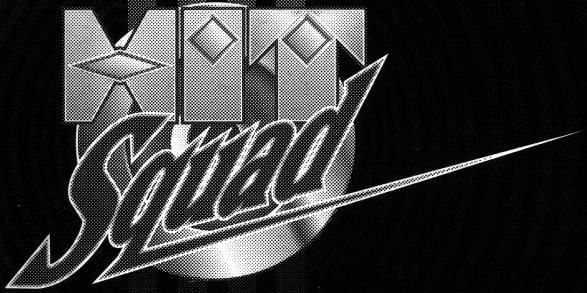
PC

AMIGA

ST

MiG-29™

FULCRUM



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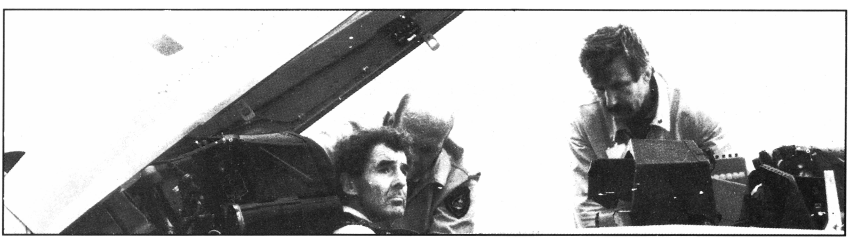
FOREWORD

by JOHN FARLEY – Test Pilot

Ever since the MiG-29 was first displayed in public at the Farnborough'88 airshow I've wanted to test fly the plane to see for myself how it handled. At Farnborough '90 I met Mikhail Waldenberg, chief designer for the Mikoyan Bureau, and Valery Menitsky, chief test pilot, to discuss the plane's aerodynamic achievements. Valery then offered me the chance of a lifetime – a flight in their two-seater to see how the plane flew. I wasn't disappointed, after years testing aircraft such as the Harrier for British Aerospace, the MiG-29 proved one of the most exhilarating flights I've ever had.



John Farley (Test Pilot) being strapped into a MiG-29 Fulcrum.

Now with Domark's MiG-29 Fulcrum flight simulation, you can experience the nearest thing to actually flying the plane; this is no over-simplified game – I was surprised at how accurate the model is. Practice flying using the combined 'angle of attack' and 'g' meter. But remember, too much 'g' and you'll lose your colour vision or, worse, black out – real features copied from the MiG-29 for this simulation.

The Soviet plane has several important features which make it different from British and American fighters. For example, on the Russian display of attitude,

the little plane symbol banks in the instrument panel as you turn (whereas with western avionics, the plane symbol is fixed and only the background banks).

I was pleased to see that the model reacted very realistically during testing. When flying, note how the high thrust and low drag of this remarkable machine allows it to accelerate at low level during a 9g turn – just like the real thing.

Try your hand at air-to-air and air-to-ground combat. But recognise that while you train and take risks, real MiG-29 pilots have only one life!

Good luck and good flying.

John Farley

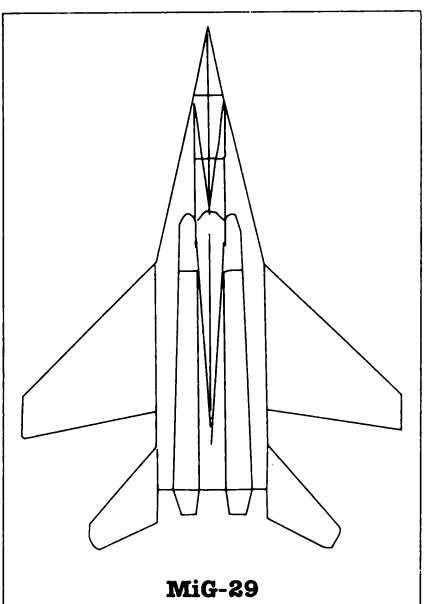
P.S.: Do try the tailslide – a feature unique to the MiG-29 air display routine. Start from level flight at 500kph, pull to the vertical and hold it. Close the throttles and wait until you slide back. To recover, pull the stick back until the nose starts to come down, at which point you should apply full power, relax the stick and accelerate away.

INTRODUCTION

The Soviet Airforce: An Overview.

When Hitler's forces rolled into the Soviet Union in 1941, the Soviet defenses were literally overwhelmed by the suddenness of the attack. Thousands of Soviet warplanes were destroyed – caught unprotected by the swiftness of the Blitzkrieg. But the Soviets worked day and night to replace the lost aircraft, even during air-raids! Much of the manufacturing was moved eastwards away from the frontline, out of bomber reach. Perhaps it is this economy of design, born out of necessity as supplies of raw materials became evermore difficult, that still pervades the Soviet aircraft design philosophy.

Traditionally, Soviet fighter designs are produced by the Design Bureaux (OKB's) to fulfill a requirement published by the central bureau. The most famous of these in the West is the Mikoyan and Guryevich Design Bureau known more commonly as MiG. Sukhoi and Yakovlev (SU and TU) are also prominent if a little less known counterparts. The word MiG has become synonymous with the Soviet Airforce or VVS as it is known, due to the exploits, in export form, of its planes in the Korean and Vietnam conflicts. Regardless of the design studio, all Soviet aircraft share a common ideology – simplicity of design, ease of maintenance,



MiG-29

toughness and where possible the ability to operate from rough unpaved airstrips of the shortest possible length. The MiG-29 for example, can take off from a strip of only 240 metres! (787 ft), the American F16 by comparison typically needs twice this.

VVS cadets who pass the rigorous weeding-out process typically begin their jet-propelled flying career on an L29 jet trainer. These are flight instructor controlled flights (FIC), but gradually pupils will do more and more of the flying until, after a year's intensive training, they graduate from the Gugarin Higher Aviation Academy. Pilots are then sent to operational conversion units where they learn to fly supersonic planes such as the MiG-21, a MACH 2 fighter whose role the MiG-29 was designed to replace. The MiG 21 is encountered in this simulation in its export form – the Chinese built Shenyang F-7M.

Soviet training has traditionally concentrated on the basics of flying – formation flying, low level navigation and a rigid regime of tactical combat flying. Historically this has led to criticism of soviet Air Combat Manoeuvres (ACM), as being too rigid and inflexible during actual combat – "Show a soviet pilot initiative, and the next thing you know he's landing in Japan" as the joke goes – a reference to the famous defection of MiG-25 pilot, Lt Belyenko to Japan in 1976. This inflexibility has had more to do with the aircrafts' relative inferiority at dogfighting than any lack of ability on the part of the pilots. Recent advances in Soviet aerodynamics in the shape of the MiG-29 and the SU-27 however, will probably lead to a new style of flying being taught at Soviet air academies, although whether this will result in American- style "Top Gun" schools remains to be seen.

The Soviet Airforce is known as the VVS (Voyenno – Vozdushnye Sily) and is itself divided into two main divisions, the **FA** (Frontovaya Aviatsiya , or frontal aviation) which is the tactical wing and the **DA** (Dalnya Aviatsiya, long-range aviation) which is the strategic air arm.

The Simulation:

In this simulation you will operate the **MiG-29** initially as a pilot undergoing

conversion training, before achieving combat status. In combat you will fly the **MiG** in a variety of locations within the Soviet sphere of influence. Each scenario has its own challenge and therefore tests the pilot in different areas of skill- air to air, air to ground, unguided missile attack and of course cannon. Don't forget to use your **MiG's** amazing manoeuvrability to dodge missiles, deploy chaff to confuse radar guided missiles and flares for **IR** guided air to air missiles. Remember to study the performance characteristics of the aircraft you encounter – A **Mirage** is a much more formidable opponent than a **Shenyang!**

Finally a thank you to you for purchasing **MiG-29 FULCRUM,** our first flight simulator. We hope you enjoy discovering the depths of gameplay within the simulation. We have had a lot of fun researching and developing it.

John Kavanagh
The Kremlin, Addlestone.

MiG-29 Development Team:

Dave Payne
Jonathan Newth
Paul Stein
Ray Jackson

Graphics:

Steven Blake
Lloyd Baker
Matthew Hicks

Music:

Jolyon Myers

INSTALLATION AND LOADING

Installation

Key Disk

The program is copy protected by a key disk. You must have the key disk in the drive to run the game.

Hard Disk

You may install MiG-29 on your hard disk. You will still need the key disk.

Loading

IBM PC and 100% Compatibles

Boot your computer as normal with **DOS.** At **A:** prompt insert **MiG-29** boot disk.

The program is called **MiG-29.**

The program runs in **VGA** or **EGA** or **CGA.** The first command line argument selects which. It can be v, V, e, E, c, C, vga, ega, cga, EGA, VGA, CGA.

eg: to run **MiG-29** in EGA type ;

MIG-29 E

If you wish to install **MiG-29** on your hard drive type **'INSTALL'** and follow the on-screen instructions.

Atari ST

Reset computer and insert **MiG-29** boot disk, the game will load and run automatically.

Hard Disk Installation

Copy all files and folders except the **AUTO** folder to hard disk. Double click on **M29.TOS** to run the game.

Amiga

Reset computer and insert **MiG-29** boot disk, the game will load and run automatically. If you have **1MB** of memory then you can select **32 colour** display. On **512K** machines select **16 colour** display. On **PAL 1MB** machines select **256** line display, on **NTSC** or **512K** machines select **200** lines.

That's a lot of options so here they are fully listed:

512K machines:

PAL 200 line 16 Colour (fastest).
NTSC 200 line 16 Colour (fastest).

