Building Buckle Up

Graeme Bird of Adhesive Technologies explains the unusual construction details of the new Rocket 40, Buckle Up

IN ORDER to produce a lightweight hull, a core material as light as the PVC foams was necessary. This could not be done with any timber except end-grain balsa. Two main problems exist with using end-grain balsa for lightweight hulls. Firstly, it is difficult to prevent it absorbing more resin than necessary when laminating face laminates, adding unwanted weight. Secondly, a mould is required to form it.

With Duracore, a new timber veneer/balsa composite, we got around both these problems by gluing a timber veneer to each surface with a phenolic glue film in a hot press. The veneer stops excess resin absorption, and the balsa can be cut and jointed into planks that can be used over the frames as you would plank a cedar strip composite boat.

We decided to build the boat in female instead of male frames. This way we could complete all but the outside surfaces of the hull, and when we faired and finished the outside surface it was fully supported with no movement possible. Also, the boat was built in a small factory and would have to be slung in ropes to turn over. We only wanted to do this when the boat was structurally complete to avoid damage.

The construction procedure was as follows:

Frames and set-up. Temporary frames made from 20mm x 300mm pine were marked from full size loftings and cut out. These were braced so they would stand square. Position alignment was checked with string lines and a dumpy level. A laminated oregon stem, ash gunwales and oregon keelson were fitted.

Female jig assembled with laminated cedar/ash frames being made up.

In order to maximise stiffness, it was decided to use evenly spaced permanent frames throughout the boat at the designed stations. These frames were made from eight laminations 8mm x 25mm of western red cedar with two of silver ash capping the inside of the frame; total dimensions 65mm deep x 25mm wide. The temporary frames were used as a form, with blocks simulating hull skin thickness between the jig and laminated frames, which were then removed, cleaned up, sanded, then stored for later use.

Hull planking. The hull was planked with 15mm thick x 35mm width Duracore balsa veneer composite planks. Balsa was 12mm thick with 1 x 1.5mm meranti veneer each side.

Planking started at the turn of the bilge upwards to the gunwales and down to the keel. West Epoxy, modified to a lightweight thixotropic adhesive with microsphere blend, was applied to the edges of the planks before they were fastened to the temporary frames with double-headed nails until the glue had dried. The planks were run out over the gunwale and butt jointed to the inset oregon keelson.

The double-headed nails were removed and the interior power-sanded with belt and disc sanders to a smooth finish. Nail holes and any voids were filled. The interior surface had a saturation coat of West System epoxy applied with a roller, laid off with a brush and allowed to cure. This was lightly sanded before glassing.

One layer of 17oz double bias was laid fore and aft, the fibre orientation being ± 45 degrees. An extra layer was added to the area under the keel frames. This was laminated with West Epoxy. A lightweight nylon fabric, called peel ply, was also laid over, wet-out and left until the resin was cured.

Planking with Duracore balsa veneer began at the turn of the bilge.

Cloth wet-out was achieved by pouring mixed resin direct from the mixing container onto the dry glass and spread out with a squeegee held quite flat, thus forcing the resin into the fabric. Then a few minutes later with the squeegee held more upright, excess resin was lightly removed from the laminate, but still leaving it slightly resin-rich.

The peel ply was then laid on and a metal roller/squeegee combination used to wet it out thoroughly, insuring it was laying down hard on top of the glass without air bubbles or ripples. Any remaining excess resin is removed at this time.

Once the epoxy had cured, this peel ply was torn off the laminate surface, taking with it all surface contamination, to leave a fair matt finish that required very little preparation for the next stage.

In keeping with the West System tradition, a high class, clear-finished, timber interior was desired. The weight of glass fibre used on the hull was too much to allow clarity through to the hull planks. Therefore it was decided a decorative veneer would be used on all visible interior hull surfaces. For this 0.7mm African ash was chosen. This was laid at a 30 degree angle forward from the vertical and vacuumed down onto a bed of epoxy adhesive in four manageable sections.

Fitting permanent hull frames. The permanent frames were returned to the boat to be fitted. Edges to be fastened to the hull were bevelled to fit, then fluted and held in place by six brass screws put in from the exterior.

