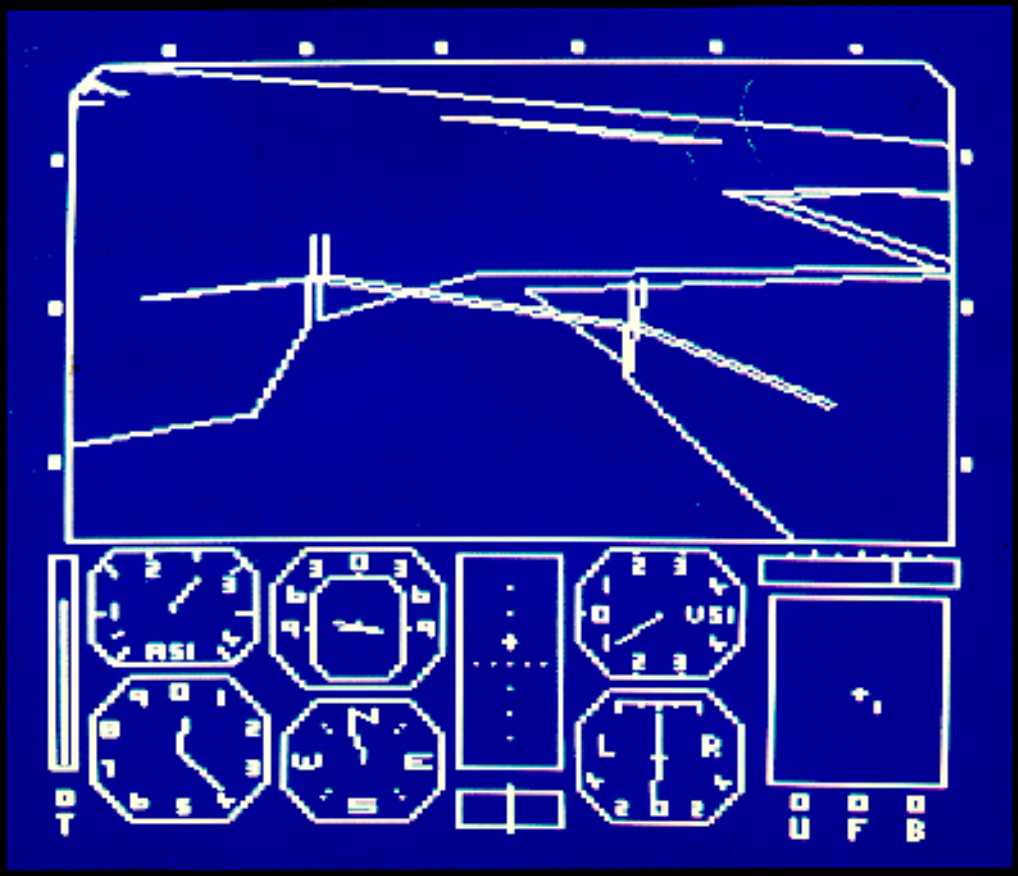
ACORNSOFT

Aviator

for the BBC Microcomputer Model B



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Aviator

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FIRST EDITION

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1 How to load the program

You will have bought your copy of this program on either a cassette or a disc. Instructions for loading both cassette and disc versions are given below. The disc or cassette contains one file, called AVIATOR.

Loading from cassette

To load and run the program place the cassette in the cassette recorder, type

CHAIN "AVIATOR"

and press RETURN; the ‘Searching’ message should appear on the screen as you do this. Now press the PLAY button on the cassette recorder and wait for the program to load. The title page will load in less than one minute and the main program will take a further six minutes to load.

Loading from disc

Place the disc in the disc drive and close the hatch. The program is loaded by means of an ‘AUTO-BOOT’, and this is executed as follows:

1. Press SHIFT

2. While holding down SHIFT, press and release BREAK

3. Release SHIFT

Note that it is not possible to catalogue or back-up this disc. The disc can be used in drive 0 of either 40 or 80 track disc drives.

When loading is complete the aircraft will be standing on the runway, awaiting your command. The dashboard controls are displayed in the lower half of the screen, and the runway ahead can be seen through the cockpit window.

Now read on to find out how to get off the ground!

2 The flight simulator

The main features provided are:

1. A sophisticated aircraft simulator based on the Mark II Spitfire.

2. Comprehensive instrument panel.

3. Three-dimensional world (map provided).

4. A perspective ‘through the windscreen’ view of the world.

5. Tests of skill (flying under a bridge for instance).

6. ‘The Theme’ – a chance to repel unfriendly life forms from outer space, both on the ground and in the air; a combined test of flying skill, navigation and tactics as you seek and destroy.

1 to 5 are detailed in this chapter and 6 is described in chapter 3, ‘The Theme’.

The simulator is based on the Spitfire Mark II single seater fighter. This type of aircraft went into service in 1940. The main difference between the Mark II and the Mark I is the slightly more powerful Merlin XII engine of the former.

The flight simulator puts you in the pilot’s seat of the Spitfire. You can make it fly just like the real thing, taking off, turning, climbing and landing. In fact, you can do virtually all the things that the real aircraft can, like loop the loop, rolling and indeed any aerobatics that you wish to attempt. But you have to be careful because if you try something that would cause a real Spitfire to run into difficulties, then it is likely that you will have the same experiences on the simulator. If things go disastrously wrong, you may find yourself struggling to regain control as the aircraft plummets towards the ground.

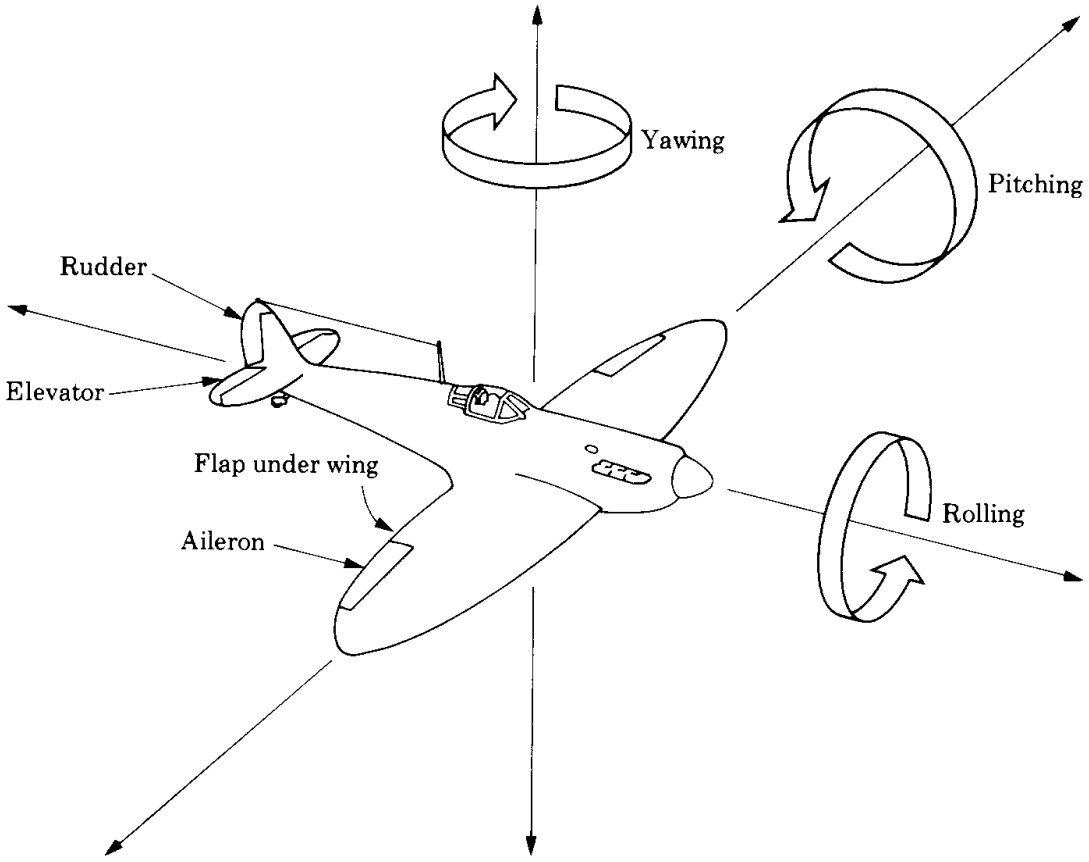
To minimise casualties and to get the most out of the simulator, you will need to read all of the instructions. You should conduct your training at a steady pace and must not expect to be able to do everything straight away.

