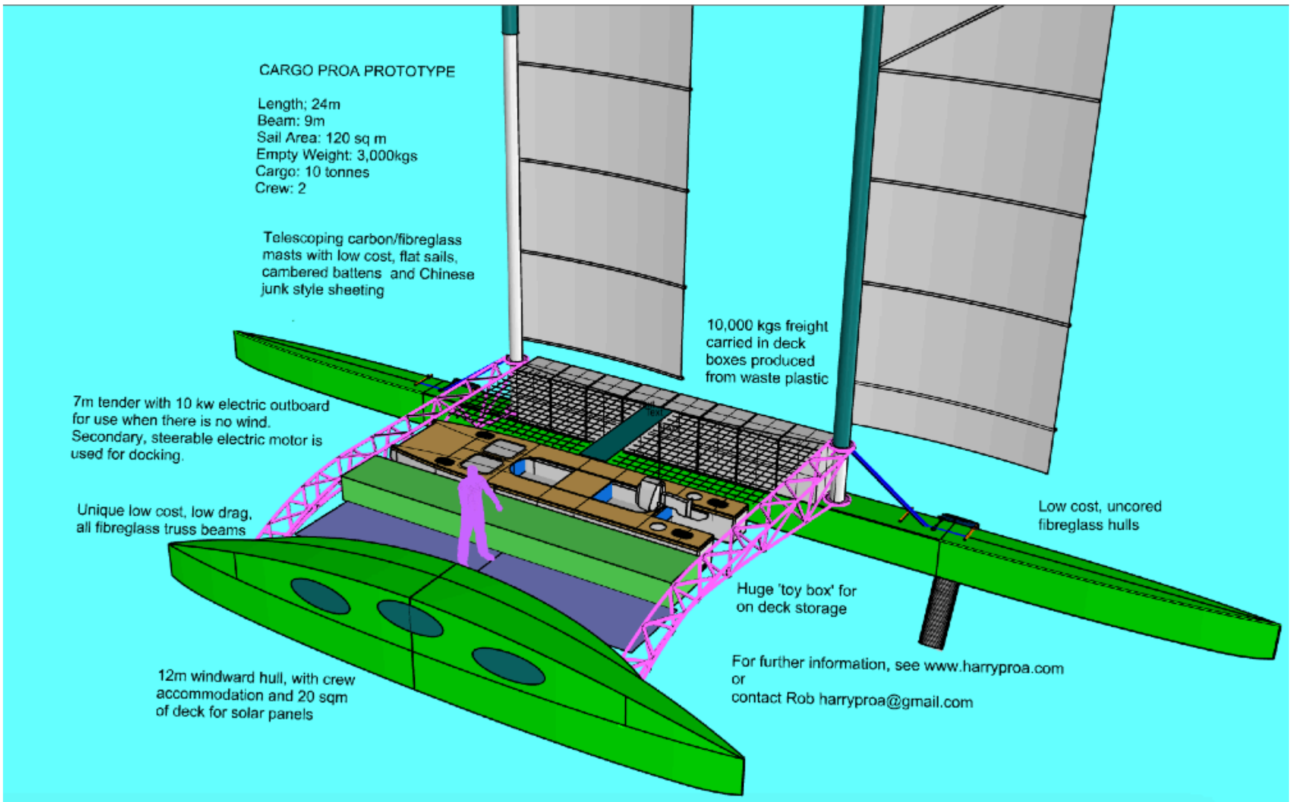
Harryproa

Cargo Proa Prototype

The prototype cargo proa build is documented here. It will be sailing late 2023. We have received funding from the United Nations Development Program to pay for the required safety equipment, fit the boat out to conduct sea trials, make any improvements to the boat and liaise with the Maritime Safety Authority in Fiji to establish safety and survey rules that are applicable to sail cargo vessels. Once we know what changes are required, the design will be modified accordingly and production will commence in a purpose built facility. This process was originally slated to take years. Thanks to the Fijian's /'can-do' attitude and increasing alarm about climate change and how little is being done to combat it, it will happen much quicker. The production is intended to be state of the art in both build methods and co operative ownership, both here and as a model for similar facilities in other island nations. As a by-product of the work we are doing turning unwashed, unsorted waste plastic into reliable, useful structural items, it may also have zero waste. The UNDP grant also covers setting up boat building classes at CATD for the mini cargo proa and the paddling canoe for near shore fishing.



