THE PHILOSOPHY OF FISHING VESSEL SAIL ASSISTANCE

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Consultant

Sail Assistance for fishing vessels must be divorced from the romance of sail and environmental considerations and be based on hard economic facts. The economics of fishing are very different from those of cargo vessels and technology must be developed to exploit the required characteristics of fishing vessels.

Introduction

This paper is not against sail assistance, but is aimed at bringing a sense of realism to a subject which is confused by emotive and conservationist issues. Whilst it would be nice to argue a case for sail assistance on the grounds of conserving finite fuel resources and on the romance of sail, the value of sail assistance will be judged almost wholly on commercial grounds.

Reports on sail assistance technology tend to fudge this question of commercial viability and when it comes to the application of sail assistance to fishing vessels, the situation tends to be even more confused because of the increased number of variable factors involved. The purpose of this paper is to attempt to put sail assistance for fishing vessels into perspective and to establish a philosophy under which a viable approach can be made. There is no easy and obvious approach otherwise it would have been done a long time ago. Modern technology can change the approach but it must be coupled with a clear understanding of the commercial factors involved.

Competition

Sail assistance is a means of reducing the amount of fuel consumed. In general this reduction in fuel consumption will be judged in a situation where speed and performance are maintained at the previous levels and will be expressed as a percentage saving. However, sail assistance is not the only way of reducing the fuel consumption and other possibilities and the potential percentage savings are:

Reducing weight 2%
Improving the hull shape 8%
Improving hull finish and the use of special paints 6%
Use of slow revving propeller 12%
Use of reaction fins or nozzle 5%
Improved main engine efficiency 16%
Use of shaft driven alternator 2%
Better utilization of waste heat 2%

All of these methods of reducing fuel consumption involve alterations or improvements in the ship and additional capital expense, in the same way as employing sail assistance. They may not all be practical or possible and can conflict with each other. What must be remembered is that when more than one of these methods is used the percentage saving is reduced because the percentage is on a smaller total and sail assistance must take its place in the line. A claimed 30% potential saving in fuel consumption by the use of sail assistance could easily be reduced to 20% of the original fuel consumption if other methods of fuel saving are used, and there will also be the negative factors of increased weight and drag.
If fuel consumption is the only criteria, then reduced speed and careful use of the throttle can show the biggest saving. A reduced speed requirement allows sail assistance to have a bigger potential as it can provide a higher proportion of the required power. However, reduced speed means longer time for a given distance which can increase crew and capital costs. The latter factor can be particularly significant in these days of high interest rates.

Capital Costs

A factor often ignored in assessing the potential of sail assistance is the effect of capital costs. The object of sail assistance may be to reduce fuel consumption, but at the end of the day it is only the overall saving which counts and this has to be measured in dollars. The promised fuel savings may look very attractive against the capital investment involved, but the servicing of the capital involved must be taken into account and this can dramatically reduce the overall savings.

A recent case illustrates this point. A proposal for a sail assistance outfit for a coastal tanker was priced at $160,000 and it was suggested that as this would save $70,000 per year from the fuel bill, the system would pay for itself in just over two years. This ignores the additional costs of installation, the cost of the time the ship would be out of commission, crew training, all of which could easily bring the capital cost up to $200,000. Interest charges on this amount to give an annual bill of say $30,000, which reduces the saving to around $40,000 per year, almost half of the previous figure and maintenance costs could reduce this still further.

These figures are not difficult to work out and any owner contemplating sail assistance is going to look at the bottom line. With fishing boats this is going to be harder to evaluate because of the more variable nature of the operations, but a very important point to remember with all sail assistance projects is that the capital costs still accrue even when the vessel is lying in harbour whilst the fuel savings are only made when the vessel is steaming.

Fishing Operations

Fishing covers a wide range of vessel types and whilst most of these could benefit from the use of sail assistance, there are two main types of vessel which are obvious targets. The first of these are the fishing vessels, usually the larger types of vessel which spend most of their time at sea, either fishing or steaming to or from the fishing grounds. The capital investment on these vessels can be justified because the equipment is in use most of the time and saving fuel to offset the capital.

The other type of vessel is the small fishing boat where the mast and sails could replace the engine with perhaps a reduction in the capital cost and a total elimination of fuel costs. These savings may have to be offset against a less reliable pattern of fishing, but within the context of current high fuel costs and interest charges, this type of craft could well become viable again.

The fishing vessels in between these two extremes represent the
majority of fishing vessels in operation today. Use of sail assistance on these vessels may only have marginal benefits in terms of overall cost savings and the introduction of masts and sails could adversely affect the fishing operations to the detriment of profits. Some fishing methods could benefit from the use of sail assistance more than others.

If the benefits of sail assistance are to be maximized for this type of fishing vessel, then the pattern of fishing will have to adapt to sail assistance, possibly using alternating crews and fishing methods will have to adapt to sail assistance, possibly by using fishing methods where propulsion by sail alone is feasible. Speeds must be adjusted to make the right balance between expediency and fuel consumption. Sailing rig designs must be closely integrated with fishing systems both to reduce investment and improve efficiency.

Conclusions

Using sail assistance on fishing vessels is much more complex a problem than with cargo vessels. The object is to catch sufficient fish of a value which exceeds the operating and capital costs of the vessel so as to make a profit, and sail assistance can play its part providing there is adequate use of the vessel to make worthwhile savings and provided the capital costs can be contained. The economics of fishing are dictated by the value of the catch rather than by the time taken to deliver a cargo as is the case with cargo vessels. Efficient fishing is paramount in any fishing vessel operation and if fishing methods are developed specifically for sail assistance, then a viable operation can result.

