SPC/Fisheries 16/WP.14
6 August 1984

ORIGINAL : ENGLISH

SOUTH PACIFIC COMMISSION

SIXTEENTH REGIONAL TECHNICAL MEETING ON FISHERIES

(Noumea, New Caledonia, 13-17 August 1984)

TEN YEARS BOAT DEVELOPMENT IN THE SOUTH PACIFIC - WHAT CAN WE LEARN FROM IT?

by

Oyvind Gulbrandsen
FAO Consultant Naval Architect

July 1984

Introduction

The opinions expressed in this paper are based on my stay in Western Samoa between 1974 and 1978 as an FAO Fisheries Adviser and trips to the region as an FAO Consultant Naval Architect during 1982-84. The opinions are not necessarily those of FAO.

Major Topics in Boat development

Looking back at the last ten years development of fishing craft in the region, there are certain topics that spring to mind. I list them below in what I consider as the order of priority:

1. Safety

An alarming number of small fishing boats are getting lost in the Pacific each year. The Governments spend large sums of money on search and rescue missions with planes and boats, but less than 50% are recovered. Taking Kiribati as an example: Over the period 1981-83 an average of 26 craft were reported missing each year. Of these 18 craft with 46 persons were never recovered. About half of these were motorized craft. There are about 400 motorized craft in Kiribati and 4000 non-powered canoes. <u>The accident rate has therefore increased tremendously with motorization</u>.

The motorized craft which get lost are generally small aluminium or plywood skiffs of 4 to 6 m length, powered by outboard motors. Generally no spare engine or sail is carried, and it is impossible to paddle the craft any distance. What can be done to improve this poor safety record?

I believe that no powered craft in the Pacific should be allowed out fishing unless it has a secondary means of propulsion. All motorized craft should be able to carry an emergency sail and the crew should be trained in using it. An emergency sail is small enough not to require ballast. The size, type and position of the sail should be decided by a naval architect. Outboard powered craft which cannot be paddled or rowed satisfactorily should carry a spare engine. A spare engine in itself is not sufficient since the fishermen often run out of petrol. This was experienced in Western Samoa where all Alias were fitted with spare engines of 5 Hp and still boats were getting lost. The Western Samoa Alias were also fitted with Emergency Position Indicating Radio Beacons (EPIRB) which worked in a few cases until the batteries had to be renewed and it was discovered that the cost of this would be prohibitive since it could only be done by the manufacturer in the USA. The system also depends on pilots listening to the emergency frequency, which is not always the case. New development should mean a breakthrough in battery life and the use of satellites to determine the exact position (INMARSAT). This system when it becomes operational will be a revolution in search and rescue, but it will not replace other safety measures. Carrying emergency sail and spare engines will, in many cases, avoid the use of the EPIRB and can, even in monetary terms, be a good investment since the towing home of a boat can be costly. Another simple measure would be more extensive use of the "buddy" system - two boats operating together and giving mutual assistance in case of problems.

All open fishing boats should have sufficient reserve buoyancy to remain afloat when swamped. This can be achieved by buoyancy blocks made of polyurethane foam or polystyrene. The cost of added buoyancy is only about 3% of the complete boat including equipment.

The safety features in the FAO designed craft are :

Fig.	Craft	Buoyancy for level flotation when swamped	Emergency sail	Spare engine	Can be paddled or rowed
1	8.5 m Alia	X	X [1)]	X	Difficult
2	8.6 m v-bottom fishing boat	X [1)]	X [1)]		
4	8.6 m motor sailer	X	X		
5	10.0 m motor sailer	Not required because of deck	X		
8 & 9	7.2 m Proa	X	X		X
12	11.0 m transport/ fishing canoe	X	X	X	X

[1)] Not included in original design, but recommended for future construction

In improving the safety at sea we can take notice of what is happening to improve road safety. A combination of safer cars, Government regulations and training of drivers has given good results in many countries.

Questions for discussion:

- Are statistics now being collected to show types and causes of accidents among fishermen with the aim of providing a basis for future action?
- What can be done to make fishermen more safety conscious?

2. Economics

Two questions are of fundamental importance:

What can you get for your fish?
and What does it cost to catch it?

To introduce motorized boats into a subsistence economy is asking for trouble. The expenses go up while no cash comes in. It does not mean that nothing can be done in such a situation but everything must be at rock bottom cost. A subsistence fisherman also needs materials for his canoe, cloth for his sail and nylon fishing lines. The target must then be to supply him with these items at as low a cost as possible. The greatest service a Fisheries Department can give is to make these items available to the fisherman.

Most countries in the Pacific have a mixed subsistence/ cash economy. There is a growing market for cash products. The imported tinned fish is visible on the shop counters all over the Pacific. Tinned fish can never be completely replaced, but as the price of tinned fish goes up the opportunities of selling fresh fish increase, provided it can be delivered at a reasonable cost.

This is what happened in Western Samoa. There was an increasing demand for fish, partly because of a rapidly increasing population. This demand could not be met by subsistance fishing inside the reef. There was a need for fishing craft capable of harvesting the deep bottom fish resources and the skipjack tuna outside the reef. After trying many different boat types the "Alia" proved most successful. However, it meant a sizeable step up in investment (at present A$ 4,700 including 25 Hp engine, 8 Hp spare engine, fishing gear and safety equipment). The full-time fishermen had no difficulty in paying for this and for the fuel, but for the part time fisherman the Alia was too big and costly. For him a smaller single outrigger canoe with half the engine power would have been more appropriate (such as Fig. 8). When planning fisheries development in the Pacific we tend to think of the full-time fisherman, forgetting that most countries have a mixed subsistance/cash economy and that a lot of the fishermen are part time.

In certain town centres, and where there is a fish buying station, the cash economy is fully developed and if the price is right this can sustain expensive boats. A good example are the "bonitiers" in Tahiti with 250 Hp diesel engines. This could only happen where you can get a high price for a good quality product.

The following table gives the approximate investment cost, including all equipment for various craft now being built in the Pacific :

Illustration Fig.	Country	Craft	Engine	Approximate cost fully equipped 1) A$	Paid by the fisherman including subsidy A$
1	Western Samoa	8.6 m alia	25 Hp outboard	4,700	4,700
2	Fiji	8.6 m boat	20 Hp Diesel	10,000	5,800
4	Tonga	8.6 m boat	20 Hp Diesel	20,000	12,000
8	Kiribati	7.5 m outrigger	9.9 Hp outboard	2,300	2,300
9	Kiribati	7.5 m outrigger	2 Hp outboard	1,900	1,900

1) Price is given as presently built in the various countries, including equipment, sail and fishing gear.

From the above table it can be seen that you can get two fishing units of the Kiribati type for one Alia and two Alias for the cost of one Fiji diesel boat.

Question for discussion:

Most craft now being promoted by Fisheries Departments for small scale fisheries are ranging from A$ 5,000 to 20,000 in cost. Is the part time fisherman being forgotten?

3. What works well in one place will not necessarily do so in another

A classic example is the Oregon type dory that was introduced into the Pacific in the first half of the '70's. This craft, which no doubt was economically viable in the U.S. with low fuel prices and high value of the salmon, proved an economic and technical failure in the Pacific. It was promoted as a "simple craft" because of the flat bottom. Fitted with a car petrol engine, it proved far from simple to keep in operation under tropical conditions. The 130 Hp petrol engine coupled to an inefficient waterjet produced very high fuel cost.

Another example is the Fiji type 8.6 m V-bottom boat (Fig. 2) with an inboard diesel engine which was initially built in Western Samoa, but proved a failure there in competition with the outboard powered 8.5 m Alia (Fig. 1). Construction was stopped after the first 10 boats, whilst more than 250 Alias were built. In Fiji, however, the 8.6 m V-bottom boat, with some modifications, caught on in a big way with about 130 built so far.

Question for discussion:

What has been the experience of the transfer of the "Alia" (Fig. 1) and the 8.6 m boat (Fig. 2) types to other areas? What are the conditions for a successful transfer?

4. Speed and fuel economy

A major reason for the success of the "Alia" in Western Samoa was the speed of 12 knots with a 25 Hp outboard which could be maintained under fairly rough conditions. Planing hulls can achieve higher speed with light load and calm condition but are no match for the "Alia" when it gets rough. Trolling for tuna was a major fishery in Western Samoa and a speed of 10 knots was considered minimum when chasing schools. The diesel powered 8.6 m V-bottom boat could only do 8.5 knots maximum and this was considered too slow. In Fiji, trolling seems to have a lower priority which could explain the reason for success there.

Speed costs money and it is getting more expensive over the years. Fig 13 gives the development of fuel and fish prices in Western Samoa over the last ten years. The fisherman has to catch three times as much skipjack tuna now than ten years ago to pay for the same amount of fuel. What is to be done? Change to diesel engines some will say. The table on the next page shows that the answer is not that simple. The diesel engine costs almost four times as much as the outboard. What you save in fuel, which is substantial, is more or less lost in higher capital costs. The exact figures of fuel cost, of course, will depend on the relative price of petrol and diesel in various countries. The successful introduction of diesel powered boats in the Pacific is linked with subsidy to overcome the high capital cost.

If the fisherman was to bear the full capital cost he would not be much better off with a diesel powered boat for engines below 25 Hp. The subsidy on the capital cost can be defended on the grounds that the fuel economy of the diesel engine means saving in foreign exchange, while the capital cost of the boat consists of a large portion of local currency if the boat is built locally.

The importance of fuel cost when catching tuna varies substantially from country to country as shown in the table below:

Country	Price for 1 litre premix outboard fuel A$	Buying price skipjack tuna per kg A$	kg of skipjack tuna to buy one litre outboard fuel
Tahiti	0.61	1.00	0.6
Western Samoa	0.47 1)	0.72 1)	0.7
Kiribati	0.80 2)	0.55 2)	1.4
Solomon Islands	0.80 3)	0.68 3)	1.2
Vanuatu	0.78 4)	0.74 4)	1.1

1) Fuel Subsidy = A$ 0.11 per litre, Fish buying at Govt. Market in Apia
2) Tarawa
3) Malaita
4) Santa Cruz

OUTBOARD VERSUS DIESEL

		8.6 m ALIA Fig. 1	8.6 m Fiji type V-bottom boat Fig. 2
1.	Power installed	25 Hp outboard	20 Hp diesel
2.	Power utilized, service speed	15 Hp	14 Hp
3.	Service speed (knots)	10	7.5
4.	Fuel consumption (litre/hour)	7.5	3.5
5.	Fuel consumption (litre/nautical mile)	0.75	0.50
6.	Fuel cost (A$/litre)	0.80	0.60
7.	Fuel cost (A$/nautical mile)	0.60	0.30
8.	Fuel cost per year - 200 trips of 20 n.miles per year (A$)	2400	1200
Capital cost:			
9.	Initial cost of hull (A$)	2700 (Samoa)	5800 (Fiji)
10.	Life of hull (years)	10	10
11.	Capital cost per year for hull at 15% interest	540	1150
12.	Initial cost of engine (A$) and installation	900	3500
13.	Life of engine (years)	2	6
14.	Capital cost per year for engine at 15% interest (A$)	540	910
15.	Capital cost per year, hull + engine (A$)	1080	2060
16.	Fuel cost (8) + capital cost (15) (A$)	3480	3260

Advantage of diesel boat: Yearly saving of A$ 220

Disadvantage of diesel boat: Lower speed: 7.5 versus 10 knots. Deeper draught which could prove difficult in reef passages and lagoons and makes hauling out difficult.

The fisherman in Tahiti needs to catch only 0.6 kg of skipjack tuna to pay for one litre of premixed outboard fuel while in Kiribati he has to catch more than twice this amount to pay for the same fuel.

Tahiti also has a very low price for diesel fuel (A$ 0.30 per litre) which, coupled with a high fish price, explains the success of the high powered "bonitier".

Generally it takes very little power to drive a boat up to 6 knots. Fig. 14, which is based on measurements on the Tonga 8.6 m boat (Fig. 4), shows what happens from there on. It is like trying to drive up the wall. By far the best advice regarding fuel economy is therefore to slow down to between 5 and 6 knots. Notice also that <u>Fuel consumption per nautical mile</u> is the correct criteria to use when comparing fuel economy of different craft.

In the heart of most fishermen there is a greed for speed. Everybody likes to go faster than the next fellow and the result is a power escalation which, in the end, only benefits the oil companies and engine manufacturers. A survey in Norway has shown that the same quantity of fish could be caught with half the engine power installed in the fishing fleet.

For all other fishing methods than trolling for tuna, speed is not essential, and diesel powered boats should generally have a maximum of 5 Hp per ton displacement installed. Actual utilized power should be maximum 3Hp per ton to avoid overloading the engine and increase life. This is a lot less than is currently being used. From a naval architect's point of view both the Fiji boat (Fig. 2) and the Tonga boat (Fig. 4) should have had half the power installed if trolling for tuna was no consideration.

The minimum speed when fishing for tuna now seems to be 10 knots according to SPC masterfishermen. Everybody agrees that the more speed the better when chasing tuna schools, but fast rising fuel cost usually does not pay off in increased catches. 10 knots is not planing speed and it is in a range where the wide planing type of hull is operating very uneconomically. It is also above displacement speed of 8 knots. In this intermediate semi-planing range there is a definite advantage in using multihulls such as a catamaran like the Alia (Fig. 1) or the single outrigger type (Fig. 8) The Alia gives 12 knots with 4 men and a 25 Hp outboard, while the KIR-1 outrigger canoe has a speed of 11 knots with a 9.9 Hp outboard and two men on board.

