PAPER

The Philippine Indigenous Outrigger Boat: Scaling Up, Performance and Safety

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ABSTRACT

The traditional indigenous double outrigger crafts, called banca boats, of the Philippines vary in size from the very small 4 meter single crew paddle boats to large 50 meter fishing vessels and passenger ferry boats. Regardless of size, the same construction techniques are used by native boat builders with wood as the main building material. Many hull forms, particularly economically important fishing boats, have been scaled up, resulting in problems related to the availability of wood for construction, safety at sea, and performance. Model experiments on craft performance show the hydrodynamic characteristics of the double outrigger form and describe characteristics important for design, construction, and operation of the crafts. The presence of outriggers has a definite effect on the heave, pitch, and roll motion of the craft as compared to the hull without an outrigger. Data analyses of maritime incident reports show a high percentage of capsizing by these motorized banca boats, highlighting the need for some regulation of their design and construction. Other concerns related to fisheries as being the main area of use of these boats are further discussed.

Introduction

In this age of modern hull forms, advanced materials, efficient engines and computerized control systems, there are still areas of the world where traditional boats ply the seas and are ubiquitous features of the coastal communities. Such is the case in the Philippines with its archipelago of 7,100 islands where the indigenous double outrigger craft, or banca, predominates and modern fiberglass or aluminum mono-hulls or catamarans are limited to the larger cities and tourist resorts. Presently, bancas are used as platforms for fishing and as passenger ferries or cargo vessels for short routes. In other areas where tourism is a significant industry, outrigger boats are used for sailing or rented for touring and scuba or skin diving. These tourist areas are increasing in number and subsequent modifications in the hull structures, general arrangements and powering characteristics to accommodate tourists and other passengers are noted. For events such as the Paraw regatta in Iloilo, an annual sailing race, boats are specially built to compete.

Philippine maritime tradition is evident in the find unearthed at Butuan City in the Southern island of Mindanao that included 9 vessel artifacts capable of ocean voyages dating back to the 8th century AD. Historical accounts of early Malay settlement of the islands consistently include outrigger boats called “balanghais” that transported “datus” or chiefs from the southern Malay islands. In many artists’ depictions of such boats, the outrigger beams contain further support for rowers that propel the craft. Hence, even then large size outrigger crafts were already in existence. Today, the basic unit of Philippine government, the “barangay” was named after these vessels that were used in the islands before the Spanish came.

The Spaniards noted the navigational skill of Filipinos, particularly the Bisaya (from the Visayas Regions) who used a compass found among the Malays and Chinese. Legaspi, an early Spanish explorer, captured a Moro in Butuan and noted that he was “...a most experienced man who had much knowledge, not only of matters concerning these Filipinas Islands, but those of Maluco, Borney, Malaca, Java, India, and China, where he had had much experience in navigation and trade.” (Blair and Robertson, 1903). Such navigational skill would have been developed through a tradition of constant voyaging and exploration where seasonal winds are favorable and literally blow boats and their passengers from one part to another.

Philippine outrigger boat designs are deemed highly optimal for their area of operation given the evolutionary and conservative nature of design changes. Such changes depend on material availability, opportunities for using engines and propellers, major functions such as fishing or tourism, as well as regulatory requirements. Present day concerns including sustainability of fish resources, conservation of the environment and safety at sea, necessitate a serious look at the nature of these crafts and a definitive study on the problems that are inherent in their operating conditions and hull form. Design and construction of these native craft do not employ standard naval architecture and engineering modeling, calculations and experiments. Hence, investigations into the basic characteristics of the banca’s hull form—particularly hydrostatics, hydrodynamics, structural materials, and powering—are needed to contribute to the knowledge about these crafts in order to formulate regulations and recommend measures that address safety at sea and environmental as well as economic concerns. (Aguilar, 2004)

Similar studies on indigenous crafts have been conducted in other nearby countries, the most relevant include those in Indonesia (Iskandar, 1999; Rafni, 1999; Ueno, 1999) where some craft types are of similar design and exhibit similar performance related characteristics (Jons et al, 1987). Specific studies on safety, resistance and maneuvering of a typical Philippine double outrigger craft have also been conducted (Aguilar et al., 2002; Aguilar et al., 2001; Shigehiro et al., 2002).

Boat size, specifically boat capacity measured through gross tonnage, is the basis for the classification of Philippine fisheries, which has two sectors: municipal and commercial fisheries. Municipal fisheries consist of boats 3 gross tons and less fishing in the coastal areas and inland waters (reservoir, lakes, rivers, ponds and the like). Coastal municipal fishing ground extends to a distance of 15 km measured perpendicular from the shoreline. Commercial fisheries include boats greater than 3 gross tons. The commercial fleet is further subdivided into three groups: small-scale (greater than 3 gross tons to less than 20 gross tons), medium scale (20 gross tons to less than 150 gross tons) and large scale (150 gross tons and greater). The commercial fishing grounds extend beyond the municipal fishing grounds out to the 200 kilometer limits of the Exclusive Economic Zone. A summary is given in Table 1, and the classifications are described below.