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Ronstan Australia: Winches and deck gear

Intra/inter island ferry/cargo vessel for servicing remote villages

It is assumed the reader has some knowledge of sailing and boat design. Those who don't should contact Rob Denney (harryproa@gmail.com) for further explanation of anything which is unclear.

Shipping goods and people in the Pacific is currently carried out by outboard powered skiffs for short distances and large diesel powered ships for longer trips. The skiffs are small, frequently overloaded and are best described as an accident looking for a place to happen. The ships are too large to access many villages which then have to rely on either skiffs or cross island trucks to get to the port. Both use large amounts of fossil fuel and require constant and expensive maintenance which is often neglected, resulting in frequent breakdowns.

In order to alleviate these problems we designed the harryproa cargo ferry. After extensive consultation, we arrived at the following requirements:

- The capacity to sail up, down and across the wind, in restricted spaces, in light or strong winds and in shallow water. ie, it should only require an engine when there is no wind. The engine requirements for this are much lower than for a boat which is primarily powered, with sail assist.
- Easily and safely handled, including loading and unloading by 2 crew for trips up to 2 days duration.
- Shallow draft and tough structure for beaching to load/unload.
- Built and repaired by local semi or unskilled labour with minimal equipment and easily obtained materials.
- Minimum structure and maintenance.
- Large, stable tender for accessing places the mothership cannot reach.
- Easily accessed stowage space for 10 tonnes of cargo.
- Comfortable covered seating for 25 passengers.
- Cyclone proofed as much as possible.

The boat type that best fits this requirement is a harryproa, (www.harryproa.com) which is essentially a large, decked in outrigger canoe. It has one long hull with the rig mounted on it and one small hull which provides stability under sail and crew accomodation. The benefits of this are:

Easier to sail. A proa shunts instead of tacking and gybing. Shunting is a low stress operation that does not require boat speed or coordinated crew work. The boat can be maneuvered with less sail area and crew effort, in more confined spaces than conventional boats. Apart from shunting, sailing techniques are the same as conventional boats. The loads on the structure do not alter appreciably regardless of whether the long hull is loaded or not. The boat will sail faster when empty, but the loads on the beams and rig are unchanged, saving structural weight. Harryproas are typically ~65% the weight of similar catamarans.

Proas originated in the South Pacific and are still quite prolific in smaller sizes. The harryproa continues this heritage and updates it by taking advantage of modern materials and construction. Though this is a new design, all aspects of the design have been tested on a variety of different harry proa designs that are currently sailing. The requirements are addressed as follows:

The capacity to sail up, down and across the wind, in restricted spaces, in light or strong winds and in shallow water. There are 3 essential elements of a boat's design for upwind sailing: Rig, leeway preventer and hull shape. The rig is 2 mainsails on unstayed masts which rotate through 360 degrees. This allows them to be completely or partially depowered by easing a single sheet. It is not necessary to lower the sails to reduce the drive force in a squall or unexpected drama. They can be made appreciably larger than conventional sails due to this. The extra area enables lighter air sailing. If reducing sail is necessary, it is an easily controlled process with the boat stopped and no flogging sails or ropes thanks to the full length battens in the sails.

Sail shape is controlled by the flexible mast and a self vanging wishbone boom. The boom is well above head height for safety reasons and acts as a bag for the sail when it is reefed or lowered. The rigs are each controlled by a single sheet. The loads on these and the halyards are low enough enough to be handled by manual winches.

