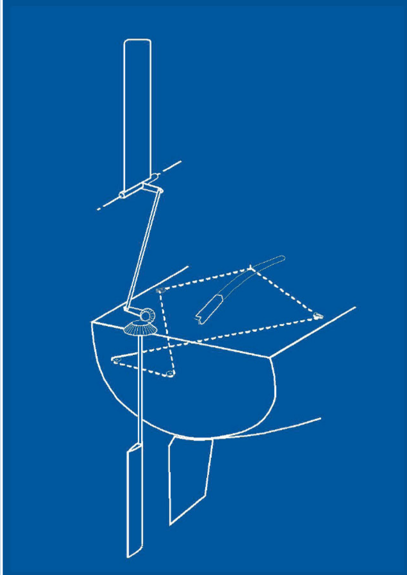
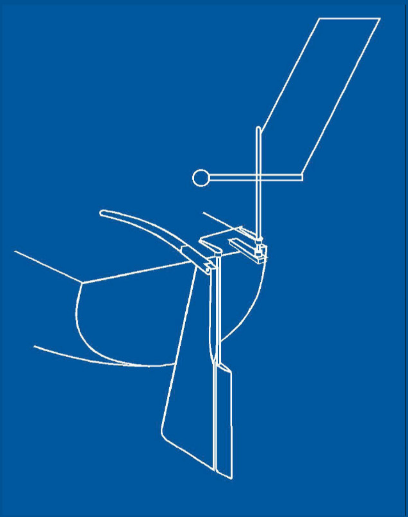
Secrets of...

Windvane Self-Steering



- **How they work ...**
- **how to choose the right type for you ...**
- **... and how to get the best from these wonderfully useful devices**



By Andrew Simpson

Secrets of Windvane Self-Steering

Written and illustrated by Andrew Simpson

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Chapter 1:
Wonderful windvanes – an introduction

Let's face it, of the many delights of sailing, steering is one task that palls the fastest. Yes, it can be exhilarating at times, even satisfying when, say, edging a sailboat to windward in light airs or overhauling a larger boat. But, as most sailors soon learn, it becomes pure torture to be stuck at the helm on anything more than a short passage. Liberation from such drudgery allows you to engage in other more constructive or entertaining activities – clearly a huge boon to offshore sailors, usually with much to attend to in the way of other duties.

Heading southwards towards the Mediterranean. Our Monitor windvane does the steering while Chele keeps a lookout.

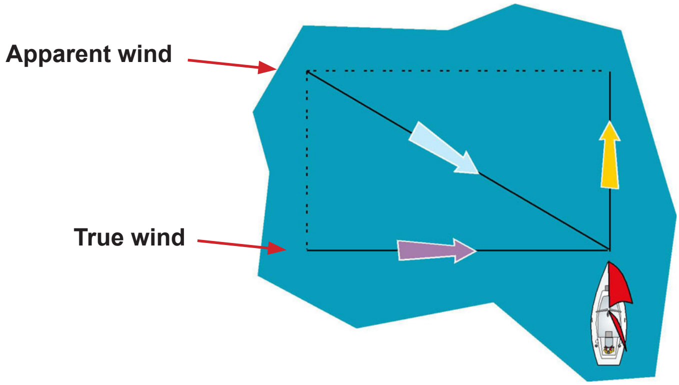
Of course you could fit an electric automatic pilot. You simply switch them on and, by virtue of sophisticated computational algorithms, they will more or less do their duty. Unfortunately, such convenience is not without its downside. They are also quite noisy, can be unreliable, and are greedily extravagant with your meagre reserves of electricity.

On the other hand, wind driven self steering gears are silent, indomitable in their reliability, and consume no electricity whatsoever. Hardly surprisingly, they are the first choice for ocean voyagers who must conserve their resources, but would also serve coastal sailors more than most fully appreciate. In the debit column we must acknowledge their higher initial costs and the greater responsibility required of the crew to have their sails set and trimmed properly.

But… hey!...that's nothing more than a call for good seamanship, isn't it?

Anyway, this isn't a head-to-head contest between electronics and mechanics. There's no competition. Windvane gears won't work in the absence of wind and there should be no shortage of electricity when your engine is running. In common with many offshore yachts, my 40 footer *'Shindig'* carries both: the tiller pilot doing duty in the very dreariest of steering conditions – a flat calm – and the windvane minding the helm when under sail.

Electronic autopilots are usually controlled by compasses (these days almost invariably fluxgate compasses) whereas windvane gears sense the wind direction and keep the boat's head at an angle relative to it. More correctly, they sense the apparent wind, which is the wind as experienced aboard the boat – a combination of the true wind and the forward progress of the boat itself.



Between the actions of the two types lies an important distinction, each with inherent merits and traps. The compass-controlled gear will deliver the kind of straight line course you can mark on your chart. This makes the navigator's job a breeze. Not so the windvane which will duck and weave with every variation in wind direction and strength. On the face of it, the latter might appear a serious flaw until you remember that we trim our sails according to the wind so there are very real benefits in reacting to its minute-by-minute inconsistencies. Indeed, because it never relaxes its concentration, a windvane will often take a boat to windward more surely than a human hand.

Look at it this way...

What would you say to a crew member who would work for days on end without sleep, never tires or complains and asks for nothing to eat or drink? Welcome aboard, would be my response!

Chapter 2:
How windvanes work

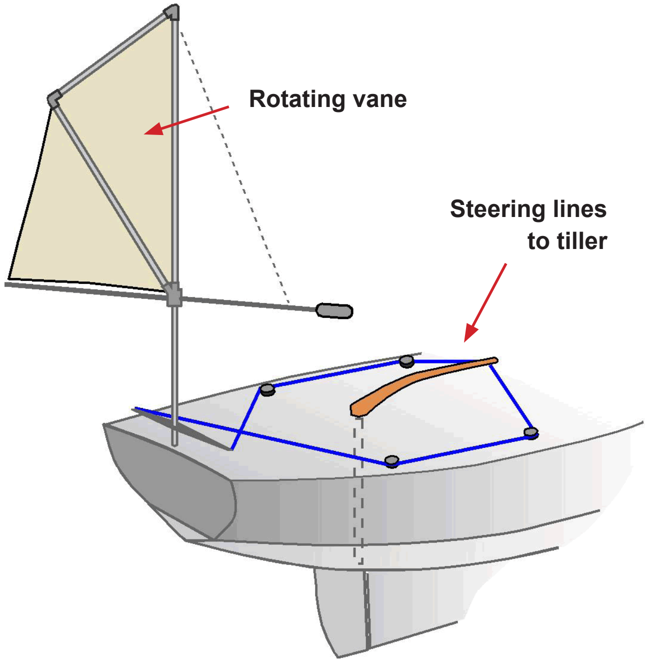
Much of the development of windvane steering for yachts arose from singlehanded sailing. Way back in 1936 the French painter, Marin-Marie used a windvane to cross the Atlantic in his motor yacht '*Arielle*'. History doesn't relate how well it worked. The first recorded use on a sailing boat was in 1955 when Ian Major also crossed the Atlantic in his yacht '*Buttercup*'. Again, not a lot is known about its efficiency.

Perhaps the true dawn of windvane technology arose in the late 1950s with preparations for the first Observer Singlehanded Transatlantic Race (OSTAR) in 1960. Amongst the five competitors were Colonel H.G. (Blondie) Hasler – war hero, instigator of the race and later credited with being one of the inventors of 'modern' self steering gears – and Francis Chichester with his 39 footer '*Gipsy Moth III*', then thought to be about the largest yacht a man could handle alone. How wrong they were!

