

Case Studies of Previous Pacific Trials and Research into Sustainable Sea Transport

In the search for new low carbon sea transport solutions to combat the challenges posed by greenhouse gas (GHG) emissions and crippling imported fossil fuel dependency faced by Pacific Island Countries (PICs) it is important that we are cognizant of the rich lessons available from history; both distant and recent.

Oceanic knowledge of the past has always been used to adjust to cultural and natural changes. Many Pacific cultures echo the Hawaiian view of time where the past is referred to as *Ka wa mamua*, or “the time in front or before” whereas the future is *Ka wa mahope*, or “the time which comes after or behind.” Such orientation is eminently practical, for the future is always unknown, whereas the past is rich in glory and knowledge.

It is logical as a first step in the transition for sea transport in the Pacific to examine the evidence available from past experiments in this field. In this chapter we explore a series of case studies for lessons from experience that can aid us in our current search for solutions for the near future. A number of core lessons can be distilled from these cases that are of direct relevance today.

Lessons from the storehouse of culture and heritage

We start with the incredible legacy of Pacific seafarers, the peoples who developed the world’s first bluewater technology.

The Story of the *SS Tokelau*

This story comes to us from a century ago and from one of the smallest and most remote countries in the world – the atolls of Tokelau.

Lessons from Pacific responses to the 1980s oil crisis

We examine a range of experiments with renewable energy technologies in the Pacific from the oil crisis in 1973-1986. There were a number of critical trials in various Pacific locations. Some never got past design stage but in other instances they proceeded to full blown trials.

1 Look First to the Past: Lessons from Heritage

“We carry the cultural and historical inheritance of ocean navigators of peerless skill and their courageous kin who crossed vast distances before the tribes of Europe had ventured forth from their small part of the earth.”

Ratu Kamisese Mara, Prime Minister of Fiji, 1999

The first successful trials of renewable energy shipping come from the deep past. With highly advanced understanding of sail and hull form and function ancestors of today’s Pacific islanders created sophisticated deep ocean vessels centuries before humans anywhere else. On such craft they colonised the entire Pacific over



Historic Legacy.



SS Tokelau.



1980s oil crisis trials.

millennia, made it their home and were at home on it – long before most other global cultures had learnt to sail over the horizon. The sea transport solutions they crafted, designed, developed and perfected are arguably the greatest technological heritage of the Pacific Ocean. In their day they were the fastest sailing machines known and were navigated over extreme distances by exceptional sailors. They maintained huge logistical kin, diplomatic and trade networks. All of this was achieved without metal. The resource base available was extremely narrow – sticks, stones, grass, bone and sharkskin. This meant a different paradigm of naval architecture and ocean connectivity had to be developed. It was this thinking that led to the multi-hull: catamarans, the asymmetrical hulled *proa* and eventually the battleship of the Pacific, the *drua*.

Across the ocean were developed an extreme diversity of hulls forms, sail types and carrying capacity. Different cultures' approaches to sea transport were shaped both by need – how far to the next land or trading route or kinship network and what sort of sea conditions were likely – and by the resource base to build vessels – from the timber and stone rich high islands of the west, to the high but far-flung islands of the south and east, to the timber, stone and fibre impoverished atolls of the north and centre. Different predominate wind patterns changed vessel type and function – from the forerunner of the modern hydrofoil in equatorial Santa Cruz to the ocean lateen sails of the tropics to the predominance of paddle power over sail in changeable temperate Aotearoa and sub-tropical Hawaii.

In this era the sea transport of the Pacific was entirely powered by renewable energy – both wind and human power. Pacific peoples mastered the ability to design and operate long-range bluewater fleets using such technology. Such vessels were not only renewable energy powered but must be considered largely sustainable in their construction and maintenance – using only naturally occurring, bio-degradable and largely self-replenishing resources.

Such technology was displaced by incoming European technology post contact and colonisation until it now only exists in small pockets. Early European vessels were also renewably energy powered – again wind almost exclusively. They in turn gave way to screw propeller driven vessels – powered first by coal-fired steam engines and then by oil. Such vessels easily dominated sailing ships due to their ability to drive loads to windward, albeit at an energy cost. The relatively low price of fuel and ever increasing gains in engine efficiency and power through most of the 20th century saw such technology assume a complete monopoly. With all but a few critical exceptions, the combustion engine fuelled with oil derivatives, now totally dominates Pacific shipping. Today, only isolated pockets of traditional sailing knowledge remain – primarily on the most remote islands of the Pacific.



