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New working watercraft : a return to former capabilities

James W. Brown

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NEW WORKING WATERCRAFT

JAMES W. BROWN
Design Consultant
North, Virginia

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I. INTRODUCTION

Backyard yacht design had been my profession for roughly twenty years when, quite suddenly, I was invited to join a team of experts on a mission to Africa in 1979. The task was to specify the terms of development loans to small countries there; how to spend borrowed money for catching more fish.

Prior to joining the team at the World Bank in Washington, D.C., I was told that there were boat design problems to be overcome and that I would be working closely with Mr. Fuji Kada, a fisheries consultant with wide experience and repute. For ten years he had been production manager of the largest fishing company in the world.

Upon meeting my colleagues in Washington I was feeling misplaced; what could a boating buff, who had done no more than draw plans for do-it-yourself sailboat builders, contribute in a prestigious group like this? At the introductions, there was a famous aquaculturist from Israel, a renowned civil engineer from Texas, two financial analysts--one Italian and one African--and there was Fuji Kada. Instead of offering a handshake, the dapper Japanese pressed his own hands together and bowed slightly in a gesture which somehow relieved me greatly. Then, his first words to me were, "Ah, Mr. Brown, the world needs one million sailing fish-boats now!"

After five weeks of following Fuji through East Africa, hauling nets and sleeping in bilges, I began to realize that he was not pulling my leg. Neither was he talking about industrial fish-boats. He was talking about canoes. "If you can come up with a viable replacement for the dugout canoe," he told me, "you can sell them by the millions."

This jibed with observations from my own travels. In the late sixties I had subjected myself to my own treatment by building a seagoing boat from my own stock plans, and in the early seventies we sailed it as a family crew on a coastal exploration of Central

Design drawings and shop manuals for owner-builders have been the author's specialty since 1962. Several hundred vessels have been back-yard built by mostly inexperienced individuals using these instructions. Sailed primarily by neophytes, "Searunner" Trimarans have traveled several hundred thousand sea miles and made many trans-ocean passages. The author's boat, below, has seen ten years of service at extended family cruising. Experience in teaching unskilled artisans to assemble and operate lightweight vessels led to involvement with fuel super-efficient workboats in the late 1970's. This document reports on early results.

America and Northern South America. On this three-year voyage we encountered several examples of "canoe people" whose indigenous boats are pivotal artifacts in their culture and essential for survival. These native craft are vital to fishing and transportation. Their builders are having real difficulty, now, in perpetuating their own fleets.

Working with Mr. Kada, I learned that this difficulty is typical of many coastal and island populations throughout the tropics and sub-tropics, all around the world. Literally millions of small craft are involved, including many owner-operated fishboats in the industrial world.

Fuel prices are not the only problem. Often these local boats have evolved through many generations to satisfy local seakeeping requirements for a specific fishery or a given cargo or a given route. The construction of these craft is usually the supreme example of local high technology, and that technology is very likely to have depended directly on local, high quality boatbuilding wood which is no longer in adequate supply.

The environment is changed. Traditional boats built with inferior wood simply do not last.

Furthermore, many peasant fisheries are faced with depleted near-shore fish resources. Burgeoning human populations, motorized fishboats, escalating fuel costs and declining catches all spell trouble for those millions who rely on "artisanal" fishermen to supply their daily share of low cost animal protein.

What can be done?

Many approaches have been tried. Aquaculture requires no boats. It is succeeding in some areas, but it is the most sophisticated form of animal husbandry. Investments are substantial; fish in ponds must be fed, and the know-how is not easily transferred.

Alternative boatbuilding materials such as fiberglass, steel, aluminum and ferro-cement, have been introduced into peasant fisheries with mixed results. The cost of importing all materials can result in hull prices infinitely higher to fishermen who are accustomed to needing zero cash money to acquire a boat...just a good tree, that's all.

Alien designs built with heavy materials have sometimes met with local acceptance so long as motors are included to push them through the water. Paddles and wind may have been the norm, but if you have spent your life struggling with oars and sails, then motors are fun. The problem is that fuel costs and mechanical breakdowns often have boosted fishfood prices beyond the ability of poor populations to buy. Outboard-powered skiffs and crude commercial motorboats are notoriously fuel-intensive. In short, alien watercraft and mechanization can aggravate the problem, especially if they tend to displace local boatbuilders and fishermen from their traditional employment.

Fishing boats, it seems, epitomize the pitfalls of many well-intended development efforts. Nothing we can offer "developing" people is nearly as good as what they already have (or used to have before the resource ran out) at anything like the same price. Canoe people solved their boat problems long ago, but since then the very earth in which they live has been modified, often by alien technology. Inferior materials used in their traditional boats cause rapid depreciation of the hulls, this at the same time that traditional boat designs show themselves incapable of going farther and staying longer to catch more fish to feed more people.

To overcome the resistance to change among traditional fishermen and to circumvent bureaucratic ballast and even to make a new boat work in a new environment, three rules of thumb apply:

1. Propose something that is as close as possible to what already exists.

2. Include only so much alien technology as is required to adapt old ways to new environmental circumstances.

3. Attempt not to modernize or encourage growth for its own sake, but simply try to return the local people to their former capabilities.

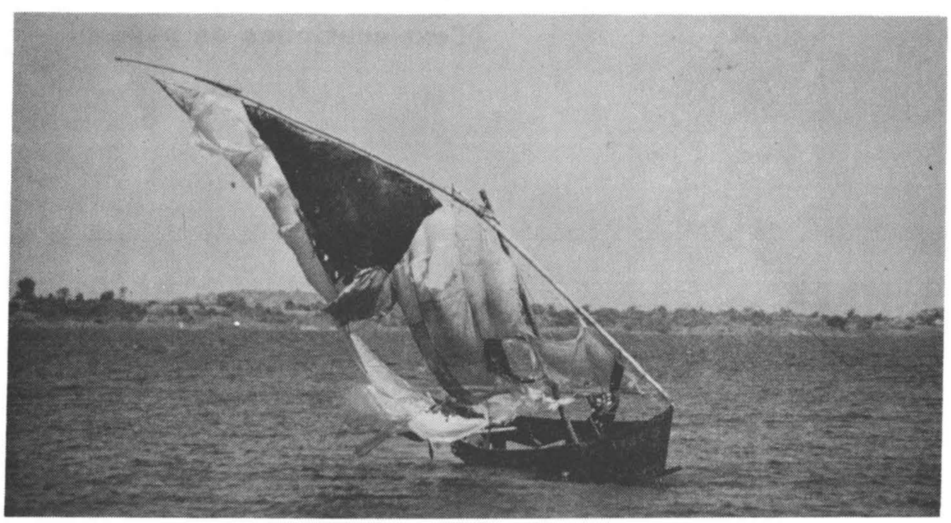
Formerly capable of providing for themselves, canoe people now appear to require "development." Environmental, social and economic conditions are changing rapidly and, so, demand rapid adaptive behavior.

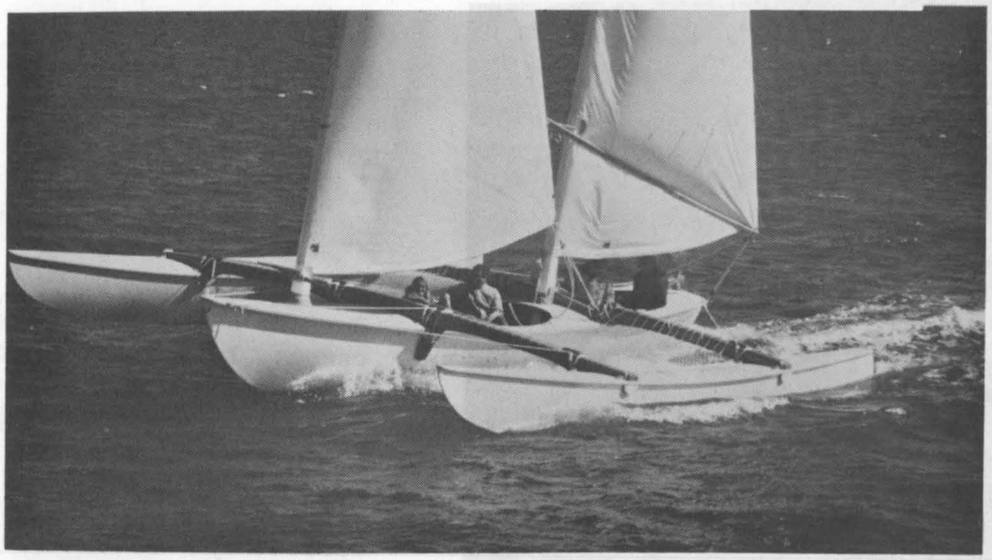
To stimulate such behavior, without stimulating the rate of demand for adaptation, appears to this writer as the correct role of development. In a very limited sense, some kind of reversion to the "old ways" is implied because those ways were not dependent on "terminally expensive" energy and materials.

Canoe people are prime candidates for the imperative transition away from a petro-dominated economy. Therefore, the role of development may be clearly illustrated with new working watercraft. As a matter of fact, truly modern workboats, built mainly of wood and propelled largely by wind, may be the most achievable and the most conspicuous examples of how to use renewables now.

(Text continues on page 9)

"Sesse" canoes of Kikuyu tribesmen on Lake Victoria are long-planked flyers, light and narrow and thus easily propelled by paddle or sail. Sails have zero "running costs" (especially when patched with plastic bags) and so are far more cost effective than outboard motors. Low productivity is overcome by large numbers of fishing units, which provides employment. Built of elegant <u>iroko</u> wood, no longer available in Kenya unless smuggled across the Lake from Uganda, these canoes and this fishery face decline.

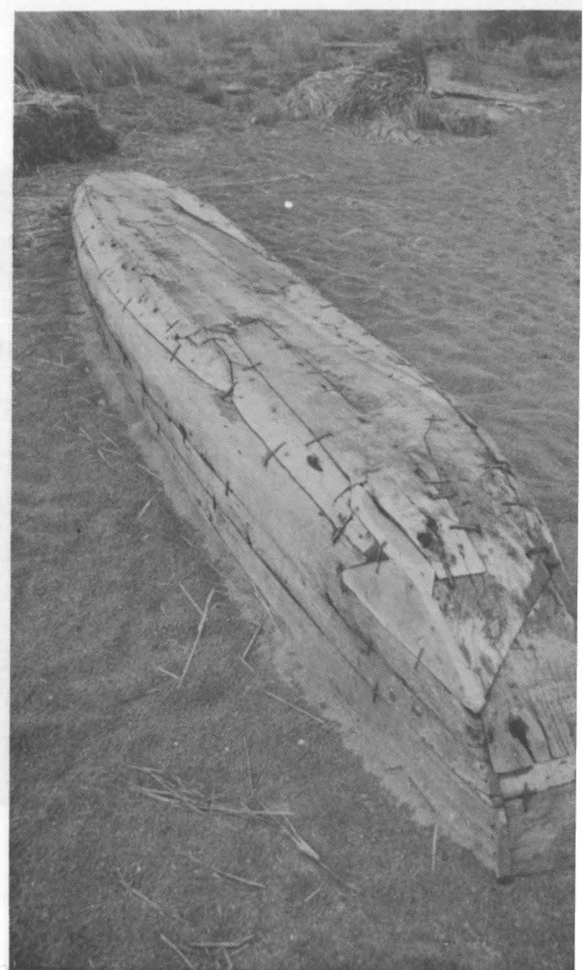


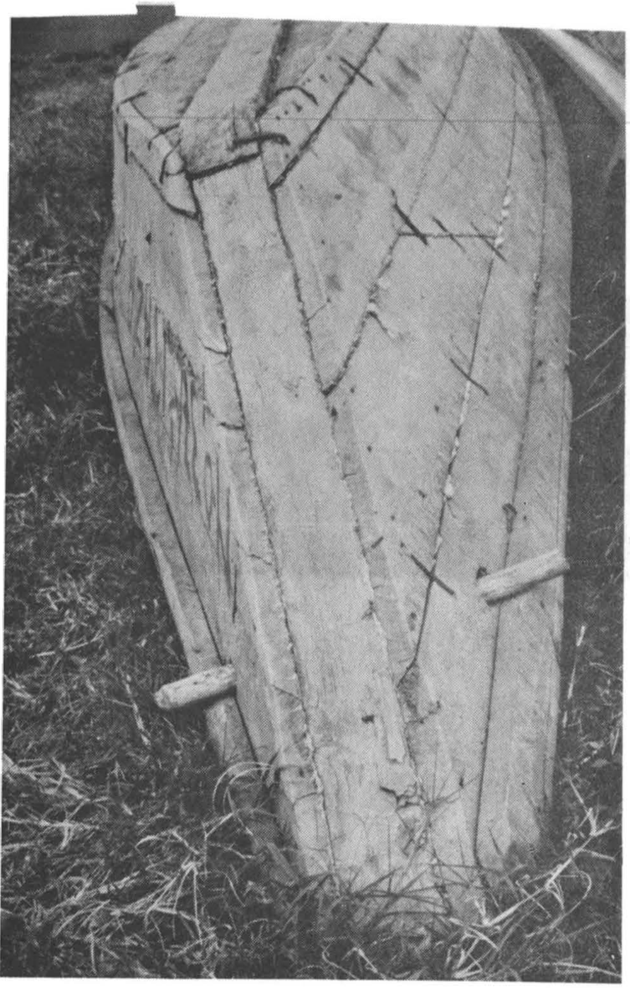


The real marine fuel crisis is not in bulk cargo ships whose capacity is measured in thousands of tons, but rather in myriad small workboats whose payload is only hundreds of pounds. The prototype sailing "pickup," above, carries one ton, hulls are laminated wood. Requiring only a volume of timber similar to the patchworked canoe, this trimaran was the first vessel to make use of a simplified method of molding wood veneers into compound curvature.

Other advancements from high performance yacht design were included, but de-tuned and simplified for workboat service. Masts require no costly wire for support, wrap-around dacron sails are efficient, epoxy adhesives and coatings are long-lived, and the components are assembled with lashings. There are no metal parts. Lean hulls and light weight permit speeds up to fifteen knots under sail, while a four horsepower motor propels the craft at five knots in calms. The prototype was designed and built in 1978 by the author and raceboat designer Richard C. Newick, with financing by famed yachtsman Philip S. Weld, to demonstrate efficient utilization of petrochemicals and fuel.

Long term savings in finite resources are compounded by investing them with renewable wood in a mostly wind-powered vehicle.





Burundi's indigenous dory-type wooden canoes, left, are massively constructed as a hedge against decomposition. Wood is porous, non-durable grevilea, the last of which is being cut. Despite water-logging and leaks, these boats still can be paddled with reasonable efficiency. Alternative steel "canoes," below, do not respond to paddle-power. Outboard motors proved non-viable in this fishery; canoes lie abandoned.

II. THE LAMINATED DUGOUT

AS DEVELOPED FOR AFRICAN LAKE FISHERIES

Rift Valley lakes are teeming with fish, which have long been harvested by certain tribes. However, the nautical heritage of the area is generally weak. In Burundi, for instance, only recently has Lake Tanganyika lost its foreboding taboo, which traditionally caused the *Bahutu* people to build their houses facing away from the water, and Royalty was forbidden even to see the Lake.

While Burundi is a beautiful country, composed almost entirely of a small group of rolling mountains on the north-eastern end of Lake Tanganyika, and has a healthful climate, it has virtually nothing to sell to its neighbors or to the industrial world. By some accounts, it is the poorest country in the world with the fastest growing population.

To contend with this growth, the government has looked to the Lake for protein. With the aid of the Food and Agriculture Organization of the United Nations (FAO), the tribesmen have been introduced to the liftnet method of harvesting a rich fish resource, primarily of sardine-sized *ndagala*.

As might be expected, boatbuilding skills are not advanced. There is virtually no remaining timber resource except for several species of fast-growing "weed" trees. The indigenous boats are built mainly with heavy, hand-ripped planks of a very porous and non-durable *grevilea* which is not well suited to boatbuilding. The dory-shaped craft are extremely crude; they absorb quantities of water, require constant bailing and continuous rebuilding from their second year of operation. The craft are paddled; the people have never rowed or sailed.

In an effort to improve the local boats and to increase their numbers, two alternative designs were introduced, both built entirely of alien materials.

The first was made of sheet steel. In order to simplify welded construction, the hulls contained a minimum of seams and bends, producing a shape which generates great resistance to being pushed through the water. In an effort to increase fish landings, this design included outboard motors for propulsion instead of paddles.

However, experience revealed that the new boats caught fewer fish than the old ones. Lack of maintenance caused frequent motor breakdowns, which reduced the number of fishing expeditions, mainly because the box-like, heavy steel skiffs could not be paddled. Consequently, hundreds of these craft have been abandoned, cast up on the once pristine beaches of Lake Tanganyika.

The second alternative design was more successful. Produced of fiberglass by trainees, these hulls were either paddled or motored, but as the price of imported polyester resins escalated, the project also encountered many small technical problems. Tropic heat and humidity required air-conditioned production and storage facilities. Recurrent breakdown of the cooling units caused costly, imported materials to go bad in storage. Quality control problems were insidious, and hull cost became unacceptable--unacceptable to the fishermen themselves, who declined to buy the new canoes. Instead, the boats were offered on loan or lease, thus depriving the fishermen of an <u>appropriate stake</u> in the venture. Consequently, the fine fiberglass hulls were not regularly operated or maintained and quickly fell into disrepair.

These examples illustrate the pitfalls of well-intended development projects. Wide divergence from the local norm, too much petro-based technology, and total dependence on imported materials all become disarmingly tempting when development funds and alien advice are made available on loan.

It was against this backdrop in Burundi that the writer was asked to participate.

Strictly speaking, this was not exactly a case of returning to former capabilities! Except that before colonial times, when there were fewer people and plenty of trees, the locals managed to take care of themselves. Now we faced a need to transplant an entire body of appropriate know-how. As usual, it boiled down to the classic development question, "What <u>is</u> appropriate?"

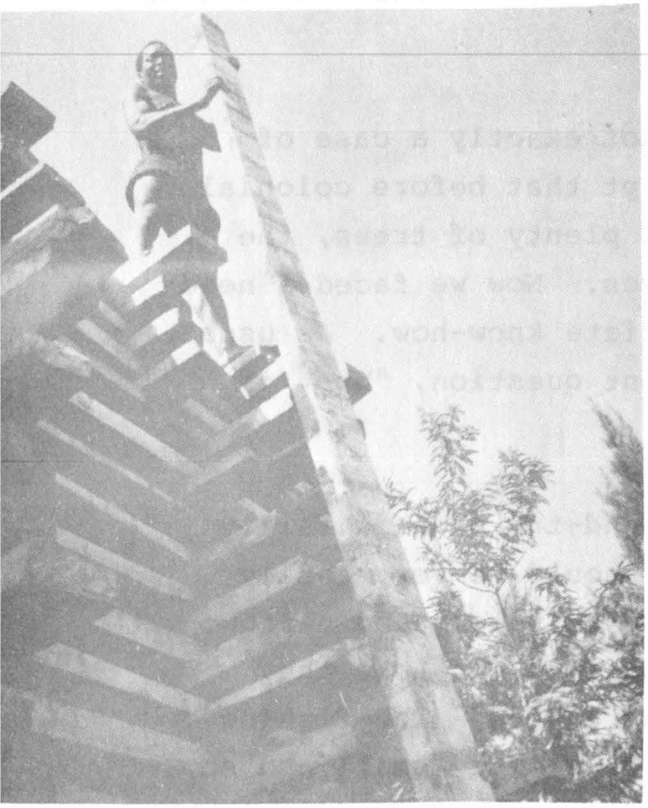
The previous attempts at cut-and-try made it fairly obvious that any new canoe for Burundi should be very easily propelled by paddle-power alone. The Lake is long and narrow. Fishermen do not go far; three miles out into the Lake they encounter stiff competition from the Zaire side. The fishing method and its equipment are simple. The crew is small and so, generally, are the catches, thus payload was not demanding in the design.

Despite the local lack of good wood, it seemed obligatory to attempt using as much local material in the new boats as possible. Importing something like steel or fiberglass causes extreme pressures on the economy of a country like Burundi, especially if something as common as a fishing canoe must be built one hundred percent from imported stuff.

After experimenting with several local woods, such as <u>grevilea</u> and <u>eucalyptus</u>, a local <u>cypress</u> was discovered which, while rife with knots, splits and pitch pockets, was fairly lightweight and stiff. If pre-cut into four-by-five inch timbers and stacked carefully in open ricks to dry, it became stable and easily worked.

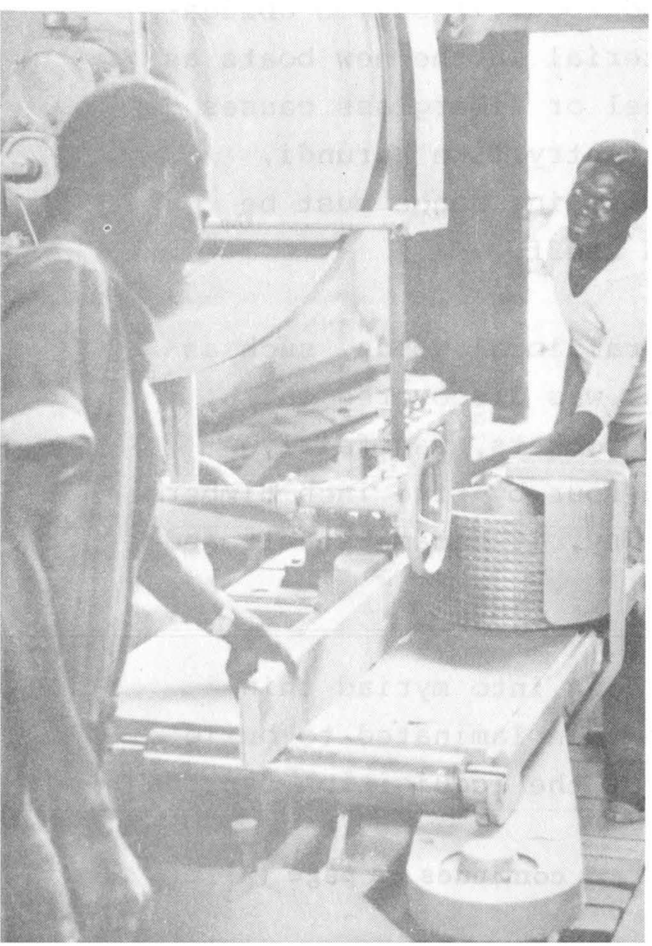
Once dry, these timbers were sawn into myriad thin strips of veneer, and these strips were then laminated to build canoes. The process was made possible by the acquisition for the

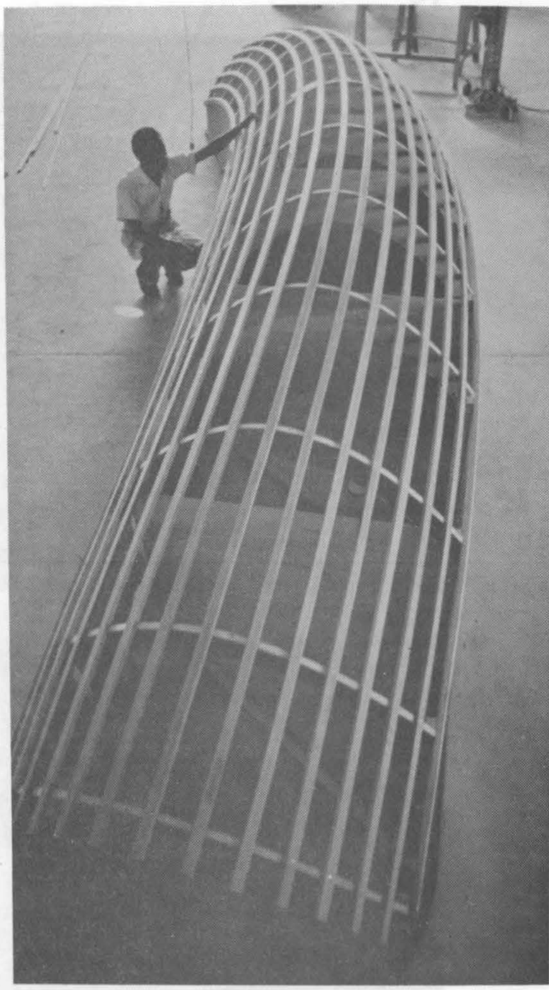
(Text continues on page 18)



Cypress for "laminated dugouts" is hand-cut in the bush, carefully stacked in ricks to dry, then resawn into veneers and finish-sanded by machine. This process is intentionally low volume and labor intensive.

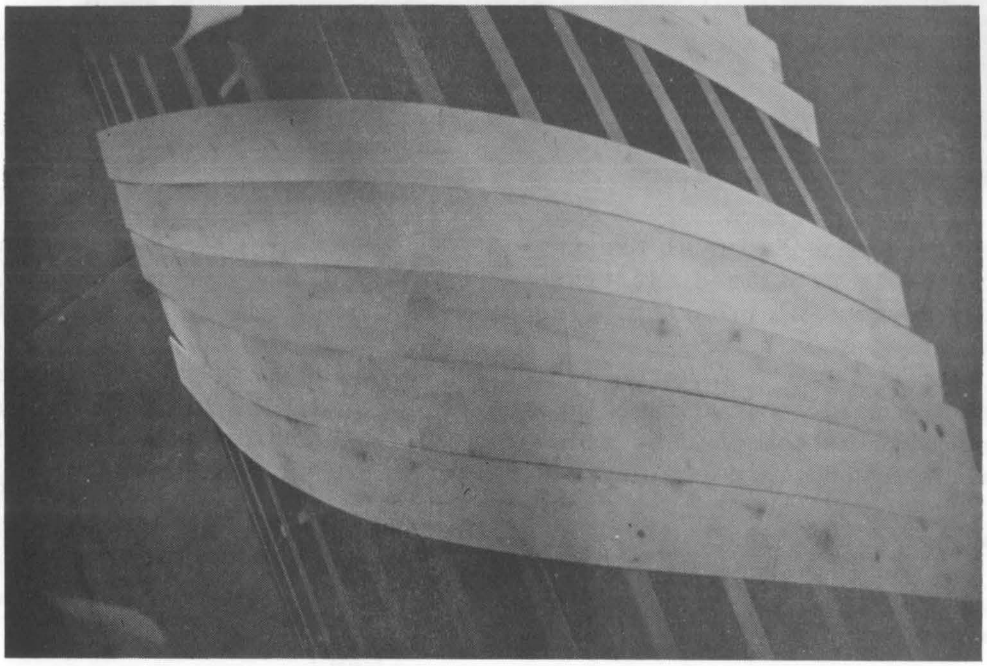
One hull's worth of veneer is pictured, lower right, at a finished cost of about fifty dollars. Machinery and tools investments for such a project total about fifty thousand dollars depending on location. Keeping the machines running can be a major problem in a remote area. The availability of pre-cut veneer, from a local plywood or furniture mill, obviates many costs and difficulties.

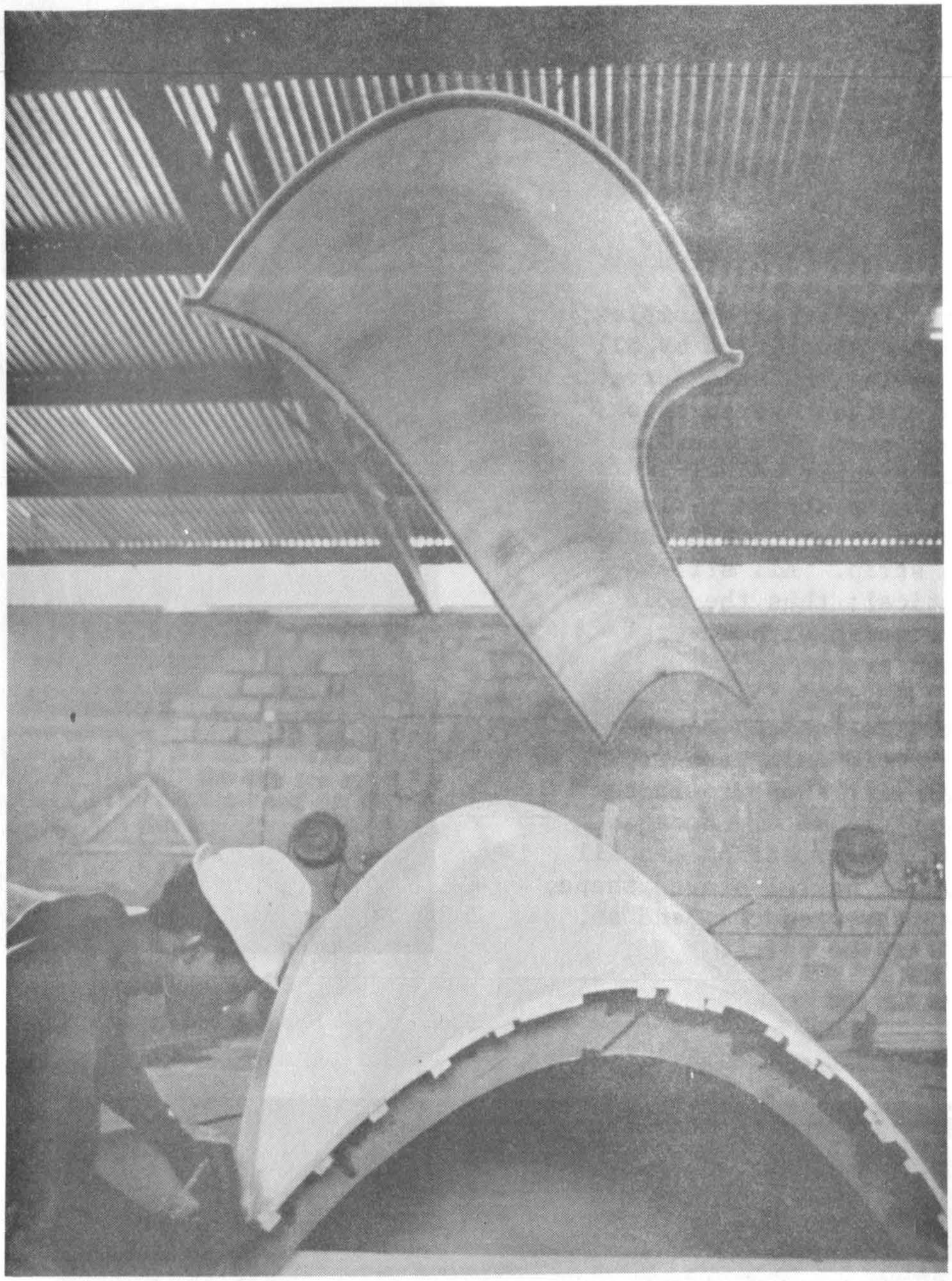




Mold construction appears complex, but is somewhat simplified by all cross-ribs having the same curve. Longitudinal curves are constant arcs in two planes. The surface described is capable of being covered by veneer strips having a "barrel stave" taper toward each end of each strip. All strips can be identical; thus the mold is quickly covered with several layers of veneer.

The boats themselves can now be built on the mold using veneer strips of similar shape to those used to cover the mold. Because these myriad veneer strips can all have identical "barrel-stave" shape, they can be mass-produced, and so, therefore, can the boats.



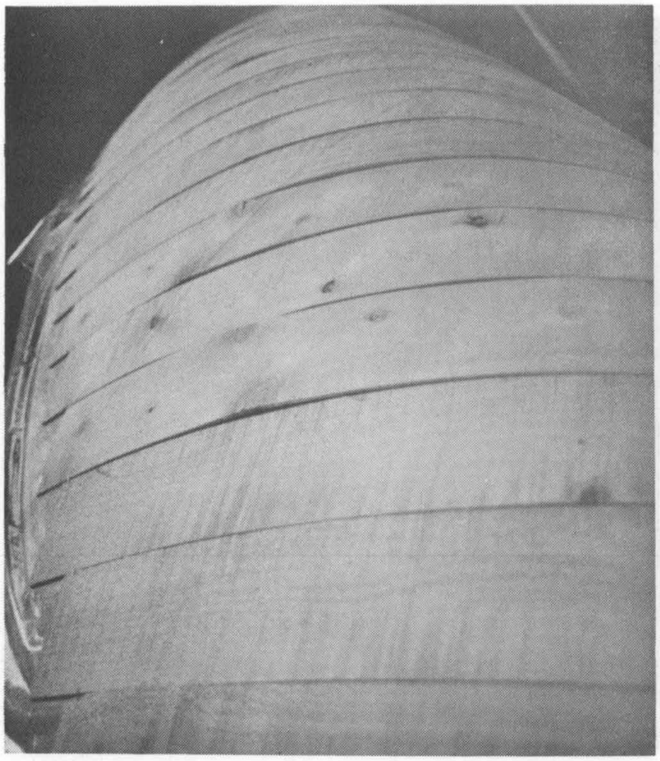


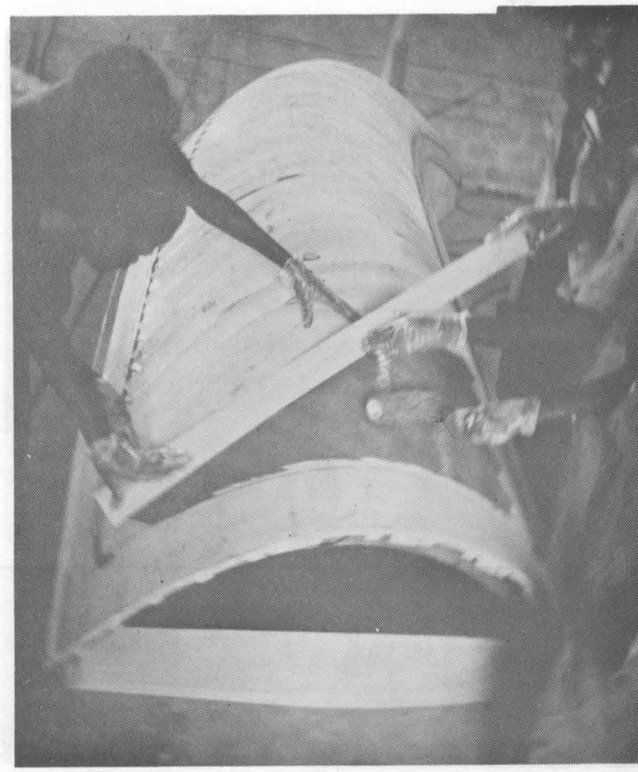
Shop leaderman Emmanuel Nkurunziza effectively mobilized his trainees for a successful transfer of vacuum-laminating know how.

