CSM 3 IN 1 R/C SIMULATOR
VERSION 10
INSTRUCTIONS

Distributed Worldwide by:
J.Perkins (Distribution) Ltd.
90 - 96 Greenwich High Road, London, England.
Tel. 0181 692 2451 Fax. 0181 692 2469
e-mail jpmail@jpmodels.co.uk

Distributed in U.S.A. and Canada by:
Horizon Service Centre,
Horizon Hobby Distributors C/o, 4105 Fieldstone Road, Champaign, Illinois 61821
Tel. (217) 355 9511 (9am to 5pm CST)

Designed and manufactured in England by:
CSM Design Consultancy Ltd

IMPORTANT: EPILEPSY WARNING
Please read before using this simulator or allowing children to use it.

Some people are liable to have an epileptic seizure or loss of consciousness when exposed to flashing lights or certain normal conditions of everyday life. Such persons could risk a seizure while watching televised images or while using certain computer programs. This may occur even if there have been no previous medical problems or experience of epilepsy.

If you or a member of your family has ever shown epileptic symptoms when exposed to flickering lights you should consult your doctor before using this or any other simulator.

Please take the following general precautions when using this simulator:
* **Make sure that the room in which you are using the simulator is well lit.**
* **Rest for at least 10 minutes in every hour of use.**
* **Do not use if you are tired or have not had much sleep.**
* **Do not sit too close to the computer monitor**
* **Ensure the display brightness is not excessive.**

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HOW TO GET STARTED WITHOUT READING THE WHOLE MANUAL!
You're in a rush to get flying? Just read (and carry out!) the instructions in the 'INSTALLATION' section and note the information about running the Simulators. Refer to 'GETTING ABOUT IN THE SIMULATORS' section if you get lost. Once you've had a flight or two you may wish to come back to this manual to find out more.

This manual contains independent sections covering the aero and helicopter simulations. For convenience of reference, information on features common to both simulations is reproduced in both sections.

INTRODUCTION

The **CSM** simulator has been written to run on **IBM PC compatible computers** with a minimum of a 486DX4/100 processor (but a Pentium is recommended), an SVGA graphics adapter with full VESA graphics support. The operating system can be DOS 4.00 or later, or Windows 95. The simulator will not run under Windows NT. Users of NT should consult their PC supplier about setting up a 'dual boot' system that will allow their machine to be optionally booted into DOS.

The programs are designed to provide serious training aids for model pilots at all levels of competence. To ensure a high degree of realism the programs use a detailed set of complex aerodynamic equations to calculate the motion of aeroplane or helicopter in real time. To make use of this precision an efficient Three-Dimensional Graphics package delivers geometrically accurate 256 colour graphics at resolutions from 640 x 400 up to 1024 x 768 (depending on the processor and SVGA card used).

The simulators allow all the important properties of (single rotor) model helicopters and single engined model aeroplanes to be defined in real units by the user to accurately simulate the performance of a given model. This allows the expert or beginner to investigate the effects that dimensional and trim changes make to the way a real model performs.

Numerous standard models are supplied but the user is encouraged to use the design facilities to simulate his/her own models. The aero simulator has been designed to provide both an aid to flight training (from basics through to full aerobatics), and a model aircraft design tool. The simulation not only uses the large number of 'real world' parameters in its aerodynamic calculations but **tailors the shape of the displayed model to match these dimensions.** In this way the simulator gives you a powerful insight, not just into the handling characteristics of your creation but also into the visual impact it will have in the air.

The new interface supplied with V10 is capable of supporting transmitters of up to 12 channels and, for even more accurate flying, gives 100% higher stick resolution than previous interfaces. The simulator provides a powerful and easy to use method of installing the 'radio gear' in your simulated models that is very like doing the job on the real thing. In most cases you need only pick the right installation from the existing list and fly, but if you wish, complex 4 servo wing set-ups can be easily tailored to your needs with the aid of the **Control Check** display.

Both aero and heli simulators can be flown with basic four-channel aero transmitters.

The mixing, rates, throw adjusters and many other facilities of your transmitter can be used in exactly the same way as on the real model. In fact the simulator moves the "model's" control surfaces in response to the servo position data from your transmitter in the same way a real model would. Set the 'linkages' on the simulated model to match the real one and you can fly the simulated model with the same control throws, pitch and throttle curves, gyro gain, rates, ATS, mixer setting, etc. that you use for real. Because the transmitter is not actually transmitting radio-waves there is no danger of interference with other RC users, and battery life is prolonged. The interface employs High Impedance Signal Coupling between the transmitter and computer to protect both pieces of equipment. Please remember that computer monitors often get a high static charge built up on them so, as an added precaution, avoid touching the screen while holding the transmitter.

INSTALLATION

To start the install program
Insert the distribution disk in drive A (or B) and
If using DOS, type at the prompt:-
> **A:**   (Enter)   {or B: if appropriate}
> **INSTALL**   (Enter)

Alternatively,

If using Windows 95 go to **'My Computer'** and double click on the **'3 1/2 " Floppy (A:)'** icon, and then on the **'install'** icon. You may want to maximise the DOS window that opens.

You will be asked which hard drive you want the simulator installed onto (e.g. "C"), Once the selection of drive has been confirmed, the necessary directory called **'CSM10'** will then be created on the appropriate drive, the required files transferred, and batch files created. If the install program finds a previously installation it will ask if you wish to overwrite it. Having installed the simulator Windows 95 users should create shortcuts as follows.

Creating Win 95 "Short Cuts" to the aero and heli simulators
Double click on the hard disk **(C:)** icon in the **"My Computer"** window.
Find and double click on the **"CSM10"** folder in the resulting window.
In the list of files you now see find the **"AERO10"** entry.
Point to **"AERO10"** and by holding down the left mouse button **'drag and drop'** it onto the Windows 95 desktop.
You should now see an icon **"Short cut to AERO10"** appear on your desktop.
Repeat this for the file called **"HELI10"** and also for the file called **"TXTEST".**

Setting up your shortcuts
Point to the **"Short cut to AERO10"** icon and click with the **RIGHT** mouse button.
In the list that appears select **"Properties"**
At the head of the page you now see click on **"Program"**
For the **"Run"** option choose **"Maximised"**
Tick the **"Close on Exit"** option
Now click on the **"Advanced" button"**
Ensure the **"Suggest MS-DOS mode a necessary"** option is ticked
Click **"OK"**
Click on **"Screen"** and select **"Full Screen"**
Click on **"Misc."**
Make sure **"Allow screen saver"** is **NOT** ticked
Set **"Idle sensitivity"** to **"Low"**
Now Click **"OK"**

Repeat this process for the **"Short cut to HELI10"** and **"Short cut to TXTEST".**
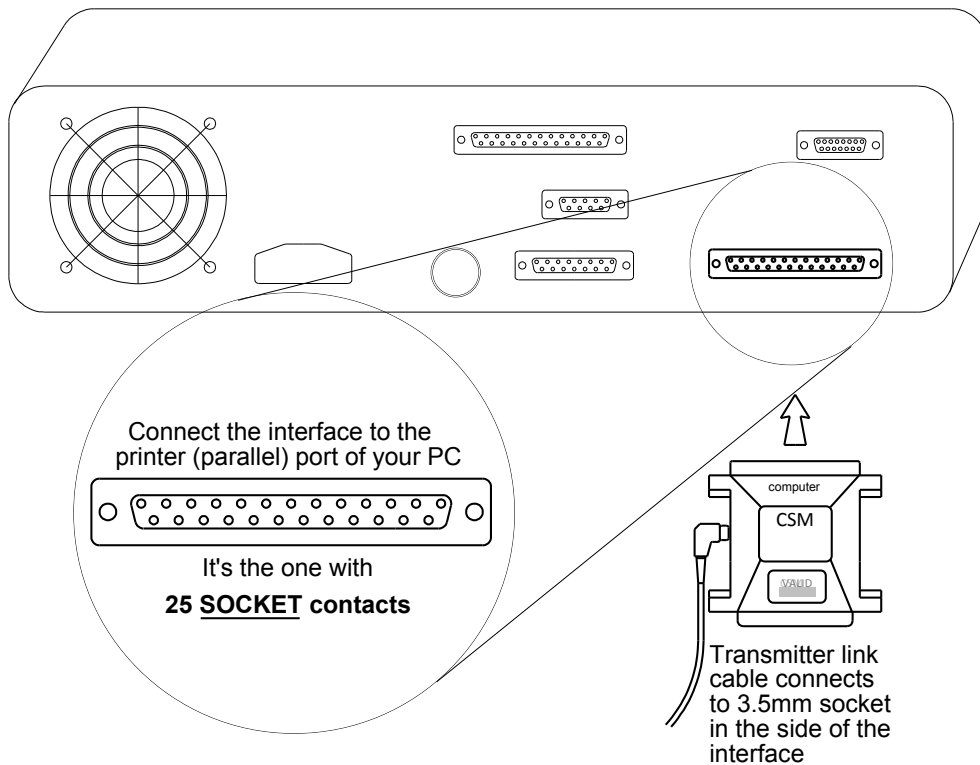Your shortcuts are ready to use.
For those wishing to use them, icons 'aircon.bmp' and 'helicon.bmp' are located in the CSM10 folder and can be invoked using the "change icon" option of the shortcut properties.
Simply double click on the appropriate shortcut to start the required simulator.
Before running the Simulator for the first time, please reboot your machine.