Ash keel frames, 12mm ply bulkheads and an ash capped 12mm ply "I" section sister keelson were cut, fitted and glued into place.

The laminated frames were glued, but not filleted on the top sides, but fillets were added under bunks and floors. For additional load spread, all bulkheads were filleted and glass taped with 17oz double bias.

Cockpit and deck framing. Tasmanian oak carlins were fitted into place over the bulkheads. Foredeck beams were laminated from the same materials as hull frames, with sidedeck beams sawn from western red cedar fitted with ash caps.

All deck beams were joined to hull frames with a solid ash knee reinforcing the gunwale joint on the inside of the frames. A threaded 6mm stainless steel rod was run from hull frame through knee into deck beam and glued into a over-size hole with epoxy to take any tensile loads.

Three Tasmanian oak stringers were run each side from the for'ard anchor well to transom, notched into deck beams. The cockpit was made from plywood, sides 6mm, seat sides 9mm, framed up with oregon.

Decks and cockpit floor. A different version of Duracore was made up for the deck. It consisted of 9mm end-grain balsa with two meranti and one ash veneer each side. Each 2400 x 1200 sheet weighed 15kg.

These sheets were pre-coated with two coats of West Epoxy on one side and orbital sanded to a smooth finish. They were then fitted and glued down to the deck frames and stringers, held with temporary screws. The sheets were scarfed together on the boat. The balsa veneer sheets were able to be bent to take the deck camber, except for the bow which was laminated separately.

Because all timber used in the boat was pre-coated with West Epoxy and sanded prior to fitting, the interior just needed a light sand before finish coating, cutting down a lot of work. It also prevented resin or glue spills from staining the clear interior finish, and spills could easily be wiped off the resin coated surface.

Cockpit seats and floor were made from the same material as the deck.

The hull/deck join was glass taped over the outside with 17oz x 150mm width double bias tape.

The cabin roof was previously moulded as the hull was fitted, completing the major structural work of the boat. The boat was then turned over in two rope slings attached to four chain hoists, which in turn were attached to the building's roof beams. It took six people two hours to turn the boat.

Outside hull glassing. The Duracore planks were cleaned up and sanded smooth enough that glass could be laid onto it without the possibility of voids. Screw holes, etc, were filled and the planking saturation-coated with West Epoxy. This was then lightly sanded in preparation for the glass.

One layer of 17oz double bias was laid across the boat with 1-2in overlaps at each edge of the cloth. Peel ply was then applied.

Once cured, the peel ply was removed and preparations for final full fairing begun.

Hull fairing. Because of the attention this boat would get and the unusual hull shape which could emphasise any unfairness, a good final fairing job was required. This we achieved with a method which we have been perfecting with the fairing of aluminium hulls over the last two years.

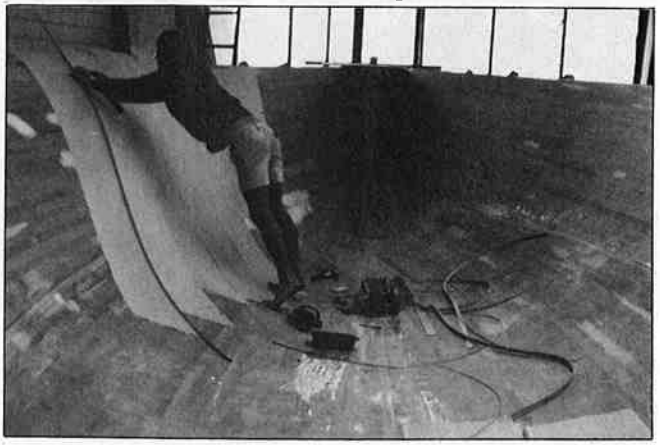
It starts with the application of neat, precisely shaped epoxy beads around the hull. A flat steel cement trowel has notches cut in at a spacing of about 60mm. These notches are 4mm wide and, in the case of this boat, 6mm deep. The depth of the notch is determined by the fairness of the hull after it has been checked with a batten. Importantly, the distance of the end notches from the ends of the trowel should be half the regular notch spacing.