Selected Herb Kane's images (4) of Pacific's seafaring heritage.

The characteristics of today's sea transport are radically different for Pacific islanders today than it was only a few generations ago. The Ocean itself has not changed – if except to become more lifeless, acidic, warmer and infinitely more polluted – it is the still the same physical distance from Port Moresby to Honolulu. What has changed is the human interaction with the ocean. There has been a massive sea change in the way Pacific peoples move *on* the ocean. This is not just restricted to the technology. Ownership and management of all but the smallest shipping assets has moved from being village and island centred to private companies based in urban centres. Localised control over transport solutions has been lost.

Ocean transportation has long preoccupied the inhabitants of this ocean. The solutions the ancestors arrived at placed them at the cutting edge of technology, design and logistics. The *vaka*, ocean-going vessels, were generally efficient and varied in design. The double-hulled vessels of eastern Polynesia were capable of sailing safely and quickly over many thousands of kilometres, the *tongiaki* of Tonga and *lakatoi* of PNG of carried extreme loads and the *flying proa* and *drua* of Micronesia and Central Oceania evolved to solve the riddle of sailing to windward. By exploiting learned knowledge of navigation, ship design/construction, vessel operational management and the ability to sail to windward on an apparent wind they made this ocean their home. To simply call them “canoes” gives a misleading impression of the scale of the world's first ocean-going technology.

Such technology was highly developed and functional, diverse in type, readily available and an essential facet to all aspects of life – from artisanal fishing and local village transport to inter-island/inter-archipelago warfare, trade and diplomacy. It was totally indigenously designed, constructed, owned, operated, and regulated. Historic maritime analyses concur on a common picture at the time of European contact of an ocean heavily populated with indigenous sailing vessels of size and capacity comparable with or greater than that of the arriving Europeans.

From primitive and cumbersome craft to highly sophisticated design exploiting complex knowledge of aero and hydrodynamics, vessel design and operations evolved and transitioned throughout the colonisation and settlement of Oceania. Vessels went from mono-hulled rafts to outriggers and Oceanic peoples invented catamarans, and then proa. Development of sail technology became advanced and specialised – leach cords, using apparent wind, reefing and systems for spilling excess wind were perfected. The ability to manoeuvre at speed to windward gave these craft capacity that visiting Europeans could only marvel at. There was no hesitation in adopting new concepts. Tongans transitioned from the load carrying but clumsy *tongiaki* to the sleek *kalia* within a generation.

Excellence of vessel construction and use was combined with advanced knowledge of navigation, star patterns and weather



Fijian camakau.

patterns. Without compass or chronometer Pacific peoples have been praised unilaterally for their ability to name and navigate extreme distances. With the ability to move at will across long and known passages came repeat voyaging and the establishment of trading networks. There are numerous examples from across the ocean. Within and between archipelagos such as Vanuatu, the Solomon Islands, Fiji, Tuamotu, Tonga and Polynesia and the atoll chains of Micronesia trade and connectivity was on a significant scale. The Tongans in particular are famed for the length of their range and the reach of their military. Polynesian outliers, most likely back migrations from central Polynesia, are found many thousands of miles apart. The extent to which these were repeated voyagers is unknown. Certainly in central Oceania, there was well-established trade between Tonga, Samoa, Fiji and the other nearby islands over millennia. Such contact obviously waxed and waned throughout history.

As a case example we look at the *Wa*, the vessel of the Caroline Islands. The *Wa* (or *Walap* in Marshallese) look the most fragile of vessels. Yet it is arguably the finest and highest performing design from the Pacific – sleek, robust and exceptionally fast. *Wa* are *proa* – asymmetrical hulls with identical bow and aft, allowing the craft to reverse without tacking and with the smaller hull always carried to windward. Carrying an ocean lateen rig, it could sail as close to the wind as most modern yachts. But these were working ships, travelling and trading extensively.