Common for all multihulls is a sensitivity to weight and trim. They are not suitable for carrying heavy loads and the worst of all is to add heavy loads forward. On Alias (Fig. 1) built for Vanuatu, Kiribati and Papua New Guinea a heavy platform for keeping the anchor has been added forward with a marked negative effect on seaworthiness, speed and manoeuvreability. Other Alias have been decked in, fitted with huge ice boxes thereby increasing weights above those for which it was originally designed. To sum up: The multihull is a good choice in the 10 to 15 knots range but it must be kept light. If heavy loads have to be carried one should question the need for high speed and ask whether a monohull at 6 knots could not do the job.

Fish Agregating Devices (FAD) has had a marked effect on the fuel economy of the trolling fleet in Western Samoa. Most of the fuel was previously spent looking for tuna schools and chasing them. With increasing fuel prices this type of fishing was no longer economic. The FAD's meant the fishermen could avoid wasting fuel and time looking for the fish. Eventually many boats stayed overnight tied up to the FAD to get both the evening and the morning bite. Maybe this could be taken one step further and have a mother vessel with ice boxes tied to the FAD and the actual fishing done by smaller and cheaper units? The mother vessel could also carry smaller fishing canoes out to the fishing area thereby cutting down on fuel cost.

Questions for discussion:

- How can Fisheries Departments prevent a wasteful power competition among fishermen? Should subsidies only be given for engines up to a specified power?
- What is the minimum required speed for trolling tuna? Does this vary from eastern to western Pacific?

5. Construction materials

At present the following materials are used for small fishing craft:

Construction method	Countries built	Examples
Planked timber	Most countries	Figs. 3, 4, 5, 6
Plywood	Most countries	Figs. 1, 2, 7, 8, 9, 12
FRP	Solomon Islands, Tahiti, American Samoa, Fiji	
Aluminium	Western Samoa, Vanuatu	Fig. 1, modified

Planked timber

A good example are the V-bottom "bonitiers" in Tahiti, built of imported redwood planking, local timber in frames and hot dipped, galvanized carvel nails for fastenings. These boats last well in spite of being highly stressed when travelling at 20 knots speed.

The round bottom hull in Fig. 4 is built with steambent frames and copper rivets. To protect against toredo a dynel/

epoxy sheathing. Alternatively regular painting with antifouling at 6 month intervals is required.

There is still a lot that can be said in favour of conventional planked construction and especially countries with their own timber resources should consider it. If durable, stable timber is utilized, boats built in "the old way" can have a surprisingly long life in the tropics. At Malaita in the Solomon Islands 24 m (80 ft) wooden inter-island boats are built with simple facilities in villages without road connection. No other construction method would permit this.

Plywood

This is the easiest method of construction to start with. The service life can be good provided high quality, anti-rot treated exterior or marine plywood is used. There are two plywood manufacturers in the Pacific: PNG Forest Products Ltd. and Fiji Forest Industries Ltd. I inspected some plywood Alias built 8 years ago from PNG "Klinki Duraply" and could not find rot or delamination. Some Alias had, however, rot in the framing which was not of decay resistant timber nor was pressure treated. Douglas fir plywood is widely used in Tahiti for making single outrigger fishing canoes powered with outboard motors.

FRP

Only in the Solomon Islands has FRP been used extensively for building canoes. There is no doubt that FRP is an excellent boatbuilding material. One problem however must be taken into account in the Pacific: possibilities of repair in remote areas. In the Solomon Islands many FRP canoes were seen with holes or abrasion damage which could easily have been repaired if the polyester resin had been available. Because the storage life of the resin is limited to 6 months, fresh resin could only be bought from the boat manufacturer in Honiara. This is impractical when living on an outer island. The air company was unwilling to fly polyester resin because of imflamability risk. Where easier access to polyester resin can be assured, FRP is no doubt a good alternative.

Aluminium

More than 150 aluminium versions of the Alia (Fig. 1) have been built in Western Samoa. The experience has mainly been positive except with cracks experienced in some Alias that have been driven too hard in rough seas with 30 to 40 Hp outboard engines. The problem of repairs in remote areas as mentioned for FRP exist also for aluminium. Aluminium can, however, take more beating than FRP before repairs become necessary. Dents can be hammered out and cracks can be patched up with a rivetted doubling which is feasible in a remote place. Major repairs requiring welding are jobs for the workshop. Aluminium welding with MIG requires complex machines that can prove difficult to keep in operation as experienced in Western Samoa. Argon gas for the welding needs to be imported.

One advantage of the aluminium Alia compared with the plywood version is lighter weight which gives a better fuel economy with the same engine. The wooden Alia when not hauled out, will soak up water and increase appreciably in weight. Because of light weight and durability, aluminium is an attractive alternative, especially for craft with speed above 10 knots.

In Papua New Guinea single outrigger dugout canoes are used for fishing and transport, powered with 25 Hp outboard engines. Figs. 10 and 11 show two versions. The dugout canoe is very heavy when waterlogged and the shape can be irregular dependent on the straightness of the log. Their main advantage is cheapness in first cost. Fuel cost however, is very high because of weight and shape. Fig. 12 shows an alternative built of lighter plywood which reaches the same speed with a 15 Hp outboard as 25 Hp for the dugout canoe. The prototype is now being tested in the Wewak area.

The choice of construction materials is often limited to what can be built locally. The large scale import of aluminium dinghies seen all over the Pacific should be avoided. Recently Kiribati has banned import of these boats. Maybe more countries should follow the example of Kiribati and try to develop craft based on their own tradition?

Question for discussion:

Representatives from each country report local experience in durability and maintenance with the following construction methods :

Tahiti	-	Planked wooden construction ("bonitiers") and plywood (canoes)
Tonga	-	Planked wooden construction Figs. 3, 4, 5
Fiji	-	Plywood Fig. 2
Western Samoa	-	Plywood and aluminium Fig. 1
Solomon Islands	-	FRP

6. Sail

Fig. 6 shows an outrigger canoe from Kiribati - an example of the very refined traditional sailing craft still seen in some parts of the Pacific. For subsistence fishing no imported craft can compete. However, as the cash economy develops the fishermen in Kiribati have jumped from their sailing canoes to imported aluminium dinghies and plywood skiffs with high powered outboard motors.

The canoe shown in Fig. 6 is rather fragile and has limitations for motorization. The new types in Figs. 8 and 9 are an attempt to produce craft with good sail performance based on the local tradition, but adapted to the use of small outboard motors.

All traditional sailing craft in the Western Pacific are "shunted" rather than "tacked". The outrigger is always kept to windward. In the Eastern Pacific however, the canoes generally tacked, that is the bow remained the bow after going about. Although sail is not at present much used for fishing in the Eastern Pacific, the type of craft survives in the form of the racing canoe (Fig. 7). The gaff sail and rudder are Western ideas and the type has been specialized for racing with excessive sail area, but the traditional concept is the same. Note the difference in the size of the outrigger float between Fig. 6 and 7 caused by the need for the latter to have sufficient buoyancy when the float is to leeward. Shunting is rather more difficult to do than tacking in a rough sea condition. The proposed new designs for Kiribati, Figs. 8 and 9, therefore, are designed for tacking with more buoyancy floats.

The single outrigger canoe is the truly Pacific type of craft found in all areas except central Solomon Islands. Persons from outside the region are confused by the assymmetry of the single outrigger canoe and want to make it into a double outrigger craft or a catamaran. There are, however, good reasons why the single outrigger canoe has such a dominant place in the traditional fishery all over the Pacific. It is the simplest way of increasing the stability of a narrow canoe while retaining the good paddling characteristics. It takes less space than a double outrigger when going through narrow reef passages and it leaves one side free for handling the fishing gear. Compared with the catamaran the single outrigger canoe is lighter and cheaper because a heavy bridge between the hulls is not required. Catamarans were used in the Pacific only for larger voyaging canoes.

An example of a type of sailing craft introduced from outside is the Tongan whaler (Fig. 3). This craft was not only used for whaling but also for fishing and general transport. The new type of motorized craft proposed for Tonga (Fig. 4) will also retain sail for use in an emergency and for fuel saving. The sail area has been reduced from 31m^2 to 20m^2. A motorized boat will not use sails in very light wind and there is threrfore no need to carry a sufficient sail area for this condition. A motor sailer will also not be sailed with the same attention as a pure sailing craft (some say engines spoil good sailors). Thirdly, large sail area requires much ballast. Fig. 4 carries 400 kg ballast mainly inside, while Fig. 5 has 1200 kg external ballast. A pure sailing boat would carry at least twice as much external ballast. Ballast is essential for safety in a monohull sailing vessel, but it costs money to install and it increases fuel consumption under power.

There has been a tendency over the last years to over-emphasize the role of sail in saving fuel. I recently saw a proposal for a small inter-island transport boat in the Solomons with twice as much engine power as would be sensible, but with a sail stuck on top to emphasize fuel saving. Fuel saving can best be achieved through reduced operating speed, installation of low horse power engines with high reduction ratio, good hull shapes and keeping the hull free from fouling. There is a potential saving in the use of sail, but it will be very much dependent on the motivation of the fisherman as to how much he is willing to slow down under sail, and the investment cost of the sail rig. The wind is free but not the equipment to catch it. Modern yacht equipment is expensive. Sails made by yacht sail makers in developed countries are too expensive for use by small scale fishermen in the Pacific. Sails must be made locally and the sail cloth imported directly from the manufacturer. Training should be provided in sail making since polyester cloth requires a different technique from cotton. It now seems that good quality cotton duck on the world market is more expensive than polyester (Terylene) which is available for A$ 3.10 per sq. m. (5.5 oz cloth). Sail cloth for fishing boats should be made with as little resin treatment as possible to increase durability. Polyester sails should be kept out of sunlight when not in use (the same as nylon nets) as continuous exposure will seriously reduce working life. An alternative cloth could be acrylic which has a better resistance than polyester to sunlight and is widely used as a steadying sail on fishing boats in Scandinavia. It stretches too much for racing yachts, but this is of minor importance on a fishing boat.

The need for emergency sail on all fishing craft operating in the Pacific has been stressed under item 1.

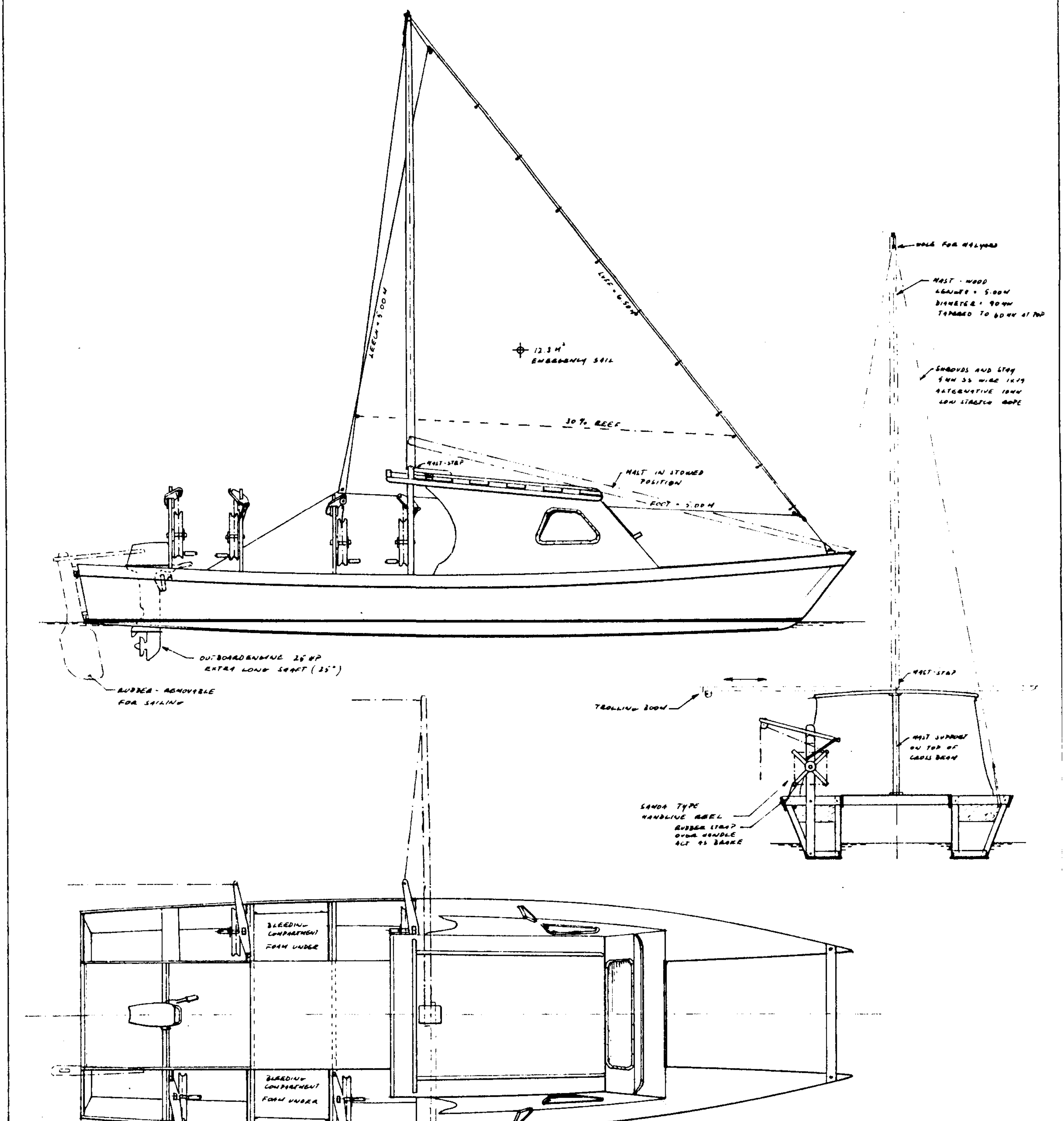
The question of the use of an increased sail area for fuel saving has to be considered case by case. For monohulls ballast must be added and the expected fuel saving must cover the depreciation of the cost of the sail rig. I believe the largest potential for the use of sail is in a multihull such as Fig. 9 used in a mixed subsistance/cash economy. Sail will be the main means of propulsion while backup power is provided by a 2 to 4 Hp outboard engine. Sail and outboard power go well together because of low investment in the engine and the ability to tilt up the propeller when sailing. High fuel cost can be partly offset by good sailing qualities.