Finished mold has two matching surfaces; the bottom mold is made of laminated wood, and the matched platen (suspended above) is a fiberglass casting of the first.

Note the black rubber gasket around the perimeter of the upper platen.

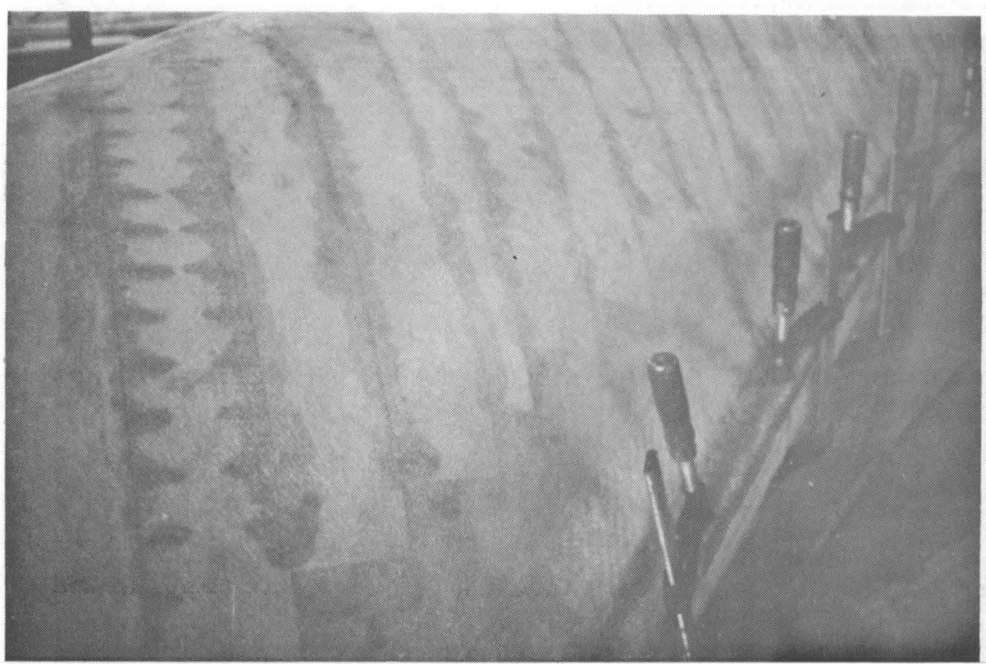
When dropped down into nesting position, this gasket forms a seal, allowing air to be withdrawn from between the surfaces with a small vacuum pump (like an air compressor working backwards). First, however, the boat part being manufactured is laminated with wet glue in between the two mold surfaces. Then the mold is closed and the air withdrawn, causing simple atmospheric pressure to exert a squeezing force upon the boat part of about 1,000 lbs. per square foot!

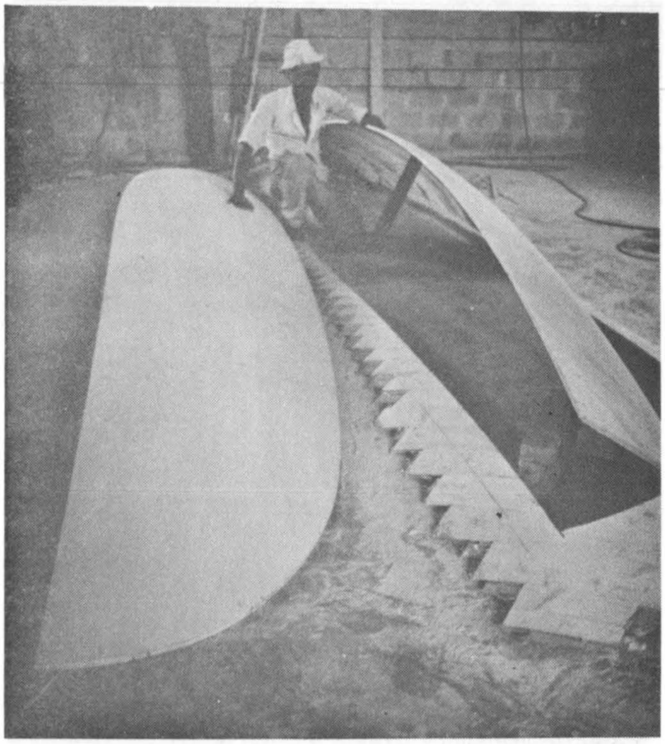




Defective wood can be used because several layers are "cross laminated" so the grain of one layer runs perpendicular to its neighbors. Defects are spanned and buried by adjacent layers.

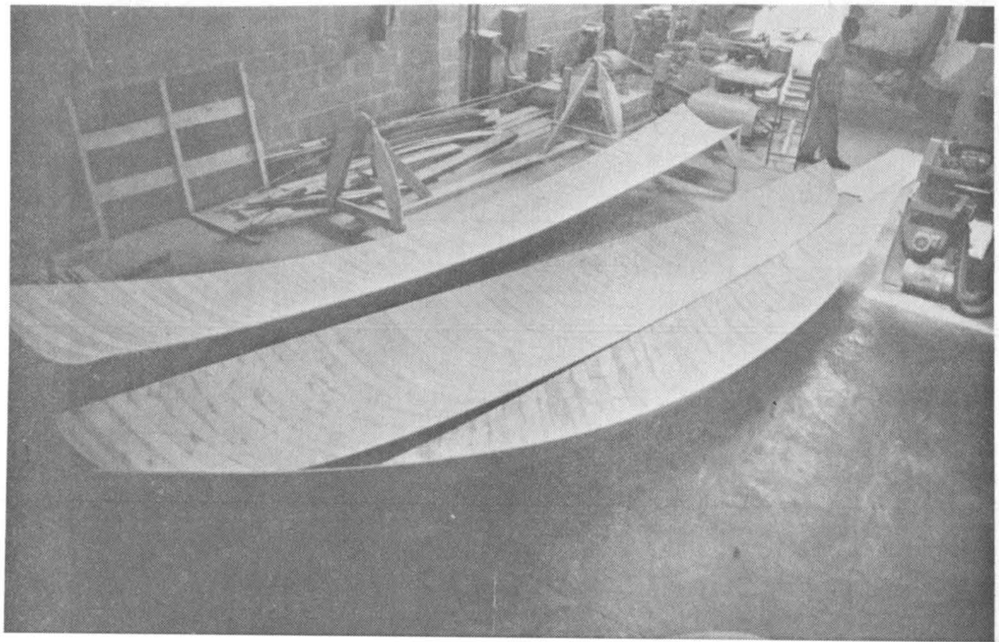
High quality waterproof glue is used between the layers. Squeezing between the mold surfaces, while in the presence of vacuum, causes this glue to be pumped and drawn into all available voids and defects in the product. As can be seen below, even saw marks are effectively filled and sealed with polymer adhesive, visible through the fiberglass platen during "suckdown" while the glue cures.





To predict the final boundary of molded half-hull panels, a special lofting method is used by the designer to construct a light fiberglass template. On all subsequent panels, this template is placed over the rough panel and simply traced around. By turning the template end-for-end and inside-out, both port and starboard panels may be marked for cutting into exact mirror-image pairs. (Scraps are used for making paddle blades.)

The production builder, or unskilled trainee, does not need so much as a tape measure to determine perfect panel perimeters. Pre-laminated and pre-cut panels are easily nested in stacks for shipment. By varying the template, hulls of many shapes and sizes can be built from the same mold. Laminating time is about 45 minutes per panel.



project of a suitable band saw and other woodworking machinery. Under the supervision of Mr. Jose Schreder, an expert Belgian boatbuilder attached to the project, the machinery was air freighted from Europe and installed in new facilities near the Lake. After suitable bureaucratic and logistic delays, all was ready to produce laminated dugouts in Burundi by the fall of 1981. It had been three years since the writer's initial recommendation.

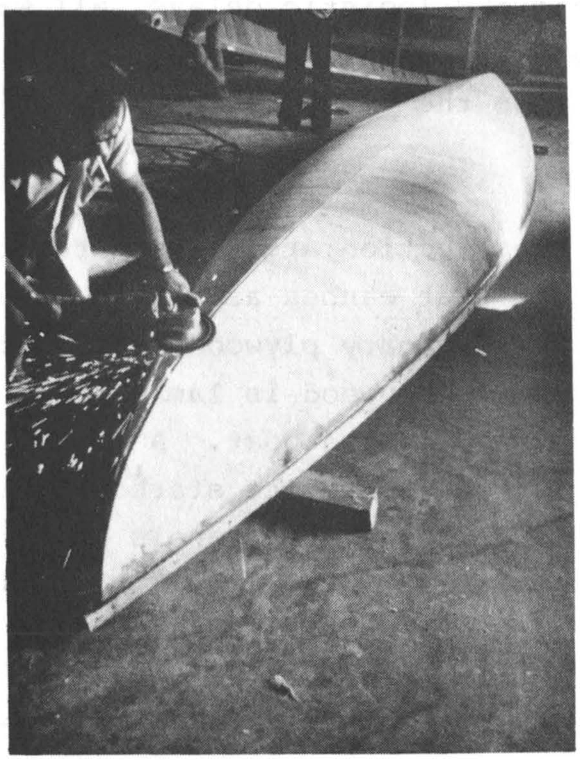
Tooling and prototype construction are illustrated in the accompanying photographs. Note that canoes are built of a "stock" building material much like ordinary plywood, but instead of being pressed into flat sheets, the plywood is laminated into long panels having compound curvature, like a boat. A mold is used to define the conformation of half (say, the starboard half) of the canoe. Full length, half-hull, three-ply panels are then produced on the mold using a matched platen and vacuum to achieve ample laminating pressure for the polymer adhesive.

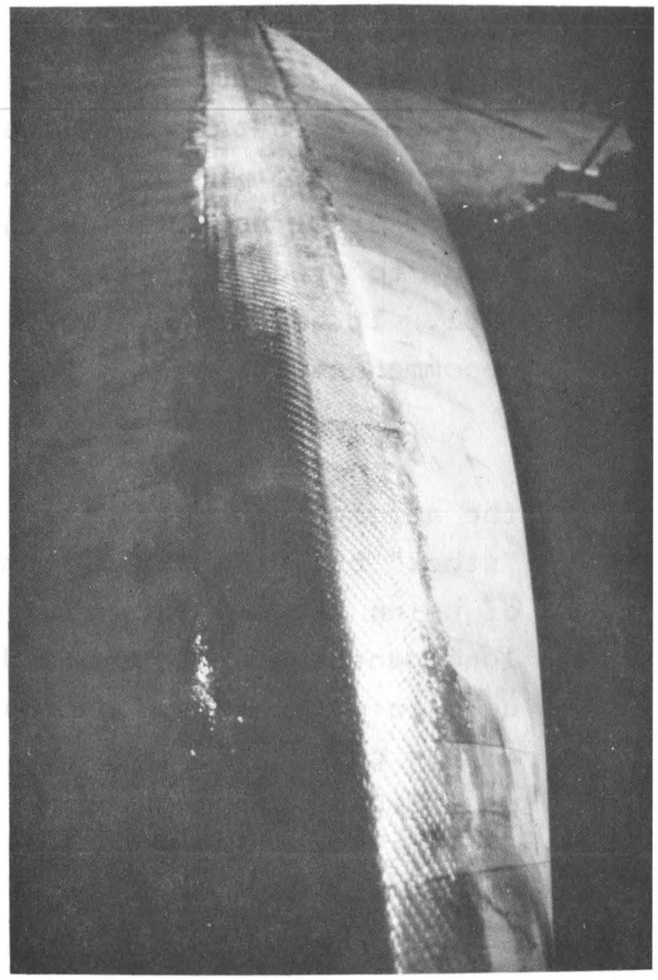
Both port and starboard halves can be produced on the same mold, and all individual veneer strips have the same profile shape.

Once trimmed to a specific boundary, the half-hull panels are joined at the keel "clam shell" style with fiberglass tape inside and out. Accessory parts are then added to the shell, which completes the canoe.

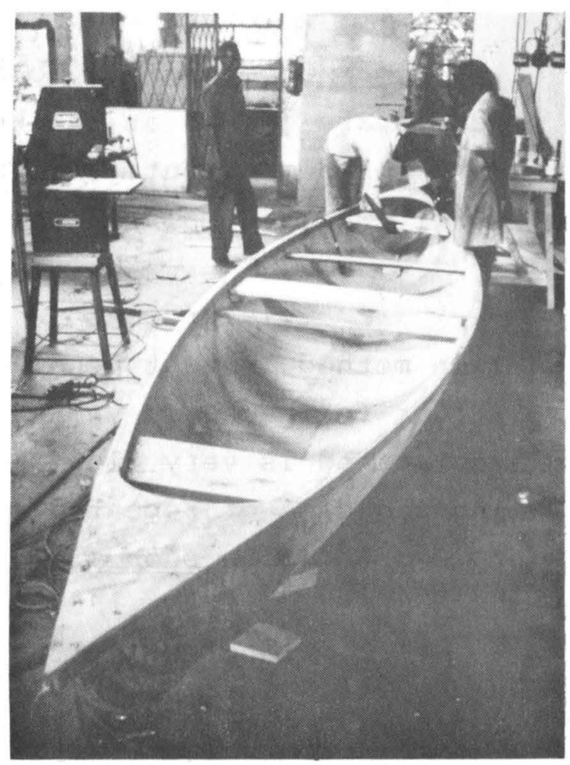
This process is called the Constant Camber™ construction method (patent pending) and was initially conceived by the writer for backyard yacht building. In its simplest embodiment, the method is very "low-tech" and "low-bucks" while still imparting a degree of repeatability (with the attendant cost advantages) to a production shop.

Transferring the technology to African trainees involved two months of intensive hands-on instruction. Small technical





Assembling the hull halves into units is simple, and can be accomplished by indigenous boatbuilders on the beach. Panels are lightly stitched together down the keel line with wire, fish-line or staples. Fiberglass tape is applied to the inside. The hull is then turned and the seam is prepared for more fiberglass tape outside. Assembly time is about one-half day per hull. (This method of seaming has been used successfully by the author in seagoing boats for over ten years). Accessory parts such as decks, railings and seats are installed in the normal manner.



The finish coating is important, for it excludes water and organisms. Where cost considerations prevent overall sheathing with fiberglass, such as in this case, all surfaces can receive an application of epoxy resin or primer, followed by any kind of paint to shield the epoxy from ultraviolet deterioration. Fungicide can be added to the coatings (even the veneers themselves can receive a preservative dip before lamination). In addition, a husky hardwood keelson is installed to protect the bottom during beaching operations. Completed hull has a value of about $600 in Burundi.

Narrow hulled canoe, above, must be coupled with a twin to form a catamaran for stability. This hull configuration is easier to paddle and makes less wind drift (away from the net) when fishing. While these boats are always fished in pairs as catamarans, the wide body canoe below is also sufficiently stable for monohull operation. This allows twin hulled units to separate out in the lake; one canoe proceeds to market with the catch while the other returns home with the net. Several prototypes of each configuration are presently in operation to determine fishermen's preferences.

problems were a constant distraction, and two separate canoe designs (two different molds) were produced in order to tailor the product carefully to the fishermen's expressed needs.

Nonetheless, the trainees grasped the undertaking eagerly and learned to cycle the mold without supervision on the seventh cycle. Many of the workers had no previous experience with woodworking or adhesives.

Still and all, the most noteworthy aspect of the laminated dugout is that it allows a deforested country to build a very lightweight structure (180 pounds for a 23-foot finished hull) mostly out of local wood. These vessels do not leak and cannot sink; and, while their service life is estimated at ten years under local conditions, they may serve for 25 years or more with proper care. About eighty percent of the canoe's weight is cheap, local wood, and about twenty percent by weight is expensive, imported glue and coatings. Trouble is, the imports cost about six times that of local wood. Imagine the cost of a one hundred percent imported-material canoe.

Maximum use of local material and local boatbuilders is in order. The next logical step in this project is to make available the panels only, pre-laminated into their canoe-like shape, for assembly on the beaches by indigenous boatbuilders, thereby preserving their traditional profession and further reducing costs.

Investments in machinery and the cost of technical assistance, if charged against each hull, would (in a bootstrap operation such as this) make the individual canoes quite expensive until production volume becomes high. The Burundi project is currently operated by a Federal Corporation, which has had its teething problems and can probably never overcome the inefficiencies inherent in a bureaucratic outfit where the buck never stops. Nevertheless, this project shows a chance of actually making money for the government, all costs included, if

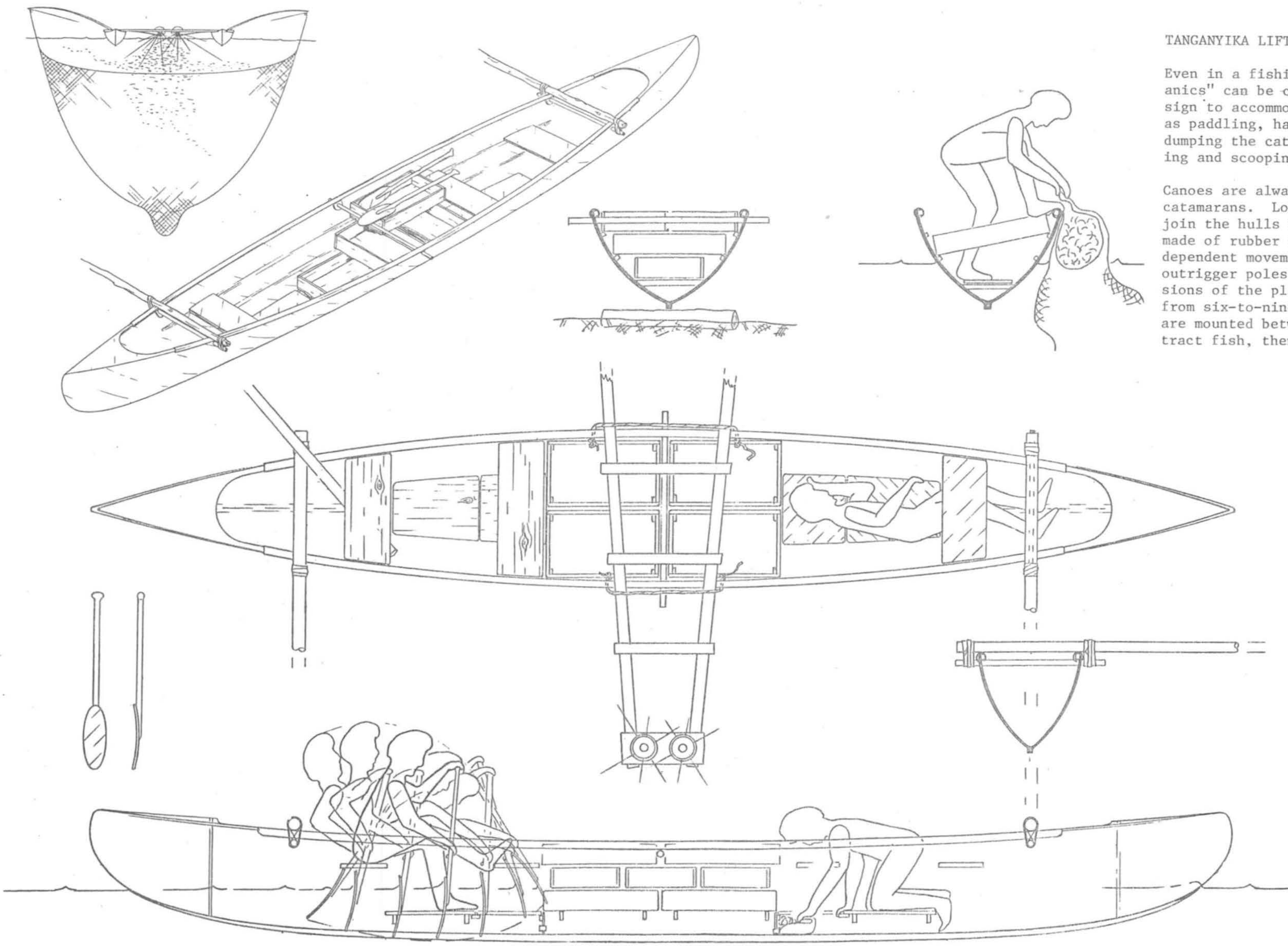
Returning to the beach after the first night of operation, the fishermen's reactions were positive; "...we can paddle this canoe faster than other canoes can go with motors...Bwana! This is one canoe which does not need an engine."

(See also back cover.)

production can reach about 350 hulls per year. Only three months after start-up, one hull per day is coming out the door, with only one mold operating. A second mold is almost finished at this writing, and Burundi's neighboring countries are inquiring about buying pre-laminated panels (which nest to ship) for their own fisheries. It appears that finished laminated dugouts can be sold on the open market, at a profit, at prices of one-and-one-half to two times the price of the indigenous plank-built dories, which is about one-half to one-quarter the price of other alien canoes. Best of all, no outboard motor is required (motors increase the fisherman's investment by over thirty percent). Building from panels only, on the beaches, would probably reduce finished prices to be directly competitive with indigenous boats, which now cost about $300. Apparently, the fishermen believe the new canoes are worth their current finished price of about $600.

Of course, any conclusions at this time are premature, but the possibility of success is a refreshing change in this context. Overall, the Burundi Fisheries Project has included many features besides boats, such as fish processing and marketing facilities costing several million dollars, and only the boat shop appears to have a chance of bottom-line success.

The prospect of exporting parts is particularly inviting to a small republic which otherwise has so little to sell but so much (oil) to buy. Foreign inquiries about pre-laminated panels have sparked a move to turn the boatbuilding operation into private hands. With increased entrepreneurial efficiencies, there is little doubt that private management would result in an improved boat at a lower price, with a greater "rate of return" to the local economy. But the real surprise is that someone in the private sector sees a financial opportunity in selling laminated dugouts to African tribesmen. It has been said of such endeavors, "If it works here, it will work anywhere."



TANGANYIKA LIFTNET CANOE

Even in a fishing canoe, "body mechanics" can be considered in the design to accommodate such operations as paddling, hauling the net and dumping the catch into boxes, resting and scooping-up stray fish.

Canoes are always fished in pairs as catamarans. Long eucalyptus poles join the hulls by way of lashings made of rubber strips, allowing independent movement of hulls. Long outrigger poles extend the dimensions of the platform to spread a net from six-to-nine meters square. Lights are mounted between the hulls to attract fish, then net is simply raised.

PROPOSED DOUBLE-CANOE FOR THE BURUNDI NDAGALA FISHERY © JAMES W. BROWN 1980	SCALE 1" = 1'
	SHEET 2

III. THE MOTHER BANCA

Nautical heritage is an important aspect of Philippine culture. Being an archipelago of large islands closely spaced, the sheltered seas between have spawned the distinctively frail-looking banca double-outrigger canoes. Since before the Spanish conquest, these craft have served as the primary vehicle for fishing and inter-island transport. Current estimates of the number of bancas in the country run between 400,000 and one million vessels. They range in size from one-man paddling canoes up to ninety-foot motorized freight boats, all outrigger stabilized. Relative to modern yacht multihulls, the banca is an extreme machine, being well developed for very high performance at low cost in calm, often shallow water.

Historically, the islands have been blessed by grand tropical forests with many noble species. Export demand for furniture, plywood and even raw logs is high because the wood is good and the labor cost is low. These exports earn "foreign exchange" money with which the country buys industrial goods and oil.

Since the 1940's most bancas have been motorized, but current fuel prices--when combined with declining fish landings--have forced many of the motorized bancas into idleness for much of the year. Hull decay is more rapid now with inferior woods used in traditional construction, and this decay is accelerated by disuse. Boatbuilders are legally restricted from cutting the kind of woods from which their vessels have evolved. Most of the islands have been severely de-forested. Consequent erosion has assaulted many near-shore areas with silt, and local fishermen have resorted to using poison and dynamite to glean remaining life from nearby reefs in survival efforts to feed their burgeoning families.

Many millions of dollars have been borrowed, and spent, to modify these alarming trends. Most attempts are focused on petro-based, industrial options which, in the writer's opinion, are the root cause of environmental degradation which is, in turn, the root cause of political insurgence.

Very fortunately, certain factions in government and industry are becoming cognizant of this apparent relationship. Current fisheries development is not focused on high-powered boats, whose dozer-like bottom trawls have been identified as a primary cause of declining ocean vitality worldwide. Instead, the little guy, the "municipal" fisherman, has been recognized as the breadwinner for that majority of the populace, the village dwellers, who are immediately threatened.

It remains to be seen if any meaningful improvement can be made in the villagers' fishboats. Their lean, lightweight bancas are very easily driven at high speed by small, air-cooled inboard engines. Because these Briggs-type engines are four-cycle, no oil is mixed with the fuel, thus avoiding a primary cause of breakdown with two-cycle outboard motors. The inboards are coupled directly to a propeller shaft, thus avoiding the cost, weight and complication of a marine transmission (usually as heavy and expensive as the engine itself). The simple units are easily maintained with ordinary tools and are far more fuel efficient than outboard motors.

Despite these economies, daily expeditions to near-shore fishing areas become increasingly non-viable when fuel cost exceeds catch value. Sailing, of course, was once the simple solution, but now the environment is changed. The banca's traditional sailing rig is cumbersome. The fishermen rightly feel that a return to primitive solutions represents a step backwards; and, anyway, why make a slow trip to an already depleted fishing ground in a boat built from an already depleted wood supply?

The analysis suggests that a new boat type is indicated, one that can go farther and stay longer. In some areas at least, the usual banca is restricted by its frailty.

The features which make it so efficient in protected waters, like its low freeboard and spidery outrigger platform, also make it unsuited for venturing out on windy days to the more distant, underexploited territory. Such expeditions require a craft which offers its crew some shelter and sustenance, so that they may stay on the fish for longer than their accustomed expeditions. Somehow, all this running out-and-back the same day must be avoided, while still making more jobs for more fishermen to catch more fish.

Gradually, the social pattern of the municipal fisherman must adapt to that changed environment. As difficult as this may be, the way can be eased by introducing a truly appropriate boat. Back to the classic question, "What is appropriate?"

Within this frame of reference, Mr. Agustine Cancio, a prominent Manila furniture manufacturer, invited the writer to propose a design for the Philippine banca fishery in January, 1982. The challenge was quite opposite from that of improving Burundi's crude canoes because the dynamic efficiency of the banca is already beyond improvement for its intended waters. Both countries face wood problems (yet we found a source in Africa). Now there appears to be abundant luan, a light Philippine "mahogany," for the next fifteen years or so. Pre-cut luan veneer is readily available.

To invest this precious resource in fuel super-efficient fishboats for local use seems appropriate. But to make ordinary luan long-lasting, it will probably have to be laminated. (Incidentally, fine tropical woods are not a renewable resource, simply because they are not being renewed. Cleared land is used for agriculture; reforestation is generally experimental involving fast-growing "weed" trees which are destined for making bio-fuels. Perhaps they can be used to make laminated structures also.)

In keeping with the rule of thumb which says, "Offer something that is as close as possible to what already exists," a design was prepared for a laminated banca hull of 32-feet length. Reasoning was that a slightly larger, higher and more seaworthy conformation was in order to contend with the changed environment...the fished-out near-shore resource. If the new boat would give confidence to the fishermen when venturing off-shore, then perhaps it would be more productive of fish. It would have to have greater carrying capacity and offer some shelter for overnight expeditions. Out where there are bigger waves, there is generally more wind, so a sail could be fitted to back-up the engine and curb running costs.

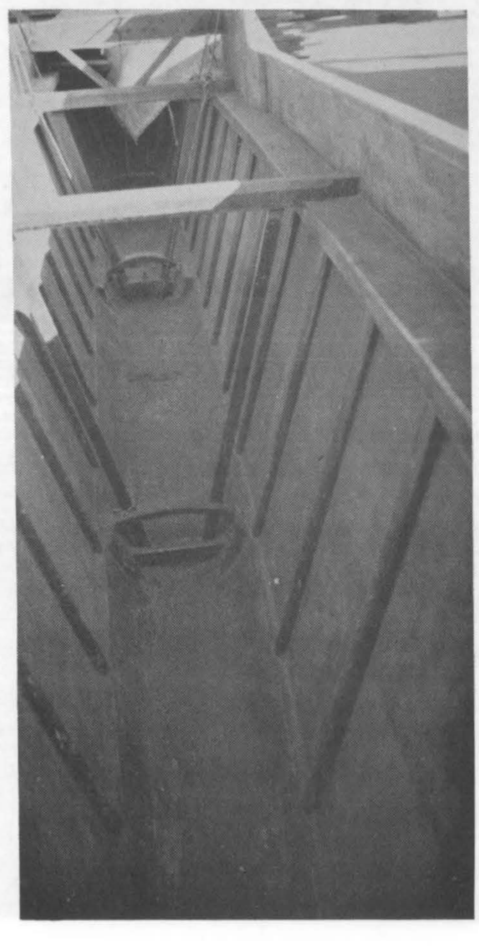
Even if these parameters appeared hastily drawn, without sufficient first-hand knowledge of the fishery, Mr. Cancio was keen to get something accomplished. If nothing else, we would demonstrate the advantages of compound-laminated plywood for the still wood-based Philippine economy.

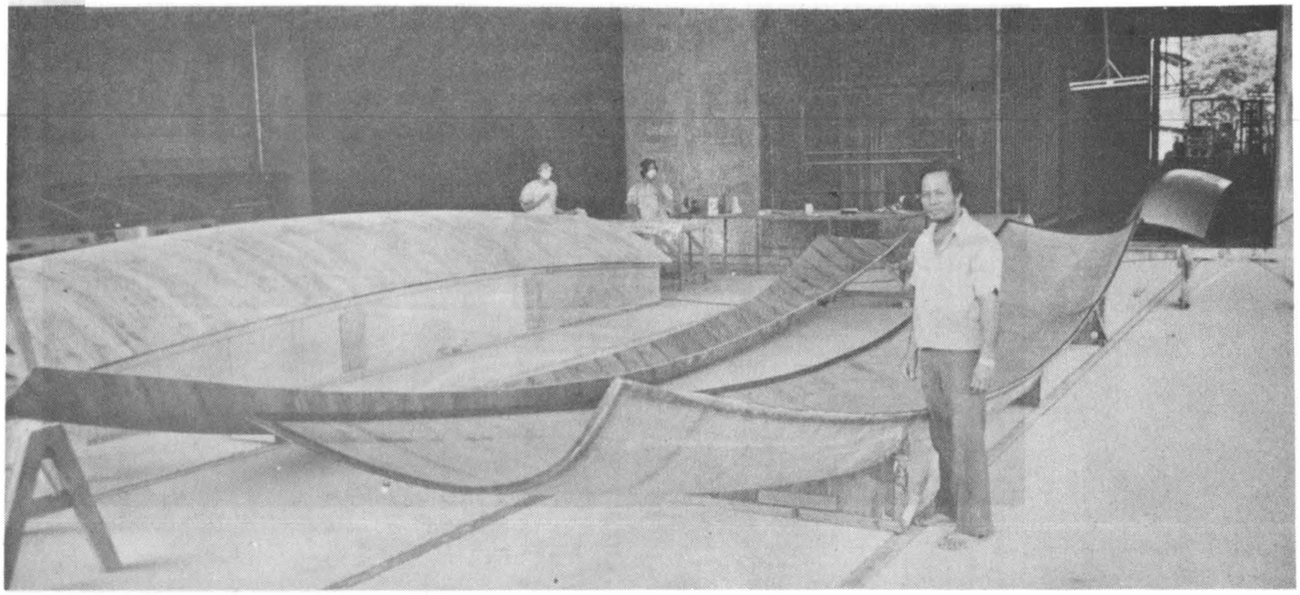
Mr. Cancio is partners with American David Socash as the licensed manufacturers of Hobie Catamarans in the Philippines. Keen watermen, they appreciated the high strength, low weight, long life, low-cost properties achievable with the Constant Camber production method. They were willing to buy the know-how and offered perpetual royalties. With this private initiative, in two months we accomplished essentially the same technology transfer, complete with an operating prototype, as had required three years under bureaucratic ballast in Africa.

