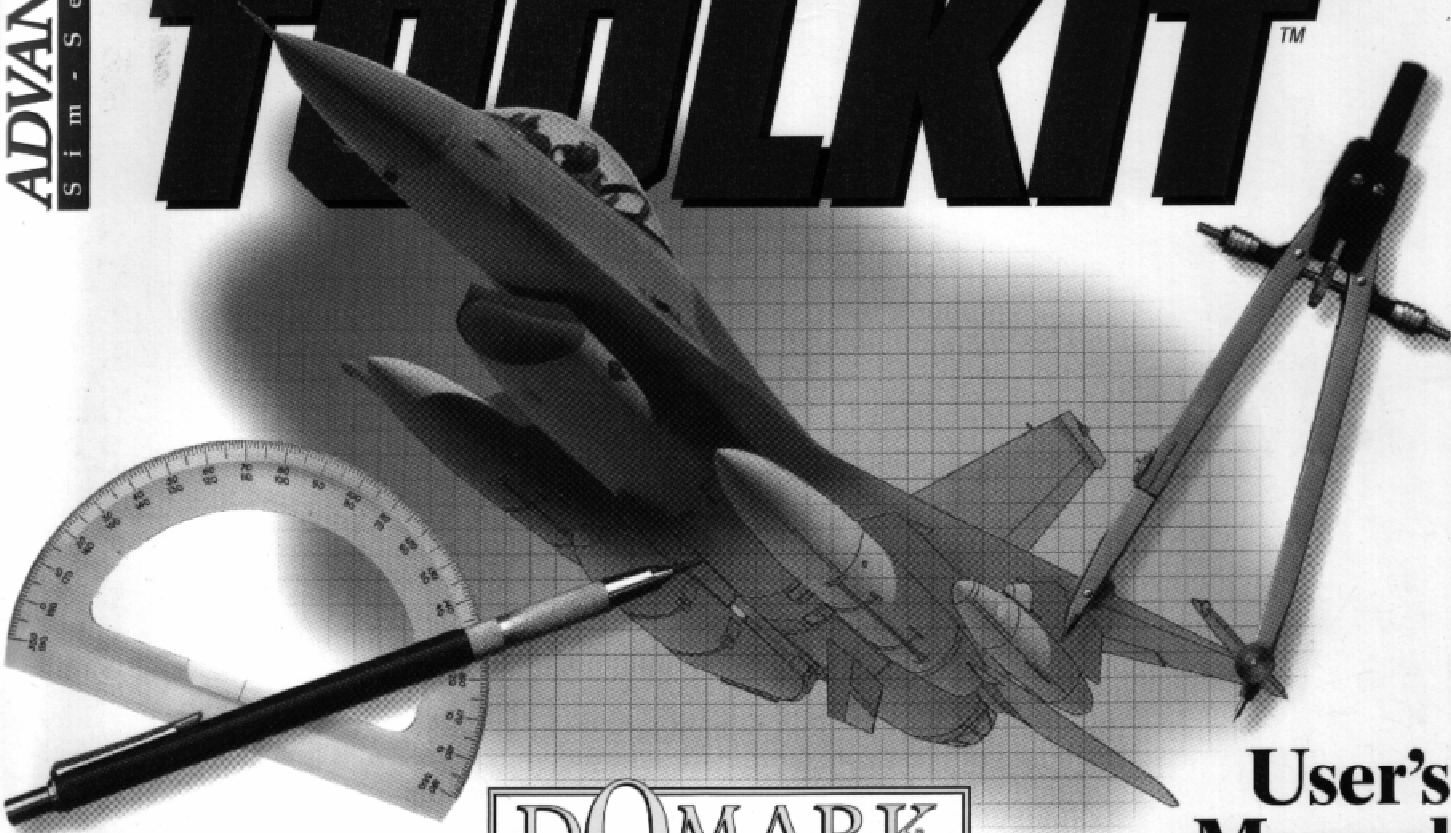
ADVANCED
Sim-Series

FLIGHT SIM TOOLKIT™



DOMARK

User's Manual

FLIGHT SIM TOOLKIT™

CHAPTER I - INSTALLATION

WELCOME

Welcome to the Flight SimToolkit. FST is a unique combination of advanced Windows based construction tools and a high performance flight simulation providing the most flexible high performance simulation system available today.

Processor

FST uses state of the art high level 32 bit coding techniques to achieve maximum performance on your PC. You will need a processor which supports true 32 bit code to run the FST simulator a 386 SX is the minimum requirement.

Graphics Drivers

The full color flight simulator outside world graphics requires a 256 color display adaptor to support its advanced graphics effects such as dynamic object light source shading and fully distance shaded terrain. The minimum requirement is a standard VGA display adaptor. FST also supports high resolution SVGA graphics for very high fidelity outside world graphics on machines with the appropriate display adaptors.

Windows

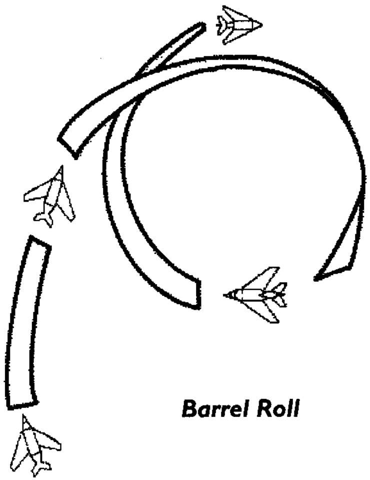
The FST tools exploit the task-switching and powerful graphical user interface benefits of Microsoft Windows to the full. All of the tools in FST are Microsoft Windows applications and are run from a master FST Project Manager under Windows so that, for example, users can switch from Terrain design to Shape editing simply by a click of the mouse. Also, other Windows applications can be used in addition to those included within FST for image editing and sound effect sampling.

FST World

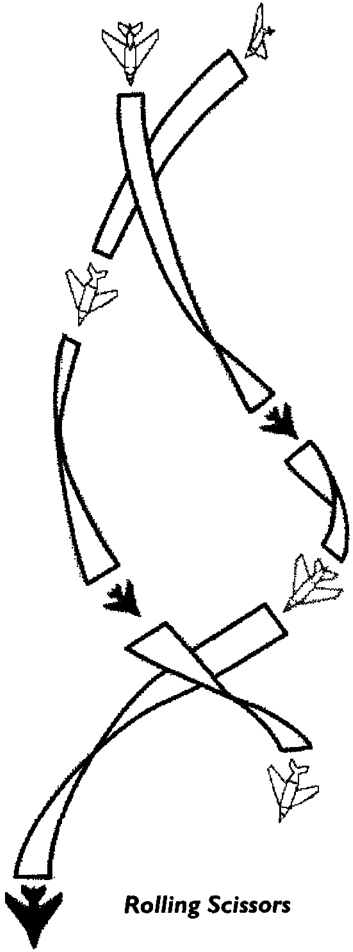
The FST world is virtually unlimited. Real terrain data from the American geological survey has been used to generate the ground providing a totally accurate rendering of the world you fly in. The FST tools also allow you to modify and extend the terrain database.

FST Flight Models

FST features a highly sophisticated parameterised aerodynamic force model. This is based upon Newton's laws, accurately calculating the linear and rotational accelerations caused by the various forces acting on the aircraft dynamically. These forces are integrated to give true velocity, position and orientation data for the aircraft every frame. The FST aerodynamic model editor allows you to change the size, position and orientation of the critical lifting surfaces, specify the power, type and positioning of the engines and control a range of other variables which combine to parameterize the model. The result is a simulator capable of accurately modeling everything from a Cessna to an F 16.



Barrel Roll



Rolling Scissors

Sound Support

FST uses digitally sampled Sound Effects for maximum authenticity. A library of aircraft Sound Effects is provided with FST. You can also incorporate your own effects using standard Windows applications.

I. I System Requirements

Mandatory

- o IBM PC or compatible, 386/486/Pentium
- o 2 Mbytes of memory
- o VGA graphics
- o MSDOS 3.0 or higher
- o Windows 3. I or higher
- o Hard disk with 8 Mbytes free
- o Mouse

Optional

- o VESA compliant SVGA graphics accelerator; ATI and S3 based provide highest performance, most local bus cards provide good performance
- o Joystick, Yoke or rudders (Thrustmaster supported)
- o Soundblaster card

1.2 Backup

Flight Sim Toolkit is not copy protected and we strongly recommend that you make a backup of the master disks before you go any further.

1.3 Installing FST

The FST installation runs from windows; (if you run it from DOS it will automatically run windows for you). To install place Master Disk I in your floppy drive and either type SETUP from the DOS command line (A:> SETUP) or double click on setup.exe in the windows file manager.

FST installs all the tools, the simulation and libraries under the directory C:\FST by default. The install creates a program group with the FST project manager as the single program item for you.

1.4 Configuring Your System

Temporary Files

A temporary directory is **not** essential to run FST – but it optimizes the performance of some of the editor functions.

The FST tools make extensive use of temporary files, by default these are created in the Current Project directory. It is advisable to set up a temporary directory on your hard disk, or preferably on a RAM disk, for these files. If such a temporary directory exists FST will make use of it through a DOS environment variable. The choice of a hard disk or RAM disk based temporary directory should be made based upon how much memory your PC has. For a 2Mbyte machine use a hard disk based temporary directory; for a machine with more than 2Mbytes it is preferable to set up a RAM disk and use that.

A RAM drive based temporary directory provides a significant speed increase during the operation of the Shape Editor and the Terrain Viewer.

Creating and using a hard disk based temp directory

i) create a suitable directory on your hard disk (if one does not already exist):

c:\> MD \TMP

ii) edit your autoexec.bat (using the DOS editor) and add the following line to the end of the file (assuming your hard disk is the C drive):

SET TMP=C:\TMP

Creating and using a RAM disk based temp directory:

i) add the following line at the end of your CONFIG.SYS file (this creates a 128 K ramdrive on your PC):

DEVICE=C:\DOS\RAMDRIVE.SYS /e 128

ii) edit your autoexecbat (using the DOS editor) and add the following line to the end of the file (assuming *your* hard disk is the D drive):

SET TMP=D:

Soundblaster

FST will attempt to autodetect your Soundblaster card if you have one installed, however it only scans DMA channel one (to avoid potential conflict with the hard disk). If you have installed your Soundblaster card using non-standard jumper configurations you may have to instruct FST. This is done by adding a line to your AUTOEXEC.BAT file defining the DOS environment variable BLASTER. E.g:

SET BLASTER=A220 I7 D1 T1

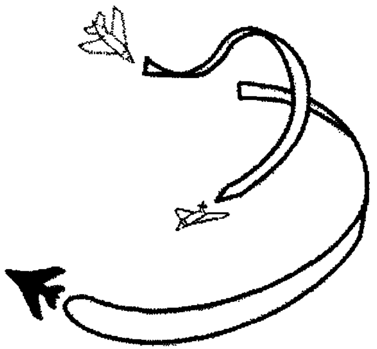
(base address 220, IRQ 7, DMA channel 1), See your Soundblaster documentation for more details.

1.5 Starting the Tools

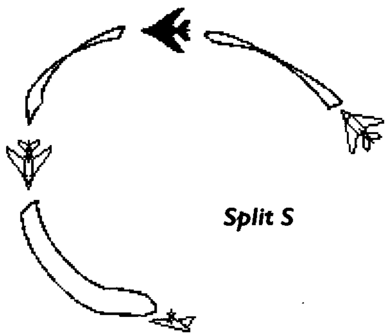
The FST tools are all Windows applications. The install program will have automatically created an FST program group for you containing the FST project manager. Start Windows if you have not already done so by typing WIN at the DOS prompt, select the FST icon in the Windows Program Manager and double click on it, this will open the FST program group. To run the project manager double click on the FST icon in the program group all of the FST tools can be started directly from the project manager buttons: the project manager also provides functions for you to create new projects and select the project that you are currently working on (by default \FST\PROJECT\).

1.6 Starting the Simulator

The FST flight simulator runs under DOS, it cannot be run directly from Windows or from a Windows DOS shell. To start the simulation change to the FST project directory (e.g. CD \FST\PROJECT) and type FLY. The simulator will start immediately – all configuration issues are controlled from menus within the simulation (access by pressing Esc).



Yo-yo



CHAPTER 2 - INTRODUCTION

2. I We've come a long way

Paris, 27th August, 1783. Professor Jacques Charles of the Academy of Sciences prepared to conduct a unique experiment at the Champ de Mars. At five o'clock, watched by thousands of excited spectators, a balloon measunng twelve feet in diameter rose from the ground and moved slowly upwards, rising higher and higher until it disappeared into the clouds. This was no minor achievement - it represented the very first time man had succeeded in getting an object airborne. The balloon flew a total of eleven miles and landed gently on the outskirts of Gonesse, a rural village. Here however it struck terror in the hearts of the simple villagers who, convinced it was a dragon, hacked it to death.

It has taken man the best part of a million years to learn the secret of flight. In his attempt to fly, he has wrestled with all kinds of inventions from bottles of dew to omithopters before finally being rewarded with success. As every schoolchild knows, it was Orville and Wilbur Wnght who devised the first powered, heavier-than-air flying machine. A satisfactory formula was thus found and, spurred on by commercial and military interests, developed at a phenomenal rate. The Wright brothers' research still underpins the basic design of every kind of aircraft we know today – from the Microlite to the Boeing 747.

Share the experience with FST

For man, the mastery of mechanical flight probably represents his supreme technical advancement it has extended dramatically his domination of the natural environment. Now you, too, can experience the exhilaration of the conquest of the air by developing customized applications at your own speed and to your own specifications. Domark and Simis, the producers of market-leading AV8B Harrier Assault, now bring you the revolutionary Flight Sim Toolkit (FST).

The Flight Sim Toolkit is a set of Tools that allow you to create a complete flight simulation and to experience exactly what it feels like to fly a plane. Ever since the PC first hit our desks, we've all been intrigued and entranced by flight simulation software. Now FST takes a quantum leap – into the world of virtual reality. Not only does it provide one of the most authentic flight simulations possible on your PC, uniquely it allows you to create your own virtual World by designing and specifying as many customized features as you desire within your world. The potential for new experiences is unlimited. Ultimately you may wish to swap simulations you have created with other FST buffs.

Just to show what can be achieved, FST comes with two state-of-the-art Flight Sims Private Pilot and Top Gun. Once you are familiar with these games you can use the powerful FST 'engine' to customize selected features from them to form a foundation for devising your own games. You can do anything you like -from changing the shape, size and properties of buildings to incorporating your home town into your virtual world. Using a working example as a basis is a good starting point and means you can add in your own features one at a time and so test the results immediately.

Alternatively you can start right from scratch and define every detail of your 3D World – its terrain, color, the objects within it and all their attributes. You can then determine the type of plane(s) you wish to fly and the route(s) you want to take. If you want to create a combat scenario, you can also specify the design of your own fighters and weapons and those of your enemy. The only limitation is your own imagination.

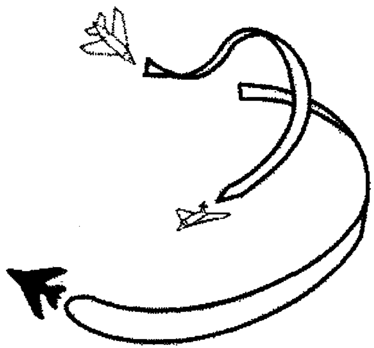
Design your world

Your two main tools are the FST Shape Editor and the FST World Editor. Use the FST Shape Editor to create new shapes for aircraft runways, buildings, bridges, roads, rivers or any other objects you want to appear in your World. Alternatively, select existing shapes for later modification.

Use the FST World Editor to create the terrain and to place the shapes in your World and give them suitable characteristics. For example, always specify that runways can be landed on otherwise you will not even be able to tax around your airfield. Controlling your World even extends to defining target shapes and behavior – for example hangars which generate enemy aircraft when you fly too close.

Other Tools enable you to enhance the flying experience itself, such as designing your own cockpit layout using the FST Cockpit Editor to superimpose dials, lamps and read-outs onto a realistic bitmap backdrop. If you prefer you can use Windows Paintbrush or any bitmap editor to create a cockpit background of your own. FST is as versatile as it is realistic!

But remember, flight cannot be achieved simply by attaching a power unit to a wing and taking off. It's obvious that such a contrivance would lack stability and be hopelessly uncontrollable. So before you can design any aircraft you have to learn the fundamentals of aerodynamics and how to fly different types of aircraft If you're a novice pilot, or even an experienced one who's a bit rusty, Chapter 4 takes you to 'Flight School' to brief you on the fundamentals of flight. It also covers the rudiments of combat, should you decide you want to create war scenarios.



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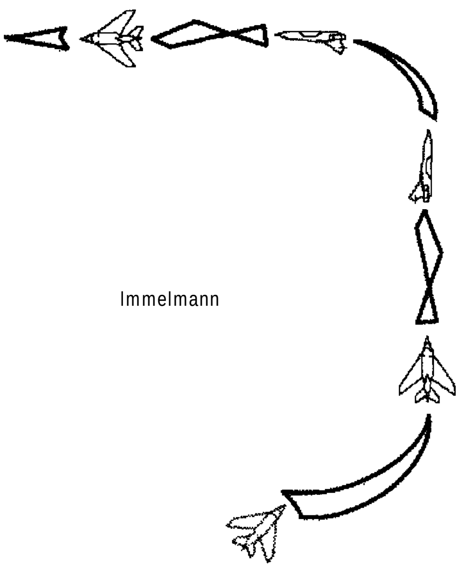

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2.2 The structure of FST

FST comprises three main components:

i) a set of Windows tools for the creation and modification of all aspects of a flight simulation

ii) a flight simulator program (FLY.EXE) which loads the data files created by the tools and implements the flight simulation defined

iii) a library of pre-defined parts for building flight simulations (i.e: 3D shapes, cockpits and so on).

2.3 What you will find in this manual:

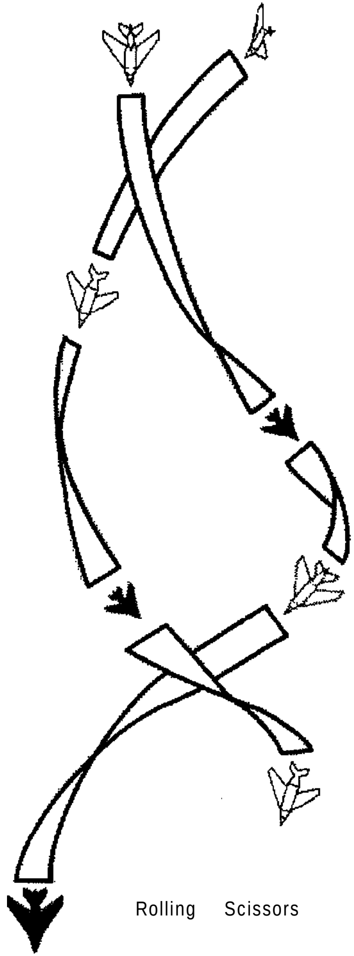
CHAPTER I outlines minimum system requirements and details configuration, installation and back-up procedures.

CHAPTER 2 – an introduction to the history of experimental flight and an introduction to FST and the accompanying manuals.

CHAPTER 3 outlines the concept and structure of an FST virtual world and provides detailed reference to the Windows Tools used to create and modify the world.

CHAPTER 4 covers the basics of flight, navigation and combat and details the specific FST flight and simulation controls required to fly in the virtual world.

TUTORIAL – step by step instructions on how to use the tools to create basic and advanced 3D shapes and incorporate them in a virtual world.



Rolling Scissors

CHAPTER 3- CREATING AN FST WORLD

3. I OVERVIEW – The FST Virtual World

3. I. I Components of the FST World

The FST virtual world is built from a set of five basic data files:

World Database Terrain Data
3D Shape
Color
Cockpit
Aerodynamic Model

All of these files are manipulated by integral Window Editors and are referenced using 8 character file names. They are linked together in a master World Data File which in turn refers to all the data files which define the virtual world. All of the files which define a simulation (known as 'a project') are kept in a single directory (the Project Directory).

The active FST virtual world comprises simulated objects moving over terrain.The terrain defines the shape of the ground you fly over. The simulation objects are made up of the aircraft you fly, the scenery on the ground (eg: houses, hangars) other moving objects (trucks, other aircraft) and navigation beacons.

All objects in the World are represented in the same manner: they have a 3D shape which defines their appearance and they have a defined position/role in the world. The type of object and its extended properties determine how it behaves in the world. For example, an aircraft flying in the world will be an object of type PLANE, its extended properties will include an Aerodynamic Model and a Cockpit.

An FST virtual world is created or modified using the window tools.

World Editor-to edit terrain data and place and edit the object type and properties

Shape Editor to edit 3D shape definitions

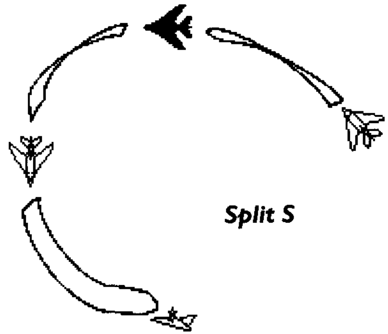
Color Editor-to edit color definitions for world and objects

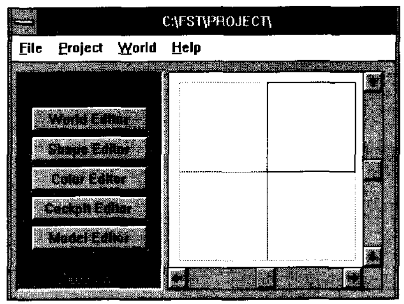
Cockpit Editor-to edit the aircraft cockpit

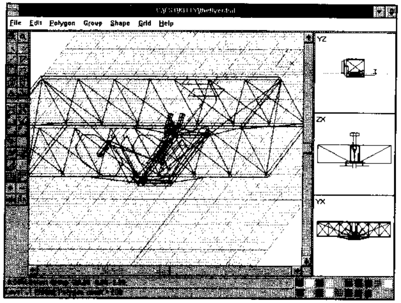
Model Editor-to edit the Aerodynamic model

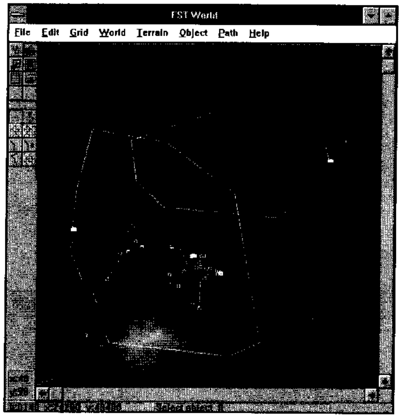
The FST project application provides access to all the tools and also provides project creation and control functions.

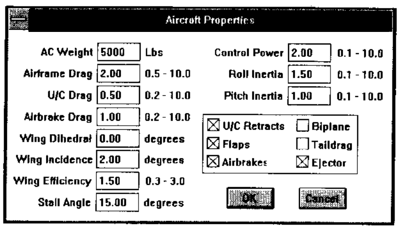
Once the FST world has been created, you need to run the FLY program to actually fly around the world. FLY automatically loads the master World file and all the data files referenced within it. Terrain tiles are loaded dynamically as you move within the world.











The FST world is almost unlimited in size. It is constructed from terrain grids which measure 50Km x 50Km in size (a terrain 'tile'). The initial default is to a World containing a I x I grid of tiles (ie 50 x 50 Km). However the Project Editor gives you the option of setting the size of the world to anywhere from Ix I to 99x99 tiles. This gives you a maximum world size of 4,950Km x 4,950Km - a vast expanse of 24.5 million square Kms).

3.1.2 3D Shapes

The FST Shape Editor is a highly sophisticated tool. It is effectively a specialist CAD tool, comparable with published software such as Autocad'" but optimized to produce 3D solid objects which can be rendered in real time. This means that the shapes which are produced are uniquely capable of functioning as an integral part of a real-time simulation,

3. I .3 World

The ground in the simulated world is generated from terrain data. Terrain data comprises a set of height points on a regular grid. It is best visualized by imagining a large rectangular grid being drawn over the undulations of the ground in the real world. If the various height measurements of all the intersection points on the grid are measured and recorded, then the contours of the ground in the real world can be reconstructed.

The cultural details of the virtual world (such as roads, rivers, houses etc.) are defined by objects placed in the terrain. Objects also define the active parts of the world (for example, trucks moving along roads). The way an object behaves is determined by its class. So an object given the class 'Anti Aircraft Gun' will always behave like an Anti Aircraft Gun by firing at aircraft in its vicinity. Likewise, any object given the NDB (Non Directional Beacon) class will emit a simulated radio signal at a specified frequency. FST also considers the aircraft you 'fly' to be objects: their class will be either Civil or Military. Only the properties assigned to an aircraft will define how it flies, its cockpit design and its appearance. Note that some of these properties are directly set up in the World Editor, while others such as aircraft shape are set up by reference to a named file created by one of the other FST editors (In the case of a shape, for example, this would be the Shape Editor).

3. I .4 Aerodynamic models

FST permits you to experiment with 'flying' a wide range of aircraft The function of the aerodynamic model is to record the size and shape of all the Important flight surfaces (i.e: wings, tail-plane and fins) and the number, position and type of engines selected. A variety of other data - such as inertia control inputs and drag - provides the simulation with the parameters to create a sophisticated generic force model, the focal point of FST. The force model draws upon Isaac Newton's laws of physics to identify the linear and rotational accelerations caused by the various forces acting on the aircraft. The model is updated once per display frame so the shorter the time between frames, the smoother and more accurate the model appears

The aerodynamic model also supplies the data which controls the flight characteristics of other aircraft flying in the FST world.