Voyages of hundreds of kilometres across open ocean were commonplace, and a "brisk trade" was carried on with the Mariana Islands to the north. Trade items included shells, tapa cloth, wooden vessels, cordage, iron, copper, nails and knives. Rai stones were brought from Palau to Yap. Physical evidence of contact with the Chamorro people of Guam in the far southern Mariana Islands includes pestles, fishhooks, and shell rings. In 1821, von Chamisso recorded a voyage of 370 km from Yap to Aur Atoll in the Ratak Chain of the Marshall Islands. Longer voyages of at least 1,600km between the Carolines, Philippines and Marianas were frequent. Star courses between islands were known on Puluwat for all major islands from Tobi, south-west of Palau, to Makin in the Gilbert Islands — clear evidence of repeated trips over various parts of this 4,800km-long region.

1.1 Lessons Learnt

There are a number of important lessons that can be distilled from the historical narrative.

Firstly, the sea transport solutions that were developed were those appropriate to the environment and the sea transport needs. The skills sets that were developed over millennia, in terms of vessel design and construction and then the seafaring knowledge to use those vessels, reflected the environment in which they were invented. This led to development of unique solutions. Lack of metals in particular led to multi-hull design and



Marshallese walap (2).

the predominant tropical weather patterns led to remarkable advances in sail design.

Secondly, the technology did not exist in a vacuum but underpinned large networks of kinship, political allegiances and trade connectivity. The ocean was a highway – not a barrier. As the Pacific moves into an uncertain 21st century, its ability to remain connected with itself regionally will to a large extent depend on its ability to maintain economic ties, particularly trade, internally. It is important we understand what has already preceded before we plan for a new future.

Thirdly, in a transition to a low carbon transport future, wind-powered technologies are likely to be a critical ingredient. Valorising exploits of Pacific ancestors and their proficiency and pre-eminence in all aspects of seafaring is a useful conduit for introducing new paradigms for future transport use.

Finally, prowess and excellence in seafaring comes from the evolution of an oceanic culture forged through continued and continual voyaging and intimate connection with a maritime environment.

2 A Lesson from WWI – Tokelau and the *SS Tuncurry*

This case study comes from the country of Tokelau, one of the smallest and most remote in the world. Tokelau is a self-governing New Zealand territory that lies about 500km north of Samoa. It consists of three tropical coral atolls (from the northwest Atafu, Nukunonu and Fakaofu) lying in a line nearly 200km long, with a combined land area of only 10km² and a population of approximately 1,400 people. Its highest point is just 5 metres above sea level. There are no ports or harbours, no airport, no deep-water passages into the lagoons and nowhere a large vessel can safely anchor. Visiting ships can only seek refuge in neighbouring Samoa, at best more than a day's sail in a fast vessel to the south. Shipping is the only means of connectivity.

According to archaeological evidence, the islands were settled by Polynesians about 1000 years ago. Tokelauan society was ruled by clans. Each atoll was independent until the 18th century, when Fakaofu conquered Atafu and Nukunonu and united the three atolls. Inhabitants lived a subsistence lifestyle, relying on fish and coconuts for sustenance. In 1889, the islands were claimed by Britain and administered by the Resident Commissioner of the Gilbert and Ellice Islands.

In 1909 the British government purchased the *SS Tuncurry* to service the tiny protectorate from Samoa to the south and the Gilbert Islands to the north. Renamed the *SS Tokelau*, she was a wooden carvel steamer built in 1903 by John Wright at Cape Hawke, NSW, Australia. Just over 35 metres in length, she was 162 gross tonnes and capable of carrying some 90 tonnes of load.

This capable little ship was driven by a single screw powered by a



SS Tokelau (2).

steel boiler producing 830kPa of steam which fed into a 25kW compound steam engine. Under this arrangement the vessel was able to achieve a speed of 9 knots. The boiler was designed to be coal fired, of which there was a plentiful cheap supply in her native Australia, but could be supplemented with wood if necessary.

