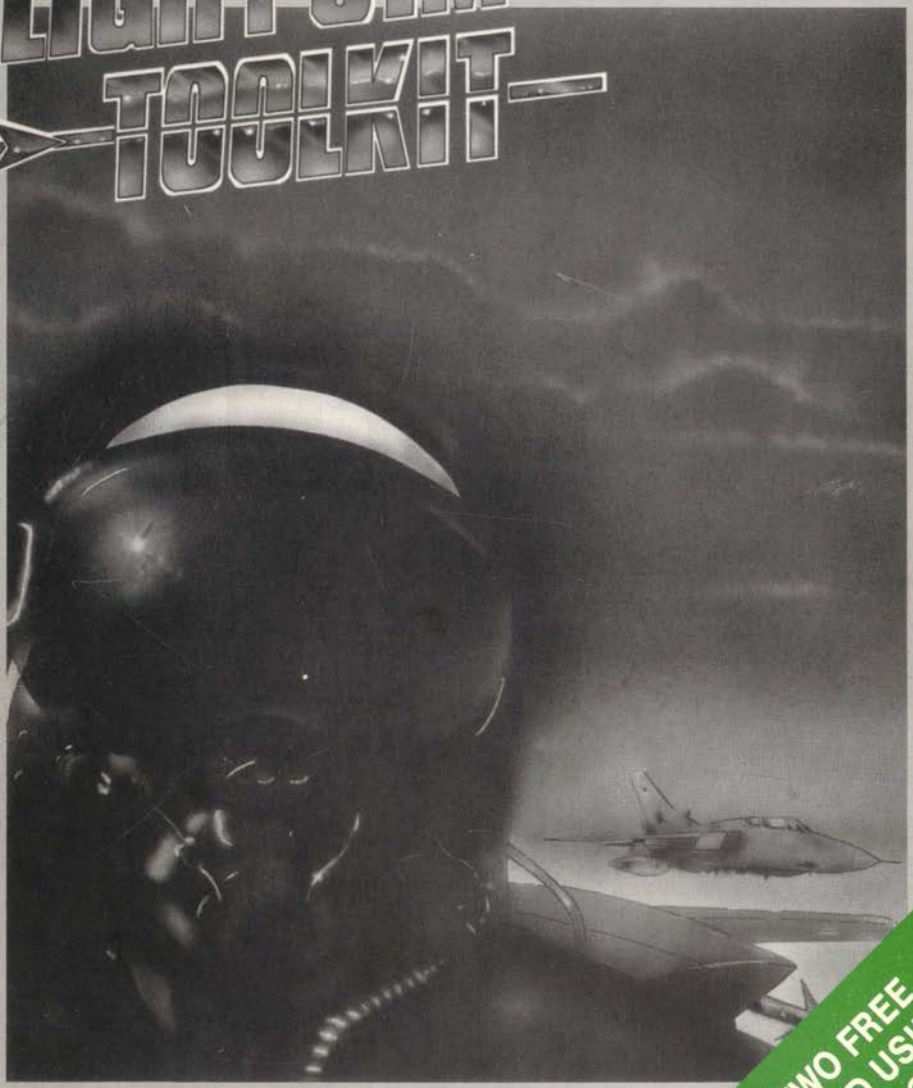
FLIGHT SIM TOOLKIT



SIMIS

INCLUDES TWO FREE GAMES CREATED USING THE *"FLIGHT SIM TOOLKIT"*

Contents

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Technical Support

Technical Support will be provided if a query is sent in writing to:

Flight Sim Toolkit
Simis Ltd
26 Chitty's Walk
Keens Park
Guildford
Surrey
GU3 3HW

Queries may be in the form of a letter or may be faxed on:

0483 235275

Alternatively send a disc with a readme file and an example.

Credits

The Software Authors;

Jonathan Newth

David Payne

Manual Editor;

Chris Tubbs

Box Artwork;

Artwork Unlimited

Pre-Flight Briefing

Before you get started a few words on how to use the manual.

We recommend that you spend time to read the Introduction and following chapters on Creating a Simulation, Creating Shapes, Creating a World, Combat, Hangers, Depots and routes, which are found later in Section 1, to acquaint yourself with the general principles of flight simulation creation. This will make life a lot easier in the long run.

Once you do get started you will find the user interface to the tools intuitive and that you need only refer to the manual when something is not clear. We do however suggest that you read the start-up and basics paragraphs in the tools chapters to gain a head start.

Installation

Risc OS

This manual assumes you are familiar with the Risc OS operating system. If you are new to the Archimedes the Welcome Guide explains how to find your way round the desktop.

Backup

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

The Discs

Flight Sim Toolkit comes on two discs which contain the following;

Tools; Contains the !Shape, !World, !Model, !Cockpit, !View tools; !System and !Sysmerge and also the base simulation !Flight.

Examples; Contains two example games, a directory of shapes.

Single floppy machines

When you are ready to start, load the Tools disc into the drive and click on the floppy disc icon on the icon bar. A window will appear showing the files on that disc.

Now follow the instructions for starting a tool as detailed at the start of the appropriate tool's chapter in Section 2.

Saving your work is simple and described in the tool's Save paragraph.

Hard disc machines

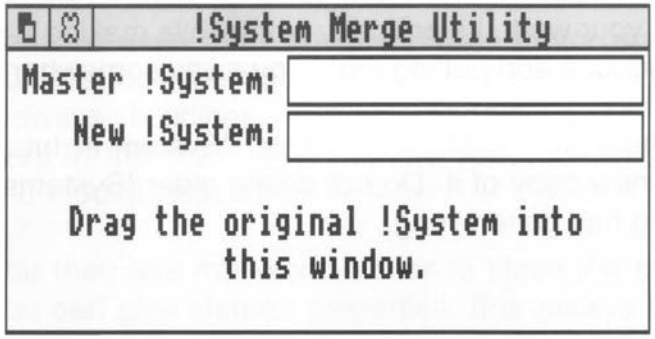
If you use a hard disc, it is recommended that you create a new directory called 'FST' and then copy both of the floppy discs into it.

You will then have to carry out a SysMerge as follows:

First you should select one !System to be be your master !System. If you are a new user of RISC OS computers, this should be the !System supplied on the First Applications Disc. All modifications should be made to this !System or a copy of it. If necessary copy

this master !System to a disc with plenty of free space. You might want to copy it to a newly formatted disc which can become your master system disc. (If so, your should give the disc a recognisable name, for example SYSTEM, using Name disc from the disc icon menu). Copy !SysMerge to the same disc as the master !System so it is readily available. You are now ready to start building your master !System.

Startup the !SysMerge application by double clicking on it. A dialogue box like this will appear



Drag the master !System directory to anywhere in the !SysMerge dialogue box. The upper box (for the Master !System) should change to path name containing your master !System. You should now drag a !System which you wish to add or consolidate into your master !System. The pathname for this will appear in the lower box. (If you use a purely floppy based system you may have to change discs during this process. If there are no problems the !Systems will be consolidated and the message "!System Updated" will appear. If there are problems, you should read the error messages and take appropriate actions. The only common error message you may see is "disc full" which should not occur if you are consoliding onto a new system disc. If you have additional files on the master !system disc you should move them elsewhere.

If an error occurs !SysMerge will report "Update failed. Correct problem then drag the ...". Once you have resolved the problem you can restart the merge process.

When !SysMerge is finished you can quit the application either by menuing on the !SysMerge window and selecting QUIT or by selecting the CLOSE () icon on the window.

You should repeat the above process on all the !Systems on all your discs until you have the one master !System. This can then be used for all your work. Its probably worthwhile making a copy of it once it is produced and putting that copy away somewhere safe.

Remember when you modify your master !System in future, you should take a new copy of it. Do not delete older !Systems just in case something has gone wrong.

Introduction

The Flight Sim Toolkit is a set of tools that allow you to create a complete flight simulation. You can either start from scratch and define every detail or you can modify one of the examples provided.

There are many important elements to consider within a complete simulation. Starting from a working example allows you to add your own features one by one and test the result immediately.

The two main tools are the Shape Editor and the World Editor. You first use the Shape Editor to create new shapes for aircraft, runways, buildings, bridges, roads. rivers or anything else you want in the world. Alternatively you can choose existing shapes and modify them later.

You then use the World Editor to place the shapes in the world. You can give shapes properties. It is always a good idea to give runways the land-on property or you will not even be able to taxi around your airfield. You can even define a shape to be an enemy hanger, which will produce enemy aircraft when you fly too close.

If you want to design your own cockpit layout you use the Cockpit Editor to position dials and readouts within the background of a sprite. You can use !Paint or any sprite editor to create a cockpit background.

You can change the performance of your own or enemy aircraft using the aircraft Model Editor. You can vary performance from a Cessna 152, to a Pitts Special, using propeller power, or from a Hawk trainer up to a Tornado with a jet engine. You can even create unlikely or impossible types of aircraft.

Section 1 contains a description of the elements of an FST flight simulation, and the concepts behind the design of FST. Section 2 describes in detail the RiscOS tools required to create the various elements of the simulation. Section 3 concerns itself with the actual flight simulation itself. There is an obvious corespondance between chapters is section 1 and 2; the chapter in section 1 describing philosophy and design and the chapter in section 2 describing the associated RiscOS tool.

Section 1		Section 2
Creating a Simulation	<>	Project structure and datatypes
Creating Shapes	<>	!Shape
Creating a World	<>	!World
Designing Aircraft	<>	!Model

Section 1

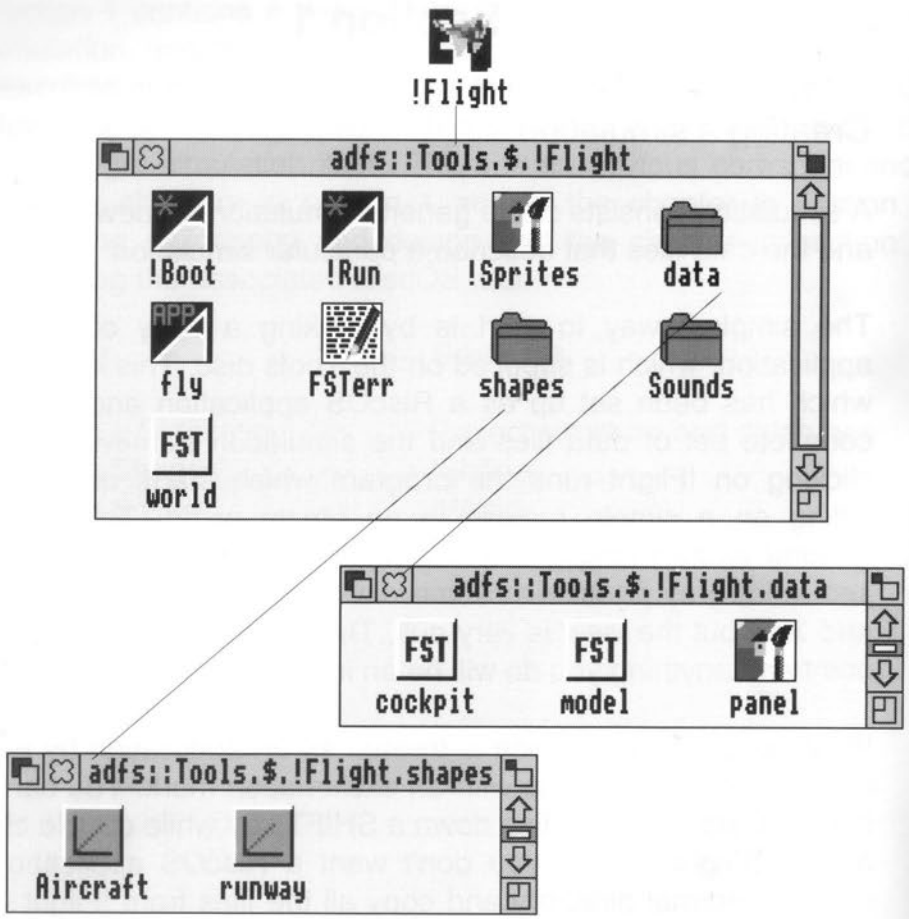
Creating a simulation.

