THE AUSTRALIAN NAVAL ARCHITECT

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Incat Tasmania's latest high-speed catamaran ferry, *Volcán de Taidía,* off Hobart during sea trials
(Photo courtesy Incat Tasmania)

THE AUSTRALIAN NAVAL ARCHITECT

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Cover Photo:
RSV *Nuyina* crossing the southern Indian Ocean on 2 October on her way to her home port of Hobart
(Photo courtesy Australian Antarctic Division)

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From the Division President

Welcome to the November edition of *The Australian Naval Architect*, I trust this finds you all well. It would appear that the acclaimed traditional Chinese curse, "May you live in interesting times" is well suited to the 2017 Naval Shipbuilding Plan, particularly following the Prime Minister's announcement with his UK and US counterparts on 16 September of the AUKUS pact which includes the acquisition of at least eight nuclear-propelled submarines and discontinuation of the project for the construction of the French-designed Attack-class conventional submarines.

In April 2016 the French-designed Attack-class submarine was selected to replace the Collins-class at an estimated cost of $90 billion (2020). The first submarine was expected to enter service in the early 2030s with construction extending into the late 2040s to 2050. Move forward five and a half years and we find ourselves starting once more.

I expect the announcement has raised a plethora of questions across the Australian maritime community; here are some of the issues which I think need to be addressed:

Technical

The Attack-class project was recognised to be complex enough without adding a major new challenge to master nuclear propulsion. The primary differences between nuclear and conventional submarines revolve around the nuances of a nuclear power plant and the critical focus on safety. On the other hand the reactors for our submarines are likely to be manufactured by the US and/or UK to an existing design, so are likely to be proven technology already integrated into the design of the selected submarine.

The extent to which Australia can contribute to nuclear engineering aspects of the selected design is limited now, but there are nevertheless likely to be design changes, like the incorporation of a US-based combat system if the selected submarine is British. To avoid the problems generated in past naval shipbuilding projects by altering a proven design, the changes made to whichever of the UK or US base design is selected should be kept to the absolute minimum.

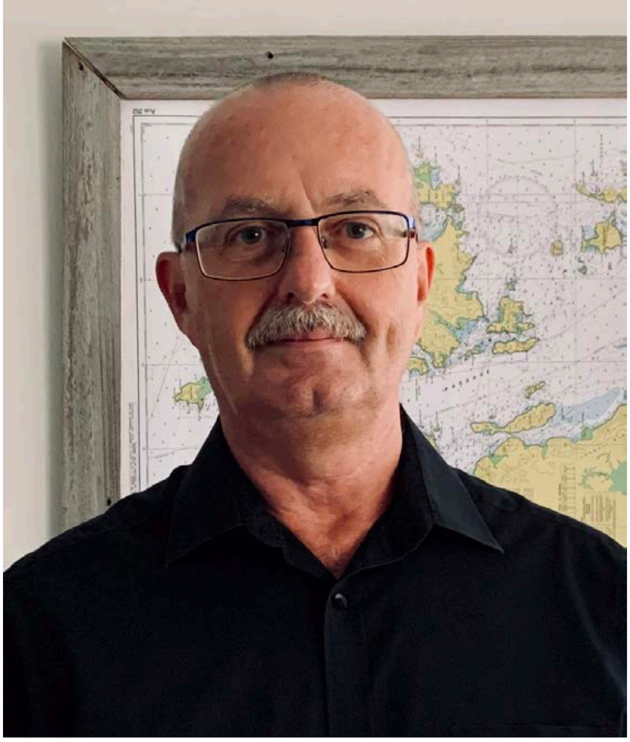
In a similar vein would it be practical to have all the submarines built in Adelaide given Australia's lack of familiarity with nuclear technology and likely need for additional facilities, the provision of which will take time?

A critical early task will be to establish a regulatory regime for naval nuclear propulsion in Australia. The Australian Radiation Protection and Nuclear Safety Authority (ARPANSA) fulfils the role of an independent nuclear safety regulator, and protocols are in place governing visiting nuclear-powered vessels, but work will be needed to create the regulatory framework for the construction and maintenance of Australian nuclear-powered vessels.

Financial

How much has been spent to date on the Attack class — how much of that will be able to be pulled through in support of the new program? How will the significant change to the Defence budget (timing and quantity) impact the rest of the Defence acquisition program?

Nuclear submarines are more expensive to acquire and



Gordon MacDonald

to operate than diesel-electric boats — how will this be managed?

Resource

Neither the Australian Department of Defence (acquisition organisation, sustainment organisation, Navy and Naval Engineering Directorates) nor Australian industry have significant nuclear technology experience, how much capability would we need and how would we obtain it? It would appear imperative that substantial effort needs to be immediately directed towards training Australian personnel to the necessary high level to ensure both sound engineering and safe operation of the submarines. Australian submariners have served in US and UK nuclear submarines but not aft of the machinery space bulkhead. As soon as security protocols and management systems are in place the bulkhead door needs to be opened to Australians for early training.

Schedule

The first step in the implementation of the nuclear submarine acquisition plan is the launching by Government and the Defence Department of an 18-month-long study into choosing between submarine designs from the United States or Britain. The first submarine may now not be delivered until close to 2040 whereas it had been anticipated that the first Attack-class submarine would be in the water by early 2030s.

Operational

Nuclear powered submarines provide a wide range of additional capabilities over their conventional counterparts with a high sustained submerged speed, considerably greater than any contemporary diesel submarine. This superior speed, range, and endurance make the nuclear submarine a very effective offensive weapon, capable of projecting power. The conventional submarine, it is argued, has superior littoral warfare advantage with shallow-water manoeuvring and exceptional low underwater self-generated noise. This difference in roles will alter the current maritime warfare capability and planning of the RAN.

To avoid a capability gap, the Government signed off on a rolling program to extend the lives of the six ageing Collins-class submarines for at least another 10 years (LOTE), beginning in 2026 at ASC's shipyard in Adelaide. Will this extension be sufficient?

Continuous Shipbuilding

The Attack-class submarine was originally intended to form the backbone of the continuous naval shipbuilding program which also includes the Arafura-class offshore patrol vessel and Hunter-class frigate, stretching out to at least 2055. The continuous naval shipbuilding program was instrumental in avoiding the naval shipbuilding workforce 'valley of death' created in 2015 when naval shipbuilding activity ceased in three shipyards as the Australian-based RAN acquisition programs came to an end. The plan will now require a significant update with the abandonment of the Attack class and the insertion of the necessary life-of-type extension of the Collins class.

It is clear that the workforce planning and facilities utilisation aspects of the Naval Shipbuilding Plan need to be re-worked to accommodate the Collins-class LOTE project in addition to the AUKUS submarines, particularly if all of the work is to be carried out in Adelaide. We can envision that this may involve shifting some of the work and workforce demand to Western Australia or even reconsideration of the decision that all of the nuclear-propelled submarines will be built in Australia.

The most worrying aspect of this change in direction is the potential for further derailment of the Australian submarine capability that could arise if the proposed move to nuclear submarines becomes all too hard, too political or too expensive. We don't want to be back here in another five years' time.

That said, it is clear that we are entering into an eventful and exciting time for naval architects working in naval new construction. I would like to thank John Jeremy and Rob Gehling for their support and guidance in crafting the President's column for this edition on what is an emotive subject.

Finally, I would like to remind you that I am seeking your assistance in providing your ideas of how we can improve the services of the Institution to make it more relevant to your needs. You should note that the Institution is already implementing a substantial upgrade of its digital offering, which should become apparent in the New Year. Bearing this in mind, please email your thoughts directly to me at gdmacdonald1000@gmail.com.

Gordon MacDonald

Editorial

Thursday 16 September dawned just like any other — then there was a press conference and our world changed. The the trilateral security partnership AUKUS was revealed. Whilst AUKUS covers a wide range of matters relevant to Australian defence and the relationship with our AUKUS partners, the United States and Britain, it is the decision by Australia to adopt nuclear propulsion for the RAN's future submarines which has attracted most attention. That it has become possible for Australia to have access to US and UK nuclear submarine technology is momentous. I recall my introduction to the world of nuclear submarines some 53 years ago when I spent some time at Barrow-in-Furness on a Vickers post-graduate scholarship at the peak of the UK's Polaris program. That visit was immensely valuable for me and very helpful as I learned the production control, quality control and test procedures involved then in building nuclear submarines which we widely adopted for the refit of the RAN's Oberon-class submarines in Sydney. What I could not see, however, was anything relating to the nuclear propulsion of the submarines or Polaris. Those doors were shut to anyone outside the very close relationship between the US and the UK forged in the 1950s — doors which have remained firmly closed until now.

Australian submariners have served in British and American nuclear submarines, but not aft ot the machinery space bulkhead. That bulkhead door has remained firmly closed.

That Australia will now be permitted behind those doors is a remarkable development. Announced at the same time was the decision of the Australian Government not to proceed to the construction phase of the planned French-designed Attack-class submarines. The decision to go nuclear gives Australia the opportunity to acquire substantially greater capability, despite the fact that the Attack-class program was likely to produce outstandingly good submarines.

The hurt expressed by France at the termination of the Attack-class project is understandable. There are others we must remember at this time — those Australians who have been working on the project with their French colleagues. To suddenly have the project which has been part of your life, possibly for years, abruptly cancelled hurts. I understand that feeling — I have experienced sudden cancellations of major projects on several occasions. In the end one has to move on and look to the future. I doubt that France will waste the experience acquired during the Attack-class project, and the experience gained by the Australians working on the project is also most unlikely to go to waste.

Suddenly, we are to build at least eight nuclear submarines in Adelaide. There is much to do before we can start building submarines of this standard and complexity in Australia, but I believe we can succeed and build them well. The project will demand strong leadership and a very high priority for resources. Again, I am reminded of the UK's Polaris program of the 1960s.

With so much work planned for naval construction in the years ahead, there will be many opportunities for Australian naval architects, engineers and scientists at the very highest level — it will be a different world from that to which we have become accustomed.

John Jeremy

The Royal Navy nuclear-powered submarine HMS *Astute* alongside at HMAS *Stirling*, Western Australia, on 29 October during a port visit
(Photo courtesy British High Commission)

The Minister for Defence, the Hon. Peter Dutton MP, the Minister for Defence Industry, the Hon. Melissa Price MP, the British High Commissioner Vicki Treadell, CMG, MVO, and the Chief of Navy, Vice Admiral Michael Noonan AO, RAN, with crew members of HMS *Astute*
(RAN photograph)

COMING EVENTS

ACT Section Technical Presentation

Technical presentations will continue as webinars for the foreseeable future, generally hosted by RINA using the Zoom platform and starting at 6:30 pm AEDT. Registration for each presentation is required, and details will be provided in the flyer for each meeting. The ACT Section's LinkedIn page at https://www.linkedin.com/groups/13915641/ will be updated with details as soon as they become available.

The program of meetings remaining for 2021 is as follows:

23 Nov Captain Andrew Beazley, General Manager, and Captain Cliff Beazley, Managing Director, Port Ash
Port Ash: The use of Manned Models in Shiphandling Training

SMIX Bash 2021

SMIX Bash was inaugurated in 2000 and is organised as a joint-venture function by the Royal Institution of Naval Architects (NSW Section) and the Institute of Marine Engineering, Science and Technology (Act & NSW Branch). It is a Christmas party for those involved in various marine industries and activities based in the Sydney area and those from further afield. The name was derived as an acronym for "Sydney Marine Industries Christmas Bash". The function is held on board Sydney Heritage Fleet's beautifully-restored barque, *James Craig*. Unfortunately, SMIX Bash 2020 had to be cancelled due to the COVID-19 pandemic.

The 21st SMIX Bash will be held on board *James Craig* alongside Wharf 7 in Darling Harbour from 5:30 to 9:30 pm on Thursday 2 December. Bookings are now open on the Trybooking website, https://www.trybooking.com/BQFLY?. Due to prevailing COVID-19 restrictions, numbers for SMIX Bash 2021 are more limited than usual, so you are advised to make bookings early!