The prospect of a return to fishing vessel types where sail is the only form of propulsion cannot be ignored. This type of vessel is probably only viable in small sizes where the capital costs are kept low so that time becomes a less significant factor in the operations. Small fishing vessels of this type could be viable whereas the larger types of fishing vessel appears to be an ever increasing spiral of increasing operating and capital costs in an attempt to make the vessel more efficient to catch more fish in order to meet these increasing costs. Small sailing fishing boats could break this spiral and with modern technology appears to be one of the most promising avenues to explore in sail assistance.

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IMPROVEMENTS IN HULL AND RIG OF TROPICAL FISHING BOATS –
KATTUMARAMS, VALLAMS AND DOUBLE HULLED BOATS

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SUMMARY

The beach fishermen of South India land a large proportion of the
total national catch. Although their boats are simple and of
antique form, tied-log rafts (kattumarams) or dug-outs (vallams),
recent studies show that these artisanal fisheries are
substantially more efficient in economic terms than those using
harbour-based mechanised boats. There is thus an incentive to
courage these traditional methods rather than the often
subsidised modern ones.

Unfortunately there is now a serious shortage of suitable logs for
kattumarams and a complete dearth of trees large enough for
vallams, so that prices are beginning to rise. Moreover, the
methods of construction result in high-drag in the kattumarams and
low stability in the vallams. The new designs, commissioned from
the authors by local boat builders primarily to overcome the timber
shortage by using local marine plywood in the "stitch-and-glue"
method, take the opportunity of improving the speed and
load-carrying capacity of the boats whilst retaining the familiar
characteristics of the traditional boats, such as good paddling for
the kattumarams and good rowing for the vallams.

The paper describes trials of the lateen rig used in these new
boats, also a design for a detachable outrigger foil for
retro-fitting to new and old vallams to give substantially
increased sailing speeds.

The new boats have been well received, 35 orders being placed for
kattumarams (Kottarkats) in the first 4 months, payment being
direct from fisherman to builder without subsidy.

Finally, the paper gives details of experiments with a variety of
rigs (sprit, lug and lateen) fitted to the authors' double hulled
surf beach fishing boats which lead to the conclusion that the
improved lateen appears to be most suitable for small boats in
tropical wind-systems, typical of Indian Ocean monsoon zones.

INTRODUCTION

Whilst most fishermen of the temperate zone gave up the use of sail
long ago, there are several hundred thousand in the tropics whose
boats are still fully rigged and which show, in South India, a
better return on capital than the modern mechanised boats, whose
trawls, it is claimed, are steadily reducing the fish stock. It
is interesting to note that a large number of these sailing fishing
boats are in India, which is said to be the tenth largest
industrial nation of the world.
These Indian fishermen have been sailing for generation after generation and although their rigs may acknowledge visits from the North (an occasional sprit-sail, for instance) both rigs and boats have more in common with those of Egypt and the Euphrates. Any attempt by a European to improve these traditional craft must be made with understanding and discretion.

**IMPROVEMENTS OF EXISTING BOAT TYPES IN INDIA**

Jim Brown in "Knock on Wood" has very lucidly explained the plight of canoe people brought about by the shortage of trees for boats. In India this problem affects the fishermen using kattumarams and vallams.

**Kattumaram**

Contrary to the Western world's terminology this is not a double-hulled boat nor is it outriggered; it is a boat-raft, kattumaram being a Tamil word for "tied-logs". These boats exist in a variety of forms along the coasts of Kerala, Tamil Nadu, Andhra Pradesh and Orissa. They are used mainly by fishermen of the ancient Dravidian culture and they exist in their tens of thousands. Most are sailed and they sail well under a type of lateen that, in some versions, is very close to the rig of the International Finn.

Their main advantages are suitability for moderate surf crossing (they are unsinkable) and low cost. For the unsinkable quality a low density wood is needed and Albizzia has been commonly used, but large logs of this species are no longer available at a suitable price. This shortage does not yet seriously affect the smaller kattumarams, nor the big craft made of a large number of thinner trunks such as those found in the Madras district. (Fig 1)

In the extreme South, however, in Kanyakumari and Tirunelveli Districts the kattumarams are of large size (24ft by 4ft, 7.3m x 1.2m) needing 5 logs each of 2ft by 1ft 6 inches (0.6m x 0.5m) scantling and these are becoming very scarce indeed (Fig 2). This is not surprising, since each boat lasts only about 10 years before the wood becomes brittle and regular replacement of an ever increasing number of craft needs thousands of large trees each year. Furthermore, this wood is also used in the Indian match-making industry and the demand leads to increasing prices.

It was for this specific reason, not to improve sailing performance, that the authors were asked to design a plywood version using the stitch-and-glue technique already employed in their Sandhopper and Sandskipper boats. The brief was to produce a boat of similar overall dimensions to the existing kattumarams, capable of being paddled in the Tamil manner with a double paddle made from a split bamboo, and sailed with the traditional rig, and two dagger boards thrust down between the logs.

Freed from the restrictions of the traditional material, the designers could have changed the shapes considerably but in the first instance kept close to the original dimensions, even introducing a deck, partly for reasons of strength but mainly to
simulate the raft so that the paddlers could kneel or squat in their accustomed manner. The principal changes made were much reduced weight (to approximately one third of the original kattumaram) a stiffer midships section, and a better longitudinal profile with a finer entry and a flat straight run (Fig 3). This gives a much improved sailing capability and a boat that can easily attain half wind speed on a close reach with a maximum of more than 7 knots (Fig 4). The boat tacks through 90° with this rig which is a variant on the local style (Fig 5). About forty of these boats have been built already by a cottage industry boatyard of the Kottar Social Service Society at Mutton in Kanyakumari District and a second workshop has just been opened by the South India Federation of Fishermen's Societies at Anjengo, near Trivandrum in Kerala State. Unfortunately from the sailing point of view, the boat goes even faster with a 7hp kerosene outboard engine and this is now a popular combination, some crews going 20 miles offshore for 3 days and 2 nights, lining for squid. They also carry sail, at present for emergency, but we expect that eventually a combination of sail and outboard will evolve, particularly in the monsoon periods of stronger winds. A larger version of Kottarkat, as this plywood kattumaram has been named, has now been built.

