OCKAM INSTRUMENTS, INC.

Why Instruments?

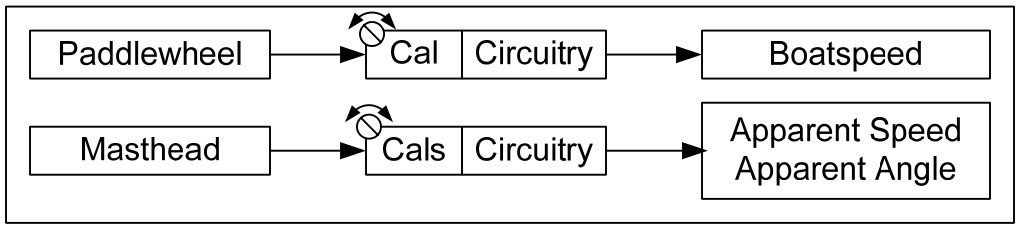
Sailing instruments do not replace your senses, they enhance and validate them. They also provide information about things you cannot sense directly, e.g. true wind and current. They are vital for comparing performance with target speed, calculating time to laylines and many other items crucial to increasing your probability of winning.

As the saying goes, "**If you don't measure it, you can't improve it**".

The Integrated Instrument system

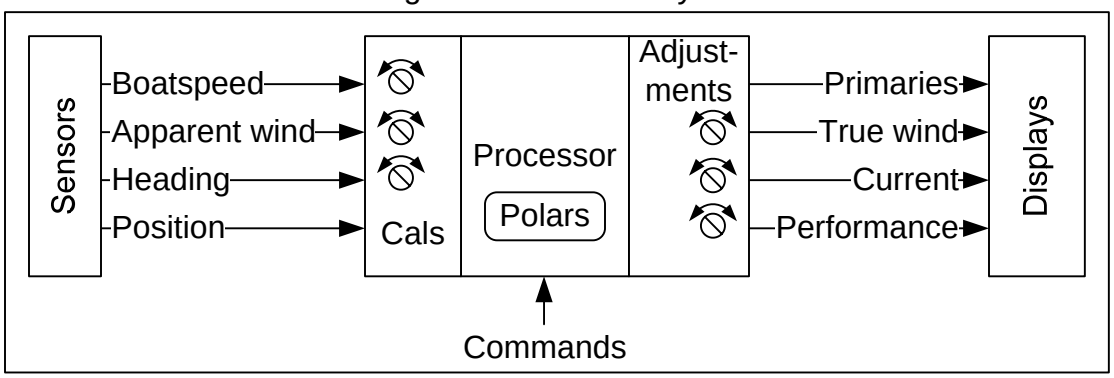
Before the digital age, there was only the stand-alone instrument which coupled a single sensor to a display – for example, a boatspeed paddlewheel driving boatspeed readout. A second instrument would be needed to display apparent wind. This class of instrument is still in use where the advantages of integrated instruments are not needed.