She was ideal for the British Western Pacific Territories having good passenger accommodation and cargo carrying capacity and of a handy size for manoeuvring in the narrow reef passages of Samoa and the Gilbert Islands. There was only one major downside. Coal bunkering was available, albeit at a high cost, in Samoa but not elsewhere in the Territories and timber to fire the steam boilers a scarce resource in the outer islands and atolls. The lead up to World War I was foreshadowed by a global energy supply crisis in the dominant fossil fuel of the era and with the outbreak of war coal for the island colonies was strictly rationed.

This did not affect the *Tokelau*, as on its transfer to colonial service it had been modified into a yacht with a ketch rig. In this manner she supplied a flawless service to the atolls of Tokelau and the islands of the Gilberts before being sold “in perfect condition” in 1916. The main routes from Samoa lie directly across the prevailing trade winds, providing a steady beam reach on most runs with a consistent 20 to 25 knots of trade breeze for the majority of the year. The steam motor was therefore only primarily required for entering port at either end of its passage.

The critical importance of reliable sea transport for these remote islands is clearly shown in this extract from 1910 where the vessel was used in the distribution of aid during a famine induced by drought:

“The Gilbert Island natives are in a terribly bad way owing to the severe drought. Private advices received in Sydney today by the mail from the islands tell of the, distress among the natives. No rain has fallen at the islands for months, and the native food supplies have become exhausted. The position became so acute that the Government steamer Tokelau was commissioned to proceed round the southern islands with rations for the distressed natives. Four whole districts on the island of Tapitania out of 16, besides many people from other districts, are being supplied by the Government. It is proposed to bring the people from the northern end of the island of Nonuti to the central village Matan, to facilitate the serving out of supplies. As much as 20 or 30 tons of rice is being distributed every few weeks to relieve the distress among the poor natives. The coconuts available on Nonata Island had been purchased by the Government for food supplies.”

Today, the cost of marine fuel is the single biggest budget line for the government of Tokelau and the fuel used to service the atolls from Samoa is responsible for some 70-80% of the country's energy footprint. Water security and disaster relief remains a continual challenge today, exacerbated by the increasing effects of climate change.

3 Lessons from the 1973-1986 Oil Crisis

There were a number of small but critically important experiments during the last oil crisis, several in the Pacific. These showed that for modest investments major savings in fuel using proven technologies were available for local sea transport and small-scale fishing. The end of the oil crisis in 1986 saw all these projects wound up prematurely. Today their findings are forgotten by the same development agencies that funded them 30 years previously.

We now examine six case studies from this period: UNCTAD-led work designing an energy efficient government freighter to service the Ha'apai group in Tonga; auxiliary sail retrofits of government freighters in Fiji; Japanese experiments with fixed wing sails on oil tankers; the United Nations Food and Agriculture Organization/United Nations Development Programme (FAO/UNDP) initiative with artisanal fishing craft across the Pacific; Jim Brown's work with multihulls in Tuvalu; and the EU funded *Tai Kabara*.

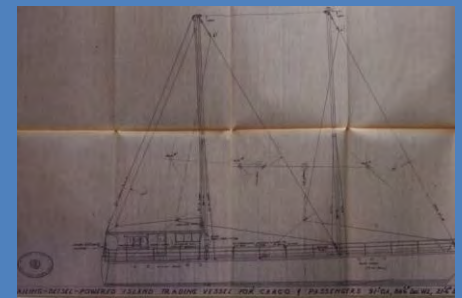
3.1 The Ha'apai study

Commencing in 1982 the United Nations Development Advisory Team (UNDAT), UNCTAD, and UNESCAP (United Nations Economic and Social Commission for Asia and the Pacific) combined resources to undertake a series of studies in the Ha'apai Group, Tonga. The principal objective was to investigate an energy-efficient government-operated vessel to operate between the Ha'apai group of islands in the centre of the Tongan archipelago and the capital at Nukualofa, 150 kilometres to the south. Having mapped the need and the options available, the project moved toward implementation in 1983. Securing funding proved difficult with donors citing *"insufficient insight into the financial and technical feasibility of the project."* Yet without funding a formal feasibility study was not possible. The vicious circle was broken by the United Nations Economic and Social Commission for Asia (UNESCAP) and the Asian Development Bank (ADB) providing the resources to recruit prominent UK naval engineers MacAlister, Elliott and Partners to work with local expertise to undertake the necessary evaluations and designs. They drew a sail-assisted general purpose vessel of 30m and capable of carrying 30 passengers and 30 tonnes of cargo with fuel savings projected at over 60%. It is assumed the sharp fall in oil prices after 1986 was the cause of no further development of this project. While we have the designs, the ship was never built.

