

The CIX VFR Club	Flight Training Notes	Exercise 18D
For Simulation Purposes only. Not to be used for real World flight	PRACTICAL VFR NAVIGATION	Issue 1.3 06/07/12

1 INTRODUCTION

This tutorial is specifically designed for Microsoft Flight Simulator pilots flying VFR flight in the UK. It is part of a series of tutorials being produced by the [Cix VFR Club](#).

If you are confused by any issue, Cix VFR Club members may post a message in the Cix Conference or Web Forum, or email the Club CFI (see web site), and we will try to clarify any points you are having difficulty with. Because you don't have the benefit of an instructor to bounce questions off, you are actively encouraged to discuss the material in this way.

Basic Navigation Theory for Flight Simulator pilots is covered in Exercise 16. This tutorial describes how to use this theoretical knowledge to create a flight plan and fly the route you have planned.

2 ELEMENTS OF PRACTICAL NAVIGATION

The Flight Simulator VFR pilot is alone in the cockpit. He hasn't got a passenger to look at the map, nor even fold it (an art in itself in the cockpit – a bit easier at a computer).

For this reason, there are two equally important elements of navigation:

- Thorough preparation before flight
- Frequent observation and calculation in flight in order to know your position at all times.

2.1 On the Ground

A properly prepared plan for a cross-country flight saves much heartache in the air. To jump into an aircraft and just go somewhere leads to the pilot constantly worrying about his position, correct identification of landmarks, and much too much “head in the office” flying - looking at the map, when he should be looking outside.

The essentials for a proper flight plan are:

A serviceable timepiece

The appropriate chart(s)

Identification of the desired route, taking into consideration terrain clearance, controlled airspace.

The suitability of the landing ground for the pilot's experience – from short grass strip to large international airport – each has their own in-built factors to be handled without stress.

A good estimate of the likely weather.

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2.2 In flight

- Accurately fly the planned heading.
- Maintain the planned cruising speed.
- Make frequent checks on ground features to ensure that the aircraft is where it is intended to be.
- Observe how close to the waypoint you are laterally – to one side or the other, or directly overhead.
- Estimate the distance.
- Is a heading change required to correct any error in lateral position? Use the 1 in 60 rule to calculate the correction.
- Record on the pilot's log the actual time of arrival (ATA) at each waypoint and note any difference from the estimated time of arrival (ETA)
- Ask yourself why there is a difference between ETA and ATA. If the heading and airspeed have been flown accurately, then the most likely reason is that the wind aloft is different in speed or direction (or both) to that assumed in planning.
- Calculate the ground speed achieved (distance divided by actual elapsed time from the previous waypoint).
- From the ATA at the waypoint calculate the ETA at the next waypoint from the estimated ground speed for the leg and distance.

2.3 Mental Aerobics

That sounds like an awful lot of work and mental arithmetic whilst trying to fly an aircraft. However, at each waypoint, the work required only takes a minute once you have done it a few times.

3 VFR FLIGHT PLANNING EQUIPMENT

3.1 The Relevant Chart

You cannot fly anywhere without a map (or 'chart' in navigation parlance). Not only is it a valuable guide to location and destination, in the real world it is illegal to fly without correct charts. For VFR flight the UK is covered by a series of aeronautical charts at 1:500,000 scale, commonly known as "half million" or "half mill" charts. Three such charts cover the whole of the UK, including Northern Ireland and part of Eire.

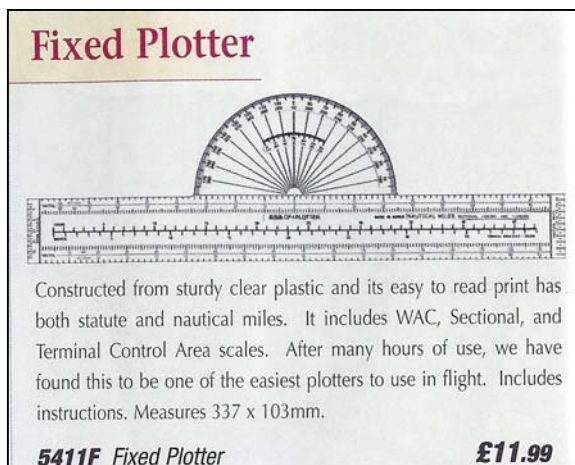
The Cix VFR Club members are encouraged to obtain these real aeronautical charts, either new at around £15.00 each or last years edition, scrounged from real world pilots who have to get a new one every year to keep up with changes. So this tutorial will assume that you have real aeronautical "half mill" charts.