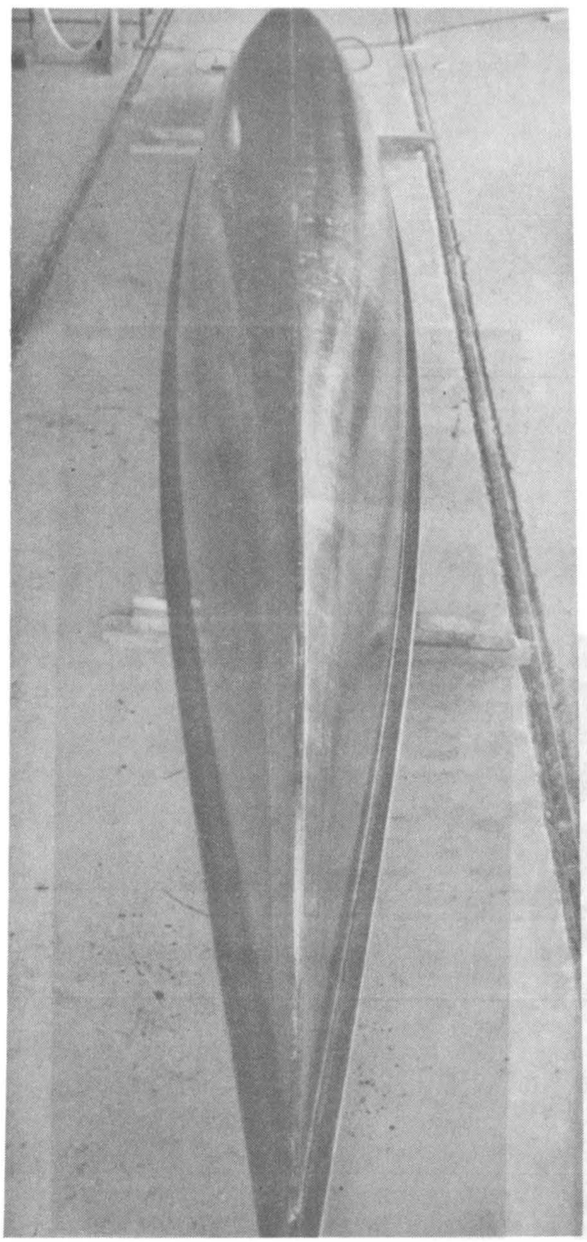
Notwithstanding, it is going to take time and inspiration to make a difference in the Philippines. After meetings with fisheries experts and development bankers and demonstrating our laminated banca to high-level government, it was concluded that her hull construction was "marvelous" but that the craft itself was "...not sufficiently different from existing boats to revitalize the municipal fishery."

(Text continues on page 31)

The ubiquitous banca; fishboat, freight handler and "family car" to the Philippines. Lithe and fast, these flat-water specials depend on very noble wood for carving their dugout bottom shoe or "casco." Preferred species are in short supply. Light plywood topsides attach to the solid shoe with nails and tie-rods, a frail combination of dissimilar materials which are vulnerable to engine vibration, dimensional instability, puncture and decay. The previous abundance of excellent materials, and a once-rich near-shore fish resource, allowed this fleet to flourish.





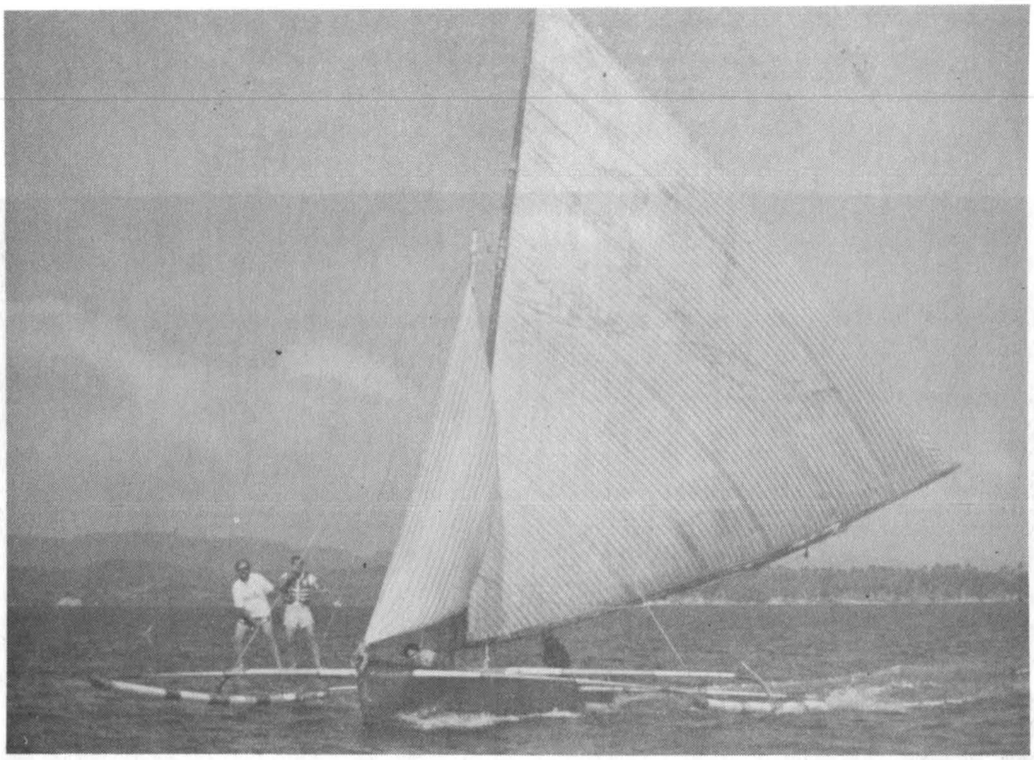


Constant Camber tooling, above, is currently housed in the Cancio lumber kiln, Cebu, Philippines. Factory foreman Lucas mobilized his crew of experienced woodworkers to cycle the mold without supervision on the third cycle. Lucas stands beside the fiberglass matched platen of the "French curve" mold; the mold itself is visible in the stall at right background. The first sample panel produced, a reject, rests on sawhorses in the middle distance. Large mold at far left is under construction, destined to produce inch-thick panels in 25-foot segments for making vessels up to 75-feet long.

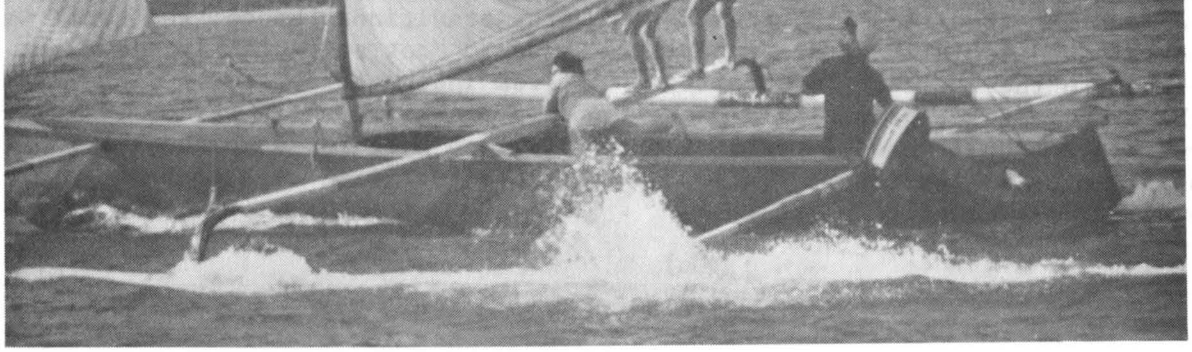
Finished 32-foot hull at left was assembled from sketches while the consultant was absent with illness. Panel laminating time is about one hour each on the "French" mold with five hours under vacuum. Hull assembly time is about one day. Hull exhibits rounded midbody and fine ends typical of contemporary ocean-racing multihulls. At 400 lbs. built weight, and a value of about $1,000, this hull carries greater payload with superior seakeeping properties relative to traditional flatwater bancas. Slightly wider, higher hulls, produced on the same mold, are to be used in pairs for the proposed "Mother Banca."

"Lumba Lumba," which means porpoise in the Philippine dialect of Visaya, is the name given by Agustin Cancio to his first banca prototype with a laminated hull. Coated with clear epoxy resin to reveal her construction, the hull is entirely without internal skeleton. Compound curves give the structure "prestressed eggshell rigidity" which avoids the need for any ribs, stringers or bulkheads. No "framing-up" stage is encountered during construction, thus relieving the demand for traditional boatbuilding skills and tools. Material usually relegated to the skeleton is invested in the skin instead, producing a puncture-resistant hull whose interior is as clean as its exterior. This allows free placement of platform connectives and interior features like fish holds, engine beds, and bunk platforms without the usual conflicts and lost space caused by skeletal components. Dividing bulkheads are sheet plywood "dropped-in" and secured with fiberglass tape. Note the replaceable hardwood beaching shoe and wide, laminated sheer stringers to protect and stabilize the hull.

Shown here rigged with the bamboo outriggers and plastic rice-sack sails of the traditional banca, the craft was judged "not sufficiently different from indigenous boats...." Her yachty appearance actually worked against her, "...too nice for a workboat," a dilemma since rectified by a coat of paint.



"Lumba Lumba" proved herself in trials to be a sporty, impractical thriller. Even with two hunky Hobie hotrodders hiked-out and hanging on (a fall could mean decapitation by the after cross beam), the craft displayed insufficent stability under pressure from the large, cumbersome sail. When broad reaching, as above, the boat was mellow and fast, but when hauled up a bit by-the-wind she heeled, burying the leeward outrigger and threatening capsize. This exercise was great fun with the warm sun in a sheltered bay, but participants agreed that some changes were in order before venturing offshore in the dark. The twin hulled "Mother Banca" shown herein with drawings, incorporates those changes.



YACHT VERSION

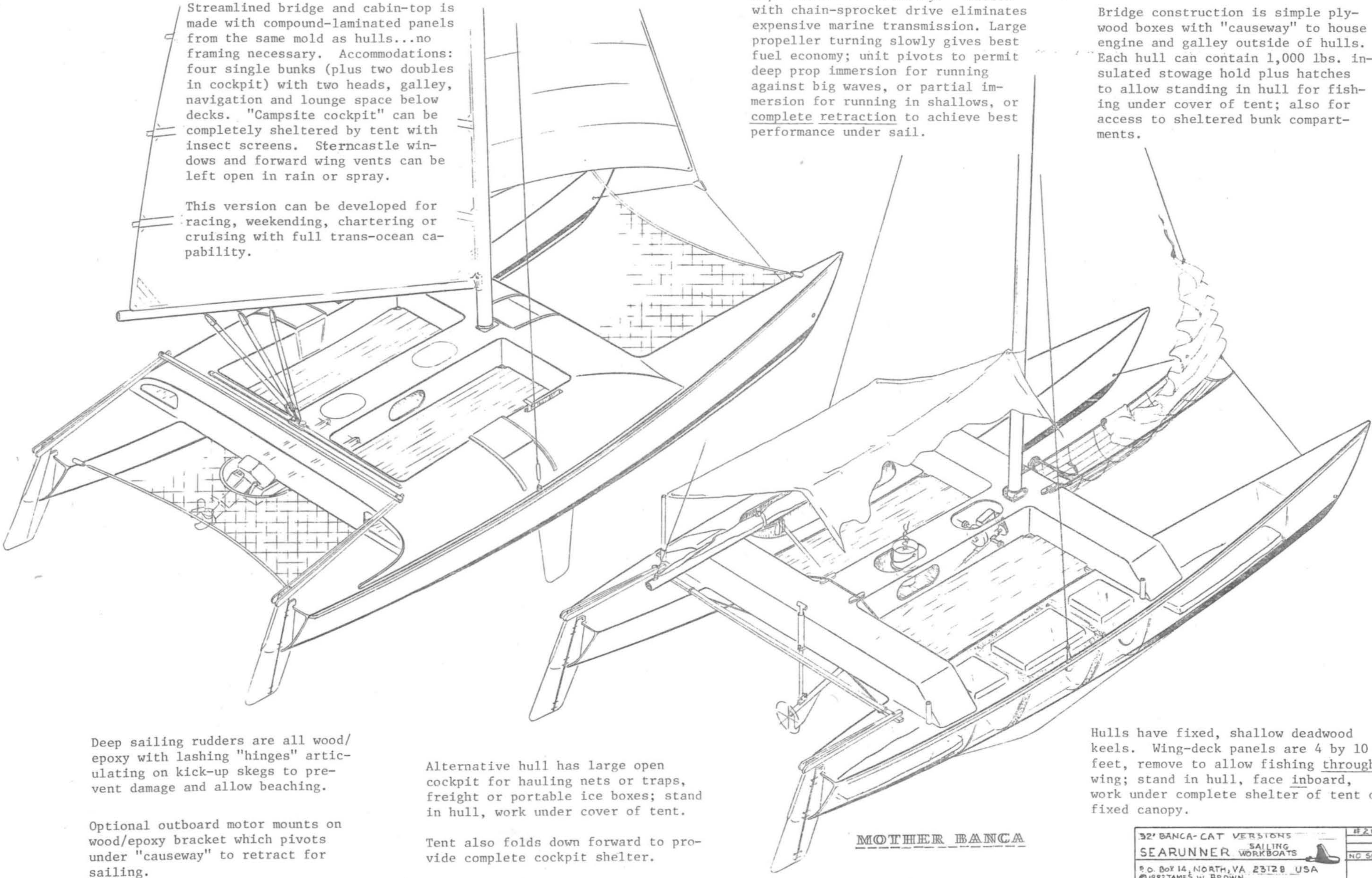
Streamlined bridge and cabin-top is made with compound-laminated panels from the same mold as hulls...no framing necessary. Accommodations: four single bunks (plus two doubles in cockpit) with two heads, galley, navigation and lounge space below decks. "Campsite cockpit" can be completely sheltered by tent with insect screens. Sterncastle windows and forward wing vents can be left open in rain or spray.

This version can be developed for racing, weekending, chartering or cruising with full trans-ocean capability.

Any four-cycle engine ten to forty h.p. mounts in "causeway." Clutch with chain-sprocket drive eliminates expensive marine transmission. Large propeller turning slowly gives best fuel economy; unit pivots to permit deep prop immersion for running against big waves, or partial immersion for running in shallows, or <u>complete retraction</u> to achieve best performance under sail.

FISHING VERSION

Bridge construction is simple plywood boxes with "causeway" to house engine and galley outside of hulls. Each hull can contain 1,000 lbs. insulated stowage hold plus hatches to allow standing in hull for fishing under cover of tent; also for access to sheltered bunk compartments.



Deep sailing rudders are all wood/epoxy with lashing "hinges" articulating on kick-up skegs to prevent damage and allow beaching.

Optional outboard motor mounts on wood/epoxy bracket which pivots under "causeway" to retract for sailing.

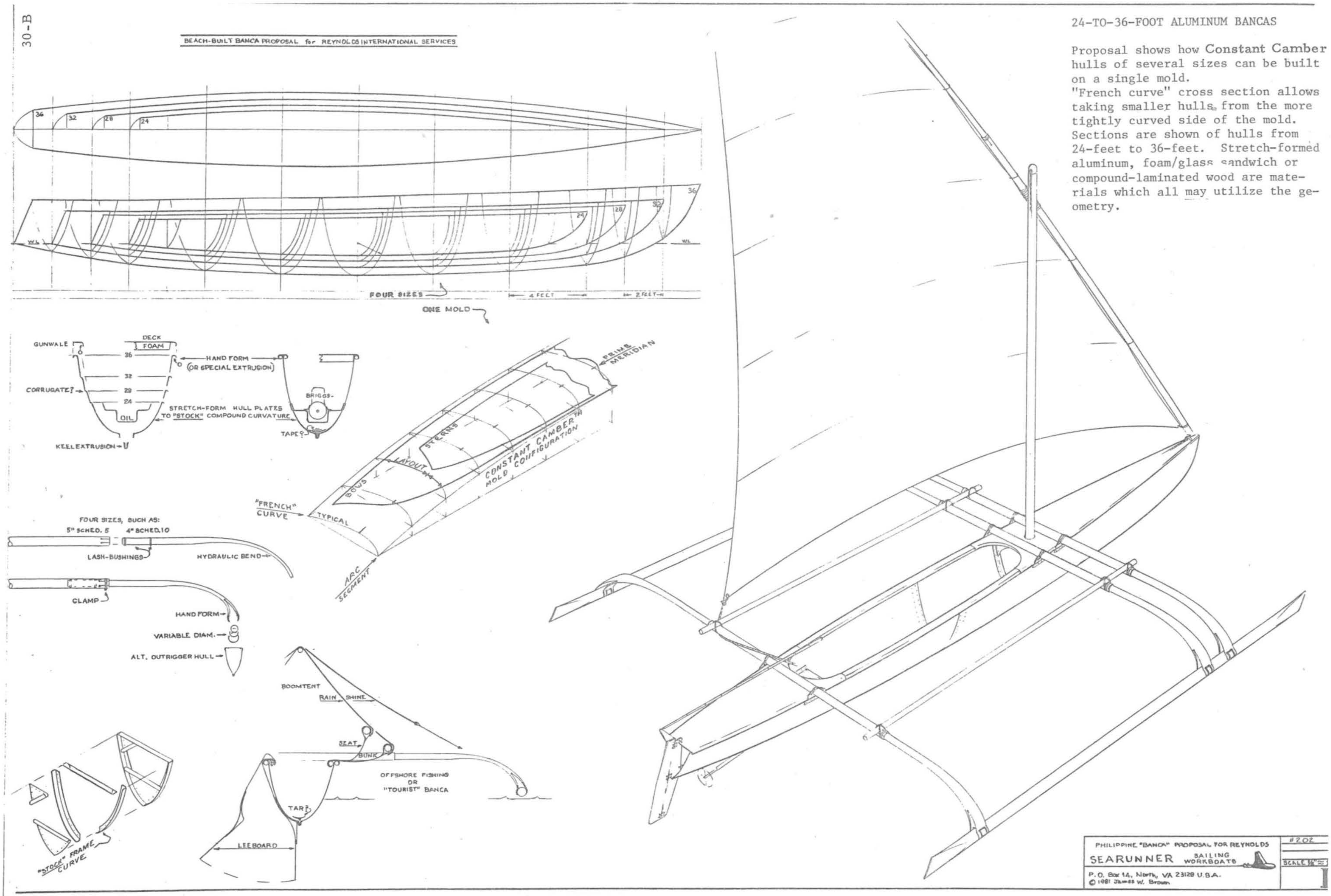
Alternative hull has large open cockpit for hauling nets or traps, freight or portable ice boxes; stand in hull, work under cover of tent.

Tent also folds down forward to provide complete cockpit shelter.

MOTHER BANCA

Hulls have fixed, shallow deadwood keels. Wing-deck panels are 4 by 10 feet, remove to allow fishing <u>through</u> wing; stand in hull, face <u>inboard</u>, work under complete shelter of tent or fixed canopy.

32' BANCA-CAT VERSIONS	#211
SEARUNNER SAILING WORKBOATS	NO SCALE
P.O. BOX 14, NORTH, VA 23128 USA ©1982 JAMES W. BROWN	



24-TO-36-FOOT ALUMINUM BANCAS

Proposal shows how **Constant Camber** hulls of several sizes can be built on a single mold. "French curve" cross section allows taking smaller hulls from the more tightly curved side of the mold. Sections are shown of hulls from 24-feet to 36-feet. Stretch-formed aluminum, foam/glass sandwich or compound-laminated wood are materials which all may utilize the geometry.

PHILIPPINE "BANCA" PROPOSAL FOR REYNOLDS
SEARUNNER SAILING WORKBOATS
P.O. Box 14, North, VA 23128 U.S.A.

#202

Had the rule of thumb failed? Or had we offered "...something as close as possible to what already exists" without including sufficient "...alien technology to compensate for the now-changed environment?"

What is needed is a real breakthrough. Development funds are available for building hundreds of boats, and somehow they must be designed, built and operated to satisfy a profusion of conflicting environmental and social requirements. After a more thorough investigation of the fishery, and borrowing an idea from the old Grand Banks cod schooners, the present proposal is for a so-called "Mother Banca."

The idea is to <u>tow</u> several small paddling bancas behind a mothership out to the fishing grounds. The mothership anchors and the crew mans the canoes for fishing thereabouts. The fresh catch is brought promptly to the mothership for storage in ice. The crew rotates, eats aboard, rests in good shelter, and the entire unit stays out as long as the ice lasts, three or four days. This tactic gives small canoes and many fishermen access to distant fishing grounds without all the daily running out-and-back.

The Mother Banca must be manned by crewmen who are willing to leave their villages for several days at a time. To promote this adaptive behavior, the new boat must be relatively commodious, have very comfortable riding motion when at anchor in a seaway, and have a dependable engine installation. She needs enough motor power to tow a string of "ducklings" and to make it home promptly against calms or headwinds when the ice gets low.

For all of that, experience with "dependability" afloat implies that this Mother should also carry sail. Neither the crew nor the catch can be left to depend entirely on the "gasoline breeze" to bring them home from longer runs to more distant resources...runs which the sails can help make at lower running costs.

Fisheries people would normally consider a legitimate diesel-powered motorboat for this Mother Banca application, but the present proposal is for a catamaran based on twin laminated banca hulls joined as a catamaran. Several justifications are offered:

1. The twin-hulled vessel is as close as possible to the existing trimaran bancas while still serving the adaptive purpose. Like the indigenous craft, the catamaran can be beached for loading and unloading while retaining a sled-like stability when grounded in the surf. It can trespass very shallow areas while still retaining a very stable no-roll motion when anchored in open water.

2. The mothership function of accommodating transient fishermen is probably performed better with the catamaran--more shaded deck space for resting in the heat; more sheltered bunk space for resting in the rain and wind; and, adequate on-deck galley facilities for simple one-pot meals with reduced fire hazard. The no-roll motion while anchored, as compared to a monohull of similar size, is probably the most attractive feature of the catamaran...and a standard property of the existing, outrigger-stabilized bancas.

3. The bridge which joins twin hulls provides an ideal mounting position for a uniquely appropriate engine installation. Any available engine of ten-to-forty horsepower may be utilized without regard to "marinizing." This means that low cost automotive or industrial engines can be adapted without the expensive accessories for cooling and exhausting normally required in below-the-waterline inboard installations. No marine transmission is specified because the forward-reverse feature is not necessary for operating from the beaches, as is amply demonstrated by existing bancas. Gear reduction is accomplished through a clutch with simple chain-and-sprockets (motorcycle parts) so that a very large propeller is driven at low r.p.m. for maximum towing thrust and fuel efficiency. The entire engine/

drive unit is arranged to pivot on a single transverse axis for retracting the propeller and shaft completely clear of the water. This allows easy access to parts usually submerged; the common bugaboo of fouling the propeller with ropes, fishlines or nets is easily rectified. Most important, the large, efficient propeller withdraws completely from the water to permit the vessel its full speed potential under sail.

Parenthetically, a gasoline engine may be the wisest choice for the Philippines. Refineries are hard pressed to meet diesel demands because gasoline must be drawn-off first in the cracking process. High gas prices cause storage gluts and a consequent restriction on diesel fuel production. Diesel automobiles pay a special import tax in the Philippines.

Gasoline inboard engines are rather dangerous when installed deep in the bilge of motorboats. The risk of fire and explosion is minimized by installing the engine in a catamaran's bridge, where drips and vapors cannot accumulate and where the entire machine is proximate to the helmsman for immediate detection of overheating. It is easily accessible from on deck for maintenance and repair.

Agreed, such an engine installation is developmental and will require a degree of cut-and-try. But the prospects of keeping it running are much enhanced by avoiding sophisticated engineering--which depends on sophisticated engineers and specialized service and uncommon parts. Even a small automobile engine like the Nissan, generic in the Philippines, could be installed in the Mother Banca complete with radiator and muffler. The result could be closely parallel to the bare-bones propulsion system of the existing bancas while still performing the necessary adaptive functions, including the ability to really sail.

4. Costs are the bottom line justification for the present proposal, both in terms of investment and operating costs. Productivity should be at least as high with the catamaran as the normal motorboat.

Investment cost of a traditional monohull motorboat of thirty-two feet, if built with fiberglass or aluminum and equipped with normal diesel power, could range between $9,000 and $14,000. No sail would be necessary because prop drag and bilge keels (required for beaching) would yield disappointing performance under sail.

Despite the added cost of two hulls and sail rig, the catamaran Mother Banca can probably be produced in the Philippines, of mostly local material, for about $7,000. Much of the saving is due to the "generic" engine installation and using local wood. A further investment reduction, with attendant social benefits, can be achieved by local boatbuilders assembling the catamarans from prelaminated parts right in the fishing villages. A modest training program would be required to introduce new glues and coatings, but the carpentry required is well within the capabilities of indigenous banca builders. This training program can be facilitated with clear graphic plans such as are provided for inexperienced back yard yachtbuilders.

Ancillary to these cost advantages is the matter of "infrastructure." Fisheries projects commonly include shoreside facilities for ice production, transportation and other fish marketing features. A very expensive item of infrastructure is harbor facilities: channels, docks and marine railways commonly associated with monohull motorboats alien to the Philippines. These harbor facilities often cost far more than the vessels which patronize them and are subject to storm damage and high maintenance costs. The indigenous bancas, however, have long shown themselves not to require such infrastructure, and the catamaran Mother Banca would uphold this versatility. Loading and discharging fish and ice can be accomplished by men wading into knee deep water, this while the vessel lies stable and upright at any stage of tide, even in a swashing surf. At about 2,000 pounds built weight, the catamaran is probably somewhat lighter than its traditional monohull counterpart (massively built to withstand pounding on its wide, flat bottom, and the relentless vibration of a diesel engine). Twin, narrow hulls are easily protected with sacrificial, replaceable "runners" on the bottom. Such a configuration is easily dragged ashore by man-power without danger of toppling, where the investment is safe from storms without expensive breakwaters. Easily maintained on any beach by its own crew, like indigenous craft, the Mother Banca can operate without need of marine railways or cranes.

Supernumerary to these investment savings is the matter of the multihull's miserly running costs.

A quick look at fluid dynamics reveals that a boat makes a hole in the ocean and requires energy to move that hole along. Moving that hole makes waves. It is a feature of waves that small waves are normally close together and move slowly, while large waves are far apart and move fast. A wide boat-hole makes much larger waves (one at the bow and another at the stern) than a narrow boat-hole. With small boats, such as these, the bow and stern waves are much closer together than they would be in nature if caused by the wind, and so cannot move fast. Thus, a wide boat cannot possibly go faster than the waves it makes unless it skims over the surface as in planing. Planing has its problems, too, and is not desirable in these working watercraft; so, let's look at narrow boat-holes.

Most monohulls are about three-to-four times longer than they are wide, but multihulls can be anywhere from seven-to-twenty times longer than they are wide. A practical width-to-length range for our Mother Banca is about nine-to-twelve times longer than wide...so narrow that this moving hole makes practically no waves at all. Where does propulsive energy go? It is mostly carried away by waves. Therefore, a narrow hole, or even two or three adjacent narrow holes, are very easily driven through the water.

This admittedly incomplete discussion must make mention of the fact that the boat which sits in a narrow hole all by itself is too tippy and, so, must be "outrigger stabilized" as in catamarans or trimarans...a concept employed to good advantage for centuries by people of the Indio-Pacific.

True, narrow hulls are poor load-carriers, even two or three together, but large payloads are not likely to be encountered in this fishery. The monohull as we know it probably originated in Northern Europe where sailors were burdened with plunder and heavy equipment for fighting the elements or fighting other sailors. By contrast, the canoe people of the tropics are like back-packers. They carry only what they need. While contemporary bancas are bringing home as little as five pounds of fish per day (average in some "depressed" areas) the two insulated storage holds of the catamaran can carry about two thousand pounds of fish and ice in a 50/50 ratio. This one-ton payload would constitute an uncommonly bounteous harvest for our Mother Banca or any vessel serving in this fishery. A wide-hulled load carrier is simply not required.

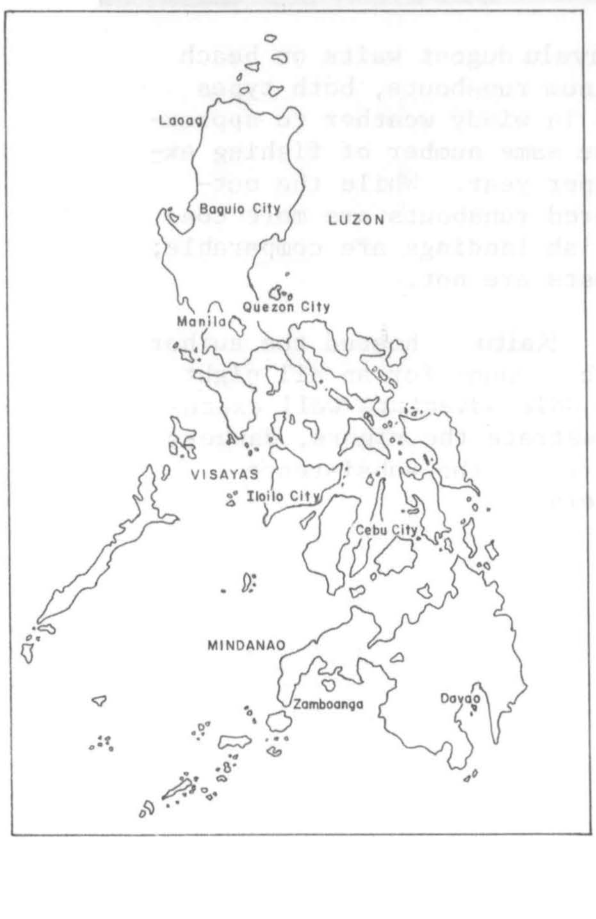
Does all of this sound "...sufficiently different from existing boats...?" While still retaining necessary similarities? Only the operation of prototype vessels, carefully modified where necessary to meet the fishermen's expressed needs, will determine ultimate suitability. Prototype construction is in progress at the Cancio furniture plant in Cebu, Philippines. Several boats are planned for introduction in various areas of the archipelago.

Water-oriented tourism is a growth industry in the Philippines. Skin diving and sailing expeditions are attractive to visitors and elite Philippinos because of all the beautiful, sheltered water and quaint seaside villages among the islands. But the traditional banca can be a bit austere for tourists, so a yacht version of the Mother Banca is also proposed. Fully capable of open sea passagemaking, with weekend accommodations below deck, and with optional go-fast hardware and sails, the yacht version may cost over twice as much as the fishing version.

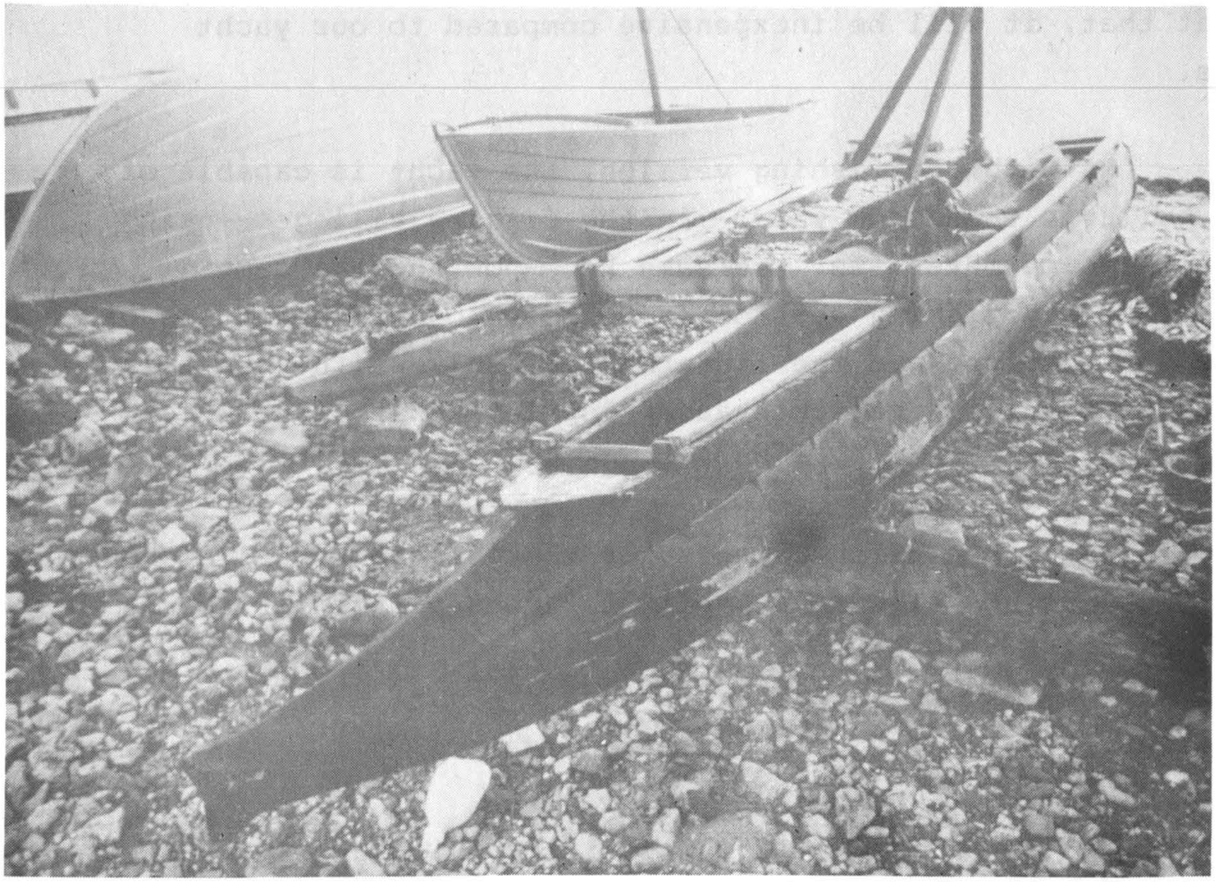
Even at that, it will be inexpensive compared to our yacht prices.