Small commercial crafts designed with outriggers include boats known as hulbot-hulbot (Danish seine), baby trawls, ring netters, bagnetters, long liners and fish carriers. Some boats, such as bagnetters, are specialized for a fishing operation, but others are multi-purpose and carry a multitude of gear types depending on the season and fishery. Medium commercial boats with outriggers include hulbot-hulbot, trawlers, bagnetters and ring netters. Large fishing fleets all over the archipelago have small to medium outrigger boats operating as light boats, service boats, catchers, search and sonar boats. Many medium and large sized boats are also rented out for cargo hauling but are banned from passenger ferry operations, although incidents involving fishing boats used as ferries have occurred. (Table 1).

TABLE 1

Common classification of Philippine fishing boats.

Fishing Boat Classification	Type	Length Overall (m)	Gross Tonnage
Municipal	Non-motorized	3-7	0.1 - 0.2
	Motorized	5-18	0.5 - 2.9
Commercial	Hulbotan (Danish Seiner)	10-25	4-30
	Basnigan (Bagnetter)	15-30	5-20
	Trawler	11-22	6-20
	Ring Netter	12-25	15-50
	Purse Seiner	20-50	40-300
	Carrier	12-50	10-250

Municipal Fishing Boats

Boat designs exhibit distinct but minor variation throughout the archipelago. There are also some designs that are specific to certain areas. Variations include the rake of stem and stern. Hull shapes may be round, flat bottomed or chined. Outrigger assemblies also vary in terms of materials, shape and construction. Comparisons show that differences between indigenous fishing boats and modern mono-hull western fishing boats are mainly due to the very narrow center hull and ubiquitous double outriggers. (Aguilar, 1997a)

Double outrigger indigenous fishing crafts are the most popular fishing platform in use, mainly because of their affordability; the cost of a boat constructed by the local boat builder is within the means of most fishermen. The availability of suitable logs for the dugout, bamboo for outriggers and other required materials is another reason. With double outriggers, the craft tend to provide a more stable working platform; the highly buoyant hull materials and outriggers tend to make the fishermen feel safe and comfortable.

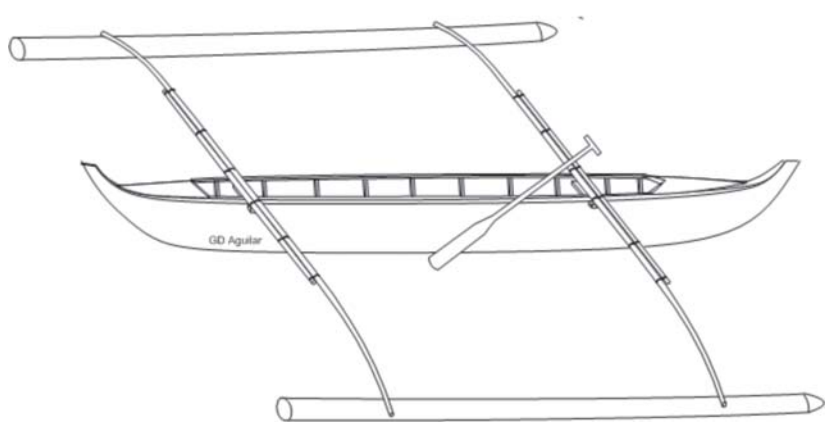
Observed disadvantages include a narrow working space, improperly matched propulsion system, and a reliance on the outriggers for stability. There are other weaknesses in an evolutionary type of design development such as the effects of installing engines, use of materials other than wood, and changes in hull shape where the lack of engineering computations is the norm. The challenge is for designers to consider these deficiencies and work towards improving the safety, durability and efficiency of the existing hull forms.

Non-motorized Boats

Propelled either by paddle or sail, non-motorized boats carry from one to several people, depending on the fishing gear. Fishing gear deployed using these boats consist of hook and line, (either single hand lines or longlines), small gillnets, pots and traps. Spear fishing, collection of shells, sea cucumbers, sea urchins and other gleaning activities use the boat as a platform. Paddled boats are powered by fishermen facing forward and the paddle stroke is near the side of the hull. The paddles are also used to steer and maneuver the boats because of the absence of a rudder. Carved from a piece of wood, paddles have a cross piece at one end that serves as a handle for the fisherman. (Figure 1).

FIGURE 1

A non-motorized paddle propelled Philippine semi-dugout outrigger boat.



The main hull consists of the lower dugout with plywood sides supported by frames. Because of the small size of this craft, one or two pieces of small diameter bamboo serve as outrigger beams connecting the outrigger to the main hull. The outriggers consist of one piece each of bamboo with the outer skin removed, the fore ends capped by bullet shaped blocks of wood, and the aft ends cut near a convenient node. According to boat builders and fishermen, removing the outer skin of the bamboo makes it more durable and long lasting. All boats, regardless of size, are usually painted by marine epoxy to ensure a longer lifespan. Also, the boats are beached or brought out of the water after use so wood borers are a rare occurrence.

Some differences in shape occur at the stern and stem profiles with each boat builder having their own style. The sheer line profile may also differ with some boats having a curved sheer all throughout its length while other boats have a straight sheer with the curves only near the aft and fore ends of the hull. Fore and aft sections may also be covered with plywood to prevent water from entering the hull, particularly during high waves in head seas.

Fishing is not the sole use for sail powered boats; regattas or sailing races have lately become popular as tourist attractions. During favorable monsoon weather, popular fishing gears for sail powered craft include trolling lines, traps, pots, hand lines and gill nets. Many payaos or rafts attached to fish aggregating devices are employed all throughout the archipelago. These are located in depths of 200 m to 2000 m. It is customary for fishermen to sail to a payao, tie their boat to it and fish with hand lines. When the payao is harvested by larger craft using purse seine or ring nets, the smaller boats are usually given a few kilos from the large catch.