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3.2 Scale Rule, Protractor and Pencil

You really need a proper half-million scale rule, obtainable from any Pilot Supply Shop. You can use a 1:50 metric draughtman's scale rule, but the cost of these is similar to an aeronautical scale rule, so you might as well have the proper tool for the job. (For the pedants of the English language, a "ruler" is a King or President etc., not a device for drawing straight lines.)

You need a protractor. The proper aeronautical navigation protractor is a full 360° protractor, but rather than being circular, it is square in shape, so it can double as a rule in the cockpit.



However, a most useful rule, which the author uses for all his real world flight planning, and which combines both functions is the "Fixed Plotter" available from Transair.

A similar plotter to the Fixed plotter is one which has a rotating circular protractor, which can be lined up with any line on the chart, making it quite easy to get bearings relative to north.

It is a matter of personal preference which tools you use, but measuring distance and angles is the fundamental requirement.

Finally you need a pen or pencil with which to write on the chart. Aeronautical charts come with a glazed finish on which you can write with a Chinagraph® pencil, or a spirit based ink pen, such as those produced by Lumograph®. Unsurprisingly, these are also available from Pilot Supply Shops. The spirit pen is more permanent, and therefore better for real world flight, but in your home cockpit, a Chinagraph® pencil is probably satisfactory.

Chinagraph pencil chart markups may be removed with a dry cloth, but spirit pen markups must be removed with methylated spirit.

3.3 The "Whiz Wheel"

The last piece of equipment you need is a means of calculating headings given the intended track and the wind speed and direction. The traditional tool for doing this is a purpose-designed circular slide rule, known affectionally as a "Whiz Wheel" by generations of student pilots. In these days of digital calculators and hand held computers, these calculations can be done by pressing buttons rather than whizzing a wheel! The slide rule Flight Computer has many more important functions, as does the purpose

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made digital variety, but for Flight Simulation, VFR, the wind calculation is about the only one you will need.

3.4 The Club Flight Planning Computer Program

The Cix VFR Club has produced a Microsoft Exel® spreadsheet track, heading and distance calculator, which is available for download on the Club web site, on the Training page. This is entirely practical for home based simulation flight planning, as naturally you will have your computer available. This tutorial will use this tool for planning a flight.

4 PLANNING A FLIGHT

4.1 You Can't Go There

Naturally, the very first action when planning a flight is to decide where you want to go. Aeroplanes don't have to follow roads, so you can go straight from your departure airfield to your destination, can't you? Well not necessarily. So you open your chart and look for reasons why you can't, and you discover that in 99 cases out of 100 in the United Kingdom, flight straight from one airfield to another is impossible under VFR. Obstacles include mountains and hills, Controlled Airspace, (of many kinds – see table below) often above you as well as around you, Restricted Areas, Danger Areas, Parachute Dropping Zones, Gliding Sites, Bird Sanctuaries, Military Aerodrome Traffic Zones (MATZs), Areas of Intense Aerial Activity (AIAAs), to name most, but not all of them.

4.2 Controlled Airspace - Why you can't Go There

The following table gives a very brief summary of the definitions of the above obstacles to VFR navigation, and the conditions in which you may fly through some of them.

See The Club document "ATC for Pilots" for a fuller definition of Controlled Airspace.

Controlled Airspace Class A	You simply are not allowed there. Period.
Controlled Airspace Class B & C	Not used in the UK
Controlled Airspace Class D	You may fly there with express permission from the controlling ATC service. If flying without radio, you must avoid it.
Controlled Airspace Class E	Only used in the area between Glasgow and Edinburgh in the UK. Treat as for Class D.