Direct action gears

To steer *'Gypsy Moth III'* while he rested, Chichester had fitted a rotating mizzen, fashioned like a gigantic weathercock and connected directly to the steering. It was operated by putting the boat on course, allowing the vane to feather into the wind, then tying off the tiller lines to the tiller as shown below. With uncharacteristic whimsy, he called it Miranda – no doubt with deliberate irony since Miranda is the heroine in Shakespeare's play '*The Tempest'.*

Despite her size and theatrical associations, Miranda was said to be a poor performer, lacking both power and sensitivity. The friction in the whole system can only be imagined, but that wasn't the only problem, as we shall touch on in the next section. For now let's accept that the output from any direct action gear is unlikely to be enough to overcome the loads found in most primary steering systems.



Meet Miranda – whose primitive approach to self steering must have been sorely taxed overcoming the friction in Gipsy Moth's primary steering system

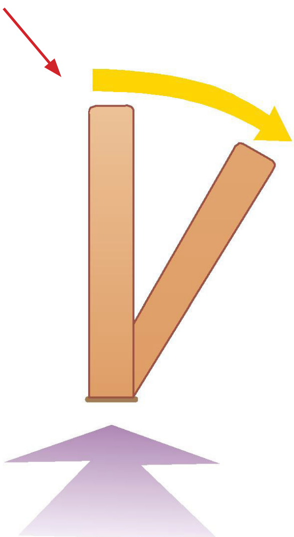
The search for sensitivity

The main problem Francis Chichester encountered with Miranda is inherent in all vanes rotating about a vertical axis. And it's easy to understand why. Let's say the boat's head falls to leeward just 5º. Will the vane sense such a small variation in course? Well an efficient aerofoil might but not a sheet of plywood and certainly not Miranda's flapping trappings. Given the heaving world in which boats exist, and remembering how any output might be lost to friction – not to mention the inevitable slack in steering lines and other linkages – such a vane stands no chance. The reality is that a boat must stray grossly off course before a vertical axis vane even recognises that anything is amiss.

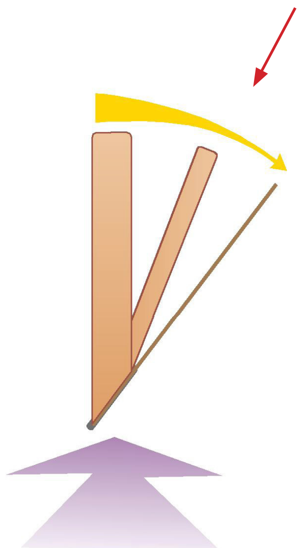
So it was clear that some means of obtaining a greater vane output was needed. The first answer to emerge was to pivot the vane horizontally. Now, if the wind pressed even slightly on one side, the vane will be pushed over. With this arrangement, the vane's rotational output is no longer limited by the yaw angle. It becomes both stronger and more emphatic.

Indeed, in practice, horizontal axis vanes proved too powerful and twitchy. In strong winds the vane would slam from side to side, inducing horrendous over-steer. To overcome this, a modern gear has its axis inclined away from the wind at about 15-20º. This has the effect of progressively feathering the vane as it is pressed over (Fig 4). This dampens the output at the extremes of vane rotation, thereby reducing the associated course oscillations. With an inclined axis of 20º the vane's angle of attack becomes zero at 30º of deflection. Incidentally, heel angle must be added to the axis angle, so an inclined axis vane becomes significantly less powerful if the boat is hard pressed. One design by Dutchman Jan Alkema counters this problem by pivoting its vane from the top.

With horizontal vanes the power output is constant over the whole deflection range. This makes them powerful but rather too violent in their actions



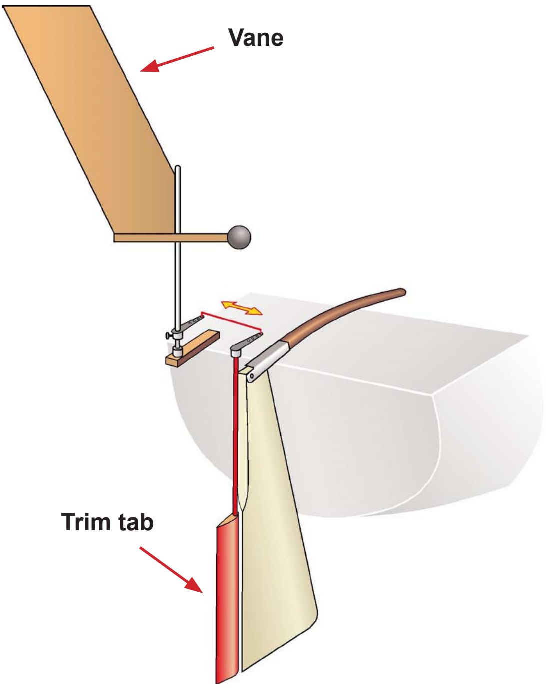
The power in inclined axis vanes diminishes as the vane is pressed over – eventually reducing to zero. This tapering off of their power makes them a lot easier to live with



Indirect action

Steering calls for a power source, whether from man or machine. There's no arguing with that. Boats live on the interface between two turbulent fluids – air and water – which continuously buffet and toss them about. Even on the best trimmed boat, the steering loads can be high – certainly more than could be consistently overcome by the puny output from a windvane acting alone. To achieve efficient self-steering, a source of greater power is needed. Fortunately, there's one to hand: the flow of water past the hull.

Let's go back to that 1960 OSTAR. While Francis Chichester was wrestling with the lack-lustre Miranda, Blondie Hasler on his turtle-decked Folkboat *'Jester'* had adopted a trick from aircraft design. On the trailing edge of *Jester's* transom-hung rudder was a small trim tab, controlled by a windvane that Hasler could adjust from the midships hatch. Whenever the boat strayed off course, the vane turned the tab and the waterflow acting upon it pushed the rudder blade over to make the appropriate correction (see left). This could be described as having a tiny auxiliary rudder that steers the main rudder which in turn steers the boat. In this context it's the simplest form of servo assistance. The relatively meagre output from the windvane – which in no way could turn the rudder itself – harnesses the much greater energy of the waterflow to do the work for it. This process of amplification means that the windvane can be much smaller. Oddly, Hasler never went the horizontal vane route, clinging to vertical axis vanes in all of his later, and considerably more sophisticated, designs.



The realisation that direct action from wind energy did not have the power needed to steer a boat was a breakthrough in self steering gear development. The trim tab type was the first to harness waterflow energy

Still more power

The story continues with Blondie Hasler. In about 1964 he was responsible for the development of a new and immensely powerful type of self-steering gear that was to form the basis of all but a few designs that survive today.

And it was an inspired bit of thinking. Recognising the limitations of the trim tab, he looked for a new way of harnessing the hydrodynamic energy locked into the waterflow. He noted that when he held an oar over the stern with the blade aligned with the flow, it produced a little drag but no hydrodynamic force. But if he twisted it slightly to give it even a small angle of attack, a powerful force developed, tending to lift the blade towards the surface – a pendulum action, from which the term 'pendulum servo' was born.

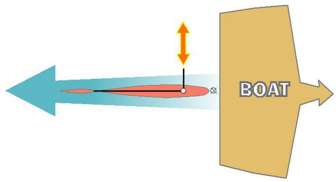
Surely, he concluded, by taking pendulum lines up to the tiller or wheel this robust action could be used to steer the boat. And he was right, as history testifies, but there were problems to be surmounted first. His early experiments produced alarming results. The servo blade slammed from side to side, hard over one way then the other, with the boat yawing wildly in response. To be useful, this essentially brutal principle had to be turned into something better mannered, that allowed a powerful initial response that tapered off as the action progressed.