The introduction of a sailing craft in an area where the tradition of sail has been lost will require more extensive training than with motor craft. Inadequate training in handling the boat and the rig will be asking for trouble.

<u>Questions for discussion</u> :

- Where are traditional sailing craft still being used in the Pacific?
- Are there examples of sailing craft recently introduced?
- Experience with different types of sail cloth?

Fig. 1.



1.0 0.5 0 1 2 M

SCALE = 1:20

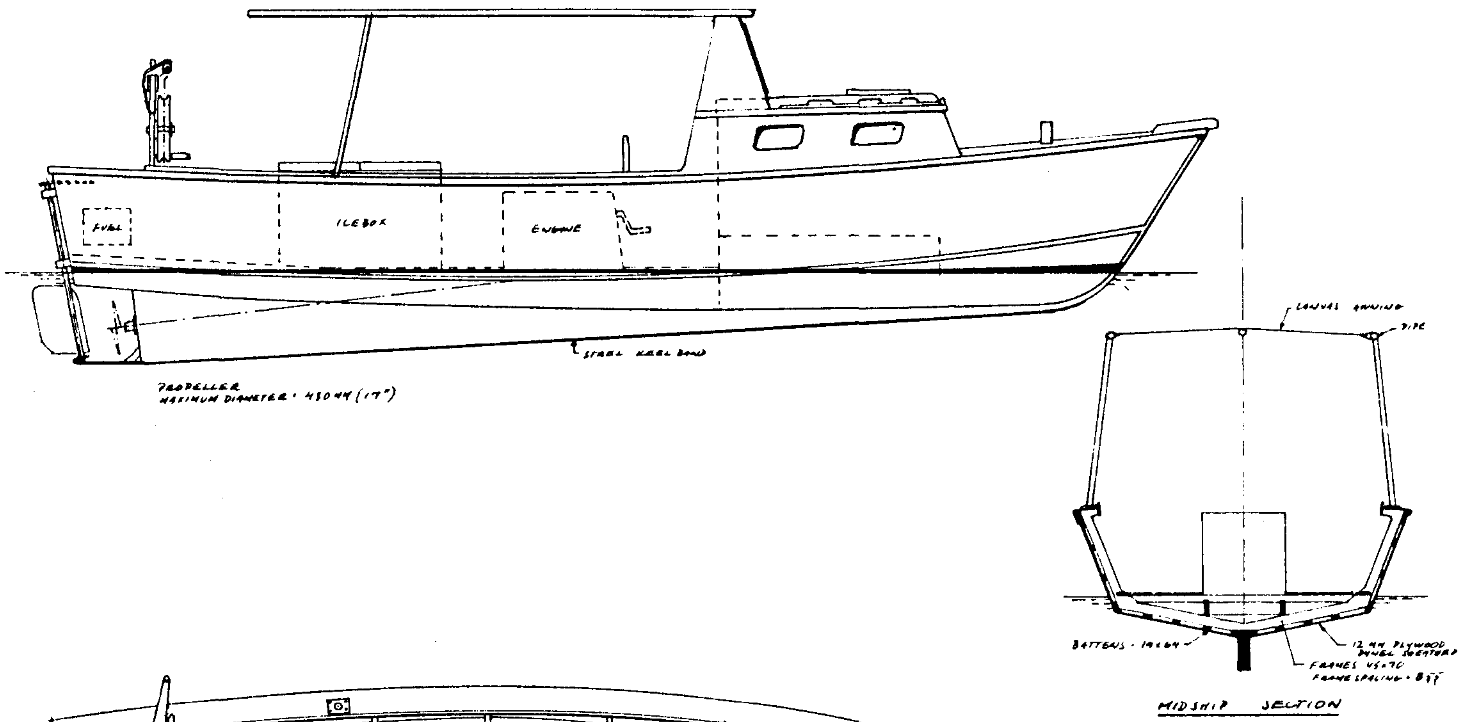
MAIN DIMENSIONS

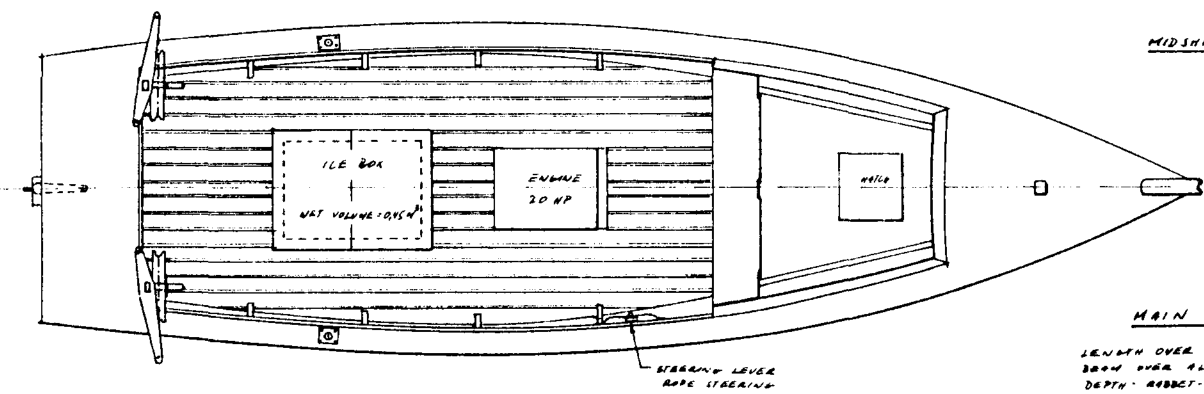
LENGTH OVER ALL	-	8.54 M
BEAM OVER ALL	-	2.50 M
DEPTH HULL	-	0.70 M
DISPLACEMENT LOADED	-	1000 KG
WEIGHT EMPTY	-	600 KG

PROPULSION: OUTBOARD MOTOR, 25 HP, EXTRA LONG SHAFT (25")
EMERGENCY SAIL 12.3 M²
CREW: 4
FISHING METHODS: TROLLING, HANDLINING

FAO FIAT PANIS	8.5 M FISHING CATAMARAN		
	GENERAL ARRANGEMENT		
	SCALE: 1:20	DESIGN NO	DRAWING NO
	DESIGN A.C.-O.G.	WES-8	5
	APIA - 1979		

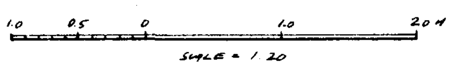
Fig. 2.





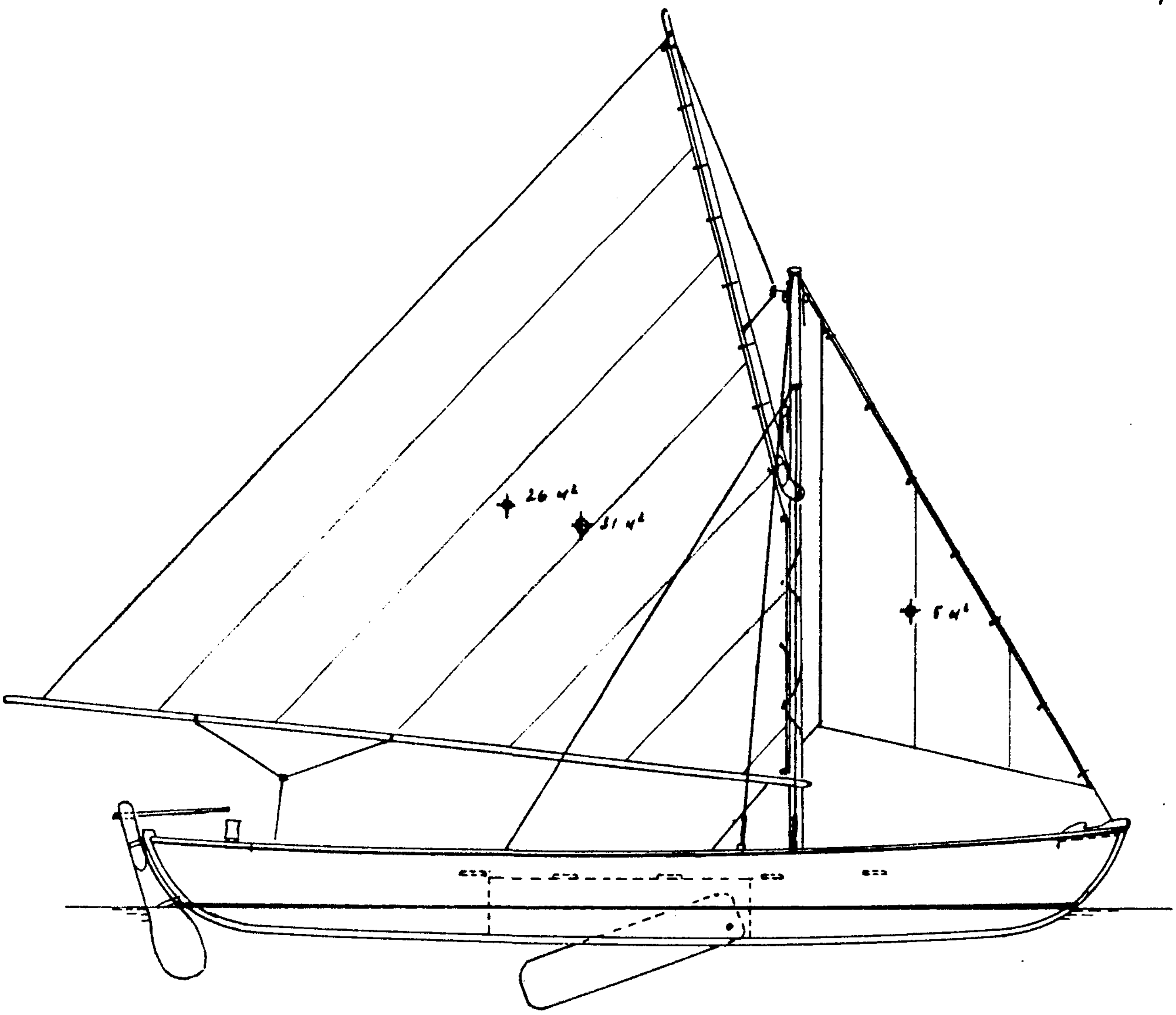
MAIN DIMENSIONS

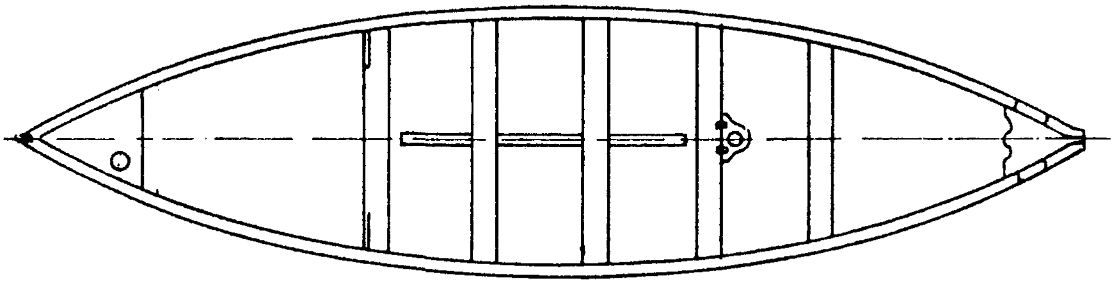
LENGTH OVER ALL - 8.6 M
BEAM OVER ALL - 2.5 M
DEPTH - RABBET - SHEER - 0.95 M
DRAUGHT - 0.70 M
DISPLACEMENT LOADED - 1,3 TONS
POWERING : DIESEL ENGINE 10 - 20 HP
SPEED WITH 20 HP = 8,5 KNOTS
CREW - 4 MEN
FISHING METHODS - HANDLINING - TROLLING

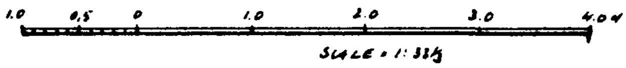


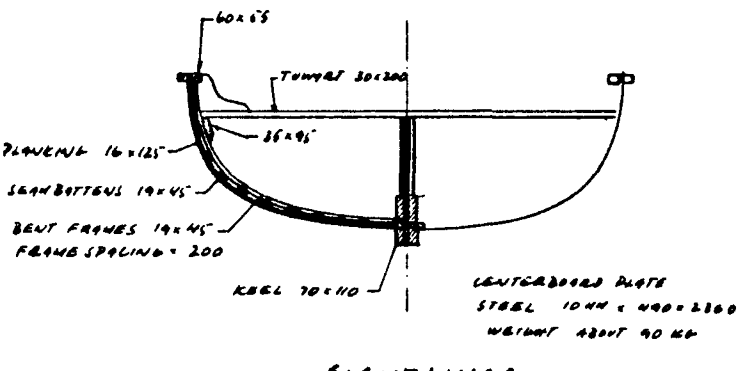
8.6 M V-BOTTOM FISHINGBOAT		
GENERAL ARRANGEMENT		
SCALE = 1:20	BOAT NO	DRWG NO
DESIGN VARIOUS	F1J-5	1
GRINSTAD. JULY - 84		

Fig. 3.