A simulation consists of the general simulation framework program and the data files that describe a particular simulation.

The simplest way to start is by making a copy of the !Flight application, which is supplied on the Tools disc. This is a directory which has been set up as a RiscOS application and contains a complete set of data files and the simulation framework. Double clicking on !Flight runs the program which starts up with a jet sitting on a simple runway in an empty world. The jet has a general aircraft shape and average performance. The cockpit is just a flat grey panel with some dials. You can take off, fly round and land but the view is very dull. This is however a good starting point and anything you do will be an improvement.

!Flight is a directory which is treated as an application by RiscOS because it's name starts with an exclamation mark. You can open it as a directory by holding down a SHIFT key while double clicking on the !Flight icon. If you don't want a RiscOS application just create a normal directory and copy all the files from !Flight into it. You don't need the !Boot or the !Sprites files in a standard directory. You can then run the simulator by double clicking on the !Run file in the new directory.

You will need to open the directory to modify the data files which control the simulation. The type of a data file is shown by its icon, provided a directory containing the appropriate editing application has already been opened. You can modify a data file by double clicking on it's icon or by dragging it to an already running editor.



'Fly' is the program that runs the simulator. It is started by the !Run obey file. Once started it reads the data files in the simulation directory to let you fly in the world you have designed. All the data files must be present for the simulation to work.

'Shapes' is a directory that contains all the shape definition files for a particular simulation. Shape files can be created and modified by the shape editor. The shape designer is the application !Shape supplied on the Tools disc.

'World' is a file that describes the position and properties of all shapes in the simulated environment. 'World' can be modified by the application !World supplied on the tools disc. Before any shape can be added to the world it's definition file must already exist in the Shapes directory. You may want to start with simple shape definitions to add to 'World', and then create the final shapes later. For example all buildings can start as copies of a box shape and then be made more realistic when you are ready. The names of shapes used in 'World' are the filenames of the shape files in the Shapes directory.

The data directory contains the remaining files required by the simulation. These are the cockpit data file (cockpit), the cockpit sprite (panel) and aircraft model files (in this case just one - model).

Sounds contains sound samples. (It is optional)

FSTerr is created by the simulation if any error occurs during execution.

You can change the features of the basic simulator in any order. You can include items from the examples by replacing any of the files in the directory with the equivalent file from an example. In particular you may want to copy shape definitions from the Shapes directory in an example to the Shapes directory in your new simulation.

You may want to improve the appearance of the cockpit, either by referring to a photograph of a real cockpit or by designing your own. Use a sprite editor (!Paint for example) for the background and then position and scale the instruments on the sprite using the cockpit designer. The cockpit sprite is in the sprite file 'Panel' and the instrument layout is in the file 'Cockpit'. The cockpit designer is

the application !CockpIt supplied on the tools disc.

To change the performance of an aircraft you use the aircraft designer, !Model. Choose between propeller and jet power and setup the aerodynamic properties of the aircraft.

Creating shapes.

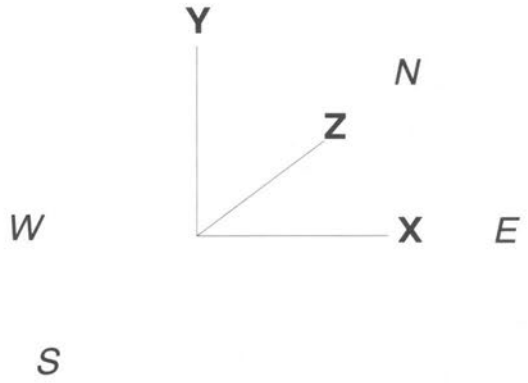
You use the application !Shape to create and modify shapes. The Shapes directory contains all the shape files for a simulation.

You can run the shape editor by either double clicking on the !Shape application or double clicking on a shape file. Each time you double click on a shape file you run a new copy of the shape editor, you may find this useful for comparing shapes, but you may not have enough memory to run multiple shape editors. It is more usual to drag a shape file onto an open shape editor window, or the shape editor icon on the icon bar.

A shape is 3 dimensional structure composed of flat coloured surfaces called polygons. A polygon has a number of points, 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.

Before you can define any polygons you have to position the points that will be polygon vertices. A shape has a centre called the origin. A point is defined by distance from the origin in each of 3 directions. These directions are called the X, Y and Z axes. The Z axis is defined as towards the front of a shape. If you imagine yourself facing forwards along the Z axis then the X axis is from left to right and the Y axis is from below to above. You can position points with either positive or negative distances along any axis. A distance along an axis is called a coordinate.

Distances are measured in metres and kilometres, accurate to the nearest 1/8 metre. This is convenient for the size of objects normally seen in flight simulators. There is a limit of plus or minus 2000 metres for any coordinate in a shape. If you want to create a shape bigger than 4000 metres across then it must be composed of several shapes that are within the limit.



The simulated world has North in the positive Z direction, South in negative Z, East in positive X, West in negative X, up in positive Y and down in negative Y.

The ground is defined as being at position 0 on the Y axis. You can't fly underground which would give you a negative Y coordinate. Any shape which will be on the ground should only have positive Y coordinates or parts of it would be underground. For example a simple box shaped building would have 4 points with a Y coordinate of 0 and 4 higher points with a Y coordinate at the height of the roof.

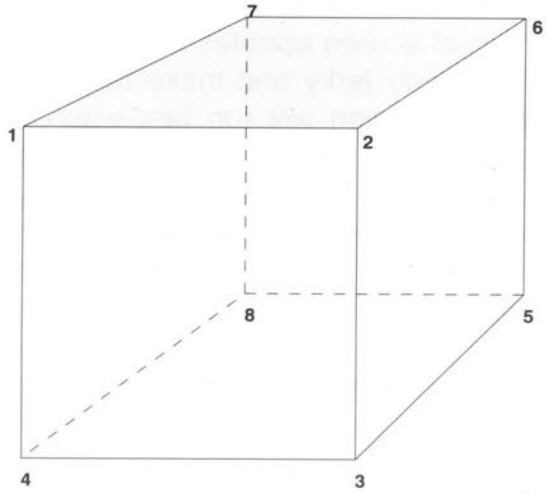
The shape editor works with flat planes on which you place points. The easiest way to visualise this is as a stack of graph paper. You can choose which individual piece of paper you draw on at any

time. The planes can be in any of 3 orientations. The shape editor uses planes cutting across the X, Y and Z axes. Most buildings and other artificial structures have sides which are in one of these planes and can be constructed using just one plane. The Y plane is the obvious choice as it is easy to visualise a building being constructed from the ground up. You can define polygons in any other orientation by moving the editor plane while connecting points.

You can edit shapes of very different sizes with the shape editor. When you first open a shape editor window it shows a view 4000 Metres across. This is the largest shape you can create. For smaller shapes you should zoom in until your shape fills the window. Use the grid lines to show you how large the shape is.

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 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 1, 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.

You can check the appearance of a shape by viewing it. This is the 'View' menu option in the shape editor and shows the shape as it will appear in the simulation. You can rotate it to check that it looks OK from all angles. Any polygons defined inside out will be obvious and you can flip them over.

If you want to see both sides of a surface you have to define a polygon for each side.

You can create lines as polygons with 2 points.

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 appear jerky and make controlling the aircraft more difficult. Your simulation will run fast when it is drawing as few polygons as possible. This means that shapes that are far away 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 50 polygons, when in the middle distance it may have fewer than 10, and in the far distance 5 lines is usually enough.

The shape editor expects each shape file to have three shape definitions. The first for near, the second for middle distance, and the third for far. You can choose the distances at which shapes change. If the change happens too near you will see the low detail shape. The distances depend on the size of the shape and your preference for good detail versus speed. The shape View option allows you to move away from the shape and check that the change is visually acceptable.

When you create roads and rivers you should use lines until you get quite close. You will usually be flying quite low and a line in the middle distance looks better than a polygon seen edge on. Look at the rivers and roads in an example to see how this works.
You have to define three shapes for each object in the world. The editor allows you to copy shape definitions between levels. You will probably find it easiest to define the near shape first and then copy it to the middle level. You can then delete some polygons and points to define the middle distance shape as the same size as the near shape. The middle shape can then be copied to the far shape and more polygons and points deleted.

You should use the Shape editor to look at some of the example shapes to see how the system works.

For a detailed description of the shape editor refer to the !Shape reference chapter.

Creating a world.

The World file contains all the information about the positions and properties of shapes. It can be modified by double clicking on it or dragging it onto the !World application window or icon bar icon.

Your simulated world is limited in size to a square 100 Kms on a side. When you first open the world editor window you will see the whole area. You can select any object in the world and zoom in see its position in more detail. Use the grid lines to show you how large the current window is.

You have to choose the colour of the ground. For a land based simulation this should be a dull green or brown. You can choose any colour from the standard 256 colour palette. You then add shapes to this base to make the world more interesting. Rivers, roads, fields, towns and hills are all possible.

If you want a sea based simulation then make the ground a sea blue. You will have to create islands as shapes on the sea. The limit of 4000 metres for the size of a shape means that islands will have to be synthesised from smaller shapes. You will have to stick to small islands unless you want your simulation to run slowly. You will have to experiment with different setups to discover what works. The example !Tornado is a sea based simulation.

You will always need a runway to start from. You should make a runway at least 1 Km long and 100 metres wide. If it is much smaller then you may be unable to takeoff before getting to the end, and landing will be very difficult. You should give runways the

land-on property, and choose one to be your start point. If you don't have at least one runway with start-point and land-on properties then the simulation framework will stop and complain. You can give any other flat shape the land-on property, so you can land on roads if you want. It is even possible to create an aircraft carrier by giving a suitable shape the land-on property. You will need to make it quite large if you want to stop on it after landing.