A bog mixture of phenolic microballoons and West Epoxy is blended to a wet, paste-like consistency. A batten is held to the hull across the boat and used as a guide for the trowel.

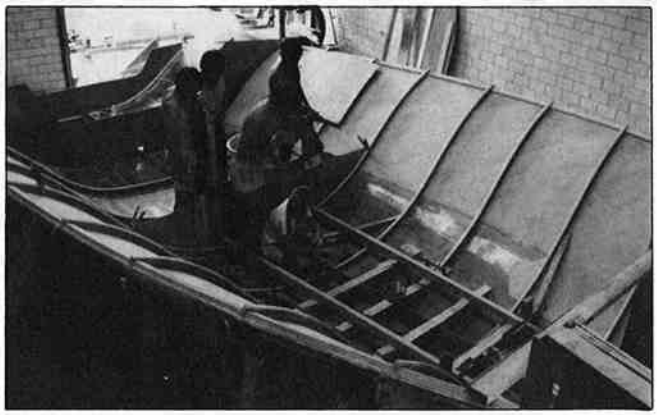
With the non-notched edge of the

Peel ply was torn off by hand when epoxy cured.

African Ash veneer was laid on exposed interiors.



Laminated frames, made earlier, were glued in place.



Keel frames and ply bulkheads were fitted and glued.

trowel, a light smear of bog is trowelled from keel to gunwales on both sides of the batten. A good amount of bog is then applied to the notched edge of the trowel with a putty knife. The trowel is pulled around the hull along the edge of the batten, leaving five beads of epoxy bog.

The beads should be crisp-edge and any dags of bog removed, or they will cause problems later. The initial thin smear of epoxy is mostly removed when the beads are applied, but it ensures the beads stay on the hull and don't peel or roll off as they tend to do when trowelled on a dry surface.

When the entire hull has beads applied and cured, the beads are sanded with 40 to 60 grit sandpaper attached to one metre-long torture boards. The boards are normally held on a diagonal and moved fore and aft or athwartships. Long battens are used to check fairness.

This sanding operation is relatively quick as only about one tenth of the hull surface area is being sanded. Care should be taken to ensure a minimum of 2mm depth is left on the beads in high spots, so an unbroken bog film can be applied later to the hull surface without having to obtain a feather edge to a high, unfilled area.

With a straight-edged cement trowel the bog is now applied to the hull using the pre-shaped epoxy beads as a guide. the bog should be as runny as possible, but still able to stay in place on the hull without sagging. The balloons should be mixed very well into the epoxy, leaving a creamy consistency without lumps. A power drill with mixing heads is best used.

The bog is applied to the hull from the keel down and takes about three screeds with the trowel. The trowel should only be moved parallel to the beads, as any movement across them may cause voids to form on the back side of the beads. Any dags on the hull will also cause voids in the screeded bog.

The angle and speed of the trowel on the final screed is important in obtaining the desired finish. The trowel should be held at about 25 degrees to the hull and moved at a speed which causes the bog to remain flat behind the trowel. Too fast, and bulges will occur between the beads; too slow and hollows will appear. This method is capable of fairing 95% of the hull surface with minimum additional filling.

Once cured, the bogged hull was sanded with 80 grit paper on orbital sanders to obtain the final faired surface. As always, small areas of touch-ups were needed.

The bogged hull was then coated with a liberal coat of pigmented West Epoxy that nylon peel ply was laid onto. There were three good reasons for this:

All low density epoxy bogs are somewhat porous. A coat of West Epoxy all but prevents water absorption;

The bog has a relatively soft surface somewhat easy to damage and scratch. the layer of resin significantly hardens the surface;

The pigmented layer of resin lets you know when sanding later undercoats when to stop sanding, and if you should stop a few strokes too late, the hard resin layer helps prevent the accidental sanding of a hollow in the easy-to-sand bog. The peel ply causes the resin coat to mirror its surface rather than the hull surface, thus the resin fills sanding marks and other small imperfections.

The peel ply was removed, edges touched up and four coats of a high build, easy to sand undercoat sprayed on, each coat a different colour.

The undercoat was then orbital sanded, starting with 120 grit paper and working back to 400 grit wet and dry, prior to proof top-coating.