3. I .5 Cockpits

A cockpit definition in FST links a cockpit background and dial definitions together. The cockpit background is a bitmap (.PCX file format) the size of the screen (either 640x480 or 320x200) on which the background for the cockpit (and HUD) are drawn. The background files can be created using the Windows Paintbrush program or any other paint programs which support .PCX files. The dial definitions which are overlaid on the cockpit background defines where the active dials/gauges and lamps are drawn and what parameters they show (i.e: airspeed, altitude etc).

3. I .6 Simulation

FST simulates the following:

Civil:

- navigation: NDB, VOR, and ILS which are linked to special cockpit dials

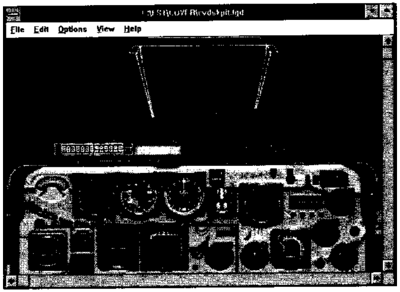
aircraft flying defined flight paths on auto pilot

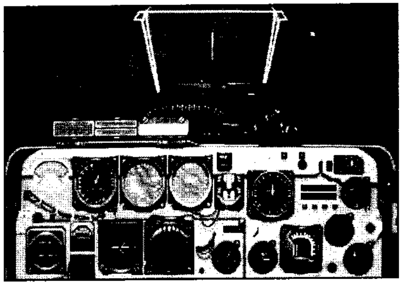
ground vehicles following pre-determined paths.

Combat

- enemy aircraft flying on auto pilot
- a full range of aircraft weapons: cannon, A-A, A-G, rockets, bombs

ground defenses AA GUN and SAM which are linked to depots for re-supply, making for the possibility of more challenging scenarios.





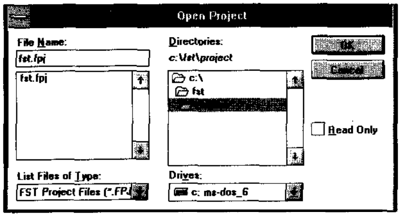
3.2 TOOLS – Reference

3.2. I Fundamental Principles of the FST Editors

All Editors follow Microsoft Windows conventions and all FST Editors are launched from the FST Project application.

Each FST Project comprises a single directory which contains all the required data files. The project application controls the current working project directory. All applications work in the current project directory (so if you want something from another project or library, you need to copy it into the current project directory).

All data files are named using standard DOS names (i.e: 8 character max) and FST defines different file extensions for each data type.



3.2.2 Project Manager application

Executive Overview

FST's central application, or'engine' is the FST Project Manager.

Use it to:

– Select a current working FST Project

Project>Open will call up a standard windows file browser box.

To open a current project, use the directory window to view the directory structure. Then select the directory you require by double clicking on it with the mouse. Once selected, the file identification FST.FPJ wil be shown in the Files window. If you now select and click on this, it will become your current, working directory - as indicated at the top of the FST PROJECT wrndow bar. Click OK to accept the selection.

– Create New FST Projects

Exactly as above, but use Project/Create instead and when the parent directory has been selected, just enter the new project name into the file box (no file extension necessary) and click on OK. A new directory will automatically be created and the necessary basic files copied into it

– Select Colors

The select colors feature opens a dialog box revealing all the color definition files located in the Current Project directory

Click on one of the colors listed to select it as the Default Colors file for the project in hand (initially COLS. FCD is selected).

Note: the selection you make now will also Influence the Shape and Terrain tools, in addition to the simulation itself (FLY.EXE).

– Access the Clipart Libraries Provided

A comprehensive clipart library is installed by default in the directory \FST\LIBRARY. Although there is no FLY.EXE in it, it is installed as a Project. If you want to browse through the clipart library, set the current directory to \FST\LIBRARY by selecting Project/Open. Then call up the relevant Tools to view the directory's contents.

If you want to import a clipart item into one of your own projects, you first need to create your own Project Directory (as described above). Then use the Windows File Manager to copy into it the file(s) you want from the library.

To do this, run the File Manager by double clicking on the File Manager icon which is usually in the Main Group Window of the Windows Program Manager. The File Manager displays the Directory Tree for your current disk drive. (Click on the drive symbol at the top of the directory tree window in File Manager if you are not in the drive which contains your FST directories).

You will see the File Manager's Directory Tree Window directory icons for each directory on the selected drive. Double click on the \FST directory This will display its sub-directories. Double click in turn on \FST\LIBRAR sub-directory and you will see the clipart files listed. Highlight the file or files you wish to copy (holding down the Control key for multiple selections) and then copy them to your Project Directory by “dragging and dropping” or by using the File>Copy routine from the File Manager Main Menu.

World Window

This window shows the total size of the project World in tiles 50km sq. A darker 50km rectangle shows the ‘active’ area of the World which you’ll be working on using the World Editor. Change the selected area by dragging the rectangle in the World window with the left mouse button. (The rectangle is limited to the total World area). The co-ordinates of the bottom left corner of the ‘active’ rectangle are shown in Kms in the main window. Note that the central tile in the World is automatically designated as 0,0. The minimum World size which can be edited is 2500 Km sq. and the maximum 24.5 million Km sq.

TOOL BUTTONS

These function similarly to the Program Manager application in Windows. They act as a launcher for the five editing tools:

1. World Editor
2. Shape Editor
3. Color Editor
4. Cockpit Editor
5. Model Editor

MENU OPERATIONS

File

About

This item displays Information about the FST Shape Editor.

Exit

This item quits the FST Project Manager.

Project

The Project menu contains items used to create and select FST projects.

Open Project

To open a current project use the directory window to view the directory structure. Then select the directory you require by double clicking on it with the mouse. Once selected, the file identification FST.FPJ will be shown in the Files window. If you now select and click on this, it will become your current, working directory – as indicated at the top of the FST PROJECT window bar. Click OK to accept the selection.

Create Project

Exactly as above, but use Project/Create Instead and when the parent directory has been selected, just enter the new project name into the file box (no file extension necessary) and click on OK. A new directory will automatically be created and the necessary basic files copied into it.

Copy Item

Used to copy files between projects.

World Menu

Size

This item opens a dialog box asking for the total size (height and width) of the project World in terms of 50km tiles. (i.e. 2 tiles wide and 3 tiles high would be a I OOkm x I50km World). The size of the World can be Increased or decreased at any time.

Color

This item opens the color file selection dialog box for selecting current colors file for project.

Anatomy of a project

FST.FPJ The project file, created by project manager as part of create new project procedure

FLY.EXE The simulator executable image

COLS.FCD A colors file (may be more than one, but only one used by FLY)

WORLD.FST Object database file created/edited by World, contains links (by file name to Shape files, Model files and Cockpit files)

TOOOOOO.FTD – Terrain data created/ edited by World

TOO 100 I .FTD - Terrain data created/ edited by world

HOUSE.FSD – 3D shape files created/edited by Shape

F I6.FMD Aircraft force model files created/edited by Model

F I6.FGD Cockpit files created/modified by Cockpit

COCKPIT.PCX – Cockpit background bitmap, created/edited by generic Paint program, linked into simulation via Cockpit Editor

Sound Sample Files:

CANNON.WAV – Cannon fire, single sample

START.WAV – Played when FST starts

DIE.WAV Played when player crashes and dies

FIRE.WAV – Played when rocket/missile is launched

GEAR.WAV – Played when gear IS lowered/retracted

EXPLO I .WAV Small explosion

EXPL02.WAV -Medium explosion

EXPL03.WAV Large explosion

LAND.WAV - Played when player lands on runway (skidding tyres....)

MAW.WAV - Missile approach warning in cockpit sound

PING.WAV – Genera “ping” type sound

CLUNK.WAV Genera “clunk” type sound

SWLOCK.WAV Sldewinder lock achieved – in cockpit sound

BULLET.WAV Near miss

E]ECT.WAV – Played when pilot ejects

FLARE.WAV Played when flares are released

CHAFF.WAV Played when chaff is released

KLAX.WAV General warning

SWITCH.WAV – Played when an in cockpit switch is moved (i.e. brakes on/off)

GLIDE.WAV – Glideslope warning played when aircraft is off ILS glideslope

LOWWARN.WAV – Played when player is near ground

STALL.WAV – Played when aircraft is stalling

]ET.WAV -Jet engine sample

PROP.WAV -Prop engine sample

Sound Effects

FST supports sampled sound playback on Soundblaster (& 100% compatibles). The sample files are stored as windows .WAV files. The simulation expects to find named files containing an appropriate sample which it plays when an event occurs (e.g. the GEAR.WAV sample will be played when you retract your undercarriage). You can change the sample played by the simulatlon by replacing the .WAV files provided with your own files.

The Microsoft Sound Recorder application which comes as part of Windows 3. allows you to record your own .WAV files.

3.2.3 World Editor

Executive Overview

The FST Virtual World is a virtually unlimited 3D space containing terrain and objects. The FST World Editor is used for three purposes: creating and editing terrain, placing objects within the World and assigning specified attributes to them. Whilst the World is effectively unlimited in size the FST World Editor works with fixed sized tiles, each being a 50 km x 50 km square. (Select the tile you want to edit with the FST Project Editor). To access the FST World Editor, click the 'FST World Editor' button in the Project Management application. This will bring up the FST World Editor pertaining to whichever project has been selected in the FST Project Manager.

The World Window

The main window in the FST World Editor shows a zoomable, scrollable view of a chunk of the FST terrain database. The minimum size of the FST World is one tile of 50 Km square. The tenain data is visualized as a 100 x 100 grid of colored squares and the intersections of the grid lines (at the borders of the squares) are the actual terrain data points. The color of each square is determined by the height of the four points surrounding it: grid squares with all surrounding points at zero height are drawn blue, squares with heights greater than zero are drawn green, with the intensity varying as a function of height (dark green for low points, bright green for high points).

The artificial coloring of the grid squares provides a rough indication of the shape of the tenain -(much in the same way as a color contour map). However be aware that because of the limited number of colors available, different heights will be drawn the same color (e.g. if the maximum terrain height is I OOOM each color will span a height of 32.25 M -there are 32 greens and the terrain data is stored to a resolution of I M in height). The exact height data for each terrain point is shown in the status box at the bottom of the main window. The tenain point nearest the mouse is always the one shown (and is revised in real-time whenever the mouse is moved).

The 50km x 50km terrain data tiles are automatically loaded into the flight simulator and rendered with distance shaded polygons to provide the ground to fly over. The color of the ground polygons is determined by its height and distance from the viewer, the FST Color Editor contains a color graduation (from ground level to the highest point) which you can define and change at will. [See the section on Color Editor].

You can also use the world window for placing simulation objects in the world and defining their behavior. Simple point, click and drag operations allow you to specify where a new object is to be placed, select an existing object, move it, edit its properties and so forth. Simulation objects are shown as white squares (red when selected) drawn over the tenain Paths or tracks which some of the simulation objects follow are also shown and edited on the world window.

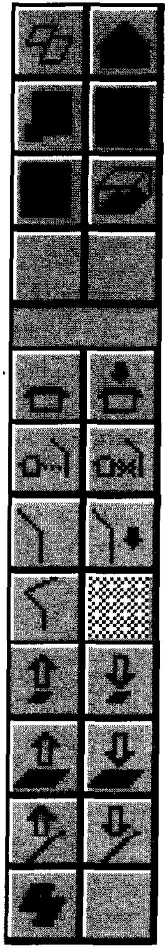
MOUSE OPERATIONS

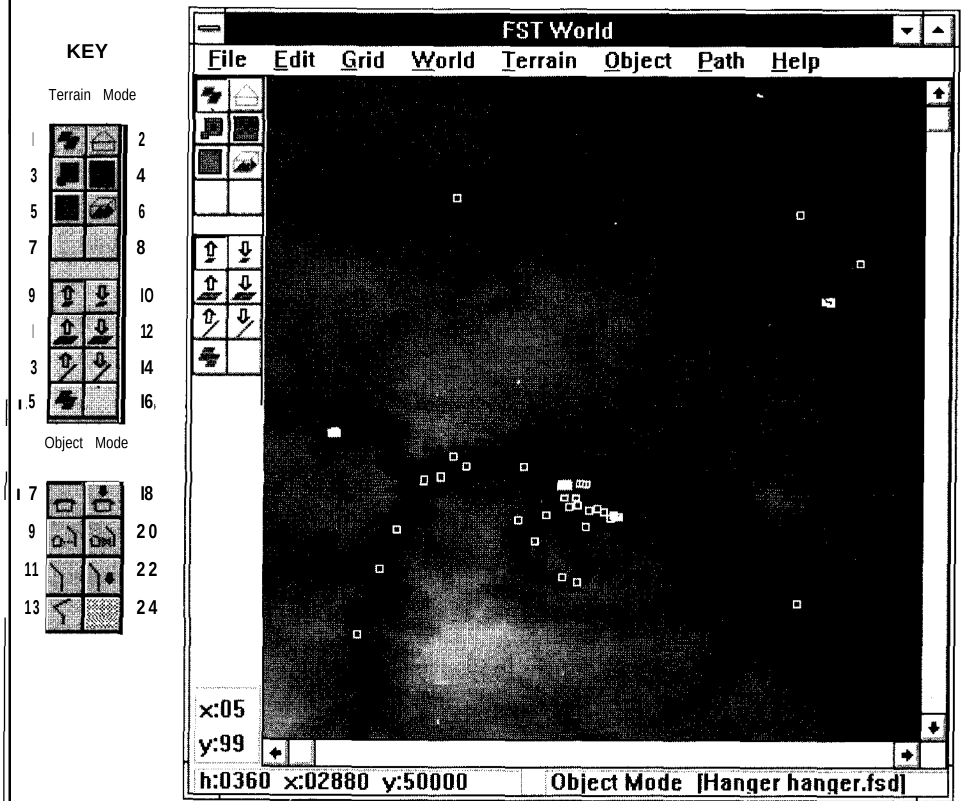
Selecting a tool

Move the mouse pointer over the required tool icon (refer to textual feedback at the bottom of the window) and click the left mouse button. If the tool icon is depressed, it becomes the active tool.

Selecting a point/object

To select an individual point (or object) place the mouse pointer over the desired point on the terrain window and click the left mouse button once. (If double click is specified then click the left mouse button twice in quick succession without moving the mouse).





FLIGHT SIM TOOLKIT

Terrain Mode
1. Select terrain editor mode
2. Select object editor mode
3. Zoom in
4. Zoom out
5. Refresh map
6. 3D view
7. Not used
8. Not used
9. Raise point
10. Lower point
11. Raise area
12. Lower area
13. Raise line
14. Lower Line
15. Fractalized area
16. Not used

Object Mode
17. Select object
18. Add default object
19. Link Hangar/Depot to path
20. Break link
21. Select path
22. Add path
23. Add point to path
24. Paste object

Selecting an area by dragging

If you want to select a rectangular area on which to perform an operation on by dragging, first place the pointer over the bottom left comer of the required area in the terrain window. Now press the left mouse button and move the mouse, with the button held down, to the top right of the area. Finally, release the mouse button. While the dragging operation is being performed a rubber band box will be drawn over the terrain window showing the scope of the drag.

World Editor Mode

As outlined earlier, the World Editor has two separate modes: Object Mode and Terrain Mode. Only one mode can be in use at any given time and they are selected by clicking on one of the top two buttons on the tool bar. The top left button is the Terrain Mode button and, when depressed, the World Editor operates in Terrain mode. Consequently, the effect of the mouse in the main window is to modify the terrain. The lower toolbox shows the range of terrain operations available. The top right button is the Object Mode button and, when depressed, the World Editor operates in Object Mode. Now the lower toolbox changes to show Object Tools, The mouse action in the main window consequently selects, modifies and creates simulation objects (and their associated paths).

Simulation Objects

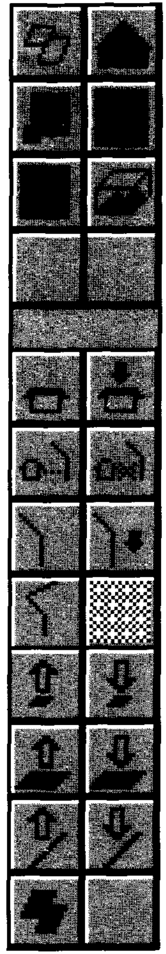
What are the functions of the objects in the world?

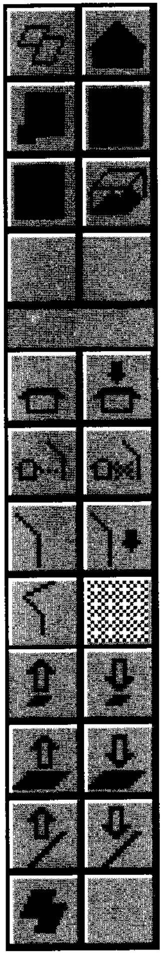
Objects are placed in the World by the Object Tools and perform two functions in the FST Virtual World:

- they provide detailed cultural features for the landscape (e.g. houses)
-they are the dynamic simulation elements in the World (e.g. Navigation beacons).

How do I place objects in the World?

To place an object in the World, select a class and shape from the Object menu (the defaults are Cultural and Box.fsd). Then position the object in the World by placing the mouse on the desired point in the World and clicking. To change the shape from the default, access the object's properties by double clicking on the object or selecting properties from the Object menu. If you use the zoom function, a plan view of the object's shape will then be drawn over the terrain. There is one restriction on where objects may be placed in that the object shape must not cross a terrain square boundary. This limits the size of objects to a maximum of 500M.





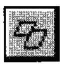
How do I orientate objects?

The FST Shape Editor always creates objects in a 3D grid with X,Y,Z co-ordinates. So when an object is placed in the World its +Z axis points North. Objects can be rotated between 0 and 360 degrees, the direction of rotation is clockwise.

What is the definition of a path?

A Path is an ordered set of 3D positions in the World. Paths are used by objects which move on a predefined track in the World (e.g. trucks which are generated by depots.) Paths are entered and edited independently of objects and then linked using a Path Object link tool. Specifically a path is a list (there is no length limit) of co-ordinates, the X and Z (Latitude and Longitude) co-ordinates are supplied by clicking on the map: the Y co-ordinate is the height of the point and is the height of the terrain by default but can be changed.

TOOL BUTTONS

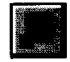


Terrain Mode

Selecting this icon changes the FST World Editor into terrain editing mode, the icon will remain highlighted when selected. Selecting terrain mode will change the second group of icons to the terrain editing icons and automatically select Raise Point as the active tool.

Object Mode

Selecting this icon changes the FST World Editor into object placing and editing mode, the icon will remain highlighted when selected. Selecting object mode will change the second group of icons to the object editing icons and automatically set Select Object as the active tool.



Zoom In

Selecting this icon will make Zoom In the active tool. Zooming in is achieved either by selecting an area of the terrain to zoom in to by performing a drag operation over the window [see section on Dragging] or clicking on a single grid square to zoom in to it (i.e. make the single grid square fill the window). Once the zoom operation has been completed the active tool will then return to its previous state.

Zoom Out

Clicking on the Zoom Out icon will reverse the action of the last Zoom In operation. Zoom Out remembers 5 Zoom In operations.

Redraw

Redraws the terrain window

3D View

This button reproduces a 3 dimensional view of the terrain currently appearing in the main window as a separate window. The 3D view can be rotated by clicking the mouse in the 3D view window. This operation requires a lot of processor power and so will be slow on slower machines. The time taken to render the view is a function of the area selected to view viewing the entire 50 Km x 50 Km terrain tile can take a long time so zoom the main window into a smaller area of interest (e.g. I 0km square) before clicking on this button.

Terrain Tools

Fundamentally, the terrain editing tools all perform the same function: they change the height of individual (or groups of) terrain data points.

Raise Point

When this tool is selected, clicking on the terrain window will raise an area around the pointer position by a specified amount. The amount by which the area will be raised and the radius of the operation are set in the Terrain menu dialog box under Tool Action.

Depress Point

Works in the same manner as Raise Point (above) but lowers the height.

Raise Area

When this tool is selected a rectangular area of the terrain will be raised by a specified amount (selected by performing a drag operation over the required area in the terrain window). The amount by which the terrain is raised is determned by the entry in the Terrain menu Change Height dialog box.

Depress Area

Works in the same manner as Raise Area (above) but lowers the area.

Raise Line

This item works the same way as Raise Area (above) but raises the ground along a line selected by a mouse drag operation on the terrain window. (Use the Tool Height and Tool Radius boxes to determine the amount by which you raise the terrain and to define the distance from the line defined).

Depress Line

Works in exactly the same manner as Raise Line (above) but depresses the ground along a line selected by a mouse drag operation.

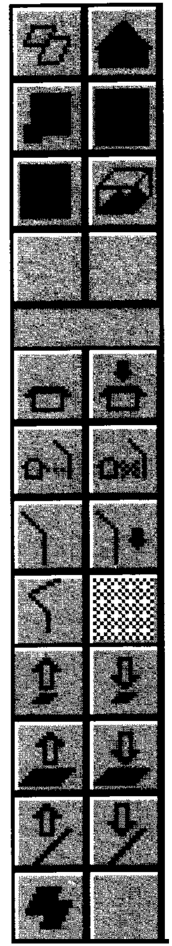
Fractalize Area

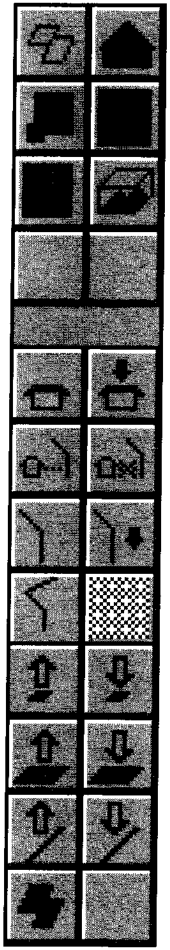
When this tool is selected a fractal operation will be performed on the area of terrain which is selected using the drag operation. The fractal operation will automatically generate a rugged landscape. Each fractal iteration selects a random fault line across the selected area and raises/lowers the land either side of the fault line. The number of iterations of the fractal algorithm run each time an area is selected is determined by the value in the Terrain Menu Fractal Iterations dialog box.

Object Tools

Select Object

When this tool is selected a single click on the terrain window will select the object closest to the pointer position. A selected object will be highlighted and drawn in full





detail. A double click on the terrain window will select the closest object and open its properties window for editing (see Properties section).

Add **Object**

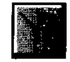
When this tool is selected a single click on the terrain window will place a new object in the World at the pointer position, (Select Object will then **automatically** become the active tool). The object will be created according to the defaults set in the Object menu properties dialog box.

Link

This tool allows Objects to be linked to a path. The tool is only available when an object of the appropriate class (i.e. one to which paths can be linked [Depot, Hangar]) has been selected. The buttons are blanked out when no appropriate object is selected. When the tool is selected a line will be drawn from the selected object to the mouse (when in the main window). You should now select a path to link to the object by clicking on (or near to) the start of the path: when this is done the editor returns to select object mode and the main window is updated showing a dashed line linking the object and path. An object can link to more than one path.

Break link

This tool allows you to break a link forged with the Link Path tool. Like Link Path the button is only shown when a Depot or Hangar is selected. To break a link select the tool then click on the path whose link you wish to break.



Select Path

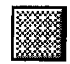
When this tool is selected clicking on the terrain window will select the path closest to the mouse pointer. This path can then be edited. The closest point in the path will also be highlighted, this can be moved using a mouse drag action on the main window or it can be edited using the Path menu items (set point height, delete point).

Add Path

Selecting Add Path primes the editor for entry of a new path. Clicking on the main window with the left button will add points for the new path: using the right button will enter the last point in the path -the editor will then return to the Select Path tool.

Insert Point

When a path is selected the Insert Point tool allows you to enter new points anywhere in the path. A new point is created by clicking on the main window and the new point is inserted into the path after the currently selected point.



Paste Object

This button is shown when there is an object on the Internal clipboard which can be pasted into the world. Paste mode can be selected from the edit menu or directly by clicking on this button. When in paste mode click on the main world window to select where the new object is to be placed (in the same manner as creating a new object).

MENU OPERATIONS

File

Save

Saves the WORLD.FST tile and associated terrain files.

About

This item displays information about the FST World Editor.

Exit

This item quits the FST World Editor.

Edit

The Edit menu items provide cut, copy and paste functions which operate on selected objects. When an object is cut or copied, its image is placed on the internal clipboard where it is stored ready to be pasted.

Cut

This item deletes the selected object and copies it into the World internal clipboard.

Copy

This item makes a copy of the selected object and places it into the World internal clipboard.

Paste

This item is active when there is a copy of an object on the World internal clipboard. Selecting Paste moves the editor into Paste mode. The cursor changes to a crosshair when in the edit window and when you click on the edit grid, a copy of the clipboard contents is made and placed in the World at that point.

Grid

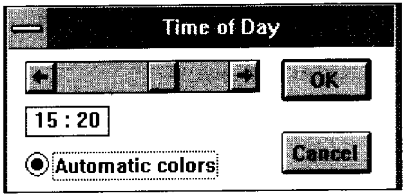
Grid size

The grid size is used to display the position of the mouse in the terrain it is active in all modes but only makes sense in the object and path editing modes. In these modes selecting a coarse grid (i.e. 250M) allows objects and paths to be placed on a regular grid and lined up neatly. The grid affects the placing of new objects (paths) and moving of existing objects (paths). To change the grid select this menu item which opens the grid size dialog box, which contains a drop down box listing a range of grid sizes (the current one being selected). Either select one of these with the mouse or enter a new size (from I M to I 000M) in the Grid size box directly from the keyboard.

