10.0 Some final considerations

10.1 On buying radar

Radar is a fairly major purchase for most boaters. Buying, installing and operating a less expensive set properly is far better than buying one with all of the bells-and-whistles and then installing and operating it poorly.

The various manufacturers' glossy brochures and websites provide a cornucopia of information that is worth your critical perusal. You will find that there are subtle differences between them. For instance, one vendor has a really good system but offers less than optimal displays, while a competitor has a superior display with a weaker antenna system. A third system has some features better than the first and the second, but is the overall performance superior?

Once you have determined which manufacturer and model will best meet your needs, the choices of options should be addressed. The expandability to interface with other "toys" should be given serious consideration. Even if you have no immediate plans to purchase a GPS, fluxgate compass, chart plotter, laptop computer or depthsounder, etc, the ability to add one or more of them later could be worth any small extra outlay. If your purchase is "interface ready" the additional devices may greatly augment the utility of the single unit operating alone.

10.2 On installing radar

10.2.1 The display

The *radar display* should be installed bearing in mind those who will need to see the display in action. The helmsman may need to be able to see the display in tight situations. Is it better to have the navigation station as the first priority? What about the visibility for the watchkeepers on a rainy night? Can they clearly see a display mounted at the chart table? Is a second satellite display at the helm necessary? If it is mounted above decks, will it be visible in sunlight? If all of these factors are resolved before the display is screwed down, satisfaction is likely to be achieved.

10.2.2 The antenna

Any discussion on the "ideal" radar antenna placement can be very controversial. The location of the antenna is critical to the performance of the radar itself. It is also the emitter of substantial amounts of microwave energy. There is a radius of approximately 1m (3 ft) around the antenna within which prolonged exposure could cause harm to a crewmember. Be cautioned, the human eye is particularly susceptible to damage from microwave radiation!

10.2.2.1 Power

On powerboats, a common antenna location is atop a radar arch. This designer feature is usually higher than a flying-bridge helm and is more than the advisable 1 m minimum safe distance from the crew. Mounting a radar antenna on the deck immediately ahead of the upper helm station is not ideal for blanking and safety reasons. The highest possible mounting is preferred to increase range performance and reduce surrounding sea clutter.

Power boaters should also determine at what speed range in which they wish the radar to provide optimum coverage and mount the antenna unit so that it will be parallel to the water surface *at that speed*. If the unit is to be relied upon for navigation in conditions of poor visibility, the antenna should be mounted to provide the best coverage at slower manoeuvring speeds, e.g. off-the-plane.

10.2.2.2 Sail

Mounting a radar antenna on a sailboat is a different problem. Sailboats can heel substantially when sailing on-the-wind. Radar performance deteriorates **significantly** as the antenna is heeled from the horizontal (see Figure 10.1) below. This inherent drawback can be overcome by mounting the radar antenna unit on a self-leveling mount, which is itself attached to the backstay, the mast, or on top of a radar mounting pole designed for the purpose.

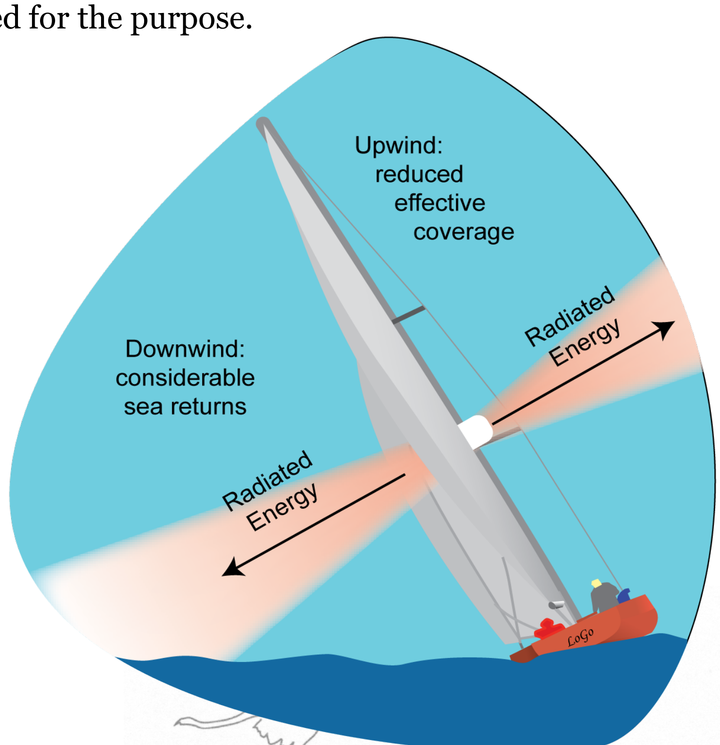

Figure 10.1 Heeled radar antenna

These self-levelling units are very effective in removing the error from heel angle while sailing, and will also significantly reduce the rolling effects in a heavy seaway

A second consideration is that sailors do not like any excess weight to leeward. A radar antenna unit mounted high on a heeling sailboat will reduce the righting moment by a small, but usually acceptable amount. On the other hand, the higher the antenna is mounted, the better the radar coverage will be, especially out towards the maximum range.

