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A PLYWOOD CANOE DESIGNED BY FAO FOR PAPUA NEW GUINEA WATERS

By

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SUMMARY

A sailing outrigger-canoe of LOA 11m, made from marine plywood, was designed in 1983 by FAO for the East Sepik Province of Papua New Guinea. The engine recommended for use is a petrol two-stroke outboard motor in the range 10 to 15hp. The concept of a plywood canoe was developed in response to the Province's request for an effective and efficient but inexpensive design of small fishing craft suited to the local conditions. Most fishermen in the area currently use dugout canoes the larger of which are often powered by petrol outboard motors, usually of 25hp capacity.

The design prototype was launched in Wewak in November 1983 and initial trials have proved encouraging. It is considered that increased use of sail and being capable of maintaining the desired speed using a smaller outboard will result in the new vessel having much lower running costs than the existing fishing units. The extent to which this is so in practice is the subject of an on-going study. Fuel consumption figures and speeds were measured using both 15 and 25hp outboard motors during trials with the canoe and are given in the text of this report.

Although ESP has fairly calm weather conditions for much of the year, some handling difficulties have been experienced when the canoe was used in moderately rough seas. Further trials in such conditions are required to gauge the severity of the problem and possible solutions are discussed. The building of a second vessel has been commissioned. This will be operated in an area where winds of 20 to 30 knots are common in the S.E. season. The performance of the vessel under these conditions will be assessed and the design modified if necessary.

One disadvantage of the new canoe compared to local craft will be the initial cost. The material costs amount to about K1,500. An assessment is being made as to whether the lower running costs of the new vessel and its projected better performance are sufficient to offset its higher initial price and so make it a more viable unit than the local canoes.

BACKGROUND

The Marine Fisheries Section of the East Sepik Province (ESP), Papua New Guinea, requested in 1982 that a design of small fishing craft be developed which was suited to the needs of the people and to the local conditions. The National Fisheries Division obtained the assistance of the Food and Agricultural Organisation (FAO) of the United Nations Development Programme (UNDP). Consultant Naval architect, Oyvind Gulbrandsen, was commissioned by FAO to visit ESP, on the North Coast of New Guinea, to design a suitable vessel.

The consultant visited the area in the company of one of the authors in February 1983 making trips to several coastal villages in ESP to examine local craft and talk with village fishermen. The indigenous design of larger craft used locally for fishing is a simple dugout canoe having a single outrigger (occasionlly two) and powered by outboard motor, sail and/or paddle. The weather in East Sepik Province is fairly mild for most of the year in

comparison to the south-east season on the Papuan Coast. Most canoes are used for transport along the coast and do not usually venture into exposed water.

Most fishing carried out in ESP is for subsistence purposes only. Preliminary fishing surveys indicate that the province has stocks of a number of species of fish which merit some level of small-scale exploitation. These stocks include tuna, small pelagics, Spanish mackerel, mullet, trevally, deep-bottom snapper and associated species. Local villagers have recently started to fish these stocks to sell to a local fish depot. Deep-bottom line fishing using handreels, gill-netting and trolling are reported as being the three fishing methods most commonly used by fishermen selling to the plant.

The local fish depot is run by the provincial government in an attempt to stimulate a small-scale fishing industry. Facilities provided by the depot include ice making machines having a capacity of about one tonne per day, and freezers and cold stores with a total holding capacity of about 20 tonnes. During the 12 months prior to March 1984 a total of 20.5 tonnes of fish were handled by the plant.

The size of the potential local market is difficult to estimate. The population of Wewak and outlying areas accessible by road is in the order of 18,000. However only a very small proportion of this number are wage earners, most being subsistance farmers. While there is the potential to export to other provinces no infrastructure exists which specialises in handling of fish. Costs involved in processing, handling, storage and transport within PNG are all relatively high whilst cheap imported fish is available at most centres in PNG.

If ESP is to break into markets outside the province at a commercially viable level the fish plant must keep its overheads as low as possible. One of these overheads is the price paid to fishermen for their catch. Any sustained increase in the fisherman's operating efficiency e.g. by decreasing the operating costs per kg of fish caught should benefit both the fishermen and the fishing industry provided suitable markets are found. The request for a new design of vessel was made because it was felt that the fish plant offered the prospect of a reliable market to potential small-scale commercial fishermen, and that the local dugouts powered by 25hp outboards were too expensive on fuel. A need was felt for a design of relatively low cost vessel capable of being built in Wewak which was more versatile, more seaworthy and considerably more fuel efficient than the local dugouts.