1MB machines:

PAL 200 line 16 colour (fastest).
256 line 16 colour (bigger screen).
256 line 32 colour (best display).

NTSC 200 line 16 colour (fastest).
200 line 32 colour (better display).

Hard Disk Installation

Create a sub-directory called **MIG** on your hard drive. Copy all files from the program disk to the directory. To run the program from the **CLI** type **CD MIG.** Press **RETURN.** Type **EXECUTE MIG-29.**

Archimedes

MiG-29 runs on an **Archimedes** with at least **1MB** of memory and **RISC OS.** This includes the **A3000.**

MiG-29 runs from the desktop, open the disc directory and then double click on the **!MiG-29** icon.

MiG-29 can be stopped by pressing **<Escape>,** this will return you to the desktop.

Loading Sequence:

When **MiG-29** is run a loading screen is displayed, accompanied by theme music, you can skip this at any time by pressing the space key. The music is followed by a **MiG-29** flyby over Red Square! You may also skip this by pressing the space bar. When the loading sequence is completed you are placed in the briefing room.

QUICK START

Mission Selection:

Selecting an option

You are placed in a briefing room with your options shown on a whiteboard. You may select an option with the number keys **(1 – 7)** or using the cursor keys (up/down). To confirm a choice press **Enter** or **Space.**

Scenario Summary

1. Basic training.

   Some ground targets and a safe enemy aircraft to practice dogfights.

2. Arctic scenario.

   A submarine to photograph and some **Harriers** as opposition.

3. Chinese scenario.

   Dogfighting with **Shenyang** fighters over the **Great Wall.**

4. Oil field scenario.

   An island with storage silos, some oil rigs and ships with **SAMs** and anti-aircraft guns.

5. Anti-terrorist ground attack scenario.

   Bridges, trucks, SAMs, train, buildings.

6. Final scenario.

   Multi-role combat in the desert. Destruction of nuclear power plant.

Pilots Log

You may enter yourself in the pilot's log.

Dying

In the training scenario dying puts you back on the runway. In all the remaining scenarios dying is terminal! You are placed back in the briefing room.

Debriefing

You may enter the briefing room during a mission (provided that you have landed) for a debrief of the current state of play by pressing **Ctrl-D.** To continue the mission press **SPACE** to re-enter the game from the briefing room.

Controls:

Head up display

Hud on/off **'H'**

Flight Controls

Engine on/off:	**'E'**
Throttle up:	**'='**
Throttle down:	**'-'**
Full power:	**Shift '+'**
Idle power:	**Shift '-'**
Landing gear:	**'L'.**
Wheel brakes:	**'W'**
Air brakes:	**'B'**
Emergency Eject:	**'Ctrl-E'**

Control Stick

Ctrl-J selects analogue joystick.

Alt-J selects switched joystick.

Ctrl-K selects keyboard.

Ctrl-L selects mouse.

Ctrl-Z calibrate analogue joystick (move stick to extremes, press fire button to exit).

Keyboard control

roll left:	'left arrow'
roll right:	'right arrow'
pitch up:	'down arrow'
pitch down:	'up arrow'
centre:	**'PAD 0'**
Joystick centre:	**'Z'**

Joystick control power: Main keyboard **'1', '2', '3'**

Pitch trim up:	**'PAD +'**
Pitch trim down:	**'PAD -'**
Zero pitch trim:	**'PAD *'**
Rudder	**'<', '>'**

Weapons System:

Cannon always available.

S-240 unguided rockets.

AA-8 Aphid heat seeking air to air missile. **HUD** marker turns red for good lock.

AS-7 Kerry air to surface heat seeking missile. The target for guided weapons must be selected before launch.

Fire cannon:	'Joystick or Mouse button **1**' or **'Delete'.**
Select Weapon:	**'BACKSPACE'.**
Select Target:	**'RETURN'.**
Fire Weapon:	'Joystick or Mouse button **2**' or **'Space'.**
Drop flares:	**'F'**
Drop chaff:	**'C'**

Aircraft System

Autostab on/off: **'A'**

Radar/IR

Cycle radar range: **'/'**

Simulation Controls:

Sounds

Engine noise on/off: **'N'**

All noise on/off: **'Q'**

Views

Keys in () are active when flying from the keyboard;

PAD **8 (F8)** – Forward view with head down displays.

PAD **5 (F5)** – Forward view without head down displays.

PAD **9 (F9)** – Forward Right.

PAD **6 (F6)** – Right.

PAD **3 (F3)** – Rear Right.

PAD **2 (F2)** – Rear.

PAD **1 (F1)** – Rear Left.

PAD **4 (F4)** – Left.

PAD **7 (F7)** – Forward Left.

MiG outside view: **'V'**

"Tower" view: **'O'**

Missile view: **'M'**

Jump to enemy view: **'J'**

Pause on/off: **'P'**

Fast time on/off: **'X'**

Toggle hedges:	**'['**
Real Aircraft model:	**Ctrl-A** (only suitable for good joysticks and fast PCs).
Simple aircraft model:	**Ctrl-S** (default).
Debrief:	**Ctrl-D** (only when on runway).
End game:	**Esc**

Navigation:

You have four waypoints preset for each scenario.

Waypoint **Zero** is always over your home base.

Waypoints **One, Two** and **Three** are set over enemy targets.

Select waypoint **';'** , this cycles through the waypoints.

There is a red steering pointer in the heading tape in the **HUD.**

There is a combined direction/range pointer in the head down compass, a red **LED** just to its right shows the currently selected waypoint.

OPERATING INSTRUCTIONS

Chapter Contents:

Section contents:

BRIEFING

When **MiG-29** has been loaded you will find yourself in the briefing room.The pre-flight briefing allows you to choose which mission you wish to undertake. The missions available are projected onto a whiteboard in the briefing room, the selected mission is highlighted. There is considerable competition between the elite pilots of the **MiG-29** squadron, this is reflected by a pilot ranking table which is maintained in the briefing room. To enter the rankings select the **Pilots** option. .

Selecting a Mission

On startup the training mission is selected. You may select an option on the whiteboard using the number keys **(1 – 7)** or with the up/down cursor keys. To begin the selected mission press **Return** or **Space.**

During the loading sequence for each mission a scene setting picture is displayed. (With the exception of training which takes you straight to the runway).

The missions available are:

Training

Solo Codename **"Blue SeaSprite"**

Codename **"Yellow Dragon"**

Codename **"White Pegasus"**

Codename **"Red Witch"**

Final (you must attain a certain score to fly this mission).

More details about each mission may be found in the **Missions** chapter later in the book.

Pilot Ranking

To enter the pilot ranking system select **'PILOTS'** and press return, the current rankings will be projected onto the whiteboard. You may enter the rankings by selecting the 'New Pilot' **(6)** option and entering your name (max 10 characters).

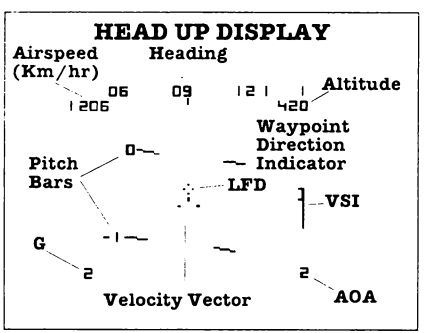
You may play as a ranked pilot by selecting a pilot **(1 – 5).** The ranking table is saved to disk every time you display the table or, if you are flying as a ranked pilot, each time you exit a mission.

DISPLAYS AND CONTROLS

Flight Instruments

The primary instruments provide the pilot with all the crucial information required to fly the plane. This information is projected onto the Head Up Display, where it is instantly available. The head down displays contain a set of instruments which duplicate this information. They are called reversionary instruments, because they provide backups in case of **HUD** failure.

MiG-29 Head Up Display Unit



The **MiG-29 HUD** has a narrow field of view. It has been praised for the manner in which it presents complex data in a simple and easily understandable way.

Altitude

Vertical height above the ground is shown in metres.

Airspeed

Airspeed is shown in Kilometres per hour (100Km/h = 54knots).

Pitch Bars

The pitch bars stay parallel with the ground at all times. You can therefore use them to recover from unusual attitudes and to keep your wings level when the horizon is not visible. The lines are at 10 degree intervals with a cross at 90 degrees. When you see the cross

you are either heading straight up or straight down.

VSI (Vertical Speed Indicator)

This shows your rate of climb or descent. It is especially useful when turning steeply near the ground. The **VSI** has two fixed markers in it, the upper marker is the centre point (zero rate of climb), the lower marker is the maximum rate of descent which the **MiG** can tolerate on landing.

LFD

The Longitudinal Fuselage Datum marker shows the direction the nose is pointing.

G

This shows the **G-force** currently on the **MiG.** The **MiG-29** service limit is 9.5g, however the airframe can withstand considerably more.

AOA (Angle of Attack)

The angle of attack is the angle between the direction of the airflow approaching the aircraft and a line joining the leading and trailing edges of the wing. For normal flight **AOA** is red-lined at **26** degrees on the **MiG-29,** however the airframe will remain controllable at higher **AOA** for short periods of time.

The lift generated by the wing is dependant upon this angle. If the angle is too high the wing stalls, lift is reduced dramatically and control of the aircraft may be lost. Conventional wings may stall at **AOA** of less than 20 degrees.

Velocity Vector

This red marker shows the direction in which the **MiG** is flying.

Heading

The horizontal band across the top of the **HUD** shows the current heading in tens of degrees. **00** is north, **90** is east, **27** is west and **18** is south.

