FERRIES

ELECTRIC HEAT

Electric propulsion was a key requirement for the students participating in the Worldwide Ferry Safety Association's 10th annual safe ferry design contest

The CAT|abao electric ferry scooped first prize at the WFSA's 10th annual student design contest

For the 10th instalment of its Annual International Student Design Competition for a Safe, Affordable Ferry, spanning 2022-2023, the Worldwide Ferry Safety Association (WFSA) decided to shake things up a little by introducing a new stipulation for the participating teams.

Previous years' contests had called for ferry designs to meet specific operational demands – for example, boats designed to handle waterways prone to strong currents and accumulated debris, or arranged to restrict the onboard spread of COVID-19 during the height of the pandemic. For these challenges, the WFSA's panel of judges had "always been neutral about the power source" of the students' proposed designs, Dr Roberta Weisbrod, WFSA executive director, announced last year.

This time round, though, the students would have to develop an electric-fuelled ferry for the Pasig River in Manila, in line with ongoing efforts by the Philippines Government to decarbonise public transport across the capital. "This ferry would be an express line to supplement existing service on the river, even cutting transit time between similar points using road transportation," the WFSA explained in its 2022 brief to the student teams.

Electric curveball

Vessel spec criteria included the capacity for 100 passengers (as well as bikes, baby strollers and luggage), with three stops on the Pasig River, and the vessel would have to be affordable to construct, acquire, operate, maintain and repair.

Of course, the additional curveball of electric propulsion created a fresh challenge for the teams, who would now have to consider the availability of shoreside chargers, battery handling-related safety and the risk of loss of power. As one example, the three stops on the proposed Pasig River route – Guadalupe, Circuit and Lawton – currently lack onshore charging infrastructure, though this is planned for the future.

And then, there are the unique characteristics of the Pasig River itself: a tidal estuary with tidal variation of approximately 1.5m, prone to strong currents and rising water levels during the monsoon season that spans June to November.

"After storms there are shifts in the bottom topography," the WFSA added in its brief to the student teams. While civic groups and government

The winning team, from City University of Applied Sciences, Bremen. From left to right: Omar Idrissi, Patrick Eymers, Alicia Meyer, Niklas Keen, Jan-Lucas Zelenka and Laurin Rösemeier

agencies have made concerted efforts to clean up this waterway, the WFSA also noted: "The river along the ferry route has turns, low bridges, and overgrowths of water lilies and waterborne debris." One thing was for sure: this was shaping up to be one of the most complex of the WFSA student design contests yet.

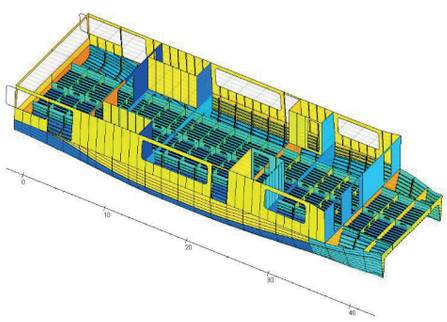
Setting the agenda

The agenda for the contest was largely set by Sammuel Lim, chairman and founding president of the Society of Naval Architects and Marine Engineers (SONAME) – the only government-accredited professional association of licensed naval architects in the Philippines, comprising 1,300 members. To sum up Lim's extensive maritime career, spanning more than 40 years, would require an article in itself, though his previous work with Lloyd's Register and the Filipino Association for Mariners' Employment (FAME), among many other positions, put him in a great position to produce the rules for this year's contest.

"SONAME and other groups have been pushing the Government of the Philippines to introduce electric vessels in the country since even before the pandemic," Lim tells *Ship & Boat International*. "There is more interest in electric vessels now, post-pandemic, and there is no issue selling the concept." However, he adds: "Government incentives for electric vessels are in place, though they are only superficial. There is a lack of real money and investment – compared to, say, Norway – to really implement this electrification drive, since the Philippines is still a developing country."

Lim adds that he was pleased with the way in which the students responded to the challenge. "The designs for the hull, passenger or cargo spaces, navigational equipment, tailshaft to propellers and other traditional vessel systems are already well established, and there are plenty of references out there," he says. "It is really about balancing what level of electrification can be installed onboard, and how feasible it is for the vessel's intended service, given the present technology and pricing levels."

While the students could pick either monohull or catamaran hullforms for their entries, Lim comments: "For this contest, the parameters were set for a river service, and so the catamaran hullform would be best as it gives enough space for installing batteries with segregation, while maximising space for the passengers and maintaining low draught and hull resistance."