ACT Section December Drinks

The ACT Section has booked December Drinks for members and friends at the Capital Brewery, Building 3, 1 Dairy Road, Fyshwick, for Tuesday 7 December at 6:15 pm. For bookings, contact the Secretary of the ACT Section at <rinaact@gmail.com>.

Victorian Maritime Industry Annual Social Event

The Victorian Section is pleased to announce the return of the Victorian Maritime Industry Annual Social Event, which has been on hiatus since pre-COVID-19 all the way back in December 2019. The event is not only a Christmas party for our Victorian members to enjoy, but a chance for all those who work in the Victorian maritime landscape to once again reconnect and share a meal and beverage at a fantastic location under the city lights.

The event will be held at The Common Man in the South Wharf precinct on the bank of the Yarra River on Friday 17 December 2021, with the event kicking off at 6.00 pm and food being served from 7.00 pm. Bookings are now open on the Eventbrite website, https://www.eventbrite.com.au/e/victorian-maritime-industry-annual-social-event-2021-tickets-192990980217.

The Victorian Section would like to thank our sponsors for helping make this event possible: Altair, Australian Maritime Technologies, the Company of Master Mariners of Australia, Thrust Maritime, and Maritime Survey Australia.

If you are interested in sponsoring this event, or require any further information, please contact the section at vicsec@rina.org.uk.

AOG Energy 2022

AOG Energy is Australia's premier oil, gas and energy trade event held annually in Perth. AOG Energy was planned to be held in March 2022 to unite the entire industry and showcase the resilience, strength and capability that the local supply chain offers. However the decision has been made to cancel this event.

AOG Energy will now return on 15–17 March 2023 at the Perth Convention and Exhibition Centre as a three-day in-person event connecting the entire oil and gas supply chain. Strengthening our renewed focus on the energy transition, AOG Energy continues to offer expert thought-leadership, Australian developed technologies and unrivalled networking functions to drive energy innovation.

Functions are likely to include the Diversity and Inclusion Breakfast, Subsea Welcome Drinks, Opening Party, NERA Energy Hub, Conference (comprising the Industry Supply Forum, Subsea Forum, and Knowledge Forum), Exhibition, and Networking Zone.

For further details, visit the AOG Energy website at https://aogexpo.com.au/

Indo-Pacific 2022

Indo-Pacific 2022, the biennial International Maritime Exposition organised by AMDA Foundation, will combine an extensive exhibition presence, a comprehensive conference program and a schedule of networking and promotional opportunities. Scheduled for 10–12 May 2022, it will be the 12th iteration of this internationally-renowned event, and will be a critical link event for Defence, government and industry as Australia defines how it will invest $90 billion on new ships, submarines and their systems and support, more than $1 billion on modern shipyard infrastructure, and more than $25 million on workforce growth and skilling to support its Naval Shipbuilding Plan into the future.

Indo-Pacific is where customers and industry will connect, where commercial maritime and naval defence suppliers will promote their capabilities to decision-makers from around the world, in the only maritime exposition of its kind in the Indo-Asia-Pacific region.

The Indo-Pacific International Maritime Exhibition and Conference will be held on 10–12 May 2022 at the International Convention Centre, Sydney. AMDA says that, once the world has transitioned past the aftermath of the pandemic, it intends that its expositions will resume their normal biennial cycle, with Indo-Pacific returning to its regular timing in the latter half of odd-numbered years, i.e. with the next one in the second half of 2023.

The International Maritime Conference 2022, organised by the Royal Institution of Naval Architects, the Institute of

Marine Engineering, Science and Technology and Engineers Australia, will allow delegates to be involved in discussions concerning the latest developments in marine engineering and maritime technology, both in the areas of defence and commercial shipping. The conference will coincide with the prestigious Royal Australian Navy Sea Power Conference. Collectively, the conference and exhibition will offer a rewarding program for all those with a professional interest in maritime affairs. The conference program will be designed to permit all delegates to visit the many industry displays in the exhibition itself, and to conduct informal professional discussions with exhibitors and fellow delegates. Registration for the International Maritime Conference includes free access to the exposition.

The call for papers went out in July, and submissions closed on 25 October with acceptances notified on 8 November. Main themes included

- Commercial ship technology
- Naval ship technology
- Submarine technology
- Autonomous vehicle technology
- Shipbuilding and sustainment
- Maritime safety
- Maritime environment protection
- Maritime cyber security

It is expected that registrations for the IMC will open soon; keep your eye on the website https://www.indopacificexpo.com.au/IMC2022/registration.asp

For further information regarding the IMC 2022 International Maritime Conference contact the Conference Secretariat at PO Box 4095, Geelong, Vic 3220 or imc@amda.com.au.

Maritime Robot X Challenge 2022

The Maritime Robot X Challenge 2022 will take place at the Sydney International Regatta Centre on 11–17 November 2022 and is a collaboration between the US Office of Naval Research (ONR), the Australian Defence Science and Technology Group (DST), and RoboNation.

The RobotX Challenge is an international university-level competition designed to foster interest in autonomous robotic systems operating in the maritime domain, with an emphasis on the science and engineering of cooperative autonomy. Team members can be from a single university or from several universities. This competition facilitates the building of international relationships between students, academic institutions and industry partners, and provides opportunities for innovators to demonstrate their potential and to make substantial contributions to the robotics community. The RobotX Challenge 2022 will be the fourth such event, the first of which was held in Singapore in 2012.

See https://robotx.org/ for more information about the challenge, and get a glimpse of the competition in Australia at https://youtu.be/oXlsnz4ye64.

The base platform for Robot X Challenge 2022 is the Wave Adaptive Modular Vehicle (WAM-V), which teams must outfit with propulsion, control systems, sensors, and other systems necessary to accomplish the competition challenges. All teams competing in Robot X must use the same core platform as the basis for their multi-vehicle multi-domain autonomous maritime system of systems.

RoboNation intends to award a limited number of the WAM-V platforms to teams that commit to participate in this and future Maritime RobotX Challenges and Forums. The Robot X WAM-V application process closed on 30 April.

NEWS FROM THE SECTIONS

Victoria

Annual General Meeting

The Victorian Section has recently held its 2021 Annual General Meeting which wrought a number of changes to the committee. The Section sincerely thanks outgoing committee members for their contributions to the running of the section over the past couple of years and beyond.

Special thanks to long-standing Chair, Jesse Millar, for his leadership throughout his tenure, especially through some turbulent times in the state with the COVID-19 pandemic. We are delighted that Jesse will be staying on as a committee member, easing in the transition of our newly-appointed chair, Tom Dearling. We also welcome our newest committee member and now Deputy Secretary, Samuel Price.

The committee at the conclusion of the 2021 AGM now stands at:

Chair	Tom Dearling
Secretary	Keegan Parker
Deputy Secretary	Samuel Price
Treasurer	Alex Conway
AD Council Nominee	Nathan Wallace
Social Media Manager	Nathan Wallace
Social Secretary	Luke Shields
Members	Jesse Millar Karl Slater

Victorian Maritime Industry Annual Social Event

With the most recent changes in the Victorian landscape regarding restrictions and public outings, we are pleased to announce that the Victorian Maritime Industry Annual Social Event will be held on Friday 17 December commencing at 6.00 pm at The Common Man--, located at South Wharf. We look forward to what should be a fantastic night, not only for local and interstate industry networking but also to celebrate Victoria's coming-out-of lockdown.

Details for ticket purchases will be sent out directly to Victorian Section members and to interstate Section Secretaries for distribution; if you haven't yet received an invite and would like to attend, then please contact the Section at vicsec@rina.org.uk. Details will also be posted on the Victorian Section's events webpage at https://www.rina.org.uk/Victoria_Section_Events.html

Keegan Parker

A Note from the New Chair

I would like to thank the Section for placing their trust in me for the next year or two. I will do my best to ensure that we

imc 2022

INTERNATIONAL MARITIME CONFERENCE

10-12 MAY 2022

INTERNATIONAL CONVENTION CENTRE
SYDNEY, AUSTRALIA

THE ROYAL INSTITUTION OF NAVAL ARCHITECTS

INSTITUTE OF MARINE Engineering, Science & Technology

ENGINEERS AUSTRALIA

Become an *IMC 2022* sponsor and stand out from the crowd

The *IMC 2022* International Maritime Conference, to be held in conjunction with the INDO PACIFIC 2022 International Maritime Exposition, will offer insightful presentation in to all facets of ship and submarine technologies.

As a sponsor you will have a unique opportunity to promote your services and products, and increase brand awareness to a diverse range of technical specialists, defence and maritime personnel and equipment manufacturers and suppliers.

IMC 2022 offers a range of sponsorship opportunities to match your marketing and promotional strategy, including:

- IMC Conference Live Streaming Sponsor
- Lanyard Sponsor
- Stationery Package Sponsor
- Catering Sponsor
- Satchel / Notepad Sponsor
- Program and Abstract Book Sponsor
- Welcome Function Sponsor

Organised by The Royal Institution of Naval Architects, Institute of Marine Engineering, Science & Technology and Engineers Australia, *IMC 2022* will coincide with the prestigious Royal Australian Navy Sea Power Conference.

It will cover advances and developments in fields including:

- Commercial Ship Technology
- Submarine Technology
- Shipbuilding and Sustainment
- Autonomous Vehicle Technology
- Naval Ship Technology
- Maritime Environment Protection
- Maritime Cyber Security
- Maritime Safety

Registration Opening - Early 2022

To find out how you can reach this engaged, motivated marketplace with an IMC 2022 Sponsorship Package please see the Sponsorship Prospectus at **www.indopacificexpo.com.au/IMC2022/sponsorship.asp** or contact the IMC Secretariat at **expo@amda.com.au**

www.indopacificexpo.com.au/IMC2022

have an active Section which reflects the broad spectrum of the maritime industry in Victoria. My particular goal over the next year is to connect with our members. Our whole reason for being is to further the knowledge of, and interest in, naval architecture and shipbuilding among the members, by connecting them with each other and with experts in the field. The more members we have communicating with us, the Committee, and with each other, the more vibrant and interesting the Section will be for all of us. I particularly want to connect with those members who are not regularly engaged with Section activities, and to broaden our methods of communication to be as inclusive of as many members as possible. Please feel free to contact myself and the Committee at any time through vicsec@rina.org.uk.

Tom Dearling

Tasmania

Controlling Marine Engine Emissions

Lachlan Colquhoun, Marine Engine Sales Manager Australia and New Zealand, MAN Energy Solutions, gave a presentation on *Controlling Marine Engine Emissions* attended by five with the Chair of the Tasmanian Section Committee, Jonathan Binns, as MC on 21 July in the Auditorium at the Australian Maritime College in Launceston. The meeting was also streamed live via the RINA Zoom software platform and attracted an additional 18 participants.

Lachlan began his presentation by providing an overview of the types of emissions produced by internal combustion engines used in marine applications, and some of the key drivers behind current and future emission limits set by the International Maritime Organisation and local regulators.

He then looked at existing and emerging marine fuels and their relative benefits from the emissions-reduction, shipbuilder's and operator's perspectives, and moved on to examine some of the technologies employed by engine manufacturers to reduce or 'scrub' emissions, and touched on some current areas of development.

Lachlan's presentation was recorded, and is now available on the RINA YouTube channel (see *The Internet* column).

Jonathan Binns

Western Australia

Design and Engineering of Wind Turbine Installation Vessels

Ken Goh, General Manager, Knud E. Hansen Australia, gave a presentation on *Design and Engineering of Wind Turbine Installation Vessels* attended by five with the Secretary of the WA Section, Nathan Chappell, as MC in the Auditorium at Engineers Australia in West Perth on 21 October. The meeting was also streamed live by RINA on the Teams software platform and attracted an additional five participants.

