WARSHIP TECHNOLOGY

A publication of **THE ROYAL INSTITUTION OF NAVAL ARCHITECTS**
For more related news please visit: **www.rina.org.uk**

OCT 2024

VESSEL SURVIVABILITY HIGHLIGHTED AT ADELAIDE MEETING

CONCEPT FOR MULTI-MISSION DRONE CARRIER UNVEILED

WARSHIP CONFERENCE HELD IN AUSTRALIA

Event focuses on future fleet, USVs and disruptive technology

AUTONOMOUS SHIPS 2024

MARITIME AUTONOMY CONFERENCE

Rapid technological development in the field of Maritime Autonomy is creating opportunities for the marine industry as well as challenges for the regulatory framework. Recent years have seen various ship projects involving coastal and ocean-going routes with different degrees of autonomy being tested. These will have significant implications for naval architects, shipbuilders, shipping companies, and maritime systems providers. In December 2024, the International Maritime Organization (IMO) will host the 109th session of the Maritime Safety Committee (MSC) where the Maritime Autonomous Surface Ships (MASS) group will meet again. The Royal Institution of Naval Architects and the Danish Society of Engineers (IDA Maritime) are organising the 3rd Autonomous ship conference on 20-21 November 2024 ahead of the IMO meeting.

Conference Topics:

- IMO MASS Code Development
- Maritime remote-control technology
- Automated onboard systems
- Autonomous technology
- E-navigation
- Safety and Security
- Impact on maritime workforce
- Environmental impact
- Legal implications and maritime regulations
- Case studies and research projects

PRELIMINARY PROGRAMME NOW AVAILABLE TO VIEW

20TH-21ST NOVEMBER 2024

COPENHAGEN, DENMARK

THE ROYAL INSTITUTION OF NAVAL ARCHITECTS

IDA Maritim

CONTENTS

October 2024

Front Cover

HMAS *SYDNEY* CONDUCTS MANOEUVRES DURING EXERCISE PACIFIC DRAGON (SOURCE: RAN)

FEATURES

WARSHIP TECHNOLOGY

Editor: David Foxwell
Production Manager: Nicola Stuart
Publications Sales Coordinator: Henry Owen
Publisher: Neil Hancock
Advertising Sales
Email advertising: advertising@rina.org.uk
Telephone: +44 (0) 20 7235 4622
Published by:
The Royal Institution of Naval Architects
Editorial Office:
8-9 Northumberland Street
London, WC2N 5DA, UK
Telephone: +44 (0) 20 7235 4622
Telefax: +44 (0) 20 7245 6959
E-mail editorial: editorial@rina.org.uk
E-mail marketing: marketing@rina.org.uk
E-mail subscriptions: subscriptions@rina.org.uk

Printed in Wales by Stephens & George Magazines.

The Naval Architect Group (English Edition)
Average Net Circulation 8,183 (total)
1 January to 31 December 2023
ISSN 2513-8227

Digital Editions
Warship Technology is published in print and digital editions.
The current and archived digital editions may be read on PC, iPad or other touchpad.
Visit **https://rina.org.uk/publications/warship-technology/** to read the digital editions or download the free RINA Publications App.

EVOLVING THREAT DRIVES NEED FOR MORE – AND MORE CAPABLE – SHIPS

"May you live in interesting times" is sometimes said to be an English translation of a traditional Chinese curse. Whether it is or not, no-one could argue that, militarily, we are in an era of 'interesting,' not to say uncertain times. But given the high level of uncertainty, how should UK government, its armed forces and the Royal Navy respond?

For her part, Dr Emma Salisbury, Robert Whitehead Associate Fellow in Military Innovation at the Council on Geostrategy, believes the answer is clear. The Royal Navy needs more ships, and it needs more capable ones, with greater firepower, she says in a recent 'Explainer' published by the Council, 'Empowering Britain's warship production.'

In her paper, she argues that the UK needs to accelerate, reduce the cost of, and boost the productivity of its naval shipbuilding programme. Naval shipbuilding in the UK continues to demonstrate 'resilience and innovation' she argues, through key projects such as the construction of advanced frigates, aircraft carriers and submarines for the Royal Navy, but the industry now faces a complex set of challenges which are reshaping its future.

Not least among these challenges are budgetary constraints, evolving technological demands, competition in the global defence market, and the difficulty of maintaining a capable workforce. The UK is not alone in facing these challenges of course: the same challenges face other countries, such as the US, where naval shipbuilding, repair and maintenance are, if not exactly in disarray, are in a parlous state, just at the time they are most needed.

"Defence budgets in Britain have been under pressure for years due to a combination of economic factors and competing government priorities. The cost of modern warships, particularly large capital ships, has escalated significantly," says Dr Salisbury. "Managing these costs while maintaining operational readiness and renewing ageing platforms is a delicate balancing act. There is also the challenge of ensuring that long-term defence programmes survive changes in government and political priorities. Delays or cost overruns can lead to projects being scaled back, re-evaluated or even cancelled, creating uncertainty for the industry and the Royal Navy's future capabilities." As she also explains, the shipbuilding industry relies heavily on a highly skilled workforce, but over the years the industry has struggled with an ageing workforce and a shortage of skilled labour. There is a gap in skills crucial for shipbuilding and, without a steady supply of skilled workers, the UK's ability to produce complex warships at the necessary pace could be severely hindered.

Dr Salisbury highlights that modern naval warfare demands ships equipped with advanced systems for cyber defence, artificial intelligence and autonomous capabilities. This shift toward technology-driven warfare requires British shipbuilders to integrate increasingly sophisticated systems into their designs. So, developing warships which are capable of current operations and adaptable to future technological advances is a critical challenge.

THE UK HAS RETAINED THE CAPABILITY TO BUILD COMPLEX WARSHIPS, BUT NAVAL SHIPBUILDING FACES NUMEROUS CHALLENGES (SOURCE: ROYAL NAVY)

As she also argues, the evolving nature of global threats underscores an urgent need to not only increase ship numbers but enhance the combat power and defences of the Royal Navy's existing warships. Combat effectiveness requires enhanced combat management systems that are interoperable with allies. And interoperability extends to integrating different weapon systems and sensors, not least vertical launch systems (VLS), which are integral to modern naval warfare, allowing ships to launch a variety of missiles efficiently and from a compact footprint.

"Adoption of standardised VLS across the fleet would not only streamline logistics and maintenance but also enhance interoperability with allied forces," Dr Salisbury states. "A common system would also enable the Royal Navy to integrate new missile types and upgrades quickly, ensuring that its warships remain adaptable," she adds, noting that development of longer range and more survivable anti-ship weapons is crucial, as is the development of new technology to defend against the rise of hypersonic and ballistic missile threats that have made conventional defence systems increasingly inadequate. Dr Salisbury is surely right when she argues that the Royal Navy should invest in advanced missile defence technology capable of countering these high-speed threats.

"The emergence of new threats... means warships must be equipped with advanced sensors and electronic warfare systems capable of being connected with an array of other sensors and platforms within a 'system of systems,' Dr Salisbury concludes. "British warship builders must remain at the forefront of these innovations, working closely with the government to ensure that the Royal Navy can operate in an increasingly contested maritime environment. Boosting the UK's naval shipbuilding is an imperative for national security." ■

NEWS

LOGISTICS

US Navy demonstrates 'game-changing' replenishment concept

The Naval Surface Warfare Center, Port Hueneme Division (NSWC PHD) recently conducted the first land-based demonstration of a Transferrable Rearming Mechanism (TRAM) that will enable US Navy surface combatants to reload missile canisters into their Mk 41 vertical launch systems (VLS) whilst at sea.

US Secretary of the Navy Carlos Del Toro has made TRAM one of his top priorities. In a speech at Columbia University in December 2022, the Navy Secretary set out the goal that: "during my tenure, we will set the Navy on track to deliver the game-changing capability to rearm our warships at sea."

The Navy Secretary said being able to quickly rearm warships' vertical launch tubes at sea "will significantly increase forward, persistent combat power with the current force".

He continued: "No longer will our combatants need to withdraw from combat for extended periods to return for vulnerable in-port reloading of weapon systems.... My intention is to perfect this capability and field it for sustained, persistent forward-strike capacity during wartime."

The Naval Sea Systems Command (NAVSEA) says the programme is on track to begin fielding TRAM in two or three years.

Tim Barnard, director of the NAVSEA Technology Office (05T), praised the speed at which the sailors of the Navy Expeditionary Logistics Support Group and cruiser USS *Chosin* (CG 65) became acquainted with TRAM in order to execute the demonstration.

"This team has been remarkable," Barnard said. "Without previous familiarity with TRAM, the sailors got spun up

TRAM WILL ENABLE US NAVY SURFACE COMBATANTS TO RELOAD MISSILE CANISTERS INTO MK 41 VLS WHILST AT SEA

for this week's shore demonstration with just a week of training. They understand TRAM is a game-changer that will allow our ships to reload missiles just like they refuel – using connected underway replenishment, steaming at speed and in open ocean."

The land-based test incorporated, for the first time, real-time analytics and direct monitoring through instrumentation, which facilitated real-time assessment and modifications that would otherwise take weeks or months. This unique approach will inform the upcoming at-sea demonstration and follow-on engineering updates.

Rich Hadley, director of NSWC PHD's underway replenishment division – which designed TRAM – explained that "by solving key relative motion challenges, TRAM is a capability enabling reloading operations while underway in significant sea states". He said TRAM "will greatly expand the fleet's logistical flexibility, resilience, as well as volume and tempo of long-range fires".

FRIGATES & DESTROYERS

COTECMAR, Damen sign contract for Colombian frigate

Corporación de Ciencia y Tecnología para el Desarrollo de la Industria Naval, Marítima y Fluvial (COTECMAR) and Damen Shipyards Group have signed a contract for technical support and the supply of components for the construction of a 'Strategic Surface Platform' (Plataforma Estratégica de Superficie – PES), a vessel that will be the first frigate to be built in Colombia.

Construction will be executed by COTECMAR, based on Damen's SIGMA 10514 design. The ship will have a length of 107.5m and a beam of 14.02m.

FRIGATES & DESTROYERS

Keel laid for Brazilian frigate

A keel-laying ceremony has taken place for the frigate *Jerônimo de Albuquerque*, the second ship in Brazil's Tamandaré-class frigate programme.