Interior finish. The Rocket 40 was

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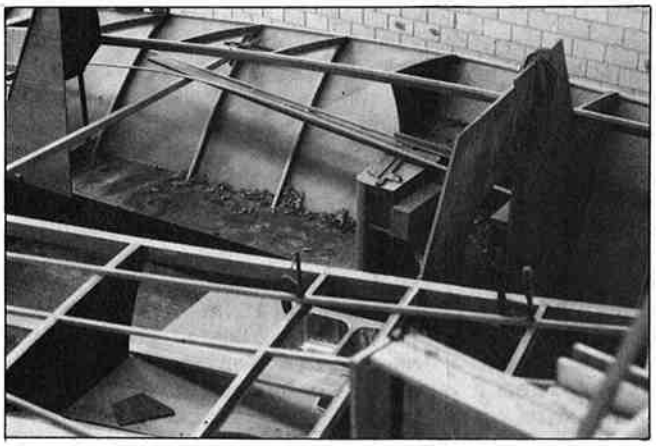
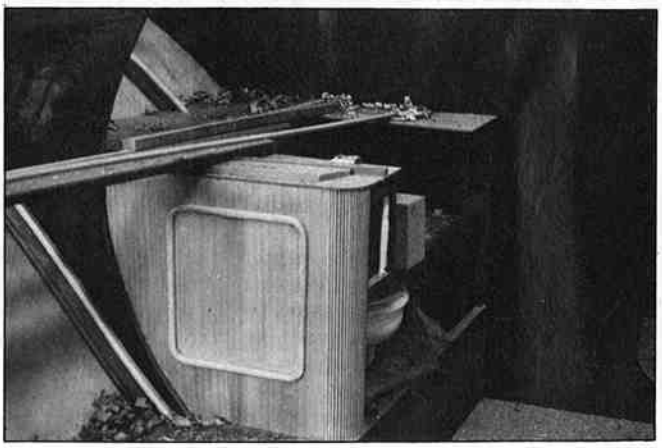
Tasmanian Oak carlins, cedar/ash deck frames in place.



Interior trim included Silver Ash and Australian Cedar.



Working Wind Waves

Offshore sailor Jay Macfarlane believes he has found from his glider-flying experiences a solution to the mysterious ways of the easterly winds blowing off the WA coastline

AFTER MANY years of sailing up and down the coast of Western Australia, I have given up using unknown currents as excuse for the occasional disparity in boat speed that sometimes occurs. Ocean-racing yachts of similar rating can hang together for a couple of days, only a few minutes between them and then on the last reach up the coast in a morning easterly suddenly the gap opens to an hour. The boats may be abreast but only a mile apart, for no apparent reason one boat seems to change into "overdrive" and within four hours is hull down on the horizon.

The faster yacht claims better helmsmanship and sail choice, the slower yachts say it must have been an unlucky current, but after careful comparisions of dead reckoning positions to observed, it is difficult to detect any measureable current flow in any of the races that I have sailed.

So with boats being equal and no current, there has to be another significant factor involved. Although the West Australian coastal plain is flat and low to the water's edge it is bordered by a 300m escarpment that runs parallel to the coast but 25 kilometres inland. This escarpment marks the edge of the central Australian plateau. Could it be that this feature, so remote from the offshore racing yachts, could be interfering with the wind that we assume to be equal?

The effect that mountain ranges have on wind flow is well known. The initial updraft on the slope of a hill provides lift for gliders.This slope soaring can give lift to twice the height of the hill. However behind the hill, in certain conditions of air stability, a wave resonance can become established that will lift a glider to ten times the height of the mountain that has set off the turbulence. This lee wave phenomena is obviously far more exciting to the glider pilot.

If you have ever watched water flowing down a stream, the effect of a barrier in setting up a set of waves can be easily seen. Equally so, you may have noticed that water flowing over a weir has its own set of standing waves even though it has not a barrier, only a sharp drop from plateau to plateau. If downstream waves can be established in these circumstances in water, why not lee waves from the Darling scarp in Perth or from any other slopes close to the sea?

The cloud formation shows the pattern of the lee wave system.