Knud E. Hansen naval architects designed TIV *Mayflower Resolution*, the world's first Wind Turbine Installation Vessel (WTIV), back in 2002. WTIVs are characterised principally by their leg structures which enable these giant vessels to be jacked high above the water surface to provide a stable platform from which their cranes can undertake the delicate procedure of installing the wind turbines. Today there are dozens of WTIVs, mostly working in Northern Europe and Asia. These unique vessels have installed about 10 000 wind turbines globally, producing 40 GW of power.

As wind turbine technology has matured and developed, the turbines have grown ever larger, from 1–2 MW in the early 2000s to the 12–15 MW behemoths on the drawing board today. Similarly, the WTIVs have also had to evolve to undertake the installation of these massive new turbines in ever-deeper waters.

Ken's presentation described the evolution of the WTIV and the unique naval architectural and marine engineering challenges and solutions which are needed. With as many as a dozen Australian offshore wind farms in various stages of planning, this presentation was timely to increase the understanding of these vessels which will soon be a common sight in our local waters.

Ken Goh is a Senior Mechanical Engineer and the General Manager for Knud E. Hansen Australia. The company specialises in ship design of many types of highly-customised vessels, including jack-up vessels, research vessels, cruise ships, yachts, ferries, naval auxiliary vessels and icebreakers, notably the new Australian icebreaker RSV *Nuyina*. The company has offices in Denmark, the UK, USA, Canada, Greece, Spain and Australia.

Ken has been involved in the design of a number of world-leading WTIV jack-up vessels. When not undertaking project work, he is researching renewable energies and autonomous operations for future shipping, and advocating virtual-reality technology for design and engineering of complex shipbuilding projects.

Question time raised some further interesting points.

Ken's presentation was not recorded.

Nathan Chappell

New South Wales

Committee Meetings

The NSW Section Committee met on 14 September and, other than routine matters, discussed:

- SMIX Bash 2021: Numbers of attendees will be reduced due to pandemic restrictions, with final numbers set later in the year; sponsors may have reduced numbers of guests; letter to sponsors to be circulated.
- TM Program 2022: Presentations have been signed up for March and May, and approaches made for others.

The NSW Section Committee also met on 26 October and, other than routine matters, discussed:

- SMIX Bash 2021: Numbers of attendees to be finalised; catering to be finalised; bookings have opened for all on the Trybooking website.
- TM Program 2022: A presentation has been secured for July, with approaches made for others; webinar format to be continued until Indo-Pacific IMC in May, and consideration given to a return to face-to-face meetings after that.

Application of Paint to an RAN Flight Deck

Piermatteo Nissotti, General Manager Marine, Eptec Group, gave a presentation on *Application of Intershield 6GV to a Royal Australian Navy Flight Deck* as a webinar hosted by

RINA using the Zoom software platform with the Secretary of the ACT & NSW Branch of the IMarEST, Geoffrey Fawcett, as MC on 18 August. This presentation attracted 12 participating on the evening, including Trevor Blakeley, former Chief Executive of RINA and now Chairman of the Confederation of European Maritime Technology Societies.

Question time raised some further interesting points.

The certificate was subsequently posted to Pier, and the "thank you" bottle of wine delivered via an eGift card.

Nuclear Maritime Propulsion Roadmap for Australia

Christopher Skinner, Editor *Nuclear Propulsion Roadmap for Australia*, gave a presentation on *Nuclear Maritime Propulsion Roadmap for Australia* as a webinar hosted by RINA using the Zoom software platform with the Deputy Chair of the NSW Section, Phil Helmore, as MC on 1 September. This presentation attracted 93 participating on the evening.

Question time was lengthy and raised some further interesting points but, despite being extended, was not enough to get through all the questions. Christopher's email address was therefore made available for participants to contact him directly.

Christopher has also written up the presentation as a paper which appears elsewhere in this issue of *The ANA.*

The certificate was subsequently posted to Christopher, and the "thank you" bottle of wine delivered via an eGift card.

Christopher's presentation was recorded, and is now available on the RINA YouTube channel (see *The Internet* column).

The New Naval Architecture Degree Program at UNSW Canberra

Warren Smith, Associate Professor, David Lyons, Senior Lecturer, and Ahmed Swidan, Senior Lecturer, UNSW Canberra, gave a presentation on *The New Naval Architecture Degree Program at UNSW Canberra* as a webinar hosted by RINA using the Zoom software platform with the Deputy Chair of the NSW Section, Phil Helmore, as MC on 6 October. This presentation attracted 38 participating on the evening.

Warren has also written up the presentation as a paper which will appear in the February 2022 edition of *The ANA.*

The certificates were subsequently posted to the authors, and the "thank you" bottles of wine delivered via eGift cards.

The presentation was recorded, and is now available on the RINA YouTube channel (see *The Internet* column).

Phil Helmore

Queensland

Horizon and Stessl Boats Factory Tour

Scott James of Horizon Boats and Stessl Boats made a presentation on *Horizon and Stessl Boats Factory Tour* to the Queensland Section on Thursday 14 October at their new purpose-built facility in Coomera, Qld, attended by 14.

Scott began his presentation with a brief history of how the Horizon Aluminium Boat company started back in 1992 and the changes which the company has undergone since then. These changes include the acquisition of Stessl Boats and the recent move to a new purpose-built facility in Coomera. Horizon Boats and Stessl Boats produce high-quality aluminium boats from 3 m car-toppers to 7 m pressed-plate boats. Between the two companies, they produce approximately 700-800 vessels each year and consume approximately 800 kg of aluminium plate each day, making them one of the larger aluminium boat manufacturers in Australia.

Scott then gave us a tour of the new factory. The tour stepped through the whole production cycle of each vessel, from the CNC machine to the bender and on to the fabricators who complete the welding of all the structure. There are eight dedicated welding bays and a boat in various stages of completion occupied each bay. Once welded, each vessel is painted before receiving the final fit-out and being shipped off to the dealers for sale or delivery to the eager customer. From start to finish, it takes approximately six weeks for each vessel to go through the full cycle and leave the factory.

Scott James discussing aluminium construction with the group
(Photo courtesy Jalal Rafieshahraki)

Inspection of an aluminium vessel under construction
(Photo courtesy Ashley Weir)

Scott walked us through the various models which they produce, totalling nearly 80 different arrangements. He also showed us a new vessel which was undergoing development at the time. The new model will be the largest model which they have produced, and is being developed for an existing client who has one of their smaller models. The vessel was undergoing final welding before being fitted with an engine for testing.

He also showed us the very first boat the company produced back in 1992. The vessel is regularly put in the water and compared against new models as a reminder of how far the company has grown throughout the years.

Scott also discussed some of the main challenges which the company is experiencing. These include problems obtaining material, machinery or welders, and current wait times of up to two months for incoming shipments of aluminium. The Australian Builders Plate standards and Australian standards have also been recently reviewed and changes made. This has caused issues over recent years, making builders re-think their designs and innovate to make their vessels safer and to maximise the load-carrying capacity. They have also had trouble with clients expecting more from their vessels than they did previously. This is changing as technology develops and people are fitting larger or multiple navigation screens or electric trolling motors with significant battery weight. This causes issues for the builder as both the helm consoles and boats themselves have to be bigger to accommodate the clients' demands.

The Queensland Section would like to thank Scott for his presentation and giving us an insight into what it takes to build quality aluminium vessels and the challenges that they face daily.

The presentation and tour was not recorded.

Ashley Weir

CLASSIFICATION SOCIETY NEWS

ABS to Class Maersk's Methanol-fuelled Container Vessels

A ground-breaking series of eight large container vessels capable of being operated on carbon-neutral methanol ordered by Maersk, along with an option for a further four vessels, are to be built to ABS class.

The announcement underlines ABS' leadership in sustainably-fuelled vessels, building on a series of recent alternative fuel newbuild orders, including Maersk's feeder vessel with dual-fuel engine technology, enabling it to sail on either methanol or traditional very low sulphur fuel, which is now under construction to ABS class.

"Sustainable global trade is an urgent priority, not just for our industry but the entire world, and this landmark project starts to make this dream a reality. As a leader in the application of sustainable fuels in shipping, ABS is proud to be able to use our experience to support it," said Christopher Wiernicki, ABS Chairman, President, and CEO.

"More than anything, decarbonising shipping requires collaboration and innovation across the ecosystem, so I am pleased to have ABS and its leading expertise with us on this journey. Our methanol-fuelled vessels will play a significant role in reaching our commitment of 60 percent CO_2 fleet reduction by 2030 compared to 2008 levels. They will also be a proving ground where we learn how to bunker and operate carbon-neutral vessels safely, efficiently and reliably, so that we can continue building momentum towards carbon neutrality in 2050," said Palle Laursen, Senior Vice President, Chief Technical Officer, A.P. Moller-Maersk.

The vessels will be built by Hyundai Heavy Industries and have a nominal capacity of approximately 16 000 TEU. The series will replace older vessels, generating annual CO_2 emissions savings of around 1 million tonnes and offer customers carbon-neutral transportation at scale.

Capable of operating on carbon-neutral e-methanol or sustainable bio-methanol, the vessels come with a dual-fuel engine setup, which also enables operation on conventional low sulphur fuel.

ABS has published guidance on Methanol as Marine Fuel, evaluating the challenges in the design and operation of methanol-fuelled vessels.

A copy of ABS' *Sustainability Whitepaper: Methanol as Marine Fuel* may be downloaded at https://absinfo.eagle.org/acton/media/16130/sustainability-whitepaper-methanol-as-marine-fuel

More information on ABS sustainability services and guidance on a range of alternative fuels is available at https://ww2.eagle.org/en/Products-and-Services/Sustainability/marine-sustainability.html

ABS News, 7 September 2021

ABS First Remote-control Navigation Notation for Keppel O&M Harbor Tug

Maju 510, a remotely-operated harbor tug developed by Keppel Offshore & Marine (Keppel O&M), is the first in the world to receive the ABS Remote Control Navigation Notation.

A trial of the 65 m tug, controlled from a remote location at the Maritime and Port Authority of Singapore's Maritime Innovation Lab, was successfully performed in April 2021. The second phase of the project, scheduled for late 2021, will see the vessel perform autonomous collision avoidance tasks while under remote supervision. *Maju 510* is owned and operated by Keppel O&M's joint-venture company Keppel Smit Towage.

The project was one of a series of industry-leading initiatives to inform the development of the recently published ABS *Guide for Autonomous and Remote-control Functions*, which introduced the REMOTE-CON notation and another recognising autonomous functions. The *Guide* sets out a goal-based framework for the implementation of these technologies on vessels and offshore units.

"This landmark project demonstrates the rapid advance of remote control and autonomous technology at sea. This vessel is the first to receive the REMOTE-CON (NAV, OP1) notation and is blazing a trail which others are sure to follow. ABS is involved in cutting-edge projects all over the world designed to advance the application of remote and autonomous functions on vessels and we are proud to play a role in supporting the safe development of this technology at sea," said Patrick Ryan, ABS Senior Vice President, Global Engineering and Technology.

"As the overall system integrator, Keppel O&M is able to provide technology solutions and integrate best-in-class systems to offer customizable remote and autonomous function for vessels. With the offshore and marine sector evolving rapidly, we are leveraging our engineering expertise and harnessing advanced technologies to stay at the forefront of the industry. In line with Keppel's Vision 2030, we are also collaborating with the Keppel ecosystem of companies, such as M1 with its connectivity solutions, to enhance our value add," said Mr. Tan Leong Peng, Managing Director

(New Builds), Keppel O&M.

"Keppel Smit Towage is pleased to receive the world's first ABS Remote Control Navigation Notation. It is a testament to our commitment to continuously harness technology and improve the safety of operations to serve customers better. Remote and autonomous functions can significantly enhance safety and efficiency of tug operations by automating simpler tasks, allowing the crew to focus on more technical or crucial matters," said Mr Romi Kaushal, Managing Director of Keppel Smit Towage.

The *Guide*'s goal-based framework also covers interactions with relevant stakeholders such as port authorities and other vessels. The *Guide* uses a risk-based approach to determine the requirements for the assessment and implementation of autonomous and remote-control functions.