Motorized Boats Less Than 3 Gross Tons

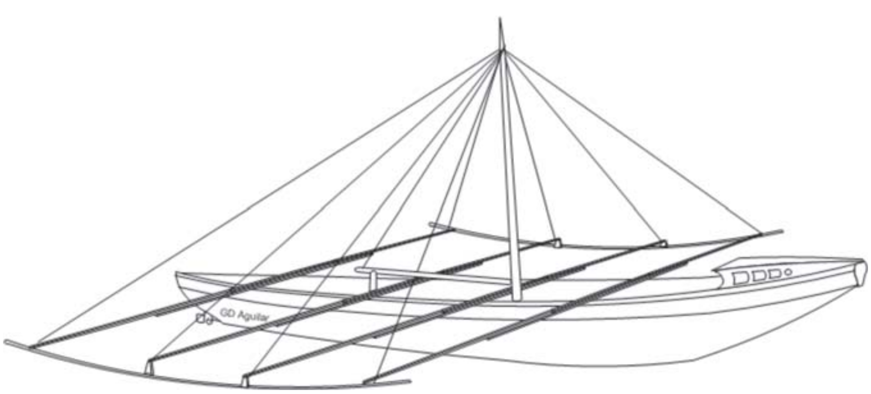
The boats most commonly used are those powered by single piston gasoline or diesel engines from 3 to 16 horsepower. Gill nets, handlines, traps, small ring nets and other small gears are operated from these craft. They are also used to transport fishermen to passive or fixed gears such as set nets, fish corrals, lift nets, fish pens or fish cages located near the shore.

Small-Motorized Commercial Fishing Boats

Fishing gear such as trawls, skim nets, ring nets, lift nets and danish seines are operated using big outrigger boats measured with more than 3 gross ton capacity. Engines are usually second-hand and reconditioned Fuso, Mitsubishi or Isuzu truck diesel engines. These engines rate from 80 to 240 horsepower and are converted for marine usage. In some cases, belt drives are also installed for driving winches needed in fishing operations such as net and towing warp hauling. Most crafts of these sizes also serve as light boats, service boats and sonar boats for commercial fishing operations. When used as light boats, electrical generators powered by smaller auxiliary diesel engines are employed.

FIGURE 2

The basnigan, a large 30 m commercial fishing boat.



Medium and Large Commercial Fishing Boats

There are still outrigger boats in this category, including the basnig or lift net boats, the large danish seiners or "super hulbot", trawlers and old mono-hulls fitted with outriggers. Others serve as carriers which are boats dispatched to several catchers located at the fishing grounds. The carrier loads the fish from the catchers and brings them to ports or processing facilities. In some instances, carriers are owned by other companies and the fish is purchased from the catchers at the fishing ground.

Some of the largest outrigger boats are the bagnetters or lift-netters with lengths of up to 30 meters or up to 20 gross tons. A main mast made of a single piece of wood is located at the middle of the hull and connected to the outriggers by large diameter stainless steel or galvanized iron wire. The shelter deck containing fishing lights, boat provisions and supplies for overnight fishing is located forward. The engine is usually located amidships and sheltered by a main engine room. One large pole extending from the main mast is used for hanging the lift net for easy deployment during fishing. (Figure 2).

Fishing operations involve a square lift net shaped like an inverted mosquito net with the corners and middle of each side attached to hauling ropes. The net usually requires 20 or more fishermen to man the lines for deployment and hauling. During fishing operations, fishermen stand on the outriggers to haul or deploy the net. Lights for attracting fish are used and a separate gasoline or diesel fueled generator for the electrical requirements of the fishing lamps is normally installed.

Total Numbers of Vessels

Scant information is available on Philippine outrigger boats from Philippine government agencies, regulatory bodies and academic institutions. For commercial and bigger municipal boats, data is available from the Coast Guard and the Maritime Industry Authority, as these have to be registered and licensed.

The only available data on municipal fishing craft is from the census of 1980 and 1985. In 1985 there were a total of 464,395 municipal fishing boats with 193,976 motor-

TABLE 2

Number of municipal fishing bancas, by region.

Region	1980 Total	Motorized	Non-Motorized	1985 Total	Motorized	Non-Motorized
NCR	3,223	2,463	760	3,553	3,046	507
I	10,894	5,258	5,636	12,720	7,519	5,201
II	6,479	999	5,480	3,085	1,138	1,947
III	16,365	9,378	6,987	21,433	13,685	7,748
IV	53,323	22,290	31,033	54,617	32,232	22,385
V	39,739	10,727	29,012	49,303	18,563	30,740
VI	27,524	8,788	18,736	28,327	12,882	15,445
VII	48,263	9,203	39,060	64,740	21,286	43,454
VIII	43,416	7,598	35,818	40,702	10,782	29,920
IX	44,489	10,088	34,401	113,459	37,208	76,251
X	26,775	7,028	19,747	20,370	9,288	11,082
XI	24,387	7,868	16,519	35,174	18,883	16,291
XII	22,961	3,402	19,559	16,912	7,464	9,448
TOTAL	**367,838**	**105,090**	**262,748**	**464,395**	**193,976**	**270,419**