INSTALLING THE SIMULATOR INTERFACE
Before commencing make sure your PC is turned off.

Connect the interface to the
printer (parallel) port of your PC

It's the one with
25 SOCKET contacts

computer

CSM

VAUD

Transmitter link
cable connects
to 3.5mm socket
in the side of the
interface

Locate the Parallel (Printer) port of your PC. This is a 25 pin 'D' connector with **socket contacts.** If you have a printer attached to your PC it may already be connected to the desired port. If so, disconnect it and install the simulator interface in its place. Observe the word "computer" on the appropriate end of the interface. If your PC has two parallel ports (LPT1 and LPT2) you can install the interface on either. The software will automatically detect the correct port. **Beware**, there may be one or more connectors on the back of your PC with 25 PIN contacts. These are NOT parallel ports (they are serial ports) please do not try to connect the CSM interface to these (it will not like it!)

Once the interface has been installed you may connect your printer to the through connector on the interface. If you are using the through-connection for your printer, make sure that the printer is turned **on** when the simulator is being used. With the transmitter turned off the printer should work normally. If however the interface and printer conflict we recommend that you connect the interface to a second parallel port (LPT2). If your machine has not already got one, your computer supplier will be able to advise you on the fitment of an LPT2 port.

Connect one end of the transmitter link cable to the 3.5mm socket in the side of the interface, and connect the other end of the transmitter link cable to the DSC/training socket of your transmitter. Your model shop will have supplied the link cable appropriate for your transmitter.

If your transmitter is switchable between PCM and PPM modulation modes **make sure it is operating in PPM mode.** (This is also sometimes called "FM" mode)

Transmitters with DSC connectors. (e.g. JR transmitters, Futaba FF8 & 9ZAP/ZHP) These transmitters have full DSC connector facilities As soon as the interface cable is plugged into the DSC connector of these sets the appropriate parts of the transmitter will automatically become active. The RF module is not powered so no actual transmission takes place. When using the simulator do not turn these transmitters on by the normal power switch.

Transmitters with trainer outputs only (e.g. Futaba Super 7 or FF7) These transmitter are **not** activated by plugging the interface cable into the transmitter. In these cases the transmitter must be turned on in the normal way. To prevent unwanted transmission from these sets you must remove the RF module or the crystal. As well as preventing unwanted transmissions this also greatly extends the battery duration.

Before running the simulator for the first time it is worth checking the installation of the interface using the program 'TXTEST' supplied with the simulator. (This program is also useful as a general health check for your transmitter and as an aid to setting up mixers etc.)
You can run TXTEST in Win 95 using the **"short cut to TXTEST"** set up in the installation process or, from the DOS prompt first change to the drive on which you installed the simulator software (say C:) by typing:-

        C: (Enter) {or whatever drive letter is appropriate}

then type:-

        CD CSM10   (Enter)
        TXTEST   (Enter)

'TXTEST' should now prompt you with:
 'CONNECT INTERFACE AND TRANSMITTER THEN PRESS ANY KEY'.
On pressing a key you should briefly see the message 'Interface test done' followed by a bar graph showing the positions of all the channels being received from your transmitter. Move the transmitter sticks smoothly and watch for a similarly smooth movement of the channel positions on screen. Most transmitters will give channel signals centred on about 1.5 ms and swinging approximately from 1ms to 2ms at the extremes of travel. Once you are satisfied that the interface is working correctly exit 'TXTEST' by pressing 'Q'.

If for any reason 'TXTEST' or the simulators are unable to locate the interface check that:-

        1. The interface is fully engaged with the parallel port.
        2. Your transmitter is active, connected to the interface and operating in PPM mode.
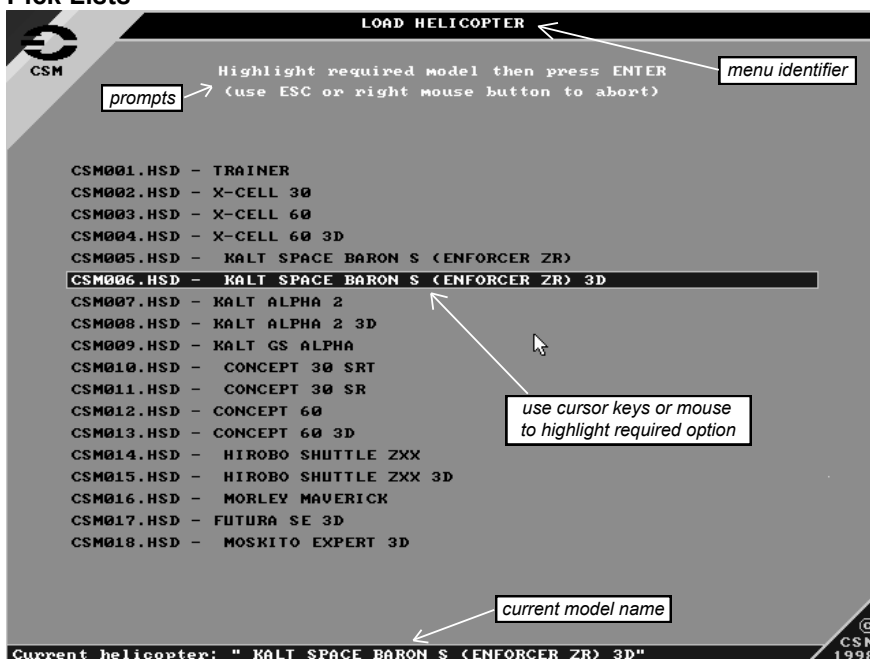   3. Your printer (if connected via the interface) is turned on

If you still have problems, read the additional information given in the 'readme.txt' file located in your CSM10 directory. To view this on screen use Window 'notepad., Wordpad' etc. or, at the DOS prompt type:

        C: (Enter)
        CD CSM10\INFO   (Enter)
        MORE< readme.txt   (Enter)

GETTING ABOUT IN THE SIMULATORS
The menu systems of the simulators use two types of screen: Pick Lists and Parameter Lists.
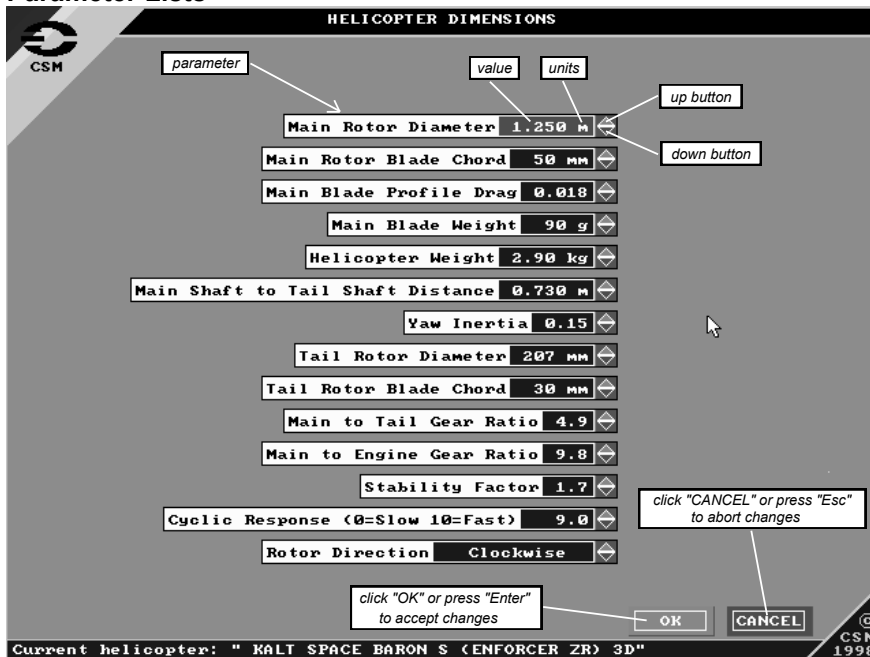Both can be used with either keyboard or mouse.

Pick Lists

A Typical Pick List menu
The Main Menu, the model load and model save menus are of this type.
Using pick lists with the keyboard: highlight the required option using the up and down
cursor keys and then press the<**Enter**> key. To exit without selecting an option press
<**Escape**>.
Using pick lists with the mouse: Point to the required option and click the left mouse button.
To exit without selecting an option press the right mouse button.

Parameter Lists

Typical Parameter list
All the menus for adjusting aircraft and weather parameters are of this type.
Using parameter lists with the keyboard: highlight the required parameter using the up and
down cursor keys. Then use the + and - keys (on the numeric keypad) to adjust the value.

Having completed all the changes on the menu press the <**Enter**> key to accept them or press <**Escape**> to cancel them.

Using parameter lists with the mouse: Adjust the parameters by clicking with the left mouse button on the on-screen up and down buttons to the right of each parameter value. Having completed all changes on the menu, accept them by clicking on the on-screen **[OK]** button or cancel them with the on-screen **[CANCEL]** button.

From here on please refer to the Aeroplane or Helicopter sections of this manual as appropriate.

HELICOPTER SIMULATOR

RUNNING THE HELICOPTER SIMULATOR
As with all DOS programs, the simulator can be run from Windows 95. (Running from within Windows 3.1 is not recommended).

Running from Windows 95
If you have configured the short-cuts to the simulators on your desktop simply double click on the **"Shortcut to Heli10"** icon.