The rest of this chapter describes all the features of the flight simulator including the three-dimensional world, the dashboard and the keyboard/ joystick controls. A section has been included to introduce the controls of the aircraft for those of you who are unfamiliar with aviation. The scope of the simulator is described in detail along with a whole section on piloting the plane. A training flight has also been suggested for you to get started. Once you have familiarised yourself with the art of flying, you can score points by landing and performing tests of skill.

An introduction to aircraft controls

This section is included for those of you who are unfamiliar with aircraft and their controls. Figure 1 shows the Spitfire control surfaces known as ailerons, elevators and rudder and also illustrates the three rotational axes of the aircraft roll, pitch and yaw. The control surfaces work on a very similar principle to the rudder on a boat, except of course instead of flowing water we have airflow. The elevators and ailerons swivel up and down, the rudder from side to side. Whereas the two elevators go up and down together, the ailerons go in the opposite direction to each other.

Figure 1 Rotational axes and control surfaces



In the aircraft:

Ailerons	Cause rolling and are activated by left and right movements of the joystick.
Elevators	Cause pitching and are activated by forward and backward movements of the joystick.
Rudder	Causes yawing and is activated by foot-pedals.

In the simulator:

All these controls can be operated from the keyboard or, if you prefer, the ailerons and elevators can be controlled by the computer joystick.

Flaps	The flaps are another set of control surfaces not actually visible on the diagram because they are underneath the wings (known as split flaps). In normal flight, they are raised to lie flush with the 'wing'. They are lowered in order to assist landings by acting as an airbrake and giving more lift at slow speeds.

The scope of the simulator

For the technically minded, here is a guide to the scope of the simulator itself.

The simulator models the forces that would be encountered by the real aircraft due to gravity, propeller thrust, aerodynamic forces due to airflow and contact with the ground. The equations of motion cover the full six degrees of freedom. A detailed list of those forces follows:

Linear forces

1. Wing lift
2. Aircraft drag (parasitic)
3. Induced drag
4. Side forces due to aircraft slip
5. Lift due to flaps
6. Drag due to flaps
7. Drag due to undercarriage
8. Propeller thrust (as a function of aircraft speed)
9. Propeller drag when gliding
10. Forwards, downwards and sideways gravitational forces
11. Upward reaction due to wheels on the ground

12. Sideways frictional forces of wheels
13. Wheel braking
14. Ground steering

Angular forces

Pitching moments due to:

– Elevator deflection
– Centre of gravity/centre of pressure
– Tail forces due to linear motion
– Tail forces due to pitch rate

Rolling moments due to:

– Aileron deflection
– Wing forces resulting from roll rate
– Wing forces resulting from aircraft slip

Yawing moments due to:

– Rudder demand
– Aircraft side, fin and rudder forces due to aircraft slip – Aircraft side, fin and rudder forces due to yaw rate

In addition, all aerodynamic related forces are adjusted with increasing altitude to allow for the decreasing density of air.

The simulator includes three axes of linear momentum and three axes of angular momentum.

Other features include:

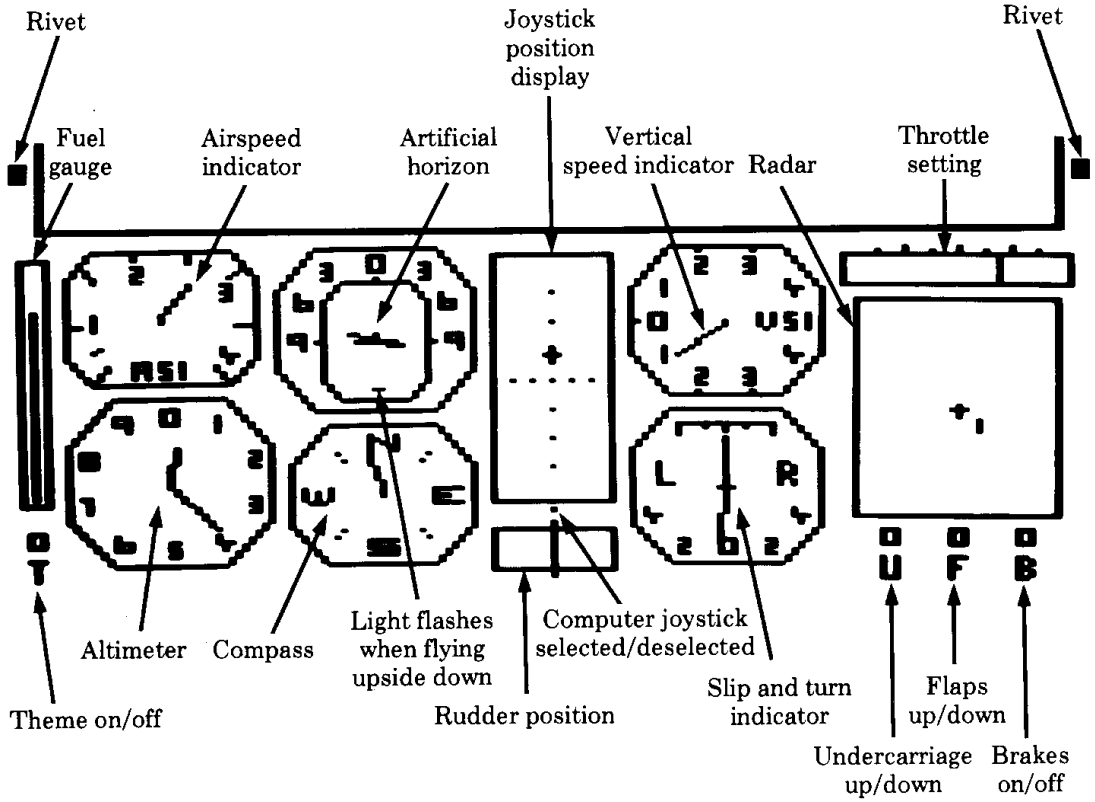
– Stalling
– Wings breaking under excessive ‘g’ forces
– Tail wheel configuration
– Belly landing
– Bumpy ground

The aircraft bullets, once fired, will continue to move through space in the direction fired, independent of subsequent aircraft manoeuvres.