This vessel was conceived to operate in tandem with smaller catamarans operating between the individual islands of the Ha'apai. A parallel study of the Lau group in Fiji is said to have reached a similar conclusion though records of this exercise have been lost.



Map of Tonga showing Ha'apai.



Design for energy efficient freighter – Ha'apai, Tonga.

3.2 Soft Sail Auxiliary Retrofits in Fiji

(see Fact Sheet – Appendix E)

In an experiment overseen by Southampton University and paid for by ADB, auxiliary sail rigs were designed and installed on the Fijian Government fleet of inter-island ferries. Two ships were retrofitted and operated. Each employed a novel standing wishbone construction on the mainsail to give a quadrilateral sail that could be furled on luff spars. The first ship was the 6-year-old *Na Mata-i-sau*, a steel-hull, passenger/cargo vessel, 27m LOA, 274GT with a single diesel engine.

Conversion was carried out at a Fijian shipyard and completed in September 1984 at a cost of USD 40,000, whereupon the ship operated normal schedules with a continuous log kept to record performance data. Good performance was obtained in both sailing and motor-sailing modes with substantial speed enhancement in the latter. The project reports list an impressive range of savings and benefits, well in excess of those projected at the start of the experiment. Contrary to predictions the vessel performed exceptionally well, realising none of the initial concerns over ultimate stability and leeward, and resulting in 23-30% overall average fuel savings plus multiple benefits in terms of increased stability (by more than 50% energy used), greater passenger comfort, and greatly reduced engine wear. Greater fuel savings could have been achieved if a feathering propeller had been fitted. Unfortunately, the vessel was lost after dragging its anchors on Moala reef in a developing cyclone in early 1985 but not before she was able to escape under sail alone after the engines failed and save the life of the Fijian Prime Minister, on-board at the time.

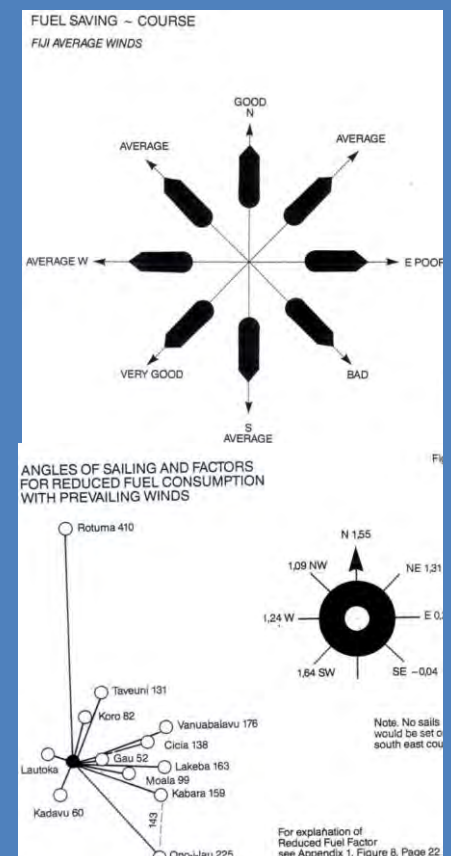
The rig of *Na Mata-i-sau* was rescued virtually undamaged and was subsequently installed on a somewhat larger ship, the *Cagidonu*. This retrofit was completed in December 1985 and showed demonstrated similar positive results on its inter-island schedules as with *Na Mata-i-sau*. The project report assessing the sailing performance recorded average fuel savings of 37% with all sails and 21% with mizzen and jib only.

Practical use of the auxiliary rig does not appear to have survived much past the end of the project monitoring. In part this may be attributable to the, by then, relatively low cost of fuel. In part it was due to the fact that the captain and crew received no reward or incentive whether they used the auxiliary rig or not. The lesson here is that a comprehensive programme is required. Simply offering up the alternative technology is insufficient.