If you have not set up short cuts, proceed as follows:
Double click on the 'My Computer' icon
Locate and open the **CSM10** folder on your hard disk.
Find and double-click on the "Heli10" entry in this folder: this will launch the simulator.

Running from DOS
With the software installed as described above you can run the helicopter simulator as follows:
If installed on drive C, type at the DOS prompt:-

C:	(Enter)	{or other drive letter if appropriate}
CD	(Enter)	
HELI	(Enter)	

THE START SCREEN: Selecting a radio installation

Please note When using an aero transmitter to fly the helicopter simulator the collective function should be allocated to the throttle channel exactly as if the collective and throttle servos were both connected to the throttle channel by a Y-lead. "4 channel" sets on the supplied list are already configured this way.

You will initially be asked which radio is in use. If your transmitter type already appears on the list you should simply select this and continue. The accurate reproducibility of our interfaces and of modern transmitters should make adjustment for these types unnecessary. If your transmitter type is not on the list or you use a non-standard joystick configuration (i.e. not standard mode 1 or mode 2) you should select "CREATE NEW TYPE" on this menu. Having done so, proceed as described under the "Creating a new radio type" section of this manual.

THE MAIN MENU
This offers the following options:-

> **Load helicopter**
> **Save current helicopter**
> **Dimensions**
> **Set-up**
> **Control Check**
> **Engine data**
> **ICG360 gyro data**
> **Flybar data**
> **Weather conditions**
> **Take-off heading**

Crash limits
Select radio
Radio system data
Rename current radio
Servo reversing
Simulation set up
Select airfield
Set viewpoints
Airfield colours
Helicopter colours
Select helicopter visual
Quit

Use the cursor keys to highlight the option you require, then press 'ENTER', or use the mouse and left mouse button to pick the required option.

TO FLY: From the Main Menu press <Escape> or right mouse button.

LOAD HELICOPTER

In this menu you will be given a list of the helicopters currently available, with up and down arrows to scroll the list if it is longer than one page. The files are stored in a directory (folder) called 'hlib' within the CSM10 directory, and on the menu you are given the file name in the form of three letters and three numbers with the extension 'hsd' e.g. CSM001.hsd, followed by a description of the helicopter. Highlight the one you want to fly using the up and down cursor keys then press 'Enter' (or point and click on it with the left mouse button). You will be returned to the main menu. Remember that when you load a helicopter from this menu it will replace the current helicopter. If you have made changes to the current helicopter that you wish to keep go to the 'save current helicopter' menu and save them before loading the next helicopter. **To exit this menu without loading press <Escape> or right mouse button.**

How to exchange model set-ups with friends:

When the list of helicopters is displayed (in the save or load menus) you can see the file name of each helicopter at the left hand side of the list. Simply note the name of the file holding the model you want to exchange. All the helicopter files are held in the 'hlib' subdirectory of your CSM10 directory. This can be copied to a floppy or attached to an e-mail to exchange. The recipient should simply copy the file to their 'hlib' directory.

SAVE CURRENT HELICOPTER

Having selected this option you will be presented with a screen listing all the helicopters available in the directory 'hlib', with up and down arrows if the list is longer than one page. The current helicopter (the one last loaded from the 'load helicopter' menu) will be highlighted in blue. If you are just saving some slight changes to the current helicopter and wish to overwrite the previously saved version then press 'Enter'. The existing name of this helicopter will now be highlighted in red. You now have the option to modify the description of the helicopter. To erase part or all of the existing description use the backspace key (marked ← and located top right on your keyboard). If you do not wish to overwrite the saved version of the current helicopter you can save the current helicopter to a new slot on the menu by selecting the 'NEW' option at the bottom of the list. The current name will now appear highlighted in red at the top of the menu. You can change the model's description as explained above. When you have completed the description change complete the save operation by pressing 'Enter'. A new file name will be created using the three letters given in the install program, plus three numbers, and the **.hsd** extension (eg 'XYZ011.hsd')

Adding a helicopter to the list

To add a completely new helicopter to the lists we suggest you proceed as follows:
Load a helicopter of similar basic dimensions from the existing list (e.g. if you are adding a '30' size helicopter start by loading, say, the Kalt Enforcer). Go through the Dimensions, Set-up, Engine data, and Flybar data menus revising the values to those of the new helicopter. When these changes are complete go to the save current helicopter menu and the new helicopter using the 'NEW' option as described above.

To exit this menu without saving press <Escape> or right mouse button.

DIMENSIONS
This menu contains the main dimensions and properties of the helicopter. They include:-

Main rotor outer diameter Enter here the distance across the main rotor (measured blade tip to blade tip).

Main rotor blade chord This is the width of the main blades. Most blades are constant chord but where they taper along their length measure the blade width at a point about 75% of the rotor radius from the main shaft.

Main blade profile drag This depends on the aerofoil section and surface finish of the blades. It has a large effect on the autorotation performance and the tail rotor trim. In order to set this we suggest you measure the rotor RPM and tail rotor pitch of your model in the hover. Adjust the pitch/throttle curve on the simulator until the simulated model hovers at the same RPM and then adjust the profile drag on the simulator to match the tail rotor trim of the simulated model to the real one. As a starting point use a profile drag of 0.015 for '60' size models and 0.019 for '30' size models.

Main blade weight This is the weight of EACH main rotor blade. If you don't have scales to weigh your blades start with 100g for '30' size machines and 180g for '60' size machines.

Weight of helicopter Measure the all-up weight of your helicopter (including blades but with an empty fuel tank).

Tail shaft to main shaft distance. Measure the horizontal distance between the main rotor shaft and the tail rotor shaft with the main shaft vertical.

Yaw inertia: This depends on the degree to which the weight of the helicopter is localised near the main shaft. Scale models will generally have higher values than 'Pod and Boom' models. Try flying with low gyro gain to see the effect of this parameter.

Tail rotor diameter Enter here the distance across the tail rotor (measured blade tip to blade tip).

Tail rotor blade chord Tail blades are often tapered in chord. Where this is so, measure the tail blade width at a point about 75% of the rotor radius from the tail shaft.

Main to Tail Gear Ratio. Measure this by turning the tail rotor by hand in normal direction of rotation and counting the number of revs of the tail need to cause one complete revolution of the rotor head. Be careful that the autorotation clutch does not operate.

Engine to Main Gear Ratio. The method by which this can be determined will depend on the method of gearing employed, but in cases where the clutch runs at engine speed a mark on the clutch outer can be used to count the revolutions made for one revolution of the rotor head.

Stability factor: (more correctly known as the Velocity Stability) is the tendency of the helicopter to level out when put into a dive. It is a natural consequence of the forward going blade generating more lift than the retreating blade. Due to the gyroscopic effect of the rotor the net effect of this difference in lift between the two sides of the rotor is for the rotor to tilt backwards. The stability of the complete helicopter is influenced by a large number of factors many of which are difficult to measure on the model. The simulator provides a single factor that allows the stability of a given model to be emulated.

Cyclic Response. Some helicopters, especially those with a pure Hiller type control systems, suffer from a slow response to cyclic inputs because the main blade cyclic pitch is indirectly controlled via the flybar. Helicopters with Bell/Hiller type control have faster responses since some of the main blade cyclic pitch control is coupled directly from the swash plate. Once again, many things such as teeter stiffness are involved and a single parameter is used to tailor the simulator response. The range is from 0 for slow (Hiller only type models) to 10 for fast (Bell/Hiller type models).

Rotor direction
Direction of the main rotor rotation (clockwise or anticlockwise as viewed from above!)

SET-UP
This menu contains the items that are mainly a matter of linkage adjustment.

Roll Cyclic Paddle Throws Measure this by putting your pitch gauge on one of the paddles. With the flybar held horizontal and pointing along the line of flight apply full right cyclic control. Then measure the angle of the paddle to the horizontal. This angle is the Roll Cyclic Paddle Throw.

Fore/Aft Cyclic Paddle Throws Measure this by putting your pitch gauge on one of the paddles. With the flybar held horizontal and pointing across the helicopter apply full back cyclic control. Then measure the angle of the paddle to the horizontal. This angle is the Fore/Aft Cyclic Paddle Throw.

Mid-stick tail pitch With the throttle and tail rotor controls at their mid positions use a pitch gauge to measure the pitch of one of the tail rotor blades. To do this sight the pitch gauge against the tail boom.

Tail pitch throw This is the deflection of the tail rotor pitch from the mid-stick value at 100% servo travel. Since the ICG360 gyro (simulated in this program) has a throw limiter, this value should be set in conjunction with the **Control Check** facility to ensure that the throws shown in the **Control Check** facility match those of the model you are simulation.

Collective pitch adjustments
These are:
Collective at 100% servo travel: Used to set the High (positive) collective throw.
Collective at 50% servo travel: Used to adjust the collective mid point.
The Collective at 0% servo travel: Used to adjust the Low (negative) collective throw.

As with the tail pitch throw, you should make use of these adjustments in conjunction with the **Control Check** facility to ensure you are getting a match between the simulator and your real model. Since the behaviour of the collective control is influenced by your transmitter pitch curves, travel adjusters etc. it is useful to make accurate collective pitch v stick position measurements on your real model as a basis for your simulator set-up. Once you have matched up the simulator with the real model, changes in the transmitter settings will affect the simulator in the same way as the real model and re-adjustment of these collective pitch parameters should only be needed if you change the linkage in the real model.
Note: If you don't have a pitch gauge for your real helicopter, now would be an excellent time to buy one!