Four ships of the class are to be built based on the German MEKO design concept. The keel-laying ceremony for the vessel took place on 6 June 2024 at Thyssenkrupp Estaleiro Brasil Sul's shipyard in Itajaí.

Thyssenkrupp Marine Systems signed an agreement to acquire the shipyard in Itajaí, Brazil in 2020. The yard currently employs a total of 1,300 people working on the Tamandaré programme.

SUBMARINES

‘Historic breakthrough’ in defence trade for AUKUS partners

A historic breakthrough in defence trade between the UK, US and Australia was announced in August 2024 following landmark export control changes.

The milestone will enable the three nations to work more closely together to develop next-generation technologies, compete with adversaries and support interoperability in the Indo-Pacific.

It is estimated the reforms – which will lift certain export controls and restrictions on technology sharing – will cover up to £500 million (US$655.7 million) of UK defence exports each year, and billions of dollars of trade across all three nations, helping boost UK economic growth.

Built on bonds with Australian and US allies, AUKUS seeks to support security and stability in the Indo-Pacific region and beyond. The trade breakthrough came via the publication of the UK’s *AUKUS Nations Open General Licence*, combined with a new exemption to the US International Traffic in Arms Regulations (ITAR) for the UK and Australia, and new national exemptions for the UK and US in Australia’s export control framework. This will lift license requirements for the export and sharing of certain defence products, including advanced capabilities, technical data and defence services.

Together, the changes allow AUKUS partners to significantly reduce barriers to defence trade and technology sharing, allowing for faster, more efficient collaboration between scientists, engineers and defence industries. This will benefit all three nations and help deliver the full economic, innovation and security potential of AUKUS.

Speaking at the time that the changes were announced, UK Defence Secretary John Healey said: “As tensions increase, and conflicts continue around the globe, our partnerships with our allies are critically important. This is a breakthrough that will allow our three nations to deepen our collaboration on defence technology and trade. Our new government will reinforce the UK’s role in AUKUS to boost Britain’s military capabilities and economic growth.”

UK Foreign Secretary David Lammy said the announcement “demonstrates how AUKUS is taking our relationship with the US and Australia to even greater heights.” The Foreign Secretary said: “By breaking down barriers to defence trade and cooperation, we’re unlocking huge opportunities for UK jobs and growth – while bolstering global security and stability.”

The announcement followed bilateral meetings between the Defence Secretary and his US and Australian counterparts, meeting US Secretary of Defense Lloyd Austin at the NATO Summit in Washington DC and hosting the Australian Deputy Prime Minister & Defence Minister Richard Marles in Sheffield.

The defence trade changes will allow for fewer licences for exports, re-transfers, and re-exports within and between the UK, US, and Australia. This will significantly enhance collaborative opportunities between the governments and defence industries in the three countries and reduce compliance costs and delivery timelines for UK programmes.

The agreement will be central to Australia’s acquisition of a sovereign nuclear-powered submarine capability from the 2030s, with the transfer of Virginia-class submarines from the US to Australia, and the transfer of equipment from the UK for use in Australia’s SSN-AUKUS submarines. It will also enable Australia to prepare for Submarine Rotational Force-West at HMAS Stirling from 2027, supporting the rotational presence of up to four Virginia-class submarines from the US and one Astute-class submarine from the UK. Consistent with the commitment of AUKUS partners, the agreement will see Australia uphold the highest standards for safety, security and non-proliferation.

Future SSN-AUKUS submarines will be built at Osborne in South Australia, using sealed, welded power units that will not require refuelling over the life cycle of the submarine. Australia is committed to the global nuclear non-proliferation regime and the agreement expressly rules out enriching uranium or reprocessing spent nuclear fuel in Australia as part of AUKUS and prevents AUKUS partners undertaking any activity that would contravene international non-proliferation obligations.

Importantly, the agreement re-affirms, and is consistent with, Australia’s international non-proliferation obligations, including under the Treaty on the Non-Proliferation of Nuclear Weapons, the South Pacific Nuclear Free Zone Treaty and our safeguards agreements with the International Atomic Energy Agency. Australia will manage all waste generated by its own Virginia-class and SSN-AUKUS submarines. It will not process spent nuclear fuel or reactors from the US, UK or other countries.

Australia Deputy Prime Minister, the Hon Richard Marles MP said: “This agreement builds on the significant progress that has already been achieved, including the passing of the US National Defense Authorization Act, the announcement of Australia’s sovereign submarine build and sustainment partners, and the ongoing work to integrate and uplift the industrial bases of all three AUKUS partners.

“The Albanese Government, alongside AUKUS partners, continues to re-affirm that Australia’s acquisition of conventionally armed, nuclear-powered submarines will set the highest non-proliferation standards through the AUKUS partnership. The agreement is unequivocal that, as a non-nuclear weapons state, Australia does not seek to acquire nuclear weapons.”

NEW AGREEMENTS HAVE BEEN SIGNED BY THE GOVERNMENTS OF THE UK, US AND AUSTRALIA THAT WILL FACILITATE THE USE OF TECHNOLOGY ON AUSTRALIA’S AUKUS SUBMARINES

WEAPONS & EQUIPMENT

New decoy launcher is 'real McCoy'

The Royal Navy has unveiled a new decoy launcher designed to help repel missile threats.

Built by Devon-based Systems Engineering and Assessment (SEA), the £135 million (US$177.6 million) Ancilia decoy launcher will replace the longstanding Seagnat system employed on major Royal Navy vessels.

Ancilia is relatively small, lightweight and capable of firing multiple countermeasures, like Seagnat. But while Seagnat is fixed – it can only fire in the direction it is pointing, and at a specific angle – Ancilia swivels rapidly and adjusts the angle the decoys are fired at to maximise their effectiveness. This means that there is no need to manoeuvre the ship to counter incoming threats.

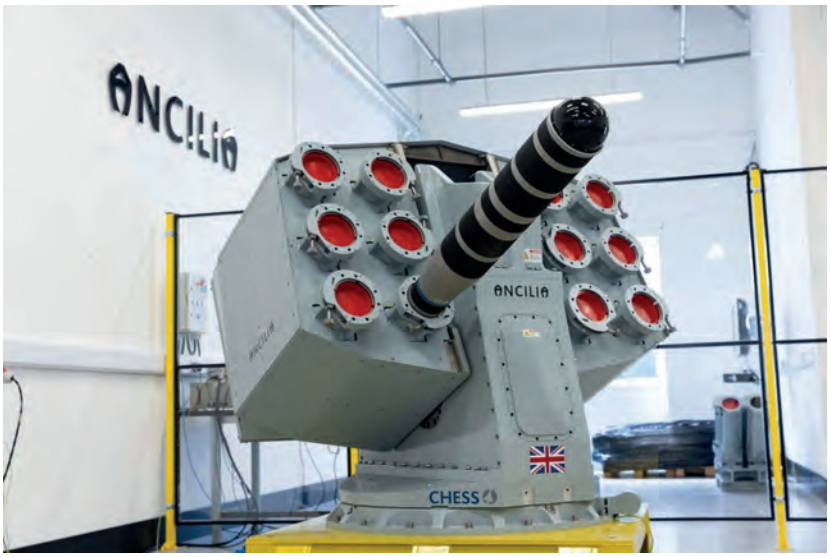
"It was impressive to witness SEA's pre-production Ancilia trainable launcher put through its paces in front of all the stakeholders," said Neil Clelland, the senior principal anti-ship missile scientist with Dstl, the government's military laboratories. "It demonstrated the real engineering progress made so early in the design phase.

"Ancilia provides a paradigm shift in the Royal Navy's capability to deploy electronic warfare countermeasures to meet the threat with new more flexible tactics. Importantly, the new countermeasures interface will enable the exploitation of intelligent countermeasures which are currently being researched to meet the evolving threat."

Together with the Maritime Electronic Warfare Systems Integrated Capability (MEWSIC) the new decoy system will be the backbone of future electromagnetic operations.

Two Ancilia systems are due to be fitted to all six Type 45 destroyers as well as the entire next-generation frigate force: eight Type 26 City-class sub-hunters, and five Type 31 Inspiration-class general purpose warships.

The current Seagnat system comprises six 130mm mortars which fire decoys relevant to the threat: flares to deny heat-seeking missiles, chaff to confuse radar-guided threats; and active rounds which descend by parachute to trick an incoming missile into thinking it is the ship or jam the missile's radar.



ANCILIA IS SMALL, LIGHTWEIGHT, CAPABLE OF FIRING MULTIPLE COUNTERMEASURES, AND CAN SWIVEL RAPIDLY AND ADJUST THE ANGLE DECOYS ARE FIRED AT

SHIPBUILDING

Future USS *Nantucket* delivered

The Freedom-variant Littoral Combat Ship (LCS), USS *Nantucket* (LCS 27), was delivered to the US Navy on 19 July 2024.

Nantucket was accepted from Lockheed Martin at the Fincantieri Marinette Marine shipyard in Marinette, Wisconsin. Delivery follows the successful completion of acceptance trials in December 2023. *Nantucket* will be commissioned later in 2024 and will be homeported in Mayport, Florida.

Following *Nantucket*, two more Freedom-variant ships are under construction at the Fincantieri Marinette Marine shipyard. The future USS *Beloit* (LCS 29) is also scheduled for delivery in 2024. USS *Cleveland* (LCS 31), the final Freedom-variant LCS, is in its final stages of construction alongside *Beloit*.

The LCS-class consists of two variants, Freedom and Independence, designed and built by two separate industry teams. The trimaran-hulled Independence-variant team is led by Austal USA. The monohull Freedom variant is built by a team led by Lockheed Martin.

WEAPONS & EQUIPMENT

New-generation torpedo tested from Royal Navy sub

Royal Navy submarines will continue to be armed with one of the world's most advanced torpedoes after successful trials of the next-generation Spearfish weapons system.

Sea acceptance testing of the latest version of the Spearfish torpedo was achieved on board a Vanguard-class submarine during three days of trials off the coast of Scotland in July 2024.

This was the first time the next-generation Spearfish has been tested on a Vanguard-class nuclear-powered ballistic missile submarine and means the boats are now able to meet the latest threats when at sea.