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Airspace Class F & G	Also known as “the open FIR” it is uncontrolled and you may fly there freely. Any airspace not otherwise designated is “open FIR”
Terminal Manoeuvring Areas (TMAs)	Class A airspace. Don’t go there.
Aerodrome Control Areas (CTAs).	Normally Class D airspace. Do not enter without permission from the controlling ATC unit. Transits for VFR traffic may be given.
Aerodrome Control Zones (CTRs).	Normally Class D airspace. Transits for VFR traffic may be given. Even when inbound for landing, you must not enter a CTR without permission from the controlling ATC unit.
Aerodrome Traffic Zones (ATZs) Normally 2nm radius, but if any runway 1850 metres or longer, the the radius extends to 2.5 nm.	ATZs are designed to protect aircraft manoeuvring at smaller aerodromes, and extend from the surface to 2000 feet aal. They do not have a Class designation, but aircraft must not enter an ATZ without permission from the controlling ATCO.
Restricted Areas and Danger Areas	Avoid. The numbers on the chart after the “/” indicate the upper limit in 1000s of feet. E.g. R214/2.5 just west of Milton Keynes.
Parachute Dropping Zones, Gliding Sites, Bird Sanctuaries	Avoid, although there are no simulated parachutists or birds (yet), and no gliders on VATSIM.
Military Aerodrome Traffic Zones (MATZs).	Since military airfields are rarely manned on VATSIM, you can simply make it a rule to avoid them.
Areas of Intense Arial Activity (AIAAs)	There are a few of these in the UK, and each one covers a significant area. The Shawbury one for example, covers all of Shropshire. They are designated because of the high volume of low level military traffic in the real world, so you can ignore them in Flight Simulator.

4.3 Horizontal Navigation – The Route

As you saw in Exercise 16, there are two forms of navigation for which you must plan – horizontal navigation – the kind you are used to, and vertical

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navigation, which you are probably unfamiliar with unless you are a rock climber. Let's deal with horizontal navigation first and plan a flight from the Club's base at Biggin Hill to Southampton.

If you draw a straight line on your chart from Biggin Hill to Southampton, you immediately discover that such a route takes you right through the middle of Gatwick Airport and its controlled airspace. Now it is true that a transit can be requested through certain classes of controlled airspace, and is often granted, but do you really want the stress of getting tangled up with a lot of big and fast aircraft on instrument approaches and departures? Let's avoid Gatwick. You probably wouldn't be welcome anyway.

The Biggin Hill departure procedures are designed to help in this respect. For example, if taking off from runway 21, you are required to fly on the runway heading for 2 nautical miles, and then to turn left to the Sevenoaks VRP, before continuing en route. You should build this procedure into your route plan.

4.4 En Route Waypoints

So you need to find a good identifiable landmark, visible from the air and marked on the chart which will make a turning point to take us first south and then west which takes us round the Gatwick Control Area. Such points of reference are called "waypoints" and are vital elements in a VFR cross country flight.

The most obvious, if not the closest to Gatwick (and therefore the shortest flight time), is Bewl Water some 5 nm south east of Tunbridge Wells. Large Lakes make very good waypoints because they stand out from a long distance and have distinctive shapes which are easily recognised from the chart. Towns, on the other hand, whilst they do have distinctive shapes, are not particularly good as waypoints, because their shape is not always as obvious from looking out of the window at 2000 feet as it is on the chart, and in poor visibility, the general shade of dirty pink which all towns display from the air is not at all distinct. Sometimes, though they are the best that is available.

So assuming that you are not particularly confident at recognising towns as waypoints, you look for something a little better for the next leg. Unfortunately, there doesn't seem to be anything distinctive other than towns. There is a mast near Heathfield, but masts can be very hard to see, and are best ignored, except that, as obstructions (Aeronautical Navigation Obstacles or ANOs in the jargon) they need to be avoided, otherwise your widow might get a bill from the mast owner.

However, the town of Lewes is shown as a VRP – a Visual Reference Point for Shoreham Aerodrome. Lewes lies on the River Ouse, which runs north south, and there are two railways – one running north-south, the other running east west, and crossing just south of the town. There are enough

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clues there to positively identify Lewes, so it is in fact, distinctive enough to be a good waypoint.

Looking westwards on the chart, it all looks terribly complicated getting into Southampton, so lets take it in little sections. A second look shows that if you fly accurately on a track of 270° there are several very useful features by which you can check our position. First of all, you will be flying parallel to the coast and only about 3 or 4 miles north, so it will be clearly visible. Secondly you will be flying parallel to and south of the South Downs, so you will see a line of hills to your right. Then there are quite a number of features which you will cross, for which you can calculate an Estimated Time of Arrival (ETA) and check this in flight against Actual Time of Arrival (ATA) to monitor your progress. They are listed below, so you can check them on the chart, and in a later stage of planning, measure the distances and calculate the ETAs.

About 7 miles west of Lewes, you cross a railway north of Brighton which disappears into a short tunnel almost exactly on your track, but you will still see it on your left and right. Railways also make very good navigational features, as there are fewer of them than roads, so it tends to be obvious which one you are crossing. In the pioneer days of flying, when there was less controlled airspace to avoid, pilots followed the railways, particularly in bad weather, leading to the old chestnut pilot joke that IFR stands not for “Instrument Flight Rules”, but for “I follow railways”.