When copying angles measured from a real model to the simulator remember that all the angles used in the simulator are measured relative to the zero lift line and if you have measured angles to the bottom of some flat bottomed blades some allowance (about 2 degrees) needs to be made. That is to say a flat bottomed blade set at 4 degrees may be lifting as if it were a symmetrical blade set at 6 degrees.

<u>NOTE:</u>
If you have edited a helicopter during your flying session your changes will be lost unless you save them through the 'Save Current Helicopter' option on the main menu.

CONTROL CHECK
This provides a continuous display of the collective pitch (in degrees), throttle position (in %) roll cyclic pitch, fore/aft cyclic pitch, tail rotor pitch (in degrees), Yaw Rate Demand (Deg./s), Gyro Mode (0 or 1) and Gyro Gain exactly as the simulated model is currently picking up from your transmitter. This should be used in conjunction with the 'Set-up' and ICG360 gyro menus and the adjustments of your transmitter to get the desired collective pitch/throttle/tail pitch relationship in all the idle-up states. Note that the cyclic pitches are measured at the flybar paddles.

ENGINE DATA

Peak power This is usually quoted in the engine manufacturers data. If conversion of units is required use the factor 746 watts is 1 Horsepower. Where no other guide is at hand take the output of a typical '30' sized engines as about 1 Horsepower. The simulator does not make any deduction from the engine power to allow for transmission losses. This is left to the user.

RPM
Enter the RPM at which peak power is attained. This is usually quoted by the manufacturer. Remember that this (and the peak output) can be greatly influenced by exhaust systems, fuel, plugs, etc.

Tank capacity This should be set to the usable capacity of the fuel tank. The simulated fuel consumption is based on data for 2-stroke glow motors and is continuously computed from RPM and throttle opening so the tank duration depends on how you fly. With electric powered helicopters an estimate has to be entered to simulate battery life. A red square on the right of the screen will appear to remind you to re-fuel (by pressing 'R') when needed. The 'R' key also re-positions the helicopter for take-off.

ICG360 GYRO DATA
The helicopters in this simulator act as if they are fitted with a CSM model ICG360 tail rotor gyro. This allows you to experiment with CSM's revolutionary "Heading Lock" system. The Gyro Data menu gives access to internal set-up parameters of the ICG360 (accessed on the real gyro via its 'computer' interface port). The pre-programmed models on the simulator are all set up with the 'default' gyro parameter values. Those wishing to experiment with this menu can find a full copy of the manuals for the real ICG360 gyro and its PC interface in the **"INFO"** folder in the **"CSM10"** folder of your hard disk. The following description is for the gyro in its default configuration.

The ICG360 is a 'Yaw Rate Demand' system. in which the rudder command from the pilot is interpreted as a request to the gyro to establish the desired yaw rate. The gyro drives the tail rotor servo as needed to obtain this yaw rate. This means that the gyro makes full yaw rate available even at high gain settings. With this system you can now use the rudder travel volume (ATV) and rudder rates facilities to set up the desired full-stick yaw rate and the gyro gain switch now becomes a 'Flight Mode Switch' for the gyro. There is no need for so called Pilot Authority Mixing - indeed you should not use pilot authority mixing with the simulator

Gyro Flight Modes
The gyro has two flight modes selectable by the transmitter gyro gain switch (or Auxiliary channel switch). With its default settings the gyro modes are:

Mode 0 (Standard Mode)
This mode gives flying characteristics that are similar to conventional systems.

Mode 1 (Heading Lock Mode)
This mode provides a much higher resistance to unwanted yawing movements than can be obtained with a conventional gyro system. **ATS mixing (collective to tail) is not needed with heading lock.**
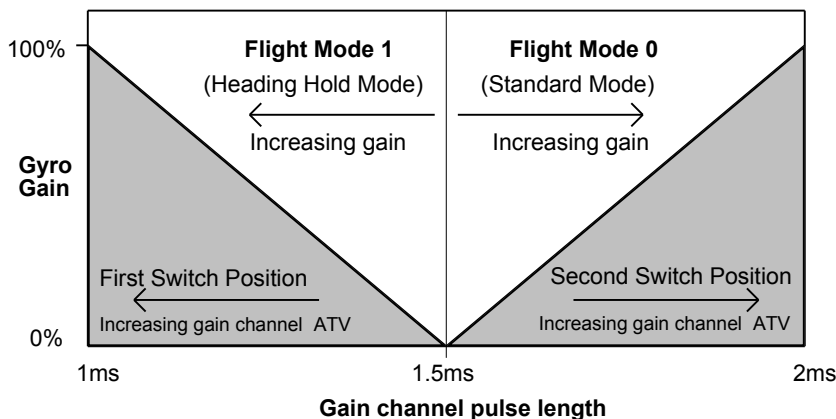

Figure 1. The Gyro gain channel acts as both gyro mode switch and gain control

The graph (Figure 1) shows the way in which the gyro gain channel provides both mode switching and independent gain adjustment of the two modes. If the gyro gain channel pulse is longer than the centre value (1.5ms) the gyro is in Mode 0 while with the gain channel pulse shorter than 1.5ms the gyro is in Mode 1. The Travel Volume (ATV) settings for the two switch positions provide a convenient way of adjusting the gyro gain for each mode from the transmitter. Increasing the ATV of the gyro gain channel increases the gain for that mode.

The gyro mode, gain, Yaw Rate Demand, and tail pitch are all displayed in the **Control check** screen and this is very useful in setting up the gyro and tail on the 'model'.

Transmitters without a gain channel, rudder rates or travel adjusters
If you are using a radio system without a suitable channel for controlling the gyro gain then you should go into the "Transmitter Data" menu and set the gyro channel to zero. In this state the gyro will run in Mode 0 with the gain fixed at 75%.
If you don't have rudder rates or rudder travel adjustment facility on your transmitter you will probably find the tail response to be over sensitive for general flying. In this case should set the gain channel to zero. This automatically reduces the sensitivity of the Yaw rate demand.

FLYBAR DATA
Flybar span
This is the total diameter of the flybar measured from paddle tip to paddle tip.

Paddle span
The length of one paddle (ignoring any small protrusions for flybar entries)

Paddle chord
The width of the paddle

Paddle weight
Weigh a single paddle using postage or other sensitive scales.

WEATHER CONDITIONS
Wind speed, direction and turbulence The wind speed you enter here is the mean wind at 2 metres (6 ft) above ground (as you would measure it with a hand held anemometer). The simulator creates a realistic wind gradient. (For those interested in boundary layer meteorology, the assumed roughness length is 2.5cm). The turbulence acts in all three directions.

Ground effect
Ground Effect is a rise in the lift created by the main rotor when in the proximity of the ground. The height and magnitude of the effect depend on the surface being flown over but typically the effect extends to a height approximately equal to the rotor diameter and has a maximum value of about 20%.

Sun (or moon at night!) direction and elevation: This gets the pilot used to the helicopter looking quite different in different lighting conditions and in various orientations. (However nothing can quite prepare you for the real sun right in your eyes just at that awkward moment!) Elevation is in degrees above the horizon, direction is in degrees clockwise with north as 0.

TAKE-OFF HEADING
Simply allows you to start the helicopter pointing north or south. Use this in conjunction with the **Set viewpoints** menu and the wind direction (in the weather menu) to practice Nose-in or tail-to-wind take-offs. If you get confused about direction look out for the flags as these will give you the wind direction.

CRASH LIMITS
Sets the maximum forward, sideslip and vertical speeds allowed by the simulator before it registers the landing as a crash. Obviously, the higher the speeds allowed, the more 'forgiving' the simulator is.
The default settings represent a good target for the beginner.

SELECT RADIO
This option allows you to change the transmitter in use while still in the simulator. The list presented is the same as given in the start-up screen.

CREATING A NEW RADIO TYPE
If your transmitter or your use of it does not fit any of the existing radio types go to the "Select Radio" menu and select "Create new type". You will then be prompted for a name for this radio. To set up the new radio you go to the "Radio system data" menu as described below.

RADIO SYSTEM DATA
In this menu you can specify the PPM signal characteristics and the channel usage of the transmitter you are using.
Servo Centre Pulse. The PPM pulse width issued by your transmitter for a centred control. If you are unsure of the value you can use the **TXTEST** program to see all your channel pulse widths. Centre all trims and take the average value for the spring centred controls (Roll, elevator, and rudder channels)
Servo Pulse Range. This is the amount by which the pulse deviates from the centre value. To measure this for your transmitter, use the **TXTEST** program and, having established the length of the servo centre pulse set all travel adjusters and rates to 100% and find the maximum pulse length on, say, the roll channel. The difference between the maximum pulse and the centre pulse is the Servo pulse range.
Channel usage. You should consult the manual of your radio system for the standard channel allocations, however if you use a non-standard stick configuration you are free to allocate channels as you want. Note that setting a channel to zero will cause the simulator to centre that control. So for example you can simulate a fixed pitch helicopter by allocating the collective function to channel zero.
Use the **"Servo reversing"** menu to get functions acting in the right sense.

RENAME CURRENT RADIO
Simply allows you to change the description of the current radio system as it appears on the **Select radio** menu.

SERVO REVERSING
If **Control check** shows a function is working the wrong way around simply go into this menu and reverse that function. The reversing is saved and loaded with the radio data so once you have got it right for one model it should be right for all the rest, and it won't affect how the 'models' fly with other radio installations selected.