Download a copy of the ABS *Guide for Autonomous and Remote-control Functions* at https://ww2.eagle.org/content/dam/eagle/rules-and-guides/current/other/323_gn_autonomous/autonomous-guide-july21.pdf.

ABS News, 4 October 2021

Maju 510 on trials
(Photo from offshore-mag.com)

DNV Awards AiP for Ammonia-fuelled Gas Carrier

Navigator Gas has been awarded a new Approval in Principle (AiP) for an ammonia-fuelled gas carrier design from classification society DNV. An industry-wide consortium, including MAN Energy solutions, Babcock International and the Norwegian Maritime Authority (NMA), has collaborated with Navigator Gas to achieve the AiP from DNV.

The design has been awarded the AiP based on the special features notation (GF NH_3) under DNV's new rules for the use of ammonia as fuel in gas carriers. DNV, alongside the NMA, reviewed the design and relevant documentation and found no potential showstoppers to its realisation.

"Navigator Gas been discussing ammonia as a fuel with our consortium partners since 2018, when this topic was on the fringes of discussions surrounding decarbonisation and the use of alternative fuels," said Paul Flaherty, Technical Advisor to Navigator Gas. "Those early discussions on feasibility led to the completion of a comprehensive HAZID in early 2019, which remains as valid today as it was then. This has also been used as the base safety case during our AiP discussions with DNV. Since our discussions began, we have witnessed an exponential increase in the number of projects around the globe looking at hydrogen and ammonia as carbon-free sources of energy. We have also been engaging with our customers and business partners to discuss their carbon-free shipping requirements for transporting blue/green ammonia to their customers."

"Obtaining an AiP from DNV for an ammonia-fuelled vessel is the first step in preparing Navigator Gas to meet the future demands of our customers and to reduce our carbon footprint through lower greenhouse gas emissions. In the longer term, using ammonia as fuel is one of the alternative fuel options we are pursuing, along with CCS, carbon offsetting and improved vessel optimisation to reduce our carbon footprint and lower greenhouse gas emissions. I would like to thank DNV, MAN Energy Solutions, Babcock International and the Norwegian Maritime Authority, for their unwavering support and input during the AiP process," said Paul Flaherty.

"We are very pleased to be working with Navigator Gas and so many leading companies on this AiP," said Torgeir Sterri, Senior Vice President, Regional Manager West Europe, DNV Maritime. "If our industry is going to continue to play a central role in the global economy, we need to be exploring all options that can get us further towards decarbonisation. At the same time, we recognise that, for our customers, how to tackle the decarbonisation challenge is going to be most challenging and significant decision they are likely to make this decade. This is why we have created class notations and guideline which give them the flexibility to find the path that fits their operations and business."

"This ammonia as a fuel concept design is supported by Babcock LGE's operational experience of delivering liquefied petroleum gas (LPG) fuel-supply systems and carrying ammonia as a cargo on gas carriers, meaning that specific issues occurring when utilising ammonia as a fuel are well understood, resulting in an inherently-safe design. Babcock LGE is enabling the transition towards a cleaner, sustainable future through innovative technologies, and we are delighted to be working with our partners in this significant project," said Andrew Scott, Business Development Director, Babcock LGE.

"MAN Energy Solutions is happy to work with industry partners in decarbonising the maritime economy where, for us, the path starts with fuel decarbonisation. Here, several zero-carbon fuels offer significant potential, with ammonia of especial interest. Since large quantities of ammonia are already transported around the world, it is a well-established commodity and using it to power ships would be a natural step. In this context, we have already announced that we expect to make a dual-fuel two-stroke ammonia engine commercially available for large-scale ocean-going ships by 2024, followed by a retrofit package to make existing maritime vessels capable of running on ammonia by 2025," said Thomas Hansen, Head of Promotion and Customer Support, MAN Energy Solutions.

"We are proud to be a part of this project and it has given us vital input on how to handle the safety concerns when using ammonia as fuel. Ammonia could play an important role in the decarbonisation of shipping and therefore the safety concerns have to be addressed. This project shows that it is possible to manage some of the challenges within decarbonisation through good cooperation," said Lars Alvestad, acting Director of Shipping and Navigation, Norwegian Maritime Authority.

DNV News, 17 September 2021

LR Classes World's Largest Container Ship

The number of container ships on the water with a nominal capacity >20 000 TEU almost doubled between 2018 and 2020, and who doesn't enjoy seeing the mainliners competing for pole position on owning the largest vessel? The record is currently held by Evergreen's vessel *Ever Ace*, delivered to LR class in July 2021. *Ever Ace* has a capacity of 23 992 TEU which is just 28 more than the previous record holder, *HMM Algeciras*.

LR's *Horizons*, September 2021

LR Introduces a new Zero-Carbon Fuel

Ever Ace
(Photo from *Horizons,* September 2021)

Monitor Framework

A new framework, created by the Lloyd's Register Maritime Decarbonisation Hub, aims to get the industry sharing best practice, helping to scale up smaller decarbonisation successes to large-scale ocean-going shipping.

In an urban design context, 'green corridor' is a term used to mean interlinked pathways or cycle routes running through a city that are rich in trees and plants, thereby providing benefits to both residents and natural wildlife. By extension, the concept was first applied to transport by the European Union in 2007 with the aim of developing integrated, efficient and environmentally-friendly movement of freight between major hubs and by relative long distances.

'Green corridors' in transport normally make use of advanced technology and seamless intermodal connectivity — or 'co-modality' — to achieve energy efficiency and reduced environmental impact which, given today's escalating concern over climate change, essentially means ensuring decarbonisation and sustainable supply chains. LR is well aware that decarbonisation is now the number one issue facing the shipping industry, its own research having shown that zero-emission vessels need to be entering the world fleet by 2030. This, in turn, requires shipping to be planning and building new shipboard solutions and land-based infrastructure immediately.

There is a problem, however, since zero-emissions solutions have so far only been deployed in niche applications, such as remote ferry routes in Scandinavia, while solutions for large-scale ocean shipping are not yet established. This dilemma has created uncertainty across the sector, with lots of different alternative fuels and propulsion technologies — and evolutionary pathways to arrive at the same — under discussion.

LR has identified the need for reliable and impartial guidance in the face of so many conflicting opinions on alternative ways to decarbonise, for the benefit not only of ship owners and operators but also fuel suppliers, shipbuilders and equipment manufacturers, policymakers and regulators, financiers and insurers, and more.

As a result, LR has this year introduced a new Zero-Carbon Fuel Monitor framework, which it describes as an evidence-based tool to assess the readiness of the most promising zero-carbon fuels and related technologies that could play a role in getting the entire shipping industry to zero emissions by 2050.

Zero-Carbon Fuel Monitor

The framework analyses the current state of development of different alternative fuels and the infrastructure which they require, giving an indication of progress towards industry-wide adoption. It does this by awarding each potential solution three different ratings: for Technology Readiness Level (TRL) — how close the technology is to being proven, scalable and safe; Investment Readiness Level (IRL) — whether the business case is robust enough to attract investment; and Community Readiness Level (CRL) — how prepared people and organisations are to adopt the new solution.

The methodology was created by the LR Maritime Decarbonisation Hub, a new initiative set up jointly by Lloyd's Register Group and the Lloyd's Register Foundation late last year and now led by Program Manager Charles Haskell. "The Hub will provide a basis for closer collaboration between stakeholders and a platform for sharing the results of decarbonisation initiatives so that we as an industry continuously learn from previous projects and evolve," Haskell said upon his appointment in January 2021.

Also joining the Hub this year as Marine Decarbonisation Consultant is Dr Carlo Raucci, who moved over to LR from University College London (UCL) where he had previously completed an LR-sponsored PhD on the potential of using hydrogen to decarbonise shipping.

Raucci explains that the Hub is divided into five different workstreams: Policy, Technology, Investment, Safety and Sustainability, all dedicated to "working with other stakeholders to provide new insights into a sustainable energy transition in shipping using safe and commercially-viable vessels." And "At the core of the Hub", he adds, "is the Zero-Carbon Fuel Monitor".

The framework looks at the different technology, investment and community readiness levels along the length of the supply chain — from the production of fuels, including the resources used, through their transportation, storage and bunkering, to usage on board ships and the propulsion machinery involved. "The entire supply chain is in consideration," Raucci stresses.

The methodology results in three separate final scores — for TRL, IRL and CRL — for each fuel "We have tried to aggregate as much as possible but producing a single score loses meaning," he says. And rather than picking any likely 'winners' in terms of alternative fuels, the Decarbonisation Hub has been using the framework to "identify bottlenecks and where more effort is needed to progress the readiness level of a particular fuel."

Raucci gives the example of ammonia, where some unknowns with safely handing the fuel onboard ships mean that the TRL score is quite low, so "if we are able to provide some new insights on these issues then we are advancing the TRL readiness level of the fuel as a whole."

Investment Challenge

One of the foci of Raucci's own work is the investment workstream, and here he observes that the IRL score for most fuels is "very low" for three main reasons. Firstly, any fuel is going to be much more expensive than current fuel so some sort of policy lead is needed to 'close the gap", he believes. Secondly, the use of technologies such as electrolysis or direct air capture/carbon capture and storage to produce zero carbon fuels is still lacking in "demonstrations of application at a scale than can be used for shipping. So more work is needed, particularly for hydrogen, ammonia and methanol", he says. And, thirdly, there is the supply vs demand problem that new fuels will not be made available until there are ships that can use them, and vice versa. Of course, ports have a role to play as well in shipping's decarbonisation effort.

Reducing dwell times of ships by advising them well in advance on when they should arrive at berth for fastest turnaround — so-called Port Call Optimisation — is just one solution, with electrification of port equipment and use of solar energy being other developments that are increasingly taking place. Then there is the whole question of them facilitating the bunkering or even production of alternative, low-carbon fuels.

Decabonisation Hub leader Haskell has cited the example of the ports of Antwerp, Zeebrugge and Hamburg, all working with industrial partners to establish hydrogen import chains, saying "The next step is to look at the shipping trade between these ports to create 'green corridors'.

"Ports have the potential to be a catalyst for the shipping industry's zero-carbon transition", he added, "but it is a chicken-and-egg scenario. Ships will need the fuel so the ports will need to supply it, but if the ports are using the fuel for other purposes, then the port infrastructure changes around that fuel." He gave the example of a port that might be importing hydrogen, perhaps as a result of national decarbonisation policy, that could choose to use the fuel to power its cranes, cargo trolleys and localised shipping like harbour tugs and pilot vessels under its control, and then look at scaling up this supply to support the deep-sea shipping industry.

"Once more than one port is supporting the infrastructure and there is trade between these ports, then that trade can start going through an energy transition," Haskell observed, adding that it is vital that we see more of these types of pilot programs, involving multiple stakeholders building up fuel supply chains, this decade "so that they can be scaled up to meet the 2050 ambitions".

Singapore Feeder Study

Meanwhile, to help visualise how the transition to alternative fuels might take place in practice, LR has embarked on its own pilot study, scoping out a suitable location and area of the shipping industry where "first movers might set up a green corridor or green supply chain".

Raucci takes up the story, explaining how after some preliminary research it was decided to focus on the containership sector and the segment of small boxships or feeders serving intra-Asian routes, particularly from Singapore towards Hong Kong. "This was because it was thought that the energy transition of the feeder fleet has the potential to act as catalyst for all the other ships calling in Singapore or Hong Kong," says Raucci, "and because there's a high volume of traffic between these major hubs" — thereby corresponding with the idea of green corridors as major trade arteries where collaboration among different stakeholders would enable new investments. "The aim of this project is to progress the IRL levels and eventually unlock small-case commercial trials on the path to reach zero-emissions by 2050 by providing more details on how the identified feeder fleet in this area could transition to zero-carbon fuel. We wanted to start to understand what challenges would be involved for a given type of fleet and to define how that fleet would transition to other fuel."

Some 200 vessels are involved in the target study, which will also look at what developments will be needed on the supply side for the production, transport and delivery to a port like Singapore of alternative fuels. "The end goal of the project will be to evaluate a common cost for both the target fleet and infrastructure," says Raucci, "which will include analysis of the cost of producing both 'blue' and 'green' ammonia in different southeast and neighbouring countries."