World

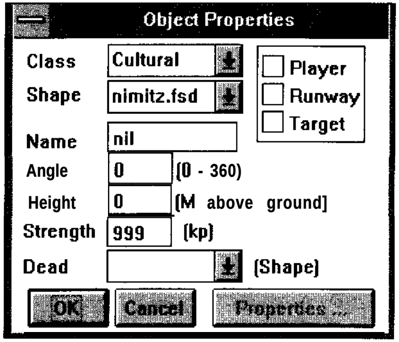
Time of day

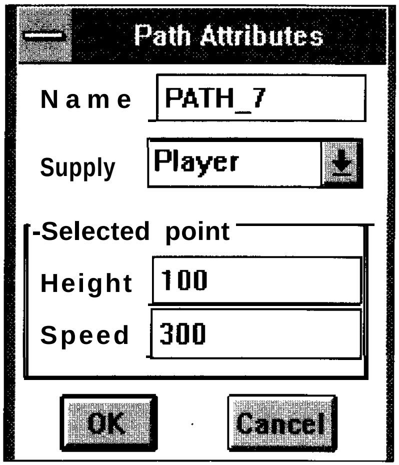
The time of day controls where the sun or moon is positioned in the flight simulation. If the automatic colors button is selected the color palette defined by the Color tool will be interpreted as Midday colors and modified as a function of time of day automatically by the flight simulation. (You can of course define your own twilight colors in the Color Editor and not select this button).



Wind

Wind speed and direction affect the flight characteristics of the plane you fly in the flight simulation.





Terrain

Tool Action

Tool Height - When Add Height is selected the value in the dialog box determines the amount by which points/areas are raised or depressed by one mouse click. Add Height is the default. When Set Height is selected a single click will set the approprtate terrain points (depending on the active tool) to the absolute height in the dialog box. (This makes the Raise and Depress tools behave identically).

Tool Radius - Set radius for Raise/Depress Point or Raise/Depress Line in grid squares from mouse click (or line).

Fractal Iterations

Number of iterations the fractal algorithm will carry out per click.

Object

Object Properties

Selecting this menu item opens the object properties dialog box for the currently selected object. This is also achieved by double clicking on an object in the object window (when in select object mode). Details of the object properties dialog box are in the next section.

Default Properties

This item allows you to choose the default Shape and Class for the creation of new objects in the World Editor. The defaults can be subsequently overridden using the object properties dialog box.

Remove Object

This item removes the currently selected object from the World.

Path

Path Attributes

This item opens a dialog box showing the name of the currently selected path, the name of the object which the path supplies and the height and speed demand of the currently selected point in the path (If one is selected). The name of the path is automatically generated when the path is created, it can be changed to any string which does not contain spaces. The Path name is only used for reference. The supply box shows the name of the object which the path supplies - if blank then there is no object selected - only named objects can be selected (see next section for more details of what supply means). The height of the current path point is absolute above sea level and is set to the height of the terrain at that point by default, its value can be changed. The speed demand is used by trucks and aircraft following the path - if set at zero it is ignored and the vehicles continue at their cruising speed.

Delete Point

This item deletes the currently selected point from the path. If it is the only point in a path the path is removed.

Remove Path

This item removes the currently selected path from the World. Any object links to the path are automatically broken.

ADVANCED SIMULATION- How is the role of an object defined?

The role of an object is defined by its Class. Every object in the FST World has a class. The class determines how the object behaves in the World. There are a number of pre-defined object classes available to the FST World Editor. The most basic Class is Cultural which indicates the object has a shape (i.e.: what it looks like) and position, but there is no complex simulation behavior associated with it. More complex classes cover navigation beacons, aircraft and trucks. Once the class of an object is determined its behavior in the simulated World is influenced by the properties assigned to it.

How do I assign classes to objects, and what are they?

Double clicking on a object (when in Select Object mode) opens the basic property dialog box, this is common to all object classes. The basic dialog box contains three elements:

i) Basic property items

Class- a pull down list containing all the available classes for the object. Selecting an item from this list changes the class of the object (deleting any properties previously entered).

Shape – a pull down list containing all the available shapes (as defined by the 3D FST Shape Editor) in this project, Selecting an item from this list changes the shape of the object

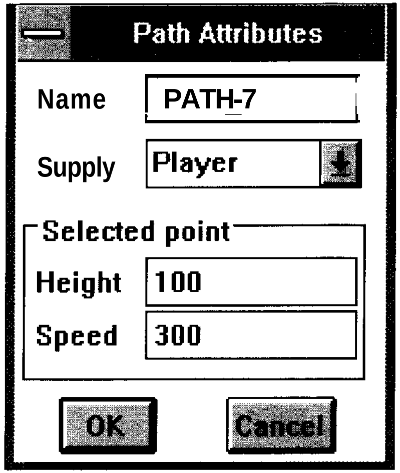
Name the name of the object -this is used in the supply field of paths (more later). It is an eight character (max) string which must not contain spaces. Objects do not need to be named.

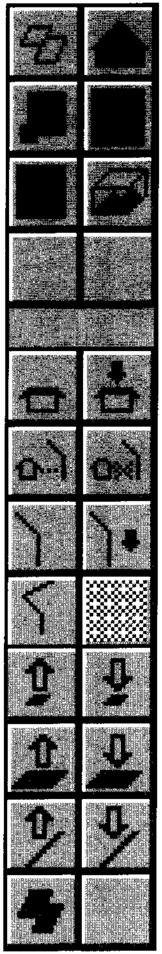
Angle – the rotation (in degrees) about the vertical. (0 = North, 90 = West etc, etc).

Height - relative height of the object above ground.

Strength – determines how an object behaves when hit (by weapons or other objects), the value is in units of Kp. This is the same unit used to determine the power of a weapon (Kp means Kill Probability), the default for a cannon shell is I Kp so an object with the strength of OKp's will survive IO cannon shell Impacts. A very high strength (e.g. 9999) makes an object effectively Indestructible; a strength of zero makes an object transparent to collisions. Thus bullets or aircraft will fly through such an object without realizing it is there.

Dead this is a pull down list of 3D shapes (*.FSD) which provide a selection for the shape of an object when it has been killed (i.e. a burnt out house shape). If the object strength is zero this option cannot be selected. If the object strength is >0 but no shape is selected and then the object is destroyed it is removed from the world.





ii) Flags

Player - selecting this flag designates this object as the player, there can only be one player. (It only makes sense for a player to be MILITARY, CIVIL or BRICK).

Runway The runway flag makes the object easy to land on and take off from. An aircraft can land anywhere, however the ground exerts a large drag on the aircraft and taking off can be impossible (try taxiing a 747 through a field it would sink!). Setting the runway flag reduces the object friction.

Target The Target flag makes the Object detectable by guided weapons.

iii) Properties button

Clicking on this button opens an extended properties dialog box (if appropriate), e.g. a beacons extended properties are its radar frequency.

What are the object classes?

The object classes are as follows:

Cultural

This is the most basic object class, it is defined by a position in the World (X,Y,Z), a rotation about its Y axis, and the shape of the object There are no advanced properties. The Cultural class is used to create objects such as houses, trees and roads in the World. All other classes have the same basic properties as the Cultural class plus their own class specific properties.

Navigation beacons:

NDB

An NDB is a Non Directional Beacon, it is used for basic navigation. The extended class properties for an NDB define that particular beacons frequency.

VOR

A VOR is a Very high frequency Omnidirectional Range beacon, it transmits an omnidirectional identification signal followed by a sweeping directional signal. The navigation instruments (OBI) in the cockpit use this information to determine what VOR radial you are flying on (see Navigation course for more information). The extended class properties for a VOR define that particular beacon's frequency.

ILS

ILS stands for Instrument Landing System - it is also a radio beacon (see page 59.) It should be oriented down its associated runway (using the rotation parameter) and placed at the end of the runway. It logically links with the ILS display in the Cockpit Editor.

Classes of aircraft which you can fly in FST

BRICK

The BRICK class provides the most convenient way of exploring the World. A brick is an indestructible aircraft which does not obey the laws of physics (unlike all other objects in FST), the brick cannot be crashed and has no maximum or minimum speed: it is designed for exploring your World. The extended brick properties will allow a cockpit to be defined.

CIVIL

This class defines a civil (non-military) plane for the player to fly. The extended properties box allows the flight model, the cockpit and an optional gear down shape to be set. To fly the aircraft so defined the object properties must have the player flag set.

MILITARY

This class defines a military fighter aircraft for the player to fly. The extended properties are as for CIVIL defining aircraft model, cockpit and gear down shape: but in addition a high speed shape is available (which will be used when the aircraft reaches its max speed) and also the ordnance which the aircraft carries can be defined.

Cannon

Rocket

Air-Air

Air-Ground

Iron Bomb

Cluster Bomb

The initial number of kill Probability Points for each weapon can be entered in the appropriate boxes.

Fixed Defenses:

AA Gun -Anti Aircraft Gun

Fires AA shells at the player aircraft when it flies within range.

Its performance is determined by the following criteria:

Burst Rate number of shells per second fired (1 - 100)

Burst Time number of seconds of continuous firing possible (before gun overheats or requires reloading)

Reload Time quiescent time during reloading (In seconds).

Each cannon shell has a KP of I.

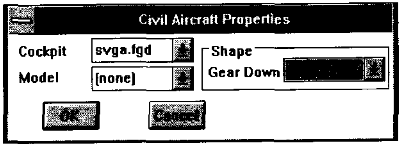
SAM - Surface to air missile

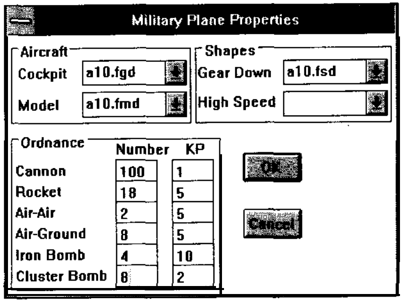
This weapon fires heat seeking missiles at the player aircraft when it flies within range. Missile performance is determined by the following criteria:

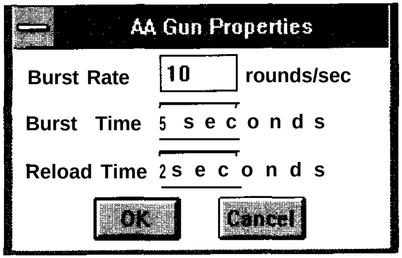
Range - number of Km at which SAM site can detect and fire at aircraft

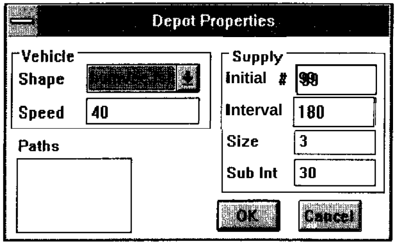
Detect Floor the lowest level at which the SAM radar can detect an incoming aircraft (in M)

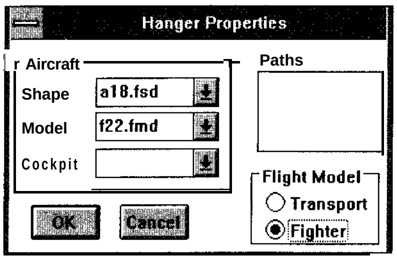
Missile KP the Killing Potential of the missiles launched by the SAM site (default 5).











Simulation

DEPOT

A DEPOT is a source of moving vehicles in the World. The extended depot properties define the shape and type of vehicle which the depot produces/generates. (See below for how to set the frequency and timing of vehicles and how to set up links to the paths the vehicles follow). Use of depots linked by paths can produce complex and non-deterministic behavior providing challenging gameplay.

Vehicle shape - sets the 3D shape of the vehicles produced by the depot.

Vehicle speed sets the maximum speed the vehicle will travel at (Km/hr).

Paths shows the list of path names linked to the depot object (using the Link path tool). This box is for reference only.

Initial #-the number of vehicles in the depot at the start of play (can be anywhere from 0 9999).

Interval -the number of seconds between groups of vehicles being sent from the depot.

Size the size of groups sent from the depot.

Sub interval -the time between vehicles in a group.

Depots do not create vehicles continuously. They are only created in two instances:

i) When the player aircraft is within 50Km of the depot

and

ii) When an object linked to the depot (via one of rts paths) needs re-supply that is either when it has been hit, or If it is a depot or hangar, running low of vehicles.

HANGAR

A Hangar generates all the aircraft (other than the one you fly) in the flight simulation. The aircraft dispatched follow the paths linked to the hangar. Their behavior when the player is in range (< 50Km) is determined by the flight model buttons - transport aircraft continue on the path until they reach the end; fighter aircraft will break off the path and intercept the player engaging him in a dogfight. The shape and flight characteristics of the aircraft generated by the hangar are set in the Hangar properties box:

Shape shape of the aircraft generated by the hangar.

Model – aerodynamic model which the aircraft despatched emulate.

Transport - the aircraft generated behave as a transport aircraft.

Fighter - the aircraft generated behave as fighters.

Paths - list of paths linked to the depot (for reference only).

DEPOTS, HANGARS and PATHS

The previous sections have outlined how to create a depot/hangar object, how to create a path and how to link them together. This section describes the effect of these operations in the actual flight simulation.

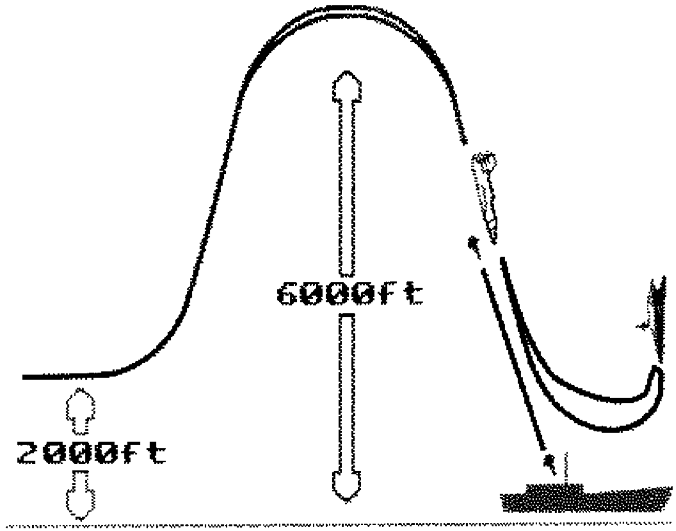
Depots and Hangars need paths to send their vehicles out on. The paths have twc purposes:

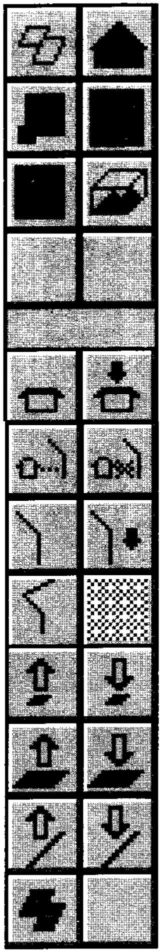
(i) to provide directions

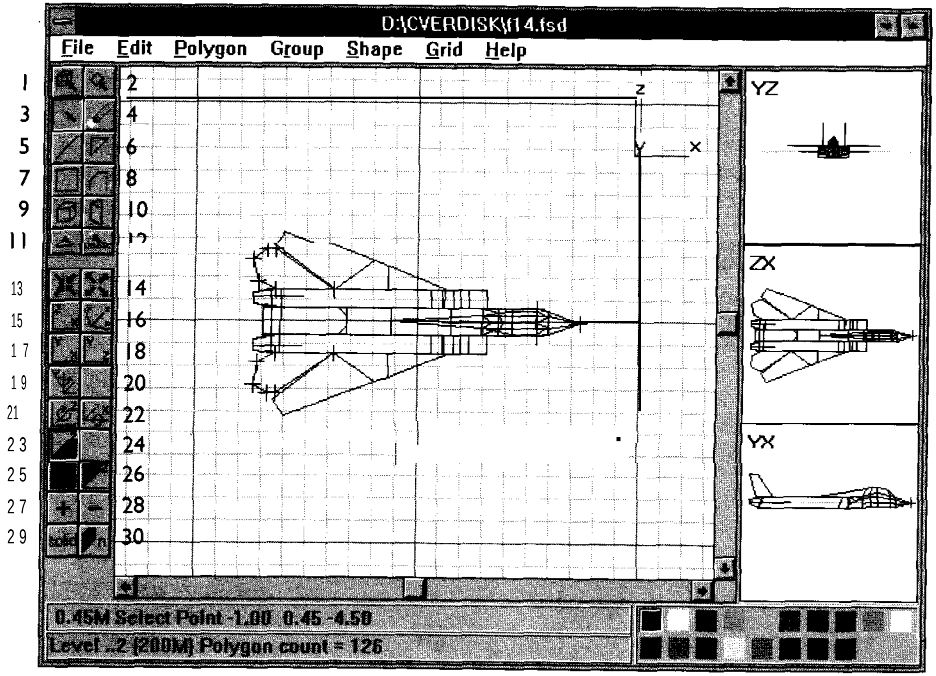
(ii) to provide logical links between depots (hangars) and other simulation objects.

The path attributes supply field allows a single named object to be logically associated with a path for supply. When a vehicle reaches the end of its path, it disappears from the world. If a supply object is associated with the path it is then supplied. 'Supply' means something different for each class of object. For example, in the case of an AA Gun 'supply' means it gets rebuilt once destroyed. In the case of a hangar, it means that the number of aircraft housed by the hangar increases by one aircraft

The supply object can be the same as the object linked to the start of the path – so forming a closed loop. Consider a situation where a hangar is linked to a path which maneuvers the aircraft down a runway, up in a circuit around the sky and back onto the runway. If the path's supply field path is the name of the hangar object, then the hangar will keep producing the same plane which will fly a circuit and logically return to the hangar, FST allows complex networks of supply to be set up between depots, hangars and fixed defences to create demanding strategic combat games.







FLIGHT SIM TOOLKIT

KEY:

1 Select Group
2. Select Polygon
3. Select point
4. Undo
5. Enter Line
6. Enter Triangle
7. Enter Square
8. Enter Polygon
9. Enter Cuboid
10 Enter Penta
11 Enter Tetra
12. Paste Group
13. Zoom In
14. Zoom Out
15. Top view
16. 3D view
17. Front view
18. Side view
19. Rotate around Y axis
20. Not used
21. Rotate around Z axis
22. Rotate around X axis
23. Edit plane ZX
24. Not Used
25. Edit plane YX
26. Edit plane YZ
27. Moves grid up
28. Moves grid down
29. Opens Solid view window
30. Enter grid offset

3.2.4 3D Shape Editor

Executive Overview

An FST 3D Shape is a description of what an object looks like in the Virtual World of the flight simulation. The FST Shape Editor is a tool for creating and modifying FST 3D shapes; it is similar in operation to most 3D CAD packages. Please note that the FST Shape Editor always operates in the 3D co-ordinate system,

BASICS

Co-ordinate Systems

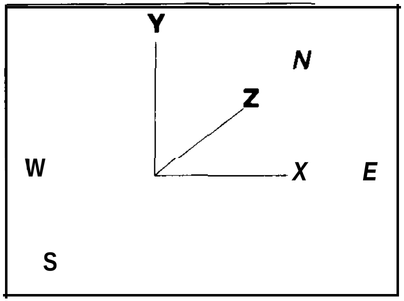
A basic understanding of the 3D co-ordinate system used in FST is essential. All the points in FST shapes are defined using an isometric projection (i.e: a scaled rendering of a 3D object in 2D) as outlined in the diagram below:

The orientation of the co-ordinate system in the World is shown above, the Z axis runs South-North and the X axis runs East-West. Up is positive Y and down is negative Y. The origin is normally at the center of the 3D shape (although as we shall see later that is up to you),

The smallest unit in the FST Virtual World is l/2 mm 3D shapes are limited to a maximum of +/- 500M.

Shape Structure

At its most basic level a shape is described in terms of flat surfaces called polygons. A polygon consists of a number of points (3D co-ordinates) at its corners (or vertices) and a base color. In the FST Virtual World a lighting model is applied to all objects, the



base colors are modified by the amount of light falling on the polygon (from the sun).

The FST Shape Editor can be used to edit 3D objects at this level, by entering individual polygons as a set of 3D co-ordinates and adjusting the co-ordinates individually. However for a complex shape this is a very time consuming task so the FST Shape Editor can operate on a higher level structure called a Group.

A Group is a collection of polygons grouped together for editing purposes. So for example one could group together 6 polygons to create a cube, this cube would then be considered as a single object for editing purposes. Groups are used for the convenience of editing only, when the 3D shape is read into the FST Virtual World the group structure is discarded and the shape is drawn as a collection of polygons.

What is a polygon?

A shape is a 3-dimensional structure composed of flat colored surfaces called polygons. A polygon has a number of points and each point is at a corner or vertex. For example a box has 8 points and 6 polygons. Each polygon in the box has 4 vertices.

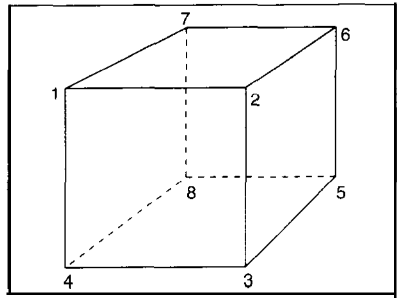
How do I construct a polygon?

A polygon must be flat or it will seem distorted when you view it from some directions. This means that all the points in a polygon must lie in the same plane. For complex shapes you should remember that a triangle is always flat, so it is often easier to use polygons with 3 points.

A polygon has 2 sides, when part of a shape it has an inside and an outside. Usually you only want to see the outside of shapes so you have to define which side of each polygon is the outside. You do this when you create a polygon by joining up points. The front of the polygon is the side created by joining the points in a clockwise direction. If you get this wrong the FST Shape Editor allows you to flip the orientation of any polygon. A polygon will only be drawn in the simulation if its points are linked in a clockwise direction.

For example in the above diagram is a cube which consists of 8 points and 6 polygons. The shaded polygon is created by using Polygon enter on points I, 7, 6, & 2 in that order (clockwise) so that the new polygon can be seen when viewing the cube from the outside. In this example the shaded polygon is in the top level of the Y axis. During the editing of a shape you can examine the points in all axis by using wireframe.

It is advisable to check the appearance of a shape by viewing it regularly. Do this by using the 'View' menu option in the FST



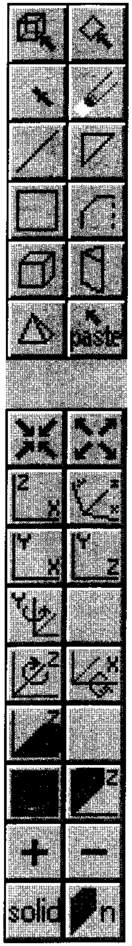
Shape Editor to see the shape as it will actually appear in the simulation. Rotate it to check its viability from all angles. Any polygons defined inside out will be obvious simply flip them over to turn them round.

If you want to be able to see both sides of a surface in your Virtual World you have to define a polygon for each side. A straight line is defined by a polygon comprising of two points. (Actually the FST Shape Editor provides a function that creates cubes automatically and solid objects- but the paragraphs above illustrate the basic principles of shape creation).

How do I construct solid shapes?

As indicated above, all solid shapes are comprised of polygons. But it's worth remembering that the Shape Editor gives you access to two shortcuts for producing regular solids:

1 Refer to the three solid entry buttons in the Toolbox (Cuboid 6-sided solid), Penta (5-sided solid) and Tetra (4 sided solid). These tools work by you placing the points for the base of the solid on the



editing grid and the editor automatically extruding the base polygon into a solid shape (the onentation of all the polygons is automatically taken into account by the editor). You can then transfer and group these basic solids together to form complex shapes.

2. A genera form of extrusion is available under the advanced menu functions which allows you to select any polygon in your shape and extrude it isometrically (or to a point) You can also control the degree of extrusion. The creation of a complex shape such as an aircraft body becomes just a matter of entering a 6-sided polygon for the cross section of the fuselage and then extruding it by the length of the aircraft!

How does polygon construction affect the speed at which the simulation runs?

Frame speed is Important in a flight simulator. Speed IS measured by the number of screen updates per second. Anything less than about 10 will make the simulation appear jerky and controlling the aircraft more difficult. Your simulation will run faster when it is drawing as few polygons as possible. To help keep the frame rate up shapes in the distance should be drawn with fewer polygons than when they are close. An example of this IS an aircraft shape. When close it may have more than 100 polygons, when in the middle distance it may have fewer than 50, and in the far distance 5 lines IS usually enough.

How do I create roads and rivers ?

When you create roads and rivers, use lines only until you get quite close. You will usually be flying fairly low and so remember a line in the middle distance looks better than a polygon seen edge-on. Further clarification can be obtained by referring to rivers and roads depicted in one of the examples provided.

Shape Detail

In the FST Virtual World 3D shapes will be seen from a range of distances. When the 3D shape is close to the viewer a more detailed 3D shape is shown and conversely at a distance a simple lower level model is portrayed. The shape structure supports the definition of shapes at different levels of detail for ranges of viewing distance. The FST Shape Editor allows you to create and edit 3D shapes at a range of levels of detail. A typical shape will have 3 levels of detail. It IS easier to create the most complex level (the bottom level) first and then to create a new level using the New Child menu option. Copy the complex shape level to the new level (using Copy & Paste menu options) and remove the high detail (i.e. the smallest polygons) from it. Repeat this operation until the number of levels required have been created. But note that it is Important to have the center of each shape level in the same place. Otherwise, when the shape IS reproduced in the simulator, it will appear to jump as one level replaces another as you approach the shape.

Shapes of different sizes

The FST Shape Editor enables you to edit shapes of very different sizes. When you first open a FST Shape Editor window it shows a default view of 20 Meters across. The largest shape you can create is I Km. For smaller shapes, Zoom In until your shape fills the window. If you're in any doubt and want to check how large a shape is, refer to the grid lines.

Editing Window

The editing window shows a 3D representation of the shape, it also shows the editing grid in 3D. All editing is done in this window.

2D Views

The 2D view windows show the shape in profile view (from the side), plan view (from the top) and elevation view (from the back), The position of the editing grid is also shown in these windows.