You will probably find that creating roads and rivers is the most difficult part of the world. The main problem is getting shapes to join up accurately. The easiest way to to this is to design the separate bits to fit onto the grid. For example you may want all road bits to be 1 Km long with the centre 500 metres from each end. You can then set the grid in the world editor to be 100 metres, enable the snap to grid option, and position the road bits exactly 1000 metres apart. This will guarantee that they join up.

You will probably not want a different shape for each bit of every road and river. It is easier to design some useful components and reuse them. For example a road running East to West only needs one shape, which you can reuse as often as you want. Rivers are more complex, but you will probably find it easiest to design a basic unit from several shapes and then repeat this unit. The examples show this technique in action.

You will find it quite simple to design a world, but it takes some practice to make it look good when you are flying around it. You should aim to put in enough objects so that something is always in view, but not so much that the simulation runs so slowly that flying is difficult.

Navigation

If you want to navigate in the world you can include radio beacons. These are VOR stations, and should look like radio masts, although you can disguise them as anything you like. You should also design your cockpit with a VOR instrument if you want to see the bearing to one of the VOR stations. You can make any object into a VOR station by giving it the VOR property and an identification code.

Combat

When you have created a world, you may want to turn it into a combat simulator. You do this by adding enemy objects. You can make any object into an enemy by giving it an enemy class.

AA Gun

AA Guns are ground based point defences. They are fairly accurate and difficult to hit without being shot down. They use a simple predictor system to aim with. Either cannon or rockets will destroy AA Guns

SAM

SAMs are radar guided. The launchers appear as red points on the radar when active. Cannon, Rockets or A-G missiles can be used to destroy them.

Hangers

Hangers produce enemy aircraft. Enemy aircraft appear 50 metres North of the centre of a hanger facing North, taxi 100 metres straight ahead and then turn 90 degrees left and take off due

West. If the hanger is too big along the positive Z axis then the aircraft will appear inside it. If you want this to happen make sure the North end of the hanger is open or the aircraft will crash into the wall and blow up before getting airborne. If you rotate the hanger object then the enemy aircraft will also be rotated, so you can make them take off in any direction. It looks better if there is a runway 150 metres from a hanger so that the aircraft appear to be using it, but they will takeoff even if there isn't one. A hanger will only produce enemy aircraft when you are within a certain distance of it.

Each hanger can only produce a limited number of aircraft. You can choose this number. If you attack a hanger and destroy it then all the aircraft inside it are also destroyed. Hangers can be rebuilt by enemy trucks. If a truck arrives at a hanger then it will be rebuilt and each subsequent truck will supply one more aircraft.
The shape and performance of enemy aircraft is setup by dragging an aircraft model file onto the hanger setup dialog box. This allows you to use the aircraft designer to control the speed and handling characteristics of enemy aircraft.

Depots

Trucks are produced by depots. You can make any object into a depot, and its trucks can also be any object. You have to be careful about the size and shape of both depots and trucks if you don't want trucks crashing into depots. Trucks appear at the first point in a route, so this should be placed close to a depot; the truck then follows the route. Make sure neither the depot nor other objects are on the truck's route. A depot produces a limited number of trucks, which you can choose. If you destroy a depot all its remaining trucks are also destroyed. A depot is rebuilt when a truck reaches it from another depot. Each subsequent truck is added to its inventory and can be sent out again later.

A depot only despatches trucks when one of the objects at the end of one of it's routes needs supplying.

You can use your imagination with the shapes of depots and trucks. An interesting choice would be a dock as a depot and a ship as a truck. The background colour should be blue, and the depot should be on the edge of an island for the simulation to look sensible.

Routes

A route is a sequence of points in the world, linking one object to another. The start of a route has to be a depot. The end point should be an object with an enemy class. The depot at the start will despatch trucks along the route at regular intervals, which you can choose. When the truck arrives at the end of it's route it will supply the object there. If this is not an enemy object nothing will happen. If it is a destroyed enemy object then it will be rebuilt. If it is a hanger an enemy aircraft will be added to it. If it is a depot the truck will go in. If it is an anti-aircraft gun then it will be re-supplied with shells. If it is a SAM site then it will get more missiles.

Designing Aircraft

You can control the performance and handling characteristics of your own and enemy aircraft using the !Model application. You should create the visible shape of the aircraft using the shape editor. There is no relationship between the visible shape and the performance of the aircraft, it is up to you to design an aircraft that performs as it's shape would suggest. You choose which visible shape and which aircraft performance model to use by dragging appropriate files onto the player or hanger attribute controllers in

the World editor.

You will need to experiment with the aircraft designer to get a feel for the effects of design changes on aircraft performance. Some designs will not fly, and it is up to you to choose a sensible numbers. For instance if you design an aircraft weighing 20000 lbs with an engine power of 200 lbs it will not take off.

You can only design small aircraft. These can range from small biplanes like a Pitts Special up to a Phantom jet. You can choose the aircraft to be propellor or jet powered, but the thrust is always considered to come from a single central engine. You can deal with multiple engines as a single more powerful engine, however they are always considered to act together, so you can not have a failure of just one engine.

The main window of the Model application shows a plan view of the aircraft at the top and a back view at the bottom. The absolute size of the aircraft is not very important, the idea is to allow you to design the relative sizes and shapes of the wing and tailplane. These sizes affect the performance and handling of the aircraft.
If you design the planform to look like a real aircraft the performance should be similar to the real thing. However if you want to design your own aircraft you will have to understand some aerodynamics.

The most important feature is the shape of the main wing. The distance of the wing tip from the fuselage is called the wing span, and the average distance from the front of the wing to the back of the wing is called the wing chord. The aspect ratio is the wing span divided by the wing chord. A very efficient aircraft like a powered glider has a high aspect ratio, which means it has long, narrow wings and flies well at low speed. The disadvantage of this design is that there is a lot of drag and the aircraft will not fly fast

without a lot of power. Fast jets usually have a low aspect ratio which gives poor low speed performance but is good for high speed.

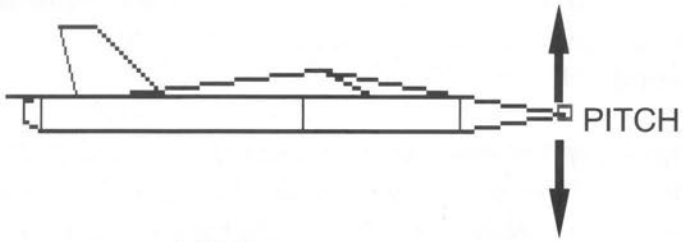
The weight of the aircraft is important. An aircraft with a low aspect ratio and low weight will fly slowly, but not as well as an aircraft of the same weight but with a higher aspect ratio.

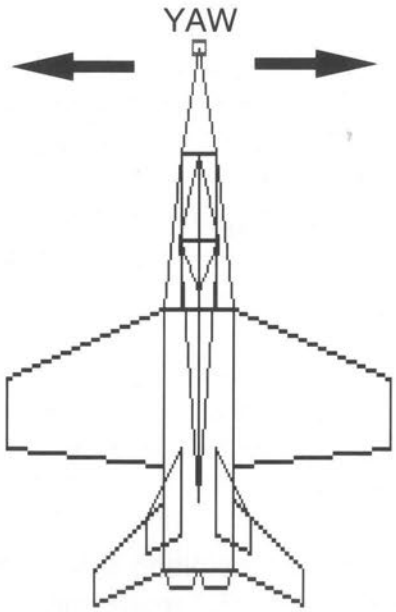
The total area of the main wing is also important. A small area will give a high stall speed, while a large area will give a low stall speed but more drag. Biplanes have a large wing area and fly slowly because they have a lot of drag. You can design a biplane by giving the wing the correct span but making the wing chord the sum of the chords of each wing. This looks odd but is a simple way to represent the total wing area.

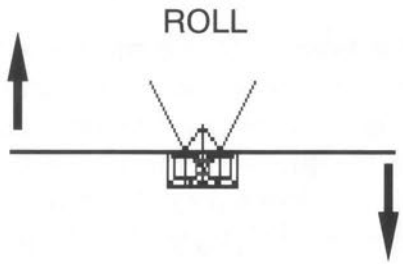
The position of the wing relative to the centre of the aircraft is not very important, as the centre of lift of the wing is always assumed to be just behind the centre of gravity of the aircraft. This makes the aircraft stable.

The position and size of the tailplane effects the pitch handling. The further back the tailplane the more pitch stability. The larger the tailplane the more elevator control and pitch stability. The size of the tailplane also affects the total drag. A very large tailpane will produce too much elevator control, excessive pitch stability and lots of drag.

The back view at the bottom of the main window allows you to change the size of the fin and the wing dihedral. A larger fin gives more rudder control and more yaw stability, but also more drag. The wing dihedral is the angle of the wings from horizontal. As you move the wing tips up the aircraft becomes more stable in roll. This means that it tends to roll level with no aileron control input.







Aerobatic aircraft have very little dihedral and require pilot control to fly level, while trainers have high dihehdral and tend to be stable in roll. You can give negative dihedral, which means that wings droop down towards the tips, and the aircraft will tend to roll upside down.

The data control box allows you to set other performance characteristics.

The wing incidence is the angle of the wing from horizontal on the fuselage. It allows the wing to be at an angle to the airflow, and therefore produce lift, while the fuselage is level. The best wing incidence gives level flight at cruising speed. Fast jets have a low incidence of about 1 or 2 degrees and slow aircraft have an incidence of about 5 to 10 degrees. If you find the aircraft is climbing at cruise speed with the nose pointing at the horizon then the incidence is probably too high.

The stall angle is the angle of attack at which the wing stalls. The angle of attack is the angle at which the airflow hits the wing. A wing produces more lift as it's angle of attack increases, but only up to the stall angle. After the stall angle the lift decreases and the drag increases. The aircraft can stall at any speed. High speed stalling can be induced by too much up elevator control, which can increase the angle of attack to beyond the stall angle. Simple wings stall at about 15 degrees, but leading edge slats, flaps and other devices increase the stall angle. Few conventional aircraft can have a stall angle greater than about 20 degrees. Some modern jet fighters use advanced aerodynamics and the stall angle can be up to 30 degrees.

The aircraft power should be related to weight. Power should usually be less than weight, although a few modern jets have a power to weight ratio of greater than one. A typical light propellor

aircraft has a power to weight ratio of about 1/4. The weight of aircraft should be realistic. A light aircraft weighs about 1000 lbs and a fast jet may weight about 20000 lbs.

The drag value depends on how streamlined the aircraft is. A low value will give a higher top speed. You should adjust the drag value to give your aircraft a realistic top speed.