<u>SCANTLINGS</u>

SCALE = 1:20

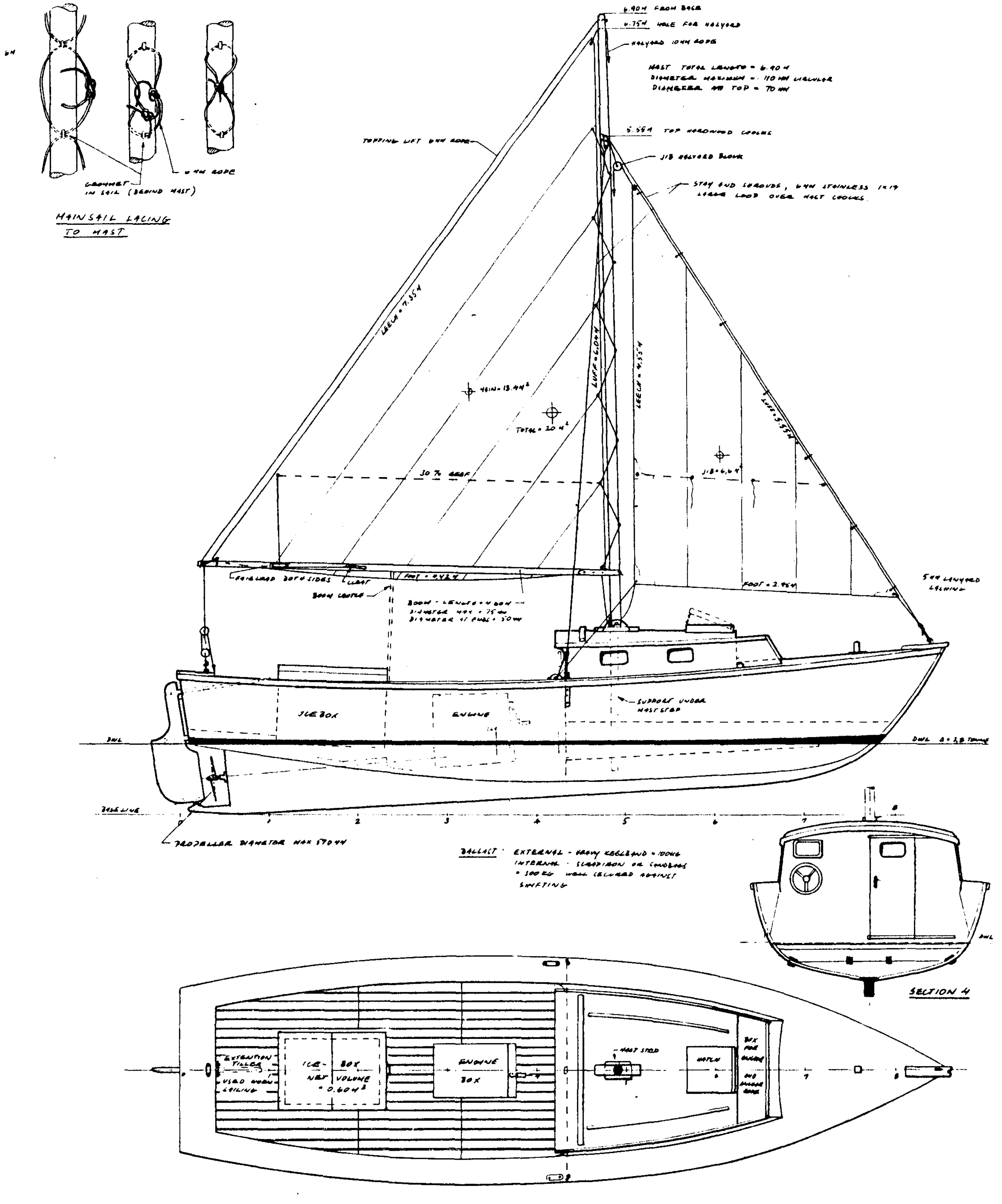
MAIN DIMENSIONS

LENGTH OVER ALL	- 9.30 M
BEAM MOULDED	- 2.30 M
DEPTH - RABBET TO SHEER	- 0.83 M
CUBIC NUMBER	- 18 M^3
LENGTH WATERLINE	- 8.5 M
BEAM WATERLINE	- 2.0 M

THIS BOAT WAS MEASURED IN NUKUALOFA, TONGA, 1983.

9.3 M TRADITIONAL WHALING BOAT		
GENERAL ARRANGEMENT		
SCALE = 1:33⅓	DESIGN NO:	DRWG. NO.
DRAWN: Ø. Gulbrandsen GRIMSTAD, JULY - 84	TON - T	1

Fig. 4

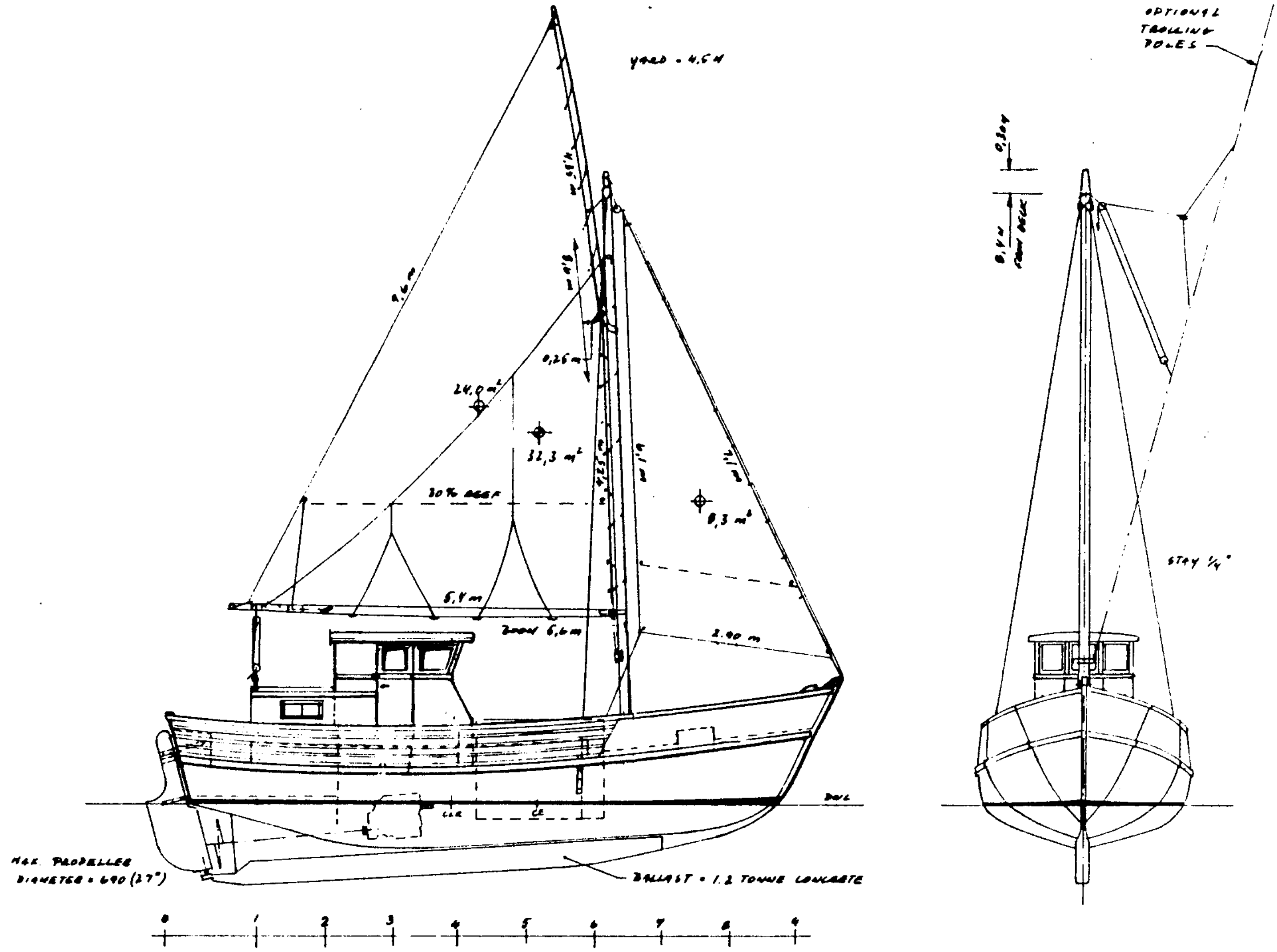


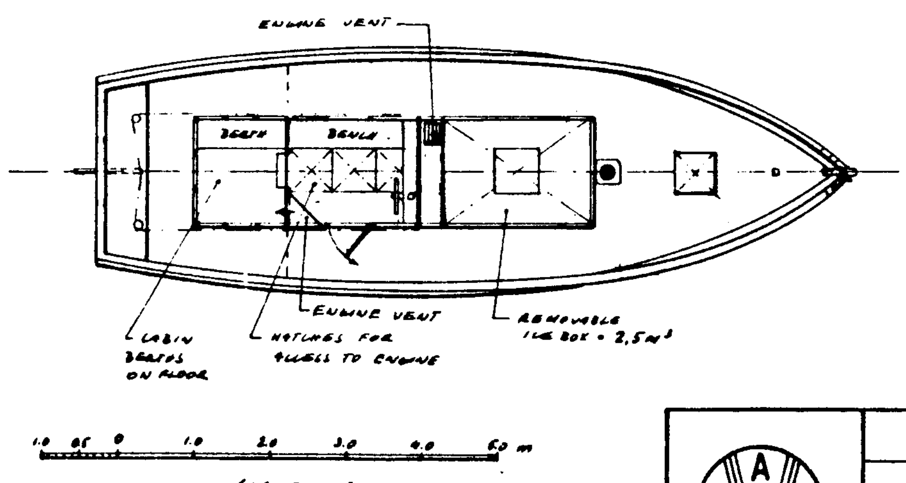
MAIN PARTICULARS

LENGTH OVER ALL	8.60 M	28'1"
BEAM MOULDED	2.61 M	8'6"
DEPTH - RABBET TO SHEER AT STATION 4	1.14 M	3'8"
LENGTH WATERLINE - DWL	7.70 M	25'3"
BEAM - DWL	2.30 M	7'6"
DRAFT DWL	0.82 M	2'7"
DISPLACEMENT DWL	2.80 TONNE	
FREEBOARD DWL	0.70 M	2'4"
ENGINE POWER	10-30 HP	
SAIL (AUXILIARY)	20.0 M²	
BALLAST	400 KG	

FAO FIAT PANIS	8.6 M MOTOR - SAILER	
	GENERAL ARRANGEMENT	
SCALE = 1:20	DESIGN NO.	DRNG. NO
DESIGN: Ø. Gulbrandsen	TON - 5	1
NUKUALOFA, FEB-83		

Fig. 5.





MAIN PARTICULARS

LENGTH OVER ALL	10.0 M	32'10"
BEAM MOULDED	3.20 M	10'6"
DEPTH MOULDED	1.20 M	4'0"
CUBIC NUMBER	38	
LENGTH WATERLINE	8.70 M	28'6"
BEAM WATERLINE	3.00 M	10'0"
DRAUGHT MAX. DWL	1.15 M	3'9"
FREEBOARD MIN. DWL	0.54 M	- 1'9"
DISPLACEMENT DWL	7.0 TONNE	
ENGINE POWER :	30-35 HP	
FISHING METHOD:	HANDLINING-TROLLING	

FAO FIAT PANIS	10.0 M MOTOR SAILER	
	GENERAL ARRANGEMENT	
SCALE = 1:50	DESIGN NO:	DRWG. NO
DESIGN: Ø. Gulbrandsen Grimstad, Aug-83	TON-6	1 A

Fig. 6.