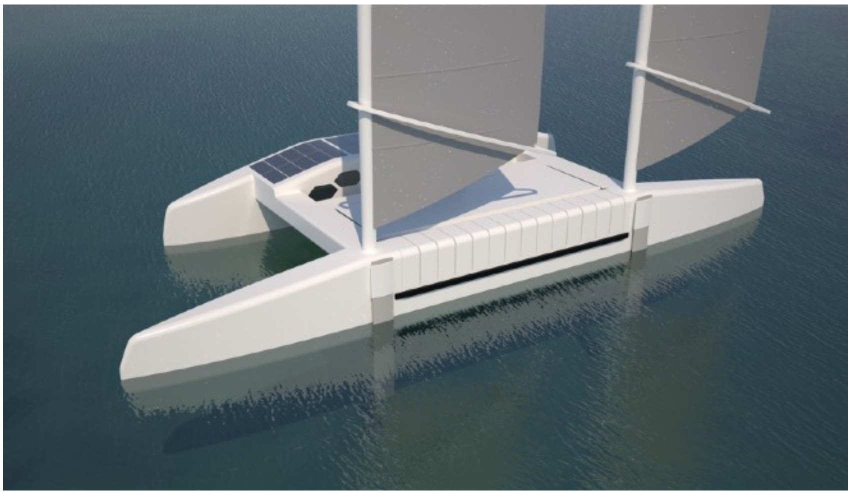
The leeway preventers are oversize rudders, mounted on the side of the lee hull. These give improved maneuverability and can be lifted to balance the steering loads, for sailing in shallow water and for beaching. They kick up in the event of a collision or grounding. Similar rudders have been in use on harryproas for 20 years.

The hull shapes are flat bottomed with small radius chines and minimal rocker. These have been shown to be highly efficient both theoretically Michelet and practically.

Easily and safely handled by 2 crew:
Raising the anchor and the sails to get under way will require both crew, sailing only one. The rig and rudders can be balanced so the boat self steers on most points of sail, leaving the on watch crew to navigate and keep a look out.

The original concept carried the freight in the leeward hull. This required a lot of organization and double or triple handling to load and unload, much of it manual. The scope for error and discontent was large. We decided to follow big ship practice and stow as much of the freight as possible in boxes, which were stored on the deck.
These boxes are fibreglass, buoyant, waterproof and can be fitted with refrigeration.
The standard size is 1.2m x 1.2 x 1.2m, with half, quarter and eighth sizes also possible. The boxes have channels in the bottom which match ridges in the deck to stop them sliding. The channels also locate lifting straps so up to 6 people can be used to carry each box. The boxes are loaded onto the deck using the booms as a crane.

It is expected that the boxes will become as useful and ubiquitous as their steel counterparts. Producing them will be another income producing operation for the boat builders.



Shallow draft and tough structure for beaching to load/unload: Empty weight is ~6 tonnes with10 tonnes cargo capacity. Draft is ~0.5m/20″ fully loaded, ~0.2m/8″ empty. This enables it to be beached at half tide, unloaded/loaded at low tide and sailed off at half tide.

The hull bottom is heavily reinforced for landing on sand and 3 easily deployed skids (2 under the long hull, 1 under the short one) are used for coral or rocks. The bottom of the hull is flat, so replacing or repairing the reinforced area is a simple matter of gluing on a replacement sheet between tides.

Minimum structure and maintenance, built and repaired by local semi or unskilled labour with minimal equipment and easily obtained materials:

Composite boat building has undergone a revolution in the last decade. Vacuum infusion of laminates has removed most of the mess, wastage and labour resulting in lighter, cheaper and much easier to build hulls. If the hulls are specifically designed for infusion, the savings are even larger. Infusion requires a vacuum pump, but apart from scissors and utility knife to cut the fibreglass and foam, few other tools.

Conventional boat building requires full size, expensive moulds and a skilled workforce. The harryproa hulls, beams, booms and bridgedeck are all single curvature shapes built in low cost moulds made from mdf or similar materials, which can be cut and joined using hardware store tools.