The dashboard

Figure 2 shows a diagram of the aircraft dashboard. Each of the instruments is described in detail as follows.

Figure 2 The dashboard



Airspeed indicator

The airspeed indicator (ASI) measures the forward speed of the plane through the air.

Units:
One unit on the dial corresponds to 100rnph.

The needle will not start to move until you are flying at 50mph and will limit at 400mph, although the plane may exceed this speed in a dive. There is a special graduation mark below the ‘1’. This corresponds to a speed of 70mph (stalling speed with flaps).

Altimeter

The altimeter measures the altitude of the plane above ground level.

Units:
One unit for the large hand represents 100 feet. One unit for the small hand represents 1,000 feet.

The needles travel around the clock again after 10,000 and 20,000 feet causing some ambiguity but you should have a good idea of the correct reading.

Artificial horizon

This instrument displays the orientation of the aircraft with respect to the horizon.

The plane symbol is fixed in the centre of the dial and the line representing the horizon varies in attitude depending on the pitch and roll of the aircraft. When the aircraft pitches up, the horizon bar moves down and vice versa. When the aircraft rolls to the left, the horizon bar tilts to the right and vice versa. A flashing light will appear near the bottom of the meter if the aircraft is upside down.

Units:
The numbers marked on the gauge are 0, 3 and 6 and these correspond to 0º, 30º and 60º of roll respectively. In order to read the inclination of the horizon, you have to imagine a pointer sitting perpendicular to the horizon bar, halfway along its length.

Compass

The compass is used to establish the heading of the aircraft and comprises the standard north, south, east, west format.

Vertical speed indicator

The vertical speed indicator (VSI) monitors the rate of climb or rate of descent of the aircraft.

Units:
One unit represents 1,000 feet per minute.

A horizontal needle signifies a zero climb rate, in other words that the plane is flying at constant altitude. When the plane is climbing, the needle registers in the upper half of the meter and when the plane is falling, it registers in the lower half. The needle limits at 4,000 feet per minute.

Slip and turn indicator

This instrument comprises two meters rolled into one.

1. The top meter is the slip indicator (sometimes referred to as a bank indicator) and has been designed in such a way as to detect the presence of side forces acting on the aircraft. These forces are induced by the plane slipping sideways and the direction and approximate magnitude of slip can be determined from the meter reading.

Units:
No units but:
L – indicates a left-hand slip.
R – indicates a right-hand slip.

2. The lower meter is the turn indicator and registers the turn rate of the aeroplane, that is the rate at which the compass heading changes during a turn.

Units:
'2' corresponds to 2 X 180º per minute.
'4' corresponds to 4 X 180º per minute.

Joystick display
This indicator displays the position of the aircraft joystick. If the elevators alone are operated, the stick symbol (+) moves vertically (up corresponds to pushing the stick forward). If the ailerons alone are operated, the stick symbol moves horizontally (left corresponds to pushing the stick left).

Rudder indicator
This indicator registers a left-hand or right-hand swing of the rudder.

Throttle indicator
With zero throttle, the needle is located in the extreme left-hand position and with maximum throttle, it moves to the far right.

Radar
The radar covers an area of 25 miles by 25 miles. The stationary symbol at the centre of the radar screen represents an overhead view of the plane. The runway is the only fixed landmark of the world to be picked up on radar and it is depicted as an elongated blip on the screen. If the Theme has been selected, the radar detects any flying objects and these are shown as a dot on the screen. If the plane is not level but is in a steep bank, dive or climb, information gained from the radar screen can be misleading.

Fuel gauge

The fuel gauge is a long narrow indicator containing a central column. The height of the column shows the quantity of fuel remaining. The fuel tank automatically fills when all the following conditions are true:

– The plane is stationary and on the runway – The brakes are on
– The engine is off

On/off indicators

A series of small lights have been included in the dashboard display. The significance of the ON conditions is as follows:

U – Undercarriage lowered
F – Flaps down
B – Brakes on
T – Theme selected

A small light will appear below the joystick position display when control has been transferred from the keyboard to the computer joystick.

Keyboard controls

A diagram showing the computer keys used in Aviator, along with their basic functions, is presented in figure 3. There follows a more detailed description on how and when to operate the keys.

To select computer joystick control TAB selects/deselects joystick

The elevators, ailerons and gunfiring can be operated using either keyboard or joystick control. The TAB key is used to switch from one set of controls to the other. The joystick indicator on the dashboard is there to remind you which mode has been selected.

To reset the program

RETURN resets the program

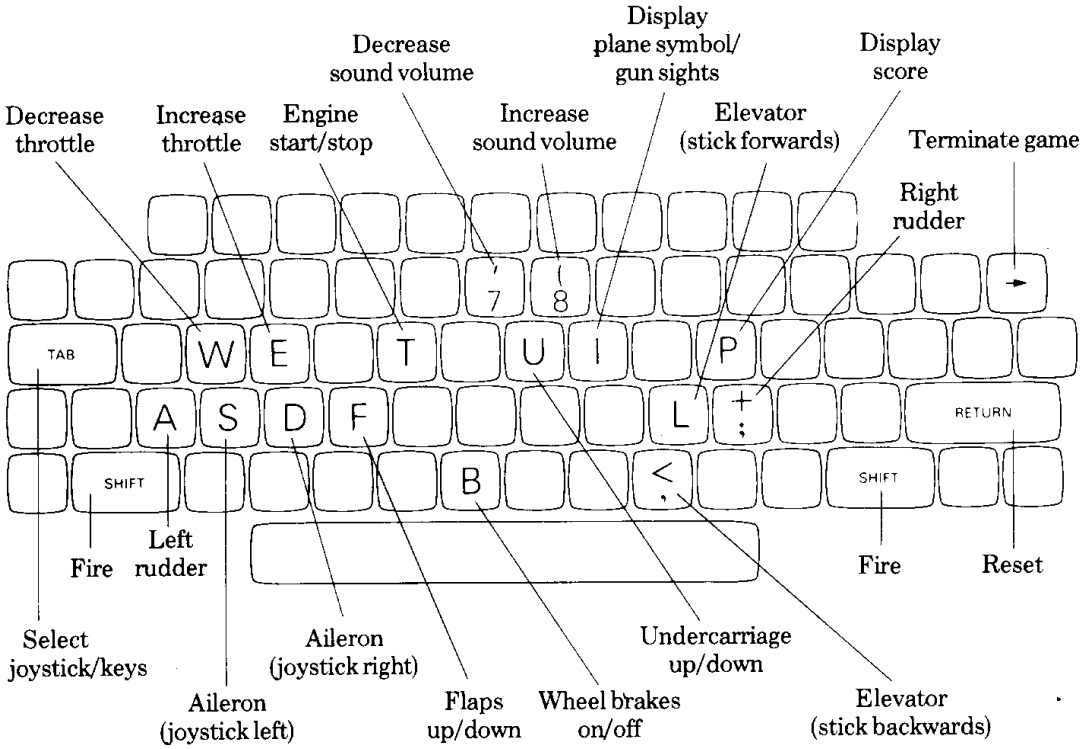
When a game has terminated for whatever reason, eg a crash, the score is automatically displayed. In order to clear the screen and start a new game, press RETURN.