Stand-alone instrument system



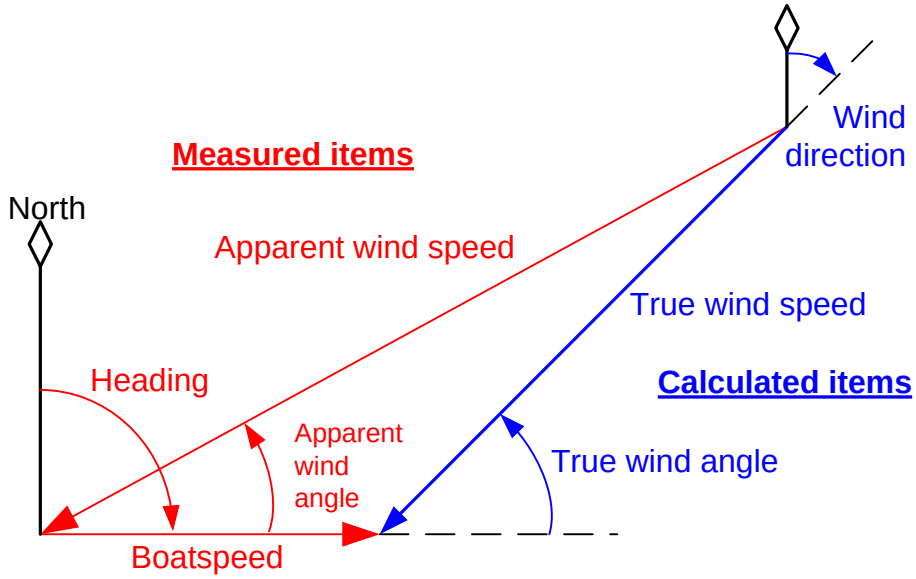
Integrated sailing Instruments read several sensors and digitally process their readings to output data that cannot be directly measured. Because of digital processing's increased ability to correct and filter, they also do a better job of displaying the basics (like boatspeed) than their stand-alone predecessors.

Integrated instrument system



True wind

Boatspeed is certainly an important item to keep tabs on, but for racing, nothing beats wind direction and true wind speed.



Onboard the boat, you can sense the apparent wind and boatspeed, but not the true wind. Integrated instruments use trigonometry to calculate true wind speed, angle and direction. Apparent wind includes boatspeed and heading, so it changes depending on current performance, e.g. during a tack. On the other hand, true wind is God's work and won't change depending on what you're doing at the moment (except maybe praying).

Why go to all this effort and expense to get true wind?

- True wind is the boat's engine. Knowing the true wind lets you get the most out of your boat and sails – e.g. polars and targets.
- Knowing the true wind, your polars and the bearing of the next leg lets you predict apparent wind on the next leg.
- Keeping tabs on wind direction lets you see even small wind shifts, so you can get onto the lifted tack and onto the favored side of the fleet. The ability to do this is worth more than a new set of sails.

The Economics of true wind

Cost
To get true wind information, you will need sensors for boatspeed, apparent wind and heading, a processor and a display. The hardware cost will be in the order of $5000. Each year you will also have to allocate some time and money for calibration and maintenance. There is also the need for crew organization and training in order to get the maximum benefit from the information.

Over and above normal costs, the cost of maintaining a boat in racing trim includes extra sail maintenance and replacement, transportation, crew cost, food and lodging, keeping the hull clean and many, many other things. If you race 10 times per year, the added cost will certainly exceed $1000 per race.

Benefit
Nobody can put a price on finishing in the money over just being there. However, assuming you want to get the most out of your ROI, investing in reliable true wind is a good place to place your bet.

- Predicting the wind on the next leg helps you pick the correct sail, eliminating a sail change that would cost you 40 seconds.

- Seeing what the wind will be doing in 5 or 10 minutes (by observing wind shear) will improve sail trimming and tell you how to advantageously position yourself relative to your competition.

- Detecting and acting on a 5º wind shift that nobody else sees is equivalent to an extra 6% in boatspeed, or 36 seconds/mile in rating.

Metrics
Everybody can see and act on the 20º wind shift. The ability to discern the 5º shift, and having the confidence to believe it is the important thing. Each degree of error in heading throws off wind direction by 1º. A 1º error in apparent wind angle can throw wind direction off by as much as 3º. This is why accurate sensors and calibration are so important on a true wind instrument system.