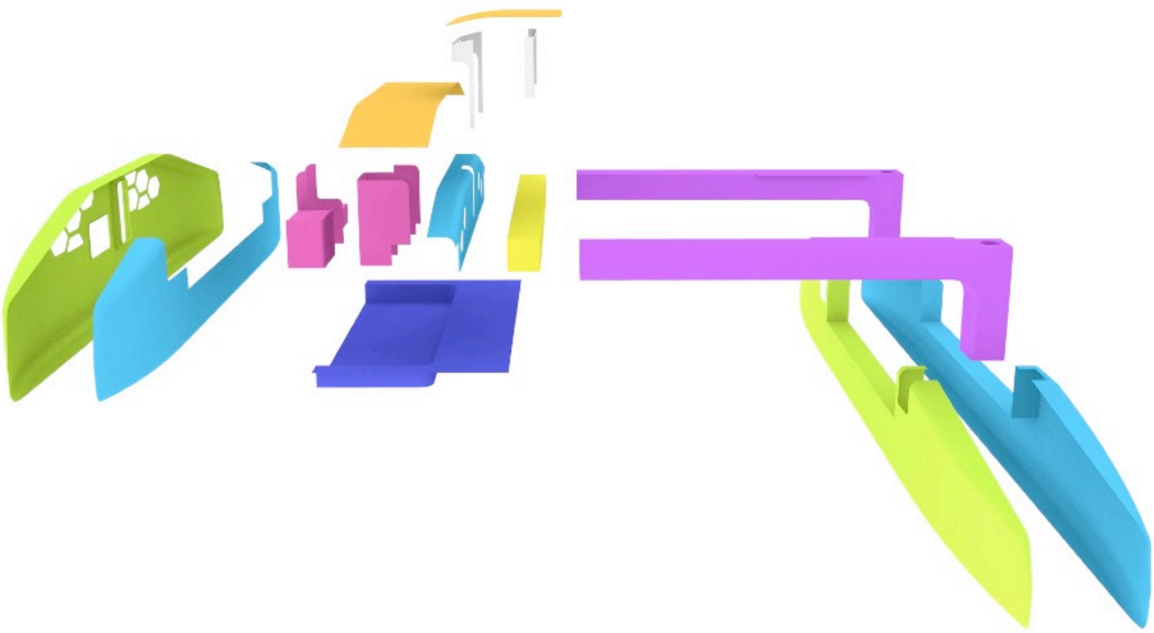
The hulls are identical apart from the length of the flat centre section. They are also symmetric top and bottom, with parallel sides. Hence, a single quarter hull mould can be used for both hulls, which are built in sections, with male/female joins which are bonded together. The joins, hatches, mast and beam reinforcing, ribs, stringers, furniture landings, doors, window spaces, shelves, etc are all included in the infusion.

Most of the work in building the moulds, cutting and placing the fibreglass, infusing and assembling the components is unskilled. A supervisor is required, but the rest of the labour force could be local. By the end of the job, they would have a very marketable skillset.

It would be possible to build the boat in the open, but a covered space (tarpaulin/tent off the side of a shipping container for example) would allow progress when it was raining.

There are 3 options for the hull construction, depending on use, cost and survey requirements.
Solid fibreglass using woven rovings,
Solid fibreglass with stringers and frames for panel stiffness. This is slightly more complicated to build, but is lighter and cheaper.
Cored construction using PVC, PET or polystyrene foam, cork, plastic honeycomb or a combination of these.

This is as easy to build as the stringer/frame option, but lighter again.
The masts, beams and rudders are built using similar techniques to the hulls but from fibreglass and carbon in its low cost unidirectional form.
Plant based resins and greener alternatives to fibreglass (flax, hemp, sisal etc) are available, but at present are more expensive.