ToolBox

The ToolBox is used to select the current editing tool, The current tool button is shown as depressed.

View Tools

The view tool controls the way the shape and editing grid are shown in the editing window.

Status Line (bottom left)

This shows the current editing grid offset from the origin, the position of the mouse in 3D (if it is in the editing window) and the function of the current tool/button.

Color Selector (bottom right)

Shows and allows selection of the available base shape colors.

THE SHAPE WINDOW

The Shape Grid

All editing operations in the 3D shape tool operate with reference to the editing grid. The grid is always locked to one of the 3 cardinal axis, it is shown in the edit window as a gray grid in the 3D editing space. The grid can be locked to each of the 3 axis using the buttons at the bottom of the view tools box. The grid can a!so be moved up and down the axis using the +/- buttons.

The grid is used for 3 primary purposes:

I -to enter 3D co-ordinates

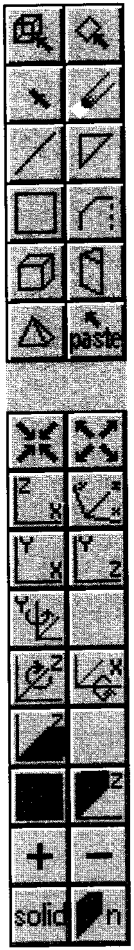
2 as a reference plane when moving groups

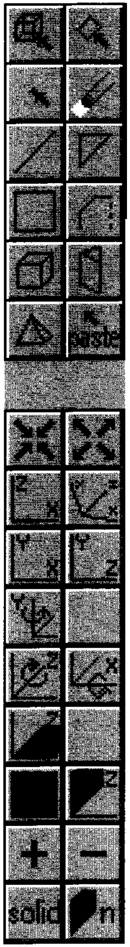
3 the size of the grid is used to deter-nine the size of solids when created.

The grid is initially set to one meter but it can be changed (using the grid menu Items) to anywhere from I cm to I OM.

Entering Co-ordinates:

Co-ordinates are used to specify the vertices (in 3D) of polygons when creating polygons and solids, and also to specify the destination of a paste operation. The co-ordinate is specified by clicking on the grid in the edit window with the mouse; the position of the mouse pointer on the gridsupplies two of the 3D co-ordinates and the position of the grid itself supplies the remaining co-ordinate.





Moving Groups/Polygons/Points:

Groups/Polygons/Points can be moved in the current edit plane (i.e. two of the three dimensions), moving is accomplished by dragging the object to its new position (select the object tab, hold the mouse button down and move the mouse).

Automatic Movement of the Edit Grid:

The edit gnd is automatically moved to a selected point or polygon when that selection is made.

TOOLBOX

The toolbox contains twelve tools Only one tool is active at any one time. The active tool is Indicated by its button icon being depressed.

Selection Functions:

All these selection functions operate on existing shape structures:

Select Group

This is the default editing tool, it is used to select a group for further editing. To select a group when in this mode click on the center of the group in the editing window with the left mouse button. The selected group will be displayed in red, a small rectangular tab will also be displayed at the center of the group, this is used for moving the group. When you have selected a group you can perform the functions under the main menu Group item on the selected group or move the group by dragging (see more later).

Multiple group selection is made by holding the shift key down, at the same time as making the group selection. A multiple group selection can be amalgamated to make one group (for moving, transforming or copying) using the Group>Group menu item.

Select New Polygon

Click on the polygon you want so select in the edit window with the left button. When you have selected a polygon you can perform the functions under the main menu Polygon item on the selected polygon or move the polygon by dragging.

Select Point

Click on the point you want to select in the edit window with the left button. When you have selected a point the only function you can perform is to move it by dragging.

Undo

This item undoes the last operation.

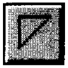
Creation functions:

These all create new groups in the shape, the cursor will change to crosshairs when in the edit window to show you that you are in a creation mode.

The following four functions create a group containing a single sided polygon:

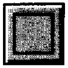
Enter Line

Click on the start and end points of the line. You will be returned to select group.



Enter Triangle

Click on the first second and last points to define the triangle, this will create a single sided polygon. You will be returned to select group.



Enter Square

Click on four points in the edit window grid to define the polygon with the left button. You will be returned to select group.

Enter Polygon

A general polygon may have 2,3,4,5,6,7 or 8 points. To create it click on the edit window grid to enter the initial points with the left button and with the right button to enter the last point. You will be returned to select group.

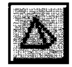
The following three functions create a group containing a number of polygons.

Enter Cuboid

A cuboid is a SIX sided 3D solid, it is defined by entering the base polygon containing four points in the same manner as entering a square, the base polygon is then automatically extruded, by the size of the grid, to meet an identical top polygon creating a 3D cuboid, you can then use the group menu tool to change its shape.

Enter Penta

A penta or wedge is a five sided 3D solid, it is defined by entering the base polygon containing four points in the same manner as entering a square, the base polygon is then automatically extruded to a ridge by the size of the grid to create a 3D solid, you can then use the group menu tool to change its shape.



Enter Tetra

A tetra or pyramid is a five sided 3D solid, it is defined by entering the base polygon containing four points in the same manner as entering a square, the base polygon is then automatically extruded to a point by the size of the grid to create a 3D solid, you can then use the group menu tool to change its shape.

Paste Group

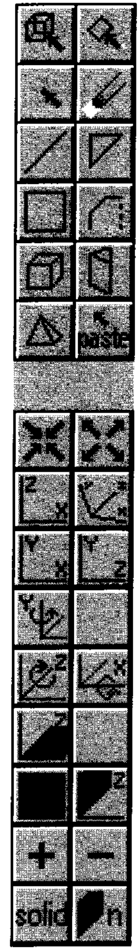
This function is used in conjunction with the main menu Edit items (Cut, Copy) and is described in detail in a later section.

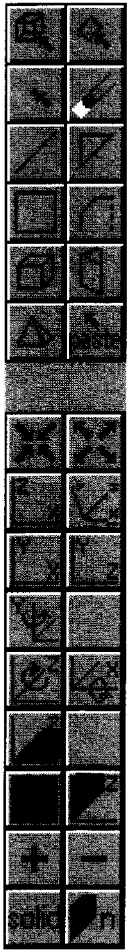
VIEW BUTTONS

There are I6 view control buttons. Clicking on a view button with the left mouse button will control the way the shape and edit grid are displayed in the main window. Holding shift down whilst clicking on the view buttons may modify the effect of the button known as shifting the control.

Zoom In

Zoom In magnifies the edit window by a factor of two, the zoom is centered about the origin. The zoom function can be modified by holding down the shift key at the same time as clicking on the zoom icon this will result in the zoom being centered about the currently selected group.





Zoom Out

Zoom Out shrinks the edit window by a factor of two, the zoom is centered about the origin As with Zoom In the shift key modifies the action. Use the shift button and double click on the control button to keep the selected group, or polygon, or point centered.

Elevation ZX Top view

This tool selects the plan or top view in the edit window so the grid is automatically moved to the ZX plane.

Elevation XY Front view

This tool selects the front view in the edit wlndow so the grid is automatically moved to the XY plane.

Elevation ZY Side view

This tool selects the side view in the edit window so the grid is automatically moved to the ZY plane.

XYZ 3D view

This tool selects a 3D view in the edit window so the grid is not moved.

The **next three buttons** - rotate the view in the edit window about the X,Y and Z axis, clicking on the appropriate button rotates the view about the shape axis by + IO degrees, modifying the button click by holding down the shift key reverses the direction of rotation. The edit wlndow view can also be rotated by clicking in the edit window itself with the right button, clicking towards the right side of the window pushes the shape in that direction, ditto with the left, top and bottom of the wlndow – this provides an intuitive method of rotating the shape.

The next three buttons select the edit plan for the ZX, YX and YZ axes respectively.

The final 3 buttons select the orientation of the grid, the current orientation is shown by the appropriate button being depressed.

The +I- buttons

These move the grid incrementally up and down the axis to which it is locked.

The n button

This opens a Set Grid Offset dialog box which allows the user to enter a value in Meters to move the grid to the level specified. When clicking, use Shift to set the default value shown in the dialog box at 0.

The solid button

This opens a 3D solid view window, if the solid viewer window is already open, clicking on this button refreshes the solid window.

Color window

The shape color window shows the available base colors for shapes. It is used for coloring shapes and showing the color of existing polygons. You can create both polygons and solids by using the color on the far left of the colors wlndow by default There are two ways of coloring parts of a shape:

1. In Select Group mode, select the group you wish to color and then select the required color patch in the color window. This will then color every polygon in the group the same color.

2. In Select Polygon mode, select a polygon and click on a color patch. This will have the effect of coloring that individual polygon. Remember that its often most efficient to color the whole shape in its predominant color first by making it a single group and then selectively coloring individual sub- groups and polygons in their colors

ADVANCED MENU OPERATIONS

File

The File menu items provide access to shape file save/load functions.

New

This item creates a new shape with no points or polygons, any existing shape in the editor is automatically deleted.

Open

This item opens a file interface dialog box, an existing shape name can be typed into the filename subwindow or directly selected from the scrollable file list window. Clicking on OK loads the shape into the FST Shape Editor.

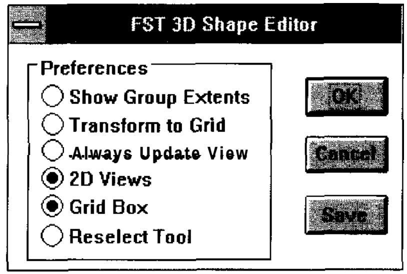
Save

This item saves the shape; if the shape has no name then the user will be prompted for one with the Save As dialog box.

Save As

This item opens the Save As dialog box, which asks you for a filename to save the shape to, you can select an existing name from the file listing box and edit the name in the filename subwindow or directly type a new name into the filename subwindow. If a file with the name you have selected already exists you are asked is you wish to overwrite the existing file.

Preferences Dialog Box



- **Show group extents**

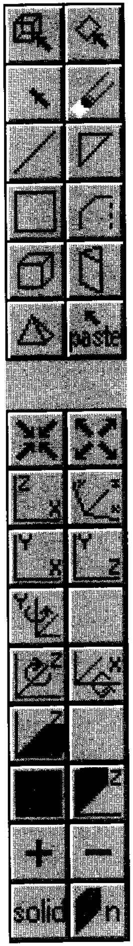
When this item is selected, a 3D box is drawn defining the maximum extent of the selected group. This is useful when editing a complex shape when the group structure may be unfamiliar. It can also be used to drag a group on a fine grid when it is difficult to see exactly where the group is.

- **Transform to grid**

This item option selects the default behavior for the 'group transform functions (i.e: rotate and scale). You can set default behavior in transform functions to ensure that all the points end up on the current grid. (This can be overridden in the transform function dialog boxes).

- **Always update view**

When this item is selected and the solid 3D view is open, every change to the shape is reflected in the 3D view. This can be very useful but on slower machines, or machines with a high resolution display **(640 x 480),** this process can be cumbersome. In these cases, clicking on the Solid button is more satisfactory



- **2D views**

This item determines whether the three 2D view windows are shown. Not revealing them obviously saves on screen space but they provide useful orientation information.

- **Grid box**

This item determines whether the 3D editing grid box is displayed.

- **Reselect tool**

This item controls the selection of the editing tool after entering a line, polygon or solid. By default SELECT GROUP becomes the active tool when the last point of a new line or polygon has been entered. When Reselect Tool is set, the existing tool is reselected and further clicking on the editing grid will enter more lines or polygons. This can save time when entering lots of lines, polygons or solids in one session.

Dialog Buttons

OK

The OK button accepts any changes made, saves them to the Project and closes the application.

Cancel

The cancel button cancels commands in a dialog box.

Save

The save button saves any changes to the Project to date. It is advisable to Save fairly frequently.

About

This item displays Information about the FST Shape Editor.

Exit

This item quits the FST Shape Editor.

Edit

The Edit menu items provide cut, copy and paste functions which operate on selected groups

cut

This item deletes the selected group and copies it into the Shape Internal clipboard.

Copy

This item makes a copy of the selected group and places it into the Shape internal clipboard.

Paste

This item is active when there is a copy of a group on the Shape internal clipboard. Selecting Paste moves the editor into Paste mode, the cursor changes to a crosshair when in the edit window and when you click on the edit grid a copy of the clipboard group is made and placed on the grid at that point. The FST Shape Editor then reverts to Select Group mode.

Copy To

This item makes a copy of the selected group and opens the Save As dialog box asking you for the name of the group, it is then saved onto disk with that name and can subsequently be retrieved in a later editing session.

Paste From

This item opens a dialog box with the names of all saved groups in a listbox, selecting a group name and clicking OK places the ShapeEditor into Paste mode with the selected group. The group is subsequently available for pasting from the internal Shape clipboard.

Select All

This item selects all the groups in the shape, it is used in conjunction with Group-Group to perform operations on the entire shape.

Polygon

The Polygon menu items are available when in Select Polygon mode and when there is a selected polygon.

Flip

This item turns the selected polygon over.

Double Side

This item makes a copy of the selected polygon facing in the opposite direction. The new polygon is created in the same group as the selected polygon.

Extrude

This option allows you to create a 3D shape from any polygon. An extrusion projects a polygon in space to another Identical polygon (facing in the opposite direction) and links pain of the polygon vertices to form a solid object (e.g. extruding a square creates a cube).

When selected, a dialog box is opened requesting the size and direction of the extrusion. Size specifies the distance from the selected polygon that the new end polygon has created. Direction controls the direction of the extrusion. Clockwise extrusion creates the new end polygon size, in meters from the selected polygon, in the direction of the colored face of the selected polygon. After the extrusion is done, the selected polygon is automatically flipped over to create a solid object. Deselecting the clockwise option extrudes the polygon away from the colored face of the selected polygon. In this case the selected polygon does not have to be flipped to create a solid shape.

Extrude to Point

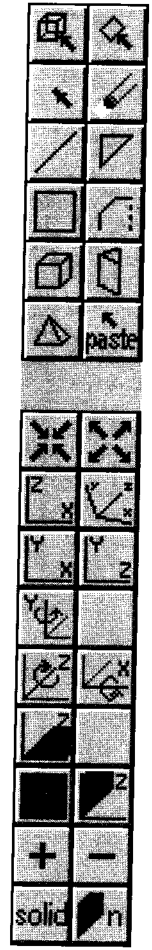
This item works in the same manner as Extrude, however the solid created is a projection of the selected polygon to a point, rather than to another polygon.

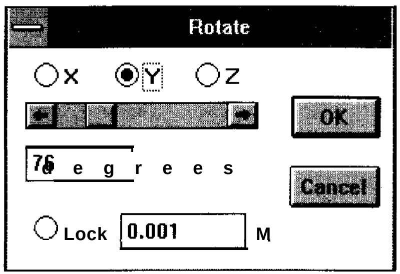
Check Polygons

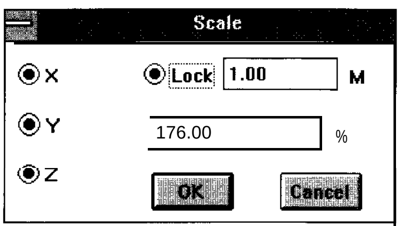
As long as you are in Select Polygon mode, this item scans through the current shape level and checks for 'Illegal' polygons. If any are found, the first is selected and a warning given. You should edit the offending polygon(s), delete the warning message then run the Check Polygons process again as a double-check. Alternatively, use Select Next/Last Polygon buttons (F I, F2) to edit the shapes and prevent any further errors.

Group

The Group menu items provide functions allowing you to create hierarchical group structures and perform transformations on the selected group.







Group

This option is highlighted when more than one group has been selected (see Multiple group selection), selecting group creates a single group which contains all the selected groups in itself This grouping action can be performed on any group (including one which is itself composed of sub-groups).

Ungroup

This item is available when a single group which has sub-groups is selected, selecting Ungroup results in the selected group being separated into its component sub-groups.

Rotate

This item rotates the currently selected group about a single cardinal axis (X,Y,Z). Select the axis by clicking on the appropriate button in the dialog box. The rotation value of the group can be entered directly into the dialog box (0 - 360 degrees) or alternatively set using the slider. The lock button determines whether the rotated points are moved onto a grid or not (the default state of this button is set in the box). When 'Lock' is selected, all the points which have been rotated will be set on a fixed grid. By default this is the same size as the current editing grid - but it can be changed to any value (by editing the value in the lock value box). Caution: rotating a group onto a coarse grid will result in the distortion of the group!

Mirror

This item transforms all the points in the selected group, you must select the axis for the transformation, all the points in the group are then mirrored along that axis through the center of the group.

Scale

This item scales the selected group by a percentage. Selecting 200 scale doubles the size of the selected group, the center of the group remains in the same place in the shape. You can scale the group about selected axis by setting up the axis you want in the scale dialog box, initially all axis are selected. Selecting LOCK TO GRID automatically locks every point in the group to a grid after it is scaled, initially on selecting lock in the dialog box the current grid size is shown next to the lock button, this can be edited.

Break Points

This item ensures that there are no shared points at spatially co-incident polygon vertices. When creating a group (either using the Group-Group menu option or when creating a solid) any points at the vertices of polygons which are in the same position in 3D space are automatically shared, so if you select a point at a joint polygon vertex and move it all the polygons with a point at that location will be changed, selecting Break Points will result in one point per polygon vertex, so you can change the positions of polygon vertices (points) individually.

Merge Points

This item is the inverse of Break Points.

Lock to grid

This item moves all the points in the selected group so that they are on the current grid in 3D.

Shape

Structure

The structure dialog box shows the number of levels which the shape contains, the transition (or visible) distances between the levels and the number of polygons in each level. The first line shows the top level, which is the level which will be seen from farthest away in the flight simulation. The following lines are more detailed and show as you get progressively nearer (more detailed levels). Selecting a level in the dialog box with the mouse and clicking on the OK button selects that level as the current level being edited.

Visible Distance

This item opens a dialog box containing the viewing distance threshold for this level in the shape. The viewing distance threshold is the distance in meters at which the shape level will be shown in the Virtual World. The viewing distance of the top level shape determines how far the object (with the associated shape) will be from the viewer when it becomes visible, the visible distances for the levels below the top level govern the transition from showing the level above the current level to showing the current level.

Select Parent

This item selects the parent of the current shape level.

Select Child

This item selects the child of the current shape level.

New Child

This item creates a new child for the current shape level, if a child already exists for the current level the new shape level is inserted between the current level and its current child. The new shape level is selected.

Delete level

This item deletes the currently selected level. But this function does not apply when there is only one level in the shape. Beware, this operation cannot be UNDOne.

Grid

This item specifies the size (in square Meters) of the boxes which appear in the grid and gives the following options:

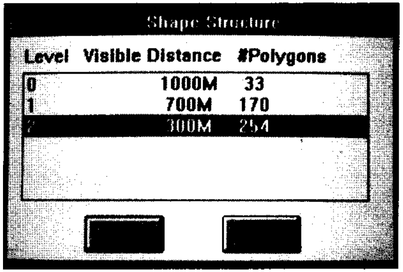
IO Meters

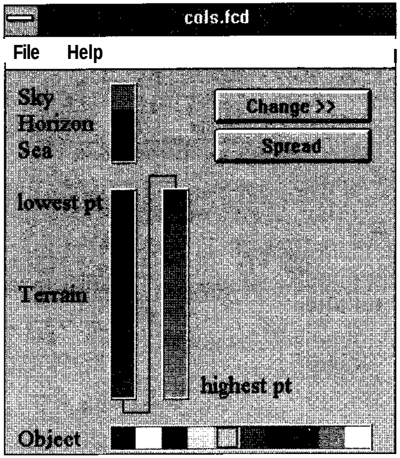
I Meters

0. I Meters

Other

This item opens a dialog box which allows you to enter the size of the new grid in Meters. The maximum size permitted is 99 meters





Help

This item opens the Windows help.

KEY FUNCTIONS

(access via the keyboard only)

CURSOR keys

(up/down/left/right)

The cursor keys rotate the view of the shape.

DELETE key

Will delete the currently selected group or polygon (depending on tool selected).

TAB or F1

Will select next group or polygon in shape (but an existing selection must be made).

F2

Will select last group/polygon in shape.

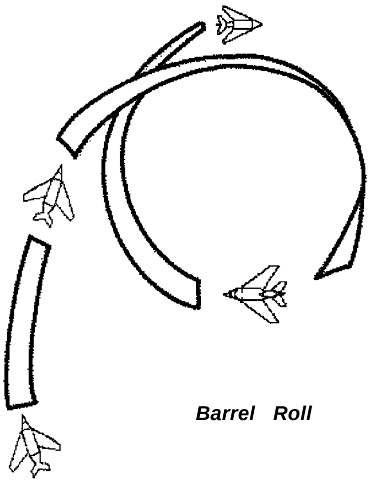
F3, F4

Move up, down level

HINTS AND TIPS

It's worth remembering to make full use of the hierarchical grouping functions whilst creating your shapes. You can save a lot of time by grouping together a selection of parts of a shape to perform a function (in other words, coloring them the same color) and then ungrouping them for further Individual editing.

-When re-sizing an object or changing an objects orientation, use the Select All function under the Edit menu. This will enable you to perform tasks such as re-sizing on each polygon at one time.



Barrel Roll

3.2.5 Color Editor

Executive Overview

The FST Color Editor controls the use of color throughout FST. All FST simulations use 256 colors selected from the entire VGA palette. There are 256 colors available in total and these are divided into four categories:

I **Ground and World colors** **You** can define these using the FST Color Editor. They control the color of the sky, horizon, sea and terrain.

2 **Object colors** -These are again defined by the FST Color Editor, and determine the colors of the surfaces of 3D objects.

3 Reserved colors These are not accessible using the FST Color Editor.

4 Cockpit colors (I 6) These are defined by the cockpit background .PCX files. (See FST Cockpit Editor section for more details).

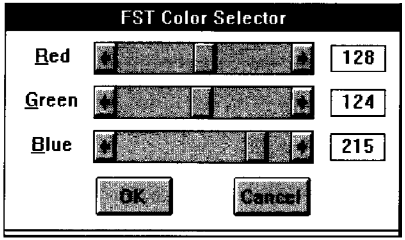
The World colon define the color of the sea (or terrain, if a terrain square is at zero height), the sky and the horizon. The sea and sky colors are automatically ramped to horizon color by the editor, creating automatic shading of the sky and the ground. (Note: this effect is not visible in the FST Color Editor). Use the terrain colors to define the color of the terrain squares in the world. The entire world has I6 basic terrain colors which cover a ramp from the lowest terrain square to the highest. These I6 terrain colors are automatically ramped to the horizon color to provide a realistic 'distance haze' effect. (This effect is not visible in the FST Color Editor).

The object colors define the color of the surfaces of the 3D objects appearing in the World A sub-window in the FST Shape Editor shows the colors available for Shapes, and the actual colors for all Shapes in the Project are defined in this editor. Each shape square shows the color of a Shape surface when fully illuminated (i.e., facing the Sun). A light source shading ramp is automatically created for each of the shape colors. The effects of the lighting model can only be seen either in the solid 3D view of the FST Shape Editor or in the real FST World. (Again, they are not visible in the FST Shape Editor).

The default colors file is called COLS.FCD. However, the Color Editor allows you to create more than one file. The files used by the simulation and the Shape Editor are selected from the Project manager.

RGB dialog box

To change a color you can either select it with the mouse and click on the change button, or double click on the color square. You can also access a dialog box with three slides for Red, Green and Blue (RGB). The Red, Green and Blue elements of the color can be changed using the sliders or by directly typing in a number from 0 to 255. The color in the main window will change continually in response to your instructions.



Buttons

Change >>

The Change>> button edits the RGB values for the selected color.

Spread

Spread automatically creates a height ramp for the terrain colors using the bottom and top color to define the end points of the ramp.

MENU OPERATIONS

File

New

This item creates a blank set of colors The ground colors are set to sensible defaults and the object colors to a set of grays.

Open

This item loads the selected file from the available .FCD color files in the project directory

Save

This item saves the colors to the current file in the project directory. If the file does not have a name this function becomes Save As.

Save As

This item saves colors to a named .FCD file in the Current Project directory

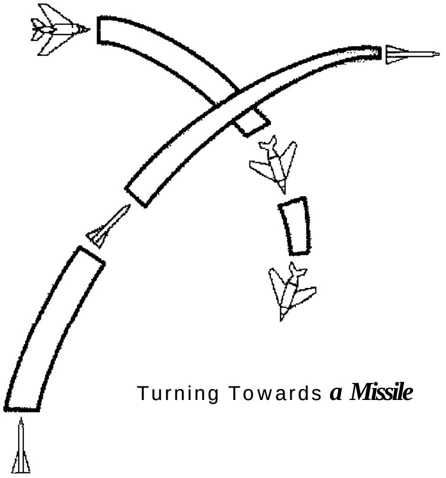
HELP

Help

This item opens Help on colors application.

About

This item opens the information box for colors application.



Turning Towards *a Missile*

3.2.6 Cockpit Editor

Executive Overview

The FST Cockpit Editor allows you to position aircraft instruments and displays within a bitmap representation of a real cockpit The cockpit backgrounds may be created using a Windows or DOS paint program. The files must be I6 color PCX files either 320 x 200 pixels or 640 x 480 pixels in size. The bitmap file must be placed in the current FST project directory The bitmap used by a cockpit file is set by selecting New from the File menu. This provides a list of all PCX files in the project directory. The I6 colors can be chosen specifically for the cockpit, the colors defined in the Paint program are loaded into FST when the cockpit is first drawn. The only restriction on cockpit colors is that color zero IS treated as transparent.

