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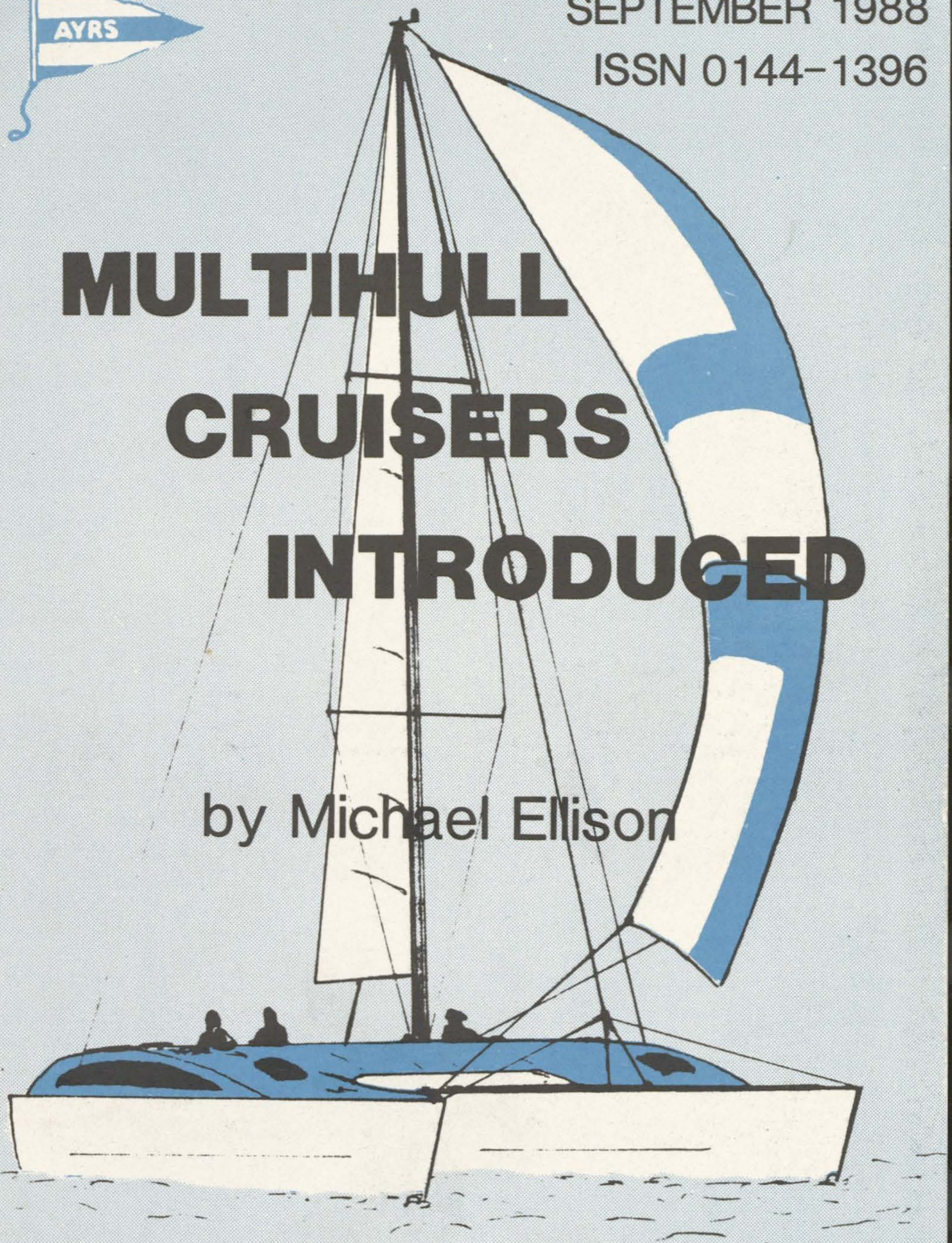
MULTIHULL CRUISERS INTRODUCED

by Michael Ellison



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MULTIHULLS - AN INTRODUCTION

MULTIHULLS have been developed to meet the varied requirements of owners both for the waters they sail in and the purpose for which they will be used. "Horses for courses" is true for yachts. Every yacht will be used for a different portion of time for enjoyment in port or at sea. Some will never race while others enjoy friendly competition with similar craft racing along a coast or further offshore.

What is a Multihull ? This publication will try to explain. Before multihulls most sailing yachts relied on heavy ballast either on the keel or low down inside, to provide stability against the heeling pressure of the wind in the sails against the resistance of the keel. Exceptions have always been the shallow barge yachts which rely on beam for stability. Recently wide beam light displacement single hull yachts have become popular and these, like barge yachts and multihulls, can capsize and be in a stable condition upside down. All such craft, including multihulls, could have water tanks built in to make them self- right but the situation is so rare that very few owners see cause for concern.

The advantage of having a yacht without ballast is the saving of weight. Weight reduces speed, increases draught and increases cost. For small craft it limits the size that can be transported by road on a trailer. Uffa Fox said that only a road-roller needs weight but he was noted for fast designs rather than comfort. Many cruisers carry heavy equipment for the comfort and convenience of their crews. There is no harm in this, provided the hull design is suitable and heavy equipment is properly secured away from the ends of the yacht.

A multihull is a yacht which relies on width and buoyancy in place of ballast for stability. Long thin hulls have less wetted surface and much lower wave making drag than a barge yacht while having the advantage of positive buoyancy for safety, wide deck area and reduced movement in a seaway for comfort. Yachts which dry out on a tidal mooring remain upright for comfortable living. There are exceptions to all these to meet different design requirements.

There are as many variations in size and design purpose between

multihulls as between yachts with only one hull. Catamarans have two hulls but many have a pod or blister below the joining "bridge" deck and this can touch the water. It is usual for a Trimaran to be so called if the floats or outriggers named "amas" by U.S.A. designer Dick Newick are shorter or of less displacement than the main or middle hull. If the middle hull is small the craft remains a catamaran.

PROA. A "proa" has two hulls, one larger than the other, with the rig on the larger hull. The "Pacific" proa is an ancient traditional craft having the float or outrigger to windward. For maximum speed this float can be kept clear of the water. The "Atlantic" proa is a Western idea to keep the weight to windward like a trimaran, without the weight and windage of the windward float, or as a catamaran with all the weights in the weather hull. In theory the proa should be an excellent racing craft but so far they have proved accident prone, often by capsize after an accidental gybe while running down wind, this puts the hull and sail in the wrong positions. For a proa to change direction the ends have to be changed so that the bow becomes the stern - a manoeuvre known as shunting.

Hydrofoil craft have, since their introduction to offshore racing and cruising, been accepted as multihulls although usually they only have one hull. This is probably because the first ocean-going "flying" hydrofoil yacht, Dave Keiper's 31 foot "Williwaw" was a modified Piver trimaran (1966-1971) while the first offshore foil stabilised yacht, David Chinery's

"Mantis IV", had buoyant foils. (1974 Round Britain race). The development of both these craft from design to completion was encouraged by John Morwood and details were published as trials progressed. In those days unusual or faster than standard yachts were not accepted by the traditional yachtsmen while multihull fleets were small and new craft and new ideas were welcome. Gerald Holtom and John Morwood coined the name "Foiler" for yachts using low aspect ratio foils to resist leeway and keep the yacht upright without lifting the hull. Gerald used the word as a trade name for his craft which by using non bouyant foils were self righting by wave action. This feature was frequently demonstrated in model tests, but at full size was impractical because you could not walk on the foils or beams while the yacht was not moving. Buoyancy provided by air tanks which could flood if the yacht capsized would be a practical way to develop this. Because these yachts sail upright sail efficiency and comfort on board are improved.

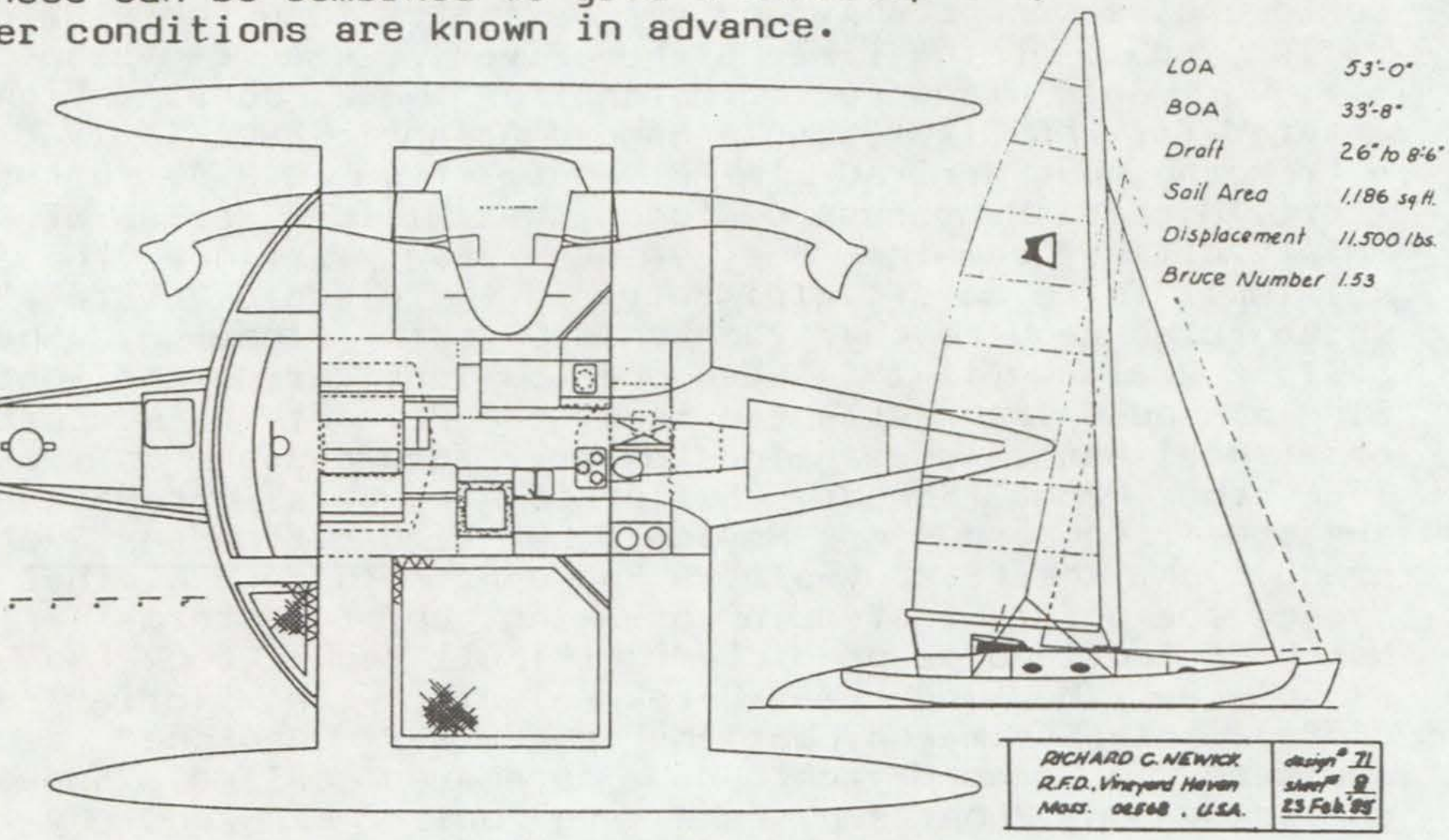
EARLY MULTIHULL CRUISING YACHTS

In the 1960's it was possible to build a multihull yacht which could cruise comfortably and yet be faster than the single hull racing yachts of the time. Arthur Piver, a keen contributor to A.Y.R.S., sold plans for trimarans for home construction. He entered for the first Single Handed Atlantic Race in 1960 with a trimaran, but arrived in Plymouth from U.S.A. after the start. Michael Henderson designed the "Miller" series of which "Misty Miller" remains one of the few, if not the only, multihull to be an official entry in the classic "Fastnet" race whose rules require that yachts are self righting. She had ballast keels until 1964 when one was lost during the Observer Single Handed Trans-Atlantic race from Plymouth to Newport. The other keel was removed prior to her return passage in 1966. By 1966 the Prout Ranger, Sailcraft Iroquois catamarans and Musters Triune and Honor Marine Ocean Bird trimarans were in production. The first two crew Round Britain race of that year proved the point. Instead of breaking up in storms off the North of Scotland as predicted multihull yachts took the first six places. The winner was Derek Kelsall, with "Toria" a 13M (43ft) racing trimaran, but the others were designed as fast cruisers. The second yacht was a catamaran called "Snowgoose" sailed by Don Robertson, she was built of wood by Prout Brothers but was not one of their production yachts which were designed later and given the same name. Ten multihulls and seven monohulls entered the race for which there was a substantial cash prize. The race purpose is to encourage the development of yachts suitable for short-handed cruising.

Since 1966 the racing monohull fleet have taken full advantage of light weight construction materials and new sail making technology to vastly improve their speed. A cruising yacht of any type can at present only expect to beat racers on handicap although a hydrofoil cruiser could be built to win outright if kept light in weight and equipped with top class sails. Racing monohulls use a number of rules to limit their speed and efficiency while in general multihulls are not greatly restricted; there are length limits for various classes, maximum sail area limits for safety and restrictions on wing masts. Under these conditions a cruiser should not out-perform a racing craft. A leading multihull designer Dick Newick offers his clients any two of three features :- High Speed, Great Comfort, Low Cost.

Early multihulls were often poor to windward, but down wind and in light wind they used to pass everything. Increased sail area and planing hull forms mean monohulls now concede the only real speed advantage to multihulls when reaching. Because the speed

of the different types of yacht varies at different angles to the wind and in different wind strengths it has so far proved impossible to produce a formula to enable single and multihull yachts to race together on handicap. Very accurate speed predictions can be made for multihulls and for monohulls, but these can be combined to give a handicap only if the weather conditions are known in advance.



