The offshore evolution of SES

Umoe Mandal has played a key role in transferring the surface effect ship concept from the naval and ferry sectors to the offshore market. Alan Bliault, FRINA provides an overview of Umoe's progress to date, and a taster of some of the new vessels to come

The surface effect ship (SES) has been a part of the fast ferry industry since the 1970s, with a significant fleet of UK-built Hovermarine craft operating in Hong Kong and elsewhere until the Australian- and Norwegian-built catamarans took over the high-speed ferry market. In Norway in the 1980s, Cirrus, Brødrene Aa and subsequently Ulstein built a series of larger SES ferries, some of which still regularly operate in the Mediterranean. Meanwhile, South Korea followed suit with a limited number of similar SES for high-speed ferry service.

In the 1990s, the Royal Norwegian Navy selected an SES design developed by Umoe Mandal (Umoe) for its coastal minesweepers and minehunters. These were sophisticated military vessels: not designed for ultimate high speed but for the most efficient point-to-point voyages, followed by the specific mine-related operations. They enabled the development of high-specification CFRP hull structures and represented the next generation of cushion systems .

Since the early 2000s, Umoe has continued its SES development with design and construction of a series of Fast Strike SES for the Royal Norwegian Navy, the Skjold-class corvettes which can exceed 60knots. The Norwegian Government approved a significant life-extension and upgrading programme for the strike craft in May 2020. The programme is a joint project between Umoe and Kongsberg Defence and Aerospace, aimed at improving cost-effectiveness and environmental impact for service up to 2030.

On the commercial side, Umoe built a number of Wavecraft-branded CFRP crew transfer vessels (CTVs) in the 2010s. Its initial success was with offshore wind farm service craft, and the company is now also focusing on the global offshore oil and gas (O&G) production industry.

O&G challenges

There are several ongoing challenges for the offshore O&G sector, where production facilities are remote from shore. Firstly, the further offshore the facility, the more difficult it is for helicopter service, due to limited flight range. Secondly, helicopters have limited personnel capacity: typically under 20 passengers. Thirdly, and probably the highest safety risk for an offshore worker, is the helicopter flight itself, requiring special helicopter-ditching training. Finally, personnel logistics by helicopter can be very expensive.

The current oil price, further exacerbated by the COVID-19 pandemic, has triggered a significant rethink by O&G operators regarding alternatives for personnel logistics. While emergency access requirements mean that helicopter facilities remain important, where production is in an area with less extreme sea states (ie, West Africa, much of South East Asia and Northern Australia) regular personnel logistics with boats may be considered.

Air cushion system

Umoe's Wavecraft Commander 27 SES concept offers a completely heave-compensated vessel. By active damping of the air cushion system, it has achieved significantly better ride comfort during a voyage. When 'docking' at a structure (ie, a wind turbine or offshore structure) crew can keep the motion at the docking point almost still in up to 2.5m significant sea states. This innovation controls the air cushion pressure to counteract the sea wave forces, therefore damping the vessel motions. For wind farm maintenance mechanics, time spent at a turbine is very expensive. If it takes an hour for a man to get over feeling not so good from the voyage, let alone sick, that is a direct cost and a limitation to work planning.

The Wavecraft Commander 27 SES can run at up to 40knots+ in the kind of sea states that wind turbine maintenance might involve, so personnel can be delivered quickly, taking advantage of shorter weather windows. At 27m loa, it is at the larger end of the range for wind farm vessels, and its 600nm range means it can reach locations at the centre of the North Sea from Norway, Denmark, Germany, Holland, Belgium and the UK.

These attributes will also be useful for logistics to infield construction vessels and the eventual turbines at the new generation of wind farms being planned further offshore in the North Sea, as well as those off the Korean and Japanese coasts. Its key attractive features include motion control, both for transit and personnel transfer, combined with acceptable operational costs.

O&G considerations

While the wind farm sector will not need large numbers of personnel at an individual turbine, this may be different at offshore power transmission stations, which are similar to small offshore O&G platforms. A Umoe O&G-adapted SES would have the options of: extended range through higher-volume fuel tankage; delivery of emergency spares and small freight using existing cranage; and change-out of as many as 100 personnel at one time, perhaps through visits to multiple facilities on one voyage loop. This is the target of Umoe's Wavecraft Voyager 32 and 38 designs (discussed later), which offer even higher speed than the wind farm-adapted design.