Waypoint Direction Indication

This red marker in the heading band shows the heading to the currently selected waypoint. To fly to that waypoint you should turn until the marker is directly above the central tick.

HUD on/off **'H'**

Turns the head up display system on/off, when the display is off (or damaged) a reversionary LFD will be projected onto the HUD.

Reversionary Flight Instruments

Altitude

Vertical height above the ground is shown in metres. One revolution of the needle is 1000M, the thousands of metres are shown as digits in the centre of the dial.

Airspeed

Airspeed is shown in Kilometres per hour (100Km/h = 54knots).

Artificial Horizon and Turn

This is a uniquely Soviet instrument. It shows the pitch and roll elements of your attitude separately on the same instrument. The pitch element is shown on a rotating cylinder as horizontal lines which move up and down in the display. Flying flat (zero pitch) puts the zero degree line in the centre of the dial. The roll element of your attitude is shown by a bar rotating about the centre of the dial. Traditional western artificial horizons use rotating roll lines free floating in pitch (as in the MiG HUD).

VSI (Vertical Speed Indicator)

This shows your rate of climb or descent.

AOA/G

Combined angle of attack and G meter. AOA is shown on the left half of the dial, it is redlined to 26 degrees. G is shown on the right side of

the dial, it registers 0->9 G's.

Engine Instruments and Controls

Engine gauge

This pair of bars shows the engine rpm's. There are three colour bands. Yellow is the idle band, green is the normal operation band. Red shows that the afterburners are on.

Fuel

This gauge shows the amount of fuel left. There is also a low fuel warning lamp.

Engine: 'E'

Turns engine on/off. The engine must be started before the throttle controls work. You must switch the engine off after landing to refuel and rearm.

Throttle up: '='

Increases throttle. When throttle is at maximum throttling up further turns on the afterburners.

Throttle down: '-'

Decreases throttle.

Full power: Shift '+'

Sets throttle to maximum. Does not turn on afterburners.

Idle power: Shift '-'

Sets the throttle to minimum. The engines will idle.

Hydraulic Systems

The hydraulic indicator shows the position of the hydraulically driven systems on the aircraft.

Indicator

Wheel Brakes

This single green light indicates that the wheel brakes are applied.

Gear Position

Three greens show that the landing gear is down. The indicators show red when the gear is retracted.

Air brakes

Two greens show that the airbrakes are applied.

Flaps

Two greens show that the flaps are extended.

Controls

Landing gear: 'L'.

The landing gear produces a great deal of drag and should be raised for normal flight to increase performance. You will not be able to lower or raise the landing gear after hydraulic system failure. It is possible to land with the gear up if the descent rate is very low and the wings are almost level.

Wheel brakes: 'W'

The wheel brakes work on all wheels and are needed for slowing down after landing. You must release the brakes before starting your takeoff. A useful technique is to throttle up to full power before releasing the brakes as this reduces your takeoff run.

Air brakes: 'B'

The airbrakes provide extra drag. This helps you to reduce speed which can be useful while in a steep ground attack or when you are too fast on a landing approach. Slowing down reduces your turning circle, which makes the airbrakes useful in dogfights.

Emergency Eject: 'Ctrl-E'

If you lose control of the aircraft – 2 missile hits or low altitude stall, you can eject to safety by pressing Ctrl-E. After a few moments the parachute will open and you will begin to spin to the ground. You can still look around using the Pad/Function keys. Press Space to exit and return to the briefing room.

Flaps

Two green's indicate that the flaps are out. The flaps increase the drag and lift of the wing, effectively braking the aircraft and increasing its performance at low speed. The flaps automatically extend below an airspeed of 250 knots.

Aircraft model indicator (PC only)

The top central light on the hydraulics cluster is used to indicate which aircraft model you are flying. A green light indicates that you are flying the complex force model. No light indicates the simple model.

Flight controls:

Control Stick

The joystick is used to control the orientation and direction of the plane in the air. You may choose between a number of ways of controlling the joystick from your computer:

1. Keyboard.
2. Mouse.
3. Switched game joystick.
4. Analogue joystick.

The control selected at startup is :

PC – joystick.

Amiga/Atari – mouse.

To change the input:

Ctrl-J selects analogue joystick.

Alt-J selects switched joystick.

Ctrl-K selects keyboard.

Ctrl-L selects mouse.

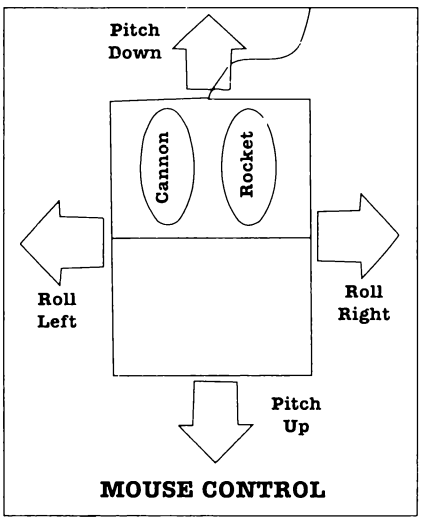
Ctrl-Z: calibrate analogue joystick (move stick to extremes, press fire button to exit).

Keyboard

The arrow keys are used to control the joystick.

Mouse

The mouse is used to represent an aircraft joystick. Imagine that the mouse is the top of a joystick. Pushing the mouse away lowers the nose of the aircraft, pulling it towards you raises the nose. Moving the mouse left rolls left and moving right rolls right.



MOUSE CONTROL

The neutral position is wherever the mouse started and it must be returned to this position for no control input. The joystick position indicators on the display are useful for fine centering of the mouse. It takes a while to get used to using the mouse, but once mastered the extra control and precision makes keyboard or switched game joystick control seem inadequate.

Switched Joystick

A switched joystick provides a crude but intuitive way of controlling the game. It requires no calibration.

Analogue Joystick

An analogue joystick is the most realistic way of controlling the game, it provides an accurate and intuitive input. You will have to calibrate your analogue joystick before use, this can be done from within the game by pressing **Ctrl-Z** whilst on the runway. Move to joystick to all its extremes, press a key on the joystick to end the calibration.

Joystick centre: 'Z'

This centres the joystick, it is most useful with the mouse.

Joystick control power: Main keyboard **'1', '2', '3'.**

You can choose the mouse control response that is best for your flight mode and experience. Low power **(1)** is useful for training, normal power **(2)** is useful for most flying, high power **(3)** is best for dogfights but makes precise control difficult.

Pitch trim

Pitch trim up: 'PAD +'

Pitch trim down: 'PAD -'

Zero pitch trim: 'PAD *'

Rudder ',', '.'

The rudder has two uses. On the ground the rudder input is used to control nose wheel steering. In the air the rudder turns the aircraft without roll, but the effect is small. You can use the rudder for small aiming corrections while attacking ground targets and for final heading correction while landing.

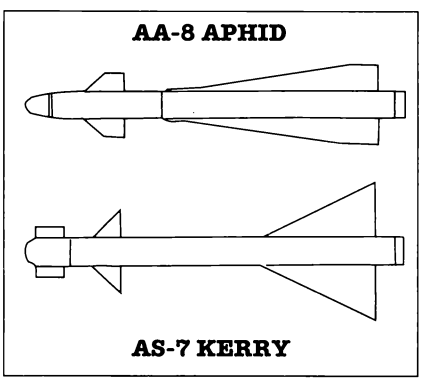
Weapons System

Cannon

The **MiG-29** is armed with a **23mm** cannon, used for air combat and ground attack. The cannon fires about **1000** rounds per minute and is initially loaded with **250** rounds. The number of rounds left is shown at the top of the stores display on the left of the cockpit.

Air-to-Surface Rockets

The **MiG-29** is armed with unguided rockets housed in rocket pods, these are used in its ground attack role. You are initially armed with 36 **S-240** unguided rockets, these are fired two at a time.



Air-to-Air Missiles

Your MiG is supplied with the **AA-8 "Aphid"** dogfighting missile. The Aphid is a sophisticated modern heat seeking air to air missile. Your MiG is armed with up to four Aphids on the outboard wing pylons. On mainly air attack missions an additional two Aphids are mounted on the inboard pylons.

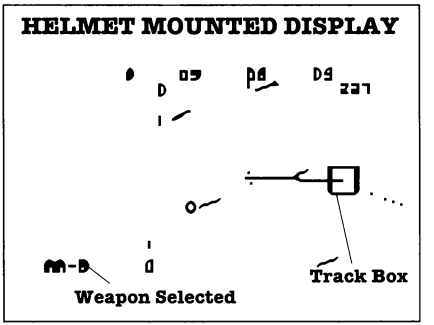
Air-to-Surface Missiles

For the MiG's ground attack role it is armed with **AS-7 "Kerry"** air to ground guided missiles. The Kerry missiles are loaded on the four inboard wing pylons. On missions with mainly ground attack targets an additional two **AS-7**'s are mounted on the outboard pylons.

Helmet Mounted Display

The MiG-29 has a helmet mounted sighting system displaying current weapon status and missile "lock" in the pilot's helmet. The sighting

system allows true off-boresight missile firing capability, freeing the pilot from the necessity of pointing the nose of his aircraft at the target to lock it up.



Weapon Selected

This shows the currently selected weapon. The MiG is armed with **S-240** unguided rockets, **AA-8 "Aphid"** air-to-air missiles and **AS-7 "Kerry"** air-to-surface missiles.

Track Box

When a guided missile is selected and a target is being tracked a track box is displayed outlining the target.