The trials involved the weapon engaging surface and submerged targets, enabling the boat's crew to operate the new weapon, test the ability to fire from the ballistic missile submarine's combat system and ensure command and control over it. It marks completion of the first-of-class firings on Astute-class and V-class Royal Navy submarines.

SHIPBUILDING

Austal awarded LCU contract modification

Austal USA has been awarded a US$54,997,317 fixed-priced incentive contract modification for the construction of two additional Landing Craft Utility (LCU) 1700-class vessels for the US Navy.

Austal USA was awarded an initial contract for the construction of three LCU 1700-class vessels, with options for an additional nine vessels, in September 2023.

The potential value of the contract for up to 12 vessels is US$379.7 million.

The contract modification brings the total number of LCUs currently scheduled or under construction at Austal USA to five.

The steel hull, LCU 1700s are a heavy-lift capability with 170tonne payload capacity. They will be deployed with the US Navy's amphibious assault ships to support a range of military operations including the delivery of tracked and/or wheeled vehicles, troops and cargo from ship to shore, shore to shore, and back to ship.

SHIPBUILDING

Fincantieri strengthens ties with Indonesia

Fincantieri has announced that Dario Deste, general manager of the company's Naval Division, recently met with Admiral Ali Muhammad, Chief of Staff of the Indonesian Navy, at the Indonesian Navy Headquarters in Jakarta. Fincantieri said the high-level meeting "underscored the robust and growing partnership between the Italian shipbuilding giant and the Indonesian Navy".

The Italy-based company said the meeting, which was also attended by the Deputy Chief of Staff and the entire Indonesian Naval Staff, reflected the strategic importance of the Multipurpose Combat Ship (PPA) programme and the broader relationship with Fincantieri.

Key discussion points included a detailed progress report on the two PPAs under contract, discussions on financing and confirmation of the delivery schedule for the two frigates for Indonesia.

The parties scheduled a follow-up meeting, which was due to take place in mid-September 2024, coinciding with the visit of the Italian Naval vessel *Cavour* to Jakarta.

FRIGATES & DESTROYERS

Orizzonte to build two FREMM EVO frigates for Italian Navy

FINCANTIERI HAS BEEN AWARDED A CONTRACT TO BUILD TWO FREMM EVO FRIGATES FOR THE ITALIAN NAVY

As part of the multi-year 'FREMM' programme to renew the Italian Navy's fleet through the construction of next-generation frigates, Orizzonte Sistemi Navali, a joint venture owned by Fincantieri and Leonardo has signed a contract worth approximately €1.5 billion (US$1.6 billion) with Organisation Conjointe de Coopération en matière d'Armement for the construction of two 'Evolution' version FREMM frigates, also known as 'FREMM EVO.'

The new units will be built at Fincantieri's shipyard in Riva Trigoso and Muggiano, with the first FREMM EVO due to be delivered in 2029, followed by the second in 2030.

WEAPONS & EQUIPMENT

Royal Australian Navy fires Standard Missile 6

HMAS *SYDNEY* FIRES THE ROYAL AUSTRALIAN NAVY'S FIRST STANDARD MISSILE 6

The Royal Australian Navy's destroyer HMAS *Sydney* has conducted a successful firing of a Standard Missile 6, representing a step-change in the lethality, air and missile defence, and long-range strike capability of its surface fleet.

The Standard Missile 6 will be progressively deployed on the Royal Australian Navy's Hobart-class destroyers and, in the future, the Hunter-class frigates.

In a statement, the Defence Ministry said the firing was "another significant milestone in enhancing the lethality of Navy's surface combatant fleet, consistent with the Albanese Government's National Defence Strategy and the Independent Analysis into Navy's Surface Combatant Fleet".

In response to Australia's challenging strategic circumstances, the Albanese Government is enhancing deterrence by boosting the Royal Australian Navy's long-range strike capabilities and providing greater capacity to strike maritime, land and air targets at longer distances.

The addition of the Standard Missile 6 augments integrated air and missile defence capable platforms. Australia has three guided missile destroyers (DDG) in service and will add the Aegis Baseline 9 combat system which will provide the ability to counter airborne threats, including ballistic missiles.

The ADF is also establishing the underpinning architecture to connect active missile defence systems through the development of the Joint Air Battle Management System which provides the foundation for further capabilities to be added over time.

The firing of Standard Missile 6 was conducted during Exercise Pacific Dragon 2024, in vicinity of Hawaii, and follows HMAS *Sydney*'s successful first-of-class firing of a Naval Strike Missile during Exercise RIMPAC 2024 in July. The Standard Missile 6 complements the Standard Missile 2 already in service.

The Standard Missile 6 is being acquired from the US and will provide Navy's surface combatants with an enhanced air and missile defence capability, increasing the fleet's lethality and survivability.

WEAPONS HANDLING/LAUNCHING

Marshall to produce more torpedo tubes for Royal Navy

UK-based Marshall has been awarded a contract to produce composite torpedo launcher tubes for SEA, part of Cohort PLC, in support of two major international naval vessel programmes.

Production will run from 2024 to 2026, with Marshall contracted to manufacture and deliver composite torpedo launcher tubes and associated equipment for integration into SEA's torpedo launcher systems.

Marshall head of sales Colin Jones said: "Building on a decades-long relationship with SEA, this contract will see Marshall continue to manufacture durable, composite launch tubes to deploy NATO standard torpedoes. It is another significant win for Marshall, which sees us utilising our expertise to provide a crucial capability for our customers."

The launcher tubes, manufactured at Marshall's composites facility in North Yorkshire, are of a highly robust design. Their filament-wound GRP structure provides a lightweight and corrosion-resistant solution ready to withstand both the harsh environment in which they are deployed and the launch pressures experienced when firing.

SEA's intelligent torpedo launcher systems are operated by a number of navies around the world. Their design allows for launcher tubes to be housed internally or mounted above deck and meets the requirements of ships of varying sizes and structures.

MINE COUNTERMEASURES

EDA KICKS OFF THIRD PHASE OF DEVELOPMENT OF NEXT-GENERATION MINESWEEPING SYSTEMS

Six European countries are collaborating to develop modular minesweeping systems based on the use of uncrewed surface vessels

In July 2024, the European Defence Agency (EDA) launched the third phase of its Modular Lightweight Minesweeping Next Generation (MLM-NG) project.

The main aim of this next phase of the European project is to raise the technology readiness level (TRL) of new mine countermeasures systems and to demonstrate the use of modular lightweight minesweeping systems in an operational setting.

The new phase of the MLM-NG project builds on the development in the first phase of the project which took place between 2011 and 2014 and second phase, which took place between 2018 and 2021.

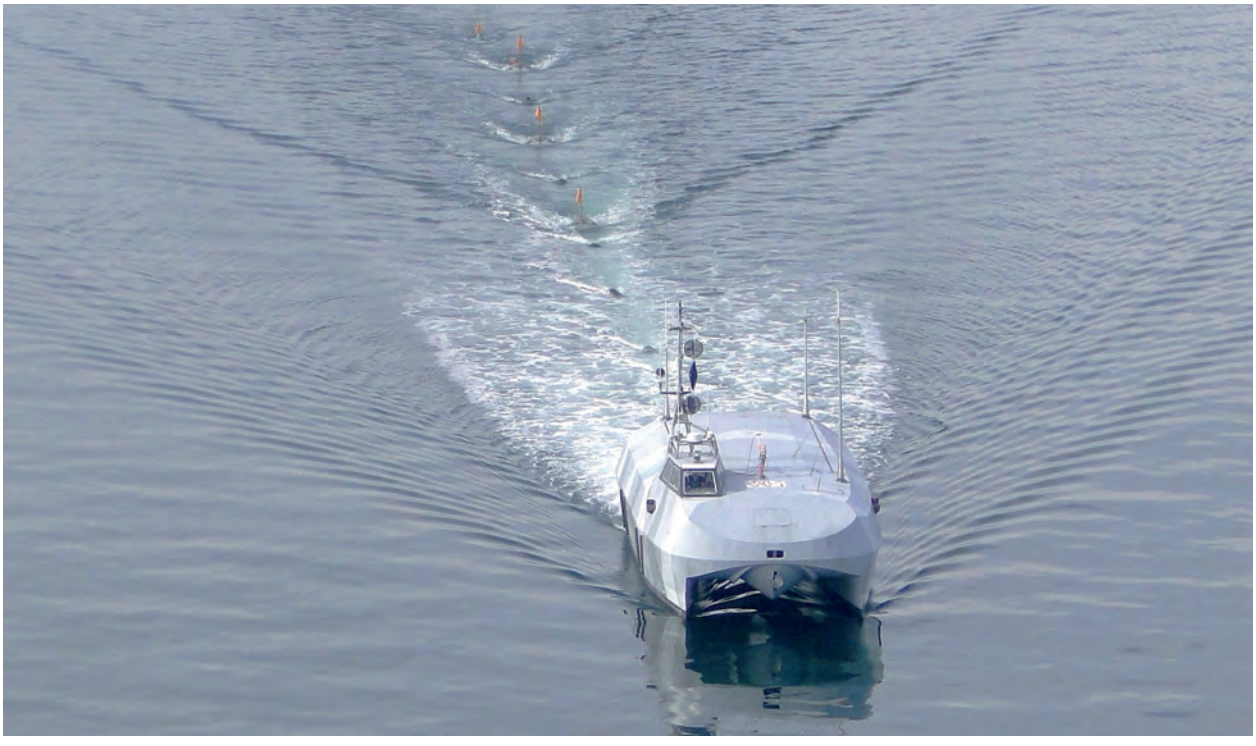
The new, third phase of MLM-NG has a budget of around €9.2 million (US$10.2 million) and involves the participation of six EU member states: Belgium, Germany, France, Finland, Poland and Norway, which is leading the project.

MLM-NG is taking place in response to requirements in several European countries for replacement minesweeping technology, or the reintroduction of minesweeping capability.

Most concepts for new minesweeping capability are based on the use of a flexible solution with autonomous and remotely operated sweep systems, but the technology is not yet mature enough to be adopted on a wide scale.

The aim of technology development efforts taking place in a number of countries is to develop mine-sweeping solutions that utilise next-generation uncrewed surface vessels (USVs) combined with lightweight sweep sources that can be operated with a single platform or by a formation of several USVs, depending on the nature of the operation.