As part of this experiment, Southampton University undertook wind data analysis of all known Fijian wind patterns to produce a comprehensive analysis of future wind-based route planning and predicted fuel saving coefficients for the main inter-island shipping routes in Fiji and Rotuma. This data remains invaluable for any



Fiji Trials.



Southampton University results.

future sail powered shipping attempt. That analysis appears to show that several of the “uneconomic” routes today, currently heavily subsidised by the Fiji government, are appropriate for sail assisted or driven vessels.

3.3 Japanese Experiments with Fixed Wing Sails on Large Vessels

In a similar experiment in 1980, Japanese oil tanker owners’ trialled an evolution of the historic “square-rigger” design, initially on a 1600dwt oil tanker, the *Shin Aitoku Maru*. These experiments are noteworthy in that the initiative was taken by the private sector supported by government research funding and thus provides an early example of a public private partnership (PPP). The Japan Marine Machinery Development Association and Nippon Kokan KK (NKK) designed, built and operated a series of air foil- rigged ships between 1980 and 1988. These rigs featured a central mast supporting a vertical rectangular steel framework with horizontal aerofoil shaped ribs. Computers were used to control the rigs to minimise extra crew requirement. In 1984 two larger ships put to sea, the 31,000dwt bulk carrier *Aqua City* and the 26,000dwt *Usuki Pioneer*.

The reported results were impressive with overall fuel savings of 30%, increased passage speeds, increased stability and greatly reduced engine wear. Contrary to initial concerns, the sail-fitted vessels were able to safely maintain course in typhoon conditions where sister vessels had to heave to. However, plummeting oil prices meant the rate of return on investment on the technology was uneconomic, especially given the cost and limits of the computer technology employed, and the experiment was largely discontinued. Some desktop technical studies of the era disputed the performance claims, suggesting overall gains of only 10% were achieved.

3.4 UNDP/FAO Artisanal Fishing Craft

(see Fact Sheet – Appendix E)

UNDP/FAO undertook a number of artisanal boat building projects globally between 1982 and 1989. In the Pacific, building on the work of Save the Children in Tuvalu (see below) FAO produced designs for ten different vessels, from a one-person paddling canoe to an 11m transport trimaran resulting in an experimental fleet of more than 350 artisanal fishing/village level transport vessels built in eight PICs, many as either pure-sail or sail-assisted designs. The uptake of the sail-powered vessels, however, was minimal and did not survive the life of the officially funded project, especially when oil prices crashed to near post World War II levels.

FAO concluded “the only places where a new type of sailing craft has gained acceptance are those where there is a living tradition of the use of sail”. Other key lessons learnt include the need for any alternative technology to be proven to have direct economic



Japanese Fixed Wing Sails.



FAO designs.

benefit or saving to the user and the need for an entire sailing culture to be re-instilled, including attention to in-country boat building skills and capacities. It also highlighted the shortcomings of short-term projects rather than long-term programmes.

The vessel designs were exemplary, have been well recorded, and are still available for future use. The Pacific assessments included a comprehensive analysis of the various options for designs, materials, and construction methods.

3.5 Save the Children, Tuvalu, and Jim Brown

Also in this period, acclaimed multi-hull designer Jim Brown worked for Save the Children in Tuvalu. Brown had previously worked on a global study of artisanal local craft that recorded that there were literally millions of small craft operating at village level and wrote optimistically of the potential for sail-powered technology to be immediately employed. Brown found that indigenously built and owned fleets throughout the tropics and sub-tropics are vital at community level for fishing and transportation, although there were major issues arising with perpetuating what has historically been sustainable craft. Fuel prices were far from the only problem. *“Often local vessel types have evolved through many generations to satisfy local sea-keeping requirements for a specific fishery or a given cargo of a given route. The construction of these craft is usually the supreme example of a local high technology, and that technology is very likely to have depended directly on local, high quality boatbuilding which is no longer in adequate supply.”*