A mere one minute or so later (2 miles) you cross a dual carriageway (marked on the chart with double bold red lines), which is the A23 London to Brighton Road (famous perhaps for being the route of the Annual Vintage Car Club Rally – the “Old Crocks Race”).

In another 4 miles you cross the River Adur. Rivers can make good waypoints if they have distinctive bends, locks, weirs etc, but caution is needed, as it may not be easy to know exactly which point on a river you are crossing. In this case, you should also see Shoreham Aerodrome on our left about 3 miles away, lying alongside the river. You need to take care, if you are below 2000 feet, to keep to the north of Shoreham’s Aerodrome Traffic Zone (ATZ) marked on the chart as a circle of maroon dots. The ATZ extends from the surface to 2000 feet. In the real world it would be wise to give them a call on the radio to advise them of your position, but in FS2004, it is unlikely to be manned on VATSIM.

In another 4 miles, you cross another dual carriageway, the A24, which runs south into Worthing. Here there is an interchange with a major road which forms another Visual Reference Point, the Washington Interchange.

In a further 4 miles, you cross the River Arun and a railway running alongside. At this point, assuming you have kept accurately to our 270° track, you should be just a mile north of the small town of Arundel.

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Straight ahead lies Chichester-Goodwood Airfield. If you are high enough to avoid their ATZ, then you can track to the overhead of that airfield, which will make an excellent waypoint. Goodwood has grass runways, so you do need to positively identify it from the runway markings and directions (14/23 and 06/24) and possible aircraft on the ground.

From Goodwood, you turn towards Bishop's Waltham VRP where you enter Southampton's Control Zone (CTR). About halfway, some 10 miles from Goodwood, you cross a dual carriageway running into Havant just at the northern extremity of the town. Actually, the nearest town to your track, the northernmost "finger" of development, is the less well known town of Waterlooville, but Portsmouth, Fareham, Gosport, Havant and Waterlooville all run into one another, so all you see is a very large urban area to your left surrounding the huge Portsmouth harbour. Flight Planning does wonders for your knowledge of geography! With some 10 miles to run to zone entry at Bishop's Waltham, you will call Solent Radar on the radio.

VRPs often look on the chart as if they would be hard to find on the ground, but in practice they are usually obvious. Bishops Waltham is a large village at a crossroads 5 miles due east of Southampton Airport, with no other towns nearby, so it ought to be relatively easy to find. As an additional check it is 3 miles west of the point where you cross a river, a road and a disused railway running alongside each other. You ought not to miss that feature.

From Bishop's Waltham VRP, it should be straightforward to proceed to a successful landing at Southampton. You will be under radar control by then anyway, so ATC should make sure you go in the right direction.

4.5 Alternate Destination

If for any reason the airfield you plan to land at is unavailable, then you cannot simply draw into the kerb and park. You have to go somewhere. So you find the nearest aerodrome to your destination at which you can land, and use that in your planning. It is a good idea if you can to use a large aerodrome which is likely to be open for long hours to maximise your options. For this flight, Bournemouth is the best choice.

4.6 Vertical Navigation

There are two issues here:

- Terrain Avoidance
- Controlled Airspace Avoidance

If there is a hill en route, make sure you don't hit it! The principal way you do this is to identify, on each leg, the highest obstacle (it may be a Radio Mast) within 5 nm either side of your track. You then add 1000 feet to this obstacle height to give you the Minimum Safe Altitude (MSA) for that leg. There is no legal requirement to fly above the MSA in VFR flight (but there is

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such a requirement under IFR and at night), but if you do fly below the MSA, then it is beholden on the pilot to take extra care, using the traditional VFR “see and avoid” principle.

Controlled Airspace (CAS), which extends to the surface may be flown over, if the top of the CAS is below you in flight. CAS may sometimes lie above you on your flights, so you need to be aware of the highest altitude to which you can legally fly. In the Biggin Hill area, for example, and for much of this route, the London TMA creates an invisible ceiling at 2500 feet, above which you must not fly.

As you build your flight plan the vertical restraints on your route are defined and added for each leg. Where is the high ground? Where is the base of controlled airspace?