Hasler had been there before with his trim tab gears. He had learned that it's all too easy to build a mechanical helmsman that knows only two commands – hard-a-port and hard-a-starboard – and now with the awesome power his newly developed pendulum servo blade bestowed, it did so all the more savagely. By contrast, a human crew will take a proportionate view of any course corrections – applying just enough helm to counteract any yaw, gradually reducing it as the boat approaches its correct heading. This is too much to expect from a machine. Yet, he knew that somewhere in the control geometry there had to be a way of introducing a damping effect that would work entirely automatically. He was thinking about mechanical feedback – a very important element in windvane self-steering gear design.

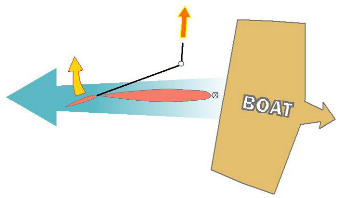
There are various ways of gaining feedback. A simple example is commonly used in trim tab gears, and is shown below in the somewhat exaggerated series of illustrations depicting a transom-hung rudder.

Basically, the push rod from the windvane acts on the trim tab's tiller at a point astern of the main rudder's axis. The tab's action on the main rudder causes it to swing towards the push rod, first reducing, then reversing, its angle of attack. In sequence it goes like this:

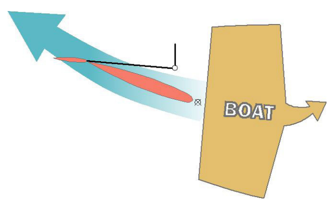
1 ***The boat is on course and the waterflow streams straight over both rudder and trim tab***



2 ***The boat strays off course. The vane senses the change in direction and turns the tab in response***



3 ***Driven by the tab, the rudder swings over. Because the link from the vane linkage is aft of the rudder axis, the tab strightens progressively. With the boat now returning to its course, the tab's effect is now zero and the rudder will turn no further under its influence.***



NOTE: Although not usually obvious, all modern vane gears use some form of feedback mechanism to tame excessive responses to course changes. Otherwise called 'yaw dampening' – a phrase that explains the objective perfectly.

Chapter 3:

Types of gear – themes and variations

So, we've covered the essential principles that lie behind windvane self steering gears. There might be a few oddball types that lie unheralded somewhere, but the vast majority fall into three basic categories with variations that we'll touch on later. For now let's look at...

Direct action

This concept involves linking the deflection of the vane directly to the steering. Chichester's Miranda fell into this group but there are no commercial equivalents today. And with good reason, since the efficiency potential of such a crude concept is woeful – greatly surpassed in efficiency terms by other more sophisticated devices.

Direct action on auxiliary rudder

Forget the inevitable friction burdens of direct action on the main rubber. There are gears (or at least one I know of) which ignore the primary steering and instead link the vane output directly to a much smaller auxiliary rudder. The best known of these is the Hydrovane which over the years has earned an enviable reputation amongst sailors. Here, meticulous engineering has minimised friction and backlash while the auxiliary rudder has been optimised to be both hydrodynamically efficient and relatively easy to turn.

Advantages:

- Because these are integrated stand-alone units there's no necessity for steering lines or other linkages to the boat's primary steering – just a single line to adjust the vanes' orientation is led forward to the cockpit. This makes such gears an attractive proposition for centre-cockpit boats.
- Very compact
- The main steering can be locked, perhaps so as to remove any weather helm.
- The auxiliary rudder can double as emergency steering if the main rudder is damaged or lost.

Disadvantages:

- Good engineering doesn't come cheap.
- Since, the wind is the only source of input power, by necessity vanes are generally larger than on other types of gear.

Trim tab

This is the simplest employment a servo effect of harnessing the waterflow caused by the boat's forward movement. As described earlier, a small pivoting 'tab' on the trailing edge of the main rudder generates enough lift to forces it from side to side.

Advantages:

- Mechanical simplicity and therefore relatively low cost

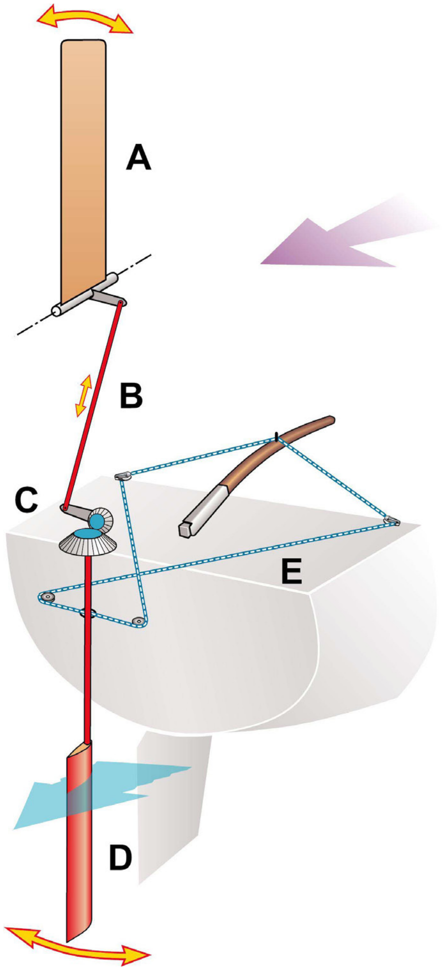
Disadvantages:

- The first action of the tab is to steer the boat in the 'wrong' direction, thus briefly accentuating the yaw before the main rudder responds to bring the boat back on course.
- Although the trim-tab concept works well on transom-hung rudders, the linkages become dauntingly complex on those hung under the hull. In my view to the point where they're hardly worth considering
- Often requires modification to the rudder

Pendulum servo

This category makes up the majority of modern self-steering gears, with a number of excellent examples on the market. The power generated by the pendulum blade is truly awesome. How pendulum servos work is shown right and is easily understood. The sequence goes like this...

- When the boat strays off course the change in the apparent wind is sensed by the vane **(A)** which is pressed to one side or the other. If for example, the boat turns to port, the vane wlll incline in the same direction.
- The vane's action is transmitted by the pushrod **(B)** to the gears **(C)** which converts the action from vertical to rotary – thereby turning the pendulum blade **(D)**
- This turns the blade which is swept to one side (again to port in our example) by the waterflow.
- The steering lines **(E)** are led to the boat's primary steeriing control – either a tiller, as shown here, or a drum and clutch arrangement on a wheel,



Advantages:

- Very powerful. On a delivery trip to the Mediterranean, I nearly lost a finger when I got it trapped by a steering line. Others have been injured by wheels and tillers suddenly swinging or spinning in response to a swerve in course
- Suitable for just about any type of sailboat. Their power makes them particularly suitable for larger vessels
- Unlike trim-tab gears, the pendulum blade always steers the right way. Indeed, in light airs and on a well-balanced boat, the blade will steer the boat without troubling the primary steering at all!

Disadvantages

- Steering lines can be intrusive
- Expensive ... but worth it

Broad reaching before a gentle breeze in the Mediterranean.
Spanish mountains just visible over the stern.

And now to the variations...

The first part of this chapter define the three core concepts: direct action, trim tab, and pendulum servo. However there are gears which combine at least two of these concepts – in at least one case all three. For example the Fleming Auxiliary Rudder and the Windpilot Pacific have pendulum servo blades operating integral rudders. The VectaVane has a trim tab actuating a pendulum servo blade. More on this soon.

