

Becoming comfortable with the padlock views and understanding the spatial relationships between your aircraft and the bandit take you a big step towards solving the 'how to get there from here' problem. In the simplest terms, whenever you use padlock your aim should be to keep the bandit between the thin lines of the canopy markers. Always roll towards any thick line. That will keep your lift vector pointed at the bandit and if you can out turn him you will have a shot.

Part II

The Geometry of Air Combat & Basic Flight Manoeuvres

Once you can lift vector, use the padlock views and manage your energy to achieve the best turn rates, you have the absolute minimum you will need to take on the bad guys. Though these ideas are basic, they can carry you a long way. With practice and fast reactions you will be able to wreak havoc on your computerised enemies.

You must also know how to get the most from your aircraft. That is very important because an advantage of only a few degrees per second may be just enough for you to dominate the fight. Ideally you will have read Chapter 4 on aircraft performance before this one, but as we have already noted, performance alone is not enough. If you depend on a good turn rate alone, you are going to spend a great deal of time watching your wingmen finish missions without you, or in the case of head to head competitions, you will spend a great deal of time watching your opponents performing victory rolls.

If turn rate alone is not enough to secure victory, what other factors are at work here? The answer is 'Geometry' and it is time to look at this aspect of Air Combat in more detail.

In order to analyse basic fighter manoeuvres, pilots draw diagrams of how the aircraft will move during the fight. The aircraft's flight path is represented by lines and circles. The way in which these paths intertwine and overlap and the angular relationship between the aircraft over time is the geometry to which we are referring.

The geometry of every manoeuvre we look at will produce an advantage against an opponent who does nothing more than attempt to out turn you by lift vectoring.

The effect of geometry to influence our perception of being out turned is generally underestimated. An opponent using simple geometrical considerations can give the appearance that you are being out turned by a bandit who may only have an advantage of a few degrees. This can make the whole situation rather difficult to judge for inexperienced pilots. You may come out of a manoeuvre almost neutral in angles only to find yourself being gunned even though you may feel that you have turned your aircraft as tightly as possible. The principle of getting an advantage by using the geometry of the Basic Fighter Manoeuvres instead of just simply pulling G is what this chapter is concerned with. It is the difference between flying smart or just banking and yanking, what we call using G for brains.

To see how this works, we will start with the simplest example, that of two pilots in a circular turning fight as shown in Figure 15. In this example we assume that both pilots have bled their speed down to their respective sustained values and are thus both fully committed to the engagement. Because both aircraft are following the same path around the circle this type of engagement is known as a one circle fight.

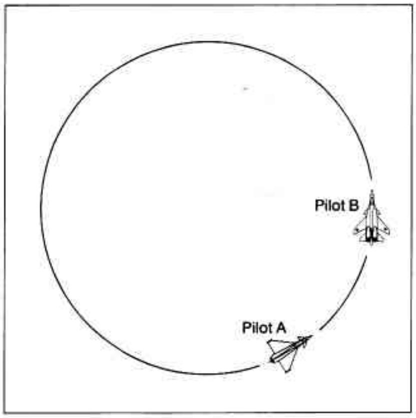


Figure 15

In this diagram Pilot A has at least 60 degrees of turn to make up in order to bring his cannon to bear. For aircraft of similar performance and against a skillful opponent closing those final angles for a shot may be a lengthy process. However, Pilot A can manoeuvre in a way that will introduce some misalignment in the circles.

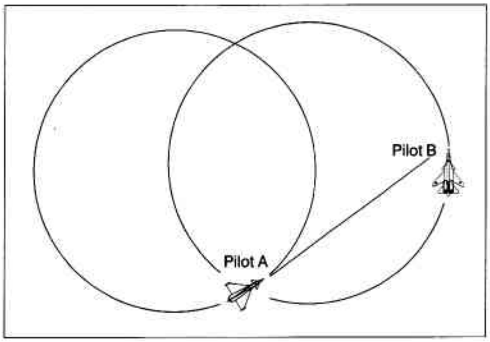


Figure 16

As we see in Figure 16, both of these aircraft are in the same position on their circles as before. However Pilot A will now get a shot and possibly a kill simply because their turn circles are now off centre. Pilot A has effectively cut the corner, creating the opportunity for a shot. This sort of position is important because against worthy opponents, gun shots from this aspect are by far the most common during simulated air combat. This is true because experienced pilots can easily avoid the potentially more common head on gun shot. Good pilots avoid head on shots because they only provide a 50/50 chance. There is no point in taking any chances when you know that with a little more time you can win a decisive advantage. Of course your main objective is to achieve the elbow with a solid 'Six O'clock' low aspect shot. However that is only common against inferior pilots, inferior aircraft or flawed artificial intelligence. While you will always be striving for the bandits 'six' and a low aspect shot, you will encounter many more opportunities similar to that shown in Figure 16 along the way, often that will be all you need.

In this example you have seen that a pilot with some sixty degrees yet to gain has achieved a snap shot simply by altering his flight path. He did not out turn his opponent or gain any angles even though that is what the bandit might think has happened. This misalignment in the turn circles has created a very basic positional advantage and you can easily see how deadly the resulting gun shot will be. You will recognise an advantage of this type when you have it, because you will find yourself looking (and shooting) into your opponent's canopy. We refer to this simple and effective type of advantage as the 'Position Principle.' Simply stated, 'The pilot who already has an angular advantage can win the opportunity for a shot by altering the position of his turn circle.' The resulting advantage is valuable because it is not just a one off, but recurs every cycle. Against a weaker opponent this may result in more than one chance to finish the fight. Understanding the position principle will give you the ability to use 'Geometry' instead of just G and that is what BFM is all about.

The question remains as to how Pilot A used the position principle to create the offset in flight paths that resulted in the gun shot shown in Figure 16. It may have resulted from several different manoeuvres, those that work well in EF2000 will be explained as we continue. However one very important option open to Pilot A in the position shown in Figure 16 is simply to out turn his opponent and to do that he will need to increase his turn rate.

How can Pilot A increase his turn rate? If Pilot A is flying at or below corner speed, turn rate and turn radius will be determined by the left hand side of the EM diagrams shown in Chapter 4. Examination of these diagrams reveals that they have some things in common. Specifically, that the left hand side of the curve is very steep. This means that a small change in speed will produce a large change in turn rate, but only a small change in turn radius. By altering his speed, Pilot A will have a much more profound affect upon his turn rate than upon his turn radius. The EM diagram for the Eurofighter at Sea Level reveals that accelerating from 140 knots to 150 knots increases the turn rate by 7dps and decreases the turn radius by 50 feet. Since Pilot A has 60 degrees of turn to make up, increasing his speed in this way would place him in position to take a shot in 9 seconds. That sounds very good but how can you get that extra speed? One would assume that the afterburner is already engaged for maximum thrust, therefore the only other option is to trade altitude for airspeed.

The Lufbery

In order to win a one circle turning fight with a bandit you will need to maintain as high a turn rate as possible. The highest turn rate is achieved at corner velocity. As we have seen from the EM diagrams in the performance chapter, corner velocity for the Eurofighter with no stores, a full fuel tank and an altitude of 20,000 feet will be 260 knots. The problem is that even with afterburner you will not be able to maintain that speed. In a sustained level turn your speed will bleed down to around 165 knots with a resulting turn rate of 19dps. However, if you drop your nose 20 degrees below the horizon you will be able to maintain a speed slightly over 200 knots. The additional speed translates into a substantial increase in turn rate. At 200 knots that means a turn rate of 27dps, an increase of 8dps.

The reason your turn rate improves so rapidly is because the EM diagram curve is very steep below corner velocity. Every extra knot of airspeed you gain is worth a big increase in turning ability. By converting some of your potential energy into kinetic energy in this fashion you can gain that extra speed. The Lufbery is simply a turn that spirals downwards. The name derives from the American ace Raoul Lufbery who first employed the technique while flying with the French Lafayette Escadrille and the U.S. Air Service during World War I.

The down side of this manoeuvre is that you lose altitude rather quickly and will soon find yourself on the deck with no additional potential energy to convert in this manner. There is, however, another way to win the one circle fight.

The Yo-Yo

We have seen that in order to gain a shot without needing to out turn your opponent you can use the position principle. In Figure 16 it was shown that Pilot A was able to manoeuvre in a way that introduced some misalignment in the circles. We saw how this produced an advantage every bit as decisive as increasing the turn rate with the added bonus that it can be achieved without any loss in altitude.

The Yo-Yo is accomplished by rolling slightly out of the horizontal plane of motion and pulling either up or down while continuing the turn. This is followed by a roll back towards the original plane of motion. The manoeuvre has the effect of cutting across the circle and creates the type of misalignment shown in Figure 16.

There are two types of Yo-Yos, high and low depending on whether the manoeuvre is directed above or below the original plane of motion. The high and low Yo-Yo in their simplest form are shown in Figures 17 and 18.

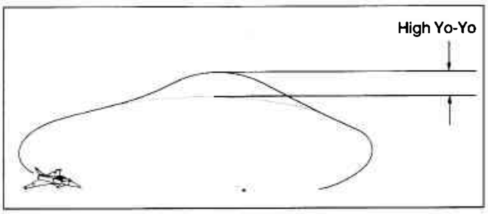


Figure 17

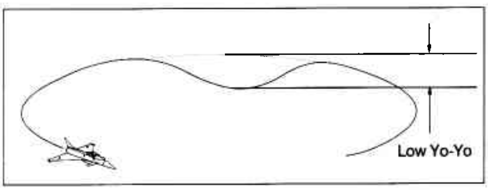


Figure 18

The choice of either rolling up into a 'High Yo-Yo' or rolling down into a 'Low Yo-Yo' is determined by the current energy state of fighter and the closure rate between the two aircraft. The High Yo-Yo is generally used in cases where the attacking aircraft is above corner velocity and has excess energy or a high closure rate. Climbing against gravity reduces airspeed which creates a smaller turn radius and also helps to avoid an overshoot. The Low Yo-Yo is the choice when the attacking aircraft is below corner velocity and does not have sufficient energy to catch up to his opponent. By trading altitude for airspeed, the attacking aircraft not only cuts the circle, but by increasing closure he also decreases the range to the bandit thereby improving the chances for a good gun shot.

In order to carry the explanation further, we can assume that you are in a turning fight with a bandit who elects to stays in the horizontal. He must concentrate on maintaining corner velocity in an effort to out turn you. You, on the other hand, execute a series of small high Yo-Yo manoeuvres of the type shown above. What you are doing by pulling into the vertical is reducing your horizontal turn radius and thereby cutting the corner on the turn circle. Each time you Yo-Yo you are using the position principle to change the geometry of the circles in your favour.

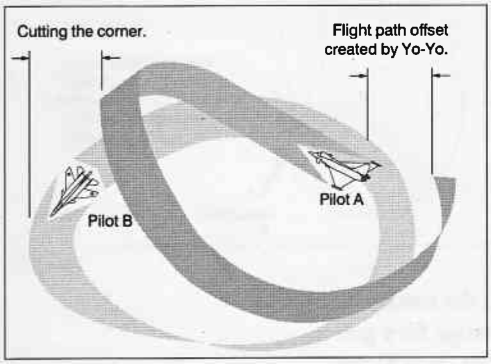


Figure 19

To understand this we can take a look at an example for a rather large Yo-Yo as shown in Figure 19.

You can see that the Yo-Yo manoeuvre has resulted in the effect of cutting the corner during the high part of the flight. When pilot A returns to his original flight path, his turn circle will be offset to the right of where it was before. The offset created will result in a gun shot for Pilot A as shown in Figure 20.

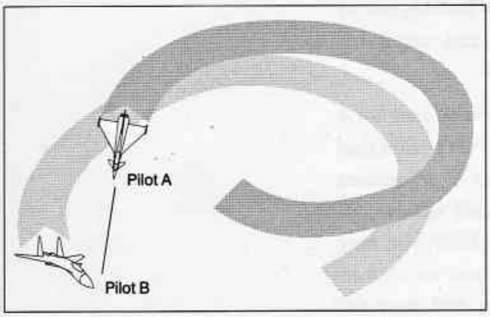


Figure 20

In order to create an advantage you may require several Yo-Yo manoeuvres to achieve the degree of offset required to ensure a shot. Large Yo-Yos can be very effective by themselves and you can get the whole thing in one go. The problem with this strategy is that the defender may observe you manoeuvring in this way and execute a Yo-Yo of his own that will bring the circles back in alignment, denying you the shot. A better strategy is to execute a series of smaller yo-yos in the hope of achieving smaller but more consistent gains.

Breakturns

You may find that you cannot gain an advantage because the bandit is countering with Yo-Yos of his own. Worse yet, that due to better energy management he has succeeded in gaining angles on you. In that case you must change your strategy before he is able to line up for a shot.

Break turns are an essential part of surviving an engagement. In the case of a one versus one engagement, a break turn may simply be a means of denying a bandit the opportunity to obtain a steady firing solution. In a multiple aircraft engagement, you may need to react to a bandit that has manoeuvred to a position on your six. In either case, immediate action is required if you are to survive.

The break turn is typically a high G turn into the flight path of the bandit. Doing so presents the bandit with the highest possible aspect angle and consequently the worst possible situation from which to execute a gun shot. Often, this means reversing into the bandit and this is not without risk. The key to survival is to manoeuvre as quickly and violently as possible, preferably out of the plane of motion that the aircraft is currently following.

One mistake that pilots often make if they find themselves in the situation of Pilot B in Figure 20 is to simply roll out of the turn and pull into the vertical. Pilot B will see Pilot A's nose coming around and in a panic simply breaks high or low. It can be very dangerous to attempt a vertical manoeuvre in defence from this position since doing so may give the type of geometrical advantage to the attacker seen in Figure 21.

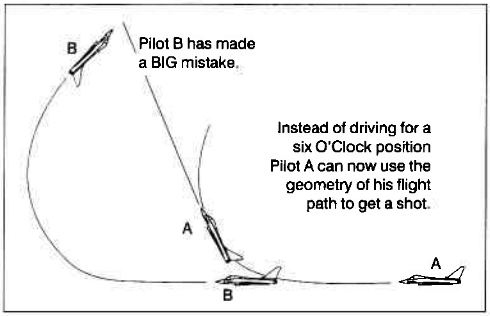


Figure 21

By breaking into the vertical, the defender has allowed the attacker to use the position principle to create a geometrical advantage for a gun shot. Had the attacker been on the same or similar turn circle to the defender while the fight was horizontal, (Figure 15) the attacker would still have had a lot of work to do. However by pulling out of plane the defender has separated the turn circles and saved his opponent the effort of creating that offset for himself.

While dangerous, a vertical break does not guarantee the attacker a shot. A certain amount of turning room is required and very often that turning room will not exist. The smaller the amount of separation between the aircraft, the more likely it is that you will survive. In addition, if the attacker is not watching his closure carefully, you may be able to force an overshoot and turn the tables. If you succeed in doing so, you can reverse by rolling into the bandit and start the process of manoeuvring for a gun shot all over again.

The break turn is most effective if you simultaneously pull back hard and diagonally on the stick, producing lift and roll at the same time and sending you into a barrel roll. The instinct of many pilots in this situation might be to roll first before pulling back on the stick. Do not hesitate. Any fraction of a second you spend rolling will not change your situation. You must roll and pull at the same time. If you make it over the top and into a dive, keep your nose pointing directly at the deck. Hitting the airbrake and turning into a high G barrel roll towards the ground is an extremely hard manoeuvre to follow.

Reducing your speed rapidly will add to the difficulty since any bandit following you down will tend to increase speed initially and may not be able to react quickly enough to avoid an overshoot.

If you are badly damaged at this point, it may be advantageous to get off the airbrake and maintain a steep spiral dive. This may allow you to extend beyond the range of the bandit's guns in order to escape at ground level.

The important thing is to deny the attacker the shot by maintaining aggressive stick actions. Remember, your attacker will be fighting to pull his gun reticle up the snake for a shot and will need to make steady adjustments to keep it stable. You must defeat those efforts by forcing him to make large and rapid changes of direction. What you do is not nearly as important as the fact that you do something quickly and violently. You may give up a snap shot opportunity, but you stand a far better chance than if you simply pursue a predictable course.

The Scissors

The Scissors is a series of reverses and nose-to-nose turns where each pilot is trying to get behind the other by forcing an overshoot. A scissors is very often the result of executing a break turn followed by a reversal. The name originates from the fact that the weaving, intersecting flight paths created are reminiscent of a pair of scissors opening and closing.

In order for the scissors to succeed you must reduce your airspeed and your turn rate to the point where the bandit will be forced out in front of you and into weapons parameters. What you are seeking to get with the scissors is an overshoot and a snap shot. If the bandit overshoots enough you can reverse early and saddle up on his tail, if not you can reverse again and repeat for another snap shot. You might think that given the difficulty of connecting with a snap shot that the advantage to be gained is not so great. The important thing to notice here is that you get a shot and the bandit does not, that is the sort of position you want. Even if you cannot achieve a firing solution, anytime you can keep the bandit in front of you the opportunity for the bandit to make a mistake that you can capitalise upon is greater.

In essence, the scissors will become a race to see who can get the slowest first.

Here is an example of the scissors in action. Consider an engagement in which both pilots are in a nose to tail one circle fight as shown in Figure 22.

Pilot A has a positional advantage but still needs to do a lot of work to get a shot. If Pilot B can match Pilot A's turn rate, it will be very difficult for him to gain any further angles. Pilot A now performs a steep high Yo-Yo. Pilot B continues to concentrate on achieving a maximum turn rate at corner and decides not to mirror the Yo-Yo manoeuvre for fear of losing any further angles. As you have seen in the section on the Yo-Yo, a large misalignment in the turn circles will occur resulting in a distinct advantage for Pilot A.

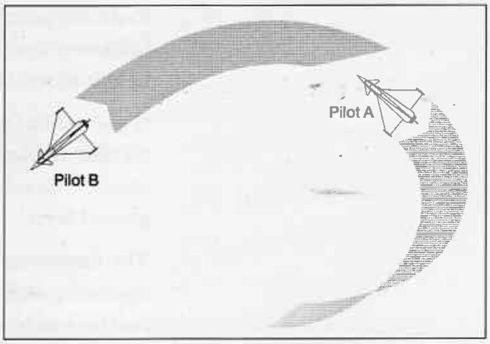


Figure 22

As you can see from Figure 23, at time 1 Pilot A has produced a misalignment that will eventually result in a snap shot opportunity.

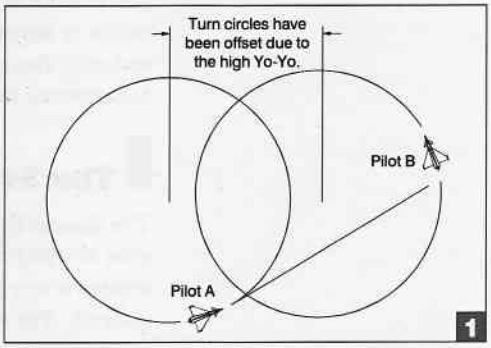


Figure 23

As both pilots continue to turn at the same speed and turn rate, Pilot A will soon have his nose on Pilot B and will be getting ready to take a snap shot as shown at time 2 in Figure 24.

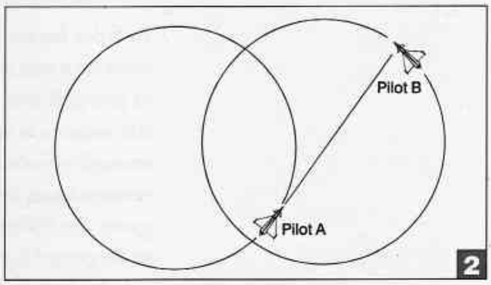


Figure 24

At time 3 pilot A has enough lead to take a snap shot, Figure 25.

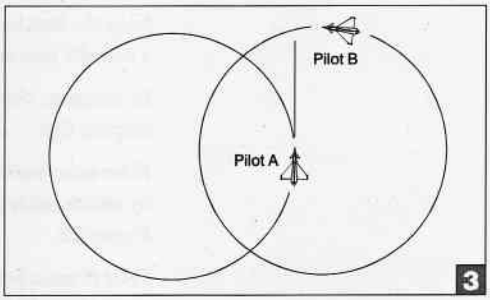


Figure 25

At time 4 the opportunity is gone and Pilot A has overshot and will need to wait until he can drive his aircraft back around the circle to try once more, Figure 26.

Pilot B realises his predicament while tracers are flashing past his canopy at time 3. He wisely chooses not to stay in his current turn and wait for Pilot A to get a second bite of the apple. At time 5, Pilot B reverses his turn into a scissors manoeuvre, Figure 27.

Pilot A cannot reverse also because doing so will not only open up a large amount of turning room, but will also place the aircraft in a one circle fight, where Pilot B will have the advantage. Pilot A therefore continues to pull hard into Pilot B. Pilot B is now hoping at best for a snap shot at point X or at worst, a neutral position at the point where the flight paths intersect. However in order to get that shot we should look at what Pilot B must do in more detail.

At time 5 Pilot A has to travel approximately 105 degrees to reach the point where the flight paths cross while Pilot B has considerably less distance to cover, approximately 67 degrees. Until time 4, both planes had been maintaining their best turn rates in an attempt to win the one circle fight. If Pilot B continues to fly at the same speed and turn rate as before, he will reach the intersection point well

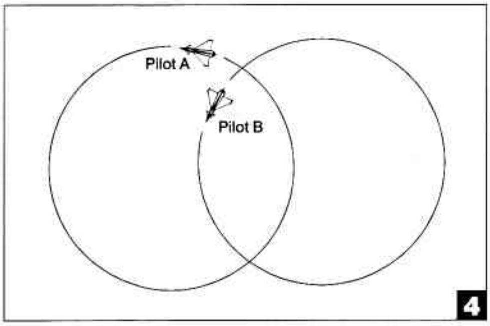


Figure 26

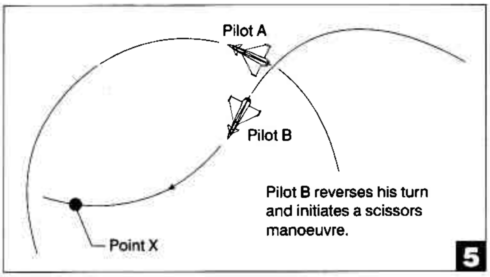


Figure 27

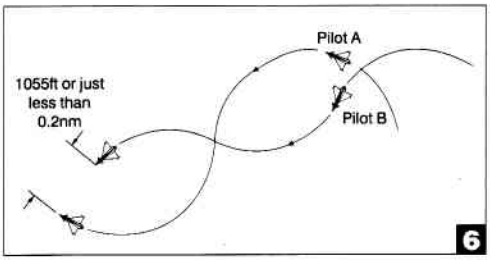


Figure 28

before Pilot A. He will then be in no better a position than if he had simply continued around the original circle.

In order to reach the intersection point behind Pilot A with the possibility of a snap shot at point X, Pilot B must simultaneously reduce his turn rate and speed in order to force an overshoot. If Pilot A continues to fly at a higher speed to maintain his higher turn rate, Pilot B will have achieved a neutral position simply by allowing his opponent to out turn him.

As the planes approach the intersection, Pilot A realises his error, brakes hard and reverses back into the scissors denying the snap shot. However, with luck Pilot B will have won the race to get slow and now has a good snap shot opportunity at time 6, Figure 28.

Pilot B has turned a bad position into a good one by allowing his opponent to out turn him.

Of course life is never so simple. Pilot A only got into this mess because he allowed Pilot B to gain a significant advantage in a way that could have been easily avoided. Pilot A observes the reversal at time 5 but cannot reverse himself for fear of opening up a lot of turning room. He must attempt to reduce his speed and turn rate in order to match Pilot B. As both pilots make an effort to reduce their speed and turn rate, the pilot who can get slower will win. While not guaranteeing an escape for Pilot A, he may nonetheless be able to produce a stalemate situation for the moment until another opportunity presents itself.

The scissors manoeuvre works extremely well against the computer controlled aircraft. You will recall that in Figure 28 Pilot A had to travel 105 degrees around his turn circle to reach the merge, while Pilot B only had 67 degrees to travel. We will now place an Su-35 in the position of Pilot A and assume that the fight is close to sea level with both you and the bandit close to your sustained turn rates. From the performance chapter we see that this puts you at just over 130 knots with a turn rate of 29dps and the bandit at 225 knots with a turn rate of 32dps. He is out turning you, and that is going to be his downfall.

The computer controlled pilots are not sure what to do in this situation, they simply maintain corner, or at least try to stay as close to corner velocity as they can, drag permitting. That means that if this

Su-35 has already bled his speed down to 225 knots, he will not deliberately try and go any slower. His computer logic will compel him to maintain his speed as close to corner velocity as possible. This is the reason that they can be forced to overshoot so often.

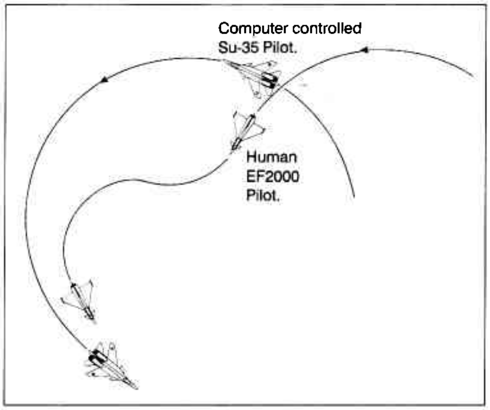


Figure 29

On the other hand, you know how to win this fight. You have a corner velocity of 190 knots and you will not hesitate to go even slower by cutting the afterburner and applying the airbrake. You will also notice from the EM diagrams that you will have a much smaller turn radius as a result of your slower speed, almost half that of the Su-35 (Figure 29).

The smaller radius will give you the option to reverse direction again in order to drop in on the Su-35's tail. In this way you will be abandoning a mere snap shot in order to convert your angular advantage into a rear aspect shot as shown in Figure 29. You will need to stay sharp in this kind of fight because the whole thing will happen very quickly. In practice however, the Su-35 is a formidable opponent. Unless this fight is taking place on the deck, he will be able to use his speed advantage to recover from this situation before you can get the kill, so the fight continues.

During the scissors manoeuvre things happen quickly and are much more fluid than the diagrams might indicate. We will now consider just how dynamic that situation can get. Suppose that at the start of the engagement, Pilot A either knows or suspects that he is too fast to win the scissors fight. Maybe he was slow to throttle back, or he delayed hitting the airbrake for a moment too long, either way he knows he must reduce his speed or risk an overshoot. How can he do that? Pilot A maintains his hard turn towards his opponent but rolls nose high into a barrel roll maintaining his lift vector on Pilot B. The vertical manoeuvre will reduce his speed as well as minimising his horizontal velocity. Pilot B will roll his lift vector towards Pilot A as well in order to capitalise on the anticipated overshoot. The aircraft will now begin to describe twin spirals as each seeks to force the other out in front. This is known as a rolling scissors and is shown in Figure 30.

Winning a rolling scissors contest is not purely a race to see who can reduce speed the quickest, although low speed performance is a critical component. Rather, the rolling scissors relies more on the inclination of the loops and dives and the subsequent reduction of forward velocity in order for one aircraft to force the other out in front. It is quite possible for this type of fight to degenerate into a series of pure loops as both pilots attempt to reduce forward velocity to the minimum. Alternately, the rolling fight may pitch upwards or downwards resulting in a vertical scissors.

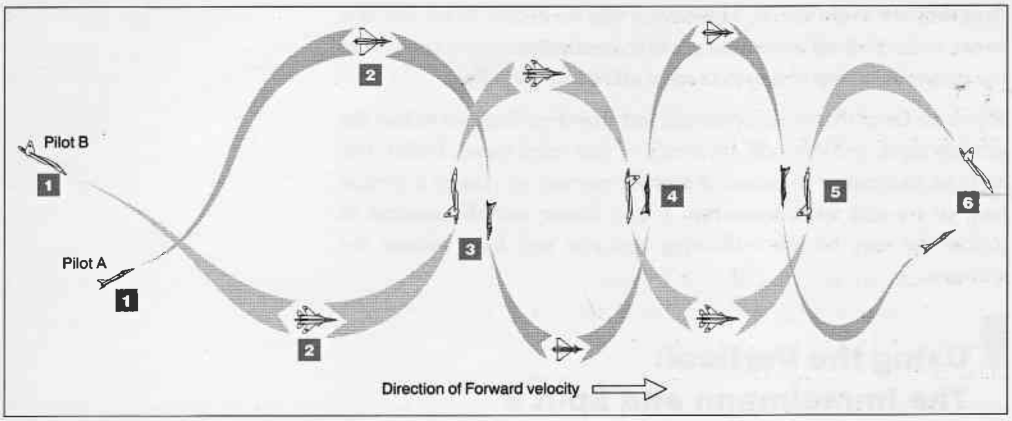


Figure 30

At time 1, Pilot A realises that he is going too fast to effectively execute a flat scissors. Pilot A pulls up and simultaneously rolls his lift vector into the direction of Pilot B as shown at time 2. Pilot B matches the manoeuvre a moment later and at time 3 he still has a slight advantage over Pilot A. However, Pilot A makes his loops larger and steeper than Pilot B so that by time 4 he has managed to nearly equalise his position relative to Pilot B. Continuing to loop more steeply than Pilot B, by time 5 Pilot A has managed to gain a slight advantage. Very shortly, Pilot A will secure enough of a positional advantage to take a shot as shown at time 6. If the situation does not work for Pilot A, he can exit the fight during the diving portion of the manoeuvre with gravity assisting the escape, Figure 31.

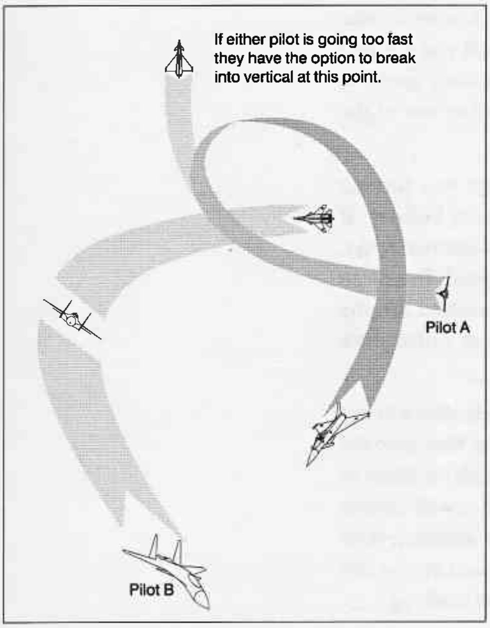


Figure 31

Another possibility occurs if either pilot judges his speed to be way too high, he may choose to go vertical during the roll. That will initiate a vertical scissors in which the pilot who goes vertical first will have a distinct advantage, because he will get slower first. Providing he is able to force the overshoot before he loses control authority, he will get the kill. Alternatively breaking out of the loop vertically downwards can be very effective since you can apply the airbrake and throttle back completely prior to going nose low. An inexperienced pilot will quickly gain speed in the dive and if you are low enough you may even get a manoeuvre kill.

Breaking the Scissors

If you are feel that your opponent is going to be able to beat you in the scissors you have big problems. Scissors are much easier to get into than they are to get out of. However if you do decide to get out, it is better to break it off as soon as possible because once you commit to the manoeuvre your ability to break it off reduces rapidly.

If you are faster than your opponent and therefore doomed to lose the scissors fight, you can take advantage of that extra speed. Either dive away in an attempt to extend if altitude permits or initiate a vertical loop to try and force a reversal. If the slower aircraft attempts to follow, he may be left wallowing and you will have broken the scissors.

Using the Vertical: The Immelmann and Split S

Using the vertical is an essential part of a flightsim pilot's repertoire. In combat it is very important to know how slow you can get before you lose the ability to use the vertical. A time honoured and useful tactic has been to unload your G slightly in order to gain speed. In so doing your turn rate drops and your opponent, who sees himself gaining angles, is inspired to pull even harder getting slower in the process. As you judge your speed to have exceeded your over the top speed, pull hard into the vertical. Your opponent will be unable to follow you because he does not have the energy to get his nose up. The term 'over the top speed' corresponds to the slowest speed at which you can pull up and still complete a loop. Few pilots like to allow their speed to drop below that level because doing so denies themselves use of the vertical.

This speed is important to you if you become trapped in a turning fight in which you are getting slower and lower as in the Lufbery. If you have already dumped your air to ground stores and external tanks, you will have no need to remember an over the top speed. In a clean configuration, you can bleed all the way down in a sustained turning fight and still make it over the top. In other words, your Eurofighter owns the vertical.

Even though you can get over the top at very low speeds, you will not always have the control authority to take advantage of it. Any over the top manoeuvre executed below 260 knots (at low altitude) is likely to leave you with low control authority and that will mean almost impossible gunnery. Staying above 260 knots prior to initiating your loop will give you enough control authority to take a shot as you exit the manoeuvre without too much readjustment or nose bobbing.

One very effective way to take advantage of your ability to use the vertical is to square the corner on the bandit during a dogfight. This involves going into the vertical then, holding a 90 degree pitch while rolling your lift vector into lead before dropping back into the fight with a considerable advantage.

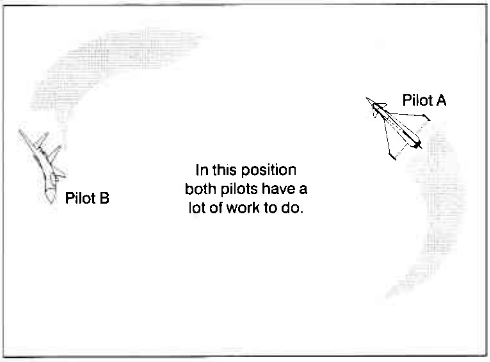


Figure 32

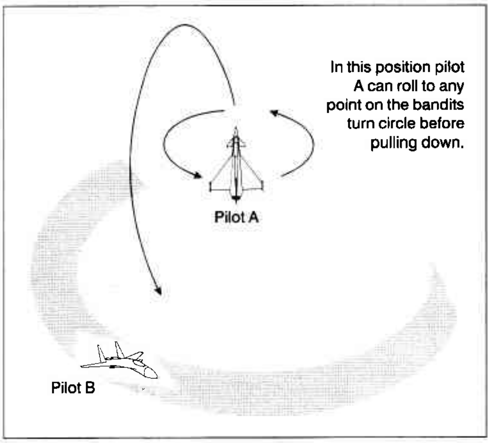


Figure 33

The two pilots in this fight (Figure 32) are faced with the prospect of a protracted engagement. If one of the pilots has the ability to exploit the vertical, he can use roll rate to out turn the bandit. An aircraft can roll much faster than it can complete a level turn. The Eurofighter has excellent low speed roll ability. By pulling into the vertical and rolling your lift vector you can pull down on to a bandit with as much lead as you choose.

The Su-35s are suckers for this and you can get a solid rear aspect by going vertical and cutting across the turn circle on to them, (Figure 33). It works best once you have them at very low altitude. They will typically continue to turn level and by using the vertical you can gain a significant angular advantage.

This manoeuvre is commonly referred to as an Immelmann, named after the German World War I ace, Max Immelmann, who first employed the technique against his allied opponents with great success. The original Immelmann employed a hard rudder turn akin to a hammerhead turn at the top of a zoom climb in order to execute a quick reversal. Nonetheless, the Immelmann as we refer to it today remains an effective tactic that you can employ against your opponents. To be successful, initiate this manoeuvre above 260 knots so that you will have enough control authority for a gun shot when you come down behind the bandit.

Of course, most of your opponents will know that if you win the vertical you will be able to cut the corner on them with deadly results. As a consequence, they will try to deny you that option by pulling up with you if they have the energy to do so. If they do not have the speed, they will pull down into the vertical and start a looping fight.

If you invert the manoeuvre and pull down into the vertical, you will have executed what is known as a Split-S. Variations where you pull into a loop obliquely either above or below the horizon are known as high and low slices respectively.

These manoeuvres are commonly employed as entry points to an air to air engagement. The pilots will utilise their corner velocity in combination with the rapid reversals possible through these manoeuvres in an attempt to convert a head on merge into the most advantageous position as quickly as possible. The choice of an Immelmann, a Split S or some variation in-between depends on altitude, entry speeds and other factors. For example, if you have an excess of energy and are above corner velocity you may choose to employ an Immelmann or High Slice. A climbing manoeuvre bleeds your speed down to corner quickly in order achieve your best turn rate. Conversely, if your speed is relatively low, a Split S or Low Slice will conserve energy and allow you to maintain the highest turn rate for the longest period of time.

At the same time, the effectiveness of these manoeuvres at low speeds should not be overlooked. Your Eurofighter can execute an Immelmann or Split-S and turn 180 degrees much more quickly than it can do so in a level turn. In addition, many of the computer

controlled aircraft can be forced to overshoot by using the vertical. When they do, you can roll your lift vector on to them and drop back down on to their six as they blow past. Just pay close attention to closure and separation and treat the opponent's snap shots with the respect that their accuracy deserves.

You have now seen what a dramatic effect the position principle can have upon your flight geometry and upon your opportunity for gun shots. However not all manoeuvres are designed to give you a mere snap shot. Executed correctly and in combination with the capabilities of the Eurofighter, these manoeuvres will allow you to obtain solid, rear aspect gun shots. This is not an exhaustive list of manoeuvres by any means, but merely those that are most effective in EF2000. Against the computer pilots, exploiting the vertical and applying solid scissoring techniques will allow you to fare extremely well. Against human opponents, the methods outlined here will suffice against those who merely use 'G for brains.'

One of the biggest challenges faced by new flightsim pilots is achieving a three dimensional awareness. The ability to visualise the geometrical patterns created in the space around your aircraft during combat is crucial to ACM. At the beginning of this chapter, we said that you would need to develop a deeper understanding of the three dimensional geometry of the manoeuvres. You now see how important this geometry is and in doing so you will have already taken those first big steps to becoming a great flightsim ACE.

You now know why the manoeuvres work, but it is not enough to simply remember a pattern of lines in the sky with a catchy name. In order to be able to fly BFM fluently, without thinking and without delay, you need to have a deeper understanding of the three dimensional geometry of the manoeuvres. In that way a correct response will become automatic so that you can do the right thing regardless of whether you know what it is called or not. This is something that will only come through experience and practice.

Part III Going on the Defensive

As you have seen, the weapons your Eurofighter carries are extremely effective. Those carried by the enemy can be equally effective and you will need to know how to deal with them in order to survive. Threats to your Eurofighter can come from both airborne and ground based sources. This discussion will focus on airborne threats. However, the techniques described will work equally well against Surface to Air Missiles (SAMs).

EF2000 simulates missile seeker head and tracking systems with a high level of fidelity. Missiles will adopt a 'Lead Pursuit' intercept course in the same way that real missiles do. Defeating, or 'spoofing' missiles depends on two strategies. You can either use counter measures or evasive manoeuvres. Countermeasures include: flares which decoy Infra-Red missiles away from your aircraft, chaff serves a similar purpose for radar guided missiles and ECM which confuses radar guidance systems. The Eurofighter automates most of the tasks involved with the use of countermeasures. You will rarely need to concern yourself with when and how to dispense these items. Evasive manoeuvres on the other hand, require concentration and timing. It is a skill you will need to practice and refine. Once mastered, these manoeuvres will allow you to avoid death at a distance and will make you a more formidable pilot.

Defeating Radar Locks

The best tactic for winning aerial engagements is to destroy the enemy aircraft at the greatest possible range. The enemy will try to employ the same tactic against you. Radar guided missiles fired from beyond visual range (BVR) will be the first threat you will encounter, so we will look first at techniques for dealing with this type of threat.

An enemy radar lock will typically be your first indication of an airborne threat. Several indications of this are provided: a warbling tone will be emitted by the DASS, the radar lock indicator lamp 'LK' will light up on your glareshield panel, and a verbal 'Radar lock' warning will be issued by the voice of your onboard computer, 'Nagging Nora'.

A good defence is to deny the enemy the opportunity to fire at long range. This is particularly important if you have no long range missiles of your own to fire back. To accomplish this, you will have to break the enemy's radar lock. There are several techniques you can employ to do this. The first is to use Electronic Countermeasures (ECM) in an attempt to 'jam' the enemy radar. ECM is very effective at long range. However, the enemy radar will eventually 'burn through' the interference as the range decreases. In addition, since ECM is an active technique, using it will light a beacon in the sky for all other enemy interceptors to home in on. If avoiding an engagement or escaping unnoticed is your goal, you will be better served to leave the ECM off as long as you can.

The second technique is to manoeuvre your aircraft so that you are flying at right angles to the enemy in order to 'beam' the radar. Aircraft radar systems work by measuring the Doppler shift, or the difference in speed between the target and the transmitter. A target that is flying at right angles to the radar will exhibit a minimal speed differential and will generally disappear from view. You can either turn to place the enemy directly off to one side, or dive vertically toward the ground.

A final technique is to break the lock by using the terrain to mask your presence to the enemy aircraft. Once again, this is especially useful if you are trying to avoid an engagement during your approach to the target area or are trying to escape into friendly territory. If you are already at low altitude, or if you have dived down to reach it, you can hide in the valleys or behind high terrain to avoid detection. If you can maintain an altitude below 200 feet, it is possible to avoid detection by enemy airborne (AWACS) and ground based early warning radar units as well as the enemy interceptors.

Missile Launch Detection

When missiles are launched, a new set of indicators appears. You will hear a repeated set of double warning horn sounds as well as a verbal 'Missiles Launched' warning from Nora. In addition, the missile launch warning lamp 'LA' on your glareshield will illuminate as well as the 'IR' or 'RA' lamps to indicate whether the threat is an Infra-Red or Radar guided missile. Missile identification is also displayed at the bottom of your screen by a message with an (I) and/or an (R) to indicate the type of threat you are facing. These will remain visible as long as the missile is tracking your aircraft.

Most long range launches will be radar guided. However, the enemy does employ AA-11 'Archer' IR missiles that are capable of being launched at a range of nearly 20 miles so it is a good idea to double check.

Radar missiles will appear on your DASS as small yellow dots. If you have your radar engaged and the missile is within the cone of radar coverage, they will appear as yellow dots here as well. If you cannot see the missile on the DASS, increase the range and/or manoeuvre until it is visible. It is a good idea to set the DASS at the minimum range that still allows you to see the missile. This provides the best resolution in order to observe whether your evasion strategies are working. As the missiles approach, you can decrease the DASS range to aid in the planning and execution of your evasion techniques.

Besides verifying the type of missile threat you are facing, it is important to determine the direction the threat is coming from. The simplest way to do this is to use the missile padlock view by pressing the F12 key. This will orient your view in the direction of the oncoming missile. How you proceed from here will once again depend on your intentions. Regardless of the course of action you have chosen, determining the type and source of the threat should be your first priority.

Defeating Radar Missiles

Once you have verified that the threat is a radar missile, the techniques described above work equally well at breaking the missile lock as they do for breaking the radar lock. The radar missiles carried by the enemy aircraft, AA-10 'Alamo', have a maximum range of about 45 miles and flight times comparable to the AMRAAM missile. However, unlike the AMRAAM, the AA-10 is a semi-active radar guided missile. This means that the firing aircraft needs to maintain radar contact in order to guide the missile to the target. If you can break the lock, you will have defeated the missile.

Since radar missiles are fired from a considerable distance, you will usually have plenty of time to react, as much as a minute or so depending on launch parameters. How you react depends on factors that include your current speed and altitude as well as the direction the threat is coming from. The course of action you take will also depend on whether you intend to engage the enemy or not.

If you have decided to engage the enemy, use the time while the missile is approaching to manoeuvre for the best position from which to launch your own weapons at the greatest possible range. Remember, the best dogfight is the one you have won before it starts.

If you have speed, altitude and fuel resources on your side and have chosen not to engage the firing aircraft, it is possible to outrun radar guided missiles. Make sure the missile is directly behind you and light the burner. You will need to fly above Mach 2 at altitudes between 30,000 and 40,000 feet in order to successfully outrun the missile.

This technique should only be considered if you are making a run for home. Obviously, running away from a missile in the direction of enemy territory is a poor strategy. You will only succeed in delaying an inevitable engagement and will be burning up precious fuel resources in the process.

Regardless of whether you have chosen to engage the enemy or not, defeating radar guided missile threats is a relatively simple matter. If the missile is still tracking you when it is inside the minimum range of the DASS, turn on the ECM. The ECM is very effective at spoofing the radar guided missiles, but it is not 100 percent effective. The yellow dots on the DASS will blink to indicate that ECM is active against those missiles, but that does not guarantee they have been spoofed. You should not be complacent about radar missile threats. Watch the approach on the DASS and radar, as well as visually when the missile comes into range. Always manoeuvre out of the path of the incoming missile.

When the missile is in visual range, you can confirm whether or not it is focused on your aircraft in the following manner. If you can see a significant portion of the exhaust plume, you are in the clear. If you see none, or very little of the exhaust plume, the missile is still headed your way. Additionally, if the missile takes a curved path in response to your manoeuvres, you are still under threat. You should prepare to take evasive actions. The evasive techniques described below for IR missile threats will work equally well for radar missiles.

Defeating Infra-Red Missiles

Except for the AA-11 'Archer' missile that has a maximum range of approximately 20 miles, most IR launches will be made either just beyond or within visual range. The AA-8 'Aphid' missile carried by the enemy has a maximum range of approximately 10 miles but is usually fired from about half this distance. Unlike BVR radar guided launches, you will not have much time to identify and react to the threat.

At this point in an engagement, you should have your radar on and your DASS set to its minimum range. It is also a good idea to make sure your ECM is engaged at this point as well. Although ECM is completely useless against IR missiles, you do not want to leave yourself vulnerable to radar guided missiles that might be launched by an approaching interceptor. In the heat of a within visual range engagement, there is nothing worse than to be killed by a BVR launch when it is so easy to defeat this type of threat.

When an IR missile is launched, you will receive the same sorts of indications as you did for radar guided missiles. If the launch is from the forward quarter, the missile will appear on the radar display in addition to the DASS, as an orange dot. Countermeasures will be dispensed automatically regardless of where the threat is coming from. The missile padlock view will help you determine the direction of the threat which will be crucial in making evasive manoeuvres work.

Missile Evasion Manoeuvring

Defeating missiles involves forcing the missile to make the greatest angular heading changes possible. In essence, you need to create an angular problem that the tracking and guidance systems are unable to solve. Missiles travel at very high velocities and although they can achieve load factors far in excess of what your aircraft is capable, their speed means that they will have a very large turning radius. Consider the following example:

	Eurofighter	Missile
Speed	Mach 1	Mach 3
Load	9G	30G
Turn radius	4,186 feet	11,239 feet

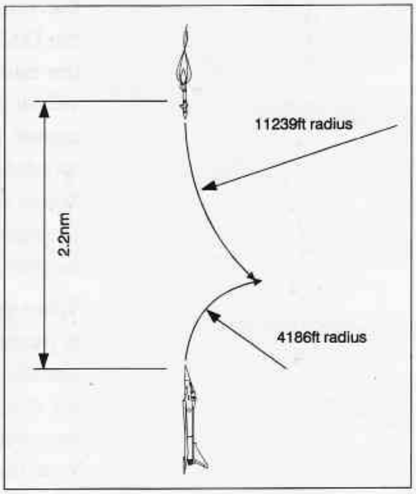


Figure 34

You will notice that the missile has a turn radius nearly three times that of the Eurofighter at these speeds and load factors. Clearly there is the potential to create a large separation in heading. As the missile detects a change in the Eurofighter's heading, it will adjust its course to apply enough lead to effect a collision. From a head on approach, a hard turn will create the greatest heading changes for the missile. Evading the missile from this position has the added advantage that you can eyeball the missile and launch your own missiles at your attacker.

However, in order for this to work, timing is critical. If you start your manoeuvre too early, the missile will have ample run to manoeuvre for a hit as shown in Figure 34.

Steady nerves and better timing can result in a good evasion. Beginning your turn at 1.5nm can create 0.3nm separation as shown in Figure 35. Here the missile is at point 1 and the aircraft at point 2 at the exact same instant. That is the instant you breathe again as you see the missile flash past in padlock.

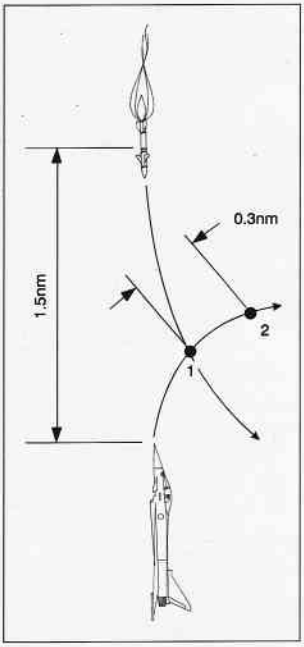


Figure 35

While this works quite well against a single missile, a serious disadvantage to this technique is that it can leave you in a bad position for a second or third missile. Naturally you can see that it makes sense to turn back into the attacker when the current threat has been

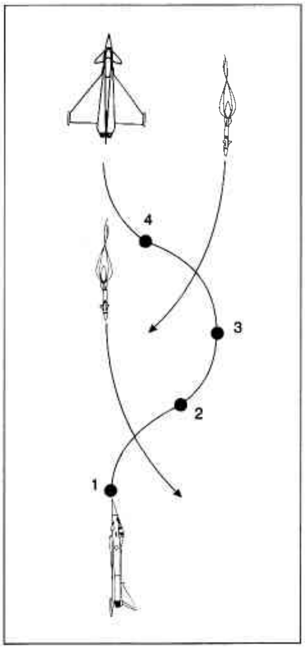


Figure 36

avoided, ready to meet the next missile head on. The flight path that results is shown in Figure 36.

Here you see that the first evasive manoeuvre begins at point 1 while the first missile is 1.5nm away and that manoeuvre finishes at point 2. The second evasive manoeuvre begins at time 3 and ends at time 4 and so on. The main problem with this technique is that it depends on the missiles being spaced far enough apart. If several missiles are approaching at shorter intervals, a second or third will kill you while you are still spoofing the first one. Of course, the DASS will be pumping out chaff and flares during this time and it is possible that they will succeed in decoying the additional missiles. But it is not something you want to trust your life to.

This is just one example, featuring but one set of missile parameters. The variety of missiles and the problem of identification means that spoofing missiles is less certain during combat. Is it no wonder that real pilots fear missile launches so much.

However, manoeuvring in a single plane of motion as we have been discussing is still not the best way to create the maximum angular heading change requirement for the missile. Manoeuvring out of plane, (using all three dimensions) is much more effective because it gives the missile compound angles to deal with. Using a barrel roll technique will allow you to evade multiple launches regardless of the missile spacing and survive every time.

The Barrel Roll Defence

Before we look at how and why the barrel roll works so well for missile evasion, let us explain how it is performed.

This manoeuvre will tend to bleed off your airspeed rapidly. In some applications that will be desirable, for example, avoiding an overshoot during a dogfight. However, for missile avoidance, bleeding speed would be disastrous. As you lose speed your ability to sustain the manoeuvre will fall rapidly to the point where you become little more than an easy target. Because the manoeuvre involves not only a hard turn, but also an unavoidable nose high stage, you will need to initiate your barrel roll at around Mach 1 in order to sustain it indefinitely if you are at sea level. The higher you are the faster you will need to be.

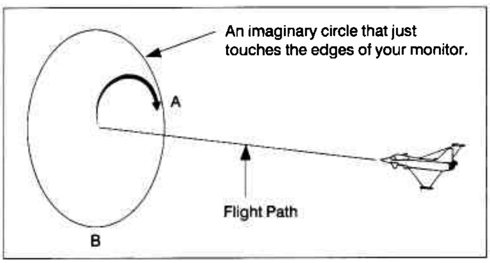


Figure 37

Initiate the barrel roll by turning into a bank and pulling back on the stick at the same time. Imagine that your monitor has a circle drawn on the screen that just fits within the visible area. You should aim to follow that circle with your flight path marker so that in the early stages your flight path will move from the centre of the circle towards the point marked A. It will then follow the imaginary circle through B and back to A again, Figure 37. As you continue in the barrel roll your imaginary circle will stay the same distance in front of you and in doing this your actual flight path will be as shown in Figure 38.

Your flight path will describe a shape through the air similar to that of a stretched out spring. The faster you are travelling the more elongated that shape will be. That is how the barrel roll is done. Now we will look at why it is such this is such a powerful defence against missile threats.

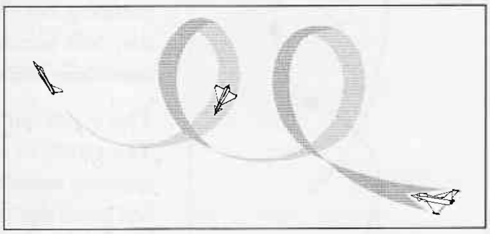


Figure 38

You will recall that there is a huge difference in turn radius for the missile and the Eurofighter. If you perform a barrel roll with the missile dead ahead, it will attempt to follow a similar but much larger spiral path based upon your predicted position. As the missile gets closer it will simply be unable to close its turn radius as tightly as yours so that the missile will in effect roll right around your aircraft at a safe distance. (Figure 39)

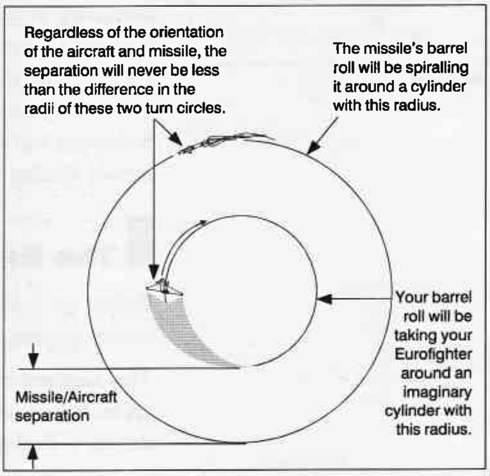


Figure 39

This technique is so effective that you can fly through nearly unlimited numbers of enemy missiles, radar or infra-red, providing you can keep them in your forward quarter and stay fast. That is the rub. In order to sustain a barrel roll you will need to be able to sustain a speed above Mach 1 and that will not always be possible depending on your weapons load out and your altitude. You should have no hesitation in dropping your stores if your survival is jeopardised.

You should be able to perfect this technique with just a little practice because, unlike spoofing in a single plane of motion, timing is not an issue here. It does not matter where the missile enters its spiral, it will still roll right past you. The only important thing is that you commence the barrel roll early enough and are able to maintain it until the last threat has passed. You will also discover that the barrel roll itself does not need to be executed with precision, the size being more important than the shape of the roll. You can even fly around a square rather than a circle, in effect boxing the missiles.

The barrel roll defence works very well against the enemy guns during a head on merge as well, although it is not nearly as foolproof as defending against missiles. The enemy will open fire at approximately one nautical mile. Just before you reach this distance, initiate a barrel roll. This will present the enemy with a very difficult guns solution and you will very likely see tracers whizzing past your canopy as he tries to compensate with lead for a shot. If you time it just right, you can pull into the bandit just prior to the merge and score gun hit for yourself. Although this is a low percentage snapshot opportunity, if you succeed in killing or damaging the bandit, that will be one less you need to worry about in the ensuing dogfight.

Missile Evasion during Dogfights

The barrel roll is the most effective technique to employ in missile evasion. However, there may be occasions when you do not have time to turn and face the incoming threat and begin your barrel roll. If this is the case, you should try to bring the missile as far forward as possible.

If you see a radar launch while in a close quarter dogfight, you should determine where it is coming from as soon as possible. If you cannot see it on the DASS, chances are that it is beyond the current range setting. Radar launches usually indicate that reinforcements are about to arrive. However, as we noted earlier, you will typically have some amount of time to deal with the radar missile threat. You will have a bigger problem on your hands soon if you cannot defeat the enemy aircraft you are currently engaged with.

If an IR missile is launched, break immediately without delay. Chances are this missile threat is extremely close. Use the missile padlock and adjust your break to turn into the missile as quickly as possible. Your DASS will be pumping out chaff and flares, but it will not hurt to add some more manually. Drop chaff and flares as if your life depended on it; it does. Evasion will be easiest if the missile is placed about 60 degrees off to one side and you turn into it at about 1.5nm. If you can set up this angle to the missile, you will be in good shape.

You should always treat missiles as a serious threat. If you do not honour that threat, the missile launch warning may be one of the last things you hear. Regardless of whether the missile is radar or IR, fired from short or long range, some action is always required if you want to survive. Practice your evasion techniques until they become second nature. In the midst of a fight, you may have barely enough time to react, much less think about what that reaction should be.

Part IV

Starting a Fight – Getting into and out of Engagements

You now have a firm foundation in the basics of air combat manoeuvres. That will not be enough however, because the artificial intelligence in EF2000 will punish you dearly for any tactical mistake you make. If you have become used to the sort of flightsim where you can storm into a fight against four or five bandits and kill them all single-handedly, you are in for a surprise; a pleasant surprise. Most flight sim pilots will be delighted to find that the tactics which work in the real world will work equally well for you in the simulation.