In earlier phases of the project, technology demonstrators were developed and proved the feasibility of the modular and lightweight concept



SIX EUROPEAN COUNTRIES ARE PURSUING THE DEVELOPMENT OF MLM-NG, WHICH IS BASED ON THE USE OF AUTONOMOUS AND REMOTELY OPERATED SWEEP SYSTEMS

for minesweeping. MLM-NG will use the results from these earlier MLM projects and further develop the relevant technologies. The project will also focus on tactics, procedures and the concept of operations for such systems.

Among the concepts and systems tested in an earlier phase of the MLM-NG project was a towed influence minesweeping system, consisting of three modified elementary electromagnetic generator surface (EEG/S) modules. Each module consisted of a set of coils to generate both static and alternating magnetic fields. In addition, each had two electrodes to generate electric fields. The EEG/S require electrical power from the towing vessel. The electrical current in each coil and electrode can be set independently, enabling the generation of complex magnetic and electric signatures. The distance between the EEG/S can be varied using cables with different lengths.

Also tested was an acoustic source, the AC-15, which consisted of two components: the dry end, with communication and control box; and wet end, with low frequency source. The communication and control box controls the settings of the LF source.

The LF source consisted of two lateral pistons, each with a diameter of 30cm, able to produce ship-like noise in the frequency band from 10 to about 100Hz. The source has a weight of 350kg in air and 100kg in water.

An uncrewed vessel – the Erprobungsträger Minenabwehr – (ETMA, test vessel for mine countermeasures) was also tested. This had a catamaran-like hull made from FRP and was manufactured by Atlas Elektronik UK based on its ARCIMS USV. It is 11.2m-long and 3.4m-wide and weighed around 7,000kg, enabling it to be lifted by crane and transported on a low-bed truck. The ETMA's propulsion system consisted of two independent systems, consisting of a Yanmar V8-Diesel and Hamilton waterjets that could propel the ETMA at up to 30knots.

A Cable Powered Advanced Acoustic Generator (CP-AAG), an acoustic noise source designed to sweep acoustically activated sea mines, was also tested in earlier phases of the project. It was developed by Thales Australia and is based on the Advanced Acoustic Generator (AAG). The main difference was that the CP-AAG utilised three-phase power from the towing vessel in order to derive all internal power required for operation. The acoustic signature was generated by a piston located at the front of the source.

The new phase of MLM-NG will culminate with a live demonstration and sea trials, which are due to take place in summer 2026 in Norway. The tests are expected to include an operational assessment in addition to technological and conceptual evaluations. During the demonstration programme, all of the minesweeping systems will be controlled from a command centre on land, without personnel in the mine danger area.

INTERMARINE AND LEONARDO HAVE SIGNED A CONTRACT TO BUILD FIVE NEW-GENERATION MINEHUNTERS FOR THE ITALIAN NAVY

In the build-up to the demonstration, the project will also address operational use, procedures, command and control principles, concept of operations and functional requirements, all of which should contribute to the main objective of the project, raising the TRL of systems and demonstrating the use of modular lightweight minesweeping in an operational setting.

A total of 10 organisations are participating in the project, drawn from the six nations. They include the Royal Military Academy and Belgian Defence in Belgium; WTD 71 and MTG Marinetechnik in Germany; the Finnish Naval Academy and Patria in Finland; the DGA in France; the Norwegian Defence Research Establishment and H Henriksen in Norway; and CTM in Poland.

Elsewhere in Europe, Intermarine and Leonardo signed a contract with the Italian Directorate of Naval Armaments in July 2024 for the procurement of a new generation minehunters for the Italian Navy.

The contract for the new-generation coastal minehunting vessels (NGM/C) and integrated logistical support is valued at €1.6 billion and covers the delivery of five vessels. Intermarine's share of the funding is €1.165 billion, corresponding to approximately 73%; Leonardo's is approximately €430 million, corresponding to approximately 27% of the total. Intermarine is project lead and design authority for the platform. Leonardo is the design authority and supplier of the combat system.

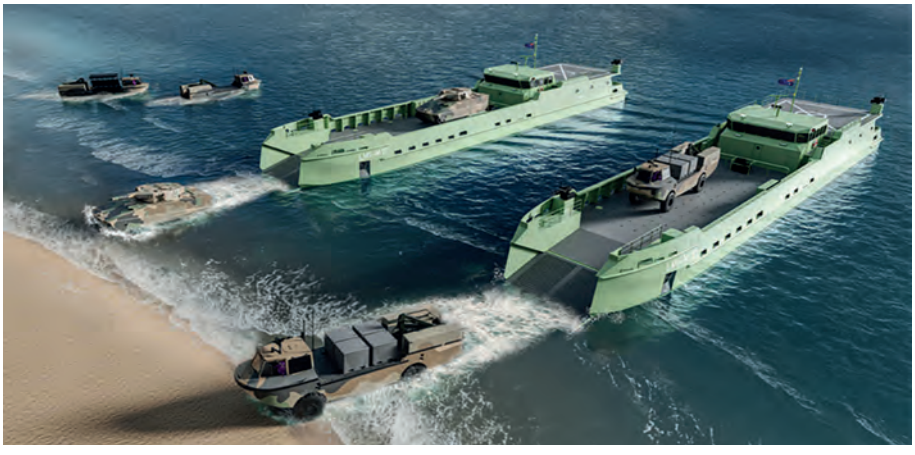
The new minehunters will be able to undertake a wide range of missions. In addition to search and clearance operations, they will undertake seabed surveillance operations for the control and protection of critical underwater infrastructures such as oil and gas pipelines and maritime data networks.

With a length of approximately 63m and a displacement of approximately 1,300tonnes, the NGM/C will be constructed at Intermarine in Sarzana (La Spezia). The combat system, including a cyber-resilient 'SADOC 4' command and control system, advanced radar and electro-optical sensors, new broadband sonar with mine detection and classification capability and integrated communications system will be supplied by Leonardo. ■

AMPHIBIOUS VESSELS

AUSTRALIAN GOVERNMENT 'ACCELERATES' CONSTRUCTION OF LITTORAL FLEET

Build of a total of 18 medium landing craft speeded up by Albanese government



THE FIRST OF AUSTRALIA'S MEDIUM LANDING CRAFT IS DUE TO BE DELIVERED IN 2026

In late July 2024, the Australian Government confirmed that the build of 18 medium landing craft for the Australian Army's new littoral fleet is being accelerated.

The government is currently investing in medium landing craft and in a new fleet of heavy landing craft as well as amphibious vehicles.

The first of the medium landing craft vessels, designed by Birdon and to be built by Austal at the Henderson Shipyard in Western Australia, is now expected to be delivered in 2026. Although the government said the shipbuilding programme was being accelerated, following recommendations from a recent strategic defence review, it did not provide specifics about how the build process would be accelerated or how much more quickly the vessels involved might enter service.

The medium landing craft and eight heavy landing craft which will also be built by Austal at Henderson are an essential component of the Australian Army's transformation and optimisation for littoral manoeuvre and will support a strategy of denial which includes deploying and sustaining modernised land forces with long-range land and maritime strike capabilities. In total, the Albanese Government is investing A$7 billion (US$4.7 billion) in littoral manoeuvre vessels.

The Landing Craft Medium will provide independent shore-to-shore and ship-to-shore capability to enable movement and sustainment of the amphibious Joint Force over extended ranges in the restricted littoral and riverine environments.

The new fleet will be capable of carrying the Joint Force's current and planned armoured and protected vehicles, as a combat-laden mission system in high seas states. The vessel will also be interoperable with the Royal Australian Navy landing helicopter dock (LHD) and landing ship dock.

Minister for Defence Industry Pat Conroy MP said: "The Albanese Government has an unwavering commitment to safeguarding Australians and their national interests, which is why we are making a record investment in defence and modernising the Australian Defence Force.

"Building Australia's new fleet of landing craft is also part of the Government's commitment to continuous naval shipbuilding in Western Australia and a future made in Australia. This pipeline of work will result in opportunities for the Australian defence industry and support a highly skilled shipbuilding workforce for years to come.

"These new vessels will enable the ADF to deploy and sustain land forces to beaches, rivers and ports in Australia and across our region, enhance our ability to work with regional military partners, and support communities across the Indo-Pacific with humanitarian and disaster relief operations."

The Landing Craft Medium will have a range of up to 2,000nm when operating with the Landing Craft Heavy, and will be capable of transporting up to 90tonnes, equivalent to four High Mobility Artillery Rocket Systems or one main battle tank, or one infantry fighting vehicle and two Bushmasters. This is similar to the capacity of large aircraft such as a C-17 Globemaster. The landing craft will be supported by

amphibious vehicle logistics which can navigate over beaches and through waterways that may be clogged with obstacles and debris.

Austal and Birdon Pty Limited signed a memorandum of understanding to jointly develop defence shipbuilding capability in Western Australia in order to deliver the Landing Craft Medium project, shortly after the Minister for Defence Industry announced a 'heads of agreement' to establish a strategic shipbuilding agreement between Austal and the Commonwealth and named Austal as the preferred vessel constructor. Birdon was selected by the Commonwealth as the preferred designer for the project.

Under the MoU Austal and Birdon agreed to work with each other to jointly develop a costed proposal for the landing craft medium project, along with exploring a range of other potential naval shipbuilding opportunities. ■

LITTORAL WARFARE CHALLENGE HIGHLIGHTED AT RINA CONFERENCE

A presentation at the RINA Warship 2024 Conference in Adelaide in June 2024 by Caitlin Hoey, senior naval architect and Ed Waters, senior principal naval architect at QinetiQ highlighted some of the challenges in the design of amphibious vessels. "Is it time to re-appraise the design and acquisition of amphibious warfare ships?" they asked.

The QinetiQ paper looked at how the changing operational environment will impact the next generation of landing ships that will be required for future amphibious operations. The paper focusses on the vulnerability implications to the ship of the methods used for offload of surface connectors – such as landing craft – and the growing need for land operations to be provided with air support, especially uncrewed aircraft. It argued that these issues will provide drivers that will change the design of landing ships when compared to contemporary and historical ships of this type.