Modern windvane self-steering gears rely on a number of separate elements:

- ► Vanes to sense the apparent wind direction. Vertical axis vanes are still to be found but by far the majority of manufacturers have opted for the more sensitive and powerful inclined axis type. The vane's inclination is adjustable on some models.
- ► Linkages. These are usually pushrods, sometimes rotating shafts, and can occasionally be cables. Where the geometry allows it, pushrods or shafts are the preferred choice because there's usually less friction and backlash – the latter being the slop in any system which can rob it of its sensitivity. Although the linkages might appear to be rather insignificant parts of the whole mechanism, it's here that the positive damping occurs, so their importance shouldn't be underestimated.
- ► Control surfaces. These are acted upon, via the linkages, by the windvane. On a trim tab gear the control surface is the tab itself; on a pendulum servo it's the servo blade.
- ► Power output. Trim tabs usually work directly on the rudder blade – whether primary or auxiliary. Pendulum servo gears acting on the main rudder almost invariably use control lines led back to the tiller or a drum on a wheel. This can be a problem on centre-cockpit boats where the routeing can be tortuous.
- ► Other makes also make use of auxiliary rudders. For example, the Windpilot Pacific also makes use a pendulum servo blade controlling its own auxiliary rudder and Scanmar's Auto-helm makes use of a trim tab to do the same job. As with the Hydrovane, the only connections to the boat are the mounting brackets and the adjustments to set the course. This is undoubtedly convenient but below is something you should bear in mind...

Worth noting...

In heavy weather a 'standard' trim-tab or pendulum windvane gear will be steering the boat via the main rudder, and the effect will be proportional to the condition. An auxiliary rudder gear, on the other hand, has only its own rudder to exert control, and this may not be large enough to keep the boat on track on some points of sailing. To help militate this to some extent, it's usually possible to lash the main rudder to, say, counteract any tendency to round up or bear away, leaving the smaller auxiliary rudder to make minor course adjustments.

Chapter 4:
Choosing and using

"It looks like it was made by a plumber," he said. The place was the London Boat Show and the speaker a manufacturer of windvane self steering gears. He was referring to a competitor's product – in this case Scanmar Marine's pendulum servo type Monitor – constructed almost entirely of stainless steel tubing and unashamedly functional, rather than beautiful, to the eye. At that time I was in the process of choosing a windvane gear to go with my 40 footer, then under construction.

Somewhat uncomplimentary though his intentions were, the remark proved a clincher for me. After all, I reasoned, if it was made by a plumber it could be repaired by a plumber should the need arise. And, more importantly, it could be repaired almost anywhere. Folk with tube bending and welding facilities are to be found in the remotest regions, whereas to replace a broken casting could leave you dependent on the manufacturer getting a replacement delivered by whatever passes for a mail service when you stray from the mainstream. So, offering silent thanks to that inadvertently helpful salesman, I trotted round to Scanmar's stand and placed my order.

Now, this tale is not intended to exhalt the Monitor above other windvane gears, though I must say it has performed admirably over the dozen or so years since it arrived. But it serves to demonstrate that choices are made for a variety of reasons, not all of which are immediately obvious. Despite the claims of the various manufacturers, there's probably no single gear that stands head and shoulders above all others, but that doesn't mean that one of them might be better than the rest for your particular set of circumstances. In rare cases it may be that only one type – or even just a single model – will be suitable.

Windvane gears are wonderful machines which will liberate you from the drudgery of steering. Almost any gear will perform adequately in fair winds and a comfortable point of sailing, but if you want to maintain that liberation in the most marginal conditions – sailing downwind in light airs springs to mind – then it's vital that you select the right gear for your boat. Factors influencing your choice will include...

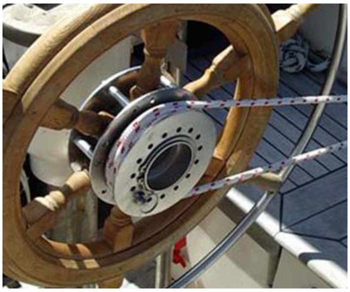
Size of boat

This is an obvious point. The larger the boat, the more powerful must be the vane gear. The manufacturers' recommendations give general guidance, but the nature of the boat is also a consideration. A well balanced vessel, easy on the helm, might get away with a smaller gear while a hard mouthed brute will need something more authoritative. And remember that physical size isn't necessarily an indicator of a vane gear's power output. The pendulum servo vane gears offer the most and may well outperform larger gears of other types. If in doubt, always err on the generous side.

Centre or after cockpit

A centre cockpit presents something of a problem for pendulum servo gears, whose output lines must be led to the yacht's primary steering system. It can be difficult – sometimes impossible – to route the lines without cluttering up the sidedecks. For this reason, centre cockpit boats often choose trim tab systems or, more usually these days, self contained gears, either direct action type of steering (such as the Hydrovane) or a servo powered auxiliary rudder, of which there are a number to choose from.

Type of steering



It's the simplest of tasks to connect a pendulum servo gear to a tiller but, as mentioned earlier, wheel steering needs some sort of drum and clutch mechanism (such as the one made by Fleming shown right) to convert a linear action into a rotary one. These work fine on most boats, but not those with hydraulic steering or with very low geared wheel steering where there are lots of turns from lock to lock. Again, an auxiliary rudder gear is likely to be the preferred choice.

Transom hung rudders naturally lend themselves to trim tab vane gears but, alas, this is a concept now scarce amongst commercial manufacturers, the majority of whom have turned to the more powerful and sensitive pendulum servos. However, both Auto-steer and Scanmar continue to supply this type.

Bring on the windvanes

OK, it's time to look at a selection of windvanes in greater detail. The brands are listed in alphabetical order. I apologise for any omissions, and invite manufacturers to send details to be included in future updates.

"Aries"

Type: pendulum servo.
Vane type: inclined axis
Boat size: 28 – 55ft
www.selfsteer.dk

This self steering workhorse has been in production, almost unchanged, for some 40 years during which time several thousands have been produced. The Aries has an enviable reputation for reliability. Originally made in Britain by Nick Franklyn, its designer, it went out of production briefly in 1990 when Nick retired. It's now made in Denmark by Peter Mattheisen. The newer gears use metric components, though spares are still available for the older imperial versions.

Construction is generally of aluminium and stainless steel, with a timber servo blade and plywood vane.

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“Auto-helm”

Type: trim tab on auxiliary rudder.
Vane type: variable axis
Boat size: up to about 45ft (13.7m)
www.selfsteer.com

California based Scanmar Marine, are unusual in that they make three types of vane gear which bear absolutely no resemblance to each other. In alphabetical order, the Auto-helm is the first.

And an unusual bit of kit it is. An auxiliary rudder hangs from a stout stainless steel frame and is controlled by a variable axis aluminium vane. A horizontal axis vane is most powerful when in the vertical position; inclining it effectively reefs it useful in strong winds. The linkage between the vane and tab is via wires running in teflon tubes – not unlike bicycle brake cables – which makes placement of the vane and rudder assemblies a very easy matter.

In emergencies, say the maunfacturers, the auxiliary rudder can be used to steer the boat should the primary steering system fail.

“Auto Steer”

Types: Pendulum servo and trim tab
Vane type: inclined axis
Boat size: to about 46ft (14m) and 39ft (11.9m) respectively
www.autosteer.com

These are exceptionally compact gears intended for the smaller to mid-size yacht. The trim tab vane gear is one of the few commercially available and is ideal for boats with transom hung rudders such as the Contessa 26 shown in the photo right.

Manufactured in the UK both units are made up of LM25 grade aluminium castings and stainless steel. The servo blade and trim tab are of timber and the vanes of plywood. The pendulum servo version can be lifted off its mount while in port to protect it from theft or accidental damage.