As with the fishing version, the yacht is capable of being built in the "back yard"--in the fishing villages--using mostly the same materials, the same know-how and the same builders as the fishing version. The most logical operators of bancas for tourists are the fishermen themselves (they're doing it now) giving local peasants an appropriate share in tourist development.

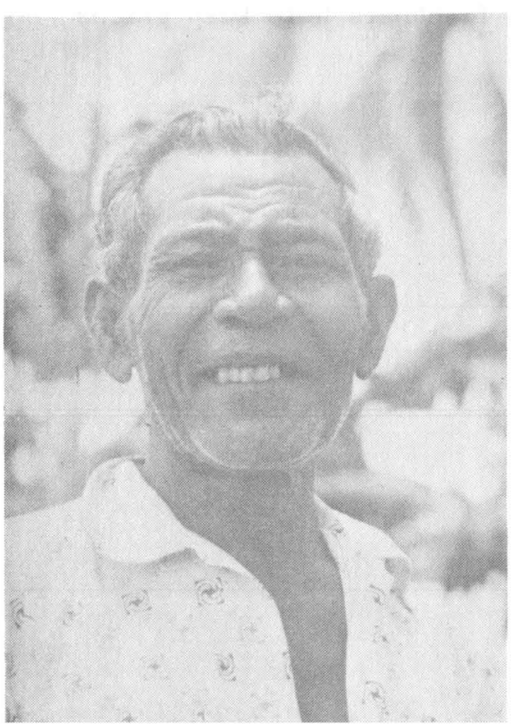
Larger, similar vessels for tourism and inter-island transportation are also in planning for construction at the Cancio facilities.



Four thousand islands comprise the Philippine archipelago. Protected waters between the islands no longer produce sufficient fish landings to satisfy the growing market of about fifty million people--most of them young. Industrial fishboats ranging farther seaward bring larger catches but at escalating costs. The local demand is for very low-priced fish; can sailing fishboats help keep prices down?



Two-man Tuvalu dugout waits on beach with aluminum runabouts, both types restricted in windy weather to approximately the same number of fishing expeditions per year. While the outboard-powered runabouts are more convenient, fish landings are comparable; running costs are not.



Mr. Josea Kaitu hosted the author aboard such a canoe for an all night sail-and-paddle adventure well executed to illustrate the rigors, dangers and pleasures of the subsistence canoe fishery.

IV. NEW SAILS IN THE NEW PACIFIC

WHERE THEY ARE NEEDED MOST

From a time ago before Christ about twice what our present day is after Christ, people of Island Asia began a maritime migration eastward analogous in scope to our contemporary reach for planets. One group now known as Polynesians, beginning from about the birth of Christ, established their culture as the most geographically dispersed on earth.

No written records or ocean-space ships survive intact to reveal the details of this achievement. Tradition holds that migratory sea-birds suggested the existence of invisible destinations, that navigators computed their positions in the mind by empirical orientation with the night sky, and that all vehicles were composed wholly of vegetable fiber.

One Polynesian footprint along the migratory path was a group of eight atolls in the remote central Pacific, now the tiny island nation of Tuvalu. Here Polynesian culture has persisted for perhaps a hundred generations, a culture wrought by incessant bombardment from sky and sea upon life forms occupying minute scraps of isolated reeftop. Tuvalu's total land area is 26 square kilometers, divided into eight atolls, scattered within a sovereign sea territory of 1.3 million square kilometers. Much of this is inaccessible to the inhabitants; only traces of their former deep-sea mobility survive, in the form of finely carved dugout canoes. Despite her rich fish resource, Tuvalu is like most Pacific island nations, paradoxically, a net fish importer. Inter-atoll transportation, involving passages of less than one hundred miles, is sporadically provided by a small, decrepit steel ship and an expensive, amphibious airplane; both require government subsidy. Local transportation, between the islets surrounding a given lagoon, serves to transport people and the food they produce on the islets. Even this intra-lagoon transportation is sometimes not available. Traffic between the atolls and intercourse with neighbor nations is entirely fuel-dependent.

Environmental changes, acculturation, declared political independence, implied economic dependence, and the energy crunch have all combined to apply unique adaptive pressure on these 8,000 people, members of the most ocean-oriented race on earth. Clearly, they have adapted to unique pressures before.

Save The Children is a non-profit foundation whose respected achievements are based on community self-help as the most effective means of benefitting youth and future. Mr. Jack Lockett, field office director for Save The Children in Tuvalu, has observed that Pacific island communities are becoming more dependent on industrial watercraft. Tuvalu is located at the end of a long and precarious line of industrial supply. Interruptions are becoming disruptive. Gasoline costs $4 per gallon; packaged food pulses through the archipelago with jarring irregularity and island communities become further disinvolved from sources on which they increasingly depend.

For the purpose of consulting on Tuvalu's long-term watercraft requirements, the writer was invited by Save The Children to visit the islands in February, 1982. The resulting recommendation was that Tuvalu Government undertake to provide most of the nation's watercraft needs through a long-term program which is highly integrated. The basic configuration, material, construction method and propulsion system should be standardized as much as possible. Local builders should be trained and equipped to produce the entire range up to, but not including, a bulk cargo ship.

Five vessel applications were identified in the following order of priority; all but the last represent a return to former capabilities:

1. Subsistence fishing canoes
2. Intra-lagoon taxi service
3. Short-range community fishboats
4. Inter-atoll ferry/transporters
5. Long-range commercial fishboats

Tuvalu's maritime environment imposes severe demands on navigation:

a. Lack of natural harbor facilities

b. Inconsistent wind conditions

c. Insidious navigation hazards

These demands suggest that vessels of all four applications should be capable of running the surf in breaking lagoon passages. Shallow draft, with keels protected by steel or hardwood runners, kick-up rudders, and retractable propellers are all prescribed to allow trespassing dangerous shoals and sustaining accidental groundings in coral and surf. Tuvalu is located in the doldrums. Shifty, gusty winds make most anchorages insecure, so vessels should be capable of being dragged ashore for protection as well as maintenance and repair. Alternatively, the larger craft must exhibit admirable seaworthiness when put to sea for protection. To make use of sailpower, Tuvalu's watercraft must be very highly developed to satisfy the conflicting demands of prevailing light airs and seasonal westerly gales... including auxiliary power to proceed through calms and for bucking directly into strong headwinds. These are not "primitive" boats we speak of, yet Tuvalu's historical watercraft, made of sculptured logs and equipped with both sails and brute force paddle power, satisfied all of the above requirements. Furthermore, they could not sink.

A critique of Tuvalu's watercraft now in use, both native and alien, indicates that none combine features which make them equally versatile compared to historic Polynesian vessels. For example:

Diesel launches suggested for lagoon taxi service have deep keels to protect the fixed rudder and propeller, thus are unstable when grounded. This instability plus inordinate weight makes them difficult to drag ashore for maintenance and repair. Sails may be fitted to diesel launches, but with disappointing results because of their wide hull form and propeller drag. Some shoreside infrastructure is probably required.

Pure sailing launches are also under consideration. Even if equipped with a small outboard auxiliary for calms, these boats cannot travel against strong winds under sail or power, and they behave like the power launches when grounded. The weight of machinery or ballast make both types potential sinkers.

Outboard-powered runabouts, such as are now infiltrating the subsistence canoe fishery, offer great convenience in mobility and beachability, but cannot sail or withstand angry seas. Outboards consume extraordinary amounts of fuel and require mixing oil with gas. Consequent errors in ratio plus potential fuel contamination lead to pervasive breakdowns. Successful repairs require special training and tools. Outboard runabouts go fast, but this speed is expensive. Let's admit that in this context much of the investment manifests itself as the cost of convenience and exhibitionism. When all costs are counted and the dividends weighed, the long-term prospect of addressing Tuvalu's watercraft problems with outboard runabouts is almost certainly zero.

One contention is that outboard motors are the problem. Not that exhibitionism and convenience are bad; it's just that their costs are unsustainable in this case. Sacrificing food for fuel is not common in Tuvalu, but it is in many outboard-ized areas. Actually, outboard motors are probably little more than symptoms of a changed environment (smaller logs are now dictating smaller canoes) and a consequent change in the society (large, community-owned craft have been replaced by one and two-man canoes).

The real concern is for the subsistence canoe fishery. A majority of Tuvalu's people still operate outside the new cash economy. With their canoes they cannot quite provide their fish-food needs now.

Independence, foreign aid, government jobs, and outside-earned income have created a growing number of cash customers, at Funafuti, for fish landed by outboard runabouts. Seen as part of a trend, an increasing percentage of the country's precious cash is to be spent on imported energy, with "terminally expensive" long tern consequences.

This, then, is to identify the need: a community-owned and operated fishboat, capable of feeding that community, at a bottom-line investment and operating cost which will ultimately result in true independence. Like what they had before.

Vessels currently in Tuvalu, or under consideration for this "short range community fishboat," resemble the dieselized lagoon taxis, and lack the <u>combination</u> of necessary features, which, again, are:

1. Very light weight and very narrow hull form to achieve shallow draft and a quantum reduction in resistance to being pushed through the water.

2. A fixed, four-cycle engine, no mixing of oil with gas, and a large, slow-turning propeller for best fuel-efficiency. The propeller must retract clear of the water to achieve...

3. High speed and good maneuverability under sail alone.

The reader may detect a pattern here; something like the Philippine "Mother Banca" from the previous chapter is being described, and the author continues to prescribe the multihull cure-all. It also appears that he is advertising his panel method of construction. Right?

Actually, the bulk of the writer's experience has been with the more usual sheet plywood construction over lumber skeleton, such as is still being used in Searunner Trimarans. The panel method was developed in response to pressure from clients to offer some alternative to sheet plywood's disadvantages. Indeed, Tuvalu may benefit from using the original method, for she would not be dependent on a supply of prelaminated, compound-curved panels produced elsewhere (although she could produce her own, if demand so indicates). If the Mother Banca works in the Philippines, something similar may perhaps be tried in Tuvalu as a pilot project alongside other, more alien designs. The point is that only prototype trials are being recommended. It appears obvious that long-term needs for watercraft should be provided by construction in Tuvalu, that several vessel sizes are required, and that the construction program should be standardized to the extent possible, as was the case in historic times. For Tuvaluan builders to laminate their own compound-curved panels, or to build any designs from any material, is to be decided only by evaluating the relative performance of different prototypes. Indeed, there may be no viable alternative to the outboard runabout in Tuvalu. Except, of course, the dugout canoe, sustained at the rate of tree growth.

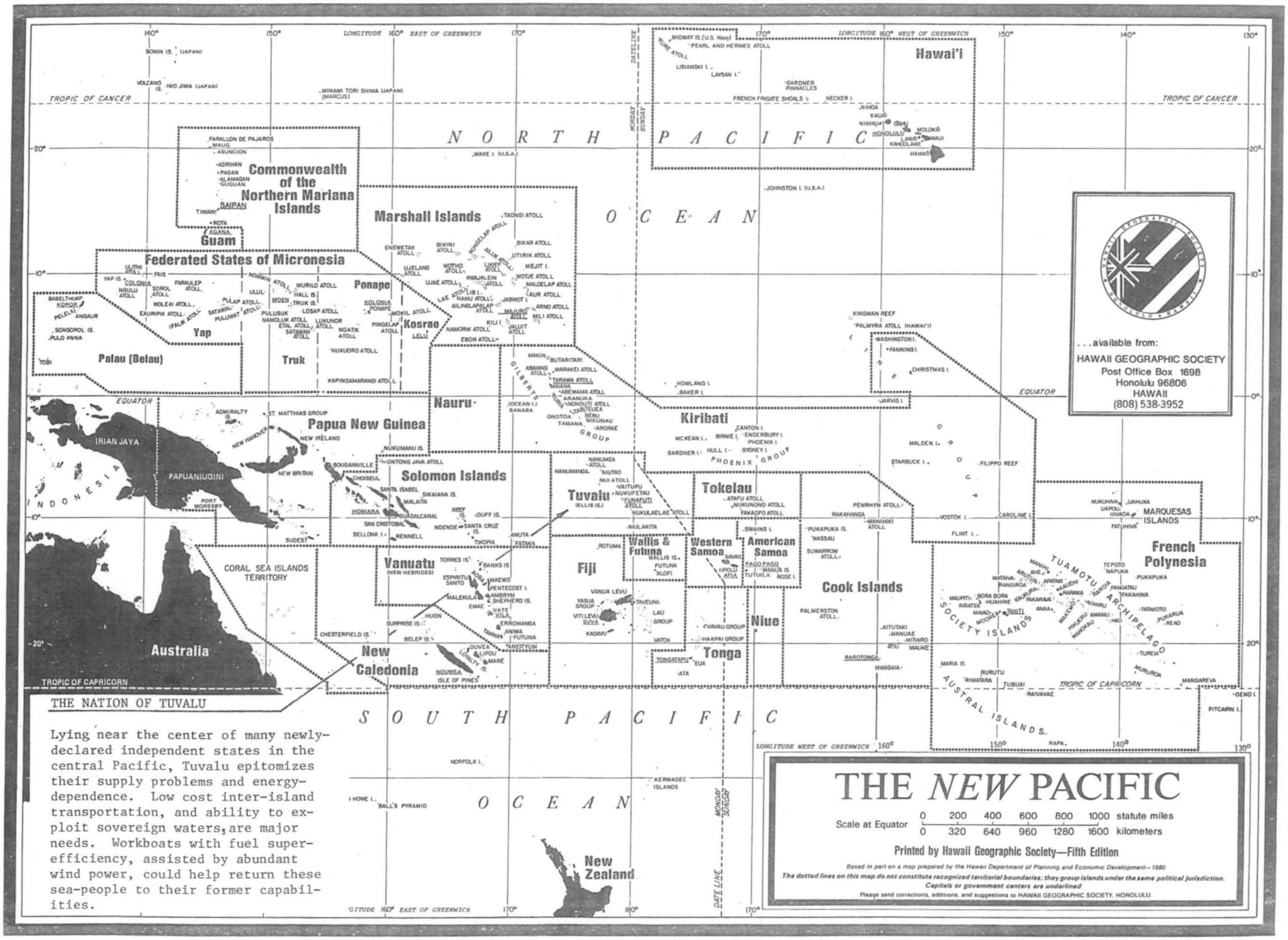
To keep pace with current pressures, something must happen faster. A minimum pilot program has been initiated to build one canoe of 32-feet (large by current standards) which is as close as possible in design to the indigenous <u>vaka</u>. A single outrigger vessel, which sails with the outrigger side always presented to the wind, this extremely efficient sailing machine has no redundant parts; every component is always in service regardless of the point of sailing. Because there is no outrigger on the downwind side, platform and rigging strains are minimized, thus allowing these craft to be produced with an absolute minimum of material for lightest weight and highest speed at lowest cost. Strictly speaking, no other proven sailboat in the world is as conceptually perfect nor as foreign to the symmetrically-attuned "western" mind. The Pacific vaka (or proa as it is usually termed by yachtsmen) sails with either end forward. It must, in order to keep the outrigger always facing upwind. Sailors of bi-lateral, one-end-pointed boats find the vaka's maneuvering tactics downright disorienting, but the issue here is to prevent the counterpart disorientation among Tuvaluans!...this while still introducing something to relieve the lack of large logs and establish intra-lagoon taxi service quickly, at a minimum investment.

Therefore, prelaminated panels for the vaka hull are being donated by Mr. Agustine Cancio in the Philippines for air shipment, paid by Save The Children, to Funafuti, which is the district-center atoll and capital of Tuvalu. There, local builders will assemble the hull and complete the vaka entirely with local materials in the traditional manner. Payload for the lagoon taxi will be about 1,000 coconuts or about eight people. Operating cost will be essentially zero unless a small motor is added for calms, and there will be no debt service encumbering Tuvalu.

Yes, this pilot program runs the risk of producing a boat "...not sufficiently different from existing vessels," and perhaps incapable of keeping scheduled rounds of the outlying islets. Potential shortfalls are accepted as a means to avoid preposterous overruns resulting from the more ambitious development schemes implemented without the benefit of conservative initial experiments. This vaka project is designed to extend a vast maritime heritage by introducing one new ingredient at a time. In this case, laminated wood is recommended as a possible alternative to dugout logs. Indigenous designs, forged through centuries by local conditions, are recommended as a possible alternative to alien craft. Local construction is suggested over wholesale imports. Side-by-side comparison with the other alternatives in actual service is acknowledged as the only means by which Tuvalu watermen can make their own intelligent choices.

The extent to which local conditions determine local design is illustrated by a comparison of Tuvalu canoes with those of their near neighbors in the Gilbert Islands, now the nation of Kiribati. Unlike Kiribati, Tuvalu gets plenty of rain. The islands are located within the intertropical convergence zone or "doldrums," a climate which produces big trees. The Micronesian canoe builders of Kiribati were forced by lack of big trees to fashion plank-built hulls from small pieces of wood stitched together, whereas the Polynesians of Tuvalu were allowed the wasteful extravagance of hollowing whole logs. More stringent material pressures imposed upon the Micronesian builders resulted in a lighter, more sophisticated watercraft for an area blessed with better sailing winds than Tuvalu has. In consequence, many Kiribati canoes have found their way into Tuvalu, where they are highly regarded.

(Text continues on page 52)



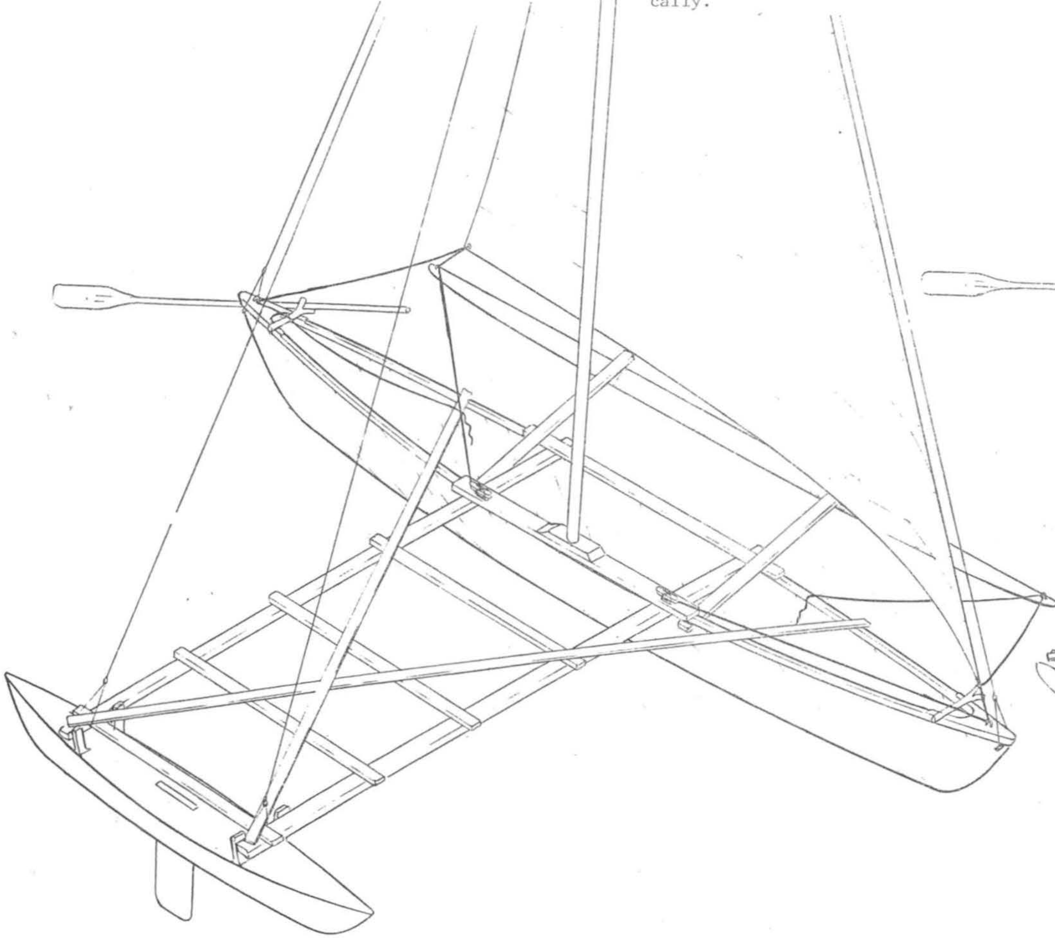
THE NATION OF TUVALU

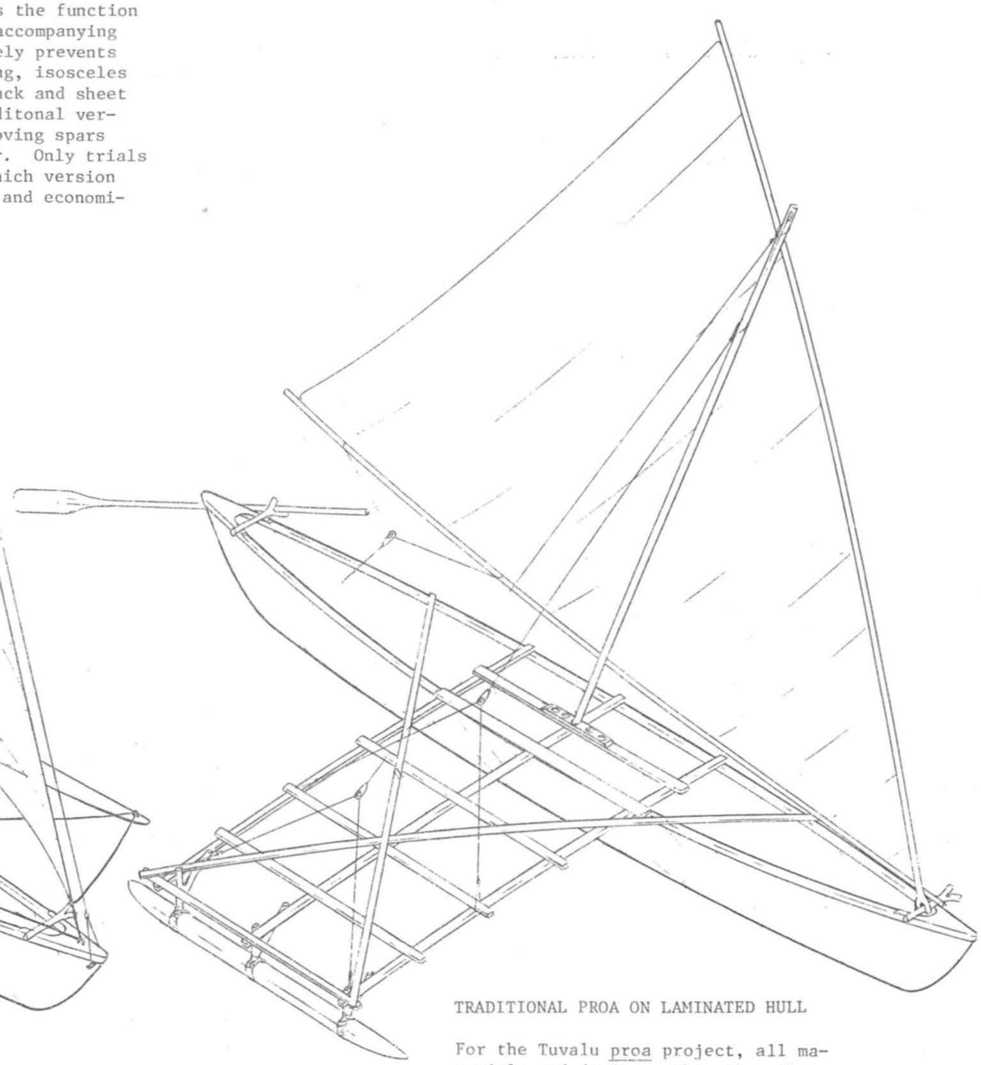
Lying near the center of many newly-declared independent states in the central Pacific, Tuvalu epitomizes their supply problems and energy-dependence. Low cost inter-island transportation, and ability to exploit sovereign waters, are major needs. Workboats with fuel super-efficiency, assisted by abundant wind power, could help return these sea-people to their former capabilities.

MODERNIZED PROA ON LAMINATED HULL

Requiring a separate outrigger hull with daggerboard trunk, laminated cross-beams and tubular aluminum mast, this version is somewhat more costly than the "traditional" proa at right. The laminated main hulls are the same, but features are included to overcome the Tuvaluan's stated objections to their own boats; propensity to capsize, and difficult maneuvering.

Separate, elevated float on downwind side (behind sail) serves the function of a "pod" shown in the accompanying photographs; it effectively prevents capsize. When maneuvering, isosceles sail simply alternates tack and sheet from hull to "pod." Traditonal version at right requires moving spars from one end to the other. Only trials in service will reveal which version works best, mechanically and economically.





TRADITIONAL PROA ON LAMINATED HULL

For the Tuvalu proa project, all materials and design, other than the hull, are to be locally provided in accordance with indigenous craft.

SEARUNNER SAILING WORKBOATS

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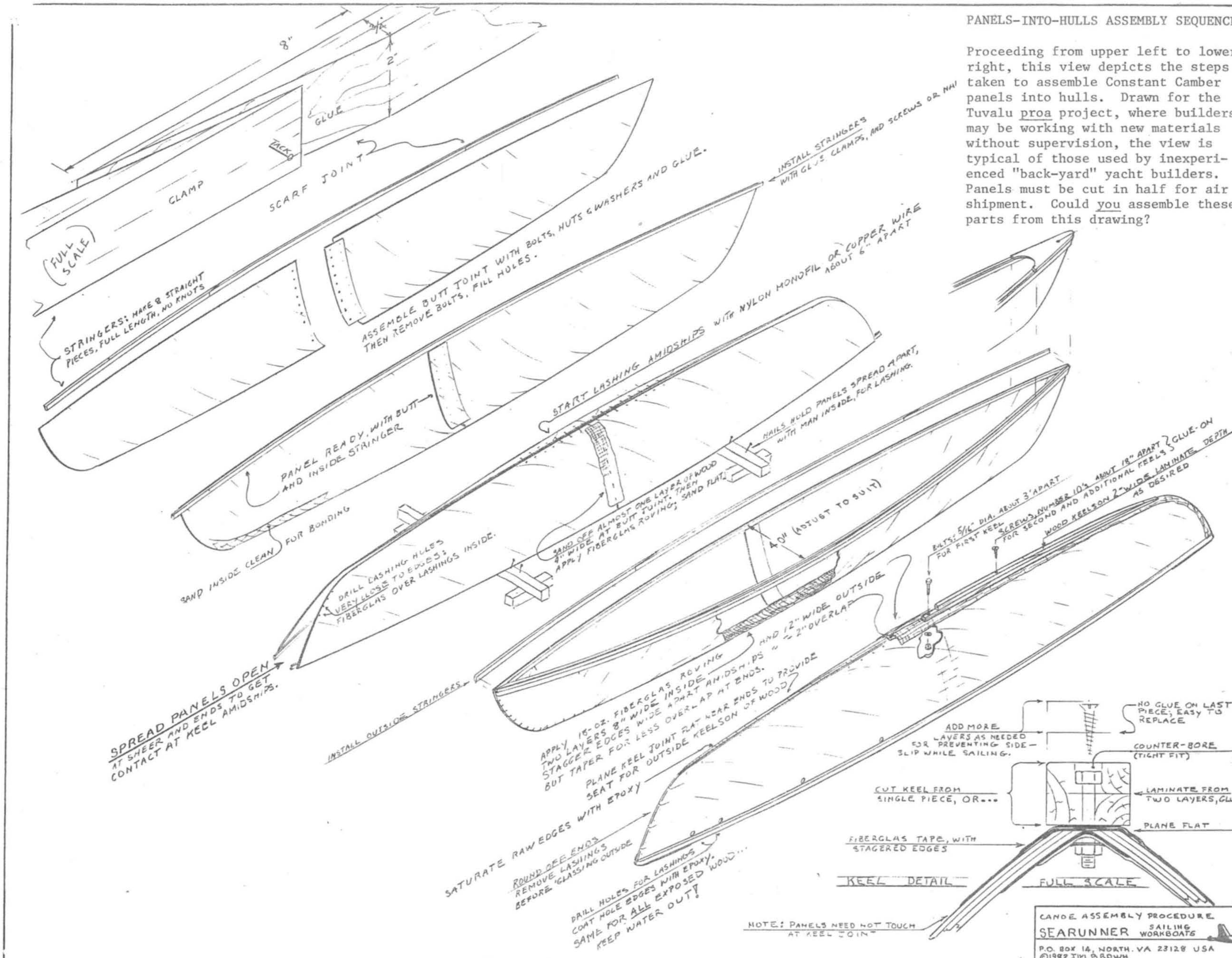
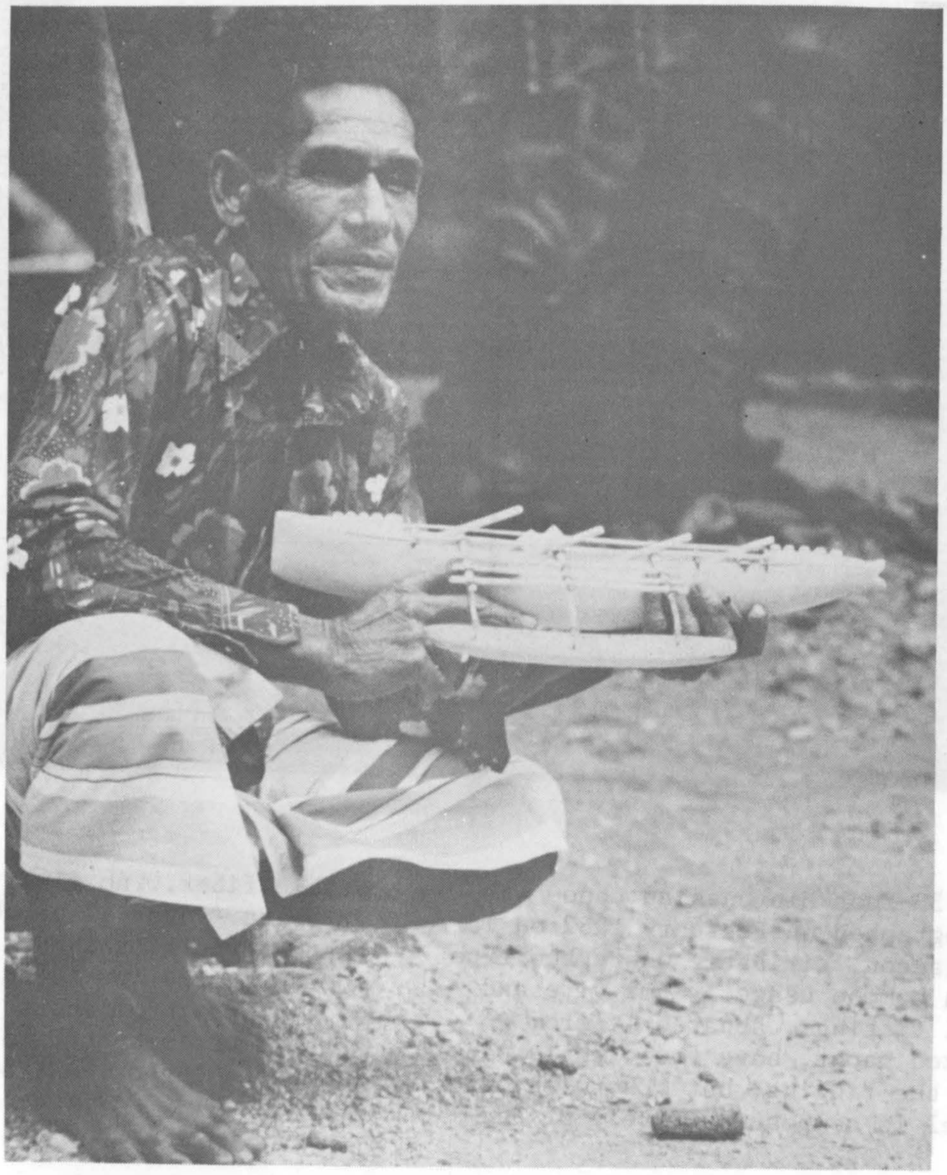
#212

NO SCALE

PANELS-INTO-HULLS ASSEMBLY SEQUENCE

Proceeding from upper left to lower right, this view depicts the steps taken to assemble Constant Camber panels into hulls. Drawn for the Tuvalu proa project, where builders may be working with new materials without supervision, the view is typical of those used by inexperienced "back-yard" yacht builders. Panels must be cut in half for air shipment. Could you assemble these parts from this drawing?