DESIGN CONSIDERATIONS

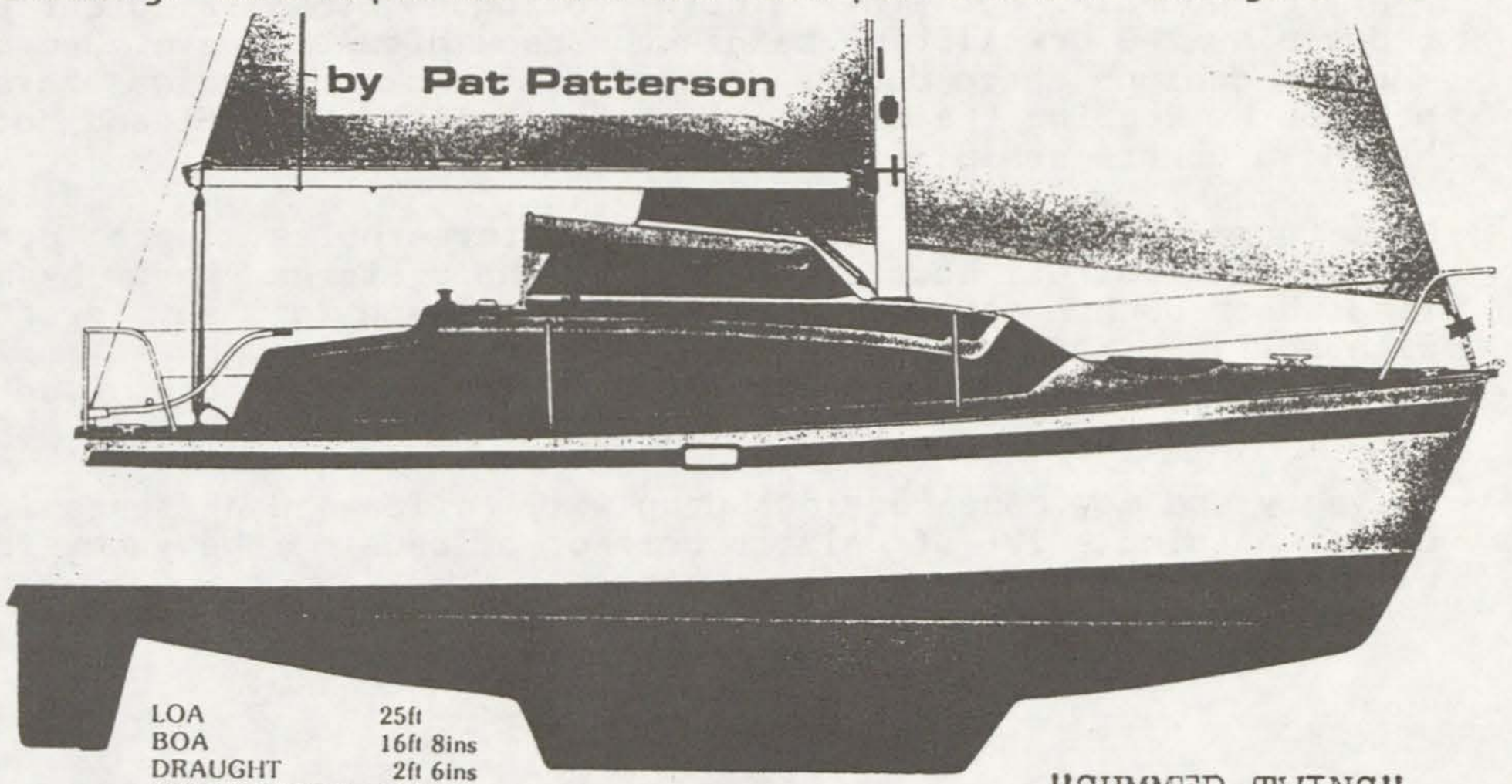
The theory was that the speed of vessels is limited to about 1.4 times the square root of the waterline length unless they had the hull shape and power to rise up and "plane" on the surface. The reason is the wave shape made by the hull which produces a hollow at the stern so that the stern lowers and the hull has to climb up a "hill".

Edmond Bruce showed in A.Y.R.S. publications, especially "Design for Fast Sailing" that the limiting wave form depends on the length to beam ratio of a hull. If the waterline length is more than eight times waterline beam the hollow falls aft and greater speeds are possible. Increasing length to beam ratio reduces wave drag up to about 16:1 when the extra wetted surface area limits the benefit. Other designers claim that the ratio is between length and midship section, but the result is similar. Most multihulls rely on this feature of long narrow hulls to exceed their waterline length speed restriction. Most fast single hull yachts rely on flat planing hull form.

In light conditions skin drag and hull windage are significant in limiting speed.The multihull has a greater wetted surface per ton displacement and much greater windage, thus giving an advantage to a light displacement monohull. As the breeze increases a racing catamaran lifts one hull steadily reducing wetted surface. A cruising catamaran should never fly a hull just as a family car should not corner in a four wheel drift. It can be done but mistakes are dangerous and expensive.

In stronger winds there are usually waves. With the wind forward of the beam, waves slow all yachts but smaller yachts much more than larger craft of any type. Some yachts are designed to ride over waves and others to drive through them. Both are wet and uncomfortable in small craft in winds of force five or more. In short steep seas of wind against tide or fresh water lakes, slicing through the waves is probably best. In the longer waves of the open ocean it may be best to ride over them. The choice is speed against comfort - reducing speed increases the time between passing wave crests and slows pitching. This improves sail and crew performance. Design of a

by Pat Patterson



LOA	25ft	
BOA	16ft 8ins	
DRAUGHT	2ft 6ins	
DISPLACEMENT	5500 lbs	
SAIL AREA	330 sq ft	
HEADROOM	5ft 11ins	Saloon
	6ft 3ins	Galley & Toilet

"SUMMER TWINS"

yacht has a dramatic effect on her movement and speed through waves. Hulls with fine sharp points at both ends have only their length to damp out pitching. With a tall heavy mast the effect can be like living in a rocking horse. On such craft reducing the height and weight of the rig can make a dramatic improvement. A hull of this type causes minimum disturbance to the water and therefore has the best light weather performance.

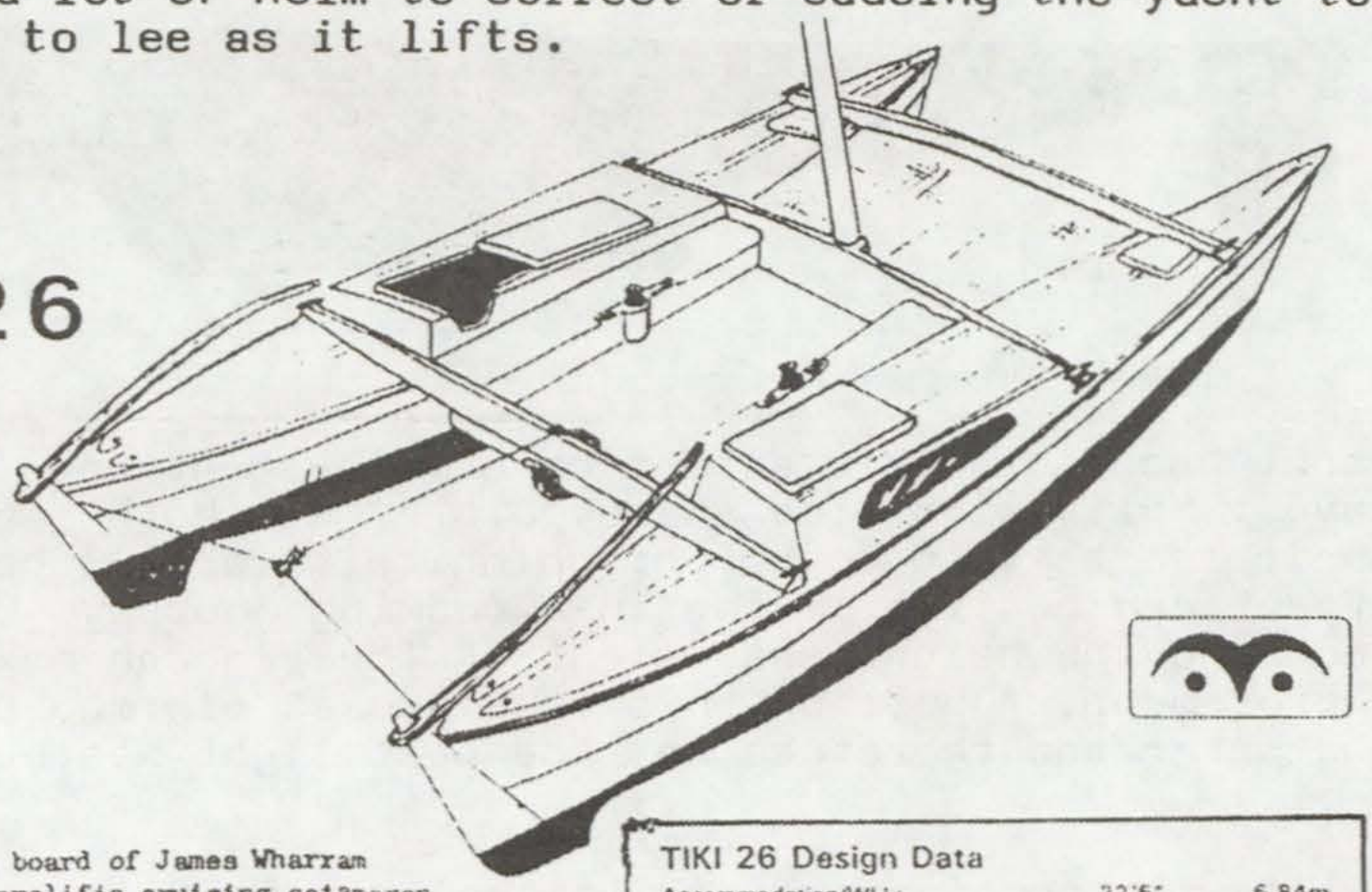
Hulls with sections which flatten out aft from midships so that the hull ends with a transom at or near the waterline damp out pitching and give more room inside and on deck. Providing the run aft is almost flat without much rocker the water will still flow cleanly aft and if the transom has a sharp trailing edge there will not be a stern wave. At speed the water leaving an immersed transom has the same effect as a hull of greater length however at lower speed there is drag from pulling water behind the hull. Weight at the ends of a yacht is always bad. By angling the transom forward there is a saving in the weight of the deck and crews are prevented from carrying weights like outboard motors and liferaft right at the stern.

Combining a flat aft section and transom stern with a fine sharp bow can lead to trouble running before steep waves - the buoyancy aft lifts the stern and the bow can drive under the wave in front. Running with too much sail in shallow water almost caused the author to pitch-pole a mark 1 "Iroquois" and as a result the Mk 2 has more buouyancy forward. By using flare and/or a knuckle it is possible to have a fine sharp bow at the waterline and more volume above. Inevitably this extra volume will slow the yacht when driving through short waves; the bow will be lifted by the forward buoyancy and the stern if flat will not sink. A feature of this combination on catamarans is that the pounding of the middle "bridge" deck is greatly reduced by the bow lifting before the deck hits the wave. James Wharram designs sharp double-ended catamarans and avoids this problem by keeping the bridge up to the hull deck level and not having a centre cabin.

Hull forms act the same for one, two or three hulls. There are trimarans with full bow sections and transom sterns that have fine sharp double ended floats. I am not aware of any craft with a fine main hull and full floats, although several trimarans have fitted extra inclined plates to lift the float bows as they drive into waves. This indicates a lack of

buoyancy and may cause serious drag well to leeward of the sail effort needing a lot of helm to correct or causing the yacht to swing violently to lee as it lifts.

TIKI 26



TIKI 26' comes from the board of James Wharram Designs, probably the most prolific cruising catamaran designers in the world. Wharram catamarans of a similar size to TIKI 26' have crossed both Atlantic and Pacific Oceans!

TIKI 26' is built by Imagine Multihulls, run by Steve Turner, a multihull builder for twelve years. Experienced in most modern materials and methods of construction, he has worked with several well known multihull designers, building prototypes and one-offs as well as production cruising catamarans.

TIKI 26 Design Data		
Accommodation/WLL:	22'6"	6.84m
Length Overall/Trailing Length:	26'	7.92m
Beam Overall:	15'1"	4.60m
Beam Each Hull:	3'11"	1.20m
Draft:	1'4"	0.40m
Sleeping Capacity:	Max. 6 people (4 in hulls double under tent)	
Weight (empty):	1300lbs	590kg
Weight of hull:	430lbs	195kg
Loading Capacity, approx:	1700lbs	770kg
Rig:	Gaff Wing Sail Sloop	
Sail area:	285sq.ft.	26.5m²

ARE MULTIHULLS SAFE?

The safety of a vessel and her crew are paramount. The requirement is always for a vessel suitable for the intended voyage and a skipper and crew with the knowledge and ability to cope with any situation that may arise. They must rely on the builder and the makers of the various equipment carried. In turn the makers of equipment, be it mast, echo sounder, cooker or bilge pump must rely on the ability of the crew to use it correctly and maintain it all in good working order. The marine environment is a harsh one for electrical and mechanical equipment so it is fortunate that the one essential piece - the magnetic compass- has been developed to almost total reliability. The "almost" is because it still depends on the crew not placing metal or magnetic objects where they will alter its reading.

The procedure for safe navigation of a multihull yacht is exactly the same as for any other craft. Their more comfortable motion and the lack of heel make chartwork, taking sights or reading instruments less difficult and as the crew are not so tired there are fewer errors. This is a matter of degree; in a storm all crews become exhausted and make mistakes. A multihull can offer greater speed to reach shelter before a storm in some cases, but most often it is safer for all types of sailing craft to remain well offshore and heave to or deploy a sea anchor. There is a book "Parachute Anchoring System" by Canasovas and others which describes the construction and use of large sea anchors by multihull yachts. This certainly seems to be satisfactory and practical in the Pacific but I have not received reports of satisfactory use in the North Atlantic. The time when it is prudent to postpone a normal passage and stop or run for shelter depends on the ability of the crew and their confidence in their yacht. Safety must always come first with the thaught "If it gets worse" or "If the main halyard breaks". In this all craft are the same.