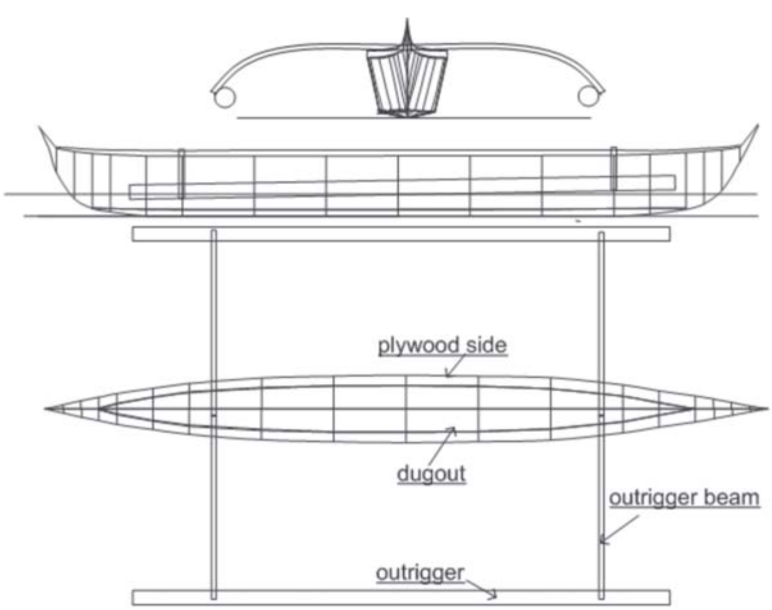
ized and 270,419 non-motorized. The majority of both types of boats are found in Region IX (Southern Philippine area). (Table 2—Region XII has since been divided into Region XII and ARMM or the Autonomous Region of Muslim Mindanao). If projected to the current year using the growth rate of the 5 year period, there should be more than 800,000 municipal crafts currently. With around 1,600 coastal municipalities in the country, this averages to around 500 boats per coastal municipality, a reasonable number if all boats including the small non-motorized boats are included. The highest number of motorized and non-motorized boats is found in Regions IV, V, VII, VIII and IX, areas that border the inner archipelagic seas of the country. These regions are also the highest fish producing regions of the country.

Construction of the Banca

Most fishing crafts of the Philippines are built by local boat builders without the benefit of boatyards, modern equipment, power tools, paper plans or the formal naval architecture design process. Boats are constructed at the seashore area with or without shelter mainly within the vicinity of the boat builder's house. It is not unusual to have the skill handed from generation to generation. The master builder usually has several understudies who assist and learn the skill from actual experience and observation. Generations of boat builders exists in some coastal communities with the present boat builders having mastered the skill from their fathers and grandfathers. With large nuclear families, even cousins and distant relatives inherit boatbuilding skills.

FIGURE 3

Generalized line drawing of the Philippine indigenous outrigger craft, the banca.



Hull details such as the shape of stern and stem, shape of hull bottom and outrigger assembly are highly localized depending on the style of the boat builder and the spread of the people using the boats. For instance, the shape of the stem and stern may vary from one coastal community to the next and it is an indicator of the origin of the fishermen or boat owner because when they move from one place or another, even from one island to another, they usually bring their boat styles with them. (Aguilar, 1997a)

Traditional Bancas

In traditional bancas, the main hull consists of a carved log dugout on which frames are embedded. Dugouts are carved by hand tools from a suitable log although sometimes lumber from hardware stores is used if there are no logs available. Wood species commonly used to make the dugout include the apitong (*Dipterocarpus grandiflorus*), tindalo (*Afzelia rhomboidea*), yakal (*Shorea astylosa*), big-leaf mahogany (*Swietenia macrophylla*) and other hardwood species. If the hull is motorized, the engine bed support is carved on the dugout hull.

The stem and stern are carved from naturally curved trunks or branches of wood and fitted to the fore and aft of the dugout. Most

FIGURE 4

Construction of a small non-motorized banca.

craft exhibit fore and aft symmetry at their waterlines. Sail and paddle powered boats are also nearly symmetrical at their profile views. For larger crafts, while the waterlines may be symmetrical, with some differences between the stem and stern profile occur because of the propeller and rudder. Naturally, dugouts of larger boats have to be carved from big tree trunks. A generalized lines drawing of the banca is shown in Figure 3, a representation that is applicable to wide range of crafts existing in the country.

Outriggers consist of bamboo floats attached by two or more transverse bamboos (referred to as outrigger beams) to the main hull. Attachment of the outrigger assembly is through lashings using monofilament polyamide (nylon) twine. Outrigger floats are lashed to the beams and the beams lashed to the main hull. For larger boats, galvanized wire and thin steel rods are sometimes used. Lashing tightly and securely is a critical skill in boatbuilding since the joint must be secure and tight enough to withstand the stresses encountered. The major advantage of the monofilament nylon is its slight elongation that allows tightening when lashed properly. It is also affordable, readily available and easy to replace. In some cases, the nylon is painted to lessen its degradation from sunlight. [i13]

In some parts of the archipelago, the outrigger beam consists of composite pieces made of naturally crooked branches of wood and bamboo lashed together by nylon monofilament. In other places, the beam is curved by heating and bending one length of bamboo to the desired shape. Others use two lengths of bamboo that are overlapped at the straight end, with both ends curved to attach to the outriggers. The most common bamboos (*Bambusa sp.*) used are small diameter, thick-walled stems for the beams and large diameter thin-walled ones for the outrigger. (The beam may be made of wood entirely but outriggers are always constructed of bamboo). Some areas use galvanized pipe as outrigger beams while others use PVC pipes for the outriggers. Bamboo outriggers are replaced as often as every two years depending on use and whether the bamboo outrigger float has been painted. Figure 4 shows the construction of a small non-motorized banca almost 6 meters in length.