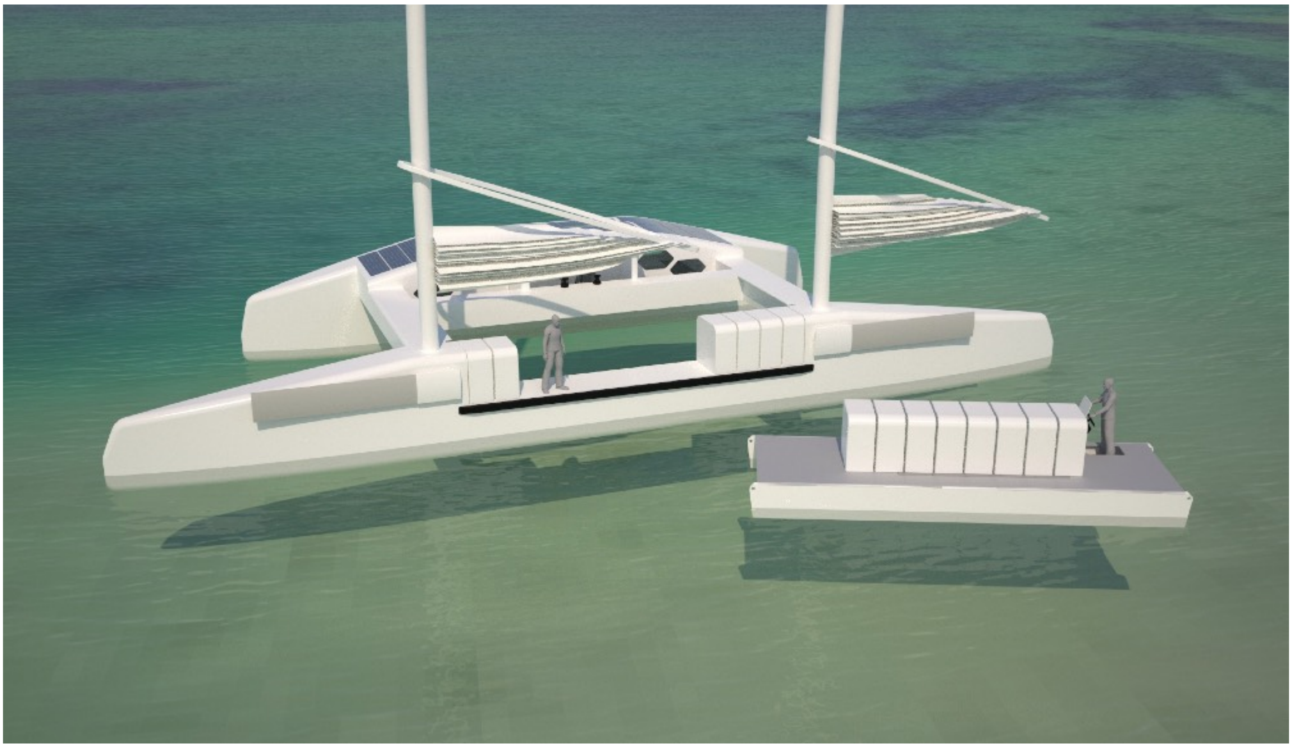
Because the boat is simple and voyages short, little fitting out is required. Icebox, 2 bunks and a cooker for the crew for overnight trips, composting toilet and bench seats for the passengers. Radio, lights, chart-plotter and AIS are run off a small battery and solar panels.
There are no holes in the hulls below the waterline and no deck fittings apart from turning blocks to route the sheets to the control station and a pair of winches for the anchor, halyards and sheets. Steering is simple wheel/chain/line to a quadrant on the rudders. Almost all fittings are bonded in place, eliminating bolts, screws and potential leaks.

The sails are of comparatively high tech material, chosen for low stretch and longevity. The panels could be machine cut in Australia, then assembled and sewn on site. The unstayed schooner rig has no headsails and minimal rigging (halyard, sheet, 2 x 6:1 blocks and tackles per sail). The sails are tied to the non rotating masts eliminating sail track, batten fittings and mast bearings. Apart from an occasional wash down with fresh water, no maintenance is required.
Temporary repairs to flat or single curvature fibreglass panels is simple: Remove the damaged material, cut a sheet a little bigger than the hole and glue/screw it in place over the hole. Permanent repairs are not much harder.

The ropes and sails will have finite lives, but with a long period of obvious deterioration giving ample time to replace them.

The bottom of the hulls will need to be kept free of growth for best sailing performance, perhaps once a fortnight to minimise the work. This can be done in waist deep water with no need for the scrubbers to get their heads wet.
The composite components will not need any maintenance apart from painting every 10 years or so with industrial paint to protect them from the sun. The unstayed masts do not require regular inspection or rigging adjustments to keep them straight. There is no wood to rot and apart from the anchors, chains, motor and a couple of wear surfaces, no metal to rust.

Large, stable tender for accessing places the mothership cannot reach:
The 9m long, 3m wide, 0.7m high catamaran tender is built with similar techniques to the mother ship. It has payload of 2 tonnes and excellent seakeeping.
It's primary purpose is to power the mothership when there is no wind and for manoeuvring. The tender will also be used to access the few places the mothership cannot and in settled weather, to make short side trips to deliver/pick up passengers/freight allowing the mothership to continue sailing.