Multihulls can capsize. This is a very rare occurence for cruising multihulls. So far we have never heard of a catamaran capsize in any storm without sail set. Remove the sails and your catamaran acts like a raft. The early trimarans with "low buoyancy" floats were thaught to be safe because they sail faster under reduced sail in strong winds; thus the crew reduce sail and the yacht is safe. Sadly three multihulls of this type were lost before it was realised that under certain conditions with a heavy confused sea after a storm in open water these yachts can capsize by the action of breaking waves without any sail set. Under sail they are safer. Since 1979 floats have had more volume, more than enough for one float to support the entire weight of the yacht. This prevents the float submerging

and allowing the yacht to roll over; she is forced sideways by a breaking wave in the same way as a catamaran. If at this time the drop keel is lifted, or if the keel is shallow so that the yacht can move sideways when hit by a wave, the risk of damage to windows and other fittings is greatly reduced.

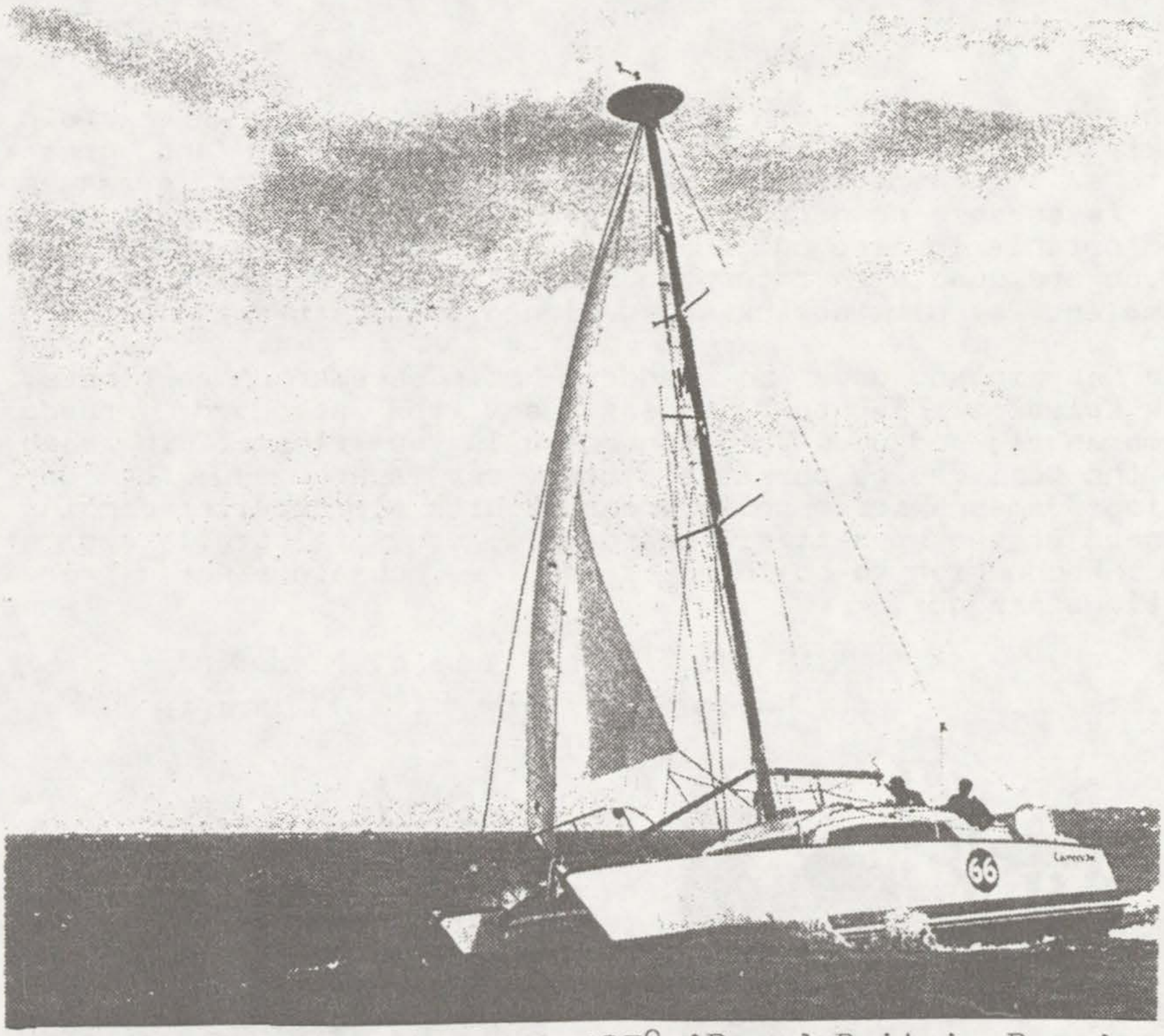
There are a number of designs, patents and ideas to enable the crew of a capsized multihull to right the vessel. These are largely ignored because the risk is not great. In fact for a cautious crew who reduce sail in good time the only risk is probably a freak squall with no one on deck to release the sheets. Many catamarans, especially the "Iroquois" and "Comanche" class by Sailcraft and the Michael Henderson designs have mast-head floats. These floats are very strongly recommended by M.O.C.R.A. and they have certainly saved several lives and some yachts. In the event of capsize they prevent total inversion so that the crew are not trapped in the cabin. The load on the float is light due to the leverage, and a passing launch can lift the mast from the water to the point at which the yacht has positive stability again. It is imperative that such a float is light in weight or it will cause excessive pitching. If the float is of disc or saucer shape it does not detract from sailing performance as it becomes an "end plate" to the sail. The "Iroquois" class have suffered several capsizes because they have narrow beam and relatively large sail area to give good performance in light wind. They also

have deep centreboards to give excellent windward ability. They were supplied with a 'hand book' or owner's manual pointing out the need for caution in winds of 18 knots or more. Still now, we sometimes read of another "Iroquois" capsize. Always the report says "suddenly without any warning". Invariably they were sailing at over ten knots, with the lee side centreboard lowered and usually with the sheets made fast. Eight knots is fast for a cruising yacht of 9M (30 feet), heavy by modern standards. The crew should be alert and pay attention, hold the sheet ready to let go in a gust. The "Iroquois" was designed as a fast coastal cruiser. Some have crossed the Atlantic. Many have survived violent storms. The Mark 2 was designed in 1966, but much has been learnt since then. The message seems clear- the vessel should be suitable for the intended voyage and the crew should have the knowledge to cope.

Multihulls do not usually carry ballast, except sometimes water in tanks in the windward hull or float. This means that very little extra floatation is necessary to make them "unsinkable". All cruising multihulls should be positively bouyant and float high enough to provide a safe platform for the crew even if split open and fully flooded. Under international racing rules any multihull entering an offshore race must float even when waterlogged. Sadly this does not quite mean that the yacht is unsinkable because fire of explosion can sink anything.

The International Yacht Racing Union (I.Y.R.U.) multihull safety rules list the minimum equipment to be an board for racing in coastal or open waters, also certain design factors such as the height of a cockpit deck above water level and the minimum size of cockpit drains. Yachts racing are pushed to the limit but they are sailing in company with others. A cruiser on her own might have to wait longer for outside assistance should lack of spares make this necessary. A cruiser should at least carry similar equipment, perhaps an extra anchor and more chain could be useful, but the rules indicate the minimum to carry.

The James Wharram designs have an excellent safety record, no yacht with his standard sail plan has capsized. This has been achieved by limiting the sail area and increasing the beam so that the yachts are stable in force seven, a near gale. By force seven the sea is so rough that the crew will reduce sail in any case. He relies on a shallow draught, easily driven hull for light wind performance and he does not have either fixed or drop keels to prevent sideways movement if hit by a breaking wave. It is the freedom to move sideways which is prevented by the deep board on the lee side of an "Iroquois". The answer to the question "Are multihulls safe" can be "yes".



"COMANCHE" by Sailcraft 1978 'Round Britain Race'

COMPARISONS

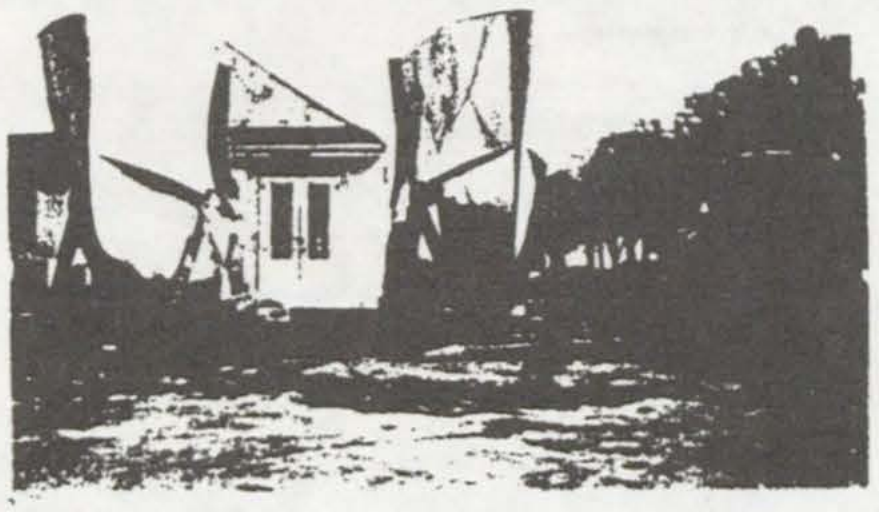
There are so many features which change within the various designs of monohulls, catamarans and trimarans that a simple table with star ratings is far from reliable. If it is not clear what advantage each type has over the others a reasoned choice is impossible. To choose a yacht because you like the rake of the mast is not practical but if you don't enjoy the look and lines of your yacht you loose much of the pleasure. Pounding round the North of Scotland to test an 8M (26') trimaran, designer Andrew Simpson would call me for every watch and remind me "We do this because we enjoy it". At 0300 in a gale it can be hard to believe, but the definition of a yacht is "a craft used for pleasure". In my opinion the craft best suited to her owner's needs will give most satisfaction.

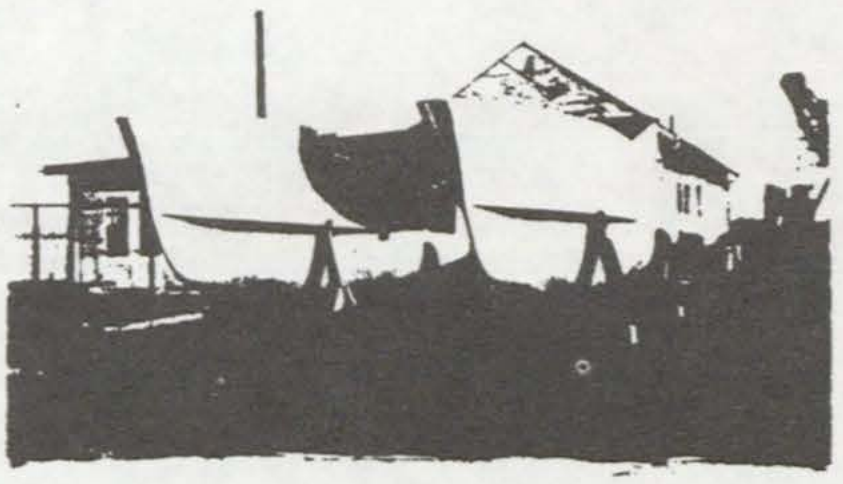
The first problem is size. The human frame and human needs do not alter. You need the same length of bunk, the same food and drink, the same charts and the same safety equipment on a voyage from A to B almost regardless of the length of yacht. A small yacht will need more food as the passage will take longer. If anything more than camping is required from a yacht of less than about 22' (7M) then a monohull has a clear

advantage. There are both catamarans and trimarans which fold quickly and lift onto trailers. They are very fast and great fun to sail if kept light. They can make long coastal passages under favourable conditions but are exhausting to sail and uncomfortable to live on. Bunks can be used if the wind changes and you are unable to return to base. Trimaran examples are the "Tremeleno" by Dick Newick who designed a hull to sail with a

Hobie Cat rig and uses the standard Hobie catamarans as floats. Derek Kelsal's "Typhoon" design uses the standard Tornado catamaran rig and uses the Tornado hulls as floats. In each case the hull can be parked and the catamaran used for day sailing. James Wharram sells plans or kits for trailer-camping cruisers of the same size. Fun to sail, easy to trail and a good introduction to building if you are considering a more ambitious project.

"BAHAMA 37" Designed by MacLear
& Harris built by H.H.Stilson in 1965.





A yacht which seems huge at a boat show, building in a garden or being painted on a hard is a very different size as she sails into the sunset with a crew and their equipment on board. After the day sailing and camping multihulls are the micro - multihull racing yachts. This class has a maximum size of eight metres (26') and the class rules are intended to encourage fast light yachts for racing inshore, able to trail behind a family car and providing basic accommodation for three crew. 'Racing' and 'Exciting' are opposite words to 'Safe' and 'Comfortable' but when considering a multihull you may require something of three of these features. An outright racer determined to win at any cost must be safe. He can't win if he does not finish the course. A family who want a multihull as a stable shallow draught platform to drift among the marshes to photograph birds, picnic or fish do not require excitement in racing terms but they can benefit from the light weight,the ease with which the craft can manoeuvre or fold onto a trailer for transport to another location.