The structure of the CAT|abao, as modelled in Poseidon

TECHNICAL PARTICULARS

CAT|abao electric ferry concept

Length	22m (overall)
	21.5m (bpp)
Breadth	7.3m
Depth, to main deck	1.75m
Draught	0.95m (design)
	1.1m (scantling)
Air draught	3.95m
Lightweight	35.7tonnes
Deadweight, design	8.8tonnes
Speed	12knots (design)
	17knots (max)
	3knots (on solar panels only)
Tank capacities	
Fresh water	300litres
Grey water	400litres
Passengers	102 (incl. 2 x wheelchairs) (design)
	197 (incl. 2 x wheelchairs) (scantling)
Classification society	DNV
Notations	✠1A IN(0.6)Z Passenger Vessel, AL, Single Hull, Battery (powered)

The student teams were not left to figure it all out on their own: in July 2022, the WFSA helpfully hosted a webinar in which the participating teams had the opportunity to quiz marine e-propulsion experts – including BAE's Joe Hudspeth, Spear Power's Jon Diller and ABB's Ed Schwarz – and John Waterhouse, principal at Elliott Bay Design Group, which has produced the concepts for a number of electric and hybrid craft.

CAT|abao concept

In total, the WFSA contest attracted 16 entries from academic institutions across Asia, Europe and the Americas. The City University of Applied Sciences, Bremen was declared the winner with its CAT|abao concept: a 22m aluminium catamaran, deemed by the judges to be "solid in virtually all respects, with a great attention to detail".

The Bremen team included six Master's students from the university's naval architecture and ocean engineering course, including team captain Laurin Rösemeier, Patrick Eymers, Omar Idrissi, Niklas Keen, Alicia Meyer and Jan-Lucas Zelenka.

"Our previous study locations and backgrounds were different, so we had to get to know each other at the beginning of the project," Rösemeier tells *Ship & Boat International*. "The design of a fully electric ferry was exciting and challenging for all of us: we had to acquire a lot of knowledge at the beginning, especially in the field of battery and electric propulsion technology." This involved the team making contact with electric drive

company Baumüller and battery manufacturer Corvus Energy for more detailed info on the aspects of the powertrain design.

"Due to the special conditions on the Pasig River – such as strong monsoon currents, short travel times/loading times, safety aspects and narrow, possibly polluted fairways at high speeds – the decision was made early-on in favour of a catamaran," Rösemeier continues. "The biggest challenge, however, was the design of the batteries and the electric propulsion with its associated systems.

"We realised early on that we would not achieve the service life we had aimed for with the battery power we had initially installed. Thus, in the advanced design phase, we suddenly needed much larger battery capacities, which brought with it many difficulties regarding our weight management."

He adds: "We were only able to solve these difficulties together in often long discussions in the team, where everyone contributed with new and innovative ideas to solve the problems. As we have often heard in lectures, the design spiral has once again shown what it means when a key design parameter changes."

Passenger movement

The CAT|abao would measure 22m x 7.3m and draw approximately 0.95m. "In normal traffic mode, we can carry up to 100 passengers, two wheelchair users and three crew members," Rösemeier explains. When operating in 'pandemic mode', the complement would be reduced to 30 + 20 passengers.

With the potential for passenger overcrowding in mind – sadly, still a problem in some developing countries, where operators are more likely to bend the rules to maximise ticket sales – the Bremen team designed the CAT|abao for a safe and stable working limit of 195 persons in total. To protect this complement, the ferry would carry a pair of 150-person liferafts, situated fore and aft, plus eight buoys and 217 lifejackets.

The vessel's layout comprises a barrier-free design for ease of movement, and to enable passengers of different ages and abilities to swiftly evacuate in an emergency. There are five escape routes in total (two fore, two at the sides and one aft) for quick evacuation, as well as breakable windows. Additionally, with COVID and other viruses in mind, the CAT|abao would carry HEPA filters and a UV light, to disinfect onboard areas before and after each trip.

Passengers would have access to Wi-Fi, USB chargers and a public address system, and the aft deck would accommodate up to 10 cycles/e-scooters. This parking space would also feature charge points.

Solar support

The Cat|abao concept is 100% electric, with no diesel genset back-up. The direct propulsion system includes: a pair of three-phase synchronous Baumüller electric motors, rated 235kW apiece; a six-pack of Corvus Dolphin NG batteries, rated a combined 754kWh; and twin four-bladed, 600mm-diameter, fixed-pitch propellers. The Corvus battery set-up comes with a thermal runaway protection system and an inert gas and high-pressure water mist system, and would be housed in an A60 insulated battery room, monitored by thermal imaging cameras.