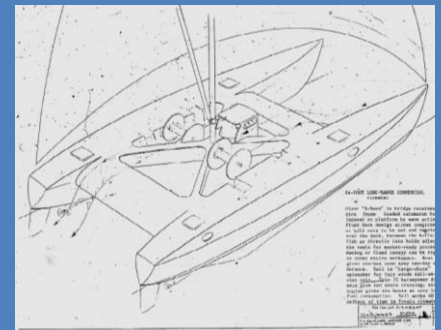
Brown believed that craft must be built locally and preferably in wood. *“Alternative boatbuilding materials such as fibreglass, steel, aluminium, and ferro-cement have been introduced into fisheries with mixed results. The cost of importing all materials can result in hull prices infinitely higher to the fisherman who is accustomed to needing zero cash money to acquire a boat ... Alien craft and mechanisation can aggravate the problem; especially if they tend to displace local boat builders and fishermen from traditional employment.”* Brown was the first to identify the negative impact importing designs and materials was having on local economies with locals assuming imports would be superior, leading to loss of locally-evolved adaptation and resilience. As wood is the mainstay of traditional local boatbuilding, he found environmental degradation and deforestation had left many communities with an inferior and diminishing resource in any case.

Brown designed alternative vessels and production methods in Africa, the Philippines, and then Tuvalu, adapting wherever possible local designs and using local materials. In Tuvalu this led to experimentation with first catamarans and then *proa* designs. There are close parallels with the needs and solutions Brown identified in Tuvalu and current Fiji research.

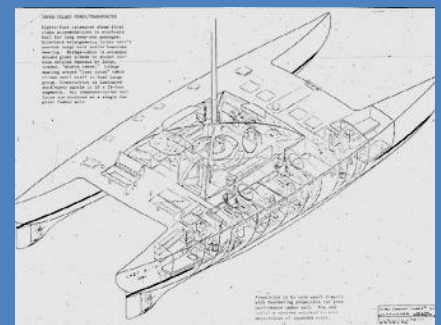
Brown is the first of these case study commentators to highlight that the savings from changing technology are not restricted to the



Intra-atoll lagoon taxi, Tuvalu.



Jim Brown design for 64' long liner.



Jim Brown design for Tuvalu.

vessels themselves. Multihull vessels are shallow draught and therefore not as reliant on shore-side infrastructure (channels, jetties, docks) needed by a deep draught mono-hull vessel. *“These harbour facilities often cost far more than the vessels which patronise them and are subject to storm damage and high maintenance costs ... Supernumerary to these investment savings is the matter of the multihulls’ miserly running costs.”*

Again in common with FAO, Brown left a legacy of designs that are valid candidates for further investigation today as they were 30 years ago. Brown’s description of the issues facing Tuvalu is relevant today and echoes across Oceania. *“Tuvalu is located at the end of a long and precarious line of industrial supply. Gasoline costs \$4 per gallon; packaged food pulses through the archipelago with jarring irregularity and island communities become further disinvolved [sic] from sources on which they increasingly depend.”* These trends have only increased over time.

Brown identified a prioritised list of applications for alternative vessels for Tuvalu, noting that all but the last represent a return to former capabilities:

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

There is no reason to suppose these priorities will have changed. While Brown’s prototypes and analysis have not resulted today in widespread adoption of sail-powered technology in Tuvalu, his 1982 insights are even more applicable today.

Thirty years ago Brown saw that sails offered easy access to renewable energy, with more immediate humanitarian results, than any other method of transition to renewables. His craft were all designed to take advantage of local, traditional wisdom and materials, combining with appropriate modern technology. He sought to involve local people in a closer relationship with the energy source, and to participate in all stages of construction and operation. *“Talent and capital must be directed towards 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.”*

3.6 *Tai Kabara* – the hand built, EU funded Island Freighter

(see Fact Sheet – Appendix E)

The *Tai Kabara* was built at Naikeleyaga village on the remote island of Kabara in the southern Lau group of Fiji by traditional boat builders between 1984 and 1987. Although only one vessel was constructed, the initial proposal was for an inter-connected fleet of three vessels servicing the Lau and Lomaiviti groups.

The plans for *Tai Kabara* were drawn up by naval architects at the

(then) Fiji Institute of Technology's maritime school. She was a 50 tonne, ketch-rigged vessel of classic carvel plank on frame construction with a full keel, secondary bilge keels or runners and cut away forefoot to allow for beach landing. *Dakua* planking, copper fastenings, and cotton caulking were all brought from Suva, the *vesi* keel, stem, and frames were cut on Kabara, as were the other scantlings from a variety of local timbers. All construction, down to caulking of the hull and construction of the standing rigging occurred on the island, in the main using rudimentary hand tools, a chainsaw and such power tools as could be run off a small portable generator.