Selecting Weapons

The cannon is always selected on the primary fire control. One of the **S-240/AA-8/AS-7** may be selected on the secondary fire control. The selected secondary weapon is shown in the helmet mounted display.

Fire cannon: 'Joystick or Mouse button 1' or 'DELETE'

Select Secondary Weapon: 'BACKSPACE'

This cycles the currently selected weapon **S-240** -> **AA-8** -> **AS-7**

Select Target: 'RETURN'

If the secondary weapon selected is a guided missile **(AA-8/AS-7)** the weapon system must attain a "lock" on a target before a missile can be fired. Pressing RETURN when a target is selected deselects it.

The target only stays selected for a limited time (~30 seconds).

Fire secondary weapon: 'Joystick or Mouse button 2' or 'SPACE'

S-240 – fires two rockets.

AA-8 – if target is selected fires one air to air missile.

AS-7 – if target is selected fires one air to ground missile.

Countermeasures

The MiG-29 countermeasures system comprises **Flare** and **Chaff** launchers. **Flares** are used to decoy heat seeking missiles. **Chaff** is used to confuse radar guided missiles.

Drop Flares: 'F'

4 **Flares** are dropped.

Drop Chaff: 'C'

Chaff is dropped 8 units at a time.

Aircraft System

Warning Lamps

These are situated on the right side of the cockpit. There are two banks of lamps, 4 failure indicators and 4 warning indicators.

Failure Lamps:

Hydraulic system failure

This indicates that the hydraulic system has been damaged, your landing gear and air brakes will remain in their current positions. You should attempt landing for repair.

Navigation system failure

The navigation computer has malfunctioned or been damaged.

Radar/IR failure

The radar and/or IR system has suffered a failure. You may lose some or all of the information displayed on the radar/IR display.

HUD failure

The head up display computer has been damaged, you will have no head up display.

Low altitude:

Stall

The aircraft is in a stall.

Low fuel

Low fuel warning. Return to base for refuelling.

Autostab

Autostab is on when indicator is lit.

The Autostabiliser

Your MiG-29 is fitted with an autostabilising system. The autostabiliser enhances the aircraft stability. This makes it return to straight and level flight although you can still fly in the normal way. You should use the autostab while you gain experience and it will always be useful for long distance straight and level flying. For combat the autostab hinders aerobatic manoeuvres and should be switched off.

Autostab on/off **'A'**

Navigation System

The **MiG-29** compass is a rotating ball with the heading marked in tens of degrees. Your current heading is shown in the centre of the ball. This compass duplicates the heading band in the head up display.

The **MiG-29** inertial navigation system has 4 waypoints which are

preset before each mission. The cockpit display consists of a pointer overlayed on the compass dial. The direction of the pointer indicates the relative bearing to the waypoint. The pointer is half green and half red with the green half indicating the direction to fly. When the green pointer is oriented directly North then you are on course for the waypoint. A white bar crosses the pointer indicating the distance to the waypoint. When the bar is at the end of the pointer the waypoint is **25Km** or more away. When the bar crosses the centre of the pointer you are directly over the waypoint. The relative bearing to current waypoint is also indicated by the red steering indicator in the head up display.

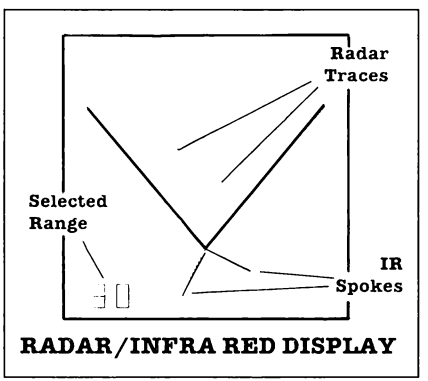
Waypoint Selected

This single digit shows the current waypoint selected. There are **4** waypoints **(0 – 3)** which are preset before flight.

Waypoint cycle ';'

This cycles the currently selected waypoint **0->1->2->3->0->.** The currently selected waypoint is displayed on the head down display.

Radar and Infra Red System



RADAR/INFRA RED DISPLAY

The combined radar and Infra Red display head is situated at the top right of the cockpit. It displays the information obtained from the forward looking radar and all round **IR** sensors.

The radar covers a **90** degree forward cone with a maximum range of **30** kilometres. The radar range is selectable from **30km, 15km** and **8km;** the range is shown at the bottom left of the display.

The Infra Red sensors provide all round directional information, but not range. **IR** signals are shown as spokes on the display.

Cycle radar range '/'

This cycles the current radar range **(Km) 30->15->8->30.** The current range is shown in the radar display.

SIMULATION CONTROLS

Sounds

Engine noise on/off: **'N'**

All noise on/off: **'Q'**

Views

Views from aircraft;

The numeric keypad is used to select all round views from the plane.

PAD **8** – forward view with head down displays.

PAD **5** – forward view without head down displays.

PAD **8/5**

PAD **7** PAD **9**

PAD **4** PAD **6**

PAD **1** PAD **3**

PAD **2**

If the keyboard is being used as the primary control input then the function keys control the outside views.

F8 – Forward view with head down displays.

F5 – Forward view without head down displays.

F9 – Forward Right. **F6** – Right.

F3 – Rear Right. **F2** – Rear.

F1 – Rear Left. **F4** – Left.

F7 – Forward Left.

View Controls

MiG Outside view on/off: 'V'

This places you outside the aircraft. The relative position of the viewer to the aircraft can be controlled on the numeric keypad (or function keys) as above.

Missile view: 'M'

If a guided missile is in flight this shows the view from the missile's infra-red eye.

While you are looking from the missile's point of view you are still in control of your own aircraft. It is advisable to be in straight and level flight before selecting another view!

Jump to enemy view: 'J'

This allows you to see the world from the enemy's point of view. If an enemy target is selected (air or ground) by the weapons system **'J'** will jump to the enemy view. It is most entertaining to select an enemy plane whilst dogfighting and follow his manoeuvres!

Control tower view: 'O'

This selects a view of your aircraft from your home runway. You can fly the **MiG-29** like a radio controlled aircraft! The control tower view automatically zooms in on you when you fly away from the tower. The maximum tower range is 10km.

Other Controls

Debrief: 'Ctrl-D'

This places you in the briefing room for a post mission debrief. You can only be debriefed after you have landed on the runway.

Pause on/off: 'P'

Fast time on: 'X'

Turning on fast time speeds up the simulation for the entire game by a factor of **3.**

Complex aircraft model (PCs only)

Select complex model – **'Ctrl-A'**

Select simple model – **'Ctrl-S'**

The complex model is a true force model. Each surface of the aircraft is modelled, the forces acting on it and the resultant lift and torque experienced by the aircraft are continuously calculated. The result is a very accurate model of the aircraft's flight characteristics. The complex model is significantly harder to handle than the simple model by virtue of its nearness to "the real thing". The complex model also uses much more processor power than the simple model, so it requires a reasonably powerful machine to run it successfully.

DEBRIEFING

You can enter the briefing room for a debrief at any time during a mission (provided that you have landed).

Your mission debrief informs you if your mission is complete, and if not how many targets remain. Your current score is also shown.

To continue the mission press **Return** or **Space** to get to the briefing room and **Return** or **Space** again to restart.

DYING

In the unfortunate event of your crashing or being shot down the screen blacks out and a death screen appears describing the reason for your crash

You are then placed in the briefing room.

MISSIONS

The missions available in **MiG-29** are:

Training

Solo: Codename **"Blue SeaSprite"**
Codename **"Yellow Dragon"**
Codename **"White Pegasus"**
Codename **"Red Witch"**

Final: Codename **"Desert Strike"**

Level of difficulty

Each mission features a different aspect of flying the **MiG-29** and demands a different level of pilot skill. In the training missions a high level of skill is not required giving you the opportunity to learn in a benign environment. The solo missions each feature a different aspect of flying the **MiG-29** and all require similar levels of skill.The Final game requires skill in all areas of combat!

Training Missions

"You're welcome to the Elite Pilots' School"

Welcome to the pilots' school at Orzusk Aerodrome. As one of the elite group of cadets chosen to train on the prestigious **MiG-29** you will be under a lot of pressure to perform well during your training and to go on to one of the many **MiG-29** squadrons around the USSR.

Once you have completed the training missions you will be assigned a number of missions based on real-world scenarios which must be completed successfully. Each scenario is designed to test one particular area of the **MiG-29**'s theatre of operations, and your skill in completing these missions will dictate how soon you can pass on to join the elite cadre of **MiG-29** veterans.

The Training Scenario

The training scenario features a number of elements to introduce you to the capabilities of the **MiG-29.** There is a firing range designed to exercise use of your **23mm cannon** and unguided **rockets.** The lake has targets for your guided **air to surface** missiles. There are a number of manoeuvring and non-manoeuvring air drones allowing you to learn the art of dog-fighting with.

Each of these elements is marked with a waypoint preset in the navigation computer.

Waypoint 0 Home runway (one).

Waypoint 1 Firing range.

Waypoint 2 Lake.

Waypoint 3 Runway two.

Your training will require the completion of the following tasks. (If you do not master these basic skills in training you will certainly die when you attempt a solo mission – but you are free to try!).

Suggested Training Programme:

Takeoff, perform a controlled turn and land on visuals.