The power supply would be supplemented by a 130m^2 spread of solar panels, rated 10kWh. "The solar panels are only there to help, as they do not have enough power to recharge the batteries on their own," says Rösemeier. "The charging station is to be housed at one of the landings, Circuit, and built using megawatt (MW) charging technology. The connection of the MW charging system and the access to the engine room are realised from the aft deck, with easy replaceability of the battery modules through the maintenance hatch cover."

He estimates that a time slot of approximately 10 minutes would be reserved for recharging during each journey, based on the performance of the Megawatt Charging System (MCS) developed by e-mobility company CharIN.

"We recommend that you charge for 10 minutes after each trip to keep the depth of discharge [DoD] between 20-80% throughout the day," says Rösemeier. "This will ensure a long battery life. Nevertheless, the ferry would be able to cover 61.5nm at a speed of 9knots with a 20% reserve, which means the boat can also be used for sightseeing or workshop trips." Six such e-ferries, working in tandem, would guarantee a 20-minute schedule on this Pasig River route.

The e-ferry could prevent 985tonnes of CO_2 emissions each year

The team estimates that, travelling at its design speed of 12knots, the Cat|abao would be able to cover the entire Guadalupe-Lawton route in 50 minutes.

Long-term view

Another consideration for the contest judges was how much the Cat|abao could save in both operating costs and emissions. The Bremen team calculated that the average per unit cost for six such ferries would be US$1.37 million.

"After about 4.5 years, the operation of the fully electric ferry pays off compared to a conventional diesel-powered catamaran," says Rösemeier. "We have assumed that the prices for diesel remain at the same level as the prices for electricity. However, it can be assumed that the prices for diesel will continue to rise, while the cost of electricity may fall with new developments in renewable energy."

The team also estimated that the e-ferry could prevent 985tonnes of CO_2 from entering the atmosphere annually: the equivalent of 124 homes' energy use in a year.

Despite the challenges involved in the Cat|abao's design process, the Bremen team noted quite a few advantages with regards to electric propulsion. One example, Rösemeier recalls, was "the ease of maintenance and the flexibility to create new unconventional designs, including the separation of the propulsion system and the energy storage system". With emerging battery tech expected to slash weight and space requirements, while simultaneously boosting efficiency and performance, he predicts a bright future for electric vessels, especially those in riverine cities facing tight local emissions clampdowns.

"For small ships in regular service, which have a fixed route and times for charging, I think that batteries will become more and more popular in the future," Rösemeier says. "For large oceangoing container ships, for example, I think we need to focus on other solutions, such as wind-assisted systems."

With first place secured, the Bremen team attended the WFSA's annual conference in New York in April this year, where its members were introduced to Mary Ann Pastrana, chairperson of Philippines domestic operator Archipelago Ferries, granting them an enviable opportunity to further discuss the design of their winning entry. "Even if the Cat|abao is not built, many aspects will support the future development of urban ferries and bring them forward," says Rösemeier.

The Bremen team highlights: "In response to the Paris Climate Agreement, Manila had committed to reduce CO_2 emissions by 70% by 2030. In April 2021, the government raised the target to 75%. However, there has been a lack of concrete steps so far. This is where the design of the CO_2-neutral CAT|abao comes in. The high-speed ferry system with CAT|abao can play a pioneering role in terms of sustainability, technology and innovation."

Runners-up

Second place in the contest was awarded to the University of Rostock in Germany, whose student team submitted the plans for a 28m aluminium catamaran, MV *Magada*. Fitted with a 360° azimuth/tiltable propeller, this vessel would feature modular, swappable battery packs, with shore charging taking place overnight.

In third place, Indonesia's ITS Surabaya presented a 30m aluminium cat with a smart system drawing on ECDIS, GPS and VDR data to safely navigate the ferry. Interestingly, this design included propeller rope guards at the stern tube aft to prevent entanglement, given the amount of debris (including ropes and fishing nets) in the Pasig River. The judges also drew attention to this vessel's "roller fenders on the sides", which they deemed "a positive feature for the narrow waterway with two-way traffic, in order to protect the vessel from allisions."

For those who believe that low-/zero-emission and safe ferry operations are eminently achievable, this WFSA contest confirmed that even newcomers to the technology can put their heads together and produce viable, cost-efficient solutions. **SBI**

The general arrangement of the 22m CAT|abao ferry concept