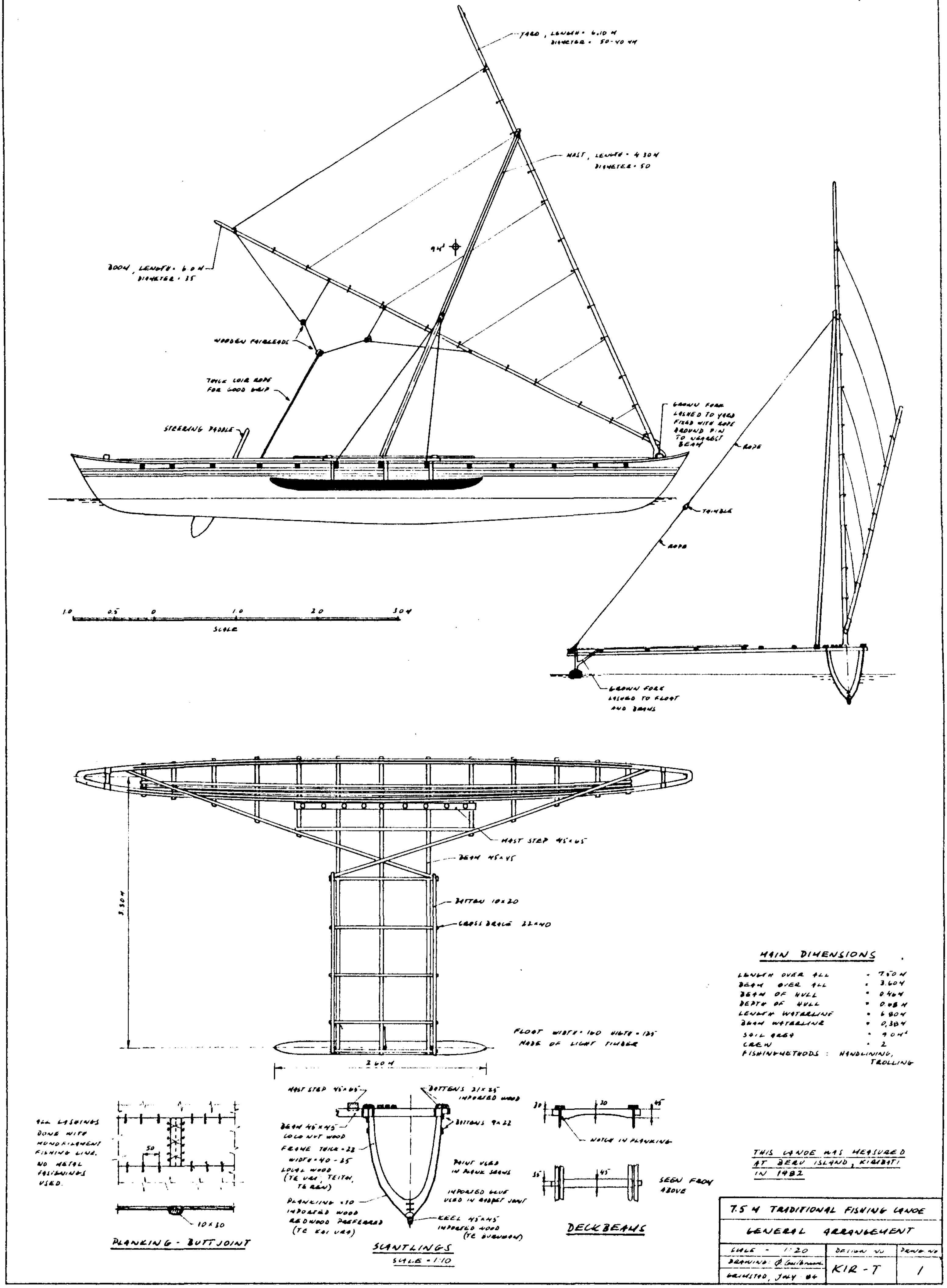
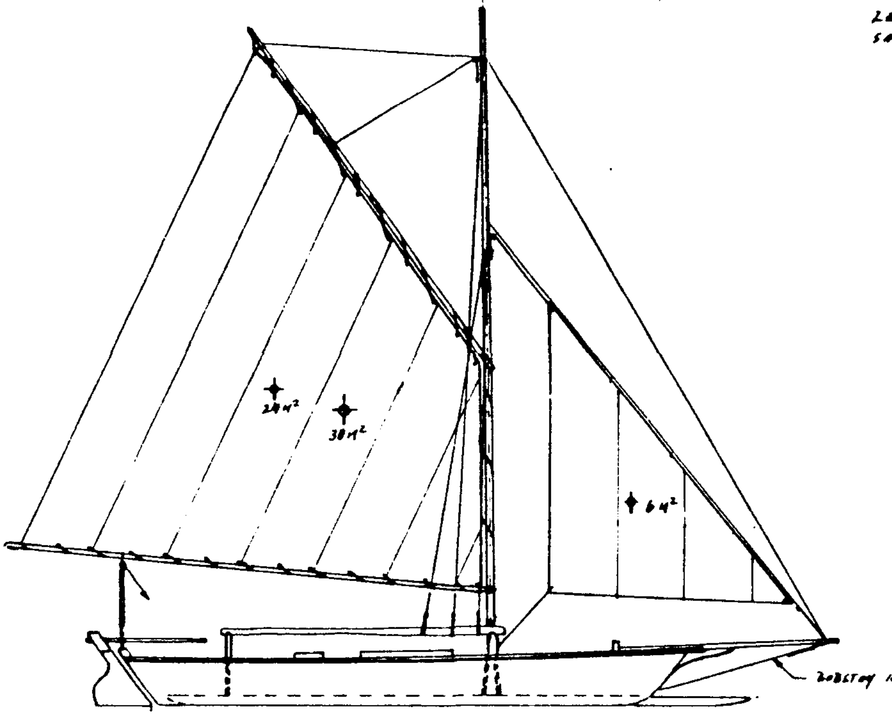
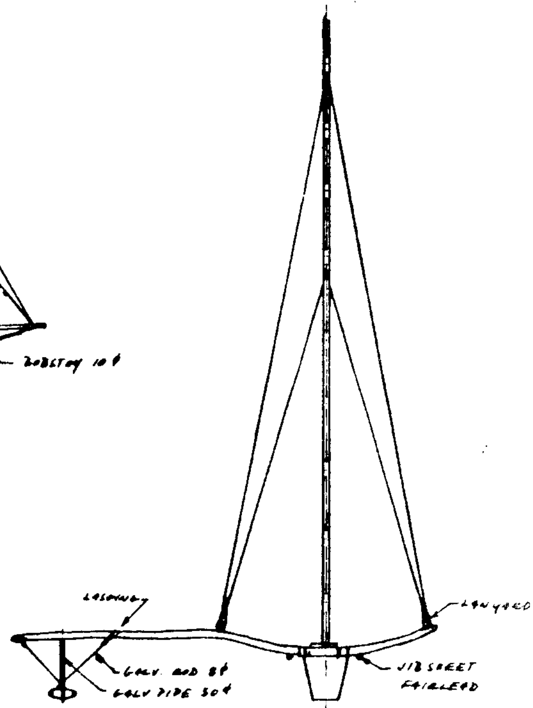

YARD, LENGTH = 6.10 M
DIAMETER = 50-40 MM
MAST, LENGTH = 4.30 M
DIAMETER = 50
BOOM, LENGTH = 6.0 M
DIAMETER = 35
9 M²
WOODEN FAIRLEADS
THICK COIR ROPE
FOR GOOD GRIP
STEERING PADDLE
GROWN FORK
LASHED TO YARD
FIXED WITH ROPE
AROUND PIN
TO NEAREST
BEAM
ROPE
THIMBLE
ROPE
GROWN FORK
LASHED TO FLOAT
AND BEAMS
1.0 0.5 0 1.0 2.0 3.0 M
SCALE
MAST STEP 45x65
BEAM 45x45
BATTEN 10x20
CROSS BRACE 22x40
3.30 M
FLOAT WIDTH = 160 HIGTH = 125
MADE OF LIGHT TIMBER
2.60 M
MAIN DIMENSIONS
LENGTH OVER ALL = 7.50 M
BEAM OVER ALL = 3.60 M
BEAM OF HULL = 0.46 M
DEPTH OF HULL = 0.48 M
LENGTH WATERLINE = 6.80 M
BEAM WATERLINE = 0,38 M
SAIL AREA = 9.0 M²
CREW = 2
FISHINGMETHODS : HANDLINING, TROLLING
ALL LASHINGS
DONE WITH
MONOFILAMENT
FISHING LINE.
NO METAL
FASTENINGS
USED.
50
10 x 30
PLANKING - BUTTJOINT
MAST STEP 45x65
BATTENS 21x25
IMPORTED WOOD
BEAM 45x45
COCONUT WOOD
BATTENS 9x22
FRAME THICK = 22
WIDTH = 40 - 35
LOCAL WOOD
(TE URA, TEITH, TE REN)
PAINT USED
IN PLANK SEAMS
IMPORTED GLUE
USED IN RABBET JOINT
PLANKING = 10
IMPORTED WOOD
REDWOOD PREFERRED
(TE KAI URA)
KEEL 45x45
IMPORTED WOOD
(TE BUKIBOKI)
SCANTLINGS
SCALE = 1:10
30
30
45
NOTCH IN PLANKING
35
45
SEEN FROM
ABOVE
DECKBEAMS
THIS CANOE WAS MEASURED
AT BERU ISLAND, KIRIBATI
IN 1982
7.5 M TRADITIONAL FISHING CANOE
GENERAL ARRANGEMENT
SCALE - 1:20
DRAWING: Ø. Gulbrandsen
GRIMSTAD, JULY 84
DESIGN NO
KIR - T
DRAWG NO
1

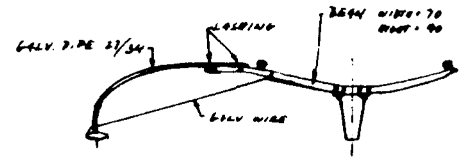
Fig. 7

MAIN DIMENSIONS

LENGTH OVER ALL, MAIN HULL EXCLUDING BOWSPRIT	= 7.50 M
BEAM OVER ALL	= 5.50 M
LENGTH WATERLINE	= 6.60 M
BEAM WATERLINE, MAIN HULL	= 0.40 M
LENGTH OUTRIGGER	= 7.80 M
SAIL AREA	= 31 M²

