Swinging the Compass - Capt Geoff
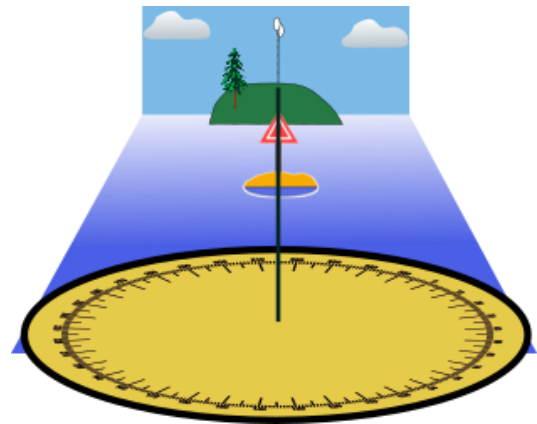
Part 2 – Introducing the Pelorus

Obligatory Caution: Use this process at your own risk. The Author of this article, Ripple Rock Squadron and Canadian Power and Sail Squadron take no responsibility for any navigational errors that may occur as a result of following this process.

Before reading this, you should read Part 1, to get an overview of Deviation, and to see if you can use a simple method to create a deviation card. Unfortunately the simple method may not work for everyone. You may not be able to find a spot where your hand held compass can sight along the centreline of your boat without itself being affected by deviation.

If you are unable to use the hand bearing compass method, I believe your best option is to use a pelorus. A pelorus is sometimes referred to as a simple compass.

It allows you to take bearings that are "relative" to the direction the boat is heading.

In the diagram on the right, the pelorus is taking a bearing of a beacon and microwave tower in line. These objects are said to be "in transit".

A professional pelorus can cost many hundreds of dollars. However you can build your own basic pelorus quite cheaply. One option is to print a compass card (google "maneuvering board pdf" for a no copyright version courtesy of the US military) and paste that onto a square piece of board, with the 0/180 marks aligned with the side edges (the reason for this will become clear).

Using a pelorus with sighting pin to obtain the relative bearing of a beacon and microwave tower in transit. Glancing downward you should be able to read the bearing on the far side of the rose.

A professional pelorus usually comes with sighting vanes (shown in illustration to right), but to keep things simple we will use sighting pin (often called a shadow pin) as shown in the upper diagram. This pin must be mounted in the exact centre of the compass rose. The sighting pin can be a long bolt, held upright by a nut, or it could be a piece of stiff wire. Whichever you choose, the pin must be vertical when the compass card is held flat. A professional pelorus also uses gimbals to keep the card horizontal. Ours will have to be mounted, or held, flat (a bullseye level can help with this). I have also loaded a file to Thingiverse if you want to use your 3d printer to create a basic pelorus on a square base.

Pelorus

The pelorus must be located where it can take bearings all round (or be able to be easily moved between two or more locations to cover all round) with the 0/180 marks aligned fore and aft.

One option for orienting the pelorus could be to hold one of the flat edges against a railing, coaming or window that is either exactly fore and aft, or thwartships (perpendicular to fore and aft). This is why the square base is useful.

Once the pelorus is positioned, the observer reads the relative bearing of the target from the pelorus (see first image). At the same time he/she asks the helmsperson what the compass reads (should be the compass course, but if ship's head is off by a couple of degrees record that, and the relative bearing value will compensate). By adding the relative bearing to the compass heading, the compass bearing of the object is known.
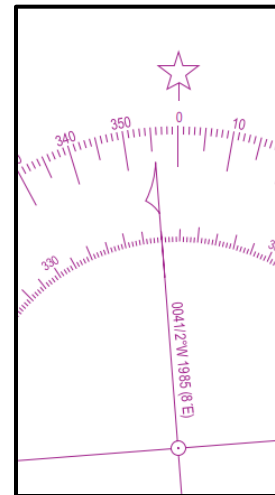
Our variation can be read from the nearest compass rose on our chart (image to the right is a screenshot from Chart 1). The Variation shown is 004 ½ W. But that was in 1985 (unrealistically old for a modern chart). To update it to 2022, we have to apply the annual change, which is shown in brackets – in this case (8'E). The change in years is 37, so we multiply 8 minutes by 37 years, for a total of 296 minutes. Dividing that by 60 minutes per degree and rounding to the nearest half degree gives us a total change of 5 degrees. As the annual change is East, and the Variation is West, we subtract the annual change, giving us 000½ degrees East variation in 2022.

Part of a compass rose from a chart, showing variation.