The vessel operated successfully as an island-owned and operated trading vessel through the Lau group for the next two decades, surviving two cyclones and several beachings, before being either sunk or scuttled in Suva harbour in 2008 where her hulk can still be seen at low tide. For a number of years, she was the only vessel regularly servicing this remote and economically marginal island chain.

The memories of the *Tai Kabara* were obviously "bitter-sweet" for the island builders. In their recollection, the vessel had worked well while it was in undisputed island ownership but the installation of a Lister diesel auxiliary after three years of island operation saw ownership and management shift to the Lau Provincial Council and disputes over the management of the vessel and the use of the profits arising from her operation. The *mataisau* were obviously immensely proud of their ability to build the vessel in the first place and when interviewed recently said they would relish the opportunity to build another.

Further data on the *Tai Kabara* project has proved difficult to source. The original plans and project documentation held in Kabara were destroyed in Cyclone Gavin. Staff at the Fiji EU office have since changed several times and no corporate memory of the project exists. There are obviously political sensitivities surrounding the fate of the vessel resulting from the dispute between island and provincial councils that still rankle to this day. Even with the savings in fuel from being a primarily sail driven vessel, government subsidies were necessary to maintain the operation economically.

Despite this, the vessel itself certainly provided proof of concept. Because of their geographical position, communities in the outer islands of Fiji depend mainly on sea-transport for provision of the ordinary necessities of life. Comparatively few of these islands have airstrips and those which do are available generally for light aircraft of limited carrying capacity. This case highlights the problems facing these communities because of their dependence on sea-transport. Because of the small populations any form of sea-transport is not viable commercially without some form of government subsidy.

The case example is noteworthy from a number of perspectives. The vessel type is not dissimilar to the type of small, locally built



New Build Soft Sail, Fiji.



Map of Fiji showing Southern Lau.

ships that dominated island trade from the turn of the century to after World War II. Local participation to the limit of available capacity was employed in designing, sourcing materials and construction, all of which were clearly well within the capabilities of the local community, but long-term control over ownership and management ultimately were not. What began as a donor-funded and island community-based adaptation strategy that appears to have shown strong initial success, was subverted as ownership shifted, first to local government and then to private interests.

At the time of her demise she was obviously in very poor shape, yet for nearly two decades had provided robust service, and was arguably at the end of her asset life. In any event, the original project had not considered sufficiently the on-going needs of maintenance or the limited commercial viability of the harsh operating environment.

4 Lessons Learnt

Collectively these experiments provided proof of concept with impressive fuel savings for minimal investment. They also show that a small investment in research and development can have far reaching results. In the last oil crisis assistance to reduce Pacific fuel dependency was available from several sources by 1976 for a range of initiatives but such funding wasn't invested in shipping until 1982. By 1986, when most funding terminated, the small investment was demonstrating significant results at defensible rates of return. The work involved various UN agencies, the EU, ADB and leading UK universities. In the case of the Japanese experiments it showed an early example of a Public-Private Partnership (PPP).

Unfortunately, most of this effort came to a halt in 1986. The assumption was made that with the end of hostilities in the Middle East, the oil crisis had finished and that the era of cheap oil was back for the long-term. It is now a point of conjecture what would have happened if these experiments had continued. What is important to note is the list of agencies that were involved in exploring low carbon initiatives in the 1982-1986 period. UN agencies – UNDP, UNCTAD, UNDP and FAO were joined by the EU and ADB. Despite the most recent oil crisis between 2006 and 2014, the growing need from climate change and the region's crippling dependency on imported oil, none of these agencies have prioritised investment into practical research in this sector since.

The research from the 1980s provides a well-marked starting point for a fresh phase of work; it is not necessarily a case of having to reinvent the wheel. Collectively there is an impressive range of designs and data emanating from the experiments of the last oil crisis. It also shows strong potential for multiple benefits from re-visiting this body of practical work, especially given recent technological advances in biofuels, rotor technology, sail design, photovoltaics and battery storage.

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