The tender bows are attached to the beam on the mothership with a hinge, allowing the tender stern to be lowered and the outboard used to power the mothership. This is the only source of external power for the mothership, which would be expected to sail anywhere as long as there was more than 6 knots of breeze. In less than this, the tender would propel it at ~6 knots.

There are a number of powering options:
Solar electric motor on a lifting leg. There is ample deck space for sufficient solar panels to power the boat during daylight hours. Beyond that, batteries and/or a gen set would be required. Apart from the environmental benefits of solar/electric it is possible to get near fully sealed, maintenance free systems which can be monitored by smart phone, thus removing the potential for operator error and maintenance.

50 hp diesel or petrol outboard with all the fuel and maintenance issues inherent in these.
Deck mounted diesel and lifting drive leg. This engine could be a lot simpler (air cooled, no electronics,

crank start, reduced and easier maintenance) and could use coconut oil as fuel if the crew were aware of the issues involved.

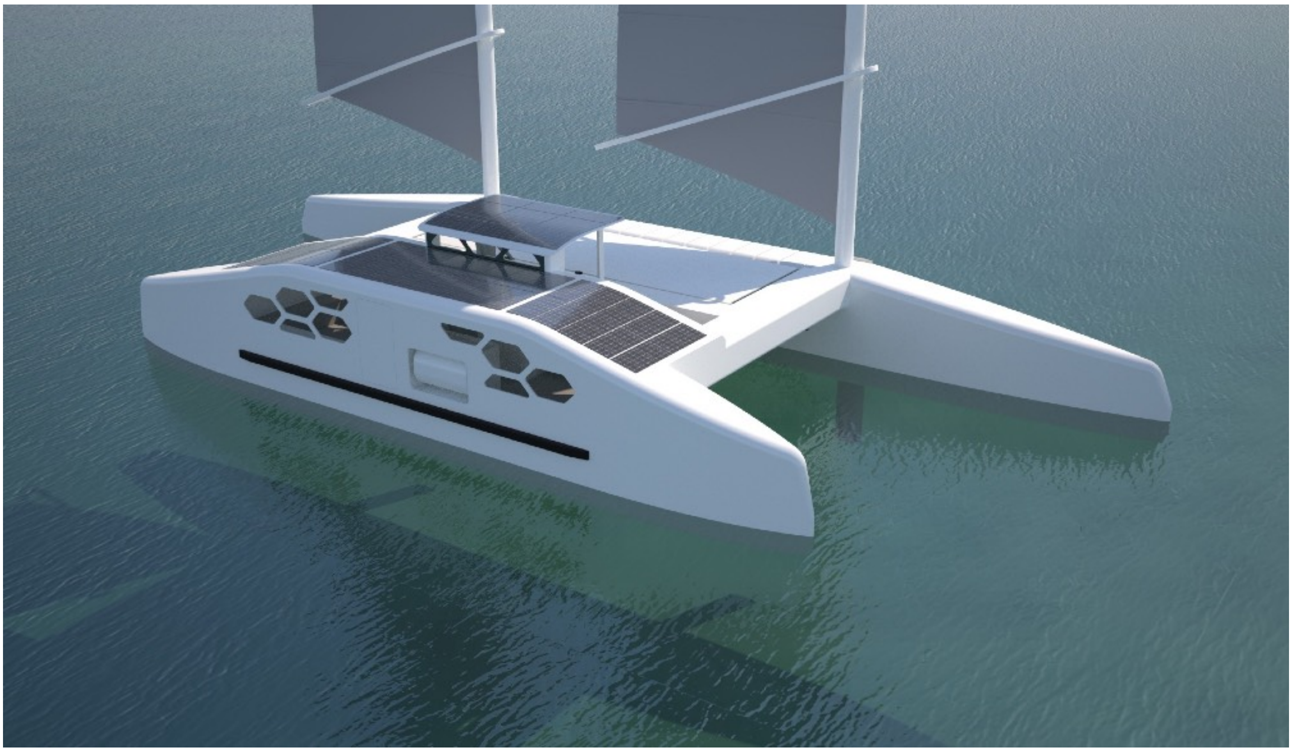
Easily accessed stowage space for 10 tonnes of cargo:
The long hull has the masts and the beams at 25% and 75% of it's length. The space between them (9m x 2.8m high x 1.2m wide) is for cargo. Long items can be stored in this space, but the majority of freight will travel in deck boxes, loaded and unloaded using the booms, halyards and winches as cranes. 12V electric winch handles for the cranes would make the job easier.