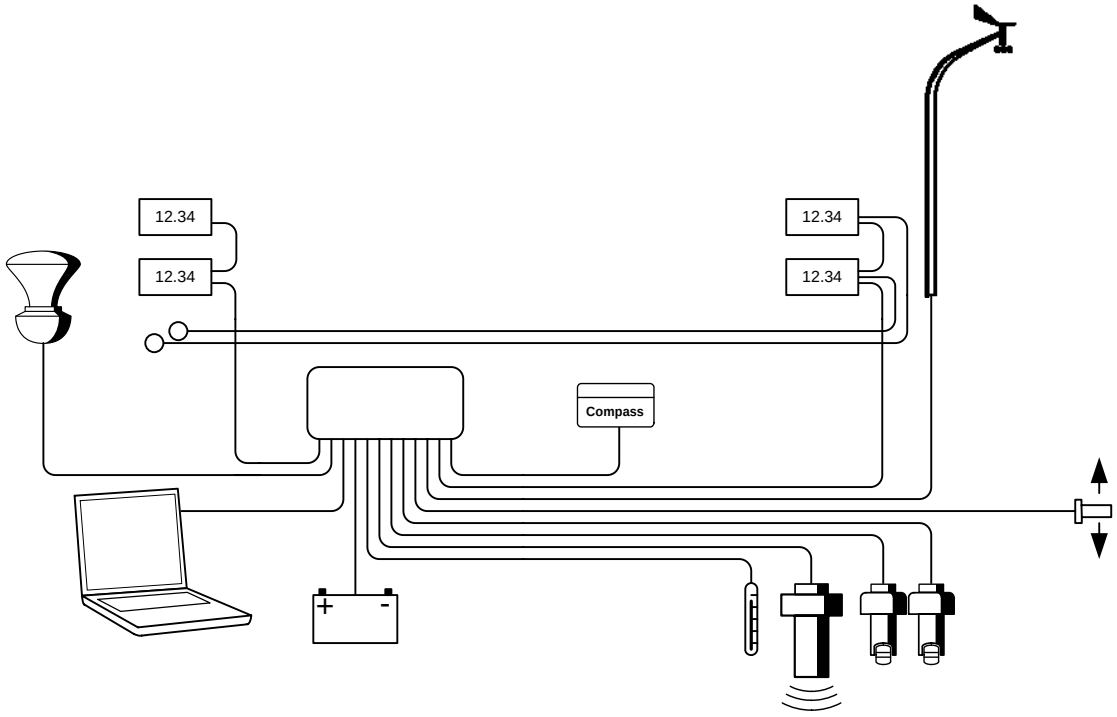
There is a reliable way to gauge how good an instrument system is at doing true wind – the change in wind direction when you tack or jibe (the “wiggle”). Again, God is in charge of the true wind: it won’t change direction just because you tack. Therefore:

Wiggle = Wind_Direction_before_tack – Wind_Direction_after_tack

There are about ½ a dozen instrument systems that claim to calculate wind direction. Finding out how much wiggle they produce is a quick way to determine which ones to consider.