There is a minimum size for a multihull cruiser able to withstand conditions that may be experienced on an offshore passage and this is around eight metres, say twenty six feet. The old "Telstar" trimarans designed by A.J. Smith and the "Heavenly Twins" catamarans by Philip Patterson are examples. The "Telstar" is also about the maximum size that it is practical to trail behind a family car, the last Mk 3 version was made light for trailing and the rig became almost too flimsy for serious offshore use. With catamarans below about 8 metres (26') it is difficult to get comfortable sitting headroom in a middle cabin with the bridge deck clear of the water without excessive windage and a yacht which looks like a floating caravan. Waves produced by a force five breeze are the same height regardless of the size of your yacht. A small bridge deck catamaran tends to pound badly and make little progress in such conditions. For conventional catamarans with narrow hulls, I consider the minimum length for comfort and stability offshore to be about 9 metres (30 feet), longer if the ends are fine, less for full rounded hulls better able to carry weight.

For an offshore multihull at the lower end of the size scale I think the trimaran offers many advantages and can probably be more seaworthy if speed is a requirement. If width has to be limited then it has to be a catamaran. The trimaran main hull provides a secure base for the mast. The forestay can be set up tight for good windward performance. Having the accommodation in one main hull gives full standing headroom without an extra high cabin while bunks and seats can extend outwards above the waterline. The weight of water and stores can be kept low while the extra cabin volume provides reserve stability in extreme

conditions. The beams, known as "Aka" in U.S.A. need to be strong beyond question but even so they can be made to fold or demount without adding a lot of extra weight. Beware of floats held in position by bracing wires, especially wires leading upwards from the hull near the waterline. The drag of these wires in the water at speed is great. The loading at the ends when a heavy load is applied in the middle of a tight wire can be enormous. Even a strut in this position can easily bend and apply a huge load at the joints. If the yacht has such water stays make sure that the attachment points have massive strength, certainly stronger than the wires.

The smaller trimaran can offer a convenient living space, one hull with the mast over the keel so that the main loads are concentrated in a strong unit without excessive weight. The floats can be of lighter construction but adequate to cope with sailing loads and strong enough to hold an unsupported fully loaded main hull with reserve for impact loads.

Around 10 metres (33') length there comes a change so that the catamaran becomes preferable for cruising. At this size there can be comfortable headroom over a middle deck without undue windage but with reasonable clearance over the water. The catamaran hulls are now big enough to provide a good cabin fore and aft with space between for galley, toilet and shower. There

is room to dress or remove wet clothes without making the boat wet everywhere and adequate ventilation can be provided through the hulls. At 11 metres (36') a trimaran offers a vast cavern of space in the main hull, if the saloon and sitting area is raised for an all - round view there can almost be standing room under the floorboards. The floats are now vast and must be divided into small compartments to prevent the free flow of water should one become flooded. On a small trimaran storage space in the floats is useful for ropes, fenders, scrubbing brush and fishing rods. On larger trimarans such equipment tends to get lost at the bottom of a vast pit and a deck must be provided to keep them in place.

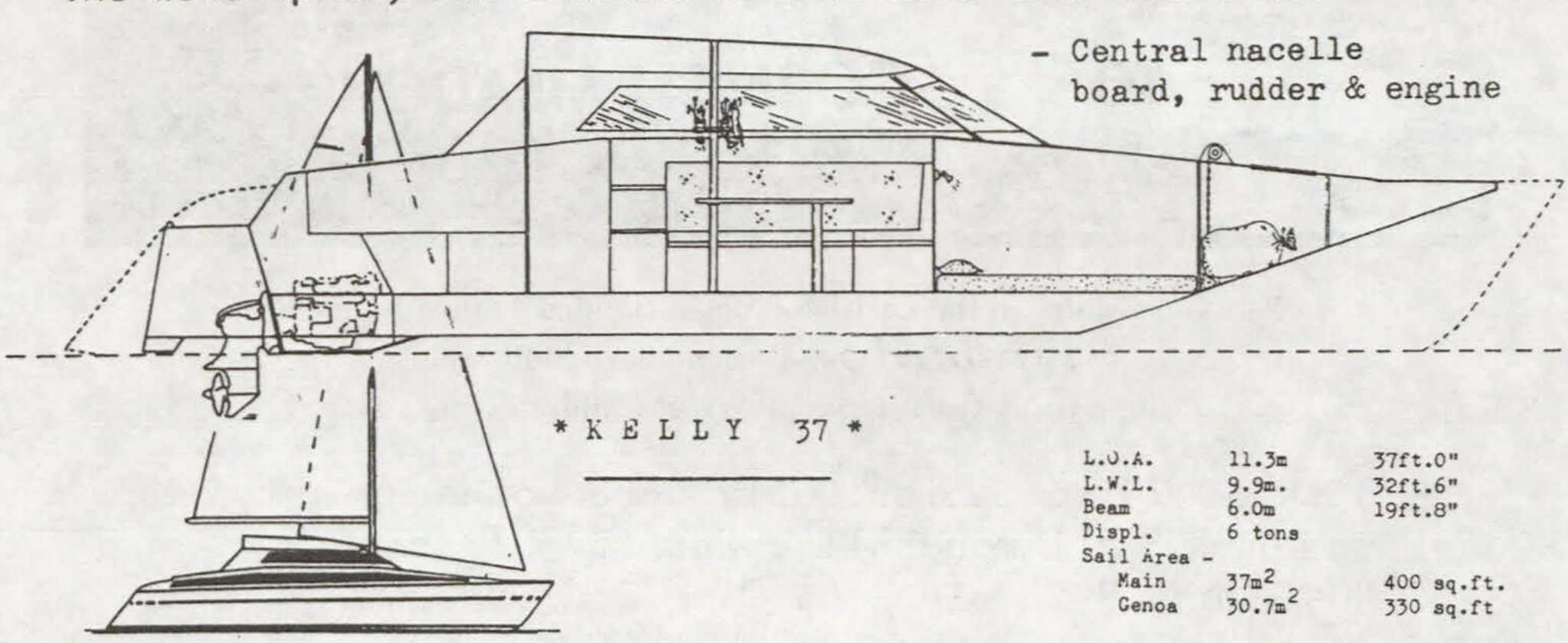
Most standard travel lifts will accept yachts of twenty feet, just over six metres beam and this is a good reason for cruising yachts to stay within this limit. There are also locks and several canals which craft wider than this cannot enter. Beam is also a restriction in marina berths and crowded harbours. Multihulls with shallow draught can often find a sheltered berth away from the main moorings but when cruising it is often useful to visit popular places if only to stock up with water and fuel. A further point here in the catamaran's favour is that the hulls are usually stronger than trimaran floats which makes them better able to withstand the every-day knocks when lots of other craft moor alongside. In a crowd the smaller craft like to find something bigger to tie up to !

Pete Goss' entry in the Carlsberg Single Handed Trans Atlantic Race
Firebird One Design Micro Multihull.
Supporting Great Ormond Street Children's Hospital.

35th of 73 to finish, only three other yachts under 30' all monohulls. 2nd to 30' trimaran "Caledonia" in class 6. Time 23d 05h 04m.

At the smallest sizes of cruising yacht the single hull offers several advantages. Again at the largest size a single hull begins to score more points. Where do you moor a seventy foot multihull sixty feet wide ? At what cost ? - although if you can build such a yacht cost will not be important. At some stage it becomes necessary to lift out for antifouling and repairs. There are ports around the world for fishing fleets where a monohull of any size can be serviced but a wide light displacement multihull can be quite a problem, especially a catamaran because the hulls do not fit a standard cradle on a slipway. Mobile cranes are generally available but the weight they can lift reduces with the distance from the vehicle so that wide beam is a disadvantage.

Single hull yachts of about 14 metres (45') can have a comfortable deck saloon to sit in and look around. They can probably cruise at a similar average speed and offer as much deck space as a catamaran of about eleven metres (36'). From this size upwards the choice is between a catamaran and single hull yacht for cruising purposes. Of course, single hull yachts are available at any size and to many people the solid feel of a heavy displacement hull ploughing along with the lee rail just awash is the greatest pleasure. For them no multihull can stand comparison. In an ideal world they would be able to sail for an hour in the cockpit of an upright multihull making twelve knots in twelve knots of wind leaving hardly a ripple to mark her passage. Such speed is obtainable from the micro multihulls and other racing craft, from trimarans above ten metres (33') if lightly loaded, from catamarans of about eleven metres (36') and monohulls of above twenty metres (60'). Below these sizes, as a general rule, weight requires a hull beam such that waves form to limit speed. Cruising yachts often have a hump or drag peak at around eight knots and this speed can only be exceeded in stronger winds when running. To sail at or above the wind speed the apparent wind must be forward of the beam, the yacht must have a favourable sail area to weight ratio and the windage of the hull and rigging must be minimal. An efficient racing multihull in calm water can achieve double the wind speed; and sailboards have also achieved this.



* K E L L Y 37 *

L.O.A.	11.3m	37ft.0"
L.W.L.	9.9m.	32ft.6"
Beam	6.0m	19ft.8"
Displ.	6 tons	
Sail Area -		
Main	$37m^2$	400 sq.ft.
Genoa	$30.7m^2$	330 sq.ft

AUXILARY POWER

Multihull speed need not be limited by waterline length therefore the drag of a fixed propeller greatly reduces the top speed as well as killing light wind performance under sail. Weight is also important and must be considered, not only because it reduces speed which to many is of little importance but because heavy loads need a strong structure to support them and the load on the hulls must be considered, for example when the yacht is aground. Every cruising yacht must be strong enough to cope with normal knocks and bumps, not just once or twice but over at least a twenty year life; fifty years is reasonable to expect. To add a heavy inboard engine adds also

the engine bearers, thrust blocks, batteries and all the extra stiffening so that , with fuel, the power unit may be a significant part of the total displacement. This is why it is not a simple matter to have a cruising version of a racing yacht be it one, two or three hulls. The buoyancy of the hull should be designed for the weight of the engine and fuel.

The choice for a cruiser auxilary is between inboard and outboard engine. Inboards can be petrol or diesel. An excellent option is the variable pitch propeller. The "Saildrive" unit from Volvo provides a leg like an outboard ready to bond into the hull, easy to install as it does not involve accurate shaft alignment and it can have fixed or folding propeller. With a transom stern or a low wing or bridge deck, an outdrive unit can be fitted which lifts clear of the water by swinging sideways or tilting aft. These units can steer for extra manoeuvrability and may include a gearbox to save the cost of one mounted on the engine although this may mean that the engine cannot run to charge the batteries with the unit tilted. Usually a multihull has shallow draught and little rocker which requires an inboard with conventional shaft to be mounted at a steep angle or to have a very long shaft. Sometimes a steep angle causes lubrication trouble. With variable pitch the blade angle is set by using a double shaft. The blades change from being in line with the keel for minimum drag when sailing through 90 degrees for neutral and on for astern pitch. There is no need for a conventional gearbox and the great advantage is that power can be used to obtain extra speed under sail without racing the engine or the yacht can drive to windward against a head sea without overloading the engine.

Propeller drag has been mentioned as a major factor in the

choice of power unit, how important depends on performance required under sail. Obviously for a yacht which always uses power to windward and in light winds drag may be acceptable. Another factor is reliability. A fixed propeller on a shaft directly coupled to the engine is simple and strong, nothing can fail to open when you need power astern. Against this is the growing problem of discarded nylon fishing nets, old rope and polythene which drift about just below the surface waiting to foul propellers and cooling water intakes. Advantage here to craft with outboards and outdrive units which can swing up and be cleared in a few moments. Special cutters can be fitted to fixed propellers to cut ropes and nets or a trunk can be built to open above the propeller so that ropes can be cut free.

On all craft, but especially light displacement vessels, it is very important to keep weight away from the ends and towards the middle. This goes against an inboard engine to transom arrangement on a trimaran. A further problem is that having the rudder in the middle would require the drive to be offset. The trimaran configuration suits a single engine installation and as trimarans are most often chosen for performance rather than pure comfort an inboard to sail drive is often chosen. Sometimes a jet unit is fitted which saves drag but is not efficient at the lower speeds of cruising yachts.

Diesel engines are regarded as being more reliable than petrol because they do not rely on electricity. This advantage is not taken up on several yachts which are fitted with marine versions of car engines without provision for hand starting when the batteries are flat. Lucas CAV make a spring starter which can replace electric starters on diesel engines up to one litre per cylinder and a maximum of six cylinders, probably at less cost than the electric starter and extra battery capacity carried by most people while the weight is certainly less. Profit margin on batteries is probably better for the boatyard... A diesel engine weighs more than a petrol unit but will give two to three times the distance per gallon of fuel compared to an outboard. The diesel will cost much more than a petrol inboard to install. For long passages under power the extra weight of fuel cancels the light weight advantage while the extra cost of petrol cancels the lower purchase price if many long passages are intended. Probably the biggest point in favour of diesel fuel is the lower risk of explosion or fire. If safety is paramount take the extra weight.

On a multihull petrol tanks can be fitted outside so that, like gas, leaks will not enter the living space. This takes care of leaks at the tank but most often the trouble is a flexible pipe that perished or a float that sticks or a connection working loose. Detectors are available and with care and proper

installation petrol marine engines can be safe and reliable. For a mainly racing multihull on which the engine is only used for short periods the choice is between inboard and outboard petrol units.

OUTBOARDS. The main complaints against outboards on multihulls are the cost of fuel, inability to drive against a head sea and being unreliable due to spray or being submerged. The fuel complaint usually applies to a large engine on a long passage. In calm conditions a tiny engine will drive a multihull at quite a reasonable speed, the large engine necessary to give bursts of power manoeuvering in tight spaces or driving out of harbour against the wind and sea is just not efficient running on a light load, it was not designed to do this and probably the propeller has the wrong pitch for the cruising speed. Better to use a smaller engine or a four stroke outboard. The engine, especially if mounted aft will not drive into a head sea because the propeller is often out of the water as the boat pitches. The same conditions may make the engine unreliable due to excessive spray or being submerged. Lack of drive may also be due to high revs and a small propeller intended for a speed boat so a change of propeller may make a great improvement. Available to cure these problems are four stroke outboards, outboards which run on 100:1 fuel mix, outboards with waterproof ignition. The type to buy as an auxiliary will have a low gear ratio and large propeller to deliver power at low speed.