The Simulation Runs With 2 Forward views - one shows the full cockpit and the other just the top half. The program finds the level of the top of the cockpit by searching up from the bottom until it finds the first transparent pixel. This can be at any height, but the simulation runs faster the higher it is as the outside World view is only drawn down to this level. Any bits of cockpit above this level are drawn over the outside World and this can be slow, especially on windows accelerator cards. A cockpit with a flat full screen width top and no head up display border will give the fastest results.

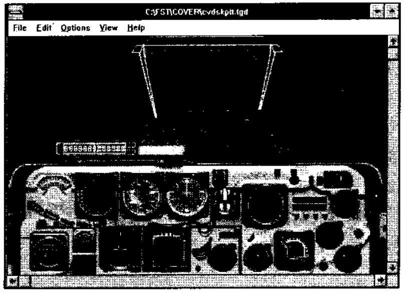
BASICS

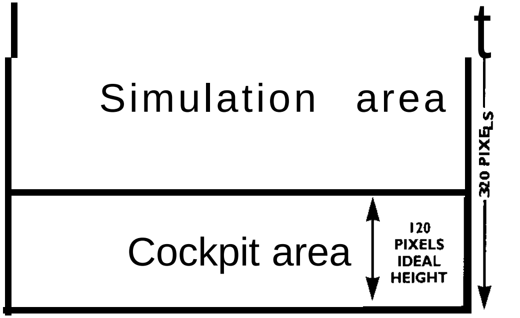
Where do I position the various gauges?

Gauges can be placed anywhere - within reason. By clustering your controls sensibly you will obviously gain the most benefit and control when flying. For example, normally numbers only are placed in the head up display. To draw a gauge in the simulation, first restore its background from the cockpit picture and then draw in lines or numbers showing the value of the gauge variable. This means that different gauges will not normally overlap, although a gauge can be placed over another if required for a special instrument. Gauges can be white, green or red. Certain complex displays, like the head up pitch ladder and radar display, are not normal gauges and will not be effected by the attached variable.

What are the gauge variables?

The simulation updates the state of certain aircraft parameters which can be used to drive cockpit gauges. Double clicking on a gauge or selecting change from the Edit menu brings up a dialog box. The variable associated with the gauge can be chosen from the right hand drop down list. Each variable has a default minimum and maximum value, but these can be changed by typing new values into the Min and Max boxes. The default values are restored each time the list is used. The variables are as follows:





View Center
The height of the center of the World view in pixels from the top of the screen. It is usually attached to the LFD gauge or the HUD gauge.

Altitude
The height of the aircraft in feet as measured by the pressure of the air. If the altimeter is set to 0 at sea level then it reads the height above sea level.

Radar Altitude
The height of the aircraft above ground in feet as measured by a radar altimeter.

Airspeed
The speed of the aircraft through the air in knots. I knot is about 0.5 meters per second.

Vertical Speed
The rate of change of height in fps (feet per second).

Sideslip
The sideways component of airspeed.

Heading
The magnetic heading of the aircraft in degrees. From 0 to 359.

Aircraft Roll
The bank angle of the aircraft in degrees. From - 180 to + 180. Left bank is positive.

Aircraft Pitch
The pitch angle of the aircraft. From -90 to + 90. Pitch up is positive.

G Force
The acceleration on the pilot caused by aircraft altitude and wing lift forces. In I/IO g units. I is normal.

Angle of Attack
The angle of the wings relative to the airflow. In I/IO degree units.

Engine RPM
Engine thrust is directly related to engine RPM. From 0 to IO0 in IO0 rpm units.

Fuel Weight
Weight of fuel carried in main tanks. In IO pound units.

Gear Up
0 for gear down, I for gear up.

Wheel Brakes On
0 for off, I for on.

Air Brakes On
0 for off I for on.

Aircraft Stalled
0 for normal, I for stalled

Low Fuel
0 for normal, I for fuel less than IO percent.

Engine Fail
0 for normal, I for failure.

Hydraulic Fail
0 for normal, I for failure.

Electrics Fail
0 for normal, I for failure.

What are the gauge types?
There are several gauge types, some of which are more suited to display certain variables than others. An altimeter dial is best for displaying altitude, while a simple dial is better for airspeed. The status and failure variables are best displayed by lamps rather than dials These are the various gauge types:

LFD
Longitudinal flight datum. This is a cross in the head up display which shows the direction of a line through the center of the fuselage. It is used by the simulation to position the height of the outside World view relative to the cockpit. If the aircraft is at zero degrees pitch the horizon will cross this point.

HUD
Head up display. A cross at the center acts as LFD. The size of the box should match the HUD outline in the cockpit bitmap. A pitch ladder and velocity vector are part of the HUD display.

Simple Dial
A single pointer that rotates clockwise with increasing variable value. The minimum variable value is at the gauge start angle and the maximum variable value is at the gauge stop value.

Altimeter Dial
Two pointers working like analogue watch hands. The long pointer shows feet from 0 to 1,000 and the short one shows thousands of feet from 0 to 10,000.

Vertical Bar

A thermometer like gauge. A solid bar extends from the base up to the value of the variable.

Horizontal Bar

A single vertical line moves from left to right with the value of the variable.

Small Digits

Numbers drawn with the smallest readable digits. They are 3 pixels wide and 5 pixels high, with a I pixel gap.

Large Digits

Numbers drawn with digits 5 pixels wide and 8 pixels high with a 2 pixel gap.

Square Lamp

A solid square, dull for off and bright for on.

Round Lamp

A solid circle, dull for off and bright for on.

OBI

A special dial type showing navigation data (see 4. I 3 for details). Can be linked to Nav I or Nav 2 variables.

ILS

A special dial type showing instrument landing data (see 4. I 3 for details). Can be linked to Nav I or Nav 2 variables.

Radar

A special display type showing radar information, not linked to any variable.

ADVANCED MENU OPERATIONS

File

New

This item creates a new cockpit. Select width and height of image required and select background bitmap from available pcx files.

Open

This item loads the selected tile from the available .FGD files in the project directory

Save

This item saves the cockpit you have created to the current file .FGD in the project directory, If the project does not have a name, this function becomes Save As.

Save As

This item saves the cockpit to a named file in the current project directory.

About

This item opens an information box for the cockpit application.

Help

This item opens Help on the cockpit application.

Exit

This item qurts the FST Cockpit Editor.

Edit

Change gauge

This item selects gauge properties to determine the nature of the dial required. Select from the following criteria: type, width, height, start angle, stop angle. You can also change the height and wrdth of a dial by clicking on the dial edge and dragging.

Add dial

This item creates a simple dial in the center of the display. You can also use a double click to edit the details and then cut and paste.

Add lamp

As above.

Delete

This item deletes the currently selected gauge.

Options

Attributes

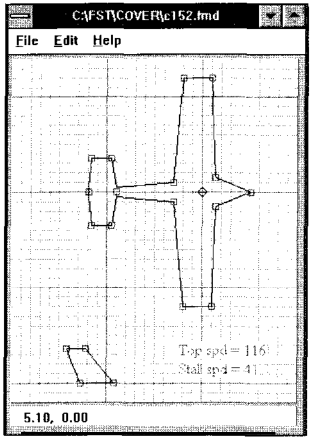
This item opens the dialog box which identifies the size of the cockpit and what its background file is. You can use this function to change to different .pcx files.

Views

Normal size

200% - doubles size of the view in the window for easier editing.

Fit tits the Window around the current cockpit.



3.2.7 Aerodynamic Model Editor

Executive Overview

The FST Aircraft Model Editor controls the aerodynamic and engine parameters of aircraft design. Its main function is to allow the player's aircraft to simulate the performance of a *real aircraft,* although it can also be used to create unrealistically high performance aircraft.

The files produced by the FST Aircraft Model Editor can be specified as the model for world objects of any aircraft class. The performance of aircraft other than the main player can be controlled by a model file. Model files have the .FMD extension. If no model file is specified for an aircraft, then the default is PARAMS.FMD.

Fundamental principles of the Editor and what can be achieved

Aircraft performance is mainly controlled by four forces.:

- lift (up from the wing)
- weight (straight down)
- thrust (forward along the line of the fuselage)
- drag (back along the fuselage)

All these must all be in balance in order to achieve straight and level flight. The weight and thrust are fixed for a given fuel load and throttle setting. This means most of the more Interesting behavior comes from varying the **other** two.

Both lift and drag vary with the square of the airspeed so if airspeed is doubled, both lift and drag are four times larger. Lift is also effected by the angle of attack of the wing. (You can increase this by pulling back on the joystick). Lift is the main force a pilot uses to control an aircraft It is usually lift that makes the aircraft move in a particular direction. In a tight high g turn, the wing has an Increased angle of attack and produces up to IO times as much lift as the weight of the aircraft.

Drag comprises of two factors: The profile drag, determrned by the shape of the aircraft, This can only be altered by landing gear or air-brakes.

The induced drag, caused by lift. Both lift and angle of attack contribute to induced drag. This means that if the engine is not powerful enough to overcome the drag, a high g turn will cause a rapid loss of airspeed. Increasing the angle of attack to maintain the turn will Increase the drag.

It is also possible to achieve some more subtle effects with the model. The lift on each wing is calculated separately so a yaw input will cause an increase in airspeed on one side and consequently an increase in lift and a small roll input. If the wings have dihedral, then any sideslip will cause an Increase in the angle of one wing's angle of attack relative to the other. This will also produce a roll Input. (This is another way that yaw input can cause roll). Note that positive dihedral angles will give roll stability. This is because any roll results in sideslip, causing the roll to be reduced.

Conversely, negative dihedral will give roll instability.

Other effects you can achieve are as follows:

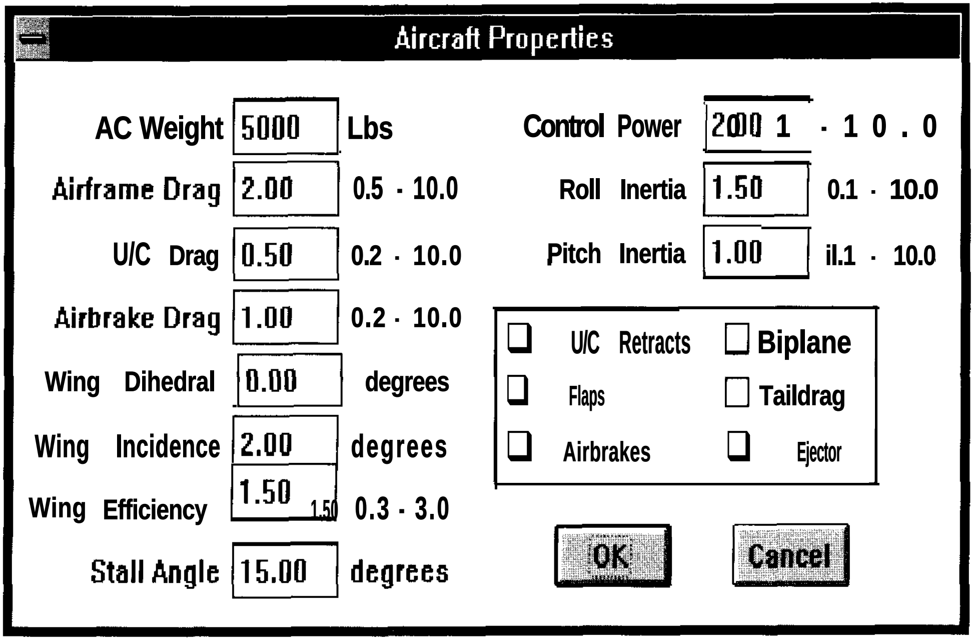
- differential drag on the ailerons, causing adverse yaw when the ailerons are used
- lift from the side of the fuselage allowing a degree of 'knife-edge' flying at high speed if the rudder is used correctly
- elevator deflection can be reduced at high airspeeds to allow more accurate control.

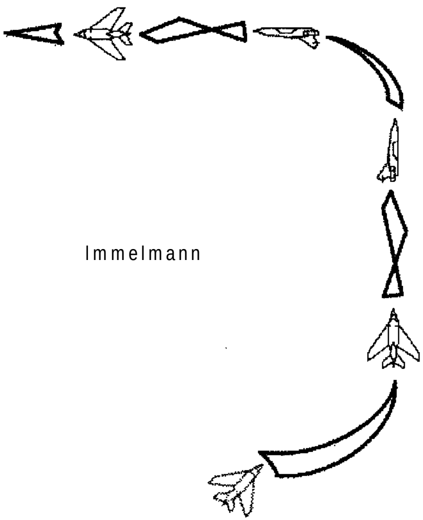
The use of a force model and numerical integration gives a much more realistic feel over a wide range of conditions than the simpler, rule-based velocity models that most PC flight simulators use. However, it does mean that the parameters need a lot of fine tuning to get exactly the right performance from a particular aircraft To fly a model therefore requires a considerable amount of skill as the inertia factor means that opposite control inputs may be required to cancel high roll or pitch rates.

(See Flight School, Chapter 4, for further guidelines on the genera principles of flight).

Main Window

The main window shows a plan view of the aircraft A circle Indicates the center of gravity and there is a side view of the tin. This is not meant to be the visible shape of the aircraft, which is created using the FST Shape Editor. The plan view is used to calculate some aerodynamic properties for the aircraft. The main factors are the





Immelmann

overall size of the aircraft, its relative size and shape of the main wings, tailplane and fin. If the plan view is roughly the same as the aircraft to be simulated then the flight characteristics will approximate to the real aircraft. You can achieve a more precise match by adjusting the numbers in the aircraft properties dialog boxes. The plan view is changed by dragging the points marked by squares. It is of course possible to create aircraft which look ridiculous. The program will analyze them but the resulting aircraft may not get off the ground. If the aircraft is a biplane it is considered to have another set of wings the same size and shape as shown on the plan. (Note: the biplane property must be set in the properties dialog box).

The parameters affected by the plan view are:

Model Editor Dialog Box

Lift coefficient: This determines the amount of lift the wing produces at a given angle of attack and airspeed. Light propeller powered aircraft generally have a higher lift coefficient than fast jets. Large span, thin wings are efficient and have a high lift coefficients, while small span, large chord ones are less efficient and so have a low lift coefficient. The shape of the aerofoil (a section through the wing) also has an effect. This is controlled by the wing efficiency value in the properties dialog.

Drag: This limits the top speed of the aircraft. Short swept back wings have lower drag than large straight wings. Likewise small tailplanes and fins have less drag than large tailplanes and fins. But the total drag of the aircraft also depends on how streamlined the entire aircraft is and this is controlled by the drag coefficient in the properties dialog.

Pitch stability: The pitch stability of the aircraft is greater if the tailplane is bigger and further from the center of lift. Elevator control is more difficult if pitch stability is low as pilot induced oscillations become more likely.

Yaw stability: The yaw stability of the aircraft is greater if the fin is bigger and further from the center of gravity. If yaw stability is low the aircraft will have less tendency to point in the direction it is moving. This allows sideslip speeds to be higher, and makes co-ordinated turns more difficult

Roll rate: The roll rate is higher if the wings are small and have low span.

Pitch rate: The pitch rate is higher if the tailplane is large and close to the center of gravity.

Roll inertia: High span wings have a high inertia. High values make the aircraft slow to start rolling and slow to stop once started.

Pitch inertia: The larger the distance from the center of gravity to the tailplane the higher the inertia. High values make the aircraft slow to start pitching and slow to stop once started. High values can make the aircraft hard to fly, but also allow maneuvers like the cobra to be performed.

Roll drag: Resistance of the aircraft to roll Large wings produce a high roll drag. Roll movement stops faster the higher the drag.

EDIT
The aircraft properties dialog box

The aircraft properties dialog box allows the entry of the following parameters

Aircraft weight: The weight of the aircraft in pounds without fuel. 500 pounds is the minimum and 100,000 pounds is the maximum. (A kilogram is about 2 Ibs).

Airframe drag: The drag coefficient of the aircraft. The lower the drag coefficient the faster the aircraft for a given aircraft, shape and engine power. The minimum is 0.5 and the maximum is 10.0

U/C drag: The extra drag caused when the landing gear is lowered. The minimum is 0.5 and the maximum is 10.0

Airbrake drag: The extra drag caused when the airbrake is out. The minimum is 0.5 and the maximum is 10.0

Wing dihedral: This is the angle the wings are tilted up from horizontal when viewed from straight ahead. The higher the angle the greater the tendency to fly with wings level, and the greater the roll induced by sideslip. The minimum is -20.0 and the maximum is 20.0.

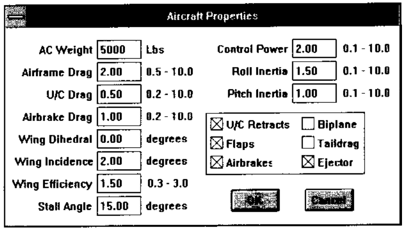
Wing incidence: The angle of the wing to the fuselage. This is the ngle of attack when the fuselage is level. A normal value (I .O to 3.0) allows the aircraft to fly level at cruising speed. The minimum is -5.0 and the maximum is 10.0.

Wing efficiency: The lift coefficient calculated from the wing plan is multiplied by this value. The wing's aerofoil section and its design affect this value. High values give a low stall speed and the ability to maintain a high g turn without losing airspeed.

Stall angle: A simple wing with no flaps, slots or other stall retarding devices will stall at about I5 degrees. A modern jet fighter with vortex generated lift may not stall until 30 degrees. Minimum is IO.0 and maximum is 35.0.

Control power: The control surface deflection caused by a given joystick input. The higher the power the more responsive the aircraft is at a given airspeed. Minimum is 0. I and maximum is 10.0.

Roll inertia: This modifies the inertia calculated from the aircraft weight and wing plan. High values make the aircraft slow to start rolling and slow to stop once started. The minimum value is 0. IO and the maximum 10.0.

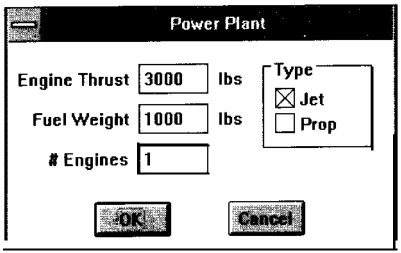


Pitch inertia: This modifies the inertia calculated from the aircraft weight and tailplane plan. High values make the aircraft slow to start pitching and slow to stop once stat-ted. High values can make the aircraft hard to fly, but also allow maneuvers like the cobra to be performed. The minimum value IS 0. IO and the maximum 10.0.

Biplane: Aircraft has two maln wings if checked.

Undercarriage retracts: Landing gear is retractable if checked.

Tail dragger: This determines the undercarriage configuration. If checked the aircraft sits on two front wheels and one tail wheel. If not checked then aircraft has tricycle landing gear.



The Engine Dialog Box

The engine dialog box allows the entry of the following parameters

Engine thrust: The thrust in pounds produced by each engine at full power.

Fuel weight: The weight in pounds of a full fuel load.

Number of engines: A single engine IS on the fuselage, 2 engines means one on each wing, 3 engines means one on the fuselage and one on each wing, 4 engines means two on each wing.

Engine type: All engines are the same type. either jet or propeller.

ADVANCED MENU OPERATIONS

File

New

This item creates a new Model.

Open

This item loads the selected file from the available .FMD files in the project directory.

Save

This item saves the model you have created to the current .FMD file in the project directory If the project does not have a name, this function becomes Save As.

Save As

This item saves the Model to a named file in the current project directory.

About

This item opens an information box for the Model application.

Help

This item opens Help on the Model application.

Exit

This item quits the FST Model Editor.

Edit

Blueprint

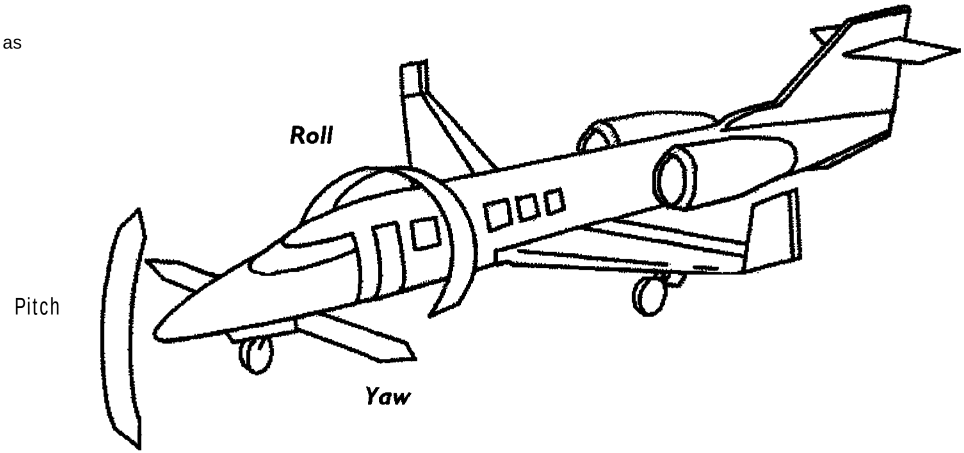
This item opens the Blueprint dialog box, which controls the overall size of the aircraft and the position of the center of gravity from the left of the plan.

Properties

This item opens the properties dialog box, as outlined on the previous pages.

Engine

This item opens the Engine dialog box, as outlined on the previous pages.



CHAPTER 4 - FLYING IN AN FST WORLD

4. I Flight School

Leading military aviation journalist Doug Richardson will now take you through the rudiments of aerodynamics and how to get the best performance out of your aircraft once you've got it off the drawing board and into the skies. If you plan to engage in aenal combat, he'll also give you a rundown on the types of weapons you'll be up against and outline some recommended moves designed to defeat your enemies.

4. I. I Aerodynamics

The Flight Sim Toolkit allows you not only to fly an aircraft, but also to design it. To master both tasks, you'll need to understand the basics of aerodynamics.

When an aircraft is in flight, its behavior is Influenced by four factors lift, weight, thrust, and drag.

Lift is the upward force created by the flow of air across the wings. Lift increases as you fly faster and/or as the angle of attack is increased. Lifting the nose of the aircraft increases the angle of attack the angle between the fore-and-aft axis of the wing and the horizontal. Lift acts upwards, counter-acting the weight of the aircraft. Lift and weight are balanced when the aircraft is in level flight. Increase the lift and aircraft will climb; decrease it and the aircraft will descend.

Thrust is the force created by the engine. It acts in the forward direction moving the aircraft through the air. As the aircraft speeds up, air resistance creates drag. The faster you fly, the greater the drag. Drag is always proportional to the square of the speed. Double the aircraft speed, and the drag increases four times. Thus trebling the speed will create nine times the drag, while quadrupling it will give a 16-fold Increase in drag. As long as thrust is greater than drag, the aircraft will accelerate. Eventually, the point will be reached where thrust equals drag-that will be the aircraft's maximum speed in level flight.

Basics Of Flying

An aircraft must be maneuvered in three dimensions - pitch (nose up or nose down), yaw (nose left or nose right), and roll (aircraft rotated to move one wing down and the other up). These movements are generated by hinged control surfaces whose position is controlled from the cockpit by means of the control column or control yoke, plus rudder pedals.

Fighters and light aircraft have control columns. Positioned ahead of the pilot and hinged at its base, the control column can be moved both forwards and backwards and from side to side. This can be done with one hand, leaving the other free to work the throttle. The control column is often referred to as a control stick. Older pilots once used the term “joystick”, a name now passed down to the vital computer add-on equipment purchased by flight sim buffs. Since it mimics the movements of a control column, a joystick is the ideal way of “flying” a flight simulator.

Control yokes are two-handed grips in “spectacle” or “handlebar” form which are mounted either on top of a control column or in front of the instrument panel in a similar manner to a car steering wheel. They can be pushed forward or pulled back or turned. On a car, the steering wheel can be turned through several revolutions, but a control yoke has much less freedom - around 90 degrees in either direction, the same as that of a control column.

Control columns and control yokes operate in the same way. Since you’ll probably be using a joystick, we’ll simply refer to this as the “stick” throughout the rest of this briefing.

Pitch is controlled by elevaton mounted at the trailing (rear) edge of the horizontal tailplane. Pushing the stick forwards deflects the elevators downward creating an upward lift from the tailplane. Since this lift is being applied well behind the aircraft’s center of gravity, the tail rises, and the nose of the aircraft is pushed down. Pulling the stick back causes the elevators to rise, creating a downward force which pushes the tail of the aircraft down, and raises the nose.

Moving the stick from side to side controls the movements of the ailerons which are hinged surfaces mounted at the trailing edge of the wing normally near the tip. Moving the stick to the right deflects the starboard aileron upwards, and the port aileron downward. This slightly increases the lift created by the port wing, and slightly reduces the lift created by the starboard wing. So the port wing rises, while the starboard wing falls the aircraft has rolled to the right. Pushing the stick in the opposite direction reverses the process, deflecting the ailerons in the opposite direction, and rolling the aircraft to the left.

The rudder is mounted at the trailing edge of the vertical tail surface and is controlled by the rudder pedals, not the stick. If the pilot pushes forward with the left foot, the rudder is deflected to the left, creating a force which pulls the tail of the aircraft to the right and moves the nose to the left. Pressing with the right foot has the opposite effect moving the rudder and nose to the right.

The power from the engine IS controlled by the throttle. On a real aircraft, this IS normally a lever which is pushed forward to increase engine power and pulled back to reduce engine power. (Second World War fighters had a protective firewall between the nose-mounted engine and the cockpit. The throttles on sever-a aircraft (most notably the B- 17) had ceramic balls on the top for an easier grip. “Balls to the wall” became a slang expression for applying full power).

Modem aircraft are very streamlined so, to help them slow down, they have one or more air-brakes. These take the form of hinged surfaces mounted on the fuselage or wings. When opened they create extra drag which can be used to slow the art-craft down or prevent it gaining excess speed in a dive.

Many aircraft are fitted with flaps to increase lift at low speeds.