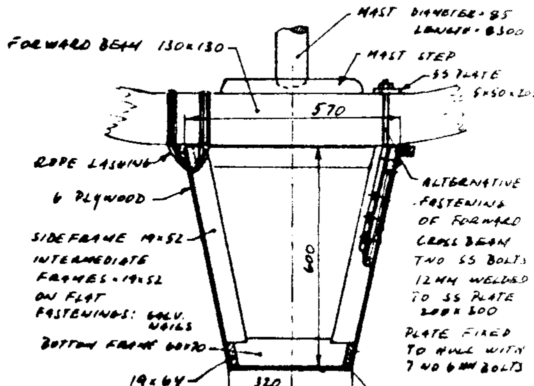






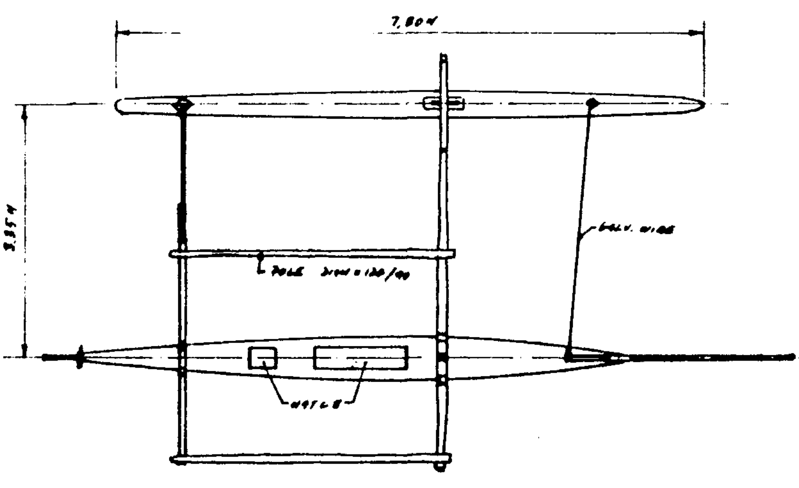
AFT BEAM

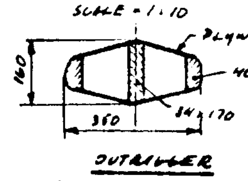
FORWARD BEAM



MAIN HULL

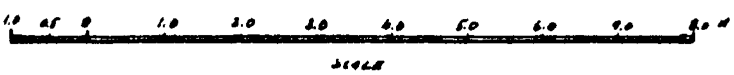
SCALE = 1:10





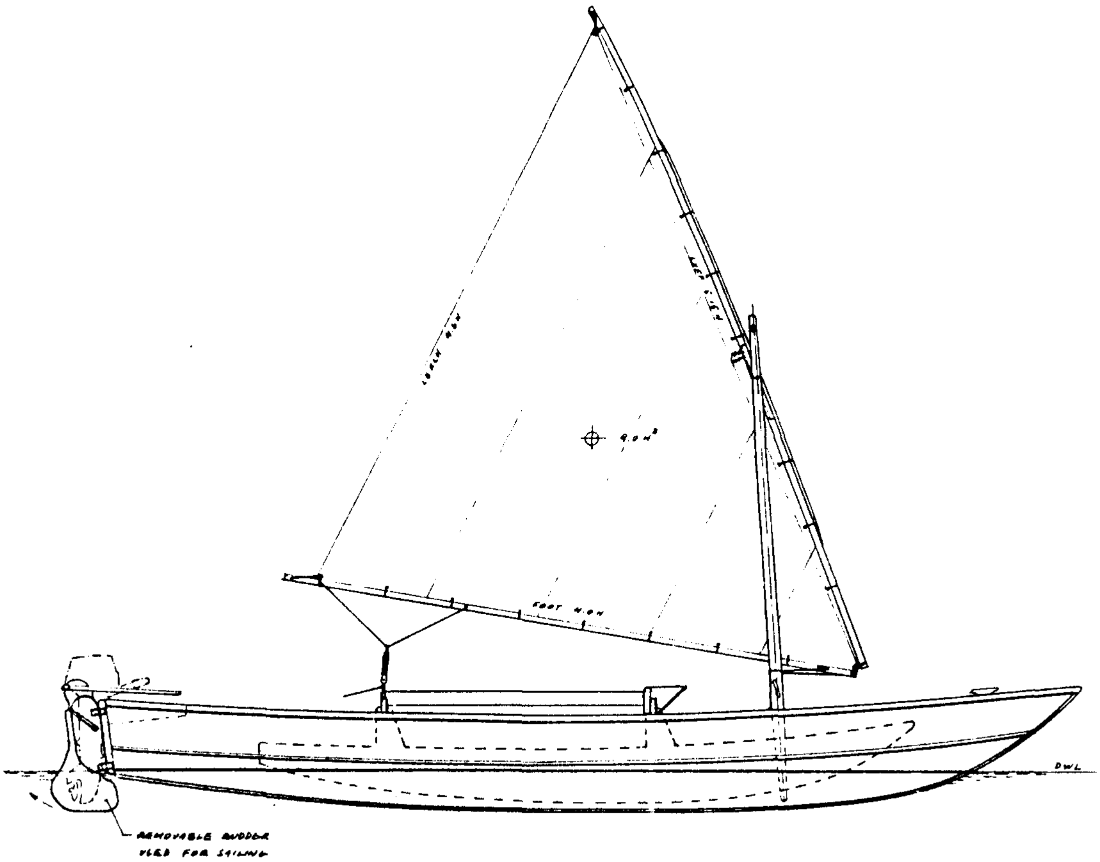
OUTRIGGER

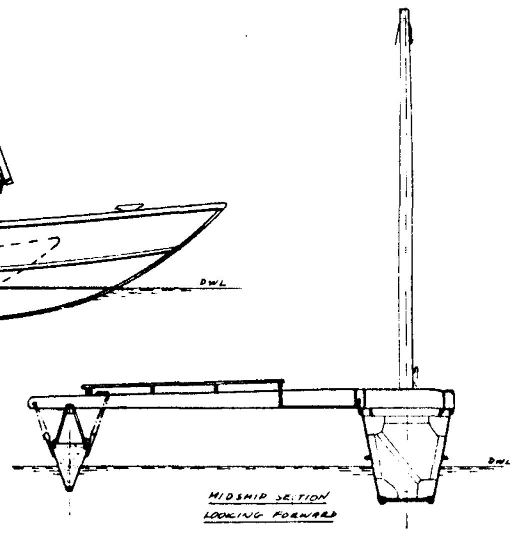
CANOE MEASURED AT PAPEETE



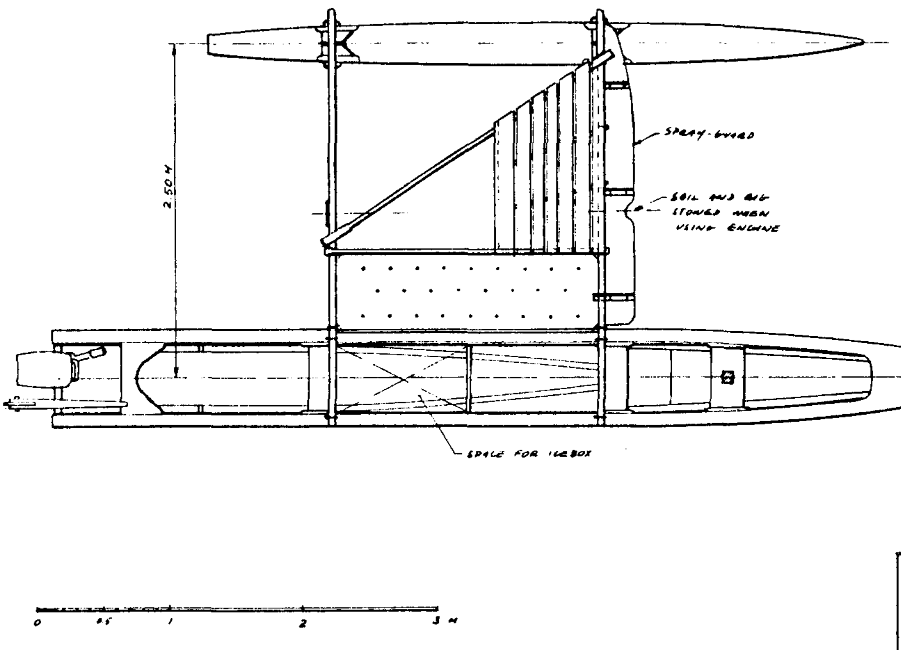
7.5 M RACING CANOE - TAHITI		
GENERAL ARRANGEMENT		
SCALE = 1:50	DESIGN NO	DRAW. NO.
MEASURED: Ø. Gulbrandsen	FPO - T	1
DRAWN: ST.D., JULY. 84		

Fig. 8.





MIDSHIP SECTION
LOOKING FORWARD



MAIN DIMENSIONS

LENGTH OVER ALL	7.30 M	24'0"
BEAM MAXIMUM	3.14 M	10'4"
DEPTH MOULDED	0.70 M	2'4"
LENGTH - DWL (HULL)	6.40 M	21'0"
BEAM - DWL (HULL)	0.55 M	1'10"
DRAUGHT - DWL	0.30 M	1'0"
FREEBOARD - MINIMUM - DWL	0.40 M	1'4"

DISPLACEMENT, SERVICE, DWL HULL = 530 kg, Outrigger = 50 kg TOTAL = 580 kg

WEIGHT EMPTY, HULL + OUTRIGGER = 260 kg

PROPULSION OUTBOARD ENGINE 6-15 HP, LONGSHAFT (20")

EMERGENCY SAIL 9.0 M²

SERVICE SPEED - 9 KNOTS WITH 8 HP ENGINE

CREW. 2-3

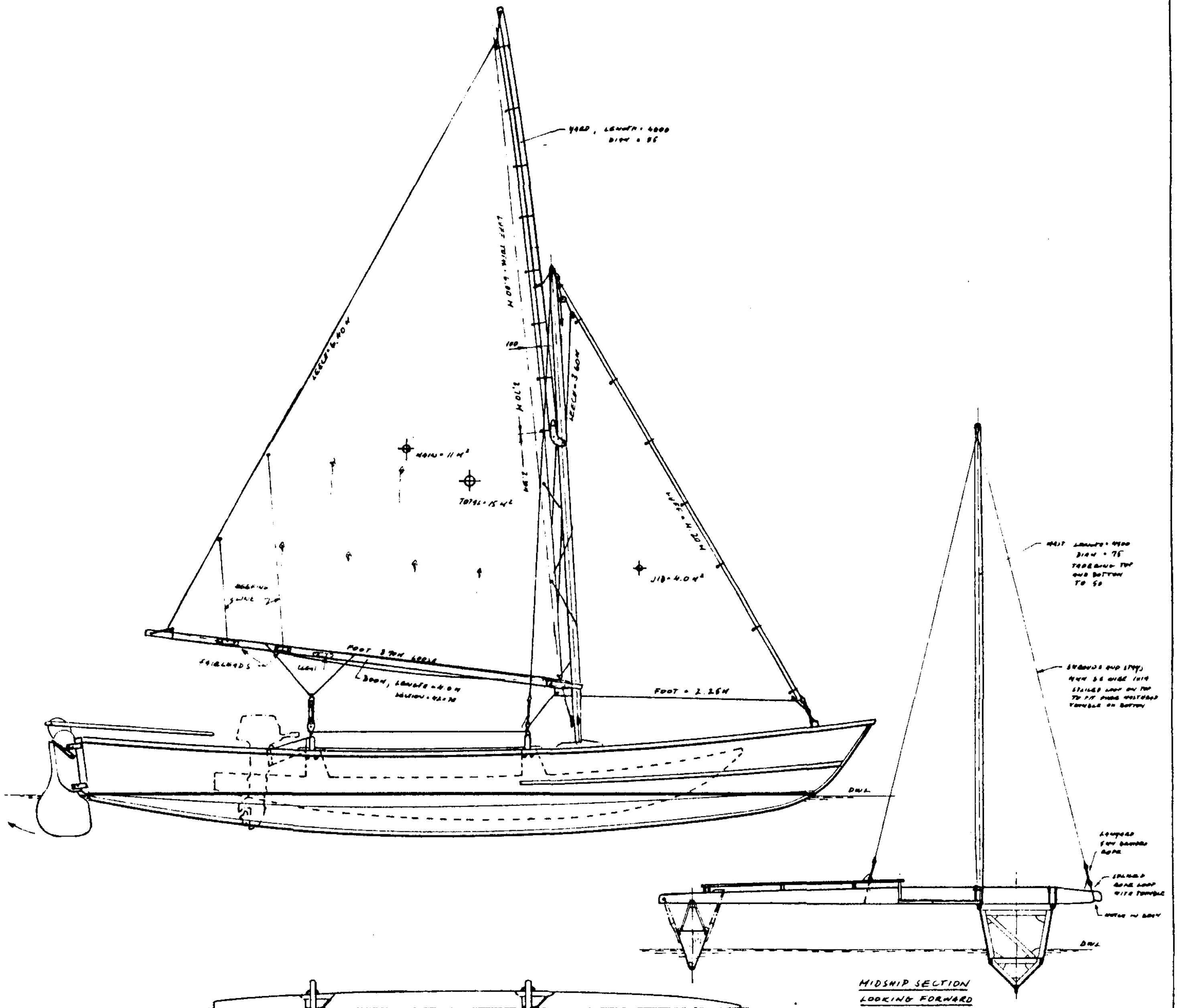
FISHING METHODS: HANDLINING, TROLLING, PEARL SHELL-LURE

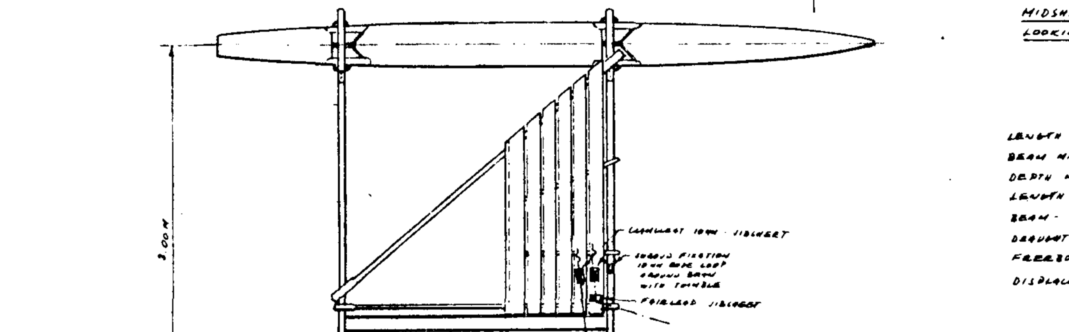
SAFETY FEATURES: THE CRAFT CAN BE RIGHTED BY TWO MEN USING ROPE FROM OUTRIGGER AFTER CAPSIZE. THERE IS SUFFICIENT BUILT IN BUOYANCY TO MAKE THE CRAFT FLOAT SUFFICIENTLY HIGH IN SWAMPED CONDITION TO BAIL THE CRAFT DRY WITH A BUCKET

REVISED JULY 1984

FAO FIAT PANIS	7.3 M PROA		
	GENERAL ARRANGEMENT		
	SCALE = 1:20	DESIGN NO	DRWG NO
	DESIGN Ø Gulbrandsen	KIR-1	1
	GRIMSTAD, SEPT - 82		

Fig. 9.





MAIN DIMENSIONS

LENGTH OVER ALL		7.27 M	24'0"
BEAM MAXIMUM		4.10 M	13'6"
DEPTH MOULDED (HULL)		0.75 M	2'6"
LENGTH - DWL	—	6.70 M	22'0"
BEAM - DWL	—	0.56 M	1'10"
DRAUGHT - DWL	—	0.39 M	1'3"
FREEBOARD, MIN. - DWL		0.40 M	1'4"
DISPLACEMENT		EMPTY	LOADED (DWL)
	HULL -	175 kg	460 kg
	OUTRIGGER	45 "	55 "
	TOTAL	220 kg	515 kg

PROPULSION: SAIL = 15 M²
AUXILIARY OUTBOARDMOTOR
2-4 HP, LONGSHAFT 20"

FISHING METHODS: HANDLINING, TROLLING, PEARLSHELL LURE.

