

Popular Computing Weekly said of Psion's Flight Simulation on the ZX81 "No words can do justice to this most elegant of programs... You will not see a better computer game till Psion produce one for the Spectrum". Here it is. Learn to fly, bank, dive and climb, see the world outside through the cockpit windows, land and take-off with the aid of the many cockpit instruments.

FLIGHT SIMULATION

ZX Spectrum

Sinclair ZX Spectrum

FLIGHT SIMULATION

Sinclair
ZX Spectrum with 48K RAM

FLIGHT Simulation from PSION

Load and run by typing LOAD "flight"

Over the last decade, with the increasing power of computers, pilots have been trained to "fly" new airliners on large scale, computer-controlled simulators on the ground. Even on a small microcomputer like the Sinclair ZX Spectrum the essential parameters of flight, the dynamics of the airplane, the navigation of the airplane, the main instruments and the representation of the outside world can be portrayed in real-time. "FLIGHT Simulation" includes these effects and represents a small, high-performance, two-engined, propeller-driven airplane.

ASPECTS OF FLYING

The essential controls of an airplane include the joystick, flaps, rudder and engine power. Moving the joystick sideways affects the ailerons on the wings causing the plane to bank to the left or right. Moving the joystick forwards and backwards affects the elevators on the tailplane so that the nose of the airplane moves down or up respectively.

The aerodynamics of an airplane are extremely complicated. Changing one control usually has more than one effect. For example the ailerons do not simply cause the plane to roll, but produce a sideways airflow which causes the plane to turn as well. You may learn and experience these effects in the simulation. The attitude and motion of an airplane is shown by many instruments and navigational aids in the pilot's

cockpit, as discussed below. The pilot needs to use these instruments to navigate his airplane on to the right line or vector for approach to a runway, to fly his airplane on the right heading or bearing along that vector and to approach the runway with the right speed, altitude and descent angle to land the airplane. Typically, the correct approach angle of descent should be about 3° which implies an altitude of about 6,000 feet at 20 miles out, 3,000 feet at 10 miles out and 1,000 feet at just over 3 miles from the runway.

The rudder controls can contribute to the turning of the airplane. When on the ground, while taxiing the rudder controls also steer the direction of the airplane.

FLYING ON THE ZX SPECTRUM

Flight Simulation on the Spectrum is a full-feature program which mimics the piloting of a small airplane in real-time and in considerable detail. The detailed dynamics of an airplane are included and even looping the loop and rolling may be performed. You may land at either of two runways, take-off, navigate with the aid of beacons and in flight view the features of the world outside through the cockpit windows.

The main display is the pilot's cockpit view with a detailed instrument panel in the lower half of the screen and a view of the world outside through the cockpit windows in the top half of the screen. Through the cockpit windows you can see the horizon formed by the light sky and dark ground, the runway lights in three-dimensional perspective if you are in the vicinity of a runway, and features on the ground such as lakes, etc. As you bank, dive and climb, so the horizon and features on the ground will move accordingly through the cockpit windows.

You may switch the display however, to a navigational chart or map showing the beacons, runways and other features to help you navigate and land the plane. After the program has been loaded from cassette, a

menu will appear asking you whether you wish to take-off, start in flight or practice the final approach for landing. Press the keys 1, 2 or 3 respectively. You will be asked whether you want to include the effects of wind. Answer yes if you are skilled and can cope with the effects of wind both in landing and navigation. Otherwise press "n" for no. The program will then change immediately to the pilot's cockpit view.

THE INSTRUMENT PANEL

In the lower half of the screen in the pilot's cockpit view is the instrument panel. There are five clock-like dials, a number of gauges, warning lights and a variety of digital read-outs. The five "clocks" from left to right are the instrument landing system (ILS), the airspeed indicator, the radio-direction-finding equipment (RDF), the altimeter and the rate-of-climb indicator (ROC).

RDF clock is the large dial in the centre of the instrument panel. A small airplane is drawn in the centre of the dial and points in the direction or heading of the plane. A digital reading on the clock gives the heading in compass degrees of the airplane. The RDF is the most important navigational instrument. At any stage the plane is logged on to one of a number of beacons on the ground. The position of the current beacon at any stage relative to the direction of the airplane is represented on the RDF clock as a flashing dot near the circumference. If you wish to head directly for a beacon, bank the airplane until the flashing dot moves round the circumference to the "12 o'clock" position. **Airspeed indicator** is a clock with one needle immediately to the left of the RDF. The needle points to the airspeed of the airplane measured in knots x 10. **Altimeter** is a clock with two needles immediately to the right of the RDF. The small needle gives the height in units of 1000 feet and the longer needle gives the next digit as hundreds of feet. **ROC** or rate-of-climb indicator is the clock-like dial on the right-hand side. It measures the vertical speed of the

airplane in units of 1000 feet per minute. When the needle points upwards above the 0, the plane is climbing and vice versa.

POWER gauge on the bottom right measures the extent of the throttle. The thrust of the engines increases with throttle but reduces in the rarer atmosphere of higher altitudes.

FUEL gauge displays the fuel remaining in the tanks.

FLAPS shows the angle of extent of the flaps. The needle points downwards with maximum flap and is horizontal with the flaps retracted.

GEAR has a green and red panel. When the undercarriage or gear is up this will be indicated in the red panel, otherwise "down" will appear in the green panel.

BCN RGE BRG is a digital readout giving information on the current logged-on beacon. BCN gives the beacon call sign of the logged-on beacon. RGE gives its range in nautical miles and BRG gives the bearing of the beacon in compass degrees relative to the airplane.