Flaps are panels mounted at the trailing edge of the wing, normally inboard of the ailerons. When extended, they hang downward from the trailing edge, projecting into the airflor below the wing. The extra lift they create allows the aircraft to fly more slowly than normal, while their drag steepens the aircraft's flight path during the approach to the runway and allows a more nose-down attitude that improves forward visibility.

DESIGNING THE AIRCRAFT

For most flight simulations, the summary of aerodynamics and controls given above would be enough to get you in the air and flying. If you're an experienced flight-sim buff you've probably skipped through the preceding text of this section. Flight Sim Toolkit allows you to design your own aircraft, and that's a process which can't be done by eye. Comic strips can make an art-craft any shape that takes the artist's fancy, and when you're fully conversant with the Shape Editor, you'll have the same freedom. When using the Model Editor however, you won't have such luxury. If your newly-designed aircraft is to get off the ground, it must obey the rules of aerodynamics, If you want your creation to fly, you'll need to know a bit more about arrctaft and what makes them airworthy.

The text which follows might not get you a job with Boeing or the Mikoyan design bureau, but will give you enough background to design aircraft which will fly. When you get bored with flying the selection of aircraft supplied with FST, you can use the Shape and Model Editors to input information on an existing "real-world" aircraft. A good source of inspiration and reference IS "Jane's All The World's Art-craft' which should be available at your local library Published every year in the UK, this massive - and expensrve - book IS one of the best unclassified sources of information on current civil and military aircraft It gives three-view drawings, dimensions, weights, engine rating, and full performance details all the information you'll need to simulate these aircraft using FST. Books on aviation history are a good source of designs from the past to experiment with - great aircraft, infamous "lemons" from the past, or promising designs which failed to make it off the drawing board or into service With FST, you can recreate them all.

The next stage is to try to modify existing aircraft and create new variants of your own design, You should try to master this technique before attempting to devise totally new aircraft from scratch. If you input the information correctly, "real-world" aircraft should fly satisfactorily, but variants or all-new designs of your own creation need careful design. There are many criteria to take into account. The main elements you need to pay close attention to are as follows:

Wing area

The larger the wing, the greater the lift it generates at a given speed and angle of attack. When you're sizing the wing, remember that it's not just a matter of having to support the aircraft's weight at normal flying speed. Lift reduces as airspeed decreases, so the wing must create enough lift to support the aircraft at takeoff and landing speeds. Designing the wing too small will result in a "hot ship" with a hieh takeoff and landing speed. Dunng the Second World War, the Martin B-26 Marauder twin-engine bomber rapidly acquired a reputation of being "too hot to handle". So a redesigned version was given a wing with a greater span and almost IO per cent more surface area. On the other hand, if you make the wing too large, the aircraft's drag will increase and the aircraft will rise. Good design is largely a matter of compromise.

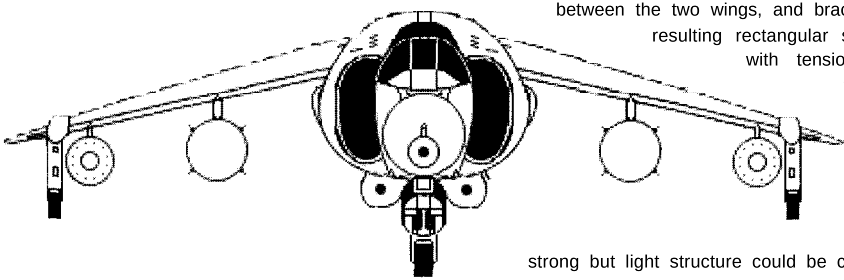
When designing your aircraft keep a close watch on the stalling speed indicated by the Shape Editor. Typical figures for present-day aircraft are:

45 - 60kts	(single piston engine)
70 8Okts	(twin-piston)
90 I I Okts	(jet trainer)
I20kts	(business jet)
150. I60kts	(airliner)

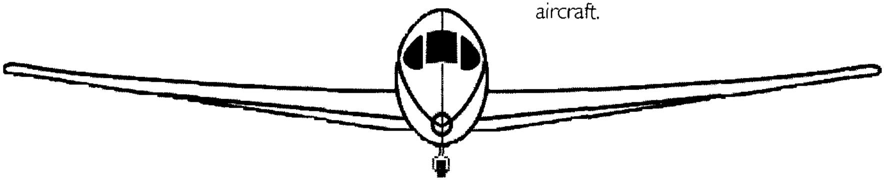
Stalling speeds of jet fighters are rarely published, but these typically have landing speeds of around I20kts.

Wing aspect ratio

This is the ratio between the span of a wing (from wingtip to wingtip) and its chord (distance from the front of the wing to the back). High aspect ratios (wings which are long and slender) are more efficient aerodynamically but their long spans require increased wing strength. Aircraft which require the maximum possible lift - such as sailplanes, man-powered aircraft, and high-flying reconnaissance aircraft have very high aspect ratios of 30 or more. However, most commercial aircraft make do with values of between IO and 20. Supersonic fighters often have even lower values.



Anhedral



Dihedral

In the early days of aviation, a common solution to the problem of creating a high aspect ratio wing with a minimum of structural weight was to use the biplane configuration. By placing vertical struts between the two wings, and bracing the resulting rectangular structure with tensioned wires, a strong but light structure could be created. By the mid- I930s improved materials and methods of construction, together with the requirement for higher speeds, saw the biplane phased out except for a few specialized applications such as acrobatic aircraft.

Wing and tailplane position

To be able to fly an aircraft must be stable. This is achieved by ensuring that the aircraft's center of gravity is ahead of the center of lift of the wing. The aircraft then has a tendency to fly nose-down, making it inherently stable. If the center of gravity is positioned behind the center of lift, the aircraft's nose will try to rise, making it Inherently unstable and impossible to fly.

With the Introduction of computerized 'fly-by-wire' systems in the early 1970s the flying characteristics of unstable aircraft could be "tamed". Flying-by-wire gives a high agility factor to aircraft such as the F- I6 and Mirage 2000. With patience, ingenuity and skill these inherently unstable aircraft can be simulated by FST.

The tailplane of an aircraft performs three functions, all of which affect stability and handling qualities. The horizontal tailplane provides a small down lift on the tall to counteract the aircraft's normal tendency to nose over. The vertical tin provides directional stability and carries the rudder and the elevators which control pitch and yaw. Effectiveness of the vertical fin, elevator and rudder depends on their size and movement -the distance between the tailplane and the aircraft's center of gravity. A small tailplane at the end of a long fuselage may be just as effective in creating directional stability as a larger tailplane on a shorter fuselage. A large tailplane on a short fuselage may give the degree of control needed, but at the price of high drag. 1950s fighters such *as* the MiG- I5 and - 17 and the F- IO Voodoo had their horizontal stabilizers mounted well beyond the end of the main fuselage.

Most aircraft have rear-mounted tails. It is possible to reverse this arrangement and to position the tailplane at the front and the wing at the rear of the aircraft. This configuration is known as a "canard" and was employed by the Wright brothers and other aviation pioneers. Within a few years, it was rejected in favor of a conventional rear-mounted tail. This was probably because the canard layout loses the built-in lateral stability created by the "weather-cock" effect of the more conventional tail However, a canard layout was again used in the early 1960s on the experimental North American XB-70 supersonic bomber and was also adopted by Sweden for the successful Viggen fighter. In rhe 1980s it was adopted for several light lighters Including the French Rafale, UK/German/Italian/Spanish Eurofighter, Sweden's JAS-39 Gtipen, and Israel's ill-fated Lavi, Careful manipulation of FST's modeling algorithms will replicate the effect of canard layouts There's plenty of other scope for experimentation. The software can simulate tailed delta wings (such as the MiG-2 I) or pure deltas (such as the Convair F- IO6 Delta Dart, Dassault Mirage III/5 series or Avro Vulcan

Stability is also influenced by the angle between the wing and the horizontal -this is known as dihedral. Seen from the front or rear of the aircraft, a wing with significant dihedral will have a slight upward slope toward the wingtips. A wing with negative dihedral known as anhedra will droop toward the wingtips. On a large aircraft it may be hard to judge this on the ground, since gravity may cause the wing to droop under Its own weight.

Dihedral makes the aircraft stable in roll. If the aircraft starts to roll in flight, the wing in the direction of roll will become more horizontal, while the other wing will tend to rise. The lower wing will generate additional lift, which will tend to level the aircraft Use of anhedral has the opposite effect and so reduces later-a stability.

Most aircraft have a few degrees of dihedral. For example, light aircraft and jet airliners typrcally have values of 4 7 degrees. Fighters need maneuverability rather than extra stability so may have no dihedral or even a slight anhedral. Larger degrees of anhedral can be seen on aircraft such as the Lockheed C-5 Galaxy, whose massive vertical tail fin provides more than enough lateral stability. The F-4 Phantom has a tailplane with massive anhedra compensated for by the wing's outer sections, which have very sharp dihedral. The Model Editor will accept negative values for dihedral, allowing you to simulate anhedral.

Installed Power

The power of an aircraft's engine or engines is entered Into the Model Editor as 'pounds of thrust'. This will normally be less than the aircraft all-up weight, although some modern jet fighters have thrust-to-weight ratios of greater than one to one. A propeller-driven aircraft will have a power-to-weight ratio of around 0.25, while a jet airliner has around 0.3 0.4, but a jet fighter with anything less than 0.4 would be distinctly sluggish. Ratios of 0.8 or higher would be more normal for air-to-air combat. If you want to simulate a propeller-driven aircraft, an appendix to this manual will show you how to convert the horsepower ratings of a piston or turboprop engine into an equivalent amount of thrust.

Horsepower to lbs Thrust Conversion Table

The exact conversion *between* Horsepower and lbs Thrust depends upon prop configuration gearbox efficiency and numerous other factors Although not accurate. the below table is a good enough guide for use with FST.

H P	Generates	lbs Thrust
I		3.6
10		36
25		90
50		180
100		360
500		1800
1000		3600
5000		18000
7500		27000
I0000		36000
20000		72000
50000		I80000

Supersonic engines use afterburning as a means of increasing thrust. This involves spraying extra fuel into the jetpipe, where it bums and generates a massive increase in thrust If you are modeling a supersonic fighter, specify the engine rating in afterburner, and throttle back in flight when you need the equivalent of dry (non-afterburning) thrust. Aviation buffs will realize that this will not actually simulate the doubling of fuel consumption caused by afterbuming. If you find this unacceptable, a partial solution would be to reduce the amount of fuel carried in the aircraft by around 25 per cent, thus reducing the aircraft's endurance. If you increase the empty weight of the aircraft by about half the weight of the missing fuel, you can just about restore the aircraft's thrust-to-weight ratio to its normal value. However, do remember that this will make the aircraft heavier than normal when landing.

If you want to simulate a propeller-driven aircraft, you need to flag the "Prop" box in the engine section of the Model Editor. The simulation algorithms will then reproduce the effects of propeller wash over the wing. The air streaming back from a propeller is faster than the normal air flowing over the rest of the airframe. The faster airflow makes the rudder and elevators more effective, particularly when the aircraft is flying slowly or close to stalling speed. A propeller-driven aircraft will thus handle better at lower airspeeds than a jet · worth remembering if you want to fly aerobatics!

4. I .2 Basic flight tutorial

Taxiing

When an aircraft starts moving, its forward speed is too slow for the rudder to be effective. Steenng is via a steerable nose wheel.

Takeoff

Once you're positioned at the end of the runway, make sure the flaps are set for takeoff Fully open the throttle: the take-off run begins. The stick will have little impact at low speed · but soon becomes more effective. Don't be too anxious to pull back the stick in an attempt to get airborne – concentrate on keeping the aircraft straight and building up the speed. Once traveling beyond the stalling speed of the aircraft, ease the stick gently back and the aircraft will slowly leave the runway.

At this point, you still have very little speed margin over stalling speed, so you should keep the climb very shallow until the air speed Indicator shows you have gained a further 20kts. As speed continues to build up, retract the undercarriage. If the aircraft you are flying has a fixed undercarriage, this will have been designed to take the wind loading of the aircraft's top speed. However, a retractable undercarriage will be damaged if left extended at high speed. If the aircraft has flaps, these can now also be retracted.

Climb

By now, you will be in a steady climb. The flight instruments will indicate your current height and rate of climb. You can vary the rate of climb by varying power. With experience, you'll learn where to position the throttle obtain the climb rate you want. (For any aircraft, this position will depend on attitude and aircraft weight).

As you approach the altitude at which you want to level out, lower the nose slowly in order to reduce reduce speed. A little practice will soon show you where the nose should be positioned in relation to the horizon to keep the aircraft in level flight. Use the throttle to control altitude, repositioning the nose as necessary to maintain airspeed.

Cruise

In level flight, keep an eye on the compass, and on the relative position of terrain features with respect to the aircraft nose. You'll probably find that you're slowly drifting to the left or right. Make shallow turns to correct for this. If the aircraft is slowly gaining or losing height, adjust the throttle to correct for this. If you are flying straight and level but changing speed, alter the pitch accordingly. Don't be in a hurry to correct for small deviations in the hope of staying exactly on course, speed, and height. Repeated tiny corrections - what pilots call "chasing the instruments" - will result in an unsteady flight path. By allowing yourself some margin of error in course, speed, and height you'll actually find it much easier to fly a steady course.

Turns

In a shallow turn involving bank angles of less than 20 degrees, removing the stick pressure alone is enough to return many types of aircraft to the straight and level. The aircraft's natural stability will be enough to level the wings. At medium angles (up to around 45 degrees), the wings will stay at whatever angle you place them without further side pressure on the stick. To restore them to the straight and level, move the stick in the opposite direction to that used to start the turn. At more extreme angles of bank, the aircraft will tend to increase the bank angle, so the pilot must correct for this by using the stick.

These rules apply to inherently stable aircraft, such as light aircraft and airliners. Fighters are designed for maneuverability rather than stability, so will have little or no tendency to recover from banks automatically.

Climbing

To begin a climb, first apply power and then raise the aircraft nose. Maintain the rate of climb by varying the pitch setting just as you did during the initial climb after take-of? End the climb by lowering the nose and reducing power.

Descending

To descend, reduce the power. Adjust throttle position to give the rate of descent you require. Adjust pitch until the aircraft is flying at the airspeed you want. Once close to the new height, open the throttle to apply more power and adjust the pitch to re-establish cruising airspeed.

Stalls & Spins

Lifting the nose of an aircraft increases the angle of attack the angle between the wing and the horizontal. This increases the amount of lift generated by the wing but also increases drag, causing a reduction in speed.

As the speed of the aircraft falls, so does the speed with which the air flows over the wings and movable control surfaces. Just as a boat's rudder loses effectiveness at slow speed, so do elevators, ailerons, and the rudder. Fly slower still and the flow of air over the wing is no longer fast enough to maintain the lift needed to support the aircraft.

The effectiveness of the control surfaces usually falls away steadily. However, in the case of wing lift the deterioration is quite sudden. The upper surface of a wing is slightly humped in cross section, and at speed the airflow across the upper surface will cling to the wing on the rear side of the hump. If the speed of the aircraft gets too slow, this process breaks down. Instead of staying at the surface of the wing, the air breaks away from the wing along the highest point of the hump. This sudden breakaway sharply reduces wing lift In technical terms, the wing is said to be "stalled".

Deprived of lift, the aircraft will lose height, and its nose will drop. The resulting shallow dive will build the speed back up until the wing functions normally. At low level, that height loss can cause you to crash.

To practice stalling make sure you have plenty of height. Regard 5,000ft as an absolute minimum. To stall the aircraft, throttle back to idle power, then pull slowly back on the stick. The nose will rise, and the airspeed will slowly decrease. When the aircraft stalls, the nose will pitch forward, putting the aircraft into a dive. Apply full power and push the stick forward, then slowly pull back to recover from the dive. Return the engine to cruise power.

Spinning can be dangerous. In the past it formed a normal part of pilot training, but many of today's aircraft are spin-resistant, so spinning tends to be taught only as an acrobatic technique. A spinning aircraft can lose up to I ,000ft with every turn of a spin so make sure you have plenty of height - at least I 0,000ft.

Not all aircraft can recover from a spin and this maneuver is banned in many types of combat aircraft. Ejection may be the only course open to a military pilot caught in a spinning aircraft.

Throttle back and lift the nose, just as you did when practicing stalls. When the aircraft is Just about to stall, pull the stick sharply backward and fully to the left or right, depending on the direction in which you want to spin. The aircraft will roll through 90 degrees or more and enter a nose-down spin

To recover from a spin, apply full rudder in the opposite direction to the spin and push the stick forward. This should convert the spin into a steep dive, from which you can pull out by slowly pulling the stick back until the horizon re-appears and the aircraft returns to level flight. Return the engine to cruise power. Don't pull back too sharply on the stick when recovering. The aircraft is flying relatively slowly and until airspeed has built up, you face the risk of stalling again.

Landing

Landing is the trickiest routine flight maneuver you'll have to master. The first task is to get the aircraft headed toward the runway at a suitable approach speed and sink rate. During this final approach your goal is to land the aircraft somewhere on the first third of the runway. Maintain your approach speed by adjusting pitch (nose position relative to the horizon) and rely on changes in engine power to control your descent rate. If it looks like you're going to land short of the runway apply more power.

To descend for landing, reduce power. Adjst pitch to obtain the airspeed for the landing approach anything from 70 - I2Okts (you want this to be I .3 times your aircrafts stall speed), depending on aircraft type - lower the flaps and adjust the nose position to maintain speed. Then adjust the throttle to provide a suitable sink rate – I ,OOOft/min would be a good value to arm for. As soon as you possible, lower your landing gear, as this will affect your speed by inducing drag. If you lower them too late (when your aircraft is moving slowly) you may reduce your speed below it's stall speed and crash!

Don't try pulling back on the stick. This would reduce your speed, bringing you dangerously close to stalling, and increase drag - steepening your descent. If you're too high and it looks like you're going to land well down the runway, decrease power to speed up your descent.

Once the aircraft is some IO 20ft over the runway, pull the stick back slowly using patch (nose position) as if you were trying to maintain this height. This maneuver is known as the "roundout" or "flare". As the aircraft speed falls away, keep slowly pulling the stick backward until the aircraft touches down. Throttle the engine to minimum power, and use the brakes to slow the aircraft to a taxiing speed.

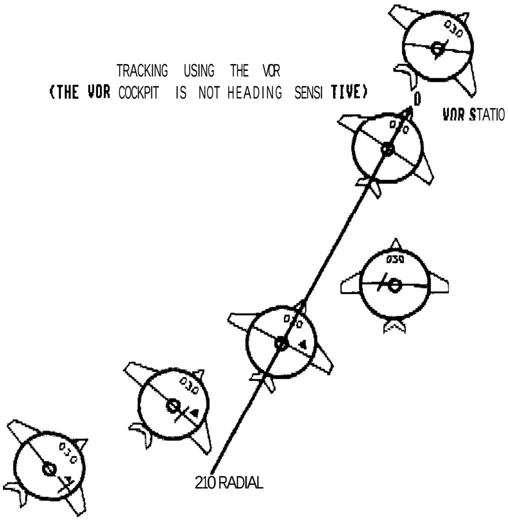
4. I .3 Navigation Systems

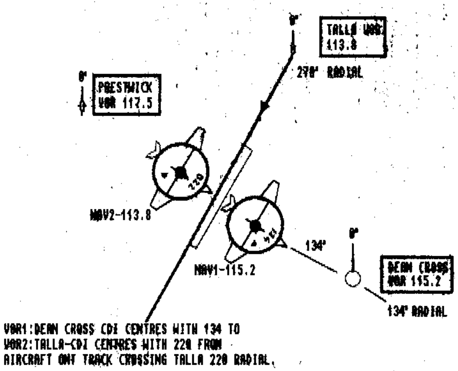
There are four ground-based aids to navigation.

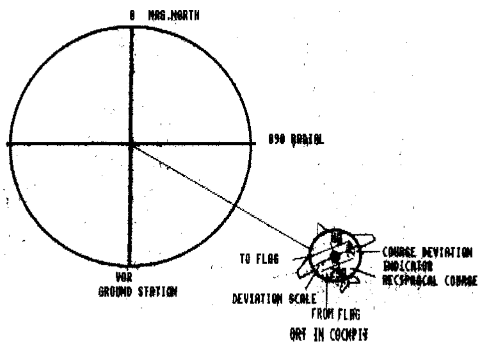
The simplest are illuminated flashing beacons located at airfields. These help you spot the location of the field at night.

A non-directional beacon (NDB) is a radio beacon which broadcasts a signal in all directions.

TRACKING USING THE VOR
(THE VOR COCKPIT IS NOT HEADING SENSITIVE)







A VHF Omnidirectional Radio (VOR) beacon is the most common civil navaid. Like an NBD, it emits a circular pattern of radio energy, but adds a second transmission to this – a single directional beam which scans through the full 360 degrees like the light beam from a lighthouse. Encoded on this rotating beam is information on the current beam direction. A VOR receiver in the aircraft can decode this, giving an indication of the aircraft's angular position with respect to the VOR beacon. The I O-degree interval bearings from the VOR beacon are known as "radials". The 0 degree radial is magnetic north, while the 90, I80 and 270 degree radials are east, south and west respectively.

The Instrument Landing System (ILS) is Intended to guide aircraft down to the runway in conditions of poor or minimum visibility. It consists of a localizer, glideslope, and three marker beacons. The localizer is a single narrow beam which can be located using a NAV receiver. The glideslope is a radio beam angled upward from a location close to the runway. The shallow angle of this beam coincides with the descent path you need to follow to reach the runway. The marker beacons send beams of radio energy vertically upwards to give an indication of the distance to the runway.

Cockpit-mounted navaids

Flight Sim Toolkit allows you to install the following navigation systems (navaids) in the cockpit of your aircraft:

Automatic Direction Finder (ADF)

When tuned to the frequency of a non-directional beacon (NDB), the ADF will display the bearing of that beacon relative to the nose of the aircraft. The needle will point directly toward the bearing of the beacon (for example, if the beacon is ahead of the aircraft, the needle will point upward: if the beacon is directly behind the aircraft, the needle will point downward). Remember that the numerical bearing shown is calculated with zero as the nose of the aircraft. It is not a compass bearing.

Omni-Bearing Indicator (OBI)

The aircraft mounted component of the VOR system comprises one or more NAV radios, each with an Omni-Beanng Indicator (OBI). Using an OBI control knob known as a Course Selector or Omni-Bearing Selector, the pilot selects the radial along which he wishes to fly by setting its numerical value on a three-digit Course Selector which appears at the top of the OBI. The reciprocal (opposite) course appean in a second three-digit indicator at the bottom of the instrument. In the center of the OBI is the Course Deviation Indicator, a needle which moves with respect to a centering mark and lateral scale marked on the face of the instrument. This shows the displacement between the current aircraft course and the chosen radial.

The word "TO" or "FROM" is also displayed, showing whether the aircraft is flying toward or away from the VOR beacon. When the TO-FROM indicator is showing "TO" the Coune Deviation Indicator will display the correction needed to bring the aircraft onto a course headed directly toward the VOR beacon. If it's showing "FROM", the corrections will bring you onto a course headed away from the VOR beacon along the chosen radial.

if you are not sure where you are in relation to a VOR beacon, turn the Course Selector knob until the needle on the Course Deviation Indicator needle is on the centering mark. The bearing of the radial you are locked on to can then be read on the three-digit Coune Selector.

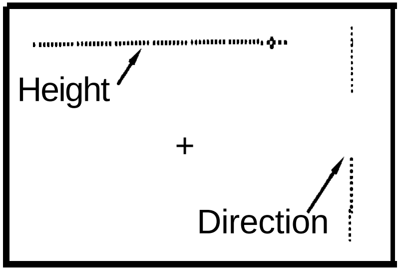
Distance Measuring Equipment (DME)

VOR beacons are also able to provide nformation for Distance Measuring Equipment (DME). Connected to a NAV radio, DME indicates the distance (in nautical miles) between the aircraft and the beacon. You may find that the VOR whose radial you are flying is not providing DME information. There is nothing wrong with the VOR beacon or your DME equipment DME does not operate out to the full range of the beacon. If you need DME distances, switch to a VOR beacon closer to you current position.

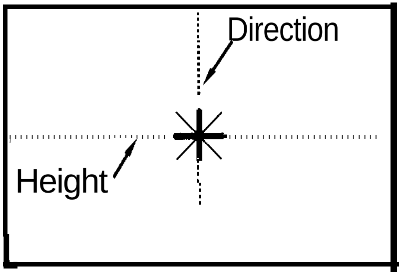
Instrument Landing System (ILS)

When making a landing in poor weather, your first task is to locate the runway. This is done by tuning your NAV receiver to the frequency of the ILS localizer, then following the steering cues given on the OBI. When operating with a localizer instead of a VOR radial, the OBI is much more sensitive, accurately guiding you onto the correct bearing for your approach to the runway.

The cockpit-mounted indicator for the Instrument Landing System (ILS) is an instrument with two needles rather than the single needle found on most conventional gauges. One needle is mounted at the bottom left of the dial, the other at the bottom right, and the two cross somewhere on the face of the Instrument. A central mark shows the position of the glideslope you are trying to follow. If you are "on the glideslope" - descending toward the runway at the correct downward angle -the two needles will cross over the central mark If you are above, below, or to the left or right of the nominal glideslope, the crossing point of the needles will indicate the direction of your error. Correct your flight path until the needles cross over the central mark, and try to hold them there. The FST simulation does not include ILS markers, so follow the ILS glideslope until the runway becomes visible.



Lines indicate that plane is too low and too far to the left.



Lines pass through crosshair showing correct height and direction.