To terminate a game

terminates a game

This key gives you the option of terminating the game before its natural conclusion. As the key only functions when the plane is on the ground, it is used mainly on those occasions when you have become demobilised on landing, either through lack of fuel or landing with the undercarriage up.

Figure 3 Keyboard controls



To start engine

Press T to start/turn off the engine

The engine will cut out and cannot be restarted after touching the ground with the undercarriage up (the propeller would be damaged) or if there is no fuel.

To control the volume of the engine noise
Press 7 to make the sound of the engine quieter
Press 8 to make the sound of the engine louder

These keys will function only if the following conditions are both true:

- The plane is stationary and on the runway
- The brakes are on

Keep the key depressed until the required volume is reached.

To fire guns
Press the SHIFT key to fire two bullets from the wings of the plane

The Theme is selected if the bullets are fired when the following conditions are both true:

- The plane is stationary and op the runway
- The brakes are on

If joysticks are selected, the fire button on the joystick takes on the role of the SHIFT key.

To apply throttle
Press E to increase throttle
Press W to decrease throttle

The throttle value will be continually adjusted if the key remains depressed.

To display score
Press P to display the current score

The score can be displayed on the screen at any time during a flight by pressing this key. The display will automatically be removed after about five seconds.

To operate undercarriage
Press U to drop/raise the undercarriage

To check whether the undercarriage is up or down, refer to the on/off indicator on the dashboard.

To operate gunfiring sights
Press I to display/remove gunfiring sights (plane symbol)

The sights can be introduced at any time by pressing this key. Besides acting as gun sights, they also provide a visual indication of the aircraft attitude relative to the world.

To operate flaps
Press F to drop/raise the flaps

The flaps can either be up or down and their current position is indicated on the dashboard.

Note: The flaps will automatically retract if the airspeed exceeds 150mph.

To operate brakes
Press B to apply/release the brakes

To check whether the brakes are on or off, refer to the on/off indicator on the dashboard.

To steer the aircraft
The following three sets of keys are used to control the elevators, ailerons and rudder. These keys can be operated by either quick, short stabs which result in a fine adjustment of the controls or by keeping the key depressed which gives a course adjustment. This is to allow any type of manoeuvre involving small or large movements to be performed effectively. The resolution of each key control is greater than that of the control position graphics display, with the result that a small increment may not necessarily register as a position change on the screen, although it will still affect the aircraft attitude. Control of the elevators and ailerons is completely transferred to the computer joystick when the joystick has been selected.

1. Elevator control

Press L to push the nose down (elevators down)
Press < to pull the nose up (elevators up)

Operation of these keys corresponds to moving the aeroplane joystick forwards (elevators down) and backwards (elevators up). The exact position of the joystick can be checked by looking at the dashboard.

2. Aileron control

Press S to roll to the left
Press D to roll to the right

Pressing S corresponds to a displacement of the aircraft joystick to the left and results in a left-hand roll; pressing D will cancel any previous S demand instantly and will then move the joystick to the right. The same characteristics apply vice versa. This special feature has been included because it offers the type of response available with a joystick.

3. Rudder control

Press A to steer to the left
Press + to steer to the right

Applying the left-hand rudder causes the nose of the aircraft to move to the left and applying the right-hand rudder causes it to move to the right. The rudder is also used for ground steering. For easy manoeuvrability on the ground, the rudder controls have been equipped with the same cancelling feature as used on the ailerons.

Computer joysticks

Only one of the pair of joysticks plugged into the computer is used in conjunction with the flight simulator. You can fly the aircraft without the use of the rudder and so, apart from occasional throttle adjustments, you can virtually fly without needing to touch the keys. If your joystick is secured so that you can operate it with one hand, this leaves the other hand free to operate keys such as flaps, undercarriage etc, and, after landing, you can use both hands to operate the rudder. The advantage of the joystick is that it gives a realistic response to your actions. You can make a small movement or a large movement quite quickly, whereas the response of the keys is a necessary compromise between speed, resolution and the pilot's reaction time.

The use of a joystick may at first seem more difficult than keys but as you become accustomed to it, you will find that you fly more instinctively and are better able to perform aerobatics and precision flying. You will also find if you have a short joystick that extending the length, besides being more realistic, will give you greater control and will reduce the effect of inadvertent hand movements.

The three-dimensional world

The world

Aviator incorporates a three-dimensional world just waiting to be explored. The world comprises land features spread over an area of approximately 15 miles by

15 miles, surrounded in all directions by barren desert. The features found in the habitated part of the world include a runway, a town, a lake, a bridge, a river, trees, mountains and fields. A map is available showing the whereabouts of each landmark.

You, the pilot, see a perspective view of the world as you would from the cockpit of a real plane. So as your aircraft flies towards the assorted objects scattered on the ground, they become larger and vary in appearance depending on the approach angle, You will find that the landmarks only come into view when they are within a certain distance and that the smaller objects are just seen at close range.

Note: The ground will always be at the same altitude as the runway.

Navigation

It is very important to keep a fix on where you are in the world at all times. Familiarise yourself with the map and use the compass to monitor your bearings. Maintain an awareness of your immediate surroundings by making use of the cockpit view and use the radar facility.

The radar is centred on the plane and covers an area of 25 miles by 25 miles. The elongated symbol on the radar screen marks the position and approximate orientation of the runway and smaller blips will appear during the Theme. Care should be taken when interpreting the radar information as strange readings can arise when the plane is steeply inclined to the horizontal.

Getting from one place to another can be made easier by flying between or alongside distinctive landmarks such as the river or certain combinations of scenery. Also the shape of each field is unique. Plan your approaches to landing carefully by ensuring that you are properly lined up at a sufficient distance away from the runway.

Piloting

You must appreciate that, like a real aircraft, it will take time to adapt to the controls and so you can expect to spend some hours in the air before you are really used to the feel of either the keys or the joystick. Eventually, flying the plane will become instinctive and you really will be at home with the controls.

You will find that the instructions involving the use of elevators and ailerons are written in terms of moving the actual aircraft joystick. These instructions can be applied directly to the computer joystick or, if you are using the keys, you can refer to the joystick position display on the dashboard.