The O&G industry will require some adaptation of its personnel reception facilities to take advantage of service by SES, as most are currently oriented to receive personnel from the helideck down to a sky lounge. In most cases though, it may not take much more than personnel control procedures for accessing the lift

or stairs from an existing emergency boat landing to go directly up to the air lounge, which remains the emergency control and registration location. Such adjustments will be simpler for units such as FPSOs or production barges than space frame jacket structures.

Figure 1: The Wavecraft Commander 27 *Umoe Firmus*

Commander class

The Wavecraft Commander 27 class SES (Figure 1) has a slender catamaran form with widely spaced hulls, simple segment bow seals and a three-lobe bag skirt at the stern enclosing a cushion with a depth of 2m and hovering draught of 0.8m. Personnel accommodation and operational spaces are above the main deck in a two-level superstructure. Below the main deck, primarily within the side hulls, are installed the propulsion diesel engines and waterjets, and, just forward of amidships, are two double-entry lift fans and diesel drivers.

Aft on the wet deck are mounted two smaller hydraulically powered fans that feed the rear seal, allowing independent control of its geometry. Air drawn in from openings in the hull sides to the main lift fans passes through ducting to the cushion. Recirculation and exhaust ducting is used to modulate the airflow with flow control louvers and steady the pressure in the cushion. This enables the vessel to maintain a steady elevation as waves pass through, minimising heave and pitch motions. The control system uses pressure sensors and accelerometers as input to the hydraulically controlled louvers. Two modes have been set up: one optimised for transit (Ride Control mode), the other for turbine access (the Boarding Control System).

Control systems for power, cushion damping and machinery monitoring are electronic and automated so far as possible. Steering and manoeuvring are handled via joystick at the helmsman's position in the wheelhouse.

Motion control

In a series of trials for wind farm operators, motions data has been monitored on the Wavecraft Commander 27 vessels *Umoe Firmus* and *Umoe Rapid* since their introduction in 2016, including a seven-month independent monitoring programme while working at the Sheringham Shoal Wind Farm, UK. This data was analysed against the ISO 2361-1 standard (1) and suggests that in typical operations, with 1-2m seas, accelerations should be in the 0.1g area or less. In general, operations of the two vessels do not lead to seasickness or significant discomfort.

The ISO standard suggests that for comfort, average vertical accelerations should be less than 0.1g for 20 minutes of exposure and 0.05g for two hours of exposure. Seasickness is likely (for non-seafarers) at above approximately 0.4g exposure. High-speed catamarans of equivalent size to the Wavecraft Commander 27 may have vertical accelerations up to 0.25g in 2m seas and so, from a 'readiness for work' viewpoint, create some degradation.

Vessel profiles

In 2019, *Umoe Firmus* and *Umoe Rapid* were taken under the wing of World Marine Offshore, which charters them out to operators. A selection of their work so far is summarised below. The vessels have made some long-placement voyages, including a long transit made by *Umoe Rapid* in late 2017 from Southampton, UK to Esbjerg, Denmark: a 10-hour voyage. The vessel averaged about 40knots in 1.5-2m seas and burned less than 25litres/nm of diesel.

- *Umoe Firmus*

In February 2016, *Umoe Firmus* (Figure 1) arrived in the UK from Mandal, Norway, and Statkraft chartered the vessel to support its O&M activities at the Sheringham Shoal Offshore Wind Farm. On 1 March 2017, *Umoe Firmus* started work at the Gemini offshore wind farm, approximately 85km offshore Friesland, the Netherlands, which comprises 150 × 4MW Siemens turbines spread across two sites in close proximity. Leo Hambro, MD of Tidal Transit and operator of *Umoe Firmus* at that time, reported that the vessel performed exceptionally well on the site, cutting transit times from three hours to 90 minutes.

