CROSSWIND CALCULATIONS MADE EASY

Mental arithmetic goes out of the window for most pilots when flying. Here's a really simple way

WORDS Dave Sawdon **PHOTOS** www.airteamimages.com

OK, you're on a very bumpy approach to R27 and the controller tells you the wind is 310/25... what is the crosswind? Sorry mate, got my hands full here!

I PRESUME you are reading this in a comfortable armchair, or on a train, or maybe even in a flying school with the rain pounding on the windows. Possibly there's a favourite tipple in one hand and some gentle music in the air. Under these conditions, if I asked you to do some mental arithmetic (and you were aged over 25), it would probably take you less than five seconds to work out "two-thirds of 25".

Now imagine the situation when you are at the holding point for runway 24. You call "ready for departure" and the tower replies with "cleared take-off; wind 280, 25 knots". What's the crosswind component? What's the headwind component if the performance is a bit tight? Is it the same as you used in your performance calculations? Not as easy as when you were on the train, is it?

Maybe you are at the end of a long flight, typically slightly longer than the comfortable endurance of your bladder. You are flying an approach which is a bit more turbulent than part of your anatomy would prefer when, at 500 feet, you call "final" for runway 35 and the tower replies "cleared to land; wind 030, 25 knots". What is the crosswind component? Would you agree that it would not be as easy now as in your armchair?

Let's be honest with each other. Do you actually calculate the crosswind component every time you are told the wind strength and direction after a call of "ready for departure" or "final"? Do you always think about the wind direction and make an appropriate aileron input? Honestly?

During my time as an instructor and examiner it has been very rare that a pilot has volunteered the crosswind or headwind components on an approach or before take-off. If I ask them, the answer is usually (with some honourable exceptions) "errr" followed by a semi-random number. Frequently they don't even know whether the wind will be from the left or the right without looking at the windsock!

It's an unfortunate aspect of aviation that we all lose a significant proportion of our intellectual capacity when we have an aircraft strapped to our back. I cannot tell you why it happens but I can show you a way around the problem when it comes to crosswinds and headwinds. The purpose of this article is to present a simple method which will allow you to assess the crosswind and headwind components with as much accuracy as you like, without any sums, without any gadgets, in less than five seconds, and whilst flying an aeroplane.

ABOUT THE AUTHOR

Dave Sawdon has recently joined the Pilot Coaching Scheme as a Full Coach. He is a freelance Instructor and Examiner for all aspects, including: aerobatics, IMC, multi-engine, tailwheel and night training. Most weekends he can be found working at Old Sarum but he travels around and can be found examining or instructing at Bournemouth, Popham, or other strips and airfields within striking distance of Winchester.

His first solos include a glider in 1971, an SEPL in 1984, an MEPL in 1996 and a helicopter in 2001. He has held a CAA CPL and an Instrument Rating since 1997 and has flown about 70 different types.

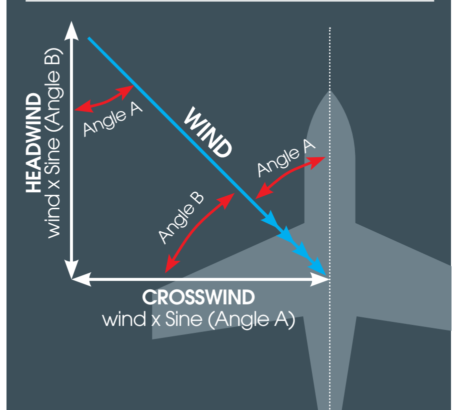
As his "day job" Dave works for a "very large blue IT company".

BASIC GEOMETRY

We will start by going back to basic geometry – but even sitting in your armchair, I doubt most of us remember about sines and cosines from our schooldays. **Figure 1** shows an aircraft lined-up on runway 36 and a wind arrow from approximately 310°. We can see from the drawing that the crosswind component is the wind speed multiplied by the sine of the angle between the nose of the aircraft and the wind direction (called the relative wind angle). We can also see how the headwind component could be calculated, either as the wind speed multiplied by the cosine of the relative wind angle, or as the wind speed multiplied by the sine of the angle between the beam of the aircraft and the wind direction.

Obviously too complex for our requirements, so students are traditionally taught the "rule of sixths", or the "clock face" rule, for crosswind assessment and nothing at all (except the whizzwheel) for the head or tail wind.

FIGURE 1



Aircraft lined up on R36, wind from 310°.