An outboard can be mounted to drive through a well or trunk in the hull. This brings the weight forward, eliminates cavitation and problems from spray. The wash from the propeller can go over the rudder to improve steering and the boat can be steered by moving the engine to manoeuvre or should the rudder fail. The trunk must be properly ventilated so that the engine receives clean air and must have means of closing to fair with the hull when the engine is lifted. The advantage of an outboard is that it can be taken ashore for service or repair or if the yacht is not being used for a long period. No engine, especially no petrol engine should be left in damp humid conditions without being used. If an outboard fails you can borrow or hire a replacement, it can also be lifted clear if it should foul or the yacht is to dry out on a beach.

Catamarans often have an engine, inboard or outboard, mounted on the middle bridge deck. Often this requires an extra long shaft to get the propeller deeper than might be expected from looking at the waterline. The engine is well forward and the drive is away from the position of maximum movement. This cavitation problem is caused by a hollow in the water between the hulls as their bow waves move aft. If this hollow prevents

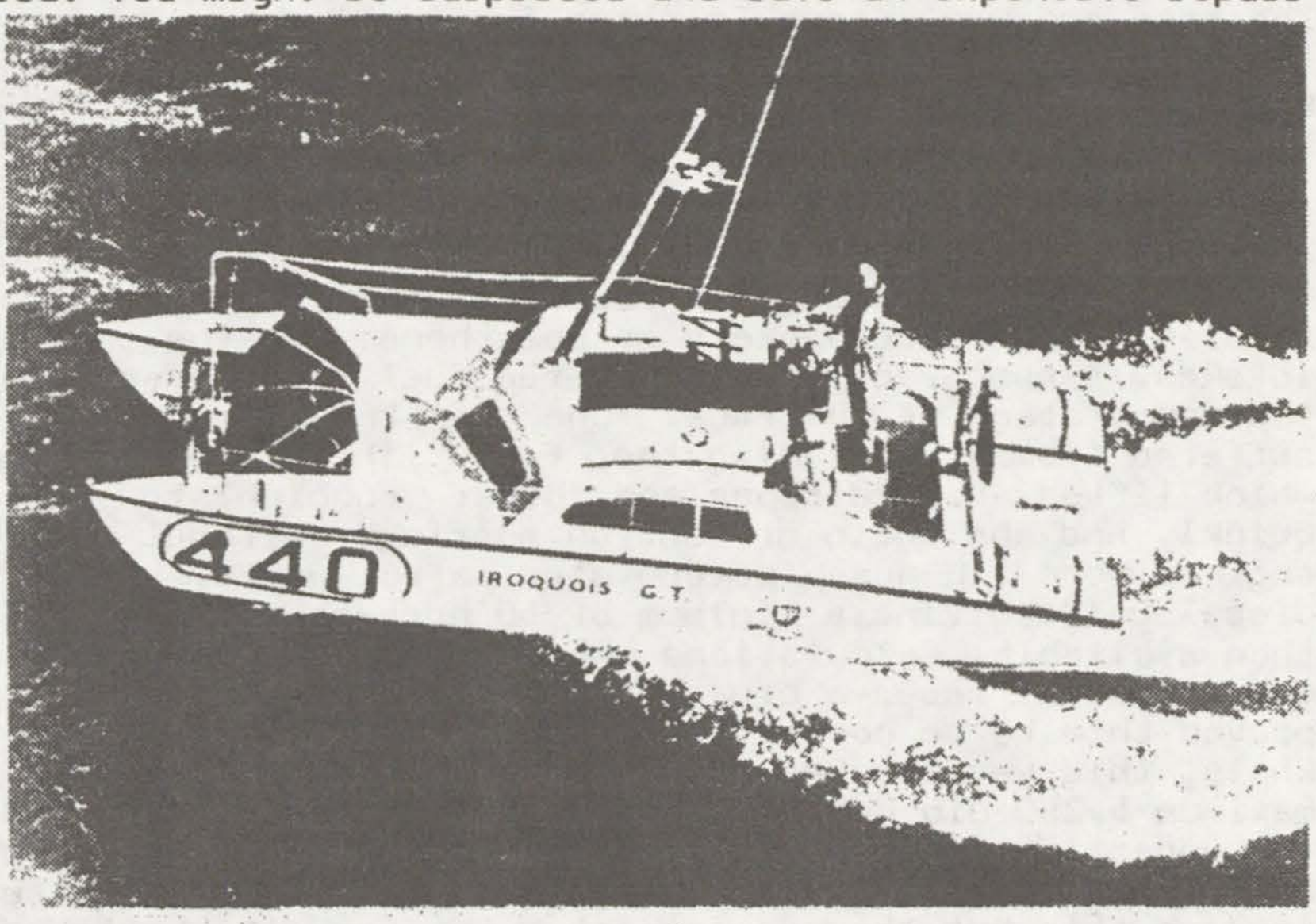
running at the optimum speed it may well be best to move the engine forward, aft or sideways. Adding an extra section to an already long shaft puts a great load on the mountings due to the leverage while the extra drag of the shaft at low speed may prevent reaching the desired speed anyway. By looking carefully between the hulls at different speeds the wave formation can be observed, moving the drive to one side makes little difference on straight courses and can be used to help manoeuvering. A catamaran of moderate beam can have an engine in one hull and be quite satisfactory when the skipper gets used to handling her in tight corners.

The Catfisher motor-sailer catamarans have a single diesel engine driving two three-bladed fixed propellers through hydraulic pumps. There is considerable power loss but fuel economy and weight should be better than running two engines. Diesel engines designed for marine use are usually heavy and slow running. Great flexibility and instant response to throttle control are not required at sea. Many industrial/automobile engines are supplied for use on yachts, these are lighter in weight and run at higher revs but can be satisfactory especially if fitted with reduction gears. Advantages include lower cost and availability of spare parts. It is most important to ensure that there is a facility to start the engine by hand and that the engine oil can be changed easily. If a small amount of water enters the engine,for example leaking through a shaft driving a cooling water pump, the oil emulsifies and becomes thick. Like ice cream in lemonade it will be impossible to suck it out through a straw. A tiny pipe stuck down the dipstick opening is not satisfactory - such an engine if fitted must be easy to lift out for repair. In general diesel engines with direct injection are less difficult to start and give better economy than indirect injection models. Multihulls do not require ballast - make sure you can start your engine when you need it.

To be reliable engines like frequent regular use. An inert lump of various metals has no mind or memory. It must be the owner who needs the practice of regularly starting the machine, saying the right words in the correct order. When not in use it corrodes, erodes or decays according to the nature of its parts - iron, aluminium or rubber. Regular use gives lubrication and protection. Batteries also benefit from discharge and re-charge or they too become lazy and the engine gets the blame for failure to burst into life. The greatest possible help to keep an engine reliable is to keep it clean. any slight leakage of fuel, oil or water is likely to be noticed before it becomes serious. Fuel pipes should be continuous metal from tank to filter, protected from chafe by rubber grommets when passing through clips or bulkheads and from vibration by loops or

coils. My personal preference is to have the first filter of glass bowl type which traps water and shows that water is present. This type is not acceptable for petrol on racing craft due to the risk of the glass breaking by accident. In general multihull engines are better installed and better maintained than on single hull yachts however there are several production yachts which need a dwarf with three arms to get into the compartment, hardly an "engine room", and carry out the daily inspection listed in the hand book. Engines on yachts of all types are less reliable than they should be. Some problems are due to fitting engines not suitable for use near salt water, some due to poor installation.Small yacht building firms are often not good mechanics. Most problems are probably due to neglect of simple precautions and care by the crew. There is an excellent book on care and problems with marine engines called "Engine Monitoring On Yachts" published by VSD.

The power needed for an auxiliary is usually greatly over estimated by owners. In a calm, a four horsepower outboard should give a two ton displacement yacht, say a 10 metre (33') multihull, over five knots if the bottom is clean. My six ton displacement monohull, 8 metre (24') waterline, maintained five knots at three hours per gallon with a four horse power petrol marine engine. To manoeuvre in tight spaces and in strong winds a 10 metre (33') multihull needs an engine with more power, perhaps 12 or 15 horsepower. Some popular outboards are not suitable for use in salt water - look out for steel pins in aluminium castings for example. Preferably ask the maker or agent for written confirmation that the engine is suitable for use at sea. You might be surprised and save an expensive repair bill !



Mk 2A "IROQUOIS" in 1969 R.B. Powerboat Race.

POWER FOR MULTIHULLS

The conclusion of 1968 seems correct in 1988 - a catamaran of modest beam can be almost ideal as a power cruiser. "Tradition" cannot be a reason for the lack of popularity - no traditional craft looks like a modern motor yacht !

To most people "power" and "catamaran" either means a racing machine or an auxiliary to be tolerated in a sailing yacht. In 1968 a yachtsman asked for a power cruiser able to maintain fifteen knots in fair weather, shallow draught to dry out upright on a mooring and with a comfortable motion so that his wife could enjoy picnic and fishing trips. The answer was an "Iroquois" sailing catamaran without mast or centreboards and the result was the first extended "Iroquois" fitted with twin inboard engines, outdrives providing steering. This power cruiser took part in the 1969 'Round Britain' power boat race finishing 20th out of 64 starters at an average speed of 20 knots. She had one of the few crews to live on board throughout the race and was second in class for the lowest powered boat to finish. One of her main advantages over other craft was a progressive increase in speed as more power was applied and not depending on two engines giving power to lift out onto the "plane". Single hull craft were reduced to about eight knots in the event of an engine problem whereas she could maintain eighteen knots on one engine if the other outdrive was lifted. The main cause of engine problems was overheating due to rubbish - cigarette packets or polythene - in the cooling water intakes. A number of craft suffered fuel trouble especially on the rough stage of the race. One of the "Iroquois" engines suffered from air entering the fuel line. Having propellers which lifted enabled ropes and other rubbish to be cleared quickly and she could dry out on moorings without worry. Her engines were 110 horse power Volvo petrol units, light weight diesel units giving a minimum of 50 horsepower each were not then available. Calculations showed that 100 horsepower would give a useful reserve cruising at fifteen knots and trials proved this to be correct. Top speed and cruising speed was 25 knots, this was reached at 4,800 r.p.m., but increasing to the maximum 5,200 did not increase speed due to bow wave drag on the underside of the bridge deck. Had the yacht been designed as a power boat the hull shape would have been altered to improve this but the requirement was for 15 knots and the owner's budget did to extend to model testing and the cost of a new hull mould.

FOILERS

Hydrofoil stabilised yachts, named "Foilers" by John Morwood and Gerald Holtom, offer several advantages to cruising yachtsmen. A lot of research and development has been done by A.Y.R.S. members and the results published, but so far the few racing craft to try foil stabilisers have not taken note of past trials and experience.

Edmond Bruce shows that removing the keel area, perhaps a centreboard, from under a hull eliminates heeling because a rounded hull will blow sideways. If the board is held to leeward at an angle of about 45 degrees so that the centre of

its immersed area bisects the center of effort of the sail then as the wind blows the hull the lift from the inclined board prevents any heel and its drag prevents leeward drift. If the craft moves (forwards or backwards) the water flow across the board maintains this lift and resistance to leeway. At no time does the yacht heel and at normal sailing speed leeway is no more than with a fixed keel. At moderate speed the board planes and there is no water on its windward surface. Mr Bruce further discovered that performance is better with this single foil to windward and holding the craft down. In theory this is not true as the board (called a hydrofoil) when to leeward is tending to reduce the displacement of the main hull as it tries to lift. If offshore sailing is contemplated experience, has proved that the single foil to windward tends to lift out of the waves and rapid action becomes necessary to prevent capsize. The next stage used two foils as a trimaran with only the lee side one in use. This configuration works and can be fast, but the yacht is sailing at an angle of heel, and with a good breeze with the craft at speed it is possible to capsize by bearing away from the wind under full helm. The cause is the change of water flow over the foil as the yacht turns - it transfers to the windward side and pushes down on the foil. To prevent this David Chinery designed "Mantis 1V" to sail with both foils immersed and for the same reason my Telstar-Foiler "Sabu" also has two foils immersed. Neither of these yachts heel more than four degres when sailing normally although when reefed they sometimes heel to windward.

"Mantis 1V" was entered for the 1974 'Round Britain' race. Due in part to anchoring to wait for fog to clear she made a slow passage to Crosshaven, the first port. While there the French 23 metre (70') trimaran "Manureva" dragged her anchor and lay across the bow and starboard foil of "Mantis". The 'wing' holding the foil was only 3.3M (4') wide (the width of a sheet of plywood) built with a single laminated beam faired by two skins of plywood having an aluminium tube at each edge. The

beam flexed in a most alarming manner and it was decided that to continue might be foolish as the beam might have been badly strained. In fact there was no trouble with the beams except that they flexed badly when sailing fast and due to the 'gull wing' when the beams twisted the foils were no longer parallel to the keel, causing enormous drag. There was a further problem with the foils in that it was difficult to lie alongside a wall and almost impossible for other craft to come alongside. The foils were lens shape 5 metres (16') long with enough buoyancy to support two people so that it was easy to climb on board. "Mantis lV" was built to a very limited budget, equipped with second hand masts and sails so that her performance was never expected to match racing multihulls. She proved very satisfactory at sea but heavier and slower than hoped for.

After "Mantis lV" a "Telstar" trimaran hull moulding was purchased without a centreboard case, and an aft-cabin yacht of similar weight and sail area was built using foils in place of the standard floats and providing floatation for positive buoyancy. The standard "Telstar" will sink if the floats and main hull are flooded although collision bulkheads should prevent this. With much help from A.Y.R.S. members "Sabu" was launched at Southampton in time to qualify for the 1982 'Round Britain' race. Racing against many similar yachts has shown that "Sabu"is neither faster nor slower than other "Telstars". With two foils immersed one might expect her to be slow on down - wind runs but in fact her position in a race depends more on navigation mistakes and crew concentration than wind direction. Some days she did well, others not.