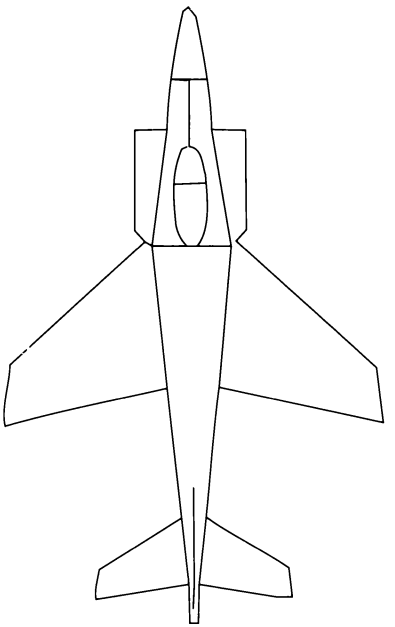
Takeoff, fly to firing range **(waypoint 1),** destroy targets, return (waypoint 0) and land on runway.

Takeoff, fly to lake **(waypoint 2),** use **AS-7s** to destroy targets, return and land.

Takeoff, fly to next airfield **(waypoint 3),** engage enemy drones using **AA-8s** and land on runway two.

Solo Missions

Codename **"Blue SeaSprite"**



SEA HARRIER

The counter-intelligence analysis section of the **GRU** has intercepted American communications traffic indicating that two days ago a Dallas "Boomer" class **ICBM** submarine developed a reactor fault and has had to surface. It is now trapped in ice but latest weather estimates suggest that the ice will start breaking up in the next twenty-four hours. The submarine is trapped **INSIDE NATO** territorial waters and consequently is unapproachable by one of our Russian sea based fleet. A continuing heavy cloud layer prevents the use of spy satellites to photograph the submarine. This is too valuable an opportunity to miss, so a single **Mig-29** will be dispatched to fly a covert mission to film the sub. To further complicate matters there are believed to be up to three British **Sea Harrier** jets operating from the ice providing air cover for the sub.

Mission:

Takeoff from airbase in **Siberia.**

Navigation at normal flight levels to within 30Km of submarine.

Descend to below radar horizon and continue to navigate to submarine.

When within visual range of sub fly towards it at 200 metres, approach to within 100 metres of submarine. Note numbers on side of submarine.

Return to base "ASAP"!

NB: We are not prepared to start **WW3** so if you are intercepted by British fighters, do not REPEAT DO NOT engage, if necessary terminate the mission.

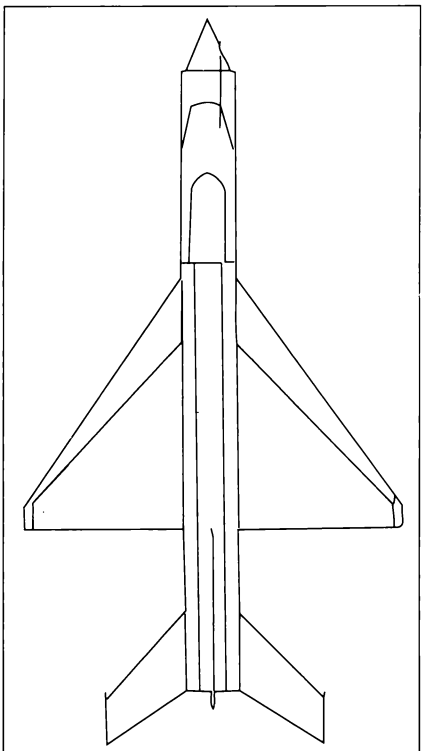
Waypoint 0 Home base.

Waypoint 1 Submarine.

Waypoint 2 Harrier base.

Codename **"Yellow Dragon"**

Over the last week there have been a worrying number of "incidents" involving Chinese illegal incursions into Soviet airspace. These incidents have always taken the same form with a group of three Chinese fighters flying into restricted airspace towards **Tbliski** aerodrome. Units of the **Tbliski's** ageing **Su-21** fighters are scrambled, but as soon as they fly into visual range of the Chinese the Chinese fighters turn around and fly home. That is until yesterday when the Chinese shot down one of the Soviet fighters. The Chinese Ambassador has sent his deepest regrets for this unfortunate "Accident"! We have decided that a single **MiG-29** should fly an



SHENYANG F-7M AIRGUARD

intercept mission to teach the Chinese an important lesson about "Tickling the bear's nose" too many times!

Mission:

Scramble from **Tbliski.**

Fly towards **Shenyang** Fighters and shadow them until they leave Soviet airspace.

Do NOT engage in hostilities unless provoked by direct action.

Return to base.

Waypoint 0:	Home base.	Waypoint 1:	Great Wall.
Waypoint 2:	Chinese runway.	Waypoint 3:	Chinese runway.

Codename **"White Pegasus"**

Tension has been rising over the last few days after the leader of the Middle Eastern state of **Arzaria, General Hasouz** proclaimed that **Arzarian** territorial waters would henceforth stretch 200 miles into open sea. (The internationally accepted standard is 12 miles). In addition, he has proclaimed that all sea traffic within this "Territorial Sea Zone" directly violates **Arzarian** territorial waters, and that any such shipping would be fired upon. Yesterday, a Soviet oil tanker, the **Rodina,** ran into severe difficulties after a fire in the engine room completely destroyed all rudder control. The **Rodina** drifted for 12 hours to within 80 miles of the **Arzarian** coast. Despite numerous pleas for help it was ignored. Eventually an **Arzarian** gunship was dispatched and the **Rodina** was boarded. After much arguing and posturing by the Gunboat captain, the crew of the **Rodina** were "removed" from the ship and the **Rodina** was then sunk by a torpedo launched from the gunboat. It has been decided that this incident cannot pass without notice and that some form of retaliatory action MUST be taken. Since **Hasouz** has directly attacked the Soviet oil supply, it has been decided that the same should happen to him. A single **MiG** will fly a covert mission to attack targets opportunely (preferably oil

refineries or oil rigs).

Mission:

Take-off from island aerodrome.

Low level flight towards oil fields.

Air-to-ground missile attack on refinery and oil rigs.

Return to aerodrome.

Waypoint 0:	Home base.	Waypoint 1:	Island.
Waypoint 2:	Oil rig.	Waypoint 3:	Oil rig.

Codename **"Red Witch"**

A Terrorist group operating WITHIN Soviet territory have been destroying road and rail links between major cities. One of the reasons they have been so hard to track down is that they constantly move their base thus making it difficult to pinpoint their location. It is also believed that they only travel on back roads and always at night to avoid detection. Fortunately the **KGB** have managed to infiltrate an agent into the terrorist group, and he has given us a date, time and approximate position of their convoy. Your mission is to provide air support for a **Spetnatz** commando group acting covertly to "remove" the terrorist threat.

Mission:

Take-off from airbase.

Navigate to predicted area of operations.

Track terrorist vehicles to base.

Destroy vehicles and base.

Return home.

Waypoint 0:	Home base.	Waypoint 1:	Bridge.
Waypoint 2:	Enemy HQ1.	Waypoint 3:	Enemy HQ2.

Final Mission:

Codename **"Desert Strike"**

Terrorist elements of a Middle Eastern state have been attacking merchant ships in the straits of **Hormuz.** The leader of the state has been shown on TV publicly ridiculing both the **USA** and the **USSR** as weaklings.

Normally this would be of no consequence, but other elements in the Middle East are now looking towards a potential **"Jihad".**

Over the last few months the KGB's Satellite Intelligence Service **(SIS)** have noted a large amount of construction work in one particular area of the Lahal desert. Analysis indicates that this construction is for a fast breeder nuclear reactor. The technology to develop nuclear weapons is already possessed by the Middle East; this reactor would provide the plutonium required for production.

It has been decided that this reactor MUST be destroyed at all costs.

Mission:

Take off from airbase in 'friendly' Middle Eastern state. Fly across border and secure an advanced airbase for further operations. Create safe path through ground defence network by destruction of ground defences and aerodromes.

Destroy nuclear facility and support complexes.

Return to friendly airbase.

Waypoint 0:	Advance base.	Waypoint 1:	Desert fort.
Waypoint 2:	Truck base.	Waypoint 3:	Fuel dump.

FLIGHT AND COMBAT

BASIC FLIGHT TUTORIAL:

A flight simulation on a personal computer can't move you physically in the same way that a real aircraft would. This means that instead of you rolling with the aircraft as it banks, the simulated world is rolled the other way instead. You will soon get used to compensating this as you move and the world staying still. Until this happens you may find it confusing that banking to the right makes the world roll to the left or that pitching up makes the world move down.

The controls of an aircraft cause the aircraft to move while the control is applied and to stay at the same attitude when the control is neutral. This means that the aircraft will not return to straight and level flight just because the controls are central.

The main control for a fighter aircraft is a joystick. Moving this backwards and forwards changes the angle of the tailplane which causes the aircraft to change its pitch. Pulling the joystick back causes the nose to pitch up, and pushing it forward causes the nose to pitch down. Moving the joystick from side to side changes the angle of the ailerons which cause the aircraft to roll. Moving the joystick left rolls left and moving it right rolls right. The controls work by reacting against the air flowing over them which means that at low speeds the controls have less effect.

The ideal control for a simulated aircraft is an analogue joystick.. This has a greater effect the further it is moved and is sprung-loaded back to the centre position. The next best is a mouse, which gives very precise control but is hard to return to its starting position to give zero control input. The simulation cockpit has a special joystick position display to make it easier to return the controls to neutral.

In the absence of an analogue joystick or mouse a switched joystick or the keyboard can be used. Both these controls have more effect the longer pressure is applied or the keys are held down. Reversing the di

immediately returns the control to zero and then continues in the new direction. These effects can be seen by noting the control position indicator.