The decision was made during discussions between the naval architect and Fisheries staff that the new design would retain the familiar outrigger canoe plan and the use of outboard motors. Improvements are to be introduced by using stronger, lighter materials on a more fuel-efficient design of hull and outrigger. This should result in a vessel of a given size having a greater carrying capacity, being more seaworthy, being lighter in weight and requiring a smaller outboard engine than similar sized local dugouts. With the provision of sail and given suitable sailing conditions considerable savings in fuel will therefore be possible.

DESCRIPTION OF THE CANOE

The general arrangement of "PNG 1", the canoe designed by Gulbrandsen, is shown in Fig. 1. Its basic dimensions are as follows:

Length over all	:	11m (36ft)
Waterline length	:	9.8m (32ft 8 ins)
Draft	:	0.3m (1ft)
Weight	:	700kg
Load at Datum Waterline	:	500kg

The designer recommends the vessel be operated by a stern-mounted outboard motor in the range 10 to 15hp. Larger outboards of 25 to 40hp may also be used but are not recommended because of their high fuel consumption rates. As given above the normal load of the vessel will be about 500kg; a maximum safe working load has not been stipulated as far as the authors are aware.

One of the striking features of the canoe is the large, hollow or foam-filled outrigger which has remarkably fine lines. The weight of the outrigger is only 70 kg but it has a reserve buoyancy calculated at about 200 kg. It is therefore sufficiently buoyant to support the weight of two to three men whilst its fine lines ensure that it affords the minimum of water resistance.

A standing lug sail of $16m^2$ has been fitted to the prototype as specified by the plans and is illustrated in Fig. 1. Other types of sail may of course be fitted, depending on local preference. The standing lug rig is the one observed on local canoes in the area. A mast of 6.5m in length is stepped on the port gunwhale and stayed to the forward outrigger beam and port bow as shown.

The design of the canoe is open, i.e. not decked over as it was felt that local conditions were such that a decked craft was not required. This feature together with the size of the platform over the outrigger beams, may be adjusted according to individual preference. Because of the buoyancy afforded by the outrigger the platform may be extended to completely cover the beams. The prototype was also fitted with a safety rail to the platform and a bow rail, both of which have proved useful although not indicated in the plans.

Local materials may be readily used to make the mast, spar and boom with very little expense. The prototype was fitted with a mast cut from a young Casuarina tree whilst bamboo was used for the spar and boom. Locally sold sailcloth, a cotton-synthetic mix, was purchased at K2.36 per square metre (K1.00 = US$1.14, fr170, £0.81). Material costs for the sail totalled about K70, the sail being sewn by a Port Moresby sail maker for K65.

The boatbuilder, Peace Corps Volunteer, Bo Alexander, reported that the cost of materials to build the vessel in Wewak amounted to K1220 excluding paint, sails and rigging costs. Depending on the quality of rigging and other details the material costs for the fully rigged vessel totals about K1,500. A record of the number of man-hours to build the prototype was not kept but the