SIMULATION SET-UP
Graphics resolution
Four graphics resolutions are possible:
1 = 640 x 400, 2 = 640 x 480, 3 = 600 x 800, 4 = 1024 x 768
Generally you will wish to use the highest resolution you can but the resolution that your machine can support will depend on:
   SVGA card memory. If your card does not have enough memory for a given mode the picture will 'strobe'. If this happens you should select a lower resolution mode. If strobing persists even at resolution 1 then your SVGA card is probably not fully VESA compatible: ask your PC supplier about a VESA driver for your card.
   Processor performance. If you find that the model appears to fly in slow motion select a lower resolution mode. This will depend on the complexity of the airfield or helicopter graphic being used. A low complexity Pod and boom model is provided in the Helicopter visuals list to help with lower performance processors.

Motion as percentage of real speed
The helicopter can be slowed down for learning purposes, either generally or to practise a particular aerobatic manoeuvre. The cyclic controls have been deliberately kept at full speed so that they respond quickly for getting you out of awkward situations easily! The tail rotor response however is slowed down by the slow motion facility and in some cases you may find it worth reducing the gyro gain to speed up the yaw response.
Remember to get used to full speed before flying the real machine! Flying the simulator at faster than real speed (up to 130%) is good for building up the reactions.

Position and height holds: with both these on the helicopter is fixed in space for the beginner to see the effects of moving the sticks. Then turn off the height hold so that the helicopter moves up and down, but doesn't move around. Eventually fly with both holds off.

Auto zoom on/off
Choosing this option toggles the auto zoom on/off. The auto zoom automatically gives a 3 times enlargement of the helicopter when it is more than 70 metres away. This helps in orientation of the helicopter, but of course does not happen in real life, so learn not to depend on it. When the helicopter is shown as larger than real life, 'binoculars' are shown around it.

Follow mode
Instead of standing still to watch your helicopter, you can follow it. There are two follow modes:-
a) **Full Follow mode**
This mode is activated by pressing the "5" key while in the flight screen. In this mode the viewpoint follows the aircraft both horizontally and in height.
b) **Height held follow mode**
This mode is activated by pressing the "6" key while in the flight screen. On pressing this key the height of the pilots view is held while the viewpoint follows the aircraft's horizontal position as in the full follow mode. You can go from any of the fixed ground viewpoints to the height held follow mode, and switch between the two follow modes as desired.
Adjusting the follow modes.
There are two values that set the way the viewpoint follows the model.
1) **Follow Mode Range**
This sets the horizontal distance the viewpoint will take from the model when stationary. (e.g a hovering helicopter.
2) **Follow Mode Rate**
This sets the speed with which the viewpoint reacts to changes in the model's position.
To see how the follow mode adjustments work imagine you are being towed about by the model by an invisible spring. The Follow mode range is the length of the spring - if you are further away than this range you are pulled towards the model - if closer then you are pushed away. The follow mode rate adjusts the strength of the spring with 100% being very stiff and 1% being very floppy!
For low follow rates (less than say 20%) the distance from the model becomes insensitive to the follow range you choose and depends more on the speed of the model and the follow rate. Reducing the follow rate is a good way of increasing the 'visual cues' about the speed of the model and can help in judging, for example, landing approaches - as the model slows up you 'catch it up' while as it accelerates it gets further away from you.
Using the follow modes.
Although the setting up of the follow modes is very much a matter of personal preference you may wish to try the following set-ups:-
1)Try the height held follow mode (with a follow range of say 10metres) for initial helicopter hovering practice. This allows you to remain 'in touch' with the helicopter and concentrate on mastering the collective and tail rotor controls before you have mastered the cyclic controls well enough to keep the helicopter hovering in a small area. Set the desired head height on fixed viewpoint 1 and then set the head height by briefly pressing "1" and then "6" when in the flight screen. The view position will then adopt the height of fixed viewpoint 1 but follow the model horizontally.
2)Use a low follow rate (say 3%) and a follow range of 20m to 'stand off' from your aerobatics. The low follow rate means that the viewpoint motion is very smooth and it is easy to judge the shape of aerobatic manoeuvres without having to worry about setting them up over a specific area as you would with a fixed viewpoint.
3)Use a follow range of about 10m with a follow rate of 20% to practice flying helicopters backwards. As the helicopter backs away from you the viewpoint will follow keeping you looking at the nose of the helicopter.

SELECT AIRFIELD
This is a pick list of the available airfields. The desired field can be chosen by highlighting the required option using the cursor keys. Field can be either a 'day' or 'night' field. In both cases the colours of ground objects can be adjusted using the **Airfield Colours menu.** Also, each

helicopter has independent day and night colour schemes. When a 'day' airfield is selected the Helicopter colours menu works on the day colour scheme. Conversely, selecting a 'night' field causes the Helicopter colours menu to act on the night colour scheme of the current model.

Custom Airfields
For those wishing to create their own flying environment, information to help you generate new airfield objects, and new airfield layouts is given in the file called 'fileinfo.txt' which is included with the simulator.

SET VIEWPOINTS
This displays and allows changes to be made to the four viewpoints for the current airfield. The viewpoints are given by their position north and east (relative to the airfield centre) and height above ground. The different viewpoints can be accessed during flight by pressing the required number (1 to 4) on the keyboard. This information is saved separately for each airfield allowing different sets of viewpoints to be used with each field.

AIRFIELD COLOURS
This shows the twelve colours used for the current airfield. To change any of them, simply pick the one to change, and alter its colour with the red, green and blue 'paintpots'. The sky and ground colours are set automatically for 'day' or 'night' as appropriate for the current field.

HELICOPTER COLOURS
This shows the ten colours being used for the current helicopter, either in daylight or at night, depending on which field is selected at the time. To change any of them, simply pick the one to change, and alter its colour with the red, green and blue 'paintpots': you'll want to keep the basic colours the same in the day or night except for intensity, but for your night flying aids you might want to try a 'glo stick' green for the boom or light the inside of the canopy in addition the having LEDs on the rotor disc and skids.

The ten colours are for: canopy, screen, inside canopy, side frames, trim, boom, boom support, exhaust, skid legs, skids and rotor blades.

SELECT HELICOPTER VISUAL
This gives a list of the different shapes of helicopter available. The colour can be altered using the helicopter colour menu, and the size will scale with the rotor diameter size chosen.

QUIT
Gives you the option to quit the simulator. Remember to save your current helicopter if required. The simulator settings and weather conditions are automatically saved on exit.

MINOR CONTROLS
You will be reminded of these when you escape from the main menu to fly for the first time during any session. These are available **during flight,** and they are :-

"S":	Toggles the sound on and off
"P":	Toggles a panel of information on and off. Includes height of the helicopter, distance from the pilot and main rotor rpm.
"R":	Re-fuels, repositions the helicopter for take off, and restarts the engine.
"1,2,3 or 4"	Changes the pilots viewpoint
"5"	Full follow mode
"6"	Height-held follow mode.
"M" Space bar or mouse button:	Takes you to the **main menu**

The current gyro gain is indicated by the colour of a small square on the left hand side of the screen as follows:-

  Green = mode 1 gyro
  Yellow = mode 0 gyro
These are on screen at all times.

When the helicopter has run out of fuel a small red square with a 'R' in it will appear to remind you to press R to re-fuel.

AERO SIMULATOR

RUNNING THE AEROPLANE SIMULATOR
As with all DOS programs, the simulator can be run from Windows 95. (Running from within Windows 3.1 is not recommended).

Running from Windows 95
If you have configured the short-cuts to the simulators on your desktop simply double click on the **"Shortcut to Aero10"** icon.

If you have not set up short cuts, proceed as follows:
Double click on the 'My Computer' icon
Locate and open the **CSM10** folder on your hard disk.
Find and double-click on the "Aero10" entry in this folder: this will launch the simulator.

Running from DOS
With the software installed as described above you can run the aeroplane simulator as follows:
If installed on drive C, type at the DOS prompt:-

      C: (Enter)   {or appropriate drive letter}
      CD   (Enter)
      AERO   (Enter)

THE START SCREEN: Selecting a radio installation

Please note: It is possible to fly the aeroplane simulator with dedicated helicopter transmitters (such as the Futaba Challenger Heli 5) though any automatic tail stabilisation mixing should be turned off to prevent changes of rudder trim with throttle!

You will initially be asked which radio is in use. If your transmitter type already appears on the list you should simply select this and continue. The accurate reproducibility of our interfaces and of modern transmitters should make adjustment for these types unnecessary. If your transmitter type is not on the list or you use a non-standard joystick configuration (i.e. not standard mode 1 or mode 2) you should select "CREATE NEW TYPE" on this menu. Having done so, proceed as described under the "Creating a New Radio" section of this manual.

THE MAIN MENU
This offers the following options:-

       Load aeroplane
       Save current aeroplane
       Wing data
       Tail surfaces
       Fuselage data
       Undercarriage
       Control surfaces
       Propulsion
       Weight and balance
       Aerofoil section data

      Weather conditions
      Take off position
      Crash limits
      Select radio
      Radio system data
      Rename current radio
      Servo reversing
      Check controls
      Simulation set up
      Select airfield
      Set viewpoints
      Airfield colours
      Aircraft colours
      Quit

Use the cursor keys to highlight the option you require, then press 'ENTER', or use the mouse and left mouse button to pick the required option.