Before attempting a flight, you should at least familiarise yourself with the instructions on taking off, climbing, turning and landing. Later on in the manual there is a brief outline of a training flight which, if followed correctly, will help guide you back to the runway.

Taxiing

To avoid the monotony of a repetitive taxiing sequence at the beginning of each flight, the simulation always starts with the plane in a position ready for take off. When the aircraft is stationary or travelling slowly, the tailwheel is on the ground and the aircraft nose is high. The orientation of the plane makes it rather awkward when taxiing as the view out of the cockpit is also inclined upwards.

In most cases, taxiing will be necessary after landing in order to ensure that there is sufficient runway to take off again.

Points to note when taxiing are:

- Ensure the brakes are off.
- Ground steering is controlled by the rudder. (It is achieved mechanically by applying a braking force to the left- or right-hand wheel.)
- When attempting a complete turn, the speed should be such that the tailwheel remains on the ground and you may find it helpful to use the
- compass to monitor your heading.
- Avoid running off the runway. The ground is very rough and the plane may crash, particularly if travelling at speed.

Taking off

Before taking off you should check the following:

- Ensure that there is sufficient runway to take off and that the plane is pointing in the right direction. (See ‘Taxiing’.)
- Check that your fuel supply is adequate.
- Centralise the elevators, ailerons and rudder.
- Make sure that the flaps are up. (The aeroplane would take off with the flaps down should you have left them down in error. However, in this event, you
- must not raise the flaps until the plane has reached a speed of at least 100mph and is travelling at a safe height.)
- Set throttle to low setting and start the engine.

Now you are ready for take-off!

With the engine running, release the brakes and increase the throttle to the maximum setting. Acceleration is rapid and as the speed increases, the airflow

will tend to lift the tail making the runway come more into view. Pull back on the joystick so as to maintain the aircraft in a nose up, tail down attitude but not so much as to cause the tail to run along the ground. In other words, the horizon should appear slightly higher than when the plane is stationary. When the speed is sufficient, the aircraft will start to rise. At this point, you will notice the runway start to drop away. Also you will see a positive reading on the vertical speed indicator and a corresponding change in the altimeter reading as altitude increases. When you are satisfied that the plane is gathering speed and will not touch the ground again, you may raise the undercarriage. This will reduce the overall air resistance of the aircraft and therefore assists in obtaining more speed. You should hold the aircraft to almost level flight until a speed of about 150mph is reached. You are now ready to begin a gradual climb.

Climbing

The rate of climb is adjusted by use of elevators and throttle. However, to obtain the optimum rate of climb for a given throttle setting it is important that the operation of the elevators be closely linked to the airspeed.

For example, if you have just taken off, your airspeed is low and the throttle setting is at maximum. The optimum climb rate is achieved by reaching a particular airspeed which happens to be 185mph for this aircraft at low altitude. You should then have a rate of climb of about 2,500 feet per minute. Climbing will result from pulling back on the joystick. It is important that you do not pitch up too steeply before gathering up enough speed as the aircraft will adopt a less streamlined nose up, tail down attitude and will waste power as a result of increased air resistance. The plane could stall should the airspeed drop too low. If the airspeed is too low, gently push the stick forward to regain speed.

Always remember that it will take time for the airspeed and rate of climb to settle down after any adjustment.

Level flight

Flying at constant altitude is often referred to as level flight although the aircraft will probably not be level but will adopt a slight nose up attitude particularly at low speed. Therefore, if you were to fly with the horizontal bar of the gunfiring sights lined up with the horizon, the aeroplane would actually be sinking. Level flight is achievable at all speeds between about 90mph and 350mph by careful adjustment of the throttle and elevators.

The speed which gives the best ‘miles per gallon’ is about 200mph.

You may at first experience difficulty in achieving level flight since it can take several seconds for the aircraft to settle down after an adjustment. You may for

instance be travelling too slowly for the throttle setting and so the plane will attempt to speed up making the aircraft climb. You will therefore need either to push the stick forward to prevent climbing and allow the plane to reach the correct speed for the throttle setting or you can reduce the throttle setting and settle for level flight at the lower speed. The necessity to maintain level flight will become apparent should you attempt the low altitude tests of skill.

Turning

Turning is easily achieved by the use of elevators and ailerons only. The manoeuvre is best done starting from a condition of level flight. You can see the horizon and this will be an important visual aid during the turn. You may wish to switch on the plane symbol (gunfiring sights) since this provides a useful reference with which to compare the horizon. Before starting a turn, always note your heading and decide which heading you require.

To start a turn, move the joystick left. The horizon will start to rotate clockwise. A more useful way of looking at it is to consider that the aircraft symbol is rolling anti-clockwise (banking left) relative to the horizon. The turn can be accomplished with any degree of bank. A greater angle of bank will result in a tighter turning circle. When the desired angle of bank has nearly been achieved, you can push the joystick to the right to avoid overshooting the angle. The joystick will need to end up in the centre in order to stop rolling completely. At this point the aircraft will start to slip to the left, causing the airflow to act on the fin and rudder. A left-hand yaw will result and this in turn will cause the nose of the inclined plane to swing towards the ground. Pulling back on the joystick will lift the nose and assist the turn. The steeper the angle of bank, the more the joystick will need to be brought back to maintain a constant altitude. Once the desired heading has been reached, the stick should be pushed forward and to the right to remove the bank angle and return to the level flight condition. Again the joystick can be pushed left to prevent overshoot and then centred to prevent a further roll developing.

With practice, the forward/backward and left/right movements of the joystick can be done simultaneously to give a smooth transition into and out of the turn.

As implied previously, turning does not require the use of rudder. However, a little left rudder in a left turn can help to tighten the turning circle, provided the angle of bank is not steep. At the other extreme,. if the angle of bank is such that the wings are near vertical, then it is no longer possible to keep the nose up by the use of the elevators alone and so if the turn is going to be of significant duration, a little right rudder in a left turn could be used to raise the nose. This is normally referred to as a little top rudder, since with the plane in this position, the rudder is actually horizontal and is therefore acting like an elevator.

Landing

Successfully landing the aircraft is one of the more difficult tasks particularly for the inexperienced pilot. Much depends on achieving a long enough approach to the landing strip so that you can have enough time to slow down, to reach a reasonable altitude and line yourself up with the runway. As you become more experienced, you will find that you can manage with shorter approaches.

Slowing down can take a considerable time particularly if you are already flying in excess of about 250mph. This has much to do with the aerodynamic qualities of this type of aircraft. Your objective is to enter the final approach phase (that is approaching the runway on a typical glide path) at a speed of about 90rnph. You can reduce the throttle in order to lose speed but you may also need to lose considerable altitude. If you start to descend you will probably not slow down at all but may even speed up depending on the steepness of your descent. In the final approach, you would therefore find it difficult to maintain a typical glide path at the low speed of 90mph without tending to speed up.