Larger Bancas for Commercial Fishing

The bagnetter is an obvious example of the same design scaled up. The bigger boat naturally requires much bigger wood for the dugout. With deforestation in most of the islands and other environmental concerns such as the resulting erosion and landslides, large wooden logs for the dugout are getting difficult to source or are increasing in price. A total log ban under Philippine law is planned, and when implemented and strictly enforced will result in the unavailability of logs for the larger dugout, leading to rebuilds of older large vessels (Figure 5).

Most of the outrigger boats are built without the benefit of plans. They are constructed

FIGURE 5

An old dugout is reused because of the scarcity of big logs; all the other parts that can be sourced from smaller sized lumber are replaced including the frames, plywood sides, top side frame, decks and outriggers.

only through the recollection and skill of the boat builder and the fishermen or owner has only to provide the length required and the type of operation for the boat. Naturally, designs are not made and the entire construction process itself is still an art rather than a serious engineering discipline. When outrigger craft have been scaled up, little attention has been paid to any performance calculations or naval architectural analysis. For larger boats that require registration, line drawings are developed after the boat has been built, signed by a licensed naval architect and submitted to the regulation agencies. In some cases, boats originally designed and built as mono-hulls are outfitted with outriggers in order to provide a more seemingly stable platform while increasing the capacity of the craft in terms of loading gear and conducting fishing operations.

Gross Tonnage and Capacity of Outrigger Crafts

A comparison between data collected in a 1987 survey where the dimensions of 592 outrigger crafts from Cebu, Zamboanga, and Sulu were measured and data available in 2003 shows how the outrigger crafts have grown in size. The main unit of measure is the gross ton which is measured in the Philippines using the Coefficient method:

$$GT = LBD*0.7/2.831 \quad (1)$$

where:

GT = Gross Tonnage

L = Longest Length of the Boat

B = Widest Breadth of the Boat

D = Deepest Depth of the Boat

The preceding formula however, does not account for the presence of outriggers; and for the larger boats, the outriggers represent extra capacities included in Gross Tonnage measurements. This measure of boat capacity is a very simplistic method for the classification of fisheries and the management of fishing effort. Other countries use more sophisticated parameters such as the Vessel Capacity Unit (VCU) that combines boat dimensions with its engine power for classification. A catch based approach recommended by FAO (FAO, 2000) is the Data Envelopment Analysis that is more suitable for fisheries management because it allows the measurement of capacity for harvesting individual species in a multi-species fishery (Pascoe et al., 2001). There are already some initiatives to improve the country's regulation and licensing system for fishing vessels and this is one approach that is being considered.

When the distribution of commercial crafts below 50 gross tons as recorded in 2003 is plotted together with an outrigger craft data survey done in 1987, it is clear that the number of large outrigger vessels has increased dramatically (Figure 6). Most of this is due to an increase in hulbot-hulbot or Danish seines which are all outrigger boats with capacities up to 50 gross tons. For this type of outrigger craft, the design has been scaled up. This is also indicative of increased fishing effort with the greater boat capacities utilizing bigger gear and operation at a larger area.

For the hulbot-hulbot particularly, the growth in vessel size has also been supplemented by the use of engine powered winches for hauling the long warps of the gear, increasing the size of main engines and employing

FIGURE 6

Comparison of craft capacities measured in 1987 and 2003.