The ordinance control box allows you to set up any armaments the aircraft should have. Leaving all values as zero will give an aircraft with no weapons.

A typical cannon has about 250 rounds. A typical load of rockets is 36. Air to air missiles are heat seeking and perform like a sidewinder. Air to ground missiles are optically guided and perform like a TV guided maverick.

Section 2

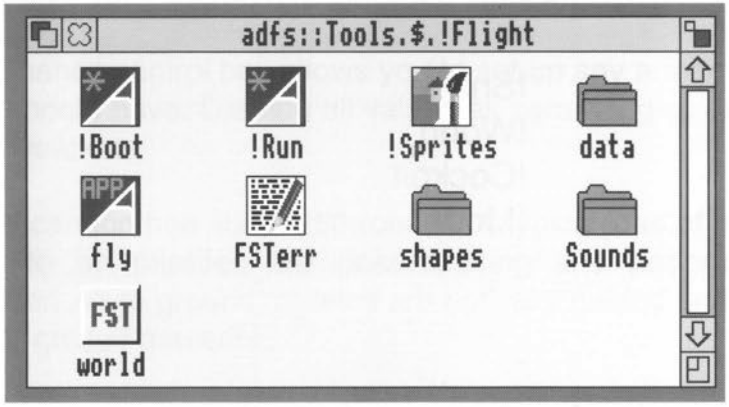
Project Structure & Filetypes

Editors

!Shape
!World
!Cockpit
!Model

Project Structure and Filetypes

Creating a Simulation in section 1 described the structure and contents of the !Flight simulation provided on the tools disk. This chapter describes concisely which elements of !Flight you need to create your own simulation and which files are optional.



The following are the basic files required to run a simulation, the data and shapes folder may empty but must exist.

!Run - application run file, sets up environment variable FST$dir used by fly to tell it where to find the world database file and its associated data and shape files.

fly - the flight sim. code.

data folder - contains FST model , FST cockpit files and cockpit sprite file. For a standalone application this folder MUST contain the FPEmulator 'Floating Point Emulator'.

shapes folder - contains FST shape files.
world - the FST world database, this file must be present and must be called world.

The following are only required if you wish you flight sim. to be a RiscOS application.

!Boot - application boot file, registers application !Sprites file with RiscOS filer
!Sprites - contains application filer sprite

The following are optional (or generated by the sim. itself)

FSTerr - generated when running application if an error occurs
Sounds - contains sound samples loaded by simulation

Filetypes (and their editors)

The Flight Sim Toolkit has two allocated filetypes

 - Shape (&c3c)

- FST (&c3b)

The shape filetype contains only 3D point and polygon definitions of objects. Double clicking on a Shape file will run the !Shape application and load that file.

The FST filetype contains the world database, aircraft model and cockpit datastructures. You cannot tell from the filer icon which datastructure is contained, however double clicking on the file runs a despatcher program which automatically runs the required tool (!World, !Model or !Cockpit). Because FST file contents are indestinguishable from the desktop it is recomeneded that you use descriptive names for model and cockpit files (which are both contained in the data folder), e.g. har_model and har_cpt.

!Shape 

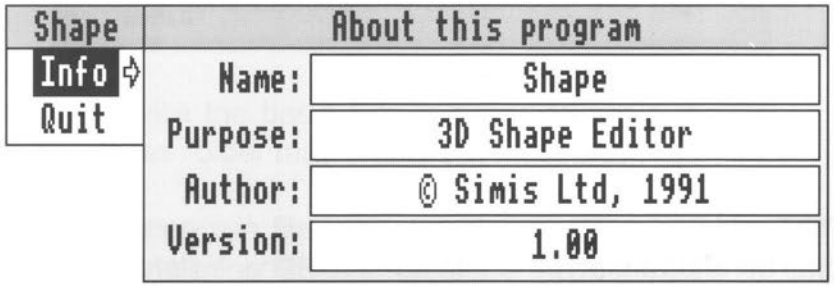
Shape is an editor, it allows you to create and edit 3D shapes.

Shape is controlled from a menu tree (for a description of menus see the Acorn User Guide Part1) and a set of windows.

Starting Shape

Shape is started the same way as other editors: by first installing its icon on the icon bar and then clicking on that icon. For more details see Acorn's User Guide; 'Documents and their editors'.

Icon bar menu:



Info tells you about !Shape

Quit removes the Shape application from the icon bar. If unsaved data exists in the shape a warning box is displayed asking you to Save, Discard or Cancel.

The Shape Window

To open the shape window click on the icon bar Shape icon with the left button.

Basics

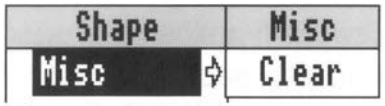
A shape is constructed from three levels, each level defines what the shape looks like at a particular level of detail. Each level is constructed of points and polygons. The Shape editor allows you to enter and adjust points and link them into polygons.
For more details of the structure of shapes see Section 1.

You use Shape in operating modes

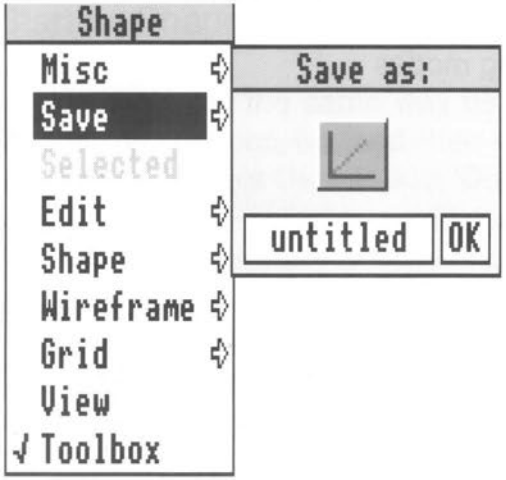
Enter point
Delete point
Enter polygon
Select polygon
Select group

Modes are chosen from the menu or toolbox.

Shape window menu:



Clear deletes everything from the database.



The **Save** menu allows you to save the shape. The save procedure is described in full in the Loading and Saving chapter of the Acorn User Guide. In order to save a file in the easiest way, you need to have on the screen the directory display for the directory where you want to save the file. Move to Save, and a box appears containing; an icon, the current filename and an OK box. If the file has not been saved before, Shape offers you a default filename of 'untitled'. If you want a different name then delete Shape and type in the name you want. Place the pointer on the icon in the menu and drag the icon into the destination directory display.

Entering and Adjusting Points

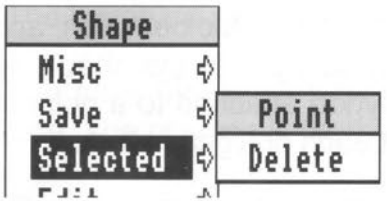
Open the Toolbox by clicking on the Toolbox item in the Shape Window menu.

Select Enter Point mode from the toolbox by clicking on the icon in the toolbox window. When in Enter point mode the cursor will appear as a pair of crosshairs in the Shape window.

To enter a point in the current plane click on the Shape window at the desired position with the left button, a cross will appear representing the point that you have entered.

To move a point already entered, drag it with the adjust (right mouse) button.

in Select point mode:



The currently selected point is shown as a box (all other points are shown as crosses). To select a point click on it when in Select point mode. To delete the selected point choose the Shape=>Selected=>Delete item from the shape window menu. The point will be deleted only if it is not contained in any polygon. Any points not contained in a polygon in a finished shape should be deleted because they play no part in the rendering of the shape in 3D and only slow the processor down.

Keyboard shortcut for Shape=>Selected=>Delete Ctrl X

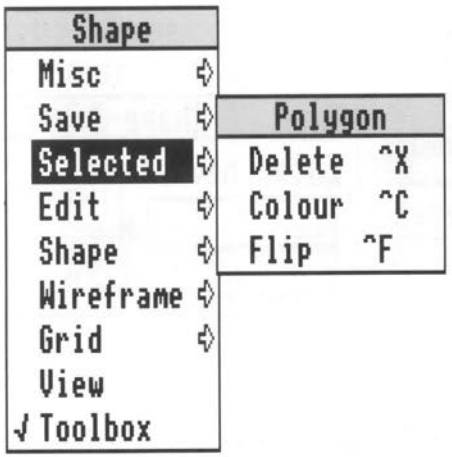
Entering and Adjusting Polygons

Select Enter polygon from the toolbox. The mouse will change to a 3 sided polygon when in the shape window.

Click on each of the points to be contained in the polygon (in clockwise order), using the up/down icons (or cursor keys) to move between planes. When you reach the last point in the polygon click on it with the right button, this tells the Shape editor to end the polygon and sets the editor mode to Select Polygon. The new polygon that you have created will become the selected polygon. This polygon will be the same colour as the last polygon created or selected. Polygons must have at least two points.

To abort polygon entry click on the toolbox Enter polygon icon with the right mouse button.

When you have entered a polygon it will become the currently selected polygon. You can also select any polygon by entering Select polygon mode by clicking on the toolbox icon and then clicking on a point in the required polygon in the shape window. Where there is more that one polygon attached to a point clicking repeatedly on that point will select each polygon in turn.



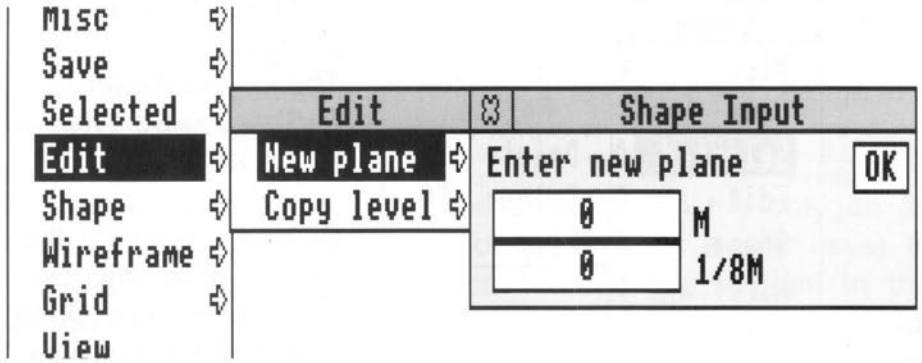
Delete deletes the seleted polygon.
The keyboard shortcut forShape=>Selected=>Delete is Ctrl X

Colour opens the colour picker, this window remains open until you close it. The colour of the currently selected polygon will be highlighted in the picker and may be changed by clicking on a different colour. If no polygon is selected then the creation colour for the next new polygon is set. The colour picker shows 256 colours, in 16 colour modes it shows the best approximation to the real colours using the current desktop palette. (In 4 and 2 colour modes it shows no useful information).