It should be noted that the price of these boats (R.9,000) is less than that of the equivalent large kattumaram (R.10 - 12,000) and this is without any subsidy or Government assistance.

Vallam

These lovely boats are dugouts with sewn wash-boards and clearly are of very ancient origin (Figs 6 and 7). They are mainly in the State of Kerala, where about 8,000 are in use for a wide variety of fishing.

Each boat is carved from a single trunk of the giant mango but such trees can no longer be found as mango cultivators are now growing a smaller variety. As no substitute timber exists, this very efficient craft is likely to disappear.

Following on the Kottarkat's success the authors were asked to design a ply-wood vallam. These boats are always rowed, unlike the kattuarams which are normally paddled, so it was possible to make a substantial increase in the beam. (Fig 8). As this boat is also much lighter than the dugout, it is faster both under oars and sail.

The rig illustrated is close to local practice except that the mast is moved a little further forward to facilitate tacking, although this is an infrequent operation in the Indian Ocean (Fig 9). A dagger board is fitted instead of the leeboard of the vallam but this may take some time to be accepted.

At the time of writing a larger sail is being made, as the increase in hull stiffness is such that with the right rig the boat will certainly achieve half wind speed. The prototype has reached 7½
knots in the UK in a 14 - 16 knot breeze. With a 7hp outboard its maximum speed is 9 knots. It can carry twice as much net as the equivalent dugout. It has been named the ply-vallam by the authors, but papadam-vallam by the fishermen!

At Rs.9,000 it is substantially cheaper than the current price of Rs.12,000 for a secondhand vallam. A co-operative factory is soon to be set up at Quilon in Kerala for the local manufacture of these boats, and it is hoped to have ten boats fishing before the monsoon in June.

A further development of the vallam which the authors are testing in the UK is the fitting of outriggers so that a larger sail area can be carried. The aim is to attain 9 - 10 knots in wind speeds of about 15 knots to encourage sailing rather than motoring. The traditional form of floats such as used on trimarans or conventional outriggers are inconvenient for fishing boats as they obstruct fishing gear.

A colleague of the authors, Malcolm Barnsley, has developed a hydrodynamic foil of much more compact shape which can be fitted to a single outrigger beam (Fig 10). The foil has only small static buoyancy, just sufficient to stabilise the boat in light winds; as speed increases hydrodynamic lift develops, so that the mainsheet can be hardened in as the boat accelerates. This is a simple technique to learn, particularly in the steady wind states of the tropics. Trials made on the prototype have been very encouraging as a speed of 8½ knots was attained in a wind speed of 18 knots, using a relatively small sail (Fig 11). Trials with a sail area more suited to the tropics will be made soon.

Double-Hulled Boats

The earlier development of these boats arose from the authors' wish to produce a substantial boat capable of working from open beaches in all weathers suitable for fishing, and so be independent of harbours3 & 4. Although this capability was demonstrated by the 5-ton Catfish (36ft, 10.9m) in Ghana over a period of 2½ years during the seventies, the authors now believe that the greater need is for smaller boats for artisanal fishermen.

With the exception of the Overseas Development Agency of the British Government and the Intermediate Technology Industrial Service, most development organisations seem reluctant to accept that double-hulled boats are economic, so progress has been comparatively slow but nevertheless steady. A project in Sri Lanka, with the 24ft (7.25m) Sandskipper is giving a further demonstration of capability (Fig 12).

Several rigs have been tried over the years. The first was on the Sandskipper prototype in Ghana in 1975 using a conventional Scottish lug, slung between the legs of a bipod mast. The sail area was quite small (180 sq ft, 15m²) and consequently inadequate. As the Ghanaian fishermen showed little interest in sail, this development was not followed up.
Later, three boats were built in Sri Lanka and the prototypes fitted with a version of the oru rig, the authors feeling that this, being a familiar sail to the Sri Lankan fishermen, would be more readily accepted. The rig performed quite well but is locally regarded as archaic (the sailing oru really only persists because of local regulations restricting fishing to sailing boats as with the Chesapeake sharpies and the Falmouth oyster boats). Its windward performance is not good because of the low aspect-ratio of the rig. Consequently the rig was changed to a larger (250 sq ft, 23m²) version of the original lug set outside a taller bipod. This gave really good sailing and a speed of 9 knots in an 18 knot breeze on a close reach has been recorded. It was quickly realised that the halyard forces required to set up a high aspect-ratio quadrilateral sail of the lug type are higher than desirable for a fishing boat.

Some parallel experiments on lateens on the smaller Sandhopper double-hulled boat (20ft, 6.1m) were beginning to give some good results so this rig has now been adopted for all the authors' fishing boats.

**Lateen Rig**

Obviously this is an old rig, much older than inferred by its Northern name (lateen - Latin - i.e. Mediterranean). There is no certainty but an increasingly held view amongst experts that this is an Asian, possibly an Indian, development of considerably antiquity. It is certainly widespread in the tropics in a variety of forms of varying efficiency, so it is sensible to examine this familiar rig.