This is where the flaps can help in landing. They are an effective airbrake and assist in slowing down the aircraft. They also help the wings to generate lift so that you can fly a little slower than the normal stalling speed before a stall will occur. The flaps cannot be employed at speeds greater than 150mph. The forces of the airflow above this speed makes them automatically retract. Therefore your task is to slow down sufficiently in order to engage the flaps and then slow down even further, lower the undercarriage* and enter the final approach phase.

Slowing down to less than 150mph can be achieved once the throttle has been reduced by attempting to maintain level flight or, if you are in a hurry, even climbing slightly. (Tight turning can also be effective if you can still end up on the approach path.) You will learn from experience how quickly you need to reduce speed and altitude and when to begin the final approach phase.

The approach path is regulated by use of throttle and elevators. If you find yourself coming down short of the runway, you may well need to increase the throttle temporarily to correct your position.

Your next objective is to pull out of the approach path such that the plane floats just above the runway. You may need a small burst of throttle during the pullout to maintain enough speed for level flight. Once the pullout is complete and you are flying just above the runway surface then throttle right back. As the plane slows down, you will need to pull back gradually on the stick in order to keep the aircraft at a constant altitude (of about 1 or 2 feet). Eventually the plane will

*If you land with the undercarriage up, the propeller will break and the engine will no longer function.

stall and drop the last foot or so. On this aircraft, you may find that the tailwheel runs along the ground during the ‘float’ period. Once on the ground, apply the brakes and use the rudder to steer. When you have stopped, you may raise the flaps, switch off the engine and take on fuel.

Forced landing

If you run out of fuel and cannot reach the runway by gliding then you will have to make a forced landing. This is possible anywhere in the world but beware of the bumpy ground. You will find that your chances of success are greatly improved by keeping the undercarriage up. If the area is featureless then you will need to rely more heavily on the instruments, in particular the altimeter, vertical speed indicator and airspeed indicator.

Effect of speed on handling

When travelling at low speed, the aircraft tends to be rather ‘sloppy’ in its response to the controls. The plane is slow to respond in roll and requires more effort to stop a roll once it has started.

The opposite is true at high speed where the aircraft feels firm and responsive. It is possible then to accomplish fast rolls which end fairly quickly when the demand is removed. The elevators become very sensitive at high speed and you have to guard against excessive sharp movements of the joystick backwards or forwards since you may overstress the aircraft by trying to pitch too rapidly. This causes large forces to develop, normally referred to as ‘g’ forces, which could result in the pilot blacking out or the wings breaking off. In the simulation if you exceed too many ‘g’s, you will hear a continuous, medium-pitch tone and will also notice a serious loss of lift as the wings come off. In a real life situation, the pilot has an advantage over you as he will be physically aware of the forces acting on his plane. The simulator therefore gives you the opportunity of retrieving your wings by readjusting the elevators in order to reduce the ‘g’ forces. Once your wings are re-attached, the audible tone will cease and you will regain your lift. This condition is most likely to occur when pulling out of a dive, looping the loop or attempting a tight high-speed turn.

Stalling

A stall will occur if the orientation of the aeroplane is such that it is steeply pitched relative to the direction of travel. The streamlined flow of air over the wings becomes turbulent, resulting in a sudden loss of lift. Stalls usually occur at low speeds (80mph with flaps up, 70mph with flaps down) where the aircraft naturally assumes the steep attitude but can occur at higher speeds if the stick is

pulled back too far. Whilst a stall condition exists, you will hear a pulsed low frequency tone.

Normally, one of the wings will stall before the other and will drop causing the aircraft to roll. There will be a rapid loss of altitude. To regain control of the aircraft, pitch the nose down in order to increase your airspeed. The turbulent condition over the wings will persist until the airspeed is well over 100mph. Ample height is therefore needed for a successful recovery. Once the stall condition has ceased, any roll will probably need to be cancelled by referring to the artificial horizon, since you are unlikely to have the actual horizon in sight. At the same time, you can gradually pull back on the stick but not too far as this could induce another stall.

Gliding

The Spitfire is capable of gliding at a fairly shallow angle of descent and therefore large distances can be covered without engine power provided that the flaps and undercarriage are up. Be careful not to raise the nose too much or the speed will drop and the aircraft will adopt a less efficient attitude to the airflow, resulting in a steeper angle of glide not a shallower one. The best airspeed for maximum range is about 150mph.

Aerobatics

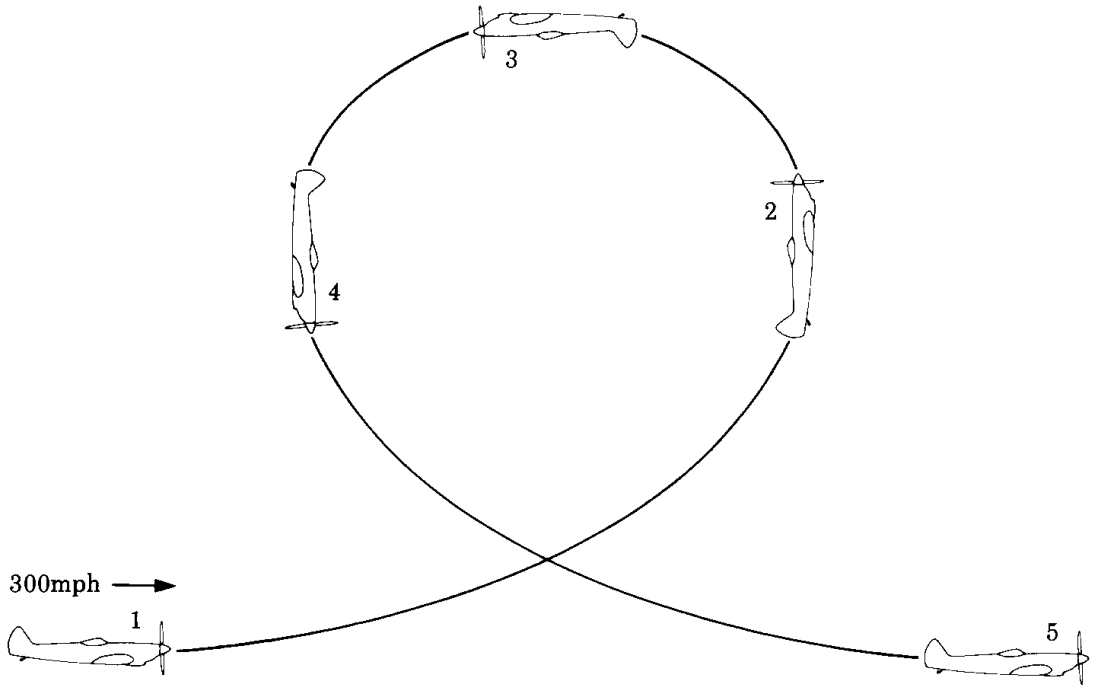
Looping

Looping the loop should be started with an airspeed of at least 300mph. Experienced pilots can begin at slower speeds but there is an increased chance that at the top of the loop, the pilot will pull back on the stick too far and cause the plane to stall.