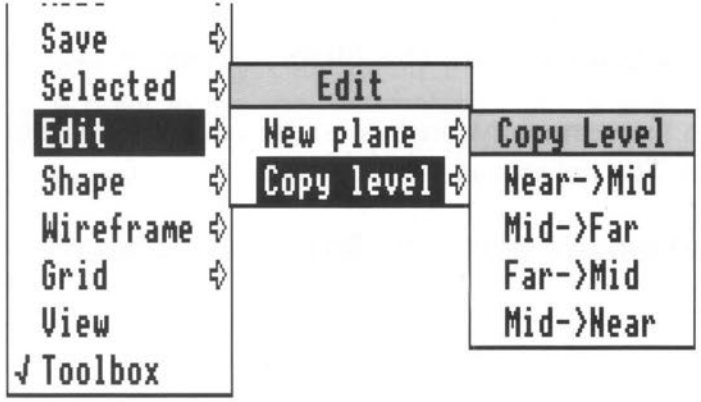
The keyboard shortcut for Shape=>Selected=>Colour is Ctrl C.

Flip turns the polygon over so that it is only visible from the other side. The polygon is then deselected.

The keyboard shortcut for Shape=>Selected=>Flip is Ctrl F

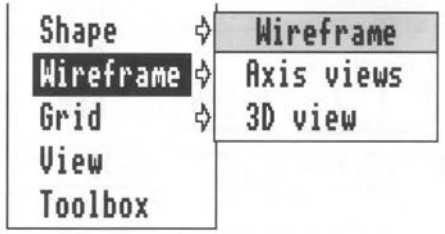


New plane creates a new working plane for point entry. Bring up the 'Enter new plane' window by following Edit=>New Plane=> and then enter the distance from the 0.000 plane that you want the new plane to be created at. The units are M and 1/8 M so to enter a new plane 1.5M from the 0.000 plane you enter 1 in the M box and 4 in the 1/8 M box.



Copy level copies the entire contents of one level of the shape (points and polygons) to another level. The editor is then set to that level. If a polygon is selected it is deselected.

Threshold is the distance in M at which the shape becomes visible in the world. Beyond threshold the shape is invisible. Between the shape threshold and the Distant to Far transition the shape is drawn as a single pixel. The colour of that pixel is set from the Distance colour menu item.

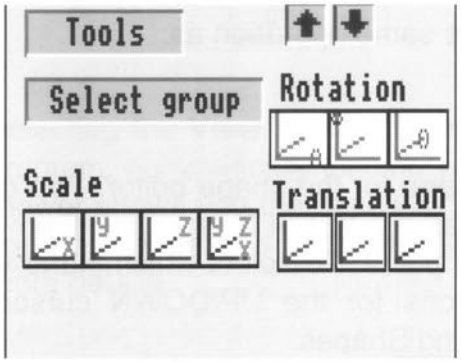


Axis views opens a window which shows the complete shape in 2 dimensional wireframe from a selection of viewpoints. 3D view opens a window which shows a 3D wireframe which can be rotated and scaled. See the Wireframe section for more details.

Colour

Shows the colour of the current polygon in hex (00-ff). Clicking on the colour icon opens the colour picker (see earlier).

Tools



Clicking on Tools extends the toolbox window to reveal these functions. If Select group is selected then the tools operate on a selected group of points. If Select group is not selected then the tools operate on the whole shape (all levels),.

Select group enables you to select a number of points with the right mouse button and then perform the translate, Rotate & Scale functions on them. Clicking with left button starts a selected group, right button adds (or deletes) from the group. The selected group is shown in all wireframe views and the main window.

Translate
Rotate
Scale

Each tool has three icons to represent its operation along/around the X,Y and Z axis respectively. The Scale tool also has a fourth scale in all directions at once icon.

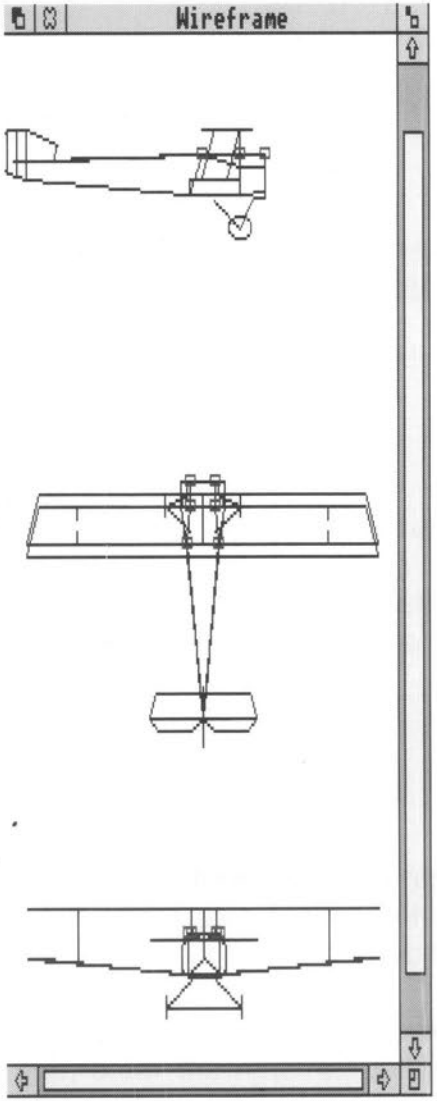
To operate a tool click on the required icon and an input box will popup, enter the required values and click on OK to perform the

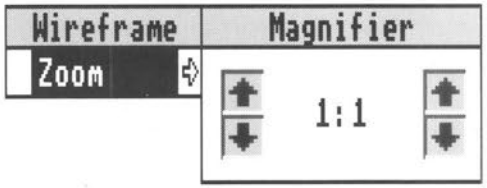
operation.

For example to move the whole shape by 5 M: Click on Tranlate in Y (middle icon), type 5 into the M box and click on OK. The shape will now be moved +5 M in the Y direction (up).

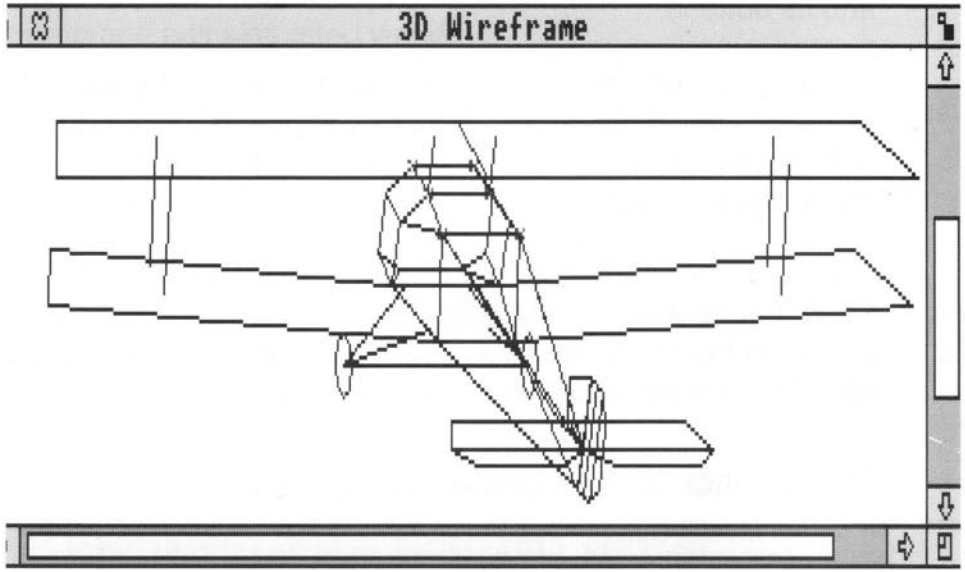
Wireframe

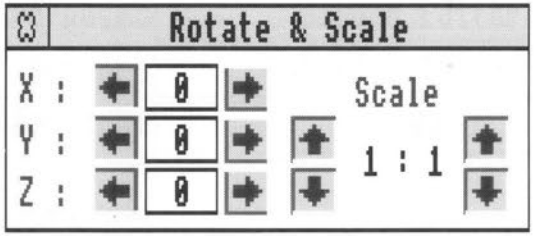
The Axis views window shows views of the shape from the X Y Z viewpoints (top to bottom). It can be zoomed independently with its own window menu.





3D view gives a window that shows a 3D wireframe view which can be scaled and rotated independently by it's own window menu.





View

The view program shows the shape as it will be seen in the simulation. You can rotate and zoom the shape with the mouse and its buttons.

Move mouse left/right	-	rotate shape about Y axis.
Move mouse up/down	-	rotate shape about X axis.
Left mouse button	-	move towards shape.
Right mouse button	-	move away from shape.

The view program shows the distance to the shape in M at the top left of the screen and the detail level of the shape (1-near, 2-mid, 3 - far) at the top right. Keys 1, 2, & 3 on the main keyboard allow you to view each level independently to distance.

To exit back to the desktop press Esc.

!World 

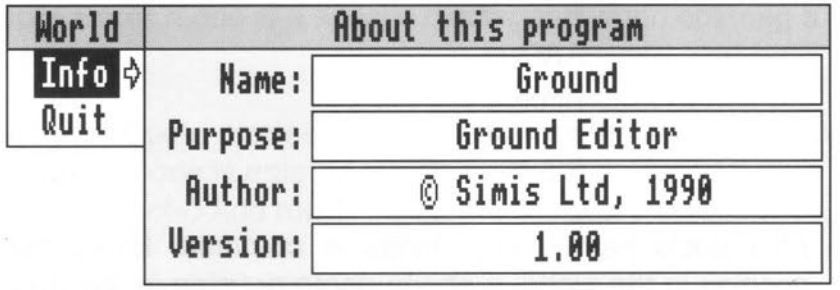
World is a simulation object database editor. You can use it to create and edit simulated worlds.

World is controlled from a menu tree (for a description of menus see the Acorn User Guide Part 1) and a set of windows.

Starting World

World is started the same way as other editors: by first installing its icon on the icon bar and then clicking on that icon. For more details see Acorn's User Guide Documents and their editors.

Icon bar menu:



Info tells you about World.

Quit removes the World application from the icon bar. If unsaved data exists in the world database a warning box is displayed asking you to SAVE, DISCARD, or CANCEL.

The World Window

To open the World Window click on the icon bar icon with the left button. The world window shows database objects and routes and allows you to create new objects, move them and alter their behaviour. The World window represent 100 sq km of simulated world database.

Basic Ideas

Objects

The world is built up from objects. There are a number of different classes of objects available; these are listed below:

Scenery
Depot
Hanger
AAGun
SAM
Beacon
Player

All objects have some things in common. Every object has a position in the world, a shape name defining its appearance in the simulation, an orientation in the world and some flags defining it's basic behaviour. In addition there are class attributes for every object, the exact range depends on the object class.

The 'Player' object is a special case, it is automatically created and cannot be deleted, it represents the player in the simulated world and its position, shape and class attributes define where the simulation starts and how the player's aircraft behaves in it.