Already nearly 60 different configurations of production and supply have been identified, he adds, and assessment of the methodology to be used is currently being finalised, "at which point we can engage more with other stakeholders". The project started three months ago and is expected to be finished before the 26th UN Climate Change Conference of the Parties (COP 26) due to take place in Glasgow from 31 October through 12 November.

"This particular project focuses on the investment challenge," Raucci says, "but everything is linked, including, for example, the technology challenges of scale, or the safety aspects of handling new fuels, or the community acceptance of having ships carrying fuels like hydrogen calling at major ports close to high-density urban populations." In the final analysis, such problems can be overcome, he believes — as has happened with widespread acceptance of LNG as a marine fuel, despite initial safety fears.

"By applying the innovative Zero-Carbon Fuel Monitor Framework, we at LR believe we can can really progress the sustainable transition of the shipping industry. It's pushing us towards innovation and is quite extensive, giving us holistic 'big picture' answers. We're very proud of how it's coming along and hope it will have a significant impact.

LR's *Horizons*, September 2021

LR Fulfils Critical role in HMS *Queen Elizabeth* Deployment

Preparing the aircraft carrier, HMS *Queen Elizabeth*, and her Carrier Strike Group (CSG1) for a seven-month Far East deployment earlier this year was a major 24/7 commitment for LR's naval experts, some of whom are permanently 'embedded' in Royal Navy support contractors in key locations including Bristol, Devonport and Portsmouth.

CSG1, as it is known, is the largest concentration of maritime and air power to leave the UK in a generation. The eight-vessel flotilla of ships, all classed by LR, left Portsmouth on May 22. It consisted of the aircraft carrier itself, designed to carry up to 40 aircraft; two Type 45 destroyers, HMS *Defender* and HMS *Diamond*; two Type 23 frigates, HMS *Richmond* and HMS *Kent*; an Astute-class submarine, HMS *Artful*; and two Royal Fleet Auxiliary support ships, RFA *Fort Victoria* and RFA *Tidespring*. Between May and December, CSG1 will have visited locations including India, Japan, the Republic of Korea and Singapore. Joint operations with a number of different navies are taking place through the deployment.

Logistical Challenge

Although LR had been active in Royal Navy-related business for more than 150 years, it was not until 1998 that the UK's Ministry of Defence requested the classification society to draw up Naval Ship Rules, published two years later. Since then, LR has classed more than 400 naval vessels on behalf of 19 navies.

Preparing the CSG1 for its Portsmouth departure constituted a major logistical challenge for LR's survey teams across the UK. Keith Ivory is a specialist in the small naval boats team. "I am involved with the passenger transfer boats that run with the aircraft carrier, and the fast sea boats that are available for the transport of marines and commandos," he explained.

"So, my responsibility was to re-profile the survey schedules of all individual supporting craft, bearing in mind that they were going out for several months. It was a juggling act ... getting them ready beforehand and then re-adjusting them when they return, getting them back into a cyclical pattern of routine inspections."

This example was repeated for the other vessels readied in Portsmouth, Plymouth, Falmouth and Newcastle. For some of the larger vessels, LR is providing further support by sending specialists to key locations to support CSG1's planned itinerary.

Knowledge Transfer

Of course, one key question about the assurance of assets engaged in CSG1's deployment is whether LR can apply some of the developments in remote inspections and shore-ship advice that have transformed routine surveys in the commercial sector. However, this is a complex challenge in a naval context because the transmission of real-time data or live-streaming video is not permitted.

But LR's Paul James, Naval Centre of Expertise Manager in Bristol, believes this may change in time but explains why this does not really matter for the moment. "Our people are constantly in touch with the assets and those who operate them," he said. "They know the ships intimately because they may have been involved in their construction or they are regularly carrying out inspections. Our surveyors know where or what to look at, and because we have specialist teams and extensive knowledge, we can provide remote assistance over the phone. Video live stream is not necessary."

However, in another and potentially more-pressing aspect of ship operation, there may well be a very useful exchange on technology developments in the months ahead. The Royal Navy may well be looking for a commercial lead on sustainability issues.

"So, as you know," said James, "the Royal Navy will face the same low-carbon challenge as commercial shipping. But it has some unique problems because a lot of low-carbon options involve highly-volatile fuels. It's not good to combine these with a combat scenario. The aim is to bring the low-carbon benefit without making the ships less safe."

Since the world's navies have a unique operating profile, environmental stewardship is likely to take more time than in commercial shipping where pilot projects are already assessing the scope for new fuels, including methanol, ammonia, and hydrogen. But the increasing urgency of the climate emergency is changing the backdrop. LR's expertise in environmental assurance may well be required in a naval context sooner than expected.

LR's *Horizons*, September 2021

LR Submarine Classification

One of the Royal Navy's Astute-class submarines is accompanying the HMS *Queen Elizabeth* Carrier Strike Group. The five-year-old HMS *Artful*, the third Astute in the class of seven nuclear submarines, was built at BAE Systems Submarines' shipyard at Barrow-in-Furness.

LR has a permanent team of submarine specialists assigned to the assurance of products, components in the supply chain, and the construction process itself. It has recently published an updated submarine assurance framework and offers these services to navies around the world.

LR's submarine offering is unique. Unlike others which set out specific build requirements, LR assures that the design and build standards of submarines are suitable and appropriately applied to materials, equipment in the supply chain, build, and subsequent through-life operation of the asset in service.

LR was the first classification society to have Naval Ship Rules and is a leader in the submarine field. It prides itself on applying a more-flexible and thoughtful approach to naval classification and asset assurance.

LR's *Horizons*, September 2021

HMS *Queen Elizabeth* during the CSG1 deployment
(Crown Copyright UK MoD)

FROM THE CROWS NEST

WWSR Spirit 2

On 8 October 1978, 42 years ago, Ken Warby blasted across Blowering Dam to set his second (and current) World Water Speed Record of 317.6 mph (511.1 km/h), thus becoming the first person to officially break the 300 mph and 500 km/h barriers, the only person to ever design, build and drive a boat to a World Water Speed Record, and still the only person in the world to hold this record.

Dave Warby of Warby Motorsport is attempting to break his father Ken's World Water Speed Record in *Spirit of Australia* in their latest vessel, *Spirit of Australia 2*.

The Warby Motorsport team is hoping to be back at Blowering Dam with *Spirit 2* before the end of the year to resume their campaign for a new world water speed record. In the meantime, the team has been carrying out maintenance on the boat and trailer.

The time at Blowering Dam in May brought frustration, but progress as well. They had problems with the starter motor and a ruptured fuel tank, not to mention the windy conditions. However, the boat attained a speed of 380 km/h and held it for one-and-a-half kilometres, the longest high-speed run so far. The boat is now handling well and the known issues have been fixed.

Phil Helmore

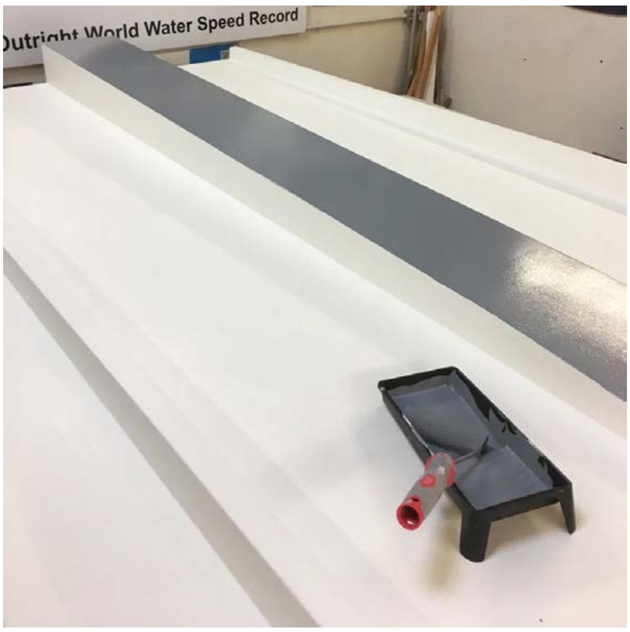
WWSR Longbow

Britain has re-entered the contest for the World Water Speed Record with a new vessel, *Longbow*, having commenced construction in April 2018.

The boat is now being painted and, with three primer coats, three undercoats and three topcoats, it means a lot of sanding of the entire hull between coats!

[*For further details, visit the Longbow website, https://www.jet-hydroplane.uk/* — Ed.]

Longbow website



Painting the underside of *Longbow*'s hull
(Photo from Longbow website)

Painting the underside of *Longbow*'s hull
(Photo from Longbow website)

SP80 Aims for World Sailing Speed Record

The world sailing speed record is currently held by Australian Paul Larsen in *Vestas Sailrocket 2* at an average speed of 65.45 kn (121.1 km/h) over the 500 m track. *SP80* is the vessel being designed and built by three young engineering students from the Swiss engineering school École Polytechnique Fédérale de Lausanne (EPFL) to attempt the world sailing speed record in 2022 and take it back to Europe. To achieve their goal they are aiming for a speed of 80 kn (148 km/h) using a boat with shaped hulls, propelled by a the usual kite wing, while the overall stability is achieved via super-ventilating hydrofoils.

Now, after testing a half-scale prototype and 40 000 h of work to validate the design of our boat, construction of the full-size vessel has begun. With the Swiss watchmaking brand Richard Mille joining the adventure as a title partner, construction has been entrusted to the Persico Marine shipyard in Italy. The manufacture of such a vessel is slightly different from more traditional boats, since TPT® carbon kits are used: pre-impregnated carbon fabrics which are much thinner than usually used. The lightness and performance of TPT® kits are essential assets for the vessel to accelerate up to 80 kn.

[*For further details, visit the SP80 website, https://sp80.ch/* — Ed.]

SP80 website

Parts being laid up for *SP80*
(Photo from SP80 website)

GENERAL NEWS

First Hunter-class Frigate Prototype Unit Completed

In mid-October the Osborne Naval Shipyard in Adelaide completed structural assembly of the first steel prototype unit for the Hunter-class frigate program, the largest surface shipbuilding project in the nation's defence history.

The 217 m^2, 28 t unit, was moved from the shipyard's primary manufacturing hall into the next stage of production where it will be outfitted and consolidated (with the addition of three more units) into the first prototyping block.

The prototype unit is one of four in the first representative ship block and is the first to have been blasted and painted, cut and constructed in the new shipyard. This particular unit and block are located in the middle of the ship and would contain the officer's accommodation.

Steel for the prototyping phase of the Hunter program has been procured from Bluescope AIS at Port Kembla, NSW and structural steel from Infrabuild in Whyalla, SA.

The Hunter program has already placed around 40 contracts with Australian businesses to support design and prototyping. Around 20 further contracts will be awarded to support prototyping, including ship outfitting, gaskets, wholeship eyeplates, insulation and deck coverings.

BAE Systems Maritime Australia Managing Director, Craig Lockhart said: "This is a significant production milestone for the Hunter-class frigate program and an important start towards establishing shipbuilding capability across the Osborne Shipyard.

"Osborne is one of the world's most technologically advanced shipyards, a purpose-built modern manufacturing facility built for the digital age to deliver next generation anti-submarine warships by a highly-skilled Australian workforce equipped to use Industry 4.0 technologies."

"Critically, the manufacture of the first unit has put into practice this step-change to shipbuilding programs of the past, as our employees test the full productive capacity of the yard maximising our ability to build high-quality ships through our pulse-line process utilising robotics that enable high-quality welds and zero defects."

"This ensures an enduring and uniquely Australian sovereign industrial capability that supports Australia's continuous naval shipbuilding strategy for future generations."

The first prototype unit being rolled out at Osborne
(Photo courtesy BAE Systems)

Austal Delivers 13th Guardian-class Patrol Boat

On 22 October Austal announced the delivery of the 13th Guardian-class patrol boat (GCPB) to the Australian Department of Defence. The vessel, *Francis Agwi*, was then gifted by the Australian Government to the Papua New Guinea Defence Force at a certificate signing ceremony held at Austal's shipyard in Henderson, Western Australia.