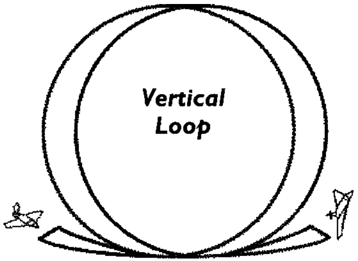
4. I .4 Combat

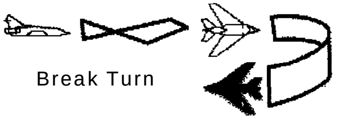
Baron Manfred von Richthoven, the legendary "Red Baron" of First World War fame, once summarized his views on air combat thus: "The fighter pilots have to rove in the area allotted to them in any way they like. And when they spot an enemy, they attack and shoot him down: anything else is rubbish."

The pilots who flew under his command had von Richthoven as mentor and teacher. A pile of floppy disks and a manual is of course no real substitute for personal tuition by the great air ace. To help keep you alive in air combat, the next few pages will give you an outline of some of the maneuvers which might help throw an enemy off your tail, or bring you into a good firing position.

Vertical Loop

If an enemy aircraft is closing on your rear and you have enough speed, go to full thrust (if you're not there already), and pull the stick back. Hold the stick back as you go through the vertical and into a dive, keeping it there until the honzon re-appears (where the ground is on the bottom). Now ease the stick forward to return to level flight.



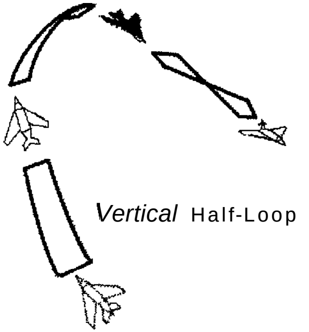


Break Turn

When pilots yell "break, break" over the radio to another pilot in old war movies, they are warning the latter that an enemy aircraft is on his tail, and suggesting that he fly a break turn. This maneuver involves rolling 90 degrees right or left until the wings are vertical, then pulling the stick back to fly a sharp turn.

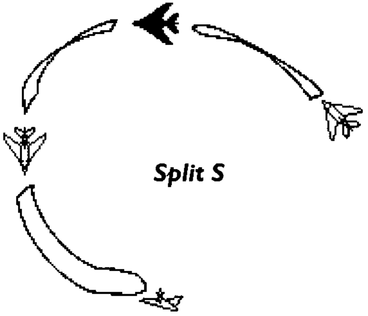
Split S

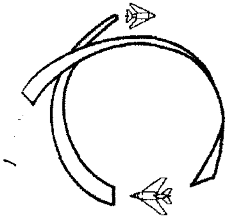
Roll though 90 degrees and start a turn. Wait until you've turned through around 90 degrees, by which time your pursuer will be assuming that you're simply pulling a Break Turn in the hope of losing him. Roll until your aircraft is inverted, then pull the stick hard back. Now fly the second half on an inverted loop by easing the stick forward as the horizon comes into view. You're now flying level with the enemy somewhere behind you. One possible way of getting into a fresh attacking position against him is to fly a Vertical Half-Loop.



Vertical Half-Loop

With the engine in full thrust, pull the stick back. Hold the stick back as you go through the vertical, keeping it there until the honzon re-appears. Now ease the stick forward and roll through 180 degrees to return to level flight.





Barrel Roll

Rolling Scissors

Barrel Roll

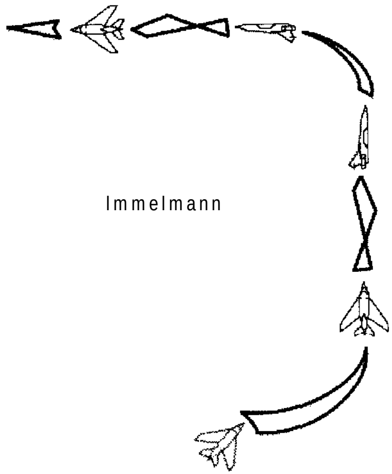
Pull back on the stick to enter a climb of around 30 degrees. Push the stick hard over to left or right, and full back. Keep rolling until you've lost your pursuer.

Rolling Scissors

Often used to counter a diving attack, where the attacker is in danger of overshooting, the Rolling Scirssors involves the two fighters Barrel Rolling around each other. Victory will go to the aircraft with the best slow-speed turn performance, acceleration and controllability at slow speed.

The Immelmann Turn

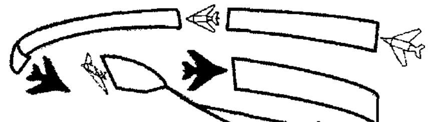
Also known as a "hammerhead turn", this method of making a sudden change in height and direction was devised by the First World War ace Max Immelman. With the engine at full thrust, pull the stick back to enter a vertical climb. Roll the aircraft so that its belly faces the direction you want to head. Push forward on the stick and level off. A word of caution: used against a pursuer with enough power to follow you into the climb, the Immelmann can be dangerous. Remember, as you reach the top of your vertical climb, your art-craft is moving relatively slowly so is an easy target.



Immelmann

Hi Yo-Yo

If you've misjudged speed and are in danger of overshooting the target, pull the stick back and enter a 20 - 30 degree climb. This will reduce your speed, allowing the target to open the distance between you. Push the stick forward and enter a shallow dive toward the target.

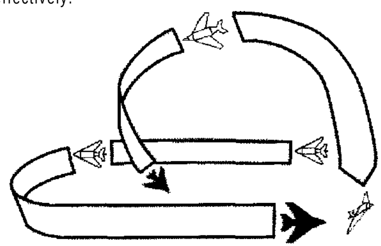


Low Yo-Yo

Low YO-YO

If the same misjudgment of speed means that you are failing to catch a fast retreating target, push the stick forward to enter a 20 - 30 degree dive. You're now trading height for speed and have a chance to pull the nose up and fire at the enemy from behind and below.

Tactics may keep you alive and get you on the tail of an enemy but, to quote Major "Micky" Mannock, who during the First World War rose from the "other ranks' to become the Royal Air Force's most successful ace with 73 victories: "Good flying never killed [an enemy] yet." To score those kills you must use your weapons effectively.



Hi YO-YO

The secret of successful air-to-air gunnery is to get as close as possible to the target before firing. Open fire at too great a range, and you're simply wasting rounds by exporting them in the genera direction of the target. Major Thomas McGuire, the second-top US ace of the Second World War used the formula – "Go in close, and then when you think you are too close, go on in closer." According to German ace Col. Erich Hartmann, "I liked the whole front of my windscreen to be full of the enemy aircraft when tired." At such a short range, claimed Hartmann, "it doesn't matter what your angle is to him, or whether you are in a turn or any other maneuver."

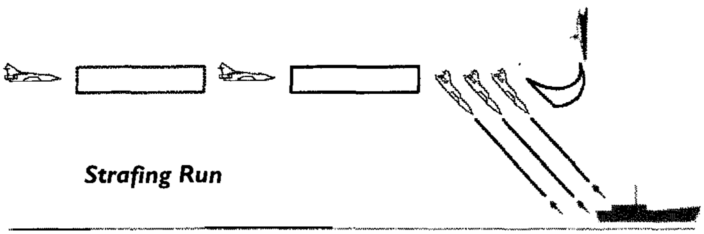
When using a heat-seeking missile in air-to-air combat, remember that the missile seeker will work best when faced with a retreating target. The weapon may have only a modest speed advantage over the target. You should aim to close the range to a few thousand yards before firing at a retreating aircraft. A modern heat-seeking missile is sensitive enough to home onto the aircraft from any direction and will have a better range when fired from the side or the front of a target. However, you may find the weapon less reliable when launched this way it may fail to lock or lose lock altogether.

A final thought which might keep you alive in simulated air combat against several opponents comes from Royal Air Force Group Captain Reade Tilley. "When actually firing at an enemy aircraft you are most vulnerable to attack. When you break away from an attack, always break with a violent skid just as though you were being fired at from behind. Because you probably are."

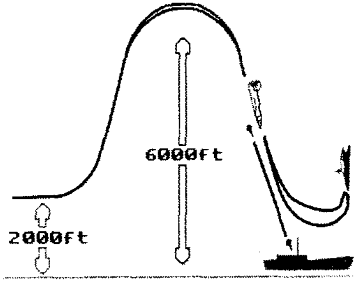
Air-Ground tactics

Strafing run

This is the simplest attacking maneuver and is normally carried out with cannon or unguided rockets. Starting from a height of 500 - I ,000ft and a position a mile or so out from the target, push the nose down to bring the gunsight or rocket sight to bear on the target. Now open fire. If you



Strafing Run



Low Altitude Dive Bombing

don't get a "kill" pull up before you get dangerously low. You could try circling around and making another run. But don't forget the Vietnam War pilots' adage "Make only one pass – hold on to your ass". A second pass against alerted defenses can prove fatal.

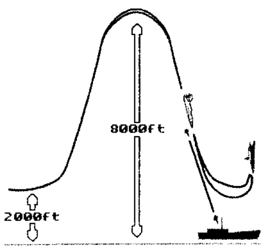
Low-altitude dive bombing

If flying at low altitude, pull up to at least 6,000ft. When you're about a mile out from the target go Into a dive towards it. Line up the sight and release the bombs from an altitude of 2,000 - 3,000ft Any lower and you're in danger of exposing your aircraft to blast damage from exploding weapons. Pull up too late and you'll crash into the ground a short distance behind the target. If you miss the target and want to risk another pass, a neat way of making your second run is to fly straight and level away from the target, pull up into a half-loop, roll out level and then begin a new dive back to the target.

Medium-altitude dive bombing

Classic diving bombing attacks during War World War II were carried out from an altitude of around 8,OOOft Once close to its target, the aircraft would be pushed forward into a dive of 60 degrees or more, 'with dive brakes being used to prevent the speed from building up to a dangerously high level. The Ju-87 Stuka could dive comfortably at an angle of 90 degrees. Pulling out took around ,500ft, so bombs were released typically at around 3,OOOft. If faced with heavy defensive fire, a modem strike aircraft can be flown at around I5,OOOft and pushed over into a dive of around 45 degrees to deliver bombs or cluster munitions. During Desert Storm USMC AV-8Bs used this tactic, releasing their weapons at a height of around 6,OOOft.

When attacking a ground target with unguided weapons you face two problems establishing an accurate aim and ensuring that there is enough height left at weapon release to complete a successful pull-out.



Medium Altitude Dive Bombing

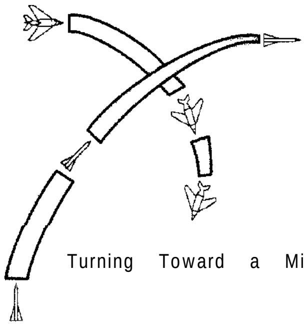
Bomb explosions may look spectacular but their destructive effect is short-ranged, particularly against protected targets such as tanks, bunkers and troops who have time to "dig in". Nothing less than a direct or near-direct hit will score a kill. During Desert Storm in I99 I, highly-trained US pilots were able to land half of their bombs within 30 40ft of their target, but even with this small miss distance the success rate of "iron bomb" attacks against Iraqi battlefield targets was only around 30 per cent, A bomb which misses the target is a bomb wasted.

When pulling up after a dive attack, remember that you need to avoid not only the ground, but also the blast from your exploding weapons. One of the Israeli pilots who took part in the I98 I attack on Iraq's Osirak reactor delayed weapon release to make sure of obtaining a hit but spent the rest of the flight back to Israel with the nagging worry that his F- I6 might have been damaged by bomb fragments.

Firing a guided weapon does not automatically result in a "kill". For a start, you may have fired at too great a range. Also be aware that all guided missiles exhibit variations in accuracy between individual rounds. In some cases the weapon may not explode close enough to its target to score a "kill". FST accurately models these small errors If firing a guided missile doesn't result in a kill the simulation is not at fault. Tty making a second pass and fire another weapon at the target.

If you come under fire from hostile air-to-air or surface-to-air missiles, the timely release of chaff or flares may distract the incoming weapon. When released, a chaff cartridge bursts to release a cloud of fine strands of metalized glass fiber. These form a radar-reflective false target which can confuse a radar-based weapon. Flares are fast-burning pyrotechnic devices designed to counter heat-seeking missiles by offering them an intense heat source which may seem a more attractive target to the missile seeker than the heat emitted by your aircraft. Timing is critical. Release the chaff or flares too soon and the missile will re-acquire you. Release them too late and the weapon will reach your aircraft before being significantly decoyed.

Pulling a sharp turn in the direction of the attack will help break the missile's lock.



Turning Toward a Missile

Never turn away from the mlssile - this gives it a simple "tail-chase" flight path and makes you easy kill. Turning toward the missile forces it to maneuver hard in order to follow you.

If you run out of chaff or flares, a sharp turn might still save you. Once again, timing is critical. The closer you let the missile approach before making the turn, the harder it must maneuver to compensate for your sharp change of course. The missile does not have unlimited maneuvering power, so what you're trying to do is to get out of its way so rapidly that it can't follow.

4. I .5 Weapon Systems

With FST, simulated combat aircraft are armed with a gun and can carry five types of ordnance - air-to-air guided missiles, air-to-ground guided missiles, Anti-Radiation Missiles, bombs, cluster munitions and unguided rockets. There's no way that the FST designers could predict the exact aircraft you want to model, and thus the weapons you'll want to carry. It is of course impractical to load up your hard disk with data on every air-launched weapon ever created. To get around this problem, the weapons provided are "generic" though in some cases you can customize these using the FST World Editor. This way you can select their weight, destructive power and, in the case of guided missiles, agility.

Cannon

Since the First World War, the heavy calibre machine gun or cannon has been a vital aircraft weapon. In the late 1950s and early 1960s over-confidence in the capability of the newly-fielded guided missiles led the USA, USSR and UK to field fighters armed only with missiles, but bitter combat experience in the skies over Vietnam and the Arab/Israel conflict in the Middle East saw a return of the gun. (So successful were the primarily gun-armed Israeli Air Force that they took to describing themselves as "the largest MiG parts distributors outside the Soviet Union"). Calibres of aircraft gun have varied from 0.30" (7.6mm) to more than 40mm. The generic gun in FST is a 20mm cannon. But this might be too powerful for the type of aircraft you're modeling. For example, this would be much too powerful if you're simulating First World War air combat between fabric-covered biplanes, so aircraft or target hardness (vulnerability to damage) can be modified using the FST World Editor. This results in the individual rounds inflicting a more realistic amount of damage. The amount of ammunition you carry can also be defined using the FST World Editor.

Unguided Rockets

Carried in underwing launch pods, unguided rockets are aimed just like the gun. First introduced towards the end of the Second World War, rockets are 2.75" or larger in calibre and pack a powerful punch against a ground target. Since an aircraft can usually only can-y a relatively small number of rockets they should be fired in short salvoes of a few rounds. Several seconds of continuous fire will empty all the rocket pods on your aircraft.

Air-to-Air missiles

In FST missiles are modeled on the US AIM-9 Sidewinder and Russian K- I3 (AA2 Atoll). Both are heat-seeking weapons, which use a nose-mounted Infrared sensor to home onto an aircraft target. Once aimed at the target and fired, they will home automatically. Missiles of this type are best fired from behind the target, since this gives the heat-sensitive seeker a good view of the target aircraft's hot jetpipe. The air-to-air missiles will not lock onto propeller-driven aircraft; so they can only be fired against jets.

Air-to-Surface Missiles

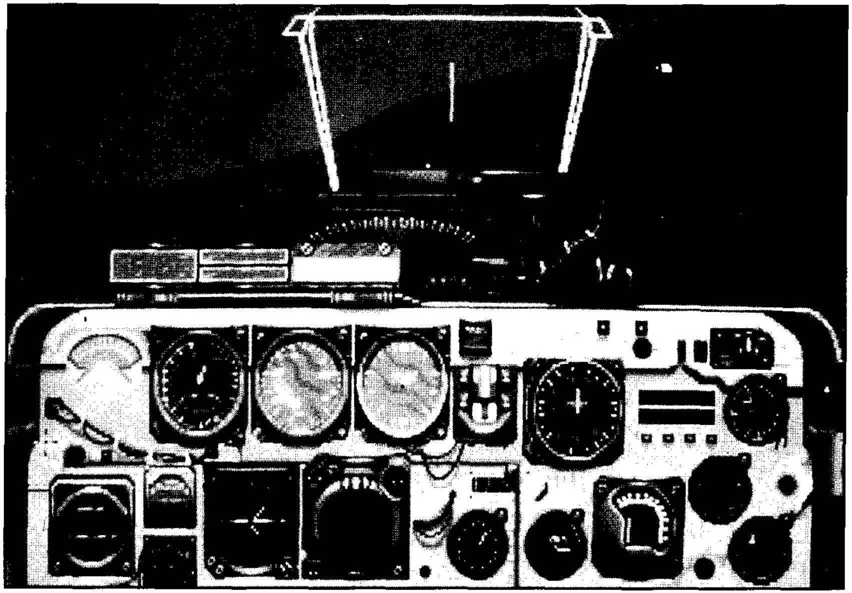
In the real world, current weapons of this type normally require the pilot to lock them onto the target before launch; or must be steered toward the target via a small cockpit-mounted joystick. New designs currently under development are "fire and forget" and that's what FST provides you with. If the aiming mark is reasonably close to a suitable ground target at the moment of firing, then the missile will lock on and home in automatically.

Bombs

Like the gun, the free-falling unguided bomb - often referred to as an "iron" bomb has been used since the First World War. It consists of a streamlined metal casing packed with explosives and fitted with fuses and stabilizing fins. bombs are much cheaper than guided missiles and carry a larger explosive payload. bombs of up to 22,000 lbs have been used operationally but typical modem "iron bombs" weigh from 250lb to 4,000lb. The smaller they are, the more you can carry on a single aircraft

Cluster bombs

Although similar in appearance to bombs, these free-falling unguided weapons contain hundreds of small bomblets rather than a single large explosive charge. Once close to the ground, the Cluster Bomb bursts open and scatters its lethal contents over a relatively wide target area. In some respects, a Cluster Bomb is the pilot's equivalent of a blast from a shotgun. The widespread pattern of destruction created by the exploding bomblets can compensate for minor aiming errors and wreak havoc against tanks, soft-skinned vehicles such as trucks, and troops caught in open terrain. Most of the explosive power of a conventional bomb is wasted since the blast is directed into the sky or down at the ground rather than laterally across the surface of the ground. A Cluster Bomb spreads is destructive effect over a wide area of terrain, maximizing its explosive power. The individual bomblets may be small, perhaps not much bigger than a hand grenade, but their sheer number give a good chance that one will land very close to a target.



4.2 HOW TO RUN THE SIMULATOR - Reference

Introduction

The core of FST is the FLY simulation. FLY is a high performance 32 bit program, it uses all the available memory via any extended memory driver (if loaded), or directly. FLY must be run from the command line for maximum performance.

FLY loads the files created using the FST tools using the world database file WORLD.FST to link all the elements of the simulation together.

How to run FLY

FLY is run from the DOS command line. You must be in the project directory: e.g

C:> CD \FST\GAME <return>

C:\FST\GAME> FLY <return>

runs the FST FLY program at standard VGA resolution (320x200) using all the default data files. Changes to the default configuration can be made using command line arguments (see next section) and through the simulation menu in the flight simulator.

Command Line Options

The command line option processor in FST simulation recognizes a set of switches which control graphics resolution and initial setup of the simulated world. The switch format is

FLY -switch I -switch2 ...

Graphics Resolution Options -S, -A, -V

Hi resolution graphics:

FLY -S 640x480 for S3 based cards

FLY -A " ATI

FLY -V " for PC's with VESA standard BIOS - (no graphics accelerator required)

World File Option -W

FLY -WNAMED.FST will run the simulation loading the world database file NAMED.FST. A named world file is created using the FST World Editor in the normal manner to create a simulation file called WORLD.FST and then renaming the file (either using the Windows file manager or the DOS RENAME command). [To further edit the tile using the FST World Editor it must be renamed back as WORLD.FST] Multiple world files can be loaded from a game shell either to provide different start positions in the same world or to create multiple mission games.

Named Player Option - P

FLY - Pname will run the simulation selecting the named object as the Player (overriding the default set in the World Editor).

This option can be used to create multiple mission games starting from different places and flying different planes in the same world.

Simulator Controls

FST is controlled from the keyboard and optionally mouse or PC game card add-ons (joysticks etc.). The keyboard controls are outlined in this section:

Engine Controls

Engine: E

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

Throttle:

Increase throttle	=
Decrease throttle	–
Throttle min-max	Keyboard I – 9.0
Zero Throttle	UNDERSCORE
Max Throttle	SHIFT PLUS

Hydraulic Systems

Wheel Brakes: W

The wheel brakes work on all wheels, they are used for slowing down after landing. You must release your wheel brakes before starting takeoff.

Landing Gear: G

The landing gear produces a great deal of drag and should be retracted for flight (if not fixed). You Will not be able to raise/lower your landing gear after a hydraulic failure, however it is possible to land with the gear retracted if your vertical descent rate IS slow enough.

Air brakes: B

The air brakes produce extra drag. They are used to slow a fast approach. In combat air brakes are useful for steep ground attacks and in dogfights.

Flaps: S

The flap control increases the angle of the flaps by IO degrees, the flaps can be set to 0, IO or 20 degrees. The flaps Increase the drag and lift of the wing, effectively braking the aircraft and Increasing its slow speed performance.

Primary Flight Controls

Control stick

The simulated control stick (or yoke) controls the flight surfaces effecting pitch and roll in flight. The simulated control stick can actually be driven from a PC joystrck, the PC mouse or keyboard see FST Menu section for selection details

Center stick: Z

Resets the stick center position, this IS useful with the mouse where there IS no physical automatic return to center.

Rudder

The rudder has two uses:
i) on the ground the rudder input controls steering
ii) in the air the rudder control controls the rudder on the tail of the aircraft its effect is to yaw the aircraft (turn it without roll).

By default the rudder controls are on the keyboard:

Rudder left	COMMA
Rudder right	DOT

Navigation Controls

NDB's

NDB's are tracked by the ADF Instrument. FST provides a single NDB radio channel for driving an ADF. NDB's are selected by scanning up (or down) the radio bands from the currently selected frequency.

NDB Scan up	/	(forward SLASH)
NDB Scan down	?	(SHIFT forward SLASH)

VOR's

VOR signals are tracked and displayed by OBI instruments in the cockpit. FST provideds two radio navigation channels capable of receiving VOR (NAV I and NAV2). Selecting a VOR beacon is done by scanning the airwaves for local VOR's from the currently selected frequency.

The OBI cockpit Instruments are set to the required radial by Incrementing (decrementing) the currently selected radial by 2 degrees at a time.

NAV channel I

VOR scan up	
VOR scan down	;
OBI radial +2 degrees	{
OBI radial -2 degrees	[

NAV channel 2

VOR scan up	@
VOR scan down	'
OBI radial +2 degrees	~
OBI radial -2 degrees	#

Instrument Landing System

Select ILS: I

I selects the strongest ILS signal i.e. the nearest.

Weapon Controls

FST has a single weapon system fire control which fires the currently selected weapon. The weapons system automatically deals with guided weapons which require target lock - scanning the world and attaining the best possible lock for you.

Fire weapon: SPACE

Instructs the weapons system to fire the currently selected weapon - if the weapon type selected requires a target lock and none has been attained the fire order is ignored.

Select weapon: BACKSPACE

Selects the next weapon type from the weapons system computer. When the stores for a weapon type are depleted the type IS skipped during selection.

Drop Flare: F

Flares are used to decoy heat seeking missiles F drops two flares which will bum 'or about 5 seconds.

Drop Chaff: C

Chaff is used to confuse radar guided missiles (SAM's).

Jettison Stores: J

Jettisons all armament and fuel containers

View Controls:

Look forwards	**FI**
Look left	F2
Look right	F 3
Look up/down	**F 4**
Look back/left	F5
Look back/right	F 6
Look back	SHIFT F I
Rotate view right	**F7**
Rotate view left	**F8**
Rotate view down	F 9
Rotate view up	FIO

Zoom In	PAGE-UP
Zoom Out	PAGE-DOWN
Missile view	ALT M
Outside view	0
Track view	V
Cockpit view	ALT V

Simulation Controls

Pause: P

Pauses the simulation, press P to restart,

Data Display: ALT T

Activates (deactivates) FST data display which shows internal simulation statistics over the world (top left of the screen).

25	frame rate (frames per second)
103	number of objects in world
223456-	memory used (bytes)

Sky Shading: ALT S, SHIFT S

Changes distance shading on the sky and ground.

Simulation Menu: Esc

Opens the simulation menu, the simulation freezes whilst it is open (see next section for details).

Fast Time: ALT Z

Accelerates simulated time by a factor of three.

Quit FST: ALT X

Simulation Menu

The FST simulation menu can be opened at any time by pressing Esc When the menu is open the game freezes. The menu is controlled using the cursor keys, the space bar and the Enter key:

Cursor up/down- select next/last menu item

SPACE- toggle current selection state

Enter - make current selection and exit menu system

Controls

Joystick

Any selection from the joystick sub-menu will select the PC games card channels I or 2 as the primary controller.

Standard Joystick

Selects a standard analog PC joystick.

Analog Rudder

Selects rudder input on channel 4 of the PC games card.

Analog Throttle

Selects analog throttle on channel 3 of the PC games card. You cannot use analog throttle with Thrustmaster stick selection (select standard joystick).

Thrustmaster Stick

Selects Thrustmaster stick as primary control with Thrustmaster stick hat on analog channel 3 controlling view direction

Thrustmaster Throttle

Selects Thrustmaster throttle (Mark I) as throttle and extra controls input (see section on Thrustmaster for more details).

Calibrate

Calibrates input devices on channels I-4. Ensure that controllers are in neutral positions and press any key to start calibration, move all controllers (do not forget Thrustmaster hat) to their limits and press any key to end calibration.

Mouse

Selects the mouse as the primary flight controller.