In the real world, if you had your life on the line, you would never enter a fight without some advantage. You would always want to get into and out of a fight with as little risk as possible. You would want to live to fly another day by surviving every mission. That is exactly the attitude that will pay off in EF2000.

Knowing when and how to approach the enemy aircraft will make an enormous impact on the success of your missions. In this section, we will take a look at tactics for entering an engagement as well as strategies to help you decide whether to engage the enemy at all. We will also consider ways in which you can stack the deck in your favour. We will conclude with some comments about getting out in one piece if the enemy proves to be more than you bargained for despite your planning and best efforts.

Interception

Most air to air engagements in EF2000 will begin BVR. The information provided to you through the JTIDS will assist you in executing an interception of the enemy aircraft without broadcasting your location by turning on the radar. Interception begins at the point you decide to engage and vector your aircraft or flight on to the target bandits. During an interception, you are primarily concerned with getting your aircraft into the most favourable position for a missile launch, both in terms of position and distance from the target and preferably undetected. The enemy is well equipped with both ground and airborne early warning radar systems. Even without using your own radar, approaching undetected will be very difficult at best.

Terrain masking and maintaining a low level approach pattern will help keep you hidden as long as possible. Flying below 200 feet will generally allow you to avoid detection by the enemy, but this is nearly impossible to maintain continuously over inland areas. You will almost certainly appear intermittently on enemy radar as you balloon over terrain obstructions. Even if you are following roadways through the valleys at signpost level, either you or your wingmen will invariably exceed 200 feet at times during turns or other manoeuvres.

The intermittent glimpses that the enemy receives may or may not alert them to your approach. A lot will depend on how preoccupied they are with other allied flights, how rigidly they adhere to CAP patrol patterns, how frequently you appear on radar and for what duration. In short, there are a host of variables. This is not to say that you should abandon attempts to employ stealth as an approach technique. Rather, it serves only to remind you that you should not rely on stealth alone. Stealth can allow you to approach a group of bandits more closely without immediately drawing in reinforcements from other areas. If you can isolate groups of bandits from each other, you can improve your chances for success.

In planning your approach, you should pay attention to the disposition of other enemy forces in the area. Once the shooting starts, reinforcements will be vectored to the area. The enemy is as capable of calling out 'Mayday mayday, we are under attack!' as you are. As you make your approach, you should keep two goals in mind: choose a direction that will minimise the possibility of an immediate engagement with other incoming bandits, while maximising your avenues for escape.

Whenever possible, approach the bandits from the side farthest away from the direction of reinforcements. If your escort flight is vectoring towards the bandits, you should try and direct your strike away from the fight in the safest direction at 90 degrees to the alerted fighters. This will help hide you from the enemy radar as much as possible. Even if this direction involves doubling back on your route, you are better off than if you fly towards other groups of bandits without the protection of your escorts.

If you are without escorts or if your flight is the one performing the intercept, your immediate task is to close to within missile range. You will need to use your best judgment while the radar is off because turning it on to paint the bandits will alert them and your advantage may be short lived. If you do this at too long a range the bandits will begin calling in reinforcements that much sooner. The closer you can get prior to turning on your radar, the better. The shorter the flight time of the missiles, the less time that the bandits will have to react.

A stealthy approach has its advantages, however getting so close as to deny you the use of long range missiles is foolhardy at best. Remember, if you get shot down with an AMRAAM or S-225 missile on the rails, you have wasted an opportunity. If you can dispatch the bandits from a distance, you can concentrate your efforts on reaching the target area with as little interference as possible. Even if one or more bandits survive a long range volley, you are better off allowing them to try and pursue you relatively isolated from other reinforcements. How you proceed if a chase develops will be covered in more detail later on. For now, position yourself for the most favourable long range missile release. This will involve accelerating towards the targets and climbing to a higher altitude if you are currently down in the weeds.

Closure

This phase of an engagement is concerned with converting a beyond visual range engagement to a within visual range engagement, ideally with some advantage. You will have to survive any exchange of missiles that will take place during the closure. Make sure that you and your flight have activated your ECM and that your DASS is engaged and operating. Assuming you can or have already deployed your own long or medium range missiles, the important thing is that you get to the merge without damage.

During the early stages of the closure you will be concerned with forward quarter missile launches. Then during the later stages of closure, just prior to the merge, forward quarter gun shots will be a threat. You can effectively deal with both concerns with the same technique: the barrel roll defence. You will want to be sure that you maintain sufficient speed to employ this technique effectively.

Merge

This phase of the fight begins once you enter minimum range (Rmin) for the short range missiles and maximum range (Rmax) for the guns. For a head on merge, both coincide at around 1 nautical mile. If you have spoofed all of the incoming missiles, you will now need to survive the next one mile of closure in order to reach the merge.

Since you and your opponent will both be within gun parameters you have the choice to go for a shot. In the case of a dogfight with a human opponent, going for a head on gun shot is little better than a 50/50 chance. You know you can out fly the guy so why improve his odds? Avoid the head on guns pass and go for a rear aspect shot. It may take a little longer, but if you are confident in your flying ability it will involve less risk of being caught by a lucky shot from a less skilled opponent. In the case of a computerised opponent in a campaign environment, do not even think about a head on shot. Their marksmanship is flawless.

Getting safely to the merge with minimum flight path separation centres on avoiding being shot in the face during the last 1 nautical mile of closure. The most effective way to do this is to stay fast and barrel roll into the merge. What you do after that depends on whether you intend to extend or stay and fight.

In a multiple bandit arena or a dynamic campaign situation, choosing to enter a knife fight with the inevitable energy sacrifice is often little more than foolish. It is almost certain to end in a long wait while your wingmen end the mission without you. If you are hoping to extend, be aware of bandits lead turning you because they may manage to get gun hits as you blow through before you reach Rmax.

If you are going to stay and fight, the most effective way to do this is to stay fast and barrel roll into the merge. You can apply the airbrake and throttle back at the last moment. Another option if the bandit is allowing you to maintain some flight path separation is to execute a lead turn.

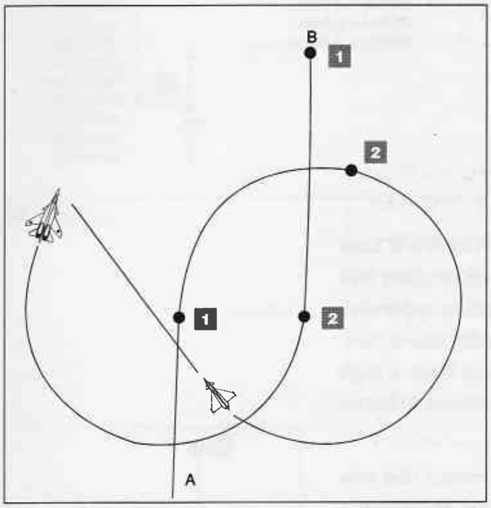


Figure 40

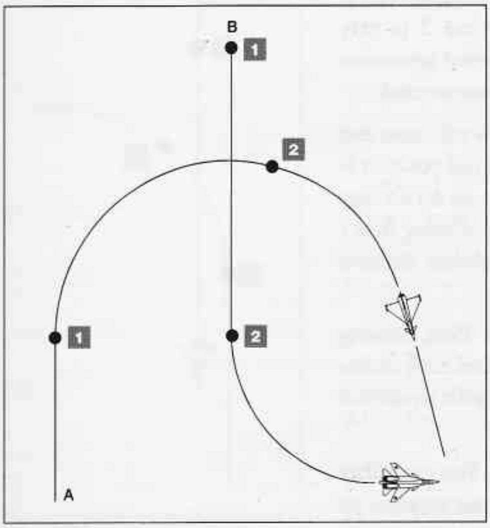


Figure 41

Lead Turns

A lead turn is a manoeuvre that allows you to get an angles advantage by turning into the bandit before the merge. One essential requirement for a successful lead turn is flight path separation or turning room. We will consider some examples of lead turns with a flight path separation equal to one turn radius. In Figure 40, fighter A and fighter B are both flying straight and level as they approach the merge. At time 1 Pilot A begins to turn into Pilot B, passing behind him so that they have the positions shown at time 2. Pilot B will see Pilot A pass behind him and at time 2 may turn in one of two directions, to the readers left or to the readers right. The diagram illustrates what will happen if Pilot B breaks to the readers left. They will both continue around their respective turn circles until Pilot A gets a gun shot as a result of his lead turn.

If Pilot B had decided to turn in the other direction as shown in Figure 41, Pilot A would still get his snap shot. This is slightly worse for Pilot B who would be forced to fly through the manoeuvre. If he reverses to avoid the snap shot, you can see from the diagram that Pilot A can saddle up firmly on his tail. If Pilot B survives the snap shot without too much damage both pilots might reverse into a scissors.

It is very common to see the bandits executing lead turns if you are trying to blow through a group of enemy fighters in the hope of extending after the merge. The bandits will often get a gun shot before you escape Rmax for the guns. Lead turning in this way requires a two turn radius separation so that you end up directly behind the bandit. Let us consider an example of two fighters at 650 knots and assume that Pilot A can sustain that during his turn.

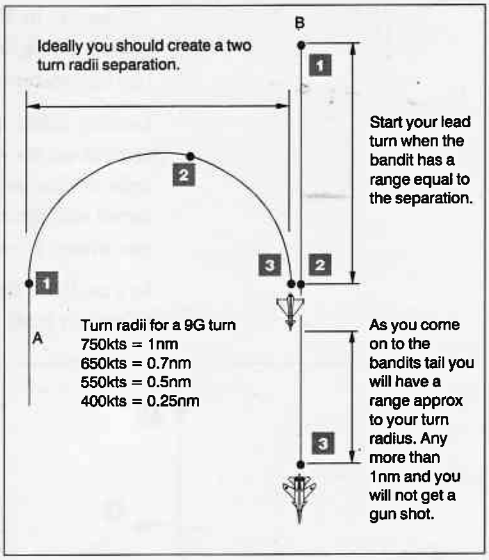


Figure 42

In this case Pilot A must maintain a 1.4nm separation and start his turn at the same distance from the bandit as shown at time 1 in Figure 42. At time 2 Pilot A is falling in behind Pilot B and at time 3 Pilot A will have a gun shot with a 0.7nm range. At 650 knots, the guns opportunity will last 1.7 seconds. That may not be enough time for a human opponent, but do not forget that the computerised pilots are deadly marksmen. Even if you blow through flying straight and fast, you have a high probability of taking hits. You should either jink or continue to barrel roll in order to avoid getting shot.

With no flight path separation, executing a lead turn means that you will need to pass in front of your opponent to achieve any angular advantage as shown in Figure 43. Here Pilot A starts his lead turn at time 1 and passes in front of Pilot B just before time 2 (a very dangerous choice). It can be done if you use some vertical separation to spoil your opponents aim but it is definitely not recommended.

There is also a strong risk here that Pilot B may take the offensive and a poorly timed lead turn can leave you in an extremely bad position as shown in Figure 44. Pilot A has executed a lead turn with no turning room. Not only did he pass in front of his opponent offering him a snap shot, but his opponent has engaged with an almost decisive advantage.

This leads to some solid conclusions for lead turns. First, turning room and timing are essential. Second, never risk a lead turn unless you are sure you have enough turning room or flight path separation as explained previously.

To defend against the lead turn you have two choices. You can either maintain a speed above 750 knots and use your escape window to ensure that your opponent comes nose on outside Rmax for the guns.

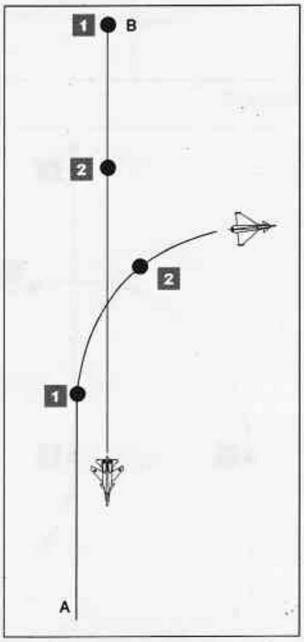


Figure 43

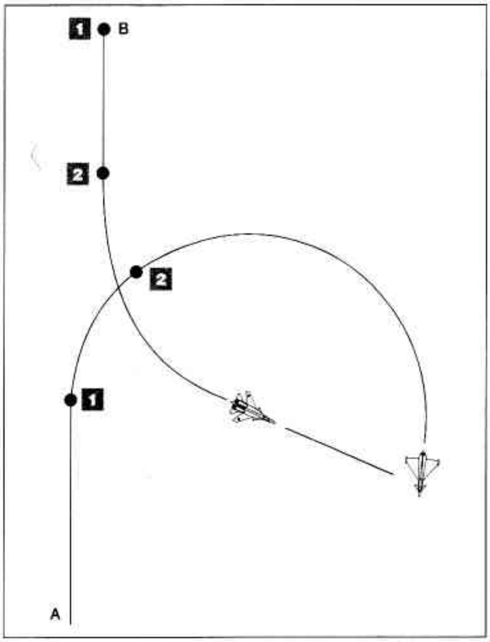


Figure 44

Or you can deny him any flight path separation or turning room by turning into him. At best you will need to avoid a guns shot before extending. At worst you may be forced to commit to a turning fight. Your best choice will depend on factors like your current weapons load out, fuel and damage status as well as the proximity of other bandits.

The computer pilots will almost always fly a pure pursuit approach during closure. It is therefore very difficult to obtain sufficient lateral separation for an effective lead turn. However, they will allow you to achieve a degree of vertical separation. The techniques outlined above work equally well in the vertical as they do in the horizontal. You can gain a lot of advantage by exploiting this tendency. A word of caution however, the computer pilots will correct for separation as they approach the merge. In essence, this amounts to their executing a lead turn on you rather than a zero separation pass if you had remained at the same flight level. We have shown examples of how to take the offensive against a lead turning opponent. Be prepared to apply these examples against the computer pilots when they commit to their manoeuvres.

Fight or Flight

Nearly all engagements in EF2000 will begin BVR. You will almost always have a choice as to whether or not to enter a fight. There are implications you need to consider when deciding whether or not to commit to an engagement with the enemy aircraft. JTIDS will present you with a very good picture of the disposition of enemy aircraft in the area, however it will not always be a perfect picture. If you are faced with an impending engagement you should ideally be aware of which enemy aircraft might be vectored towards you once the fight has begun. Obviously you do not want to be winning the fight you are only to find enemy reinforcements have shut your escape window tight.

The best strategy is to avoid engagements whenever possible while en route to your target if you are on a strike mission. If the enemy succeeds in forcing you to dump your stores during a fight, your mission is a failure even if you make it back to base in one piece. If there is a route available that will guide you around enemy fighters, take it. If you can employ stealth to sneak past enemy fighters, use it. Unfortunately, this is not always possible. The enemy AWACS and ground based early warning radar systems are just as effective as your own. Escort flights typically will not attack you unless you approach to within 40 miles. However, CAP flights may be vectored in from as far away as 200 miles of your location to intercept you. In addition, there is always the possibility of scrambled fighters from nearby bases. Finally, if there are enemy fighters loitering near the target area, you will have no choice but to engage them before you can complete your mission. As we have already noted, you are in for some surprises and some challenges.

If it is clear that the enemy has focused their attention on you, stealth is no longer important. A complete 360 degree radar sweep is a good idea before you commit to a close quarters dogfight with the enemy aircraft. A low altitude or 'look down' radar sweep is particularly recommended. You will want to know if there are other enemy aircraft in the area in order to make an intelligent decision whether to fight or take flight.

Basically, all enemy aircraft that are within interception range of your current location during the anticipated time span of the engagement should be considered as part of the threat. Of course, this is difficult to judge. How long an engagement will last will depend on the number of aircraft involved and the weapons remaining at your disposal. A guns only engagement will obviously take much longer than if you have an ASRAAM or two on the rails.

If you are flying alone, engaging the enemy is not worth the risk while there are other enemy flights within 40 nautical miles. If you become stuck in a protracted guns only scenario, you are going to be listening to launch warnings while your speed bleeds down until you are little more than a target. If you can survive the fight and the incoming missiles, you are soon going to be in a one versus many engagement, desperately looking for a way out. Here is one way to size up the situation and assess the risks.

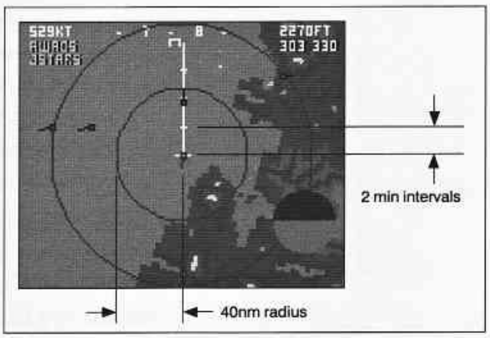


Figure 45

Look at the situation shown on the MMD in Figure 45. There are two bandits dead ahead at about 35 nautical miles. The direction line is marked at 2 minute intervals to a stationary target (not 1 minute as mentioned in the manual). The bandits dead ahead would be 4 minutes away if they were stationary. If you wish, you can check the closure speed and calculate how long it will be until you merge with the fighters. However, a simple rule of thumb is to halve the time on the direction bar. In this case, that places you 2 minutes from the merge. Two other groups of bandits are also visible to the West about 50 and 80 miles away. Assuming that they will vector towards the ensuing fight, by the time you engage the fighters ahead, the closest group on the left will have closed the gap considerably.

Entering a 1 vs 2 fight presents you as an almost stationary target to incoming bandits. In this example the bandits can be predicted to join the fight at 4mins and 6mins.

Figure 46

When you reach the merge as shown in Figure 46, you have a choice to either engage or extend. If you engage you will be relatively stationary to the incoming bandits to the east. With one group of bandits only 4 minutes away and another group 6 minutes out, an engagement would be very risky. In fact, you will be dealing with incoming missiles much sooner than these times indicate. Remember, if you want to survive the mission never engage without an advantage.

If you are relaxed about the mission or if your only objective is to have as much fun as possible while dogfighting against impossible odds, take a chance. Spend two minutes manoeuvring on the bad guys. If you have not finished the fight by that point, try to extend. If you are flying a campaign by yourself or with your squad mates, do not stick around here. Pick some clear sky and head into it with your afterburner blazing or you are going to finish a lot of campaigns early. A more worthy objective is to do as much damage as possible and survive. Landing back at your base with a wing shot up, several dead bandits and a mission complete message is more satisfying, more productive, more realistic and gets you just as many cheers.

At this point, prudence would dictate that you seek to engage the enemy fighters on more favourable terms or avoid an engagement entirely. Change course and allow the nearest bandits to chase you to a position where you judge you will have time to complete the engagement without the interference of other enemy aircraft. Alternatively, you may be able to drag the bandits in the direction of other allied flights allowing you to engage with a better balance of numbers on your side. Finally, you might be able to shake the bandits off entirely and look for another route to your target.

The first thing to determine is whether or not you are going to be able to outrun the bandits. This will depend largely on your fuel load because you will certainly need to use the afterburner for a clean escape. As an approximate guide, at 40,000 feet with afterburner on expect to use approximately 5kgs of fuel every second. Once you lose your drop tanks you have less than 14 minutes on afterburner, at ground level not much more than 10 minutes. Fuel considerations have always been a major factor for real pilots. In EF2000, getting back to base safely may depend on how you manage the fuel in this situation. Assuming that you do not have enough fuel to run away on afterburner, let us consider what to do.

Extending – The Chase

As an example, let us assume you are being pursued by bandits that have a closure of 100 knots. At that rate the bandits will be gaining

1nm every 36 seconds. You certainly do not want to push on regardless while the bandits drive within missile parameters with a perfect rear aspect. If you cannot outrun the bandits, at some point you must break back into them and fight. However, the range you allow the bandits to close to prior to your break and the speed at which the break is executed at are very important. This will depend to some extent on what weapons you and the bandits have loaded. (The enemy's weapons can be seen with the F7 view key although you may consider this as cheating.) We have, however, developed some general guidelines to follow.

You will want to be going fast enough so that when you complete your break you have enough speed to evade any missiles that may be fired at you. To make the most of the barrel roll defence against missiles and guns, you will want to be at or slightly above Mach 1 when you complete your turn. The higher you are, the faster you can fly at 100 percent throttle without afterburner and the less speed you will bleed off during your turn.

If you are flying at 40,000 feet, you can exceed Mach 1.5 at 100 percent power even if you are carrying some air to ground ordnance. If you are carrying only air to air weapons, you can achieve even higher speeds. If you maintain 100 percent power and begin your break at Mach 1.5 you will complete your turn with plenty of speed to spare. If you are at 20,000 feet, you will only achieve about Mach 1.3 at 100 percent with some stores on board and will drop below Mach 1 in a hard turn unless you engage your afterburner. At lower altitudes the speeds get progressively slower. You will have to both engage your afterburner and back off on your turn rate in order to maintain your speed throughout the manoeuvre.

At speeds above corner velocity as we have been discussing, your turn rate is generally lower the faster you go. Although your turn rate will be greater at slower speeds, you will need to ease off on the stick in order to complete your turn with enough speed left over. Otherwise you will be too slow to effectively evade the enemy missiles or gun shots. The result is that if you initiate your break at Mach 1.5 (or your best speed at lower altitudes) and intend to maintain a speed above Mach 1 at completion, a sharp turn will take about 15 seconds to complete.

You will want to time your turn back towards the bandits in order to accomplish two things. First, you want to be beyond Rmin for your own weapons. For example, if you want to fire AMRAAM missiles, Rmin is about 4 miles. For the S-225 LRAAM, that distance increases to about 11 miles. Secondly, you want to be beyond Rmax for the bandits' weapons in order to ensure a neutral position from which to set up your shot.

If you initiate your turn at Mach 1.5 at 40,000 feet and that the bandits have a 100 knot closure on you. During the 15 seconds it takes you to turn around, the bandits will cover about 4nm. Each additional 100 knots of closure for the bandits equates to roughly 0.5nm that they will cover. The numbers work out very similarly for lower altitudes.

We can now take these numbers and create a rule of thumb to follow in a chase situation. We need to pad these numbers up a bit to compensate for less than ideal conditions such as damage to your plane, heavy bomb and fuel loads and the like. Any extra cushion we apply will translate into a larger separation when the turn is completed which is to our advantage. If the bandits are pushing Mach 2 and we come head on at Mach 1, the combined closure will be roughly 1 mile every 2 seconds. The computer pilots are excellent shots and can line up on you very quickly. On the other hand, you will need those extra couple of seconds to bring your weapons to bear.

As a general rule: initiate your turn at about Mach 1.5 or your best speed at 100 percent throttle if it is below this number. Allow 5 miles for a zero closure rate and an additional one half mile for every 100 knots of closure. To this figure, simply add the desired separation you want to achieve at the completion of the manoeuvre.

Armed with this information, you can choose when to initiate your turn in order to create whatever separation you desire (Figure 47). In our example, you are being chased at 40,000 feet and the bandits have a closure rate of 100 knots. Starting your turn when they are 15 miles back will result in your coming head on at least 9 miles away, or just outside Rmax for their short range missiles. If you have AMRAAM missiles available, you will be in a very good position to take a shot.

The minimum distance at which you should turn back is dictated by the Rmax for the enemy guns, or approximately 2 miles of separation. Using the same example as above, you would want to initiate your turn when the bandits have closed to about 7 or 8 miles. If you delay any longer, the bandits will have a guns opportunity as you come nose on while you do not.

Remember, at altitudes of about 20,000 feet or less, you will have to engage your afterburner during your turn in order to maintain speed. You may also have to ease off on the stick in order to avoid bleeding so much speed that you are unable to avoid any missiles fired at you. Aim for an exit speed of about Mach 1. Finally, give yourself a little more cushion if your turning ability is compromised by damage, excessive weight or simply to provide a little more separation. There is almost no downside to turning back a little too early. If you wait too long however, you will almost certainly be facing a head on gun shot by the computer pilots and they are deadly accurate with their aim.

If long range missiles are fired at you, it is possible to outrun them if you can achieve a speed of Mach 2 at 30,000 feet or slightly faster at higher altitudes. At lower altitudes, you will not be able to fly fast enough. At 40,000 feet you will need to achieve a speed of about Mach 2.2 in order to outpace the missiles. Any higher, and once again they may catch you. If you are already at 40,000 feet you can try diving slightly to build up speed more quickly.

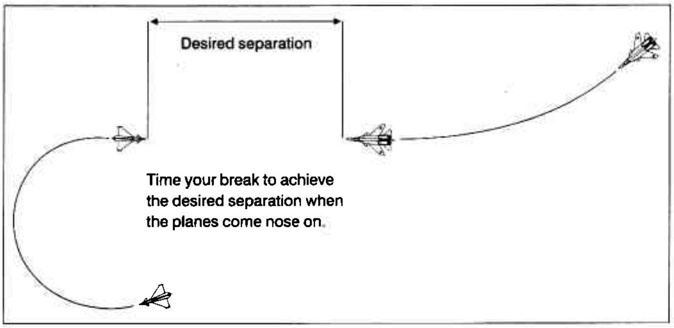


Figure 47

If you feel you can not achieve the speed necessary to outrun the missiles or you do not have the fuel resources to run away at full afterburner, you will need to turn back. Allowing ample space for evasion is critical. Initiating your turn when the missile is about 8 or 9 miles away will provide the minimum separation in which to execute a barrel roll defence. Turning back at 10 miles is probably a wiser choice. If the conditions for a fight are not yet optimal and you are hoping to extend further, you can delay a bit longer and merely turn 90 degrees to the missile in order to beam its radar. Once the threat is past, you can continue your efforts to extend.

You can allow the bandits to continue closing so long as you do not receive a launch warning. If the bandits have no missiles left you will be able to prepare for a guns only engagement. Delaying your break may encourage the bandits to disengage due to their own fuel problems. There is also the hope that help of some sort may arrive. However, do not get too cosy. The lack of launch warnings may only indicate that they are saving one or two short range IR missiles for the end game.

By the same token, it is a very good idea to save one or two of your ASRAAM missiles for just these situations. If other bandits are in hot pursuit a few minutes further back, how quickly you dispatch the closest set may determine how badly things will turn out for you when the reinforcements arrive.

Escape

After a struggle, you have managed to dispatch the closest set of bandits. You have no missiles remaining and your cannon is nearly depleted as well. The reinforcements are knocking on your door and you are looking to exit through the escape window. How do you manage to get back to a friendly base?

It is possible to extend from almost any situation in EF2000. When you are in a close in guns fight it is very difficult, but not impossible.

In order to escape from a close quarters engagement, begin a defensive spiral. The defensive spiral is basically just a barrel roll but going directly towards the ground. You will need altitude to make this work which is another good reason for picking your fights with a good total energy status. Spiral downwards until the bandit falls out of gun range. The bandit will be taking shots at you but this manoeuvre is extremely difficult to follow. You can even extend in this fashion with a damaged wing. Simply barrel roll in the same direction that the damaged control surfaces are forcing you to go. This is definitely not a situation you want to be in, but it is good to know you can get out if you have an open window.

Determining where that window is involves many of the same considerations discussed in the section on deciding whether to engage in the first place. It is very important that you maintain your awareness of the location of other enemy flights. If your JTIDS is damaged, you will have to rely on your memory to determine the best direction in which to make your escape.

Whenever possible, initiate your escape after you have completed as near a head on pass as possible with the enemy. The time it takes for him to turn around and pursue may be all the head start you will have. Drop whatever stores you may still be carrying, light the afterburner and dive away at zero G in order to use the extra boost of gravity to create the most separation in the shortest amount of time. Immediately start calling for help if you have not already done so. As your speed increases, slowly climb to an altitude where you can outrun the enemy more easily. As your altitude increases, you may be able to disengage the afterburner and hold any pursuers off with zero closure.

A very important point which is often overlooked in the heat of the moment is the direction you are facing when you attempt your escape. A perfectly executed disengagement will do you no good if you end up charging into enemy territory on full afterburner. Time your escape manoeuvre to head you in the direction of nearby allied flights, allied SAM sites or simply away from enemy territory if nothing else.

One final piece of advice. If the situation is utterly hopeless, remember to use your nylon escape window rather than allow yourself to be destroyed in the aircraft. Your mission scores will be higher if you bail out than if you are killed. It may be a long walk back to the base, but the success of the campaign on the whole will be greatly enhanced.

Chapter 7

A2G Combat

Basic A2G Combat

Advanced A2G Combat

CHAPTER 7

Chapter 7

A2G Combat

'Fighter pilots make movies - bomber pilots make history'

Operation Desert Storm has often been cited as an example of what airpower can do nowadays. But what were the aerial accomplishments which distinguished this war from its predecessors? Certainly not the few dozen Iraqi aircraft that fell to allied missiles. No, the most important feats airpower achieved in this war were the almost total destruction of Iraq's military infrastructure as well as a healthy attrition of its ground troop strength even before the ground war started.

While Air to Ground (A2G) combat may lack the glamour usually attached to the duelling knights of the sky, it is at least as important as clearing the skies of the enemy, if not even more important. If you take a look at the objectives of the typical A2A missions, they are usually concerned with either assisting one's own attack aircraft to reach their target unmolested (Fighter sweep, Escort) or to deny the enemy's aircraft exactly that (CAP, Intercept).

EF2000 recognises the importance of A2G combat, and you will usually find quite a few A2G sorties waiting in the campaign missions list. But in order to accomplish the objectives outlined in the mission description, you need to have a thorough knowledge of both the weapon's capabilities, limitations as well as some idea how to use the Eurofighter's A2G combat avionics to deliver them right on the money.

This chapter is designed to give you that knowledge. Using the Simulator A2G weapon training missions, you will employ each and every A2G weapon in the Eurofighter's inventory and become proficient with them.

Remember, when things become too hectic or complicated, you can always pause the game to get a grip on the situation. After you have finished this chapter, you should have no trouble getting a 100 percent rating in the 'Target Destroyed' category. Strap in, start your engines and let's go.

Part I Basic A2G Combat

Smart Weapons

Due to the ever increasing costs of modern fighters, few countries can still afford to procure them in the vast numbers they did perhaps 20 or 30 years ago. Obviously, this meant that fewer planes would be used to try to destroy a given target, and it became necessary to increase their efficiency in order to achieve the same, if not better results than in an attack with a greater number of planes. One of the ways to achieve that goal was to make the weapons aircraft carry smarter and hence more accurate, thus allowing a single plane to take out a target where 30 or 40 might have failed before. The Thanh Hoa Bridge in North Vietnam was probably the first target where the advantages of smart weapons became quite obvious. The bridge was the target of several 'dumb' weapon strikes during the Rolling Thunder campaigns, and it was never hit, let alone destroyed in these attacks. In contrast to that, it was completely wiped out in the first attack with smart bombs (sources are a little unclear whether it was conducted with laser- or TV-guided bombs), thus demonstrating the superiority and effectiveness of smart weapons.

Mission 1

The ALARM Anti-Radiation Missile

Mission Target

SAM Launchers

Briefing

Next to interceptors, surface-to-air-missiles pose the greatest threat to a combat pilot's survival. Thankfully, you do not have to suffer through their attention without being able to fight back. The ALARM anti-radiation missile enables you to kill enemy SAM launchers without coming into the lethal envelope of their missiles.

The ALARM can be employed in two ways, direct and indirect. In the indirect mode, the missile can be fired in the direction of an enemy

SAM launcher from up to 32 miles away. It will climb to a height of 40,000 feet, shut down its rocket engine and, if no SAM radar comes up, will stay there indefinitely (the real world parachute deployment and slow descent to earth are not modelled in EF2000). On the other hand, if a SAM radar comes up, the ALARM's rocket motor will start again and it will descend for the kill. If you want to fire the ALARM in the direct mode, you need to find an active SAM within 25 miles of your aircraft. The ALARM will lock on to it, no matter where it is in relation to your aircraft. In contrast to the indirect mode, you do not have to be heading in the SAM launcher's direction, you can shoot the ALARM off-boresight or even over the shoulder.

Figure 1: The Initial Situation

Since the enemy SAM launchers usually open fire when you are 15 miles away, both modes give you a healthy safety margin to stay out of the enemy's missile envelope.

Flying the mission

When you hit the cockpit, you will be at a height of 8,000 feet, heading in a direction of 200 degrees (Figure 1).

Advance the throttle to 100 percent, increment your waypoint to your target waypoint number 3 **SHIFT** **W** and select the ALARM missiles **BACKSPACE**. You should find that you have to turn a little to the left to fly towards waypoint 3. If you have done everything right, you should be about 35 miles from waypoint 3, heading towards it. Try firing the first ALARM in the Indirect mode, all you have to do is to wait until you are about 30 miles from your target waypoint. Continue to fly towards it, when you have reached the required distance, simply fire the missile in the direction of waypoint 3 (Figure 2). You might note that because it has not locked on to a target, the missile does not appear as a yellow blip on your DASS.

Figure 2: 'SHOTGUN', The First ALARM is on its way

The ALARM will climb to 40,000 feet and sniff for SAM radar emissions. In order to give your missile a target, you have to continue to close in on the missile launcher to get the enemy to paint your plane with their radar (Figure 3).

Figure 3: DASS illuminated

As soon as your ALARM detects these emissions, it will restart its engine and close in on the source of the radar emissions. You can confirm this by watching your missile in the weapons view **F8**, if everything is working like it is supposed to be, you should see a sight resembling Figure 4. At this point, you should also see it as a yellow blip on your DASS.

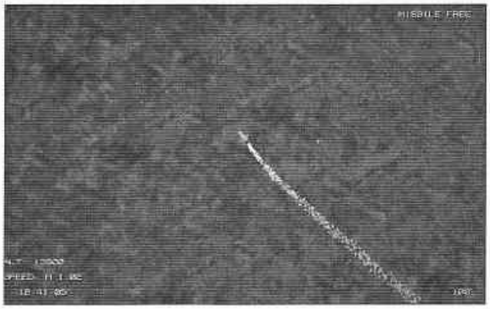


Figure 4: The ALARM becomes active

Now, what to do next? Though you could toggle through the active SAM launchers using the C key and fire your next ALARM, there is a 50 percent probability in this mission that you will target the same SAM launcher that your first ALARM is already latched on to. This demonstrates the main problem of launches in the indirect mode, you trade a shorter reaction time for a loss of control. In a worst-case campaign scenario, an ALARM launched in the indirect mode might go after a SAM site that is abeam or behind you, leaving the ones in front of you where you wanted it to go unattended.

Due to the reasons outlined above, the best thing you can do at this point is to turn 90 degrees (because you do not want to get closer to the SAM launcher than necessary) and wait until your first missile is no longer in the air (hopefully, after hitting the target). You can confirm this by either following your missile in the weapon view or by keeping an eye on your DASS and watching the red cross and the yellow blip merge. The merge indicates that you have just destroyed the first enemy SAM launcher.

For the next launcher, try using an ALARM in the direct mode. Turn back towards waypoint 3 and watch your HUD carefully. At a range of about 28 miles from the waypoint, you should see a box appear next to the diagonal waypoint cross. The next thing that should happen is that a cross overlays the box. That is the ALARM's seeker trying to lock on to the radar emissions. It might fade away once or twice, but will eventually stay in the box. At that point, you have a valid lock and can launch your missile (Figure 5). Notice that this time the missile appears instantly as a yellow blip on your DASS, indicating it is locked on to a radar source.

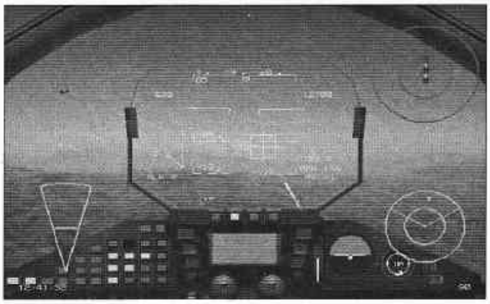


Figure 5: Firing the ALARM with a lock (Direct Mode)

As before, there is no need to close in on the SAM launcher and become a target yourself. Turn until your are no longer closing in and let your missile do the dangerous work (Figure 6). If you have done everything right, the 'Mission Accomplished' message should appear on the screen moments after your second missile has destroyed its target. In campaigns you want to avoid firing your ALARMs in the indirect mode. It is much more effective and

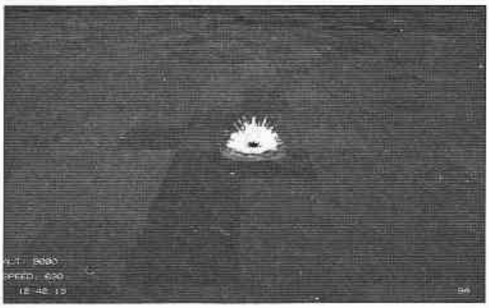


Figure 6: The End of a SAM Launcher

quicker to toggle through the active SAM sites and allocate an ALARM to each one.

Mission 2

The Maverick Electro-Optical or Infrared Guided Missile

Mission Target

Tanks

Briefing

Throughout history, NATO's main opponent, the Warsaw Pact, has always had the luxury of a huge numerical advantage in almost every weapon class, and Main Battle Tanks were no exception. NATO's armies would have been hard-pressed if the task of stopping those tanks had rested exclusively on their shoulders, and therefore it was never in question that aircraft would be tasked to destroy enemy tanks as well. Unfortunately, hitting a moving target with dumb bombs while hugging the ground at 600 knots is not that easy. The need for something more precise became apparent and the Maverick guided missile was conceived.

The Maverick is designed to lock on either the television picture or the infrared signature of its target, and its range against tank sized targets in EF2000 is about 15 miles. Although the real world Maverick is a fire-and-forget missile, the Maverick in EF2000 did not work quite that way until the release of the TactCom or SuperEF2000 upgrade . The missile would only hit if the target did not drift out of the seeker picture displayed on the left MFD while the missile was on route to the target. To ensure this, you would have had to continue to fly towards the target, preferably in a shallow dive, until the missile had hit. Thankfully, this awkward procedure is a thing of the past, and you can now conduct your Maverick attacks from level flight. Still, both versions of the Maverick share the same, somewhat simplified (compared to real world employment) targeting procedure, in which the Maverick will auto-lock on the first suitable target, and you only have to slew its seeker head close to the next target, not exactly on it.

Flying the Mission

At the mission start, you will be at 16,000 feet heading towards waypoint 2. Select the Maverick as your active weapon, advance your active waypoint to number 3 SHIFT W, turn towards it and put the plane in a shallow, -5 degree descent (Figure 7) until you've reached an altitude of about 10,000 feet.

As you close in on the waypoint, you will notice that there is a deep valley just to the right of the waypoint cross, that is were the tanks are hiding. You might want to utilise the time you need to fly to the targets to set up a few things, like zooming the Maverick sight picture (those tanks are awfully small and quite hard to see) and to switch off the Horizon ball. You will notice that the Maverick has apparently already locked on to the first tank (from over 30 miles away), but that you are still out of range. If the aiming cross is hanging on the edge of the display with a dot in the middle of the aiming square, the seeker is locked on to a target that is currently not within the limits of the display. In that case, use the right SHIFT and the cursor keys to slew the picture until the dot disappears. You will find that you will have to make this adjustment constantly to keep the target area in the sight picture.

Figure 7: Heading towards the tanks

As you continue to close in on the targets, you will get the 'In Range' message at a range of about 14-15 miles, even though the tanks are still beyond visible range. At this point, you could start to fire your Mavericks with a reasonable chance to get some hits. Unfortunately, due to the somewhat 'jumpy' way your Mavericks actually lock on to targets, it is rather likely that you will inadvertently target the same tank more than once. With only four Mavericks to take out the four tanks required for the 'Mission Accomplished' rating, you cannot afford to waste a single missile.

So, instead of firing blindly from long-range, you should wait until the tanks are visible (this happens at a range of about 6 miles) to ensure you do not target the same tank twice.

If you have trouble making out the tanks on the valley floor, you might want to adjust the detail setting to Low Detail ALT D, without the textures to hide in, the tanks are readily visible. You can also double the seeker's magnification to make things easier.

When the tanks finally become visible, you will have to work quickly to get all four in one pass (or you could use the pause key and do this at your leisure).

Fire the first Maverick as soon as the tanks appear (since it is already locked on) and use the right SHIFT and the cursor keys to slew the seeker head on to the remaining targets. Due to the 'Jump and Lock' , you have to keep track of which tanks you have already targeted, it is unfortunately quite common that the seeker will jump back on to a tank already served with a Maverick. Do not worry if you do not succeed on your first try, a little practice will get you there (Figure 8).

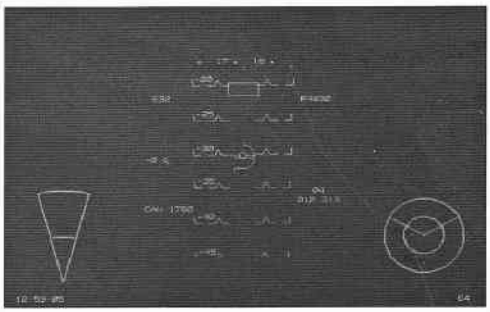


Figure 8

Mission 3

The Laser-Guided Bombs GBU-12 and GBU-16

Mission Target

Mineral Burn Building

Briefing

Although the constantly improving bombing computers of modern fighters enable pilots to drop dumb bombs with remarkable precision, there a few targets where very close is just not good enough, they have to be hit precisely on the spot. Probably the most famous example illustrating the need for this kind of extraordinary precision was the Iraqi headquarters building where a laser-guided bomb was dropped into a 2x2m ventilation opening located on the roof. The bomb dropped through the ventilation shaft and exploded on the ground level, virtually demolishing the building from within. This feat would have been utterly impossible without the help of laser-guided bombs. Although these bombs are effectively nothing more than dumb bombs upgraded with a laser sensor, steerable fins and a guidance package, these additions enable the bomb to detect the laser reflections which bounce off the target and to steer its fall in a way to precisely hit this spot. Dropping the bomb with someone else's laser illuminating the target would be rather boring and therefore, you will always have to self-lase your target in EF2000. And just in case you were wondering why you cannot drop them from the distances indicated in the manual, laser-guided bombs are not powered in any way, and their range is therefore the same as that of their unguided cousins.

Flying the mission

Compared to the first two missions, this is almost a milk run. When you hit the cockpit, you are already almost on top of the target. Just advance the throttle and make sure your plane flies level and in the waypoint's direction. Select one of the two kinds of laser-guided bombs you are carrying, switch your view to the central MFD (Keypad ▒) and activate the TIALD (▒) laser system.

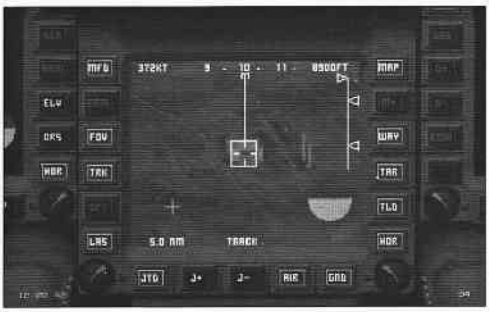


Figure 9: Tracking the target, Laser illuminating it

Because the co-ordinates of your primary target are programmed into your onboard computer, the square target box should already rest on the big building next to the two chimneys on the right side of the target complex. Zoom in to verify this, and if everything is in order, enable the tracking and activate the laser (Figure 9). Unfortunately, computers sometimes do not work as they should and you might find that the target box initially rests quite some distance to the left and above the target (this happens if you replay the mission after destroying the target the first time around). In that case you will have hold down the right shift key and use the cursor keys to slew the target box over the building. When the target box rests on the building, activate both tracking and laser illumination.

Before we proceed, you might take a short peek through the HUD to make sure you are still flying level and towards the target waypoint. The next thing you should focus on is the range scale on the right side of the TIALD display. The two triangles on the right side of the scale denote the range bracket or basket into which the guided bomb has to be released, and the single triangle on the left side represents your plane's position in relation to that bracket. Since you are still a good ways off, the left triangle is locked on the top of the scale, indicating you are still out of range. As you close on the target, it will move down, and you can release the bomb at any time when it is between the two triangles on the right side (Figure 10).

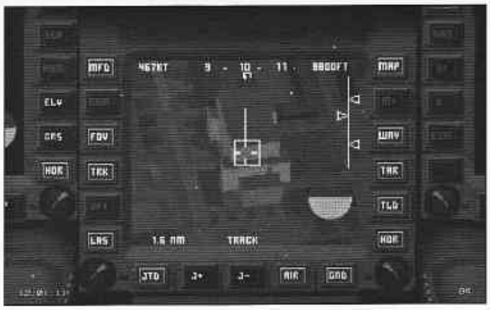


Figure 10: Time to release the bomb

After you have released the bomb, take another peek through the HUD to check your plane's attitude. If everything is okay, you can either watch the TIALD display or follow the weapon to check if it hits. Well, that was not too difficult, was it? In case you have trouble co-ordinating all the mouse clicks, view changes and cursor movements remember that you can always pause the game and take a moment to get your bearings.

Just in case you were wondering about Offset-Tracking (OFT), its necessity is a pure myth. The manual suggests that you would need it for targets where a low contrast would prevent the TIALD from achieving a stable and solid lock. But, since you can even lock on to an arbitrary spot on the ground, it is hard to picture a situation where you could not lock on to a target and would have to use OFT.

Mission 4

The Sea Eagle Anti-Ship Missile

Mission Target

Ships

Briefing

Since before World War II, aircraft have been in the business of sinking ships and although merchant ships are usually undefended and easy targets, fighting ships are normally equipped with an impressive array of defensive weaponry which makes the prospect of flying close enough to drop iron bombs rather unattractive. Anti-Ship missiles allow aircraft to target and destroy ships without coming into the engagement envelope of their weaponry, the aircraft can stand-off and launch its attack from a safe distance. If you want to sink ships in EF2000 without becoming a target yourself, you are going to need the Sea Eagle. With a range of 65 miles, it gives you the means to deliver a meaningful punch while staying reasonably safe.

Flying the mission

In contrast to the other simulator missions, you are still on the ground at your airfield, and while some people might like to fly a distance of 500 miles just for weapon practice, instead press **SHIFT** **S** three times to skip the uninteresting parts. After all, we are here to learn about the weapon, not how to fly long-range missions. Anyway, the three time-skips should have transported you to a point about 70 miles from waypoint 2 (Figure 11).

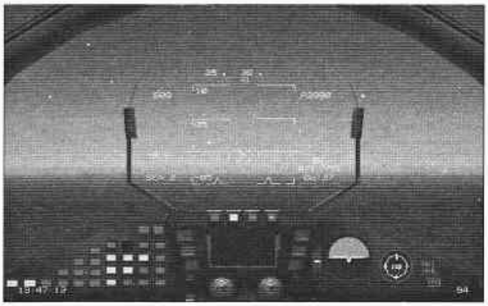


Figure 11: Starting your attack run

Since the enemy ships are near waypoint 3, you should increment your waypoint **SHIFT** **W**, steer toward it and select the Sea Eagle **BACKSPACE**. After a few seconds, the ships will appear on the radar and a target box becomes visible on the HUD (Figure 12).

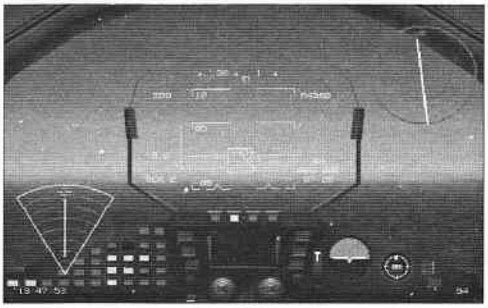


Figure 12: Radar contact

At this point, they are 70 miles away and your Sea Eagle has not locked on to them yet. Continue to fly towards them and at about 65 miles from the ships, the Sea Eagle will lock on to the closest ship, the Slava-class destroyer. The cross that appears in the target box gives you a visual confirmation of that fact (Figure 13).

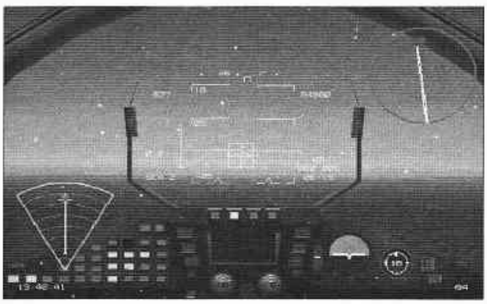


Figure 13: Sea Eagle locked on target

Though the ship is now within the theoretical range of the Sea Eagle, you should wait until the ship is a little closer, preferably within 60 miles and you have dropped to 3,000 feet. You can estimate the range to the target with the help of the arched lines on your radar screen, each represents a 10 mile increment. If the target is within 60 miles, fire the first Sea Eagle and switch your radar lock to the second ship (**C**), the Kirov-class cruiser. Wait a few seconds until it is within the 60 miles limit as well and launch the second missile. At that point, your work is done, you might as well turn around lest you inadvertently fly into the ship's missile envelope. Your Sea Eagles will continue to bore in on the ships, and after about 2 minutes you should hear two explosions and get the 'Mission Accomplished' message.

Dumb Weapons

Although smart weapons are certainly more efficient than their dumb cousins, they are also more expensive. Therefore you will still find plain iron bombs, unguided rockets and a few more golden oldies in the arsenals of modern airforces. As the unflattering 'dumb' designation suggests, the responsibility for success rests squarely on the pilot's shoulders. No matter at what speed, altitude and dive angle you approach the target, there exists exactly one point at which the release of the weapon will ensure a hit. Though the weapon computer helps a little, it remains for you to steer your aircraft towards that point and to release the weapon at the right moment.

Mission 5

The CRV-7 Unguided Rocket

Mission Target

Warehouse

Briefing

In EF2000, the CRV-7 Unguided Rocket is perhaps the most versatile weapon you will come across. Though their effectiveness has been toned down considerably in the TactCom upgrade, they will still take out almost everything, ranging from AAA and SAM launchers up to bridges, hangars and ships, you will just have to use more rockets than before to get the same result. The 19 rockets per launcher still represent a credible punch when you consider that you can carry up to six CRV-7 pods. The rockets are aimed with the help of the HUD pipper. If you point it at the target and it is in range, the rockets will take care of it. The maximum range mentioned in the manual is a little optimistic, if you fire the rockets from 4 miles away, they will run out of steam long before they reach the target, their effective range is closer to 2 miles. That still leaves you with the problem that you have to fly the aircraft in such a way that you are pointing at your target when it is in range. Depending on the target's size, that may be rather difficult at times and in order to hit small targets you will probably need to practice a little. Fortunately, your target for this mission is quite large.

Flying the mission

As usual, you are in the air, inbound for your initial point, waypoint 2. Advance your waypoint to 3 SHIFT W and steer towards it. Try to centre the waypoint caret precisely, it points directly towards the warehouse and the sooner you are flying directly towards it, the better. Adjust your throttle to get a speed around 600 knots and start a shallow descent. As you approach the waypoint, you will notice that the HUD

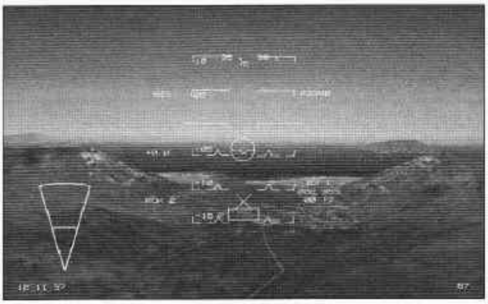


Figure 14: Lining up for the rocket attack

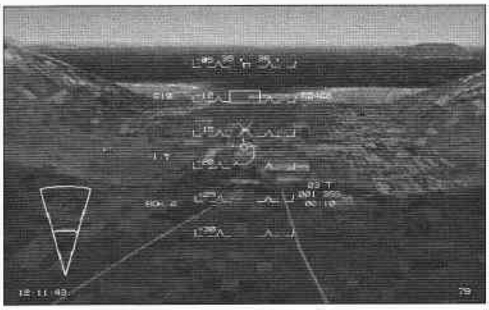


Figure 15: Initiating the attack

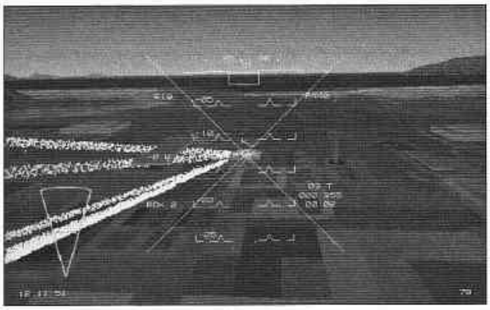


Figure 16: Rocket salvo on its way

displays a cross over your target, line up on it as precisely as possible (Figure 14). The Eurofighter's navigation computer overlays the position of every waypoint with an X on the ground and if you are attacking fixed targets as in this mission, the X for your target waypoint is smack on your primary target.

When you are about 3 miles from the target, push the nose down to put the pipper below the target, you want to be all set up when the target comes into range (Figure 15).

Though placing the pipper below the target may not make sense at first, it has the advantage that as you come in range, you will pull the nose up to put it on the target, thereby shallowing your dive angle. In addition, it is harder to push the nose down and it would take longer to correct your aim than the other way around. When the pipper rests squarely on the target and the range clock has started to run down counter-clockwise (indicating you are in range), commence firing the rockets. Due to their reduced effectiveness, you will have to salvo at least ten rockets into the building (Figure 16).

By now it is high time to conclude the attack and pull up, lest you join the carnage on the ground. You do not have to watch your rockets all the way in, use the check six view F3 for Battle Damage Assessment (BDA).

Mission 6

The BL-755 Cluster Bomb

Mission Target

Small ships

Briefing

As you have probably noticed during the last mission, it is actually quite difficult to hit something as big as a warehouse. Smaller targets obviously present an even greater challenge and if they are somewhat randomly distributed over a wider area, the task of hitting them all precisely borders on the impossible. Fact is that most small targets do not even need a big knock-out punch, a small amount of ordnance is usually enough to do the job. The BL-755 Cluster Bomb has been developed with these thoughts in mind. Instead of delivering a big punch to one place, its submunitions spread out and explode all over the place. In EF2000, you can use the BL-755 to take out SAM launchers, AAA, aircraft and even small ships. It is usually delivered in a low-level (preferably between 150-200 feet), high speed bombing run to ensure its submunitions will spread over a wide area. To aim this weapon, you are going to use a weapon computer sub-mode called Continuously-Computed-Impact-Point (CCIP). It will display a small horizontal mark across a longer, vertical bomb fall line. The intersection between those lines represents the point where your bomb would impact if you would release it right now. Though this is a marked improvement over the times where such a release mark only existed for one speed, one altitude and a specific dive angle, it is still up to you to fly your aircraft in such a way that the release marker will come to rest on the target during your approach.

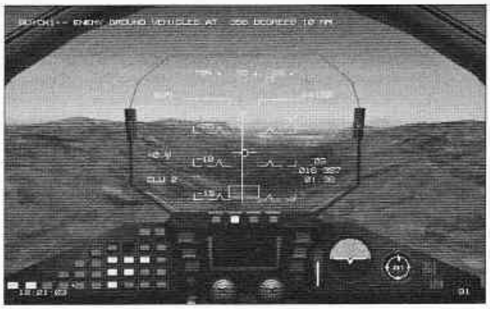


Figure 17: Heading for the valley's left side

Flying the mission

Your target for this mission is a column of three small ships that have just left the harbour and which are heading due north. The harbour itself should look familiar, you have already visited it to destroy the warehouse. The easiest way to ensure a hit on a ship is to pass over its whole length from bow to stern, so you want to start your alignment with your targets as soon as possible. As you come into the valley that leads towards the harbour, fly on the left side of it and try to loose as much altitude as you dare (Figure 17). The goal is to arrive at the harbour at an altitude of about 200-300 feet.

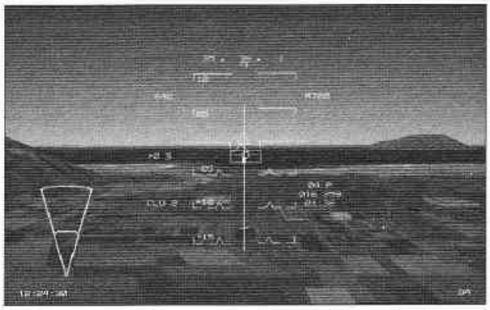


Figure 18: Alignment looks good

As you go for the deck, you should already be able to make out our targets in the distance, but do not fly directly towards them, continue to fly towards the valley's left side. Delay your turn towards them until the bearing is due North, this should give you the perfect alignment for your attack run. If things look like Figure 18, you are set for the bomb run.

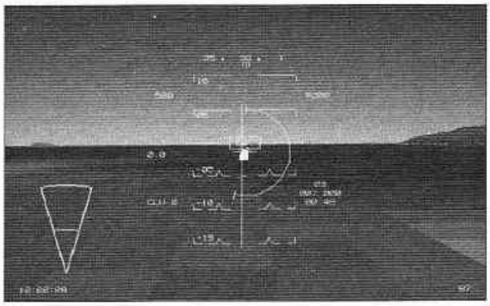


Figure 19: Ready to release the bombs

Note that in this picture, the altitude is still a little high, the preferred attack altitude is 200 feet. Figure 19 shows how things should look moments before you will release your first bomb.