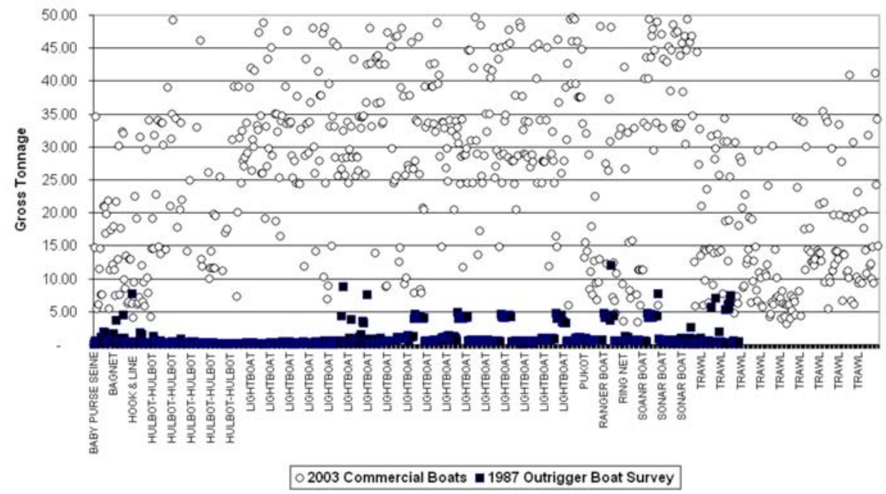
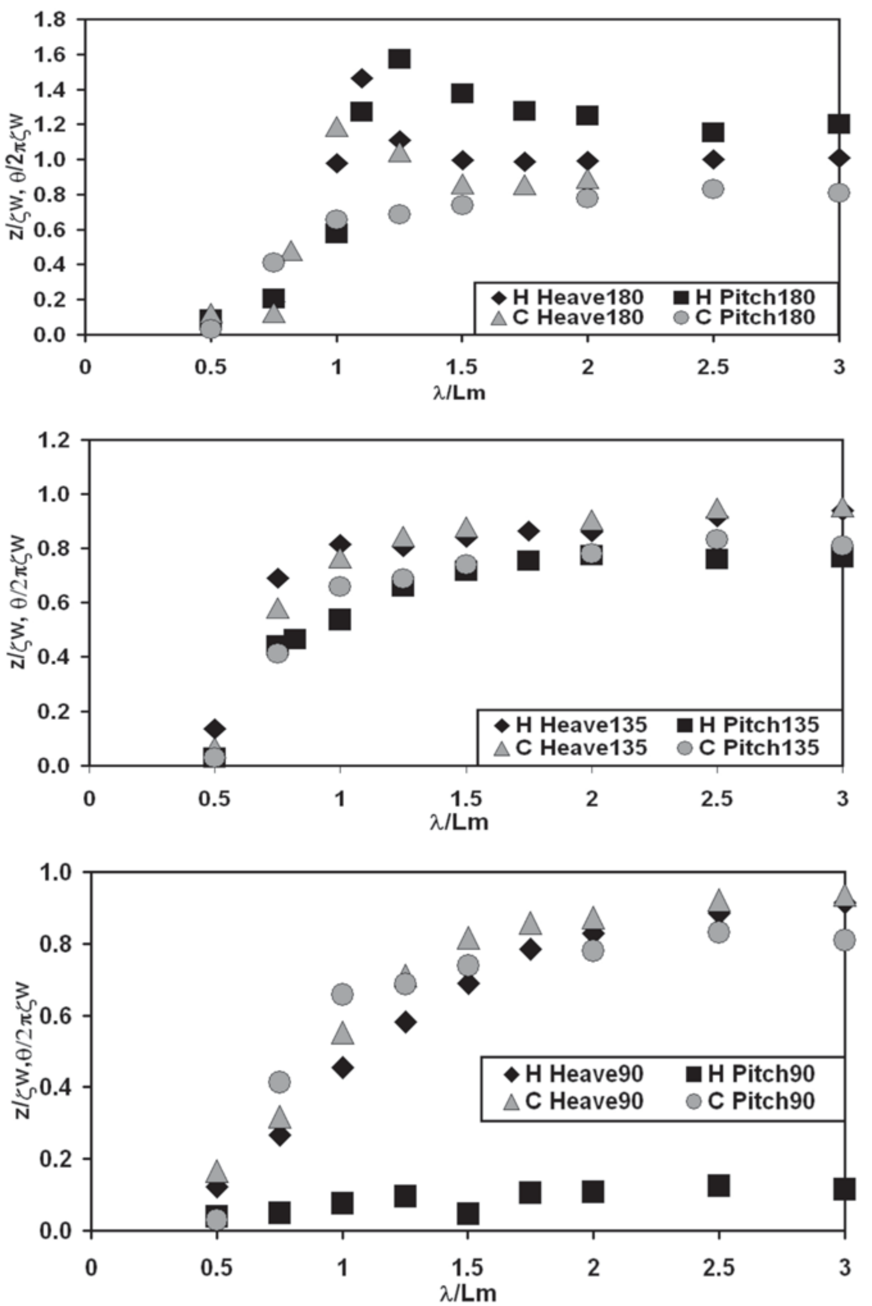


FIGURE 7

A hulbot-hulbot outrigger craft (20 meters length overall, 35 gross tons) with a steel hull covered by concrete and solid wood outrigger beams (20 centimeters to a side) at the center.

FIGURE 8

Heave and pitch response of the outrigger craft (C) compared to the hull without outriggers (H) at different headings (180-head seas, 135-bow seas, 90-beam seas).



stronger and larger construction materials. The efficiency of this fishing operation has led to its being banned in a majority of municipal waters all throughout the archipelago, but the greater demand for fish has made fishermen adjust by increasing boat sizes and operating in areas outside of municipal waters. An example of this craft is shown in Figure 7, located in the largest fishing port complex of the country, Navotas in Metro Manila. The fishing vessel shown is an outrigger hulbot-hulbot, almost 35 gross tons in capacity with a length of 20 meters and breadth of 3 meters. The hull is made of steel and the deck of concrete. The outriggers are still made of several bamboo bunched together but the outrigger beams are solid wood 20 centimeters to a side. These boats are even termed "super-hulbot" already because of their sizes in comparison to the original small outrigger "hulbot-hulbot". In terms of instrumentation, many boats of this size are equipped with modern communications and fish finding equipment for more efficient operations.

Static Stability of Outrigger Designs

The popularity of the outrigger form in the archipelago is mainly due to its very stable condition in calm water. Experiments show a very high righting arm (gz) at small angles of heel of the outrigger when compared to the same hull without the outrigger. Calculated metacentric height for a 3 meter model was 4.83 meters, almost 14 times that of the hull without the outrigger. (Shigehiro et al., 2002) This accounts for the popularity of the form because fishermen and passengers feel safe with the minimal motions of the craft at small sea states with the outrigger immediately righting the hull. Outriggers also have an effect on the draft and trim of the boat at different initial angles of heel.