It seemed more practical to investigate the presence of wave by car rather than by boat. During the fresh easterly conditions of our summer mornings it is easy to drive towards the hills from the coast and co-relate areas of strong wind with speedometer readings. Sure enough only a couple of trips were required to find consistent areas of strong wind separated by zones of light wind. More interesting, these areas remain static throughout the day, so much so that one farmer might remark "I wish this wind would quit blowing all this dust in the house", while another, only a couple of kilometres closer to the hills, might remark "what a beautiful day" while sitting in light breezes all morning.

It can only be assumed that this cyclic variation of wind speed is the result of vertical air movement, a vertical movement that has been set up by lee waves established when the wind rushes down the hill-side. In areas of down draft in the wave system a stronger wind is encountered on the surface while in areas of updraft a much-reduced wind speed is experienced.

The wave length of lee waves, or the distance between two bands of stronger wind, depends on wind speed; while the amplitude of the wave is determined by not just the extent of the vertical movement of the air but by the shape of the hill that causes the movement. Obviously a vertical face is more likely to instigate savage but short-life turbulence whilst a well-shaped slope will set up a laminar undulation that will continue for a dozen cycles or more. In this respect Perth is well endowered as our lee waves can be detected up to 15 miles offshore or 50km from the hills.

If average windspeed is taken in knots in the area of wave, say at 300 metres above sea level, then the wave length can be calculated in kilometres at a quarter wind speed. This formula can be modified by change in temperature, when the wave length can be expected to marginally increase as the temperature rises through the day.

Therefore in a 14kt breeze the upper air might be 20kts to give a wave length of five kilometres. This means that in an easterly breeze on the America's Cup course the Twelve

Watching the Cup

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the World Twelve Metre fleet racing championship earlier this year.

The base coverage, of the cup and preliminaries, initiated by the Channel 9 network, with other television channels picking up and putting their own overlays of expertise and commentaries with it, will be even better.

The 1983 winning skipper John Bertrand will be joining Bruce Stannard as expert commentator. And a system of graphics is being planned that at all times will show where the boats are on the course in relation to the rounding marks and each other.

So you could watch the race on tele, drift down to the docks to see the boats come in — maybe from the top deck of Lombardos with a frosty glass of Swan in hand.

Then, for the inquests, drift around to the hostelries — some beautiful old ones have been renovated for the Cup — The Auld Mug, Sail and Anchor, The Esplanade, Norfolk, Fremantle hotels among them.

You won't find too many front-line crewmen there — Twelve Metre match racing is a deadly serious, thoroughly exhausting business that leaves the participants just enough energy to walk or cycle back to the crewhouses for dinner and bed.

But there will be characters from the support teams, yachting writers, America's Cup buffs and groupies, reliving and arguing about the day's events.

Many events are planned for Perth to coincide with the Cup period including a Festival of Sport with 27 major sporting contests, among them a world heavyweight title fight on Jan 25, and a cricket test. Holiday WA offices have details. Δ

Building Buckle Up

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turned upright for deck finishing, interior trimming and fitting attachment.

The interior was trimmed and edged with silver ash. The two front and rear bulkheads were painted gloss white to keep the interior light and bring more out of the feature woodwork. The mast and chain plate bulkheads, bunk fronts and cabin sides are clear finished in Australian cedar.

The resin coated interior was touch-sanded and prepared, then sprayed with a high gloss clear, two-pack polyurethane.

Deck finish. An accurate deck fittings plan was drawn. This allowed preparation to ensure sound and trouble-free fitting attachment.

All holes to be drilled throughout the Duracore deck were marked and drilled oversize by at least three diameters of the bolt to be used. A jig was used on the drill bit to allow the oversized hole to be only drilled through to the inside of the end-grain balsa, stopped at the internal veneers. These holes were then filled with West Epoxy thickened with microfibre blend.

Fitting base pads were cut from a glass fibre epoxy composite sheet made up from two layers of 34oz triaxial glass fabric laid at 90 degrees to each other, vacuumed onto a flat surface with nylon peel ply on one side. The base pads were cut on a bandsaw with a metal cutting blade to the exact size of the base of each fitting.