The Mission calls for the destruction of two of those three ships. If you want to play it safe, you should

Figure 20: Just like it should be

release each bomb when the release marker (the small horizontal line that crosses the bomb fall line) is smack in the middle of the ships. But since you are carrying bombs which distribute their load in a rectangular pattern, you can get all three ships with two bombs. Delay the release of the two bombs until the release marker is just short of the bow of the first and the second ship, respectively. If the timing was right, your check six view should look like Figure 20.

Mission 7

The Mk-83 bomb

Mission Target

Mineral Burn Building

Briefing

Although Laser Guided Bombs are much more precise than their unguided ancestors, they are also more expensive and their use is therefore usually reserved for high-value targets or targets where avoiding collateral damage is paramount. For the more mundane targets, the plain old Iron Bomb is still used today and thanks to the sophisticated weapon computers found in fourth-generation fighters, they can be delivered with a lot more precision than before. For the delivery of these bombs in EF2000, you will use the same CCIP mode as with the BL-755 and we will even use the same level delivery method as with the BL-755. Although EF2000 does not model blast damage by your own bombs at the moment, we will use the 2,000 feet lower limit for this delivery. After all, it is still possible DiD will implement it in a future patch.

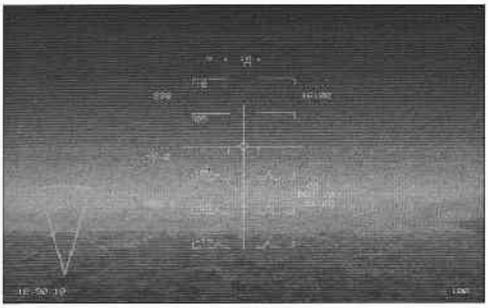


Figure 21: A familiar sight

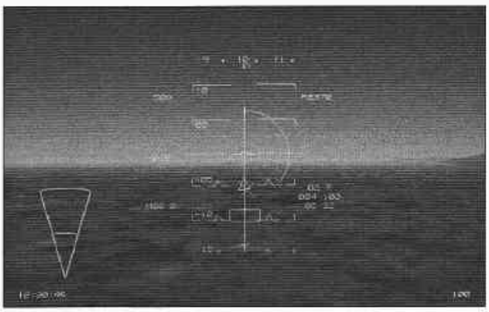


Figure 22: Everything set for the attack

Flying the mission

The target for this mission should be familiar, it is the same building you already destroyed during the Guided-Bomb exercise. Since it is a rather big building, a Mk-82 will not do the job, select the Mk-83 as your active weapon **BACKSPACE**. You start at the same point as during the GBU mission, at 16,000 feet, 7 miles from the target (Figure 21)

Since the Mk-83 bomb should be released from around 2,000 feet in the level release mode, you need to loose altitude real fast. Chop the throttle, roll the plane through 180 degrees, pull on the stick until you have attained a dive angle of 70-75 degrees and roll the plane right side up. When you pass through 5,000 feet, pull back on the stick to pull out of the dive. The goal is to arrive at an altitude between 2,000-2,400 feet when you are about 4 miles from the target (Figure 22).

Do not forget to throttle-up again, though no one shoots at you during the training missions, you do not want to become used to delivering your bombs at speeds of less than 500 knots, this is positively unhealthy during campaigns. As you continue to close in on the target, make small heading corrections so that the vertical bomb line always runs through your target. You will notice that the release marker slowly creeps up towards the target as you draw nearer. If you do not see the release marker, you are flying too high, in the HUD-only view it becomes visible when you are at an altitude of less than 2,400 feet, if you are flying above that altitude, get down. At the moment the release marker crosses the target, release the bomb (Figure 23).

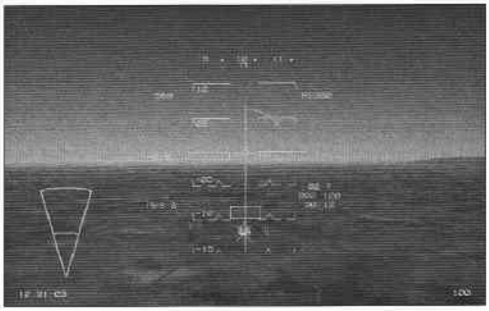


Figure 23: Bombs away

Mission 8

The Durandal Anti-Runway Bomb

Mission Target

Runway

Briefing

Compared to fighting the enemy's aircraft in the air where they might get lucky and shoot down a few allied planes, it would be preferable if they were denied the opportunity to come up at all. Since most fighters still need an even stretch of concrete to get airborne, destroying the enemy's runways fulfils this requirement quite nicely. Unfortunately, runways are rather hard to destroy. If you just put a few ordinary bombs on them, the resulting, holes are easily patched up. The Durandal Anti-Runway Bomb solves this problem. Though a dumb bomb as far as the delivery is concerned, it is not exactly simple in the way it goes about its business. After release, a parachute deploys to slow it down and to ensure that it points down. Then a rocket motor fires and drives it straight down, through up to 400 mm of concrete. Only then does it explode and the resulting hole is much larger since the explosion occurs virtually within the runway's foundation. In EF2000, you will use the CCIP delivery mode you should be familiar with by now to ensure it will hit in the place you want.

Flying the mission

Bombing runs rarely get easier than this. When you hit the cockpit, you will find that you are already

Figure 24: Almost too easy

perfectly aligned with your target runway and just a little too high (Figure24).

Select the Durandal as your active weapon, push the stick to get down and open the throttle to 100 percent. You should get used to flying at very high speeds when you are near enemy airfields, even more so when you are in the process of bombing them. They are virtual nests of SAM and AAA, and you should avoid both if you are interested in a long and successful career in EF2000. Level off when you get below 500 feet and continue to make small heading corrections to stay aligned with the runway. In case you are wondering, the weapon computer takes the diverging trajectories of the different types of bombs into account and adjust the height at which the release marker becomes visible accordingly. For the Durandal, you will have to be below 500 feet in a level attitude to see the marker. If you've done everything right, you should see a sight resembling Figure 25.

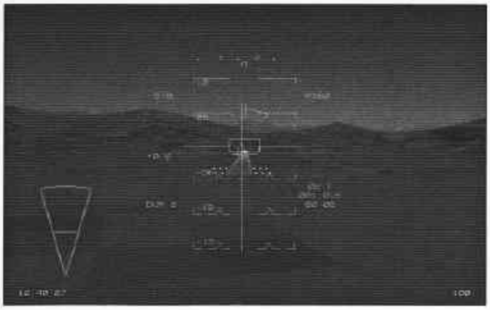


Figure 25: One more second...

As soon as the release marker crosses the runway threshold, feel free to release the first Durandal, and to give the enemy's runway repair team a proper workout, repeat that process a few hundred feet further down the runway.

Conclusion

Well, that should not have been too difficult. Hopefully, you have been rather successful in the preceding missions and have chalked up a number of destroyed ground targets. But even if you had a little trouble delivering some of the weapons, you do not need to throw in the towel just yet. First of all, these things do get easier the more you practice them and secondly, you do not need to be proficient with each and every weapon. In EF2000, each target can be destroyed with a variety of weapons and as long as you are deadly with most of the A2G weapons, you will probably do fine.

Part II

Advanced A2G Combat

Advanced Targeting

As you may have gathered from this section's title, there are still a few things to be learned about A2G combat. But, since the procedures you have used so far constitute the foundations for the things we will take a closer look at, you should have a solid grip on the basic targeting procedures before you proceed.

One of the first things we will do is to take a look at some alternate delivery methods for the Iron bombs, the Mk-82 and Mk-83. If you are not a 100 percent comfortable with the level release mode or the CCIP HUD symbology yet, go back to the appropriate training missions to get up to speed.

During the Iron Bomb training missions, you have probably noticed that the release marker passes awfully fast over the target, you have got to have your timing for the release wired pretty good, otherwise, you will probably get long or short rounds quite often.

Though reducing your speed during the bomb run would give you a longer duration in which the release marker rests on the target, this would also make you a slower and hence, easier target, and the AAA crews would probably express their gratitude by blowing you out of the sky, so slowing down is definitely not an option. But still, there is a way to improve your accuracy without becoming a target.

Dive Bombing

The answer is dive-bombing. Though most people probably associate the Ju-87 Stuka and hence, World War II, with this type of bomb delivery, it is neither outdated nor has it been an exclusively German technique at any time. The Japanese learned to fear the American SBD Dauntless dive bomber at Midway, and the Allied forces used dive bomb attacks from medium altitudes with success during the Gulf War.

So, how does dive bombing improve the accuracy? It is simple, dive bombing reduces your apparent speed over the ground, giving you a

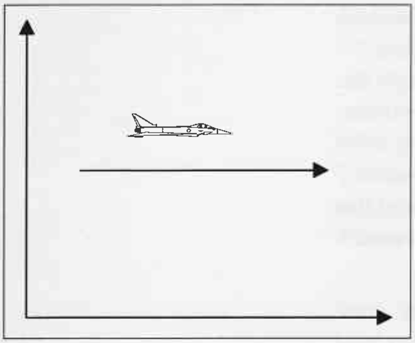


Figure 26

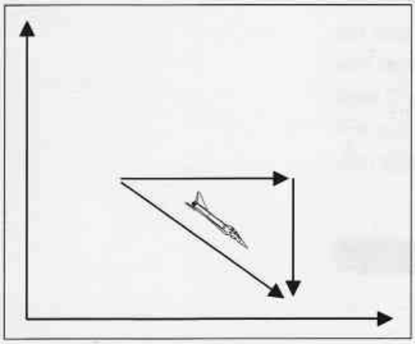
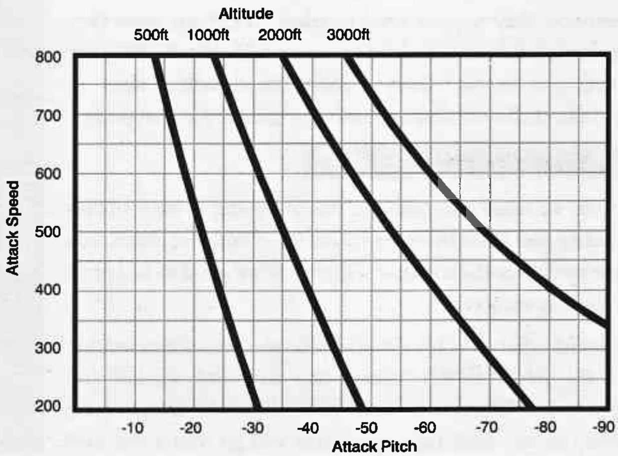


Figure 27

longer time to aim for and to release your weapon on the target. To go slightly mathematical on you for a moment, consider your aircraft and the velocity vector that represents its forward speed. When you are flying level, your velocity vector is parallel to the ground and this is reflected in your ground speed (Figure 26).

As you push the nose down and angle your flight path out of the horizontal plane, you split your velocity vector in two components: a horizontal component which represents your speed over ground and a vertical component that represents the speed at which you are approaching the ground (Figure 27). As you can see, the length of the horizontal component is less than the length of your original velocity vector, and you are therefore flying slower with regard to the ground. If you take that example to the extreme, imagine a dive angle of 90 degrees. You would have no forward velocity at all, and your time to aim the bomb would only be limited by your desire to avoid following your bomb into the target. This is actually the reason why very steep dive angles (greater than 60 degrees) are a little problematic. You approach the ground so fast that your time to line up is significantly reduced compared to medium (30-50 degrees) or shallow (less than 20 degrees) dive angles because you have to start your pull-out manoeuvre earlier. As you may have noticed, Nagging Nora is usually a little nervous when it comes to diving and starts to scream 'Pull-Up' quite some time before it is absolutely necessary to abort your dive. The chart below gives you the real minimum altitudes at which you have to pull out of your dive.

Minimum Pullout Altitude



As you can see, the altitudes in this table are significantly below those at which Nora starts screaming, and you will usually loose about 3-4 seconds when you pull-up as soon as Nora suggests it. Though this means that you have significantly more time to line up and to release your bombs than Nagging Nora implies, you should keep in mind that these low altitudes place you smack in the middle of the enemies' AAA envelope, which reaches up to 6,000 feet. So, to stay out of that envelope as well as avoiding the ground, you should add 6,000 to each of the altitudes you derive from the table above.

Why did we not tell you about dive bombing in the first place? Because, executing a dive bomb attack is more difficult than level bombing. You have to co-ordinate a few more things to initiate it and the whole purpose of the previous chapter was to ease you into the 'blowing things up' business. Actually, the roll and pull down you used in the level bombing to get down fast is a technique you will need again for dive bombing, but compared to the level bomb run, you will have considerably less time to correct line up errors. But enough talk, time for another sortie.

Mission 1

Dive Bombing Delivery of the Mk-83 and -82 Iron Bombs.

Mission Target

Mineral burn building

Briefing

For this hop, we will use the Simulator Training mission for the Mk-82 again. Actually, we are going to use it twice, because we will practice dive bombing attacks with both medium and shallow dive angles. Though the former offers greater precision, they require good weather conditions since they are initiated from an altitude around 15,000-20,000 feet. Since you cannot always count on cloudless skies in EF2000, shallower dive angles come into play at that point.

Flying the mission

Before we enter this mission, you are going to have to play weather god first. In order to get the clouds we want, you have to change the weather selection from good to bad prior to clicking on accept.

As usual when you hit the cockpit, select the right weapon for the job (Mk-83), centre the waypoint marker and throttle up. When you are 7 miles from the target, push gently on the stick (otherwise you will go into a red-out) until you are in a shallow dive of about 15 degrees. Though

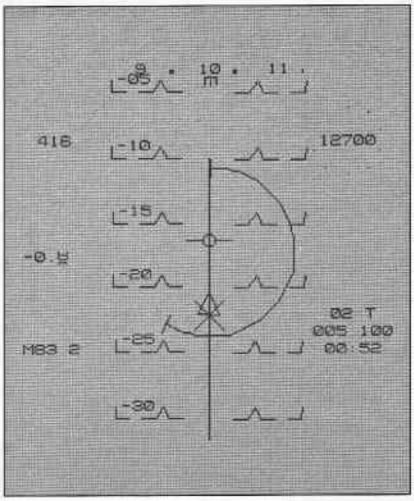


Figure 29: IFR Bombing

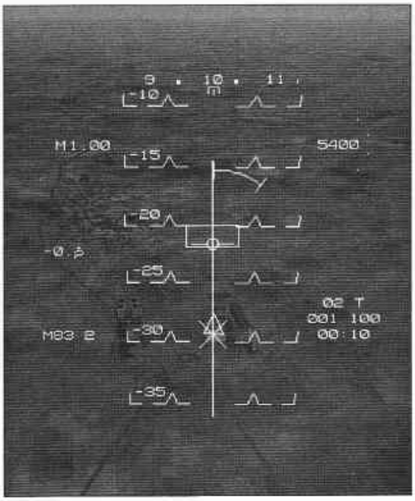


Figure 30: Now would be a good time to release the bomb . . .

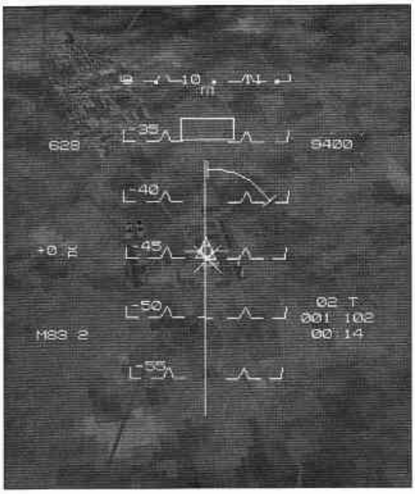


Figure 31: Target centred

you will not be able to make out the ground yet, you should see the X that marks the position of the primary target. Correct your line-up so that the vertical bomb fall line runs smack through it (Figure 29).

If you have trouble reading the HUD against the white background, you should change the HUD colour (U). Hold your attitude until you have broken through the clouds and can make out the target. When you have a visual on the target, push again gently on the stick until your dive angle is between 20 and 25 degrees. That should have brought the release marker into the HUD. Concentrate on keeping the target centred and fly the release marker onto the target (Figure 30).

As you have seen, the shallow dive angle has given you enough time to acquire the target visually and to correct your line-up after you have broken through the clouds. Okay, you cheated a little and used the waypoint X to line up without having the target in sight, but remember it only marks your primary target. When you want to attack additional targets in the vicinity of the primary target, you need to eyeball them, and steeper dive angles will not give you enough time to accomplish that with a cloud base around 9,000 or 10,000 feet.

The second time around, you will practice medium dive angles (between 30-55 degrees). When you hit the cockpit, select the Mk-83, correct your heading so that you are flying precisely in the direction of waypoint 2 and throttle up. When you are 3 miles from the target, roll the aircraft through 180 degrees and pull back on stick. Continue to pull until you have the target in sight and it rests between the -45 and -50 degrees pitch marks on your HUD. At that point, roll the aircraft upright again. Due to the high angle of attack you built up through the quick pull on the stick, the velocity marker will probably rest slightly beneath the target, just like it should be. All that rolling around may have messed up your line-up a little, so make the necessary corrections to bring the bomb fall line over the target again (Figure 31).

If your line-up is off by a somewhat greater margin, you probably did not roll the plane through exactly 180 degrees before you pulled back on the stick and you have therefore not only pulled down but to one side as well. There you have it, the secret for a well executed diving attack is an exact half roll. If you are satisfied with your line-up, you can now either just wait until the release marker comes to rest on the target or you can pull back slightly on the stick to accelerate that process. If you initiated your attack from about 15,000 feet, you should be lined up and ready to release at around 9,000-10,000 feet. At this point, you have two options. If the target is heavily defended by AAA, pull up to stay above its engagement envelope of 6,000 feet. If things look quiet enough and you have become proficient in lining up, you might try to get another target on the same pass. If your next target is close by, another 1,000-2,000 feet of altitude should do the job, but if your targets are somewhat scattered, you should figure in an altitude reserve of about 4,000-5,000 feet to allow enough time to line up properly on your next target. If you want to make a habit of hitting multiple targets in one pass, you should adjust your run-in heading so that those targets are roughly on the same bearing. That way, you can actually flatten your dive angle as you line-up on your secondary and tertiary targets, whereas if the targets are distributed perpendicular to your flight path you would have to maintain or even increase your dive-angle.

Strafing – when nothing else is left

One quite effective A2G weapon is sadly neglected in the manual, it is your onboard Mauser Bk-27mm cannon. It is very effective against ground mobiles like AAA, SAM launchers or parked aircraft and although it is difficult to hit such small targets, strafing can help make your visit to an enemy airfield quite successful even when you only connect with a small percentage of your 1,760 rounds. One of the small targets you will see quite often in EF2000 are SAM launchers and if you want to make ground attacks safer for your wingmen, you should try to take out as many of them as possible before the rest of your flight arrives. To practice it, we will take a second look at the ALARM Weapon Simulator mission, but this time, we will do it the hard way.

Mission 2

Strafing ground targets with the Mauser Bk-27mm Cannon

Mission Target

SAM Launcher

Briefing

For a successful strafing run you need two things: a steady hand on the stick and the same HUD A2G mode you have already used with the CRV-7 Unguided Rockets. In case of the SAM launchers, you will also learn to appreciate your ECM equipment, it will make the hazardous business of flying close to the SAM launchers considerably safer, but you should keep in mind that its effectiveness has been toned down in the TactCom release. In the earlier versions, an activated ECM pod was a magic shield as far as radar guided threats were concerned, nothing could penetrate it. Though this was quite comforting, it was not exactly realistic. In the current release, the ECM will render most radar guided threats harmless, but you will get the occasional leaker which will kill you if you are not prepared for it. SAMs are more dangerous in this regard, you will get more leakers and they are also more deadly, one hit may be enough to kill you.

When a radar guided missile has been fired on you, consult your missile padlock. Do not rely on the DASS to tell you which missiles have been spoofed, the flashing is not a reliable indicator. The best way to determine whether a particular missile is tracking you or not is to look for a bearing change. If you are not manoeuvring and the bearing to the missile does not change (the missile seems to stay at the same place on your canopy), it is still tracking you. In this case, it is time to demonstrate how much you remember from the missile evasion section.

Flying the mission

Since you have already flown the mission, you will probably remember where the SAM launchers are, but just to be on the safe side, they are in the vicinity of waypoint 3, slightly to the right of it. Therefore, as soon as you hit the cockpit, advance your waypoint to number 3, throttle up and get down to around 3,000 feet. Since ground targets are easier to recognise when they do not have textures to hide in, you might also want to set the detail level to low, and do not forget to switch on your ECM equipment.

About 5 miles from the targets push the nose slightly down to enter a very shallow dive with a pitch between -5 and -10 degrees. Adjust the throttle to get a speed of around 600 knots, preferably a little faster, but definitely not slower. In campaigns, AAA is usually positioned in close proximity to the SAM Launchers, and one of the best ways to avoid getting hit by AAA is to fly above 600 knots. The targets should become visible at about 3 miles. At that point, select one of the three SAM launchers, steer towards it and put the pipper below it (Figure 32). The middle and right launchers are the ones the program has tagged as mission targets, if you destroy them as the first two, you will get the 'Mission accomplished' message and the 'End Mission' menu, so you should select the left launcher as your target on the first or second pass.

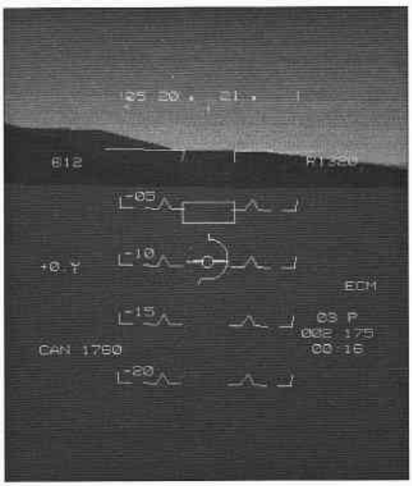


Figure 32: Lined up, closing the range

If you have trouble making out the target, you might want to darken the HUD colour, the darkest setting is the least distracting during strafing runs. In case you happen to fly such a ground attack mission during the night, you should remember to activate your night vision goggles V, they will make the task of detecting those small targets at night considerably easier. But back to the current attack, when the range clock reaches its halfway-mark, pull up, place the dot in the middle of the HUD pipper squarely on the target and commence firing. Due to the fact that the small targets are almost hidden by the HUD symbology, you will have to of fire blindly at that point. Continue firing until either the target blows up or you are uncomfortably close to the ground. As mentioned earlier, Nagging Nora usually starts complaining a little early. In shallow dives, you can safely continue your approach for a few more seconds after the first 'Pull-Up'. After you have pulled up, use the view to check the position of the remaining SAM launchers in relation to the one you (hopefully) just blew up and whose smoke column should make the line-up for the subsequent attack on the second launcher a little easier. Extend until you are 3-4 miles away, keep your speed up and your altitude between 2,000-3,000 feet. When you commence your turn for the second run, engage the afterburner and do not pull too hard on the stick. You should avoid bleeding off too much speed, apart from the danger of flying to slow in the neighbourhood of AAA (not in this particular case, but we do not want to form habits that might be unhealthy later on), the Eurofighter has a tendency towards nose-snap-backs when the speed is below 400-450 knots and you centre the stick after a hard turn, which might complicate your line up unnecessarily. Continue to work on the targets until you have destroyed them all or have run out of cannon rounds trying.

Should you get fired upon while you are conducting your strafing run, you obviously have to honour the threat lest you become a great ball of fire. Since you are already close to the ground, the easiest way to dispose a of missile closing on you is to induce it to fly into the ground. Remember, all missiles in EF2000 fly lead pursuit trajectories (meaning they are aiming at a point where you are going to be in a little while), so a slight pull-up immediately followed by half-roll and a somewhat sharper pull towards the ground should place that intercept point below the earth's surface. A SAM trying to meet you there will most certainly meet something more solid than air molecules before it gets there. Naturally, you should not become so engrossed in inducing the SAM to fly into the ground that you auger in yourself, so do not forget to level out again.

Targets and selecting the right tools for the job

By now, you should have a solid idea how to deliver ordnance on the target. In this section, we will take a closer look at which weapons will destroy a given target, how to improve your chances for survival through careful weapon selection (for the psychotic as well as for the thinking man) and how to maximise the damage you can inflict on the enemy.

The first thing you need to know when you have been assigned a given target is how much of what kind of ordnance will be sufficient to destroy that target. The following tables give you that information for the general-purpose ordnance in EF2000. The bracketed number behind the weapon's designation is the maximum number you can carry on your Eurofighter. Because of the significant differences between Pre-TactCom and Post-TactCom values, both tables are shown.

Table 1: Pre-TactCom

	CRV-7 (76)	Mk-82 (7)	Mk-83 (4) / BL-755 (5)	GBU-12 (7)	GBU-16 (4)
Target Class 1: Mobiles, Runways	1	1	1	1	1
Target Class 2: Small Buildings, Headquarters, Oil Containers	2	1	1	1	1
Target Class 3: Medium and Large Buildings, Bridges, Tunnels, Chimneys, Cooling Towers, Hangars, Bunkers, Ships	4	2	1	1	1
Target Class 4: Hardened Aircraft Shelters (HAS)	6	2	1	1	1

Table 2: Post-TactCom

	CRV-7 (76)	Mk-82 (7)	BL-755 (5)	Mk-83 (4)	GBU-12 (7)	GBU-16 (4)
Target Class 1: Mobiles, Runways	1	1	1	1	1	1
Target Class 2: Medium and Large Buildings, Bridges, Tunnels, Chimneys, Cooling Towers, Hangars, HAS, Bunkers, Ships, Small Buildings, Headquarters, Oil Containers	10	2	3+	1	1	1

As you can see, it has become rather more challenging to destroy things in the TactCom version. As if it was not enough that the CRV-7 and the BL-755 have lost quite a bit of their lethality, the small targets now need a bigger punch as well. So, in case you were wondering why you could not kill as many additional targets as before, that is the reason. These changes make your job more difficult, but, they do reflect reality a bit better than the rather optimistic damage values of the Pre-TactCom versions, especially in case of the BL-755, which is now virtually useless against anything but soft and small targets. It is still the first choice if you have to take out greater numbers of mobiles (AAA and SAM launchers) and since the enemy has a habit of parking its aircraft in neat rows in front of their hangars, you can probably take out more aircraft with a couple of cluster bombs than with a full complement of A2A missiles.

But, back to our main topic, weapons selection. With a maximum of seven hardpoints for light A2G ordnance (Mk-82, GBU-12, ALARM, Durandal). You only have four or five hardpoints for the heavier pieces (CRV-7, GBU-16, Mk-83, BL-755, Sea Eagle). With no provisions for multiple ejector racks, the number of A2G weapons you can carry on the Eurofighter is somewhat limited. In order to judge the different A2G weapon's efficiency, we will have to take into account how much you can carry of each type and how many you need to destroy a given target.

At first sight, the GBU-12 looks quite promising. It will give you a maximum of 7 destroyed targets, one for each hardpoint you use. On the other hand, this would leave you without hardpoints for fuel, ALARMs or additional A2A missiles. It will also need one A2A missile slot for its illuminator. Aiming guided bombs is in itself a somewhat complicated process, which is not particularly appropriate for use against targets of opportunity, as it is usually quicker and easier to drop a 'dumb' bomb.

There is no such thing as the one-for-all anymore. Before TactCom, you could just load up with rockets pods and be certain to take out a lot of almost anything that was out there. Now, you will probably be better off to be prepared for anything, carrying a mix of A2G weapons that will suit your 'best-guess' of what the situation at the target will look like. But do not worry, we will show you a few ways to improve your odds.

Weapon loads for the thinking man

You are convinced that your prime objectives are: getting to the target, destroying it and getting back. You have listened carefully to the briefings telling you about the foolishness of making repeated passes over a well-defended target and do not really like scraping the paint of your plane's belly whilst making low-level rocket attacks. You know that one bomb of the right type will take out the target, and that you have done your job as soon as that objective is achieved.

If some or most of the above passes through your mind when you look at the armament screen prior to takeoff, you definitely belong into the 'thinking' category.

You will take a look at your target, select your favourite weapon to take it out and make sure you will get there and make it back, even if your escort and wingmen screw up and you will have to do it all by yourself. That means using 2 of the 4 'heavy' hardpoints for your primary armament, taking a centre-line fuel tank to extend your range and to enable you to fly low-level for a considerable distance to take advantage of terrain masking. Add 2 ALARMs in case you do not have a Wild Weasel flight scheduled or are not convinced they will do the job and mount 2 additional A2A missiles of your choice. With that package, you will have a reasonable chance to defend yourself against ground-based and airborne threats en-route to the target, to get the job done when you get there and to make it back.

Weapon loads for the psychotic man

You have taken a look at the chart displaying those big red circles denoting enemy SAM coverage, noticed the reports about the numerous enemy CAPs circling the target area and have not been all that impressed by the support you have been getting from your various escorts and wingmen. In short, you are convinced that reaching the target is a dubious undertaking at best and that making it back to base falls into the realm of rather optimistic fiction. Despite all this, you are still loyal to your fellow flyers and even if you will not make it back, you feel that you should take out as many enemies as humanly possible to make it easier for the next poor fellow who has to risk his life.

Even if you will not make it home, a lot of enemies will not make it either. Additional fuel? Why bother, the fuel in the internal tanks is more than enough for the one-way trip, the fuel tank(s) are just a waste of precious hardpoints anyway. Your ECM equipment will probably reduce the effectiveness of the enemy's SAMs enough for you not to get shot down by one, enemy interceptors pose a much bigger threat, but 6 AMRAAM's and 2 ASRAAM's will probably take care of the first 2-3 waves of enemy fighters. Since most if not all your wingmen will be gone after the first waves of enemy CAPs, 4 Mk-83s will give you a big enough punch to take out your own as well as your wingmen's primary targets. Since the enemy will have probably taken the time to amass legions of AAA and SAM launchers at the target area to take you out, a BL-755 carried on the underbelly hardpoint and placed smack in the middle of all those green dots should be enough to show that you do care. By the time you have delivered all that ordnance, the next wave of enemy fighters will have arrived, but perhaps you can take out one or two with your cannon before a lucky IR missile finally gets you...

Weapon loads for the 'thinking psychotic'

You are neither comfortable with the thinking nor the psychotic approach? Granted, the enemy's capabilities are nothing to joke about, but they are not ten feet tall either. There is a fine line between being dangerous and being foolish. The difference is knowing when to call it a day and head home as well as a weapon loadout which makes both coming home and wrecking havoc possible. Starting with the basic loadout of two ASRAAMs and four AMRAAMs, we will look at how to use the remaining seven hardpoints to achieve both goals.

Although you can only mount the smaller A2G weapons on it, the central hardpoint will take the biggest external fuel tank there is and it would therefore be a waste to use it for anything else. No matter how close or far the target is, additional fuel gives you tactical options like flying low, taking a longer and safer route to the target or engaging the afterburner for a prolonged time to make a sharp exit.

No matter how much pounding the enemy has already taken, you will not find such a thing as an undefended ground target. There will always be a few SAM launchers around, but a pair of ALARMs will help to reduce the threat from that direction. Enemy fighters are another big threat to your continued well-being and you'd therefore be rarely wrong to use 2 hardpoints for additional A2A missiles.

With only two hardpoints remaining, you should select a weapon that will take care of your primary target as well as enabling you to take a shot at an additional target as well. This weapon would be one of the big-punch bombs, either the Mk-83, GBU-12 or GBU-16, or, in case of ships, two Sea Eagle Anti-Ship missiles.

The careful consideration of when it is safe to stay and when it is high time to bug out is the main difference between the thinking, the psychotic and the thinking psychotic approaches. When you have taken out the primary target, take a look at the tactical situation. If the sky is filled with AAA tracers, or the next wave of enemy fighters is barely out of missile range, it is time to call it a day and leave. If not, you might want to take the time to make a few additional passes and distribute the remainder of your armament. Keep your speed up so the AAA will not hit you and watch your JTIDS display very closely, if enemy fighters close in and you are low on A2A missiles, discretion is the better part of valour. The same is true if you start to take AAA damage, do not wait until one or both engines are on fire before getting out.

Getting there – Avoiding the enemy's attention

In the preceding sections, we have concentrated on targeting procedures and selecting the right weapons for the job, presuming that you would always reach the target unmolested. Unfortunately, things are not quite that easy in EF2000's campaigns and advanced simulator missions. You have to come to terms with two kind of threats along the way, enemy fighters and SAM sites.

SAM sites have, from your point of view, two distinct advantages compared to enemy fighters - they do not move, and your ECM equipment will reduce their effectiveness quite a bit. That does not mean you should go looking for trouble by overflying them on purpose, it is your responsibility as a flight leader to give your wingmen a chance to get to the target. Use your JTIDS display to plot the safest route for your flight, you should avoid flying closer than 30 miles to enemy SAM sites, that will give you healthy safety margin. If you cannot avoid passing close to an enemy SAM site, order your flight into echelon formation, get down to low level and use terrain masking. Fjords and deep valleys (those where the streets and railway lines are in, depicted as brown lines on your moving map display) are extremely well suited to hide your flight, and even if the enemy manages to pop a missile in your direction, you just need to bring a mountain between it and you to break its lock.

If you are carrying ALARM anti-radiation missiles, you also have the option of simply destroying the SAM sites along the way. While this may sound rather attractive to the more psychotic pilots, it will probably leave you with the problem that you will have nothing left by the time you get to the target and meet the SAM launchers you cannot avoid.

Speaking of things you cannot avoid, apart from the SAMs around the target area there is also the matter of enemy fighters. In terms of how dangerous they are for you, they can be broadly divided into two categories.

For the first category, enemy escorts or the strike flights themselves, the basic rule 'If you don't bother me, I won't bother you' applies, though the escorts seem to regard even passing close as threatening behaviour and will attack you when you come closer than what they rule as a safe distance, which is usually around 30-40 miles.

The second category, enemy CAP flights and, in case you go after their airfields, scrambled alert fighters, exist solely to make your life miserable, and as long as you insist on trying to destroy the target, they will eventually detect and come after you.

Since it is impossible to completely avoid fighters of the second category, we will take a look at how to avoid those who fall in the first category. As with the SAM sites, your most valuable tool is your JTIDS display. Apart from some unfortunate exceptions where the terrain makes early detection of enemy strike flights impossible, it gives you an early enough indication of possible trouble. Enemy strike flights are colour coded as completely red 'sperms', and their escorts are orange, the same as yours. If you detect such a combination, watch

them closely and extrapolate their route. If you reckon that they will come closer than the aforementioned distance of 40 miles, you should adjust your flight's flight path to avoid that meeting and pass at a safe distance. As with SAM sites, terrain masking works in this case as well, but if no fjord or deep valley is handy, you should not try it. The enemy fighters need just one whiff of you, either visually or on radar to become extremely paranoid and come after you. A small break in the mountainside you are using to hide from them is enough to give them that small whiff - in short, it is a lot easier and safer not to get too close to them in the first place.

That does not sound exactly 'gung-ho', does it? Certainly not, but when you fly a fighter that is loaded to the gills with fuel and A2G ordnance, 'gung-ho' is not the attitude compatible with that load. Even if your opposition is just an unescorted strike flight, you will probably be wasting missiles you will sorely miss when you meet the fresh and relaxed enemy CAP over the target.

Welcome to the real pain, CAP flights. Especially in the early stages of a campaign, they usually consist of four Class-1 fighters each (presuming you use the higher difficulty settings, with the lower settings, you might get the easier targets earlier), and are rarely found cruising all by themselves, it is much more likely to find at least two, one circling one of your ingress waypoints and a second smack over the target.

CAP flights will detect you when you come within 65-70 miles, and it does not make the slightest difference if you are flying in low earth orbit or are scraping the paint on your aircraft's underbelly at that point, terrain masking simply does not work against these guys at close ranges, though a low-level approach will help you to avoid long-range CAP intercepts (they sometimes get vectored to your position from 200 miles away).

Since there is no way in EF2000 to destroy a ground target from 70 miles away, you will have to at least remove the CAP over the target. As soon as the first CAP detects you, it will spread the word and the other CAP flights will head towards the fight. The best you can hope for is that you have finished off one CAP before the next joins the fight. In order to minimise the hassle you have to go through before you reach the target, you will probably find that you have to deviate from your planned flight path to avoid the CAP that sits on your ingress route. With a little luck, you can take out the target CAP, destroy the target and be gone before the hostile cavalry arrives.

In addition to enemy interference, there is still the matter of fuel to consider. Though hugging the ground may be fun and will shield you from SAM sites, long range CAPs and passing enemy strike flights, the Eurofighter uses fuel at a prodigious rate when you fly at low level. Due to the long distances you will have to fly on most strike missions, it is simply impossible to fly the whole distance at low or even medium altitudes. In order to get your fuel consumption down to a level that will allow you to reach the target, you should fly really high, at least around 40,000 feet. Though that may sound positively dangerous, it is not quite that bad. Although the long-range CAPs will get vectored towards your flight earlier than they would if you had approached at low level, the enemy will not scramble additional fighters against you, and since the high altitude improves your A2A missile's hit rate considerably, you might find the trade-off between higher fuel consumption or higher vulnerability to be acceptable.

A Case Study
– Levelling an Enemy Airfield

Until now, the training hops have been largely academic. Apart from the ALARM and strafing exercises, your simulated life has never been in danger. It is time to change that, and we will round off this chapter by taking a peek at one of the advanced simulator missions.

Mission Objective

Airfield Denial

Primary Target

Runway

Secondary Targets

Hangars, Tower and Control Buildings

Mission Briefing

This mission will be your introduction to integrated strike packages. As in the real world, you will not be alone, you will be accompanied by Escort Flights, Wild Weasel Defence Suppression Flights and other Strike flights whose targets are the buildings at the airfield. A pre-strike refuelling completes the line-up. As outlined above, your primary concern should be the runway, but in case the other strike flights miss their targets, you should be prepared to destroy those as well.

Arming the aircraft

Start with the basic A2A loadout of 2 ASRAAMs and 4 AMRAAMs. Since you will have an escort on this mission, you should not need more A2A ordnance than that . The airfield will be very well defended by both SAMs and AAA, it might therefore be a good idea to take 4 ALARMs with you. You will not need any additional fuel on this mission, the target is not that far away and you can also top off your internal tanks enroute to the target, so take a Durandal on the underbelly station. That leaves two more hardpoints for an additional A2G weapon of your choice. You will probably have a favourite one by now, so go ahead, take whatever you like.

Flying the mission

After you have hit the cockpit, you will have to wait for approximately 2 minutes before you get the permission to taxi. If you are impatient, you can press [redacted] twice to advance to your taxi clearance, and if you are not all that fond of taxiing to the runway, a third press should deliver you to the end of the active runway, ready for takeoff. From this point on, do not use the time-skip feature, it sometimes has the nasty habit of transporting you just a little too close to the action. Anyway, advance the throttle, engage the afterburner and blast off. After takeoff, raise your gear and head for the tanker, which should be around waypoint two. Climb to around 20,000 feet, and bring up your refuelling HUD when you have levelled off. When you are within 30 miles of the tanker, ask for permission to join. Be careful to note not only the hose to which you should connect but the tanker's callsign as well, because as you come up on tanker, you will find not one, but three tankers assigned to refuel the strike package. Your refuelling HUD defaults to the tanker with the callsign ECHO1, which is the lower of two tankers flying in a vertical stack formation, separated by a mere thousand feet. The high tanker's callsign is RAZOR1, the third tanker that flies slightly behind and to the left of those two is an American tanker with the callsign WILDCAT1. So, whatever tanker gave you the clearance to join, make sure to get behind the correct one. If your refuelling HUD points to the wrong one, you might need to recycle the refuelling mode once or twice until it picks up your assigned tanker's beacon (Figure 33).

Figure 33: Ready for the Pre-Strike drink

You might note that while you refuel, an enemy strike package passes your flight on the left, just outside the distance where the enemy escorts feel obliged to act.

After refuelling continue your flight towards the target. Stay at 20,000 feet until you are close to the target, your speed should not exceed 500 knots or you will overtake the Escort and Wild Weasel flights.

Even if the Wild Weasel flight has done its work, there will probably be a few SAM launchers left. Around 35-40 miles from the target, you should get the first indications of enemy SAMs. Activate your ECM equipment, order your wingman to do the same and select the ALARM as your active weapon. As soon you have a valid lock (Figure 34) fire the first missile, switch to the next target and fire again. Repeat that process until you have either fired all your missiles or no untargeted SAM launcher remains.

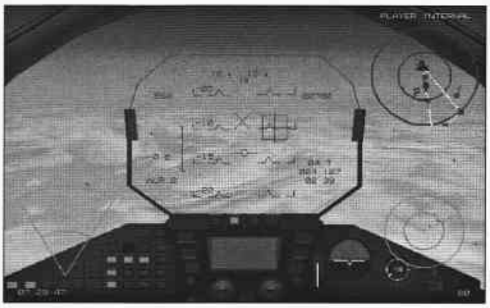


Figure 34: Time for the ALARM

As in the ALARM training mission, there is no need to close on the target until your ALARMs have reached their targets, so turn around or just circle until you've witnessed the end of the launchers.

Now it is time to turn your attention towards your primary target. If you are still above the cloud deck, it is time to get down below it. The runway's heading is 155, so if you just fly directly towards it on your inbound heading of around 130, you would cross it at an angle and would have to time the release of the Durandal very well to hit the runway. To make your life easier, turn slightly left and fly a heading of around 100 degrees. Use the cockpit scroll view to keep the runway in sight and turn towards it just before you are parallel to it. Correct your line-up to fly along its entire length and go for it. Keep your speed up, preferably above 500 knots and release the Durandal when the release marker is smack on the runway. As you may have noticed by now, there might have been a few tracers flying around. The AAA is concentrated to the Northwest of the airfield between the airfield and the sea, so you should either just climb straight on or break left after the attack. Use the check six view for BDA (Figure 35).

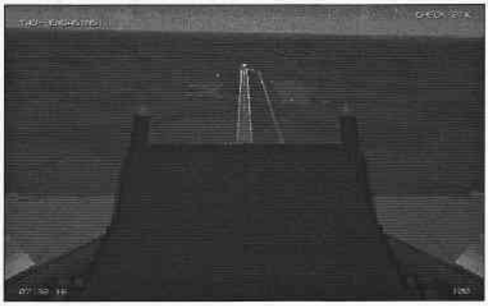
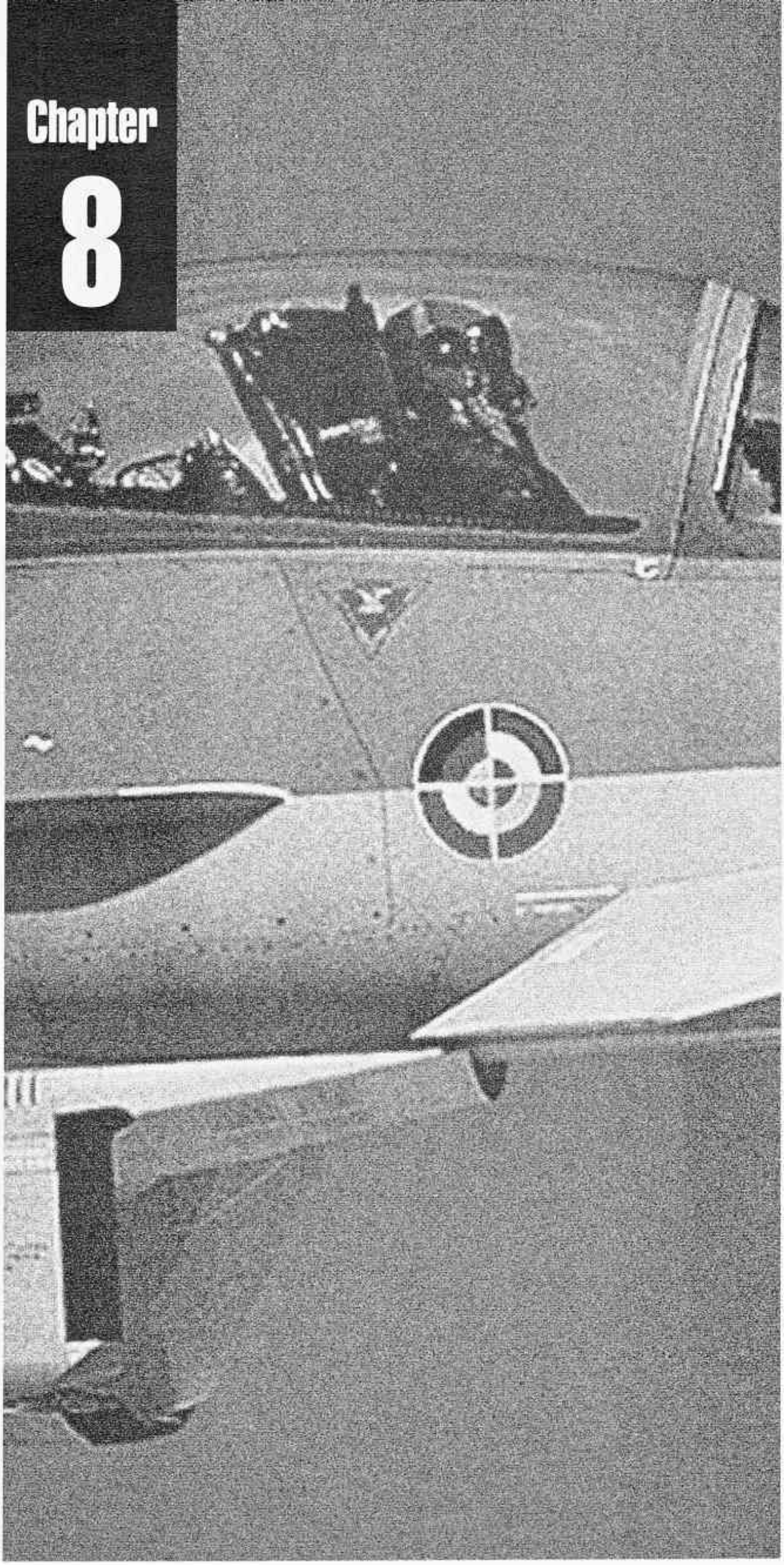


Figure 35: Primary target destroyed

If you are the thinking type, this is the time to go home. Your primary target is destroyed and you have probably already taken out 4 additional targets, not a bad days work. On the other hand, there is still a little ordnance left and neither the AAA nor the airborne threats are really grave yet. So why should you not dispatch a few of those buildings still standing? Since the AAA is off to one side of the airfield, you should execute your attacks parallel to the runway. As an additional safety measure, keep your speed above 500 knots and your altitude below 9,000 feet (that is the altitude at which that flak comes into play). With these parameters in effect, you should probably use shallow diving attacks to deliver your ordnance. If you have taken iron bombs with you, two passes should be enough, with rockets, you have a little more material to play with. Continue until either your ordnance is gone, nothing is left to destroy or the remnants of the strike package or the fighters inbound from around 140 degrees become a threat. If any of these conditions apply, take a last look around and head home.

Chapter 8



ADVANCED
SIMULATOR
WALKTHROUGH

A2A COMBAT

WINGMEN

AIR SUPERIORITY

A2G COMBAT

CHAPTER 8

Chapter 8

Simulator Walkthrough

In the preceding chapter, we have primarily concentrated on the different A2G weapon's targeting procedures, their usefulness against different classes of targets and how to determine an effective weapons load for your aircraft. What we actually aimed those weapons at has been of secondary importance, A2A combat has been non-existent and to top all that, you have almost never been shot at.

It is time to come down from cloud nine. Though these conditions were useful because they allowed you to concentrate on learning the ropes, they are hardly what you can expect to find in campaigns. The kind of target you will have to destroy will not only be important in terms of what type of weapon you are going to use to destroy it, but will also determine to a certain extent how you approach its location. You will have plenty of opportunity to demonstrate your knowledge of A2A combat as well your proficiency in SAM avoidance and destruction. In addition to that, you will also have to learn how to use your wingmen effectively.

Sounds like a lot of stuff? Right, that is why we will not get into the meat grinder of a full-blown campaign just yet, instead we will sneak that knowledge on to you by accompanying you through the advanced simulator missions.

Part I A2A Combat

The Basics – You against the world

Before you try to command one or more wingmen, you should refresh your knowledge of A2A weaponry, radar, BVR combat and Basic Fighter Manoeuvres. In order to get you back in the groove, we will first take a look at those Air Combat Simulator missions that pitch you against one or multiple bandits. Since all these fights start well outside visual range and WVR combat has been thoroughly covered in Chapter 6, we will mainly concentrate on the BVR aspects of the fights.

Mission 1

1v1 MiG-21

Mission Briefing

Although the MiG-21's maiden flight was over 40 years ago and its basic design is therefore somewhat dated, you should not get complacent when you face one in EF2000. Though it is not as manoeuvrable as the later Soviet designs and you would have a definite edge in close quarter combat, most A2A engagements start beyond visual range and in that scenario, the MiG-21 carries the same kind of deadly radar A2A missiles as its successors.

Arming the aircraft

It is unlikely that you will need about 6,000kg of additional fuel to cover the approximately 70 miles to your target, so you can either unload the external fuel tanks before you start the mission or jettison them as soon as you enter the cockpit. Although you could mount two additional long range A2A missiles under your wings, you really should not need more than one or two of those two take out a MiG-21, so the six already mounted on your aircraft are enough.

Flying the mission

When you hit the cockpit, you are already almost set up for the kill. The MiG-21 is right in front of you, range 67 miles and heading directly towards you. Throttle-up to 100 percent, light the afterburner and initiate a climb to 40,000 feet with a pitch rate between 25 and 30 degrees. The goal is to arrive at said altitude with a speed of at least 600 knots to extend the S-225's range to about 50 miles, since we want to deal with the MiG while it is still BVR.

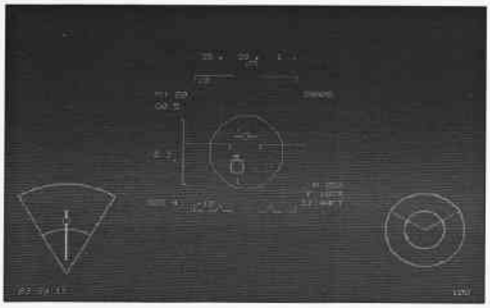


Figure 1: Ready to go

When you level off, the MiG-21 should be about 50 miles away, and the S-225 should be locked on to the target and ready to go. If things look similar to Figure 1, launch the first missile.

After you have fired the missile, disengage the afterburner and throttle back to about 85 percent, there is no need to close the range quickly while your missile is still on its way. At about 45 miles, the MiG will launch its radar-guided missile, switch your ECM on to reduce the threat. You will encounter some jamming from the MiG's ECM equipment yourself, and the S-225 might lose its lock in the process. Do not launch an additional missile until you are sure that your first has actually missed, there is a good chance that the missile will reacquire its lock. Although you can allow yourself to waste some missiles on this mission, you will never have enough when you are on a campaign mission and we do not want to form bad habits here. Usually, that first missile should take out the MiG, if not, try an AMRAAM since the range should be down to about 20-25 miles by now and the S-225 is not especially hot at medium to short ranges. In the highly unlikely case that one misses as well, switch to guns and get ready to demonstrate how much you really understood of the lessons of Chapter 6.

Mission 2

1v1 F-16

Mission Briefing

The F-16 is certainly a different animal than the MiG-21. Though advances in A2A missiles and avionics have aided it in outgrowing its basic design of a light, daylight fighter, the F-16 has retained its high thrust/weight ratio and remains a worthy opponent in close quarter combat.

Arming the aircraft

The F-16's dogfighting strength is precisely the reason why we should try to take care of it before the fight enters the phone-booth. The default weaponry consists rather mysteriously of short range A2A missiles only, rectify that mistake and mount at least 2 AMRAAMs. By the way, if you think it is unfair to add more weapons, you might want to fly this mission once with the default armament to check what the other side considers a fair fight. As before, you will need the extra fuel about as much as a fish needs a bicycle, so leave it at home.

Flying the mission

On this mission, your success hinges mostly on being within the right parameters when you fire the AMRAAMs. As soon as you hit the cockpit, throttle -up, engage the afterburner and turn slightly left to head directly for the F-16. The missile launch warning you will get immediately should give you an indication as to how the other side feels about leaving its long range weapons at home. Switch on your ECM to reduce that threat, and use the missile padlock and DASS to make sure that nothing closes in on you. But back to the main concern, firing the weapons in the right parameters. Concentrate on your HUD readout, and fire your first AMRAAM as your speed passes through 450 knots, the range should be about 28-29 miles (Figure 2).

Figure 2: Time for the first AMRAAM

Disengage the afterburner and throttle back to 95 percent in order to keep the closure rate from getting too high. The reasoning behind reducing the closure rate is to be still in the heart of the AMRAAM's engagement envelope just in case the first missile misses. If your AMRAAM misses, you should have the opportunity to fire the second when you are still 14-15 miles away. Although one of the AMRAAMs should have connected, it is still possible that the F-16 has survived them and will close in for the kill. Good luck.

Mission 3

1v4 F-16

Mission Briefing

Well, the last two missions have been essentially warm-ups, it is highly unlikely that you will be faced with an easy 1v1 situation in a campaign setting. You will usually find yourself badly outnumbered, and in order to get you used to it, our American allies have provided 4 F-16s for your single ship combat graduation mission.

Arming the aircraft

As usual, leave the external fuel tanks at home and mount two S-225s in the place of the under-wing fuel tanks. Leave the four ASRAAMs in place, it is somewhat likely that you will get one or two leakers and you will need the ASRAAMs for the close quarters fight.

Flying the mission

As in the 1v1 F-16 mission, you will start the fight with the enemy planes being due north, 30 miles away and heading directly towards you. Throttle-up, engage the afterburner and switch on your ECM equipment. The first F-16 will soon come in range, fire the first S-225, switch to the next target and fire again. Repeat that process until all F-16s have been served that way (Figure 3).

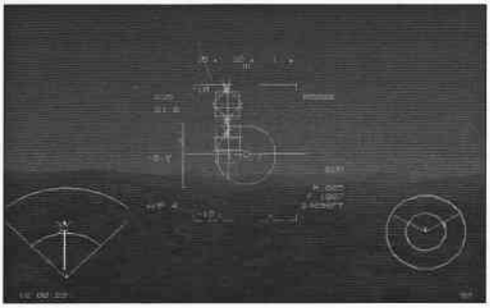


Figure 3: Initial volley underway

As before, throttle back to reduce the closure rate. Do not become too distracted by the enemy's missile launches, at that range, they are only radar-guided and your ECM will take care of most of them, you just need to switch to the missile padlock occasionally to make sure that your ECM really is successfully jamming the enemy's long range A2A missiles. Keep an eye on your radar and DASS and watch your missile's progress. The F-16s will initiate evasive manoeuvres to break the lock, if it appears that one has succeeded, lock it up again and send an AMRAAM on its way. Unless you have been especially unlucky, at least two of the four F-16s should be dead when you come into IR-missile range. Although the surviving F-16s will fire their ASRAAMs at that point, hold your fire for the moment and concentrate on evading the incoming missiles. The ASRAAM has a better hit rate when fired from behind the 3/9 line at a somewhat slower target, both parameters are easier to meet when you have sucked the F-16s into a turning fight. If you get only one survivor, things are straightforward, just apply the appropriate BFM to get behind it and nail it with either guns or an ASRAAM. Against two, things are a little more dicey, but not intolerably so. The main concern is not to focus on one exclusively, switch your padlock occasionally to get an idea what the other one is doing. If it has manoeuvred on to your six, you might want to concentrate on getting it away from there first. It is also quite useful to pop the occasional ASRAAM at a passing enemy, it usually it gives them something to think about and disturbs their concentration for a while, you can use that time to get the other.

Part II Wingmen

A little help from your friends

As unlikely as it is to find a situation where the enemy sends up just a solitary plane to fight you, it is equally unlikely that you will be completely alone when you face him, at least not initially. Usually, you will get at least one wingman, in a lot of campaign missions there will be three and on ferry flights, five of them.

This sounds like a lot of help, but the AI pilots in EF2000 are not exactly the hottest on earth. They do not hit their assigned ground targets very often and their missile avoidance skills are not very impressive either. The ECM helps as long as the missiles are radar-guided (remember that you have to tell them to turn it on, they will not use it without permission), but they die at a fearful rate when forced to contend with IR missiles.

So, why even bother with wingmen? Well, they are there anyway and although they will probably perish in the first exchange of fire if you let them blast off towards the enemy, you can improve their survival rate by keeping them on a short leash.

Mission 4

2v1 MiG-21

Mission Briefing

The MiG-21 is not a primary threat so consider this mission as an opportunity to use the wingmen commands effectively. If you get it right you should get your wingman a kill and help him live to tell the tale.

Arming the aircraft

Apart from the fuel, you can leave everything like it is, this mission's objective is to get you used to issuing wingmen commands, not to fight yourself.

Flying the mission

Unlike in the first missions, the enemy is not right in front of you but at your 3 o'clock, closing in from a heading of 90 degrees (Figure 4).