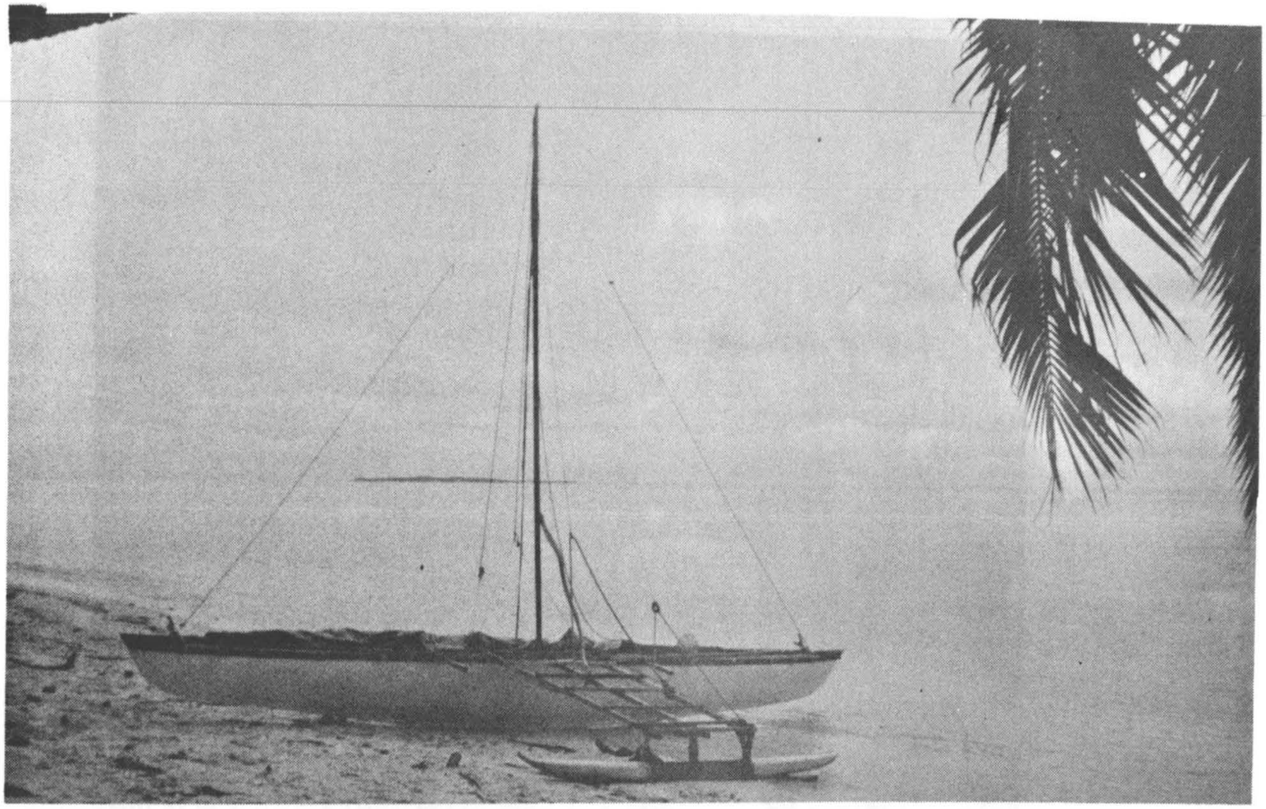




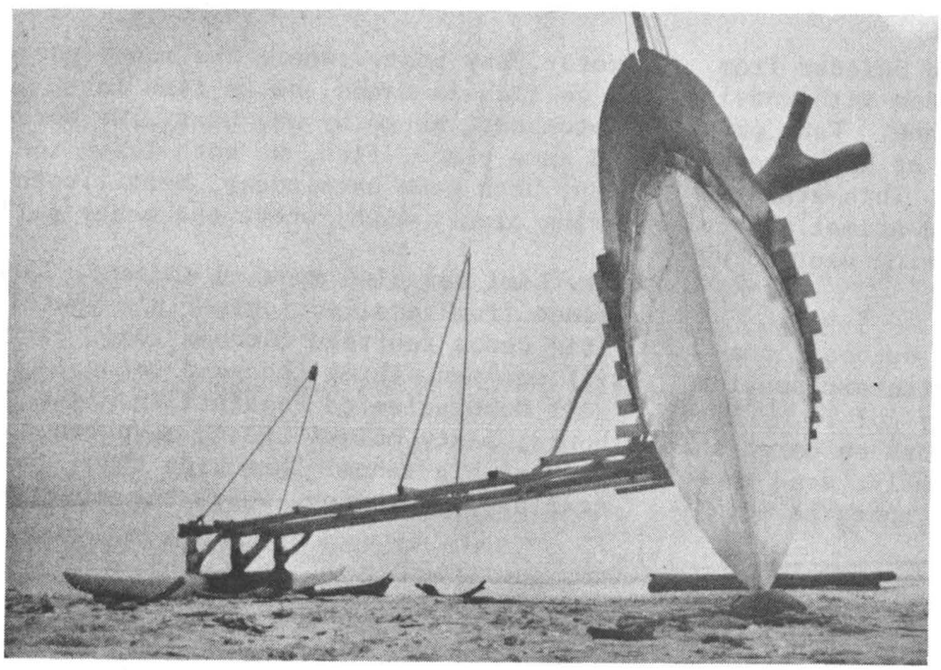
Mr. Tinilau Lomi, canoe builder from Nukulaelae, Tuvalu, poses with model of skipjack-fishing canoe. Four paddlers propel the craft at high speed to stay with the fish. This athletic contest between man and animal has cultural importance now being usurped by outboard runabouts.

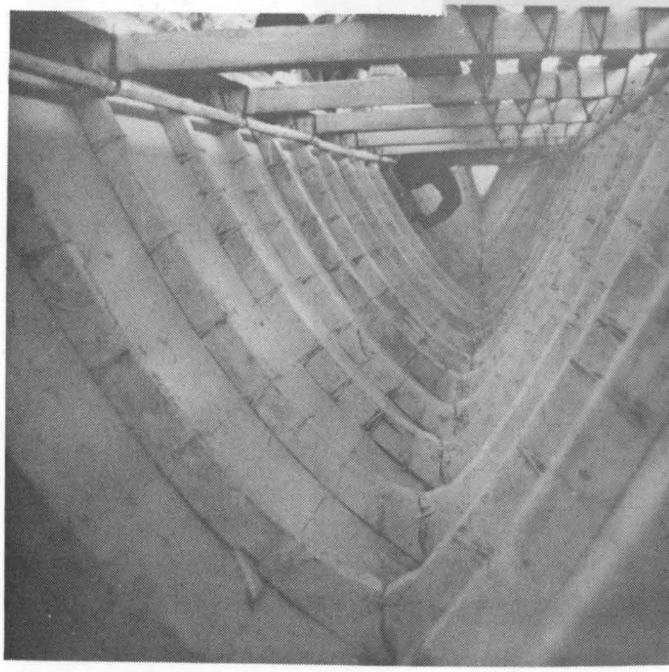
Mr. Lomi's reaction to outboard runabouts is punctuated with exclamations of, "...where the money go? ...My first son leave Tuvalu, go work on cargo ship, live months without family, send money home. My next son use money to buy motor, buy boat...where the money go? I go fish in canoe, he go fish in motorboat, he go by me, bzzt...We both go same place, fish, we both leave today, both come back today, bzzt...both bring plenty fish, where the money go?"

Mr. Lomi has also modeled another, larger canoe from recollections of his youth. "Big canoe fourteen fathoms long, carry fifteen men, three thousand coconuts, sail Nukulaelae to Funafuti in eight hours, sixty miles! No no more can do, no more big canoe. Now ride ship, ride seaplane, pay money, where the money go??"

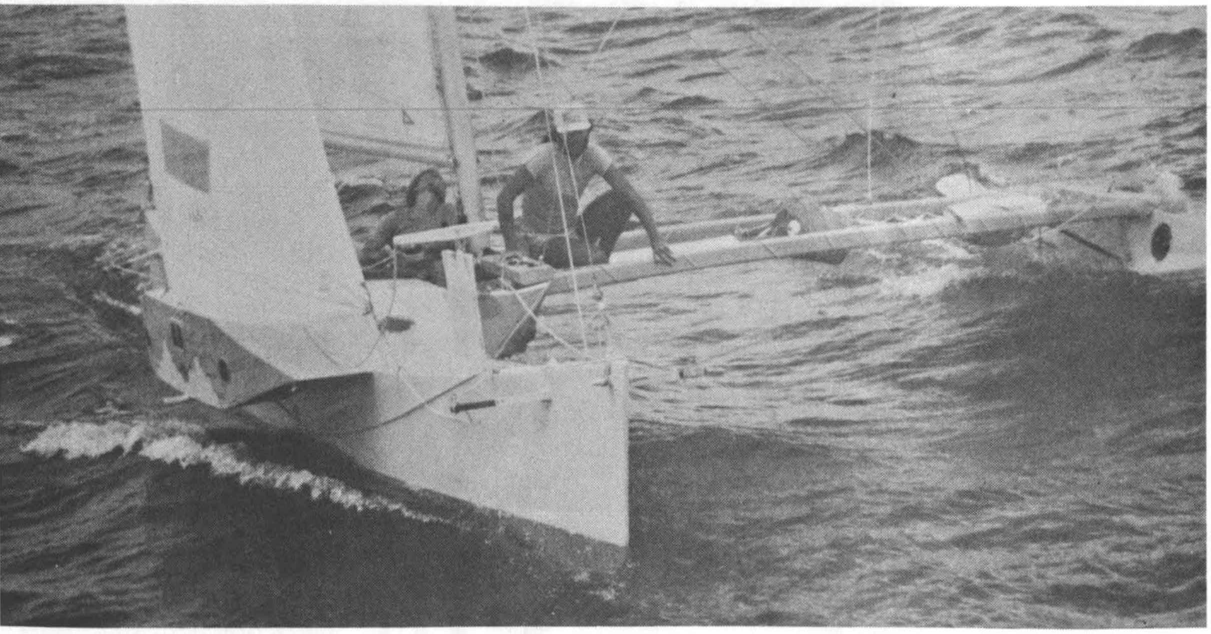


This 33-foot Micronesian canoe was photographed in February 1982 on Tarawa lagoon, Kiribati, where the type is in common usage. Some wire and metal fittings, apparently from a wrecked yacht, have found their way into the rigging, but otherwise the vessel is composed entirely of vegetable fiber...no glue, nails, nuts, or bolts. Just 32 planks of wood and thousands of lashings. Capable of speeds in the low teens on windpower alone, she is of about the size and arrangement proposed for the first laminated lagoon-taxi at Funafuti, Tuvalu.



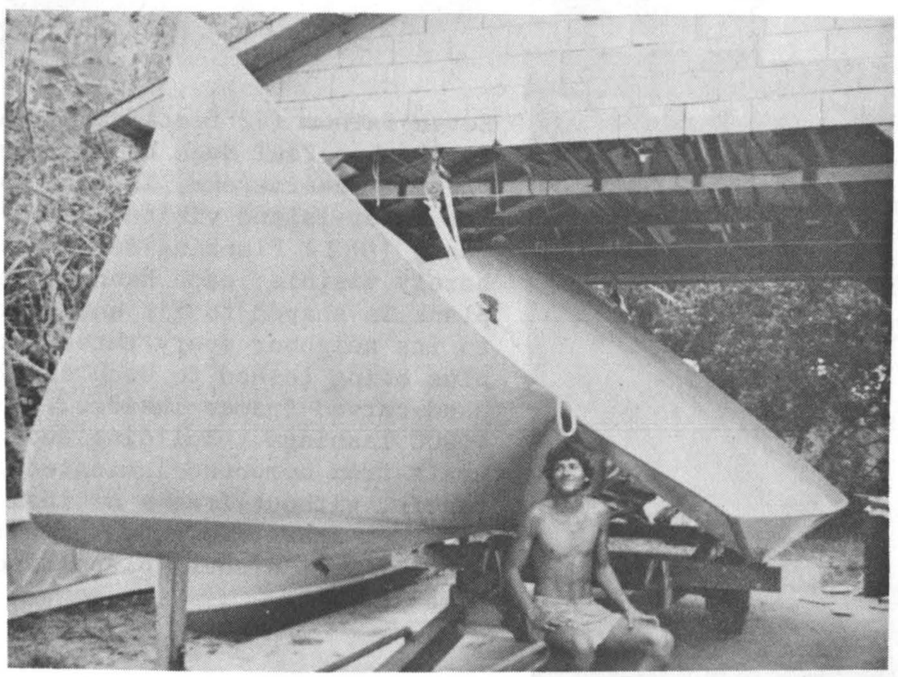


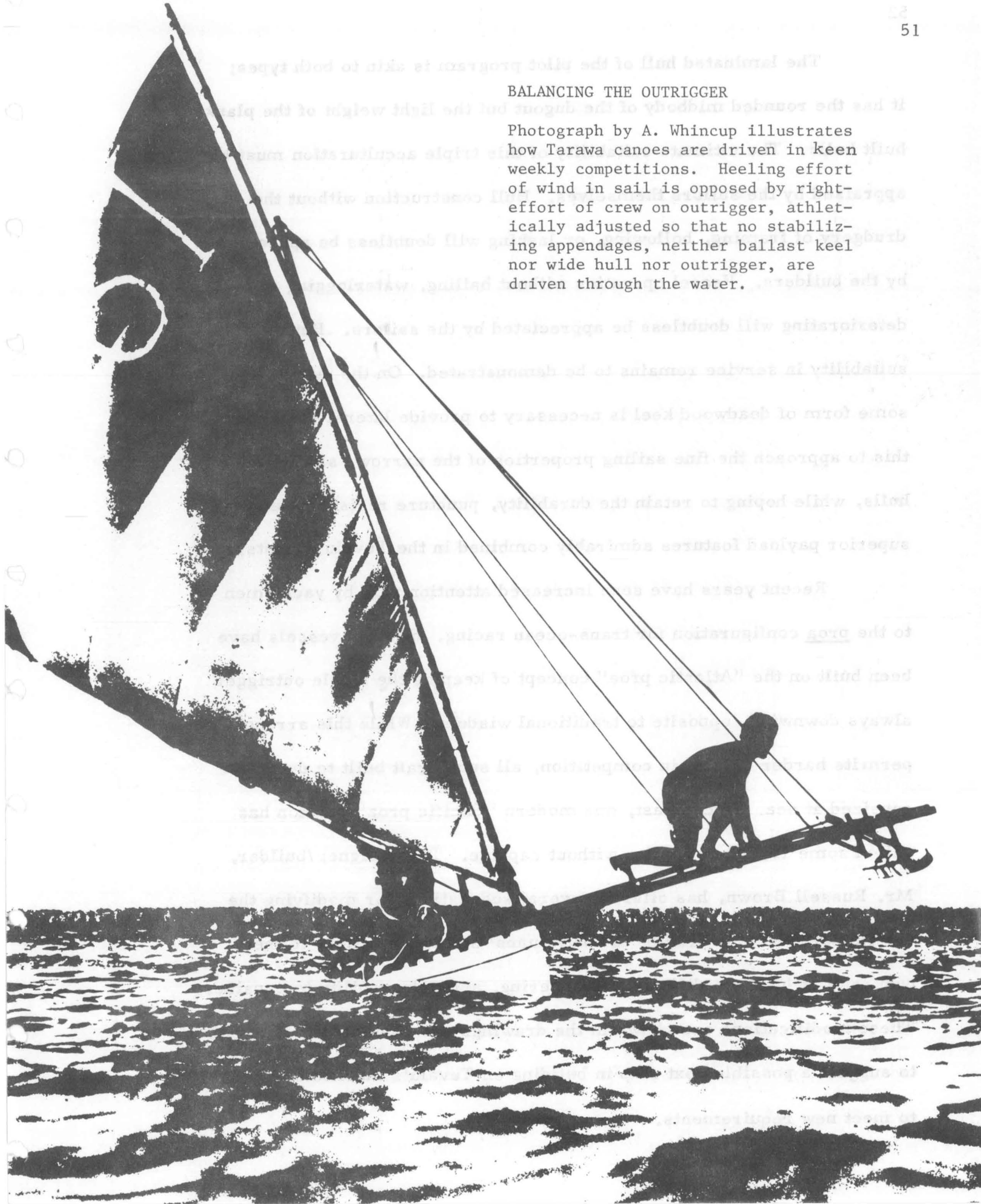
Seven fathom (42 feet) canoe built for Bishop Paul Meea by his brother Orea at Teaoraereke, Tarawa, used for inter-island visitations, February 1982. Planking seams are barely visible; each hand-carved plank is shaped to fit and stitched to its neighbor every three inches, plus being lashed to each of 47 hand-carved frames inside...about 4,000 lashings. Building such a craft from compound-laminated panels, without frames or lashings, or leaks, is a system which Brother Orea wishes to appraise for himself.



At a total materials cost of about $1,500 including epoxy coatings and used sails, Mr. Russell Brown built the above 30-foot plywood proa on the Pacific principle (outrigger always to windward) at age 16 in 1976. He subsequently sailed the craft about 10,000 sea miles, mostly in the Caribbean, and lived aboard for three years. Several single-handed passages were completed. One double-handed voyage was made with crew Mark Balogh (shown) of fourteen days non-stop against trade winds. The craft was also sailed in close competition with the latest multi-hull yachts twice her length and 150 times her cost.

New 37-foot proa (below) by the same designer features pronounced "pod." Such vessels are based on Pacific sea-craft and may yet be appropriate for Tuvalu waters on account of maximun performance for rock bottom cost...a far more extreme comparison with the proa than with any other known, proven, sailing configuration.





BALANCING THE OUTRIGGER

Photograph by A. Whincup illustrates how Tarawa canoes are driven in keen weekly competitions. Heeling effort of wind in sail is opposed by right-effort of crew on outrigger, athletically adjusted so that no stabilizing appendages, neither ballast keel nor wide hull nor outrigger, are driven through the water.

The laminated hull of the pilot program is akin to both types; it has the rounded midbody of the dugout but the light weight of the plank-built hulls. The ultimate suitability of this triple acculturation must be appraised by the sailors themselves. Hull construction without the drudgery of framing, hollowing, or lashing will doubtless be appreciated by the builders. Vessel operation without bailing, waterlogging and deteriorating will doubtless be appreciated by the sailors. But ultimate suitability in service remains to be demonstrated. On the new canoe, some form of deadwood keel is necessary to provide lateral resistance, this to approach the fine sailing properties of the narrow, sleek Kiribati hulls, while hoping to retain the durability, puncture resistance and superior payload features admirably combined in the Tuvalu dugouts.

Recent years have seen increased attention paid by yachtsmen to the proa configuration for trans-ocean racing. Several vessels have been built on the "Atlantic proa" concept of keeping the single outrigger always downwind, opposite to traditional wisdom. While this arrangement permits harder driving in competition, all such craft built to date have capsized at sea. In contrast, one modern "Pacific proa" version has sailed some 10,000 sea miles without capsize. The designer/builder, Mr. Russell Brown, has offered several suggestions for modifying the traditional proa to overcome the Tuvaluans' stated objections to their own craft, which are difficult maneuvering, and vulnerability to capsize. These modifications are shown in the drawings and photographs herewith to suggest a possible next step in building on Tuvalu's maritime heritage to meet new requirements.

Such "modernized" canoes could contribute to the preservation of Tuvalu's critical subsistence-canoe fishery, where no cash is exchanged for the catch. Because cash must be exchanged for fuel, the subsistence fishery must be mostly powered by sail or paddle.

Intra-lagoon taxis are also to serve many Tuvaluans who have yet to participate in the incursive cash economy. Thus the modernized sailing vaka may perhaps fulfill this application. If not, then any alien substitute will wisely make efficient use of sail... or depend on subsidy.

Three additional watercraft requirements remain to be addressed briefly: short range community fishboats, inter-atoll ferry/transporters, and long range commercial fishboats.

The present assumption is that none of these applications can be served by adaptations of traditional, single-outrigger canoes. While even that assumption may be open for re-examination (because large modern proas are certainly possible with modern materials), it is known that ancient Polynesians found the double canoe or catamaran best suited to their deep sea voyages. A 32-foot double canoe is small by historic standards, but an adaptation of the Philippine Mother Banca is proposed as about the right size for trials as a community fishboat in Tuvalu. It could be equipped with sufficient power to blast through breaking lagoon passages against wind and current, thus extending the range and duration of fishing expediations outside the lagoon. With an engine of about fifty horsepower, such a craft could participate in the skipjack fishery, which requires bursts of speed up to fifteen knots to stay with the fish.

Ice production facilities and a fish cold store are being installed at Funafuti now, so that larger fish landings can be accommodated without waste.

Community ownership and operation of a Mother Banca-like vessel would require an investment of perhaps $10,000 and running costs of who-knows-how-much depending on to what extent the sails are used to conserve fuel. Productivity is similarly impossible to project; the resource is there, the market is there, and community spirit for such ventures is deep-seated. Only prototype operation will generate a believable financial analysis. The same catamaran can be tested in lagoon launch service and weighed against the proa prototype for cost effectiveness. The catamaran configuration, built either of sheet plywood over timber frame or from prelaminated panels, appears appropriate for all the same reasons as in the Philippines except more so in Tuvalu's more demanding marine environment.

For these same reasons, a similar, larger vessel is proposed for inter-atoll service. Deep sea passages of ninety miles maximum separate the eight main islands of the nation. Passengers and small mixed freight are currently moved by Tuvalu's own ship, the affectionately regarded hundred-foot rustbucket named "Nivanga," which is urgently in need of replacement.

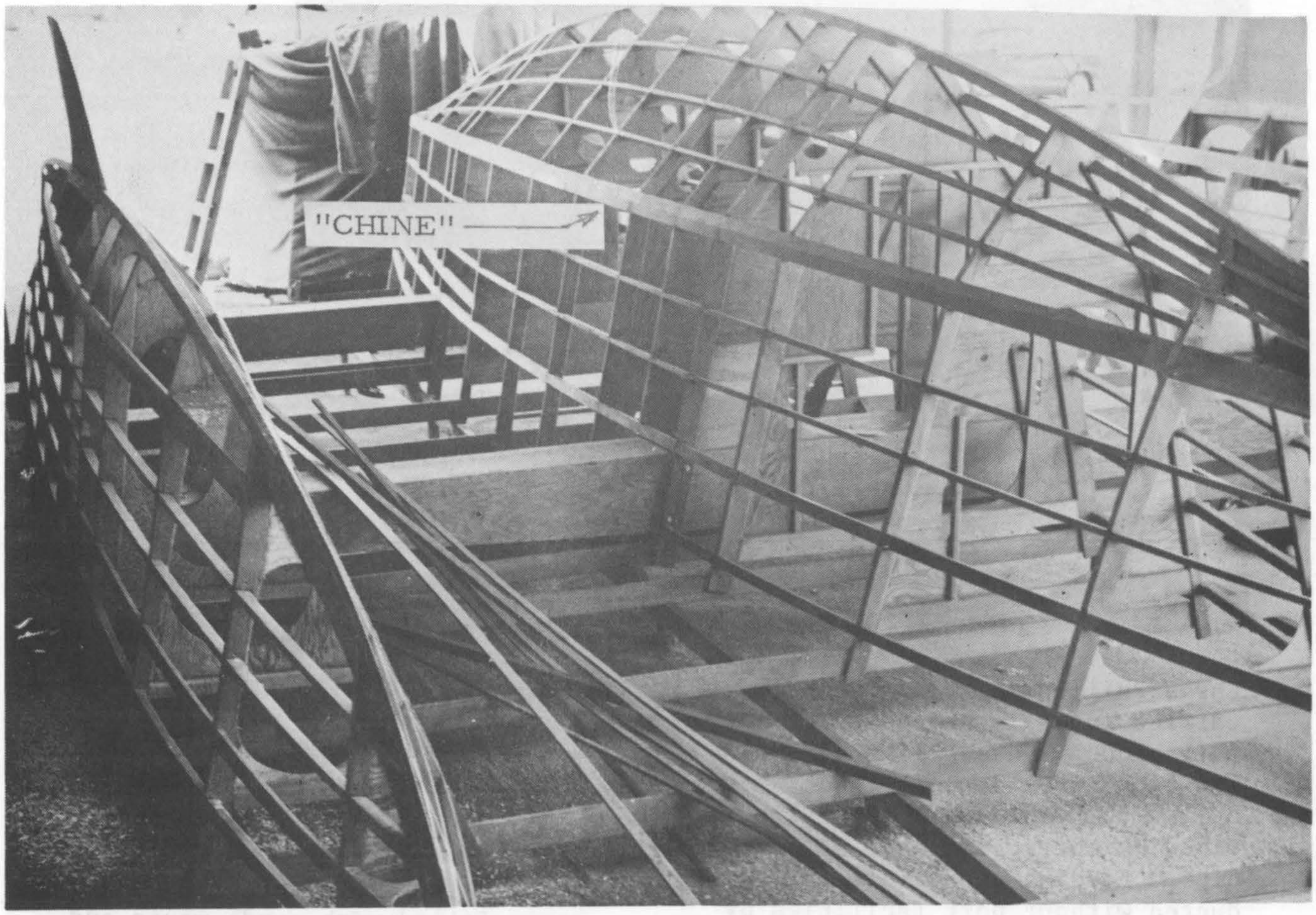
The primary function of "Nivanga" is to move passengers and mixed freight between atolls. The secondary function is in moving bulk gargo from Suva, Fiji to Funafuti. The passenger/luggage service conflicts with bulk cargo deliveries and vice versa.

To be effective with bulk cargo, the new "Nivanga," now under consideration, should be designed and operated mainly for that service. Inter-atoll traffic can be handled by separate, smaller craft. A sail-assisted catamaran of about 65-feet, with a payload of about ten tons, is recommended. Such a vessel will require an investment cost of about $150,000, built in Tuvalu. If operated between any two atolls 300 times per year, its fuel bill would run less than $1,000 per year. Compared to the traditional motor vessel alternative, savings could be nationally significant. Safety and comfort characteristics of these large multihull seaboats are considered appropriate for service in Tuvalu waters, as discussed in the following chapter.

The final vessel application for Tuvalu concerns the country's only apparent opportunity to achieve financial independence -- selling fish to other countries.

It is just possible that a successful short-range community fishboat operation could accumulate preserved fish for export. If indeed that should transpire - if the local demand is satisfied - then Tuvalu's distant waters could perhaps be exploited to the same end by vessels with greater range and endurance. Complex economic factors, led by running costs, have converged on foreign industrial vessels fishing in Tuvalu's waters. Current trends indicate that, given the right boat, the country is in a favorable position to harvest its own pelagic resource. If first costs and running expenses can be massively reduced then vessels of such limited capacity as five-to-fifteen tons payload might be gainfully operated within sovereign waters and the catch sold outside to earn foreign exchange. Design proposals appear in the subsequent chapter. Both applications for vessels in the 65-foot range, inter-atoll ferrying and long-range fishing, can be met with similar catamarans built, owned, and operated by Tuvaluans. They are entirely consistent with the proposed integrated program beginning with canoes. However, the higher risks of financing large "prototypes" suggest that worth be demonstrated in Tuvalu by existing boats brought from other areas of the Pacific for local trials. Offers of such demonstrations appear in the following chapter. Using this "demonstration charter" option, the cautious approach of proceeding with minimum pilot projects can be extended throughout the entire project, and time to learn is assured.

To build and operate watercraft resulting from this long-term plan requires an ambitious training program which advances at a rate determined by the trainees and the acceptance of the boats. If the boats are good, if they <u>work</u> in the real world <u>and</u> at the bottom line, this rate of advance could be surprisingly quick because of the people. These are not of mountain tribes whose kings never saw water in a body. Tuvaluans are true sea people. While the culture and the territory of many new nations have been blitzed by industrial influence, Tuvalu is still intact. It is in a unique position to demonstrate to others in the New Pacific how, again, to take care of themselves.

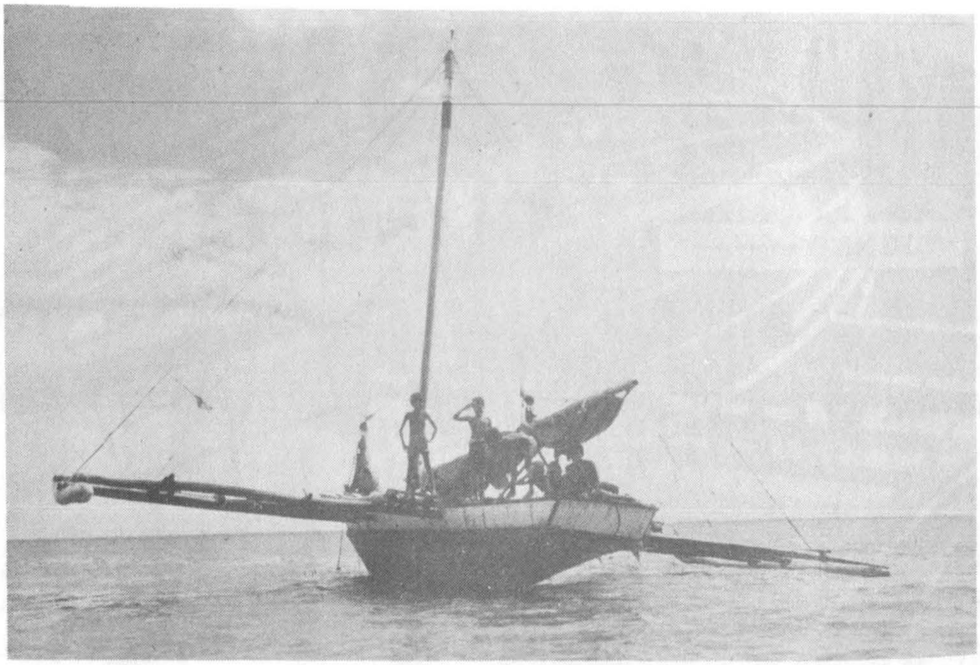


FRAMING-UP...The Old Way

Conventional lumber skeleton requires transverse frames carefully built of quality wood in accurate conformity with tabular offset measurements. Frames are then erected and aligned on a level jig. A profusion of notches are then cut into the frames of correct size and location to receive all the longerons. Timber "logs" at "chine" and keel are sculpted with bevels to define the correct angles, which progressively change from end-to-end. The entire surface is then "faired" (planed down to curved grade) to receive flat plywood sheets bent into position, marked, removed, cut to profile, and finally installed with glue and frequent fasteners into the skeleton.

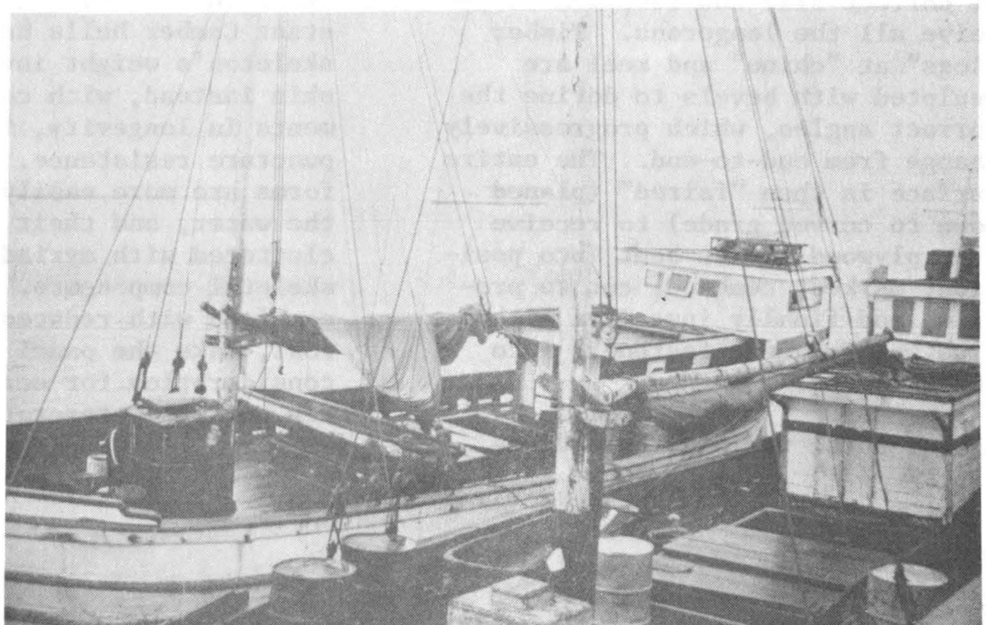
All of these tedious, demanding operations simply go away when building with pre-laminated compound-curved panels.

In order to minimize structural weight, the full weight of this hull is normally divided about equally between skeleton and skin. By contrast, Constant Camber hulls have most of the skeleton's weight invested in the skin instead, with consequent improvements in longevity, insulation and puncture resistance. Molded hull forms are more easily driven through the water, and their interiors are not cluttered with myriad rot-vulnerable skeletal components. These advantages, combined with reduced complexity and cost, make the panel method worthy of consideration for series production of New Working Watercraft.