ILS is the Instrument Landing System dial on the left of the panel. It is a guidance system which aids the pilot in the approach to the runway. A radio beacon at the start of the runway emits a signal, the position of which is displayed on the ILS as a flashing dot. When the airplane is on the correct approach to the runway, the flashing dot will be at the centre of the ILS. If it is not at the centre, you the pilot should steer towards the dot. Thus if the dot, representing the runway is on the left, the pilot should bank to the left until the dot moves to the centre. If it is above the centre, the plane is too low and the joystick should be pulled back.

Ra or Radio altimeter is a digital readout and part of the ILS system. A reflected radio signal from the ground measures the height in feet of the airplane from the ground to the wheels. It gives a precise measurement for landing.

THE PILOT CONTROLS

Joy stick — The joystick of the airplane is represented on the keyboard of the ZX Spectrum by the cursor arrows (keys 5, 6, 7 and 8). Press ← (key 5) to bank left. Press → (key 8), to bank right. Press ↑ (key 7) to move the joystick forward and point the nose of the plane down for diving. Press ↓ (key 6) to pull the joystick towards you so that the nose of the plane goes up for ascent.

Rudder — The rudder on the tailplane can help to turn the plane and is controlled by the keys "Z" to turn left and "X" to turn right. While taxi-ing on the ground, the gear is steered by the rudder controls.

Power — The engines' thrust or power is controlled by the keys "P" and "O". By pressing the key "P" the throttle is increased and the engines give more power while pressing key "O" reduces the throttle and engine power (note "O" is to the left of "P").

Flaps — The extent of the flaps on the wings is controlled by the keys "F" and "D". Press the key "F" to extend the flaps further and press the key "D" to retract, or partially retract, the flaps (note key "D" is to the left of key "F"). The flaps can be extended or retracted to a varying degree (as shown on the gauge) and should only be fully extended for the final stage of landing to avoid stalling at reduced speed. With the flaps retracted, the stall speed of the plane is 80 knots, while with full flaps, the stall speed is 60 knots. Extending the flaps while the plane is at high speed could possibly damage or tear off the wings of the plane.

Gear — The gear or undercarriage can be extended by pressing the key "G". If the gear is down pressing the key "G" will retract the undercarriage. The undercarriage should not be dropped at high speed as apart from increasing the drag on the plane you may damage or destroy the undercarriage.

Beacon — To change the current logged-on beacon,

press the key "B". So long as you press the key "B" the current beacon will change sequentially until you obtain the navigational beacon you require.

Map — Press the key "M" to switch the display from the cockpit pilot's display to the map or to switch back from the map to the cockpit pilot's display. You may press several keys simultaneously.

Never press the BREAK key.

THE MAP

If you press the key "M", the display will change to a navigational chart or map showing the runways, features on the ground such as lakes and the position of the navigational beacons. The map shows the four compass points of NORTH (N-0°), EAST (E-90°), SOUTH (S-180°), WEST (W-270°). There are two airports, a large international airport called MAIN and a small local airport called CLUB. MAIN has a long runway of over a mile in length and is therefore easy to land on in a small plane. CLUB however is a small local airport and therefore has a short runway of some 800 yards.

The runway of MAIN lies along the line east to west (90°-180°). Therefore on your final approach for landing the plane must be travelling on a heading of exactly 90° or 270°. The runway of CLUB on the other hand, lies along the line north to south.

The map also shows the position of the various navigational beacons and a variety of landmarks and features on the ground. Near the airport MAIN, there are two beacons some three miles beyond each end of the runway with call signs of ME and MW. Airport CLUB has two beacons CN and CS two miles beyond each end of the runway. There are three other navigational beacons OA OB and OC.

NAVIGATION

The most difficult part of flying is the approach and landing at an airfield. You can experiment with the controls in varying the speed, altitude and direction of

the plane at a reasonably high altitude without worrying about the navigation. If you wish to land the plane, however, you will have to navigate the plane on to the right vector and on to the right course, and you will have to approach the runway at roughly the right glide angle. This is a difficult task and requires a lot of practice and experience before you can achieve a landing successfully.

The map and instruments will help you to determine your position precisely. You will then need to think of the approximate manoeuvres and course to approach the airfield on the right flight path. The runway of airport MAIN lies east to west in the simulation on a line (or vector) from 90° to 270° or vice-versa. You may approach the runway from either end. For example, if you wish to approach the runway from the east to the west, you must first manoeuvre the airplane far to the east of the runway. If you use the beacon ME you will need to fly the plane until the beacon is on a bearing (or vector) of 270°. If you then bank on to this bearing on a course or heading of 270° you will be flying on exactly the right flight path for your approach to the runway. As you fly towards the beacon ME, to keep on the right flight path you must ensure that both the heading and the beacon coincide at 270°. As you fly over the beacon in the later stages of the approach, the bearing of the beacon will of course change to 90°. Similarly, you may use any of the other beacons to set a course for a particular flight objective. When heading directly for a beacon, remember that your heading and the beacon bearing must always coincide precisely. Flying is difficult for the uninitiated and if you have trouble navigating yourself to the runway for final landing you can always use the option at the beginning of the program to give you an automatic approach and allow you to experiment with the final touchdown.

Once you have touched down, you must reduce the power to zero to bring the plane to a halt. You may taxi and steer using the rudder controls and take off again.

Key	Pilot Control
↑	Joystick forward (dive)
↓	Joystick backward (climb)
↖	Joystick to right (bank to right)
↗	Joystick to left (bank to left)
Z	Rudder control (left)
X	Rudder control (right)
P	Increase throttle (more power)
O	Decrease throttle (less power)
F	Increase flap extent
D	Decrease flap extent
G	Lower gear (undercarriage) if up. Raise gear (undercarriage) if down.
B	Change beacon sequentially
M	Switch from cockpit display to navigational Map or back to cockpit.