The nature and performance of the lateen turn upon the characteristics of the long single yard. Once the sail is hoisted, stretch in halyards and stays is relatively unimportant. But it is essential that the yard is of adequate stiffness to suit the sail, and few present-day rigs achieve this; unduly bendy spars will spill wind too soon and produce drag and little lift. This is a common fault. With small sails it can be overcome by buying the finest bamboo of the largest section obtainable; for slightly larger sails the bamboos can overlap at the halyard and be well lashed together (Fig 12). With an even larger sail, the lower yard can be a teak pole topped with a more bendy bamboo tip, as thinnings from teak plantations are not expensive.

In UK the authors have successfully experimented with yards built as hollow plywood beams, with bamboo tips. This seems to give the optimum balance between light weight, strength and controlled stiffness (Fig 13).

The next most important point is the angle of the yard. Research work done in wind tunnels on forestay angles on Genoas indicates that the steeper the angle the more efficient is the sail, and that this effect is quite marked. So the lateen yard must also be steep. This, in combination with the need for large sail area in gentle winds and a high aspect-ratio for efficiency, means that the
spar will be long, probably longer than the boat. But the spar is relatively light and a suitable fixed crutch at the stern of the boat overcomes the problem of stowage when not in use (Fig 14).

The lateen is not a difficult sail to reef but taking in a deep reef is a lengthy operation, probably one of the reasons this rig dropped out of use in temperate climates. But in most tropical regions the winds are remarkably steady and the sail area required varies by the season rather than by the hour.

To deal with the most likely short-term variations in wind the authors use a diagonal reef which is quick and easy, but for seasonal variations a bonnet is used, which can be removed during the monsoon together with the lightweight yard-tip.

An essential piece of gear for the management of a lateen is the vang, the rope controlling the horizontal swing of the yard. Proper use of the vang greatly reduces the sheet load when close hauled and assists in setting the sail when running. This reduction of sheet load makes the use of cotton sailcloth more acceptable as there is less need for the toughness of a fabric such as Dacron which, apart from its high cost, degrades in sunlight.

One of the traditional methods of tacking a lateen, when set on a single mast, is to run off downwind and lead the mainsheet fall round the bow and back up to the weather quarter. The remainder of the mainsheet is let go so that the mainsail blows out in front of the boat like a flag. The mainsheet is then hauled in on the other side of the boat on which has now become the leeward side. Meanwhile the vessel is turned back onto the wind. In effect this is a gybe without any shock. This method has been used successfully with the authors' boats but it does need sea room, and most fishermen in India prefer to take down the sail, paddle the boat round and set it again on the new tack.

However, using a short bipod mast well forward avoids all these problems as the sail can be set between the legs of the bipod and tacked through the wind in the normal way. This position of the mast has the additional advantage of keeping all gear well clear of nets.

A double halyard arrangement is used with the weather halyard set up to act as a backstay whilst the leeward one is slackened away (Fig 14).

No mention has yet been made in this paper of the Bermudan sail, so characteristic of modern sailing boats. This was not used in the double-hulled boats where the bipod mast was preferred because it does not obstruct the bridge deck and the fishing gear.

The Bermudan rig, moreover, has a headsail which requires a tight luff and complex staying which are inconvenient for fishing. It seems unlikely that the better sailing performance of this rig compared with the lateen would be sufficient to outweigh the disadvantages of unfamiliarity and complication. Nevertheless it
is recognised that no comparative data exists and the authors hope that they may soon be able to supply this. In any case, a small engine will be carried for direct windward work or for when the wind is very light, so optimum windward performance may not be required. The important factors are overall efficiency, cost, handling and fishing.

Future Work

The authors' associated Company, Gifford Technology, has been appointed by the Commission of the European Community to investigate methods of energy saving in the propulsion of artisanal fishing boats. This is a substantial programme, probably extending over two years, which will investigate the relationship between hull form and propulsion methods (inboard engine, outboard, sail) and relate these to fishing function and climate. An important part of this work will be a rigorous analysis of the relative efficiency of different rigs and sailcloths. It is possible that the difference between good quality cotton sailcloth and manmade fibres may not be as important as race results indicated when the new cloths were introduced. Races are won by comparatively small margins. Because of the difficulty of interpretation of wind tunnel tests, especially where cotton cloth is concerned, a pair of identical 20ft Sandhoppers will be used, as double-hulled boats will eliminate heeling angle variation. One boat will be fitted with a modern Bermudan rig acting as a trial horse, and the other will in turn have the rig variations, which will include centreboard/leeboard comparisons. The boats will be sailed in company and thus have direct comparisons but their courses will also be observed through theodolites at the ends of a measured baseline and thus actual speeds and courses will be continually observed and computed. Wind speeds will be measured and electronically averaged.

Funds are not unlimited so the first rigs used will be lateen, spritsail and gaff with, of course, the Bermudan pacemaker. Later trials will, it is hoped, enable more development to take place on whichever rigs show the most promise.

CONCLUSIONS

The first conclusion is that the lateen is an efficient sail for tropical fishing, with considerable potential for development. The second is that it is at least as important to improve the hull as it is to improve the rig, and that fitting good sails to a heavy hull may give disappointing results.

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REFERENCES


BIOGRAPHICAL NOTES

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Specialised in structures and marine civil engineering, started design of small fishing boats in 1960 and small hovercraft in 1968. Awarded OBE and RINA's Small Craft Group medal in 1981 for work on artisanal fishing boats.

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Geographer, formerly lecturer at Southampton University, special interest in meteorological and geomorphological aspects of tropical fisheries.

The authors are joint directors of Catfish Ltd, a non-profit-making company building experimental small fishing boats.