5 BUILDING THE FLIGHT PLAN

5.1 The Pilots Log

There needs to be some sort of form in which to tabulate the results of the calculations. It can be combined with another form which pilot’s use to log the significant data of their flight. The combined form is called a Pilot’s Log, or “Plog” for short. These can be designed in many ways, but the one illustrated on the next page is one which the author devised for his own real world use. It has the advantage that it allows more information to be logged than most of the pre-printed versions available commercially from Pilots’ Supplies shops. The first section of interest is the route section, which starts at the “From” and “To” headings.

5.2 The Route Data Entry Stage

You start building the flight plan by drawing a line from Biggin Hill Airport to the mandatory 2nm point on the runway heading. This point is called “Biggin 2DME” in FlightPlanner and is in the “Waypoints” section of the database near the top. Continue the line to Sevenoaks VRP and then to Bewl Water. You might prefer to use green for your planned track, as there is less green on the chart than other colours, so it stands out better. You then measure the distance and the track angle relative to north, using the protractor against a line of longitude as explained in Exercise 16. Now draw two parallel “track lines”, preferably in another colour, black perhaps, 5nm each side of the track. These serve two purposes.

- 1) They form the boundaries within which to look for high ground and determine the minimum safe altitude, and
- 2) They form a zone within which, unless you make a gross error of navigation, you should be positioned even if a drift off course due to the wind or compass error is greater than anticipated.

Check the chart carefully for high ground. Spot heights are shown as heights above sea level and are marked in bold black type with a dot to

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denote the position. You should be able to see a spot height of 820 feet some 4 miles west of Sevenoaks and almost on your track. The MSA for this leg is then $1000 + 820 = 1820$ feet.

Moving on, you do the same thing for the leg from Bewl Water to Lewes VRP, and from Lewes to our next waypoint just north of Arundel. Finally draw in the legs from Arundel to Bishops Waltham, and from Bishops Waltham to Southampton and measure the distances and track, and find the MSAs. Be careful on the leg from Bewl Water to Lewes, because the highest obstacle is not high ground, but a mast at Heathfield, the top of which is 1004 feet above sea level. For this leg then, although the highest ground is 646 feet above sea level, some 5 miles east of Heathfield, the MSA is 2004 feet.

The final element of the data entry stage is to decide on an altitude to fly. With the London TMA above us at Biggin Hill, you cannot fly above 2500 feet. In fact ATC will normally instruct you to fly “not above 2400 feet” to give a margin for altimeter or pilot error. You might as well stay at 2400 feet all the way, then, which keeps you above your MSA on each leg. However, in the Solent Zone, you will be instructed to fly “not above 1500 feet” to provide the mandatory 1000 feet separation from IFR traffic in the zone, so you might as well enter 1500 feet for the last leg.

With luck (or more precisely, careful measurement), you should now have a Plog which looks something very close to Figure 2.

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PWD's FLIGHT LOG																
Date			Aircraft							Fuel						
Aerodrome	R/W	Wind	Temp	QNH		QFE			B/fwd	:	Useable					
										Airborne			147			
										T/O & Taxi			L.P.H.			
										Alternate			30			
										Reserve			Tot. Fuel			
Tacho Start				Tacho End				Tot. Hrs								
Startup		Brks Off		Take-Off		Landing		Brks On		Shut Dn		ETD		ATD		
:		:		:		:		:		:		:		:		
From	To	MSA	Alt	TAS	TrkT	Var	Wind	HdgT	HgM	G/S	Dist	Time	ETA	ATA		
Reg. QNH										Totals		0 0				
Waypoints			HgM	G/S	Dist	Time	ETA	ATA	Notes							
R/T																
Facility																
Frequency																
Ident																

Figure 1 The Pilots Log

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PWD's FLIGHT LOG															
Date		Aircraft							Fuel						
Aerodrome	R/W	Wind	Temp	QNH	QFE	B/fwd		:	Useable						
						Airborne			147						
						T/O & Taxi			L.P.H.						
						Alternate			30						
						Reserve			Tot. Fuel						
Tacho Start					Tacho End					Tot. Hrs					
Startup	Brks Off		Take-Off	Landing	Brks On		Shut Dn	ETD	ATD						
:	:	:	:	:	:	:	:	:	:						
From	To	MSA	Alt	TAS	TrkT	Var	Wind	HdgT	HgM	G/S	Dist	Time	ETA	ATA	
Biggin Hill	Biggin 2DME	1876	2400	75	210						2				
Biggin 2DME	Sevenoaks	1876	2400	105	101						7				
Sevenoaks	Bewl Water	1876	2400	105	146						15				
Bewl Water	Lewes VRP	2007	2400	105	232						20				
Lewes VRP	Arundel	1813	2400	105	270						20				
Arundel	B/ Waltham	1837	2400	105	280						25				
B/ Waltham	S'hampton	1500	1500	105	266						6				
Reg. QNH											Totals	95			
Waypoints		HgM	G/S	Dist	Time	ETA	ATA	Notes							
RT															
Facility															
Frequency															
Ident															