Pilot holes were drilled through the pads where the fastening bolts were to pass through and they were glued down to the deck in position, held by temporary screws going into pilot holes drilled in the epoxy deck plugs. These pads spread the surface shear load while the epoxy plugs gave three times the load spread of the bolt, and also prevent water from finding its way into the balsa deck core.

The deck received three or four coats of West Epoxy applied with a roller and laid off with a brush, the last two pigmented. Glass or dynelling was unnecessary as the epoxy coating covered three hardwood veneers, a very hard, durable, damage-resistant surface in its own right. Δ

Worlds Moth march

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Hobart Nationals in 1985, before redesigning his rig. He had worked as a sailmaker with Ian Brown, but he left and developed a high aspect mainsail for his own boat. Sailing in the 1985 State titles he won convincingly and, last season, after finishing fourth in the Albany nationals he successfully defended his state title.

His new boat was called *Stray Goes to Customcraft,* which he says caused "a little bit of a fracas". In the nationals he modified it to *Stray Goes to Custom.*

The hull weighs 16kgs, and is produced from 6mm Divinycell foam with Kevlar inside and out. It has carbon fibre framing. Cuddihy says he has "immense faith" in Michael Rennie, the principal of Customcraft. He will stick with an over rotating rig, which he believes is 5 to 10 per cent more efficient than a standard rotating rig, and he will look at deeper sails "because of the water conditions in SA".

His mast will carry an adjustable "prodder," developed last season to control mast bend.

Victorian boat builder Jim French has built more than 90 Moths for sailors in Australia and overseas.

In his home state he has a considerable influence on the development of the class and, until business commitments limited his free time French was also a regular competitor. Next season he plans to compete again in a new skiff design which he calls the *French Wombat Mk II.*

The new shape will have flatter sections aft, with chines towards the transom. French is aiming to get more stability and faster planing in heavier winds, although he feels his current round bilge design may be better in light winds. The chine on the new boat will run out about half a metre from the transom.

The deck layout, planform and bow will remain untouched. French says: "It's a logical progression in the search for a perfect boat. Going any narrower would be silly."

He and Ian Ward often consult each other on their developments and French says: "Wardy knows what he's doing. He's been around a while."

French already has expressions of interest in new skiffs and scows from local, Japanese, Swiss and American sailors.

For his own Worlds campaign French expects to sail his latest skiff design, with business promotion in mind. However, he believes there may not be enough light weather in SA to favour the skiffs. He has had thoughts of entering a sailboard, which he also builds. He says nobody can tell him definitely whether boards are banned. He believes the world controlling body of Moths "needs their backsides kicked".

"I'm pushing the sailboard aspect to put a needle in their balloon. It's a development class and maybe in 10 years time it might lead to another dimension we haven't thought of."

Queensland and South Australia's fleets will also have new boats on the water. The South Australians, however, have their work cut out organising the regatta. As well as the National titles and the Worlds, there will be a warm up regatta for international competitors from Dec 28 to Jan 2.

State champion Greg Hammon, chief organiser of the series, says it has a budget of $21,000. The Commonwealth Bank has come forward with $3000, plus a boat for promotional purposes, and there may be an Australian Yachting Federation grant, but much of the money will have to come from entries. For that reason entries in the Nationals will be $50, and the Worlds $100. Overseas competitors

Red hot rigging

(From page 54)

years ago the same boat would have been using a snapshackle of at least 326gm, four times the weight.

Larger versions of these titanium snapshackles are also available and are being used by many of the Twelve-Metre syndicates.

Apart from Kevlar, the other rope we have found to be extremely useful is a polyester not produced for marine use at all. Marlow SRT is a very high-density polyester of balanced lay construction. It is manufactured as an abseiling rope for those brave guys who slide down ropes out of helicopters. The great virtue of SRT, apart from its high strength and low stretch, is that it does not kink and as a consequence is the most free-running sheet rope I have come across. Because it is designed to take abrasion, it is very hard wearing. It is the most perfect rope in every respect for one ton headsail sheets.