In conjunction with Gifford Technology they have been appointed by the British Overseas Development Administration, the Intermediate Technology Industrial Service and the Commission of the European Communities to participate in a variety of projects for the improvement of artisanal fishing boats.
Fig. 3  PLYWOOD KATTUMARAM, 'KOTTARKAT STRUCTURE

Fig. 4  "KOTTARKAT" IN U.K.
SECTION ALONG CENTRE LINE

FIG. 5 'KOTTARKAT' RIG

Fig. 6 VALLAMS AT QUILON - SOUTH INDIA
Fig. 7 VALLAMS AT QUILON - SOUTH INDIA
Fig. 8 PLY-WOOD VALLAM - "PLY-VALLAM"

-- Fig. 9 PLY-VALLAM
Fig. 11 OUTRIGGED PLY-VALLAM IN U.K.
Fig. 12 MODIFIED SANDSKIPPER IN SRI LANKA 1983
Sail Powered Pearl Fishing Catamaran: DMB

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The pearlshell racks and seedling plant of Cygnet Bay Pearl is located on
King Sound in the tropical north of Broome, one of the most isolated areas
of the island continent. The company produces cultured pearls.

Bruce Brown and his brother, being able to discover the Japanese
secret of producing cultured pearls, spent 10 years experimenting with
various ways of inserting the necessary irritative substance into the oyster
so that the oyster would survive and grow a perfectly-shaped pearl surround-
ing the irritation.

I understand their method is similar to that used by the Japanese
but, of course, the details are secret.

Only a percentage of the oysters produce pearls and it is necessary
to regularly visit the grounds where the pearl shell oysters grow naturally
so as to replete the pearl farm back on the Australian mainland.

The pearling grounds lie approximately 240 miles across the south-
east trades so providing an ideal situation for the use of sail. Sailing
pearling lugger have, of course, worked out of Broome since the last cen-
tury and there are indications that Asian peoples used the north of Australia
for pearling and beche de mer in centuries past.

In any case, the pearl farming is quite a change from the crocodile
shooting that originally supported the Browns.

The brothers considered that a modern sailing catamaran would be
the ideal vessel for their purposes and to replace their existing traditional
diesel trawler. Accordingly, they approached me for a design.

When the pearling catamaran arrives at the grounds it will lower
two to four divers over the side on hoses.

The divers receive about $2 per shell and the vessel will hold about
4000 shells, or two tons. It may take up to eight days of drifting backwards
and forwards to gather a full load.

The shells are stacked in crates in tanks through which sea water
is circulated continuously to keep the shells alive. The vessel has to
carry 16 1/2 tons of sea water in the tanks on the way back to the base.

Currently, in this remote area fuel costs approximately 60¢ per litre,
and with a sails, rig and equipment cost of $50,000 it will take something
like three years to recover the fuel saved, assuming that the maintenance

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Fisherman," and are reproduced with permission of the author.
like three years to recover the fuel saved, assuming that the maintenance costs for the rig are not higher than the cost of engine maintenance.

Should fuel costs increase, as seems likely, and should sail power prove reasonably economical, then more sail powered vessels of the work boat type could appear on the Australian scene.

Detailed thinking behind the design is as follows.

1. A waterline length of greater than 21 metres is necessary to obtain Government assistance with the construction of the vessel.

2. The sea water tanks for the pearl baskets had to be located close to the centre of gravity and this dictated the general arrangement of the boat. Divers have to work inside the tanks to stack the baskets, making for fairly large tanks.

3. The tropical sun in north west Australia is fierce and shade for the helmsman and crew is essential. As the crew of, say, 10 people will be at sea for an average of two to three weeks, it is necessary to carry sleeping accommodation, cooking, stores, desalination plant for fresh water and considerable additional equipment.

4. Engines are, of course, required in case the wind fails and for in harboring maneuvering. The two Perkins 70hp diesels are fitted with variable pitch feathering propellers so that she can sail, motor sail and generate power from the propeller shafts under sail. She needs an auxiliary power plant for the dye compressors, sea water tank pumps and electricity. Under power she achieves a comfortable 10 knots with a top speed of 11 knots.

5. On the way to and from the pearling grounds the divers will have little to do so there was no point in having a rig with expensive sail handling equipment for short handed work. The most important thing is to reduce wear and tear and keep it all simple, bearing in mind the remoteness of the location. The two equal height masts reduce the size of the sails and the capsizing moment. The headsails hank on; the main and mizzen have slides and all sails are constructed from ultra-violet proofed cloth and stitching protected with an anti-chafe coating.

I had the pleasure of crewing on her maiden voyage from Perth to Broome. She sails quite comfortably at 9-13 knots and easily reaches a speed of 18 knots under reefed mainsail alone in 34 knots of wind.

On a long voyage there is no requirement to keep pulling into port for refueling, so the overall passage time is very little different from that of a power boat.

Even in light winds the average speed is high. We had 11 knots on the log in 8 knots true wind.

Construction was by SBF Engineering of Perth and is all welded aluminium. The two deckhouses are comfortably fitted out with six berths, lounge, dining table, chart table, freezer, fridge, microwave oven, hot showers and 240v power. A 20kVA MWM alternator set provides the 240v power which, in addition to the domestic loading, also powers circulating water pumps, bilge pumps and de-salination plants.

The 24v power for engine starting, SATNAV, autopilot, radar, etc. is supplied from the generator via a rectifier to two battery banks. 24v power can also be obtained from a propeller shaft driven alternator.
At present the gearing for the shaft driven alternator is too low as it takes about 13 knots to get 20+ amps under sail. Once this is corrected the system will work well.