The ceremony was attended in person by RADM Wendy Malcolm CSM, Head of Maritime Systems, Department of Defence, Capability Acquisition and Sustainment Group (CASG), Air Commodore Fiona Dowse, Senior ADF Officer WA, and Captain Gary Lawton, Commanding Officer HMAS *Stirling*, with Papua New Guinea being represented by the Commanding Officer of *Francis Agwi*, Lieutenant Elizah Lourie. With border restrictions currently in place which prevented guests from interstate attending, pre-recorded congratulatory messages were presented from both the Minister for Defence, The Hon Peter Dutton MP and His Excellency Mr John Kali, Papua New Guinea High Commissioner to Australia.

The vessel is the third of four Guardian-class patrol boats to be delivered to Papua New Guinea under the Pacific Patrol Boat Replacement Project (SEA3036-1), part of the Australian Government's Pacific Maritime Security Program. The project supports more than 200 direct jobs at Austal Australia and more than 200 indirect jobs nationally through Australian businesses contracted by Austal.

Austal Australia's expanded service centre in Cairns, incorporating a 1200 t (80 m LOA) slipway and a 1120 t mobile boat hoist, continues to provide in-service support for the growing Guardian-class patrol boat fleet; with more than 100 people now employed in a variety of engineering and sustainment roles in the Far North Queensland city.

The 39.5 m steel monohull patrol boat — designed, constructed and sustained by Austal Australia — is based on a proven design which has included the 38 m Bay-class, 56 m Armidale-class and 58 m Cape-class patrol boats which are in service with the Australian Border Force and Royal Australian Navy.

The thirteenth Guardian-class patrol boat *Francis Agwi* recently delivered by Austal Australia
(Photo courtesy Austal)

The first RAN Evolved Cape-class patrol boat was launched on 19 October
(Photo courtesy Austal)

New RAN Patrol Boat Launched

The first of six evolved Cape-class patrol boats was recently launched at Austal Australia's shipyard in Henderson, Western Australia.

Head Maritime Systems, RADM Wendy Malcolm, said that the vessels would replace the Navy's Armidale-class patrol boats and would be used as interim patrol vessels until the commissioning of the Arafura-class offshore patrol vessels.

Austal has commenced construction on the remaining five boats, the first of which is expected to be accepted by the Navy early next year.

The 58 m long vessels are being built with a number of enhancements, improving operational capability and crew capacity compared to the vessels already operated by the Navy and Australian Border Force.

New Era in Fleet Maintenance

A call for tenders was issued at the end of October for a capability life-cycle manager (CLCM) to maintain the Navy's Hobart-class destroyers.

The destroyers will be the first major class of ship to be sustained through a CLCM arrangement, which has been timed to support the Hobart-class destroyer upgrade project.

This is a significant milestone for Plan Galileo, which is a response to the Australian Government's National Naval Shipbuilding. Plan Galileo will ensure the significantly larger and more complex fleet that will result is effectively sustained.

The CLCM will work collaboratively with personnel in Defence's Systems Program Office, which oversees the sustainment and maintenance of the Hobart-class destroyers, as well as other organisations providing through-life asset management for the class.

Head Maritime Systems in Defence's Capability Acquisition and Sustainment Group, RADM Wendy Malcolm, said that CLCMs would be a key element of the innovative way that Defence and industry work together to sustain the Navy's existing and future fleet.

"The CLCM's role is critical to asset management and engineering functions, optimising an asset's capability, including cost-effective vessel sustainment, and providing capability enhancement and integration services for capability updates and upgrades required over time" she said.

The CLCM will implement a common baseline of systems, standard processes and contractual terms to drive commonality across Navy assets. This will ensure a more effective use of resources and aim to reduce the complexity for the supply chain for future capabilities.

Tenders will close on 21 January 2022.

Svitzer Defence Contract

On 6 September Svitzer Australia was announced as the successful tenderer for a long-term contract to provide towage services for the Department of Defence, servicing the Royal Australian Navy.

Svitzer, as the winner of the Defence Marine Support Services Package 3 tender, will provide towage services for Australia's naval fleet, the management of Navy towage assets, and the development of naval personnel training in major ports around Australia.

With over 20 ports nationally, Svitzer supports and promotes local maritime organisations, service providers and local employment.

Svitzer has previously supported Defence as a towage subcontractor in several Australian ports and has a long and proven history in Australia.

Svitzer began providing services to the Royal Australian Navy on 1 October 2021.

Nuclear Powered Submarine Taskforce

On 16 September 2021 the Prime Minister of Australia, the Prime Minister of the United Kingdom and the President of the United States of America, announced an enhanced trilateral security partnership between Australia, the UK and the US (AUKUS).

AUKUS is a momentous partnership in Australia's history which will significantly deepen the three countries' cooperation on a range of security and defence capabilities for decades to come.

The first major initiative under AUKUS is Australia's acquisition of at least eight nuclear-powered submarines. The Australian Government intends to build these submarines in Adelaide.

This announcement means the Australian Government will no longer be proceeding with the Attack-class submarine program.

Australia, the UK and the US have committed to a comprehensive program of work over the next 18 months which will bring this capability into service. The optimal pathway to achieve this is through a significant increase in Australia-UK-US defence collaboration.

This period will be used to examine the full suite of requirements which underpin nuclear stewardship, with a specific focus on safety, design, construction, operation, maintenance, disposal, regulation, training, environmental protection, installations and infrastructure, basing, workforce and force structure.

The Government has established a Nuclear-powered Submarine Task Force led by VADM Jonathan Mead AO to facilitate Australia's role in AUKUS.

VADM Jonathan Mead AO RAN
(Photo courtesy Department of Defence)

UK Submarine Design Contracts

The day after the announcement of the AUKUS partnership, Britain awarded BAE Systems Plc and Rolls-Royce Holdings Plc contracts worth £85 million (about $A155 million) each to develop the design of a new generation of nuclear submarines.

The companies will deliver design work over the next three years on a successor to the Astute-class submarines used by the Royal Navy, the UK Defence Secretary, Ben Wallace, said.

The funding will support 350 jobs and may lay some of the ground work for the Australian project.

Rolls Royce has been the sole provider of reactors for Britain's fleet of nuclear submarines for more than 60 years, while BAE Systems builds both the Astute-class submarines (SSN) of which three are still under construction and the Dreadnought-class ballistic missile submarines (SSBN), four of which will be built for the RN.

Other companies including Babcock International Group Plc are working with the UK Ministry of Defence to firm up designs on a range of options for a new nuclear-powered submarine known as SSNR.

The BAE Systems contract will engage about 250 jobs at its shipyard in Barrow-in-Furness, while 100 staff at Rolls Royce in Derby will be involved in the development of nuclear propulsion systems for the new class.

Austal USA Contract for US Navy

Austal USA has been awarded its first steel vessel construction contract by the United States Navy, a $US145 million (about $A198.5 million) construction of two Towing, Salvage, and Rescue ships (T-ATS 11 and 12).

The contract includes options for up to three additional T-ATS ships, which, if exercised, will bring the total cumulative value of the contract to $US385 million.

Austal was initially awarded a $US3.6 million contract by the United States Navy for the functional design of the Navajo-class T-ATS vessels. The fixed-price incentive (firm target) contract modification, includes the detailed design and construction of T-ATS 11 and 12, as well as the option for the additional ships.

The T-ATS contract is the first steel ship construction program awarded by the United States Navy to Austal USA and will be the first program to be delivered in the new steel shipbuilding facilities nearing completion at the shipyard in Mobile, Alabama.

The 80 m Navajo-class T-ATS has ocean-going tug, salvage, and rescue capabilities, with a multi-mission common hull platform, capable of towing heavy ships. These ships will be able to support USN fleet operations and a variety of missions, including oil-spill response, humanitarian assistance, and wide area search and surveillance.

The shipyard previously announced that it had submitted a bid to build the United States Coast Guard's Offshore Patrol Cutter and continues to execute a Light Amphibious Warship (LAW) concept studies and preliminary design contract for the USN and US Marine Corps. Austal USA's new steel line and facility expansion also positions it well to be a follow-on frigate yard for the USN.

Incat Tasmania's latest high-speed catamaran ferry, *Volcán de Taidía*
(Photo courtesy Incat Tasmania)

Incat Delivers Second 111 m Catamaran

Incat Tasmania has delivered its latest high-speed ferry, *Volcán de Taidía*. The 111 m catamaranwill operate in Spanish waters alongside her sister ship *Volcán de Tagoro* which was delivered by Incat in 2019.

Volcán de Taidía sailed to Spain via Auckland, across the Pacific Ocean to Tahiti and the Panama Canal before crossing the Atlantic to her new home in the CanaryIslands. Naviera Armas will operate the vessel between Las Palmas de Gran Canaria and Santa Cruz de Tenerife.

The company has an extensive fleet of vessels, and when she enters service *Volcán deTaidía* will be the sixth Incat-built vessel operating in the fleet. She is also the second Naviera Armas newbuild direct from Incat Tasmania, having obtained other Incat-built vessels on the second-hand market.

Volcán de Taidía has capacity for 1200 people, including crew, and the vehicle deck allows for 595 truck lane metres plus 219 cars, or in car-only mode she can accommodate 401 cars. Passenger spaces are divided into three classes, First Class, Business and Economy, each area offering bars and food service areas.

The ship is powered by four MAN 20V diesel engines driving Wartsila waterjets. *Volcánde Taidía* achieved over 42 knots with 600 t deadweight during trials.

Passenger seating in *Volcán de Taidía*
(Photo courtesy Incat Tasmania

Both vessels will operate out of the new private port facility strategically located in the centre of the Canary Islands at Las Palmas and developed by Naviera Armas in 2019. Nelson Mandela Pier is the first privately financed passenger terminal in a Spanish state-owned port. The new ships and terminal demonstrate Naviera Armas's commitment to its passengers and freight customers.

Principal Particulars

Designer	Revolution Design
Length OA	111.9 m
Beam mld.	30.5 m
Draft	4.1 m
Speed	42 kn at 600 t deadweight
Max DWT	1000 (approx.)
Complement	1200 persons (including crew)
Vehicles	595 truck-lane m plus 219 cars, or 401 cars
Main engines	4 × MAN 28/33D STC 20V engines, each rated at 9,100 kW at 100% MCR
Water jets	4 × Wärtsilä Lips LJX 1500SR
Gearboxes	4 × ZF 60000 NR2H
Ride Control:	Naiad Dynamics active trim tabs and retractable T-foil
Class	DNV ✠ A1 HSLC R1 Ferry "B" EO

Austal Philippines Delivers 118 m Ferry to Fred. Olsen Express

On 5 October Austal announced that Austal Philippines had delivered *Bañaderos Express*, an Austal Auto Express 118 high-speed trimaran ferry, to Fred. Olsen Express of the Canary Islands.

The delivery signals the completion of the $A190 million contract for two trimarans, announced in December 2018. The first vessel, *Bajamar Express* was constructed by Austal Australia and delivered in July 2020. *Bajamar Express* was acknowledged by the Royal Institution of Naval Architects as one of 2020s significant ships.

Capable of transporting 1100 passengers and 276 cars at a cruising speed of over 37 kn, the new ferries for Fred. Olsen Express feature class-leading interior amenities and facilities, including multiple bars, kiosks, a retail shop and children's play area.

Austal Philippines has delivered *Bañaderos Express*, the second of two 118 m trimarans for Fred. Olsen Express from the company's shipyard in Balamban, Cebu
(Photo courtesy Austal Philippines)

Following the vessel's maiden voyage from the Philippines to the Canary Islands, *Bañaderos Express* will join *Bajamar Express* to offer a dedicated trimaran service on the route between Santa Cruz, Tenerife, and Agaete, Gran Canaria, from the fourth quarter of 2021.