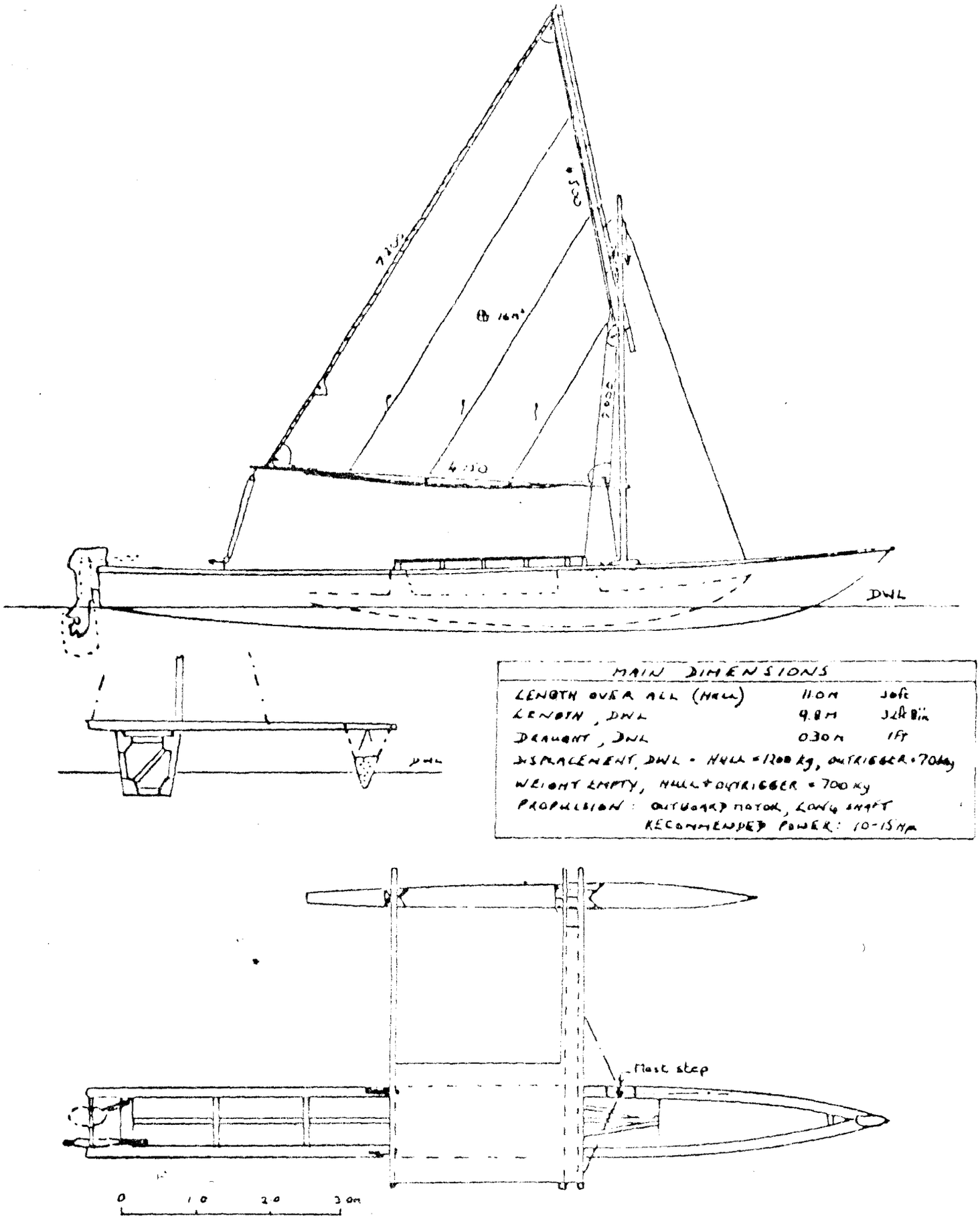

Figure 1. "PNG 1", A Plywood Canoe Designed by FAO.

builder estimated that 3 men would take about 3 to 4 weeks to complete one vessel.

Two local builders have given quotes of K4,500 and K5,000 respectively, to build one canoe. Subsequent vessels, they state, would be supplied for less as the material and labour costs of the building jig are included in the price of the first. A quote assuming series production has still to be obtained.

SEA TRIALS

Reports received from the builder of initial trials of the prototype in relatively calm weather were very encouraging. The canoe's speed when powered by a 15hp petrol outboad motor exceeded that of similar sized local canoes using 25hp outboards. This gives an immediate saving in fuel costs of about 40%. The present costs of these outboards is in the region of K835 for 15hp and K995 for 25hp i.e. the 15hp is 16% less expensive than the 25hp.

The East Sepik Provincial Fisheries Officer, Kris Sengo, who is reponsible for the operations of PNG-1 reports that local fishermen are very impressed with the design and would be interested in obtaining similar canoes for themselves. Molean Chapau, has however experienced a number of problems with the prototype in moderately rough weather. These are listed below:

(i) an outrigger beam broke in rough seas,
(ii) the outrigger tended to lift out of the water in wave heights of about one metre and over,
(iii) when travelling into or against the direction of waves greater than a certain height the outboard propeller sometimes lifted out of the water causing handling difficulties,
(vi) cavitation of the propeller when turning at speed.

Solutions to these problems are discussed below. The outrigger beam broke as a result of a misinterpretation of the plans. The beams were notched at the gunwhale, thus reducing their strength, but this was not in fact required. Outrigger beams correctly fitted and constructed from well-chosen timber are unlikely to break in future.

The outrigger lifting out of the water in rough weather or under sail may not be a problem if correct use is made of the crew as moveable ballast, just as practised on the Papuan sailing canoes. The initial problem when the canoe was operated by Molean Chapau was that inadequate provision had been made for crew to walk out over the outrigger and so balance the canoe as required.