Multihulls and hydrofoil craft benefit from a sail plan with a low centre of effort to reduce the heeling moment and the inertia of a high mast although in light winds a tall rig is a bonus because of the wind gradient. So far a proper sail rig for cruising multihulls has not been developed, but experiments continue. "Sabu" has a new mast and "flying gaff" rig. This has increased the sail area by 25% and reduced the mast height by over a metre (4'). On some courses the rig is fast but unless I become brave enough to slack off the lee side shroud the sail cannot set properly with the wind free. "Sabu" has cruised to France and made several passages along the South English coast. The foils damp out much of the movement including a big reduction in pitching which can be uncomfortable on these small trimarans.

In gale conditions with breaking waves "Sabu" proved safe on all courses but she would not lie head or stern to sea with a conventional sea anchor in a force seven wind in open water - she just swung beam on to the waves. It proved much more comfortable to sail slowly heading to windward with the storm jib sheeted midships, a small area of mainsail and the helm lashed. When hit abeam by a breaking wave the lee foil lifts and as she slides to lee the weather foil digs in and heels the

yacht to windward bringing water onto the windward deck and over the cabin. The cabin side slopes and is not large so there is little danger of it being stove in. The wing decks were built solid with compartments like an egg box for strength, lightness and buoyancy. Calculations indicate that she has a positive righting lever when heeled to 90 degrees by virtue of the immersed wing and cabin side.Tests with model foilers by Gerald Holtom show that they self right by the action of the wind and waves if forced upside down provided that the foils and wing are not buoyant. In the case of "Sabu" the wings are buoyant for convenience in harbour and a small mast float was originally fitted to prevent total inversion. There is a full description of the "Sabu" project in A.Y.R.S. publication 95.

Conclusions: Foilers offer similar accommodation to trimaran yachts with the following advantages.

1) They sail upright which is more comfortable and more efficient for the sails.

2) Foils are lighter and less expensive to construct than floats.

3) It is less complicated to make a foiler fold for transport, canals or marina. There are of course problems

1) The minimum strength is unknown. The foils on both "Mantis 1V" and "Sabu" were built strong enough to support the entire weight of the yacht in sailing trim. In rough water the entire weight has been supported by one foil but there is also considerable shock loading when sailing to windward fast in rough water.

2) The ideal foil shape is unknown. There are indications that long shallow flat foils may be preferable to deep high aspect ratio foils. David Chinery did a lot of research and trials before adopting the lens shape foils of "Mantis 1V" - the problem was making a rigid connection to the hull to prevent twist.

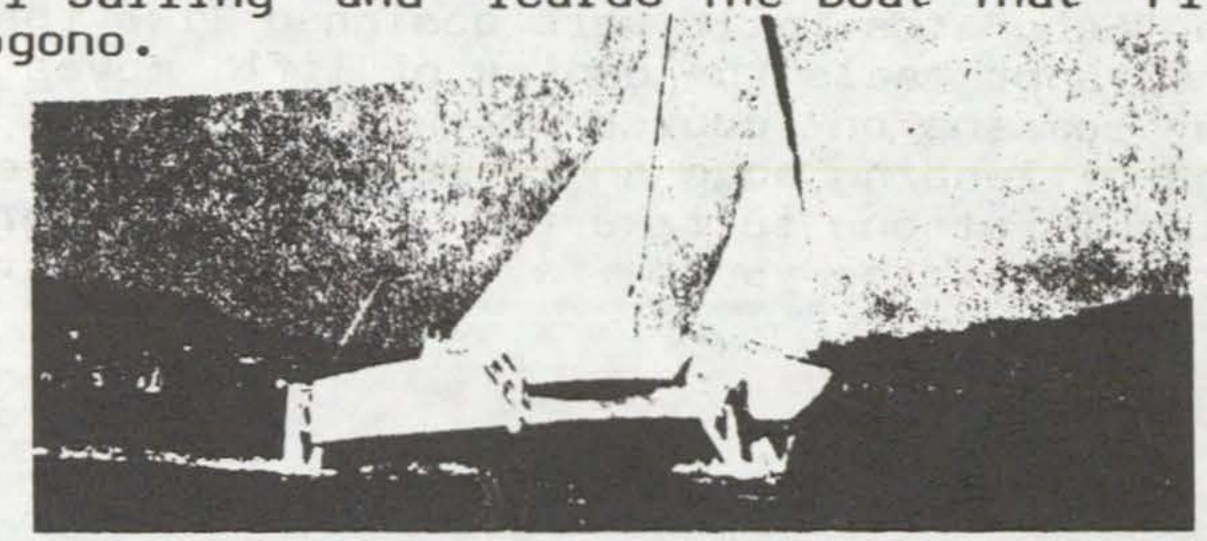
3) If both foils are immersed when sailing they must be set fore and aft in line with the water flow when running dead down wind. Notes: In theory keel area or projected foil area should be 4% of sail area but 6% of sail area seems most usual for foilers. On "Sabu" the foils were designed like the wing of Concorde. If the yacht heels the centre of lift moves forward steadily and she remains on course without tending to bear away. The change of leading edge angle is supposed to reduce tip loss. The tip is strong to take the weight when grounding. Foils are just clear if the yacht is upright on hard level ground.

FLYING HYDROFOILS

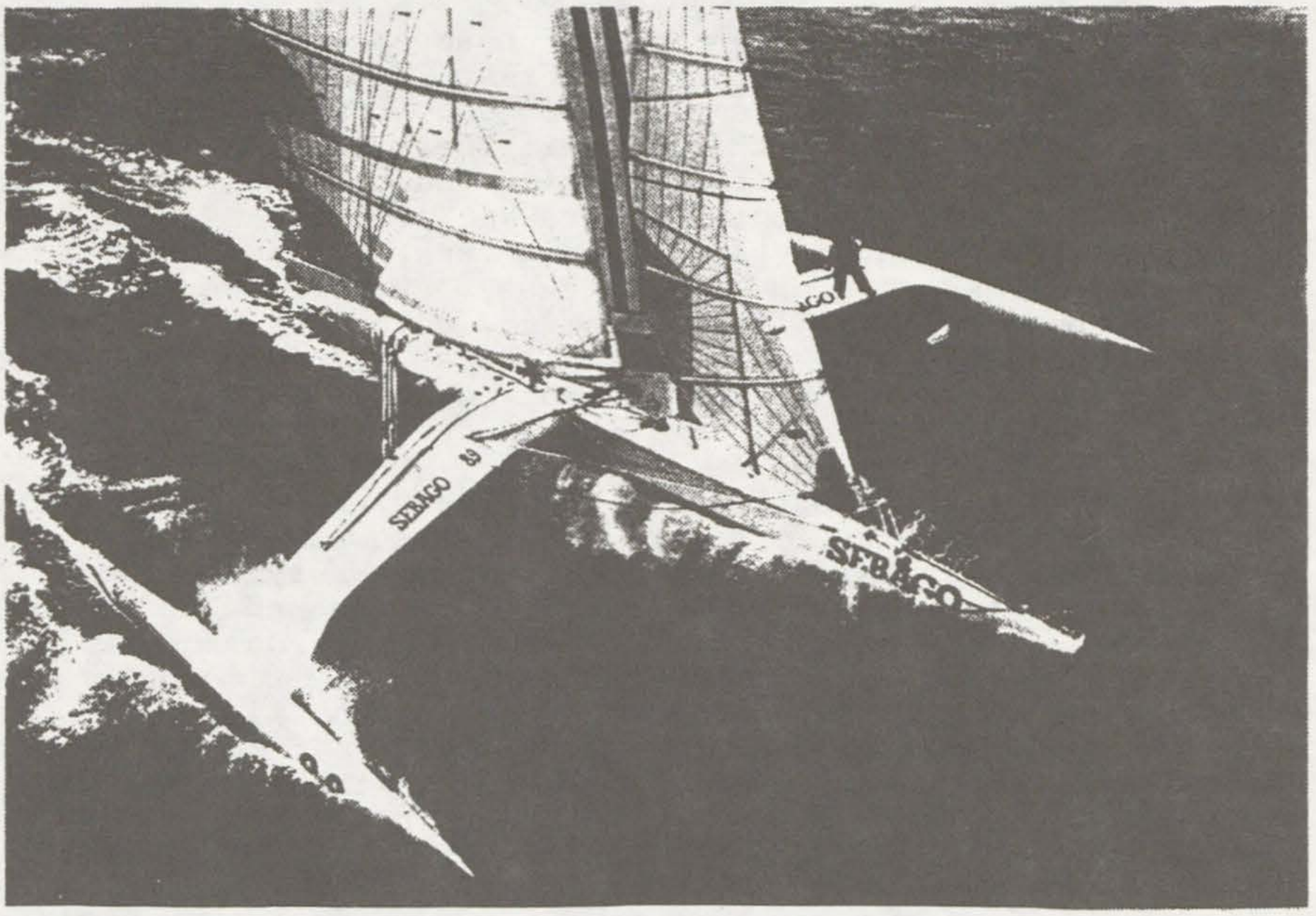
David Keiper proved with "Williwaw" that a flying hydrofoil offshore yacht can be practical by sailing from U.S.A. to New Zealand and back. "Icarus" and "Mayfly" have shown that, for limited sail area classes, flying hydrofoils are the fastest craft in sheltered water by consistently raising world sailing speed records. ("Icarus" increased from 21.6 knots in 1972 to 28.1 in 1985. "Mayfly" in 'A' class from 16.4 knots in 1972 to 23.0 in 1977). The fastest "Tornado" without foils is about 18 knots. For offshore racing yachts lifting foils are now being fitted to trimaran floats but in general they have not been accepted, mainly because they offer no advantage in light wind or sailing close hauled. It probably seems that the improved performance would be more than cancelled by the increase in weight and windage necessary to fit and carry the foils. Performance in storm conditions is unknown. In our publication 68 and in our book 'Sailing Hydrofoils' (1970) we published details of the mosquito class trimaran "Sulu" with photos from 'Yachting World' showing a retracting lifting foil which folded into a case like a centreboard. At speed this foil tended to lift too much and rise to the surface but James Grogono has devised a method of lift control which limits lift from inverted 'T' foils if they rise above a set depth by bleeding

air down the strut. An inverted 'T' foil aft, as discovered by Philip Hansford the designer of "Mayfly" gives automatic control of the hull attitude fore and aft. If the bow lifts the foil takes a positive angle and lifts the stern. If the bow drops the foil aft takes a negative angle and pulls the stern down. Such foils can be fitted to the rudders of conventional multihulls to damp pitching, but multihull rudders are already loaded to the limit. All fittings and adjacent structure would have to be strengthened if foils are not part of the original design. Unlike low aspect ratio foil stabilisers, lifting foils only work when the yacht is moving forward at a reasonable speed, and do nothing to help stability when the yacht is hove to with headsail aback. The advantages of lifting foils for a cruising yacht can almost certainly be obtained at lower cost by more conventional means however it would be a very interesting project.

Useful hydrofoil references are "Sailing Hydrofoils" -(A.Y.R.S. publication 74)- A.Y.R.S. 90, "Hydrofoil Options" also "Hydrofoil Sailing" and "Icarus The Boat That Flies" both by James Grogono.



WILLIWAW at speed. Note weather foil is out of the water



"SEBAGO" Philip Steggall, 4th 1988 C.S.T.A.R.(U.S.A.)

HANDLING MULTIHULLS

In the 1960's it was considered that multihulls needed special skill and care in handling. At the time there were some very difficult craft about, new and experimental. Some light weight with high topsides, no streamlining, long keels and shallow rudders. These craft earned a reputation for missing stays and never getting to windward. Today the multihulls have improved greatly and the yachtsmen have also gained the experience of handling or watching light displacement, high freeboard monohulls which can seem just as awkward when "parking" in a confined berth with a strong cross wind.

The windage and light weight of a multihull does mean that care and some skill is required to handle them, especially in a breeze. This skill can easily be acquired by practice away from danger. It can not be learnt in a confined marina because part of the art is to be bold and keep the vessel moving forwards or backwards so that the rudders are able to steer. Speed is always dangerous, a gentle nudge as two yachts touch with a fender between is harmless. A collision at three knots probably means that the crew do not have time to position a fender and will at least result in expensive repairs to guard rails and paint on both vessels.

A multihull under sail when brought head to wind will stop very quickly and then rapidly start drifting astern. When tacking the crew can either be smart and get the headsail across quickly, perhaps easing the mainsail sheet if it was set to windward of midships, or they can let the headsail back to push her head well round onto the new tack. With any yacht it is foolish to stand on too far before tacking, much better to leave room to wear round just in case a sheet takes a riding turn, a sudden wind shift or a reflected wave during the manoeuvre mean that you "miss stays". This was standard practice in past time when ships worked under sail.

A further feature of multihulls which requires the same action as with ancient ships is to run before a squall. If the yacht is overpowered or in danger of capsize bear away and run before the wind. If the sheets and halyards are released the mainsail may flap against the spreaders and tear. The damage will be much less than a capsize would cause. The only time not to bear away is when sailing close hauled. Hard on the wind it is best to ease the sheets or head up into the wind. If too much sail is set and the yacht comes head to wind in these conditions she will be driven astern, then swing beam on to the wind and waves.If the halyards are released and free to run it should be possible to get the sail off before she swings: beam on without sail is uncomfortable but not dangerous. Beam on with no forward speed, sails sheeted in hard, in a squall could be a disaster. The risk depends on the sail area set, the strength of the wind, steepness of the waves and design of the yacht.