Later, in 2019, *Umoe Firmus* was upgraded from a 12- to 24-passenger configuration and the vessel changed from British to Danish flag. At the same time, Umoe's Foresight solution, offering upgraded instrumentation and data logging, was installed as a pilot for potential future vessel installations. Foresight monitors key mechanical components in real time to give the user an accurate indication of onboard machinery health. The prototype installation has been used to plan how to move away from traditional time-based maintenance to a condition-based maintenance strategy.

Umoe will offer Foresight as part of the SenseLOG maintenance programme. The shipowner will own the data and cut cost through better maintenance. In turn, Umoe will have a shorter response time for maintenance requests, ensuring the best possible availability of the vessel. Together with machine prognostics, the vision is to reduce waste by increasing ship and machinery component life and thereby reducing maintenance costs.

Currently, *Umoe Firmus* is based in Oostende, Belgium, working for Siemens Gamesa at the Rentel offshore wind farm,

Figure 2: The 24-passenger *Umoe Rapid* was commissioned in 2017

and operated by World Marine Offshore. It typically travels 70nm per day to the SeaMade (Mermaid and Seastar) wind farms, located 50km and 40km offshore Belgium. Construction of these sites has been ongoing through 2020.

- *Umoe Rapid*

Umoe Rapid (Figure 2) was built to upgraded 24-passenger capacity and commissioned in May 2017. In August that year, *Umoe Rapid* completed its first charter at the world's first floating wind park, the 30MW Hywind Scotland array; and subsequently at the 402MW Dudgeon offshore wind farm for Statoil, under a cargo and crew transfer contract.

From October 2017 to the end of January 2019, *Umoe Rapid* spent 16 months working for Adwen Offshore, supporting turbine installation work at Trianel Windpark Borkum and Global Tech 1, two of Germany's largest, most distant North Sea wind farms. High service speed was achieved with 25% reduction in fuel consumption compared to traditional wind farm CTVs, as well as safe boat landing in up to 2.5m wave height. Seasickness was substantially reduced, as reported by crew and passengers and shown by third party monitoring. The result was an expansion of safe accessibility of wind turbines and other offshore installations for an average of 33 technicians per day, proving the boat's credentials as a reliable, profitable workhorse.

During 2019, *Umoe Rapid* worked on a contract for a repair and coating campaign at the 350MW Wikinger array, which is Iberdrola Renewables' first project in Germany, located in the German waters of the Baltic Sea. Currently, *Umoe Rapid* operates from Vlissingen to the Borssele II wind farm, approximately 25km from the southern Dutch coast, on long-term charter.

The Voyager series

Looking towards long-distance offshore logistics, Umoe has developed two larger SES designs, the Wavecraft Voyager 32 and Voyager 38, to transfer larger personnel numbers to offshore manned facilities and/or in-field accommodation and construction vessels. Configured as pure personnel carriers, they range from 60-150-passenger capacity. Table 1 gives the key statistics and Figure 3 shows an impression of the Wavecraft Voyager 38.

In their current configuration, Umoe has set on-cushion draught at 0.8m for all designs. The Voyager design has lower off-cushion draught than the Commander design (Table 1) due to slender hulls. The hull width depends on operational aspects such as heave compensation and passive hydrodynamic dampening in transit.

Propulsion powering is set to give up to 10knots higher maximum speed than the Commander class, while tankage

Figure 3: A rendering of the forthcoming Wavecraft Voyager 38

Figure 4: The Wavecraft Voyager 38's personnel transfer systems may include a motion-compensated gangway and SeaSpyder

will still enable a 600nm range. Care has been taken to incorporate engines that meet the latest EU / USCG EPA Tier 4 environmental standards. The power and controls systems have the same configuration as the Commander class, but are simply uprated. Operation and performance thus has a documentable track record.

While careful trade-offs need to be made so as to maintain the speed capability, these larger vessels will have the flexibility to incorporate facilities such as DP2 dynamic positioning, and platform access via a stern-mounted motion-compensated gangway and/or SeaSpyder personnel transfer system (Figure 4). Clearly, the balance between personnel and fuel payload can also be adjusted should a higher cargo capacity be required.