Figure 2 The Route Entered Manually on a Plog

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5.3 The Wind Calculations Stage

In Exercise 16 – Navigation Theory, section 5, we introduced the concept of there being two different speeds which define an aircraft’s motion through the air – airspeed and groundspeed. For a given airspeed, the ground speed was seen to be influenced by the direction of the wind, as seen in figure 3 below.

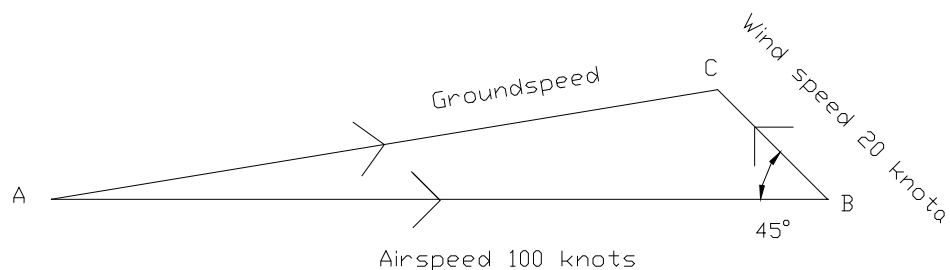


Figure 3 The Effect of the wind on Speed

In the vector diagram above, the airspeed is 100 knots, and so a line is drawn to a scale of 10 knots per centimetre, i.e. 10 centimetres long. The wind, 20 knots, is drawn as a line 2 centimetres long at the correct 45° angle relative to the direction of travel. In the diagram, the direction of travel is 090°, and the wind direction is $90^\circ + 45^\circ = 135^\circ$ (wind direction is always measured FROM the source direction, so a northerly wind is FROM the North, not TO the north). Similarly, if the direction of travel is 330°, then the wind direction is $330^\circ + 45^\circ = 375^\circ$ or 015°. Groundspeed is the measured length of the side A – C, which is 87 knots.

The very same vector triangle is true for the effect of wind on the direction in which the aircraft travels, although the trigonometry isn’t quite that simple because a correction has to be made for the fact that the wind direction relative to the aircraft is not 45° when the aircraft is flying the correct heading to achieve a 090° track, but 36° (see figure 4 below).

With graph paper, rule and protractor, it is a straightforward exercise to draw a wind diagram for each leg of a flight, and even easier using the wind side of the old faithful Whiz-Wheel, but in these days of computers, there is a much easier way.

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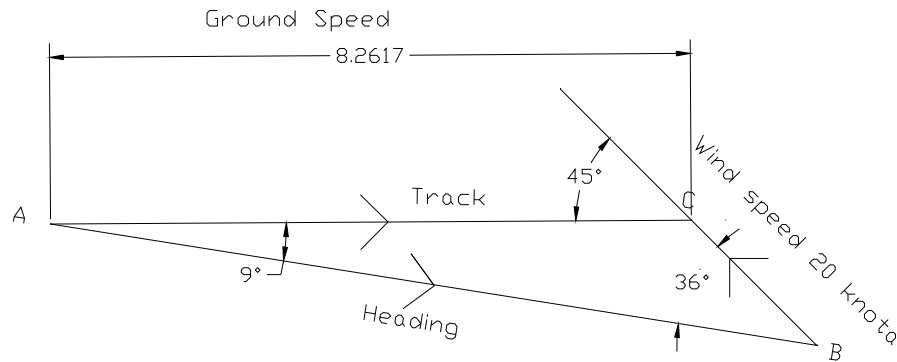


Figure 4 The Wind Diagram

The Club has produced two Excel spreadsheets to simplify the flight planning task.

Drift_Calculator.xls is the simple version. You enter the True Airspeed, the magnetic variation and the wind speed and direction, and it calculates the true and magnetic headings to steer and the groundspeed. Enter these values manually in your Plog for each leg.

In the more complex Version – **FlightPlanner.xls** you enter your departure and arrival aerodromes and all your waypoints between. It then calculates the whole route for you, and produces a Plog which you can print out and to which you can add other relevant data.