CREW: 2 - 3

SAFETY FEATURES: THE CRAFT CAN, AFTER CAPSIZE, BE RIGHTED BY TWO MEN STANDING ON THE MAIN HULL USING ROPES FROM OUTRIGGER.
BUILT IN BUOYANCY BLOCKS WILL MAKE THE CRAFT FLOAT SUFFICIENTLY HIGH TO PERMIT BAILING THE CRAFT DRY WITH A BUCKET

REVISED: JULY 1984

FAO FIAT PANIS	7.25 M PROA		
	GENERAL ARRANGEMENT		
	SCALE - 1:20	DESIGN NO.	DRAW NO
	DESIGN: Ø. Gulbrandsen	KIR - 2	1B
	GRANSTED, OCT - 82		

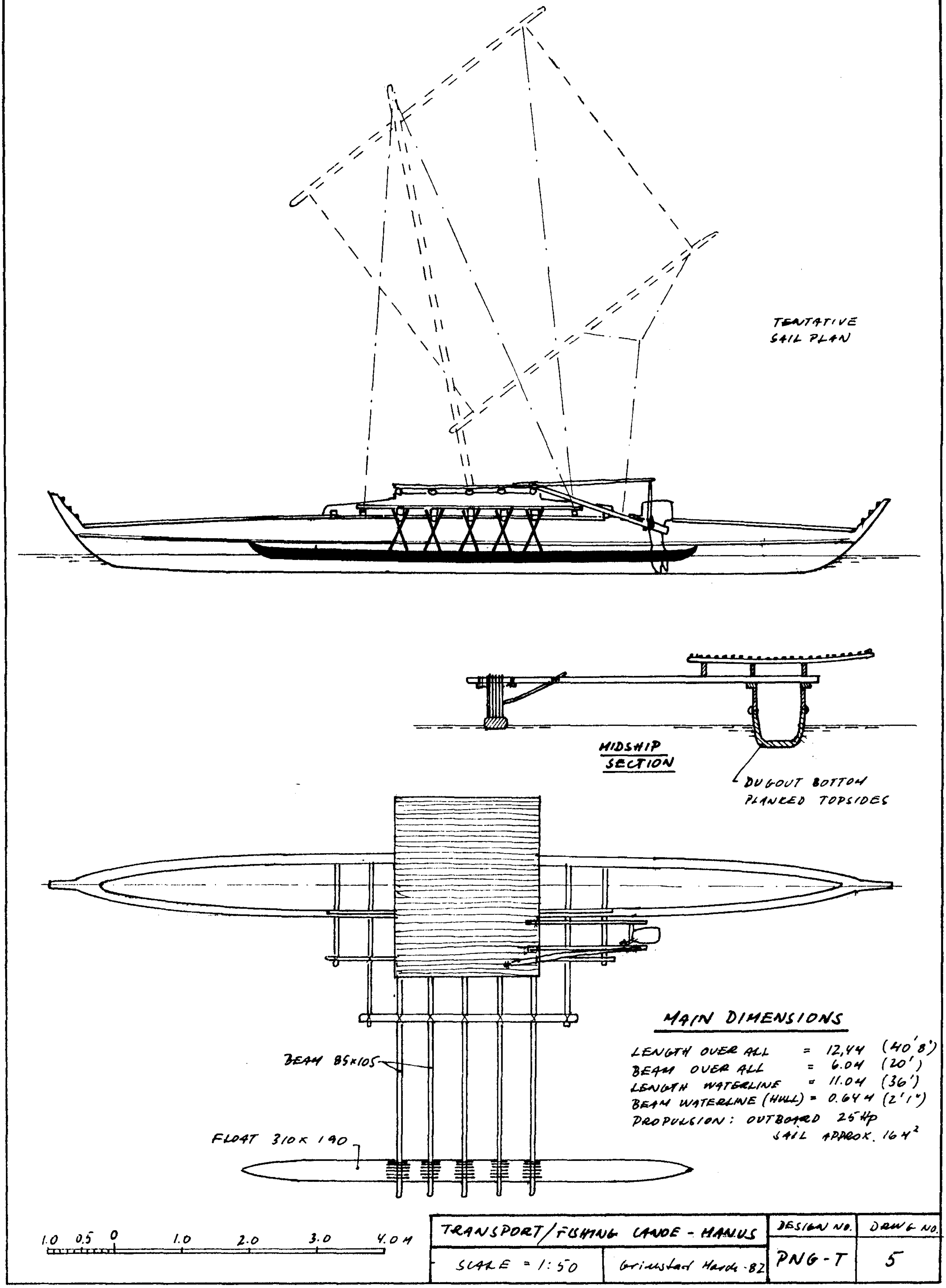
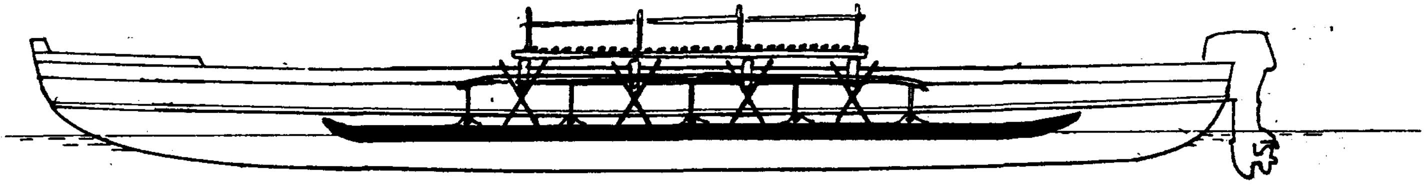
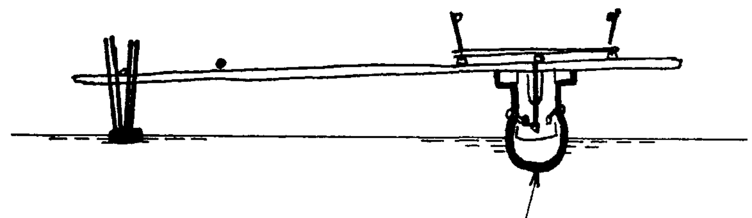
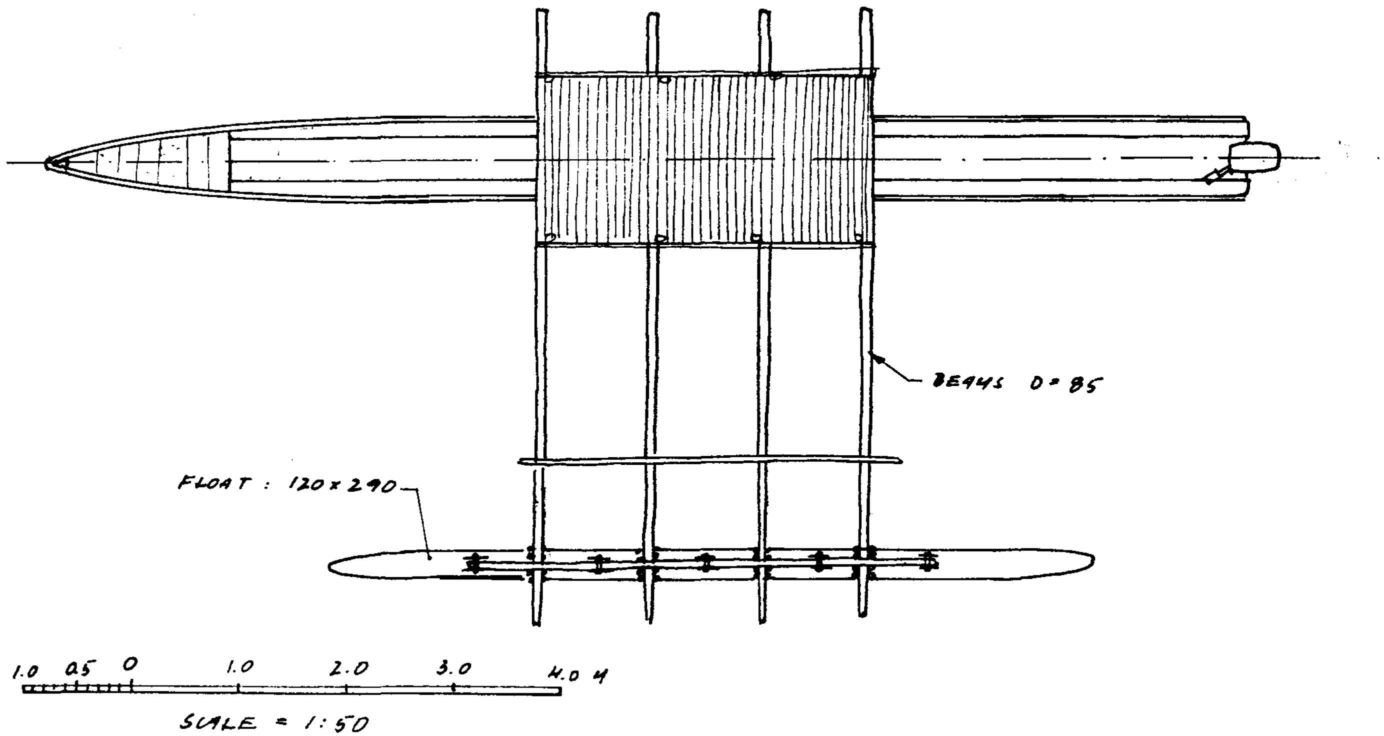

TENTATIVE SAIL PLAN
MIDSHIP SECTION
DUGOUT BOTTOM PLANKED TOPSIDES
MAIN DIMENSIONS
LENGTH OVER ALL = 12,44 (40'8")
BEAM OVER ALL = 6.04 (20')
LENGTH WATERLINE = 11.04 (36')
BEAM WATERLINE (HULL) = 0.64 M (2'1")
PROPULSION: OUTBOARD 25 Hp
SAIL APPROX. 16 M²
BEAM 85x105
FLOAT 310x190
1.0 0.5 0 1.0 2.0 3.0 4.0 M
TRANSPORT/FISHING CANOE - MANUS
DESIGN NO.
DRWG NO.
SCALE = 1:50
Grimstad Hardi 82
PNG-T
5

Fig. 10.

Fig. 11.





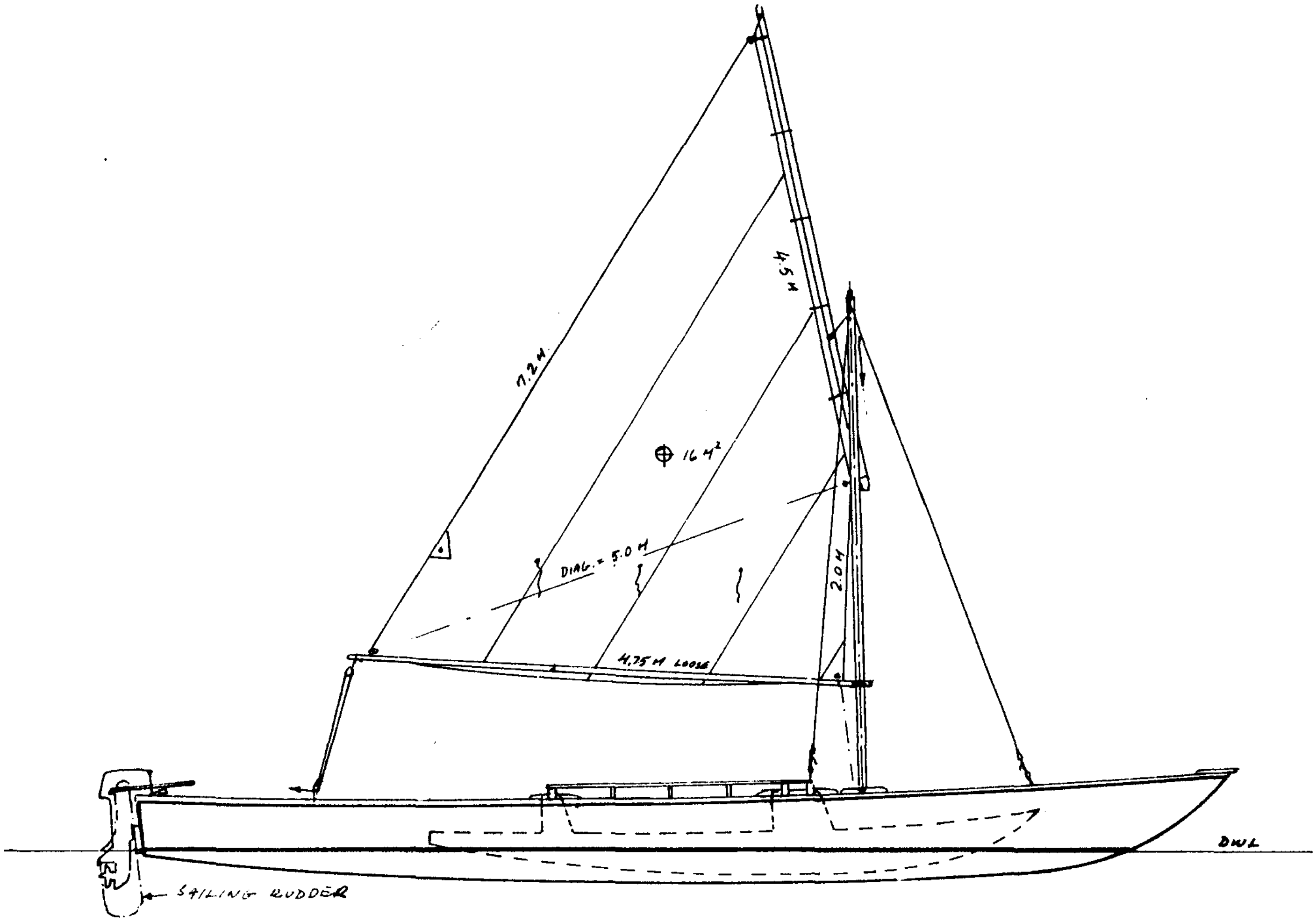


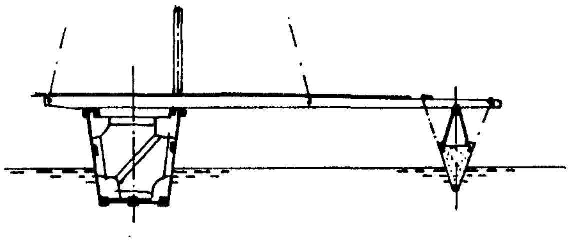
MAIN DIMENSIONS

LENGTH OVERALL = 11.0 M (36')
BEAM OVERALL = 5.7 M (19')
LENGTH WATERLINE = 10.3 M (34')
BEAM WATERLINE (HULL) = 0.50 M (1'6")
PROPULSION : OUTBOARD 25 Hp