The loop is accomplished simply by pulling back on the joystick and continuing to hold it back until the plane has performed a complete loop. The joystick should however be pulled back very gradually to start with so as to avoid exceeding too many ‘g’s and, as the speed decreases, it can be pulled back further, tightening up the loop. Figure 4 shows the aircraft position at various points in the loop. On the simulator, the artificial horizon will indicate whereabouts you are in the loop. As you pitch up, the horizon bar moves to the bottom of the meter. When you are in position 2, the bar will jump to the top of the meter and the light will flash indicating an inverted condition. In position 3, the bar has moved down to the centre line again. You should be able to see the real horizon at this point but don’t forget you are upside down. As the loop progresses, the horizon bar will move to the bottom of the meter and jump again

to the top at position 4. Finally, the bar will come to rest on the centre line and the actual horizon will appear on the screen as you reach position 5.

Figure 4 Loop the loop



Rolling

There are two distinct ways in which to roll the aircraft through a complete revolution.

One way, known as the ‘barrel roll’, is to pull the joystick back until the nose is perhaps 20º or 30º above the horizon (this would have to be judged by looking at the artificial horizon). To roll anti-clockwise, you must then push the joystick to the left whilst keeping the stick held back. As the plane rolls upside down, the nose will dip towards the ground but should not drop below the horizon unless your roll rate is too slow. Eventually you should reach the original position but the nose will probably be lower than it was initially. The manoeuvre is completed by pushing the stick to the right and then to the centre in order to stop the rotation. The roll should be started at speeds above 160mph, although it can be done at speeds as low as 110mph but with a risk of stalling. The higher the airspeed and/or roll rate, the less the nose needs to be above the horizon at the start of the roll. The plane actually performs a cross between a roll and a loop (a corkscrew).

The other type of roll is called the ‘slow roll’.

The beginning is very similar to the barrel roll except that the nose does not need to be as far above the horizon. As the plane rolls round, the joystick is gradually pushed forward so that by the time the plane is upside down, it has been pushed forward far enough to keep the nose above the horizon. The next half of the manoeuvre requires the joystick to be gradually brought back to the start position.

If the roll is carried out very slowly, then there will be a tendency for the nose to dip when the wings are vertical, in which case ‘top rudder’ may be necessary to keep the nose above the horizon. (Top rudder means turning the rudder away from the ground.)

Useful manoeuvres

Combinations of loops and rolls can be put to good use. Here are a couple of examples:

1. A half loop followed by a half roll

If you wish to turn the plane around so that you are travelling in the opposite direction and over your original flight path, then provided you have the speed, you can perform the first half of a loop the loop manoeuvre by pushing the stick forward once you are fully inverted and the horizon is back into view. At this stage you could maintain inverted flight for a while if you wish. If you then do the second half of the slow roll manoeuvre, you will find that you have achieved your objective. You will also have gained a lot of altitude.

2. A half roll followed by a half loop

If you are already at high altitude and wish to accomplish the same objective but by losing altitude instead of gaining it then you could do a half roll followed by a half loop. The half loop will actually cause the aircraft to lose height because of the inverted start position. Therefore it is important to practise this at an altitude of at least 5,000 feet. You will be able to see how much altitude is actually needed in order to pull out of the manoeuvre safely.

Training flight

Here is a series of steps which you can follow in order to practise the basic flying techniques.

1. Take off northwards.
2. Climb to 2,000 feet.
3. Maintain level flight at 200rnph for a couple of minutes.
4. Gently bank to the left; turn until heading south.

5. Maintain level flight at 200mph and at 2,000 feet.
6. Continuing on this course, you should see the runway pass by on your left-hand side on the radar; fly several miles past the runway.
7. Gently bank to the left; turn until heading north.

You should now be on course for the runway. The radar should give you a rough idea. If you are not on course then aim to put yourself in line with the runway as soon as possible. As you approach, you will see various land features before seeing the runway. Refer to the map to check your position.

Point scoring

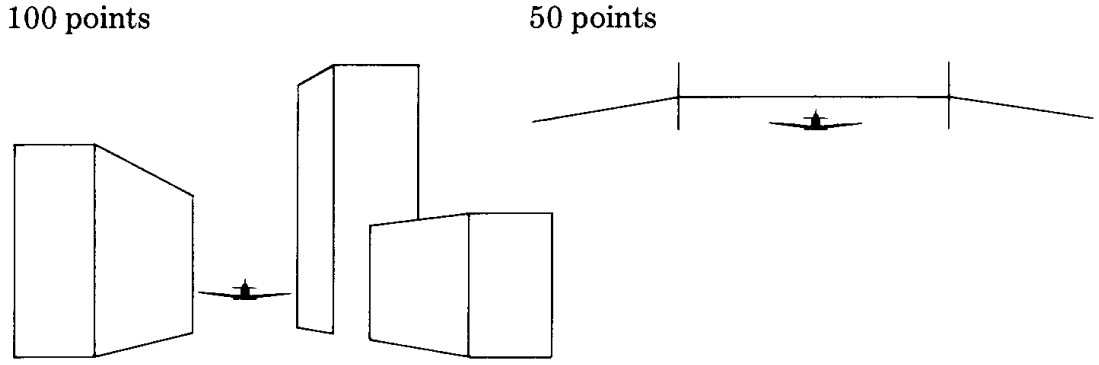
The flight simulator scoring system awards points either by landing or by completing the tests of skill (see below). 150 points are gained by landing the plane without crashing. In order to qualify for landing points, you must make sure that your altitude has exceeded 500 feet since you last took off. Additional points can be scored in the Theme mode and these are discussed in chapter 3.

Your score and high score can be displayed on the screen at any time by pressing P.

Tests of skill

A special feature of the simulator enables the pilot to score points by demonstrating his or her flying skills.

100 points are clocked up by flying through any street of the town at a height lower than the lowest building. 50 points are also scored by flying underneath the bridge. A crash will result if any part of the plane hits the superstructure of either the bridge or the buildings. Points are awarded and an audible tone will sound as the plane completes the manoeuvre. Points will be doubled if you can perform the manoeuvres flying upside down!



3 The Theme

The Theme introduces an exciting challenge to ‘Aviator’ which involves locating, chasing and destroying unfriendly beings from outer space.

Theme selection

Fire the guns to select the Theme. The Theme on/off indicator will then light up on the dashboard, provided the plane is stationary on the runway and the brakes are on when the guns are fired.

Setting the scene

It is the 1950s. You were a Spitfire pilot during the war and have maintained a keen interest in aviation. In order to keep flying you have moved to one of the remotest parts of America, where you are currently earning your living as a crop sprayer. You live near an airstrip halfway between two towns, Acornsville and Deadwood Creek. You have managed to purchase an old Spitfire and in your spare time have restored it to a fully operational condition.