The latest iterations of small radar antenna packages are remarkably light, weighing from about 6.5 kg (14.5 lb) for a 46 cm (18 in) domed antenna, to about 7.5 kg (16.5 lb) for a 61 cm (24 in) domed antenna. If at all possible these units should be mounted well above the height of a pole-type mount. A self-levelling mount on the backstay or on the mast itself is the preferred solution.

Note: Generally accepted practice is to mount all transmitting antennas higher than receiving antennas. Because radar has a large energy pulse it should be mounted on a plane by itself whenever possible. However, some modern radar pole units mount a GPS antenna in close proximity to, and higher than, the radar antenna.

Most radar users become avid disciples of this unique device as their experience broadens, especially after a couple of experiences in marginal visibility. Radar has the unique advantage over devices which rely upon external signals in that *all* of the needed components are onboard with you. No satellite failure or power outage ashore can affect the radar operation. Well setup, well-maintained and well-interpreted, radar can be truly magic on a nasty night.

10.3 Down the road?

It is unlikely that dramatic improvements in the basic radar functions of recreational models of radar equipment will occur in the near future. However, it is quite possible that existing complex clutter and interference rejection circuitry, used in commercial and military radars, could be integrated into the receiver's small *Printed Circuit Board* (PCB).

That is not so much the case in the display console portion of the set. The digital processor which drives the computer monitor type of display presentations in all of today's units, can still be improved to significantly increase the quality and detail of the picture. As always, the only constraints are the cost, with perhaps very small weight and power consumption penalties.

10.3.1 ARPA, Mini-ARPA or ATA

A capability in "big ship" commercial radar sets, which is gradually becoming more generally available on the upper-end of the small marine radar model selection, is called *Automatic Radar Plotting Aid* (ARPA), or *Mini-ARPA*, or ATA (*Automatic Tracking Aid*). The display unit uses digital processing to "keep track of" targets that either the display program has recognized or the operator designates. The drawback is that this feature requires much more computational power and considerably more memory capacity. However, as the necessary hardware continues to drop dramatically in cost, the expense of adding these features is becoming more reasonable.

Here is a broad-brush explanation of how this ability is achieved, but not of how it is implemented in any particular product.

The stream of analogue data from the radar receiver is changed into a form of digital data that can be fed into the computer memory, according to the antenna's azimuth and by range. Consider that an antenna rotating at 10 RPM will be rotating at 60° per sec. If the radar beam-width is 5.2° it will be illuminating a point object for 0.08667 sec. On medium range the radar is transmitting 1500 pulses per second. Therefore, that <u>point object</u> will be illuminated by *130 sequential pulses,* or *run length,* as the antenna sweeps past it! That is a very large amount of data to save and examine.

These data are written into a memory location reserved for that particular azimuth and range block. Results are saved for a number of consecutive transmitted pulses with the new echo history replacing the oldest in rotation. The echo history from subsequent pulses is compared to the previous ones. As noted earlier, noise or grass is random in nature. A noise echo will seldom fall at the same memory location two or more pulses in a row, thus it may be ignored.

The series of echoes reflected from a solid object will overlap or be within one memory *range cell* from the previous location. The logic programmed into the system can then drop or ignore the random noise. It will only pass "possible" returns to the display function for further processing depending upon the run length of sequential echoes. This process can really clean up much of the "atmospheric static noise" from the displayed picture. However, it will not remove much of the sea or rain clutter whose echoes are usually "wide" enough to pass the test.

Intermediate processing considers the start azimuth and the stop azimuth of each "target paint" and can usually refine the overall azimuth accuracy to well below that of the radar beam-width. These processes are very memory intensive but you can see how extraneous noise can be "winnowed out", cleaning up the entire basic display and improving the accuracy of the displayed information.

Once these data are passed to the next level of processing it has range and azimuth information *tags* attached to it for display and for the tracking functions to use. Thus the display will appear to be crisper and more detailed.

When either the operator or the system “designates” a target trail for tracking, a whole new processing sequence is initiated. The computer program “draws a circle” around the return, and the location of the return from the next antenna sweep is compared to the previous one. If the second falls within the circle criteria, programmed into the computer logic, the second return is then used to calculate the heading and speed of the target **in relation to the receiving vessel**. Using this derived heading and speed, the tracking function calculates where the **next return** should fall and draws a smaller circle around that position. This is known as *target prediction*.