The only drawback is that because of its very high density and tight construction it is very difficult to splice. For genoa sheets we splice in about 90cm of wire, talurit on a 10mm Barient "J" lock, then we continue to splice up the crimp. This gives a sheet that will pass through most genoa cars.

We also use the SRT rope for reef lines. The other problem with SRT is that it comes in only one size — 11.5mm.

While on the subject of genoa sheets, it is our experience that Kevlar is not a good idea. You can get away with using Kevlar sheets on light and medium No. 1 genoas and there are advantages in reduced friction in doing this. However, when it comes to heavy sails, especially Kevlar No. 3s', polyester sheets are the only answer.

The problem is that with Kevlar sails and wire halyards and hull construction being as stiff as it is there is no give in the system. Furthermore with a No. 3, the sheet angle on the car is very nearly 90°. Kevlar does not like this sort of treatment.

The developments that have taken place both in sail and hull construction in the past three years have increased rigging loads dramatically. We are now specifying materials that are at least 15 per cent stronger to cope with the extra loads incurred.

Runners are being loaded to a far higher degree than before. The load at the forestay load cell on the leading one tonners was between 6500 and 7500lb (3000kg — 3400kg). This gives us a runner load of about 4500lb.

Under these loads the heat build-up created by surging the runner tail on a winch is considerable and is enough to melt an inferior quality rope.

Different makes of winches with their different gripping patterns have different effects on the runner tail and we found that particular rope types performed better on certain winches.

On *Panda, Phoenix* and *Highland Fling* the Marlow KT3 Kevlar performed very well but on *Jade* we had to use Gleitin polyester and on *Cifraline* we had to use rope-wire runner tails.

In Grand Prix yacht racing there is no compromise. Those who compromise do not win! Δ

PETER MORTON runs a rigging company in Poole, England, and is co-director of Riggarna UK Ltd.

Navigating the coast

(From page 45)

subtracted to arrive at the correct bearing.

Using the hand-bearing compass. Being a magnetic compass, this also is subject to influences. Typically, plain steel rigging can cause an error when used for support. However, while it is sensible to be aware of the problem, it is absurd to let it deny the navigator a safe position on a rolling deck. Better a little error than a navigator overboard.

It pays to find the part of the boat least affected by deviation during good conditions, but always use the safest part when a sea is running. Typically, this might be leaning against a boom gallows or with one arm hooked around the mizzen mast. Short of a massive influence, the difference between deviation and human error will be impossible to establish.

Most hand-bearing compasses have a light, but unfortunately most such lights work as well as marine torches; that is they fail prematurely and refuse to work again. As a result, night bearings become difficult if not impossible. But there are ways, one of the best being to stand under a deck floodlight. If this is so overpowering as to destroy night vision, an assistant can hold a torch just above and behind your head whilst you are taking a bearing. Almost dead batteries are appreciated for this operation.

Where an object is below the horizon from the deck but visible from aloft, a bearing from it can be taken by climbing the mast and noting a conspicuous shape above. During the night this could be a star, whilst during the day a dent in a cloud is often relevant.

Whatever is used, call the object down to a person on deck who makes a note so that there can be no confusion by the time the deck is regained. The conspicuous object is then 'shot' and the resultant bearing will closely match that of the horizon-down object beneath.

Hand-bearing compasses have a low heeling tolerance. Their cards readily stop swinging to the least tilting. Preventing this on a rolling deck can be very difficult, but it is vital if anything like accuracy is to be enjoyed. The operator must secure himself as well as he can and use his waist as a pivot point, rather like a kerosene gimballed lamp. Otherwise, where circumstances demand a tighter hold on the ship, use the shoulders as the pivot point and the arm as the gimbal, the elbow being a sort of counterweight. The free arm holds on.

Beware of snapping bearings too quickly. Even a well dampened card can take a while to stop swinging and this must be allowed for regardless of conditions. Very often the worse the conditions, the more important the accuracy of a sight and this difficult-to-attain ideal must always be the aim.

The theory of coastal navigation is very simple and can be learned quickly. The practicalities take a little longer and extract a few booboos along the way. The part the student must concentrate on is to avoid making big booboos. Approach the subject with care and commonsense and the rest will take care of itself. Δ