Figure 4: Bandit at 3 o'clock

Turn right at once, throttle-up, but stay out of afterburner for now. As you roll out of the turn, your wingman will ask you for permission to engage. Order him to engage, and wait for the cross to appear over the target symbol, indicating that he has in fact fired a missile. As soon as that happens, order him to disengage and to come into arrow formation. Engage your afterburner and commence an immediate turn towards a heading of 270 degrees, directly away from the MiG. With a little luck and the right timing (both not necessarily evident when you try this for the first time), you should be able to outrun the missiles the MiG launched at you, hence saving your wingman's virtual bacon. The MiG on the other hand will continue heading towards you, closing the distance and almost certainly managing to fly into the missile your wingman launched.

Mission 5

2v1 Su-35

Mission Briefing

In this mission, you will meet Russia's premier A2A superiority fighter, the Su-35. Highly manoeuvrable, with up to 8 A2A missiles, it is always a tough nut to crack. Though you have a nominal numerical advantage, do not kid yourself, this will not be a milk run.

Arming the aircraft

Guess what you can leave at home? Hint - it is not a weapon. Instead, take as many A2A weapons as you can get on the aircraft, there is no such thing as too much ordnance when you go up against the best.

Flying the mission

In this scenario, the enemy is again right in front of you, range about 67 miles. Since this is outside the range of every A2A missile you have, you should use the time to accelerate and gain altitude, so throttle-up, engage the afterburner and initiate a climb to about 40,000 feet. During the climb, the range should have closed to about 55 miles, and due to the gained speed and altitude, this falls within the S-225's range. Your wingman will have repeatedly asked for permission to engage, you may now order him to do just that. Hoping that just one missile will take out such a highly manoeuvrable aircraft as the Su-35 is a little too optimistic, so fire a missile yourself to ensure that the Su-35 really falls to the initial volley.

As before, as soon as your missiles are on their way, order your wingman to disengage, close into arrow formation and commence a turn towards 180 degrees. If you have not done so already, plug in your afterburner to get your speed up and to accelerate out of the enemy's missile envelope.

Usually, the two S-225s should be enough to do the job. In the unlikely case that the Su-35 has survived all those long-range missiles, you have to turn around to re-engage.

Mission 6

2v2 MiG-21

Mission Briefing

Though this mission doubles the number of enemy missiles your flight has to face, we have already seen that it is possible to guide your wingman through an encounter against a single enemy. Let us see if it works as well against two.

Arming the aircraft

As usual, take the standard 'anti-air' loadout of 8 long-range and four short-range A2A missiles and leave the additional fuel at home.

Flying the mission

The MiGs bear in from the north, range about 70 miles. Since you are initially heading East, commence a left turn, throttle-up, light your afterburner and climb. As you reach 40,000 feet and about 600 knots, disengage the burner and throttle back. Order your wingman to engage and after he has fired at both MiGs, fire one S-225 at each yourself. As before, now is the time to head for a less dangerous place. Order your wingman to disengage, and commence a turn to get the hell out of dodge. Your missiles should not take too long to cover the distance to the MiGs, you might sneak in a glance at the Missile View F8 to see if they have already reached their target or, heaven forbid, have missed. Usually, both MiGs should fall to the initial volley. If not, turn around and launch additional missiles as necessary, but do not allow your wingman to re-engage.

Mission 7

2v2 Su-35

Mission Briefing

As in the 2v1 scenario, things have become a little more dangerous. The Su-35 is much less impressed by missiles launched at it and it usually takes a little more work to take two of them out of the picture. Since the MiG-29's performance is about on par with the Su-35's (perhaps slightly less capable), we can skip that mission and concentrate on the more formidable threat.

Arming the aircraft

Standard A2A.

Flying the mission

On this mission, you will start in the worst initial situation so far, you are low (9,000 feet) and slow. Down there, your long range missiles are almost worthless, so, throttle-up, light the afterburner and point the nose at the sky. At least your enemy is co-operating by being right in front of you. By the time you are at about 35,000-40,000 feet, you should be in missile range, order your wingman to engage and do so yourself. This action should be immediately followed by the chicken routine, order your wingman to disengage, turn around and make good your escape.

By now, you may have become aware of a certain pattern - fire, turn around and run. At face value, this tactic certainly does not reflect a very aggressive attitude, but, given the restrictions thrown upon you by your wingmen's lack of basic survival techniques, it is a rather effective one. If you continue to bore in on the enemy fighters for a little turn&burn, the only thing that is likely to burn is your wingman as soon as you come into IR missile range (and remember, the Russian IR missiles have a significantly greater range than NATO's). In addition, your wingmen tend to fire (and waste) additional missiles at their targets as soon as a missile's lock is broken, though the missile might re-acquire the lock only seconds later. With the turn and burn jet fuel (T&BJF) tactic, you will avoid both problems

If you have a mindset that leans more towards aggressive than sensible, rest assured that there will be more than enough situations where circumstances will not allow you to turn around and you will be forced to close in on the enemy fighters (for example, when you are escorting a strike package or an AWACS aircraft), but whenever circumstances allow the employment of T&BJF, do it.

Mission 8

4v4 Su-35

Mission Briefing

A fitting end for Section 2, four of each side's finest against each other. It is also a common campaign scenario at the higher difficulty levels, so you might want to practice it to the point where you do not have any trouble surviving and can guide your flight through it without loosing all your wingmen in the process.

Arming the aircraft

Just to be on the safe side, load as many long range missiles as the EFA will carry, 4 S-225s and 6 AMRAAMs. The more Su-35s you can take out at long range, the better and of course, leave the fuel tank at home.

Flying the mission

First order of business, climbing and accelerating. When you have reached a reasonable speed, altitude and are in range, order your wingmen to engage (Figure 5).

Figure 5: Time for the first volley

After each enemy's target box is crossed (indicating it has at least one missile allocated to it), fire a S-225 at each of the Su-35s yourself to make sure that most, if not all, will perish in the initial exchange. Execute the T&BJF tactic and head for greener pastures. Usually, all the Su-35s will fall to the first wave of your flight's missiles and if you executed the retreat quickly enough, your wingmen should still all be with you.

This scenario (your flight against a CAP of four Class-1 fighters) is a regular feature in campaigns, though you are usually carrying less A2A missiles and more A2G ordnance. In order to prepare yourself, you should adjust your armament accordingly, take the fuel tanks and a couple of ALARMs or rocket pods. Due to the weight and drag imparted by that ordnance, you will find your EFA is significantly less nimble and it becomes even more important to destroy the bandits at long range.

Part III Air Superiority

Mission 9

Airwar

Mission Objective

Air Superiority

Mission Briefing

To own the contested skies over the battlefield has always been a prime goal for air forces. Air Superiority allows one's own A2G attacks to proceed in an orderly and unmolested fashion, whilst keeping your ground troops protected from unwanted enemy attention.

Arming the aircraft

As usual, leave the additional fuel at home, and blast off.

Flying the mission

You thought 4 Su-35s were difficult? How about 10 MiG-29s and 8 Mi-24s? Well, it is not as bad as it sounds, you will get help from a flight of four F-16s and four F/A-18s. Still not quite an equal fight, but with a little tactical sense, manageable. Although the mission description calls for you to clear the skies of all enemy aircraft, it is the fighters that are your mission targets as far as scoring and mission completion is concerned.

As you hit the cockpit you are heading directly for the middle of the hornet's nest, the air base where the helicopters are duking it out. As you expand your JTIDS display, you will notice two groups of additional targets, one slightly behind and to the right and one a little left, but further away. These are the fighters you need to take out.

Since you do not want your wingmen to waste their precious missiles on the helicopters, steer a course of about 120 degrees which will keep the helicopters out of your wingmen's radar scan cone. Since the fighters are still out of missile range there is nothing wrong in gaining speed and altitude, as you close the distance. When the first group comes into missile range (check your JTIDS display to make sure), turn left until they appear on the left edge of your radar. Do not turn further left than necessary, if your wingmen get a whiff of the helicopters, they will go for them.

Order your wingmen to engage and get ready to contribute to the barrage as necessary. Only fire when you are sure your intended target has not already been fired upon.

The biggest challenge in this scenario is to keep your Situational Awareness, knowing what is where. If you head right into the middle of the fight, you will soon find yourself surrounded by enemy fighters and too busy evading enemy missiles to contribute anything useful to the fight.

The obvious solution would be to stay outside the 'bandit cloud', and this is one of those rare cases where the obvious is also right. The enemy fighters will be too busy deciding which of the allied flights poses the most serious threat and tend to drift into the cloud at some point, ceasing to be a direct threat to you. When this happens, you are free to cruise along the outer perimeter of the fight. As long as you still have long-range missiles, there is nothing wrong with staying about 15-20 miles away from the fight. Turn occasionally towards the fight, scan for fighters not yet targeted by missiles and fire upon them. Be careful not to waste your missiles on the helicopters, you can always gun them after you have taken care of the fighters. After you have launched a missile, turn around to avoid being sucked into the fight. Do not give in to the temptation of watching your missiles all the way in, that is one sure way of getting drawn in too far.

At some point, you will run out of long-range missiles, and in order to get a valid IR missile shot, you will have to fly much closer to the bandit cloud than before. With a little luck, there will not be that many fighters left, but in case there are try to find a target a the very edge of the cloud and challenge that one.

In order to get the 'Mission Accomplished' message, you and your wingmen (while they are still with you) have to shoot down a minimum of 8 fighters, helicopters do not count towards mission success. Sometimes, the other allied flights will shoot down enough fighters to make it impossible for you to reach that number. Do not feel too bad if this happens, if this was a campaign mission, the most important fact would be that the enemy fighters are dead, not who did them in.

Mission 10

Escort

Mission Objective

Revenge

Mission Briefing

Transport aircraft flying through contested airspace are easy prey for enemy fighters. Slow, not very manoeuvrable and unarmed to boot, they should not be there at all. However, since they are sometimes the only means to get critically needed supplies to the front in time, they have to fly through the thick of it. In this mission it is your job to ensure that they reach their destination safely.

Arming the aircraft

The default armament is not too far off for this one, just replace the underwing fuel tanks with A2A missiles. Keep the underbelly fuel tank, you will need more fuel than the distance implies.

Flying the mission

Well, headquarters screwed up big time on this one. The normal procedure for escorts and escorted aircraft is to rendezvous at some safe and cosy place, preferably before entering hostile airspace. In this instance however, the transports are already well into enemy territory, and the enemy fighters are closing in on them.

Get in the air as fast as you can, as you soon as you are airborne, turn towards a heading of 30 degrees. Keep the throttle fully open and the afterburner plugged in, you are almost 40 miles behind the transports. The enemy fighters have about the same distance to cover to the transports, but since the transports are heading towards them, there is no way for you to prevent those fighters from getting the first drop on the transports. When you and your wingmen get into missile range, both transports will already have one or more missiles headed towards them, engage the enemy fighters and hope that the transports' pilots know something about missile evasion.

This particular scenario is essentially a race and therefore, you will not be able to employ the T&BJF tactic. Therefore, it is likely that you will loose one or two wingmen in the initial exchange.

After the smoke clears, have a look around to see if one or, miraculously, both transport aircraft have survived the encounter. The game's designer did not seem to expect this, you will get the 'Enough enemies destroyed' message as soon as the last enemy fighters explodes. But, in case there are survivors, your mission is not over yet. There are six Su-25s circling waypoint 3, and a SAM launcher waits for the occasional, unsuspecting transport to fly by as well.

Though the Su-25s pose little threat to you, they tend to suck the transports into dogfighting with them and the transports will eventually stall out and crash during those fights.

Therefore, engage the afterburner again and head for waypoint 3, you need to take out the Su-25s before the transport(s) arrive(s). The SAM launcher will come up at some point during those fight, just switch to ALARMs for a moment and dispatch it.

If you have cleared out all remaining threats, accompany the transports to their final destination, you should get the 'Mission Accomplished, Well Done' message as soon as they touch down.

Mission 11

Intercept

Mission Objective

Offensive Counter Air

Mission Briefing

As already stated in the last mission's briefing, transports are a crucial ingredient for a functional logistics organisation. Hence as obvious as it is to protect your own transport aircraft, it is equally important to destroy the enemy's and in this mission, your going to do just that.

Arming the aircraft

Well, the word has spread. Your previous aerial exploits are already legend, and it seems that your weapons officer has decided that someone of your ability really does not need a full complement of A2A weaponry anymore. If you agree with him, you may leave half of your possible long-range A2A weapon load at home, but on the other, one never knows what to expect.

Flying the mission

Your target for this mission are two of those six engine Antonov An-225, the world's biggest aircraft at the moment (Figure 6).

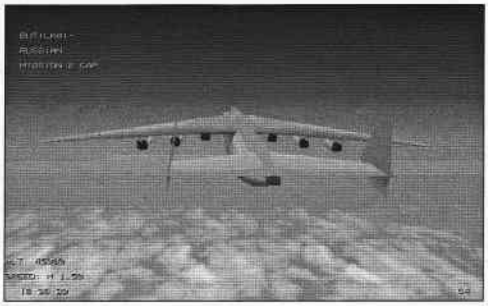


Figure 6: Let's see how many parachutes come out of this

Actually, this mission is not that difficult. In order to get a 100 percent success rating, you just need to take out both Antonovs. But, as in the AIRWAR mission, the biggest threat to your personal mission success are the other allied fighters that are also in the area which will take pot-shots at your targets, they may nail one or even both Antonovs before you have a chance to get them.

Since you are in a race get at the targets first, leave the throttle open and the afterburner on after takeoff. Head for waypoint 2 and do not get distracted by the enemy incursion AWACS is calling out to you, another CAP will deal with it.

Climb to a useful, long range missile compatible altitude (above 25,000 feet) and order your wingmen to engage as soon as you come in range.

If the Antonovs are still around when you arrive at the scene, concentrate on them at first, your S-225s will have a bigger chance of hitting slower and less manoeuvrable targets anyway.

After you have dispatched the Antonovs, practice your A2A combat skills by taking out as many of the remaining enemy aircraft as you can.

Mission 12

AWACS

Mission Objective

Offensive Counter Air

Mission Briefing

Have you ever switched off the AWACS data-link on your JTIDS display or flown a campaign after your AWACS has been shot down? If the answer is yes, you know the sudden feeling of uncertainty creeping up on you, not knowing what's out there is certainly no fun. Well how about inducing that feeling in your enemies? Taking out their AWACS will virtually blind them and make your task considerably easier. Unfortunately, the enemy knows a high value asset when he sees one, and you are going to have to fight your way in to get at the AWACS.

Arming the aircraft

The default armament is almost right, just replace two ASRAAMs with AMRAAMs, if it is possible to do your killing at long range, why not take advantage of that?

Flying the mission

The mission description indicates that a second pair of EFAs will support you and your wingman, but they are not as conscientious as you. They take ages to get airborne and are also not especially quick in catching up with your flight, so you have to ensure that both flights get together (a few 360s while you are airborne helps to pass the time).

However, make sure that you have rendezvoused with the second group before you reach waypoint 2. As you close on the waypoint, you will notice that the other group breaks left, away from the original flight path at about the same angle you take towards waypoint three. Watch their progress for a little while, sometimes, they get distracted by the strike group that is cruising around in that area and forget all about the AWACS they are supposed to shoot down. If this happens, you need not bother with the flightplan anymore, go straight for the AWACS. (You might want to give T&BJF another chance, this is one of the situations where it works quite nicely).

In the second flight sticks to the original plan, it is equally important that you keep your end of the bargain as well. It is very important to keep your speed around 500 knots and to follow the planned route, you neither want to arrive significantly before nor after the other group has turned towards the targets.

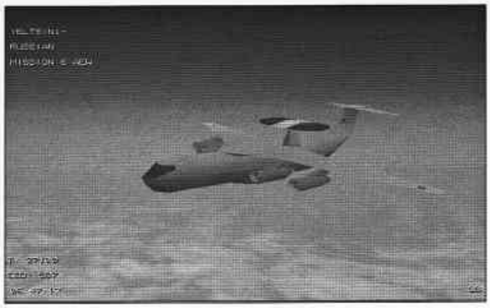


Figure 7: AWACS

If the timing was right, the enemy fighters escorting the AWACS will be thoroughly confused, when confronted with more than one group of fighters, they cannot seem to make up their minds.

This is your chance, go for the AWACS (Figure 7) and mop up the remaining fighters afterwards.

Mission 13

Mission Objective

Base Defence

Mission Briefing

The CAP tasked with Base Defence has been lured away from its station by a superbly timed deception manoeuvre, so instead of enjoying a quiet afternoon, you have to scramble and intercept the enemy strike force boring in.

Arming the aircraft

No time to change anything, just get into the air.

Flying the mission

Since it might be a little dangerous to face the 4 Su-35s and 4 Su-27s escorting the 6 Tu-16s all by yourself, use [redacted] [redacted] to get yourself to the runway and make sure your wingmen are right behind you when you takeoff.

Order them to engage as soon as you are airborne, and turn towards a heading of 90 degrees to get into the action yourself. Keep the afterburner plugged in until you have reached a speed of around 600 knots, there is no need to waste your time trying to climb to altitude, all the action will take place low down.

Switch your ECM on (tell your wingmen to do the same) and start firing your long-range missiles. Do not wait until you get a shot cue, with your wingmen firing and the plethora of targets out there, your chances of toggling through the targets fast enough to get one that is currently untargeted are minimal. Just switch targets and fire, keep this up until all your long range missiles are gone.

Most of the targets you will see at first will be the escorting fighters, the bombers try to dash through the fight at low altitude (Figure 8).

Figure 8: Low-level raiders

If possible try to avoid to get into a turning fight with the escorting fighters, concentrate on avoiding the IR missiles headed your way and try to get the bombers, (you may wish to use the priority button on your radar to isolate the bombers). Your wingmen (those who survived the initial exchanges) will primarily concentrate on the enemy fighters, giving you a chance to get the bombers.

All in all your flight needs to destroy 11 of the 14 enemy aircraft, getting the bombers before they bomb your base is, strangely enough, not necessary for a successful conclusion.

Part IV A2G Combat

By now, you should have a useful bag of tricks for both defensive as well as offensive A2A missions. You will have plenty of opportunities to put that knowledge to good use as we re-focus our attention back to A2G combat. As in the Advanced Training missions for A2A combat, the following missions will expose you to the full extent of modern air combat. You will have to concentrate not only on your flight, but also on the things happening around you, maintaining both local as well as area Situational Awareness (SA).

The mission descriptions are not quite as detailed as in the weapon training chapter, you know how to navigate around an air base by now and are well versed in weapons targeting and release procedures. If all the A2A combat of the preceding section has atrophied your basic A2G knowledge, take a few minutes to reacquaint yourself with your favourite A2G weapon(s) and to re-fly the relevant weapons training missions.

Mission 1

Bridge

Mission Objective:

Interdiction

Primary Target:

Road Bridge

Secondary Target:

Railway Bridge

Mission Briefing

Keeping the enemy from resupplying his forces is a very effective way of degrading his fighting capabilities. A tank that has no ordnance to fire and/or no fuel to move is just a useless collection of expensively crafted advanced metals. The same is true for aircraft, SAM launchers and the myriad of other things that constitute the Table of Equipment of a modern army or air force. There are three ways to keep the resupply from reaching the front lines. The first is to destroy the goods themselves that constitute said supply. The second is to go after the means of transport that bring it to the front lines like trucks, ships and railways. The third and probably most effective is to destroy the critical infrastructure needed to transport those goods. In EF2000, these are somewhat appropriately called 'Choke Points' and if you destroy the bridges and tunnels that are in this infrastructure category, you will definitely disrupt the enemy's resupply.

Arming the aircraft

The default load for this mission are 3 LGBs, 4 ASRAAMs, 3 AMRAAMs and 2 underwing fuel tanks. Get rid of it immediately by clicking on 'Clear all'. Bridges are pretty big and hence, somewhat easy to hit. There is no need to use a weapon that robs you of a valuable long-range A2A missile, in addition to requiring you to go heads down and fly in straight line over the target, following a predictable flight path for a considerable amount of time. Instead, take the basic A2A defensive load (2 short-range and 6 long-range A2A missiles), 2 ALARMs, an underbelly fuel tank and a pair of Mk-83s.

Flying the mission

After you have hit the cockpit, take a moment to study the tactical situation around you. As you expand the JTIDS display to its full range of 320 miles, you should notice two enemy strike groups, one at waypoint 6 and one at waypoint 3, both heading in the general direction of your target at waypoint 5. There are also two CAPs near the target. Friendly assets consist of another small strike flight including escort, a flight of helicopters performing fire suppression at the target and a tanker cruising between the base and waypoint 6.

Since it is always useful to have a full tank of gas, top off your tanks after takeoff. As you get your fuel, you will also have a little time to study the situation in more depth. You will probably notice that most of the enemy airborne hardware seems to cluster around your ingress route to the target, whilst the egress route seems rather unpolluted except for the strike group heading away from you (if you use the Browse View, you will see that it is not a strike group but a transport plane being escorted by two MiG-29s). So, your second command decision of the day (the unscheduled refuelling being the first) should be to deviate from the planned route and to proceed roughly along your egress route towards your target. Although you are flying directly towards the target at that point, do not advance your waypoint to the target waypoint, since this automatically issues a 'running in' command. If you do this your wingmen will start their attack run from a little too far out. Use your JTIDS display to get a bearing towards the target and either 'hand fly' the plane or use the autopilot's heading mode. Adjust your speed to be around 500 knots. Try to avoid getting too close to the transport plane, as its escorts will consider you a threat and attack your flight.

One of the two CAP flights (consisting of just one MiG-29) near the target will head in the general direction of the second strike flight and will most likely dispose of the escort before turning its attention towards your flight. Not exactly a reason to get nervous, just turn towards it, order your wingmen to engage and fire one or two missiles on it yourself. Disengage and turn around before you come into the effective range of the MiG's missiles, you can outrun the missiles fired at you whilst your missiles will probably hit because the enemy will continue to bore in.

One of the architectural properties bridges and runways have in common is that they are generally considerably longer than than they are wide and you should take advantage of that fact to increase your chances of a successful attack by flying along its length instead of crossing at an angle or, even worse, flying perpendicular to it. In EF2000, you can use the moving map display to locate the streets and railways that lead towards those bridges (they are represented by the brown lines) and if you start your attack by flying along those streets for the last few miles to the target, you will find that you are almost automatically lined up correctly.

Figure 9: Running in (slightly right)

In the mission at hand, the street and railway run in a South-Westerly direction from the target, and split about 30 miles south-west of it (Figure 9).

Adjust your course so that you intersect the street at that point and follow it towards the target from there. It is time to get down towards the weeds and advance your waypoint to the target waypoint so that your wingmen will start their attack as well.

Continue the NOE flying until you are about 10 miles from the target. At that point pull back on the stick and climb to around 7,000-8,000 feet. Select your ALARMs if any SAM sites are up and fire them as soon as you have a lock. Continue to use the street as a reference and look for a blue line that intersects it, you should see it quite a while before the bridge itself becomes visible. When you are about 3-4 miles from the target initiate your attack. A medium angle diving attack will probably work best, fly the release marker slowly towards the target and release it when it rests squarely on the middle of the bridge (Figure 10).

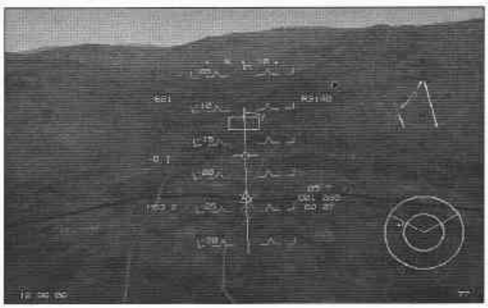


Figure 10: Get those ferries ready

After you have released the bomb, stay low and head away from the target through the valley.

Climb back to a useful A2A combat height and cover your wingmen's attack. With a little luck, one of them will actually hit the second bridge and you all can go home.

Due to the somewhat dynamic nature of EF2000, your attack might not unfold quite as smoothly as described above. The biggest variable are enemy aircraft. The fighters escorting the transport might get lured into a fight by other allied planes and latch on to your flight as additional threats. Also, despite the fact that the enemy strike group slowly advancing towards waypoint 5 consists solely of helicopters (which pose no threat whatsoever if left alone), your wingmen will start calling 'Bandit', attack them and will most likely get shot out of the sky if your flight comes too close to that group.

But actually, that is not that important. The objective of this mission was to destroy the bridges, if you accomplished that and learned how to use the map to figure out the best approach to the target, you did just fine.

Mission 2

Carrier

Mission Objective

Anti-Ship

Primary Target

Kusnetsow Class Aircraft Carrier

Secondary Targets

Udaloy and Slava Class destroyer

Mission Briefing

A carrier battle group is, without question, the major player in sea warfare. It is able to create a bubble of a significant radius in which nothing is able to exist without its permission. The Russians were slow in recognising this and have ignored naval aviation for quite some time. However, in the last two decades, they have worked hard to reduce the lead the United States and NATO, have enjoyed for the last 50 years. The carriers of the Kusnetsov class are the latest products of this effort, and whilst they are still smaller and not as capable as the American super-carriers, you most certainly do not want them sitting smack on your supply routes.

Arming the aircraft

As usual, start with the standard fuel and A2A loadout, 2 ASRAAMs, 4 AMRAAMs and an external fuel tank on the underbelly station. In EF2000, the dedicated anti-ship weapon is the Sea Eagle, and since you can launch it without flying into the range of the ship's SAMs and AAA, you can leave the standard 2 ALARM anti-radar missiles at home and take 4 Sea Eagles with you. The remaining stations will be used for two additional AMRAAMs.

Flying the mission

A look at the JTIDS display should make it clear that following the waypoints is one sure way to get into a lot of trouble (Figure 11).

Figure 11: Enemy airshow near waypoint 4

The enemy seems to have gotten word of your flightplan and has positioned his fighters accordingly. But thanks to our AWACS, we know exactly where they are and can avoid them. As in the preceding mission, simply follow the egress route which looks relatively clear, with just one CAP cruising near waypoint 7. Since this mission does not have a predetermined target waypoint, you can even use the egress waypoints to navigate, advancing past waypoint 5 will not automatically issue the 'running in' command.

After takeoff, you will notice that your fighter is not very nimble, the four Sea Eagles are real drag and weight monsters and you should adjust the tactics you will use to clear the CAP out of your way accordingly. You do not want to get involved in a knife-fight while carrying this load. Since your route along the egress waypoints is somewhat shorter than the planned one, you should keep your initial speed low (around 400 knots) to give the escorting F-22 fighters a chance to get to the CAP first. Though it is highly unlikely that they will take it out completely, they might at least deplete them of their long-range missiles and even shoot down one or two enemy fighters.

When you are sure the F-22s have engaged the CAP, it is time for you to get ready for the fight with the surviving enemy aircraft. Get high (at least 40,000 feet) and keep a speed of at least 600 knots, this will improve the hit ratio of your long-range A2A missiles significantly. Do not wait until they turn towards you and open fire, take the offensive yourself. Turn towards them well before they are in missile range, accelerate and tell your wingmen to switch on their radar, ECM and to engage.

As usual with this kind of encounter, employ the T&BJF tactic after you and your wingmen have fired the first missile volley, though on this particular mission, it actually does not matter whether you lose your wingmen or not, they would not help you against the ships anyway. Your wingmen get very confused if their ground targets have moved from the point where they expect them to be and with mobiles, this is usually the case. So even if one or more of your wingmen survived the encounter with the CAP, do not be surprised if they head away from the enemy fleet as soon as you issue the 'running in' command.

But that aside, you should have survived the fight with the CAP. Continue to close in on the enemy fleet, when you are about 80 miles away, select the Sea Eagles and start looking for targets. There are two groups of ships, one group of Neustrashimy class frigates and, slightly behind and to the right, the carrier group. Switch through the targets until your radar displays the Kuznetsov class designation, that is the ship you are looking for (Figure 12).

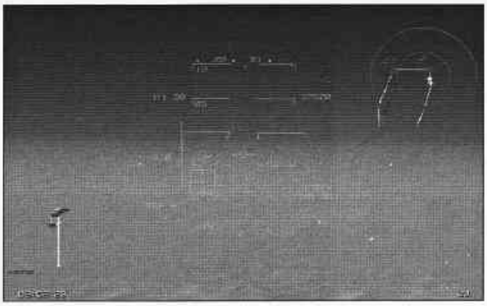


Figure 12: The Kusnetsov in your sight

Wait until you are well within the Sea Eagle's range, then fire the missile. Dispatch the remaining three missiles on destroyers of your choice.

Mission 3

SAMS

Mission Objective

Suppression of Enemy Air Defences (SEAD)

Primary Target

ZSU-23

Secondary Target

None

Mission Briefing

Probably the most hazardous missions flown in modern fighters are Wild Weasel missions. Instead of avoiding the enemy hardware that is specifically designed to shoot down aircraft, you will go in before the main strike force to seek them out and to goad them into locking on to your aircraft to give away their position. The mission briefing calls for the eradication of suspected SAM sites near waypoint 3. Welcome to the latest Intelligence screw-up. Instead of the suspected SAM launchers, the enemy has actually deployed ZSU-23 AAA vehicles. Due to their smaller engagement range, they do not constitute the same threat as SAM launchers, but since they sit smack on they ingress route to the tunnel, every strike flight that tries to attack the tunnel would have to pass right in front of their muzzles, so they have to be taken out anyway.

Arming the aircraft

For this mission, the default weapon loadout is almost ideal. The only problem the 4 ALARM loadout presents is that it is absolutely useless against SAM launchers or AAA guns that do not use their radar. If they do not lock up your aircraft, you cannot fire the ALARM (well, you could fire it in indirect mode, but it would not destroy anything either as long as no radar comes up). So, instead of just 4 ALARMs load 4 ALARMs and 2 CRV-7 rocket pods, that way, you will be armed for both co-operating as well as unco-operating targets.

Flying the mission

As far as distance to the target is concerned, this is just a short hop, it is just about 100 miles to waypoint 3. The biggest obstacle between you and the successful conclusion of this mission might be your own fangs, or A2A aggressiveness. There are quite a few A2A targets flying around on this mission, including such easy and tempting pickings like transport helicopters and fully loaded Su-25 Close Air Support aircraft. Try to avoid being sucked into a fight with these aircraft or their escorts, there are other allied flights out there to take care of them. Even if you get fired upon, try to ignore it (as hard as that may be at the time), drop down to low level and follow the valley that leads towards the tunnel. Your targets are a short distance beyond waypoint 3, so stay in the valley after you have passed the waypoint. Due to the small engagement envelope of the ZSU-23, you will not get a radar lock from 30 miles away, you have to be pretty close before they lock you up and you can fire your ALARMs (Figure 13). You might even need to goad them into activating their radar with a low pass.

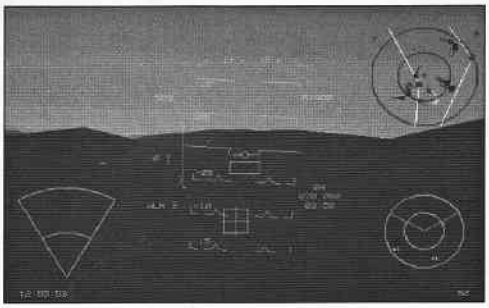


Figure 13: ALARM lock

Do not forget to issue the 'Running In' command to your wingman, he might actually help you on this mission. Unfortunately, only two of the three ZSU-23s fall into the category of co-operating targets, the third will simply not use its radar so you cannot take it out with an ALARM. But that is why we took the CRV-7 rocket launchers along. Once you have dispatched the third ZSU-23, you have achieved the mission objectives and might as well head home, but on the other hand, transport helicopters make great gunnery targets...

Mission 4

DAM

Mission Objective

Strategic Strike

Primary Target

Sluice Control

Secondary Target

None

Mission Briefing

When it looks like the war is going to last for a while, it is not enough just to destroy the enemy's supplies or the means through which they are distributed to the front lines (Interdiction strikes). If you plan for a protracted conflict, you need to destroy the enemy's production capabilities as well. These kind of strikes are generally called 'strategic strikes' since they are not immediately relevant to the situation at the front line. In EF2000, one group of strategic targets are dams. In addition to their function as water reservoirs, they are also used to produce electricity, so taking them out has a double impact on the enemy's capabilities.

Arming the aircraft

This is one of the two types of targets where the use of precision guided munitions is really justified (the other being EW sites - see mission 5). Since there are usually people living downstream from the dam, you do not want to accidentally destroy the whole dam and flood everywhere. Taking out the turbine house and rendering it inoperable will do just fine. Therefore, it is okay to take a pair of GBU-12s with you, load an underbelly fuel tank and stuff as many A2A missiles as possible on the remaining pylons as you will have sufficient Wild Weasel support, but no escorts and there will be plenty of enemy fighters around.

Flying the mission

Since this is a long range mission, get up to at least 40,000 feet. Since you do not want to overtake the other strike and Wild Weasel flights, keep your speed below 500 knots. Apart from their primary mission, these flights have a secondary function as bait for enemy fighters and missiles. Sounds cruel? Well, war is cruel, even the simulated one.

A quick look at the planned route reveals that switching ingress and egress route will not do you much good, they are only a few miles apart and fighters cruise around both. You can try to fly a really long, roundabout route, but you would lose the option of mutual support from the other flights. But, it is not really necessary to try to sneak on to the target, you can go right for it and survive. Actually, there are even two ways to do this.

First, you can duke it out and fight your way through the numerous CAPs lining the way to the target. Stay about 15-20 miles behind the other flights and as soon as an enemy flight engages, get involved as well. Since the enemy fighters will have to split their attention, they tend lose quite a bit of their deadliness. The problem with this approach is the sheer number of fighters you will encounter, more than the number of missiles you can carry. On the other hand, due to the number of allied flights involved in this scenario, the enemy fighters tend to run out of missiles as well. That leaves you with basically a few good old-fashioned guns-only duels, but since your are still burdened with your A2G weapons, not exactly even-handed ones. So, if you are confident enough in your air to air gunnery skills, this might be a fun way to do things. If you are, on the other hand, not quite sure you like dogfighting with 2 GBUs and an underbelly fuel tank, you might consider the following approach.

As above, stay about 15-20 miles behind the other flights. As you come up on waypoint 3, get down on the deck and open the throttle. The idea is to simply blast through the dogfight arena. Stay down, do not turn to engage and keep your wingmen close. You might get an occasional missile launch, but since they will be side or rear quarter shots, you should be able to outrun them. The only fighters you cannot avoid are the CAP right over the target area, but with 4 against 2, this is not much of a challenge.

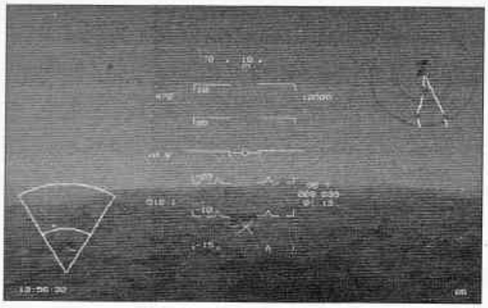


Figure 14: Finally at the target

No matter which approach you used, you hopefully got through and will have the dam in your sight as in Figure 14.

Your TIALD should already be centred on the turbine house; enable tracking and lasing and wait until the release marker indicates that you are in range before you release the weapon. To avoid the worst of the flak that is deployed around the dam keep your speed around 600 knots and your altitude below 8,000 feet.

Mission 5

Early Warning Radar Site

Mission Objective

C3I Strike

Primary Target

Control Building

Secondary Target

None

Mission Briefing

If SAMs, AAA and fighters are the arms of an enemy air defence system, EW sites can be described as its eyes. These are the guys who alert the SAM, AAA and fighter crews to interrupt their tea break and get ready for you. At least, that is how it works in real life. As already mentioned, in EF2000, there is no indication that it makes the slightest difference if you approach stealthily at low level or high up with ECM and radar blazing for everyone to see. If the EW sites worked as they do in real life, the latter approach should earn you the attention of several waves of scrambled alert fighters, but it ain't so. Nevertheless, control buildings and radar globes are fun things to blow up and just in case DiD sort of activates these EW sites with a patch, we should be ready and know how to degrade their value significantly.

Arming the aircraft

EW sites are the second class of targets where Laser Guided Bombs come in handy. Not necessarily because of the danger of collateral damage, but because they are situated on mountain plateaus which are about 6,000 feet high, and there always seems to be bad weather with a cloud base around 9,000 feet when you have to attack them. This leaves you just 3,000 feet to play with if you use Iron Bombs. Unless you enjoy 'blind bombing' through the clouds, LGBs make your job easier. Thanks to their precision, one is usually enough, so take one on the underbelly station. EW sites tend to be heavily defended by SAMs and AAA, so take two ALARMs, just in case your WW escort does not make it to the target. Distribute A2A missiles of your choice on the remaining stations, since there are two refuellers up (one near the base and one near waypoint 3), you do not need to take additional fuel with you.

Flying the mission

As usual in the advanced simulator missions, you are not alone. You have an F111 escort jamming aircraft with you, and though the Tornados seem to have chickened out, there are 6 Hornets for the Wild Weasel role, probably not a bad replacement. They are already in the air and en-route to the target, so you better hurry and get airborne yourself. As with all long-range missions 40,000 feet is a good cruising altitude, you do not even need to refuel if you stay high for most of your flight.

Hardly surprising, you will attract the attention of a couple of Russian fighters on your way to the target. Do not be too shy about participating in these fights, they are usually just two of them and they are also concerned with your Wild Weasel and Jamming escort. Since aircraft tasked for those roles are not exactly lavishly equipped with long-range A2A missiles, it sort of falls into your area of responsibility to help the strike package reach the target. It is especially important to protect the Wild Weasel escorts, the are brutally effective when it comes to suppressing enemy air defences, probably the only area in EF2000 where AI pilots might surpass human pilots.

Depending on how good you were at protecting your WW escort, you will either have a milk run towards the target or may have to destroy the SAM and AAA nest near the target yourself to give your wingman a chance, he most certainly will not make it if there are still a couple of SAM launchers around.

Once you have taken care of all that escorting and wild weaselling, there is still the matter of the control building left for you to finish. Get under the clouds, bring up the TIALD screen on your central MFD and concentrate on a straight and level approach to the target. Remember that the target elevation is 6,000 feet, your best altitude is just below the cloud layer between 8,500-9,000 feet (Figure 15).

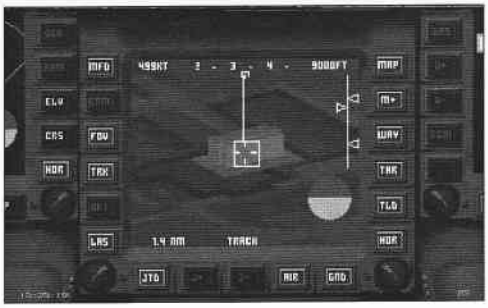


Figure 15: Just under the clouds

If you find the altitude and speed values to be suspiciously even in Figure 15, remember that the autopilot makes LGB bomb runs significantly easier if you have managed to lose half a wing on the way to the target... Just wait until all parameters are met (enable tracking and lasing and so forth) and release the bomb when everything looks okay. Do not waste your time looking through the HUD, due to the rapidly rising terrain and the low altitude at which you fly over the target (remember, it is just between 2,500-3,000 feet), the 'window' or amount of time in which you can release the bomb is somewhat shorter than it would be if you overflew the target at the usual 8,000-9,000 feet.

After you have destroyed the target, collect your wingman, climb up to high altitude again and head home.

Mission 6

Tunnel

Mission Objective

Interdiction

Primary Target

Southern Tunnel Entrance

Secondary Target

Northern Tunnel Entrance

Mission Briefing

Apart from bridges, tunnels are the second type of targets in EF2000 that belong into the 'Choke Point' category and the reasoning behind destroying them is therefore the same as with the bridges, take them out and the enemy will certainly have a problem with his resupply.

Arming the aircraft

Although your arming sergeant seems to regard tunnels as point targets to be hit with LGBs, you have to balance the required precision versus the danger involved in the predictable, straight line LGB attack. Actually, tunnels are not that difficult to hit with iron bombs or rockets, and as we have seen in the SAM mission, the enemy usually does not leave the choke points undefended, making a quick diving attack somewhat more suited to the situation. Therefore, take the basic A2A loadout of 2 ASRAAMs and 6 AMRAAMs, an underbelly fuel tank, two ALARMs and the dumb weapon of your choice, either Mk-83s or CRV-7 rockets.

Flying the mission

In this mission, you will again get an Escort and Wild Weasel support and a second strike package has decided to come to the party as well. This amounts to a total of 10 allied aircraft involved in this strike. When you have got that much support, it is safer to stay with the pack and follow the waypoints. Get up high for improved fuel efficiency and adjust your speed to keep close to the rest of the gang (499 knots will do fine). If you want to keep your refuelling skills current, you can top of your tanks shortly after takeoff.

Do not worry if some of the green dots representing your Escort and Wild Weasel flights deviate slightly from your route, they will stay close enough for mutual support.

Although there are quite a few enemy fighters up, this mission illustrates the 'Distance Rule' as far as enemy escorts are concerned. As you progress towards your target, you will notice that there are several fighters that do not get involved. These are the ones tasked with escorting the enemy AWACS. As long as you do not get too close to the AWACS and hence, become a threat, they will not mind you taking out their supply route.

Actually, if you follow the waypoints and keep your speed to around 500 knots, this mission becomes almost boring. The Escort and Wild Weasel flights flying in front of you will take care of the few enemy fighters that attack the strike package. So, you can either lie back and enjoy browsing through the fights or speed up a little and join the fun.

Whether you just enjoyed the uneventful cruise towards the target or helped to decimate the enemy's air force, you will eventually come up on the target. As with bridges, there are easy and hard directions from which to attack tunnel entrances, the difference being that there are two easy and two hard ones with bridges but there is only one easy direction from which to attack a tunnel entrance.

Tunnel entrances are usually surrounded by steep mountainsides on three sides, the only open way leading towards them is along the street and railway that enter the mountain through the tunnel entrance.

As with the bridges, do not follow the waypoints all the way to the target. Since your target is the southern tunnel entrance, turn right to get a little room and attack your target from more or less due North, following the street that leads towards it (Figure 16).

If things look like Figure 16, your pullout will lead you right to the secondary target. Dispatch it at your leisure (remember to use the street as run-in line) and get home.

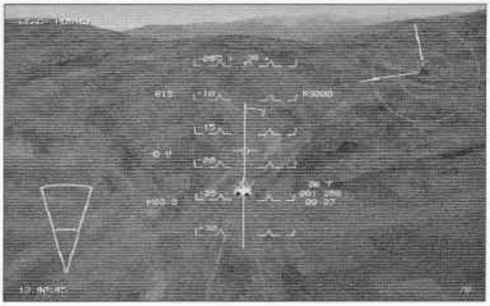


Figure 16: A different kind of Northern exposure

Mission 7

Harbour

Mission Objective

Interdiction

Primary Target

Warehouse

Secondary Targets

Fortified Marinas, Cranes

Mission Briefing

Apart from actually sinking the ships that carry the enemy's supplies, destroying the harbours that are needed to load and off-load those supplies is the next best thing to deny the enemy his seaborne resupply. In EF2000, harbours are virtual target bonanzas, not all that heavily defended and as you probably remember from the weapons training missions, the targets tend to be of the bigger variety, so they are easy to hit to boot.

Arming the aircraft

The distance to the target is comparatively short, so there is no need for additional fuel. Since we want to take advantage of the fact that we are heading towards a target rich environment, carry as much mud-moving ordnance as possible. Since ships and harbours are a somewhat logical combination, take two Sea Eagles as well. With these thoughts in mind, load up with 2 Sea Eagles, 2 CRV-7 rocket pods, and 3 Iron Bombs. The bare-bones A2A load of 2 ASRAAMs and 4 AMRAAMs completes the loadout.

Flying the mission

As you can see in Figure 17, it is rather quiet out. There are just two groups of enemy aircraft flying around.

Since this is your first night sortie, it might be just as well that you do not have to worry too much about

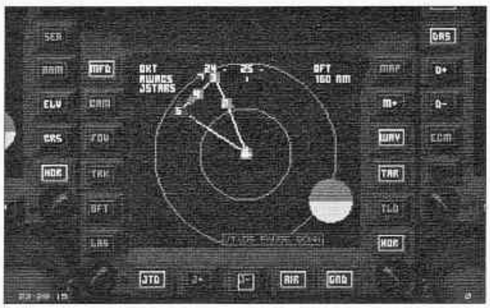


Figure 17: Quiet Night

the enemy while you are getting used to flying with reduced visual cues. Headquarters seems to agree with this evaluation, there is no Escort or Wild Weasel support, it is just your flight, two Escort Jammers and another strike group. Switch on your night vision goggles and get airborne.

As you fly along the route towards the target, you will notice that the red crosses denoting SAM installations are situated in the middle of the sea, meaning these systems are shipborne and not your usual SAM launchers. What a happy coincidence that you happen to have loaded two Sea Eagles, ALARMs would not have helped you the slightest against those SAM systems. So, as you turn towards waypoint four, bring up your Sea Eagles and dispatch the Slava class destroyer as well as the Neutrashimy class frigate. After you have fired the missiles, you should do a few 360s, or you and your wingman will be attacked by the shipborne SAM systems before your Sea Eagles silence them permanently.

Apart from the enemy 'fighters' which happen to be helicopters, the way to the target should now be clear, so concentrate on getting the parameters for your first pass right. At the target itself, there is the usual puffy flak waiting for you, so get below 8,000 feet for your attack run.

If, despite the night vision goggles, you still have problems making out the ground targets (those lights can be distracting), remember that reducing the Detail Level not only improves the frame rate but also removes the textures making your targets stand out. You can also use the waypoint cross which rests squarely on your primary target to set up the attack on the warehouse (Figure 18).

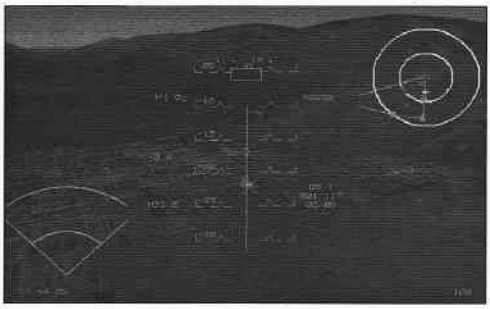


Figure 18

With all these aids, you should be able to make out the target and hit it. Use the rest of the targets to practice your night-time bombing skills, remember, one out of three campaign missions will be flown at night.

If you decide to take on the helicopters as well (or they make that decision for you), keep in mind that these are not the harmless transport helicopters found in mission 3, they are attack helicopters. Head on passes against them is just a way complicated way of committing virtual suicide.

Mission 8

Ships

Mission Objective

Anti-Ship

Primary Targets

Various Destroyers, Frigates and Oil tankers

Mission Briefing

Just because it is easy to destroy harbours does not mean we will forget about ships. The last strike has reduced the harbour's ability to handle traffic significantly, and this has led to a big backlog of ships awaiting their turn. Instead of directing them to different harbours to unload and service them, the enemy has just ordered them to anchor in the bay and wait until it is their turn. We are going to make them pay for that mistake.

Arming the aircraft

Unbelievable but true, the default loadout is almost exactly what the doctor would prescribe for a heavy anti-shipping strike, 4 Sea Eagles and 2 CRV-7 rocket pods should give you quite a punch. Just unload the underbelly fuel tank, the target area is a mere 100 miles away, so there really is no need for extra fuel.

Flying the mission

Headquarters is surging aircraft to take advantage of that opportunity and in the ensuing haste they have forgotten to assign you a wingman. Fortunately, enemy air opposition is light, and there are enough allied fighters around to help you out should you feel threatened by one of those helicopters cruising around. The enemies AWACS is constantly calling out are neutral fighters, they will not bother you.

Get in the air quickly and head directly towards the red crosses denoting the SAM equipped enemy ships, unless you hurry, there may not be enough targets left for you.

When the first of these crosses touches the 80 mile ring on your moving map display, bring up the Sea Eagles as your active weapon. The Air-Sea radar should depict a sea full of targets (Figure 19) and will have already have locked on to the first target.

Wait until the range is less than 60 miles before you fire the first missile. Switch to the next target, and fire when it comes into effective range as well. Repeat that process until all your Sea Eagles are gone. If each of your Sea Eagles hits its intended target, you have already done what the program regards as your share and will get the 'Enough enemies destroyed' message. Unfortunately, some may miss. They may have been fired just outside their effective range of 60 miles, in that case, you are to blame. On the other hand, the ship(s) may have

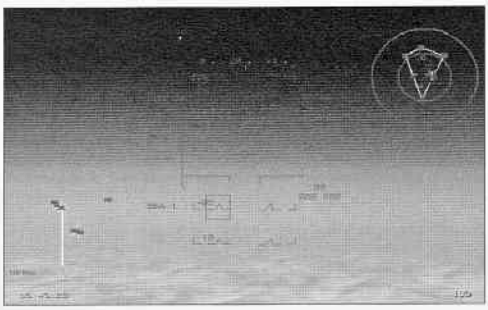


Figure 19: So many targets, so little ordnance.

been sunk by a missile fired from another aircraft. There is nothing you can do about it or could have done to prevent that wasteful double targeting. Unlike the A2A radar, the Air-Sea radar does not communicate with the sets in the other aircraft to show you which ships have already been taken care of.

But, you still have the rocket pods. Get beneath the cloud layer and use the red crosses on your JTIDS to lead you to the remaining ships, the Air-Sea radar becomes useless as soon as the last Sea Eagle is gone (you might want to save one to retain its services). Activate your ECM equipment, the warships are of course equipped with SAMs and AAA. The ECM will help you against the former, but you have to keep your speed up to neutralise the second. Switch your night vision goggles on, they make the visual search a lot easier. Roam the area and take out as many ships as you can before your ordnance runs out and you have to head home.

Mission 9

Oil Rig

Mission Objective

Strategic Strike

Primary Target

Oil Rig

Secondary Target

None

Mission Briefing

Just like in the Dam mission, the destruction of this mission's target would degrade the enemy's general fighting capability rather than have a direct impact on the fuel situation at the front. But, nevertheless, once those fuel reserves are depleted, the ability to produce replacements becomes very critical and you could immobilise more tanks by taking out a single oil-rig than with a whole squadron that does nothing else but shooting tanks.

Arming the aircraft

The default armament of four LGB and 2 Iron bombs is not exactly a ringing endorsement of our bombing CEP. You can safely exchange the GBUs for A2A missiles, and unload the TIALD pod as well. Two two Mk-83s should be more than enough to take out the target, and since the target is not that far away, you can leave the underbelly fuel tank at home as well.

Flying the mission

On this mission there is no direct support available, you are going to have to fight your way through to the target yourself. Although there are two more strike flights headed for the same target, they tend to get side-tracked and are not a big help against the target CAP.

The route to the target is essentially a straight shot, so just climb to the usual cruising altitude (40,000 feet+) and head for the initial point. Though there are quite a few enemy fighters up, they do not seem too keen to engage you, even the biggest group of six fighters to the right which cruises slowly towards you only engages after you have almost passed them. Just keep your speed up and continue on your course towards the target, you should be able to simply outrun any missiles fired at you. With a little luck, the enemy CAP over the target has already been shot down by a flight of friendly F-14s that happened to come by, so you are left with your original job, taking out the oil-rig.

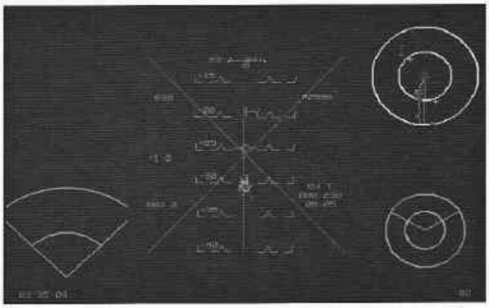


Figure 20: Better look for another gas station

Switch on your night vision goggles, bring up the Mk-83s and confirm that you still know how to deliver a devastating dive-bombing attack (Figure 20).

Mission 10

Tanks

Mission Objective

CAS

Primary Target:

Tanks

Secondary Target:

Trucks, SAM Launchers, AAA

Mission Briefing

The Eurofighter may also be used for Close Air Support missions. Unfortunately, the ground war has yet to come alive in campaigns, so if you really like to bust tanks, the Maverick weapons training mission and this one are the only ones where you will have the opportunity to do so.

Arming the aircraft

Since you have to destroy two tanks to get the 'Enough enemies destroyed' message, the default loadout with only two Mavericks is perhaps slightly optimistic. There is always the chance that the

Maverick's lock will jump off your intended target just as you release the weapon. Apart from the Mk-83, the Maverick is the only weapon in EF2000 with which you can destroy tanks, therefore, replace the cluster bombs with another pair of Mavericks and leave the fuel tank at home, the mission is just a short hop.

Flying the mission

NATO certainly means business on this mission, apart from your flight of two, there are four F-16s and six A-10s headed for the target area to wipe out the enemy. Support flights include four F15s and one lonely Harrier as escorts and four F/A-18s as Wild Weasels. If EF2000 modelled mid-air collisions, they could become the main concern on this mission. But since this not the case, you can concentrate fully on your targets, the enemy tank column.

Figure 21

As you approach the target area, you will notice the small village at the bottom of the valley. Your targets, the tanks, are on the hills on the right side of the valley, you are after the left of the two columns (Figure 21).

Dispose of the tanks first, since they are the reason you went on this sortie. It is actually not much more difficult than in the Maverick training mission, but due to the number of other ground vehicles populating the target area, it is easy to pick the wrong dot on the ground and waste the shot. Therefore, take your time and make sure that you really have a tank locked up before you fire the missile (you can use the IRST for target identification, when you are close enough, it will display a nice close-up of your target). After you have accomplished your primary mission, you can still humour your psychotic side by reducing the enemy's transport pool a little.

Chapter 9

THE ENEMY

AIRCRAFT & WEAPONS

AIR TO AIR TACTICS

GROUND BASED THREATS

CHAPTER 9

Chapter 9 The Enemy

Declassified Information on the strengths and weaknesses of the enemy.

By now you will have a thorough understanding of the capabilities of the Eurofighter. The performance chapter and the advanced sections on A2A and A2G combat provide all you need to know to maximise the effectiveness of your aircraft and its weapons systems. This chapter will give you a thorough working knowledge of the technical specifications and tactics for all the significant enemy threats.

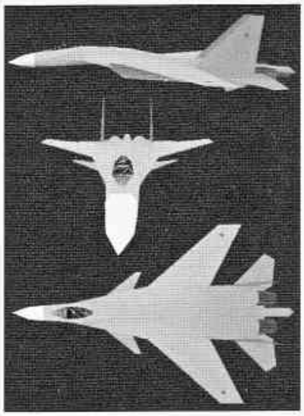
Part I Aircraft & Weapons

The following tables supply you with essential information on the abilities and typical mission armament for all the primary enemy air threats.

Su-35

Target Type – Soft   DASS Code 1

Within EF2000 the Su-35 is the primary air threat. Deployed in significant numbers you will find more often than not that if you get flamed in a dogfight it will be at the hands of an Su-35.



Su-35

Critical Performance Table Su-35

	Sea Level	20,000 feet	40,000 feet
Top Speed	690	925	1250
Corner Velocity	261	357	526

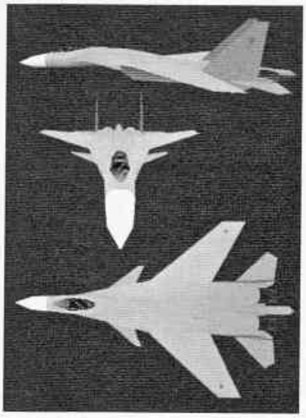
Typical Loadouts

Although the manual refers to the Su-35 as possessing 14 pylons only 8 of these are ever used in the game.

CAP	2 Aphids
	4 Archers
	2 Alamos
Intercept	2 Aphids
	4 Archers
	2 Alamos
Anti-Ship	2 Aphids 4 Archers 2 Moskit

Escort	2 Aphids
	4 Archers
	2 Alamos
WW	2 Aphids,
	4 Archers
	2 Kilters
Ground Attack	2 Aphids 4 Archers 2 S5 Rocket Pods

Strike	2 Aphids
	4 Archers
	2 KAB 500s
	or 2 FAB 500s
	or 2 FAB 250 HDs (for runways)



Su-33

Su33

Target Type – Soft DASS Code 1

Virtually identical in appearance to the Su-35 you will be unable to tell them apart visually unless you utilise one of the exterior views that gives aircraft identification details. In combat however, the more experienced pilot will be able to recognise an Su-33 by the higher speeds (compared to the Su-35) at which it likes to dogfight. This can lead the unwary into a merge at the wrong speed.

Critical Performance Table Su-33

	Sea Level	20,000 feet	40,000 feet
Top Speed	670	900	1190
Corner Velocity	326	447	659

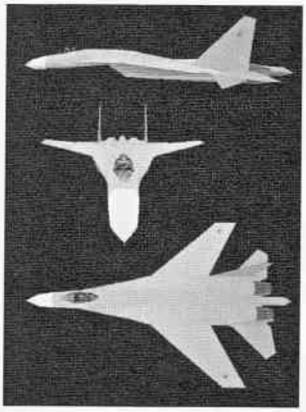
Typical Loadouts.

Although the manual refers to the Su-33 as possessing 10 pylons only 8 of these are ever used in the game.