Comfortable covered seating for 25 passengers:
Bench seats around the cabin in the windward hull provide seating with plenty of space for moving around and storing luggage. This area is separate from the crew's quarters in the ends of the hull and blocked off from the wheel, winch console and navigation station from where the boat is sailed. There is also safe seating/lounging space on the deck if the weather is suitable.

Access to the cabin is via a stairway on the windward side of the boat.
Boarding is through an opening in the cabin side. The door can double as a gangplank if required.

Cyclone proofed as much as possible:
Cyclones are a fact of life on the proposed routes. With enough warning, harryproa cargo ferries have enough sailing speed to sail away from the path of a cyclone if the forecast and options permit. Alternatively, they are light enough to be pulled up a beach on rollers using the boat's winches. The rigs can be removed by the crew using a simple gin pole in a couple of hours. The rest can be tied down or separated and the components moved to a safe spot. They are also shallow enough to shelter in mangroves where few other boats can access and require smaller ground tackle on a cyclone mooring than equivalent boats, especially with the rigs and their windage removed. The shallow draft also means that if the boat is blown onto a beach, it sits at the water's edge, removed from the full force of the waves.

The interest in the sailing cargo ferry has been high, and from all over the world. It has also inspired a number of people to consider a boat of this size for other purposes, the most popular of which is as a live aboard world cruiser. The scope that a boat of these dimensions offers for such a craft is immense. Double cabins with island beds and ensuites, huge galley and living spaces, plenty of room for lounging inside and out and a payload of 10 tons meaning near unlimited toys! All with the signature harryproa ease of handling (2 people can easily manage getting under way, one can handle it under sail or motor) and performance.



The other popular use is as an expedition boat. Carrying up to 20 people for rapid trips to and from remote areas for up to a month with enough room and payload for the food and equipment such trips require and for everyone to still be on speaking terms at the end of the trip. Essentials for this use are a nice motion and easy handling by novices. The harryproa meets these requirements better than anything else available.

One of the surprising things about the cargo ferry is the low cost and weight. This is entirely due to Intelligent Infusion and all the savings that flow from it. A live-aboard version could be considerably lighter, without all the certification and overbuilding required for a hard-working people carrier. It would also be cheaper to build, offset by the cost of the fit-out for private use. A whole lot less cost than a 'state of the art' catamaran. Plus it sails faster, has more space and is easier to operate.

CARGO FERRY SPECIFICATIONS

Length leeward hull: 24m/80'
Length windward hull: 17m/56'
Beam: 9m/30'
Hull Width: 1.2m/4'
Beam Clearance loaded: 1.2m/4'
Empty weight: 6 tonnes/tons
Sail area: 200 sq m/2,150 sq'

CARGO
Capacity: 10 tonnes/tons
Deck Boxes: 16 x 1.2m x 1.2m x 0.6m / 4′ x 4′ x 2′ with optional half and quarter sizes.
Over size (timber, sheets, drums, etc): max 10m x 3m x 2m/33′x10′x7′

PASSENGER ACCOMMODATION
Seating: 25
Standing headroom: 2m/6′8″
Toilet: 1 x composting/dessicating

SAFETY
Capsize proof: Sheet release attached to simple heeling/pitching waterline sensor
Unsinkable:
Foam cored, 8 watertight bulkheads per hull and cushion bow

OPERATION
Minimum 2 crew, inside/outside sheltered steering, helm separated from passengers, 360 degree vision

TENDER
Length: 9m/30′
Beam: 3m/10′
Passenger capacity: 10
Cargo Capacity: 2 tonnes/tons

Estimated cost: $AUS250,000/$US175,000