Because of the vessel's size and weight she is very stiff and can carry full sail in quite strong winds. For the skipper's guidance we have produced a sail polar diagram which shows wind speeds and directions.

SBF Engineering of Naval Base, just to the South of Perth in Western Australia, are becoming well known throughout Australasia for their aluminium vessels.

The company has tended to specialize in comparatively lightweight high speed boats, including the much publicized Rottnest Island ferry "Sea Flyte." However, it has also built large numbers of yachts and other slower vessels in aluminium and steel.

"DMB" is not the first catamaran built by SBF Engineering -- a 53' pleasure catamaran was constructed previously, and the company is currently finishing a 50' motor sailing catamaran for the Lizard Island Research Station in Queensland. Both these vessels were also designed by Lock Crowther.

Design No. 69: Aluminium Trawler/Game Fishing Catamaran: Crowther 46

Originally this vessel was designed as a maximum versatility marine biological research vessel for a remote island station on Australia's Great Barrier Reef. The catamaran concept is ideal for motor sailors and this vessel sails well saving considerably on fuel costs.

Accommodations are for nine below or considerably more on day trips which means she is entirely suitable for game fishing or just plain cruising. Below decks there are two forward cabins each containing three berths and ample storage. Further aft in the port hull is an owners cabin with a pull-out double berth, seat, desk and hanging locker. The same area in the starboard hull is set up as a laboratory with sink and bench space. This area can of course be fitted out with individual requirements. Right aft on the starboard hull against the engine room bulkhead is a toilet and shower.

The main cabin area between the hulls is a large saloon with "U" shape galley, freezer, dinette, settee/berth and inside steering station. There is full headroom throughout.

Right forward in each hull is a large hold/storage area with a watertight floor. Here are stowed spare sails, minor cargo, motor bikes, etc. This area and the engine rooms aft are divided off from the main accommodations by watertight bulkheads. These bulkheads plus watertight doors leading to the forward cabins ensure she will meet maritime regulations requiring continued operations with any one compartment holed and flooded. This also ensures that she is almost impossible to sink, despite the aluminium construction. The structure will meet maritime regulations for strength and there is no problem meeting full offshore survey requirements.

Twin 40 H.P. diesels (Lister) located in separate engine rooms are accessible via large deck hatches and provide 11 knots. They are rubber mounted to drive via variable pitch feathering propellers. These propellers allow efficient sailing in the feathered position and can be varied in pitch
for optimum fuel efficiency in any sea condition, from motor sailing in light weather with one engine ticking over at a high setting to pushing into a storm with low pitch for maximum thrust. Of course pitch can be optimized for maximum bollard pull -- around 5,500 lbs. -- when trawling.

A small 4 kw diesel generator set provides 240V or 110V power for domestic appliances. It can also supply 12V D.C. to the batteries in addition to the main engine alternators. Either or both engines can be fitted with a hydraulic pump to operate such equipment as anchor winch, trawl winch, long line capstan winch, etc. The anchor itself is self stowing locking in under the fore beam. The chain drops into a self-draining locker in the wing deck.

Additional self-draining lockers are provided in the wingdeck leading edge and the whole area acts as a permanent ventilation system forcing air via baffles into the forward cabins.

The cockpit has a full bench behind the cabin containing an outside steering station sheltered by a spray/sun dodger roof and windscreen. All sail controls lead to this area so that one person can set sails, roller reef headsails, adjust sheets, etc. without any problems.

The mast aft rig makes the mainsail small and easily handled. It needs reefing only in extreme conditions. The two headsails are intended to be operated independently. Both are fitted with roller furling/reefing equipment. The larger headsail is of light cloth to assist setting in sloppy light wind conditions. The other sail is a general purpose sail which operates over a full range of wind strengths being progressively reefed to storm jib size. The boat will sail under this sail alone which makes it ideal for lazy people.

If desired, a section of the cockpit floor is designed to drop down below the waterline to form a dive platform.

Oil cargo tanks are incorporated into the bilges providing 3900 litres of additional fuel capacity. These tanks are intended to be used to transport fuel oil to remote areas. They do provide an incredible range under power and along with the sails make her a true ocean passage vessel.

The hulls are fitted with long skegs allow the vessel to be beached for antifouling and protect the rudders and propellers. She draws about 3'-7" making her ideal for shallow reef strewn areas.

Experienced amateurs can fairly easily learn to work in aluminium and in fact many of our designs are currently under construction by amateurs in this material. For large boats (45 feet up) it has proven the quickest, cheapest lightweight form of construction available. Corrosion is negligible and provided care is taken to avoid electrolysis, the maintenance requirements are minimal. It is incredibly strong and light and should you run her aground, the worst that can happen is a few dents.
"DMB"

SPECIFICATIONS:

Name: "DMB"
Type: Pearleshell diving vessel, carrier boat, accommodation platform and display emporium.
All aluminium, diesel powered sailing catamaran.
Owner: Cygnus bays Pearls Pty Ltd, Broome, WA
Designer: Lock Crowther, Turramurra, NSW
Builder: SBF Engineering Pty Ltd, Naval Base, WA
LOA: 78'9"
DWL: 99'0" (21.03 metres)
Beam OA: 30'0"
Measured depth: 6'9"
Draft DWL: 4'0"
Displacement empty: 38,000lbs, DWL: 82,000lbs, loaded: 78,000lbs
Cargo capacity: 32,000lbs seawater and 4,500lbs pearleshell
Hull/B DWL: 11.68
Power: 2 x 27 shp Perkins diesel engines
Propellers: 2 x variable pitch
Gearboxes: 3:1 reduction
Sail Area: 2443 sq. feet with 1 genoa 2798 sq. feet
Max. stability: DWL 980,000 ft lbs
Cruising speed under power: 9 knots
Range: 1,350 nautical miles
Construction: multi-chine welded aluminium to Bureau Veritas and USL
Accommodation: for 14+
Water tanks: Re-circulating to carry 4,500lbs of live pearl shell
Cleaning equipment carried: 'Hookah' diving gear for four pearl divers
Area to be fished: North-western Western Australia
Electrical installation: By B&H Electric of Perth
Hydraulic Equipment: Manufactured and installed by M&J Engineering
Sails and rigging: From Rolly Tucker of Fremantle
Sail Winches: Berlow, Australia — "Handraulic"
Fishing winches: M&J Engineering — Hydraulic
Propellers: Westmeken controlable pitch from Antelope Engineering, Sydney
Auxiliary engine: MWM Australia
Aluminium: Comasco
Echo sounder: Furuno color
Radar: JRC
Satcom NCS
Radio: SSB Codan
Auto pilot: Cetec Banmar
A State of the Art Sail-Assisted Fishing Vessel for the Third World

Frank Crane, Director Aquarian Research
David A. Olsen, Ph.D., Director, Thompson Management, Inc.
August Ciell, Beeline Seafoods
Thompson Trawlers
3000 N. Atlantic Ave.
Cocoa Beach, FL 32931

The modern era of fisheries development has been marked by an increasing awareness of energy efficiency. As petrochemical prices have continued to rise, energy efficiency has become nearly a developmental equivalent for economic efficiency. At the same time, population pressures have increased the demand for marine protein so that the harvest of underutilized resources has become an increasing priority. In developing nations, the quandary between need for protein and deficit balance of payments created by petrochemical imports has plagued all concerned.

One solution to these problems involves the reintroduction of sail as an auxiliary power source. We say auxiliary here because sail alone tends to limit access to the resource, both temporally and geographically. As an auxiliary, sail simply enhances profitability of existing fishing operations. Although there has been much discussion of the sail assist concept, much of it has centered on the reuse of historical hull forms and sail plans. Effective reintroduction should utilize the tremendous body of engineering data available if an efficient hullform, and a workable sail plan, are to be combined into a functional fishing platform for use in today's fisheries.

Today I would like to discuss one such effort to develop a fishing vessel which can attempt to address these concerns. The vessel in question is the 38' sail assisted multi-purpose fishing boat developed by Aquarian Research.

Some background on the history of the project may be of interest in order to bring out the degree of collaboration between state of the art sail and fishing technologies that has been employed. The genesis of the project came from the U.S. Virgin Islands Saltonstall Kennedy funded fishery project. Information and experiences gained there, and throughout the Caribbean, indicated that, although many of the more developed areas were converting from sail and sail assist to pure engine powered fishing boats, this conversion was not being successful.

The reasons for this lack of success were various and included:
1. Small outboard powered boats, which extend the range of fishing activities, have proven unreliable and expensive to operate.
2. Larger inboard powered vessels were expensive to purchase and operate.
3. Expansion of fishing activities resulted in resource overexploitation which made the vessels become uneconomical.
4. Increased fuel utilization created economic problems within
the country in terms of hard currency necessary for petro-
chemical imports.

The boat design criteria, then, were set out to deal with these
problems. It was our goal to produce a boat which could operate in
conditions ranging from primitive low technology environments, and
yet still compete with the high technology approach that we take
with the remainder of our domestic fleet. The design addressed the
following areas:

1. Range of operations - instead of relying on boat speed to
   expand the area of fishing operations, we chose to work on
   a design that could spend longer periods at sea comfortably
   and refrigerate the catch.
2. Fuel efficiency - Although designed as a sail assisted
   boat, fuel efficiency under power was incorporated into
   the project through efficient hull form, size and low
   horsepower requirements.
3. Resource limitation - The boat is designed to be fished in
   a variety of resources, allowing maximization of returns
   through utilizing a variety of resources.

The basic design criteria selected are in Table I.

We felt the optimal vessel could be developed from these
general specifications.

The boat specifications to meet these criteria are shown in
Table II.

The design by Robb Ladd N.A. incorporates a shallow canoe
body with a high center of buoyancy and a low center of gravity
to insure a most stable hull form. By using modern hydrodynamics,
and an approach using beam as a dimension towards cargo carrying
capability, and an aid towards stability, we were able to exceed
our original goals.

Boat speed and performance are greater than anticipated by
our computer analysis.

We constructed a C-flex plug of hull and deck, and built a
split hull mold, deck mold and various small parts molds for the
production of the boat.

The FRP lay up was designed to A.B.S. commercial standards
and uses the newest P.P.G. fiberglass products. All materials
are applied by hand to maintain the highest quality laminate.
Longitudinal and transverse framing are high density foam covered
with glass. The bulkheads are marine fir or cored fiberglass.

The hull to deck joint is first mechanically fastened, and
then heavily glassed together.

The ballast is 7000lbs. of lead within the keel encapsulated
in glass.

The rudder is FRP shell over a S.S. rudder stock with provis-
ion for a tiller on deck.
All metal is of marine grade alloy to cut maintenance dollars.

To date, four boats have been completed. The first has served as prototype for testing various fishing gears. It has bottom longline shrimp and groundfish trawl and trolling gear on board. The second is similarly equipped and is being employed under a lease arrangement to the Virgin Islands Government in a program of exploratory fishing. The other two are working as productive members of the Thompson Management Fleet.

Performance to date has been extremely encouraging.