“Cape Horn”

Type: pendulum servo
Vane type: inclined axis
Boat size: up to about 55ft (17m)
www.caphorn.com

This deceptively simple looking vane gear comes in two sizes. The smaller Jean-du-Sud model is suitable for boats below 40ft (12m) while the Spray version deals with the larger yachts. Designed by Yves Gélinas, the Cape Horn is made in Canada and is largely contructed out of stainless steel. It has a fabric covered vane and a timber servo blade. An interesting feature is the ingenious cranked shaft that both controls the rotation of the servo blade and introduces yaw dampening feedback.

Unlike other gears, there are no steering lines on deck Instead there’s a mechanical linkage through the transom or topsides, either to the steering quadrant or tiller.

Each Cape Horn vane gear is made to measure and, for those intrepid enough, is guaranteed for one global circumnavigation or 28,000 miles!

“Fleming”

Types: pendulum servo and servo controlled auxiliary rudder.
Vane type: inclined axis
Boat size: up to about 65ft (20m)
www.flemingselfsteer.com

Designed by Kevin Fleming, and now manufactured in Australia (for a time they were made in California), these elegant vane gears make extensive use of duplex stainless steel castings for their principal mechanisms. Duplex stainless steel is said to be almost twice as strong as the more conventional 304 or 316 grades, and such is the confidence in the choice of this material that, for the original owner, Fleming Self Steering guarantees its castings for life.

“Hydrovane”

Type: Direct action vane on auxiliary rudder.
Vane type: variable inclined axis
Boat size: up to about 50ft (15.25m)
www.hydrovane.com

Amongst modern vane gears, the Hydrovane stands alone as a design concept. An inclined axis vane acts directly on a well balanced auxiliary rudder. Because there’s no servo effect, the Hydrovane is dependent on the power generated by the vane. Hardly surprisingly, the vane is therefore larger than on a comparable servo type unit.

A couple of ingenious features allows the sailor to fine tune the vane output. Firstly, the ratio between the vane output angle and the corresponding amount the rudder turns can be selected from three settings of a spring loaded knob – essentially changing the mechanical advantage of the linkage. Secondly, the inclination of the vane’s axis can be altered anywhere between horizontal and 30˚ – thereby effecting its sensitivity.

Manufactured in the UK and marketed from Canada, construction is in aluminium and stainless steel with a nylon rudder blade and a fabric covered vane. The size and strength of the rudder is such, say the makers, that it could be used to provide emergency steering if the main system were to fail.

“Monitor”

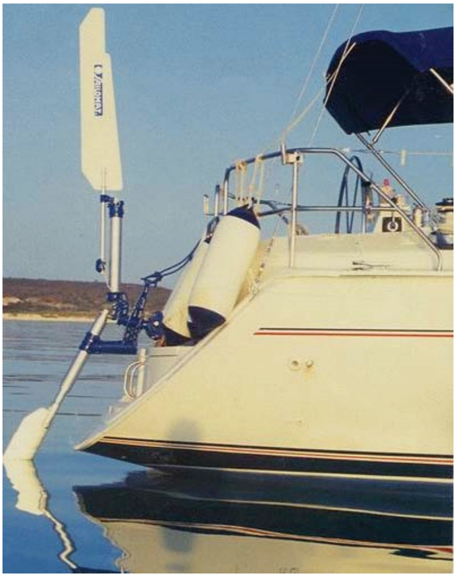
Type: pendulum servo
Vane type: inclined axis
Boat size: up to about 60ft (18m)
www.selfsteer.com

The second vane gear from the Scanmar stable is by far their most popular model which, say the makers, was the only wind operated gear to be used (by seven boats) in the 50ft class of the 1994/95 BOC single-handed around-the-world race. Certainly, it is well regarded by long distance racers and cruisers alike.

As I mentioned earlier, the Monitor is made up mainly from stainless steel tubes. A pair of gears links the vane action to the servo blade and it comes with two vanes – a large extruded polycarbonate one for light airs and a smaller plywood one for heavy weather. In my experience, the larger vane works best across the widest range of conditions, and I only rig the smaller one when things get really exciting.

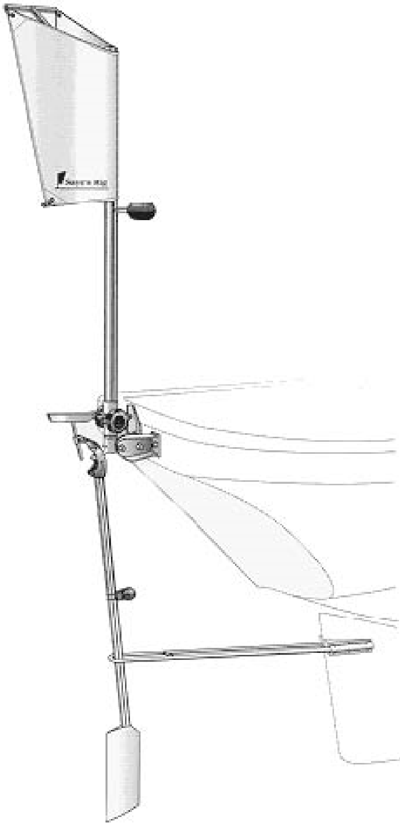
“Sailomat”

Types: Pendulum servo and servo controlled auxiliary rudder
Vane: Inclined axis
Boat size: up to about 65ft (19.8m)
www.sailomat.com



Made in Sweden and marketed from California, the Sailomat is the brainchild of Dr Stellan Knöös who first developed the design over 30 years ago. The gears are engineered mainly from aluminium extrusions and castings, with stainless steel fastenings and plastic composite bearings.

The vane to blade ratio can be fine tuned by altering the length of the blade lever arm at the top of the pushrod. The Sailomat is the only vane gear to have its servo blade swept aft. This feature, combined with the natural pitching of a boat at sea, helps the blade shed any floating weed or other flotsam, says Dr Knöös.



“Saye’s Rig”

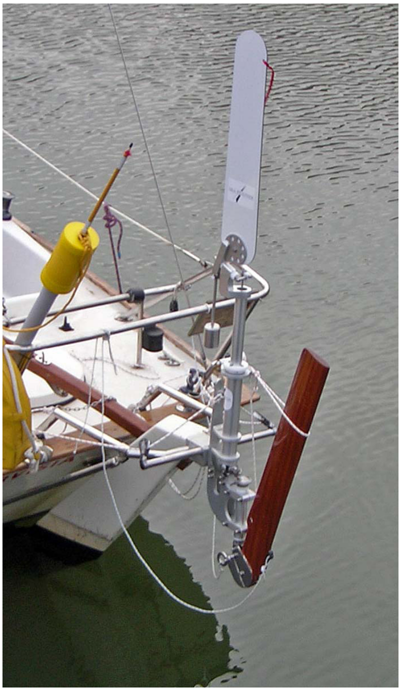
Type: trim tab
Vane type: vertical axis
Boat size: up to 65ft (19.8m)
www.selfsteer.com

The third and last of Scanmar’s Californian offerings sports a sailcloth V-shaped vane – the only vertical axis vane in our selection. Unlike horizontal axis vanes which flop from side to side, this rotating vertical axis vane has a relatively compact ‘footprint’ which makes it a good choice on boats whose sterns are overhung with mizzen booms or cluttered with such things as wind generators and gantries.

The Saye’s Rig’s tab is mounted below the water on what only can be decribed as an aft-leading tiller. This gives the tab considerable leverage, increasing its effect. The gear is made from bronze castings and stainless steel tubing. The trim tab is of solid glassfibre.