A week's visit was made to Wewak by David Cook in early May 1984 to inspect the canoe for the first time and to rig it with mast and sail. To cater for the need to maintain stability a number of planks were strapped between the outrigger beams, fore and aft, thus effectively extending the platform over the outrigger. With these planks in position, two men could together walk out over the outrigger without it submerging. Hence with this provision stablity should not be a problem in the weather conditions in which fishing is usually carried out. This however

still requires verification under moderately rough conditions.

The problem of the propeller lifting out of the water in a following or head sea is a feature found in many long, narrow canoe-type craft. Precautions must be taken under certain sea conditions to avoid this from happening because the operator may loose control of the craft which may broach and take in water. Once waves have reached a certain height most canoe operators do not usually point their craft directly into or down the direction of the waves but rather run at an angle across the waves and so endeavour to minimise the problem.

The weather remained calm for the week that David Cook was at Wewak. There was hence no opportunity for him to test the performance of the craft in rough seas.

A number of steps could be taken to reduce or prevent the propeller lifting out of the water, these include:

(i) mount the outboard on a bracket at the side
(ii) mount the outboard in a central well
(iii) lower the height of the transom which is currently 70cm above the water line when the vessel is not under load
(iv) increase ballast at the stern
(v) use an outboard with an extra long shaft.

Molean Chapau left for an overseas course shortly after experiencing the handling difficulties and therefore did not have the opportunity to test these possibilities. With reference to (i) above the double-hulled canoes of Central Province all have centrally mounted outboards and steering is by an aft-mounted rudder or steering oar. A side-mounted outboard bracket was fitted to the canoe in May and a rudder and tiller assembly to the transom. Trials with the bracket were inconclusive due to the calm conditions at the time.

Further trials must be undertaken with "PNG 1" in fresh to moderate conditions and tests made to ascertain which of the above arrangements is most satisfactory. The National Fisheries Division has commissioned the building of a second vessel so independent trials and modifications can be made in an area which regularly experiences much rougher conditions than does ESP. Under these conditions the vessel will be thoroughly tested and, if necessary, alterations made to the design in consultation with the designer.

RUNNING COSTS

Preliminary trials have been undertaken on the running costs of operating "PNG 1" under load using both 15hp and 25hp outboard motors in calm conditions. The results of these are given in Table 1.

TABLE 1: Fuel consumption rates using 15 and 25hp outboards on PNG 1 : preliminary findings.
(The canoe had a crew of 4 and 340 kg of concrete ballast.)

Motor	Distance Travelled (nautical miles)	Fuel Used (litres)	Fuel Consumption (l/nm)	Speed (knots)
25hp	6.5	8.75	1.35	9.9
15hp	6.5	4.9	0.75	7.8

During these trials it is calculated that the canoe averaged 7.8 knots with a 15hp motor and 9.9 knots using a 25hp motor. The 15hp motor consumed two stroke outboard motor fuel at a rate of 0.75 litres per nautical mile which corresponds to a cost of K0.31/nm. The rate of consumption of fuel by the 25hp was 1.35l/nm which gives a running cost of K0.56/nm. Costs calculated from BP's quote of K82-60 for 200 litres of pre-mixed fuel, May 1984). Hence although about 44% cheaper to run when using a 15hp outboard in comparison to a 25hp, the canoe is also about 21% slower. Under similar conditions to the test runs 200 litres of outboard fuel would take the canoe 266nm when powered by a 15hp motor and only 148nm when powered by a 25hp motor. Comparable trials should be made using a 10hp motor on the plywood canoe as well as trials with propellors of different pitch. Similar trials should also be made using all three sizes of motors on local dugout craft.

CONCLUSION

A design of canoe suited to workshop assembly production has been developed, for East Sepik Province, which has certain advantages and disadvantages when compared to local craft. One disadvantage of the new design is its initial cost. Approximately K1500 is tied up in materials alone (builder's estimate). The material cost of a dugout is only a fraction of this. A study of the local fishery is being made to determine which is the more viable type of craft to operate under the conditions prevailing at Wewak. Only when the results of this study are known together with the results of further sea trials in moderately rough conditions, will it be possible to state whether the new plywood canoe is to be recommended for use by the fishermen of East Sepik Province.

ACKNOWLEDGEMENTS

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