Umoe has spent quite some time simulating vessel motions in different oceans of the world. The simulation tool is developed and validated using experimental data from the Commander class operations, as well as from extensive model tank trials. There are several cases to consider: in transit; while loitering at zero/low speed, while personnel wait to board the facility; and during transfer docking.

For instance, consider the Gulf of Thailand in 2.5m significant wave height (Hs) and low speed. By applying the ISO seasickness criteria (1), the percentage of people who may feel seasick was shown to be between 2- 4% for all sea directions apart from almost direct abeam, which will normally be avoided by the captain. Once executing personnel transfers to an offshore platform, the motions are predicted to affect around 2% for people waiting 30 minutes in 2.5m Hs. One may expect anyone who did feel queasy to be given priority to board the facility first, of course.

	WAVECRAFT		
GENERAL	**Commander 27**	**Voyager 32**	**Voyager 38**
Hull material	Composite Sandwich Materials (CFRP)	CSM/CFRP	CFRP
Main operation	CTV	CTV	CTV
Passengers	24	60 - 90	100 - 150
Crew	3 - 4	3 - 6	6 - 7
Offshore personnel transfer	~2.5m Hs	~2.5m Hs	~2.5m Hs
MAIN CHARACTERISTICS			
Length overall	26.6m	31.2m	38.2m
Length (load line)	23.9m	26.5m	33.5m
Width overall	10.4m	11.8m	11.8m
Draught off cushion	3m	2.1m	2.1m
Draught on cushion (in transit)	0.8m	0.8m	0.8m
Deadweight	15tonnes	25tonnes	37tonnes
MACHINERY			
Main engines	2 × 1,440kW	2 × 2,240kW	2 × 2,880kW
Lift fan engines	2 × 360kW	2 × 550kW	2 × 550kW
Aux. engines	2 × 65kW	2 × 44kW	2 × 60kW
Propulsion	2 × steerable water jets	2 × waterjets	2 × waterjets
Thrusters	-	-	2 bow, 2 stern
PERFORMANCE			
Max. speed	45knots	52knots	55knots
Economy speed @ 85% MCR	38knots	48knots	50knots
Cruising speed	38knots	48knots	50knots
Cruising speed @1.5m Hs	30knots	40knots	45knots
Fuel consumption	21litres/nm	23litres/nm	26litres/nm
Range @14m³ fuel	600nm	600nm	600nm
CAPACITIES			
Fuel oil	15m³	14m³	25m³
Fresh water	1.5m³	1.6m³	3.5m³
Grey water	1.5m³	1.9m³	2m³
Black water	1.5m³	1.9m³	2m³
Ballast (seawater trim)	8.5m³	13m³	7.2m³
FiFi remote control monitor	-	300m³/h	option
DECK			
Cargo crane - SWL	480kg@5.7 m	option	option
Cargo capacity	4tonnes	2tonnes	2tonnes
Deck load	1tonne/m²	0.5tonnes/m²	1tonne/m²
Storage capacities on deck	40m²	25m²	25m²

Table 1: Particulars for Umoe's SES range. All classed by DNV GL, 1A1 HSLC R1 Full Term MCA High Speed Offshore Service Craft

MAROFF programme

In addition to its commercial design developments, the Norwegian Research Council is supporting Umoe's efforts to progress its SES technology in a new MAROFF programme, which aims to deliver the Norwegian Government's maritime strategy for promoting innovation and environmentally sustainable value creation in the maritime sector. The programme provides support and funding to maritime firms and research institutions for projects that target innovative solutions to challenges identified in the Maritim21 and MARUT processes. At present, there is a focus on electric- and hydrogen-powered ferries, as well as improved environmental impact via hybrid powering.

Umoe will focus on optimising the total vessel concept by conducting a parameter sensitivity study on the most important hull parameters in order to design an even lighter hull construction, which will result in more fuel reduction and lower CO_2 emissions. Other focus areas include enhanced propulsion solutions, fire protection and autonomous operations. Various approaches will be applied, including simulation, model testing, CFD and FEM. *SBI*

References

1. ISO 2361-1 Mechanical vibration and shock – Evaluation of human exposure to whole body vibration, second edition 1997