Large Philippine "vinta" above still carries inter-island cargoes under sail alone. Vessel lies aground at low tide revealing efficient, narrow hull with "wide-track" stability provided by outriggers made of plastic pipe. Loading operations are conducted without port facilities by wading stevedores. Cost effectiveness of such vessels allows them to serve ports and cargoes which would otherwise be abandoned, a leading cause of alarming centralization. (Manila is predicted to become the second-largest city in the world by the year 2,000.)

Wooden freight boats in Manila were originally pure motorboats, now are retro-filled with crude masts and sails to cut fuel consumption. Owned by individuals and operated at marginal profitability, there is no question that these sail-assist investments are worthwhile. Cost of masts and sails have been minimized to achieve short-term buy-back, an example worth following when retrofitting deepsea merchant ships.



V. BIG BOAT BUY-BACK

In May 1982, the first American Conference on Sail-Assisted Power Technology was held at Norfolk, Virginia. Several convincing examples of working sail-assisted vessels now in service were presented at this conference. Panel discussions were augmented by harbor cruises in the actual craft. Technical aspects and cost factors were analyzed from some, limited, commercial experience, and the consensus was as follows: Practically any kind of boat, even a tugboat, can reduce fuel consumption by adding sails. Savings depend on weather, route, cargo, boat, and sailor, and are variously contended to be in the range of 15% to 30%, theoretically higher in ideal weather conditions. These savings speak only of reduced fuel consumption and have no bearing on the overall economic viability of specific vessels. Most examples did not answer the question, "Savings in comparison to what?"

Some confusion was observed at the conference between pure commercial ventures and other endeavors which may be primarily intended to create unique vocations or nostalgic life styles. While sail power may be effective in both such applications, the unresolved issue is how effective.

Fuel savings in the range of one-fourth are significant, but must be weighed against the added costs of investing in, and operating, the second motive power feature. The issue of "buy back" is critical; how long must fuel savings accrue in order to recover the added costs of mast, rigging, sails, maintenance and depreciation. This buy-back time is influenced by many variables, including such accessory costs as additional insurance, debt service, and other "unseasonal headwinds." Nevertheless, a conservative appraisal suggests at least fractional economic benefits for windpower, on conventional boats at 1982 fuel prices.

Indeed, the Sail-Assist Conference served to expose at least one definitive success: the retrofitting of a bulk motorship with auxiliary sail by Windship Development Corporation. While other, more ambitious projects, such as a Japanese sail-assisted tanker and several research vessel proposals, show little chance of short term buy-back, the Windship Development achievement does just that. Three years of operation should turn this retrofit from a bold venture into reduced freight rates for shippers and increased profits for ship owners.

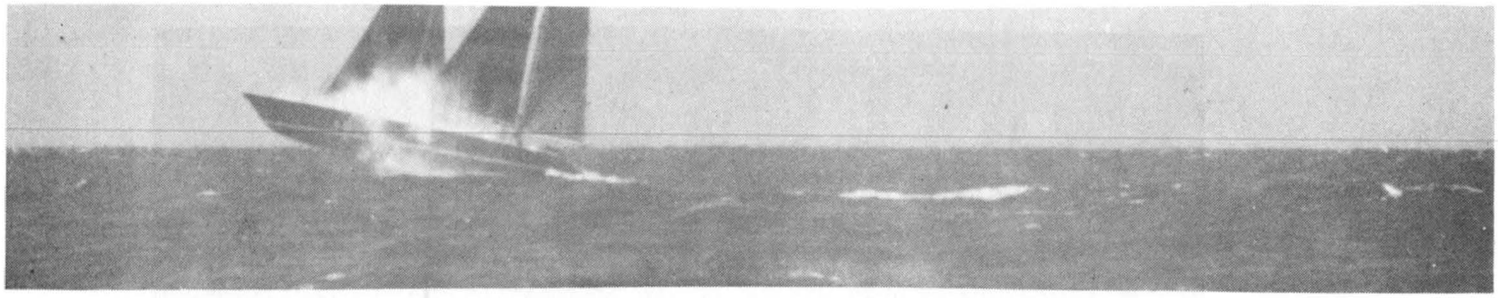
However, this convincing demonstration was conducted on an aging ship. Thousands of similar vessels now ply the oceans without sails and their operation is financially marginal. This discourages additional investments to upgrade existing, aged equipment. Implications for sail-assist on new ships are positive, but the construction of new ships is depressed by current economic conditions. By this analysis, prospects for sail-assist equipment to become widely utilized on marginally-productive merchant ships are not good and, on <u>highly</u> productive merchant ships, not necessary (or so the logic goes at current oil prices even with short term buy-back!).

Clearly, this is not a simple endeavor to catch the wind. To contend with bulk cargoes and world economics is beyond the scope of this report except that New Working Watercraft must make economic sense.

"Mini Lace" in trials demonstrates the pushbutton control capability of her auxiliary sail. Rotating mast and hydraulic controls were designed and retro-fitted by Wind Ship Development Corporation, Lloyd Bergeson, president. Sail fabrication was by Hood Sailmakers. This unit has demonstrated both reduced fuel consumption and increased speed sufficient to insure a short 3 year buy-back for the equipment.

Achieved with minimum research and capital costs, this is the most significant proof to date of the commercial viability of sail power for merchant vessels.

Photo: Edward Rosa

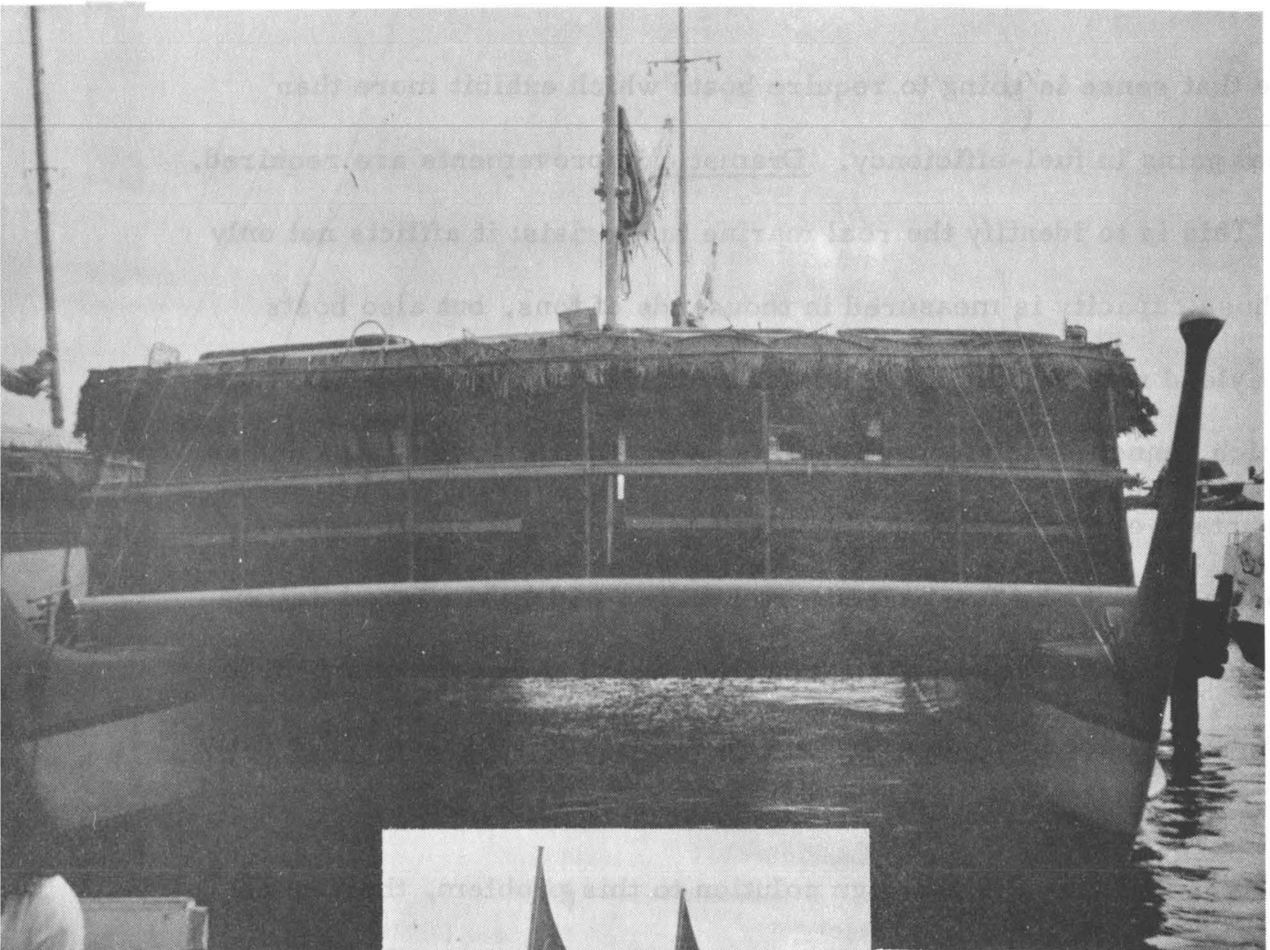


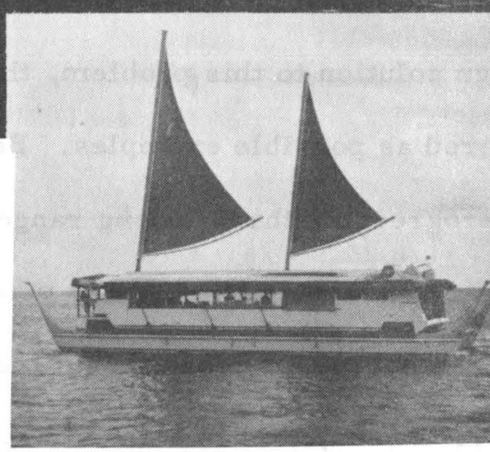
Sixty-foot catamaran "El Tigre" combines raceworthy performance with commodious accommodations for inter-island tourist excursions. Designed by Mr. Peter Sprouk, built of laminated wood, and operated in the West Indies, the boat has withstood merciless pounding in competition, above, but also pays her way in the tourist trade. Because these two endeavors are entirely distinct, normal operation as a workboat sees more sedate handling, with a corresponding wide safety margin when passengers are aboard. Many similar craft operate year 'round in the Caribbean, where strong trade winds and seasonal hurricanes test any vessel. It is generally agreed by the operators that punishment to structure and risk of capsize are far greater when the boats are driven hard against the wind in races than when conservatively guided through storms. Working multihulls, therefore, can exhibit unprecedented safety. They are not designed for racing. When loaded with cargo and sailed at conservative schedule-keeping speed, their inherent resistance to capsize reduces that likelihood to a level below the chance of sinking in conventional boats. They are inhabitable even if floating upside down. The wooden multi-hull cannot sink because there is no ballast or heavy machinery to overcome buoyancy and airlock within the structure. More importantly, the type is extremely forgiving in the more common catastrophe afflicting all boats: stranding or shipwreck in shallows or against the shore.

To make that sense is going to require boats which exhibit more than fractional gains in fuel-efficiency. Dramatic improvements are required.

This is to identify the real marine fuel crisis: it afflicts not only ships whose capacity is measured in thousands of tons, but also boats whose payload may be only a few hundred pounds. It is these latter watercraft which cannot simply consolidate more cargo into fewer ships and so take advantage of the "economy of scale." To transport small catches, carry-on freight, and a few passengers between widely scattered destinations is the immediate challenge. The fleet which once performed these services has declined commensurate with the rise in oil price. The daily lives of millions are directly affected.

If indeed there is a design solution to this problem, the vessels illustrated in this report are offered as possible examples. Beginning with a lowly paddling canoe and progressing through long range commerical fishboats to inter-island ferry/transporters, each of these examples is potentially "fuel super-efficient." That means more than a fractional gain. That means even an infinite gain... "Bwana, this is a canoe which does not need an engine." Like the paddling canoe, the sail-assisted workboat which really sails is capable of continuing to operate even in the event of massive restrictions in local fuel supply. Even if petroleum remains regularly available, its cost will nonetheless make it inapproachable for a vast segment of the world economy. Something renewable must be used for boat propulsion, and construction. It had better be cheap as well as available.





Mr. Rudy Choy, venerated multi-hull designer from Hawaii, has achieved noteworthy success with sailing catamaran workboats. Vessels such as the one at left are literally sailing nightclubs offering Hawaiian entertainment with a superb view of Waikiki Beach. Eighty feet long, carrying 150 passengers on dinner cruises, these laminated wooden craft are licensed by the U.S. Coast Guard for service on the sheltered leeward side of Oahu. Passenger volume in 1981 approached two hundred thousand. Narrow hulls and sails make the fuel consumption of five vessels less than that of eight buses bringing patrons from nearby hotels. The type would be ideal for motor-only ferry service on urban waterways such as Manila's Pasig River.

Sixty five foot catamaran above is Choy's appropriate design for deep-sea service between Hawaiian Islands, where channel winds and seas are infamous.

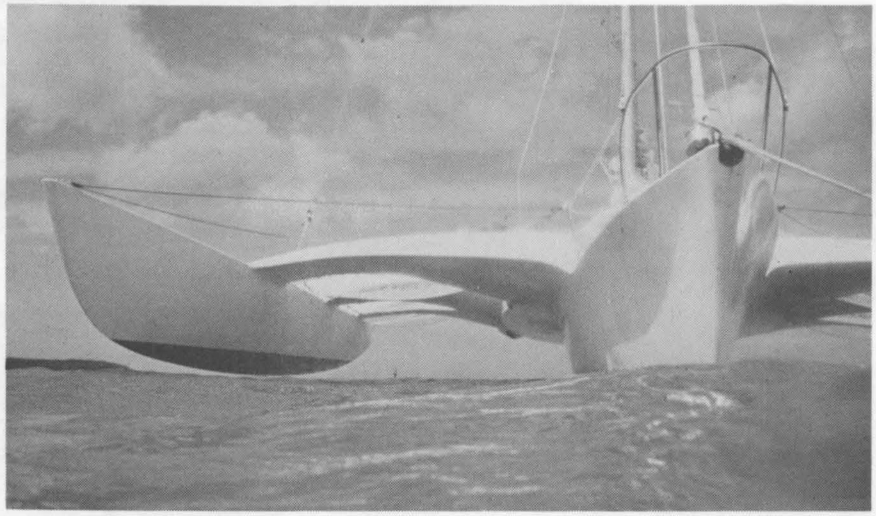
<u>SPECIAL OFFER</u>. With inimitable Hawaiian hospitality, Rudy Choy offers to demonstrate the capability of this vessel to development decision-makers considering New Working Watercraft for inter-island ferry service. Fully inspected and licensed by U.S. Coast Guard.

Therein lies the intrigue of "commercial sail." Wind is cheap, and it is available, sometimes. Strictly speaking, a wind machine need not be efficient because the "fuel" is everywhere. But not always. Light winds and calms can be compensated for, today, by auxiliary motors and performance boats. These technical inputs make it quite feasible to reduce fuel consumption not by one-fourth, but by three-fourths when under power. Narrow hulls and light weight then compound fuel savings by offering such good performance under sail that perhaps another three-fourths (of the remaining one-fourth) can be eliminated by simply not running the engine three-fourths of the time. And, if the engine declines to run at all, the only sacrifice may be the schedule.

This claim is admittedly boastful, and subject to the same "unseasonal headwinds" as the retrofitted merchant ship. Yet with the smaller workboats we are no longer concerned strictly with the buy-back time of sail equipment. These new watercraft can provide services which, without fuel super-efficiency, will be simply abandoned, or else fulfilled by fuel-intensive vessels whose long term costs will demand long term subsidy from other segments of the economy which are already hard-pressed. Investments not sunk into that alternative should easily finance the development of these new fuel super-efficient watercraft.

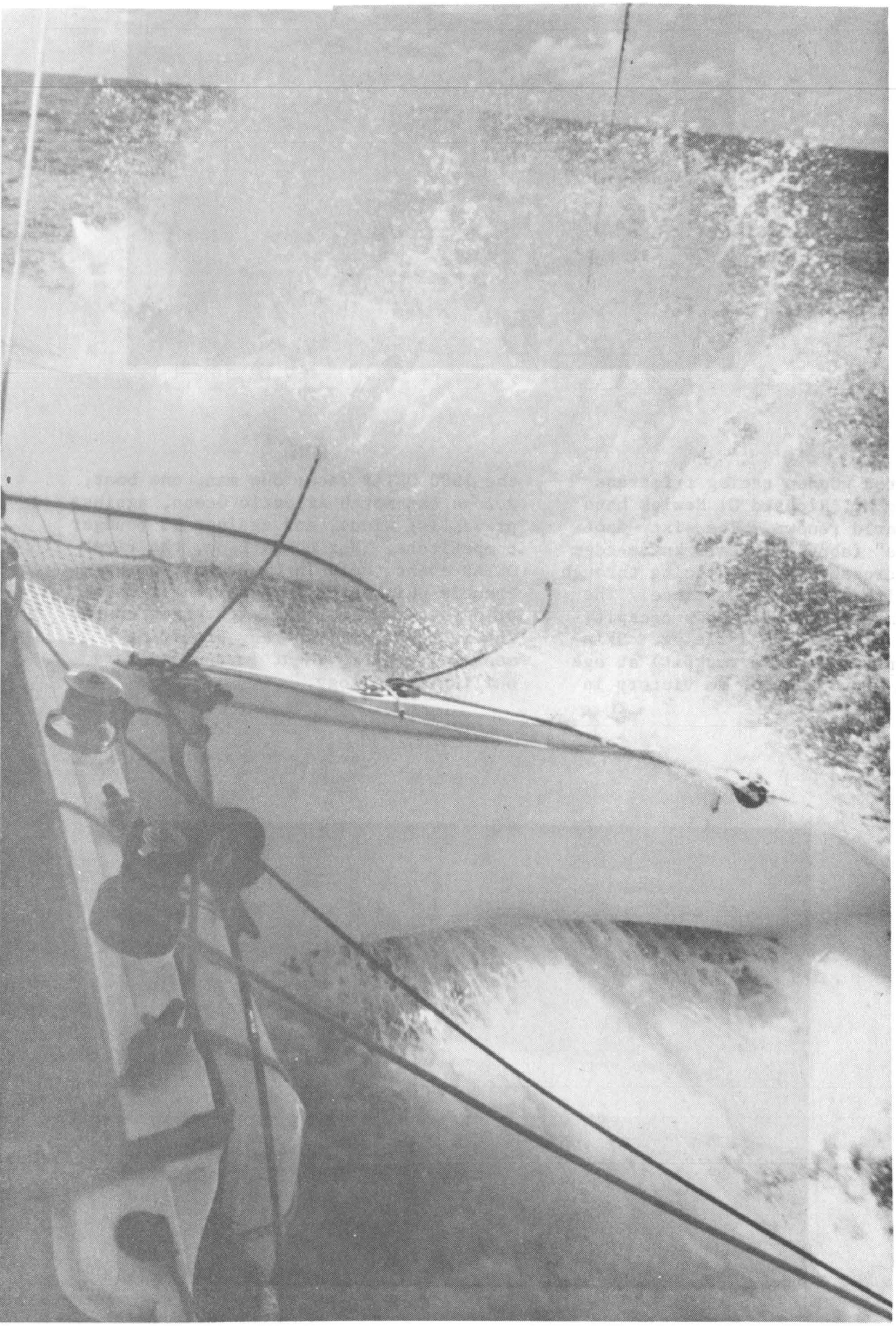
Appropriate windpower may have another predictable effect: commercial utilization of sails would be conspicuous. The combination of modern technology with ancient principle, on a commercial level, would offer a convincing example of how that combination might be proliferated through other modern disciplines.

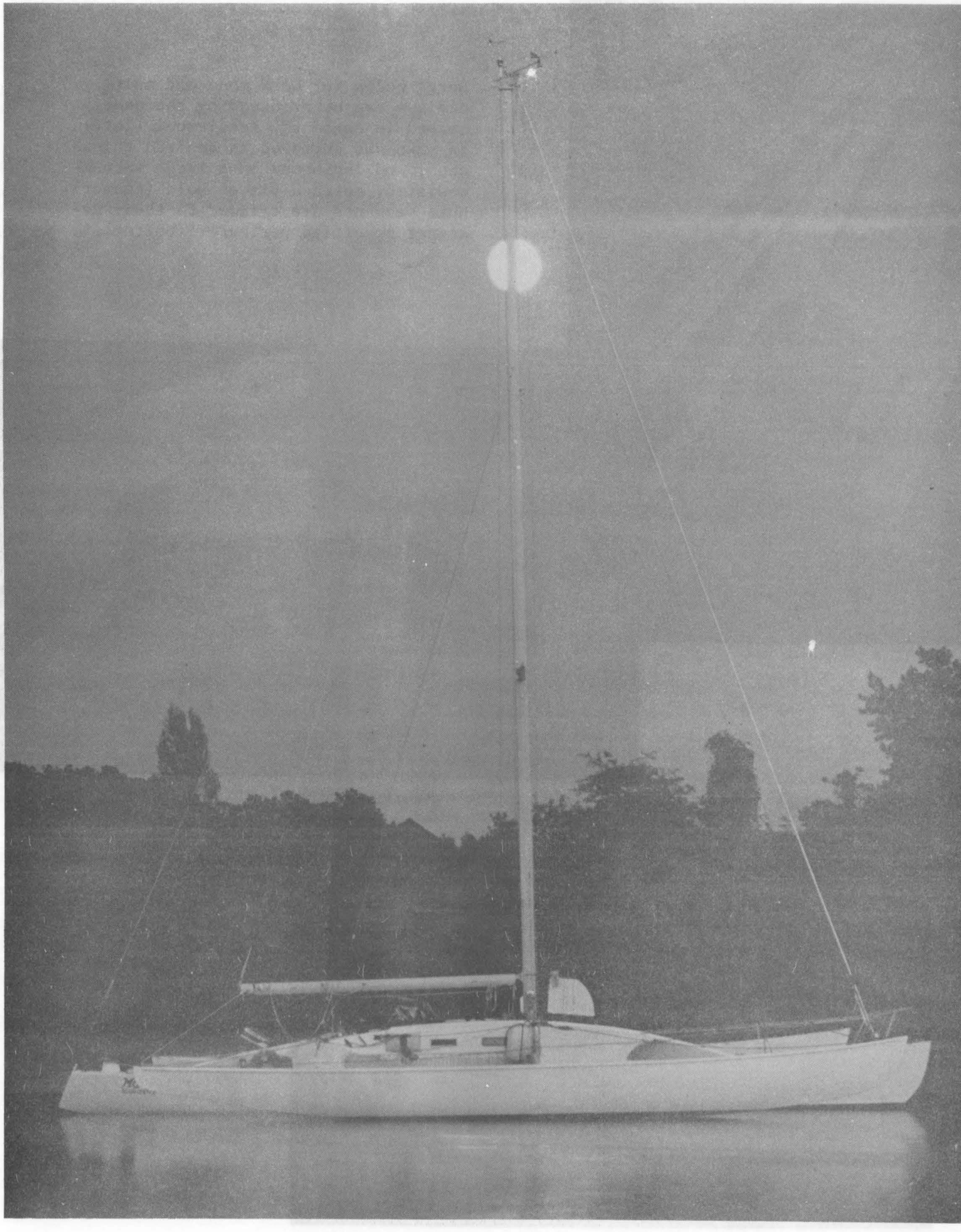
(Text continues on page 76)

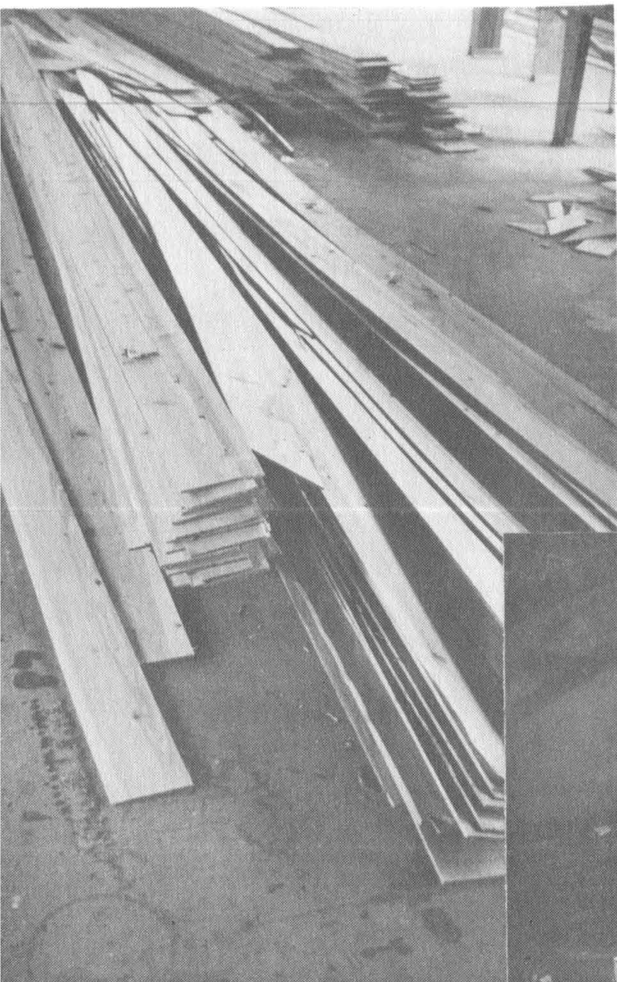


Two laminated wooden racing trimarans designed by Mr. Richard C. Newick have received world renown. The sixty-foot "Rogue Wave" (above) reveals knife-edge hulls and crossbeams for slicing through wavetops with minimum resistance. The smaller "Moxie" (below) shows cockpit layout for single-handed racing. Skipper, Philip S. Weld (in cockpit) at age sixty-five drove "Moxie" to victory in the 1980 OSTAR race; one man, one boat, across the North Atlantic Ocean, against prevailing winds, and against 93 younger competitors. For comparison, the first OSTAR event, held in 1960, was won by Francis Chichester in a sailing time of 40 days. "Moxie" sailed the same course in eighteen days, thereby providing a measure of improvement in contemporary sailing technology.

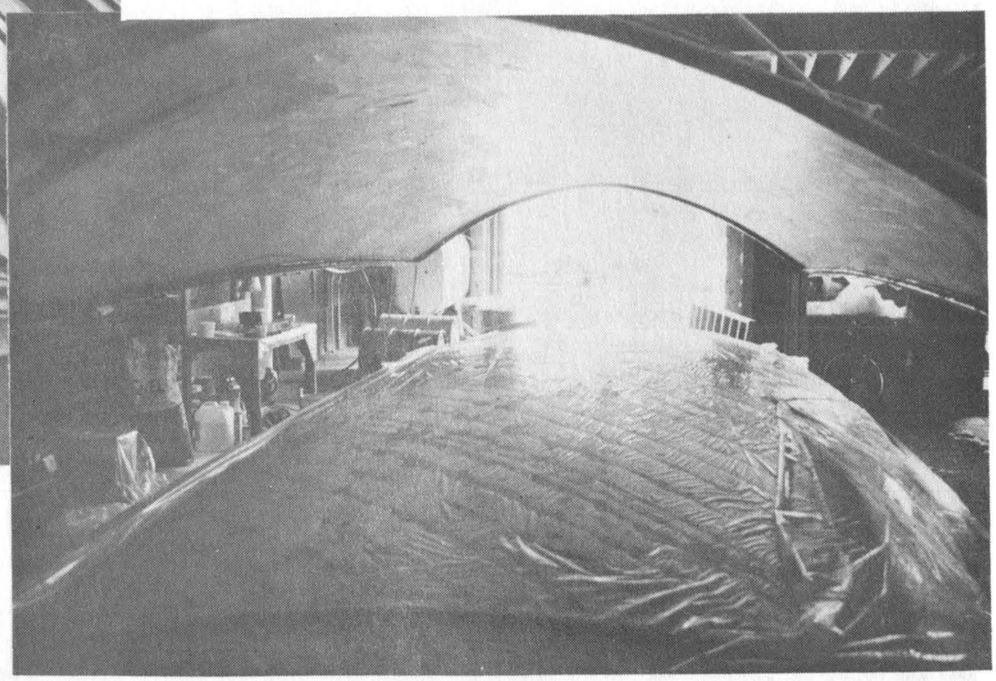
ROGUE WAVE at speed

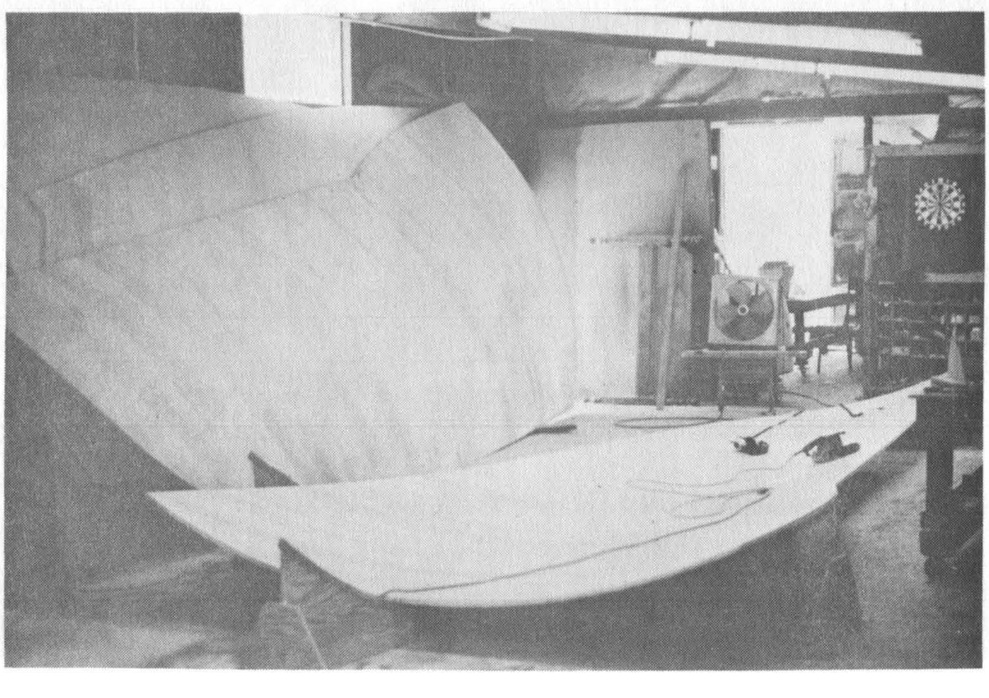




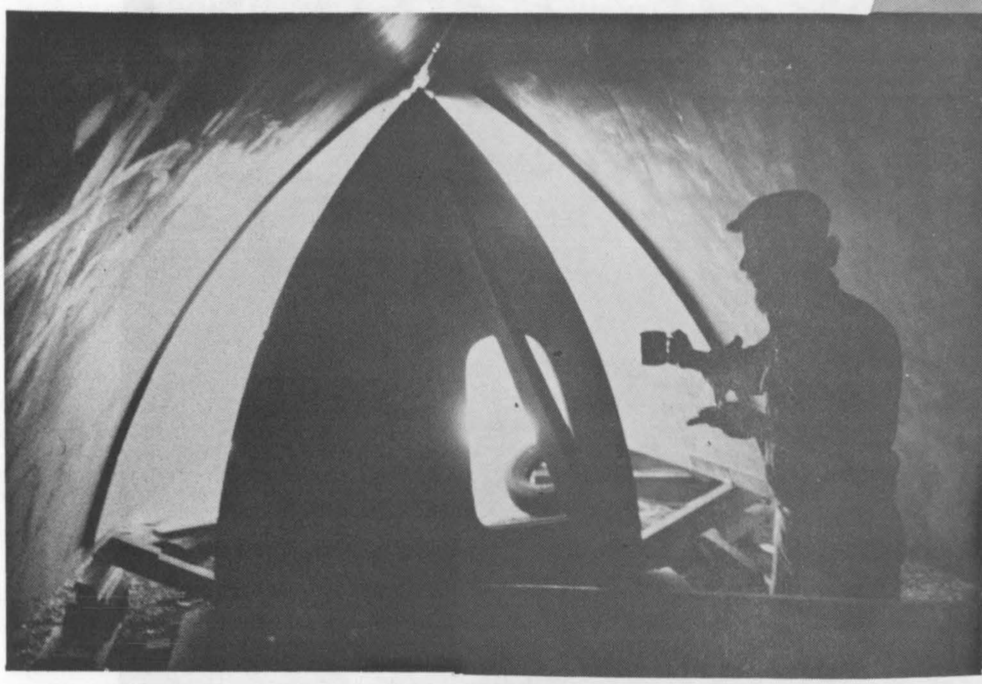


Large hulls for both mono and multi designs can be produced by the panel method in segments. Local wood (left) is sawn and surfaced to desired thickness, and laminated on a large vacuum-assisted, matched platen mold (center). Hull segments are trimmed to their designer-specified perimeter (bottom).