If you are using the real weather as transmitted from the VATSIM server, you won't normally be able to get the wind in advance of your flight, before you log on. However, you can use the weather data from Servinfo to get winds at most of the airfields en-route. Best of all, you can log in (free) to the Meteorological Office Aviation Weather site, and download a forecast known as Form 214. This gives the winds at various altitudes, which is more useful than the Servinfo data. The VATSIM weather comes from the same source, so you can use the winds from the Form 214 forecast in FlightPlanner or Drift Calculator before logging in to VATSIM.

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FLIGHT LOG														Pilot		P Dodds			
Date				08/12/05				Aircraft				G-GYAV				Fuel			
Aerodrome	R/W	Wind	Temp	QNH			QFE			B/fwd	:	Useable							
Biggin Hill										Airborne		55	147						
Southampton										T/O & Taxi		20	L.P.H.						
										Alternate		12	30						
										Reserve	1		Tot. Fuel						
Tach Start		Tacho End		Total						Tot. Hrs	2	27	74						
Startup	Brks Off	Take-Off	Landing	Brks On	Shut Dn	ETD	ETA	ATD											
:	:	:	:	:	:	:	:	:											
From	To	MSA	Alt	TAS	TrkT	Var	Wind	HdgT	HgM	G/S	Dist	Time	ETA	ATA					
Biggin Hill	Biggin 2DME			105	210	4	135 20	200	204	95	2	2							
Biggin 2DME	Sevenoaks			105	101	4	135 20	107	111	87	7	5							
Sevenoaks	Bewl Water			105	146	4	135 20	144	148	85	15	11							
Bewl Water	Lewes			105	232	4	135 20	221	225	102	20	12							
Lewes	Arundel			105	270	4	135 20	263	267	116	20	10							
Arundel	Bishops Waltham			105	280	4	135 20	274	278	119	25	13							
Bishops Waltham	Southampton			105	266	4	135 20	258	262	115	6	3							
Reg. QNH									Totals	95	55								
ALTERNATE																			
Southampton	Bournemouth	135		100	240	4	135 20	229	233	100	21	12							
Waypoints		HgM	G/S	Dist	Time	ETA	ATA	Notes											
R/T	Biggin Hill	Biggin Hill	Thames	Solent	Southampton	Southampton													
Facility	Tower	Approach	Radar	Approach	Approach	Tower	SOS												
Frequency	134.80	129.40	132.70	120.22	128.85	118.20													
Ident																			

Figure 5 The FlightPlanner Plog printout with wind calcs and other data added

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If the wind is from 135° at 20 knots, then the Plog, as generated by FlightPlanner.xls looks like Figure 5. Within FlightPlanner, we can also enter the appropriate radio frequencies for the flight, from a published Flight Guide, or the AIP (links on the Club web site), the MSA and planned flight altitudes,. This has been done in Figure 5.

5.4 Magnetic Variation

Magnetic variation is the difference between magnetic north and true north and varies throughout the world, and with time. In the UK at the moment magnetic variation is between 2° and 5° west of true North across the country, and moving east at about 1° every 11 years. If you look at the aeronautical chart immediately west of Shoreham aerodrome, you will see a diagonal dotted line running at an angle of some 10° east of north. This is known as an isogon and connects point of equal magnetic variation. At a point some 5 miles north of Shoreham, is marked “2.5° W”. Along this line then, magnetic north is 2.5° west of true north. If you look westwards on the chart at Lyme Bay, half way between Dorchester and Exeter, you will see the next one, at 3.5° W. As an approximation, 2° is used for this flight, which is as accurate as you need to be.

5.5 Fuel

You may have noticed in Figure 5 that in the top right hand corner is a section labelled “Fuel”. FlightPlanner calculates the fuel required for a flight automatically, based on the values entered in some of the boxes in the section. The boxes which require user entry are described in the table below. To prevent problems with the calculation, the boxes where data entry is not possible are locked.

Useable Fuel	This figure is taken from the aircraft operating data. The useable fuel is the total fuel capacity, less what is left in the tanks when the engine(s) stops. For the Cessna 172, total fuel capacity is 155 litres, and useable fuel is 147 litres.
L.P.H	This is the number of litres per hour of fuel burned in the cruise. This information is also available from the aircraft operating data. For the Cessna 172, it is 30 litres per hour at 105 knots.
T/O & Taxi	This is the time taken from startup to the end of the initial climb. It is most commonly estimated at 20 minutes. The programme converts this into a fuel quantity.
Reserve	It is a legal requirement to allow a reserve of 45 minutes fuel to allow for unexpected conditions en route or prior to landing, but not including the fuel required to fly to the alternate airfield. To be extra safe, one hour is often used, and that is the value used in Figure 5.