TABLE 1: RULE OF SIXTHS

RELATIVE WIND ANGLE	RULE OF SIXTHS	SINE OF WIND ANGLE	ERROR
10°	1/6	0.17	1%
20°	2/6	0.34	1%
30°	3/6	0.50	0%
40°	4/6	0.64	-2%
50°	5/6	0.77	-7%
60°	6/6	0.87	13%
70°	6/6	0.94	6%
80°	6/6	0.98	2%
90°	6/6	1.00	0%

The "rule of sixths" makes use of the happy coincidence that the sine of 10 degrees is very close to 1/6th, sine 20 degrees is very close to 2/6ths and so on. **Table 1** shows the full story. This method is a fairly accurate approximation for most relative wind angles but we can see that there is a significant error at 60 degrees. Because of this some pilots modify the rule for 60 degrees and use 0.9 rather than 6/6ths, in order to get the error down from 13% to 3%.

To use this "rule" you first determine the relative wind angle, and then multiply the reported wind strength by the appropriate fraction. So, if the reported wind is 350/25 and you are using runway 03:

* the wind angle is 40 degrees
* 40 degrees gives 4/6ths
* the crosswind component is therefore 4/6ths of 25kt, say 17kt-ish.

If a second table were produced, with the wind angle column turned upside down, this same method could be used to calculate the head/tail wind component. So why don't people use it in practice?

All we have to do, at 500 feet on a bumpy day, having drunk too much coffee three hours ago, with someone in the back asking why something-or-other is happening and with ATC talking on the radio, is work out the wind angle and then multiply the wind speed by the appropriate fraction! The honest truth is that the sums are too complicated for most people to perform whilst flying an aeroplane. It's therefore no surprise that most pilots don't bother to calculate the components and occasionally get an unpleasant surprise.

> 'We lose a significant proportion of our intellectual capacity when we have an aeroplane strapped to our back'

FIGURE 2

To make calculating crosswind components easier, use the aircraft's Direction Indicator (DI).

What we need is a simple technique for accurately estimating the crosswind component; a technique which requires virtually NO brain power for those days when the remaining brain cell has had enough. Something visual and easy that doesn't require sums or a gadget. And here it is.

DIRECTION INDICATOR

In virtually every aircraft there is a Direction Indicator (DI) that looks vaguely like the one shown in **Figure 2** and we can use this as a form of analogue computer (those of you who have an older style ribbon DI need not despair, I'll discuss how you can use the same techniques a little later).

At first, reading this may sound complicated but believe me, with practice it is very easy.

You are going to mentally draw the vector triangle on the face of the DI. The distance from the centre of the DI to the edge represents the reported wind speed. Once you are lined up on final approach, simply find the reported wind direction on the outside of the DI scale and mentally drop a vertical line down on to the horizontal centre line. The proportion of the centre line that lies between the vertical line and the centre line is the proportion of the wind speed that is at right angles to your direction; in other words, the crosswind.

Let's look at that more slowly.

Look at **Figure 3**. You are either lined-up for take-off, or on final approach, for runway 35 and the wind is reported as 040/25. Imagine the DI being a picture of the horizontal situation, drawn with a radius that represents the wind strength in some scale or other. In other words, if the wind is 25 knots the radius of the DI represents 25 knots.

Step 1: Find the reported wind direction on the outside of the DI (shown as a large blue arrow). You now have the first piece of information; the wind is from the right.

Step 2: Mentally drop a vertical line down from the wind direction on the outside of the DI to the horizontal centreline.

Step 3: The horizontal centre line represents the crosswind axis so visually scale-off the crosswind component as a proportion of the length of the crosswind axis, i.e. the wind speed. In Figure 3 it looks like the crosswind component is just less than 80% of the total length, say just less 20 knots. Mathematically, the answer is 19kt. With a little bit of practice this is fast, and as accurate as you choose to make it. It also inherently wakes you up to whether the wind is from your left or your right – it's written on the face of the DI.

Even airliners have to consider the crosswind and be able to correct the crab angle for landing.

HEAD OR TAIL WIND COMPONENT

Once you are comfortable with the technique it can be used to estimate the head or tail wind component in addition to the crosswind.

Look at **Figure 4**. You are lined up for departure, or on final approach, or simply want to know the wind components on heading 135.

The wind is reported as 180/30. What are the headwind and crosswind components?

You already know how to assess the crosswind component and can estimate that it's close to 20 knots. We can use the same technique to assess the headwind component. Just project a horizontal line from the wind direction on the outside of the DI to the vertical centre line (which represents the head or tailwind axis) and visually scale-off the headwind component as a proportion of the length of the headwind axis, i.e. the wind speed. In Figure 4 it looks like the headwind component is about 22 knots (mathematically the answer is 21 knots).