The authors of the paper noted that the LPD, with its roots in the Second World War, developed from the 1950s onwards, but has evolved relatively little over the intervening decades. "For instance, though there are many differences in design detail, the general concept of the Royal Navy's Albion-class LPDs is essentially identical to that of its Fearless-class predecessors designed in the 1960s," QinetiQ's authors noted. "These ships are designed to offload relatively large utility landing craft from relatively close to the enemy shore due to the slow speed of the landing craft. This was considered acceptable at the time these vessels were designed with reference to the range of threats from shore, and the defensive measures that could be applied by the escorting task group and in extremis landing ship self-defence weaponry. The offload capability was, likewise, designed to support the contemporary concepts of land warfare, whilst the whole package was constrained by the technology available at that time."

However, as they noted, the last decade, and in particular the last few years, have seen dramatic changes in all of these aspects that will inevitably have to be considered extremely carefully by those tasked with designing the next generation of landing ships.

COMMISSIONED IN 2014, HMAS *CANBERRA* IS TYPICAL OF RECENT AMPHIBIOUS SHIP DESIGNS

RFA *MOUNTS BAY* AND *CARDIGAN BAY* ARE ALSO TYPICAL OF RECENT EXAMPLES AMPHIBIOUS VESSELS DESIGNED BEFORE RECENT CHALLENGES EMERGED

Amphibious operations have always had to deal with an adversary's attempts to defend their shore and the littoral waters from which these operations are launched. Historical A2/AD measures such as mines, inshore attack craft and coastal artillery remain effective, but proliferation of shore-launched anti-ship missiles – including hypersonic and ballistic types – and swarming drones (air and surface) have only multiplied these threats. In addition, the widespread access to surveillance technology including satellite and uncrewed aircraft as well as traditional maritime patrol aircraft can act as a force multiplier for both simple and sophisticated A2/AD systems.

"The concern is not only the rising capabilities of these weapons, but also their proliferation to many countries and even non-state actors," said QinetiQ's authors. "Recent examples of how effective A2/AD can be in the littoral environment can easily be found: these include the Ukrainian successes against the Russian Black Sea Fleet with uncrewed surface vessels and the use of anti-ship missiles by the Houthis in Yemen.

"To be effective land forces now require access to uncrewed aircraft systems to provide situational awareness, reconnaissance, electronic warfare and even engage adversaries. Some of these systems will, no doubt, be carried ashore by the landing force and even operated from connector craft. However, it is likely that larger air systems, potentially crewed and uncrewed, will be needed to provide intelligence, surveillance, targeting and reconnaissance (ISTAR) and precision strike. As such, it is suggested that aviation facilities on the next generation of landing ships will need to take this into account as well as the landing force offload that has historically been the primary driver for the flight and hangar deck design."

QinetiQ's experts also expect that, in future, there will be less emphasis on the use of heavy armour such as main battle tanks in amphibious operations than historically, as evidenced by recent reorganisation of the US Marine Corps. This reduction in heavy armour being but one result of a move towards landing forces of overall lighter and smaller scale and logistics burden. This, they note, may have significant impacts on the design of not only the connector craft (especially as regards challenges related to high speed operation), but also the systems and equipment fitted to the landing ship to deploy and recover them.

"In order to remain effective in the face of the evolving operational environment, it will be necessary for the designers of the next generation of landing ships to think innovatively and not simply follow the formula that has been successful in the past," the paper argues. "In short, an LPD-style configuration with a twin spot flight deck is very unlikely to provide a suitable answer to the challenge. It appears that force resilience, in the form of a larger number of affordable ships, will be preferable to a lower number of individually more capable ships, and that a through deck design offers many advantages compared to a forward superstructure/aft flight deck approach.

"Perhaps the greatest challenge will be that relating to surface offload of medium and large daughter craft. Whilst proven, the well dock has many shortcomings and may not be suitable for future needs. Submerged lifting platforms have the potential to provide a more capable alternative and are worthy of further development.

"Through-deck designs appear to offer significant potential advantages for future amphibious ships. New methods of surface offload may be needed to overcome the constraints imposed by well docks. Modularity will be key in providing not only a multi-role capability but also in adapting to rapidly evolving technology," they concluded. ■

CONFERENCE

RINA WARSHIP 2024 CONFERENCE IN AUSTRALIA ACCLAIMED AS MAJOR SUCCESS

The first in RINA's long-running series of 'Warship' conferences to be held outside the UK took place in Adelaide, Australia in June 2024, and focused on the Royal Australian Navy's significant need for, and investment in, new vessels

THE KEYNOTE SPEECH AT THE WARSHIP 2024 CONFERENCE WAS GIVEN BY REAR-ADMIRAL RACHEL DURBIN, HEAD OF NAVAL ENGINEERING, ROYAL AUSTRALIAN NAVY

For the first time in the 30-year history of the RINA Warship Conference, the Institution and its sponsors conducted the annual event outside the UK, at the Adelaide Convention Centre – with resounding success.

As Rob Gehling, Secretary of the Institution's Australian Division explains, the conference was organised by RINA headquarters in the UK, with support from long-time sponsor BMT, supported by ANSYS, ASC, Babcock, Defence SA, SH Defence and University of Adelaide.

The conference focussed on a wide range of subjects related to the theme 'Future Surface Combatants,' including:

- Future surface fleet mix;
- Design for constructability and supportability;
- Facilities and shipbuilding;
- Automation in design and construction;
- Digital engineering;
- Offboard autonomy and partially or fully autonomous ships; and
- Disruptive technologies.

During the event, ASC Shipbuilding (BAE Systems) conducted informative group tours of its Osborne South shipyard on the afternoon preceding the conference.

Following strong support from industry sponsors and with registrations exceeding expectations ahead of the conference, Rear-Admiral Rachel Durbin, head of Naval Engineering, pronounced the conference a success in her opening keynote address. Her address included an explanation of the Australian Government's plan to implement the 'Enhanced Lethality Surface Combatant Fleet' review.

The second keynote address was presented by Glen Callow, chief technology officer at Austal Limited, who drew parallels between his pre-Austal experience in the establishment of autonomous trucks in the mining industry and the development of autonomous ships.

The conference was run in two streams over the two days, with papers covering subjects including:

- Large uncrewed surface vessels
- Ship design
- Production
- Energy
- Human Factors
- Digital engineering
- Survivability
- Structures

THE SECOND KEYNOTE ADDRESS WAS GIVEN BY GLEN CALLOW, CHIEF TECHNOLOGY OFFICER AT AUSTAL, WHO FOCUSSED ON THE DEVELOPMENT OF AUTONOMOUS SHIPS

RINA'S WARSHIP 2024 CONFERENCE ENJOYED A SIGNIFICANTLY HIGHER NUMBER OF REGISTRANTS ON PREVIOUS YEARS

Several of the papers presented at the conference are highlighted in this issue of *Warship Technology* and others will be highlighted in future issues.

In addition to the many papers from around Australia, there was good representation of speakers from overseas including the UK, Canada, US, Denmark, the Netherlands, Sweden and Singapore, with registrants also from Japan and New Zealand.

Registrants had access to the papers through an app which enabled them to book a seat for individual sessions, to prioritise their attendance, should a disproportionate number of attendees wish to attend sessions.

The importance of this facility became apparent, particularly in the after-lunch session on the first day when the Stream 2 room was at full capacity. It is intended that registrants will continue to have access through the app to videos of proceedings.

Q&A sessions were conducted at the end of each session, covering all the papers presented, the intention being to take questions through the app rather than from the floor. This was successful in maximising use of the available time, especially when some papers drew many questions.

The final session concluded with a wrap-up discussion chaired by Jake Rigby of primary sponsor BMT, who had acted as technical chair of the conference, touching on many of the subjects listed above.

The success of the conference was illustrated by registrant numbers, which were significantly higher than in previous years. ■

SWARMING ATTACKS AND UNCREWED VESSELS: NEW CHALLENGES TO WARSHIP SURVIVABILITY

The RINA Warship conference in June heard that surface combatant survivability needs to be revisited to address challenges posed by attacks by multiple UAVs, and that uncrewed vessels have challenges all of their own

Future warships will have to be able to survive – and fight – in the face of a new range of threats. Some of the ships in question could well have a reduced crew or be uncrewed. Two papers presented at the RINA Warship 2024 by representatives of QinetiQ addressed some of these issues, one examining survivability in the face of attacks by multiple uncrewed aerial vehicles (UAVs), the other addressing survivability issues facing next-generation warships with a reduced crew or no crew.

A paper by QinetiQ consultant, marine survivability Andrew Martin and associate systems engineer Josh Neill noted that parallel developments in uninhabited (uncrewed) small surface vessels (USV) and 'loyal wingman' concepts for combat aircraft suggest that large USVs (LUSVs) will form a significant element of many naval forces in the future.

LUSVs could function as distributed sensor nodes and additional magazines in a network of linked combat ships, they suggested, highlighting potential roles also examined in other papers at the conference. But as they noted, "this form of vehicle offers both opportunities and challenges, one of which is the survival of the LUSV in combat."

Their paper, '*Designing to survive beyond 2040 – opportunities and challenges of LUSV*,' explored the implications of ultra-low crewing and uninhabited LUSVs for vessel security, vulnerability, damage control, repair and recovery. In doing, they explored opportunities for radically different operating methods alongside the naval architectural issues that will arise as LUSVs break the dependence on human limitations.

They noted, at present, these vessels represent a first generation of LUSV, based on commercially available ship designs, but as experience in the operation is gained, a second generation will evolve, characterised by being purpose-designed to operate with minimal concession to the needs of personnel onboard.

LUSV challenges

As with any warship, one of the key drivers to their design will be their survivability against a range of threats, but without a crew onboard, new issues arise. "Major design decisions will need to be faced, including whether such vessels are expendable, whether their uncrewed status allows operation in areas where the threat is too great for crewed ships, and where the balance will lie between susceptibility, vulnerability and recoverability in the design," Martin and Neill noted.

LUSVS ARE LIKELY TO HAVE MULTIPLE ROLES AND PROVIDE SIGNIFICANT OPPORTUNITIES BUT COME WITH SURVIVABILITY CHALLENGES TOO

QINETIQ BELIEVES THAT MAJOR DESIGN DECISIONS WILL NEED TO BE FACED REGARDING LUSVS, INCLUDING WHETHER SUCH VESSELS ARE EXPENDABLE OR NOT

"We are currently in an era where experimentation will start to reveal both the questions we, as naval architects, should be asking, and some of the solutions. However, the next generation of LUSVs is going to need to survive in the combat environment of the 2040s and as designs are prepared now, questions of survivability must be explored."