Routes

Routes are used to link objects in the world together. Specifically routes run from depot class objects to any other object. The behaviour of a depot in the simulated world is to supply ground vehicles to the world at intervals. These vehicles follow routes until they reach their destinations (any object), the behaviour of the vehicle upon reaching it's destination depends upon the class and state of the destination object.

World 'modes'

You use World in three operating modes

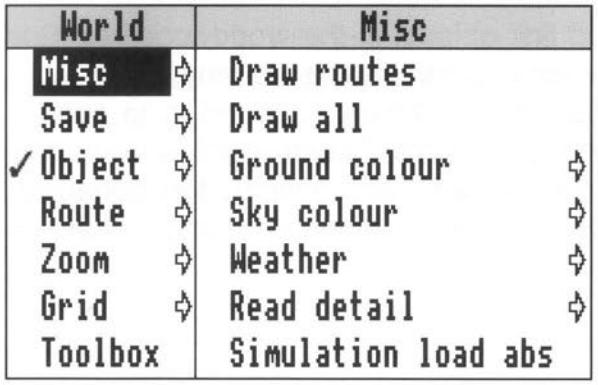
- **Object** mode is used to create, move and modify objects.
- **Route** mode is used to create and modify routes.
- **Route Enter** mode is a special mode used when entering a route.

Object and Route modes are chosen from the menu or toolbox. Route enter mode is entered via Object mode:
(World=>Object=>Add route).

To add a new object to the world -

Drag a shape file from a directory viewer onto the world window. An object with the selected shape will be created at the point where the drag ended. The object will be of scenery class as default.

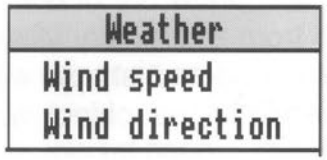
World menus:



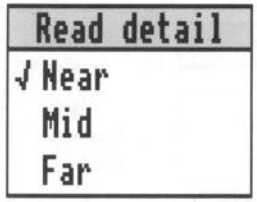
Draw Routes on/off: when on routes are drawn on the world window in all modes, when off (default) routes are only drawn in the 'route' modes.

Draw All on/off: when on all objects are drawn in detail, when off (default) only the selected object is drawn in detail, the remainder of the objects are drawn as boxes bounding the maximum size of the object.

Ground colour - colour selector (default green) used to set the basic ground colour. Sky colour - colour selector (default blue) used to set the sky colour.

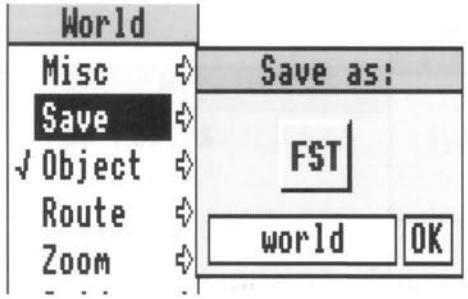


These menu items allow you to set the basic weather parameters.



Read Detail controls how the world editor loads and displays shapes. When a shape is dragged onto the world window to create a new object the Shape file is opened and read to determine how the shape should appear in the world window. By default the Mid detail plan view of the shape is loaded for display. This can be altered via this menu option, the more detail loaded the more information will be displayed in the world window, however the trade off is the redraw speed of the objects in the window.

Simulation load abs: is short for simulation load absolute filenames. The default is OFF which means that data files (world, Model, Shape, Cockpit) will be loaded by the simulation from positions relative to the simulation 'Fly'. ie. the world database file 'World' is in the same directory as Fly & !Run, all the Shape files referenced are in a directory called Shape and the rest of the data files are in a directory called Data (all on the same level). If the Abs option is selected then Shape, Model, Cockpit & Sprite files are loaded using full filenames, this means that they do not need to follow the prescribed project structure. ie you can share the data files between projects. NB this function is only useful if you have a hard disc or are on a network.

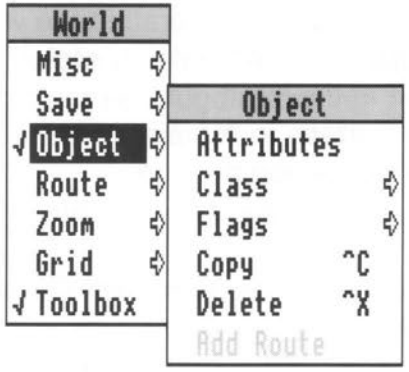


The **Save** menu allows you to save the database. The save procedure is described in full in the Loading and Saving chapter of the Acorn User Guide. In order to save a file in the easiest way, you need to have on the screen the directory display for the directory where you want to save the file. Move to Save, and a box appears, containing an icon, the current filename and an OK box. If the file has not been saved before, World offers you a default filename of 'world'. If you want a different name then delete World and type in the name you want. Place the pointer on the icon in the menu and drag the icon into the destination directory display.
If the file has been saved before then the full pathname will be displayed in the filename box, to save the file click on the OK box.

World=>Object

Clicking on World=>Object sets the editor into Object mode, the Object item will be ticked in the menu when in Object mode. In Object mode clicking on the world window with the left button will select the nearest object. The selected object will be hilighted and displayed in detail. The object may be moved by draging it with the adjust (right mouse) button.

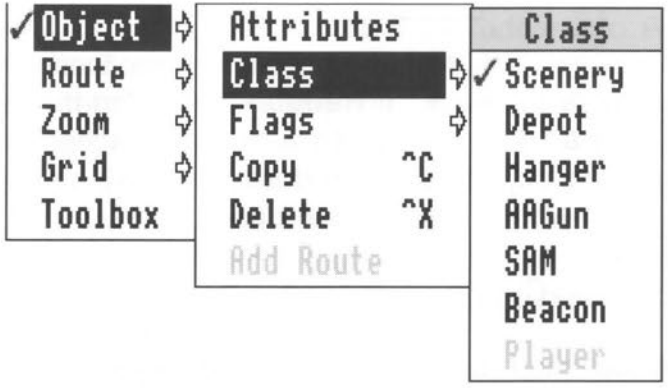
The World=>Object submenu has selectable entries when an object is selected:



- display/modify class behaviour of object
- set class of object
- general behavior of objects
- create a copy of the object
- delete object from the world
- if the object is a depot add a new route

World=>Object=>Attributes

Selecting this menu item opens the Object Attributes window, the class behaviour of the currently selected object is displayed (and may be modified) in the window. For more details see the attributes section.



Scenery - the object merely exists in the world, it plays no part in the simulation.

Depot - the object supplies trucks in the world at regular intervals, it has routes linking it to other objects in

the world.

Hanger - the object supplies enemy aircraft to the world at regular intervals.

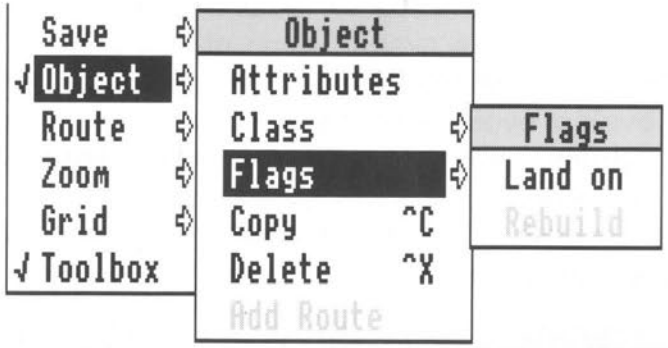
AAGun - the object is an anti aircraft gun.

SAM - the object is a Surface to Air missile launcher.

Beacon - the object is a navigation beacon.

Player - you!

To set the class of an object, select the required menu item in this menu.



If **Land on** is set (ticked) then the player may land on the object (i.e. a runway or taxiway). If **Rebuild** is set and the object is the destination for a route then when a vehicle reaches the object to supply it and the object has been destroyed it will be rebuilt. If the flag is not set the object will remain 'dead'.

World=>Object=>Copy

Copy the selected object. The copied object will inherit the attributes and flags of the original but any associated routes will not be copied. The keyboard shortcut for this operation is Ctrl C.

World=>Object=>Delete

Delete deletes the selected object from the world database. If the object has routes starting or ending at the object those routes are also deleted. The keyboard shortcut for this operation is Ctrl X.

World=>Object=>Add Route

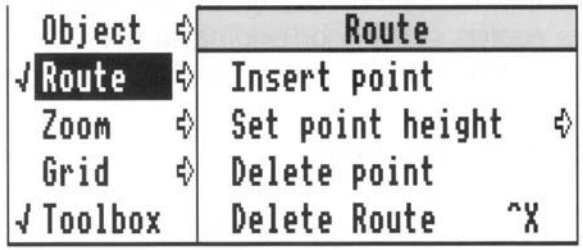
Add Route can only be performed from a depot class object. A new route starting at the depot object is created, the World editor mode is automatically changed to Route Enter. Clicking on the world window with the left button enters a turning point on the route (or an intermediate destination), clicking on the right button links the end of the route to the nearest object. Subsequent changes to a route are made in Route mode. (Each route must contain at least one intermediate point).

World=>Route=>

Clicking on World=>Route sets the editor into Route edit mode, the Route item will be ticked in the menu. Route mode may also be selected from the toolbox. All routes in the world will be displayed.

To select a route click on it, the selected route will be highlighted and it's points shown as small blocks, the point closest to the mouse click will be also be selected (shown as a filled block). These route points can moved by dragging them using the adjust (right) mouse button.

The World=>Route submenu has selectable entries when a route is selected:

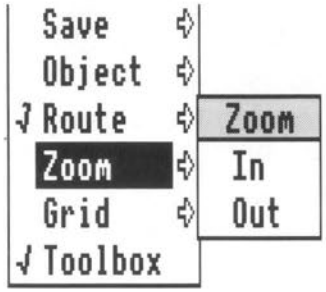


Insert point adds a new point to the selected route, the new point is added after the currently selected (filled) point.

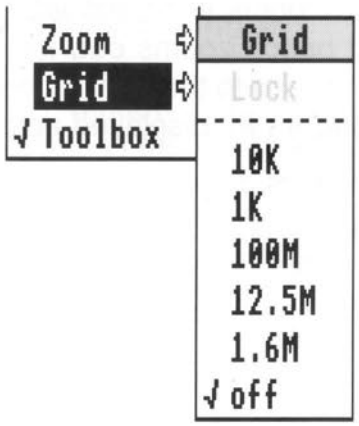
Choosing **Set point height** opens an input box showing the selected point's height in meters (Default 0). This may be changed from the input box. Route points will typically want to be greater than zero when crossing bridges.

Delete point deletes the currently selected point, a route must contain at least one point so this item has no effect if the select route only contains one point.

Delete route deletes the currently selected route.