CAP	2 Aphids
	4 Archers
	2 Alamos
Intercept	2 Aphids
	4 Archers
	2 Alamos
Anti-Ship	2 Aphids 4 Archers 2 Moskit

Escort	2 Aphids
	4 Archers
	2 Alamos
WW	2 Aphids,
	4 Archers
	2 Kilters
Ground Attack	2 Aphids 4 Archers 2 S5 Rocket Pods

Strike	2 Aphids
	4 Archers
	2 KAB 500s
	or 2 FAB 500s
	or 2 FAB 250 HDs (for runways)



Su-27

Su-27

Target Type – Soft DASS Code 1

Although a little outdated compared to its canard equipped derivatives, the Su-27 is still nonetheless a formidable threat, especially at low level where, like the Su-33 it is able to sustain its corner velocity. A testing opponent even for a relatively clean Eurofighter.

Critical Performance Table Su-27

	Sea Level	20,000 feet	40,000 feet
Top Speed	710	965	1260
Corner Velocity	342	468	690

Typical Loadouts

Although the manual refers to the Su-27 as possessing 10 pylons only 8 of these are ever used in the game.

CAP	2 Aphids
	4 Archers
	2 Alamos
Intercept	2 Aphids
	4 Archers
	2 Alamos
Anti-Ship	2 Aphids 4 Archers 2 Moskit

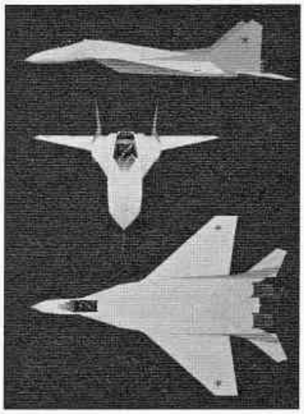
Escort	2 Aphids
	4 Archers
	2 Alamos
WW	2 Aphids,
	4 Archers
	2 Kilters
Ground Attack	2 Aphids 4 Archers 2 S5 Rocket Pods

Strike	2 Aphids
	4 Archers
	2 KAB 500s
	or 2 FAB 500s
	or 2 FAB 250 HDs (for runways)

MiG-29

Target Type – Soft DASS Code 1

A smaller compliment of A2A missiles than the Sukhoi's and conservative performance within EF2000 ease the MiG into the lower threat category. However, the much higher speeds at which the MiG will enter and manoeuvre in dogfights can embarrass a Eurofighter pilot whose staple diet has been Su-35s.



MiG-29

Critical Performance Table MiG-29

	Sea Level	20,000 feet	40,000 feet
Top Speed	740	1000	1320
Corner Velocity	423	579	853

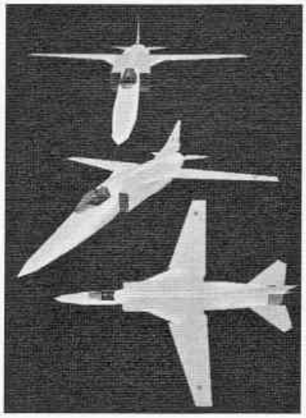
Typical Loadouts

The MiG-29 has 6 pylons.

CAP	2 Aphids
	2 Archers
	2 Alamos
Intercept	2 Aphids
	4 Archers
	2 Alamos

Escort	2 Aphids
	4 Archers
	2 Alamos
WW	2 Alamos
	4 Kilters
Anti-Ship	2 Aphids 2 Alamos 2 Moskits

Strike	6 KAB 500s
	or 6 FAB 500s
	or 6 FAB 250 HDs (for runways)
Ground Attack	2 Alamos 2 Kerry 2 Rocket Pods



MiG-27

MiG-27

Target Type – Soft   DASS Code 2

Seriously dated, the MiG-27 should be easy prey for all Eurofighter pilots, even those burdened with extensive A2G stores. The absence of the deadly Archer from their wings severely limits their effectiveness. If you worry when you face this fighter re-read Chapter 6.

Critical Performance Table MiG-27

	Sea Level	20,000 feet	40,000 feet
Speed	***	***	***
Corner Velocity	399	546	805

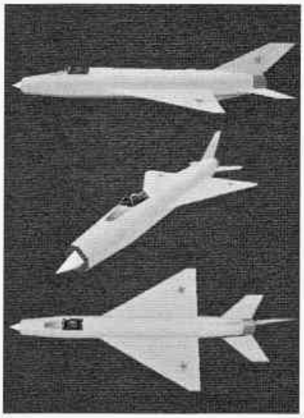
Typical Loadouts

The MiG-27 has 7 pylons, but only 6 are used in the game.

CAP	2 Aphids
	4 Alamos
Intercept	2 Aphids
	4 Alamos
Escort	2 Aphids
	4 Alamos

WW	4 Alamos
	2 Kilters
Ground Attack	2 Alamos 2 S5 Rocket Pods 2 Kerrys

Strike	2 FAB 500s and 4 FAB 250s
	2 Aphids and 4 FAB 250s HD (for runways)
	or 6 KAB 500s



MiG-21

MiG-21

Target Type - Soft   DASS Code 2

Even though constant avionics upgrades have kept the MiG-21 in the fight it is horrendously outclassed in EF2000. Yet, the Russians have recognised this fact and have therefore aimed to keep the MiG-21 out of close quarters combat by loading it with 4 Alamos and no IR missiles at all.

Critical Performance Table MiG-21

	Sea Level	20,000 feet	40,000 feet
Top Speed	***	***	***
Corner Velocity	383	525	774

Typical Loadouts

The MiG-21 has 4 pylons used in the game.

CAP	4 Alamos
Intercept	4 Alamos

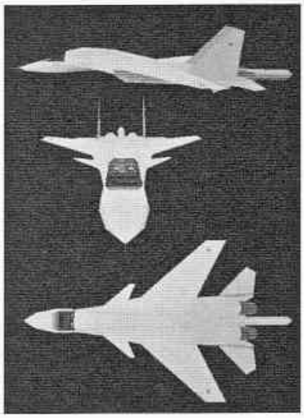
Escort	4 Alamos
Ground Attack	4 S5 Rocket Pods

Strike	4 FAB 250s
	or 4 FAB250s HDs (for runways)

Su-34

Target Type - Hard   DASS Code 2

The Su-34 is fairly agile and able to keep an average pilot at bay for what could be vital seconds. Whilst it will naturally take more cannon rounds to destroy than a fighter, an adept pilot should really have no trouble with an Su-34. Any missiles used to hasten its demise could be sorely missed should a fighter arrive.



Su-34

Critical Performance Table Su-34

	Sea Level	20,000 feet	40,000 feet
Top Speed	***	***	***
Corner Velocity	***	***	***

Typical Loadouts

Although the manual refers to the Su-34 as possessing 10 pylons only 6 of these are ever used in the game.

Strike	6 KAB 500s	WW	6 Kilters
	or 6 FAB 500s	Anti-Ship	6 Moskits
	or 6 FAB 250 HDs (for runways)	Ground Attack	2 S5 Rocket Pods

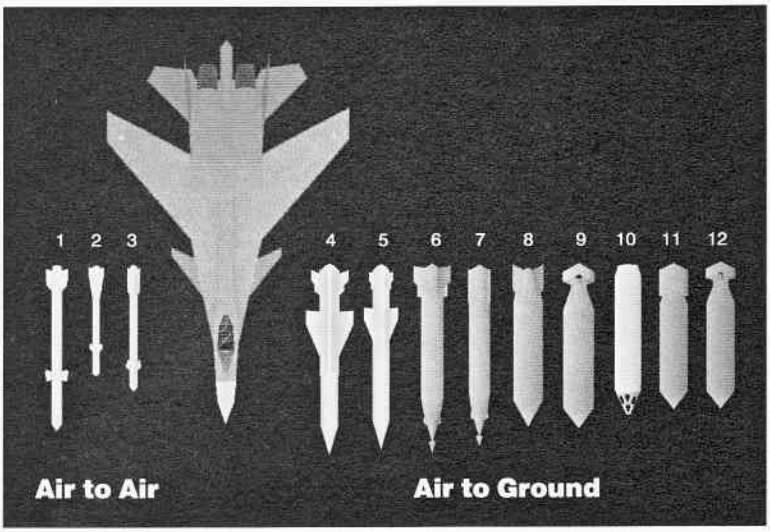
Enemy Ordnance

Air to Air

1. Alamo
2. Aphid
3. Archer

Air to Ground

4. Moskit (Krypton)
5. Kilter
6. KAB 500
7. KAB 1500
8. RBK 500
9. FAB 500
10. B8W
11. FAB 250 HD
12. FAB 250



Hard and Soft Targets.

Each enemy (and allied) aircraft is designated as either a hard or soft target. The differences are straightforward, but can have a huge impact on your air-to-air weapon selection and deployment tactics.

Hard Targets

In ideal conditions hard targets are able to withstand a single AIM-9, ASRAAM and even AMRAAM hit and continue flying and fighting. Only the S-225 carries enough punch to down a Hard target with one hit. All large aircraft, including refuellers, are considered hard targets. Due to their bulk and inherent strength your cannon is also less effective, so expect to require between one and a half to two times as many hits to destroy a hard target.

Therefore when you attack escorted strike flights, AWACS or refuellers it is more efficient for you to employ any S-225s you have against them, rather than their escort. The most destructive enemy missile is the Archer. It has the capability of downing an allied hard target in one hit.

Soft Targets.

Soft targets are everything else. Although they too can escape with only severe collateral damage as a result of a proximity hit from an AIM-9, ASRAAM or AMRAAM it is very rare indeed.

Enemy Air to Air Weapons

We now know the typical weapon loadouts for all the enemy airborne threats, whether engaged in counter-air or interdiction roles. Since it is unlikely that the enemy aircraft will attempt to bomb you whilst you are in the air, we will concentrate on the three types of air-to-air weapons that will be employed against you.

Alamo
Max. Range 35-45 miles

In EF2000 the Alamo falls between the S-225 and AMRAAM in terms of performance. It possesses approximately a 20 percent greater range than the AMRAAM, under ideal conditions, and flies at a similar speed. Figure 1 shows you a range comparison. In graphic terms this clearly shows the advantage of the S-225. However, due to the slow speed of the S-225 if you were to continue on a head on approach you will fall within the Alamo's effective range long before your S-225s have reached their target.

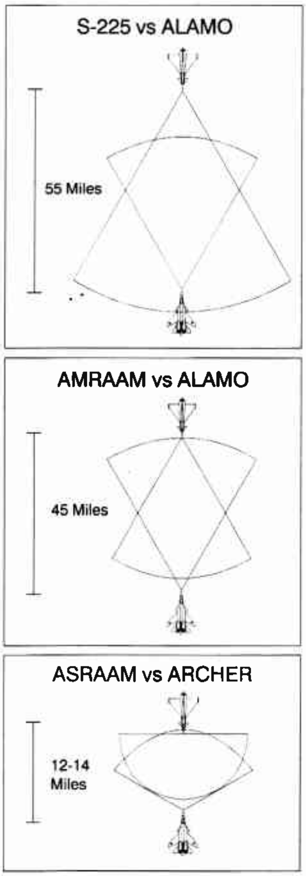


Figure 1

Archer
Max. Range 12-14 miles

The Archer has a similar performance envelope to the ASRAAM. Its over-the-shoulder capability is not as great and this is to some extent compensated for by a slightly better range. A high speed and superior front aspect acquisition and tracking enable the Archer to secure a higher percentage of head on kills than the ASRAAM. As such, the Archer is the deadliest air-to-air weapon you will face.

Aphid
Max. Range 3-5 miles

Although an all aspect missile, the Aphid is on a par with the AIM-9M in actual performance as modelled in EF2000. In anything other than a rear aspect shot against a slow moving target, the Aphid is more of a nuisance than a threat.

Enemy Weapons Deployment

Since the enemy is totally focused on ensuring your demise you will find that as soon as you enter their weapons envelope they will instantly fire on you. With all the enemy missiles this can work to your advantage. You need only present yourself as a target for short periods, long enough for the enemy to evaluate you as a threat and fire upon you, yet short enough to allow you to fly out of his weapons envelope in a matter of seconds. A series of such feint attacks can result in an enemy CAP or intercept flight expending all of its Alamo's at completely unco-operative targets.

If you choose to employ your long range missiles at the edge of their envelope you run the risk of allowing the enemy to perform the same manoeuvre on you. The majority of the time however, you will find that the enemy pilots are co-operative targets and will continue to fly towards you and deeper into your missile's envelope. If you decide to use

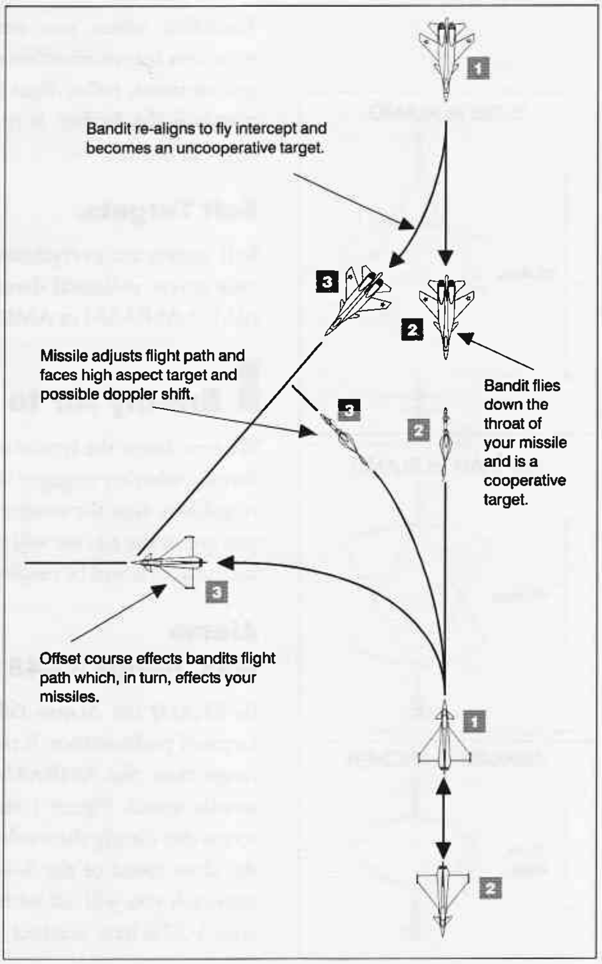


Figure 2

the T&BJF tactic it is important that you perform an accurate 180 degree turn, see Figure 2, to effectively fly the enemy into your missiles (point 2). If you were to fly more of an offset course (as in point 3) the enemy pilots will compensate, since they always fly pure intercept. As the enemy pilots realign to you, your missiles will also have to adjust their lead intercept to take account of their target's shift. This can result in missiles running out of fuel, being forced to intercept high aspect targets or having to contend with doppler shift.

Part II Enemy Air to Air Tactics

As we discussed in Chapter 4, when becoming embroiled in a dogfight enemy pilots will exclusively attempt to exploit the maximum performance from their aircraft. They will thus do everything they can to get themselves and you to fight at their corner velocity. Armed with this information and assuming you are by now competent in the execution of the scissors you should be able to turn most single plane engagements to your advantage, but, you must understand the varying strengths of each enemy aircraft you face.

As an example, first try a Custom-Air-To-Air, Guns only, medium altitude mission against an Su-35 and then a MiG-29. You will easily spot the difference in the dynamics and speed of the fight.

Against the Su-35 at medium altitude you will be keen to allow your speed to decay below 200 knots, do the same with the MiG-29 and you will find yourself in a boom and zoom fight reminiscent of World War II as the MiG consistently blows past you hot. Although you have a turn rate advantage on the MiG by flying to your corner velocity, this will result in a series of snapshots against a target moving twice as fast as you. Therefore you will need to adjust your flying to compensate for the different performance of each enemy aircraft.

By using the IRST sight to identify a target you can enter the merge at a speed that, following your break, will give you the most options against that particular aircraft type.

The most important thing to remember is to ensure you do not consistently turn too tight. It is very easy to achieve a high angle of attack in the Eurofighter which bleeds your speed at a phenomenal rate. Whilst this allows you to achieve tight turns and a smaller turning radius than the enemy, it leaves

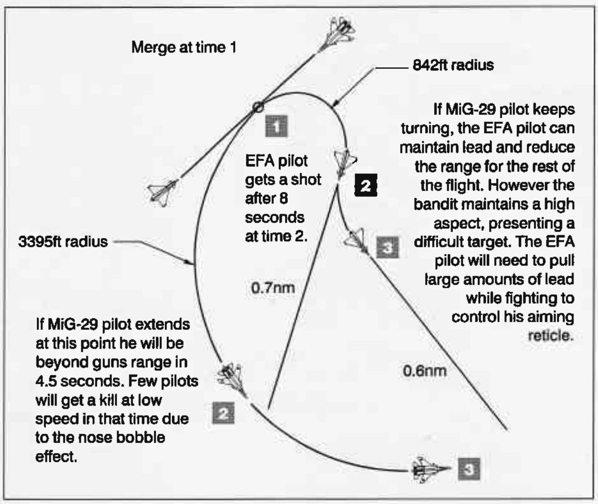


Figure 3

you slow and wallowing, hence expect to find yourself in a series of head on passes against an AI pilot who's gunnery skills are legendary. Figure 3 illustrates the dilemma faced by a Eurofighter pilot who starts a fight with a MiG-29 at 20,000 feet. For simplicity we will assume that both pilots will fly to their sustained turn rate.

By taking advantage of the substantial advantage in turn rate of the Eurofighter (7 degrees per second) it is easy to see how the EFA pilot will feel he is winning the fight. He will have had several long range snapshots between points 2 & 3 and will be able to see the velocity vector in his HUD showing lead, which he can sustain all the way round the circle.

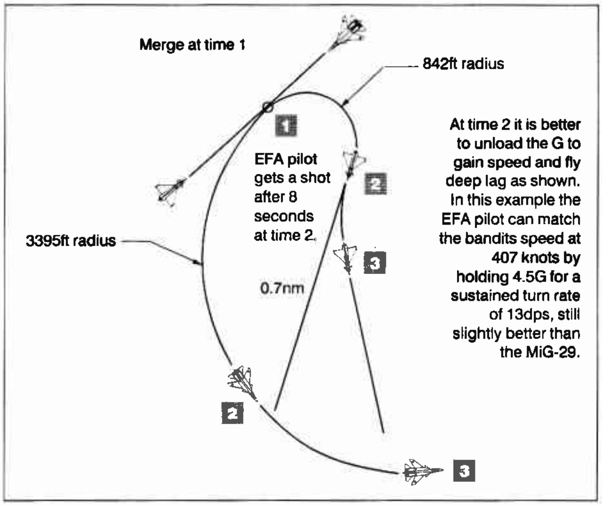


Figure 4

The downside to all of the above is:

1. The snapshots will be at extreme range against a fast moving target, even the best pilots will not have enough time to set up an accurate tracking solution and deliver enough hits to end the fight here.

2. As the MiG completes his circle he will possess more control authority, due to his higher speed and will have no difficulty lining up for the head on shot. Meanwhile the slow speed of the Eurofighter leaves our pilot struggling to bring his nose to bear with any sensible amount of precision, the pitch bobbling dominating his attention, the rest is that painful 'pinking' sound as MiG's rounds rip into him.

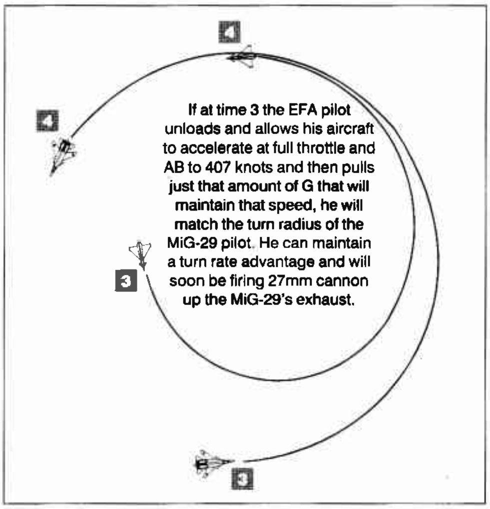


Figure 5

The simplest way to avoid the above is not to fly lead pursuit, see Figure 4. Ease off the G, push your throttle wide open, light the afterburner and get your speed up to 407 knots. Adjust your flight path so that you fly to the bandit's elbow, thereby increasing your turn radius to match his.

Then the fight will look something like Figure 5. Now it is simply a case of carefully regulating your speed by using the stick to increase or reduce G, leave the throttle wide open and afterburner lit. You now only need to pull 4.5 G to maintain 407 knots. As you close in on the MiG simply pull more G to convert your lag to lead and line up the shot.

Be aware that this will increase the duration of the fight, but virtually guarantees that you will not have to face a head on guns shot. An added benefit is that you will have more speed to spoof any missiles that might be launched at you.

Enemy Corner Velocity

Although the enemy pilots will attempt to fly to the corner velocity of their aircraft, as we already know from the performance chapter there are only two aircraft that can sustain their corner speeds at maximum G, the Su-27 and Su-33 and then only at sea level.

To overcome this problem the enemy will trade altitude to regain speed lost during a hard turning fight. You will have experienced this in dogfights already, as the enemy's speed drops below his corner he dives. Once he regains the speed you find he immediately employs it, rolling his lift vector back on to you.

One easy way to deny the enemy the ability to recover energy is to take the fight low. The enemy are adept at avoiding the ground, but not foolproof, so in addition to closing one window through which the enemy can escape to gain speed, you also introduce an immovable obstacle for them (and you) to fly into. Nevertheless, in most cases being low will be an advantage, since missiles fired from long range will also have to contend with the terrain around you.

Should you decide to take the fight to higher altitudes you will find that the turn radius of the best enemy fighter is almost three times your own. A dogfight at 40,000 feet therefore will quickly degenerate into a series of fragmented jousts, it being unlikely that you will ever have more than one fighter within a mile of you at any time. To prosper in such an engagement you must do everything you can to retain altitude. Do not allow yourself to be sucked low in a diving spiral. Without great care it will only be seconds before you find yourself some 15,000-20,000 feet lower and right in the heart of the enemy's optimum performance envelope.

Multi-Plane Tactics.

Single plane engagements should be meat and drink to the average pilot by now, however, one versus many dogfights require you to take a step further if you are to triumph.

Fighting three top line enemy fighters alone in a guns only engagement is a situation no one wants to find themselves in. However, in the most arduous campaigns it is very likely that you will need to expend all of your air-to-air missiles before your mission is complete. It is fairly certain therefore that you will at some point find yourself entering the early stages of a 'Guns Only' turning fight with more than one enemy aircraft.

Therefore it is important for you to understand how the enemy will fight and what you can do to maximise your chances of survival.

Enemy pilots.

Individually, the artificial intelligence (AI) pilots are easy prey. By understanding the strengths and weaknesses of their aircraft you will be able to fight them on your terms. As a pair however, the Russian pilots become formidable opponents, much greater than the sum of their parts. The lethality of the pair comes down to two major components. Firstly they have flawless communications, they know exactly what their wingman is going to do. Secondly, they do not care about getting flamed half as much as you do and are therefore willing to act as bait without regard to their own safety.

In order to triumph against multiple bandits you need to imagine you are actually fighting all the aircraft at the same time, it is vital that you do not allow yourself to suffer from target fixation.

The enemy will not queue up to fight you one on one, they will all be throwing punches at you throughout the fight, or attempting to get into position to land a blow. If you concentrate on destroying one fighter, it takes but a few seconds for the AI to recognise this and plot your demise based on the fact that they will be able to predict your actions and flight path relative to the target you have fixated.

To avoid falling into this trap you need to become unpredictable. This does not mean that you do not know what you are doing, only that the enemy should not. This is surprisingly easy to accomplish and with a little practice you will find that you will be able to beat superior odds most of the time.

The secret to defeating them is to keep your situational awareness at a level higher than you might have expected. As you merge with the enemy you should be cycling through padlock so that you know exactly where each bandit is and what it is doing. As you manoeuvre, engage the bandit that is the greatest threat to you, this will be the one which is likely to bring his cannon to bear first and in most cases will be the bandit which has turned the hardest and is thus physically closer to you.

By keeping a constant track of the targets in padlock, using the ■ key to cycle through them, you will find that it becomes prudent to swap targets frequently throughout the fight. Each time a bandit starts to slip out of your effective cannon range you should be looking for an alternative target much closer to you. Be wary of going head to head for a guns shot, unless you know you can bring your cannon to bear well before the bandit completes his turn.

This constant target switching forces the enemy pilots on the defensive. Since they work as a team, they always back one another up. As you switch the focus of your attention they have to re-evaluate which of them is threatened and adjust their flying in order to support the comrade now under threat.

The AI Trap.

The jaws of the AI trap are relatively easy to spot, especially if you have been keeping a constant vigil as the dogfight unfolds. You should only ever get caught by this if you are either severely damaged or recklessly careless.

As soon as an enemy aircraft you have been chasing unwinds the G and begins to level off, as soon as it looks a most inviting target, prepare to break violently. A switch to padlock will reveal his comrade in the closing stages of lining up a fatal gunshot on your six. Occasionally, you will have time to spray the bait bandit before you need to break, but you can only be sure of this after checking padlock - a quick view change is a small price to pay for your continued survival.

If you do spot the comrade saddling up behind you break hard towards him and kill your speed. This will present you to the bandit as a high aspect target which means fewer potential hits. It is likely that you can cause the chase bandit to overshoot as you initiate what may develop into the scissors.

Practice in the Custom Air To Air simulator will soon ingrain the components of this scenario into your subconscious. Your ability to spot the threat developing and reactions to counter it will become second nature.

Threat Signature.

During the course of a campaign there will be certain enemy aircraft that, no matter how hard you try to be and act inconspicuous, you cannot evade their attention. This will usually be CAP and intercept flights as well as escort fighters that you stray too close to. However, it is possible to minimise the threat that you to pose to enemy flights, at least in their minds, which can buy you valuable time. By shifting your flight path so that you are not pointing directly at them reduces your threat signature as does turning your radar off, or at the very least not attempting to lock them up.

When intercepting any type of strike flight that, for one reason or another, has no escort your threat signature can be very important.

By carefully plotting your intercept using only passive measures, such as JTIDS, the IRST and Padlock, it should be possible for you to get to within a few miles of the strike group without prompting them on to the defensive.

It is important that you get as close as possible, since a couple of miles can be the difference between an engagement that starts and ends in your ASRAAM's no-escape zone or a protracted dogfight-chase-dogfight as the strike group splits up.

When enemy strike flights hit their IP they will all but ignore any threats, concentrating their attention on the task in hand. Of course, if they have got that far you have almost failed, but, the IPs can be some distance from the target so if you can assess that the strike flight is running in your cloak of stealth can be discarded.

Damage.

The enemy pilots are as reluctant to take damage as you are, therefore, if they have the energy as soon as they take any hits they will immediately go defensive. The level and extent of their jinking is down to the conditions that exist when they are hit, for example their speed, altitude and the proximity of the offensive aircraft. The most common evasion technique is to roll and reverse the manoeuvre they were in when they took damage. With this in mind, you will find that small snapshots only add to your frustration as the bandit jinks more and more. By firing only when you are confident that the burst will destroy the bandit you can save yourself precious time.

As with the Eurofighter, the enemy planes can sustain varying levels of damage before a catastrophic failure or explosion. This accumulation of damage has an effect on their flight performance, as a guide, planes that are trailing smoke suffer between a 25 and 35 percent reduction in the G load that they can withstand. Unfortunately, the enemy pilots recognise this so, although you will not get to gloat as a bandit inadvertently rips his wings off in a high G turn, you will be able to take advantage of the degraded flight performance of his aircraft.

Part III Ground Based Threats

There are only two types of ground threat in EF2000, Anti-Aircraft-Artillery (AAA) and Surface-to-Air-Missiles (SAMs). Both can be found defending sites of importance and certain ships mount both SAMs and AAA.

AAA

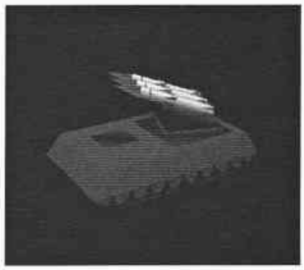
Effective Range: 1.8 miles DASS Code 3
Damage to destroy:
4 direct 27mm hits, 1 CRV-7, Maverick or Alarm.

ZSU-23

In terms of damage potential, AAA is as lethal as enemy airborne cannons, fortunately it is not as accurate. In general AAA only becomes a problem if you are either flying slowly or in a straight line.

As we discussed in the A2G chapter, you need only keep your speed above 600 knots and your chances of being hit by AAA are remote.

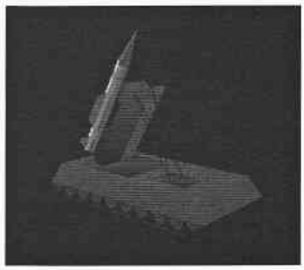
When positioned around airfields you will find them at the end where the enemy aircraft become airborne. Therefore if you are about to engage an Alert fighter that is scrabbling into the sky it is likely that you will find his first break is directly over his AAA. If you follow at a slow speed do not be surprised to pick up punishing damage as you pirouette above active AAA units.



SA6

SAMs

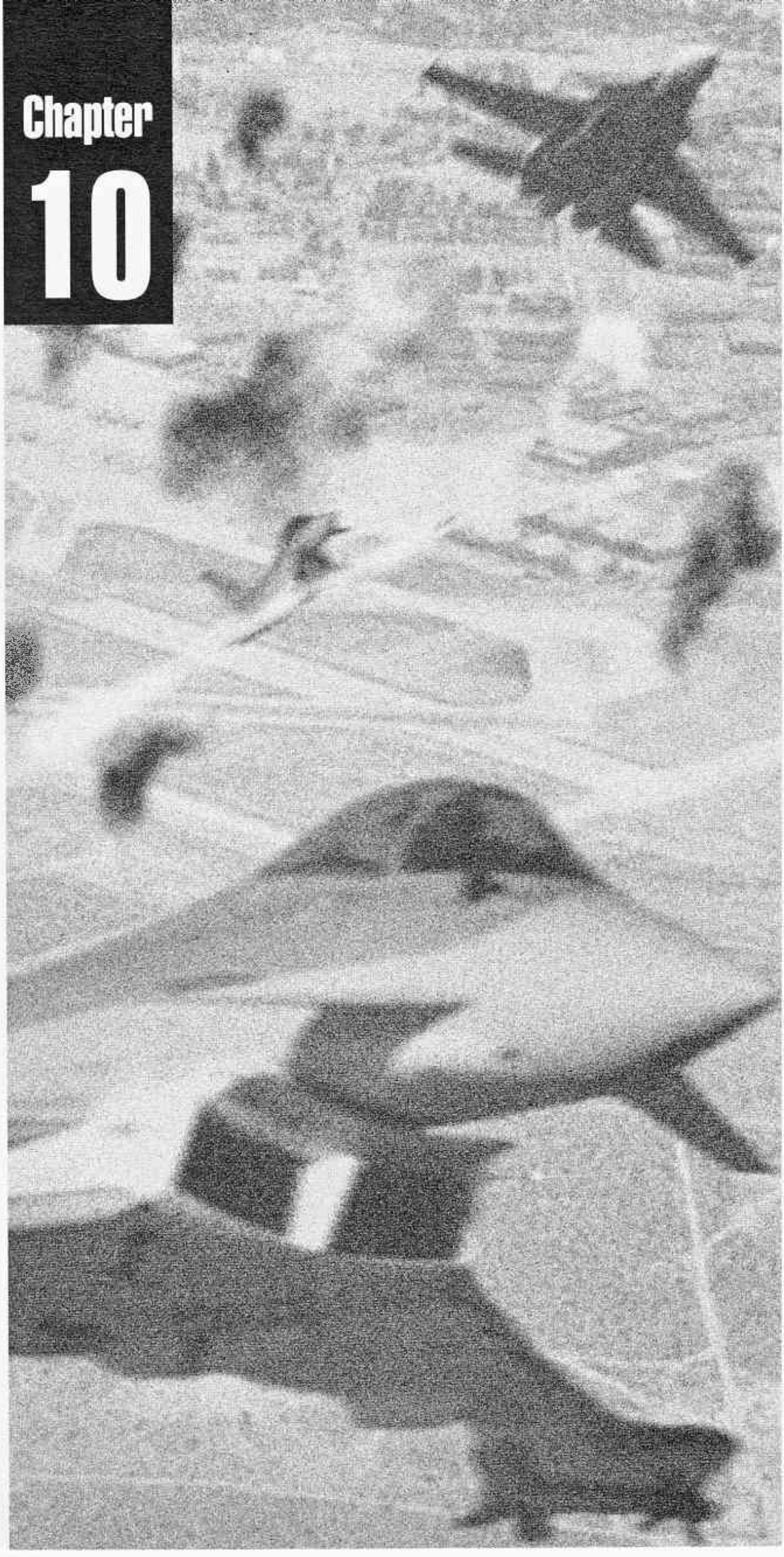
Effective Range: 18-20 miles DASS Code 3
Damage to destroy:
4 direct 27mm hits, 1 CRV-7, Maverick or Alarm.



SA11

SAMs pose a much more significant threat than AAA, since a single hit can inflict fatal damage. With improved resistance to ECM in the TactCom upgrade, SAMs are the greatest threat after frontline fighters. The most dangerous part of their threat envelope is close range, 1-2 miles. At this stage in its flight the SAM is relatively slow and hence more manoeuvrable. At speeds of less than 500 knots it is almost impossible to spoof a SAM launched within a mile of your aircraft. At greater ranges and high altitudes SAMs can be treated like any other missile, barrel rolling and terrain masking work equally well.

Chapter 10



SOLO CAMPAIGNS

DIFFICULTY AND MISSION SELECTION

EDITING AND PLANNING MISSIONS

ARMING AND TACTICS

CHAPTER 10

Chapter 10 Campaigns

No matter how much fun training and simulator missions might have been, campaigns are probably the main reason why you are playing EF2000. In addition to the core flight simulation, DiD has also included its WarGen engine to provide you with a fluid and dynamic campaign where you will never quite know what will happen on your next mission. Though some aspects of WarGen are not as perfect as most of us would like (the missing ground war being the main complaint), the missions are still more difficult, challenging and therefore ultimately more interesting than the canned missions found in other simulations. You are going to find yourself immersed in a war simulation where missions are being flown throughout the whole theatre of operations. You and your mission will be just a part of the whole picture. Nevertheless, your influence can be decisive, and this chapter is designed help you to make the right decisions on both the strategic (how to win the war) as well as on the tactical (how to win a mission) level.

Part I

Difficulty and Mission Selection

Selecting Campaign difficulty

When you decide to start a new campaign, you will immediately notice one of the biggest differences between the original EF2000 and the TactCom release. Instead of being instantly dropped into the mission selection screen, you will find yourself facing the screen where mice and men are separated.

In contrast to the three (always changeable) difficulty levels available in previous versions, the setting you choose at this point will stay with you all the way. If you get second thoughts about your choice while you are conducting the campaign, you have to start over - there is no way to change the setting from within the program once you have passed this screen. In addition, you can also select if the player's performance (yes, that means you!) should influence the course of the campaign. If you select no, you will just take part in a very complicated game of chance and your best efforts might be wasted just because your PC's random number generator has had a bad day.

On top of that, the selected difficulty level has also a direct impact on the campaign's initial situation. It can range from being still in possession of the better part of Norway (all the way up to Bodo) at Rookie level, down to having just the three Southernmost airfields left at the Topgun setting.

All things considered, this is not a decision to be taken lightly. The most important factor guiding your decision should be that playing flight simulations is about having fun. Do not go for the higher levels if you get your nose blooded over and over again, instead, select one which fits your level of ability and enables you to achieve victory most of the time.

Consider the Top-Gun setting for example. You will not only go up against the best of the best, you will also start with considerable numerical and tactical disadvantages. As already mentioned, you will usually start with only the three southernmost airfields still in NATO's hands, though you might get lucky once in a while and get

Bergen as your fourth base. With only three bases, either your JSTARS or your AWACS plane will already be out of the picture and you can consider yourself to be either very lucky or very good if the remaining intelligence aircraft survives day one. Even with four bases, it is likely that you will loose either the JSTARS or the AWACS plane during the first day.

Though the loss of the JSTARS plane might be survivable, the loss of the AWACS usually dooms the campaign. With NATO practically surrounded by the Russians, you will more often than not fly smack into the middle of a hornet's nest of Class-1 fighter CAPs. Even if you expand your DASS display to its full range of 80 miles, the enemy will become aware of your presence at the same time as you detect him. Hence, you cannot simply avoid fights through careful and early adjustments to your flight path, you have to wade through everything they send your way.

While it is not completely impossible to do it the hard way, you will probably fail more often than not for the simple reason of the lack of timely intelligence.

If you do not like to fight blindly, here is the way to avoid it. In EF2000, the danger to your AWACS and JSTARS is closely tied to the possession of Molde, the fifth NATO base. As long as you do not have it, your airborne intelligence platforms are in danger, but as soon as you have Molde, they are safe. To take advantage of that fact you have to wimp out a little and step the difficulty level down to 9.

At this level, you can be thrown into the war with anything between 3 and 5 bases in the Southern part of Norway. With 3 or 4 bases, you can very easily experience the same frustrating course of events as on the Top-Gun level, so recycle back to the main menu immediately. To make sure your AWACS and JSTARS are safe, you will have to repeatedly click on 'Start a new Campaign' until you have 5 bases, even if this smells a little like cheating, because life (and the campaign) are going to be lot more enjoyable that way.

Apart from the initial situation, the difficulty selection also influences how hard the actual fighting in the campaign will be. The following parameters are affected by your choice:

Effectiveness of Player and wingmen chaff and flares.

The higher the difficulty level, the less effective you and your wingmen's chaff and flares become.

Effectiveness of enemy chaff and flares.

Conversely, the enemy's chaff and flares will get more effective at the higher difficulty levels.

Ability of player's missiles to reacquire a lost lock

The higher the difficulty level, the less likely it is that your missiles will reacquire a lock once that lock has been broken.

Air tasking order of enemy planes in the campaign

The number of enemy aircraft you will have to face is also influenced by the difficulty setting, as is the way in which they are deployed against you. At the higher levels, the enemy will fight you more actively, which means they will launch a greater number of offensive missions like Strikes, Refueller or AWACS kills. You will also find that there are more CAP flights up than at the lower levels and those CAPs will be both larger and more dangerous, since they will usually consists of 4 Class-1 fighters instead of a pair of MiG-21s found at the lower levels. You will also encounter more escorted strike flights who's flight paths regularly cross yours.

Mission selection

In the early stages of a campaign, you will get a long list with all possible kinds of missions, including Airfield Denial, Strategic and Mobile Strikes, as well as Escort, Wild Weasel and CAP missions. As the campaign progresses and the number of available aircraft drops, this list will get shorter, but unless you only like CAS missions, which unfortunately will not appear in campaigns, you should find one of a kind you like. However, likes and dislikes should not be the prime factors which lead your decision. You should strive to select the mission which will have the biggest impact in a given situation. In order to determine which mission that might be, you have to know how WarGen decides which side is on a winning streak; we will disclose that right here and now.

Player Rating

In an EF2000 campaign, success depends on two factors, Player rating and base captures. During each 8 hour period, one of the two sides may capture air bases, and the Player Rating determines which side that will be. If the Player Rating is below 30 percent, only the Russians may capture bases, if it is between 30 and 70 percent, both sides will alternately have a chance to grab one, with NATO having the first chance. If the Player rating is above 70 percent, it will always be NATO which gets the opportunity to gain ground. Therefore, it is of utmost importance to get the Player Rating above 70 percent as soon as possible and to keep it there.

WarGen uses the following formula to calculate the Player Rating:

$$\frac{\text{Current Player Rating} \times 3 + \text{Overall Rating of Last Mission}}{4}$$

Since you will always start the campaign with a 50 percent Player Rating, both very good and very bad initial missions have a significant impact on your Player Rating. With just two excellent missions, you can push the Player Rating above the 70 percent limit beyond which only NATO can capture bases. On the other hand, fail spectacularly twice in a row and you will probably serve the Russians victory on a silver plate.

Overall Mission Rating

With all the different missions you get presented with at the start of a campaign, there will be some which are bound to be difficult, but more promising in terms of achieving a high score. At the start of a campaign, both sides will obviously have quite a number of aircraft flying around. If you choose a strike mission, for example, you will probably have to kill a couple of enemy CAPs to get to your target, not to mention the occasional strike package which you cannot avoid. While this is not impossible, and certainly presents a challenge, you may well get killed in the process. Even if you do not get killed it is likely that you will be forced to jettison your A2G stores to outmanoeuvre an especially obnoxious Su-35 and that would represent a mission kill which would not look good on the balance sheet.

On the other hand, if you are confident that you will make it through to the target, a successful airfield denial mission on the first mission cycle (in which NATO may capture bases) may very well result in an immediate base capture for NATO, especially since it has become a little easier to get a 100 percent Overall rating on a Strike mission in the TactCom version of EF2000.

The reason for this is that the way in which the Overall Rating is calculated is quite different in the TactCom version. Table 1 illustrates the criteria used by WarGen to calculate overall rating.

For all mission types, the following restrictions also apply:

- If you do not land the aircraft before you end the mission, your score will be reduced by 10 percent.
- If you eject, you lose 10 percent.
- If you get killed, your Overall Rating will be reduced by 20 percent.

One of the most important changes is that if you completely destroy the primary target on a strike mission, you have already earned your 100 percent score, and there is no need to kill another 5 targets as you had to in previous versions. On all other missions, it has also become a little easier to get a decent score by just doing what you were assigned to do, although there is still some incentive to go out and be all you can be.

Table 1: Overall Mission Rating Formulas

Mission Type		
Intercept / CAP	Number of Kills / Number of Missiles Fired	x 50 + (Number of Kills) x 10 (Up to a maximum of 100%)
Escort / Ferry	Number of Escorted/Ferry planes lost / Initial Number of Escorted/Ferry Planes	x 75 + (Number of Kills) x 10 (Up to a maximum of 100%)
AWACS, JSTARS Refueller, Escort	(70% If escorted aircraft survives, 0% otherwise) + (Number of Kills) x 5	(Up to a maximum of 100%)
Wild Weasel	Number of SAMS/AAA killed / Number of ALARMS fired	x 50 + (Number of AAA/SAM Kills) x 10 (Up to a maximum of 100%)
Strike	% of your target destroyed	
Wild Weasel	Number of Sea Eagle Hits / Number of Sea Eagles fired	x 70 + (Number of Additional Targets) x 10 (Up to a maximum of 100%)

One last piece of advice concerning initial mission selection. You should keep in mind that even a 100 percent score on the first mission will only result in a Player Rating of 62 percent for the second mission cycle in which it is the Russian's turn to capture bases. Due to that threat, you should augment NATO's defences during the second cycle to keep the Russians from capturing one of your bases. Concentrate on killing as many enemy bombers as possible, they are the ones who kill your ground mobiles and weaken your base. In addition, you should select the earliest possible takeoff time and use the re-arming feature extensively - but more on that later.

Base Capture

Once you have pushed the Player rating safely above 70 percent, it is time to learn how you can influence the capture of bases. Even with a rating well above 70 percent, you will not capture a base on each turn. In fact, you might not capture any at all. The Player Rating just determines which side will have the chance to capture a base, it does not influence the actual capturing process. Whether a base may be captured or not depends on its strength, which in turn is largely determined by the number of aircraft, SAMs, and AAA it has left when WarGen looks at it before generating the files for the next 8 hour period. Since there are usually quite a few aircraft, AAA and SAM batteries around an air base, you can see that all that near-suicidal strafing practice recommended in Chapter 7 will finally bear some fruit. To make things a little more challenging, the two base pairs Vaernes/Orland and Narvik/Andoya are treated as one big airbase by WarGen, so you have to whittle them both down if you want to capture them.

Although airfield denial missions are certainly the most decisive missions you can fly, that does not mean you should spend all your time in EF2000 levelling air bases. As long as your rating is above 70 percent, you might still sneak in the occasional anti-ship, strategic strike or interdiction mission just for the heck of it. On the other hand, if you have not captured an air base for a while, it might be a good idea to give your computer comrades a hand during the next mission cycles.

Last but not least, base captures also decide when it is all over. Though NATO will not admit defeat until all bases are in Russian hands, you need to push the Russians back until they are down to 3 bases to win the campaign. There is also the possibility that the war will not end until WarGen checks the overall situation, usually at the 00.00 hours mission cycle.

Part II

Editing and Planning Missions

As we have seen, mission selection is not a step to be taken lightly, but at some point, you will have to make up your mind. First we will take a look at some ways to enhance your chances for a successful flight and improve your run-of-the-mill, WarGen generated flight plan before we progress to full-blown mission planning.

Editing a mission

You can dismiss the types of flights where changing waypoints does not make much sense, typically defensive A2A missions like CAPs, AWACS, JSTARS and Refueller escort missions, as well as the ferry flights. Unless one of the waypoints lies smack on top of an enemy SAM site (somewhat likely if you started on the higher difficulty levels in a defensive posture) you can just leave the waypoints as they are.

With all other types of flights, there is usually room for improvement on the flight-plan WarGen has generated, to put it mildly. WarGen does not seem to have made the connection between enemy SAM sites and plane losses or between distance to fly and fuel consumption. Sometimes, it looks like the only requirements WarGen has to meet when generating a flight-plan is that the first and last waypoint coincide with your home base, and that one of the points in between should rest upon the target. Obviously, we can do a lot better than that.

Changing the route

Probably the single most annoying feature of a WarGen generated Strike mission flight-plan is the fact that it usually routes your flight through the thickest enemy SAM site concentrations on the map. While your flight will be relatively immune to SAMs as long as you keep your ECM on, your Wild Weasel escort tends to fire on the first SAM site that locks them up, wasting their precious ALARMs on targets that should not concern them.

It is not difficult to make a computer-generated flight-plan safer and more sensible, you just need to keep two things in mind - keep it

Figure 1. WarGen's flight-plan.

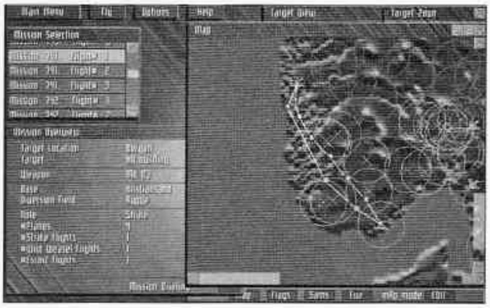


Figure 2. Player adjusted flight-plan

Figure 3:The Strike package

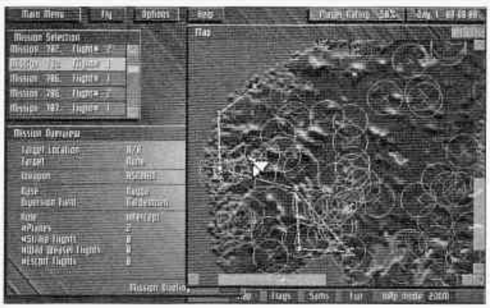


Figure 4: The Refueller kill

short, and avoid enemy SAM sites. Figures 1 and 2 show you how to implement these rules.

Though the WarGen generated flight-plan might follow a more scenic route, it is nevertheless a little hard to understand why you should cruise for ages through enemy airspace before you finally strike your target (just in case it is a little too difficult to recognise, your target is Bergen, where the cursor rests). As you can see, the adjusted flight-plan keeps you under Allied SAM protection for most of your flight, although that support is largely symbolic (they do not seem to be very eager to shoot down enemy fighters), so you should still be prepared to fend off airborne attacks while you are over Allied territory, but at least you will not be bothered by enemy SAMs. Additionally, the shorter route allows you to complete the flight on internal fuel, enabling you to take more weapons with you.

If your mission consists of more than one flight, WarGen will automatically adjust the flight-plans of the accompanying flights for you. This will only become apparent after you have taken off, so do not switch to the other flights to check if the changes were made. If you do, the changes will be deleted and WarGen reverts back to the original flight-plans.

Combining missions

Another way to improve your chances for success is through the concentration of forces. If you are one of the slightly aggressive, psychotic souls who wants to blow up things from day one, 00.00 hours, you can improve your chances of getting through by combining your mission with one whose targets are within the same general area and whose takeoff times are fairly close. With the number of missions being generated in the early stages of the campaign, this is not as uncommon as it may at first sound. Figures 3 & 4 show the routes for two missions to the Molde area whose takeoff times are within 10 minutes.

The mission we will take a closer look at is the Refueller kill. These Offensive Counter Air missions normally come up on day one, when the enemy air force is still completely unblooded and intact; in fact, it is usually one of the very first missions to depart the allied bases. Nevertheless, you are expected to fight or sneak your way through all those 4-plane, Class-1 fighter CAPs out there with just one wingman. While this is not completely impossible, you will probably still need a combination of great timing and a hefty amount of luck to pull it off.

On the other hand, why not use some other allied fighters to keep the enemy fighters occupied while you blast their airborne service station out of the sky? To get this airborne bait, simply scroll through the mission list and look for a strike package whose target is close to where the refueller is supposed to be. Look at the takeoff time as well as the route they will take to the target. If they depart from the same base as you or one that is nearby, their takeoff time is close to yours and the WarGen generated flight-plan (at least the ingress part) does not look like a recipe for suicide, note their mission number and get airborne.

If they do not depart from the same base as your flight, get over to the base where the package will takeoff from, and set-up a slow circle over the base. Switch to browse view and keep one of the package's planes in view so you do not miss them when they takeoff. The actual takeoff time may differ slightly from the one given in the mission briefing, but they should eventually get on with it. When they do, stay close and do not waste your missiles on every CAP that fires at them (you are not, after all, escorting them). However, if it looks like they are about to be annihilated, you should help a little to prevent that from happening.

As you get close to the target area, let the remains of the strike package take the lead by about 15-20 miles, and when they came under attack by the enemy CAP, blast through (either at 40,000 feet with the throttle wide open or stealthily below 200 feet), locate the refueller and kill it.

In the same vein, albeit a little more complicated, it is also possible to combine two strike packages. If you find two that fulfil the basic preconditions regarding departure point, target and takeoff time, select to fly the one whose ingress route looks more hopeless. Change the waypoints to match the route of the other strike package as closely as possible (remember, you can not switch back and forth to check the placement of the waypoints, all changes to a mission will be lost as soon as you look at another one) and get in the air. If your flight takes off first, you might want to position the second waypoint a little way off perpendicular to an imaginary line connecting the waypoints one and three. This should enable you to pass the time while the other strike package takes off, and to keep your package intact (your Escort flight will stay with you whatever you do, but the Wild Weasel flight will follow the route independently). Even if the timing does not work out right and your Wild Weasel flight goes on its way to the target without you (or falls behind when you accelerate to catch up), you are not necessarily worse off, because the other strike package should be accompanied by a Wild Weasel flight as well, and you still add another escort and another strike package to your flight. If everything works as planned, the enemy should look at a monster package of 20 aircraft coming its way, and even the toughest AI Su-35 driver might feel a little apprehensive facing those odds.

Vigilante Tactics

The last way to augment computer-generated missions is through 'Vigilante Missions', which means that you should wreak havoc wherever and whenever possible. As long as you have ordnance left, your plane is relatively undamaged and it would not amount to virtual suicide, you should try to expend any remaining ordnance on something that will hurt the enemy. Prime candidates are, of course, air bases and the mobiles found at them.

If you are rather fond of surprising the enemy, you can use the Ferry Flight missions as a base for some unscheduled raiding. Take a look at the map to find a prospective target site close to the forward air base to which you are going, load the weapons you need for your target of choice and takeoff. The first requirement for a successful Ferry Vigilante mission is that you get all your wingmen safely to the forward base. If you still have them with you when you enter enemy territory, you are bound to loose a few and that will ruin your Overall Rating. Simply follow the route to the destination and ask for permission to recover. Once granted, your wingmen will promptly land and you will have that particular problem solved. You are now free to roam through the enemy airspace and take pot-shots at all kinds of targets of opportunity.

Thanks to the new Rating formulas, changing Ferry Flights to Vigilante missions is a very easy way to get an excellent Overall Rating with comparative ease as long as you do not get yourself killed in the process. As soon as your wingmen have landed at their destination, you have already got a 75 percent Overall Rating, the enemy will have no scheduled CAP in the air since they do not expect your visit and you just need to get 2 or 3 additional targets (unsuspecting SAM launchers, for example) to earn your squadron commander's approval.

The only other way to improve a computer-generated mission is not to fly one at all. Instead, we will dedicate a little time to the biggest addition TactCom brings to the basic EF2000 package.

The Mission Planner

Until the release of TactCom, you were stuck with the targets WarGen picked for you and the most desired feature for the Add-On was a Mission Planner to change that. The tool to create your very own missions has arrived, and we will use it to maximum advantage.

You can enter the Mission Planner at any time you have free (unused for computer-generated missions) EFAs to play with. Once inside, you will soon discover that the Mission Planner should be more appropriately called the 'Strike Mission Planner', because it does not allow the creation of purely defensive CAP or Escort missions. Apart from that small restriction, you are completely free to set up strikes with up to 16 aircraft. The mechanics to set up a mission are explained in the TactCom manual, therefore we will primarily concentrate on the small but important bits and pieces to enhance the chances for a successful mission.

Selecting Target Class and Target Site

Somewhat logically, when you plan a mission, you should still strive to follow the two main rules laid out for mission editing - keep it short and avoid SAM sites. It will sometimes be a little difficult to adhere strictly to the first rule - for starters, your free fighters will not be at the forward bases. Secondly, you will find that a lot of the targets near the front line will be either inoperational or already fragged for a computer-generated strike. You can determine if a site is already fragged for a computer-generated strike by looking at the bottom left corner of the Mission Planner screen, if the 'Targeted' label is followed by a number greater than zero, the site you are looking at will be visited by allied planes within the next 8 hours.

Though you could ensure that you will arrive at the target first by picking the earliest takeoff time possible, you would essentially create a double mission which would be a waste of resources, since the computer-controlled flight might reach the target only to find that it has already been hit. Therefore, no matter which target class you select, pick a site that has definitely not been targeted yet.

Determining Strike Size

The next steps are to pick your base, determine the number of aircraft you want on the strike and to assign them their role in the strike package. Although you can take up to 16 planes, it is somewhat doubtful whether it is beneficial to use that many. As a first step, it is a good idea to start assembling the package by using 4 aircraft as Escorts. As far as the two strike flights are concerned, the main problem is that computer-controlled planes are still not that good at hitting ground targets, while they are very good at being blown up by the enemy. If you use a full compliment of seven computer-controlled strike aircraft in two strike flights, you may look at seven doomed planes for little or no return and you might sorely miss those aircraft when you want to enter the Mission Planner the next time around. Therefore, you should leave the second strike flight at home. The decision as to how many (if any at all) wingmen you should include in your strike flight depends on the air threat you expect to face. If the campaign is already in its later stages and you have been pushing the Russians back for a while you probably will not need any wingmen to back up the regular Escort. If you are going after an enemy air base, a Wild Weasel escort is probably a good idea (remember, AAA/SAM and base strength). All things considered, a 9-plane strike package (you as the solitary striker, 4 Wild Weasel aircraft and 4 Escorts) is probably the most effective way to do business with the Mission Planner.

At face value, this seems to be a contradiction of the 'concentration of force' advice given in the mission editing section, but it is actually not. The aircraft you combine when you merge two computer generated missions would go on those missions anyway and you are, in a small way, just keeping WarGen from committing its forces piecemeal. On the other hand, the aircraft you do not use on a Mission Planner mission will not be used elsewhere and you are helping to preserve your forces if you do not endanger them needlessly.

Selecting Aircraft Types

If you decide to go with a big pack anyway, there is also the option to change the aircraft types for all groups except the one you fly in. Although the mission planner offers you the full range of allied (and neutral) combat aircraft to choose from, you should not simply take the ones you like best with you, since most aircraft actually represent a step back compared to the Eurofighter's capabilities. There is, for example, no other plane besides the Eurofighter that can carry 6 long-range and 4 short-range missiles in the Escort role. The F-16 with 6 AMRAAMs and 2 ASRAAMs comes close, but lacks the capability to carry the long-range Allied A2A missile, the S-225. On the other hand, there are a couple of aircraft types which can make the Wild Weasel and Strike groups a little more effective.

The most effective aircraft in terms of ALARM carrying capability is the A-10, which can carry up to 10. Unfortunately, the A-10 is not a fast plane and if you want them to stay with you, you have to adjust your speed to what they are capable of, which is a top speed of around 340 knots. If you want something that can keep up with you, the next best plane for the Wild Weasel role is, rather surprisingly, the F-14 Tomcat, which can take 6 ALARMs. If you think that this stretches realism a little too far, the Tornado IDS with 5 ALARMs should get your approval.

If you want a bigger punch for the strike package, the prime candidates are the Harrier with 7 GBUs, the JAS-39 with 6 GBUs or the F/A-18 which can also carry 6 GBUs. One thing to keep in mind though is that all these aircraft share one disadvantage, their defensive armament with the mentioned loadouts ranges from minimal at best (2 AMRAAMs for the F/A-18) to non-existent for the rest of the aircraft. Thus, if you are not sure whether the route to the target will be relatively clear of enemy fighters, you might want to give the Eurofighter another go, it will always have a proper defensive loadout.