LUSVs are expected to be less expensive to purchase than comparable crewed vessels with the same capabilities. However, if a LUSV is both a significant sensor node and a magazine for missiles, then the purely financial value of the vessel will still be large. Even more significant may be the functional value of the vehicle – without it the fleet operation will be jeopardised. In this case the LUSV cannot be considered to be expendable and some effort will be needed to ensure that it survives in a combat situation.

For any vessel that is not considered expendable, there will be an ongoing need for protection against underwater shock. Although a LUSV, particularly a multihull design, may not respond to shock in exactly the same way as a traditional monohull, the approaches used for protecting equipment on board will be very similar including the use of ductile materials and shock mounting. Protection will also be needed against ballistic attack. For armour solutions for LUSVs, these will likely focus on protecting any area where an energetic fragment could pose the threat of catastrophic failure. This includes magazines and fuel systems.

As Martin and Neill noted, the fundamental principles of concentration of critical equipment, duplication of major capabilities and separation of duplicate capabilities will apply to LUSV in the same way as crewed warships. Achieving adequate separation will be more difficult in LUSV if they are smaller than fully crewed warships but will prove of value against smaller threats such as medium-calibre gun shells, even if larger anti-ship threats weapons are overmatching the survivability of the LUSV.

Damage control measures

Without crew, damage control and firefighting must be fully automated for LUSV. This will represent a new philosophy for firefighting: some spaces may be sacrificial; others must have rapid extinguishing systems. Re-entry to a fire-damaged compartment will not be possible. In each case early and reliable detection of fire will be critical, and it may be necessary to link this to an intelligent damage-control command system to ensure both early intervention and minimisation of false alarms. As the damage-control command system will be safety critical, it should be robust and able to survive initial weapon effects.

As QinetiQ's experts noted, there is the potential for uncrewed spaces to be inerted while at sea, using hypoxic atmosphere control, either by processing the air to

WITHOUT CREW, DAMAGE CONTROL AND FIREFIGHTING ON A LUSV WOULD NEED TO BE AUTOMATED

increase the nitrogen content at the expense of oxygen, or by filling the space with another gas such as carbon dioxide or argon gas. This will require the compartment to be gas-tight. Such a technique is well suited to void spaces. Maintaining a hypoxic environment will be very difficult when faced with penetrating and explosive damage to a compartment and may need to be backed up with other measures such as exclusion of flammable materials or use of automatic fire-fighting systems. These might be particularly important in machinery spaces where hypoxic atmospheres are more difficult to control as combustion air is drawn in, heat must be exchanged and fuel and lubricant gasses may be found.

Traditional methods of flood limitation such as wedges, plugs and boxes all require human intervention to fit, particularly as any damage tends to be hard to predict and difficult to access. LUSVs will not have this option, therefore most flood limitation must be passive. Buoyant syntactic foams will play some part, bonded to the hull, or filling void spaces. Such materials are regularly used to provide buoyancy in free-flood underwater vehicles. Their performance under shock and ballistic attack is not usually a driving factor in their design but some research has been conducted on which to make estimates of their vulnerability. Self-healing materials do not currently exist to cope with the size of damage that an explosion will create but for small-scale cracks and tears they could form part of a composite layer in a structure that might limit the permeability of a bulkhead and thus reduce the longitudinal spread of floodwater.

One of the key functions of crew is to conduct maintenance and repair of equipment. For a LUSV these must be conducted alongside; there is little scope for battle damage repair while underway. An exception to this might be the employment of intelligent fluid systems which use 'smart valves' to sense pressure drops caused by leaks or damage and automatically re-route a flow network to maintain supply, avoiding the damaged area. Martin and Neill noted that this is a technology at a high readiness level having been demonstrated through the UK Royal Navy DINCS project.

As they also noted, conventional explosive threats will remain relevant for the foreseeable future. Anti-ship missiles, ballistic missiles, mines and torpedoes will remain potent threats and accessible to non-state organisations, as evidenced by the use of advanced missiles by Hezbollah (2006) and the Houthi group (2023-24). Weapons designed to disable destroyer-sized targets are likely to overmatch smaller LUSVs.

A subset of traditional explosive attacks is likely to be the AI-enabled swarm threat, particularly when the LUSV is in harbour, or operating close to shore. The wars in Nagorno-Karabakh (2020) and Ukraine (2022) have been characterised by extensive use of UAVs. In parallel the widespread employment of 'drone swarms' indicates the growing potential for UAV swarm attacks, particularly when allied to artificial intelligence. This would tend to indicate that there will be a need for LUSV to employ some form of self-defence, and this may raise questions about the necessity for a human-in-the-loop for self-defence, particularly in harbour or close to shore, or whether such defence can be automated.

As Martin and Neill also noted, when LUSVs are in harbour, or close to shore, they may be boarded and damaged. One broad interpretation of the International Convention on Salvage (1989) might even suggest that boarding an uncrewed vessel with a view to bringing it into a safe condition might actually count as salvage. In these situations the physical security of the LUSV might require the temporary accommodation of small crew (perhaps flown out to meet the vessel in port).

EXTERNAL COMPONENTS CRITICAL TO A SHIP'S CAPABILITIES – SUCH AS RADARS, GUNS AND ANTENNAE – ARE HIGHLY VULNERABLE TO WIDESPREAD EXTERNAL FRAGMENTATION

This would change much about the arrangement of a vessel. A possible solution to this would be to employ containerised accommodation modules that are easily added or removed.

LUSVs will also be heavily dependent of communications to operate, both with secure military data sharing, but also communications with port facilities to arrange maintenance and with operators to continuously monitor machinery and other onboard systems. "Interception of low-level machinery control signals could allow cyberattacks on more sensitive systems, or force shutdown of essential machinery," QinetiQ's paper noted. A possible counter to this will be to limit the amount of communications so that the majority of operations, such as navigation and collision avoidance are conducted autonomously without external control.

In conclusion said Martin and Neill, advances in ship autonomy, AI and threat severity are likely to result in the widespread adoption of purpose-designed LUSVs as a major component of naval fleets beyond 2040. They offer design opportunities for breaking the architectural dependence on human performance and physical characteristics, but will come with challenges, some of which will be associated with survivability and the effect of removing the crew from many threat scenarios may be met with radically different approaches to vessel survival.

Vulnerability reduction

In a paper entitled '*Survive the Swarm! Warship vulnerability to swarming uncrewed aerial vehicle attacks*,' Neill described methods of vulnerability reduction for surface vessels against a swarming UAV attack and an investigation modelling a salvo of armaments against a frigate-size vessel using QinetiQ's Survive software capabilities.

In the scenario modelled at QinetiQ, the number of bombs incident on the ship is varied, up to a maximum of 15 concurrent strikes. The best- and worst-case damage cases for the 15-bomb scenario were interrogated. Implications for damage control following a swarming UAV attack were also discussed.

"As the century progresses, UAVs continue to gain in popularity for navies modernising their forces," said Neill, "and this trend is likely to continue. While these new technologies aim to enhance the capabilities of naval platforms, the ability to endure the threat posed by attack from such craft is also being considered."

As he noted, naval platforms today are typically armed with either intercept missiles or close-in weapon systems (CIWS) to deal with incoming air threats such as missiles and aircraft. Crew may be less experienced in use of the combat system and air defence systems to track and address larger numbers of smaller air threats simultaneously than is conventional.

If a swarming UAV attack was to occur, it is plausible that vessel air defence capabilities will become overwhelmed, due to the inability to employ sufficient countermeasures for all avenues of attack, leading to multiple successful weapon strikes being delivered to a single target.

Neill explained, in warship design, survivability principles of redundancy and separation, and concentration and protection, are typically considered for damage from a single threat weapon. How these principles fare in the context of multiple weapon strikes is in need of urgent consideration, hence QinetiQ's modelling of an attack on a frigate by a salvo of small, guided bombs.

"This is a novel type of vulnerability assessment whereby a large number of threat weapons are modelled as striking the same target vessel as part of a single damage scenario," said Neill. "Usually when carrying out typical vulnerability assessments, only a limited area of the vessel is damaged and vulnerability reduction design philosophies are typically developed with this in mind. Investigation of a scenario whereby damage is inflicted to several locations on the vessel will therefore give a fresh view as to what vulnerability reduction strategies need to be considered for the modern threat of a swarming UAV attack."

The modelling carried out in the QinetiQ study highlighted specific changes that could be made to frigate design to improve survivability. In addition, general learning points for mitigating damage from a swarming UAV attack delivering multiple, externally detonating, fragmentation warheads were identified.

The studies found that a surface combatant such as a frigate is most vulnerable when damage was dispersed along the full length of the ship. "Equipment close to the hull is the most vulnerable to this type of attack," said Neill. "This should be borne in mind when employing other vulnerability reduction measures," but "carrying out traditional damage control methods following a swarming UAV attack may be challenging due to the possibility of a large number of casualties, the widespread damage caused and the potential for several fires being started."

According to Neill, conventional vulnerability reduction measures such as separation and redundancy, and concentration and protection should continue to be employed and in the case of separation and redundancy, armouring can also be employed to protect against a widespread fragmentation threat affecting a large portion of the vessel. This could take the form of modern, lightweight protection, placed around critical internal components to catch fragments, he suggested. This would minimise any impact on the overall design.

But, as Neill underlined, one unsolved issue is that external components critical to a ship's main capabilities – such as radars, guns and antennae – are also highly vulnerable to widespread external fragmentation. "It is challenging to determine a solution to protect all of them," he concluded, highlighting the fact that redundancy and separation of such equipment is less effective against this nature of swarm attack. "It follows that the likelihood of damage to the main capabilities of a vessel is quite high from a swarm attack and damage prevention through signature management and hard-kill and soft-kill countermeasures will play an important role in maintaining capability." ■

THE MATE SHIP: RAPID ENHANCEMENT OF SURFACE FLEET LETHALITY

A paper presented at the Warship 2024 RINA conference in Australia heard an analysis of how the Royal Australian Navy might meet a requirement for greater fire power and more missile-armed vessels

The Royal Australian Navy's surface fleet is well-equipped in sensor and combat management systems but lacks the ability to deploy sufficient effectors, but a class of vessels could be constructed based on existing high-speed vessel designs to act as 'missile magazines,' Gareth Arnold, from the Naval Construction Branch told the conference.