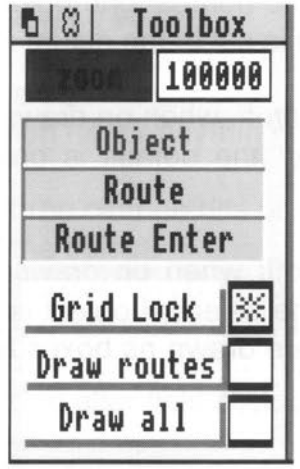
The **Zoom** menu allows you to zoom in (and out) on the world. **Zoom in** magnifies the world by a factor of two (**Zoom out** shrinks it by a factor of two). Zoom will zoom in/out around the selected object or route, if none is selected then the centre of the world is used.



Lock on/off: when lock is on all objects loaded or moved and all route points are locked to the current grid. 10K->1.6M controls the courseness of the grid. 'off' turns the grid (and Lock) off.

World=>Toolbox

The Toolbox window shows general information about the world database and allows control over how it is displayed in the World window. All toolbox options are available from the world menu structure.



Zoom - Clicking with the left button zooms in on the world by a factor of two (clicking with the right button zooms out) left button zooms in, right button zooms out. The icon to the right of the zoom button shows the amount of the world (in M) displayed across the window.

Editor modes

Object
Route
Route enter

To select the editor mode either click on the mode icon in the toolbox window or select the mode from the Mode menu operation on the World window menu. Details of the editor modes are discussed in the World window section.

Grid Lock - on/off: controls the position of objects/routes in the world at the end of a set or drag operation. If lock is on the object/ route is set to the nearest grid point to the mouse, if lock is off the the object/route is set to the actual mouse position.

Draw route - on/off: when on draws routes in Object mode as well as Route mode (the default is only to draw routes in the route modes).

Draw all - on/off: when on draws all objects in detail, when off (default) only the selected object is drawn in detail, the remainder of the objects are drawn as boxes bounding the objects maximum size.

Attributes Window

This window shows and allows modifiction of the behaviour of objects in the world editor. The attributes shown depend upon the class of the object, the first five fields are common to all objects:

Object class is set via the Object=>Class menu options.

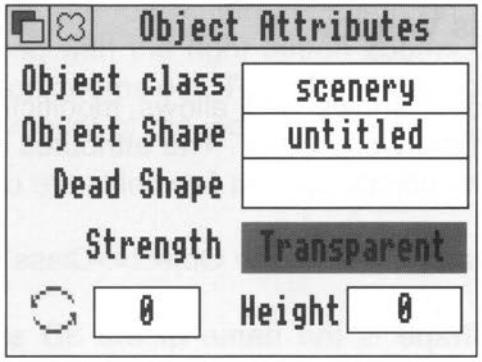
Object Shape is the name of the 3D shape which defines the appearance of the object in the world. Object shape is not alterable in the attributes window.

Dead Shape is the name of the 3D shape which defines the appearance of the object in the world when it has been destroyed in the simulation. It is initialy blank, this indicates no 'dead' shape. To set the dead shape, drag the required shape file from a directory viewer onto the Dead Shape icon in the attribute window, the shape name will appear in the icon.

Strength can take the following values:

Transparent	- cannot be hit
Fragile	- one cannon hit (or anything else) will destroy the object
Weak	- at least three cannon hits or rockets required to destroy the object
Strong	- can only be destroyed by rockets or missiles
Indestructable	- cannot be destroyed however much you try

Initial value is set to Weak, to alter field click on icon and value will cycle.



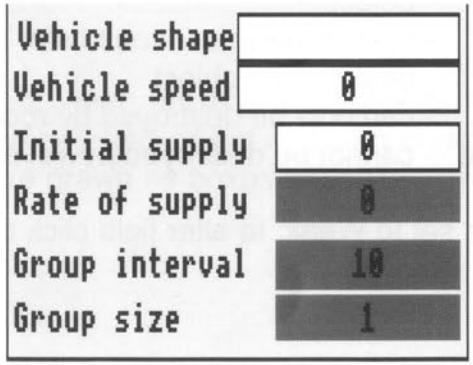
Rotation - this is the orientation of the object on the ground in the world, it is in degrees (0 - 360). The change rotation click on the rotate icon and type the required value into the popup input box.

Height - the height of the object above the ground in M.

Class Attributes:

Scenery - none

Depot:



Vehicle shape - this defines the appearance of the vehicles produced by the depot in the simulation. To set: drag a shape file onto the icon.

Vehicle speed - this is the top speed of the vehicles supplied by the depot (in Knots). To set: click on icon, an input box will popup.

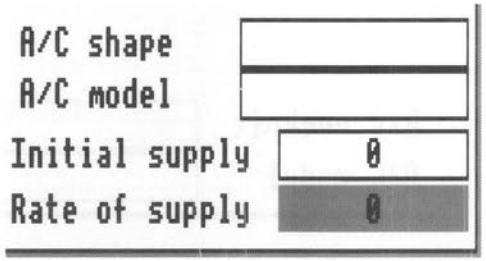
Initial Supply - this is the number of vehicles in the depot when the simulation starts. To set: click on icon, an input box will popup.

Rate of Supply - this is the interval (in minutes) between the depot sending out groups (convoys) of vehicles. To set: click on icon, the value will cycle.

Group interval - this is the time (in secs) between each vehicle in a group being despatched form the depot. To set: click on icon, the value will cycle

Group size - this is the size of a group supplied by the depot.

Hanger



Aircraft shape - this is the shape of the aircraft launched from the hanger. To set: drag shape file onto icon.

Aircraft model - this is the aerodynamic model for the aircraft

launched from the hanger. The model file also defines the weapon load carried by the aircraft). To set: drag model file onto icon.

Initial supply - this is the number of aircraft in the hanger at the start of the simulation. To set: click on icon, an input box will popup.

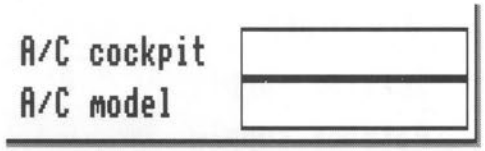
Rate of supply - this is the interval (in mins) between aircraft being launched from the hanger. To set: click on icon, the value will cycle.

AAGun - none
SAM - none

Beacon

Identification - the VOR beacon identification code. To set click on icon, an input box will popup.

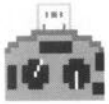
Player



Aircraft Cockpit - This field sets the cockpit shown in the simulation, to set drag cockpit file onto icon. If this field is not set the bottom of the screen will be black in the simulation.

Aircraft Model - this field sets the aircraft model for the player

(you!), if you do not set this then you will have a basic model to fly with average perfomance. To set: drag model file onto icon.

!Cockpit 

!Cockpit is an editor, it allows you to create and edit aircraft cockpit and head up display layouts.

Starting !Cockpit

!Cockpit is started in same way as other editors: by first installing its icon on the icon bar and then clicking on that icon. For more details see Acorn's User Guide "Documents and their editors".

Icon bar menu:

Info tells you about !Cockpit.

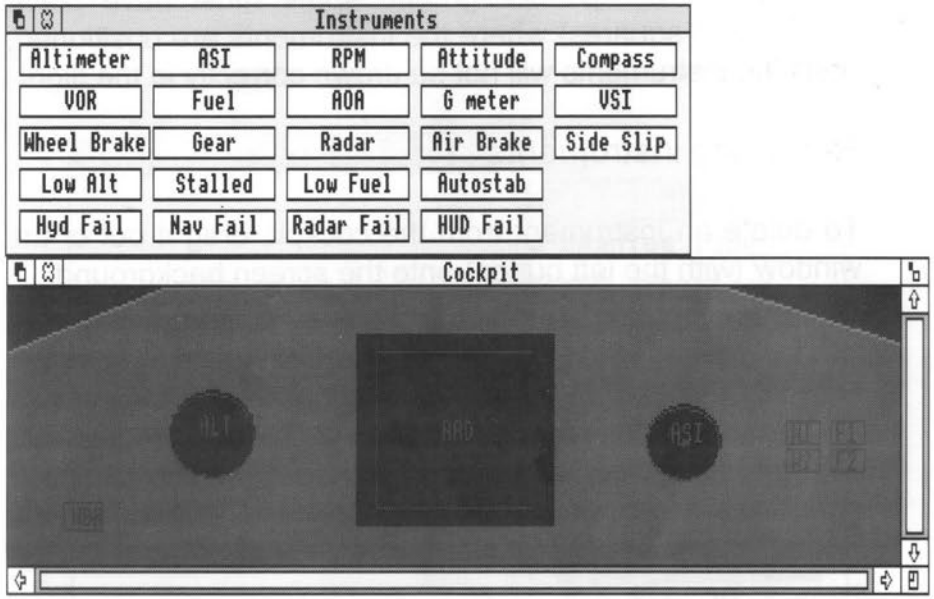
Instruments and HUD open the respective windows.

Quit removes the Cockpit application from the icon bar.

Clicking on the icon bar icon with the left mouse button opens the main Cockpit window and the instrument window.

The Cockpit window

This window shows the layout of the head down instruments and the cockpit background.



Setting the cockpit background

To set the background drag a sprite file onto the window. The sprite file must contain only one mode 13 sprite 320 pixels wide and 100 pixels high. (See the example in !Flight.data.sprite). The sprite must NOT contain a palette or a mask.

Adding instruments

To add a new instrument to the cockpit drag the required instrument from the instruments window (with the left mouse button) onto the cockpit window, this can be positioned on the cockpit with the left button and resized by dragging with the right button. The cockpit background sprite must have black areas (circles and squares) where the instruments are positioned; if they don't the instruments will not be drawn correctly in the flight sim.

Removing instruments

To delete an instrument from the cockpit, drag it out of the cockit window (with the left button) onto the screen background.

Window Menu

Save=>

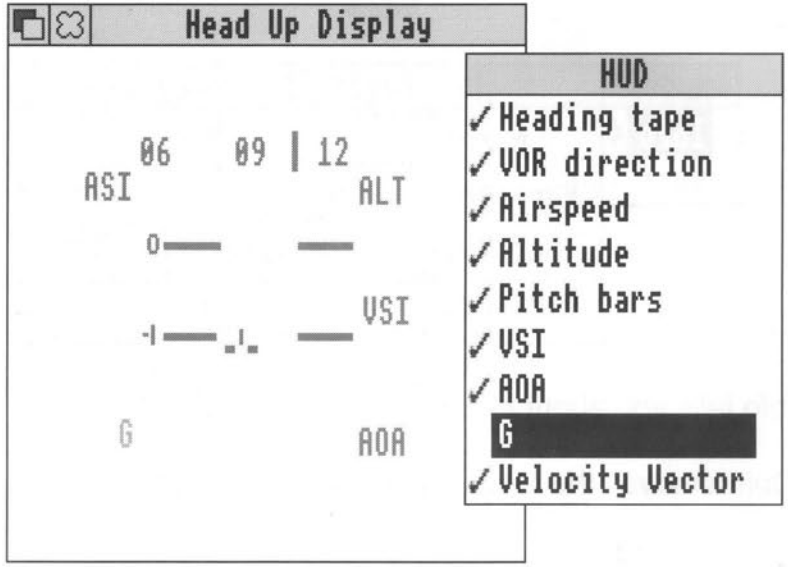
Save works in the same manner described in the previous tools.