What to hit and how to get there

After you have decided on how many planes and which types you want to participate in the strike, you have to assign targets. In that context it is useful to know exactly which targets have to be destroyed to close down an enemy installation.

Installation	Critical targets
Air bases	Runway & Control Tower
Early Warning Radar Sites	Control Buildings & Radar Globes
Harbours	Fortified Marinas & Dockside Cranes.

Once you have determined the strike's size and assigned targets, waypoints are next. In addition to keeping the route short and clear of enemy SAM sites, you should consider including a refuelling waypoint depending on the distance to the target. Set the waypoint heights to a fairly high number, since altitude improves your fuel efficiency as well as the effectiveness of your long-range missiles.

If you have been rather successful in conducting the campaign, you will discover that it is hard to find enough ground targets to blow up at any one place in the later stages of a campaign. Select a secondary target site and place a waypoint over its location to give you the chance to distribute any unused armament on something useful.

Bingo bases

As far as distance to fly is concerned, there is obviously no way to avoid the long transit flight from the rear base to the target, but you do not have to go all the way back once you have hit the primary and secondary targets. Though it is important to bring the aircraft back in one piece, it does not matter which base you return it to. Just set a waypoint over the Allied base that is closest to your targets to mark it as your unofficial Bingo Base and to have its position fed into the navigation computer. After you have hit your targets, you can simply bring up that waypoint (you do remember which number it was, don't you?) and enjoy the abbreviated trip home.

Speaking of home, to make lining up on the runway a little easier, you should place the next to last waypoint about ten miles from the air base on the extended runway centre line. Table 2 gives you the runway headings for all air bases in the Scandinavian Theatre of Operations. (Incidentally, you can also use this table to place the IP for a runway attack if you do not want to use the ILS to line up for the Durandal run).

Table 2: Air Base Runway Headings

Runway Heading	Base(s)
16/34	Kristiansand, Bergen, Molde, Orland, Narvic, Hammerfest, Kirkenes, Severmorsk, Apatity, Chalmy Varre, Alakurtti, Sovayarvi, Suoyarvi, St. Petersburg, Shimsk, Tikkakoski, Myland, Pori, Helsinki, Talin, Vaxjo
09/27	Rygge
01/19	Gardemoen, Visby
09/27 and 14/32	Vaernes
08/24	Bodo
15/33 and 03/21	Andoya
11/29	Bardufoss

The last thing you need to do is to pick a takeoff time, and you are almost ready to blast off.

Part III

Arming and Tactics

Arming the aircraft for an A2A mission does not present much of a problem. Since it is desirable to do as much damage as possible from long-range, you should take just 2 ASRAAMs on the outer pylons and use the rest for long-range missiles. Due to the enhanced lethality of the S-225 in the TactCom version, it is the prime choice for the remaining pylons, though you have to take at least 2 AMRAAMs with you because the next to outer pylons are weight limited and will not support the S-225s. It is not a bad idea to have two pairs of AMRAAMs handy, the long minimum range of the S-225 would otherwise leave a considerable gap in your engagement envelope. Last but not least, the underbelly pylon will not take any A2A weapons anyway, so you can carry an external fuel tank on it without sacrificing any tactical options.

For A2G missions, things are slightly more complicated. Though you do not have to take out five additional targets as before the release of TactCom to get the maximum score of 100 percent for a Strike mission, you are still going to face enemy defences in the form of AAA/SAMs and fighters. In addition, there is also the matter that you should kill as many mobiles as possible at enemy air bases to convince WarGen that you have earned the right to capture another one. The arming section of Chapter 7 should help you to solve the problem of which weapon to use for the primary target, but due to the dynamic nature of a campaign, the secondary weapons load largely depends on which stage of a campaign you are at and how well or badly things have been going so far.

Both at the beginning of a campaign and if the enemy is advancing on you, the enemy's defences will be rather strong and your main problem will be to get past them. Your secondary armament should reflect that need and should therefore consist of defensive armament, like additional A2A missiles and ALARMs.

On the other hand, if you have been doing rather well in the early missions, you will discover that the enemy air activity will soon drop to a rather low level and the fighters you will meet in the air will not exclusively be Class-1 fighters anymore - you will see more of the inferior MiG-21s and MiG-27s. This is mainly due to the way reserve forces are activated in EF2000, they only come into play when the respective side advances and captures air bases. As long as you keep the enemy on its toes, the air threat should remain on a very manageable level after the first day or two and you can always avoid the enemy's SAM sites through careful route planning. Thus, you can use more of the available pylons for basic A2G weaponry (for example, mount 4, instead of 2 Mk-83s) and go out to hunt for some secondary and tertiary targets. The remaining question is what to do with the underbelly pylon. The answer depends largely on how you want to approach the target, at high or low level.

The high level approach is obviously the riskier, you are out there for all to see, and there is a certain probability that the enemy AWACS will vector fighters towards your flight sooner than would be the case if you approached at low level. On the other hand, the high altitude will boost your long range missile's kill ratio significantly, and with the help of your wingmen and your Escort, you should be able to take care of quite a number of enemy CAPs, all whilst taking advantage of improved fuel efficiency.

The low-level approach should reduce the level of attention the enemy air force dedicates to you (you will vanish from its screens just like the enemy strike packages do and always manage to pop-up at the wrong place and time), and you will probably get a lot closer to the target before you have to participate in the A2A shooting match developing around you. The disadvantages of this approach are higher fuel consumption and the much reduced lethality and range of your A2A missiles, though you can mitigate the latter problem by initiating a rapid climb to altitude when you anticipate detection will soon be unavoidable.

At the end of the day, it is more of a temperamental thing than anything else. Both approaches work, and it largely depends on which you feel more comfortable with. To get back to the original question, if you take the high approach, you can use the underbelly pylon to carry, for example, a Durandal anti-runway bomb, one of which is enough to take out a runway, or a BL-755 CBU. If you take the low level option the centreline fuel tank is the most prudent choice. With armament taken care of, it is time to go.

Surviving the missions and maximising the score

By now, you are probably wondering if we would get to fly at all. Keep in mind that briefings and debriefings in real world air operations usually take up considerably far more time than the actual mission, and the time you spend setting up a sensible mission flight-plan in an EF2000 campaign is definitely not wasted.

Ready to go

Here we are, finally sitting in the cockpit and waiting for the taxi clearance. Before you become bored, use the time to perform a basic pre-flight-check and take care of a few things like programming the autopilot (if you are part of a strike package, do not alter the selected speed or you will lose package integrity), set the DASS to the range you want, and set up your map and JTIDS display.

If you like to manually taxi to the runway, instead of using SHIFT S you should wait until you have received the taxi clearance before you start. Otherwise, your wingmen, always mindful of rules, will not follow until they are cleared to taxi. Wait until everybody is formed up on the runway, advance the throttle and blast off. If you 'self-taxied' to the runway and your Escort seems rather unwilling to follow you, the reason might be that you still have waypoint 1 selected as your current waypoint. Just advance the waypoint, and your Escort will come storming after you.

If you are part of a strike package mission and have an in-flight refuelling scheduled, do not get too nervous if you do not find the refueller in the immediate vicinity of the refuelling waypoint, they are sometimes a considerable distance from it. If the refueller is actually closer to you than the refuelling waypoint, you should still proceed to the refuelling waypoint before you head for the refueller and ask for the clearance to join. Your Escort will not refuel if you do not pass the refuelling waypoint. The Wild Weasel flight will go there first anyway and fall quite a bit behind if you cut the corner. With the refuelling done, there is no pretence to hide behind, time to head for Indian country.

Time acceleration and its problems

Due to the fact that EF2000 models a real theatre of operations, the distances you have to fly to reach the target are sometimes considerable, and even if you just have to cruise around your air base to protect a refueller or an AWACS, you might have to do it for a couple of real time hours before something happens. To help you to advance past the boring parts there are two ways to pass the time more quickly, time-skips SHIFT S, which jumps up to 30 minutes into the future, and accelerated time SHIFT T, which speeds up the game's time by a factor of five. At first glance, time-skipping looks like a more efficient way to get you past the boring parts and it is, in terms of time needed to get to the action. Unfortunately, it will often drop you off a little too close to the action, usually within the enemy's missile envelope. At this point, you will have lost the considerable advantage over the enemy of your long range A2A missile, the S-225. Time-skipping also denies you the chance to use your JTIDS data link to evaluate the tactical situation and change your flight's course to avoid contact with the enemy, or at least meet them at a time and place of your choice. With all this in mind, you might want to stay away from timeskips and instead use the slower, but considerably safer, time acceleration.

Taking care of enemy CAPs

Whether you are on a strike or an A2A mission, you are bound to run into enemy fighters sooner or later. When this happens, it is time to remember a few things from the advanced simulator missions, mainly the wingmen commands and the Turn and Burn Jet Fuel (T&BJF) tactic. Thanks to the increased lethality of the S-225 in the TactCom release, you finally have a reasonable chance to kill enemy fighters without exposing your wingmen to the Alamo threat. But in order to make it work, you have to keep them on a pretty short leash. Do not let them engage fighters that are no direct threat to you and do not release them to attack their ground targets as soon as you have passed the IP if it is still a considerable distance to the target. In both cases, get your wingmen back into formation by issuing the commands 'Engage-Engagement-Disengage' (3-3-9) in quick succession.

The next condition that has to be met for a successful long-range killing spree is sufficient altitude to maximise the range advantage. If you are a follower of the 'High Altitude, Come and try to get me' school, that should not be a problem. If you are the sneaky, low altitude type, you must, at some point, get out of the weeds. If you detect a CAP that is bound for you, accompanied by AWACS messages like 'Enemy fighters heading for Strikegroup Bazooka' or words to that effect, the low altitude is no longer an asset, it has become a liability. Do not try to sneak away, it will not work anyway and you have to initiate the climb to altitude early enough to arrive at 30,000 feet while the enemy is still over 50 miles away.

Well, there you are at 30-40,000 feet, with an enemy CAP barrelling down on your flight. Plug in your afterburner, turn towards the CAP, activate your radar and order your wingmen to do the same. Lock up the closest fighter and shoot as soon as you get the first tone. Order your wingmen to engage, wait until every enemy fighter has a missile flying towards it, then issue the disengagement order and turn around. Since your are probably heavily loaded with fuel and weapons, leave the afterburner on until you have completed the turn and the closure rate with the enemy fighters has at least dropped into double digits (the Eurofighter's radar does not seem to be troubled by the fact that the target is behind you). Listen for the Splash messages and use the Missile and Browse views to evaluate your attack. If any fighters have survived, turn around and repeat the process. If you timed everything right, your flight should be able to launch two missile volleys before the enemy even has a chance to fire at you, and two volleys should be all you need.

Alert Fighters

Unfortunately, not all enemy fighters are as easy to kill, there are some which can be a real pain - Scrambled Alert fighters. You will get to know them when you attack an enemy air base (at least as long as the enemy still has some fighters at that base), and by the very nature of the circumstances under which you meet - you at low altitude, busily shooting up the place, them just taking off, invisible on radar and JTIDS until they are airborne - a carefully planned, long-range intercept just will not happen. If you just execute your ground attack, the first sign of trouble will be a 'Radar Lock' warning from Nagging Nora, most likely followed by an IR missile launched at point-blank range. At this point, you are on the defensive and that is never an appropriate position for a fighter pilot, virtual or otherwise. So instead of waiting for the Alert fighters to announce their presence, go after them while they are still on the ground and extremely vulnerable.

In order to destroy them on the ground, you obviously have to detect them first, so instead off attacking your primary target as you would normally, make a pass down the length of the runway. The Alert fighters should either already be at the end of the runway, ready for takeoff or taxiing toward it. In the first case, your pass down the runway should enable you to take out at least one of them with your cannon and if you happen to have a cluster bomb handy, drop it on the other one. If you do not have a cluster bomb with you, commence a very hard turn and re-attack with your cannon if the second fighter is still on the ground. If he is airborne switch to IR missiles and launch one immediately, the fighter should not be able to spoof it at its low speed after takeoff. In case the fighters are still taxiing towards the runway, you have a little more time for A2G gunnery practice, but you should still get on with it, your main deed is still to be done.

However, if you do not detect fighters on the run- or taxiways during your initial pass, you are either lucky because this particular airfield does not have Alert fighters ready, or, in deep trouble because the Alert fighters are already airborne. Switch to padlock view and scan for enemy targets; if you find some which are suspiciously close (within 2-3 miles), you have found the Alert fighters. Order your wingmen to engage immediately and if you have not trapped an enemy fighter on your six, extend for 2-3 miles, dragging the Alert fighters away from your target. What you most certainly do not want to get involved in is a turning fight right over the enemy air base, where the low speed you will eventually end up at will make you a ripe target for the SAMs and AAA.

SAM/AAA plinking

In EF2000, AAA and SAMs are always deployed in two parallel lines around airfields along the 180-360 bearing line. Therefore, it should not be much of a problem to avoid flying through the AAA while you are conducting your bomb runs. Just note where the AAA/SAM lines are situated and adjust your run-in to and break away from the target accordingly. High speed and jinking also help to reduce the AAA's lethality. Once you have taken out your primary and additional targets, remember that you should destroy as many AAA/SAM batteries as possible to sap the base's strength before you head home.

The safest way to conduct an attack against the lines is to approach at right angles, starting at one end, not somewhere in the middle. This way, you will generate the highest possible bearing change rate for the AAA guns you are not attacking and you will always have a safe side towards which you can break after your attack run. However, in the TactCom/SuperEF versions you will find that most of the SAM/AAA launchers are deployed in clusters, with between 3 and 8 units of the same type in each one. Since they are packed fairly tight, an attack with cluster bombs is the most effective way to dispose of them. If you do not have cluster bombs with you, good old strafing will do and thanks to the tight grouping, you might get more than one unit in a single pass. Then there is only one more thing left to do - get home.

Leaving the scene of the crime

In order to maximise your Overall mission and ultimately, your Player Rating, you not only need to destroy a certain number of targets, you have to get your plane home as well. Especially in the early stages of the campaign, the last good opportunity to leave the target area usually comes before you have destroyed everything you had planned to. When you are down to just one ASRAAM and a few cannon rounds, it is not necessarily a good idea to engage the next 4-plane CAP that is heading your way. When things look like they are about to get dicey, consider how much you have accomplished up to that point. If you got your primary target (in case you have been on a strike mission) plus two or three additional targets or even just a couple of ordinary targets if you have been on an A2A or WW mission, your Overall rating profits more from the safe return of your aircraft than from the one or two kills you might get before you get the chop. On the other hand, if you are on an airfield denial mission, your Player Rating happens to be a good chunk above 70 percent and you are sure that you will get a couple of those parked aircraft before going down, you might as well take the chance. The base capture determination is not influenced by how much above 70 percent your Player Rating is, if you can take the 20 percent hit in the Overall rating the loss of the aircraft will mean without dropping below 70 percent, you might gain more from staying and performing virtual kamikaze. But apart from this exception, it is better to bug out and once you have decided to head home, do it like you really mean it. Plug the afterburner in and climb to 40,000 feet. You should be able to reach about Mach 2 at that altitude, and that is fast enough to leave even the quickest enemy fighters behind you. Do not forget to collect your remaining wingmen by advancing the waypoint past the target waypoint and issuing the engage-disengage command sequence to make sure they really understand you want to go.

The Extension Manoeuvre

If the turn for home would result in rotating the enemy fighters into your forward or beam quarters, you might have to perform what is commonly called an extension manoeuvre before you can set course for home plate. The extension manoeuvre is essentially a series of small turns designed to keep the enemy fighters in your rear hemisphere while you slowly sneak onto your heading for home. Since the enemy fighters in EF2000 always fly pure pursuit intercepts, it works like a charm. For example, let us assume your heading for home is due south and you have a pair of Su-35s approaching on a bearing of 240 degrees, (2 o'clock), about 40 miles out. If you simply set course for home and tried to blast past them, you will come close enough to get a couple of IR missiles launched at you. Instead of facing that prospect, turn left until the fighters are well in your rear hemisphere between 4 and 5 o'clock and accelerate away. As you pull away, you will notice that the fighters drift towards your 6 o'clock. The reason for this is the pure pursuit they fly, they simply point their noses at you and hope to catch up. When they are settled on your six, you can slowly initiate the first heading change towards your home bearing of 180 degrees. Make a slow turn without any excessive pulling and banking (that just slows you down) until the fighters are back between your 4 and 5 o'clock. Do not turn more than that or you will give them the chance to cut the corner and to catch you. Again, fly in a straight line until the fighters have drifted back to your 6 o'clock before you initiate the next turn. By executing this series of small, incremental turns, you will eventually get back on the heading for home without giving the enemy fighters a chance to get within promising missile launch parameters (granted, they might launch missiles at you, but you can simply outrun those without problems).

Nevertheless, the enemy fighter pilots sometimes have problems admitting defeat and might follow you all the way home. If they do, adjust your course to drag them towards the closest friendly CAP which will happily take care of them. If none are airborne (not uncommon in the latter stages of a campaign), you will probably have to endure the enemy's company all the way home until the Allied SAMs deployed around your air base, which are usually the only ones awake and prepared to fire at enemy aircraft, convince them to turn back.

The only thing left to do is to land the plane, but that should not be a problem and if there are no threats nearby you can always use SHIFT S. In case you do not get a clearance to land, simply ignore it, you do not get penalised for reckless flying in EF2000.

Re-arming - Getting back up again

Just when you thought the worst was over, here we are, suggesting that you go up again right after you have arrived home safely. In case you had not noticed it yet, as soon as you land on an allied air base and have come to a complete stop (wheelbrakes on and engines off), you will get re-armed and re-fuelled. Therefore, the option to get back into the fight definitely exists and we will look at some of the reasons why it would be beneficial to do so. By the way, do not get cute and try to re-arm at an enemy air base, the mission will end automatically when you shut down your engines.

First and foremost, the war does not stop just because you have finished your mission. For both the interval before you enter and after you have left the stage, WarGen computes the results for the missions that have been scheduled, which is incidentally the reason why it takes considerably longer to 'skip to takeoff' time when you are scheduled to go late in the 8-hour time period. For example, the enemy strike flight you noticed approaching your base when you landed will get there, and will probably do a fair amount of damage.

As outlined in the paragraphs discussing the Player Rating, base capturing is ultimately a battle about mobiles - destroying the enemy's while protecting your own - and you should always think about what you can do to achieve these goals whilst keeping an eye on your Player Rating.

That could mean, for example, that you should help to protect your own or other allied bases from an enemy strike. If your Player Rating is below 70 percent (meaning the Russians may capture bases), you should definitely consider going up again. You are in all probability a much better pilot than anything the computer can throw against an enemy attack, and you can even improve a CAP or Intercept mission's Overall Mission Rating that has suffered from missile misses, because bombers are rather easy to gun down once you have disposed their fighter screen. In order to maximise the influence you have on the enemy attacks, you should select the earliest possible takeoff time to ensure that no attack slips through before you have a chance to participate in the defence.

On the other hand, if you have the Russians on the run and you have been on a strike mission, you might consider visiting your target again, especially if it is an air base. In case you are not all that enthusiastic about strafing to take out the enemy's SAM launchers and AAA guns found at those places, you could, with the second attack in mind, adjust your initial weapons load to include 2 pairs of ALARMs in addition to what you need to take out your primary target. This would enable you to take out a combined total of 8 enemy air defence mobiles from both visits, all without scratching the paint on your plane's underbelly.

Since you would essentially fly an unscheduled mission the second time around, you will not get any help from support flights, neither Escort nor Wild Weasel. Whether your wingmen will accompany you on your second trip up north depends on whether you have asked for permission to recover before you landed. If you did, your wingmen will have landed as well and there is no way you can convince them to go back up again. On the other hand, if you performed an unauthorised landing, your wingmen will just circle the base, waiting for you to join them again. Which of the two options you take should depend on the amount of armament left on your wingmen's planes, but since they usually dispense ordnance quite liberally, it is probably better if you let them land.

Even alone, you will find it surprisingly easy to reach your target again, because in addition to being unscheduled for the Allied side, your mission will come as a surprise for the Russians as well. This means that the usual strong CAPs on your ingress route and over the target will not be there and you will probably only have to face a hastily dispatched long- range CAP. It is not uncommon to have to fight just this one CAP, even when there have been three or four the first time around. So, if you feel fit for a rematch, do it.

Chapter 11

NETWORK CAMPAIGNS

MISSION PLANNING REVISITED

NETWORK AIR COMBAT

CHAPTER 11

Chapter 11

Network Campaigns

Although it seems hardly possible to improve upon the complexity and fun of an EF2000 campaign, you actually can - with a networked campaign. EF2000 allows you to connect up to 8 players to combine forces against the Russians, and you will find flying with human wingmen to be an order of magnitude greater than doing business with the AI variety. But even with NI (Natural Intelligence) wingmen, an EF2000 campaign will not become a series of milk-run missions and in this chapter, we will show you how to use your fellow human players to maximum advantage as well as pointing out a few of the net-specific problems you have to consider when planning and flying networked campaign missions.

Part I

Mission Planning Revisited

Join-up order and mission selection

On the mission selection screen, you will notice that EF2000 adapts the mission list to the number of people connected. With four or less, you will find that the presented mission list is not significantly different from the one you get in a single campaign, though CAPs or Refueller kill missions will not appear if you fly with more than two people. With more than four, the list will exclusively consist of strike package missions. The reason for this is that EF2000 strives to keep all players on one mission and the only missions in EF2000 in which more than four planes can participate are the escorted strike missions. The first four players in a large group will always form the strike group, players 5 and 6 will get the A2A slots and players 7&8 may perform the Wild Weasel part of the deal. You should keep these numbers in mind during the network start-up process, the order in which people join the network is important in two ways. First, as already mentioned, their place in the join-up queue decides which kind of mission they will most probably fly and should therefore be determined by their respective preferences and abilities in respect to the three different mission classes into which they will be divided. (Obviously, the leader should be the group's best mud mover). Secondly, EF2000 always pairs up players to establish which wingman you will see when you use key (wingman padlock). Therefore, players who should (or want to) fly as a team should join the network as a team, starting with an odd number. Speaking of order to join, since you will sometimes get a two player escorted strike with numbers 3&4 flying escort on a 4-player net, you should exercise the same caution when joining the net on a four player net as you would with more players. Of course, this classification is only valid for WarGen-generated missions, if you use the Mission Planner to create a mission, you can put the players into whatever category you like.

Armament for more than one group

The number of people participating in the netmeet usually decides the amount of work you have to do 'on the ground' before you can all jump into your respective cockpits and get airborne. Provided you all fly in one group, you can dispense with most of the preliminaries and perform a more or less straightforward mission selection/planning/editing. Nevertheless, everybody should get around the server's machine to get a glimpse at the target, the route, and the SAM threats along the way or at the target area. Since it is not possible to arm the aircraft selectively, everybody in the main group gets the same armament as the leader, and the selected armament should therefore reflect both what you need to take out the target as well as what the people flying the mission feel most comfortable with. It does not make much sense to lug around tons of dumb bombs if your fellow pilots cannot hit anything worthwhile with them, GBUs might be a better choice under these circumstances. For any additional groups (A2A and Wild Weasel), the armament will always consist of what EF2000 considers the appropriate for the job, which means 4ASRAAMs, 2 S-225s, 6 AMRAAMs plus the underbelly fuel tank for the A2A complement and 2 ASRAAMs, 2 AMRAAMs, 2 S-225s, the underbelly fuel tank, and some combination of ALARMs, BL-755 cluster bombs and CRV-7s for the Wild Weasel aircraft.

With more than four flyers, the pre-flight process becomes slightly more complicated. The considerations mentioned above still apply, but there are some additional things you should take into account.

Communicating with your wingman

One of the most basic but often overlooked pre-flight tasks is to divide your team into 2-plane sections. As already mentioned, EF2000 pairs up players for the F11 wingmen padlock view anyway (the odd man out usually gets a computer-controlled wingman), so there is nothing wrong with teaming up before you join the network to ensure that the wingmen padlock actually shows you your designated 'Get that MiG off my six' man. To make that rescue somewhat more likely, you have to ensure that the section members can communicate properly with each other. If you have a fancy communication set-up (both cable-based solutions as well CB sets have been used by network squads), that is not difficult to achieve, but. if you have to rely on messages shouted across the room, you had better position people destined to fly together in close proximity (or you do it the other way around, form sections from people sitting next to each other). It will be difficult enough just to keep a proper formation if your wingmen sits at the other end of the room, but co-ordinating a fight will become utterly impossible.

Communication protocols

If you have not participated in a netmeet before, you probably have no idea how hectic and confusing things can become once the shooting starts. Everybody will be shouting something like 'I got him', 'Which one shall I take', 'Help, I've got two Su-35s on my six' and so on. The same kind of problem has plagued real-world combat pilots ever since radios became standard equipment in aircraft during World War II, and in order to bring order to the chaos, several communication techniques have been developed.

One is the fighter brevity code, which consists of a number of agreed code words like 'bandit' for enemy aircraft, 'angels' for altitude, 'splash' for a successful intercept and so on. The digitised radio messages in EF2000 are very good examples of how to employ the fighter brevity code properly and you should try to use the same terms when you talk to your wingmen, they will be familiar with the terminology and the chances for misunderstandings will be minimised.

The usefulness of the fighter brevity code will be enhanced when you combine it with the so-called Who, What and Why system. For example, if you called 'Cowboy, break right, bandit five o'clock', Cowboy (the who part) knows that he should break right (the what section) immediately because the bandit [at] five o'clock (the why bit) is about to shoot him down, all conveyed without making a big fuss about it. Though it might be a little difficult at first to structure your messages according to such a strict pattern, you will find that you never forget to mention something important once you get used to the message structure.

Friendly Fire

Friendly fire is probably the harshest and clearest proof of a failure to communicate. It is usually the direct result of players becoming too eager to get a kill, they tend to concentrate solely on the enemy aircraft they are pursuing without much thought about where the cannon rounds that miss the enemy might impact. Whenever you are about to engage an enemy fighter in a dogfight, make sure that you are actually engaging a free fighter and not one which a team-mate is already working on. Communicate clearly which fighter you want to engage with a message like 'Engaging Su-35, in right hand climbing turn at angels 20'. If someone else has already engaged that particular fighter, he will most likely recognise the parameters and should either clear you to engage if you are in a better position or tell you not to engage . If you are told not to engage, follow that advice, unless you want to collect a few of your wingman's cannon rounds that fail to hit the enemy. On the other hand, if you are engaged and someone else moves in on your target, you should make the same evaluation and if the other guy is in a better position or you have not made much progress against the Su-35 you have been dancing with for the last 5 minutes, let the other guy have a go at it.

As soon as you are not engaged, you should move into a supportive position and try to manoeuvre in such a way that you can re-enter the fight from an advantageous position. By being prepared to hand off fighters to one another throughout the dogfight you will become a more potent unit. This kind of teamwork will enable you to keep the upper hand even if you are loaded with A2G ordnance and your Eurofighter is not as nimble as usual.

Pre-flight co-ordination and leader selection

Above the two-player, wingmen level, you will also have to maintain strike package integrity for up to three groups of aircraft, two of which will already be in the air and en-route to the target when the mission starts.

This involves such things as deciding on a common speed and altitude for the whole package, whether you want a close or distant escort from your A2A guys, at which point the Wild Weasel flight should accelerate to take out the SAMs at the target and assigning secondary responsibilities (for example, which pilot(s) from the strike flight should double as Escort in case the Escort flight perishes on the way to the target before all enemy fighters have been dealt with).

If you try to start co-ordinating all this in the air after take-off, you will most likely fail, because people will become absorbed with flying their planes, watching the enemy fighters on the JTIDS, finding the refueller and so on. Instead, get everybody together before take-off and clear as many of these small details as possible before the mission starts. You should also select a strike leader, who will become the person who calls the shots in the air. That does not necessarily have to be the server or someone else from the strike group, it should ideally be the person who has the most experience with EF2000 (network-campaigns). Though having someone telling you what to do is not entirely consistent with the general 'Let's fly together and have fun' attitude that will hopefully be evident at a netmeet, it is the only way to avoid the confusion that would reign if two or three headstrong people try to push their idea through of how to conduct the mission. Remember, you joined the air force to protect democracy, not to practice it. On the other hand, you can always select someone else for the next mission if the current strike leader should be overwhelmed with the task (democracy at work in the end).

Part II Network Air Combat

Once you have sorted out all the mundane things, it is almost time to get back into the air. But first, you need to know about another distinctive difference between single and networked campaigns.

Player Rating on the Net

One big and rather pleasant fact about networked campaigns is that unlike a solo campaign, the Player Rating and with it, campaign success and failure, is not only influenced by the leader's overall rating but by the performance of all human players on the net. The Overall Ratings of all the human pilots are averaged and it is therefore of utmost importance that everybody takes his part in the mission very seriously and tries to maximise his own score.

Network A2A combat

As in the single campaigns, enemy fighters are usually the biggest hurdle you have to overcome to achieve mission success, and we will therefore first take a look how to get past them.

T&BJF Turning

Hardly surprising, the tactics you can employ against enemy fighters in a single campaign work equally well in a net-campaign and although your fellow human pilots are certainly capable of a much wider range of air combat manoeuvres than their AI colleagues, the most efficient way to take out an enemy CAP is an old acquaintance - the T&BJF tactic. Although your wingmen will probably have less trouble avoiding enemy missiles than your computer wingmen, there is still no need to make a mission more dangerous than necessary. As long as you can fire at the enemy without drawing fire yourself, you should use that range advantage and the T&BJF tactic enables you to do just that. In addition, your human wingmen will most certainly not fire their missiles at such a wasteful rate as the computer wingmen do and you will find that you can take out an amazing number of enemy fighters with four human players without ever getting shot at yourself. Thus, there is no need for any fancy flying, as long as you have a couple of S-225s left, the good old-fashioned long-range killing will do just fine.

Speaking of long-range killing, while you are actually shooting at the air targets, you should co-ordinate the long range missile volley and distribute the targets evenly amongst the players from both strike and escort groups alike. After all, it might be a bit embarrassing if the one or two aircraft designated to take care of later threats get shot down with a full load of A2A missiles still on the pylons.

Basic Drag

Still, there may be a few occasions where the T&BJF tactic cannot be applied and you have to use something different. Against the AI controlled aircraft in EF2000, the most successful tactics are variations on the drag. Just as a reminder, the basic drag tactic involves offering the enemy an apparently easy target as bait. Though the following examples describe the situations as they would develop for a 2 plane section, the tactics themselves are easily adapted to work for bigger sections as well.

Figure 1 shows you how to convince enemy fighters in EF2000 to swallow the bait. At point 1, the distance between the two Eurofighters should ideally be around 10 miles. This separation has to be achieved before the enemy fighters come into radar range, because the drag will not work if they can see both Eurofighters on radar. The leading Eurofighter should have both its radar and ECM on and to get the enemy's attention, it should lock up every enemy fighter in the approaching group as soon as they come into radar range (which is the EF2000-equivalent of waving a red flag). This should convince every enemy fighter that it is under attack and they will defend themselves by initiating their own attack (in case they were still cruising in their CAP pattern) and turn towards the leading Eurofighter. As soon as this happens, the leading Eurofighter should initiate its turn away from the enemy fighters and accelerate away. Since the enemy fighters in EF2000 always fly pure pursuit intercepts, they will in turn adjust their course to keep the fleeing Eurofighter centred on their radar (See Point 2). Due to the separation between the leading and trailing Eurofighters, this turn should rotate the

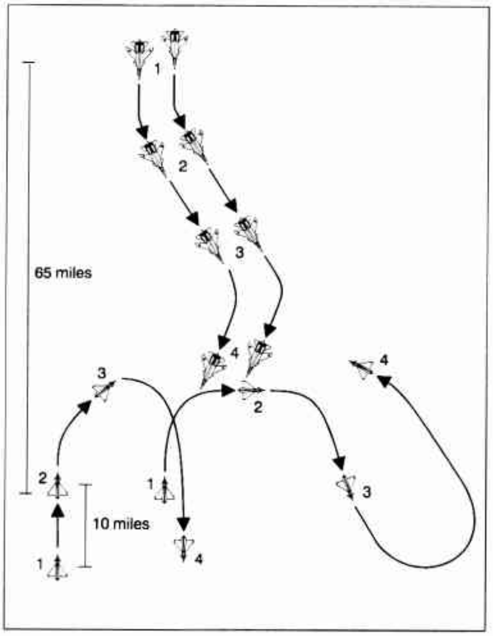


Figure 1

enemy's radar scan cone away from the second Eurofighter before it comes into radar range, and it will hence remain undetected. The decision as to who should play bait depends on what you plan to do after the enemy has fallen for your trick, but it should usually be the plane who has the fewest long-range missiles left and therefore the smallest chance to contribute to the initial volley.

Point 3 shows the first step of the endgame if the timing has been perfect. Eurofighter A is heading away from the enemy at maximum warp, and the enemy fighters are totally oblivious to the danger approaching from their right quadrant, the missiles launched from the trailing Eurofighter will come as a complete surprise to them. With a little luck, all the missiles will find their mark and the fight will already be over at that point. If not (for example, if the enemy CAP consists of 4 fighters in which case it is unlikely that all will be killed by the first missile volley), it is very likely that the enemy fighters will reconsider their decision as to which fighter poses the greatest threat and will turn towards the fighter that has just fired on them (see Point 4). In this case, the Eurofighter that has just fired on the enemy fighters should continue its turn until it is heading away from the enemy and it is the former bait fighter's turn to engage the enemy. If the enemy fighters do not switch their target, the trailing Eurofighter gets another chance to launch a missile salvo. After you have practiced this manoeuvre a little, you will find that it usually enables you to launch two missile salvos at the enemy without being fired upon yourself.

Trap Drag

In case you are low on long-range missiles and the enemy CAP is stationed fairly close to an Allied air base or CAP, you can also use the drag tactic to hand off the enemy fighters to a fresh Allied CAP or draw them into the air base's SAM engagement envelope (Figure 2).

In this case, it is obviously advisable that all fighters stay together and form a big bait group, since you do not want to offer the enemy alternative targets.

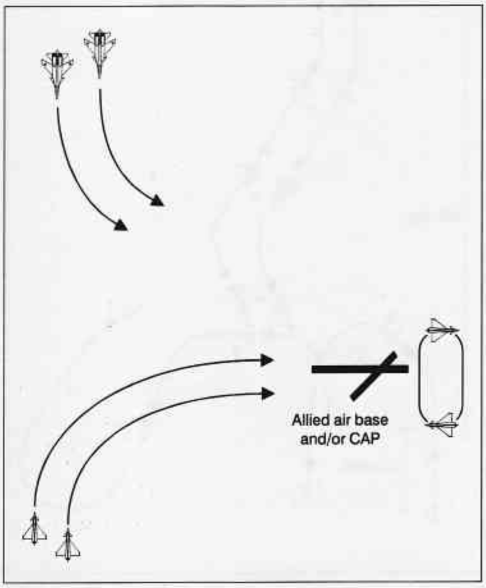


Figure 2

Split Drag

Last but not least, the drag tactic is also a very good way to separate an enemy fighter escort from the bombers they are supposed to protect.

The initial situation (Figure 3) is similar to that of the basic drag tactic, but you should widen the gap between the two Eurofighters to about 20 miles.

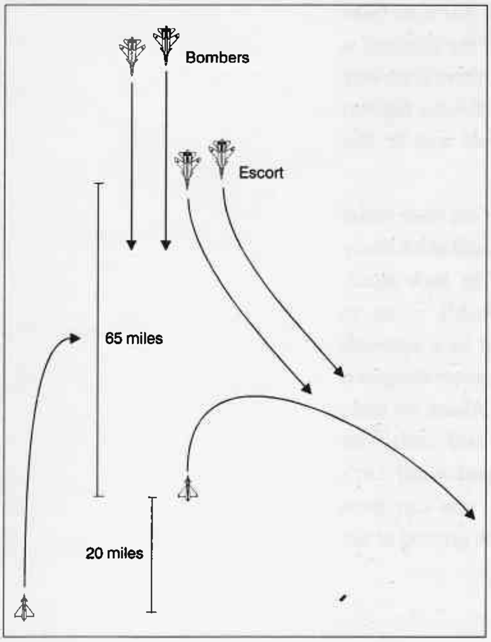


Figure 3

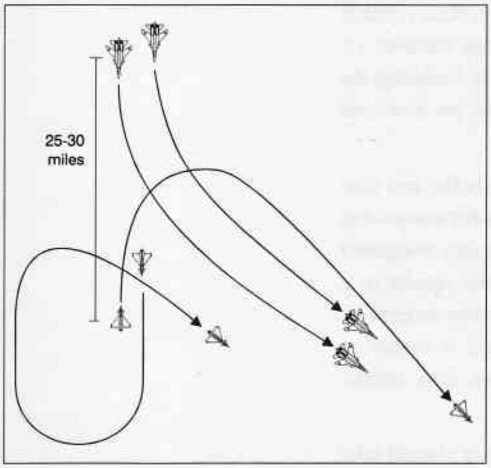


Figure 4

The reason for this is that you want the dragging fighter to draw the fighter escort as far away from the bombers as possible before the trailing fighter initiates his attack. This way, even if the escort fighters decide to turn back towards the bombers (this rarely happens, though they should do it every time), they will come too late to save their sheep. In case that they do turn back, the trailing fighter has to hurry up the killing a little and clear the arena before the escort fighters arrive, but if the escort does not come back, he can pop the bombers at his leisure. In the latter case, you should not forget that the bait fighter still has a little problem in form of the escort fighters on his hands, which will probably be rather annoyed at this point. If there is an Allied base or CAP nearby (which is not unlikely, since enemy strike forces are quite often found over Allied territory), he should simply drag the escort fighters towards it. If no outside help is in sight, the trailing Eurofighter has to bail his wingman out. Since there is no chance that he could catch up to the fleeing bait fighter and his pursuers, the bait fighter has to draw them back towards his wingman. He should do this by changing his heading ever so slowly back towards his wingman (essentially, an extension manoeuvre towards his wingman). Once both Eurofighters are on a collision course (Figure 4), you should prepare for a similar kind of 'bait-switch' as in the ordinary drag tactic.

The approaching Eurofighter should generally act very aggressive (locking the enemy fighters, ECM on) in order to draw the enemy's attention away from his fleeing wingman. Naturally, if he has any long-range A2A missiles left, he should fire at the enemy fighters as soon as they come into range, but since enemy strike groups tend to be rather big, he is probably down to a few remaining canon rounds. As soon as both Eurofighters have passed each other, the approaching fighter should break towards one side to change his heading by roughly 90-120 degrees.

When it becomes clear that the enemy has again fallen for the bait switch, the formerly fleeing fighter should break towards the opposite side and prepare to take the offensive. However, this manoeuvre will only work if the enemy is still a considerable distance (more than 25-30 miles) behind the fleeing fighter, if the distance is less, the break of the approaching fighter across the enemy's noses will put him right into the middle of their long-range missile envelope. If the distance is too small or the enemy does not fall for the bait switch, there is no way around a good, old fashioned 2v2 dogfight to save the fleeing fighter, but with 2 humans against two AI pilots, that should not be too difficult.

Due to the sheer number of targets that will pop-up on your radar screen when you are bashing enemy strike flights, you will most likely run out of ammunition very quickly. But, you are in luck again, because the rearming feature, which you have probably come to appreciate in the single campaign works equally well in a network campaign. And to make things even more enjoyable, your wingmen can re-arm as well, they just need to get down to an Allied air base, switch off their engines, engage their wheelbrakes and voila, full loadout on board again. In case you have one of these hard-assed 'Let's hunt them back to base' enemy CAPs on your tail, you can even re-arm in relays, there is no need for you all to be on the ground at the same time.

Network A2G Combat

The differences between single and network campaign A2G combat appear relatively minor compared to the rather large number of additional options network A2A combat offers (after all, buildings do not move). Nevertheless there are a few points, both positive and negative, that we should examine a little closer.

The most positive aspect of a network strike package is the fact that you will be accompanied by pilots whose abilities to hit something with their A2G ordnance betters that of your computer wingmen probably by a few orders of magnitude, which usually results in a couple of spare Mk-83s to distribute on handy secondary targets. In addition, you can count on getting a little help when it comes to transforming all those mobiles at enemy air bases into smoke columns.

But, before you go on a free for all bombing spree, you should take care of what you set out to do, levelling all primary targets. As you enter the mission, everybody will get a short glimpse at a network briefing screen describing his target, and you should note everyone's target at that point. If someone buys the farm before destroying their target, you will know which target(s) should become your primary secondary target(s).

Still, because ground attacks in a network can be devastating for the enemy, he will not take them lying down, and the two perils known to a strike package, enemy fighters and SAMs, will be very much in evidence. With a proper, human escort, you should have no trouble getting past most of the fighters you will meet on the way, and since you will usually carry a few long-range A2A missiles on your Eurofighter, you should not be too shy about evening the odds a little yourself.

However, just like in the solo campaign, you will probably come across a few occasions where the number of enemy fighters you have to shoot down on your way to the target has depleted your flight's long-range missile stock (especially if there are not enough people to form both a strike group and an Escort). But instead of diving headlong into close-quarter air combat, which is never a very good idea as long you have a few tons of high explosive hanging under your wings, you can apply yet another variation on the drag tactic.

Drag&Attack

The 'Drag&Attack' tactic is basically the same as drawing an enemy fighter escort away from the bomber group they are supposed to protect, the only difference being that your targets do not move or stick to a set pattern. Therefore, you can proceed in almost the same way as before.

If you happen to have a spare Escort fighter handy, he is the most logical candidate to play bait, since he has no pressing business at the target anyway. If not, you will have to find a volunteer from your strike group to draw the enemy fighters away (usually the guy who has the most trouble bombing). This selection should also be subject to the fuel state of the remaining fighters. Since it is rather likely that the bait fighter will have to use his burners at some point, you should not dispatch the fighter with the least amount of fuel.

As with the bomber escort, your bait fighter should accelerate to be about 20 miles ahead of the main group as he comes into the enemy's radar range (65 miles). As soon as the enemy fighters detect him, and he has their attention, he should change his course by 90 degrees and accelerate away, preferably towards a SAM-free zone with the CAP flight in hot pursuit. The remainder of the strike flight should avoid any threatening behaviour, that is, radar off and ensure they are a little offset to the CAP, rather than flying towards it.

As the enemy CAP will most likely swallow the bait, the rest of the strike group will have a fighter-free shot towards the target apart from the occasional Alert fighter and any long range CAP/Intercept that get vectored down to see where all the noise is coming from, but you already know how to take care of them.

When the main group has delivered its ordnance, the bait fighter should extend back towards the target (see page 292 for a discussion of the extension manoeuvre) to hand off the pursuing enemy fighters to his now much more manoeuvrable wingmen.

Be prepared to destroy the bait fighter's assigned target just in case he cannot make it back to the target or has had to jettison his A2G load to facilitate his escape.

The SAM threat

With the fighters out of the way, there are still the SAMs to take into account, and due to the somewhat toned down ECM effectiveness, this threat is considerable. A SAM launch during a bomb-run tends to ruin your concentration quite thoroughly and even if you manage to evade it, you will probably have to start over.

On a single campaign strike, there is not much you can do about it apart from firing your ALARMs and hoping for the best. With a couple of human wingmen, you should be able to reduce the SAM threat down to a manageable level. The first step is the long range 'Weaselling'.

Long range Wild Weasel

When your group approaches the target, everybody should have the ALARM selected as his active weapon. When you come into the SAM's radar range (30 miles) you will start to see the red crosses on your DASS, and the ALARM's seeker head should start to lock on to the emissions, although it is very conceivable, even likely, that not everybody will get locked up by the enemy SAMs at the same time. However, if more than one plane is locked up, you should quickly decide who will be the first to fire his ALARMs. Only one plane should fire ALARMs at any time, since there exists no symbol to designate SAM launchers already fired upon as for air targets. Hence, there is no way of knowing which SAM launchers already have an ALARM coming their way and you would probably waste a couple of ALARMs if you all fire at the same time.

As soon as the first wave of ALARMs are on their way, the whole strike group should execute a quick 180 degree turn and head away from the target, there is no sense in getting closer than necessary at this point. After the ALARMs have hit their targets, you can turn back towards the target and repeat the process.

Bait Wild Weasel

However, the attack will not always run quite so smoothly. One of the most common examples of the enemy's refusal to co-operate is a failure to lock up aircraft that are still outside the effective range of his SAMs. This is usually the case if you have a lot of red crosses on your JTIDS display, but nothing comes up on the DASS as you approach the target. A few of those crosses might be AAA radars, but if more than two or three crosses are visible on the JTIDS display, you can bet that there are a few sneaky SAM crews among them.

If the situation roughly develops as described above, do not fly blindly into the trap. Split your group into two elements, the main pack should stay outside the SAM's range whilst one fighter goes in and tries to get the enemy to light up his radars, in which case the pack can safely fire from outside the SAM's range while the bait fighter can concentrate on evading the SAMs fired at him.

Nap Of the Earth Weaselling

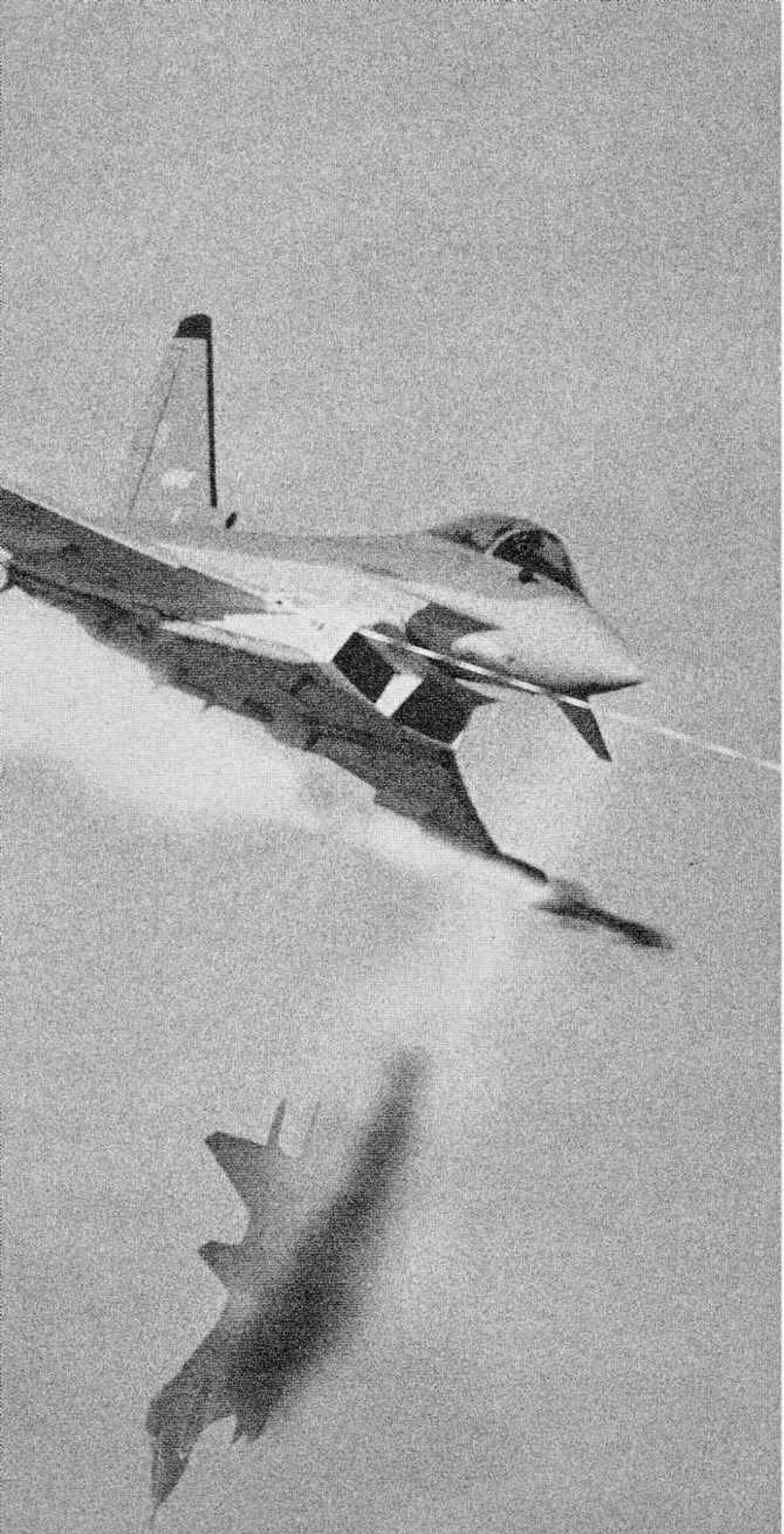
The most dangerous scenario evolves when the enemy refuses to lock up the bait aircraft in the above situation and the whole package has to go in to play SAM bait. Now it is time to remember that a solid piece of ground is one of the most efficient ways to break a missile lock. You should therefore circumvent the target outside the SAM's range at low level until you have found a suitable mountain or coastline inside the SAM envelope behind which you can hide when fired upon. Once you have found a piece of real estate that fits the bill, turn in towards the target and cautiously pop up from time to time to draw the enemy's fire.

The remaining problem in connection with SAMs at the target is that there are usually more launchers deployed to protect the target than your group can kill with ALARMs. If you have fired all your ALARMs and there are still a few SAM launchers around, you have essentially two options. The first is for the whole group to go in roughly simultaneously coordinating your time on target (which should reduce the threat for each aircraft) and kill the remaining launchers with cannons (not without risks and rather time consuming). Or, fly back to the nearest Allied air base, re-arm and to repeat the long-range Weaselling.

In fact, you should always consider re-arming when you feel that your group has still some unfinished business at the target.

Chapter 12

Quick Combat



CHAPTER 12

Chapter 12

Quick Combat

Introduction

There may be occasions when time is short, or when you just cannot face the prospect of planning yet another mission. You may not feel like setting up a simulator mission because you crave the instant gratification of a dogfight. On those occasions, Quick Combat is just what you need, the opportunity for quick kills and no fuss.

Quick Combat consists of a set of twelve pre-set missions of varying degrees of complexity with enough variety to cater for all tastes. As you fly these missions, points are awarded for each of your kills. You amass points until you either quit or buy the farm. However, one strong attraction of Quick Combat is the lure of ever higher scores. The Score in Quick Combat may be used as a yardstick by which you can measure your progress and the effectiveness of your tactics. The skills that enable you to succeed in Quick Combat translate readily to the heart of EF2000, the Campaigns. For that reason your quest for points will force you to develop and improve. You will mature as a flightsim pilot in ways that will bring you success throughout the simulation.

Figure 1

Since EF2000 is a non-linear flightsim, it does not behave in a predictable or predetermined way. This extends to quick combat, the only thing that is the same twice in these missions is the starting conditions. What happens after that depends on what you do, no two encounters will ever be exactly the same. With that in mind a 'recipe' solution to quick combat is not feasible. We will therefore explain the strategy and tactics that will get you through all twelve missions alive and with high scores like those of the Authors, Figure 1.

Tour of Duty

Success in quick combat comes by adhering to one simple concept, survival. Getting to the end of every mission alive must be your prime objective. If you dive into a fur ball with ten bandits for the excitement of the moment, you will discover that in this simulation your moment of glory will be just as short as it would be in the real world. Instead, picking your fights and staying safe will bring greater rewards. Think of these twelve missions as a tour of duty. Survive them all and you get to go home. Make survival your main goal and you will begin to fly and think more like a real fighter pilot. That means entering an engagement fast, shooting early and extending. Blow through each engagement hot, picking the kills up along the way, and not only will your flying improve but it will take a giant leap closer to real air combat.

Entering a Mission

These missions do not start on the sort of terms a fighter pilots likes. Every mission starts you off low and slow, almost as if the guys at DID were saying, 'There, get out of that one' with an evil grin on their faces. Ask yourself where you would really like to be in this fight and then get there. Getting the fight on to equal terms simply means lighting the burner, checking the radar and the JTIDS information, then putting your aircraft into the best possible position for an attack. Initially that means you will need to get away, get fast and get high. Basically you need enough separation and altitude to make your S-225s effective. This will serve the dual purpose of also allowing you to re-enter the fight in a way that will enable you to spoof incoming missiles with much more certainty.

Getting High

So we have decided that almost without exception, you want to start the fight high and fast. You want as much energy as you can get in terms of both height and speed. So in most cases you can light the burner and get your speed up to 400 knots before pitching up to about 60 or 70 degrees, then climb to 40,000 feet. If you have bandits within 40nm you should turn away from the bandits first and gain altitude while extending. You can now pick the altitude where you want the fight to begin. The optimum altitude to be at, from almost every perspective is 40,000 feet. At that altitude you will have more effective, longer ranged missiles, superior dogfight performance and the option to convert your height to speed. The catch is that whatever altitude you climb to, the enemy will match you, tele-porting to the same altitude in the same time as you, regardless of whether they are bombers or fighters. Whilst this may sound ominous it is actually good, it means that you do not need to give up your altitude in order to engage.

However, do not stick rigidly to the high altitude philosophy, in some of the missions you will need to extend away from the fight using terrain masking. Also, as you gain in confidence and ability it will be easier for you to commit to a fight as eagerly as the enemy does in order to reach certain high value assets before further support arrives.

Time to Plan

Once you are at 40,000 feet you may already be picking up missile launch warnings so simply turn on the ECM and continue to increase your speed. Ideally you want to wait until you have at least achieved Mach 1.5 and have some 40-50 miles of separation between the first group of bandits. At this range you know even the most effective enemy missile cannot reach you and you can all but ignore launch warnings while you go heads down to the JTIDS to assess the situation.

This is the time to plan your mission. You need to look at the positions of the enemy threats including neutrals and in some cases friendly aircraft. You must decide where you will fly and which groups you intend to engage in what order. Although you may feel a strong urge to follow the letter of the mission objective you will often find that the odds are stacked so highly against you that you need to exercise a little creativity. By using this time to develop your strategy you will ensure each engagement starts and ends on your terms.

Strategy

Continue to extend until the first element of the enemy are some 40 miles behind. By this time you should have a clear idea of where the most lucrative targets are and what stands between you and them. Now is the time to adjust your flight path gently as you decide where you are going to go and what you are going engage.

Initially you should search out the easy points, such as neutrals (they are the blue aircraft markers on the moving map display) and the unescorted Russian AWACS and JSTARS. All of these targets can be despatched with cannon rounds on a single pass. You must save your missiles for the enemy fighters.

Ideally you want to entice and encourage patrolling bandits to desert their posts and chase you to a point that allows you to run in on a target unmolested. Dragging them around the arena and pulling them away from targets will generally take a while and involves some time spent gazing at the JTIDS. Use the accelerated time feature (SHIFT T) to reduce the tedium. Do not spend too long in the moving map display while in accelerated time though because it is way too easy to find your self ploughing the fields before you realise it.

Certain neutral assets, such as the Gripen fighters can be used offensively by simply dragging the pursuing bandits towards them.

Although you will be sacrificing points that could have been added to your score this may reduce the enemy to numbers that you can successfully engage by yourself. You can do the same with allied flights and indeed on some missions you will find that bandits will ignore you completely and concentrate solely on the other allied planes. When you spot this it is an opportunity for you to save precious missiles and earn points the old fashioned way with your cannon. However, you must be very sure of your ability or extremely close to your previous high score in order to warrant the risk of a dogfight.

Tactics

What are the tactics that work? Getting high and fast is a good start but you would be right in thinking that there might be more to it than that. The only thing that will get you through the waves of hungry fighters and home again is 'hit and run' tactics. Just as in the real world, you need to intercept to within weapons parameters, deliver your Air to Air ordnance and leave the fight. Entering a visual engagement means that your BVR strategy has failed. Every second that you remain in a within visual range engagement your situational awareness will drop and your mortality factor will rise. You can fly headlong into ten bandits, launch all your missiles and spoof all inbound enemy missiles on the way through. You may get a few as you blow through but if you stop to fight you are dead. Any fighter pilot will tell you that going around in little circles in a hostile theatre is a guaranteed way to commit suicide.

By using your long range missiles you can whittle the enemy intercept flights down to manageable levels and with further extensions you can drag those bandits that remain into a chain, stretching them thin. Then you can turn and take them out in ones and twos using your ASRAAMs, before extending again as shown in Figure 2.

Treat each fight like a mediaeval joust, use your all aspect missiles on the way in, or gain rear aspect as quickly as possible before extending again. On the Top-Gun setting you will be alone in the theatre, this means that when you have expended all of your BVR missiles you should strive to fight the enemy one on one. You can do this by constantly dragging fighters from the main group thus denying the enemy the benefit of a numerical advantage.