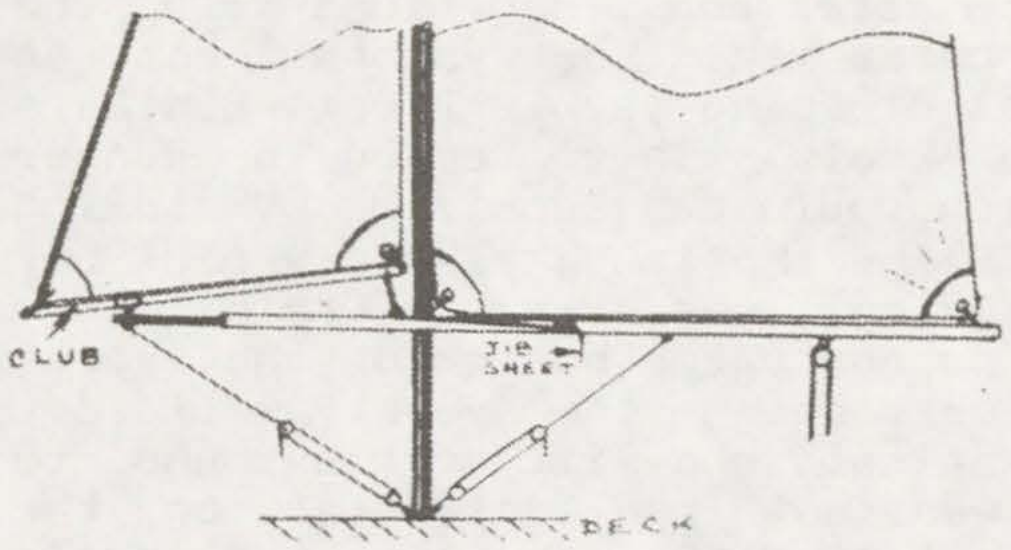
This is perhaps the place to mention lifejackets. On multihulls these should be of the inflatable type. If the yacht goes over you might not get clear with a buoyant jacket. Inflatable lifejackets must only be worn outside clothes and harness. A M.O.C.R.A. crew member put an extra coat on over her lifejacket because she felt cold. By mistake he jacket inflated. The pressure was such that she could neither breath not shout for help. Luckily her husband noticed and a knife was handy so the only damage was a coat and lifejacket. It is prudent for the crew to put on lifejackets before there is danger and the skipper must consider when this should be. In fog or when rounding a headland with a dangerous race for example. Probably the greatest risk of drowning is going to or from the yacht in a dinghy. These rules apply to yachts of all types.

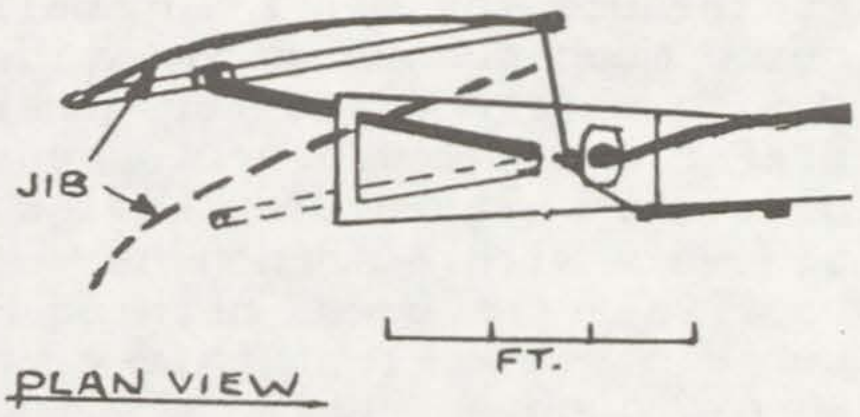
SAIL RIGS

Due to their great stability at small angles of heel the mast of a multihull, especially a foiler or catamaran, needs to be stronger than on a monohull using the same sail area. The monohull when hit by a gust will heel over easily at first but with steadily incresing resistance. On a multihull most of the energy will be absorbed by rapidly increasing forward speed.

There is little point in putting a carbon fibre and kevlar wing sail over a rough hull with a square deck house and lots of netting causing drag. Our publication 103, "Optimum Yachts" shows that the "una" or single sail is the most efficient. It gives the optimum sail area to displacement. Increasing sail area beyond the optimum increases speed but stability becomes a problem, also a high rig may increase pitching if the hull is not designed to carry it. Yachts with several sails, for example a cutter or ketch can be easier to handle, stronger because the mast or masts are shorter and more stable due to the lower center of sail area. In general terms the cutter can be a useful rig but the ketch is not good to windward, often performance improves with the mizzen stowed even with the drag of the bare mast and rigging. Sails developed for single hull yachts work as well on multihulls, special rigs are being tried but none have shown great advantages so far. Note that full length sail battens make any sail more efficient, giving more drive, longer life and being easy to stow. Their use on monohulls is prevented only by racing rules which are administered largly by sailmakers. On multihulls they are allowed.

A wide beam can give a very good angle to the stays which can reduce the compression load in the mast and cross beam. There are a number of problems to watch. If the shrouds are taken out the headsail can not be sheeted properly and an extra set of sheets may be necessary. If the shrouds are not abeam of the mast there will be strange loads as the hull flexes in a seaway. Often multihull masts have the stays leading over spreaders to the cabin top with the extra load taken by a steel frame so that the rig is the same as it would be on a monohull.





PLAN VIEW

"BOOMSPRIT" RIG

CHOOSING A MULTIHULL

Some people make lists, others keep in mind what they need. To make a "right" decision you need information. Experience is a good way of obtaining information, so try to sail on as many yachts as you can, with the kind of sailing you hope to enjoy before you buy. To charter a yacht is expensive, to buy one and find she is less than satisfactory will be even more expensive unless you are one of the lucky few who can buy and then sell at a profit !

It is incredible how many bunks an ingenious designer can cram into a tiny boat. Because a 10 metre (33') catamaran can sleep eight, including three "double" bunks it does not follow that eight people could or would enjoy a night on board except perhaps for a fair weather night passage with three on watch. On all small craft forward bunks are uncomfortable in rough weather and it is really not a joy to sleep with ones head over the toilet. The extra space offered by multihulls is one of their great advantages but overcrowding reduces enjoyment.

Multihulls over 14 metres (45') can provide luxury accommodation. There can be standing headroom on the catamaran bridge deck and trimarans can have living space in the floats. At this size a fit crew are needed to handle mooring ropes and sails, they will need power assistance to raise the anchor. Two engines are desirable for manoeuvring in confined spaces. The owner should have reasonable experience before taking on a yacht of this size.

For the 1978 Round Britain race I entered a Comanche cruising catamaran and at Sailcraft the builders during trials we were able to sail three similar yachts together. One had centreboards, one had fixed keels and the third had stub keels from which boards could be lowered. Under sailing trials there was no measurable difference in performance between the three yachts sailing together. My own preference, and the yacht we took on the race had centerboards. these reduce the amount of room in the cabin, are extra weight, weaken the hull and clutter the deck with lifting gear. In return for these disadvantages I can lift the lee side board in heavy weather, I can reduce the draft in shallow water and I can float off the beach much sooner as the tide comes in. For yachts kept on drying moorings and for general cruising yachts Prout Brothers prefer long, low aspect ratio keels. They tested a Ranger catamaran with a drop keel which could be capsized by towing sideways with a launch but with the shallow keel she would not capsize - there was nothing holding low down to trip over. Certainly a keel of this type protects the bottom of the yacht when grounding. Using a swinging mooring the yacht will dry facing the ebb tide and as she floats she will scrape round to face the flood tide, this can wear out the gel coat on the bottom if it is not properly protected. For cruising multihulls

these low aspect ratio keels need not be deep enough to cause problems in canals; fresh water tanks can be built into them and they stiffen the hull. These keels must not extend too far aft or they enlarge the turning circle, Prouts leave a good gap ahead of the rudders and then provide a skeg to support the hull when ashore; it seems a very satisfactory design.

To choose a yacht you must know how many people you want on board and how far you intend to sail. Consider the importance of speed, how rough are the conditions you wish to sail in and how rough could the water become if you get "caught out". These factors will determine optimum size and this should influence choice between monohull, catamaran and trimaran. Compare also running costs in your area. The main expenses are moorings, insurance, lifting out for scrub and paint, dinghy park if you have to row out to your yacht. Time from home can also be a factor, sometimes you can find a convenient mooring for a multihull where a monohull cannot go. Sometimes a marina can fit in a monohull but does not welcome multihulls. These are all factors to consider. A yacht has to be safe at sea and suitable for her crew to handle. On passage a small yacht will exhaust the crew and range will be limited by weight of stores. Even with power winches a large yacht may be too big for a man and his wife to handle easily and a crew will be needed. Never buy any yacht at a boat show - book a trial sail and compare with others before deciding. If you can't sail on a yacht which is for sale try to get out on a sister ship. When you have found what seems a suitable craft get an independent surveyor experienced in that type of yacht and the material of which she is built, give him full details of the purpose for which she is to be used and take note of his summary.

When trying a yacht look at the basic features and if these are satisfactory look at the details which can be altered or adjusted. If standing headroom is required and is not available alteration means rebuilding the cabin. If there are not enough hand holds it may be easy to provide some. Between these two extremes are features such as sharp corners in the entrance hatch or steps. At sea you and your crew can be thrown about, especially on a monohull, yet on many yachts you are beyond reach of a hand hold while moving from one position to another. On a monohull the cook must work at a steep angle, is there a secure harness to enable both hands to be used when cooking ?

Opening tins or peeling vegetables can be difficult on a monohull at sea - yachts are for pleasure and this should include the cook ! All yachts need ventilation but the needs are very different for hot climates and cold conditions. Canals have flies and mosquitoes, the ocean breeze tends to be cool. Opening windows leak - always. If they don't leak now they will next season so make sure the drips drain away harmlessly into the bilge and not onto the radio or the bunk below. Most fibreglass yachts are designed so that the rain comes into the cabin when the door is open. The shape of the bulkhead is not for "looks" or "streamline" but simply to make it easy to lift the moulding out of the mould in the factory. It is quite

simple to put a wedge into the mould or put a fairing over the entrance, perhaps with sliding cover, so that doors can be open even in heavy rain or with spray from ahead. Obviously most people are happy with the present arrangement but there are alternative yachts for those of us who like to sit inside with the door open. It seems to be a feature of multihull yachts that owners are more individual and are more prepared to make alterations to suit their own needs. Their requirements may not match yours.

Earlier we gave exceptions to the main multihull advantages of comfort, speed, shallow draught, light displacement, positive buoyancy and safe wide deck space. Several g.r.p. production multihulls rely on owners to provide buoyancy. Prout Snowgoose and Telstar have compartments with watertight bulkheads but as sold can sink. Some of the racing trimarans must be the most uncomfortable craft afloat, massive beams cross cabins so that the crew have to crawl fore and aft, toilets in compartments so small they can't be used, galleys that can't be used at sea, wet sails and bunks in the same space. If the crew do not have proper food and rest for more than about 24 hours speed and safety will be impaired. There are very comfortable multihull cruisers at all sizes where speed has not been a requirement at all. These yachts are often of moderate rather than light displacement. Their hulls are wide to provide living space. They offer the comfort of sailing upright without violent movement, shallow or modest draught and wide deck space. Having modest sail area and positive buoyancy these are probably the safest yachts afloat, a feature greatly helped by owners attitude not to cut corners for the sake of a few seconds or hold on to a big headsail for the thrill of an extra few knots.

On multihulls with wide decks, especially trimarans, guard rails round the outside can give a very false sense of security. To be useful rails must be above knee height, below this they are trip rails. 66cm (26") is a useful minimum height and with stanchions of this length the leverage of a person falling from a distance can break them from the deck. The best answer is to rig a jack stay and use a safety harness in more than light weather when leaving the cockpit and always hook on at night. Every safety harness line should have two hooks so that the wearer can move without being detached and a release so that he can abandon the line in emergency. You don't want crew members going up with the mainsail or down with the anchor. If you sail with children guard rails can have netting stretched to prevent them falling through but at sea they should always be tied on. Multihulls usually have large secure cockpits which are ideal for young people however they are sometimes short of places to hold on in rough conditions. The cockpit drains must be adequate although it is most unusual for a crest to break on board and few cockpits are so deep that they would endanger the yacht if they did flood. Sizes of drains according to cockpit volume and height of cockpit deck above waterline are laid down in the multihull safety rules.

Most yachts are built to comply with these rules even if they are not designed for racing. Anyone contemplating the construction of a multihull should study the rules which are internationally being agreed by the I.Y.R.U. - they are based on experience and are altered from time to time. They exclude yachts from racing if the centreboard case opens into the cabin. The reason is that if the hull partly floods water will enter through the trunk and prevent bailing out. In fact the hulls should already have positive buoyancy and towels or a blanket can be used to block the opening so owners of yachts with this feature are not in any great danger; the rule came in when an effort was made to bring multihull and monohull safety regulations to a common standard.

CONSTRUCTION MATERIALS

Production cruisers are usually "fibreglass" moulded. For series production where the cost of making the moulds can be recovered from fifty or more mouldings this is probably the least expensive way to obtain a hull and deck/cabin. The hull and cabin, a "bare shell", is a small portion of the total cost of a yacht. The actual amount may be less than a quarter, how much less depends on electronic equipment, type of engine, standard of interior finish and the rig. Glass Reinforced Plastic (g.r.p.) hulls of polyester resin are very satisfactory. They are easy to repair either in emergency with other materials or when warm and dry with more glass and polyester resin. Much has been written about "osmosis", many yachts have been sold cheap when the owner thinks a minor problem with a few blisters is a terminal illness. Osmosis is usually caused because the new hull in the mould or after release was not kept up to the required temperature for the full period required for it to cure. This results in some of the chemicals evaporating leaving the hull very slightly porous. Fortunately multihulls are not often built in such numbers that hulls have to be stored outside after building; they are usually fitted out in the same building as the moulding so that the temperature is maintained. This is where a surveyor earns his fee but in general osmosis is not a multihull problem.

PLYWOOD

Many plywood multihulls have been built. Quick, simple, inexpensive, light and strong are credits. They can rot quickly if not kept well ventilated and protected. Plywood can be sheathed; this is best done when the yacht is new and dry. Glass and epoxy, nylon and resorsenol glue or glass and polyester are the three most usual materials for sheathing in order of my personal preference. Plywood suffers badly from voids between the veneers of wood in the plies. Look along the edge of a sheet of plywood, even some "marine grade", and you will find gaps. If water enters at a seam or joint and runs down into one of these gaps rot will result. Also gaps are a weakness and prevent the sheet taking a fair curve when bent.