TO FLY: From the Main Menu press <Escape> or right mouse button.

LOAD AEROPLANE
In this menu you will be given a list of the aeroplanes currently available, with up and down arrows to scroll the list if it is longer than one page. The files are stored in a directory called 'alib' and on the menu you are given the file name in the form of three letters and three numbers with the extension 'asd' eg CSM001.asd, followed by a description of the aeroplane. Highlight the one you want to fly using the up and down cursor keys then press 'Enter' (or point and click on it with the left mouse button). You will be returned to the main menu. Remember that when you load an aeroplane from this menu it will replace the current aeroplane. If you have made changes to the current aeroplane that you wish to keep go to the 'save current aeroplane' menu and save them before loading the next aeroplane. **To exit this menu without loading press <Escape> or right mouse button.**

SAVE CURRENT AEROPLANE
Having selected this option you will be presented with a screen listing all the aeroplanes available in the directory 'alib', with up and down arrows if the list is longer than one page. The current aeroplane (the one last loaded from the 'load aeroplane' menu) will be highlighted in blue. If you are just saving some slight changes to the current aeroplane and wish to overwrite the previously saved version then press 'Enter'. The existing name of this aeroplane will now be highlighted in red. You now have the option to modify the description of the aeroplane. To erase part or all of the existing description use the backspace key (marked ← and located top right on your keyboard). If you do not wish to overwrite the saved version of the current aeroplane you can save the current aeroplane to a new slot on the menu by selecting the 'NEW' option at the bottom of the list. The current name will now appear highlighted in red at the foot of the menu. You can change the description as described above. When you have completed the description change complete the save operation by pressing 'Enter'. A new file name will be created using the three letters given in the install program, plus three numbers, and the extension .asd eg 'XYZ011.asd'
Adding a aeroplane to the list
To add a completely new aeroplane to the lists we suggest you proceed as follows:
If possible, load a aeroplane of similar basic dimensions from the existing list. Go through all the menus revising the dimensions etc as required for the new aeroplane. When these changes are complete go to the save current aeroplane menu and the new aeroplane using the 'NEW' option as described above.
To exit this menu without saving press <Escape> or right mouse button.

DATUM LINES
In defining the aeroplane in the simulator the position of the main components (wing, tailplane, fin, propeller, etc.) are all referenced to the datum lines. For vertical positions this is a horizontal line running along the fuselage. This line should be chosen so that it is horizontal in normal flight. For lengthways measurements the reference is the leading edge of the wing at its root.
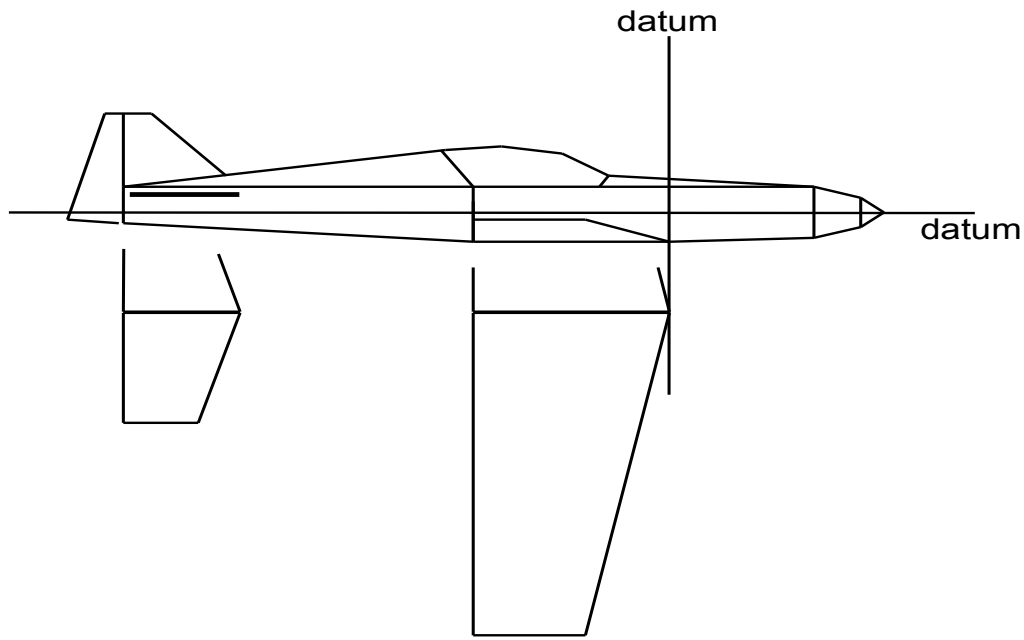
datum

datum

Figure 1 The datum lines from which positions are measured

WING DATA
Use the cursor keys to highlight the option to change then use the + and - keys, or use the mouse and left mouse button on the screen 'buttons'.

The shape of the wing drawn on the model as you fly accurately reflects the values you set in this menu helping you to visualise your design. Even the rigging angles and washout are drawn! Experienced modellers will be able to get their design sorted by the 'if it looks right, it is right' principle.

Parameters included are:

Wing Span
Measure this in a straight line from wing tip to wing tip (even where the wing is strongly swept or has large dihedral). Depending on the units you work in it may be useful to convert using metre roughly equals 40 ins.

Wing Root Chord
Measure the width of the wing where it joins the fuselage. (Convert if needed using 1 inch = 25.4 mm)

Wing tip chord/wing root chord ratio in %
Measure the width of the wing at the tip, divide this by the root chord and multiply by 100.

Dihedral in degrees
This is the dihedral of each wing (not the total dihedral of both). As a rough guide 0.5 inch under each tip of a 60 inch span wing gives 1 degree of dihedral. Dihedral gives roll stability in upright flight (but instability when inverted!)

Leading edge Sweep back in degrees
As with the dihedral, this is the value for each wing and the same rough guide applies. Sweep is used to give some roll stability and has the same effect in upright or inverted flight.

Washout in degrees
This is the amount by which the angle of attack at the wing tips is less than the attack at the wing root. This is often done to reduce the tendency of highly tapered wings to tip-stall. As a guide, 1/8th inch over a 7 inch chord is about 1 degree.

Wing incidence

This is the angle between the chord line of the wing (at its root) and the fuselage datum (also known as the rigging angle). The incidence angle is positive when the leading edge of the wing is higher than the trailing edge.

Wing Root height above datum
Apart from its aerodynamic significance, **this parameter also dictates the type of model drawn on screen.** If this value is positive, the simulator draws a high wing model; if it is zero or negative it draws a low wing model.

TAIL SURFACES
As with the wing data the values entered here are not just used in the aerodynamic modelling of the aeroplane, they are used so that model drawn during flight has tail surfaces which match the shapes specified here. The distances of the tail and fin behind the datum are also correctly represented in the graphics, however, for aesthetic reasons, the vertical disposition of the tail surfaces are not transferred to the graphics.

The Tailplane Span, Chord, tip chord/root chord ratio, and sweep are all required as for the wing.

Tailplane L.E. behind datum
With the model in normal flying attitude (with datum line horizontal) measure the horizontal distance between the wing leading edge at the root and the tailplane leading edge at its root.

Tailplane L.E. above datum
With the model in normal flying attitude, measure vertically up from your chosen datum line to the leading edge of the tailplane at its root.

Tailplane incidence
This is the angle (also known as the tail rigging angle) is measured between the chord line of the tailplane and the fuselage datum. The incidence angle is positive when the leading edge of the tailplane is higher than the trailing edge.

Fin Post Height
Measure the full height of the fin at the rudder hinge line. Include any part of the rudder hinge line that extends down the rear of the fuselage.

Fin Chord at base
The width of the fin at its widest point.

Fin tip/base chord ratio
Measure this as for the wing and tailplane.

Base of fin L.E. behind datum
With the model in normal flying attitude (with datum line horizontal) measure the horizontal distance between the wing leading edge at the root and the tailplane leading edge at its root.

Fin Centre above datum
Estimate the position of the centre of area of the fin and measure from this point down to your chosen datum line.

FUSELAGE DATA

Nose ahead of datum
With the model in normal flying attitude (with datum line horizontal) measure the horizontal distance between the wing leading edge and the nose of the model.

Fuselage height (maximum)
Find and measure the depth of the fuselage at its deepest point.

Fuselage width (maximum)
Find and measure the width of the fuselage at its widest point.

Fuselage aerodynamic centre above datum
Estimate the vertical position of the centre of side area of the fuselage and measure from this point down to your chosen datum line.

Fuselage aerodynamic centre behind datum
To find this, estimate the centre of side area and mark it. then find a point 70% back from the nose to the centre of side area and mark this second point which will be approximately the aerodynamic centre. Now measure horizontally from this second point to the wing leading edge.

UNDERCARRIAGE
Main Wheels behind datum
Note that the type of undercarriage (tricycle or tail-dragger) is automatically set by the relative position of the main wheels and the centre of gravity. If the main wheels are behind the centre of gravity the undercarriage will be a tricycle, if the main wheels are in front of the centre of gravity it will be a tail-dragger.

Wheel track
The distance between the two main wheels.

Rolling friction coefficient
Depends on the surface; low (say 0.1) for hard, smooth surface, high (say 0.5) for long grass. Influences take-off and landing run.

Limit to bank on touchdown in degrees
The limit of bank beyond which the wing tip touches before the wheels.