Resistance

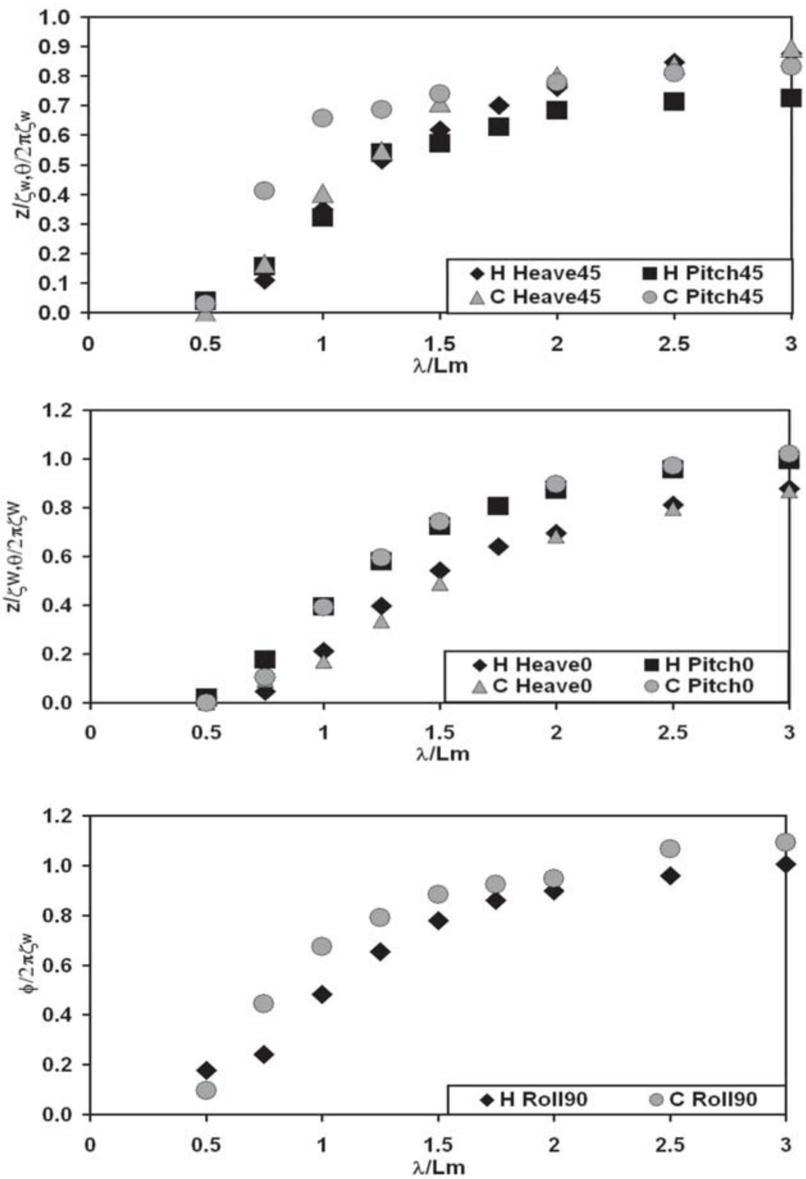
Experiments showed that outriggers significantly increase drag compared to the same hull without outriggers. This results in increased horsepower requirements particularly for bigger crafts with large outriggers. As speed increases, the difference in resistance between the hull with outrigger and that without outrigger also shows a linear increase. Small craft have only one bamboo outrigger float slightly inclined from fore to aft but bigger boats have up to four double layer floats with much larger wetted area and displacement for both outriggers. (Aguilar et al, 2001)

Seakeeping

The outriggers have an effect on hull response to waves, depending on the direction of the waves. Results of experiments at the National Research Institute for Fisheries Engineering in Japan and sea trials in the Philippines showed that the outrigger boat experienced greater heave and pitch motions in head

FIGURE 9

Heave and pitch response of the outrigger craft (C) compared to the hull without outriggers (H) at different headings (45-quarter seas, 0-following seas) and roll motion of both at beam seas (90 degrees).



seas when compared to just the hull without outriggers when the wavelength to boat length ratio (λ/Lm) is less than 1 or when the wave length is less than the craft length. However, when λ/Lm is greater than 1 or the wavelength is greater than the craft length, the presence of outriggers has a damping effect with lower pitch and heave motions for the outrigger craft. At bow seas, outriggers result in less heave response with λ/Lm less than 1, less heave but greater pitch at λ/Lm = 1 but show almost the same response to heave and pitch motions at λ/Lm greater than 1. At beam seas, the outriggers result in greater heave and pitch motions (Figure 8).

At aft quarter seas, the presence of outriggers amplifies both heave and pitch motions of the craft. At following seas,[S.K25] less heave motion is exhibited by outrigger craft without much difference in pitch. For rolling motion at beam seas when the value of λ/Lm is less than the ratio of the distance between outriggers to wavelength, the roll motion of the hull with outrigger is lesser but when the value of λ/Lm is greater than this ratio, the motion of the hull without outrigger is lesser. This result points to the damping effect of the outrigger to roll motion if the wavelength is less than the distance between outriggers at beam seas. If the wavelength is greater than the outrigger distance, there is an increase in the rolling motion of the outrigger hull compared to that without outrigger. Less heave motion is exhibited by outrigger craft in following seas without much difference in pitch. Increase in roll motion is exhibited when the wavelength is greater than the outrigger distance (Figure 9).