The best way to learn to fly is to practice. **MiG-29** has a special training scenario which simply returns you to the starting position on the first runway if you crash. This allows you to learn to control the **MiG** without waiting for the program to go through a long restart sequence.

You can select the training scenario from the briefing room. You will be placed on the first runway with your engine idling and wheel brakes on. Press **CTRL-D** to exit to the briefing room and select another scenario.

You should have the controls and display reference card to hand to remind you of all the keyboard functions.

Take off:

When you are ready to take off check that your controls are central and then use the **=** key to throttle up to full power. You will start to move as the brakes are not powerful enough to hold you against full power. Press **W** to release the wheel brakes which allows you to accelerate faster.

Your airspeed is the number at the top left of the Head Up Display **(HUD).** This is in kilometres per hour **(km/h).** 2 km/h is about 1 **Knot.** When your airspeed is over 300 **Km/h** you should pull back on the joystick to take off. This may take a large control input but as soon as you leave the ground return the elevator to neutral. If your nose has pitched up to more than about 10 degrees you should move the stick forward to reduce your pitch to 10 degrees. 10 degrees is the first line marked with a 1 on the **HUD** and the central green cross gives the position of your nose.

You should retract your landing gear by pressing **L** as soon as convenient.

Straight And Level Flight:

Keep your wings level by correcting with sideways movements of the joystick. If the left wing is low then move the joystick to the right until the horizon is level and then centre the joystick. If the right wing is low use left joystick. If the horizon is out of view you can look at the lines in the **HUD** which are always

parallel to the horizon.

Initially you should try to fly at a height of between 1000 and 2000 metres. Your height is shown at the top right of the **HUD.** Maintain height by keeping the central green cross on the horizon.

If you get into an unusual attitude you should always level your wings before using the elevator to pitch your nose back to the horizon. If you lose control you can use the auto-stabiliser to recover. First centre your joystick by pressing **Z** and then switch on the auto-stabiliser by pressing **A.** You may prefer to leave the auto-stabiliser on for your initial flights.

Turns:

When you have mastered flying straight and level it is time to practice turning. A fast jet is not easy to turn quickly. The faster you fly the more force is required to make the turn. This force is known as **g** force and the **MiG** can produce over **10g** in a tight turn. This is 10 times the force of gravity. The only way of producing this force is by using the wings. When you are banked over the lift from the wings is going sideways rather than up and you use this force to turn. Pulling back on the joystick not only pitches the nose up but also increases the angle of the wings to the airflow, thus producing more lift and therefore more **g** force.

Flying straight and level requires **1g** of lift. Simply banking the aircraft produces just **1g** over to one side allowing the aircraft to turn slowly. To turn fast the aircraft should be banked until the wings are nearly vertical and then the elevator can be used to control the rate of turn. It is quite difficult to control the bank angle while pulling back on the joystick, but controlled high **g** turns are an essential part of flying a high performance aircraft like the **MiG-29.**

While practicing turning you will probably notice that the nose of the aircraft drops towards the ground. This is caused by sideslip and makes turning at low altitudes difficult. The best way to counteract this is to bank to less than 90 degrees and to use the elevator to keep the nose up. The closer you are to 90 degrees the more elevator you will need.

Navigation:

When you can make controlled turns it is time to learn to navigate. Fighter aircraft have simple navigation systems so that the pilot can concentrate on flying and combat. The **MiG-29** simulation includes several waypoints, which are points on the ground preprogrammed into the navigation system.

The training scenario starts with **waypoint** 0 selected which is set to the centre of your base runway. To return to this runway you can use the red line on the compass display at the top of the **HUD.** When the red line is centred you are flying directly towards the selected **waypoint.** The head down navigation instrument also shows information about the **waypoint.** The green line shows the direction relative to your nose and the white cross bar shows the distance. You can change waypoints by pressing the **;** key.

To return to base keep heading towards **waypoint** 0, and keep your altitude to about 1000 metres. If you are too high you won't see any ground features.

If you fly with afterburners on you will use more fuel and your range will be much less. If you have gone too far during practice you may run out of fuel before you can land to refuel. This is an easy way to get back to base.

Try and experiment with different throttle settings and the airbrake to see what effect they have on speed. It takes a long time to lose speed in straight and level flight, but tight turns at low throttle will burn off speed much faster. Climbing steeply will reduce speed and diving steeply will increase it.

At low levels the speed of sound is a barrier which the **MiG** can only just break. Its top speed is 1400 **Km/H** at sea level and even afterburners increase your top speed by less than 150 **Km/H.** If you go higher the top speed will increase to 2500 **Km/H** at 10000 metres.

Landing:

When you can navigate back to your base runway, the next problem is landing on it. A good landing requires a low descent rate with the wings nearly level and a low enough forward speed to stop before the end of the runway.

The secret of a good landing is a good approach. This means that you need to

start a long way out from the runway. The base runway is aligned North-South and there is no wind so you can land from either end. A simple way to align the aircraft with the runway is to fly over the runway heading North or South and keep going at an altitude of about 1000 metres for at least 30 seconds. Then make a tight 180 degree turn until you are heading back to the runway. Unless you have flown slightly off the due North or South course, the turn will put you to one side of the direct line to the runway. You should get back to a straight line from the runway as soon as possible.

A good speed for the approach is 500 **Km/H.** The throttle should be reduced to zero and the airbrake used if needed. At 500 **Km/H** and about 5 kilometres from the runway, lower the landing gear and take off the airbrake. Point the aircraft's nose down, directing it at the start of the runway. Increase throttle slightly if the speed gets too low. The steeper your descent the less throttle you will need to maintain airspeed. The landing gear adds drag and therefore slows you down. When you are about 2 kilometres out you should start to slow down to about 250 **Km/H** and lower the landing gear.

There is a red aircraft symbol in the centre of the **HUD.** This is your velocity vector. It shows the direction in which you are actually travelling as opposed to the direction the aircraft's nose is pointing.

The slower you fly the more you have to keep your nose up to maintain level flight. The velocity vector shows your true direction and as you slow down you can use it to show you where you will land. Your nose can be well above the horizon but your downward speed can still be too high to enable a safe landing. The velocity vector shows this. In addition, the vertical speed indicator in the **HUD** shows your descent rate. This has to be above the lower line for a good landing. When you are down to about 10 metres you should pull back on the joystick to round out for a gentle touch down.

If you slow down too much you will stall. This happens when the angle of attack of the wings to the airflow is greater than about 20 degrees. If you stall, the nose will drop and you will lose height. If you are low you will hit the ground. If while landing the velocity vector gets close to the bottom of the

screen, then this is a good sign of an impending stall. The angle of attack indicator at the bottom right of the **HUD** is also useful.

When you are safely on the runway, ensure that the nose is down, apply wheel brakes and use the rudder/nose wheel steering to stay on the runway. You will automatically be refueled when you stop.

ADVANCED FLIGHT:

The **MiG-29** uses advanced aerodynamics. It does not have a fly-by-wire computer system and therefore relies on good handling and pilot skill for its performance. The most remarkable feature is its controllability at very high angles of attack. A conventional wing stalls at about 15 degrees but the **MiG** is still under control at 25 degrees. The drag is of course considerable at high angles of attack and the afterburners are essential for maintaining speed.

This **MiG-29** simulation has two different aircraft models. The standard model is designed to compromise between ease of flying and realism. There is also a more advanced model that is a much more accurate simulation, but which requires a fast computer to run effectively.

This is because the forces acting on the aircraft are calculated and then used to determine its acceleration and velocity. If the time step for this calculation is more than about 1/10 second, inaccuracy can build up causing oscillations. It is also more difficult to fly. (A fast response time to control inputs is important). This limits the advanced model to 16/32 bit computers with a clock speed of 16 MHz or above which can maintain a frame rate of over 10 Hz.

A good analogue joystick is also an advantage for flying the advanced model. A good joystick has very little backlash which means that it returns to precisely the central position when released. A second joystick for rudder and throttle is also very useful. With enough practice the mouse works quite well but keyboard control is difficult.

Some of the manoeuvres and techniques discussed in this section can only be performed by the advanced model. This is enabled by pressing **CTRL-A.** Using the fast time feature makes the advanced model hard to control and it

may become unstable on slower computers.

The **MiG-29** airframe is very strong and can take about 13**g**. An experienced pilot can take about 10**g** after which there is a high risk of blacking out. Blacking out is not covered in this simulation, but using full elevator control at high speeds is unwise as there is no fly-by-wire system to prevent you breaking the airframe. There is a **g** meter at the bottom left of the **HUD** and this should be used to avoid pulling more than 10**g**.

The reduction of air density with altitude is simulated. This means that the aircraft can fly much faster at high altitude, but it becomes harder to control. Thin high altitude air does not provide much lift so high **g** manoeuvres become increasingly difficult. The **MiG** has an operational ceiling of about 20,000 metres (60,000 feet). Above this altitude the air is too thin for the jet engine which produces almost no power.

The drag increase at the speed of sound is also simulated. This prevents high speed flight at low level. The **MiG-29** can fly at1,400 **Km/H** (Mach 1.1) at sea level, but up to 2,500 **Km/H** (Mach 2) at an altitude of 10,000 metres. This means that flying high is the best way to reduce travel time. However, dogfighting at high levels is difficult.

The simulation deals with unusual aircraft altitudes and continues to calculate forces on the aircraft even when far outside the normal flight envelope. This allows you to perform the full range of aerobatics.