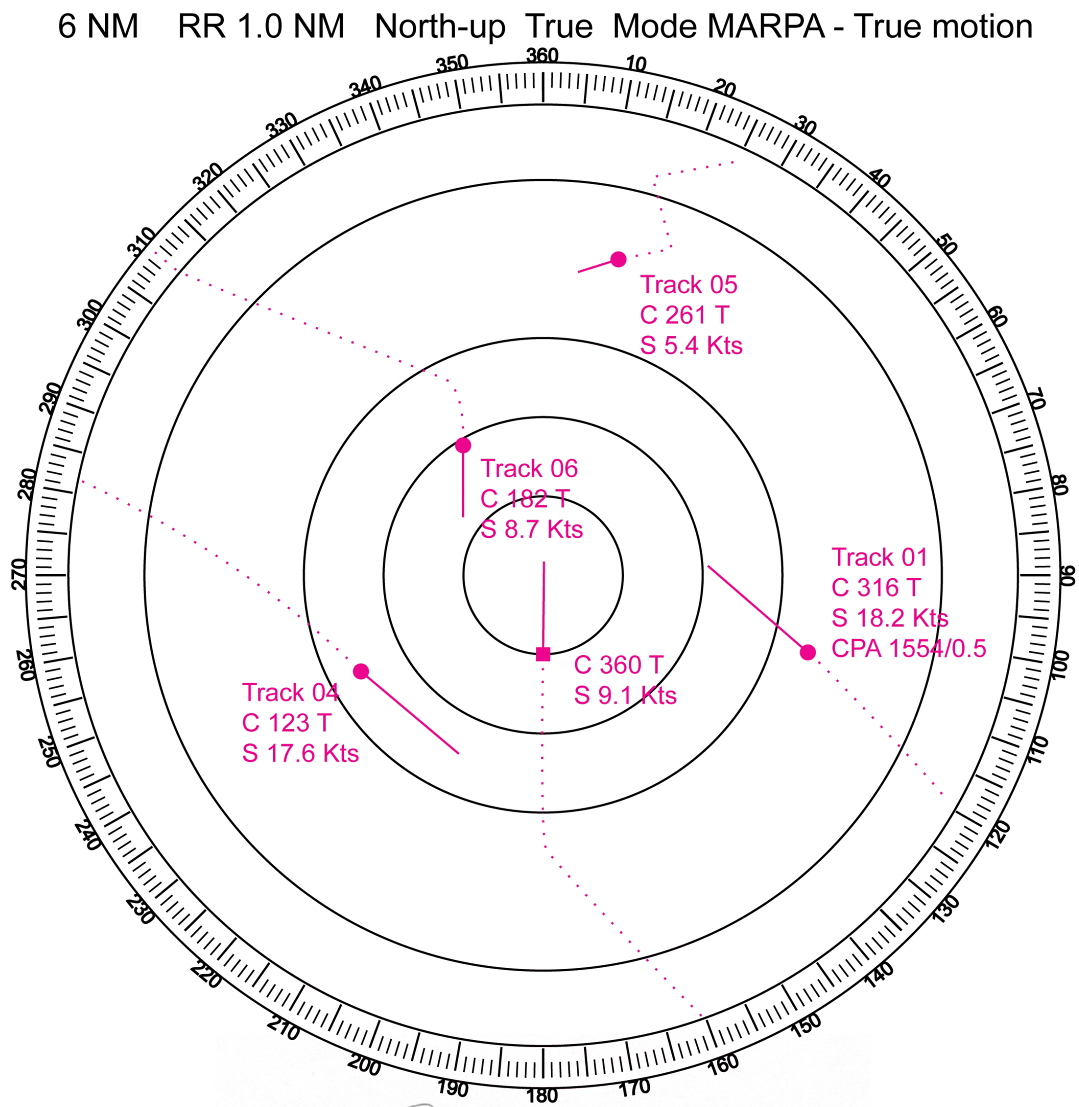

Figure 10.2 Possible MARPA information display

As the process continues, the heading and direction continued to be refined and the prediction circle is slowly reduced [to a programmable system minimum] until the target manoeuvres and the “track smoothing” becomes extremely accurate. Using this information, the display function can overlay a vector indicating the target’s calculated heading and speed, and display an alphanumeric designator applied by the computer or the operator.

This information immediately allows the further calculation and display of Collision Warnings, CPAs and Time To Go alarms without any further operator intervention. When these features are coupled with a colour display, dangerous situations can be instantly brought to the watchkeeper's attention.

Figure 10.2 is not definitive and is shown only to give you an idea of the sorts of information which "might be displayed" on a MARPA equipped radar display. It is not meant to represent any existing mini-MARPA system. "Our vessel" is indicated with the unique "square" icon. Track 01 is showing a CPA alert at the time 1554 at the distance of 0.5 NM.

Radar on commercial vessels can have quite a large number of "tracking channels" but the number available on a recreational radar set is still quite restricted (10 channels being the standard at the time of writing).

You can reasonably expect these most desirable features to work their way down into the less expensive models as the technological revolution works its magic on the costs of computer memory and VLSI chips. The addition of colour enables visual cues of warning or dangerous situations to augment the audio alarms of today. Patience and awareness are the watchwords for a whole new level of radar magic.

10.4 The last word

There it is! You have been subjected to a good look into the inner workings of a recreational radar set, its **good** and its **not so good** facets and features. Any boater, power or sail, with a well-founded radar, who has discovered themselves in thick fog outside an unfamiliar harbour or facing a lee shore in deteriorating weather, will tell you that it beats GPS. As the commercial says, **"Try it... you'll like it!"**