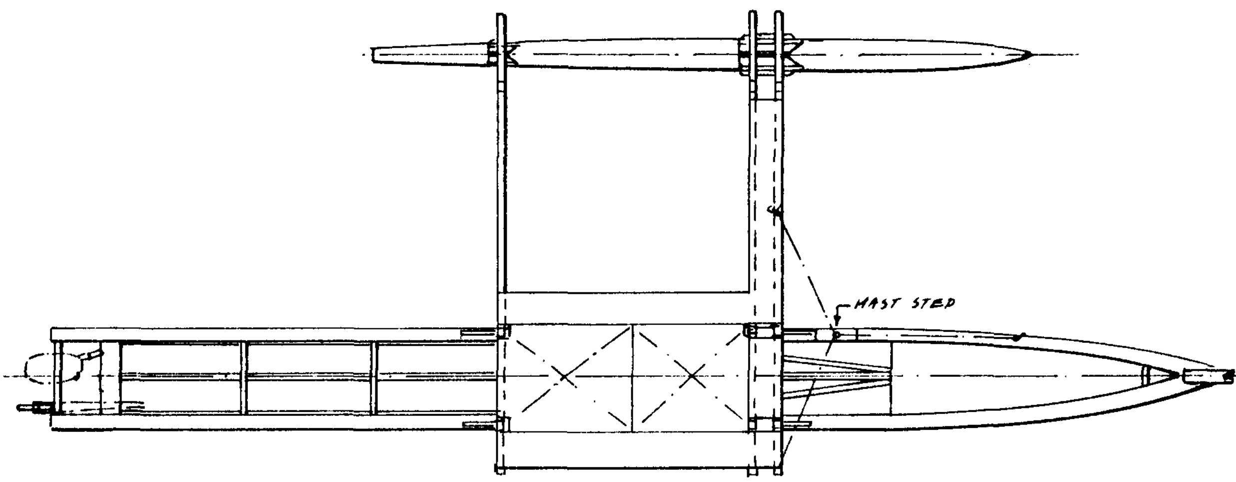
TRANSPORT/FISHING CANOE		
WEWAK AREA		
SCALE = 1:50	DESIGN NO.	DRWG. NO
DESIGN: TRADITIONAL	PNG-T	3
GRIMSTAD, MARCH - 83		

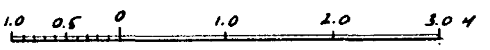
Fig. 12.





MAIN DIMENSIONS		
LENGTH OVER ALL, HULL	11.0 M	36'
LENGTH, DWL	9.8 M	32'2"
DRAUGHT, DWL	0.30 M	1'
DISPLACEMENT, DWL - HULL = 1200 kg, OUTRIGGER = 70 kg		
WEIGHT EMPTY, HULL + OUTRIGGER = 700 kg		
PROPULSION : OUTBOARDMOTOR, LONG SHAFT (20") 10-25 HP RECOMMENDED POWER: 10-15 HP		

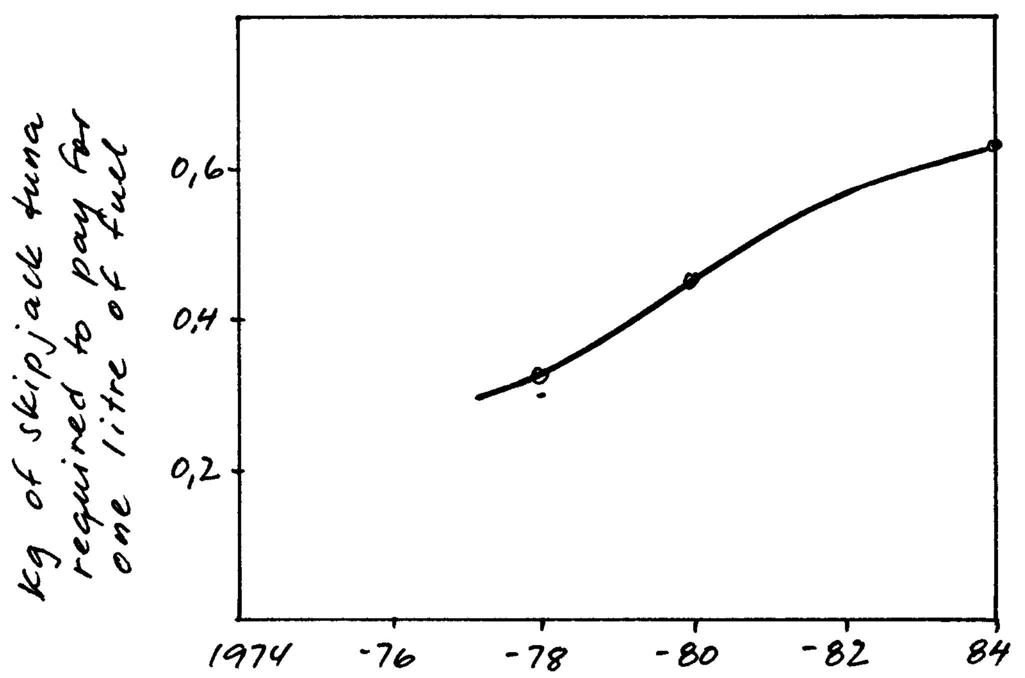


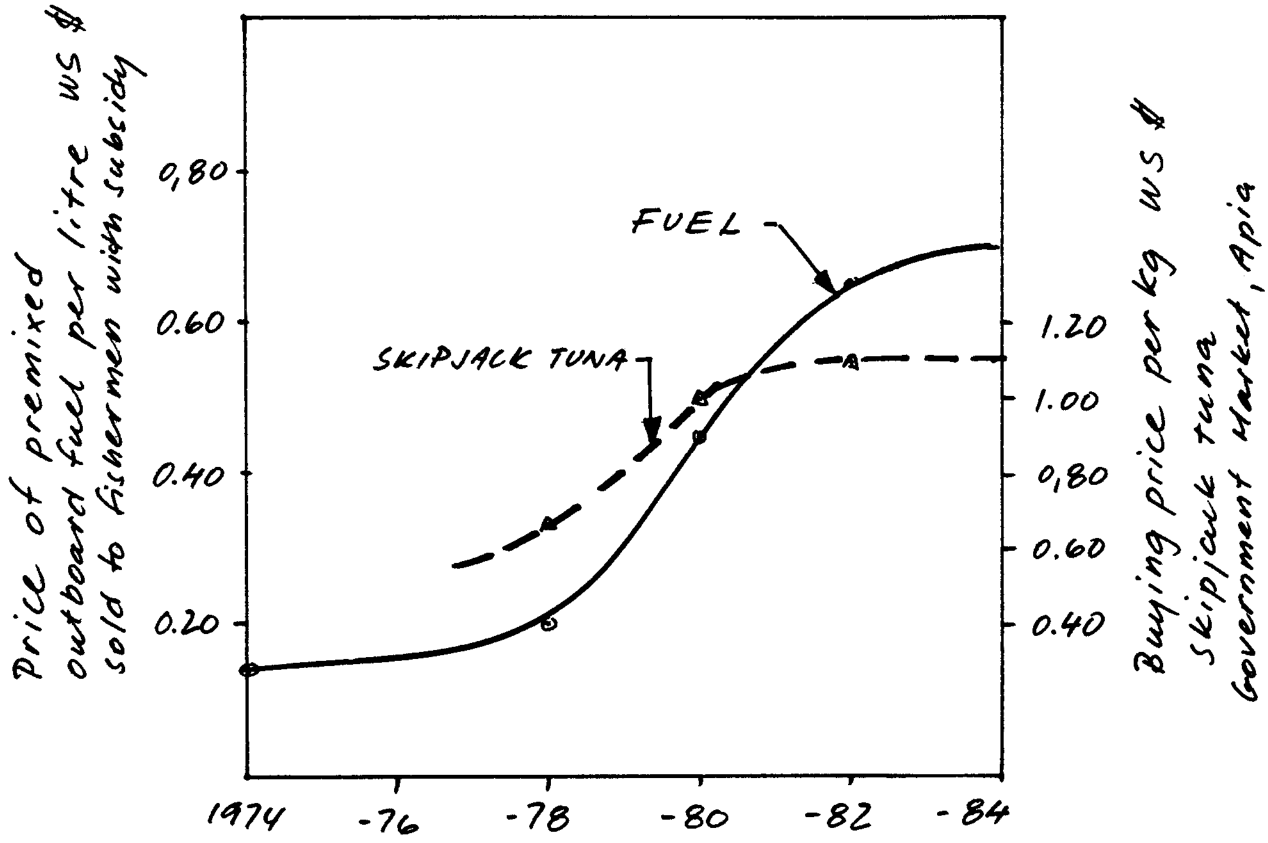


SCALE = 1:50

11.0 M TRANSPORT/FISHING CANOE		
GENERAL ARRANGEMENT		
SCALE = 1:50	DESIGN NO.	DRWG. NO.
DESIGN: Ø. Gulbrandsen	PNG-1	1
Grimstad, April, 1983		

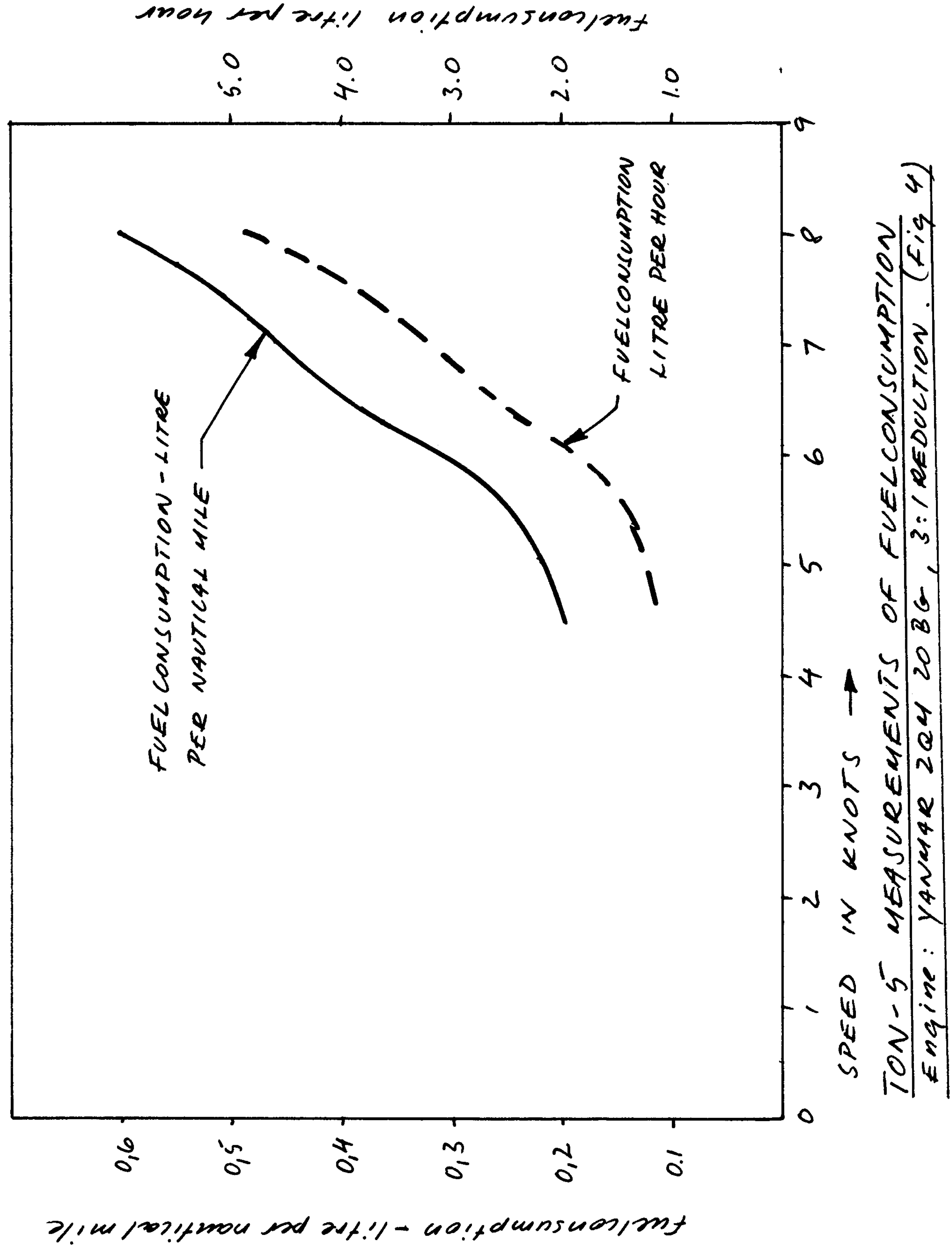
Fig. 13.





PRICE OF FUEL AND SKIPJACK TUNA IN APIA, WESTERN SAMOA.

Fig. 14


TON-5 MEASUREMENTS OF FUELCONSUMPTION
Engine: YANMAR 2QM 20BG, 3:1 REDUCTION. (Fig 4)
SPEED IN KNOTS →
0
1
2
3
4
5
6
7
8
9
fuelconsumption - litre per nautical mile
0.1
0,2
0,3
0,4
0,5
0,6
fuelconsumption litre per hour
1.0
2.0
3.0
4.0
5.0
FUELCONSUMPTION - LITRE PER NAUTICAL MILE
FUELCONSUMPTION LITRE PER HOUR