Realization of the Integrated Instrument

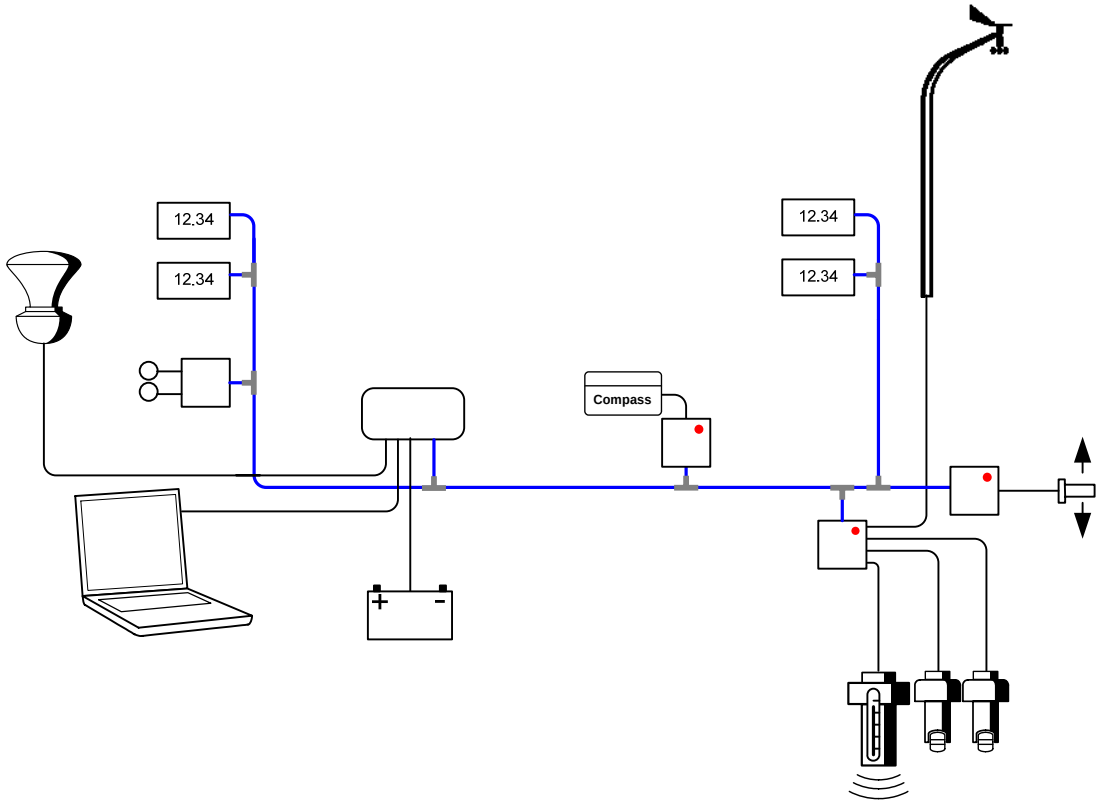
Centralized
One philosophy for integrated instruments is a centralized design where everything connects to the processor except the displays, which can be bussed (daisy-chained).



The system shown above is not particularly large (boatspeed, wind, compass, GPS, loadcell, depth/temp and a laptop). But as the system gets bigger, problems start cropping up.

- There is a maximum number of connections and mix of input types (analog, serial, pulse, etc.) that can be accommodated by the processor, which is set at design time. Once you have reached either limit, you're done, even if you haven't used up all the plugs.
- The wiring is difficult to maintain and a challenge to troubleshoot. You have to dismantle the processor in order to change or test the cables, and when there are a lot of them, just touching something can cause new problems.
- The weight of the sensor and control button cable home-runs mounts up.

Distributed
Another philosophy is to put everything on the bus, with small interfaces serving as connections for sensors, and connected at a convenient point.



This is the same system but designed with distributed architecture.

- The number and type of processor inputs are no longer limited. Each sensor is mated to a small interface nearby, and there is plenty of room on the processor for the few cables that make sense there. The processor box can be smaller and lighter. The input requirements for the sensors are now independent of the design of the processor.

- Wiring is easy to maintain and troubleshoot. If you have a problem with heading, you know where to go, and there are only two wires to look at, with plenty of room to do so.

- You save weight by eliminating sensor and control button cable home-runs.

Calibration and Adjustment

All instrument systems, including stand-alone types, require calibration to deliver the accurate outputs you've paid good money for.

Calibration adjusts for sensor inaccuracies, installation misalignment and environmental issues (e.g. boundary layer and sail upwash). It is not all that difficult to do, requiring only a few dedicated hours under good sailing conditions.

Adjustments scale or warp outputs to correct for unmeasured or unknown effects (such as wind shear and gradient), or when calibrations do not completely correct the sensor inputs.

Most instrument systems provide some means of calibration, either through hardware (screw turns) or software commands, or both. Some calibrations tend to be static; once set, they pretty much stay where they are, while other calibrations always seem to need changing.

As much as the sails or winches do, instruments need a single responsible and knowledgeable individual who has been given authority to adjust and maintain them. Although there are elements of both in it, calibration is neither rocket science (only simple math skills are needed) nor voodoo ritual (not everything that affects the instruments is measured and corrected for – e.g. wind shear).