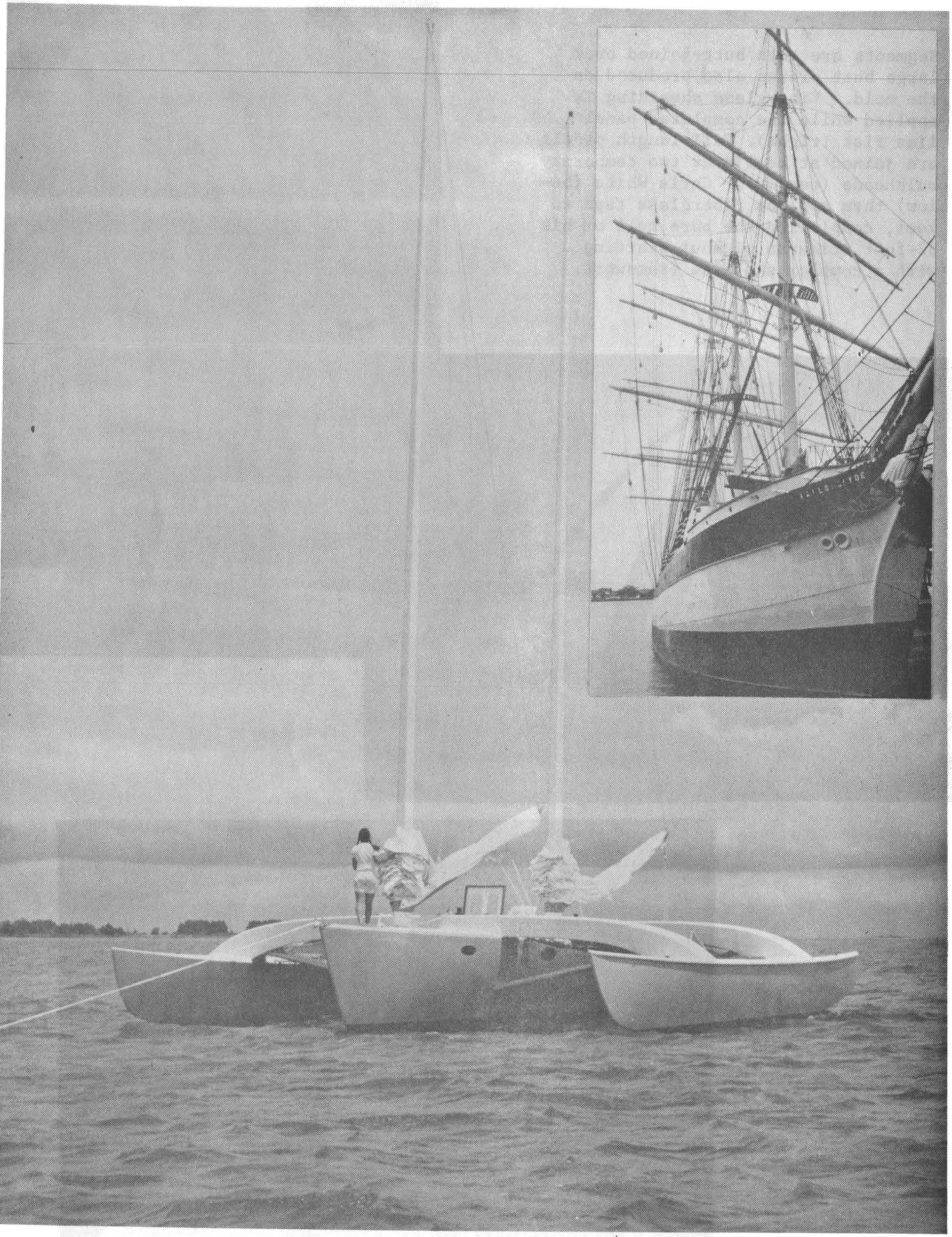


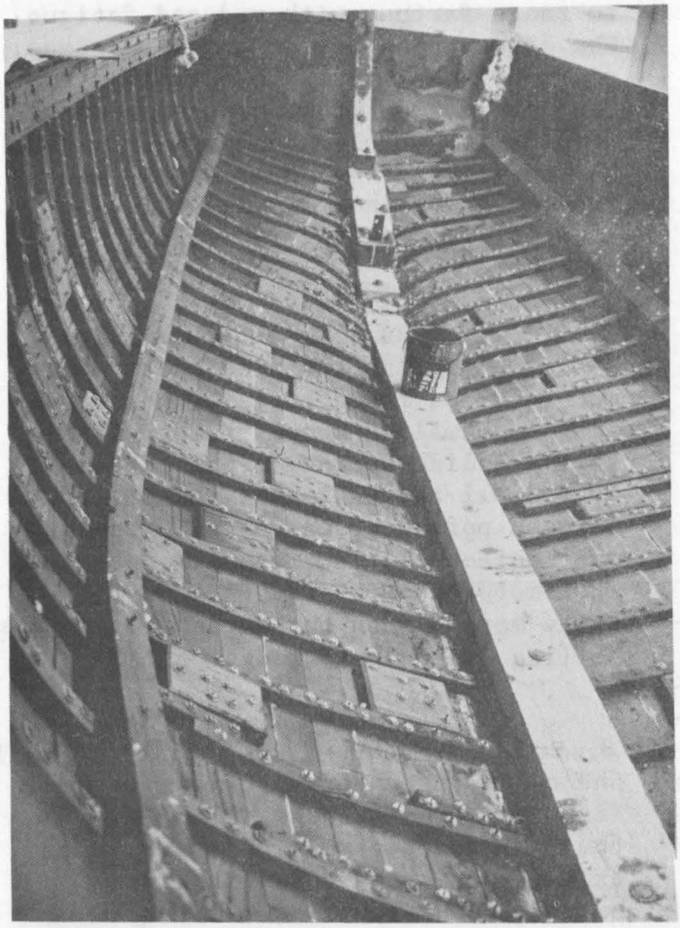


Segments are then butt-joined over large butt plates also produced on the mold. Fiberglass sheathing is applied while the completed panel lies flat (right). Full-length panels are joined at keel over two temporary bulkheads (center). Chris White (below) then applies fiberglass tape to keel, completing the bare hull of his 52-foot trimaran without starting with a complex skeletal framework.



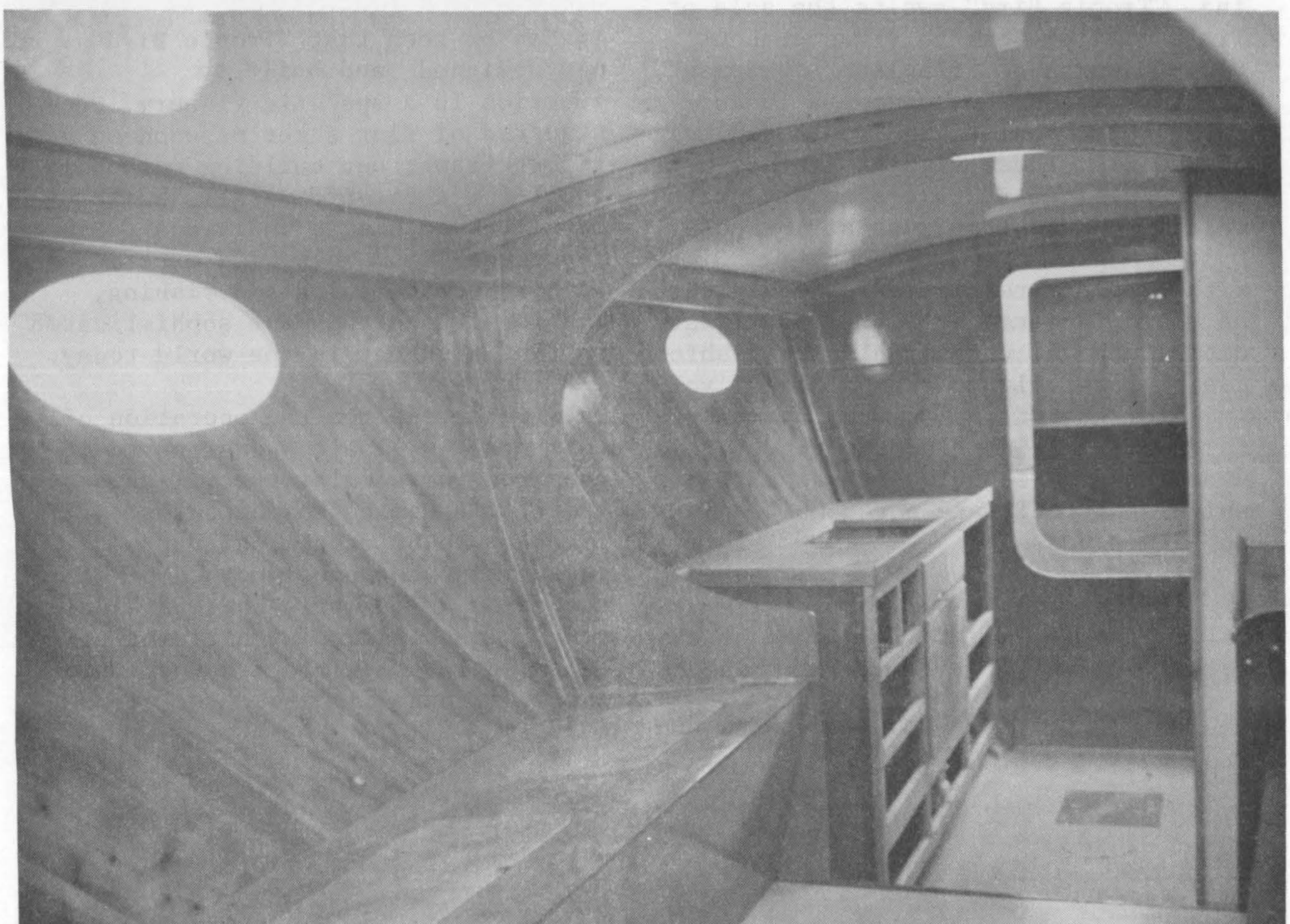
Unstayed JUNIPER compared to squarerigger FALLS OF CLYDE





The 52-foot "Juniper" (opposite) designed and built by Chris White features three hulls all laminated on the same Constant Camber mold. Two simple plywood cross beams join the hulls into a robust unit, and identical, hexagonal, unstayed, hollow, wooden masts were glued-up inside a vacuum bag. Her simple rig and build-method result in labor savings of about half, and materials cost savings of about one-third. Exceptionally drag-free rig and sail dynamics make her sailing performance extraordinary for her cost. Performance under power is somewhat enhanced by low wind drag from spars and rigging. Classic rig (inset) was incapable of combination with steam power during commercial sail's decline because of wind drag. By contrast, modern stayless rig with "wrap-around" foil sails gives motor-sailing synergetic efficiency.

Conventional construction view is included for contrast with "Juniper's" interior.



The 56-foot "Tropic Bird" (opposite) charges through tradewind seas at twelve knots under sail alone in the Alenuihaha Channel, Hawaii. Designed and built by Mr. Tim Mann for long-range commercial fishing, the craft contains two insulated fish holds of 3,000 lbs. capacity each, and one refrigerated fish hold of 8,000 lbs. capacity for a total payload of seven tons.

While this capacity is uncommonly small for a 56-footer, it is not disproportionate to Mann's investment cost of $76,000 for materials and equipment. Long range operating cost in tradewind areas is exceptionally low. With a sailing speed potential about twice that of conventional sailing workboats, the big trimaran also makes nine knots in calms with her 75-horsepower diesel, burning only 2 gallons per hour. (Most seven ton fishboats with ocean capability would burn at least ten gallons per hour, <u>all</u> the time.)

Not yet fully operational at this writing, "Tropic Bird" awaits the sale of Tim's smaller boat to finance about $10,000 worth of "flagline" equipment for fishing on the seamounts (underwater volcanoes) to the south and west of Hawaii. These fishing grounds offer underexploited resources to any craft which can make long runs at low cost.

With complete refrigeration equipment on board (powered by a small auxiliary diesel engine) very high value fishfood can be carefully preserved (small volume) for traditional specialty markets in Hawaii. Aside from the above, this vessel has three unique capabilities which apparently are not combined in any other vessel:

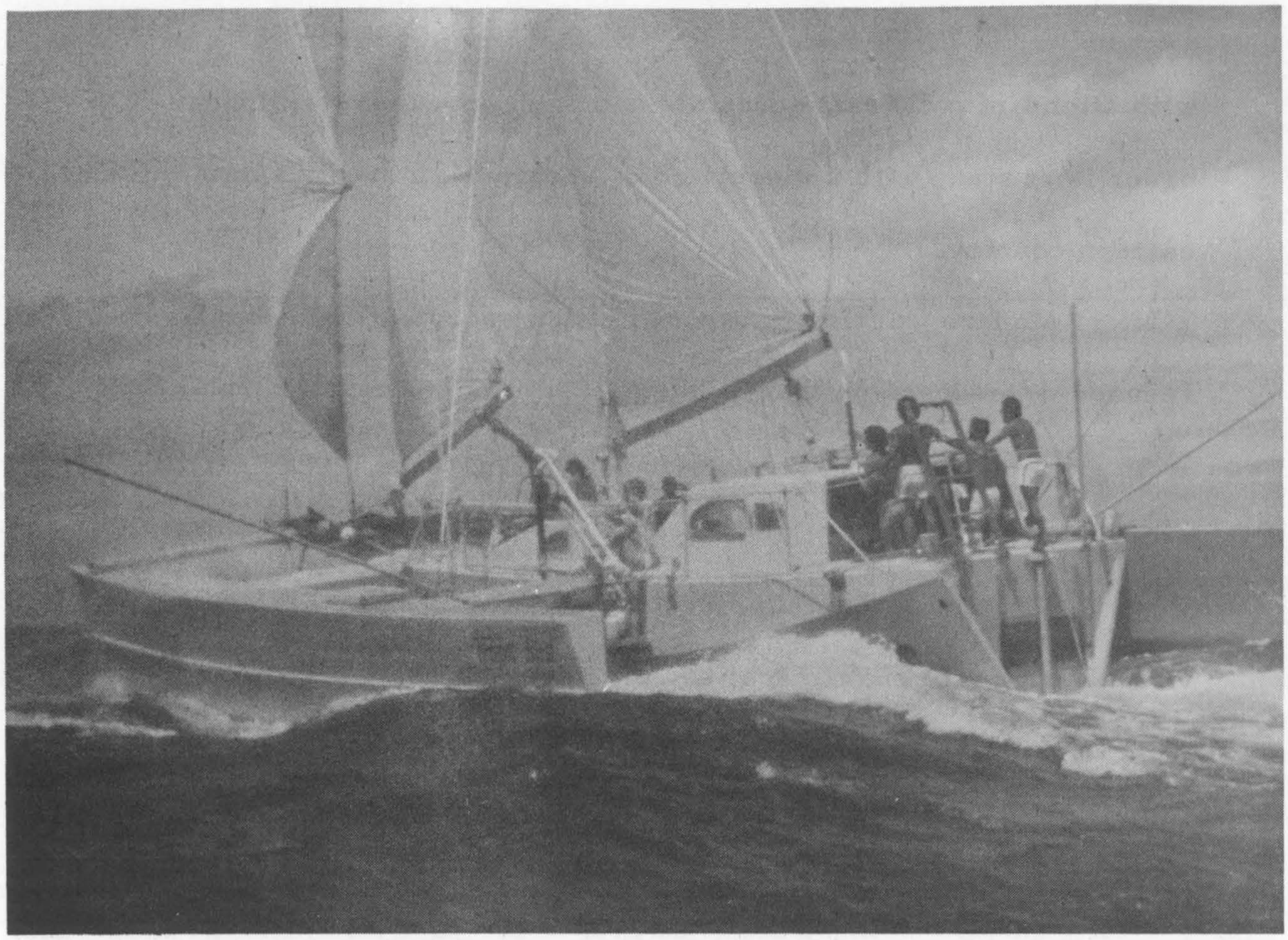
1. It can work in open ocean without rolling, thus enabling the crew of this relatively small, inexpensive fishboat to range farther with reduced fatigue. She can even anchor in tradewind seas, riding like a barge, to permit bottom fishing in 100-fathom depths using hydraulic line haulers and anchor winch. Bottom fishing, anchored on the seamounts, is planned during periods of "rest" while waiting to haul-in flag lines.

2. It can sail fast enough to troll, easily achieving the nine knots minimum required for artificial bait trolling in Hawaiian waters. Therefore, this trolling operation can be conducted all the while the vessel sails between port and seamounts, whereas most sail-assisted fishboats must motor most of the time, using sails mainly with the engine to achieve tolling speed or to reduce rolling.

3. Tropic Bird has the "ability to fail." She can mount an expedition to a far fishing ground without speculating in the fuel/catch game. If a particular expedition is unsuccessful, Tim is not burdened with a devastating loss.

It can be seen that "Tropic Bird" was designed and built to function in a specific fishery. Constructed of flat sheet plywood on a timber frame, her building method is ideal for a one-off vessel, built largely by a single individual. She expresses Tim Mann's wide experience in both boatbuilding and fishing, and is perhaps the most sophisticated sailing fishboat in the world today.

Data gathered from the operation of this craft will allow designs to be prepared for similar special-purpose craft. If demand so indicates, a fleet could be economically propogated using the panel method of construction as in Chris White's "Juniper," with possible significant effects on inter-island transportation and long range fishing.



TROPIC BIRD trolling in the trades...

"The ability to fail."

(See also front cover.)

SPECIAL OFFER Mr. Tim Mann offers to demonstrate the practicality of this sail powered fishboat to Development decision-makers in Hawaiian waters, or under charter anywhere in the tropical Pacific.

The timing is right. Public interest in nautical achievement is evidenced by the Tall Ships, and by the great expansion in sail yachting. Economists confirm that the worldwide down-turn results in large part from industrial voraciousness for materials and fuels in finite supply. Petroleum dependence is identified as a leading cause of centralization, with attendant political, economic and environmental fragilities. World order is at stake with a disruption of supply from even a single middle-eastern country.

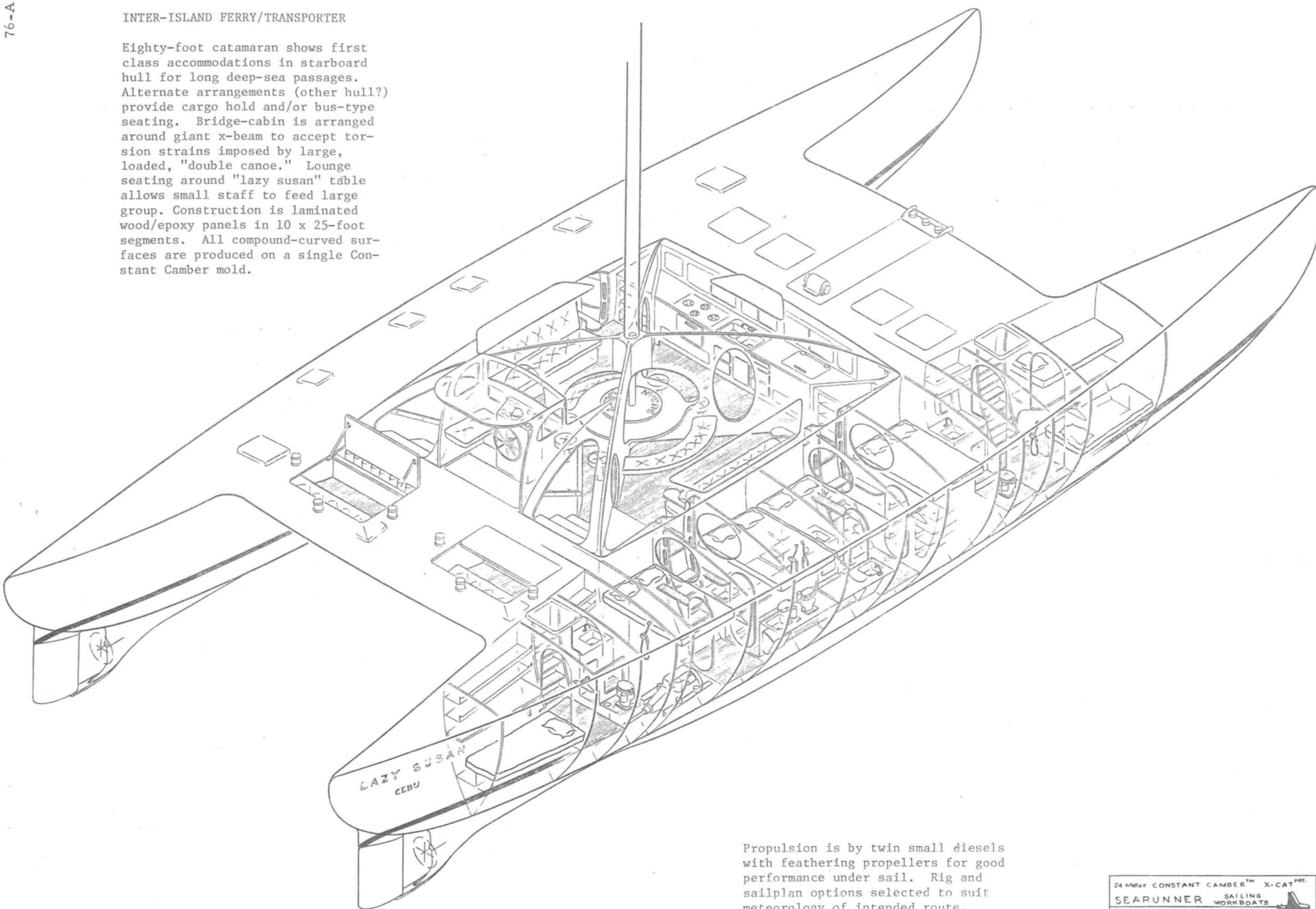
Modern working watercraft which carry sail will display their reduced dependence on that "system" very conspicuously. Imagine! "New Sails in the Sunrise." They will doubtless be recognized for their propitiousness.

Both the technical and economic aspects of sail power carry virtual long term guarantees; architecture and equipment proven by modern yachting can be readily de-tuned and beefed-up for commerical service. And buy-back time comes down with the same inevitability that fuel prices go up.

Sail power also has the ingredient of "magic." To put sails into widespread commercial service will require funds for research, and for the construction and operation of prototypes. Raising funds in today's economy requires more than virtual long term guarantees. It requires hope. The image of commercial sail, even though it looks distinctly different than in the days of yore, presents a most conspicuous sign of hope. It is the image of doing things the old way -- with renewables -- but with exciting new tools... a correlation between the nostalgic past and an acceptable future. And it is just now coming into view.

INTER-ISLAND FERRY/TRANSPORTER

Eighty-foot catamaran shows first class accommodations in starboard hull for long deep-sea passages. Alternate arrangements (other hull?) provide cargo hold and/or bus-type seating. Bridge-cabin is arranged around giant x-beam to accept torsion strains imposed by large, loaded, "double canoe." Lounge seating around "lazy susan" table allows small staff to feed large group. Construction is laminated wood/epoxy panels in 10 x 25-foot segments. All compound-curved surfaces are produced on a single Constant Camber mold.

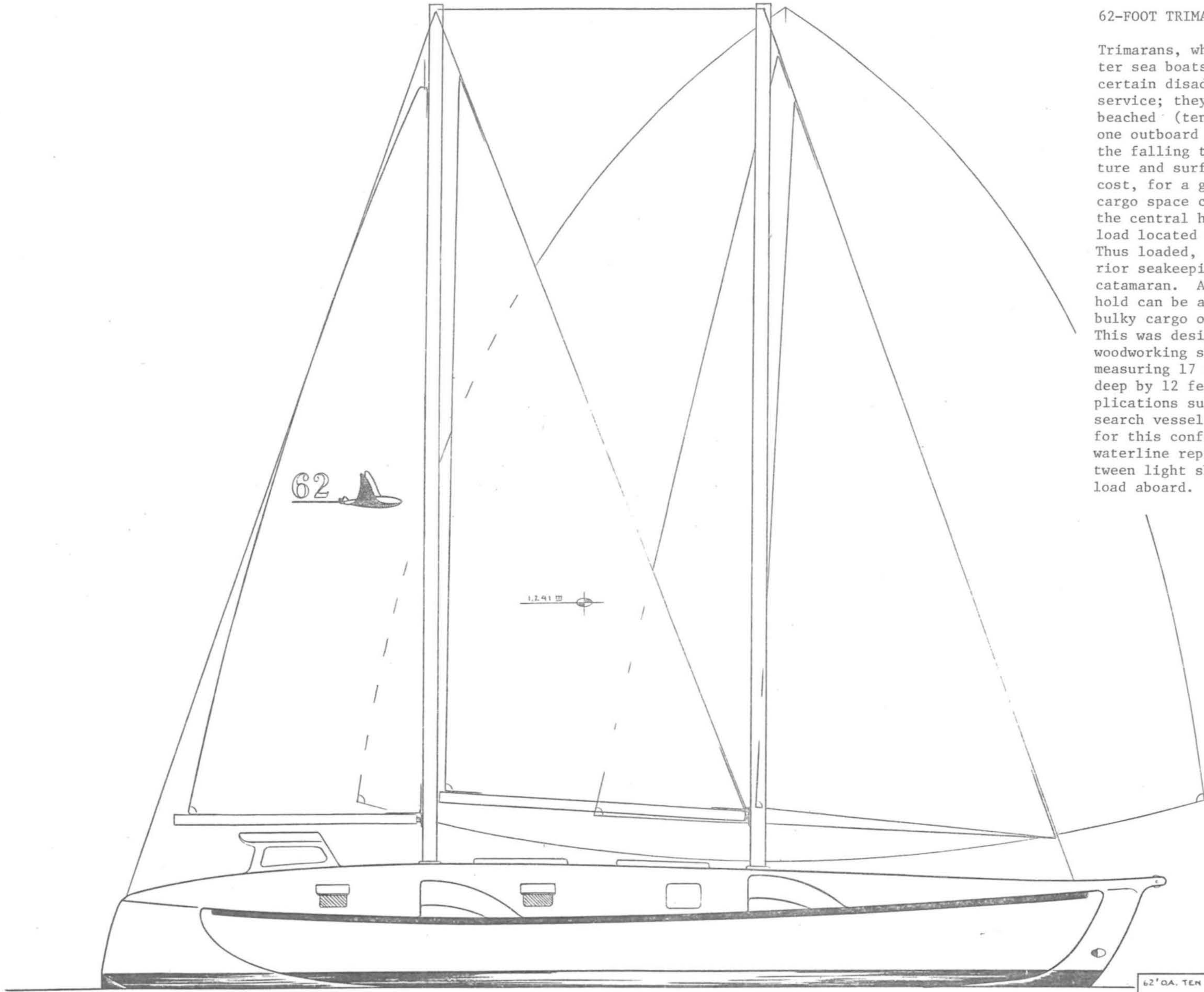


Propulsion is by twin small diesels with feathering propellers for good performance under sail. Rig and sailplan options selected to suit meteorology of intended route.

24 Meter CONSTANT CAMBER™ X-CAT pat.
SEARUNNER SAILING WORKBOATS
SCALE .03M
I
P.O Box 14, North, VA 23128 U.S.A.

62-FOOT TRIMARAN MERCHANTMAN

Trimarans, while perhaps making better sea boats than catamarans, suffer certain disadvantages in commercial service; they are not stable when beached (tending to flop over onto one outboard ama in the surf or with the falling tide) and have more structure and surface area, thus more cost, for a given payload. However, cargo space can be concentrated in the central hull, with the heaviest load located down deep amidships. Thus loaded, they can exhibit superior seakeeping properties to the catamaran. A single, large cargo hold can be advantageous for very bulky cargo or special applications. This was designed to accommodate a woodworking shop in the central hold measuring 17 feet long by ten feet deep by 12 feet wide on deck. Applications such as clinics or research vessels may be best suited for this configuration. Wide waterline represents difference between light ship and ten tons payload aboard.



62' OA. TEN TON CAP. MERCHANTMAN

SEARUNNER SAILING WORKBOATS

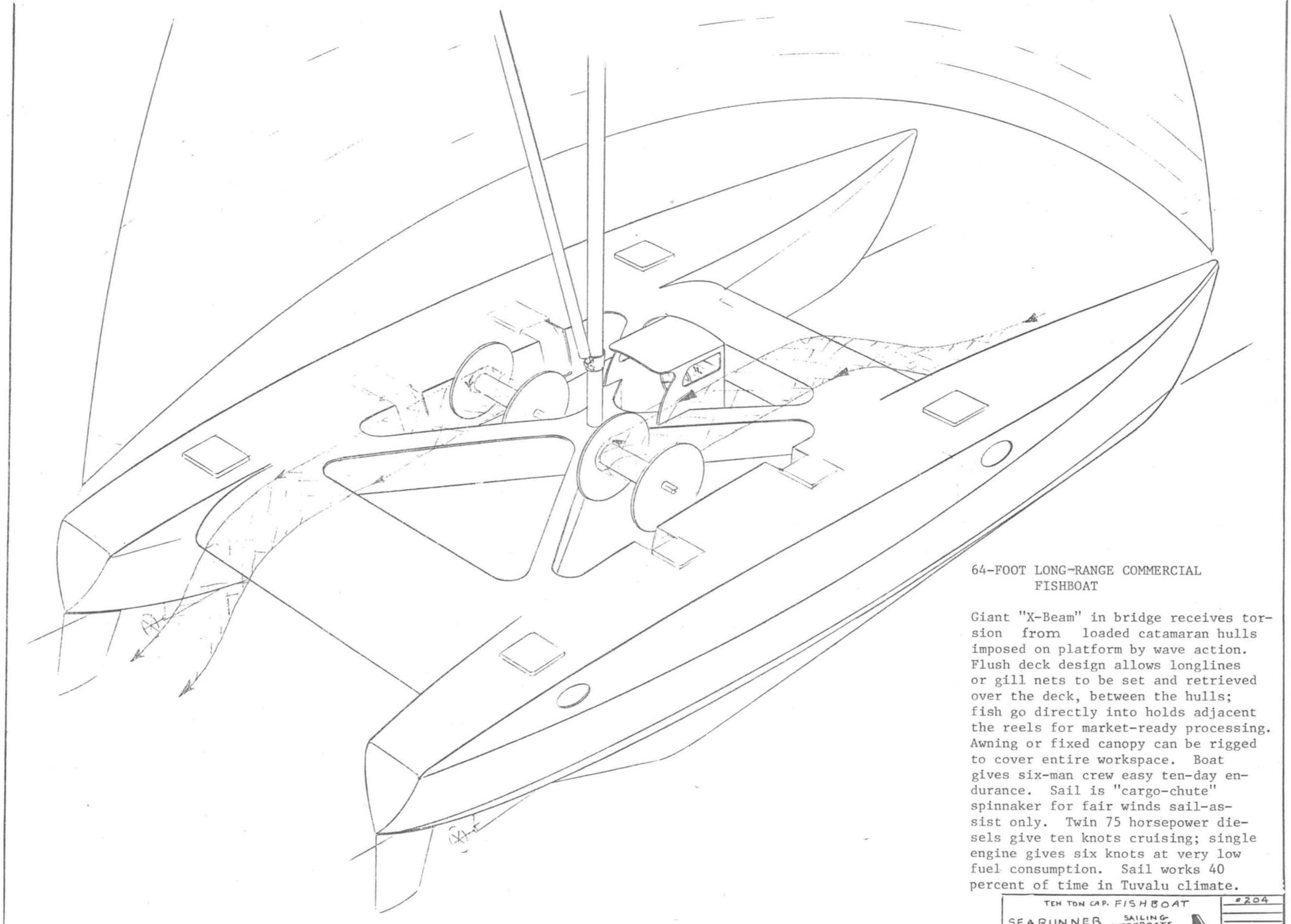
P.O. Box 14, North, VA 23128 U.S.A.

#203

(1.03 m)

SCALE 3/8" ≈ 1'

II



64-FOOT LONG-RANGE COMMERCIAL FISHBOAT

Giant "X-Beam" in bridge receives torsion from loaded catamaran hulls imposed on platform by wave action. Flush deck design allows longlines or gill nets to be set and retrieved over the deck, between the hulls; fish go directly into holds adjacent the reels for market-ready processing. Awning or fixed canopy can be rigged to cover entire workspace. Boat gives six-man crew easy ten-day endurance. Sail is "cargo-chute" spinnaker for fair winds sail-assist only. Twin 75 horsepower diesels give ten knots cruising; single engine gives six knots at very low fuel consumption. Sail works 40 percent of time in Tuvalu climate.

TEN TON CAP. FISHBOAT	#204
SEARUNNER SAILING WORKBOATS	
P. O. Box 14, North, VA 23128 USA ©1981 JAMES W. BROWN	

CONCLUSION

Sails offer easy access to renewable energy--probably easier access, with more immediate humanitarian results, than any other method of transition to renewables. New Working Watercraft can take advantage of local, traditional wisdom and materials, while combining appropriately with modern technology.

While it is premature to tout these new boats as survivors in a changed environment, apparently they are at least promising mutations. Prototypes are being placed into operation as fast as funding permits; new projects are in planning for Maine, Guyana, Honduras, Enewetak and Tuvalu. Time alone will determine their survival on the "bottom line."

If indeed some models endure true workboat service, it will be because they provide a unifying influence around which human development can exist with little social or technical risk. Compared to most energy options, laminated wood and synthetic sail cloth require only a small infusion of alien material and know-how.