Nose up attitude limit on ground
For a tail-dragger, this is the normal attitude of the model on level ground.

Nose down attitude limit on ground
For the tail-dragger the nose down limit will be a crash limit. For Tricycle types it is the normal attitude of the model on level ground

CONTROL SURFACES
The size of the control surfaces are all expressed as a percentage of the main surface of which they form a part. There throws are expressed in degrees. The throws are all defined as the deflection from centre (so a rudder throw of 30 degrees means that the rudder moves 30 degrees either side of the centre). As a rough guide remember 1 degree is a slope of about 1 in 60. So an elevator of 2 inch chord with a movement of 0.5 inch either side of centre has a throw of about (0.5/2)x60 = approx. 15 degrees.

Flap Span /wing span ratio
The wing is assumed to be fitted with flaps out as far as the inboard end of the ailerons. So, for example, setting 30% flap span automatically gives 70% aileron span. For a model with full span ailerons simply set the flap span to zero.

Flap in fully up/down positions
For flap positions, a positive value represents a downward deflection of the flap and negative values an up deflection of the flap. Note that the pre-programmed models have been set up with equal up and down deflections to prevent problems with basic radios when no flap channel is used. Use the **Control check** in conjunction with this menu to set up the flaps as you require.

PROPULSION
Peak power
This is usually quoted in the engine manufacturers data. If conversion of units is required use the factor 746 watts is 1 Horsepower. Where no other guide is at hand take the output of a typical '30' sized engines as about 1 Horsepower.

RPM
Enter the RPM at which peak power is attained. This is usually quoted by the manufacturer. Remember that this (and the peak output) can be greatly influenced by exhaust systems, fuel, plugs, etc.

Tank capacity
This should be set to the usable capacity of the fuel tank. The simulated fuel consumption is based on data for 2-stroke glow motors and is continuously computed from RPM and throttle opening so the tank duration depends on how you fly. A red square on the right of the screen will appear to remind you to re-fuel (by pressing 'R') when needed. The 'R' key also re-positions the model for take-off.

Propeller Diameter and Pitch As marked on the propeller.

Propeller blade chord
In measuring this on a real prop remember that the majority of the thrust comes from the outer part of the propeller, so you should measure the chord at a point about 75% out from the hub.

Number of Blades
Yes, we know you can set it to one blade. Speed freaks will tell you they go faster that way.

Propeller hub above datum

Right Side Thrust

Down Thrust

WEIGHT AND BALANCE
Aircraft weight in Kg
Measure the all up weight of your model with empty fuel tank, but with fully charged Nicad (remember $E=mC^2$)

CG behind datum
For wings of modest sweep and taper an initial value about 25% of the wing chord is a good starting value. The more rearward the CG (centre of gravity) the more responsive the model in pitch. Very rearward CG positions will give rise to instability in pitch especially on the glide (when there is no prop-wash to enhance the effectiveness of the tailplane).

Yaw Inertia.
The figure shown here is the ratio of the radius of gyration of the aeroplane in yaw to the wingspan of the aircraft. Calculation of the inertia from the disposition of weight within the aircraft is a lengthy procedure and matching of the simulator to an existing model may be more quickly done by matching the flight characteristics. Stall-turns are a manoeuvre much affected by the inertia in yaw. Note that quite small change in the Inertia (say a change from 25% to 30%) can have a large effect on handling.

Pitch Inertia
This figure is the ratio of the radius of gyration in pitch to the fuselage length. As with the yaw inertia quite small changes can have large effects

Roll Inertia
Like the yaw inertia this is the radius of gyration in roll divided by the wingspan. The crispness of four-point rolls is much affected by this value.

AEROFOIL SECTION DATA
To simplify the use of the simulator a filing system allows the data in this section to be saved to and loaded from a library. This filing system is similar to that used for the models themselves. When you load an aerofoil from the library its data and name become part of the model's data. You then modify the aerofoil data of a model independently of the library. When you are in this section the name of the aerofoil section of the current model is displayed at the top of the screen. If you modify the aerofoil data of the model the name will them appear with the word 'Modified' in front of it to remind you that a change has been made.

You may add aerofoils to your library by editing the data for the current model and saving it in the library. If you wish to experiment with aerofoil types we suggest you obtain a suitable book, for example 'Model Aircraft Aerodynamics' by Martin Simons (ISBN 0 85242 441 8) The following parameters are used to characterise the aerofoils in the simulator.

Lift slope dCl/dAlpha
The rate of change of lift coefficient with angle of attack. Typically, this will be around 0.1 per degree for most aerofoils.

Attack at onset of stall
This is the angle of attack at which the lift slope levels off .

Width of stall
This allows for the adjustment of the sharpness of the stall.

Max Cl beyond stall
The wing will continue to produce lift beyond the stall and will reach a maximum at about 45 degrees angle of attack. It is this peak value that is required here. You will find wind-tunnel data for this difficult to find but values between 0.5 to 1 are typical

Cd beyond stall
The drag coefficient of the aerofoil increases sharply at the stall and continues to rise with angle of attack up to a maximum with an attack angle of 90 degrees. It is this maximum value that is required here. Again, data is not frequently found but values of around 1 are typical.

Cd at zero lift (Cd0)
At model sizes, this drag coefficient Cd0 is typically 0.012 to 0.02 with the lower values being appropriate for

Rise in Cd from Cl=0 to Cl=1
If you have the Cd versus Cl curve for the aerofoil take the value of Cd for C1=1 subtract Cd for Cl=0 and use the resulting value here. Typically, this will be around 0.02

Cd rise per % camber
Typically about 0.001 and can be ignored for modest camber wings

Change in attack for min. Cd per % camber
This is usually small and can be set to zero

Change in stall angle per % camber
Depends on the camber line employed and is typically 0.5 degrees per % camber

Change in Zero lift angle per % camber
Also camber line dependent. Typically -1.8 degrees per % camber

Pitching moment coefficient (Cm) per % camber
Depending on the type of camber line employed this can range from -0.05 to +0.01 per % camber.

Wing section camber in %
Set this to zero for a symmetrical section ! A typical semi-symmetrical section has 2 - 3% camber while highly cambered sections (such as Eppler 385) used for some sailplanes have perhaps 5 - 6% camber.

WEATHER CONDITIONS

Wind speed, direction and turbulence The wind speed you enter here is the mean wind at 2 metres (6 ft) above ground (as you would measure it with a hand held anemometer). The simulator creates a realistic wind gradient. (For those interested in boundary layer meteorology, the assumed roughness length is 2.5cm). The turbulence acts in all three directions.

Sun (or moon at night!) direction and elevation: Sets the lighting direction for the model and the airfield.

Thermal strength
Measured in metres/second, this can be set to zero if thermals are not required.

TAKE OFF POSITION

Air launch : The model is already in the air, at a height of 150 ft (50 metres) travelling North.

From ground : usual take-off

CRASH LIMITS
The default settings are a good target for the beginner. The landing must also be reasonably level, and the limit of bank on landing is set in the 'Undercarriage' menu. Additionally, for tail-draggers, the nose down attitude limit (in the undercarriage menu) is a crash limit.

SELECT RADIO
Use this option allows you to change the transmitter in use while still in the simulator. The list presented is the same as given in the start-up screen.

CREATING A NEW RADIO TYPE
If your transmitter or your use of it does not fit any of the existing radio types go to the "Select Radio" menu and select "Create new type". You will then be prompted for a name for this radio. To set up the new radio you go to the "Radio system data" menu as described below.

RADIO SYSTEM DATA
In this menu you can specify the PPM signal characteristics and the channel usage of the transmitter you are using.
Servo Centre Pulse. The PPM pulse width issued by your transmitter for a centred control. Aileron trim errors on the models is an indication that this value is not right for your transmitter. You can simply adjust this value until **Control Check** shows the ailerons in trim with your transmitter trims centred or, if you want to be more accurate, use the **TXTEST** program to see all your channel pulse widths. Centre all trims and take the average value for the spring centred controls (Roll, elevator, and rudder channels)
Servo Pulse Range. This is the amount by which the pulse deviates from the centre value. To measure this for your transmitter, use the **TXTEST** program and, having established the length of the servo centre pulse set all travel adjusters and rates to 100% and find the maximum pulse length on, say, the roll channel. The difference between the maximum pulse and the centre pulse is the Servo pulse range.
Channel usage. Your radio system manual should be consulted for help with the possible arrangements of channel allocation your transmitter supports. Always use the **Control Check** facility to make sure that the controls are all working as you want. If you use a non-standard stick configuration you are free to allocate channels to suit just as you would with a real model.
Note that allocating channel zero to a function will cause the simulator to centre that control. This should be done with the left and right flaps where a radio without a suitable flap channel is in use.
You may allocate more than one function to any channel. For example, you may allocate both flaps to the same channel, you can even drive both flaps with the elevator channel to give coupled flap & elevator on stunt models even with a basic 4 channel radio (use the servo reversing and flap throw adjustments to get the right direction and amount of flap movement). You can configure the wing servo arrangement in any way that your transmitter permits from 1 servo (both ailerons on the same channel and no flap channel) all the way to 4 servo with both ailerons and both flaps driven from different channels. Remember that you can use the **"Servo reversing"** menu to get functions acting in the right sense.

RENAME CURRENT RADIO
Simply allows you to change the description of the current radio system as it appears on the **Select radio** menu.