"Sea Feather"

Type: pendulum servo
Vane type: inclined axis
Boat size: up to about 30ft (9.15m)
www.sea-feather.co.uk

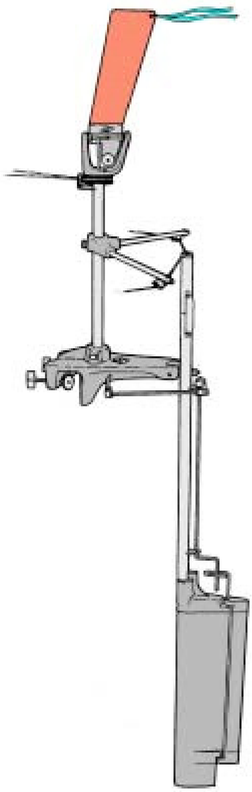


This diminutive vane gear is intended specifically for smaller boats. Indeed the inspiration for its development arose when Paul Dolton, its creator and now manufacturer, failed to find a gear to suit his Kingfisher 22.

Built in the UK, the Sea Feather uses stainless steel, anodised aluminium and acetal bearings to produce a neat little unit which should appeal to those owners of small boats whose electrical resources are most likely be stretched by the demands of tiller pilots.

"Vecta Vane"

Type: double servo action pendulum
Vand type: inclined axis
Boat size: up to about 30ft (9.15m)
www.brading.co.uk



Another compact vane gear for the smaller boat – this one built in the UK on the Isle of Wight. The Vecta Vane works on much the same principle as the now extinct Plastimo Navik: the tab turns a servo blade, the blade is pulled to one side by the waterflow, and steering lines led forward to the tiller steer the boat. Materials include aluminium and stainless steel, with the vane made of plywood.

A useful feature is that the whole unit can be clamped onto a bracket, in much the say way as does an outboard motor. This means that as a defence against both pilferage and damage, the gear can be stowed below or ashore when not in use.

“Windpilot”

Types: pendulum servo and servo controlled auxiliary rudder
Boat sizes: up to about 60ft (18m)
Vane type: inclined axis
www.windpilot.com

When Peter Förthmann started to make the second generation of Windpilot self steering gears he opted for a technically demanding route. Most of the components in each of the three models Windpilot offer are made of pressure die-cast AlMg 5 aluminium alloy – a costly process using material noted for its resistance to corrosion in seawater. The castings are used in combination with stainless steel tubing and timber vane and servo blades.

The first Windpilots had fabric-covered vertical axis vanes but the type’s limitations became apparent and the switch was eventually made to inclined axis vanes.

Germany based Windpilot now markets three models – two sizes of the pendulum servo variety and one having a servo-controlled auxiliary rudder.

the

Obtaining a windvane

For obvious reasons this is a global market so it should come as no surprise to learn that all manufacturers will ship worldwide − both for complete installations and spares. Full details of sales and after-sale services can be obtained by following the links to individual manufacturers

Chapter 5:

Get the most from your windvane gear

Miraculous though windvanes might seem, there are limits to what they can achieve. What we have is a dramatically unequal pairing. A relatively tiny device harnessing wind and water attempts to control a much larger device also harnessing wind and water. We're referring, of course, to our windvane and sailboat.

Now, as many of us have learned, some boats are better behaved than others. Some are light on the helm and others are not. Often the situation can be improved by adjusting the sail trim but that isn't always possible – perhaps because the sails (particularly mainsails) are stretched or maybe because the boat is just poorly designed.

We shall be looking at what can be done to improve our chances of success very soon. But before we do, let's mention instances where you can expect to have problems.

Very heavy boats

The definition of heavy displacement has changed over the past few decades. It was once the case that, by today's relatively lightweight standards, almost every boat fell into this category. So I'm not talking about your average solidly built cruiser but sailboats at the distinctly elephantine end of the scale.

The problem here is inertia – a resistance to change – in this case changes in direction. If a boat is so heavy that it responds slowly to helm movements, it will have difficulty keeping up with a windvane's constant vigilance. If it has a long keel – common amongst heavy boats – the situation becomes worse.

To have even a chance of success, very heavy sailboats need very powerful windvane gears.

Very light boats – including fast multihulls

Here the problem is not one of pure speed but of acceleration. Windvanes sense the apparent wind and this can alter wildly if a sailboat is slow one moment and hurtling along the next.

The effects of acceleration vary with the point of sail and it's something of an irony, since it's such a rewarding experience, that a beam reach will produce the most dramatic variations. See page 23.

Beamy boats – excluding heavy multihulls

Design fashions have changed over the years. Yesterday's monohulls were comparatively narrow with a greater proportion of their hulls below the waterline. When heeled their underwater shapes remained fairly symmetrical – having what yacht designers refer to as 'well balanced lines'.

Contrast this with your typical cruisers today, the hulls of which resemble large dinghies – much beamier and with shallower draughts and wider transoms. When heeled their hull lines are more asymmetric.

Having said all that, some words of encouragement are in order. Thanks to a better understanding of hydrodynamic principles (and with a raft of very helpful computer programs) most modern designs are superior to those of former years. Yes I know there will be howls of protest from the baggywrinkle brigade but I'm unrepentant. I wouldn't trade my modern, light displacement sailboat for any I've sailed over the decades. And, just for the record, it behaves impeccably under its windvane gear.

Make life easier

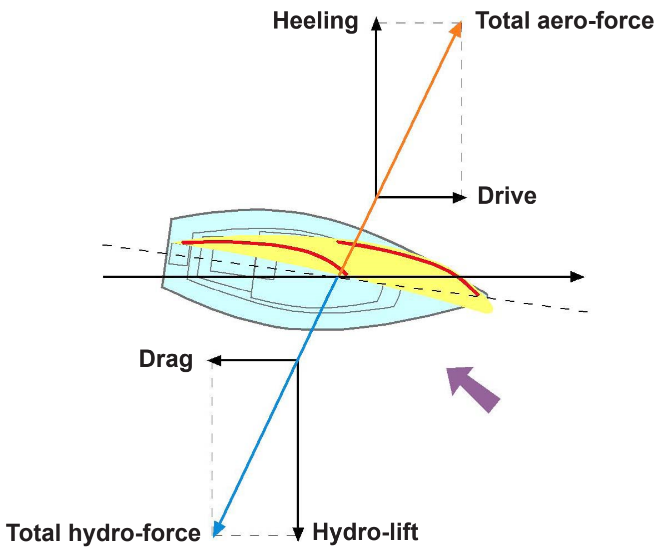
One of the fundamental truths of living with windvanes is…

If you find it hard to steer your boat, a windvane will face the same problem

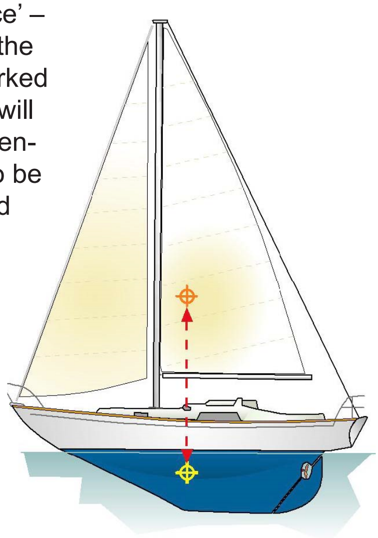
So, how can you make life easier for both yourself and your sailboat? A lot of the solution lies in the relationship between your sails and your hull – more specifically the forces acting upon them.

The illustration below shows a sailboat in plan view. On the leeward side you will find the aerodynamic forces, heeling force and drive force, produced by the sails (which can be considered as a single aerofoil). These combine to produce the total aero-force which we can think of as 'drive'.

On the windward side are hydrodynamic lift and drag – both derived from the immersed portion of the hull. These combine to produce the total hydro-force which we can think of as 'resistance'. Clearly the drive must exceed the resistance for the boat to move forward.