To date, we have logged hundreds of miles in our prototype in all weather conditions and in a variety of fisheries, captained and crewed by non-sailing fishermen. Except for its maiden voyage, the boat has performed beyond our expectations, i.e. in very light air, 4-7 knots real wind, she sailed to windward and came about smartly and close reached very well at 3-4 knots using a 3 blade fixed prop with a moderate cargo load.

We have engaged the prototype in various fisheries during field tests with good results in each type:

1.) Bottom longlining using 5 miles of line set in the Gulfstream current. Setting up to 3500 hooks per day, this operation is normally carried out with the engine running, for safety, so the boat can be stopped quickly.

2.) Trolling under sail using 4 lines, 2 on outriggers and 2 over stern.

3.) Trawling has been done both under power and under sail using the engine for hydraulics only. We were able to set 56' shrimp nets and doors, and tow at 2½ knots plus retrieve nets and doors in 20-25 knots of wind.

4.) Surface longlining, traphauling, vertical set lines seining and gillnetting have not been tried although we have both the deck space and maneuverability to accommodate these fisheries.

The prototype boat is equipped as a high technology fish boat, incorporating sophisticated electronics and hydraulics to power the fishing gear.

Electronics include a 2000 watt color scope fish finder, a radar with radarwatch to aid in navigation and positioning, a Loran-C with computer A, speedo/log, sea temperature gauge to aid in pelagic fish locations and raid telephones. Additional equipment under consideration is a Satnav and Weather Fax to obtain ocean surface water temperature maps.

Our sailing gear includes a Hood roller furling headsail and a stow-away mainsail system so that the sails can be easily and efficiently handled by one man. Sheet leads were kept simple and straightforward to a common winch area that does not interfere with fishing operations.

We opted not to use a self tending jib on our prototype, although this is easily installed and gives even less chance of interference to fishing.
The fishing gear includes 2 trawl winches and 600 ft. of wire on each, a longline reel with 5 miles of wire and a trap hauler/lass for pulling traps, hauling in the bag and hauling the anchor.

We have a gallows frame on the aft deck which provides us with two points for trawling and allows easy maneuverability. This also provides us with attaching points for the backstay from the mast and sheet for mainsail, which keeps these things well above deck level.

Boats in remote areas may be equipped with less sophisticated, yet very reliable, electronics. A typical set up might include a white line recording fish finder, sea temp, gauge, and VHF radio or C.B. radio. Sailing gear could include rollover furling or hank on headsail and a slab reefing traditional mainsail.

The fishing gear could be powered by D.C. or a simple belt driven hydraulic pump depending on the fishery in which the boat will engage.

We currently have under development for us a small self-powered salt water ice machine that will produce 500 to 800 lbs. of soft ice/24 hrs. This unit will allow longer trips, and will be able to land a better product.

Maintenance costs are minimal, and we are extremely pleased with the performance to date. Its sail performance ability has been tested in both light and heavy weather. Aquaria I has been to, and returned from, the Bahamas in 35 to 40 knots of wind in November, and has fished since January in conditions ranging from 0 to 65 knots. Aquaria II was delivered to the Virgin Islands in 35 knots of wind.

These trials have shown us that we have a stiff, stable working platform that will sail as close as 40° to the wind. She handles well in all conditions. We were particularly concerned that its design would perform well in light weather, since much of the world's fisheries are found in light to moderate airs. The design minimizes wetted surface, and the propeller location maximizes thrust and has done well in light airs.

Fishing performance has been extremely encouraging. When compared to our fleet of 60 to 90 foot longliners and trawlers, the economic advantages are obvious. We are currently adding a total of three of the series to our fleet operations.

Finally, although final evaluation is ongoing, we are becoming increasingly convinced that the operating efficiencies and catching power of our sail assist will significantly improve the profitability of our fleet operations.
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<thead>
<tr>
<th><strong>TABLE I</strong></th>
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<tbody>
<tr>
<td><strong>Design Criteria for Sail Assist Fishing Boat</strong></td>
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<tr>
<td>1. 34' - 38' L.O.A.</td>
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<td>2. Hull speed 7½ - 10 kts.</td>
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<td>3. Fuel consumption of 1 gph or less</td>
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<td>4. Fish hold for 5000 lb. iced fish</td>
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<td>5. 175 - 200 gallons of fuel</td>
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<td>6. 60 - 120 gallons of H2O</td>
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<td>7. 2 men - fish/sail</td>
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<td>8. Accomodations for 3 - 4 men for 4 - 7 days</td>
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<td>9. Sail area enough to perform in high to moderate winds</td>
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<td>10. Reasonable windward performance</td>
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<td>11. True multipurpose capabilities</td>
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<td>12. Bollard pull of 3500 lbs. or better</td>
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| **TABLE II**                               |                                             |                                             |
| **Specifications for**                      |                                             |                                             |
| *Aquarian 38* Sail Assist Multi-Purpose Fishing Vessel*|                                             |                                             |
| L.O.A.                                      | 37'6"                                      |                                             |
| L.W.L.                                      | 33'4"                                      |                                             |
| Beam                                        | 13'0"                                      |                                             |
| Draft                                       | 5'0"                                       |                                             |
| Fish Hold                                   | 6,500 lbs.                                 |                                             |
| Work Deck Area                              | 260 sq. ft. (approx.)                      |                                             |
| Fuel Capacity                               | 240 gal.                                   |                                             |
| F.W. Capacity                               | 100 gal.                                   |                                             |
| Sail Area                                   | 734 sq. ft.                                |                                             |
| Hull Speed                                  | 8.5 knots (approx.)                        |                                             |
| Engine                                      | Perkins Diesel 4L08M 50 HP                 |                                             |
| Ballast                                     | 7,000 lb. Lead                             |                                             |