42 m Patrol Vessel from Incat Crowther

Incat Crowther has announced that construction is well underway on a 42 m patrol vessel for operation in Thailand.

The vessel is being built by Seacrest Marine in Muang Samutprakarn, Thailand, and has been developed as a solution to a strict set of mission requirements for use in patrol, rescue and enforcement activities within Thai domestic waters.

The vessel will be the eighth Incat Crowther vessel to be built by Seacrest Marine and will accommodate 16 crew and 6 officers below decks with a fourteen-day autonomy.

The main deck will house crew and officers' messes, galley and stores, laundry, captain's cabin and arms stores, with a full walk-around deck. The aft deck has a deck crane and a fast rescue vessel for at-sea boarding activities.

The upper deck houses a radio room and ship's office. Deck-mounted armaments are located around the exterior decks, as well as a fire-fighting monitor.

Starboard quarter of 42 m Thai patrol vessel
(Image courtesy Incat Crowther)

Powered by three MTU 16V2000 M86 main engines driving fixed-pitch propellers, the vessel will have a top speed of over 34 kn. Low draft was a key requirement, which has been addressed by the incorporation of Incat Crowther's highly-efficient propeller tunnels.

The vessel is scheduled for sea trials later this year.

Principal particulars of the new vessel are

Length OA		42.0 m
Length hull		40.0 m
Length WL		38.8 m
Beam OA		7.90m
Depth		4.30 m
Draft	(hull)	1.50 m
	(propellers)	1.90 m
Passengers		23
Crew		5
Fuel oil		24 000 L
Fresh water		10 000 L
Grey water		1000 L
Sullage		1000 L
Main engines		3×MTU16V2000 M86
		each 1630 kW @ 2450 rpm
Propulsion		3×fixed-pitched propellers
Generators		2×134 ekW
Speed	(service)	30 kn
	(maximum)	34 kn
Construction		Marine-grade aluminium
Flag		Thailand

MHO Asgard and *MHO Apollo* from Incat Crowther

Incat Crowther has announced the delivery of a pair of Incat Crowther 35 crew-transfer vessels. Recently delivered by Afai Southern Shipyard in Guangzhou, China, *MHO Asgard* and *MHO Apollo* are the first hybrid CTVs in operation with extensive zero-emission capability. The vessels will service the Hornsea Project 2 offshore wind farm in the North Sea for Ørsted. The vessels are the third and fourth Incat Crowther-designed vessels for MHO-Co., following on from *MHO Esbjerg* and *MHO Gurli*.

Starboard bow of *MHO Asgard*
(Photo courtesy Incat Crowther)

MHO Asgard and *MHO Apollo* are powered by an advanced propulsion system which was developed in collaboration with Danfoss and Volvo Penta. The system comprises a pair of diesel drive-trains and a pair of diesel-electric drive-trains, each driving Volvo Penta IPS drives. The main diesel engines are Volvo Penta D13 units, each producing 515 kW. The generators used for the diesel-electric propulsion train are Volvo Penta D8-MH units. A further three of these units are located in the hulls amidships, alongside a Volvo Penta D5 used as a harbour generator. Propulsion is via highly-efficient Volvo IPS units. Additionally, a Corvus battery system provides stored power for zero-emission operation.

The system offers exceptional flexibility, allowing the vessel to operate in zero-emissions electric mode for up to 8 hours, or in combination with diesel propulsion for a maximum speed of 25 kn. The flexibility is enhanced by the use of multiple modular generators, meaning that power generation can be optimised for the operational profile.

Incat Crowther worked with MHO-Co. to develop a design which improved on its predecessors, offering even more space and functionality. The incredibly flexible layout features a vast 110 m^2 foredeck with multiple tie-downs, a deck crane, a moon pool and the capability to take B2W (bring-to-work) systems. The Z-Bridge B2W system has been trialled on *MHO Esbjerg*.

MHO Asgard and *MHO Apollo* accommodate 24 technicians in mid-deck cabins. A comfortable saloon for technicians is located on the main deck with 24 suspended seats, lockers, a pantry and a separate mess. Additional technicians' rest spaces are also located on this deck, as is a large wet room with lockers and showers.

"Designing and building hybrid CTVs is a huge step in the environmental direction, and I am proud that we at MHO-Co. have found partners who share our vision for sustainable development in the offshore industry," said MHO-Co. CEO and founder, Mik Henriksen.

Ed Dudson, Managing Director of Incat Crowther Europe, said "*MHO Asgard* and *MHO Apollo* demonstrate Incat Crowther's growing reputation for collaboration with operators and developers of new propulsion technologies, delivering fully-integrated solutions based on proven platforms."

Principal particulars of *MHO Asgard* and *MHO Apollo* are

Length OA	34.4 m
Length WL	33.3 m
Beam OA	11.0 m
Depth	4.15 m
Draft (hull)	1.45 m
Personnel	24
Crew	8
Fuel Oil	67 600 L
Fresh Water	3500 L
Sullage	2500 L
Diesel engines	2×Volvo Penta D13 each 515 kW @ 2250rpm
Hybrid System	2×Danfoss EM-PMI each 550 kW @ 2250 rpm
Propulsion	4×Volvo IPS 30
Generators	5×Danfoss EM-PMI Volvo D8 each 230 kW @ 1900 rpm
Speed (maximum)	25 kn
Construction	Marine-grade aluminium
Flag	Denmark
Class/Survey	DNV 1A HSLC Crew Windfarm R1

Sea Change from Incat Crowther

Incat Crowther has announced the launch of *Sea Change*. The Incat Crowther 22 is the world's first zero-emissions hydrogen fuel-cell-powered electric-drive high-speed passenger ferry. Delivered by All American Marine in Bellingham, WA, USA, the project has been spearheaded by the vessel owner SWITCH Maritime and was brought to fruition by a consortium of contributors, including Incat Crowther, Zero Emissions Industries, BAE Systems and Hornblower Group, with whom Incat Crowther worked closely on the recent NYC Ferry newbuild program.

The project is supported by a grant from the California Air Resources Board, administered by the Bay Area Air Quality Management District, which came from the California Climate Investments initiative, a California statewide program that puts billions of Cap-and-Trade dollars to work to reduce greenhouse gas emissions, strengthen the economy, and improve public health and the environment—particularly in disadvantaged communities. Upon delivery, the vessel will operate in the Bay Area of California and exhibit the viability of the hydrogen fuel-cell marine technology and demonstrate a pathway to commercialisation.

Launching *Sea Change*
(Photo courtesy Incat Crowther)

The vessel is equipped with a hydrogen fuel cell power package provided by Zero Emissions Industries (formerly Golden Gate Zero Emission Marine), comprising 360 kW of Cummins fuel cells and Hexagon hydrogen storage tanks with a capacity of 246 kg. This system is integrated with 100 kWh of lithium-ion batteries provided by XALT and a 2×300 kW electric propulsion system provided by BAE Systems.

Incat Crowther developed an arrangement for the vessel which accommodated the new propulsion technology, integrating it into the vessel's structure and systems. The vessel's hullform was optimised to reduce resistance, whilst further efficiencies were gained in the structural design for *Sea Change*, with Incat Crowther delivering its customary mix of robustness and low mass.

Incat Crowther also took a leading role in navigating the regulatory framework for the new technology, working closely with numerous branches of the US Coast Guard and key stakeholders.

The vessel is accessible by disabled persons and includes ramps to the bow and side loading gates. The bow utilises a standard bow radius for use in many US cities. The elevated wheelhouse affords excellent visibility over bow loading operations.

Incat Crowther is proud to contribute to such a project, leveraging a long tradition of involvement in the implementation of alternative propulsion technologies.

Principal particulars of *Sea Change* are

Length OA		22.1 m
Length WL		21.8 m
Beam OA		7.50 m
Depth		2.50 m
Draft	(hull)	1.10 m
	(propellers)	1.50 m
Passengers		78
Crew		2
Fresh water		378 L
Sullage		378 L
Hydrogen		Hexagon 246 kg
Fuel cells		Cummins 360 kW
Batteries		XALT 100 kWh lithium ion
Propulsion motors		2×BAE Systems each 300 kW
Propulsion		2×fixed-pitch propellers
Speed (maximum)		20.5 kn
Construction		Marine-grade aluminium
Flag		USA
Survey		USCG Subchapter T

Tamoya from Incat Crowther

Incat Crowther has announced the launch of *Tamoya*, an Incat Crowther 17 to join *Reef Ranger* and *Reef Resilience* in the Great Barrier Reef Joint Field Management Program fleet with Norman R. Wright and Sons being the project manager and builder.

Tamoya packs a lot of punch for her size, which is dimensioned specifically to fit the home port berth. The main deck is dominated by an aft working deck with a quick launch-and-recovery system for a 3.4 m RHIB, dive racks, deck winches, BBQ area, a sink and multiple deck

Tamoya on trials
(Photo courtesy Norman R. Wright and Sons)

lashing points.

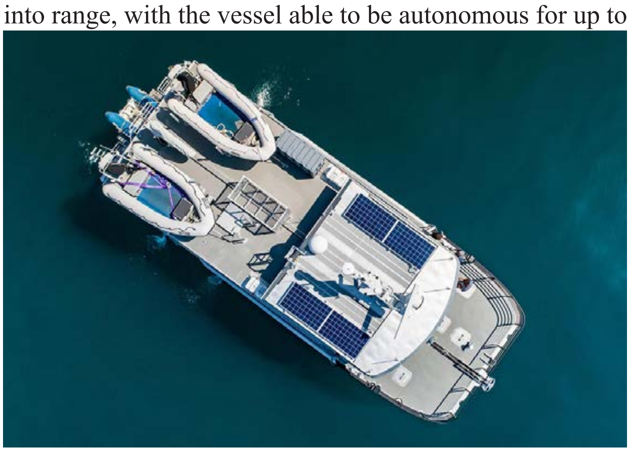
Inside the main deck cabin is a wet room, mess, full-size galley and chest freezer. The elevated wheelhouse accommodates the captain's bunk, whilst side doors provide direct access to the foredeck. Under the wheelhouse is a pair of twin cabins, with a further pair of single cabins located aft on the main deck.

The roof includes ample cargo area suitable for up to two 4.5 m RHIBs, a deck crane and multiple storage boxes, topping off a highly flexible and functional vessel. The deck crane allows the loading of cargo onto the roof, as well as answering the call for both on-board RHIBs to be launched and recovered easily and safely.

The hull has been specifically designed for the demanding operation and features a new-generation Z-bow, large reserve buoyancy and a nacelle to combat rough seas from south-east trade winds. Developed with operational experience from the existing fleet and computational fluid dynamics, the new hull has proven itself in recent sea trials.

Energy efficiency is aided by roof-mounted solar panels to maximise the use of available renewable energy and reduce environmental impact.

Built to a high standard which balances weight, robustness, and maintainability, *Tamoya* is highly efficient and powered by twin MAN i6-850 main engines driving fixed-pitch propellers through ZF V-drive gearboxes. She effortlessly cruises at a service speed of 20 kn. The efficiency translates into range, with the vessel able to be autonomous for up to



Bird's eye view of *Tamoya*
(Photo courtesy Norman R. Wright and Sons)

10 days at sea with a 500 n mile range.

Principal particulars of *Tamoya* are

Length OA		18.60 m
Length WL		17.90 m
Beam OA		6.50 m
Depth		2.60 m
Draft	(hull)	1.10 m
	(propellers)	1.50 m
Personnel		12/24
Fuel oil		6600 L
Fresh water		1000 L
Sullage		400 L
Main engines		2×MAN i6-850 EPA Tier III each 625 kW @ 2300 rpm
Gearboxes		2×ZF 510V
Reduction ration		2.222:1
Propulsion		2838 mm diameter fixed-pitch propellers
Speed	(service)	20 kn
	(maximum)	28 kn
Construction		Marine-grade aluminium
Flag		Australia
Class/Survey		AMSA DCV Class 1C/2C

20 m Landing Craft from Incat Crowther

Incat Crowther has also released details of a 20 m landing craft under construction for the Great Barrier Reef Joint Field Management Program fleet, with Norman R. Wright and Sons being the project manager and builder. This vessel will add another string to the bow of the fleet, with beach landing capability combined with long range and fast cruise speed to significantly improve the program's capacity to manage the 470 island protected areas within the Great Barrier Reef World Heritage Area.