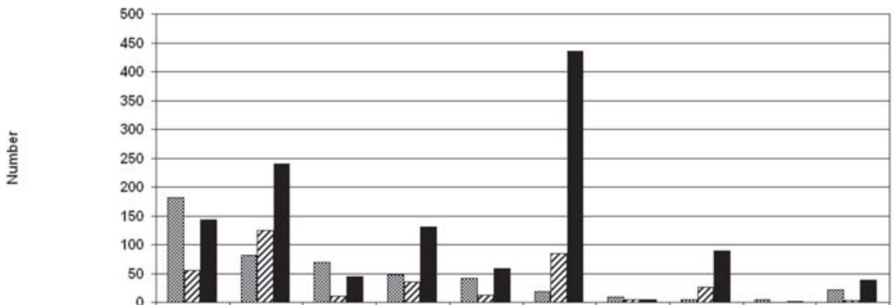
The response of the hull to different wave conditions also indicates the importance of keeping the outrigger beam structure and its attachment to the hull as reliable as possible. This is the main reason why boat builders reinforce the central portion of the outrigger beam, sometimes doubling or even tripling the beams attached to the main hull. Severe stresses occur at these attachment points as recorded by strain gauges placed at several points during the experiment. Anecdotal evidence from survivors of capsized double outrigger craft supports this finding although more research on this aspect needs to be conducted. Experiments on the structural characteristics of trimarans (Coppola, 2003) show also that the greatest vertical and longitudinal shear distribution is located at the point where the main hull connects to the outrigger beams.

Constructed of bamboo, the structural integrity of the outrigger beams cannot be guaranteed over a period of time. Other structures, particularly plywood at the side hulls, are also vulnerable in cases where the material is weakened and the structure is exposed to abnormal loading during rough seas. This partially explains why incidents of capsizing are so numerous when the safety record of outrigger boats is examined over a ten year period (Figure 10).

In the presence of large waves or during typhoons, structural failure of the outrigger beams almost always results in capsizing. (Sigua and Aguilar, 1999). Safety concerns point to the need for the imposition of limits on the wooden, semi-dugout outriggers either through size or horsepower limits.

FIGURE 10

Record of maritime incidents in the Philippines from 1991 to 2000.



	Aground	Sank	Caught Fire	Drifted/Engine Trouble	Collision	Capsized	Rammed	Missing	Flooding	Others
M Vessels	181	82	69	47	41	18	9	4	4	21
F Vessels	55	125	11	36	12	84	4	26	0	3
M Bancas/Others	143	240	45	131	58	435	5	89	1	39

Nature of Incident

Changes in Fisheries and Fishing Vessels

Beginning approximately 10 years ago, there has been a consistent decline in municipal fisheries production (Bureau of Agricultural Statistics). This trend indicates the depletion of fish resources in most of the coastal areas because of the proximity to the population, the increasing number of fishermen and amount of fishing effort and the consistent environmental degradation of the marine waters. Management of fishery resources is identified as the most crucial element to effectively sustain production. Problems related to management include the inability to enforce laws and regulations, destructive fishing practices such as dynamite and cyanide fishing, non-optimized gears and lack of information about the existing resources and state of the environment.

Before the Fisheries Code, the exploitation of fishing grounds was basically open access where anybody can fish anywhere without any control. This is consistently pointed out as the main reason for the depletion of most of our fishery resources. Commercial fishermen can no longer operate and catch at traditional grounds during the peak season, leading to loss of business. On the other hand, the municipal fishermen using much smaller boats must be able to harvest such schools with greater capacity, requiring better gear and therefore higher capitalization. Since such capital is found in the richer commercial fishery, some compromise may be necessary between commercial fishing operators and the municipal fishermen, such as fleet-type operations or the contracting of catching services. For many commercial operations, the challenge would be to find areas far offshore and outside the 15 kilometer limit. Within Philippine waters, the NE Philippine waters and Luzon Sea as well as waters west of Palawan are viewed as development areas where the commercial fleets displaced by the law could perhaps operate. The large outrigger boats currently used by these commercial fishermen may not be suitable for these open areas.

For all crafts operating in Philippine waters, it is necessary to implement registration and licensing to have an accurate estimate of fishing effort. Such information, when coupled with biological data on fishery stocks, can be very useful in instituting effective management schemes for a sustainable fisheries. The registration system must also include inspections to determine seaworthiness and the presence of basic safety equipment on board these fishing crafts.

Given all these challenges in operating conditions and the tendency of fishermen and boat builders to adapt their boats and operations in order to survive or turn a profit, it is essential to c onduct further research on the nature of these crafts. Results of this research can then be translated into information for boat builders, standards for regulatory agencies and recommendations to managers of the resource. There is also a more urgent need to address the safety concerns over the disproportionate number of motorized bancas that capsize. This should involve establishing operating criteria for fishing in areas with heavy maritime traffic; disseminating information to fishing operators and fishermen about the need for increased safety preparedness due to the nature of the Philippine outrigger form.

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