Arnold said the vessels could provide enhanced lethality to the Royal Australian Navy in a relatively short timeframe, with small crew requirements and could be built by Australian and/or allied shipbuilders based on existing designs.

"While the numbers of effectors that the Royal Australian Navy can deploy is limited, the quality of the effectors is suitable," he said. "The Royal Australian Navy employs modern variants of the Standard missile family and the ESSM. Tomahawks are being acquired, as is the Naval Strike Missile. Upgrading to improved effectors, such as hypersonic missile, would provide additional lethality, but the developmental nature of these weapons mean that they do not provide a viable short-term improvement.

"We can reasonably conclude that while the Royal Australian Navy's sensor and combat management systems are suitable and the nature of the effectors available is appropriate, it needs more strike and air-warfare effectors. Therefore, the problem becomes, 'How do we best increase the surface fleet's strike and air warfare effectors in the shortest possible time?'"

Arnold said there are three obvious solutions to providing the fleet with more effectors, which are to increase the effectors carried by each surface combatant, to acquire additional vessels, or to convert non-combat platforms to carry effectors.

"To increase the number of air warfare and strike effectors, the most efficient means would be to increase the number of vertical launch system (VLS) cells carried by platforms," he told delegates, noting that the VLS can fit a broad range of effectors.

"Given the modular nature of a VLS, this approach initially appears simple. Indeed, VLS cells were added to the Adelaide-class frigates as part of an upgrade, demonstrating that the task can be performed.

"However, the availability of sufficient space and weight for a VLS aboard other major surface combatants would be very difficult to find. The ANZAC class, for example, would have no capacity for an increase to VLS count without significant hullform change due to having no available weight margin. Any modifications that involved the modification of ship's hulls would have massive implications for almost every aspect of the vessel."

Arnold continued: "If additional surface combatants were acquired to increase effector count, the Hobart class would be the clear choice as it is the Royal Australian Navy combatant that carries the largest number of effectors.

THE ROYAL AUSTRALIAN NAVY WOULD BENEFIT FROM GREATER FIRE POWER IN THE FORM OF MORE MISSILE-CARRYING VESSELS

However, large surface combatants require several years to build, even designs that have been previously constructed, like the Hobart class and major surface combatant builds commonly run behind schedule."

Even if new vessels of this type were built, the Royal Australian Navy would then have to man the vessels. With a Hobart-class ship requiring a crew of 186 plus 16 for air crew and support, this would be a significant burden for a Navy that already experiences many manpower issues.

Procurement of new 'military-off the shelf' corvettes or frigates would also involve issues similar to those of the acquisition of new Hobart-class vessels and existing designs could not be expected to mount the same sensors, combat systems and effectors as use by the Royal Australian Navy. To change the systems to systems in use by the Royal Australian Navy would involve developmental work and not to change them would involve introducing new systems into service, which would also be developmental.

"The acquisition of 'off the shelf' vessels would not be the quick fix that it initially appears," said Arnold, noting that another option is adding missile capacity to other Royal Australian Navy vessels to supplement major surface combatants.

He noted that arguments have already been raised to arm the currently in-build Arafura-class offshore patrol vessels with anti-ship missiles and, possibly, additional missiles. The Arafura design is intended for constabulary duties and thus has lower shock hardening and damage control, but the existing radar is unsuited for higher-end warfighting and the class has no radar illuminators to guide self-defence missile such as the ESSM. "These issues would require massive redesign and modification to address, but if not addressed would create a platform with limited offensive capability in higher end warfighting and huge vulnerabilities," Arnold told delegates at the conference.

"If an arsenal ship concept is considered as a base concept," said Arnold, "a review of the issues that dog other solutions provides a set of criteria that would

BUILDING MORE HOBART-CLASS SHIPS WOULD TAKE TIME AND BE A SIGNIFICANT BURDEN FOR A FORCE THAT ALREADY HAS MANPOWER ISSUES

describe a solution to the question, 'How do we best increase the surface fleet's strike and air warfare effectors in the shortest possible time?'

"The vessel would need speed, range and endurance comparable with Royal Australian Navy major surface combatants so that it could operate in concert with them. The speed and range requirements are then defined by those of the ANZAC class – the Royal Australian Navy's largest class of surface combatants, at 11,000km range and 27knots or greater maximum speed, respectively.

"The vessel would need to be able to carry a large weight of cargo' composed of VLS cells. The number of cells carried by the vessel is determined as a trade-off of cost versus capability, as the Mk41 can be configured to have an effectively arbitrary number of cells. To add maximum lethality to the fleet, a larger number of cells would be better. However, the cost of the system rises as the number of cells increases, particularly if the payloads are considered. Larger numbers of cells also risk rapid depletion of limited stocks of missiles if the vessel is damaged or destroyed."

Arnold said that for the purposes of his study, a compromise measure of 64 cells was set. This equates to a 16m x 4m x 8m, 300-tonne cargo. In addition, a

THE SPEARHEAD CLASS COULD POTENTIALLY BE MODIFIED TO ACT AS A MISSILE CARRIER

THE PAPER PRESENTED AT WARSHIP 2024 SUGGESTS HIGH-SPEED VESSELS COULD POTENTIALLY BE ADAPTED TO OPERATE AS 'MATE SHIPS'

number of measures of effectiveness of solution can be identified. These include minimising crew per cell, thus gaining maximum lethality per person for a personnel-limited Royal Australian Navy; minimising cost-per cell, similarly maximising additional lethality for what remaining budget can be found in an environment with a large number of acquisition programmes; and minimising time-to-service. This implies building as close to an existing design as possible.

Due to the intended role of accompanying major surface combatants, names such as the 'Partner Ship' or 'Ship Mate' were considered before the concept was christened 'Mate Ship' as a play on the traditional Australian value of 'mateship,' that is, companionship or friendship between men.

Having ruled out existing major surface combatants and 'off-the-shelf' designs, Arnold noted that the recent Surface Fleet Review had suggested the acquisition by the Royal Australian Navy of six 'Large Optionally Manned Surface Vessels (LOSVs)'.

The vessels, based on the development of the US Navy's 'Project Overlord' are intended to carry a VLS payload – nominally 32 cells – and be able to operate in an autonomous manner, though to date the Royal Australian Navy has stated that they will be 'minimally manned'.

The optionally manned vessels are intended to act as additional VLS magazines for major surface combatants. "Given that these vessels have a very similar role to the Mate Ship and are already included in defence planning, does a role for the Mate Ship still exist?" questioned Arnold.

The LOSV design is not yet specified but is based upon the Project Overlord large uncrewed surface vessel (LUSV) and was used by Arnold to assess the suitability of the LOSV as a missile carrier.

"The LUSV appears to have range capabilities in line with Mate Ship Requirements," Arnold said. "It would also likely have sufficient endurance due to lacking crew. The hulls used for LUSV testing have as yet not included high-speed designs, so unless different hullforms are chosen it would not meet the speed requirement. The LUSV carries 32 VLS cells to the Mate Ship's 64, thus adding less lethality per vessel. However, these numbers are largely arbitrary due to the VLS's modular nature. The LUSV optimises the crew-per-cell metric and also overcomes the survivability concerns around the Mate Ship, as long as the LOSV developed is operated unmanned.

"Crucially however, the LUSV does not provide the quick addition of lethality that the Mate Ship could provide. Currently, Defence states that the LUSVs will be delivered 'in the 2030s.' Considering the developmental nature of autonomous vessels and regulations, the tendency for naval shipbuilding programme to run over schedule and the current planning to build the LUSVs at Henderson along with four other classes of naval vessel, it can be reasonably assessed that 'in the 2030s' could mean 'by 2039." Thus, only building the LUSVs would result in a 15-year capability gap."

Arnold argues that this capability gap could be addressed by building Mate Ships derived from the HSV-2 Swift and the Spearhead class, in the interim. The Royal Australian Navy could then use the platforms as test beds to determine if to integrate such a capability into fleet doctrine and whether aspects of the Mate Ship concept – such as higher speed and organic defences – should be included in the LUSV designs.

"Furthermore," Arnold explained: "Austal USA is involved in LUSV development and are incorporating autonomous aspects into later Spearhead-class hulls. Thus, the Mate Ship and LUSV concepts could converge as an 'auto-mate ship.' Placing only VLS cells and a minimal combat system aboard platforms designed to move hundreds of personnel leaves significant space aboard the Mate Ship. This provides opportunities for later development of the capability."

Arnold said one option would be to transport not only missiles, but also unmanned vehicles into a battlespace, for the use by major surface combatants. However, this would involve significant developmental work and should thus not be considered until the original capability was achieved. It would, however, help major surface combatants keep improving their capabilities whilst not adding further to hamper to their already packed hulls. Both HSV-2 Swift and Spearhead-class vessels have embarked helicopters, and an aviation capability would thus also be a developmental opportunity.

Arnold also noted that development of hypersonic weapons by Australia and its allies may produce weapons too large to fit into the launch cells of existing VLS, as achieving hypersonic speeds is a fuel-intensive exercise. The relative lack of clutter on a Mate Ship compared to major surface combatants would allow for the installation of launch systems for these large weapons. ■

DRONE CARRIERS

CONCEPT FOR MULTI-MISSION DRONE CARRIER UNVEILED AT RINA CONFERENCE

Drawing on design practice employed in surface combatants and aircraft carriers, a project to develop concept designs for drone carriers has been developed in response to growing use of naval USVs

The use of drones in naval warfare has come sharply into focus since the Russian invasion of Ukraine and the use of uncrewed units by the Houthi militia against commercial shipping in the Red Sea.

Their use has highlighted their cost-effectiveness as anti-ship units and raised concerns about how warships might best be modified to defend against them. In 2024 alone, Magura V5 uncrewed surface vessels (USVs) developed in Ukraine have been responsible for sinking of three different warships.

Despite these successful use cases, the use of drones as offensive assets has not become widespread, but a paper presented at the RINA Warship 2024 conference in Australia in June suggests greater use of drones launched from vessels – even dedicated drone carriers – could be approaching.