There is a velocity vector in the **HUD.** This is the red aircraft symbol. It shows you the point in space towards which you are actually moving. It stays close to the central green cross at high speed and low **g.** When flying at low speed or high **g,** the velocity vector can be a long way from the centre. For example, at 25 degrees angle of attack, the velocity vector is 25 degrees below the centre line of the aircraft, and out of the field of view of the **HUD.**

The velocity vector can be very useful for accurate flying. For example, when you are pulling a high **g** turn you have to keep the velocity vector above the horizon to avoid losing height. If you are below 100 metres and the velocity

vector is much below the horizon you should start worrying. The velocity vector will show you exactly where you will touch down when landing. For a controlled,slow landing, the nose may have to be nearly 10 degrees above the horizon and you have to use the velocity vector to monitor your "round out".

The elevator on the **MiG-29** is very powerful and is easily capable of holding the nose up even when the wings are fully stalled. The design of the wings prevents them from producing roll instability as they stall, so it is quite easy to fly the aircraft with the wings at 25 degrees angle of attack. However, there is a large amount of drag at these high angles and you will need lots of engine power to sustain them for long periods of time. If you fly slowly enough and with insufficient power, the elevators will be incapable of holding the nose up and a full stall will develop.

The controls become less effective as airspeed drops. Below about 200 **Km/H** this effect is very noticeable and there is no choice but to wait for airspeed to build up to regain full control.

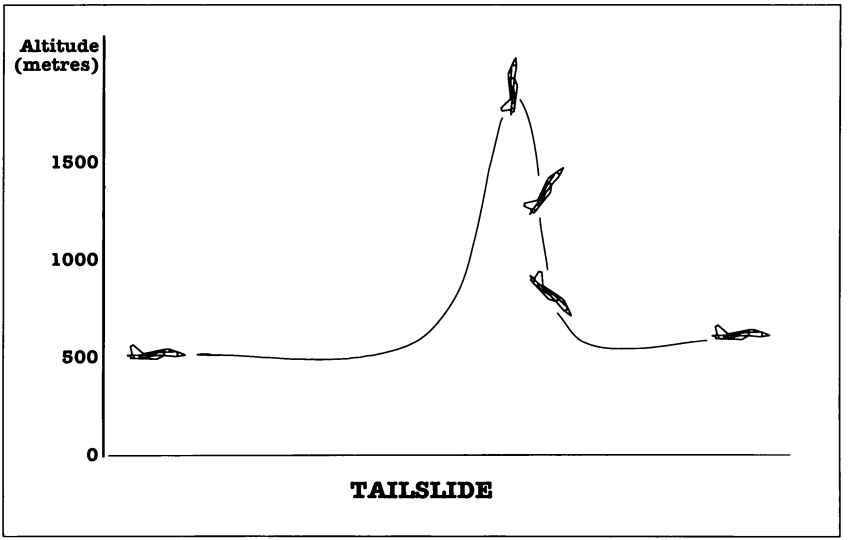
AEROBATIC STUNTS:

The **MiG-29** is famous for its tailslide manoeuvre which would probably be outside the envelope allowed by a fly-by-wire aircraft. This manoeuvre is quite easy to perform provided you have sufficient height for recovery.

Fly straight and level at about 500 metres altitude and about 800 **Km/H** airspeed. Pull back hard on the stick while reducing throttle to an idle. Aim to climb at 80 degrees upwards as shown by the **HUD** and ensure the wings are level while you still have sufficient airspeed for control.

Your airspeed should drop to zero by about 1,500 metres altitude and you will then start to slide backwards. Note that the elevator control is reversed when moving backwards so you will need to pull back on the joystick to make the nose drop faster.

Let the nose drop until you can see the velocity vector again and apply full power and pull out carefully. You should be back in level flight at about 500 metres altitude. The only real problem is trying to recover too soon and getting



locked into a stall right down to the ground.

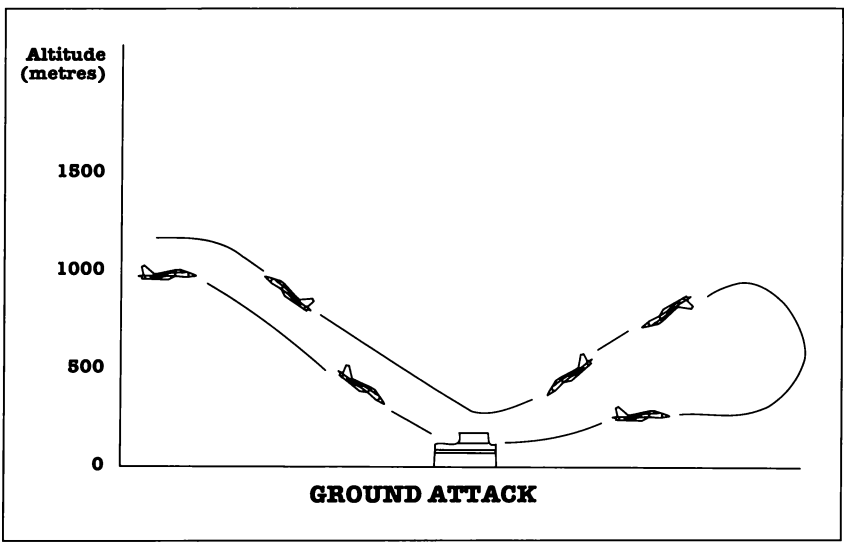
Another fun manoeuvre is a dead stick landing. Start from about 2,000 metres near a runway and switch the engine off. You need to descend at an angle of about 10-20 degrees to maintain airspeed and pulling any tight turns will lose speed very quickly. Wait until you are very low before lowering your landing gear and "round out" precisely. Any ballooning after the "round out" can lead to a stall and a crash.

AIR TO GROUND ATTACK

You have three different weapons to use for ground attack. The simplest is the cannon. This is always ready for use simply by pressing the main joystick or mouse button, or by pressing the **Delete** key. Some of the shells are "tracer" which mark the path of the shells. The trajectory of each shell is simulated as it

falls under gravity and you will see it explode on contact with the ground or any solid object. The explosions clearly mark the impact point of the shells and you can use this to steer a long burst onto the target. You only have **250** rounds so you can only do this a few times in any one sortie.

The effective range of the cannon is about 2 kilometres, but you will probably not hit anything at over 1 kilometre. The cannon is useful against soft ground targets which include trucks, anti-aircraft guns, **SAM** sites and some buildings. The best way to use the cannon is to approach in a shallow dive at low throttle. If you miss on the first pass, the simplest way to get back is to open up to full power and fly straight ahead for a few seconds. Then do a fast half loop, cutting power as you go over the top, and keep going over until you can see the target. Do a quick half roll to level, apply airbrakes and fire when close. Allow plenty of height to pull out of the dive as pressing on until the target is



hit often does not give you time to recover.

The **S-240** unguided rocket is the default weapon selection as shown by the type at the bottom left of the helmet mounted display. A salvo from both underwing stations can be fired at any time by the second joystick or mouse button, or by pressing the spacebar.

The **S-240** will destroy any target, although some may require several hits. The rockets drop with gravity, but are fired slightly upwards so that they cross your centreline after about 1.5 kilometres, which is a good firing range. The tactics for the **S-240** are very similar to the cannon, but you only have 36 salvos so they should not be wasted in ranging shots.

The **AS-7** Kerry heat seeking missile can be used to attack any major ground target. The **AS-7** is activated by cycling your chosen weapon using the **Backspace** key. Any target that is tracked by your combined infra-red and radar system, and shows as a yellow point on your head down screen, may by designated by looking at it and using the **Return** key. The target nearest the centre of your view will be chosen. This means that you can designate targets while looking sideways. The selected target will be shown by a box drawn around it on the helmet mounted display. However, the missile will only lock onto targets within 45 degrees of your heading, so you should be flying towards the target before firing.

Some targets may require more than one hit to destroy them and you only have up to 6 **AS-7's** so you will have to use them carefully.

Some ground targets are defended by anti-aircraft guns or **SAMS.** It is advisable to reduce these defences before attacking the main target.

Anti-aircraft guns may be ground based point defences or mounted on a tank or a ship, depending on the scenario. They are fairly accurate and difficult to hit without being shot down. They use a simple predictor system so the best defence is to weave continuously while flying away and trust to luck while attacking. Either cannon or rockets will destroy anti-aircraft guns.

The **SAMs** are radar guided, with various ranges. The launchers appear as red

points on your radar when active. The only way to avoid their attention is to fly low. They can be destroyed by cannon, rocket or **AS-7** missiles.

If your infra-red system detects a **SAM** launch you will hear a warning and the direction of the missile is shown as a red line on the head down display. Your only defence is to drop radar reflective chaff and turn hard. Some missiles may have enough fuel to turn back for a second pass if you manage to dodge the initial attack.

The training scenario allows you to practice ground attack without any opposition. There is a rocket firing range at **waypoint** 1 which is North-West of your base. You should approach the range from the South to see the range markers on the ground. The target is at the North end of the white **V.** If you enter the South end of the **V** at about 200 metres and about 800 **Km/H** and fly straight at the point of the **V,** you should be able to fire your rockets from a range of about 1500 metres and score a direct hit.

Waypoint 2 is a lake with a target barge in the middle and a tank on the shore. Both these targets can be designated for the **AS-7** missile, although a successful rocket attack is more satisfying. The tank is difficult to hit.

Waypoint 3 is an airfield. There is a hangar which can be destroyed by **AS-7** or rocket and a **Mirage** aircraft on which to practice with air-to-air weapons. The hangar will keep producing replacement **Mirages** until you destroy it.