The relationship between these forces determines ‘helm balance’ – whether good or bad. Now look at the illustration on the right – the same boat side-on, with the centres of drive and resistance marked on the sails and hull respectively. It’s easy to see how the boat will heel but, since the two forces are vertically aligned, there’s no tendency to turn, either to windward or leeward. The boat is said to be perfectly ‘balanced’, offering a very easy life for both human and mechanical helms.



Now let’s imagine a change in sail trim has moved the centre of drive aft, as shown in the illustration left There is now a turning moment that will push the bow to windward. This is weather helm.

Again, looking right we see the opposite happening: the centre of drive moving forward of the centre of lateral resistance. No prizes for guessing that this is ‘lee helm’ – a much less desirable event because your boat could crash gybe if it continues uncorrected.

On well-designed boats with sails in at least fair condition, minor tweaking of the sails will neutralise the helm. Weather helm can often be reduced by easing the mainsheet, while easing or taking a roll in the mainsail will help reduce lee helm. So...

SUCCESSFUL SELF-STEERING RELIES ON GOOD SAIL TRIM

More serious problems arise if:

- ► The hull is so badly designed that the boat is inherently cranky. Less likely these days when designs have generally improved.

- ► The boat develops strong weather helm when heeled. This is another indicator, either of poor design or bad sail trimming. Clearly it's sensible to try correcting the last possibility first.

- ► The sails are badly stretched – particularly true of the mainsail where any bagginess will move the sail's centre of drive aft.

- ► The sailplan and hull are wrongly placed in relation to each other. A popular design of the 1960s was notorious for weather helm which, it was found, could be totally eliminated by fitting a short bowsprit and jib. Don't bother taking a bow, designer. You should have got it right in the first place.

So, sail trim is often the answer to helm balance problems. As a general rule it's usually better to set too little sail than too much. An over-pressed sailboat can be a handful at the best of times, even for a human helm. With the windvane in charge, often a reduction in sail will be rewarded by an increase in speed, thanks to sailing more upright and with fewer deviations from the course.

Is there anything else one should be wary of? Definitely. Let's start with…

Main steering problems

Certain forms of sailboat steering don't lend themselves to windvanes that rely on linkages (often pendulum lines) to the primary steering. Examples are:

- ► Hydraulic steering. Unlike wire, push-rod or torque tube systems whose components always stay in the same relative position, there is 'slippage' in most hydraulic systems, However, if it's possible to disconnect the hydraulics, or to fit a bypass valve, you may be able to use the emergency tiller.

- ► Wheel steering which has more than the usual number of turns 'lock-to-lock' are also problematic. This is commonly the case with hydraulics. The problem is that there may not be enough travel for the pendulum lines to be effective.

- ► Check that the main rudder bearings are not tight. Plastic (commonly acetal) bearings will swell a little, possibly binding on the stock. Manufacturers should allow for this, but don't always get it right. Spade rudders are most susceptible. Their cantilevered, high aspect-ratio forms place huge side loads on their neck bearings, where their necessarily large diameter stocks emerge from the hull. Skeg-hung rudders tend to be freer. Where rudder bearings are concerned, better a little slack than too tight.

- ► The same can't be said for primary steering linkages – wire, chain, torque tube, what-ever. If there's too much play or slack in the various connections you will lose sensitivity.

- ► If you have an electric autopilot mounted below deck, check that if offers little or no drag when switched off. If it does, you should disengage it when using the windvane.

So much for the boat. What about the steering gear?

- Whatever gear you choose should ideally be fitted on the centreline. Yes, you sometimes see gears mounted off-centre – often to leave bathing platforms and the like unobstructed – but your self-steering will almost certainly perform less efficiently on one tack than the other.

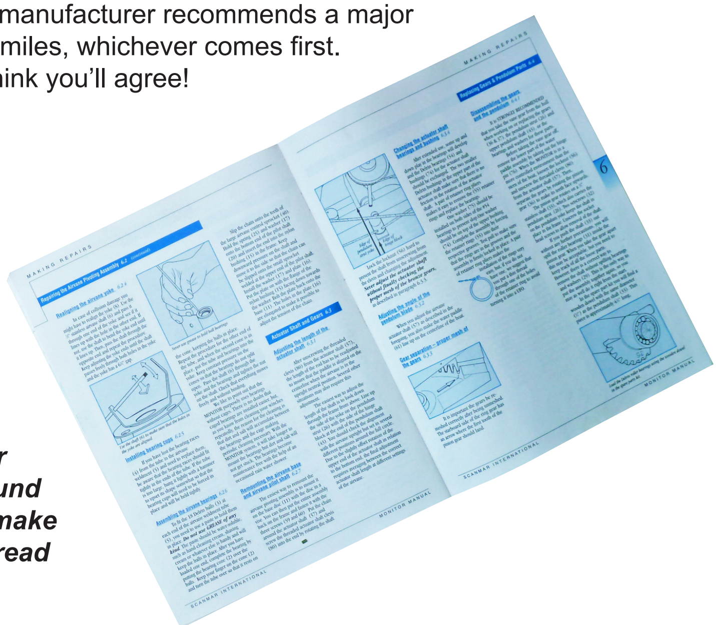
- Let the vane breathe! On cruising sailboats it's almost inevitable that the stern becomes the perch for all manner of clutter. Barbecues, lifebuoys, fishing tackle, cockpit dodgers and the like can seriously impede the flow of air to the vane. This is another instance when a windvane gear might work better on one tack than the other – this time because the airflow over the vane varies from side to side.

- Use good quality ball bearing blocks – and as few of them as possible – to lead the pendulum lines. Ideally the sheaves should be of at least 2in (50mm) diameter and it's important that they be properly aligned.

- For pendulum lines themselves use high strength, low-stretch rope such as Spectra or Dyneema. 1/4in (6mm) diameter is usually sufficient,

- Make sure the pendulum lines aren't too tight. Again, a little slack is the better option. This is especially important in light weather.

- Don't forget regular maintenance, as recommended by the manufacturer. In most cases this involves nothing more than rinsing the gear in fresh water to remove salt crystals from the bearings. One manufacturer recommends a major service every 5 years or 25,000 miles, whichever comes first. Hardly an onerous schedule, I think you'll agree!



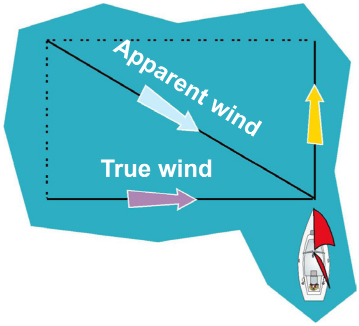
Windvanes are surprisingly intricate devices, as you may discover if ever you disassemble yours. Watching ball and roller bearings bouncing around the cockpit is likely to make you wish you had first read the manual...!

The world as windvanes see it...

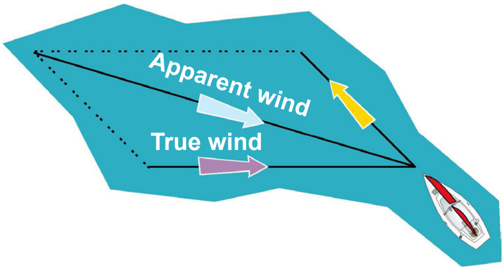
We've already noted that windvanes sense the apparent wind – the combination of the true wind and the sailboat's speed and direction over the ground. It might be helpful to elaborate on this theme.

To keep things simple, let's assume the wind is blowing at a constant 10 knots and our sailboat's speed remains at 6 knots regardless of the point of sailing – the latter in reality an unlikely presumption, since boat speed varies with point of sailing.