If we know our deviation, we can then use TVMDC (example below) to find the true bearing of our target, which we can then plot on our chart. This gives us a line of position that we must be on. If we took a bearing of a second object and also correct that to true, plotting it will give us a fix where the lines cross.
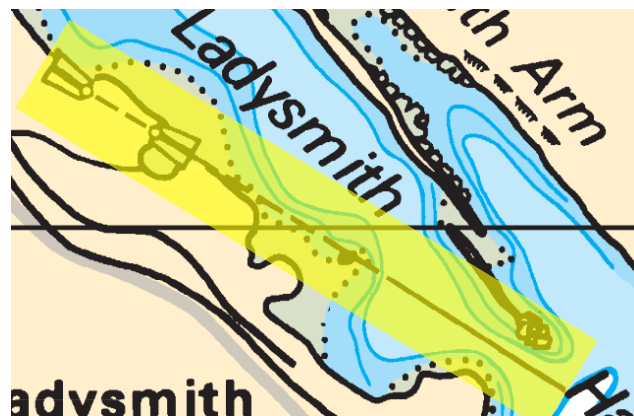
However we are getting a little ahead of ourselves, as we are not sure of our deviation. To find our deviation, we must know the true bearing of the target we took the bearing of, so that we can work backwards to find the deviation.

So we need to find some way of obtaining a true bearing. Ranges, which are two marks on the shore, are used to guide a vessel along a safe route into a harbour. Keeping the ranges in line keeps your vessel in the safe channel (if you know when to use them). The image to the right depicts a set of ranges (highlighted in yellow). With your boat positioned so the two range marks in line, you must be somewhere on the line drawn from them. So you know the exact bearing of the ranges from your vessel.

The same principle applies to two objects "in transit", as shown in the first image. Aligning your plotter on the two objects will show you the true bearing of the transit.


From CPS training chart 9996. These ranges do not exist.

Do not use for navigation.

The diagram on the right shows all the factors involved with this calculation, making it a bit complex at first glance. The daymark and microwave tower transit, is plotted on our chart to find a True Bearing. Applying Variation to that, we then know the Magnetic Bearing of the transit. The relative bearing is taken when the transit lines up (see first diagram above). Deviation on that compass heading is the difference between magnetic bearing and compass bearing.

In this case, we found that our Compass Bearing was 030 (compass head at time of sighting) + 110 (the relative bearing from the pelorus) = 140. Looking at the chart, we plotted the transit as 164(T) and the variation for our position (updated to this year) from the nearest compass rose was 19E. We can put this all into a TVMDC equation to obtain the deviation.
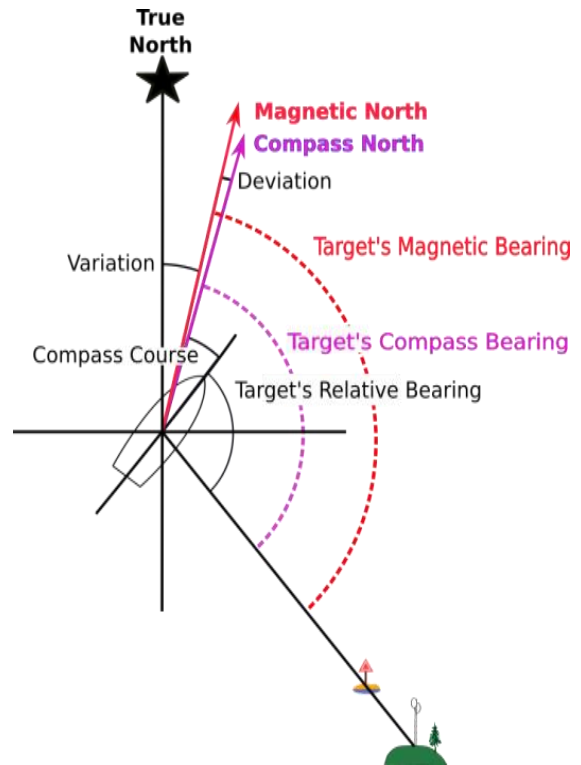
True Bearing: Taken from chart using plotter.

Variation: Taken from chart, nearest compass rose. Updated to current year.

Magnetic Bearing: True bearing plus or minus Variation.

Use CADET mnemonic to decide whether to add or subtract Variation/Deviation

Compass Bearing: Compass head plus Relative Bearing.

In the above example compass head 030 plus Relative bearing 110 equals a compass bearing of 140.

Compass to True

Add East
(Subtract West)

C AD E T

Or

When converting
True to Compass
Add West
(Subtract East)

T	V	M	D	C
164	19E	145		140

As you can see from the TVMDC equation, the only unknown value at this point is deviation. Using CADET, the deviation value is calculated as 5E. Note that this deviation is for the compass head at the time, which was 030.