Keyboard

Selects the keyboard as the primary flight controller.

Display

Horizon Shading

Turns horizon shading on/off.

Simulation

Ground Crash

When checked hitting the ground results in damage (normally terminal) to the aircraft, When not checked your aircraft will bounce.

G-lock

Turns visual effects of G-lock on/off.

Sounds

Engine Noise

Turns engine noise on/off

All Noise

Turns all noise on/off.

Save as Default

Saves your preferred setup (including joystick calibration) to hard disk. The defaults are loaded automatically when FST is re-run.

Thrustmaster

Thrustmaster WCS Joystick

The Thrustmaster joystick is a standard PC analog joystick with four buttons and a hat which is used for view control in FST.

Trigger	Fire selected weapon
Button I	Cycle weapon selection
Button 2	Gear up/down
Button 3	Air brakes

Hat

Push forward	Look forward (cycle look up / look down)
Push left	Swing view left 60 degrees
Push right	Swing view right 60 degrees
Push down	Look back

Thrustmaster WCS Throttle Mark I

The Thrustmaster throttle has a IO position throttle control, six buttons and a rocker switch.

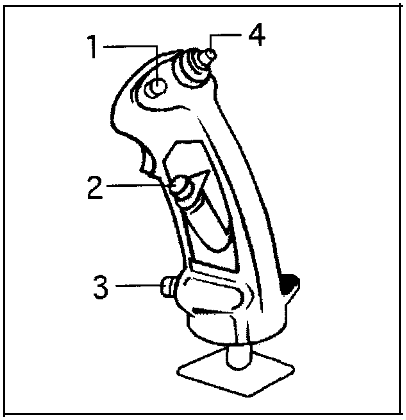
Select DIP switch position 5 for use with FST.

Rocker

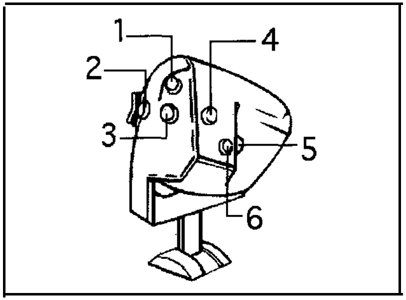
Centered	Forward view
Up	Left view
Down	Right view

Button

I	Drop Flare
2	Drop Chaff
3	Cycle Weapon Selection
4	Flaps
5	Gear
6	Air Brakes



JOYSTICK



THROTTLE

Thrustmaster WCS Throttle Mark II

The Mark II Thrustmaster throttle is a sophisticated controller. It requires programming to get the best performance. The file FST.ADV contains one possible setup for use with FST.

Sound Effects

FST supports Soundblaster and 100% Soundblaster compatible cards to play digital sampled Sound Effects. If a Soundblaster is not detected FST has an internal PC speaker driver which generates fixed sound effects (you cannot change them). If a Soundblaster is autodetected then the sampled sound driver will be activated -this plays samples derived from .WAV files in the current directory-for a detailed list of events and associated files see relevant section in Chapter 3.

Glossary

A

A-A:	Air to Air (as in missiles)
AAA	Anti-Aircraft Artillery.
ADF:	Automatic direction finder.
ACM:	Air combat maneuver;: air combat tactics used to destroy the enemy.
Airmanship:	The concept of good (i.e. safe) flying.
Afterburning:	A way to augment thrust of a jet engine by injecting fuel into the hot exhaust gases of the engine. It greatly Increases the power of the engine but at the cost of very high fuel consumption. This effect can be mimicked by FST.
A-G:	Air to ground (as in missiles)
Ailerons:	Control surfaces on outside trailing edge of wings, determining roll.
Airfoil:	Wing section
Airspeed:	Aircraft's speed in relation to the surrounding air.
Airspeed indicator	Instrument showing the aircraft's present airspeed
ALT:	Altitude above sea level.
AMRAAM	Advanced Medium Range Air-to-Air Missile

Angle of attack: The angle of the aircraft's wing to the airflow over It. The higher the angle of attack, the greater the lift (and drag) generated by the wing, until the stall is reached.

Angle of climb: The angle at which the aircraft is climbing, which can be visualized as the angle of the aircraft's nose above the horizon.

Angle of dive: The angle at which the aircraft IS diving, which can be visualized as the angle of the aircraft's nose below the horizon.

ARM: Anti-radiation missile.

Artificial horizon: Instrument showing the aircraft's altitude in relation to the ground. Used where the true horizon cannot be seen, for example when flying in cloud or at night.

Atmospheric pressure Pressure of air on the earth, measured by a barometer in inches (or millibars) of mercury. At sea level, it would typically measure between 28 and 32 Inches. Also referred to as barometric pressure.

B

Bank: Angle of the aircraft's wings from the horizontal. when viewed from the front or back.

Bandit: Enemy aircraft

Barometric pressure: See atmospheric pressure.

Blackout: Pilot's loss of vision or consciousness under conditions of positive Gs.

Blip: Image on a radar scope.

Bogey: Unidentified aircraft

Break: Defensive combat move if attacked from rear, executed by turning sharply into the attacker's line of attack causing him to overshoot.

BVR: Beyond visual range.

C

Canard configuration: Where the tailplane is positioned at the front of the aircraft and the wing at the t-ear. Canard IS the French word for duck, and Canard aircraft fly similar to how a duck flys.

CDI: Course deviation indicator instrument.

Ceiling: The height of the base of the cloud cover, or an aircraft's maximum altitude.

Chord Wing measurement, taking from the leading edge to the trailing edge.

COM:	Communications (radio)
COM-NAV / NAV-COM:	Radio which combines communications and navigation.
Control yoke	Control wheel and all its connections controlling ailerons and elevator.
Cruise:	Economical cruising speed.

D

Dihedral:	Angle of upward tilt of the wings from the horizontal when viewed from the front or back.
DME:	Distance measuring equipment: indicated by a radio which determines and displays the distance from a VOR in nautical miles.
Dogfight:	Air to-air combat with enemy aircraft at close quarters.
Drag:	Air resistance
Drag factor:	An index for the increasing drag caused by extra fuel/weapons/weight loading.

E

Elevators:	Control surfaces determining the pitch of the aircraft Usually located on the tailplane, except on aircraft with a canard configuration.
Engage:	Commence combat.

F

Fire & Forget:	Missiles with automatic homing device which, once 'locked on' to its target will track and follow the target without further intervention from the pilot who fired it.
Flaps:	Adjustable wing sections, found on the trailing edges. Lowered on landing and take off to increase the lift and/or drag of the wings.
Flare:	The leveling off action executed just before landing, a couple of feet above the runway by raising the aircraft's nose just before touchdown. Also a superhot chemical ejected from the rear of a plane to avoid heat seeking missiles.
Fly by wire:	Sophisticated real-time computer system which controls the aircraft by interpreting control movements by the pilot and then translating them into actual changes in the aircraft's configuration. Fly-by-wire enables pilots to fly aircraft which are inherently unstable, since the computer controls the aircraft's altitude.

G

Glideslope: Navigation aid used on ILS approaches providing vertical guidance to aircraft as they approach the runway to land.

Ground speed: Actual speed of the aircraft. relative to the ground. It is a function of airspeed, windspeed and direction.

Group: A number of polygons grouped together for editing purposes.

H

Heading: Direction in which the aircraft is pointing not always the same as that in which it is traveling owing to the effects of windspeed and direction, Measured in degrees.

Heading Indicator A gyroscopically controlled compass a more accurate indicator than the magnetic compass.

Horizontal stabilizer Also known as tailplane. Part of the tail surface along the aircraft's lateral axis used to help control pitch.

HUD: Head up display. Back projection of Instrument data onto windscreen so that the pilot can read data without looking down into the cockpit.

I

IFR: Instrument Flight Rules. Rules of theair covering times when visibility is poor (See VFR).

ILS: Instrument Landing System.

K

Knots: Nautical miles per hour. A nautical mile measures approx. 6,076 feet. Often abbreviated to Kts.

L

Landing gear The wheels and associated structure which the aircraft uses to land and maneuver on when on the ground. Most aircraft have either a tricycle undercarriage (one undercarriage leg under the nose and one under each wing) or are taildraggers (one wheel under each wing and one under the tall). Landing gear may be fixed or retracted to reduce drag.

LCK: Lock.

Lift The force generated by the airflow over the wing which supports the aircraft

Longitudinal axis: Axis running nose to tall through an aircraft's center of gravity

M

Magnetic: The reading on a magnetic compass.

Magnetic deviation: Angle of variance between geographical or 'true north' and 'magnetic north' which differs from location to location. Should be taken into account for navigation.

MIL Standard power and acceleration measure

MRM: Medium range missile.

N

NAV: Short for navigational, meaning navigational radio.

Navaid: Navigational aid. Usually (but not always) electronic.

NBD: Non directional beacon.

Negative Gs: One 'G' force is the force of gravity when one is stationary and standing on the ground. When aircraft maneuver rapidly, the pilot feels an apparent increase in the force of gravity caused by centrifugal or centnpetal force Positive G is this force acting downwards and negative G the same force acting upwards. This is the same force which you experience (mildly!) as a lift starts and stops.

NWS: Nose wheel steering.

O

Omni-bearing indicator: Indicator relaying information about the aircraft's positioning relation to the VOR station it is currently tuned into.

Overshoot: To fly over and past an objective. such as a runway when approaching. or an enemy target aircraft.

P

Pitch: The movement of the aircraft about the axis, passing laterally through its center of gravity, i.e.: from wingtip to wingtip.

Point: A position in 3D space defined by its distance from the origin down the X, Y and Z axis.

Polygon: A flat colored surface defined by a number of points (2 - 8) defined in 3D.

Positive G's: See Negative G's

R

Radar Radio detection and ranging.

Radio stack: The area where the COM, NAV and transponder radios are installed in the instrument panel usually stacked on top of one another.

Rate of climb: Measured in feet per minute, this is the rate at which an aircraft is climbing read on the vertical speed Indicator in the cockpit.

REO Display: Radar/Electro-Optical display.

Roll: Rotation of the aircraft about its longitudinal axis, i.e.: when viewed from ahead or behind.

Rudder Control surface of the aircraft determining yaw, located on the trailing edge of the fin.

S

SAM, Surface-to-air missile.

Shape Level: A number of groups which when drawn in the virtual world (or shape viewer) defines the visual appearance of an object when at a certain distance from the viewer.

Shape : A number of shape levels that together define the appearance of an object at all visual ranges within the virtual world.

Skid: When the aircraft is flying at an angle to the direction of the airflow. A very 'draggy' way to fly and normally either the result of poor airmanship or a deliberate way to induce very high drag

Spin: Rapid and stable rotation of the aircraft about one wingtip caused by one wing being stalled and the other one fully or partially unstalled. Particularly dangerous close to the ground. Standard recovery technique is to centralize all controls, ease forward steadily with the stick until the rotation ceases, then steadily ease out of the resulting dive. Allow yourself plenty of altitude for practIce!

Stall: Sudden loss of Increase and drag caused by the breaking up of the airflow over a wing. Caused by either a too high angle of attack, or too low airspeed or a combination of the two. A dangerous maneuver close to the ground which may lead to a spin.

Stall speed: Slowest speed at which the aircraft can fly speed at which the aircraft will stall.

Standardized instrument Cluster: Industry-standard placement of the 6 most commonly used flight Instruments. Top row left to nght: airspeed Indicator, altitude indicator and altimeter. Bottom row: (left to right) turn co-ordinator, heading indicator and rate of climb indicator.

All the objects in each Project are Shape files to which you give location and other propertieswithin the world (i.e., the World file). Aircraft, other transport and friendly/enemy forces are also all given their properties within the World file.

As you grow more proficient you can define not just the appearance and performance envelope of the aircraft within the simulation. but quite literally all attributes of everything -that's why we call the resulting simulation a "virtual world".

We'll assume that, to be reading this QuickStart Tutorial, you're not the sort of person who approaches computer software the easy way, so here, as just a taster of FST's potential, is how to define a shape in this case a warehouse and position it in your virtual world, having defined its role within the world i.e., its properties But keep your FST manual close at hand -there may be points you want to look up in more detail.

3.Using the Shape Editor to create a Warehouse

What this tutorial aims to do is teach you how to build a fairly straightforward object then how to place it in your Virtual World. This is always the way objects are created in FST. As in real life, they are drafted and constructed beforehand, then when the final design is satisfactory , they are put in position in the virtual landscape (which can be designed at any stage or as you go along). So don't attempt to create a building or other object 'in situ' it won't work!

Warehouses are big regular shaped buildings which are easy to construct in FST. Having loaded the software, start the FST Project file by clicking on the Project menu and selecting the CREATE function, then define the Project you wish to create the warehouse within Use standard Windows terminology to specify the Project files location.

Then open the FST Shape Editor by clicking on the relevant button.

You might like to use File/Open to inspect some of the pre-created Shapes and get some tips about how they are built up. However, we're going to build a warehouse and to start the whole thing off, you need to select Flle|CreateNew. The main FST Shape Editor window constantly gives you a 3D view of whatever you're creating. The Menu Operations along the top and tool buttons down the left hand side of the display give you all the powerful drawing aids you require. At the same time, the window on the right hand side gives you a real time picture of the shape you are creating in each plane. Along the bottom is your color palette. We'll come on to this later.

Think about a warehouse in its most basic form In simple tens it actually consists of a "box" shape (called a "cubold" in FST) with a sloping roof on top. Visualize its total shape as two shapes stuck together the basic box shape and the roof shape. This is how you need to think in order to create the object in FST Shape Editor as you will be constructing the two elements separately, one on top of the other.

Since any respectable warehouse is going to be big - maybe 60 meters by 40 meters, the first thing you should do is adjust the grid on which you are working. Do this using the grid/ IO Meters menu option.

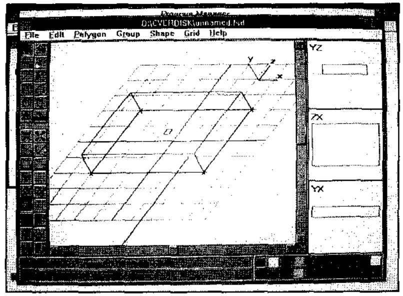
Now zoom the picture out, using the appropriate tool button, so you will be able to see the Warehouse as you create it. Do this by clicking on the top nght hand button of the lower button group.

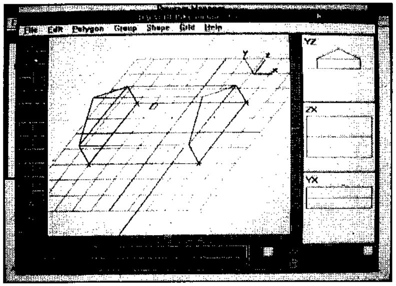
Now let's draw the "cuboid" base of the warehouse shape. The grid defines ground level and the heavier lines on the grid define the center of the object. Lets make the warehouse 60 meters wide and 40 meters deep. Each square on the grid is I Om x I Om. To draw the cuboid, first click on the Cuboid tool button. (That's the one with the box picture on it - fourth down on the left hand side in the top set of buttons). Then define the floor plan of the warehouse by clicking on each "comer" around the center point.

Make the first click on the grid point 2 boxes "forward" (from your perspective) of the center point and 3 boxes "to the left". Then click on the "forward/right" point, which will be 6 boxes "in front of' this first point. Note that each time you click on a grid point, the software marks the point with a red cross. Now complete the shape by clicking on the "right/back" comer and lastly on the "back/left". Watch what happens.

FST Shape Editor automatically constructs the box shape you wanted scaled at 60 meters across, 40 meters deep and IO meters (the default size of the grid you originally selected) high. Now all it needs is a roof and some coloring and it'll be complete. A word of caution: note that the order in which you click the points to define your shape determine which plane you are working in. In other words, if you're not careful you may find you are designing something inside out' or below ground level! By clicking on the point in clockwise sequence, the software knows that you want the object to be realistically and logically shaped when seen from your viewpoint.

The roof is defined using another shape button - this time the one immediately to the right of the cuboid button you just used now. Move the grid "up" IO meters by clicking once on the + button (second from the bottom, lower group, left hand side). The grid now corresponds with the top of the hangar's current roof line. (See how the location of the grid line is shown in real-time on the three single view windows on the right hand side of the FST Shape Editor).





Click on the roof shape button and define the base of the roof (again it's Important to do this clockwise, as you did the floor plan of the warehouse). The warehouse now has a roof. All that remains is for you to color in the warehouse and then you can positron it, and make as many carbon copies of it as you want to scatter over the landscape, in your Virtual World.

The color key is in the lower right comer of the FST Shape Editor, So far you have dealt with SHAPES, but you want to color PLANES, i.e., you want the sides of the warehouse one color and the roof surfaces another. So change from the default Shapes tool to the Planes tool by clicking on the Planes button (top button, top section, right hand side). Then click on one of the large roof planes, then click on the gray color - extreme left of the palette. Repeat this for the other roof surface.

We suggest you use a lighter color for the warehouse walls. But you won't be able to click on every surface of the shape unless you rotate it within the window. With FST Shape Editor you can rotate your objects, as you work on them, in all three dimensions.

In this case you want to turn it round its vertical (y) axis Do this by clicking on the Rotate Y Axis button (fourth from the top, lower block, left hand side) until you have defined colors for all surfaces of the warehouse.

Your warehouse is now complete. Save it using the FilelSave command. You'll want to see what it looks like in solid, not just as a wireftame, so click on the Solid button (extreme bottom left).

Congratulations! You've just constructed your first Object. And contrary to what you may think, you'll actually find your warehouse comes in rather useful. It provrdes a bit of useful scenery and can be used for many other functions if you specify certain "Properties" when you insert it into the virtual landscape. The next section illustrates how some of these concepts work and provides you with an outline for preparing your own complete scenario based on a hypothetical, but lifelike, simulation.

SECTION 2: ADVANCED TUTORIAL

Creating a Simple Combat Scenario

Let's structure a scenario. Suppose you're already fairly proficient at "shoot-em-up" style simulations and you want to set yourself, and your friends, a more difficult proposition. With FST you have enormous scope!

Let's also assume that you have experimented with the FST Editors and can see that it is possible to create or modify the clipart aircraft and other object shapes that come with the system and are loaded into the Library directory.

Setting the Scene

It's 1943, the height of the U-Boat war. You are RAF Coastal Command, with a coastline and shipping to defend from U-Boat attack. Your aircraft ranges the ocean, seeking out and destroying surfaced Nazi U-Boats. The aircraft themselves are obsolete and defenseless bomber types - but that doesn't matter because they are well out of range of Nazi land based fighters and the Nazis never had aircraft carriers.. But did you realize the Nazis did lay down and actually launch an aircraft carrier. Suppose they had actually commissioned it?

Suddenly, the whole picture changes - with the sailing of the Nazi's first aircraft carrier -the Graf Zeppelin. (In fact, and fortunately for the allies, the RAF got to the Graf Zeppelin before she was completed, damaging her and her yard so badly that the Germans never finished the project).

But this is not real life, this is simulation, and in simulation anything can happen limited only by your own imagination and your dexterity with the software.

So let's examine this challenge in a bit more detail. The aircraft carrier Graf Zeppelin is approaching your shores. Her escort of U-Boats is so formidable that your surface fleet is neutralized. She carries a powerful fighter force of navalized FW 190's. Your task is to sink her escorting U-Boats, then she will be forced to break off the action because she will be cold meat to your surface fleet. But her U-Boats are all armed with powerful flak and sail brazenly on the surface under the protection of her FW I90 fighter umbrella.

Sink the U-Boats and you win. But if the U-Boats' flak and the Graf Zeppelin's FW 190's shoot down all your Spitfires, you have lost and the command of the seas passes to the Nazi aircraft carrier.

Let's look what you can do with FST to recreate this situation as realistically as possible. In order to mimic this scenario you will need to:

I Edit the aircraft carrier shape which comes in the FST clipart collection (the USS Nimitz) until it looks to you like a Nazi aircraft carrier. Since (fortunately) no one ever saw such a ship, you have the freedom to change this shape as little or as much as you wish.

2 Give the Graf Zeppelin Shape the Property of a "Hangar", so that FW 190's fly out when your aircraft approaches.

3 Define the navalized FW I90 fighters which would operate from the Graf Zeppelin. If you think that a hypothetical navalized FW I90 suffered a performance penalty over it's land-based cousin, you need to change the properties of the navalized FW 190. With FST you specify this too.

4 Define the U-Boats -their shape and their anti-aircraft artillery capability.

5 Lastly, you must specify your own resources: how many fighters and how many airfields. Maybe YOU want to add a further layer of complexity by giving yourself a bomber force as well. Really, the sky's the limit... For the purpose of this tutorial, we'll restrict the simulation to a fighter war.

So let's look at each of these processes in turn:

I Use the Nimitz shape as a basis for the Graf Zeppelin.

First you must open the Nimitz shape and save it as the Graf Zeppelin Do this by clicking on the Shape Editor button to load the FST Shape Editor Tool from the FST Project Editor. Then use the File|Load menu function to load the file called Nimitz from your default FST clipart directory (See Setup instructions for further details of default set-ups). Save it with a new name using the File/Save As menu function. Give it the name Grafzep. FST will automatically add the file extension .FSD.

Now change the hull shape of the Nimitz. How you want it to look is up to you. But one obvious difference is the flight deck Every World War II aircraft carrier had a "straight through" flight deck, not the "angled" flight deck which you see on the Nimitz. So let's see how to remove that angled flight deck.

To see the whole aircraft carrier in the viewer zoom out using the Zoom Out Button (top right, lower bank of buttons) until you can see the whole ship. The angled flight deck is that part of the flight deck sticking out to the left hand side of the ship. Remove it gradually by clicking on each part using the mouse. As you highlight each part of the shape it will color red.

Remove it with the Del key or the Edit|Cut menu function. To remove polygons (structured 3D shapes), click on the top left button of the top bank of buttons, to remove planes (2D components of the Nimitz), click on the top right button.

When you have removed the angled deck use the drawing tools -the buttons in the upper bank of buttons, to structure a new hull. You will need to rotate the ship about its Y-axis in order to work on the left hand side of the ship. Do this with the fourth button down of the lower bank of buttons. You will have noticed by now that the upper bank of buttons are drawing tools, while the lower ones assist you in manipulating the shape.

The grid which you see is three dimensional and we covered how to use it in Section I of this tutorial when we built the warehouse. Move the grid up the ship shape, using the + Button (bottom left) so that you can work on different parts of the shape.

We cannot tell you WHAT to do to the shape to change it from the Nimitz to the Graf Zeppelin -that's down to your imagination, But if you experiment with the drawing tools you'll find that you have all the resources you need to produce exactly the image you want. When you have finished the shape, use the File|Save menu function to save it. Then whenever you want an FST Project to include your Graf Zeppelin shape, simply copy the GRAFZEP.FSD file into that Project's directory.

2 Give the Graf Zeppelin the properties of a "hangar".

Next you should position the Graf Zeppelin into the Project's "World".

Do this by clicking on the World Editor button from the FST Project Editor to open the FST World Editor. You will see the FST World divided up into gridsquares. Select the part of the total "World" you want to place the Graf Zeppelin (preferably sea!) by clicking on it with the mouse. You will notice that you can select different parts of the world using the mouse before you click on the World Editor button.

With FST World Editor open, choose where you want the Graf Zeppelin to be and move the mouse pointer over it. Make sure the Object Editor button is highlighted (top left button), click the Place Object button (top right, lower button block) and then double click on the location you want to place the Graf Zeppelin.

This opens the Open Properties dialog box. First select "Hangar" from the drop down edit box CLASS. Then give this hangar the shape you have just created by selecting "Grafzep" from the alternatives in the Shape drop down edit box. Click on the Properties... button at the bottom of the dialog box. This opens a further dialog box which you can use to populate the Graf Zeppelin with its complement of fighters. Select FW 190 as the shape to use, FOKKER as the Model and click on the Fighter radio button. Then click on Enter to shut this dialog box and Enter again to save the properties of this object.

3 Change the properties of a "navalized FW 190".

If you want to change the performance or armament parameters for your navalised FW **190,** simply edit the Model file using the FST Model Editor. Explore the options, you'll find most of them are self-explanatory.

4 Define the U-Boats and their AAA capability.

You can position U-Boats in the sea around the Graf Zeppelin in the same way that you placed the Graf Zeppelin herself in the virtual world

Use the FST World Editor, but instead of using the properties option "Hangar", select "AAGun" and instead of "Grafzep" use the Shape "U-boat". Clicking on the properties. button will offer you options for the AA gun. Enter values that seem realistic to you for Burst Rate (no of shells in each salvo), Burst Time (speed of fire) and Reload Time. When you run this Project you may find you want to change these parameters you can easily change them in exactly the same way that you set them up,

5 Specify your own resources.

Having achieved the first four steps above, you already know how to add objects to the game and have defined their properties. You can insert your own airfield or airfields (using the hangar properties and any suitable shape for a "base"). Specify the shape of fighters you want to use (Mustangs? Spitfires? The choice is yours) and their properties using the Model Editor.

Start the simulation by copying all the files you will be using into the directory for this simulation using the Windows File Manager, together with the files listed in the 'Anatomy of a Project' section.

Then exit Windows and start the game from DOS by typing FLY at the simulation's directory prompt. If it doesn't work exactly as you planned (or if you find it either too easy or too difficult to win) simply use the FST tools to modify the simulation exactly as you please.

Credits

Design and programming	Jonathan Newth & David Payne of SIMIS Software
Producer	Darren Andenon
Marketing Product Manager	James McCormack
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3D Shapes and Artwork	Dee Lee, Jason Cunningham, Caroline Stroud, Alan Tomkins, Mark Richards, Rob Hill, Jo Groombridge and Matt Hicks
Manual	Julia Battersby, Jonathan Newth & Tammy Williamson