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The minimum legal fuel which must be on board before you take off is then calculated, and in our example it is 72 litres, as shown in Figure 5. If you want to do the calculation manually, simply add together the airborne time, the take off and taxi time, the time to the alternate and the reserve, then multiply this time by the litres per hour figure.

$$\text{i.e. } 53\text{m}+20\text{m}+12\text{m}+1\text{h} = 2\text{h } 25\text{m} \times 30\text{lph} = 72 \text{ litres}$$

It is elementary, my dear Watson, that if the fuel required exceeds the useable fuel, you will have to break your flight and refuel en route. You would be amazed, however, how many pilots in the real world, fail to do this and simply run out of fuel whilst still in the air. That results in either death or an automatic prosecution by the CAA!

5.6 All Finished

That concludes the ground flight planning. The process may take you an hour at first, but with practice, a reasonable trip such as illustrated here, can be planned in about 20 minutes. Furthermore, if you save the Plogs to disk, the same flight can be planned much more quickly on a subsequent occasion, changing only the wind data for the day in question. All the other data which can be added to the Plog will be done in flight.

6 FLYING THE FLIGHT PLAN

With a good flight plan, the actual flying is considerably easier than if no flight plan is prepared. In the real world, one would add “and much safer”. As you start the engine (you always start your simulated flights with a cold dark cockpit, don’t you), you log the time in the Startup box on the Plog. Similarly, you enter the Brakes Off time, Take Off time and so on, throughout the flight. You will get a QNH from the VATSIM controller you are talking to, so can enter that too, rather than either trying to remember it, or write it on a scrap of paper which you can’t find when you need it.

6.1 Know Your Position

The most useful aspect of the Plog, though, is to keep an awareness of your position at all times. Firstly, fly the heading and altitude for each leg as accurately as you can at the cruising speed you decided on in your plan. You should also note down any clearance instructions given you by ATC. Use your own abbreviated form, so long as you can read it back!

Shortly after take off, you add the time to fly to the next waypoint to your take off time to get the first estimated time of arrival (ETA) and simply continue waypoint by waypoint, logging the actual time of arrival at each waypoint, (ATA) and the ETA at the next. At each waypoint compare the ATA with the ETA to check that the wind hasn’t unexpectedly changed, or worse, you have arrived at the wrong place, and think (suggestion is very powerful) that it is the **right** place. The ETA and ATA at a waypoint should generally

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be within one minute, or at most two minutes of each other for legs of 20 to 30 miles or so.

You only enter the minutes on the Plog in the ATA and ETA boxes, because they are small – the hour is normally self evident from your take off time, which is entered in full. So assuming you pass overhead Bewl Water at time 25, then the ETA at Lewes is $25 + 12 = 37$. If the ATA at Lewes is 39, that is within acceptable tolerance, and assuming that you are at the right place because the ground features match the chart features, the ETA at Arundel will be $39 + 10 = 49$, and so on.

If you do this methodically, then at any point en route you will know precisely where you are. Taking the example above, you passed overhead Bewl Water at time 25, so where are you now? It is time 33, so you are 8 minutes into the Bewl Water – Lewes leg. That puts you (as near as it is necessary to know) $8/12 \times 20 = 13.3\text{nm}$ from Bewl Water and to the west. If you have not maintained a Plog, the best you can say, if ATC suddenly come on and asks you to report your position, “approaching Lewes from the east”. It is much more professional to say “seven miles east of Lewes heading 223°”

7 QUICK METHODS

If all the above leaves you cold – “its far too technical” or “I’m only flying a computer”, then at least do the drift calculation for each leg to give yourself the satisfaction of arriving at the right place at the right time and not being blown inexorably away from your planned destination. ATC can see an unplanned track, where the wind calculation hasn’t been done, because it will be a continuous curve at best, but more usually a very squiggly line. Even in a brisk crosswind, professional pilots will fly accurate straight lines waypoint to waypoint.

Of course if you do your flight planning using FSNavigator, then you can ignore the whole of this tutorial, and either just follow the FSNav track line on screen, or switch on the autopilot and let FSNav fly the route for you. As a VFR pilot and a member of the Cix VFR Club, however, that would be bordering on heresy, and not satisfying or fun at all!