Instrument window

This window shows all the instruments available for creating a cockpit. It's use is described in the previous section.

HUD window

The HUD window allows you to control the symbols displayed on the HUD. The HUD instruments are in fixed positions, the window menu allows you to 'turn on' (or off) and instrument. (If no hud symbology is selected no hud will be drawn).

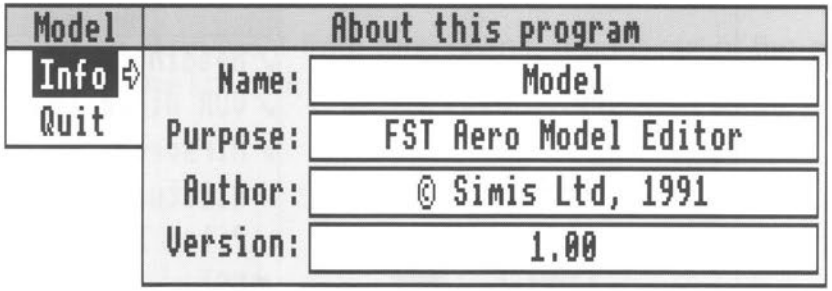


!Model

!Model is an editor, it allows you to create and edit aircraft models.

Starting !Model

!Model is started in same way as other editors: by first installing its icon on the icon bar and then clicking on that icon. For more details see Acorn's User Guide "Documents and their editors".
Icon bar menu:

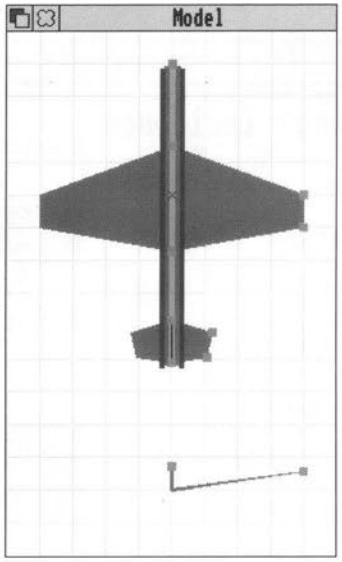


Info tells you about Model.

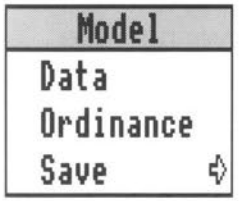
Quit removes the Model application from the icon bar.

The Model window

The main model window shows a plan and an end on view of an aircraft's major flight surfaces. The twelve hilighted points on the aircraft can be adjusted by draging them with the left mouse button. The effect of dragging a point is to change the shape of the flight surface. Each of the points is restricted in movement. The red cross in the centre of the plan view is the centre of gravity of the aircraft.



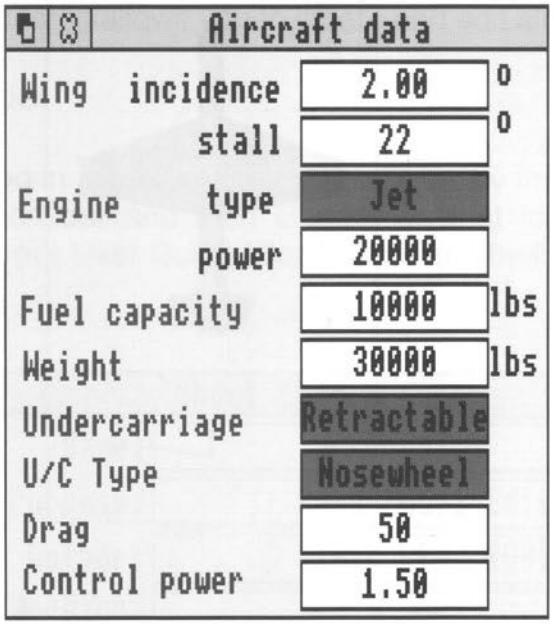
Window Menu



Data and ordnance open the corresponding windows.

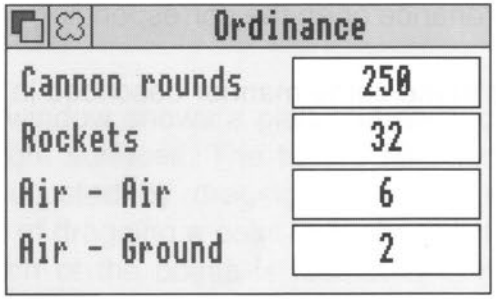
Save works in the same manner described in the previous tools.

Data window



This contains general parameters covering the aircrafts performance, engine and undercarriage layout.
To change parameter click on the values boxes.

Ordnance window



This window contains parameters defining the weapons the aircraft carries.

To change parameter click on the values boxes

Section 3

Aircraft Controls

Flight Controls

Engine on/off	'E'
Throttle up	'='
Throttle down	'-'
Full power	Shift '+'
Idle power	Shift '_'
Power 10 - 100%	1,2,- - - 0
Landing gear	'L'
Wheel Brakes	'W'
Air Brakes	'B'
Emergency eject	'Ctrl-E'

Control Device Selection

Analogue joystick	'Ctrl-J'
Keyboard	'Ctrl-K'
Mouse	'Ctrl-M'
Calibrate joystick	'Ctrl-Z'

Keyboard Control

Roll left	←
Roll right	→
Pitch up	↓
Pitch down	↑

Centre	'PAD 0'
Joystick centre	'Z'
Pitch trim up	'PAD +'
Pitch trim down	'PAD -'
Zero pitch trim	'PAD *'
Rudder	'<' '>'

Weapon system

Fire cannon	joystick button 1 mouse button 1 'Delete'
Select weapon	'Backspace'
Select target	'Return'
Fire weapon	joystick button 2 mouse button 2 'Space bar'
Drop flares	'F'
Drop chaff	'C'

Avionic systems

Autostab on/off	'A'
Radar range	'/'
Select VOR	';'

Simulation Controls

Sounds

Engine noise on/off	'N'
All noise on/off	'Q'

Views

Keys in () are active when flying from the keyboard

Forward with intruments	PAD 8 (F8)
Forward without instruments	PAD 5 (F5)
Forward right	PAD 9 (F9)
Right	PAD 6 (F6)
Rear right	PAD 3 (F3)
Rear	PAD 2 (F2)
Rear left	PAD 1 (F1)
Left	PAD 4 (F4)
Forward left	PAD 7 (F7)
Aircraft ouside view	'V'
'Tower' view	'O'
Missile view	'M'

Miscellaneous

Pause on/off	'P'
Fast time on/off	'X'
Select database exploration model	'Ctrl-B'
Real aircraft model	'Ctrl-A'
End simulation	'Esc'

Aircraft Displays

Head Up Display (HUD)

The functionality of each of the available HUD features is described below:

Altitude: Vertical height above the ground displayed in feet.

Airspeed: Shown in Knots (1Knot := 1.25 MPH)

Pitch Bars: The pitch bars stay parallel with the ground at all times. You can use them to recover from unusual attitudes and to keep your wings level when the horizon is not visible. The lines are at 10 degree intervals with a cross at 90 degrees (the nadir). If the cross is in the centre of the HUD then you are either travelling straight up or straight down.

VSI (Verical Speed Indicator): This shows your rate of climb or descent. An essential source of information when manoeuvring close to the ground. The VSI has two markers, the upper marker is the centre point (zero rate of climb), the lower is the maximum rate of descent allowed for landing.

LFD (Longitudinal Flight Datum): Shows the direction the nose of the aircraft is pointing in.

G: Shows the amount of G that the aircraft is pulling during manoeuvres.

AOA (Angle of Attack): Is the angle between the direction of the airflow approaching the aircraft and a line drawn between the leading and trailing edges of the wing. The lift generated by the wing is dependant on this angle. Too high and the wing stalls, lift is

dramatically reduced and the aircraft may become uncontrollable . Conventional wings stall at less than 20 degrees of AOA.

Velocity Vector: Gives an indication of the true direction that the aircraft is flying in.

Heading: A tape indication across the top of the HUD and shows the current heading in tens of degrees. 00 is north, 9 is east, 27 is west and 18 is south.

Beacon: Direction to next nav. point is shown in the HUD by a red marker in the heading tape. You fly towards a or beacon by aligning the marker with the central tick.

Weapon: Shows the weapon you have selected (AA, AG, R)

Radar

The Radar display covers a 90 degree forward cone with a maximum range of 30 miles. The radar range is selectable from 30miles, 15 miles and 7 miles. The range is shown at the bottom left of the display.

Indicators and warning lamps

Landing Gear: Indicates whether the Landing gear of the aircraft is locked up (red) or down (green).

Wheelbrakes: Show when the wheel brakes are selected on or off.

Airbrake: Indicates the position of the airbrake.

Autostab: Indicates whether the autostab is on or off.

Low Alt.: Low Altitude warning lamp.

Stall: Stall warning lamp.

Low fuel: Fuel warning lamp.

Hydraulic fail: Hydraulic failure lamp.

Nav fail: Navigation system failure lamp.

Radar fail: Radar system failure lamp.

HUD fail: Head Up Display System failure lamp.

Flight Instruments

Altitude: Vertical height above the ground shown in feet. One revolution of the needle is 1000ft, thousands of feet are shown as digits in the centre of the dial.

Airspeed: Shown in knots (1knot = 1.25MPH)

Attitude Indicator: This shows your roll and pitch relative to the horizon. The blue half is up and the green half is down. The attitude ball is useful for aircraft designs that do not have a HUD or for when the HUD has failed.

VSI (Vertical Speed Indicator): This shows the rate of climb or descent.

AOA: Shows the angle of attack of the wing to the airflow.

G: Indicates the amount of G that the aircraft is pulling.

Sideslip Indicator: Sideslip is when the aircraft is skidding sideways in the air. The sideslip indicator is useful when performing coordinated turns using the rudder to reduce the effects of sideslip. If the indicator reads to the left, you are slipping left and should bank less or use left rudder to coordinate your turn.

Compass: This is a magnetic compass which can be used as a main or reversionary instrument.

Engine Instruments

RPM: Shows your engine revs.

Fuel: Shows the amount of fuel you have remaining.

Keyboard Shortcuts:

!Shape

Delete point	Ctrl X
Delete polygon	Ctrl X
Select colour	Ctrl C
Flip polygon	Ctrl F

!World

Copy object	Ctrl C
Delete object	Ctrl X
Delete route	Ctrl X

ndex