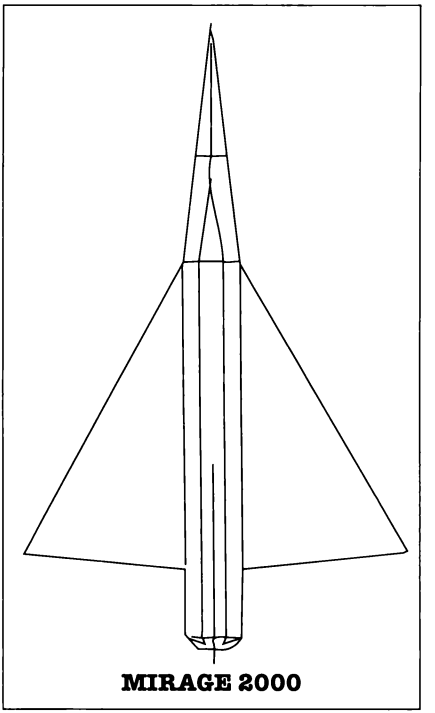
AIR COMBAT

Dogfighting is an essential part of the **MiG-29** simulation. The final scenario is probably impossible to complete without first gaining air superiority.

In the final scenario the enemy aircraft are **Mirage 2000** and **MiG-29's** which means that you have some strong opponents. You will also be outnumbered, sometimes by as many as 4 to 1. The only advantage you will have is pilot skill, so it is worth using the harmless aircraft in the training scenario for practice.

You have 2 air combat weapons. The first is the cannon. You have to be very

close to the enemy aircraft and probably behind it to stand much chance of hitting it. If it is turning you will have to shoot a considerable distance ahead. It takes a lot of practice to judge the lead distance, but the first time you see the explosions of your shells hitting the airframe,followed by a trail of smoke as it spirals towards the ground, it will seem worthwhile.

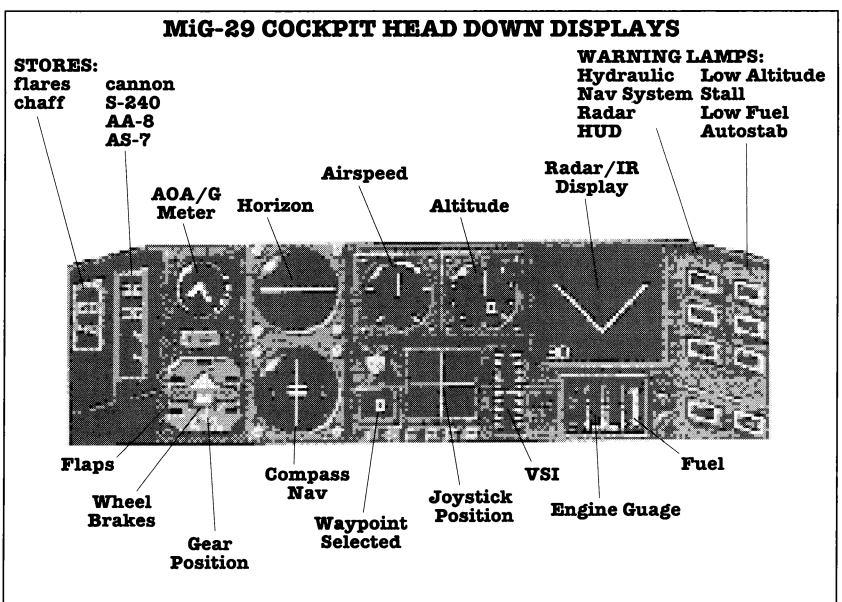

MIRAGE 2000

The easier of the weapons is the **AA-8** Aphid heat-seeking missile. You select this with the **backspace** key. You designate your target with the **return** key. The chosen target is the one nearest the centre of your view, which does not have to be forwards. The **AA-8** has similar limitations to the **AS-7** and can only lock onto a target that is within its view cone. You should only fire at a selected target that is ahead of you. The selected target is boxed in standard **HUD** colour which turns red when the heat signature is very strong. This is when its jet exhaust is towards you and your missile has the best chance of hitting. You can fire when the box is green but the success rate will be lower.

The enemy is also equipped with cannon and heat seeking missiles. If you avoid flying straight and level in front of enemy aircraft you will probably not be hit by cannon fire. However enemy missiles are a bigger problem. There is a

warning alarm sound when an enemy launch is detected and the direction of the missile is shown by the red line on the head down display. You can decoy the missile with well timed flares and by pulling high **g** evasive manoeuvres. Once the missile has gone past it is harmless and cannot return for another pass. Enemy aircraft can only launch missiles when you are in front of them, so the best defence is to get behind them. This is often impossible when fighting more than one opponent.

The head down display shows the position of enemy aircraft when in front and when range can be measured by radar or laser ranging. They appear as a green point. When they are out of the range sensors' field of view, their direction is measured and shown as a green line.



There are many different successful tactics for air combat, but there are a few golden rules. The most important is maintaining energy. The energy is in two forms, height and speed. You can usually trade one for the other, but both at once is an advantage. However too much height puts you into thin air where high **g** turns are impossible and it is much harder to avoid missiles. It is best to stay below 5000 metres for good manoeuvrability.

It is very easy to lose airspeed when performing high **g** combat manoeuvres. You should usually use afterburners to maintain speed. If you have some spare height you can dive to regain speed, but otherwise you must level out, which makes you more vulnerable to missile attack.

A useful technique is to make sure your opponent is designated and use the direction line in the helmet display to keep in touch with his position. The all round infra-red sensors can track an enemy aircraft when it is out of view.

APPENDICES

AIRCRAFT PERFORMANCE DATA

MIKOYAN MIG-29 FULCRUM

Dimensions (metres to nearest .5m)

Length:	17.50m
Span:	11.50m
Height:	4.50m
Wing Area:	32.00m^2

Weights (kg to nearest 100kg)

Empty:	10,200kg
Takeoff:	16,000kg
Combat:	13,700kg

Power (kN, from 2 x Tumansky R-33D turbofans)

Thrust (Dry):	81.3
Thrust (Augmented):	50.0

Performance

Vmax (High altitude):	Mach 2.2
Vmin (Sea level):	Mach 1.1
Ceiling:	16,800m

Armament

Internal Cannon:	**30mm**
Missiles:	**AA-8 Aphid, AA-9 Amos, AA-10 Alamo, AS-7 Kerry**

BRITISH AEROSPACE SEA HARRIER FRS.1

Dimensions (metres to nearest .5m)

Length:	14.50m
Span:	7.50m
Height:	3.50m

Wing Area:	18.50m²

Weights (kg to nearest 100kg)

Empty:	5,900kg
Takeoff:	8,900kg
Combat:	7,800kg

Power (kN, from Pegasus 104)

Thrust (Dry):	95.5
Thrust (Augmented):	N/A

Performance

Vmax (High altitude):	Mach 0.97
Vmin (Sea level):	Mach 1.2
Ceiling:	16,800m

Armament

Internal Cannon:	Two **30mm Aden**
Missiles:	**AIM-9L Sidewinder,** or **.550 Magic, AIM-120 Amrram**

SHENYANG F-7M AIRGUARD

Dimensions (metres to nearest .5m)

Length:	14.00m
Span:	7.00m
Height:	4.00m
Wing Area:	23.00m²

Weights (kg to nearest 100kg)

Empty:	5,300kg
Takeoff:	7,900kg
Combat:	6,800kg

Power (kN)

Thrust (Dry):	60.0
Thrust (Augmented):	34.0

Performance

Vmax (High altitude):	Mach 2.00
Vmin (Sea level):	Mach 1.0
Ceiling:	18,200m

Armament

Internal Cannon:	Two **30mm**
Missiles:	**PL-2, PL-2A, PL-7,** can also be configured for **Sidewinder** and **Magic**

DASSAULT-BREGUET MIRAGE 2000

Dimensions (metres to nearest .5m)

Length:	14.00m
Span:	9.00m
Height:	4.50m
Wing Area:	41.00m^2

Weights (kg to nearest 100kg)

Empty:	7,600kg
Takeoff:	11,800kg
Combat:	10,200kg

Power (kN from SNECMA M53)

Thrust (Dry):	95.0
Thrust (Augmented):	64.0

Performance

Vmax (High altitude):	Mach 2.35
Vmin (Sea level):	Mach 1.20
Ceiling:	18,300m

Armament

Internal Cannon:	Two **30mm**
Missiles:	**Matra Super 530D,** or **Matra .550 Magic**

AIR TO AIR MISSILE PERFORMANCE

Many simulations simplify the operations and aerodynamics of missile systems. In **MiG-29** we have attempted to model this as accurately as possible. In practice this means that a missile has a 30-40% chance of impact if fired without red lock, rising to 80-90% chance of impact with confirmed red lock. The reasons for this are many and complex, but put simply, an object travelling at Mach 3 may travel very fast, but doesn't turn exceptionally well. Altitude and launch velocity (the speed at which the fighter that launches the missile is travelling) make a big difference to effectiveness. Missiles travelling at Mach 3 can pull turns of up to 30**g** which sounds formidable but produces a turning circle of no better than 16 degrees/sec – a figure any respectable fighter can manage at subsonic speeds. The **MiG-29** uses **IR** guidance on its **AA-8** Aphid , a short range missile, which gives true fire-and-forget performance ie; the plane is free to manoeuvre once the missile has been launched. As previously stated, the optimum firing position is therefore with the target directly in front of you, heading away from your aircraft – the **IR** heat signature is at its best and the target has less chance of out-manoeuvring your missile.