Using really good glue to seal all the edges during construction is a big help. A second hand plywood yacht at a favourable price can be a bargain if sound and with good equipment. If rotten in parts of the skin only, it can be repairable but you will only have a plywood yacht when you finish. If frames are also rotten do not consider trying to repair; better to build a new hull and re-use fittings and equipment. Plywood yachts are often of hard chine construction. This does not seem to detract from performance in any way but beware of the noise of water slapping against the flat surface of a hull of any material it can be like trying to sleep in a drum ! Yachts should be curved and rounded where possible to prevent pounding.

SANDWICH CONSTRUCTION

This practice uses a strong outer and inner skin over a softer core material. The method is used for "one off" or limited production where the cost of a mould would not be justified. Often the bridge deck and cabin top or other flat areas of g.r.p. moulded yachts are of sandwich construction, the core material can be laid in the mould, glassed in and pulled flat by vacuum pump. The composite is strong, stiff, light and offers excellent insulation reducing noise and condensation. It is usually difficult to add extra fittings such as winches which were not in the original specification because the foam or balsa core has to be cut out and extra strength added to spread the load. There have been cases of foam delaminating from the skin where there is considerable flexing over a period. Balsa wood seems to take a better bond with glass and has much greater compression strength, but a balsa panel will weigh more than one with a foam core. In the case of damage water penetration across the balsa grain is minimal, and it seems superior to foam where the weaker bond allows greater sheer. The surface finish on a foam sandwich yacht is never as good as a hull taken from a top class mould. Finish relies on days of sanding, filling, sanding and painting.

WOOD CONSTRUCTION

For multihulls this usually means diagonal strips of wood laid up over a light framework of bulkheads and stringers. A very strong light weight method of construction. Some commercial builders use vacuum bags to glue hulls over a jig - virtually a boat shaped plywood sheet with no joints between sheets. A very satisfactory method of construction, although major permanant repairs can be difficult. Makers claim that with epoxy glue the wood is further protected and vastly superior. However, early multihulls built this way over thirty years ago are still in excellent order. Ordinary wood rots and is eaten by worms but borers do not seem to penetrate the glue of plywood or diagonal wood built craft. Wood does not withstand neglect like a fibreglass yacht.

METAL MULTIHULLS

Aluminium would seem to be an ideal material with which to build multihulls, I have heard of very few and none in series production. The benefits are great strength and light weight, it can stand much abuse. Repairs need specialist equipment and tools probably not available in remote ports. Great care is needed to avoid all brass and copper which with salt water quickly makes holes in aluminium. Paint and antifouling must be chosen with care. It is probable that a racing hull can be built lighter and stronger from exotic composite materials than from aluminium and exact compound curves required by computer aided design would be difficult to obtain from a sheet material. Steel is too heavy for small size multihulls because of their extra hull area, larger craft such as catamarans for fishing have been built of steel. There have also been ferro cement multihulls but again this is too heavy for small monohulls and would seem to have nothing to offer multihull builders at present.

COMPOSITE MATERIALS

Man's first craft were almost certainly of composite construction - hides over a wood frame. The "Cutty Sark" is of composite construction - wood planks over iron frames. Racing multihulls are being built of exotic composite materials having all manner of brand names to hint at their largely secret components, probably to confuse their competitors. The results are very light weight and incredibly strong hulls with strength only where it is needed. The cost is not quite as far out of our world as one might think. If a hull can be built at one quarter of the weight of a conventional one from materials costing eight times the price per kilo the resulting unit cost is double. As already mentioned the hull cost is only a small part of the total, and the saving can be continued because a lighter hull needs a smaller mast and rig. No doubt these yachts can be repaired but I doubt if suitable materials will be widely available for some time. Due to problems with shelf life and costs of storage it is probably best to rely on air transport of materials when repairs become necessary. If usual cruising equipment is to be carried the extra cost of ultra - light construction does not seem justified at present.

To Summarize - the type and size of yacht depends on where you plan to sail, the purpose for which she will be used and the number of people involved. Remember that people and their equipment - cooker, toilet, lifebuoy etc. have a fixed size and the wind and waves are predictable to a degree. A yacht which is too small or one which is too big will not be satisfactory and could be dangerous.

BUILDING A YACHT

This should be a short chapter. My advice is don't ! - That is if you enjoy sailing. Building a yacht can give great pleasure. It is a challenge of greater magnitude than sailing an ocean and failure can be just as devastating. To build a yacht needs many skills, the materials to use can match your own experience and knowledge. With modern glues and materials a degree in chemestry will be a great help. So will a course in structural engineering and an apprentceship as a cabinet maker. If you lack the experience to be certain you have chosen the right design the result of two to four years of work will be a yacht which does not give the pleasure you are entitled to enjoy after such effort.

My advice, which I took myself, is always to search hard for a hull shape similar to the one you require. If you start by buying a bare hull from a known builder you instantly achieve four major advantages. First the hull has a value. If you have to change your job or move house or some other factor changes your life you can sell the yacht, usually for a fair sum at least taking account of the materials you have used. A part built "home made" hull will be very hard to sell, people assume you have made some drastic mistake. Second the yacht when

launched will be easy to insure after a survey. This is because you are not listed as the builder, they can look up tables and find the risk this type of craft represents. You may declare quite a different purpose, speed and use but the insurers still like a known builder. Third the yacht will eventually have to be sold when you need to sail further, or not so far, or with more or fewer people according to life. When this time comes she will have greater value and be easier to sell. Fourth point is cost. It can cost less to have the hull built at a yard than to build it yourself. You start with heating a building shed in which to work. This costs money each week for rent and power. Next you buy the materials. Unless you are in "the trade" you will pay more for material than the commercial builder who will get trade and quantity discounts. Next you use the material. Unless you are especially skilled you will waste a great deal more than the people using the materials all the time. Even experts cut timber the wrong length, put too much hardener in the glue and run out of welding gas. It does not happen to them on the Friday of a holiday weekend.

If you are really determined to build your own hull you can cetainly succeed. Many home built hulls are superior to production hulls. Several designs are available for home construction but you need much more than a set of plans. A designer is entitled to expect a builder to know how to build,

how to make joints, which glue to use, which way the grain should run in plywood. An amateur usually needs a set of building instructions with the plans. He also needs to cost the materials and estimate the time. He should make a time table which is realistic for his building conditions. He will add in days for delays and days for other duties. If lucky he can make and keep a series of deadlines for completion of various stages. James Wharram and Derek Kelsall are two British multihull designers who cater for home builders both can now offer part built or kit hulls. Derek runs weekend courses for people to go and get hands - on experience. James Wharram Associates have an association of builders who share their experience, problems and knowledge through a journal. There is no special advantage in building one, two or three hulls - they all take time and care which could be spent afloat.

Which material is "best" for home construction depends on the skill and knowledge of the builder. There are books on building in most materials, each writer prefers the material he has used and writes about. Several times A.Y.R.S. has tried to produce a reference book simply giving comparisons of the costs and skills needed to build a yacht from different materials. There are two boxes of trade leaflets and cost sheets all made out of date by changes in price and by new materials being introduced. The giant I.C.I. made a new material from cement and glass which can be so resilient they made a spring to demonstrate its properties. So far it has not become available to boat builders.

EPOXY RESIN. This is a chemical which forms a very strong and waterproof bond and covering which is excellent on dry wood. "Dry" means wood kept in a low humidity and not just stacked under cover in a shed. In humid climates this is difficult for amateur builders who should consider resorcinol glue for wood construction or polyester resin and glass. Epoxy glue with filler has excellent bonding and filling properties and is very good for joining other materials. The shelf life of these products is important, bargain glue which is time expired can be an expensive mistake on the hull but may be satisfactory for interior work and for building the tender. Some British suppliers are listed at the end of the publication.

The Geougeon brothers in the U.S.A. registered the trade mark "WEST" for yacht building by the diagonal strip plank method using their epoxy resin. The initials stand for Wet Epoxy Saturated Timber. Diagonal planking was developed for early flying boat hulls and was used for high speed patrol boats. Use of epoxy brings several advantages but even with the preferred Western Red Cedar timber the epoxy does not saturate through the veneers. It does soak into the surface fibres to give a really good bond. Moisture in the wood reduces the strength and increases the weight of the structure and must be avoided. Standard epoxy must be protected from sunlight (ultra violet) but a chemical can be added to the outer layer if a clear finish like varnish is required.

Cascover Sheathing is the trade name of the Borden Chemical Company for covering hulls or decks with nylon using resorcinol glue. The company can supply materials or send a team to sheath a hull at the building site. The material is not as smooth or hard as epoxy but it gives great protection against surface damage and is very flexible so that timber can move normally without the nylon peeling off.

Fibreglass Sheathing refers to polyester resin and glass cloth. I have used this on a new plywood cabin and deck with satisfactory results.Heat is important during the cure, the

wood must be dry but a de-humidifier does not seem essential. There are a number of rotting hulls about which have been sheathed with g.r.p. and the glass peels away. Often one observes that the outer layer of wood fibre pulls off with the glass indicating that the bond is not as strong as with nylon, perhaps because the material is less flexible or because moisture has worked under the glass. With "Sabu" the "wing" decks to the foils are of plywood and one side was sheathed with epoxy and glass, the other with nylon and resorcinol. Both sides have proved entirely satisfactory in spite of a higher than ideal moisture content for the application of epoxy. When extensive repairs were necessary it proved slightly easier to cut back and scarf new plywood into the resorcinol sheathed deck, but it was hard to grind a suitable joint with the epoxy although the fresh epoxy glue with filler has such excellent gap-filling properties that exact matching joints are not required.

Cruising yachts should be built with the knowledge that over a life of fifty or more years repairs are going to be necesary. Influence from the motor industry where you scrap the car when the paintwork gets dull has spread to yachts, yet the standard of strength and tradition of quality has largely been maintained. Repairs I refer to are not only the hull, which should be accessible in emergency without using the axe. Pipes to the bilge pump, gas, water and fuel pipes,and electric wires all need an occasional inspection and replacement. Every electrical joint should have enough spare wire for two or three new joints to be soldered on as they go green and fail. Perhaps a new system of damp-proof jointing will arrive. Fifty years ago many yachts had no more electricity than an ordinary torch. On the yacht you build now, what will the owner consider essential in 2040 ? How could you think of building without provision for....? More people will mean more polution, more leisure time, more marinas and shore parking. People will grow, six foot bunks and six foot headroom will receive the lack of respect we now show for 5'6". At least it is reasonable to plan in the knowledge that the wind and waves will be similar to those of today.

ORGANISATIONS PROVIDING NEWS & INFORMATION

Amateur Yacht Research Society; 10 Boringdon Terrace, Turnchapel, Plymouth PL9 9TQ, England. (Subscription £ 15 per year)

International Yacht Racing Union; 60 Knightsbridge, London SW1X 7JX
Multihull Deutschland; Parkallee 227, 2800 Bremen, W.Germany
Multihull Offshore Cruising & Racing Association; 14 Kings Close, Woodbridge, Suffolk, 1P12 4EU, England. (1988 subscription £ 8)
New Zealand Multihull Sailing Club; Box 3337, Auckland, N.Z.
Northwest Multihull Association; P.O. Box 70413, Ballard Station, Seattle, WA 98107, U.S.A. (Newsletter $ 15 or $ 20 overseas)
Royal Yachting Association: Romsey Road, Eastleigh, Hants SO5 4YA

DESIGNERS OF YACHTS MENTIONED

"Cornish Meadow" by Martin Smith; Modular Mouldings, Lower Quay, Gweek, Helston, Cornwall, TR12 6UD.
"Havkat 27" by Lars Oudrup, Hessgade 40, DK 5500 Middelfart, Denmark.
"Iroquois GT" by Reg White, 52 Seaview Rd., Brightlingsea, Essex
"Kelly 37" by D.H. Kelsall, Sandwich Marina, Sandwich, Kent CT13 9LY
Newick Designs, RFD - Box 309, Vineyard Haven, MA 02568, U.S.A.
Prout Brothers, The Point, Canvey Island, Essex SS8 7TL, England
"Summer Twins" by Pat Patterson, Foss Quay, Millbrook, Torpoint, Cornwall PL10 1EN
"Tiki 21" by Wharram Designs, Devoran,Truro, Cornwall TR3 6PJ.

MULTIHULL PUBLICATIONS

Multihulls. (bi-monthly) U.S.$ 3.50, U.K. £ 3.00. 421 Hancock St., Quincy (Boston), MA 02171, U.S.A. (Overseas $ 22p.a., $ 39.50)
Multihull International. U.K.£ 1.00 U.S.$ 30p.a., $ 46.00 airmail 53 High Street, Totnes, Devon TQ9 5NP, England
Sea People/Sailorman. Magazine of Polynesian Catamaran Association. Foss Quay, Millbrook, Torpoint, Cornwall PL10 1EN.
Multicoques Magazine (bi-monthly) French 165F Europe, Overseas 210F. Le Campus; Bat.E,2,av. du Parc; 95033 CERGY Pontoise Cedex, F.

CONSTRUCTION MATERIALS

Epoxy glue and resorsenol (Cascover) from Borden. (U.K. Gougeon agent) Wessex Resins Ltd., 189 Spring Rd.,Sholing, Southampton SO2 7NY
Epoxy,carbon fibre, fillers. Structural Polymer Systems Ltd., Cowes, Isle of Wight, PO31 7EJ, England.
Epoxy and g.r.p. materials. Strand/Scott Bader Ltd., Wollaston, near Wellingborough, Northamptonshire NN9 7RL, England.

Mr Lonbet's "TIKI 21" by Voilerie Domon of Saint-Sornin, France. One of 450 plans sold by July 1988 by James Wharram Designs.