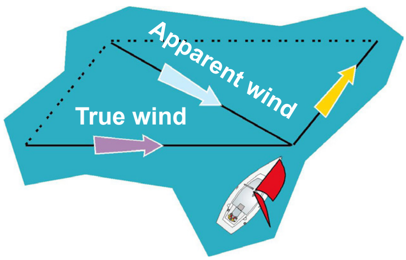
The first illustration (right) shows the boat on a beam reach, sailing at 90° to the true wind. What the vane experiences is a 12 knot wind coming from 60° off the port bow. Expect changes in the apparent wind to vary wildly on this point of sail.



In the next illustration, the skipper decides he would like to sail closer to the wind so alters course until the true wind is 45° on the bow. Remember that nothing has changed except the course. For the vane, on the other hand, quite a bit has changed. The wind has strengthened to over 15 knots and is now only a little more than 25° off the bow.



But the skipper isn't enjoying himself. It's altogether too lumpy on that point of sail – and that's not what they came out for. He bears away to put the true wind on the port quarter – a broad reach. This is both a fast and comfortable point of sailing but the signal to the windwane has weakened to a little over half what it was before. No problem for a decent gear.



Still not satisfied, our witless skipper turns tail, eases both mainsail and headsail, and runs dead downwind. Yes, his personal comfort has at last been assured but for the windvane this is disappointing. All it experiences is the wind decreasing to a miserable 4 knots and blowing from directly over the transom. It takes a very sensitive windvane gear to thrive in these conditions. Pendulum servo gears could be steering with the pendulum blade alone.

So, what can we learn from all this? Well…

1. The apparent wind – and therefore the signal the vane experiences – gains in strength the further forward it moves. Even the least efficient windvane gears should have little trouble steering a boat to windward.

2. The other side of this coin is that the further aft the apparent wind moves, the weaker becomes the signal. It's when sailing downwind that the very best gears justify their existence. The problem is greatest on the lightest, swiftest sailboats where a surge in speed – perhaps surfing down the face of a wave – can reduce the vane's input to zero – even a negative number, momentarily converting a signal from astern to one on the nose!

3. Perhaps counter-intuitively beam reaches can also be awkward. In our somewhat flat-footed example above, we pinned boat speed to a constant 6 knots. But, of course, this isn't the reality. A beam reaching sailboat is extremely responsive to changes in wind strength – accelerating and slowing with changes in its velocity. A strengthening gust will increase boat speed, the apparent wind will move forward, and the gear will bear away in response. A slackening wind will have the reverse effect.

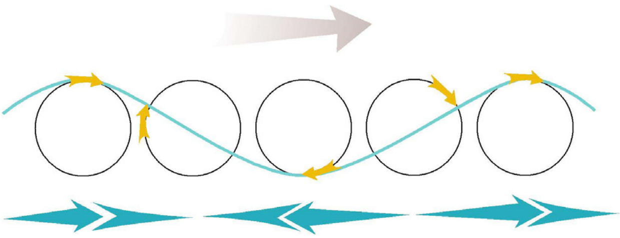
Downwind sail trim secrets

In terms of directional stability, boats prefer to be pulled than pushed. When broad reaching or running, the action of any sail aft of the mast is to exert a twisting force that strives to spin the boat to windward.

Running downwind is potentially dangerous in heavy conditions and the situation isn't helped by the nature of the waves that inevitably form. In comfort terms, of course, the contrast between beating and running is to step through a portal from misery to relative luxury. As if by magic the apparent wind speed drops and there's an almost instantaneous end to the drenching spray and the bone-jarring pounding. The sense of relief can be overwhelming but it's time to be wary. The welcome respite can mask a very real threat.

The author mid-Atlantic aboard his 35ft trimaran. 1974

For there's more to waves than just an alternating series of watery ups and downs. It's the actions within them we should watch out for. Anyone who has helmed in following seas will recognise the forward surge you get as a wave crest passes under you, and then the lurching sensation that occurs as you sink into the trough. They could be forgiven for thinking that this simply the contrast between the start of a downhill slide followed by the prospect of an uphill grunt, but that's far from being the whole story. What's not always appreciated is that there's an orbital action within each wave, and that the surface water moves in different directions depending on where you are on the wave face.



Shown right is a simplified representation of the way waves work. Think of a single water molecule on the rim of an imaginary wheel. As the wheel rolls forward, the direction and strength of the surface flow changes. In the illustration, both the strength and direction are represented by the blue arrows at the bottom. Now we should imagine a boat sailing downwind – that's to say from left to right in the diagram. It's blowing hard enough for the boat to sail faster than the wave train. Let's examine what may happen step by step

- When our boat reaches a crest, the surface flow adds to its speed and gives it a playful flick into the void beyond. This is the surge we relished earlier.
- Due to that acceleration, the windvane suffers a reduction in signal and, for a brief moment, the steering becomes less effective as the inflow velocity over the rudder blade is reduced. The timing is unfortunate to say the least.
- Now boosted by gravity, the boat surfs joyfully down the slope gathering speed as it goes, then …
- ...when it reaches the trough it encounters the surface water rushing up to meet it – our braking effect.
- This is the moment of peril. The rear half of the boat still wants to accelerate while the bow is baulked by the counterflow. It's a bit like slamming on the front brakes of a bicycle. If the bow digs in, the whole shebang could slew round and … oops! … the scene is set for a classic broach (or diagonal capsize for a multihull) with all the mayhem that such events bring.

The likelihood of such an occurrence would be much greater with a mainsail set. That twisting force we mentioned earlier would see to that. By contrast, headsails – including spinnakers and cruising chutes – essentially tow the boat behind them, an action that lifts the bow and stifles any tendency to yaw.

But we must keep things in perspective. For those leary of setting spinnakers, I recently heard of a boat that carried a cruising chute night and day over an eighteen-day transatlantic crossing. A more traditional approach is to set twin headsails (see previous page). Unfortunately, the absence of a mainsail will mean a monohulled boat will roll more than usual. A deep-reefed main or storm trysail will help reduce that effect.

The danger in such circumstances is excessive SPEED. By far the best defence is to SLOW DOWN – either by reducing sail or towing some form of drag device. Even a bight of rope will do but make sure it can't foul your windvane's pendulum or auxiliary rudder

Finally...

The whole world of sailing has changed radically over the last three decades or so. Gone are the days when a watch on deck meant several hours at wheel or tiller; and when coastal navigation involved taking bearings, plotting them on paper charts and using vector diagrams to allow for tides and currents. The demands on ocean navigators weree even more demanding, for they were obliged to use advanced skills requiring sextants, chronometers and sight reduction tables – all essential tools in the arcane workings of astro-navigation.

The long and the short of it was that thirty-odd years ago to sail out of sight of land was quite a big deal. To cross oceans unthinkable without years of experience. Some sailors never gained enough confidence to do either, hugging the coasts and missing out on great adventures.

Yet, these days, all of these complex functions can be carried out by machines. Indeed, we have become so familar with them we take them for granted. Clearly there are huge benefits in these developments, but there also losses. Although tedious, often strenuous, and sometimes downright perilous (here I think of changing headsails on a pitching foredeck) hands-on seamanship kept sailors in touch with their boats. But could it be that all of this technical convenience also insulates us from the fundamentals, leaving us dangerously exposed?

Earlier we acknowledged that, miraculous though they might seem, windvane self-steering gears won't – or can't – always compensate for a crew's lack of skills. But I can promise you one thing: the process of working with them will enhance your knowledge of your boat and also give you fresh insights into the basic principles.

As if the liberation from the tedium of steering was not enough, it's my belief that windvanes can actually help sailors reconnect with the boats they sail.