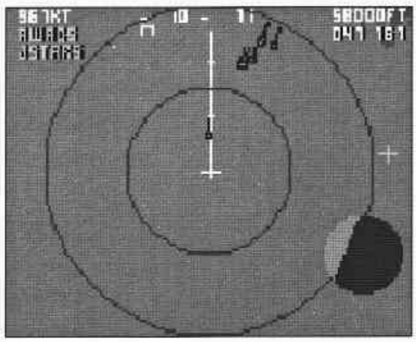


Figure 2

You will soon be able to go back for two and three at a time, especially if you have some ASRAAMs on the rails. Taking even two Su-35s on guns only is a big risk and not the sort of thing you would do with your life on the line. Better to survive this mission and be a hero on the next one, when you have all your ordnance. If you are extending with

Figure 3

'guns-only' do not turn back unless you are sure that you have some real advantage. For instance if you are running from a lone MiG-21, turn back and put him out of his misery. However if you are running from two Su-35s just keep going. Do not extend too far though because if you reach the edge of the world your mission stops rather abruptly as you fall off the edge, as shown in Figure 3.

In order to extend in this way you will need to stay on full afterburner, fortunately in Quick Combat your fuel supply is non-depleting. You will therefore be able to remain on full afterburner for as long as you wish. In some missions you will find that you have been given a centreline drop tank, so you should always dump it. By keeping out of close combat it should be possible for you to retain your A2G ordnance on the missions that need it. If you have followed the above strategy and tactics you will always get an opportunity to use it and secure more points.

Ending the Mission

Each mission in Quick Combat will end after a pre-set duration shown on the mission clock in the bottom left hand side of the screen. Quitting a mission before it is over will have the same effect as if you had been killed. Once the mission clock reaches zero you will be given an end of mission menu. You will have the option to cancel the menu and continue to fly, or to end the mission and proceed to the next one.

You can improve your score by continuing after the mission has ended by choosing the cancel menu option. During that extra time you will be able to ensure that you have killed every possible target. You will also be able to enter dogfights knowing that if things get too hot you can press SHIFT Q and move on to the next mission.

Each of the target objects in EF2000 has some point's value. Here is a ranking in order of what each target is worth.

Air:	
EFA	650
F14	300
F15	550
F16	500
F18	400
F22	600
JAS39	200
Harrier GR6	150
Sea Harrier	160
SU27	250
SU33	300
SU35	400
MIG21	300
MIG27	400
MIG29	550
MIG31	500
F117A	300

F111R	600
Tornado	400
TU16	100
TU22M	200
SU34	600
A10	300
SU25	400
Hercules	500
C17	500
Antonov	500
IL76	500
Apache	300
Chinook	100
MI26	100
MI24	200
KMK2	100
IL78M	100
JStars	250
Sentry	700
Mainstay	800
Land:	
Bedford 1	500
Bedford 2	500
BMP 1	500
Challenger	500
D 30	500
JUG 1	500
JUG 2	500
JUG 3	500
M 163 Vulcan	500
M198	500
MLRS	500
Mobridge	500
M110	500
M1973	500
Patriot 1	500
Patriot 2	600
Pontoon	500
Rapier	500
RM70	500
Roland	500
Marconi S373	500
Marconi S723	500
SA 6	500
SA 11	500
T80	500
Warrior	500
ZSU 23 4 Shilka	500
Sea:	
Invincible	1000
Carrier	900
Kuznetsov	600
Type 42	500
Udaloy	500
Leander	500
Neutrashimy	500
Kirov	500
Slava	500
Akula	500
Vanguard	500
Oil Tanker	500
Supply	500

That is what the targets are worth when you kill them. Do not kill friendly targets though because they cause negative points and reduce your score.

If you are determined to achieve a high score then you will need to take some risks. If you are going to be a hero, it is better to take the big risks in the early missions. That way death will not cost you too much time. As you progress through the missions and your score mounts, you can become more and more cautious. It is also wise to take few risks until the mission has officially ended. That way if you take damage you will not be forced to wait those agonising minutes for the menu. After the mission is officially over, you can cancel the menu and continue. After that point you can become more daring because you have the ability to extract yourself from any situation by hitting SHIFT Q. You will then be permitted to continue with the next mission.

Mission Run-Through

We can now look at how these techniques apply to the first mission on the Top-Gun setting. When you enter mission one you will see in Figure 4 that you begin low and slow.

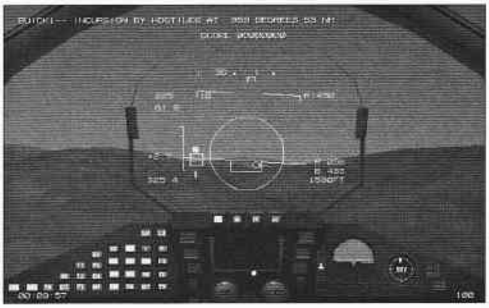


Figure 4

You need to correct this as soon as possible by climbing as shown in Figure 5.

In Figure 5 you have simply gone to full afterburner to get your speed up, then pitched up to 70 degrees.

In Figure 6 you have levelled off with the bandits at 44nm and closing.

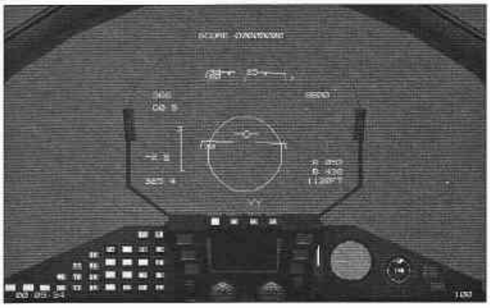


Figure 5

You will need to dive slightly to keep the bandits inside the aiming reticle and you should Launch the S-225s at around 40nm and the AMRAAMs at around 20nm as shown in Figure 7. In this mission all of the missiles have been launched at the fighters. You can come back for the bombers later and finish them with guns.

Figure 8 shows your S-225s heading for the fighters on the far left. Your AMRAAMs are heading for the centre group and the bombers on the right do not have any missiles locked on to them.

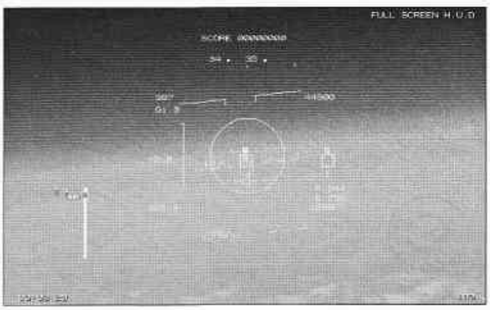


Figure 6

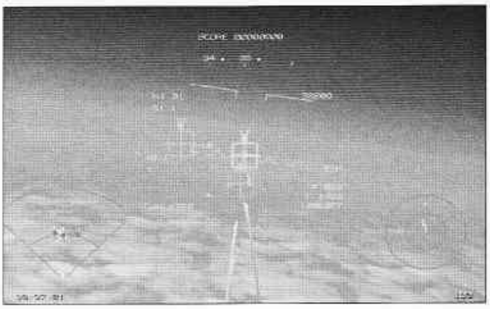


Figure 7

Figure 8

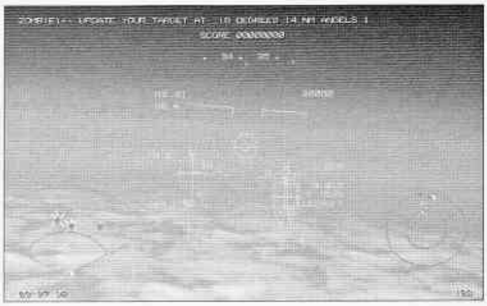


Figure 9


Figure 11

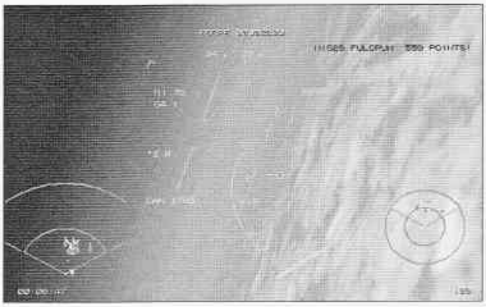


Figure 12


Figure 14

Figure 15

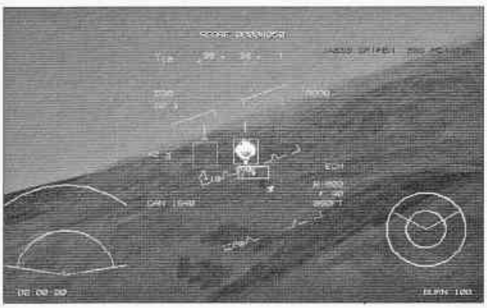


Figure 17


Figure 18

Figure 10

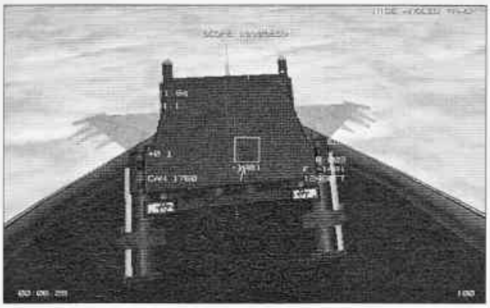


Figure 13

Figure 16

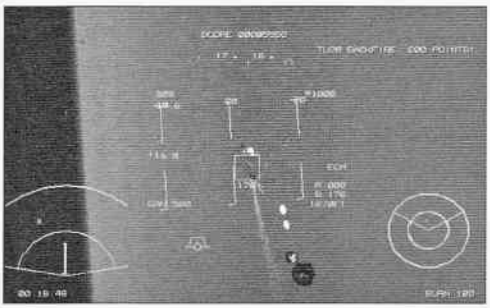


Figure 19

In Figure 9 you have closed within 13nm, the sky is thick with missiles, your ECM is on and it is time to start barrel rolling.

The first points are awarded as you barrel roll through the bandits with missiles spiralling around you as shown in Figure 10, 11 and 12.

As you blow through the remaining bandits with a score of 3,850 check your tail for MiG-29s doing lead turns. Figure 13 shows you climbing for altitude again while scrolling through the bandits in the Wide angle track view.

You made it through your first engagement. You went in 'Head On' spoofed everything they threw at you and have now extended beyond 6 nautical miles of the closest bandit without a scratch (Figure 14). So far so good, but you still have a long way to go, and those bombers are still out there.

A quick check on the MMD (Figure 15) reveals that the main group of fighters are in pursuit. Turning back too soon would be suicide, let them chase you around the arena while you pick up points.

Figure 16 shows neutral aircraft off in the distance with bandits in hot pursuit. One of those neutrals will be the AWACS so use the **SHIFT** **T** command to reduce your journey time and go get him.

Figure 17 shows you removing the neutral escort fighters, followed by the AWACS (Figure 18).

With the enemy fighters strung out all across Europe, it is time to go back for the bombers who are now unprotected and therefore easy targets. You will find them circling in a holding pattern, until you turn up for the duck shoot (Figure 19).

The fighters have been chasing you for long enough, it is time to welcome them home. That is what you have been saving those ASRAAMs for. Figure 20 shows you mopping them up. Naturally then it is back down to the bombers to strafe the chutes.

You do not get any points for strafing the chutes, but those guys did bomb your base after all, so they deserve some special attention. Figure 21 shows a

Tu-26 pilot with a collapsed cute. And so the mission ends. Figure 22 shows that there are still bandits left to be killed but with no ammunition left it is time to quit and go on to the next mission (Figure 23).

Completing the first mission with a score of 7,700 deserves a pat on the back, congratulations and free beer in the officer's club. Do not get too excited though, you still have another eleven missions to complete and survival will become more and more difficult. As your points mount, your virtual life will become more precious to you, every engagement will stretch your nerves and increase the tension. Completing your tour of duty will be a big relief and an unbeatable high score your only reward.

The missions in Quick Combat can be used purely to unwind from a difficult day, or more seriously as training aids for the campaigns just to get you warmed up and into the right frame of mind. You may choose to fly Quick Combat for its own sake but whatever reason you choose, watching the scores mount will appeal to your competitive spirit and you will soon be pushing yourself towards just one more attempt at the big one, competing against yourself to the point of addiction. Don't say we didn't warn you.

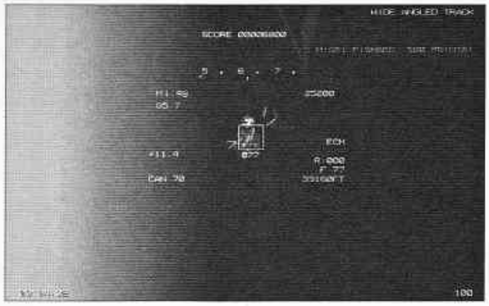


Figure 20

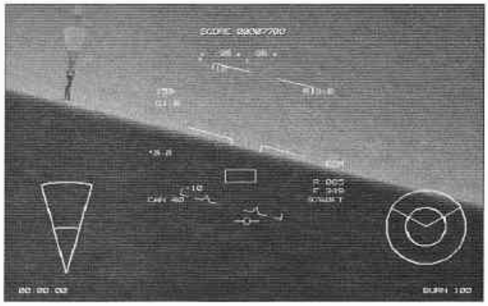


Figure 21

Figure 22

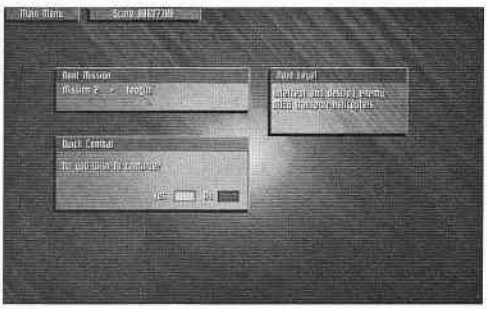


Figure 23

Chapter 13

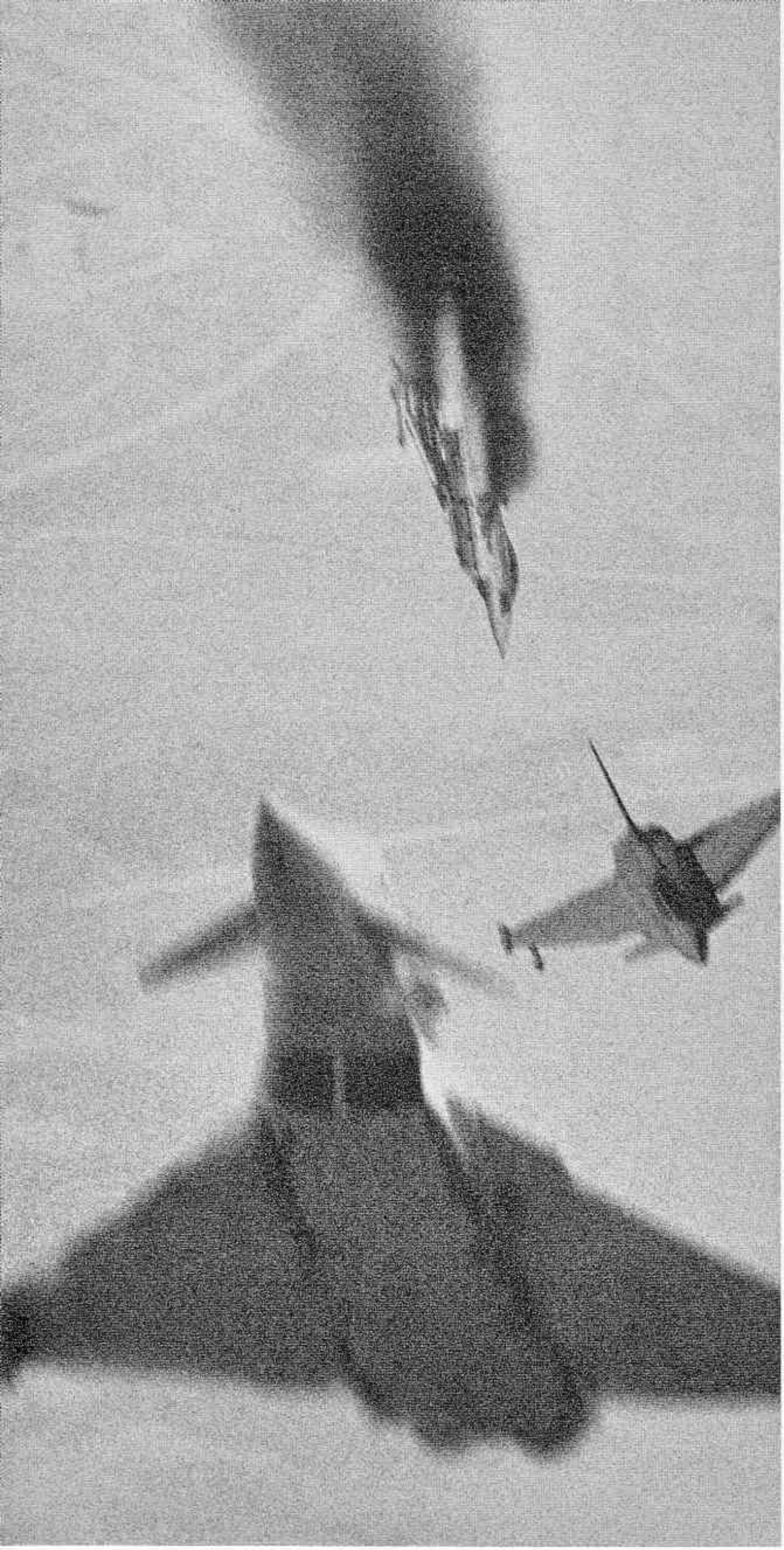
NETWORK & MODEM PLAY

GETTING CONNECTED

MODEM PLAY

BECOMING KING OF THE SKIES

LOCAL EF2000 SQUADRONS



CHAPTER 13

Chapter 13

Network & Modem Play

Playing EF2000 with other human players over a network or modem connection is something that every serious flight simulation enthusiast should try at least once. Be warned, however, that doing so may change your social life forever. We have already seen how human wingmen can enhance the campaign experience; the level of co-ordination and control possible is many times greater than when you play with computerised wingmen. No longer do you have to hope that your wingmen will behave intelligently. With other human players at your side, you can communicate your intentions and carry out your missions with a much greater level of control and hopefully, with significantly more success. However, campaigning is just a part of what you can do with other human players in EF2000. The game offers a variety of aerial combat options that allow you to test your dogfighting skills against other human pilots, both individually as well as working together as a team.

In this chapter, we will look at these options, as well as the particulars of getting your network and modem connections up and running. In addition, we will provide some resources that will allow you to find other players in your area or around the world. Once you do, you will discover the thrills that only come through competitive head to head play.

Part I Getting Connected

The intent of this section is to provide a guide for setting up the hardware and software for network and modem play. The two things that put most people off the idea of multi-player play are the potential costs involved and the complexity. We will provide you with details of what you need to get to set up, and help remove the complexity by providing you with step by step instructions. Network play requires a greater commitment of resources than does modem play, however, the rewards attainable over a network are much greater in terms of play options and performance.

Over a network, you can connect as many as 8 players, whereas a modem connection is predominantly a one on one affair. In addition, campaigning with human wingmen is only possible over a network. While we will look at ways in which you can utilise your modem to participate in team competition, the difficulties of communicating with your human wingman make teaming up over a network, where all the players are in close physical proximity, a more satisfactory experience.

We have already noted that networks carry with them a greater cost than modem hook ups, but it need not be an overwhelming burden. If you have the luxury of other players nearby and can meet to bring your computers together, you should definitely consider establishing a network hook up. Now we will take a look at what is required.

Network Shopping List

In keeping with the theme of a low cost and uncomplicated set up, the following 'recipe for success' is based around 10base2 (coaxial) network installations. Later in the chapter we will cover 10baseT (twisted pair) installations that, although more expensive, do carry some inherent benefits. Both of these are 'Ethernet' set-ups that represent a significant improvement over the older 'Arcnet' installations.

Whether you choose coaxial or twisted pair, you will want to make sure that the hardware you obtain is Ethernet based.

Here is a list of the hardware items you will need for a coaxial Ethernet installation:

- One Ethernet network card per computer.
- One 'T' piece connector per computer.
- Two network cable terminators,
- One length of coaxial cable for the first two machines, plus one additional length for each additional computer.

Here is a list of the software drivers you will need:

- LSL.COM
- NE2000.COM (1)
- IPXODI.COM (2)

(1) The specific driver for your network card may be different, NE2000 being the most common.

(2) Again, the specific driver may be different; IPXODI is the most common.

The choice of which Ethernet card you obtain is the only part worthy of mention here, everything else is pretty much the same wherever you get it from. The first step is to make sure you get a card that will fit in your machine. All machines will probably have ISA (Industry Standard Architecture) slots available, but it may be that these are already occupied by other peripherals such as modems, sound cards, CD-ROM adapters and the like.

Most newer machines, especially those with Pentium processors will have PCI (Peripheral Component Interconnect) slots which allow a peak throughput far greater than that of ISA. You are more likely to have an available PCI slot in your machine as opposed to an ISA slot. Given the performance advantage which PCI provides, this will generally prove to be the better option. PCI network cards carry a cost premium, but the benefits will outweigh the costs in the long run. A Plug n' Play compliant card is worth the investment if your computer supports it. This will take much of the heartache out of setting up the IRQ (Interrupt) and I/O (memory address port) values for the network card.

If you choose to purchase an ISA network card, make sure you get a 16bit version. There is only a minimal price difference compared to the older 8bit cards, but difference in performance is massive. ISA network cards can often be picked up second hand since many individuals as well as businesses are upgrading their systems. It is vital that you get the original manufacturer's software utilities for the network card as well as any documentation if you choose to follow this method of acquisition.

An important part of your selection criteria should be the type of network connector(s) on the back of the card. Typically, cards come equipped with either a BNC plug (for coaxial cable) or a RJ45 socket (for twisted pair wiring), or both.

The BNC plug looks like a short metal cylinder projecting from the back of the card while the RJ45 socket looks like a telephone jack. The best choice here would be to get what is known as a 'Combo' card, or one that has both BNC and RJ45 connections. This way, you will have the flexibility of being able to connect to both major styles of networks. Some cards also provide an AUI port (for thick Ethernet cable) which looks like the kind of socket you would plug a joystick into. AUI cable is typically used only for large network 'backbones' and is not recommended for gaming installations. If the card you select has an AUI port, consider it a bonus as long as the other, more commonly used ports are available.

If you have a choice as to the manufacturer of the Ethernet card, try to get one of the well-known brands, like 3Com or Intel, which are fast, reliable and easy to set up. Beyond that, go for something fairly reputable, or if looking at an off brand clone, ensure that it has been tested and approved by Novell network labs. Most clone manufacturers produce cards that conform to the NE2000 standard.

Network cards require an IRQ and I/O address in order to function. These are set either through physical jumpers on the card, or through software on newer, 'jumperless' cards. A set up utility should be provided on diskette if the card is of the jumperless variety. Regardless of how the card is set up, it should also come with software drivers to communicate with the network. If you have a card that did not come with drivers, try using NE2000.COM since this is the most common driver available. The best cards come supplied with utilities that help you determine what IRQ and memory address port settings are available so that it will not clash with other devices already installed in your system.

Network Hardware Set Up

If physically installing a network card into your machine is something you consider beyond your capabilities, you should seek specialised help before attempting it. Likewise, if doing so would void your computer's warranty, have a professional do the work of installing it for you.

If you are able to install the card in your machine, it is very important that you check to see which IRQ and memory address port settings will not clash with another device. If the card uses physical jumpers, you should make these determinations prior to installation and set the card accordingly. If you have purchased a jumperless card, you will need to install it first in order for the software utility that chooses these settings to function.

Typically, you will have your sound card set to either IRQ 5 or IRQ 7, and will probably have IRQs 10-12 free for the network card. Most cards tend to be preset for IRQ 10 and memory address port setting 300, both of which are often free. If you need to change any of the settings, read the manufacturer's manual carefully before doing so to ensure you are following the correct procedures. It is also wise to look for markings on the card itself as manuals often contain incorrect, or conflicting information, particularly on budget cards.

If you are unsure as to which settings to use for the card, you can obtain a utility such as Norton Sysinfo or CheckIT Pro to identify which resource settings are available. If you do not have one of these advanced packages, information regarding IRQs can be obtained using the MS-DOS 6 utility 'MSD' (Microsoft Diagnostics) - just type 'MSD' at a DOS command prompt to launch this utility. If all else fails, you will have to resort to guesswork to identify the available settings. This can be particularly time consuming as it involves removing the card and altering the settings with each attempt before re-inserting it and rebooting.

Coaxial Network Cabling

Once the card is installed and properly set up, you need to connect your machine to others on the network. If you are using coaxial cables, they are hooked together in a continuous chain using the 'T' connectors to join them together. A 'T' connector is attached at both ends of the chain, and a terminator is attached to the open side of the 'T' connector on each end. Attach the bottom of the 'T' connectors to the BNC connector on the Ethernet cards for each machine. The hardware set up is now complete.

Twisted Pair Network Cabling

If you are using twisted pair cabling, instead of having a long line of cable with attachment points ('T' connectors) as in a coaxial set up, each card is individually connected to a central 'Hub'.

The benefits of this type of set up are that if there is a faulty cable, it will only affect one PC. The cabling is also simpler to set up and generally less expensive. Overall network performance is generally improved since each computer has its own dedicated stretch of cabling as opposed to all computers communicating over a shared cable. The disadvantages of this type of set up come down to the cost of the hub itself. While it is possible to purchase low cost hubs, these offer only marginal performance gains compared to a cheaper coaxial set up. Better quality hubs do offer worthwhile advantages, but the higher cost is likely to rule out this option for the majority of groups. Furthermore, this setup requires that the owner of the hub be present at all network sessions or prepared to allow access to it. This can prevent ad-hoc network sessions unless you also invest in a coaxial solution, which increases costs.

Network Software Set Up

Once you have copied the required software drivers to your hard disk, you will need to create a file to tell the software what settings your network card is using. This file should be named 'NET.CFG' and will look like this:

Link driver NE2000
Frame Ethernet_802.3
IRQ 10
Port 300

The 'NE2000' statement refers to the name of the card driver you are using. The frame setting is constant, while the IRQ and Port statements should reflect what you have set for the card.

Loading the network drivers can be performed from a DOS prompt, although most people will want to either include them in their AUTOEXEC.BAT file or write a specific batch file for them. Basically, you should have the following lines for the batch file:

C:\NETWORK\LSL
C:\NETWORK\NE2000
C:\NETWORK\IPXODI

Assuming that C:\NETWORK is the directory containing the required files, and that NE2000.COM and IPXODI.COM are the appropriate drivers. If not, replace these with the appropriate filenames.

If you have a problem with your Ethernet card, it will usually show up when you try to load these drivers. If the card is not responding, you could try assigning it to another IRQ or memory address port setting and altering the batch file accordingly. If this does not work, try swapping the card for another one. Beyond that, you should seek help from someone who has done this kind of thing before.

Super EF2000 Software Set Up

For Super EF2000, your network card drivers should have been installed and set up automatically by Windows 95. You should ensure, however, that you have told it on initial set up that you want to run over an IPX network. You should also change the Frame Type setting to '802.3' rather than the default 'Auto' setting. This can be done by selecting network from the control panel option on the menu bar. Select the 'IPX/SPX Compatible Protocol' for your network adapter, followed by 'Properties', and finally the 'Advanced' tab. Click on 'Frame Type' and then select the 'Ethernet 802.3' option in the 'Values' box.

Connecting in EF2000 with a Network

Have everyone fire up EF2000 and select the 'multi-player' option from the 'Main Menu'. Change the connection type to 'IPX'. All players should type in their names and ensure that the same network socket and channel numbers are selected. One player should switch the 'Game Server' option to 'Yes' (Figure 1) and all other players should set the server option to 'No'. If two or more groups are playing over the same physical network, each group should select different socket and/or channel numbers. When everyone is ready, the server should hit the 'Listen for other players' option. The other players should all hit the 'Join network' option. If you are using TactCom or Super EF2000, all players will see the same option, 'Start network'. It does not matter 'who does what when' unless you want to be in a specific order in the game, for example, if you want to take on specific roles in a network campaign. Once all players appear on the server's screen, you are ready to continue.

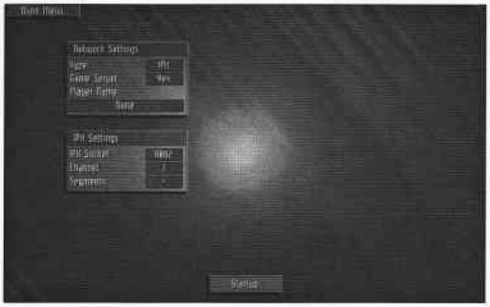


Figure 1

If the server cannot see any players when they have selected to join the network, there is a problem with the network set up. This may be due to a faulty connection somewhere, so check the cabling and try again. If that fails, you may have a defective cable or 'T' connector. If you are using coaxial cable, isolate the weak link by removing one section at a time. If you are using twisted pair cable, try running a different cable from the hub to the troublesome player. Trial and error are often the key to success here. If the problem does not appear to be related to the cable connections, it may be in the network card or driver settings. If you have access to the Novell utility called COMCHECK or your card came with suitable diagnostic software, you can use it to help determine whether or not a particular machine is communicating with the rest of the network. Ultimately, trial and error may be the only way to determine where the problem lies, although unlike cabling problems, this tends to be harder to diagnose. Be patient and work systematically to find the problem. Once you have a functioning network, you will find future problems are few and far between. Once you have hooked up successfully, the server should select 'Main Menu'. The server can now choose 'Campaign', 'Simulator' (for individual missions), or 'Quick Combat' if a head to head scenario is what you prefer.

PC Performance Implications for Networking

If all participants on the network are running similar machines, performance across the network will be the same for everyone. A slower machine's lack of performance will show up the most when the server is downloading the mission to all the other players. The slowest machine will hold the rest of the group up - by as much as several minutes - until the downloading is complete. In these situations, all you can do is watch and wait. As long as something is happening on the server's screen, the network is still functioning and everyone should wait patiently until the downloads are complete. For this reason it is not advisable to mix machines of wildly differing performance and specifications. In general, aim to have closely matched machines with ideally a minimum of 16MB of RAM in each. Whenever possible, the fastest machine should be employed as the server in any network hook up unless compelling reasons exist to have a specific player, and consequently his machine, take on this role.

A phenomenon known as 'warping' can also be an indicator of poor performance across the network. When warping occurs, the planes to will seem to jump around on the screen. This is usually caused when the information packets going around the network become un-synchronised and is most commonly seen when network players are flying in tight formation. Even with the fastest of machines, this still happens to a certain extent. The bottleneck tends to be the network itself. However, solving the problem requires spending large amounts of money to purchase and install high speed hubs and network cards. This is generally beyond the budget of all but the most dedicated and fortunate. Practical solutions to minimise warping come down to hardware upgrades: faster processors, more RAM, better hard disks, video cards and the like. Choosing a good network card can make a noticeable difference and is also likely to be the least expensive option, especially if your computer is reasonably fast already.

Part II Modem Play

Flying EF2000 over a modem allows you to fly against human opponents from the comfort of your own home. Modem play cannot offer the same options (campaigns are not possible) or the performance of a network, however, it does not require you to transport your PC to another location every time you want to hook up with another player.

Shopping List

There are two types of modem as far as installation is concerned: internal and external. Which you choose depends to a certain extent on preference, but there are some other considerations that may force you to choose one over the other.

An internal modem is inherently neater than its external cousins. Once installed, internal modems require only that they be plugged in to the telephone socket - there are no messy data cables or power supplies to clutter the place up. However, an internal modem does occupy an expansion slot in your computer. If you are low on slots, you might need to consider an external version instead.

External modems do carry a slight price premium compared to internal due to the higher manufacturing costs involved in making their casings and power supplies. One advantage that external modems do have over their internal cousins is that you can follow the progress of your phone call by the activity lights on the front panel of the modem casing. Troubleshooting modem connections is often made easier if you can 'see' what the modem is doing, something you cannot do with internal modems. You will need to have room for the modem and its power supply at your workspace. You will also require an unused serial port on your computer and a serial cable to connect the modem to the port.

The external modem you buy should come equipped with a power supply and serial cable. If for some reason it does not come with a serial cable you need a 25 pin 'D' connector at one end for the modem and either a 9 or 25 pin 'D' connector for your PC. You should check the spare serial port socket at the back of your machine before you go out and purchase one. Be sure you purchase a 'standard' serial cable rather than a 'null' modem cable. Null modem cables are used to hook two computers together and simulate a modem connection between them. Theses cables will not work when used with a real modem.

Regardless of whether you purchase an internal or external modem, the only other item on your shopping list will be the telephone connecting cable if it was not supplied with the modem.

The choice of modem manufacturer will come down to any personal preferences you may have as well as your budget. Generic modems can be bought for very reasonable prices but do not necessarily represent the best value for money in the long term. Some advanced modems (such as the top of the line units from US Robotics) can provide a slight increase in data transfer rates when connected to a similar unit at the other end. If you intend to use your modem to connect to on-line services such as Compuserve or the Internet, the speed advantage can make up for the higher initial investment, especially if you are charged for your time on line.

Whichever type or brand of modem you choose to buy, make sure it is able to support speeds of at least 28,800bps (also known as 28.8k baud). Some units will also provide you with the ability to send and receive faxes and may even add voice mail capabilities as well. These features have no bearing on your gaming facilities, but may be worth consideration, depending on what other uses you may intend for your modem. Be sure that the modem will support error correction and data compression to maintain quality and increase throughput of data. In general, name brand modems will have better support from software vendors for other applications you might care to use, as well as better support from the manufacturer if you have any problems down the road.

Hardware Set Up

If you have purchased an internal modem, you should check the IRQ and COM port settings prior to installation. You will most likely have your mouse plugged into COM1 (IRQ 4) which should leave COM2 free (IRQ 3). Check the manufacturer's installation guide to ensure you have the correct settings, then follow the procedure detailed in that guide for installation into your PC.

If you have purchased an external modem, simply plug the data cable into your PC (with the power off to avoid surges) at one end and into the modem at the other. Plug the power supply into the modem and connect it to the mains. You will need to determine which COM port corresponds with the serial port that you have connected your modem to. In most cases, this will be COM2. However, you should consult your computer's installation guide to confirm the settings.

The final part of installation for either modem will be to connect it to the telephone socket using either the cable supplied by the modem manufacturer or one that you have purchased yourself. Hardware set up is now complete and you can power up your PC.

Super EF2000 Set Up

If you wish to use Super EF2000, you will find that Windows '95 will automatically detect your new modem when you boot up (be sure the modem is turned on if it is an external version). Windows '95 will take you through a step by step process to ensure the modem is properly identified and set up for its use. If you encounter problems at this stage, use the on line help facility within Windows '95, or refer to Microsoft's technical support line.

Connecting in EF2000 with a Modem

Once your modem is set up and operational, and you have someone to connect to, start EF2000 and select the 'Multi-player' option from the 'Main Menu'. Change the connection type to 'Modem'. Select whether or not you are to be the server - the server will be the one making the call. If you are the answering player, you should set the game server option to 'No'. Enter your name in the player name box before checking the modem settings.

The 'Port' setting should be set to the COM port that the modem is using, whether internal or external. The 'Baud' setting will control the speed at which the machine will attempt to send data to your modem. This setting should be the same for both machines and is not strictly dependent on the maximum speed of your modem. If your modem supports data compression, the setting should be higher than the speed of your modem for compression to have any effect. You should try to connect at the highest setting at which the two modems can reliably communicate. For two 28.8k modems, you should initially use the 57,600 baud setting. Success will depend on the quality of the telephone connection among other variables. Experimentation is often required to find the best rate for any given pair of modems. If you have slower modems or experience connection problems, try setting a lower baud rate until you can reliably communicate.

You will generally will not need to change the two 'FIFO' (First In, First Out) settings. These control the FIFO buffer, which is a component of high speed serial ports. There are few, if any, reasons to change the length (size) of this buffer.

The modem initialisation string will default to ATZ which is fine for most users. If connection problems are experienced, try using AT&F1 instead. This will reset the modem to its default settings with hardware flow control enabled. Hardware flow control is required for error correction and data compression to work. EF2000 will take advantage of these features if your modem supports them. You should consult your modem manual to determine whether other strings are needed to enable these functions.

Select 'Tone' or 'Pulse' in the 'Dial Method' box as appropriate for your telephone service. Finally, if you are the game server, you should input the telephone number of the other machine in the large box (Figure 2). The hang up string should not need to be changed.

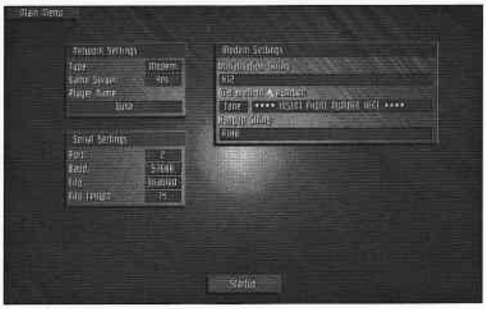


Figure 2

When the set up is complete, you are ready to attempt a connection. Once connection has been verified, the game server can select the 'Main Menu' followed by your choice of play option. Note that the campaign option does not appear as this requires the transfer of too much data between machines to be viable.

If you experience problems with a connection, the first item you should try to change should be the baud rate. Some modems and serial ports are incapable sustaining high baud rates without loss of data or, in the worst cases, loss of connection entirely. Reducing the baud rate can help mitigate this problem. You should not need to reduce the baud rate below the maximum speed of the slowest modem except in the most extreme cases. For extremely bad connections, it may be necessary to disable data compression and force the modems to connect at a less than maximum speed, for example, a 14,400 baud connection between two 28,800 baud modems. Initialisation strings to accomplish this vary from one modem to the next and you should consult your modem manual to determine the appropriate values. It is worth pointing out, once again, that both users should always use the same baud rate settings when attempting connections in EF2000.

PC Performance Implications with Modem Play

With a modem connection, you will not be able to enjoy the same levels of performance that can be gained by a network connection. Nevertheless, if both machines have high speed modems and line quality of the connection is good, the performance should be very similar to a network connection in terms of the amount of warping you experience. As in network connections, the fastest machine should ideally take on the role of server. This is more difficult to achieve consistently with modem as opposed to network connections if it is desirable to share the cost of telephone calls.

If you find the level of warping intolerable, you have a number of options available to you - though some may be quite expensive. First, you could consider a higher speed modem, especially if you consistently connect with players that have faster modems. Second, you could try to persuade your telephone company that their line quality is suspect and needs tuning - do not hold your breath while you wait for a result. Alternatively, you could consider a much faster method of connection. The only option here that is even remotely practical from a financial standpoint is to use an Integrated Services Digital Network (ISDN) connection. This type of connection requires both special phone lines as well as special modems at both ends. Connection speeds up to four times that of high speed modems are possible, however, the costs may well outweigh the benefits. You should check with your telephone service provider and obtain a detailed quote for installation, line rental and call charges before committing to this type of solution.

KALI & KAHN

With the advent of software utilities such as KALI and KAHN, you now have the ability to use the internet in order to hook up with one or more players from around the world for the price of a local telephone call. KALI and KAHN are programs that simulate an IPX network over an internet connection. However, instead of linking the computers with network cards and cables, you connect to other players using your modem and the internet as 'virtual' cable.

In order to use either of these programs, you will need to have a modem and a reliable link to the internet. The faster each of these are, the better your connections will be. A 28.8k modem is a must and relatively easy to obtain and install. Securing a fast connection to the internet will require you to research the Internet Service Providers (ISP) which are in your area. Providers are springing up in nearly all metropolitan areas, and competition among them is driving prices down while increasing the quality of service. Unfortunately, there is no easy way to determine whether a given ISP is faster than any other without experimentation. If possible, try accessing the internet through different providers and compare the speed with which you can browse through web pages, retrieve information and files. While not a perfect gauge of speed, even a casual test will reveal differences that may affect performance when you try to play EF2000 over the internet.

Copies of KALI and KAHN can be obtained by accessing their respective home pages on the internet.

For KALI, the address is: http://www.axxis.com/kali

For KAHN, the address is: http://www.teleport.com/~nbright

Both KALI and KAHN allow you to connect to 'Servers' on the internet that act as meeting areas to locate other players as well as the actual link between players. In operation, the two programs are nearly identical. The main difference between them is how they transfer data across the internet. KAHN employs a data compression routine that can increase the effective speed of the connection significantly. Not all programs respond well to compression. Fortunately for us, however, EF2000 is one that responds exceptionally well. For this reason, KAHN is (at the moment) preferable to KALI for EF2000 play over the internet. Future versions of KALI will undoubtedly add compression features, and you can always check the KALI home page on the internet to keep abreast of new developments.

KALI offers additional features and utilities such as a 'chat' function that allows you to type messages to other players connected to a game server. In addition, there are more servers available for KALI. We suggest that you download both programs, since both offer their own distinct advantages.

Once you have a copy of the software, you will have to install and configure it on your computer. You will need to 'UnZIP' the files you downloaded from the internet to a directory. Both programs come with fairly good documentation, and several 'Frequently Asked Questions' (FAQ) files are available at each program's home page.

When installation is complete, you should have a batch file called LOAD.BAT in your directory that will automate the loading of the software drivers. Executing this batch file will start a program called PPPMENU that allows you to dial up and connect to your ISP. Once the connection is made, you can exit to the DOS prompt, ready to load either KALI or KAHN and access one of the gaming servers.

In order to connect to a server, you need to type KALI (or KAHN) followed by the address of the server you wish to access. A typical command for this looks might look like:

KALI @SERVER ... or ... KAHN 123.456.789.0

KALI and KHAN servers are separate entities - you must use the proprietory software to access each server. Once you have accessed a server, you can chat with other players connected at that server if you have the KALI 'chat' utility - a program called Kchat. This utility works reasonably well with KAHN, although some of the functions are unavailable unless you are running KALI. You can use Kchat to ask players if they want to join in a game of EF2000, discuss the particulars of who should be the server, what type of game to play.

When you want to begin a game of EF2000 with another player (or players), exit Kchat, start EF2000 and follow the procedures for establishing a network game outlined earlier in this chapter. You will want to make sure that you and your opponent(s) agree on socket and channel numbers before you go off to fly.

When connected to the server, you will often hear players refer to 'ping times'. This is a measure of how long it takes for a signal to make the round trip from your computer to the server and back again. The lower your ping time, the smoother the game play will be. Ping times are measured in milliseconds. Any value under 400 is considered adequate, although ping times of less than 300 are preferable. Kchat will list the ping times for all players connected to the server. The player with the lowest ping time should take on the role of the server, all other factors being equal. Of course, all factors are never equal and consideration should be given to computer speed when determining who should take on the role of the server. For example, a slow computer taking on the role of server is not desirable.

Several factors affect ping times, although the quality of your ISP, and consequently your connection to the internet, is the most important. Once again, if your ISP seems to be deficient, consider seeking out another if that is possible.

There are dozens of KALI servers, though you will not find EF2000 players on all of them. At the time of writing, SimNet (205.158.35.75) was the most likely place to find players, followed by TNP (207.51.75.99). To reach these servers, type:

KALI @SimNet ... or ... KALI 205.158.35.75

KALI @TNP ... or ... KALI 207.51.75.99

In order to use the '@name' format, the appropriate information must be entered in the KALI.CFG file. Check the KALI documentation for instructions on how to edit this file if necessary.

There were far fewer KAHN servers at the time of writing. The most likely place to find EF2000 players on KAHN can be reached by typing:

KAHN 205.217.6.114

Since KALI and KAHN simulate an IPX network connection, it is theoretically possible to connect up to eight players using these utilities. In practice, connecting more than four players will result in a great deal of warping. However, if all players have low ping times, a four player game can be quite satisfactory and two or three player games using KAHN will be very smooth indeed.

Although campaign play is an option you can select when using EF2000 in IPX network mode, the speed of the connection through KALI or KAHN is far too slow for satisfactory play. Limit yourself either to 'Simulator Missions', or 'King of the Skies' scenarios.

If you are using Super EF2000, you will need to obtain the Win95 version of either KALI or KAHN. You should set up your windows dialler to connect to the internet, start KALI or KAHN, and select an IPX network game when you are ready to begin play. Consult your ISP for information on how to set up your windows dialler if you are having problems connecting to the internet.

Using KALI and KAHN literally opens the world to you for head to head play in EF2000. If you do not have access to a local network, or cannot find opponents within reasonable modem calling distance, KALI and KAHN provide a relatively low cost alternative.

Part III Becoming King of the Skies

If the computer pilots offer you only modest challenges in a dogfight, then you will certainly appreciate the excitement that only flying against another human opponent can provide. While the computer pilots are excellent fliers and deadly marksmen, their tactics are predictable - they fly 'by the book'. Human pilots, on the other hand, are by nature unpredictable. This makes them deadlier, more challenging opponents, and makes defeating them that much more satisfying.

By selecting the 'Quick Combat' option from the 'Main Menu' you will be presented with the various 'King of the Skies' options. These give you the opportunity to fly head to head air combat against your friends, either as a free for all or as pre-assigned teams. There are three options in the TactCom release for head to head combat: 'Solo Play', 'Team Play', and 'Base Defence'. (If you do not have TactCom installed, only the 'Solo Play' option will be available.) Whichever option is selected, the server can assign the weapons load out that will be the default for the duration of the game.

The damage caused by the cannon is augmented in 'King of the Skies' for a more deadly experience. However, the maximum amount of damage that a plane can take has been increased to enhance survivability. This means that it will take at least two air to air missile hits before a plane is destroyed. Overall, aerial gunnery has been made more challenging in the TactCom release than it was in previous versions. This puts a great deal more emphasis on good air to air gunnery techniques and enhances the enjoyment of aerial duels.

All three of these options will provide you with fast and furious, non-stop action, where scoring points by destroying your opponents is the name of the game. When a player is destroyed, they are reincarnated on the runway with a full complement of weapons, ready to take to the skies and rejoin the excitement. Points cannot be scored against a recently reincarnated player for a period of approximately one minute to give them the opportunity to takeoff safely and re-engage. This protected mode is indicated by an 'X' appearing over the target designator box when the relevant plane is viewed in the air to air

HUD mode. Other pilots should beware, however, as they are not prevented from receiving damage from the protected player.

Points Scoring

A running total of each player's kills and deaths is kept in the 'Solo Play' scenario. Players are credited with one kill each time they destroy an opponent and one death each time they either crash or are shot down. The following table shows how points are scored for the 'Team Play' and 'Base Defence' scenarios. Ground attack points and the landing bonus are only awarded in the 'Base Defence' scenario.

Action	Team Play Score	Base Defence Score
Shooting down an opponent	+ 2 points	+ 2 points
Shooting down a team mate	- 5 points	- 5 points
Being shot down	- 1 point	- 2 points
Crashing into the ground	- 4 points	- 8 points
Destroying enemy ground based (1)	+ 2 points	
Destroying friendly ground based (1)	- 5 points	
Destroying enemy ground target (2)	+ 5 points	
Destroying friendly ground target (2)	- 10 points	
Landing on an enemy runway	+ 20 points	

(1) 'Ground based' refers to mobile targets: AAA and SAM launchers.
(2) 'Ground Targets' refers to buildings: hangars, the control tower, etc.

Solo Play Option

In 'Solo Play', the server selects which air base the pilots will takeoff from: Orland or Vaernes (approximately 40 miles apart). The server also selects the weapons load out, time of day and weather conditions for the fight. 'Solo Play' is a 'free for all' environment where the players enter into one large furball of dogfighting activity. Situational awareness is vital, as is good air to air gunnery skills - your limited complement of missiles (if you are carrying any) will be used up all too quickly.

When you enter the game for the first time, you will be parked on the ground facing perpendicular to one of the runways. Unlike campaign or simulator missions, the ground around the airfields offers no rolling resistance - it behaves as if it were one huge stretch of tarmac. Assuming there are no obstructions in your path, you should light the afterburner and takeoff immediately. Once in the air, the goal is to shoot everyone else before they shoot you, and to do so as many times as possible in order to get the highest number of kills. Your opponents are identified by having their names displayed below the target tracking box in the HUD and padlock views.

A running total of the number of kills you have scored, as well as the number of times you have died is provided continuously on the screen. Shooting down another player increments your number of kills by one. If you are shot down, or if you crash into the ground, the number of deaths you have is incremented as well. Each time a player dies, a screen will appear briefly which displays who just killed whom (or who just crashed). A list showing how many kills and deaths each pilot has appears as well.

You cannot rearm your plane, so when you have expended all your ordnance you have to die in order to be reincarnated in a fully loaded aircraft. Crashing into the ground results in an additional death for you, but it may be preferable to allowing one of your opponents the glory of another kill. The same holds true if you are severely damaged.

If all pilots have been set to takeoff from the same airfield, care should be taken not to engage planes that have been recently reincarnated. Shooting at them while they are protected will waste your precious ordnance. If you have just taken off, you should be looking to press this advantage, you can afford to take risks that might otherwise be considered unwise. However, do not become so careless that you crash into the ground. Although your opponents cannot increase their kill total if they shoot you down while you are protected, your total number of deaths will increase if you manage to kill yourself.

Team Play Option

If there are more than two players participating, dividing the group into teams allows for a greater emphasis on tactics and leader/wingmen engagements. The aim being to succeed as a team, which means protecting your wingmen, as much as shooting down the opposing team's planes. The 'Team Play' scenario (Figure 3) provides the option of dividing the players into two teams: red and green. The server can assign players to each team, select which air base (Orland or Vaernes) each pilot will start from, as well as weather and time of day options.

Figure 3

As in the 'Solo Play' option, players are identified by having their name appear under their target tracking boxes. However, the boxes and names are now colour coded to reflect which team they belong to: red or green. This allows you to quickly identify friend or foe.

A running total of each team's score is displayed on the screen continuously. Individual scores are only displayed when a player dies, and the information is colour coded to reflect team affiliations. As in 'Solo Play', there is no allowance for rearming your plane. However, because crashing results in a larger overall loss of points for the team than allowing yourself to be shot down by an opponent, the latter is the preferred option. If one team member is out of ammunition, one very good tactic is for that player to act as bait in order to draw opposing team members into a position where his team mate can line up for an easy kill.

Base Defence Option

The 'Base Defence' scenario adds several new features to the standard 'Team Play' option. Your team must now not only defeat the other team in the air, but also defend your air base from attack. At the same time, you will have to fight your way past the other team in order to attack the ground targets at their air base.

In addition to scoring points for air to air kills, you will receive additional points for destroying any ground targets at the enemy base (except runways, which cannot be destroyed in any case). Ground targets do not rebuild, and you will only get points when a target is fully destroyed. Damaged buildings give you no points, however, repeated attacks will eventually destroy the targets and score the points. The AAA and SAM sites do not fire on you, so destroying these is somewhat easier here than it is in campaign play - do not forget to attack these valuable targets.

There is also a large bonus score for successfully landing at the enemy base. To do this you will need to land, come to a complete halt on the runway and sit for a few seconds with your engines off and wheelbrakes on. In reality, this is extremely difficult to achieve without giving the other side the same opportunity at your own base. In addition, when you are lining up on finals, you are a slow moving and very predictable target. If other members of your team are engaging the enemy in the air and they manage to shoot them down, the enemy will be reincarnated on the runway, providing him with an easy kill. Co-ordination among the team members is, therefore, an essential ingredient for success.

Unlike the 'Solo Play' and 'Team Play' scenarios, rearming is possible in 'Base Defence'. In order to rearm, you must land at your home air base, come to a complete halt with you wheelbrakes on, and turn off your engines. It is therefore possible to have one or more players establish a CAP position to try and prevent the enemy from successfully bombing your base. If the CAP flight fires off all their missiles, they can land and rearm with no point penalty. Pilots who are taking on a CAP or Escort role should be careful not to drop any unwanted air to ground ordnance too close to their base to avoid accidentally destroying friendly units or buildings. The scoring table clearly shows that destroying any kind of friendly unit or building carries a large penalty.

Weapons Load outs

Prior to entering your chosen 'King of the Skies' scenario, the server has the option of selecting the default weapons load that will apply to all pilots. The default load outs work reasonably well, although experimentation can add further hours of enjoyment, for example flying with guns only in 'Solo' or 'Team Play' scenarios. Other combinations could prove to be rather dull, for example, taking long range missiles, especially in large quantities. Such a load out would inevitably result in stand off engagements at long range and few, if any gunfights.

For the 'Base Defence' scenario, free fall bombs are the easiest to deliver on target, especially if you intend to employ a high speed, dive bombing attack. Cluster munitions simplify the destruction of AAA and SAM sites. On the other hand, Rockets require more time on target, and GBUs require the pilot to fly a more predictable path. Both of these types of ordnance increase the difficulty and demand more co-ordination from wingmen providing cover (assuming there is a CAP over the base), which can add excitement to the scenario. Once again, experimentation will determine what kind of scenario your group enjoys the most.

Air to Air Tactics

When playing the 'Solo' scenario, it is every man for himself. The best tactics may seem mercenary, but when the object is to score the most points against any and all opponents, this is precisely the attitude you must take - nice guys WILL finish last.

One effective technique is to swoop down on an enemy as he is reincarnated, positioning yourself so that you can settle in on his six as he takes off. You will not score a kill if you shoot him right away, but you will be in an excellent tracking position to do so when his protected period has expired (the 'X' disappears from his target tracking box). Another technique, if more than two players are involved, is to avoid engaging your opponents until they have engaged someone else. In this way, you can 'attack the attacker' while his attention is focused on scoring hits on his own target, rather than on you. Once you dispatch this player, you should be in a good position to take his original target as well. However, remember to pay attention to the newly reincarnated player lest he returns the favour you recently bestowed upon him!

As we have already noted, these tactics may seem unfair and you may feel reluctant to employ them. However, if you start scoring too many points it will not be long before your opponents feel the urge to gang up on you in return.

When flying as part of an air to air team, co-operation is the key to success. Do not try to continue a fight against uneven odds. If your wingman gets shot down, look for a good opportunity to disengage and extend in the direction of your base. This way you can bring your wingman (and his fresh missiles) back into the fight on your own terms.

Consider putting some planes in a blatantly obvious CAP position while having one plane hidden in the terrain waiting to engage from his secret location when the furball above begins. Take care not to have too much separation in these instances as you may find the high level CAP outnumbered while the low level hidden plane is too far away to be of any use.

Base Defence Tactics

In 'Base Defence', always ensure you have some CAP around your airfield to prevent the enemy from getting those high scoring ground hits, or even worse, managing to land. Any planes not assigned to perform a defensive CAP should consider their tactics carefully. One option is to have an escort for planes assigned to bomb the enemy base. In this case, the aircraft should fly in fairly tight formation in order to provide adequate cover. Alternatively, if all attack aircraft are intending to make a bombing run on the enemy base, it may be better for them to split up, thus dividing the enemy interceptor threat.

It is also possible to break through to the enemy base by means of sheer speed. When departing your home airfield, climb on maximum afterburner to 40,000 feet or higher, then continue to accelerate towards the enemy base. At the speeds you will attain, the enemy will have one of two choices as to how they can engage you. First, they can climb to intercept you head on. At high speeds, evading head on missile shots is relatively easy. Once you have evaded the missiles and any head on gun shots, continue at full afterburner. Maintain your altitude if still some distance from the target, or initiate a high speed diving attack if you are close to your target. You will blow right past the interceptors who will not be able to close on you before you destroy a few of their ground targets. Even if they subsequently manage to catch you and shoot you down, you will have scored a large number of points. Secondly the enemy may sweep towards you from one side, turning gradually in order to maintain a higher speed, or attempting to lead turn you. Manoeuvring on to you in this fashion gives them a small window in which to get a rear aspect missile shot. In practice this is difficult to achieve, (unless using ASRAAMs and AMRAAMs) as the required combination of speed, turn rate and target aspect is hard to maintain whilst staying out of the missile arc of the inbound ground attack plane.

Finally, if the enemy CAP decides to loiter near their own airfield, stay aloft, dive bomb their base from a great height and immediately make a run back to your own base.

Suggestions for Play

Applying some rules to the 'King of the Skies' scenarios is worth considering in order to make the experience more enjoyable. Rules may seem pointless for 'Solo Play' since the scenario lends itself to an opportunistic atmosphere. However, a rule establishing an engagement area away from the air bases can be enacted in order to avoid too many protected mode kills as players come off the runway after being reincarnated. An example might be to declare that all encounters must occur 'over the sea'.

Limiting the armament to 'guns only' also works very well in 'Solo Play' and 'Team Play' modes. This ensures that dogfights occur at close proximity and can add a great deal of excitement to the aerial battles.

For 'Team Play', flying with a 'no radar' rule allows players use terrain masking and stealth tactics in order to sneak up on opponents undetected. Padlock views will still work in these circumstances but the range is minimal in comparison to radar. In the 'Base Defence' scenario, the 'no radar' rule works particularly well if you are prepared to put time and effort into the tactics and routing to get you to the enemy base.

'King of the Skies' also provides ample opportunities for organised competition. Many local groups and on-line services sponsor events ranging from tournaments to ongoing competitions. If you are keen to demonstrate your air combat prowess in EF2000, these are definitely worth seeking out. The most common format is the 'ladder' competition. A ladder functions by arranging players into a vertical ranking. New players enter at the bottom and climb towards the top by defeating other players ranked above themselves. Ladder competitions are generally sponsored by Internet sites, local network groups and bulletin board systems, as well as on-line services such as Compuserve.