SERVO REVERSING
Available on aileron, elevator, rudder, flap and throttle channels to allow you to match the direction of control in the simulator to your transmitter. Since radio manufacturers have not standardised on the sense of the PPM pulses (i.e. some use a long pulse for right aileron while others use a short pulse) the servo reversing set in the simulator will not generally be the same as the servo reversing set on your transmitter. Servo reversing data is saved and loaded as part of the Radio system data so changes won't affect other Radio set-ups in the simulator. Also, once you have the reversing set right for one aeroplane it will be right for all the other simulator aeroplanes.

CHECK CONTROLS
This displays a rear view of the aeroplane to show the elevator, aileron, flap and rudder positions in degrees and throttle position in percentage, that the simulated model is currently receiving from your transmitter.

SIMULATION SET-UP
Position and height holds are not available in the fixed-wing version as they are of limited use.

Graphics resolution
Four graphics resolutions are possible:
1 = 640 x 400, 2 = 640 x 480, 3 = 600 x 800, 4 = 1024 x 768
Generally you will wish to use the highest resolution you can but the resolution that your machine can support will depend on:
          SVGA card memory. If your card does not have enough memory for a given mode the picture will 'strobe'. If this happens you should select a lower resolution mode. If strobing persists even at resolution 1 then your SVGA card is probably not fully VESA compatible: ask your PC supplier about a VESA driver for your card.
          Processor performance. If you find that the model appears to fly in slow motion select a lower resolution mode. This will depend on the complexity of the airfield or helicopter graphic being used. A low complexity Pod and boom model is provided in the Helicopter visuals list to help with lower performance processors.

Motion as percentage of real speed
The helicopter can be slowed down for learning purposes, either generally or to practise a particular aerobatic manoeuvre.
Remember to get used to full speed before flying the real machine! Flying the simulator at faster than real speed (up to 130%) is good for building up the reactions.

Auto zoom on/off
Choosing this option toggles the auto zoom on/off. The auto zoom automatically gives a 3 times enlargement of the aircraft when it is more than 70 metres away. This helps in orientation of the aircraft, but of course does not happen in real life, so learn not to depend on it. When the aircraft is shown as larger than real life, 'binoculars' are shown around it.

Follow mode
Instead of standing still to watch your aeroplane, you can follow it. There are two follow modes:-
a) **Full Follow mode**
This mode is activated by pressing the "5" key while in the flight screen. In this mode the viewpoint follows the aircraft both horizontally and in height.
b) **Height held follow mode**
This mode is activated by pressing the "6" key while in the flight screen. On pressing this key the height of the pilots view is held while the viewpoint follows the aircraft's horizontal position as in the full follow mode. You can go from any of the fixed ground viewpoints to the height held follow mode, and switch between the two follow modes as desired.
Adjusting the follow modes.
There are two values that set the way the viewpoint follows the model.
1) **Follow Mode Range**
This sets the horizontal distance the viewpoint will take from a stationary model.
2) **Follow Mode Rate**
This sets the speed with which the viewpoint reacts to changes in the model's position.

To see how the follow mode adjustments work imagine you are being towed about by the model by an invisible spring. The Follow mode range is the length of the spring - if you are further away than this range you are pulled towards the model - if closer then you are pushed away. The follow mode rate adjusts the strength of the spring with 100% being very stiff and 1% being very floppy!

For low follow rates (less than say 20%) the distance from the model becomes insensitive to the follow range you choose and depends more on the speed of the model and the follow rate. Reducing the follow rate is a good way of increasing the 'visual cues' about the speed of the model and can help in judging, for example, landing approaches - as the model slows up you 'catch it up' while as it accelerates it gets further away from you.

Using the follow modes.

Although the setting up of the follow modes is very much a matter of personal preference you may wish to try the following set-ups:-

1)Try a follow range of 2-3 metres and a follow rate of 70 - 100% with the fixed wing simulator. This gives a tight formation 'gun camera' type of view of the model and is very exhilarating when the model is flown close to obstacles, through tunnels etc. Watch out for the shadow of the model as you get little warning of the ground coming up to hit you!

2)Use a low follow rate (say 3%) and a follow range of 20m to 'stand off' from your aerobatics. The low follow rate means that the viewpoint motion is very smooth and it is easy to judge the shape of aerobatic manoeuvres without having to worry about setting them up over a specific area as you would with a fixed viewpoint. You may wish to use the height held follow mode to keep your viewpoint at a constant height.

Total Energy Variometer display

This is a type of 'rate of climb' indicator that takes into account airspeed changes and is the ideal thermal soaring aid. When enabled in this menu a total energy variometer will appear as a vertical bar type display on the left of the screen. Green indicates climb and red indicated sink. The full scale of the display is ±5 metres per second.

SELECT AIRFIELD

This is a pick list of the available airfields. The desired field can be chosen by highlighting the required option using the cursor keys.

Custom Airfields

For those wishing to create their own flying environment, information to help you generate new airfield objects, and new airfield layouts is given in the file called 'fileinfo.txt' which is included with the simulator.

SET VIEWPOINTS

This displays and allows changes to be made to the four viewpoints for the current airfield. The viewpoints are given by their position north and east (relative to the airfield centre) and height above ground. The different viewpoints can be accessed during flight by pressing the required number (1 to 4) on the keyboard. This information is saved separately for each airfield allowing different sets of viewpoints to be used with each field.

AIRFIELD COLOURS

This shows the twelve colours used for the current airfield. To change any of them, simply pick the one to change, and alter its colour with the red, green and blue 'paintpots'. The background sky and ground colours are set by whether it is a 'day' or 'night' field.

AIRCRAFT COLOURS

This shows the ten colours being used for the current aeroplane, either in daylight or at night, depending on which field is selected at the time. To change any of them, simply pick the one to change, and alter its colour with the red, green and blue 'paintpots'.

The colours are: fuselage, screen, top of wing, underside of wing, top of tailplane, underside of tailplane, fin, rudder, nosecone, fuselage trim.

The shape of the aeroplane is determined by its dimensions, e.g. whether it is a high or low winger, shape of its wings etc.

QUIT

Gives you the option to quit the simulator. Remember to save your current model if required. The simulator settings and weather conditions are automatically saved on exit.

MINOR CONTROLS
You will be reminded of these when you escape from the main menu to fly for the first time during any session. These are available **during flight,** and they are :-

"S":	Toggles the sound on and off
"P":	Toggles a panel of information on and off. Includes height of the aeroplane, distance from the pilot and main rotor rpm.
"R":	Re-fuels, repositions the aeroplane for take off, and restarts the engine.
"1,2,3 or 4"	Changes the pilots viewpoint
"5"	Full follow mode
"6"	Height-held follow mode.
"M" Space bar or mouse button:	Takes you to the **main menu**

If enabled, a total energy variometer will be displayed on the left hand edge of the screen. When the aeroplane has run out of fuel a red square with an 'R' in it will appear to remind you to press R to re-fuel.

Aerodynamic printout program
It is intended that the majority of the aeroplane design process is carried out in the simulator. However, as an aid to analysing and constructing your designs this program provides the designer with a printout of the main dimensions of the aircraft created in the simulator. Additional aerodynamic data not available in the simulator are included in the printout. For convenience data are provided in imperial and metric units.

Running the data printout program
The simulator interface is not required for this program.
Windows 95 users should make and use a shortcut to 'AIRPRINT' in the manner described earlier for the simulator.
DOS users should type at the prompt:-

C:	(enter)
CD CSM10	(enter)
AIRPRINT	(enter)

From the opening screen select the port to which your printer is connected (usually LPT1). Check your printer is on line with paper loaded and simply follow the on-screen prompts.

In addition to the information already covered in the Aero simulator section of this manual the following additional parameters are provided:-

Wing area: (sq. ft & sq.m)

Wing loading: (oz/sq.ft & kg/sq.m)

Wing Aspect ratio
The ratio of wing span to mean chord. High values as used on gliders minimise induced drag (drag due to producing lift)

Wing aerodynamic sweep
This property, which depends on wing taper and leading edge sweep, promotes roll stability.

Tail area (in sq. ins, sq.m and percent of wing area)

Tail aspect ratio
For good stall characteristics this should generally be kept smaller than the aspect ratio of the wing.

Fin aspect ratio
High values here may be prone to fin stalling at high yaw angles.

Approximate stall speed
The figure quoted is for a power-off glide with zero flap and Centre of Gravity (C of G) in the middle of its range.

Approximate full power duration
For a check on tank provision. (Assumes typical 2 stroke glow motor is used)

Wing aerodynamic centre
Useful in deciding the correct C of G position for the model. With modest wing camber the tailplane loads are minimised with the C of G close to this point.

Neutral point
Most rearward C of G position for which pitch stability can be expected when on the glide.

Useful additional Reading

'Model Aircraft Aerodynamics' by Martin Simons. ISBN 1-85486-121-2 A good text on general aerodynamics (including some on helicopters)

'Radio Control Model Helicopters' by John Drake ISBN 0-85242-722-0 Useful for the coverage of aerodynamic considerations of model helicopter design.

'Flying Model Helicopters' by Dave Day ISBN 0-85242-883-9 Good introduction for the pupil heli pilot.

U.S. readers should also consider a copy of Ray Hostetler's **'Complete Helicopter Manual'**

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E-mail CSM_Ltd@compuserve.com

The information in this manual is supplemented with information given in a 'readme' file on the disk. In case of problems please read this file as it may contain a solution.