One day you are approached by the local sheriff who tells you some unbelievable news. Apparently, over the past couple of days, strange sightings have been reported by some of the local people. The whole episode started with a bright light in the sky, similar to a meteor, followed immediately by a total breakdown in communications. The tradespeople from Acornsville and Deadwood Creek have been working round the clock in order to regain contact with the outside world. But to no avail. Farmers have been astounded by the sudden development of mysterious phenomena in their fields. Their crops are being rapidly devoured by alien life forms which grow to a colossal size, sprout tentacles and take to the air. Radar sightings have added more credibility to their stories by confirming the existence of unexplained flying objects at an altitude of 3,000 feet.

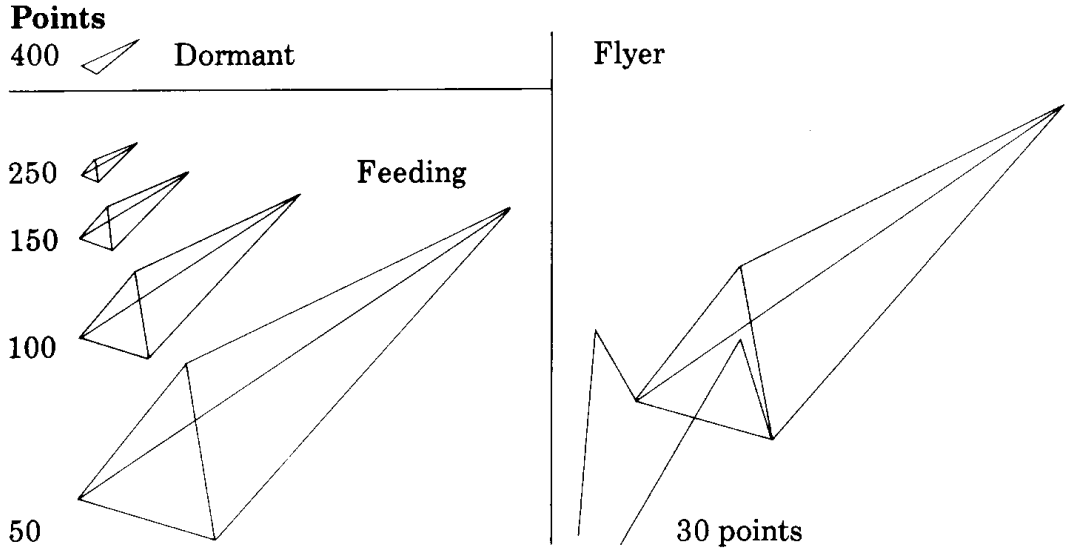
You are listening to the tale in amazement when the deputy arrives on the scene with the devastating news that a life form similar to those already described has descended on Deadwood Creek and wiped out the whole population in a matter of minutes. Deadwood Creek is now a wasteland.

Realising that a similar destiny awaits Acornsville, you board your fully armed Spitfire and taxi towards the end of the runway.

Objective of the Theme

Your task is to save the population of Acornsville and to score as many points as possible along the way. The aliens attack in waves of eight and with each wave they fly faster and faster. If you allow one to reach Acornsville, you will be 'TOO LATE' and the game ends.

You score points by destroying the aliens, as follows:



After every wave you are awarded 500 bonus points.

The success of your mission relies very heavily on the tactics you employ. A good strategy is essential concerning the best times to attack the fields or defend the town. Here are some useful tips:

1. Buzz the fields.

2. Keep an eye on the radar and fuel gauge.

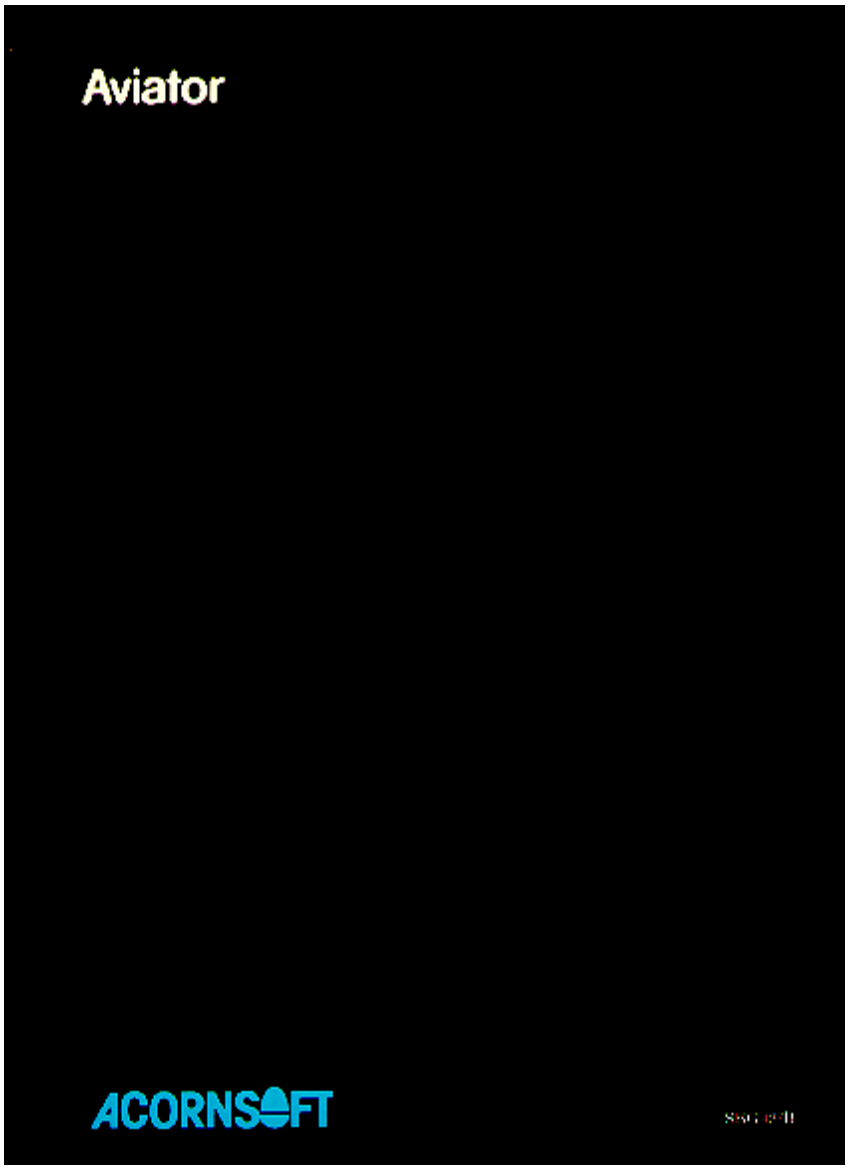
3. Remember to make the most of your gunfiring sights and that the range of your guns is only 1.5 miles.

4. An alien has a zone of vulnerability which you must hit in order to destroy it.

5. When an alien is hit it will create a great deal of turbulence in its vicinity. Therefore you should aim to strike as far away as possible.

6. The small 'dormant' alien is only visible at close range.

GOOD LUCK!


Aviator
ACORNSOFT