These competitions generally employ very specific Rules of Engagement (ROE) for play and are meant to simulate many of the same kinds of scenarios real pilots use to hone their air combat skills. The two most common ROE employed in these competitions are: 'Clean Pass' engagements and 'Anything Goes' .

In the 'Clean Pass', or as it is commonly referred to, the 'Turn and Burn' (TNB) ROE, the players agree to fly towards each other and execute a head on pass. Weapons are not used prior to the merge. Once the planes have passed each other, a turning dogfight ensues. There are often variations on the type and amount of armament carried by the aircraft, from guns only to guns and missiles of differing types. The altitude at which the fight begins is also subject to variation, although both aircraft are assumed to be at the same altitude and in close horizontal proximity when they merge.

'Anything Goes', contrary to the title, is not a free for all environment. Rather, the 'ATG' scenario, as it is often called, simply means that no clean pass is required. The players initiate the fight when they come into weapons range, often employing long to medium range missiles in an attempt to defeat their opponent from beyond visual range. No requirements for a clean pass or assigned altitude are mandated in an ATG competition.

By allowing players to start either from the same, separate air bases, EF2000 lends itself nicely to competitions employing either ROE. For example, in a TNB competition, the pilots may takeoff together, fly in opposite directions to an agreed altitude, then turn back towards each other for the clean pass. In an ATG competition, the pilots may takeoff from different air bases and fly towards each other in whatever manner they choose, high or low, fast or slow, directly or indirectly. The tactics employed are entirely at the discretion of each pilot.

When one pilot is killed, the scenario is reset from the beginning - no reincarnation here - just a new pair of planes and another joust between knights of the virtual skies.

The final section of this chapter provides a listing of many local groups that sponsor activities ranging from casual modem play to serious network campaigning and competitions. In addition, a few resources are provided to help you find other players who are 'itching for a fight'.

Part IV

Local EF2000 Squadrons and other Resources

SQUADRON LISTINGS

We have compiled a brief listing of some 'local' EF2000 squadrons who meet for networked and modem play. The groups range in size from a few individuals to organisations of over two dozen members. This listing is not intended to serve as an endorsement or recommendation for any particular group. The information contained herein is subject to errors, omissions and may have changed without notice.

COUNTRY	CITY/STATE	SQUADRON NAME, CONTACTS AND ACTIVITIES
ARGENTINA	Buenos Aires	The Megadeath Killers Martin Marconcini **gryzor@ibm.net**
AUSTRALIA	Brisbane	The 62nd Fighting Falcons Michael Barnes **michaelb@onthenet.com.au** The Fighting Falcons hold monthly network gatherings which emphasize campaign play as well as team competitions. The Falcons maintain a website where you can obtain additional information: www.onthenet.com.au/~kennw/
	Wagga Wagga	The 131st Australian Tactical Fighter Wing Tom Dunsmuir **lrc@tpgi.com.au**
BRUNEI	Darussalam	The 244th Virtual Fighter Wing D. "Socrates" Soekratis **virtual@ppl.brunet.bn**
CANADA	Cranbrook, BC	The 1st Canadian Tactical Eurofighter Squadron Leonard Hjalmarson **lenh@cyberlink.bc.ca** The Squadron maintains a large, active database of information on Eurofighter operations at their website: www.cyberlink.bc.ca/~lenh/ef2.htm
	Sudury, ON	JABO 32 Squadron Hubert "Maverick" Sauter kanina@osiris.isys.ca
ECUADOR	Guayaquil	The Air Tigers Eduardo Raad arcasol@telconet.net

ENGLAND	Banbury	The 616th Bulldogs Leon "Badboy" Smith **badboy@h2hbbs.demon.co.uk** Charles "Pappy" Renfroe **crenfroe@socketis.net** The Bulldogs are a large and very active squadron in the UK. The squadron maintains a BBS which is host to ladder competitions. Regular network sessions are held at a nearby US Air base. http://members.sockets.net/~crenfroe/
	Berkshire	Squadron XIII Dominic "Col.Killerz" Silk **dsilk@elo.com** Squadron XIII hosts large two day netmeets at hotels in the southern counties. In the past events have included European Network Meets, organised in association with the 631st TFW Kaiserslautern Germany (ENM 1.0 - England, ENM 2.0 Germany) which involved pilots from Britain and Germany competing and campaigning together for three solid days.
FINLAND	Rovaniemi	11th Finnish Fighter Squadron Dr. Tuomo "MadDoc" Leino **tleino@sun3.oulu.fi** The Squadron meets to protect Lapland from all simulated incursions. Many members of the squadron are fighter pilots for the Finnish Air Force.
GERMANY	Kaiserslautern	631st TFW 'The Falcrums' Jürgen Breidenstein **100255.1153@compuserve.com**
SCOTLAND	Livingston	The 117th Tactical Fighter Wing "The Ghost Squadron" Ray "Viper" Purvis **100735.3430@compuserve.com**
	RAF Largs	The 217th Squadron "The Fighting Gaels" Desmond Coughlan **101472.22@compuserve.com**
SINGAPORE	Singapore	140th Tactical Eurofighter Wing - Far East Sebastian Lim **bfg9000@singnet.com.sg**
	Singapore	244th Virtual Fighter Wing D. "Socrates" Soekratis **socrates@singnet.com.sg**
SPAIN	Madrid	ALA 10 Squadron "Fernando" **allimadrid.ot@mad.servicom.es**
SWEDEN	Stockholm	The Delta War Hawks Marcus Hirt **d93-mhi@nada.kth.se**
		1st Swedish Independent Fighter Wing "The Devastators" Jojje "#FloZZy#" **jr@engelholm.se**
UNITED STATES		
Alaska	Anchorage	907th Composite Squadron Anthony "Polar Bear" Steensgaard **rigby19@rapidnet.com** "Top Cover for North America" is the mission of the 907th. All members are formerly US Armed Forces Reserves and most are combat veterans although everyone is welcome to participate in network campaigns, modem play and friendly competition.
Alabama	Auburn	The Death's Head Squadron Marshall "Cranky McCrank" Riser **cranky@hotmail.com**

California	El Cajon	The Electronic Flight Group Wade "Yasser" Marshall **efg@adnc.com** Ian Radcliffe **72262.3317@compuserve.com** The Electronic Flight Group does virtual airshows, hosts monthly network meetings and competitions. For more information, visit the EFG's homepage at www.adnc.com/web/efg
	Los Angeles	49th Tactical Fighter Wing "Baja Bandits" Bret "Raider" Ekstrand **bret@oc-net.com**
	Stockton	209th Virtual Fighter Squadron "Delta Hawks" Jeffrey "Rhino" Babineau **rhino@digicity.net** The Delta Hawks are a group of network flight simulation enthusiasts who meet regularly to participate in cooperative campaigns. The Delta Hawks stress fun and teamwork in their desire to create a realistic atmosphere of flight simulation. Additional information about the Delta Hawks is available at their website: http://value.net/~crenna/deltahawks.htm
District of Columbia		101st Tactical Fighter Wing "Wolfpack" George "Shiner" Sauter **gsauter@access.digex.net**
Connecticut	North Haven	203rd Tactical Fighter Wing Gustav "Mamba" Lessing **102076.1572@compuserve.com**
Georgia	Atlanta	40th Tactical Fighter Wing "The Pukin' Dogs" William "Doc" Farrar **75124.3462@compuserve.com** The Pukin' Dogs host monthly network meetings and encourage local modem play and competitions.
Hawaii	Kaui	The Flying Hawaiian Dogs Joe "Surfdog" Abramo **surfdog@aloha.net** The Flying Hawaiian Dogs participate in modem and network based play, as well as Internet competitions.
Illinois	Chicago	60th Tactical Fighter Wing Victor "Duke" Zaveduk **76711.27@compuserve.com** The 60th draws a large membership of over two dozen active players from all over the Chicago area including southern Wisconsin and northwestern Indiana. Monthly networked campaigning sessions, local modem play and competitions.
Indiana	West Lafayette	13th Aero Wing Michael "Sabre" Rennick **rennick@cartoon.ecn.purdue.edu**
Louisiana	New Orleans	159th Fighter Group "Coon Ass Militia" Aaron Rodriguez **bambam@gs.net**
Maryland	Baltimore	101st Tactical Fighter Wing "Wolfpack" George "Shiner" Sauter **gsauter@access.digex.net**
Massachusetts	Salem	The 508/617th Electronic Tactical Fighter Squadron "The Flying Eagles" Mike "Sledgehammer" Beaulieu **76430.3205@compuserve.com** Les "Showboat" Hall **71552.3235@compuserve.com** The Flying Eagles host networked sessions every 4-6 weeks. Local modem play and competitions are an ongoing feature.

Michigan	Detroit	810th Tactical Fighter Wing "Fighting Falcons" Dan "Maverick" Shook **104440.1533@compuserve.com**
New York	New York	718th Tactical Fighter Wing "Skyscrapers" Bill "Enforcer" DelPrior **bdpjr@aol.com** Tom "Roustabout" D'Angelo **70661.1605@compuserve.com** The 718th boasts a large membership from NYC and surrounding areas. They host regular network sessions, modem play, local and have organized national competitions for squad based flight simulation enthusiasts.
Oregon	Grants Pass	The Benevolent & Fraternal Order of Sewer Rats Col. Lee L. Stone (Ret) **n7svh@cdsnet.net**
	Portland Portland Net.Group	555th Virtual Tactical Fighter Wing "Triple Nickel" Darrel Baker **darrelb@k9.com** Mike "Caustic" Sutton **caustic@teleport.com**
Pennsylvania	Fayetteville	717th Tactical Fighter Group Al "Goblin" Lehman **alehman@ccmhost.ddre.dla.mil**
South Dakota	Rapid City	37th Virtual Fighter Squadron SrA. Todd "JetAce" Harmon **jetace@rapidnet.com** The 37th VFS calls the Ellsworth US Air Force base home. The squadron has experience in F15, F14, F16, and F22 aircraft.
Tennessee	Nashville	40th Tactical Fighter Wing "The Pukin' Dogs" Eric "Muad'dib" Fether **efether@ibm.net** The Pukin' Dogs host monthly network meetings and encourage local modem play and competitions.

Additional information about EF2000 squadrons, activities and other Eurofighter related activities can also be found at the following sites:

DiD (Digital Image Design)
www.did.com
Developers of EF2000 and the TFX Military simulation series.

Ocean Software Limited (UK)
www.oceanltd.com

Ocean of America, Inc. (USA)
Publishers of EF2000 and other fine simulations.

The 1st Eurofighter Air Wing. Official home for Eurofighter operations.
www.ef2000.com

CompuServe
GO:ModemGames

Enemy Lock On! (the military flightsim magazine)
www.elo.com

Sim Tech
www.sim-tech.co.uk

Chapter 14

HARDWARE

GETTING EF2000 RUNNING

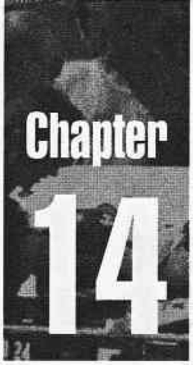
PC PERFORMANCE IMPROVEMENTS

BIOS CHANGES

GRAPHICS CARDS

JOYSTICKS

Chapter 14



Hardware

This chapter will offer assistance in the performance tuning of your PC, selection of appropriate hardware, and advice in setting up EF2000 under both DOS and Windows '95. We will also explore the use of programmable joystick/throttle combinations and identify some sources for further information on these topics.

Important

Some of the suggestions in this chapter may require the alteration of hardware or software settings. You must understand that any such alterations are undertaken entirely at your own risk, the publisher and authors of this book can accept no liability for any damage or loss which results from following any advice contained in this chapter. You are strongly advised to ensure that you have current back-up copies of your hard-drives, and a record of all current BIOS settings. You should also consult the supplier of your equipment to ensure that any such changes do not invalidate your warrantee or maintenance agreement.

Part I Getting EF2000 Running

Introduction

Before we look at the hardware that you are using, we should ensure that you have created a suitable environment for running EF2000. The way that you approach this will differ between Windows '95 and DOS, so we will consider these operating systems separately. We will look at the configuration files, and the steps necessary to set-up the Windows '95 version of EF2000. Always remember to take a copy of configuration files before you edit them.

EF2000 - DOS Version

DOS

EF2000 does not require a highly specialised set of boot files as it makes use of the DOS4GW extender. The only problem that you are likely to encounter is in ensuring that memory is not wasted.

This problem is usually caused by an excessively large disk cache. You should experiment to find if a disk cache makes a significant difference to load and quit times. You may want to locate the line in your config.sys or autoexec.bat files that contains the command for your cache (smartdrv etc.), and temporarily disable it by placing REM in front of the line. This can be done using the DOS edit command, or the Windows notepad.

If you determine that the cache helps, check the amount of RAM that it uses. Following the command will be the amount of memory dedicated to the cache, try different settings, say 1024, 2048, 4096, and check for the best performance. Be careful, if you take too much RAM away from EF2000, it may create it's own cache file, which will significantly affect mission load times. Also ensure that write caching is turned off as this can cause problems not only with EF2000, but with most other sims and games as well. If you are using Smartdrv, use something like this: smartdrv c 1024 (this will turn off write caching, and set-up a cache size of 1024).

You should not need to perform any other tuning, but if you still have problems, check to ensure that you have no drivers or programs being loaded by the autoexec.bat or config.sys files that are not required while you run EF2000.

Windows '95

The DOS version of EF2000 will not run directly under Windows '95, but it can be called from a shortcut on the desktop that will cause your PC to reboot in DOS mode, then return to Windows '95 when you quit EF2000. The procedure for setting this up is as follows :

1. Right-click on the desktop and select **NEW** then **SHORTCUT** (Figure 1).
2. Use the browse option to locate the ef2000 directory, then double click on **ef2000.bat**.
3. Select **NEXT** then alter the suggested name to something suitable.
4. Select **FINISH**.

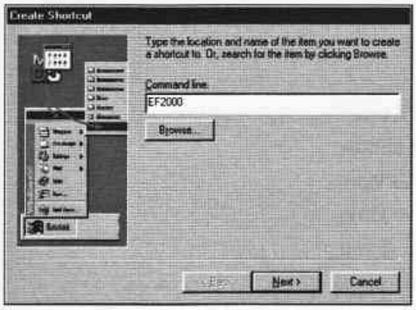


Figure 1

This is the basic configuration, but we are not finished yet.

1. Right-click on the shortcut and select **PROPERTIES** (Figure 2).
2. Select the **PROGRAM** tab, and click on the **ADVANCED** button
3. Check **MS-DOS** mode, **Specify A new MS-DOS configuration**
4. You must ensure that any special drivers required by your PC are entered in the config.sys and autoexec.bat windows (Figure 4). Pay particular attention to CD-ROM and network drivers.
5. Once this has been done click on **OK**.

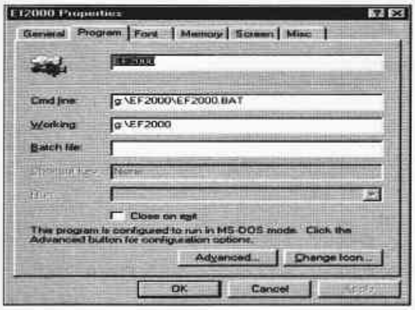


Figure 2

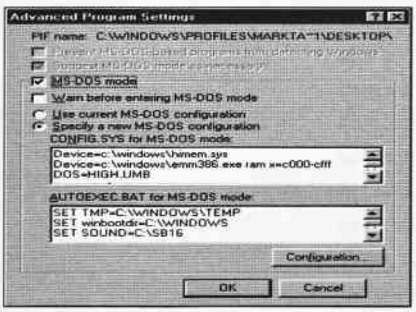


Figure 3

You now have a shortcut that will re-boot your PC using the config.sys and autoexec.bat files that you've just entered, so now is a good time to test it. If everything works as expected proceed to the next paragraph, otherwise, try and spot any error messages during booting as these will normally help to identify any wrong commands. Corrections can be made to the shortcut by repeating the procedure above.

There is one change that you may wish to make to the shortcut. If you find that the delay while your PC reloads Windows '95 on the occasions when EF2000 does not run correctly and crashes is a bit tiresome, add a pause statement to the autoexec.bat file just before it runs EF2000. The effect of this will be to halt the batch file and give you the opportunity to decide if you want to continue by pressing a key, or stop the file by pressing **CTRL** **C** and answering yes to the question that follows. If you are using EF2000 in single player mode, let it continue, but always halt the file when playing over a network as there is a greater likelihood of problems occurring in this mode. If you do this, your PC will run the EF2000 files when it is re-booted; to return to Windows '95, watch for a prompt to press ESC to return to Windows '95 which appears during the boot process.

Super EF2000 - Windows '95 Only

With the Windows '95 version, it is not necessary to establish any special shortcuts, as the program can be selected from the normal Start menu. However, there are a couple of things that you should sort out before you load EF2000; sound and joystick settings.

Sound

This should be straight forward as Super EF2000, like all other Windows '95 programs, relies on the operating system to handle sound cards. All that is necessary is to confirm that your card has been correctly recognised by Windows '95. If you are getting sound from other Windows '95 programs, Super EF2000 should also work. If you do not get any sound in the program, but other programs are working, check the settings in the in-flight option menu (key). If the sound options are not set correctly adjust them here. If for any reason they are greyed out and cannot be changed, it may be necessary to re-install the program. If you want to avoid this, you may wish to make a copy of the ef2000.cfg file which is in the program directory below the directory where you installed Super EF2000.

DirectX

Super EF2000 ships with the Microsoft DirectX drivers. It will automatically check the version of DirectX installed on your system and will install the new drivers if required. The install program will also check your graphics drivers to see if it recognises them. If it does not, it will suggest that it replaces them. Be very careful when you answer this question; the fact that the install program does not recognise them does not mean that they will not work correctly with DirectX, so only let it replace your drivers if you know that they will not work correctly. If you have installed a game and you notice that your screen refresh rate has suddenly dropped, or your graphics card control panel no longer works, you may find that it has replaced your drivers without asking. If this occurs, either re-install your cards software, or re-select the correct driver from the screen properties box.

Joystick Settings

Once again, all Windows '95 programs use the settings established by the operating system. Before attempting to use a joystick within Windows '95, it is necessary to set it up correctly by selecting settings on the Start menu, followed by configuration then joystick. You must choose a suitable joystick type from the options offered. In order to make the correct choice, you must understand a little about the way that joysticks work.

A basic joystick without any special functions is usually a 2-axis 2-button stick as far as Windows '95 is concerned, but unfortunately a top of the range ThrustMaster FLCS is also a 2-axis 2-button stick, unless it is attached to a WCS or a TQS, in which case it is a 3-axis stick, why ?

The answer is to be found in the way that joysticks communicate with the PC. They attach to the PC via a 15-pin D connector, and they pass signals to the game card that are translated into a number which increase or decreases as the joystick moves. There is one of these numbers for the up/down movement and another for the left/right movement, these represent the 2-axis part of the standard joystick. The game card has the ability to support two joysticks, each with two buttons, attached to each D connector, this is exploited by those manufacturers who include a throttle control. The throttle is presented to the computer as though it was the up/down part of the second joystick, this is the 3rd axis of our three axis joystick. If you have rudders attached to your system they of course appear to be the left/right movement of the second stick.

Now, back to the original problem of selecting the correct option for your stick. If it is a programmable stick, the 2-button choice should be correct. Even if there is a specific selection like ThrustMaster available do not use it if you have a way of programming the stick, as these special selections are for the non-programmable versions. Choose 3-axis if you have a throttle, but do not choose 4 axis if you also have rudders, just check the rudder option box just below the joystick type.

If you have a basic 2 or 4 button stick then choose the appropriate option, if you have a ThrustMaster PFCS or FCS choose the ThrustMaster option, and with a CH Flightstick Pro select the Flightstick option. Once this part is complete, you will be able to progress to the calibration of your stick.

The calibration should be straight forward, but do ensure that you take the trouble to do it carefully, as the result will be used by every Windows '95 program that uses the joystick. Once completed, do remember to save the calibration results. You will now have the opportunity to test your stick. When you move the joystick, the bars displayed on the screen should each move to the extremes of their box, if they do not, there is something wrong with your set-up, and it will have to be resolved if you wish to avoid jerky or limited control responses in the sim. Check your trims, and the choices that you have made in the set-up procedure.

Background Tasks.

One of the aspects of Windows '95 that is frequently exploited is its ability to run several task at the same time. In reality, since Windows '95 is only able to use a single processor, it just shares the available processing power between the various tasks. In normal use, you tend to spot these activities only when they involve disk access, but if they occur when you are in flight, you will notice the frame rate suffering, and control responses will get very jerky. Before running Super EF2000, ensure that as many of these background tasks are shut down as possible. Look in the bottom right corner of your screen, you may see several small icons there that represent things like a virus checker or performance monitoring software. If you shut these functions down, you will stop whatever they were doing, but you will get a smoother flight.

Once you have closed down all the things you can find, try this little trick: press CTRL ALT DELETE .

As you may already know, this will not reboot your PC as it did under DOS, but it will display a list of the programs that are currently running, and their status. Usually this is used to locate programs that are not responding and gives you the option to shut them down. In this case, use it as a quick check to ensure that only the necessary programs are still loaded. If you recognise a program that should not still be active, you can end the task from this screen, but only do this if you fully understand the implications of shutting it down.

An alternative is to temporarily move unnecessary programs from the start-up folder. If you right-click on the start button, you can open the button and get access to the levels of menu below this point. If you open the program folder, then create a new folder and move the items you wish to disable into it, from the start-up group, you will be able to restart Windows '95 without loading the programs. Remember to put them back later.

A better solution is to set-up multiple users on your system, and create a profile that does not load any of the non-essential programs. This can easily be done by using the Passwords option on the Control Panel screen. Select the USER PROFILES tab and check the USER CAN CUSTOMISE option, and the two boxes in the User Profile Settings section. Make sure that you re-boot your PC to bring the changes into action, then log on to the PC using a new user name such as games, then make the necessary changes to the Start menu. You can

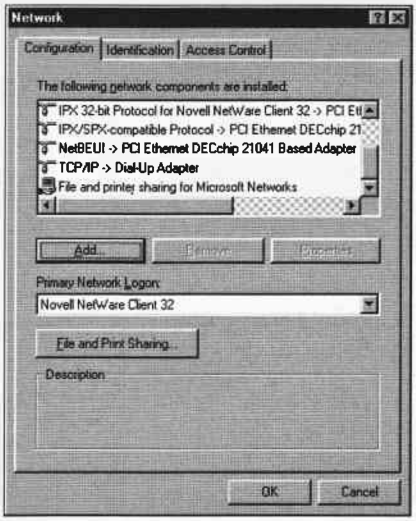


Figure 4

quickly switch between these settings by selecting **CLOSE ALL PROGRAMS AND LOG ON AS A DIFFERENT USER** from the Shut Down option on the Start menu.

Whatever you do, it is still likely that other tasks will run while you are flying. They should be infrequent, but there is little that can be done about them. If you get occasional pauses while flying, it is probably due to one of these tasks, but it is worth checking that you do not have the TCP/IP protocol bound to your network card as this can cause a similar problem. You can check this by right-clicking on the network shortcut which is found on the desktop, and selcting the properties option (Figure 4).

Part II Performance Improvement

Introduction.

If you are entirely happy with the performance of your PC, please skip this section. If, however, you are noticing poor frame-rates, or you find that EF2000 takes a long time to load/unload, there may be some useful comments in the following section.

Whenever the subject of performance improvement is discussed, it is necessary to set a few ground rules. It is not possible to specify a PC that will out-perform every other PC in all circumstances, as the requirements for a fast DOS based sim are not the same as those for one running under Windows '95. Thus we will need to consider the original DOS version of EF2000 separately from Super EF2000 when we talk about hardware requirements.

Benchmarks

What do they do ?

Before we change anything, it is useful to establish the current performance of your computer so that you can measure the improvements (if any) that are made as you progress through this chapter.

There are many benchmark programs available; most of the ones used in magazine reviews are based on running a number of standard business applications in a controlled environment, this tests the performance of the system under a real working load. This is fine for business applications, but these scores do not provide a good indication of the performance that we are likely to get from a graphically intensive sim like EF2000. Our needs are better served by a benchmark designed to measure the performance of the graphics subsystem.

In any measurement of this type, we are not just measuring the performance of the graphics card, but of the systems ability to keep the graphics card working at peak performance. The point of the benchmark is to focus on an easily measured aspect of system performance that is relevant to the perceived performance of EF2000, that is frame-rate.

When we talk about frame-rates, we are referring to the number of times that the screen could be updated each second. It is these updates that we see as movement on screen. The word 'could' in the last sentence is important, because there is a physical limit on the number of frames per second that can actually influence what you see. Your computer monitor has a vertical refresh rate which describes the number of times that the monitor image is updated each second, a typical value for this would be 72. Thus if a benchmark indicates that the screen could have been updated 100 times, the image would only have been updated 72 times on the screen.

This does not mean that there is no point in having a system capable of performing faster than the refresh rate of the monitor. When a program like EF2000 is running, it is performing many tasks at the same time, the result of this is that the actual frame-rates achieved are never likely to approach the refresh-rate of the monitor.

When interpreting the results of any benchmark program, pay more attention to the improvement over your original score than the score itself.

Selecting a Benchmark

The best benchmark of all, is the actual program that you wish to use, unfortunately DiD did not put a readily accessible frame counter into EF2000, so we must rely on other sources for the benchmark.

You may have come across a program called 3Dbench. In its original form, it was a VGA benchmark that became popular on Compuserve and the Internet. Although it was useful for comparing systems, the VGA limitation became a problem. Unfortunately, the relative performance of graphics cards varies depending on the screen mode (resolution) and colour depth. So a card that is a top performer in a VGA mode, may not do as well in the higher SVGA modes. When flight sims were only using VGA modes this was not a problem, but now that EF2000, and others are using SVGA modes 3Dbench needed an upgrade. Fortunately, Chris Dial has released a new 3D benchmark that handles SVGA as well as VGA graphics, it only tests a single SVGA mode, but it is significantly better than the old VGA only solution. The score produced by this program is directly influenced by the other components of your PC, and it is therefore a good general benchmark for our purposes.

There are other benchmarks, such as Vidspeed (V4.0), that provide a more focused assessment of the graphics card, with less influence from the rest of your system. This sort of test is useful if you are assessing the merits of different graphics cards, but as we are more interested in the improvement of the system as a whole, Chris Dial's 3DBenchmark is probably a better choice.

Obtaining a Benchmark Program

If you have access to Compuserve or the Internet you will be able to download the programs mentioned in this Chapter, if you do not, you may be able to locate them on magazine cover disks. If you are unable to do this, the best alternative is to use another similar program which does have a frame-rate feature. The important thing is to establish an objective assessment of the performance of your PC before any changes are made, and to provide a means of measuring the effect of the changes.

Using the Benchmark Program

Which ever method you choose to use, the following steps are the same. Ensure that you keep detailed notes of the changes that you make, record the results after each change. If you will be running Super EF2000, the Windows '95 version, you can still use the DOS benchmark programs to help you recognise the improvements that you are making in areas such as BIOS tuning, but do not rely on DOS based measurements of graphics card performance to choose between different cards, as they will behave very differently in the two environments. A table of results from various systems is presented in Table 1, this is offered to help you identify how far away from the best systems your current configuration is. But remember, the important thing is how your system feels, do not worry if you are 10-15% below the best systems in your processor category, there will always be those who can squeeze a few more frames out of a benchmark, but the difference may not be noticeable in the actual program.

Table 1: SVGA Benchmarks

	Processor	Chris Dial's SVGA Benchmark score
Pentium Pro	200	76-93
Pentium	200	60-70
Pentium	166	55-62
Pentium	150	48-54
Pentium	133	48-52
Pentium	120	44-49
Pentium	100	38-43

N.B. The overlaps in scores between different processors shows how a well tuned system can out perform a less tuned system with a faster processor.

Part III BIOS Changes

Introduction

So having used the benchmark program to assess your current system performance, and carefully noted the results, it is time to begin making changes. The first area that we will consider is the BIOS. This is the software that controls the way in which the memory, CPU, and other components of the system interact at a very low level.

It is critical to understand that changes made at this level can have wide ranging effects, including rendering your PC inoperable, loosing the contents of your hard disk or even damaging hardware. If you are not happy taking this kind of risk then please do not make any changes to your BIOS, as the authors and publishers of this book will accept no liability for any damage or loss which occurs.

To get access to the BIOS settings you must follow the instructions that were supplied with your computer, or are displayed during the boot sequence when you turn the power on. Once you have gained access to the BIOS, you should have a look at the various settings, and check that they are set to the correct choice for your hardware.

Typically, the default setting are not the fastest available, since the slower settings will often result in fewer reported problems. There will be many different options, but only make alterations after noting the original settings. Getting the best combination will only be achieved after much experimentation, or direct help from the supplier of your system, but there are one or two settings that are worth checking.

BUS and Memory Speed

The original PC had a bus speed of 8Mhz, this speed governed the flow of data from the ISA card slots to the processor and memory of the PC. Motherboards retained the ability to run at this speed for long after it was necessary for compatibility reasons, so you should ensure that the speed is set to the highest value available, usually 11Mhz. Another area to check is memory speed and wait states. The motherboard manufacturer has no idea what type of memory you will use, or the speed of the memory, so the default settings tend to be conservative. If you know what the speed of your memory is, use that setting, if not, have a close look at a SIMM, the speed may be printed on the SIMM, or on each chip. You are looking for a number that ends -70 or -80, or even -60, the lower the number, the faster the SIMM. Once this setting is correct have a look at the wait states, this will often be set at 1 or 2, and may have to stay at this setting, but it may be possible to set it a little lower without any adverse results. If you do change this or any other setting, verify that it is producing a performance increase and check that your software works correctly. If you do not get any improvement, or you experience system crashes or unexpected software problems, return the settings to their original value and see if the problems is eliminated.

Upgrades

A final option is to upgrade the BIOS itself. Many modern motherboards allow the user to load new versions from disk. If you have one of these motherboards, there will be instructions regarding the source of upgrades and the upgrade methodology. In general these files are easily available from the Internet and other on-line services, but please be very careful when upgrading the BIOS, as it is possible to render your motherboard unusable in some cases. Not all upgrades result in performance increases, so ensure that you have a copy of the original BIOS in case you need to revert to it after an upgrade.

Processors

The minimum processor recommended for EF2000 is a DX2-66, but this will not permit satisfactory results in anything other than the lowest detail settings, and a good graphics card is also essential. A more realistic minimum would be a fast DX4-100 PC, but if you want to use the higher detail settings a Pentium is essential. In our experience, a P133 is fine for the highest detail setting though a faster processor will always help.

The only aspect of the processor to consider other than speed, is the presence of a floating point unit (FPU). There are a number of Pentium equivalent processors available from Cyrix which do not have the FPU implemented in hardware. These processors will generally outperform their Intel equivalents in most benchmarks except floating point calculations. Unfortunately a number of simulations including EF2000 make use of floating point calculations, so the performance of EF2000 on these processors is significantly below their Intel equivalents.

Another possibility is the Pentium Pro. This processor was originally targeted at the 32-bit workstation or server market, but with a little adjustment it also makes a fine simulation platform. There were some problems with early versions of the Pentium Pro that required some motherboard features to be turned off. This resulted in slow graphic performance and supported the view that the Pro's were not suitable for leisure software. These problems have been fixed for some time now, but most motherboards either have them turned off by default, or do not allow access to them via the BIOS set-up routines. Fortunately there is a program called Fastvid, produced by John Hinkley, which will handle this for you. The program is available on the Internet and Compuserve, but if you cannot get it, the settings to check in your BIOS relate to the linear frame buffer, write posting and banked VGA write combining. In most cases turning all three on will have a dramatic affect on graphic performance, but as usual, it is wise to try various combinations of these features to ensure that you achieve the maximum possible performance gain.

Memory

If there is less than 22Mb of RAM available to EF2000 after DOS and any drivers have been loaded, it will create a swap file on the hard disk. This will significantly slow the program when it has to access this file, so it is better to ensure than EF2000 has enough RAM available if possible.

If you have less than 24Mb in your PC then there is little you can do other than add more RAM, but you should ensure that you use a de-fragmentation program on your hard disk. If the swap file is spread around your drive because the available space is fragmented, it will further degrade performance. The swap file will take around 14Mb of disk space, so ensure that you have enough space available.

Super EF2000 will need at least 16Mb of RAM, and will use the virtual memory provided by Windows '95 when required, so for the best performance, you may find that it is necessary to increase the RAM beyond the 24Mb required by the DOS version. Before doing this, check and see if the lack of RAM causes you perceptible problems, if not then do not bother with the upgrade, but even if you are happy at the moment, you will find that 32Mb is likely to be required by future sims.

If you intend to add memory to your system, check if you have any free SIMM sockets before purchasing additional SIMMs. It is not uncommon to find that a PC is shipped with all SIMM sockets in use, in which case you will need to remove some memory before you can add new SIMMs.

If you have more than 24Mb of RAM but you are still experiencing problems, you may find that you are assigning too much RAM to your disk-cache. If you are not sure how to verify this please check the comments in the section covering Config.sys and Autoexec.bat earlier in this chapter.

Part IV Graphics Cards

BUS Types

There are three basic types of card available, ISA, VLB and PCI. Of these, ISA are the slowest, and should not be used in any PC capable of supporting VLB or PCI cards. It is becoming rare to find VLB slots on new motherboards, but they still exist on many older boards, but unfortunately most producers of graphic cards are concentrating on PCI cards, so the availability of new VLB cards is decreasing.

There are many different brands of card available, but they often use very similar chips, so the differences are not as great as it may appear. When choosing a card, it is necessary to decide if DOS or Windows performance is the critical element, as most cards are better in one or the other environment. In general, any new cards will offer acceptable performance in Windows and DOS, but there are some cards that have been fully optimised for Windows and have very poor DOS performance, the Diamond Edge 3D cards are a good example of this.

Most manufacturers have cards suitable for DOS or Windows, so it is the chip-sets that become important. Currently the ARK2000PV is one of the most popular choices for DOS programs, with cards produced by both Hercules and Diamond using it. The Matrox Millennium is a popular choice for Windows '95, and is a very good DOS performer as well. These are just examples, and there are many other good cards based on the ET4000/ET6000, S3 and other chip-sets.

VESA Support

Another consideration is VESA support. The VESA BIOS extensions, permit software developers to write to a standard interface that can provide significant improvements in graphic performance. The current version of the VESA standard is 2.0, very few cards support this level, but many support the earlier V1.2. The DOS version of EF2000 uses a program called UNIVBE to provide VESA 2.0 support for most manufacturers cards, but if you are using a Matrox

Millennium card you may experience difficulty, as the version of UNIVBE supplied by DiD does not support this card. Fortunately, the Millennium is one of the few cards that does support VESA V2.0, so you must rename the file called univbe.drv, in the EF2000 directory to avoid problems.

If you do decide to get a new card, give careful thought to the amount of memory on the card. The memory will not affect the speed of the card, except in a few specialised cases, but it will limit the colour depth available at higher resolutions, or the resolutions at which certain special functions such as 3D support can be used. In general, we would not recommend using a card with less than 2Mb of RAM, and if you have a large monitor (17inch or greater) you may consider 4Mb appropriate if you use Windows.

3D Cards

In its current forms, EF2000 cannot make use of 3D acceleration, but DiD have stated that they may add this facility to future versions of the program. There are several competing 3D chip-sets available, and as yet there is no clear leader. Under Windows '95 this is not a particular problem as it seems likely that they will all support the Microsoft Direct3D standard. Under DOS it is necessary for the program to specifically support the card, and this is unlikely to happen until the developers can see a clear leader. By the time you read this, the situation may have changed, but at present resist the temptation to buy one of these cards unless there is clear support from developers for the product.

Drivers and BIOS updates.

Whichever card you get, try and obtain the latest version of the drivers, or BIOS, if it is flash-upgradable.

Part V

General Joystick Comments

Introduction

A lot of people pay little attention to their game card. If you are having problems with poor or erratic response to control inputs, do not jump to the conclusion that your joystick is faulty, the problem may be the game card.

Conflicts

One very common problem is having more than one device sharing the same address space. Most sound cards have a joystick port, and many motherboards or multi-function I/O cards also have a joystick port, so it is not only specialised game cards that have to be considered. If you do have two active ports, some programs will work correctly, others will appear to give poor response, and some may not work at all. If you have fitted a dedicated game card you must ensure that all other joystick ports are disabled. This may require a change to BIOS settings, or the alteration of a jumper or a switch, but the documentation supplied with your hardware should explain the procedure.

Speed

Even if you have a dedicated game card, you may still encounter problems if you have a fast processor. Once again these problems may be program specific, but you will probably notice it most during the calibration of your stick. The game card passes a numeric value to the program for each position of the joystick, the function of the calibration routines in DOS based programs or in Windows '95, is to establish the high and low values for each axis. Some programs can have problems if the values are very high, causing over sensitive or twitchy responses to joystick movements. EF2000, in both versions, has a joystick sensitivity setting that can help, and we will discuss its use later in this chapter, but rather than rely on the program settings, it is better to avoid the problem in the first place.

A number of manufacturers produce speed adjustable game cards which allow either manual or automatic compensation for the processor speed. Such cards include the CH Gamecard III, and the ThrustMaster ACM card. These are not expensive cards, and if you have a fast Pentium processor they may prove a wise investment.

Adjustment

If you already have one of these cards, check that it is correctly adjusted. The CH product is automatic, as long as you have called the set-up program from your autoexec.bat file. If you have recently installed Windows '95, or re-installed DOS or Windows, check that you still have the correct entry in the file, as without it the card will not be functioning correctly.

If you have a ThrustMaster ACM card, run the calibration software that shipped with your card, and adjust the remote dial, or the rotary control on the back of the card to centre the on-screen indicator. If you no longer have the software, it can be downloaded from Compuserve or the internet.

Once these adjustments have been made, it is then appropriate to use the in-sim adjustments to fine tune the joystick response.

Sensitivity Adjustment

The in-flight menu, accessed via the [illegible] key has a setting for joystick scale. This needs to be adjusted to a point that gives you just enough control response that you can still achieve a sensible maximum G, without becoming twitchy. If you leave it at the default setting, you will probably be limited to between 5 - 6G manoeuvres, but this will leave you with a distinct lack of flexibility when you start to get into the more advanced tactics discussed elsewhere in this book.

If you want to get the sensitivity set correctly, you need to start a simulator mission, and fly up to about 40,000 feet, then go into a dive with the afterburners on. When your air speed indicator hits around 1.5, pull out with the stick fully back and watch the G indicator on the HUD. If you adjust the joystick scale setting so that the indicated G force is around 9.4, you will have a fighter that is manoeuvrable, but still controllable.

Programming your Stick

Introduction

There are many different programmable sticks available today, and although they may differ in their flexibility and complexity, they all have the same objective, to keep your hands on the stick and throttle as much as possible. This is know as HOTAS - Hands On Throttle And Stick, and it most closely approximates the control systems used by real fighter pilots. In this section, we will explore the best way to make use of the equipment that you have available.

General Advice.

Whether you have the full ThrustMaster or CH kit, or a Suncom joystick, you are faced with the same problem, which functions to put on the stick, and which to leave on the keyboard. Even with the ThrustMaster FLCS and TQS combination, which could probably handle all the keystrokes required, the complexity of the button combinations makes full HOTAS unsuitable for most of us.

There are some functions that must be on the stick/throttle, like afterburner and airbrake, but there are others that are positively dangerous like gear and eject. So it makes sense to review the keyboard functions and divide them into three groups, essential, optional, dangerous. The first of these groups must be allocated a place, the second can use up remaining space, and the third must not be used. Table 2 below gives an example of these groups.

Table 2: Joystick Button Functions

Must Have	Useful to Have	Must Not Have
View controls	ECM	Gear
Weapon selection	Radar controls	Deploy chute
Weapon release	DASS range	Jettison stores
Chaff & flares	Wheelbrakes	Engines On/off
Padlock views	Auto Recovery	Eject
Afterburner	Laser Controls	Quit
MFD selection	Rudder	
Airbrake	Autopilot	

When you allocate the position to each function, try to keep similar functions together so that you do not need to keep referring to a button guide all the time. Also, try to keep the layout that you use for different sims as similar as possible, it will make it much easier to switch from one to another if critical functions like weapon select and release are always in the same place. Above all, keep it simple; the ThrustMaster equipment will let you program a different setting to a button depending on the position of a switch and whether a particular button is pressed or not, the number of combinations is huge, but so is the potential to get the wrong function, so use this level of complexity with care.

Finally, there is a peculiarity regarding the cannon. If you use the joystick trigger to fire the cannon, you will get a much slower rate of fire compared to using the keyboard spacebar. Within each of the following sections we will explain how to get the maximum benefit from this peculiarity, since more shells in the sky means quicker kills, and the faster cannon can be 2-3 times quicker than the normal rate of fire. If you do not achieve this sort of improvement, you may need to increase the typematic settings in your PC BIOS.

FLCS

TQS

ThrustMaster Set-up

There are several possible combinations of programmable ThrustMaster equipment, ranging from the WCS II, to the full FLCS/TQS combination. For the purpose of this section, we will assume that you have the FLCS/TQS combination, but if you do not, please read on as there will be some ideas that you can adapt for your own use.

Super-Cannon

The first of these is the Super-Cannon. The most basic implementation requires that you program the spacebar on to a button, with the /H modifier to ensure that the gun will fire as long as the button is depressed. This is the way all the other sticks will have to implement this function, but with the FLCS you can go one stage better. The trigger on the FLCS is a two stage device, the first position emulates the normal trigger press and is passed through the game card in the normal way, but if you pull the trigger back fully, you can have the FLCS pass a keyboard action through to the computer as well. If you program the second position to the spacebar, you have the best of both worlds, slow or fast cannon fire rates, just include this line in your .B50 file:

BTN TT2 /H SPC

Grey Keys

Any long-term user of ThrustMaster kit will be familiar with this problem; when PC keyboards were first invented, they adopted a layout that placed certain keys like insert/delete and page up/down, as shifted versions of the number-pad keys. After a little while, the manufacturers decided that it would be better to make these keys directly available by placing them on their own, usually a grey key. When you press a key, the keyboard controller gets something called a scan-code, this tells it which key, or keys have been pressed. Thus, when you press SHIFT 9 for page-up, it sends a different scan-code from pressing the dedicated page-up key. Unfortunately, two things have happened, firstly, ThrustMaster equipment does not differentiate between the scan-codes it only recognises the results, so SHIFT 9 and page-up look the same. This would not be a problem if it wasn't for the trend among developers to recognise the scan-codes, and program different functions to SHIFT 9 and page-up. If this was the end of the matter, ThrustMaster would have a problem, but fortunately they have provided a method to allow their equipment to recognise scan-codes via a technique they call Raw codes.

This section could not begin to cover the complexity of Raw-code programming, but if you study the following example, you will see that the codes have been provided for the steering of the Laser Designator.

LaserTD_Up = (RAW(#59 #E0 #75 #E0 #F0 #75 #F0 #59))

LaserTD_Down = (RAW(#59 #E0 #72 #E0 #F0 #72 #F0 #59))

LaserTD_Left = (RAW(#59 #E0 #6B #E0 #F0 #6B #F0 #59))

LaserTD_Right = (RAW(#59 #E0 #74 #E0 #F0 #74 #F0 #59))

DiD have responded to the problem by adding keys to cover many of the functions originally mapped on to the grey keys, but this is a problem that will occur in other future sims. Raw codes cannot be programmed into the WCS II, so in that case there is no solution other than relying on developers not to repeat this sort of thing.

Mode Switch

Both the TQS, and the WCS II have a mode, or dogfight switch. The availability of this switch represents a key difference between ThrustMaster and the other manufacturers, as it allows different actions to be assigned to all the other keys dependant on the position of this switch. Although we have said that we should keep it simple, correct use of this switch can help us achieve our goal. On a multi-role aircraft like the EF2000, the different weapon systems for air to air and air to ground require separate controls. Rather than dedicate different buttons to the same basic function, it is better to let the switch position determine the mode that we are in, and let the same button select the active weapon in each mode. The third position is best reserved for a safe navigation mode, or can be used to quickly set the systems up for close quarter dogfights.

Track-ball

All versions of the TQS have some form of mouse substitute, either a track-ball, or something similar. The device can be programmed to emulate the mouse, or generate key strokes. Generally it is better to let this emulate the mouse, especially in a sim like EF2000 that makes good use of the mouse for view control and instrument selection. So although it may be tempting to try and use it for the laser designator, it is better to place this function on a hat switch.

Other Considerations.

The precise functions that you allocate to each hat or button are largely a matter of personal choice, you should study the sample files on the EF2000 CD and see how you can adapt some of the ideas for your own use. It is not the most complicated set-up possible, but they provide access to the main functions, without adding unnecessary complexity, but even so, they make use of facilities that are not available on other programmable sticks, such as toggle settings and non-repeating key presses.

CH Products Set-up

A unique feature of the CH Throttles is their ability to program other joysticks, including those from ThrustMaster, so it is difficult to be precise about the likely configuration that a typical user may have, but we will assume a CH-Pro throttle, and a CH F-16-Combatstick for the purposes of this section.

Super-Cannon

This is deceptively simple, being just a matter of selecting the button to be programmed and pressing the spacebar. However, the default setting for programming is the macro setting. This allows a combination of keys to be recorded, and the button will send the key press and release when it is first pressed, then if the key is held down it will continue to press and release the spacebar as fast as allowed by the maximum key rate specified in the Set-up Menu. This is not really fast enough for the Super-Cannon function, and if you set the key rate too high, it will make it very difficult to achieve other functions that just require a single key press like missile release. The correct approach is to select 'Keys held until release' instead of the macro function, this will simulate holding the spacebar down, and will not release it until you release the button.

Remember, the CH approach to programming allows you to alter the function of the trigger as well as the other buttons, so if you want to program the trigger to simulate the spacebar, you can do it.

Throttle Wheel

The CH equipment may lack the mouse control found on the ThrustMaster TQS, but the Pro-Throttle can make use of the spare throttle wheel on the F-16 stick. A good use of this is to put a function like radar range on to the wheel.

General

The functions assigned to each button and switch will be largely a personal choice, but in the absence of a mode switch, you may prefer to keep the air-to-air functions on the stick, and the air-to-ground functions on the throttle to avoid confusion. Although there are fewer possibilities for complex set-ups with CH than ThrustMaster, there are still enough buttons and switches to cause problems if you do not group the controls sensibly and try to ensure that you do not need to press two buttons on the same device in quick succession, e.g. do not put the chaff/flare and the weapon release in a position operated by the same finger, you do not want to choose between kill or be killed. Study the sample file provided by CH, take note of the way the functions have been grouped and see if you can improve on the layout.

Suncom and Others

With all other programmable sticks, try to follow the examples previously discussed, and ensure that your allocation of functions to the stick remains as consistent as possible between the different sims that you own.

The Super-Cannon should be achievable with most sticks, just remember to program the spacebar to a button, and ensure that it is allowed to repeat when held down.

Glossary

AA, A-A or A2A – Air-to-Air.

AAA or 'Triple A' – Anti Aircraft Artillery.

ACM – Air Combat Manoeuvres – dogfighting tactics involving more than two aircraft.

ADI – Attitude Director Indicator – a cockpit instrument which displays an aircraft's pitch and bank angles relative to an artificial horizon.

Afterburner – Part of a jet engine that increases the power of the engine by mixing fuel with the jet exhaust.

AG, A-G or A2G – Air-to-Ground.

AGL – Altitude above ground level.

AGM – Air-to-Ground Missile.

Aileron – Control surface on an aircraft wing that produces aircraft roll.

AIM – Air Intercept Missile.

Alamo – NATO designation for the R-27 semi-active radar missile.

ALARM – Air-Launched Anti-Radiation Missile.

All-Aspect – Weapons that are effective at any angle to the target.

ALT – Altitude above sea level.

AMRAAM – Advanced Medium Range Air-to-Air Missile.

AoA – Angle of Attack – the angle between an aircraft's velocity vector and a reference line pointing straight ahead of the fuselage.

Aphid – NATO designation for the R-60 IR missile.

Approach – line-up prior to landing.

ARM – Anti-Radiation Missile, a missile which targets radio-emitting targets such as radar.

Archer – NATO designation for the R-73 all-aspect IR missile.

Aspect Angle – the angle formed by a line running directly to another aircraft and a line parallel to the other aircraft's longitudinal axis.

ASRAAM – Advanced Short Range Air-to-Air Missile.

Attitude – the state of an aircraft in terms of pitch, bank and yaw.

Autopilot – A mode in which the flight control computer takes over the control of the aircraft, leaving the pilot with less to do.

Avionics – Electronic systems in the aircraft.

AWACS – Airborne Warning And Control System.

Bandit – Enemy air threat.

Bank – the angle of the wings about the longitudinal axis referenced to horizontal.

Bank – To roll the aircraft to one side and induce a turn.

BDA – Battle Damage Assesment

Beaming – flying perpendicular to the emissions from a threat radar.

Bingo – Fuel is low.

Blackout – Loss of consciousness due to excessive forces on the pilot.

Blast-Fragmentation Warhead – An explosive charge which creates a large amount of shrapnel.

Bogey – Enemy air threat.

Bracket – an ACM tactic in which two (or more) aircraft fly opposite sides of a threat formation.

Break-Through Pressure – pressure needed to overcome the G-limiter on the joystick.

Break – To suddenly turn in the hope that any enemy following will lose his tactical advantage.

Bug-Out – leave a dogfight.

Busy Work – fighter pilot slang for cockpit tasks.

BVR – Beyond Visual Range.

Callsign – A pilot's or controller's codename.

CAP – Combat Air Patrol.

CCIP – Continuously-Computed-Impact-Point.

CEP – Circular Error Probability (measure of bombing performance).

Chaff – packets of foil used to decoy or obscure radar systems and radar guided missiles.

Compass Tape – heading indicator at the top of the HUD.

Continuous Wave Radar – A system which emits radio waves continuously, as opposed to pulses (see **Pulse Doppler Radar**).

Corner Velocity (or 'Corner') – the velocity at which an aircraft achieves its best turn performance.

DASS – Defensive Aids Subsystem.

Dogfight – Engaging enemy fighters at close range.

DPS – degrees per second.

Drag Factor – A number which indicates how un-aerodynamic external stores on an aircraft are.

Drag Manouvre – decoy manouver to distract fighters away from their targets.

Drogue Chute – a parachute released to slow the EF2000 when landing.

Durandal – Runway cratering bomb.

ECM – Electronic Counter Measures.

Element – two aircraft working together as a team, possibly as an element of a larger flight.

Elevators – aircraft control surfaces, located at the back of the horizontal stabilisers, which provide pitching moment.

EWR – Early Warning Radar.

FAB – Fugasnaya Aviatsyonna Bomba – Russian designation for 'general purpose bomb'.

FBW – Fly-by-wire – a flight control system which transmits flight commands via wires to servo actuators which drive the ailerons, rudders or other control surfaces. In most FBW systems, pilot input is processed and possibly negated by a flight computer before being sent to the control actuators.

FCS – Flight Control System. See also **HOTAS**.

Fire and Forget – A missile that once fired, will guide itself to its target.

Flak – Shrapnel produced by AAA shells exploding.

Flame-Out – stalling of aircraft engine due to circumstances; for example damage.

Flaps – Control surfaces on aircraft wings which increase lift for a given flight condition and allow a lower airspeed than is normal in flight.

Flaperons – a useful control surface that's a cross between ailerons and flaps.

Flares – Pyrotechnic packages which burn with intense heat designed to confuse Infra-Red missiles.

FLIR – Forward Looking Infra-Red.

Fuze – an adjustable triggering device in a missile, bomb or other weapon.

G – A force acting upon the aircraft and pilot when manoeuvring, expressed in terms of the earth's gravitational force.

G-Suit – A suit worn by pilots which reduces the effects of high g numbers.

GBU – Guided Bomb Unit.

GPS –Global Positioning System.

Hard Points – weapons pylons for carrying anything except fuel (see **Wet Points**).

HARM – High-speed Anti-Radiation Missile.

HOTAS – Hands On Throttle And Stick, which puts all controls at the pilot's fingertips.

HSI – Horizontal Situation Indicator – a cockpit indicator which combines a compass with information from an inertial reference system or navigation beacons to indicate relationship of the aircraft with the planned course.

HUD – Head-Up Display.

IFF – Identify Friend or Foe.

ILS – Instrument Landing System.

Indicated Airspeed – the airspeed shown by an airspeed indicator and not corrected for error due to air density variations caused by altitude and temperature.

IR – InfraRed.

IRST – Infrared Search and Track – an EF2000 system that tracks aircraft and missiles using the heat generated by their engines and by their friction with the air.

Jamming – Confusing the enemy radar by using high-energy bursts of a certain frequency.

JSTARS – Joint Services Tactical Radar System.

JTIDS – Joint Tactical Information Data System.

KC – Mid-air refuelling tanker.

Kerry – NATO designation for the Kh-23 A-G missile.

KH-23 – a radio command A-G missile.

KIA – Killed In Action.

Knock it Off – Slang for 'end the mission'.

Knots – nautical miles per hour.

Kts – Abbreviation for **Knots**

Lizard – A term often used to describe the enemy leader.

Load Factor – the force acting on an aircraft as a multiple of the force of gravity.

Lock – Acquire a target and fix weapons aiming systems on it.

Loose cannon – A renegade pilot.

LGB – Laser Guided Bomb.

MACH – Unit of speed equal to the speed of sound at your altitude.

Manoeuvre Kill – the result of an aircraft inadvertently colliding with terrain during a dogfight.

MFD – Multi-Function Display unit.

MIA – Missing In Action.

MiG – Mikoyan Gurevich - the founders of one of major Russian aircraft design bureaus.

MMD – Moving map display.

NATO – North Atlantic Treaty Organisation.

Nautical Mile – 6,076 feet.

NAV – Navigation.

Negative G's – G-force that forces you out of your seat.

NOE – Nap Of the Earth – very low altitude.

Ordnance – bombs, missiles, bullets and other offensive hardware.

Pincer – same as a Bracket manouver.

PIO – Pilot Induced Oscillation – oscillation in an aircraft's flight path or attitude caused by a pilot failing to compensate for the lag time between pilot input and aircraft reaction.

Pipper – a small dot at the centre of the aiming reticle.

Pitch – the angle of an aircraft's nose above or below the horizon.

Pitch Bobbling – unstable up and down movements of the aircraft's nose at low speeds, often accompanied by lateral instability.

Pitch Ladder – pitch indicator in the HUD.

PK – Probability of Kill.

Plinking – Slang term for using iron bombs and unguided munitions against armoured vehicles.

Positive G's – g-force that forces you into your seat.

Predictor Sight – a computerised gunsight that predicts the flight path of the cannon's shells.

Pulse Doppler Radar – Radar that emits short bursts of radio waves and detects objects by the returning echo.

RADAR – RAdio Detection And Ranging.

Redout – Effect felt by pilot when pulling negative g's for too long. Caused by blood rushing to the head.

Rookie – Inexperienced pilot.

Rudder – Control surface on the tail of an aircraft which affects the yaw of aircraft.

ROE – Rules Of Engagement – rules governing the conditions under which a fighter can engage or fire upon a bogey.

Roll – rotation around an aircraft's longitudinal axis.

SA – Situational Awareness – the amount of awareness a pilot has about the tactical environment around him.

SAM – Surface to Air Missile.

Semi-Active – used to describe a missile which must be guided until its own radar can take over.

Sideslip - motion of an aircraft to the right or left perpendicular toits longitudinal axis.

Six O'Clock - directly behind an aircraft, where it is most vulnerable.

Stall - an abrupt loss of lift occurring when the AOA increases to the point that the airstream separates from the wing surface.

Statute Mile – 5,280 ft.

Stealth – ability to avoid detection.

Terprom – terrain following system.

Terrain Hugging – flying at 500 ft or below, following the contours of the land.

Threat – Any enemy in your vicinity.

Thrust – Power produced by your engines, usually referred to as a percentage.

TIALD – Thermal Imaging and Laser Designation (LGB aiming system).

Trim – setting aircraft controls or trim devices so that the aircraft maintains a desired attitude.

Trim Tab – a small control surface attached to an aileron of other larger control surface for the purpose of making small trim corrections to that surface's position.

True Airspeed – indicated airspeed corrected for installation, compressibility and air density errors.

TWS – Track While Scan radar mode.

VASI – Visual Approach Slope Indicator system of lights for landing assistance.

Velocity Vector – an indicator in the HUD which shows predicted path of travel.

Vertical Velocity – the sink or climb rate of an aircraft.

Virtual Cockpit – true 3-D scrolling, panning cockpit.

VSI – Vertical Speed Indicator.

Waypoint – A position in the world to which you have to fly.

WCS – Weapon Control System.

Wet Points – hard points for fuel tanks

Wild Weasel – Stirke and jamming mission, specifically against enemy air defence systems.

Wingman – A flying partner.

WP – WayPoint.

WVR – Within Visual Range.

WW – Wild Weasel.

Yaw – rotation of aircraft about its vertical axis.

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