By crossing the transit at 30 degree course increments we can gather enough data points to create our deviation table. Here I've created a table to track the compass course, relative bearing and compass bearing, so I can compare it to the Magnetic bearing (derived from our chart) to determine deviation for each course. (In the table, we were a degree off course at 060 and 090. By recording the actual Head and Relative Bearing we get an accurate Compass Bearing. As deviation changes fairly slowly, a degree or two off course does not cause a problem for the final result).

The magnetic bearing of the range is the same as we calculated above and stays the same regardless of course. The 030 compass course's relative bearing (and calculations) are also the same as above.

The remainder of the data would be obtained by crossing the ranges while steering each compass course shown in the right hand column.

Magnetic Bearing	Deviation		Compass Bearing	Relative Bearing	Compass Head
145	3	E	142	142	000
145	5	E	140	110	030
145	3	E	142	081	061
145	0		145	056	089
145	2	W	147	027	120
145	4	W	149	359	150
145	4	W	149	329	180
145	3	W	148	298	210
145	1	W	146	266	240
145	0		145	235	270
145	1	E	144	204	300
145	2	E	143	173	330

As above, the deviation is determined by comparing the Compass Bearing of the transit against the known Magnetic Bearing.

(Note that for Compass Courses of 150 and above, after adding the Relative Bearing, we need to subtract 360 from the total.)
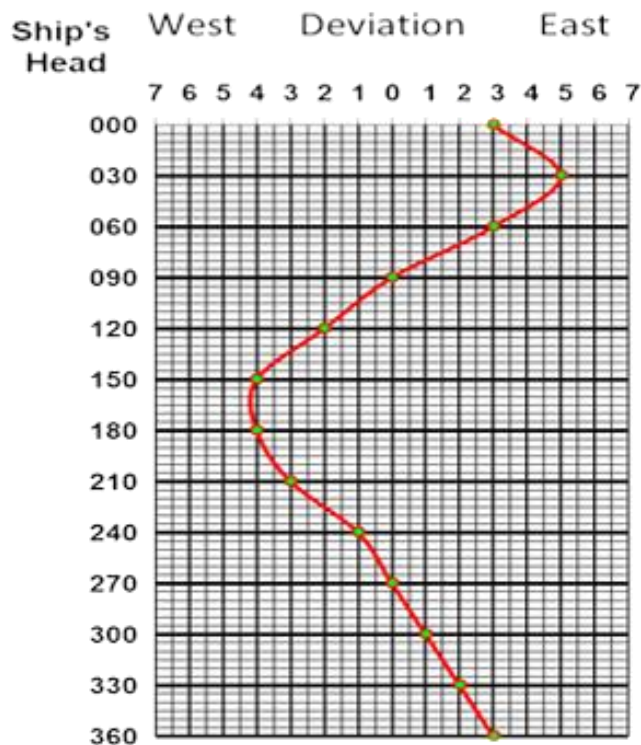
The results are then plotted on a deviation table, as seen to the right. For any course, you can read across to the curve to determine Deviation for that Compass Course.

If crossing a transit on various courses doesn't work for you (sometimes it is hard to hold the Compass head right on the desired Compass course at the desired moment), there are a couple of other options available to you that don't require such precise steering at a critical moment.

Our GPS can be really useful for this, as you can use its bearing capability, (discussed in Part 1). Place your next waypoint on a distant, but identifiable point and then at slow speed, make slow alterations to North, 030, 060, … Stay on each course for a moment to ensure the compass has settled, take your relative bearing, confirm the GPS waypoint bearing, record your data, then alter to your next course. When all data is recorded, you can create a table like the one above, by using the magnetic bearing from the GPS, rather than the transit we used originally. Note: if you move any distance while carrying out this process, the GPS bearing may change, so make sure that you use the updated GPS bearing to compare against the pelorus measured bearing for that heading.

Without GPS, you need to stay fairly close to a known position and slowly turning the vessel while taking bearings of that distant point. Get the true bearing from the chart using your known position and the distant point, and convert it to magnetic (the same way we used our position in the marina and again when using the transit method).

It can be a bit tricky to slowly turn the boat in a small enough circle to not affect the target bearing (remember that at a distance of 5 nautical miles, the bearing of an object will not change by one degree if your turn diameter is less than 160 metres [500 ft.]). Some people use their dinghy to push the stern around.

Again, the results are plotted using the same method we used for taking transits.

In part 3, we will look at using the pelorus and the sun to create a deviation table. (It's easier than it sounds.)