What could be easier?

But what, you might say, if you aren't lined-up with the runway and want to know the crosswind and head/tailwind components? Maybe you are at the holding point, at dispersal or approaching the airfield. There are two solutions; one is simply to rotate the DI so that the runway heading is at the top, but a better answer is to use the ADF or VOR indicators in exactly the same way as described for the DI. This is also the answer for those with a ribbon DI: use one of the other compass roses.

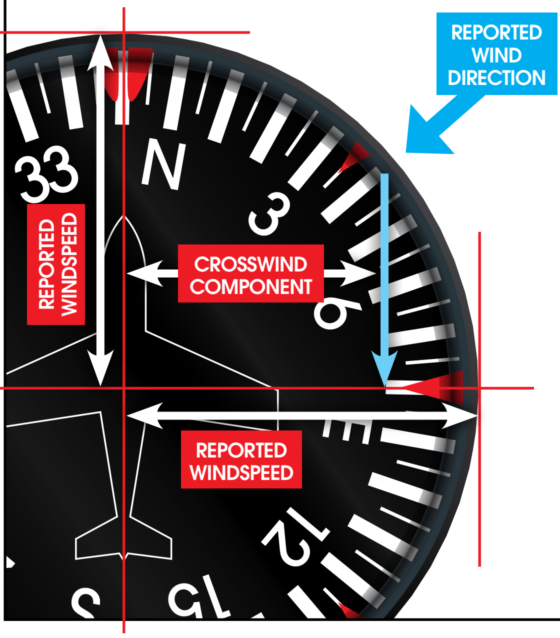
Possibly you're flying a very basic aircraft with no compass rose type instruments at all? If you stick or draw a compass rose on your kneeboard you can still use the method. In fact, with a compass rose of any type you are now able to accurately estimate wind components without doing sums. Isn't that a relief?

PRACTICE IN THE BATH

Use the compass rose in Figure 2 to practice on while you're in the bath. Turn the DI to represent a turbulent approach into a shortish airstrip with a runway orientation of 345°. The wind is 030/25.

Estimate the crosswind component. Is it inside the demonstrated crosswind capability of your aircraft? Will the headwind component have been reduced sufficiently to give you concerns over the landing distance available? Mind the bubbles!

FIGURE 3

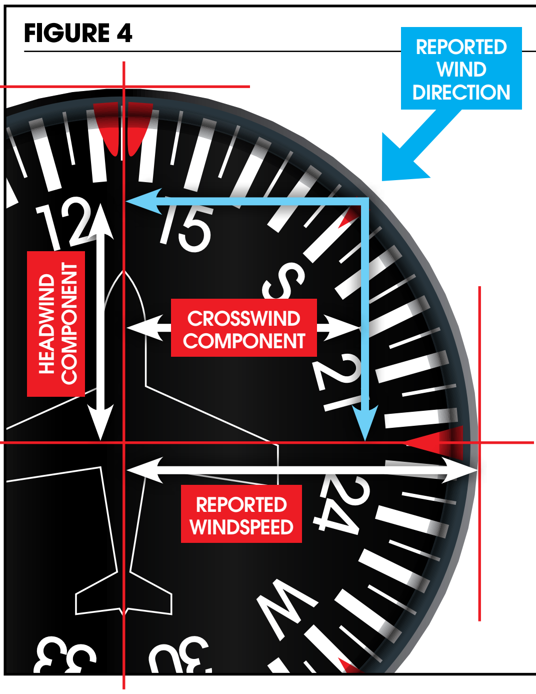


STEP 1
Find the reported wind direction on the outside of the DI (shown as a large blue arrow). You now have the first piece of information; the wind is from the right.

STEP 2
Mentally drop a vertical line down from the wind direction on the outside of the DI to the horizontal centreline (shown in blue).

STEP 3
The horizontal centre line (red) represents the crosswind axis so visually scale-off the crosswind component as a proportion of the length of the crosswind axis, ie, the wind speed. In Figure 3 it looks like the crosswind component is just less than 20 knots (mathematically the answer is 19 knots).

FIGURE 4



Try this example yourself. The wind is reported as 180/30. What are the headwind and crosswind components?

CROSSWIND
Using the method above, we can assess the crosswind component and estimate it's close to 20kt.

HEADWIND
We can use the same technique to assess the headwind component. Just project a horizontal line from the wind direction on the outside of the DI to the vertical centreline (which represents the head or tail wind axis). Visually scale off the headwind component as a proportion of the headwind axis, ie the wind speed. Here it looks like the headwind component is about 22kt (mathematically the answer is 21kt).