To involve local people in a closer relationship with the energy source, bold action is indicated. Talent and capital must be re-directed toward less petro-intensive systems. New tools are needed; tools which accomplish more work with less energy and, as such, are a real pleasure to use.

VI. APPENDIX

Preceding material is complete through June, 1982. Updates are added from time to time in the following appendix.

Projects featuring fuel super-efficient workboats (and other laminated structures) are undertaken by the writer working in conjunction with several associates mentioned in this document. Full design and implementation services are available. Readers wishing to receive further information please contact:

JAMES W. BROWN Design Consultant

Post Office Box 14, North,
Virginia 23128 U.S.A.

Telephone (804) 725-3167

NATIVE FISHERY VITAL SIGNS

QUESTIONNAIRE

These twenty questions are for analyzing local trends to determine design parameters for new boats, starting with the assumption that new boats are not necessarily indicated. Go fishing! Ask questions of both fishermen and government; record and correlate answers by number on separate sheet.

1. To what extent have fuel price escalations influenced this fishery?

   Are there boats standing idle?

2. Current ratios... pounds fish/trip : pounds fuel/trip
   price fish/lb. : price fuel/lb.

3. Is there activity in the market for used motorboats?

   Examples: prices, depreciation, operating cost, income.

   Is there activity in the market for used sailboats?

   Examples: prices, depreciation, operating cost, income.

4. What new boats are being built or sold? Locally built or imported?

   Examples: prices, depreciation, operating cost, income.

5. Are fish prices increasing? Examples by species over 1 year, 5 years.

6. Are fish landings decreasing? Examples by species over 1 year, 5 years.

7. Is the nearby fish resource depleted? Is there a distant underexploited resource?

8. What is the duration and rhythm of current fishing expeditions? About how many expeditions/days per year?

9. Is this rhythm culturally oriented? That is, will these fishermen resist modifying their life style to go farther, stay longer, and adopt new fishing tactics?

10. Judging from above answers, is a new boat type indicated? Or, should efforts be made to expand the existing fleet for the current fishery? Will a new boat type really be more productive in the existing fishery? ...sufficiently more efficient to pay its (increased) cost?

11. Will a new boat type be intended for harvesting high value fishfood for export? Or low value fishfood for local consumption?

12. How will a new boat type impact the current employment situation for fishermen and boatbuilders?

13. If a new boat type is really indicated, can you arrange to go fishing in the nearest local equivalent, using any new methods, in order to determine accurate design parameters for new boats? If so...

14. What fishing method(s) will be used? Different methods for different species? What method/species show best chance for increased production? (Emphasize one, avoid multi-purpose hodge-podge.)

15. Get load requirements:

Average catch payload

Maximum catch payload

Gear and equipment weights

How many fishermen?

Live well? Water weight?

Ice weight (full payload in ice outbound, 50/50 ice/fish ratio inbound for tropics, equals same weight both ways)

16. Are sails appropriate in the new design?

Is the run long enough to suggest sail?

Get meteorological records, analyze wind.

What is the course for sailing?

Assuming a substantial improvement in sailing performance and ease of handling (compared to existing sailboats?), will the fishermen readily accept new sailing fishboats?

17. Any cultural resistance or acceptance factors for the new boat proposed?

18. How much will the new boats cost? Will increased production justify that cost?

19. How will fishermen acquire the new boats?

Credit?

Outright purchase?

Is insurance available?

20. Are the above questions about present economic viability really applicable? Or is this a case of <u>do something!?</u>

CONSTANT CAMBER^{tm} CAPABILITIES

The geometry which allows compound-curved surfaces to be covered with strips of veneer -- each strip having the same profile shape as all other strips (patent pending) -- is mathematically strict. Adherence to this "family of surfaces" permits molded wood to be produced quickly. Prior to this technique, "molded wood" structures such as boat hulls were produced with great tedium. It was necessary to hand carve or "spile" each strip to fit against its neighbor with substantial edge contact...no gaps. Because this took time, each strip was installed with glue as it was spiled, and riddled with staples to achieve good contact pressure with the layer below. Glue was allowed to cure as the builder progressed, one layer of strips at a time.

Now, with all veneer strips pre-cut to identical shape, all three layers (or more) can be applied with one batch of glue. Pre-cutting the veneer thus allows using a vacuum bag or platen to achieve contact pressure, making it unnecessary to use any staples at all, except in the very ends of the strips just to hold them in position until vacuum is applied. By this three-stage acceleration - veneer, staples and vacuum - production time, per square foot of hull, is cut by roughly two-thirds. Assembling the half-hull panels without the need for complex skeleton yields another significant saving, yet this method takes full advantage of a new under-standing of wood as an engineering material. Resulting structures are extremely rigid and light, approaching or exceeding the physical properties of the most sophisticated "man made" materials. To tell the truth, compound laminated wood is man made. The combination of polymer adhesives with resins in wood is not merely a mechanical sticking-together. A chemical bond is produced which essentially welds wood layers together. When layers are arranged with the wood grain in one layer about perpendicular to the grain of the proximate layer, common splitting, swelling, warping and rot are essentially eliminated. Then, when the resulting panel is given compound curvature (bending in both directions), fantastic rigidity results as in the structure of an eggshell. "Molded wood" is no longer wood in the classic sense. It is the undisputed champion for fatigue-resistant, rigid panel structures, especially when cost is considered. Modern adhesives and coatings give this product excellent longevity, and the Constant Camber technique now makes it simple to fabricate.

However, there are certain geometric limitations to the surfaces which can be described by this material. Wide, flat areas are inherently weak, sharp bends and "progressive" curves are difficult; and re-curves, or "S" sections are tricky. These shapes commonly occur in boat design, therefore Constant Camber may not be suitable for certain hull configurations. We have found however that limitations inherent to the geometry place useful constraints on the designer, preventing him from adapting exotic shapes which may be imaginative but not dynamically necessary.

Fig. 4

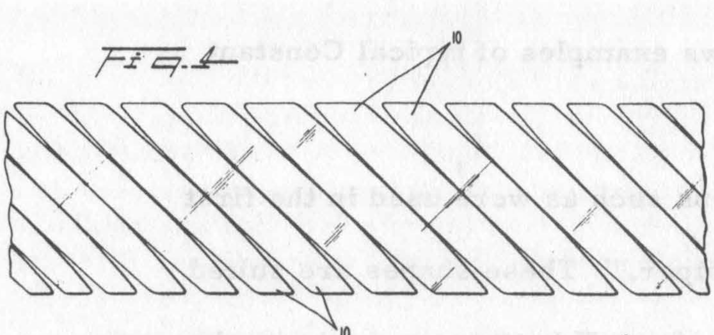
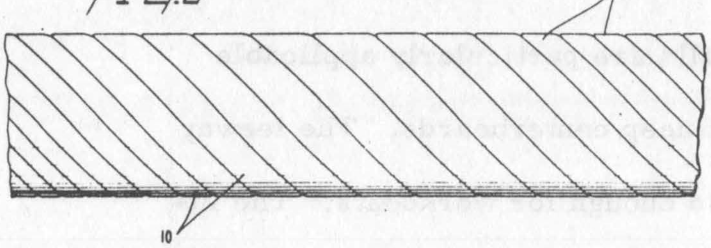


Fig. 5



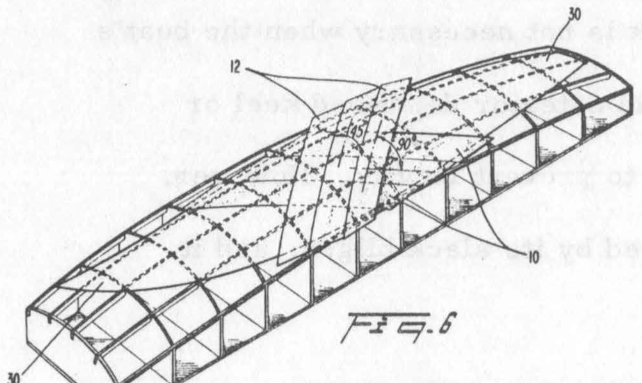
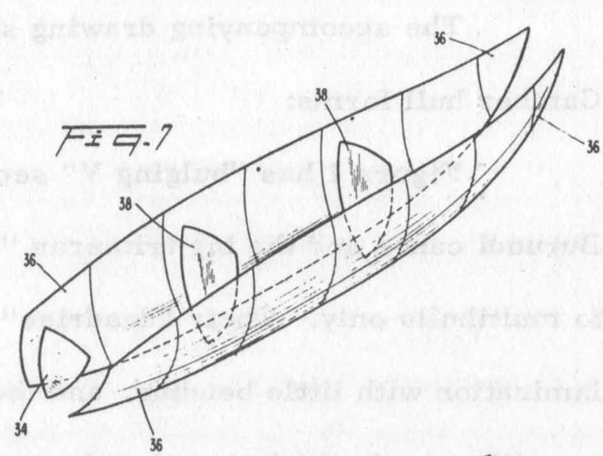


Fig. 6

Fig. 7



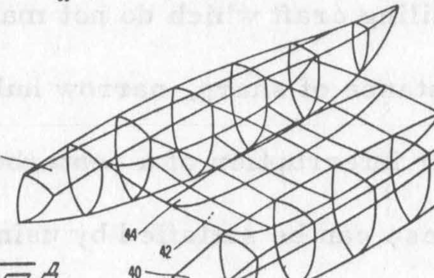
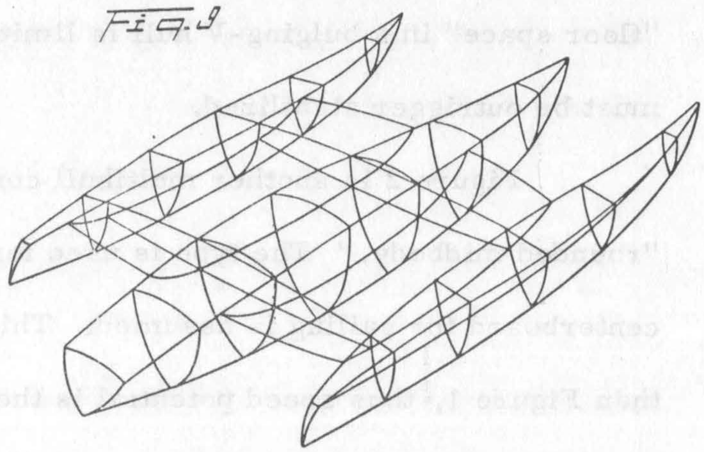


Fig. 8

Fig. 9



A few drawings from the patent application illustrate the basics of the "invention." Figures 4 and 5 show how identical strips of veneer are used to "plank" the toroid mold, without spiling each strip to a unique shape. Figure 6 shows a boat panel being laminated with diagonally opposed layers of pre-cut veneer. Figure 7 shows basic hull assembly. Figure 8 and 9 are the most interesting. They demonstrate how a series of panels from the same mold can be used to build boats of different sizes and configurations, including hulls, decks and wing stream-lining panels...all without skeleton. Figure 10 is a frameless, CONSTANT CAMBER tm house, with figure 11b showing a detail of the laminations.

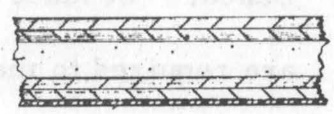


Fig. 11b

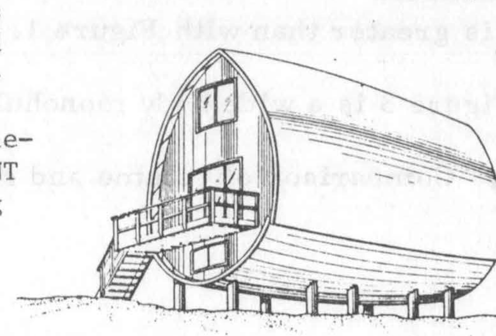


Fig. 10

Patent Pending

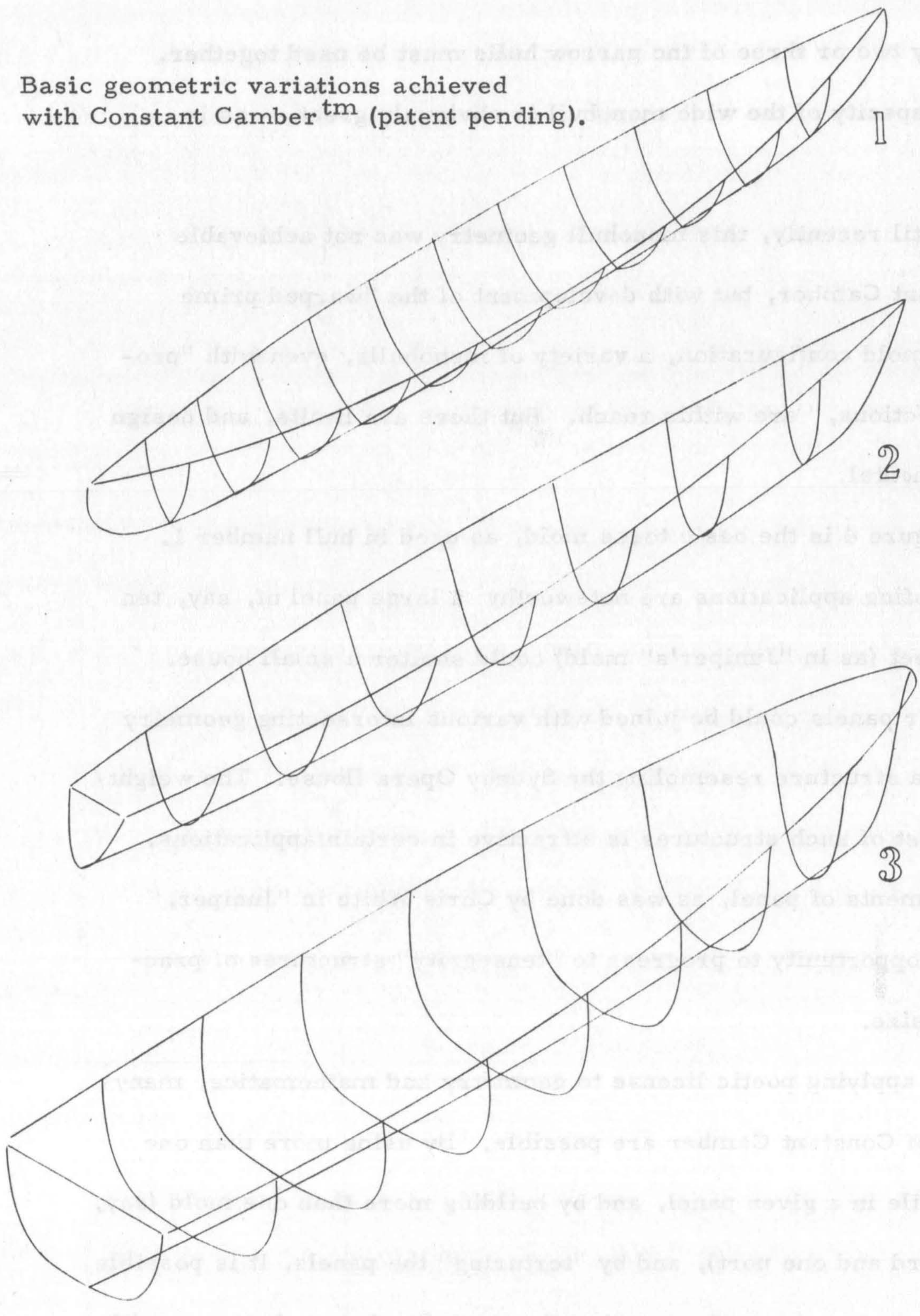
The accompanying drawing shows examples of typical Constant Camber hull forms:

Figure 1 has "bulging V" sections such as were used in the first Burundi canoe and the big trimaran "Juniper." These shapes are suited to multihulls only. Their "deadrise" or sharp V bottoms permit simple lamination with little bending, and the hulls are particularly applicable to sailing craft which do not make use of deep centerboards. The leeway resistance of sharp, narrow hulls is good enough for workboats. The interior interruption of a centerboard trunk is not necessary when the boat's purpose can be satisfied by using a simple exterior deadwood keel or "runners" in combination with the V hull to prevent leeway. However, "floor space" in a bulging-V hull is limited by its slack bilges, and it must be outrigger stabilized.

Figure 2 is another multihull configuration; this one has a "rounded midbody." The type is used for speed where the use of a deep centerboard for sailing is assumed. This hull has less "wet surface" than Figure 1, thus speed potential is theoretically higher and fuel consumption under power is minimized. Floor space is increased. Hulls of this nature are used in "Rogue Wave," "Moxie," and the "Mother Banca." Because of the accelerating "French curve" sections, veneers are required to make tighter bends during lamination, and the design challenge is greater than with Figure 1.

Figure 3 is a wide body monohull such as is used for burdensome sea skiffs. Comparison of volume and stability with the multihull forms

Basic geometric variations achieved with Constant Camber^{tm} (patent pending).



reveals why two or three of the narrow hulls must be used together. Carrying capacity of the wide monohull is obviously great -- as is resistance.

Until recently, this monohull geometry was not achievable with Constant Camber, but with development of the "warped prime meridian" mold configuration, a variety of monohulls, even with "progressive sections," are within reach. But there are limits, and design is developmental.

Figure 4 is the basic torus mold, as used in hull number 1. Obvious roofing applications are noteworthy; a large panel of, say, ten by twenty feet (as in "Juniper's" mold) could shelter a small house. Or, modular panels could be joined with various intersecting geometry to produce a structure resembling the Sydney Opera House. The weight/strength/cost of such structures is attractive in certain applications. Joining segments of panel, as was done by Chris White in "Juniper," affords the opportunity to progress to "tensegrity" structures of practically any size.

By applying poetic license to geometry and mathematics, many variations of Constant Camber are possible. By using more than one veneer profile in a given panel, and by building more than one mold (say, one starboard and one port), and by "torturing" the panels, it is possible to define a great many surfaces using Constant Camber techniques, with consequent time/cost advantages.

As yet, however, the design challenges can be dizzying. Designing the mold to compensate for springback, torture, "flattening-fattening," and specific grain orientations, is an empirical endeavor. Prototype construction and basic research have demanded much from the "eyeball" boatbuilder.

Predicting panel perimeter is the main challenge, for hull shape can be dramatically influenced by minor variations in panel perimeter. To achieve a variety of specific hull forms from a single mold requires model work and/or a graphic method called "projected arc lofting," wherein involutes are unwrapped. This operation has not yet been sufficiently formalized to permit computer programming despite expert attempts. The wild variable is the "torturing" or contortion of the panels <u>after</u> they are cut to final perimeter. Panels are tortured as those perimeters are mated. Because torturing affects both curvature <u>and</u> perimeter, interactively, it makes both difficult to predict.

Nevertheless, the opportunity to quickly produce compound-laminated wood opens prospects for many new products which make use of inexpensive, renewable-grade wood for producing highly sophisticated structures... doing more with less. Boats have been the first embodiment, but they are probably not the most commercially important.

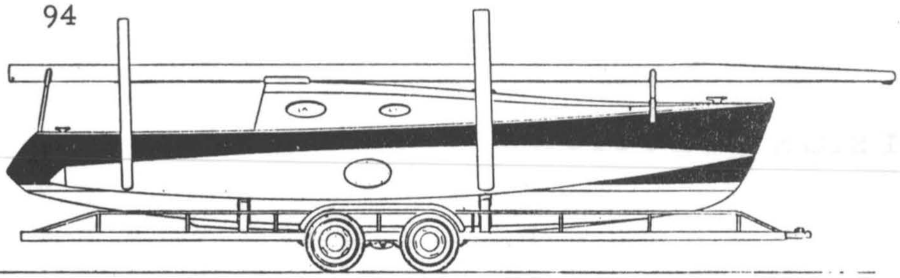
DESIGN SECTION

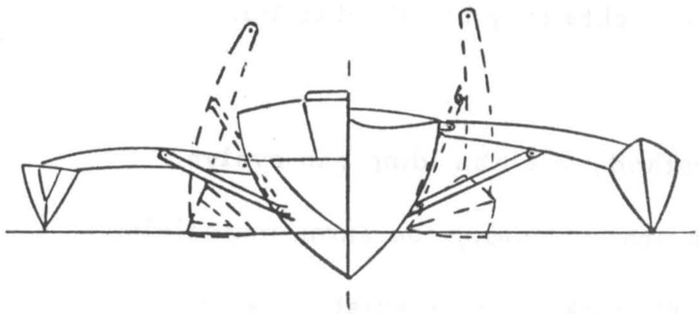
New designs for workboats and yachts may be added to this section as they are developed.

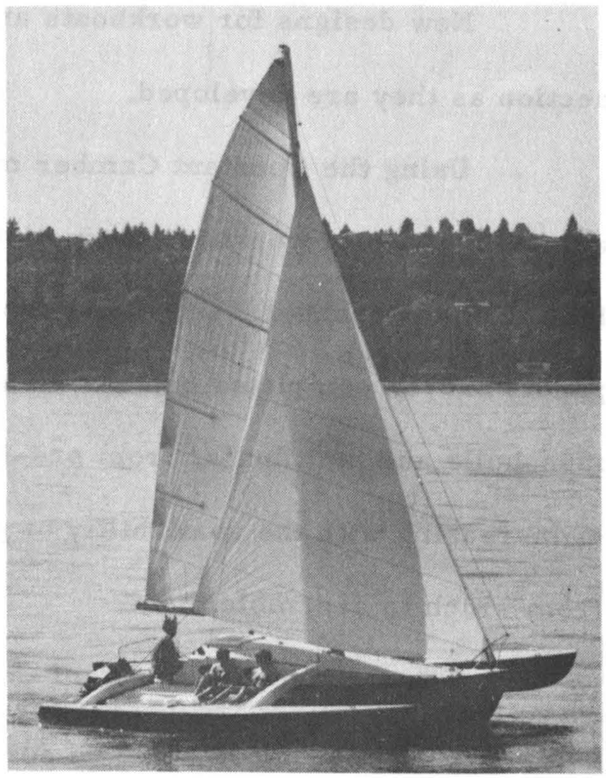
Using the Constant Camber method, yachtbuilding can evolve as an extension of workboat production projects using the same materials, tooling and personnel. Local and export markets may exist for raw panels and/or completed boats of either type. Owner-building of both monohulls and multihulls, from pre-laminated panels, shows promise of increasing with the availability of popular designs and the panels from which to assemble them.

For a current portfolio of Constant Camber yacht designs please contact:

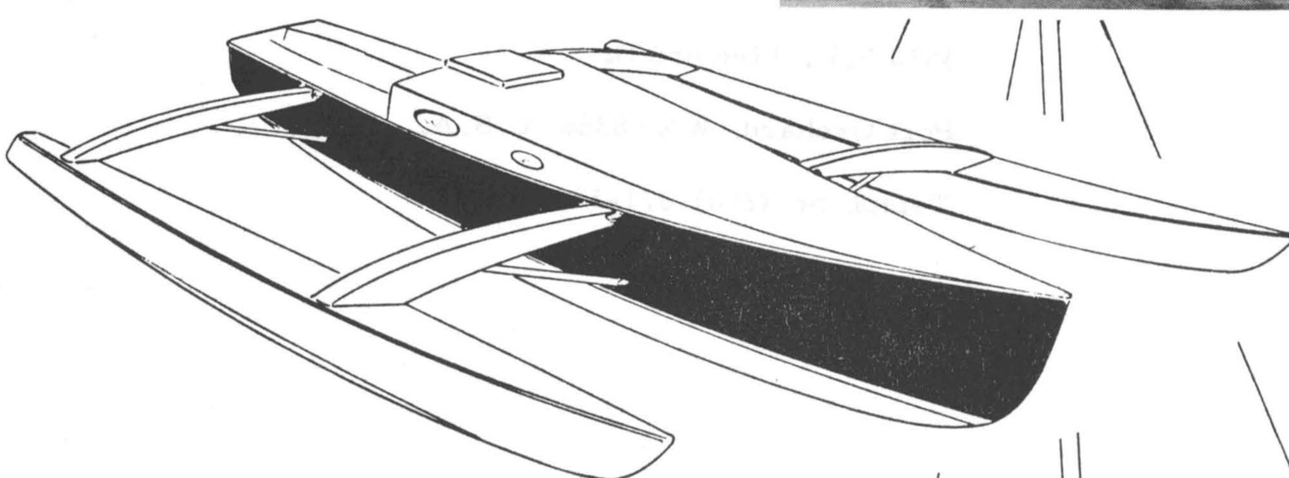
John R. Marples
4530 S.E. Firmont Dr.
Port Orchard, WA 98366 U.S.A.
Telephone (206) 871-5634

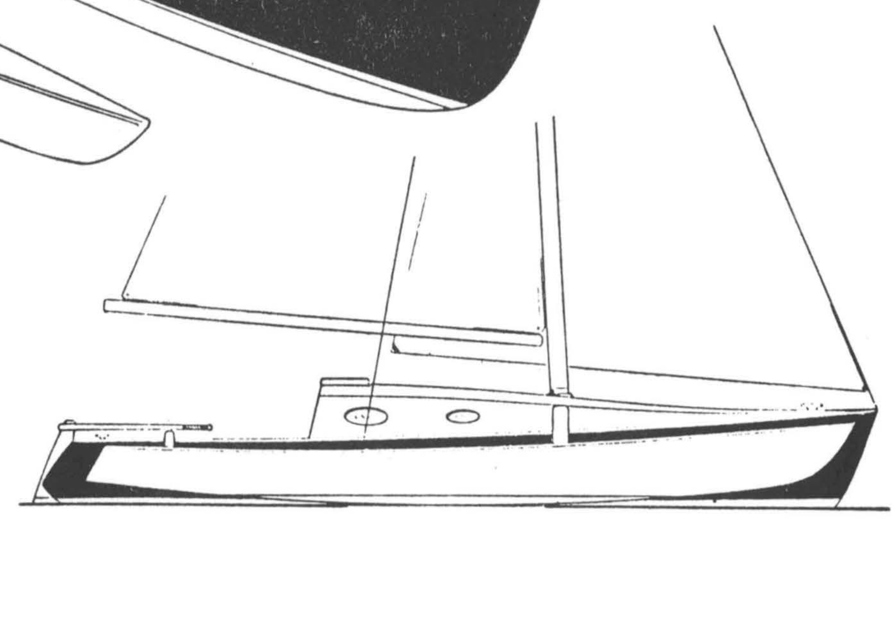


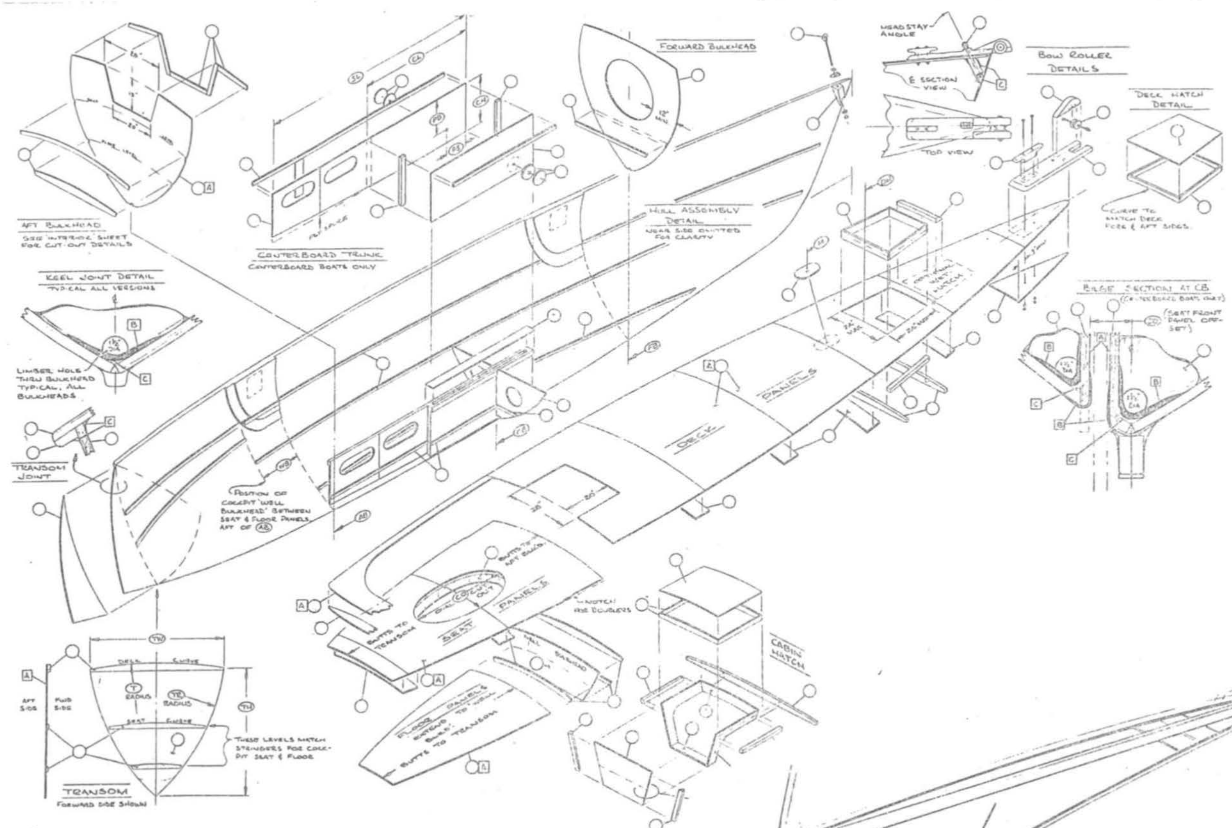


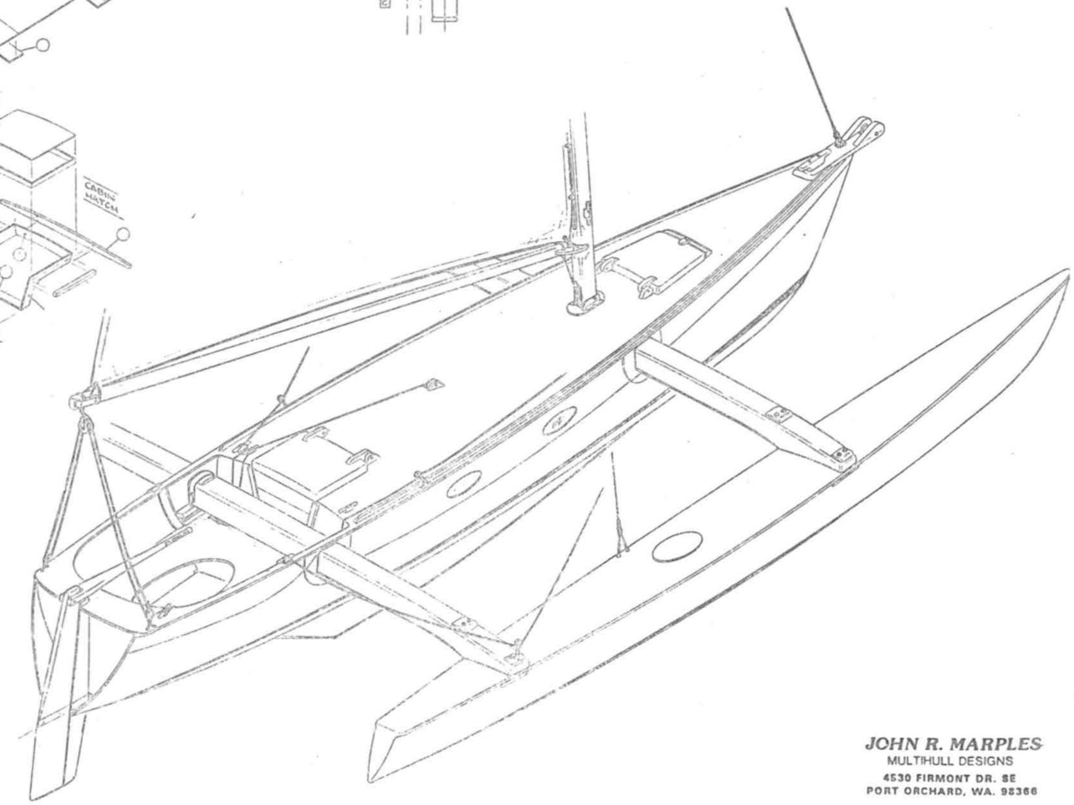


"Constant Camber 26" is typical of a range of fine yachts designed for owner building by Mr. John R. Marples. Crowded marinas dictate the current trend toward trailerable boats, and this trimaran can fold down even while afloat to fit a monohull's berth. Yacht-building is an obvious adjunct to work-boat building projects proposed in this report.









These construction drawings by Mr. John R. Marples illustrate the assembly procedure for a trimaran yacht. The isometric views with "exploded" diagrams provide <u>enough information</u> for the inexperienced builder to visualize the entire project from the start. Numbered "balloons" and lettered "boxes" provide instructions and specifications called out in a separate shop manual. This format , and the simplified construction method, were developed for individual back-yard builders, and are now utilized in technology transfer for production of New Working Watercraft.

JOHN R. MARPLES
MULTIHULL DESIGNS
4530 FIRMONT DR. SE
PORT ORCHARD, WA. 98366

A RETURN TO FORMER CAPABILITIES