Speaking at the conference in Adelaide, Rui Pinto da Costa from Damen Naval highlighted the surge in the use of uncrewed vehicles in military operations and described work undertaken to explore the operational potential of the application of uncrewed systems deployed from a dedicated surface ship, engaging with the naval architecture and design challenges associated with such a vessel.

The paper presented at the conference updated work originally undertaken at Instituto Superior Técnico in Lisbon, the aim of which was to develop innovative warship concepts and design tools for new-generation surface combatant design. A conceptual design process for a dedicated drone carrier was developed, with a multi-role operational concept and requirements comparable to modern North Atlantic Treaty Organization navies. This conceptual design process included an overview of the surface warship preliminary design methodologies, and the development of a concept of operations for drone carriers, along with the definition of operational requirements, the development of a ship synthesis model and development of two ship concepts for different NATO end-users. The overall aim was to design a naval asset capable of deploying large numbers of uncrewed units – above water, underwater and aerial – whilst operating outside a conventional task force.

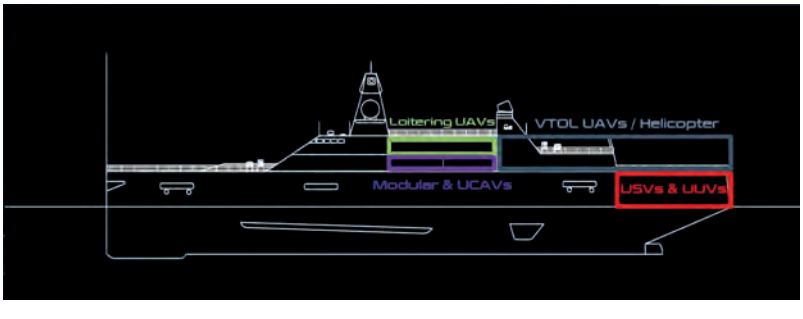
The final conceptualised vessels, when detailed and analysed, were found to merge various characteristics from modern surface combatants such as frigates, destroyers and cruisers and conventional aircraft carriers. “The operational potential of these ships… is particularly high,” said da Costa, noting that they drone carrier would be “exceedingly versatile”.

Da Costa told the conference that despite the successful drone attacks by Ukrainian USVs and units operated by the Houthis, most drone carriers are likely to be modified vessels converted to a new role. Purpose-built drone carriers might be even more effective, and with this in mind, a project was developed at the Centro de Engenharia e Tecnologia Naval e Oceânica (Centre for Marine Technology and Ocean Engineering, CENTEC) at University of Lisbon, in order to develop methodologies, processes, best-practice and a toolset for the conceptual design of purpose-built multi-mission drone carriers.

Findings from this work were published and discussed in a number of fora, leading to the development of potential improvements and modifications to the drone carrier concept that were incorporated into the more recent work and incorporated into two distinct concept solutions.

Da Costa noted that the drone carrier’s payload volume fraction resides on the lower end range of aircraft carriers while the enclosed volume is closer to a small to medium-sized frigate with payload densities lower than most warships but being closest to aircraft carriers.

Both concept solutions complied with the operational



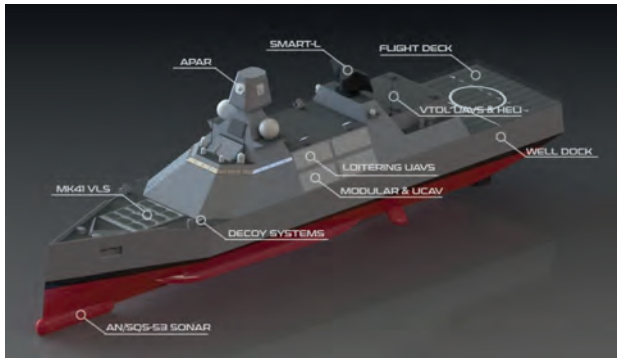
THE DRONE SHIP CONCEPT MERGES CHARACTERISTICS OF SURFACE COMBATANTS SUCH AS FRIGATES, DESTROYERS AND CRUISERS AND AIRCRAFT CARRIERS

requirements established for the study, and with end-user goals. Both concepts were further elucidated and then modelled in 3D in order to develop the conceptual designs. The initial design stages of a drone carrier were undertaken, along with the development of a customised ship synthesis model.

"The concept solutions were both determined to be compliant with the design requirements and could thus be considered successful concept solutions and ready for refinement," said da Costa. "The solutions were later developed and 3D models of the concept ships were developed, from which the design formulas used in the synthesis model were further refined.

"Further challenges and improvements are underway," he concluded. "These include the further refinement of the ship synthesis model and reducing the large computational power requirements that served as bottlenecks to development of the model. Additionally, this model is currently being used to make single optimized iterations of concept warships when considering single ship operational requirements. The model is thus evolving in order to be used to optimise a small fleet of ships with varying configurations or to optimise a single ship concept." ■

THE DRONE SHIP CONCEPTS DEVELOPED DURING THE PROJECT ARE ABLE TO DEPLOY USVS AND UNDERWATER AND ABOVE-WATER UNITS

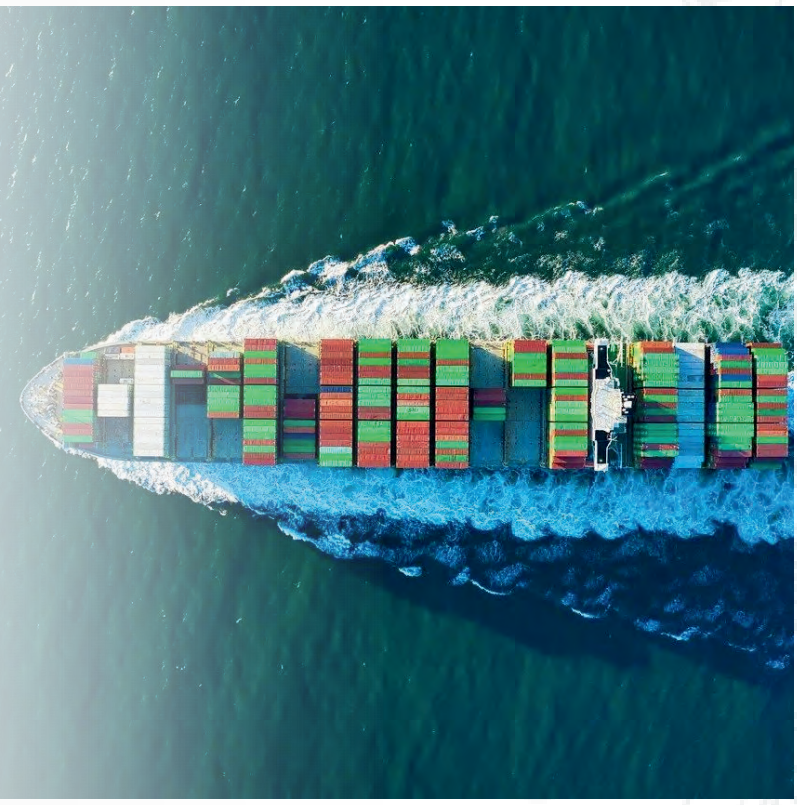


THE DRONE CARRIER'S PAYLOAD FRACTION RESIDES AT THE LOWER END RANGE OF AIRCRAFT CARRIERS; THE ENCLOSED VOLUME IS CLOSER TO A SMALL TO MEDIUM-SIZED FRIGATE

CII 2025

TECHNICAL CONFERENCE: MANAGING CII AND ASSOCIATED CHALLENGES 2025

In January 2024, the Royal Institution of Naval Architects (RINA) hosted the first Technical Conference on Managing CII and Associated Challenges at the IMO Headquarters in London. The conference resulted in bringing together 90+ industry stakeholders who exchanged feedback and insight on CII's first year. The 2024 conference, supported by SPNL and the Nautical Institute, allowed the delegates an opportunity to hear from two keynote speakers – Mr. Tianbing Huang, Deputy Director, Sub- Division of Protective Measures, Marine Environment Division, IMO and Julien Boulland, Global market leader for sustainable shipping within Bureau Veritas Marine & Offshore, head-office commercial team, among many other presentations including from companies such as Ardmore Shipping; d'amico società di navigazione spa; MSC Cruise Management (UK) Ltd; DNV; Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping; International Chamber of Shipping; Royal Caribbean Group; and many more. The IMO must conduct a review of the CII before 1 January 2026, and following initial feedback, changes are expected to CII, though it is not yet clear on what the final outcome will be. The Royal Institution of Naval Architects is proposing a follow up conference in January 2025, and is inviting companies to share how they manage performance as a system, and to explain how continuous improvement in energy efficiency may be achieved.



Carbon Intensity Indicator (CII) – What is it?

The Carbon Intensity Indicator (CII) is a mandatory rating measure for ships, developed by the International Maritime Organization (IMO), that came into effect on 1st January 2023. As part of its commitment to addressing climate change, the IMO has been working on the development of a Carbon Intensity Indicator (CII) for international shipping. The CII is intended to measure the carbon efficiency of ships and assess their relative carbon emissions performance. The concept of the CII was introduced in the IMO's Initial Strategy on Reduction of GHG Emissions from Ships, adopted in 2018. The strategy sets out a vision to reduce total annual greenhouse gas emissions from international shipping. The CII is intended to be a key tool to assess and monitor the carbon intensity of ships, providing a standardized and transparent measure for evaluating their energy efficiency and emissions performance. It is expected to be a dynamic indicator that can be updated periodically to reflect technological advancements and best practices. However many sectors of the maritime industry have expressed concerns regarding the unintended consequences of implementation of CII.

21ST - 22ND JANUARY 2025

LONDON, UK

Conference Topics:

- **Experience with managing and complying with CII**
- **Challenges with implementation of corrective actions**
- **Experience with effectiveness of corrective actions**
- **Lessons learnt**
- **Intersection with commercial and contractual issues**
- **Best practice energy efficiency management approaches**

THE ROYAL INSTITUTION OF NAVAL ARCHITECTS

SPONSORED BY:

HEMPEL
Trust is earned

Scan QR code to download the report

Retrofit Research Programme

ENERGY EFFICIENCY RETROFIT REPORT 2024:

Applying wind-assisted propulsion to ships

lr.org