This landing craft provides vehicle access to beaches or boat ramps via a hydraulically operated ramp. Operations are supported by reinforced hull bottom for beach groundings, a low hull draft of only one metre, protected propellers and a kedging winch at the stern.

The large working deck is capable of carrying deck cargo and vehicles, such as four-wheel drives, trailers, an excavator, compact track loader or small tractors. In addition to the bow ramp, the vessel will have a UNIC deck crane capable of lifting 680 kg at a 7.5 m radius. 12 passengers can also be accommodated on this working deck on folding seats. Multiple deck lockers also add to the vessel's functionality.

The wheelhouse deck features a full walk-around, with the aft deck featuring the vessel's rescue boat and crane, laundry and bathroom. Exterior wing stations forward on this deck afford excellent visibility over the working deck and bow ramp. The wheelhouse features lockers and a single bed.

A feature-packed main-deck cabin includes a twin cabin, a large mess and a fully functional galley fitted with similar equipment to the larger *Reef Ranger* and *Reef Resilience*, with a separate fridge and freezer and a large pantry, alongside ample countertop space. Below decks is a pair of twin cabins and stores.

Powered by an MAN propulsion package identical to *Tamoya*, the hull offers long-range capability of 500 n miles at 20 kn with low engine loading, enabling the landing craft to efficiently and effectively deliver construction materials and equipment to remote locations.

For over 40 years, the Queensland and Australian Governments' Reef Joint Field Management Program has planned and executed field operations in the Great Barrier Reef World Heritage Area.

The addition of these new vessels is part of the program's significant expansion, with additional funding, improved vessels, and more staff to better undertake fieldwork and incident response in this iconic and vast World Heritage Area.

The delivery of the fourth Incat Crowther-designed vessel for the Great Barrier Reef Joint Field Management Program fleet follows the company's maxim of *Your Vision, Our Innovation* by consistently delivering bespoke solutions to support the Great Barrier Reef World Heritage Area.

Principal particulars of the 20 m landing craft are

Length OA		21.25 m
Length WL		20.16
Beam OA		6.50
Depth		2.50 m
Draft	(hull)	1.00 m
	(skeg)	1.29 m
Personnel		14/24
Fuel oil		7700 L
Fresh WL		1000 L
Sullage		400 L
Main engines		2×MAN i6-850 EPA Tier III each 625 kW @ 2300 rpm
Gearboxes		2×ZF 665
Reduction ratio		2.233:1
Propulsion		2864 mm diameter fixed-pitch propellers
Speed	(service)	20 kn
	(maximum)	25 kn
Construction		Marine-grade aluminium
Flag		Australia
Class/Survey		AMSA DCV Class 1C/2C

Electric Dream vessels from Incat Crowther

Incat Crowther has announced that design is well underway for the first all-electric passenger ferries for operation in Singapore. The Incat Crowther e28s, designated Electric Dream by the project partners, will carry passengers between mainland Singapore and Shell's facility on the island of Bukom, replacing the conventional diesel-powered ferries currently used. "Shipping's future will involve different parts of the sector using different fuels, and electrification is a solution to decarbonise short voyages, including port operations," said Nick Potter, General Manager of Shell Shipping and Maritime, Asia Pacific & Middle East, in Shell's recent press release. "Switching to zero-emission fully-electric ferries is part of Shell's ambition to help accelerate progress towards net-zero emissions in the shipping sector."

The vessels, to be built, owned and operated by Singapore's publicly-listed aluminium vessel builder and operator Penguin, are notable as being the Shell Energy company's first all-electric vessels globally. "Our Electric Dream project is much more than just electric ferries and shore chargers," said James Tham, Penguin's Managing Director. "It is Singapore's first real-world commercial application of marine electrification".

Incat Crowther already has eight vessels in operation featuring electrified drive-trains, including the recently-launched *Sea Change*, a 21 m catamaran ferry utilising hydrogen fuel cells. The Electric Dream vessels will continue Incat Crowther's zero-emissions trajectory, utilising battery banks and eliminating any fossil fuel onboard, creating zero emissions and very little noise.

The all-electric ferries are powered by a lithium-ion battery system with a capacity of 1.2 MWh and run at speeds of over 20 kn with zero emissions and noise. When berthed at Shell Bukom, the ferries will be charged via a combination of fast charging during peak hours, and slow charging during off-peak hours and overnight.

"Incat Crowther has a rich history in adapting new technology to market, and has played a leading role in applying this new propulsion technology to this application," said Ed Dudson, Managing Director of Incat Crowther Europe. "We've real-world experience in electric drivetrains, energy storage and alternative fuels such as hydrogen and LNG. To have the opportunity to bring our experience and expertise to this project is a significant endorsement for us".

Principal particulars of the Electric Dream e28s are

Length OA		27.90 m
Length WL		27.80 m
Beam OA		9.00 m
Depth		2.20 m
Draft	(hull)	1.08 m
	(propellers)	1.33 m
Passengers		200
Crew		4–6
Fresh water		1000 L
Sullage		800 L
Batteries		1200 kWh
Motors		2×Danfoss T3000-1500 each 530 kW @ 2000 rpm
Propulsion		2×fixed-pitch propellers
Speed	(service)	20 kn
	(maximum)	22 kn
Construction		Marine-grade aluminium
Flag		Singapore
Class/Survey		Bureau Veritas

Bird's-eye view of *Electric Dream*
(Image courtesy Incat Crowther)

32 m Crew-transfer Vessel from Incat Crowther

Incat Crowther has announced that China's first purpose-built catamaran crew-transfer vessel is under construction at Afai Southern Shipyard in Guangzhou, China. To be operated by Goldsea Marine & Offshore Engineering (Shanghai) Co. Ltd, the vessel will support China's growing offshore wind-farm sector. The Incat Crowther 32 will represent a step change in vessel capability in the area, offering stability, performance and functionality unmatched by vessels currently serving the industry.

Incat Crowther has collaborated with the operator to develop a bespoke design, based on a semi-SWATH platform. The platform offers stability in big seas and a comfortable ride for personnel. The vessel will be propelled by controllable-pitch propellers offering excellent fuel economy and 20 t bollard pull.

Comfort is enhanced by a resiliently-mounted cabin and the fitment of suspension seats for 12 technicians. The main deck features four single cabins, two bathrooms, a locker and change area, and a storage area for lift bags. There is also a refreshment area and adjacent settee.

The upper deck has two single cabins, a bathroom and a pantry and mess area. The wheelhouse is elevated, providing excellent visibility over the bow, even with containers on deck.

The vast foredeck offers enormous loading flexibility, with twist-lock container securing, cargo tie-down points and a deck crane capable of 2 t at 10 m reach. Numerous deck lockers are situated around the main deck.

Incat Crowther's Resilient Bow Technology minimises impact loads at the wind turbine boat landings and reduces onboard accelerations. This, combined with the high bollard pull, will provide a transfer wave height in excess of 2 m.

Below decks are a workshop and a utility room, housing storage and laundry facilities.

The vessel will be powered by twin MAN D2862LE466 main engines, each producing 1029 kW, driving controllable-pitch propellers. The vessel will have a service speed of 20 kn, with a maximum speed of in excess of 25 kn.

Principal particulars of the new 32 m crew-transfer vessel are

Length OA		32.10 m
Length WL		29.33 m
Beam OA		10.00 m
Depth		4.15 m
Technicians		12
Crew		6
Fuel oil		39 000 L
Fresh water		25 000 L
Sullage		2000 L
Main engines		2×MAN D2862LE466 each 1029 kW @ 2100 rpm
Propulsion		2×controllable-pitch propellers
Generators		2×TBD
Speed	(service)	20 kn
	(maximum)	25 kn
Construction		Marine-grade aluminium
Flag		China
Class/Survey		CCS ★ CSA Catamaran HSC, Cargo, Greater Coastal Service ★ CSM

Stewart Marler

Starboard bow of 32 m crew-transfer vessel
(Image courtesy Incat Crowther)

RSV *Nuyina*

Nima Moin
Senior Surveyor
New Construction, Marine & Offshore Rotterdam, Lloyd's Register

Introduction

While much has been said and written about the new polar ship *Nuyina,* and much more will be heard about her missions and achievements in the years to come, this paper aims to provide a brief insight to mark her first arrival in her home port. She arrived in Hobart, Tasmania on 16 October 2021 after a 47-day 12 958 n mile voyage from the historical fishing port of Vlissingen (Flushing in English) in the North Sea. *Nuyina* will be replacing the retired *Aurora Australis* which had served Australian Antarctic Division (AAD) for more than 30 years.

Her Naming

Her name was proposed by Australian schoolchildren through a 'Name our Icebreaker' competition. The word Nuyina, pronounced as "noy-yee-nah", means 'Southern Lights' in palawa kani the language spoken by Tasmanian Aborigines. The name signifies the long connection that Tasmanian Aboriginal people have with the southern lights, or in other words with aurora australis.

Her Birth

The official delivery of the Australian Antarctic Division's icebreaking Research and Supply Vessel (RSV) *Nuyina* took place three months earlier in the port of Vlissingen on 28 August 2021. Her journey from design, to construction, and commissioning at Damen Schelde Naval Shipbuilding (DSNS) was not free from challenges and took more than five years, see Table 1. Not to mention the preceding five years of contemplation and planning at the government's desk. Her naval architectural design was undertaken by Knud E. Hansen, a Danish-based leading independent consultancy with a portfolio of more than 800 ships built to their design since 1937.

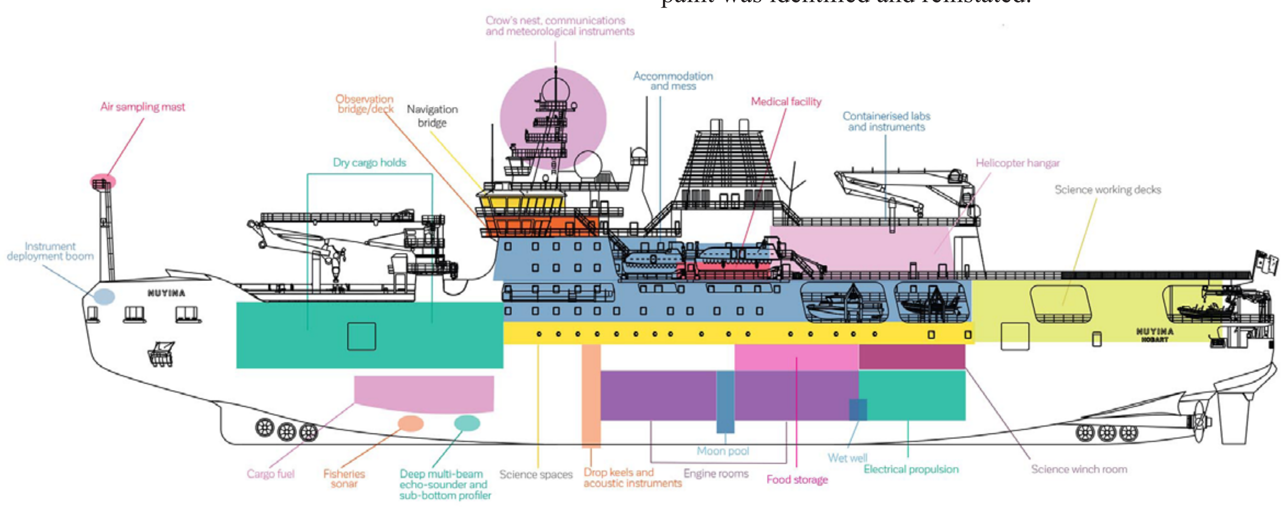
She is designed to accommodate and deploy a wide range of vehicles from land, sea and air including helicopters, landing barges and amphibious trucks to support diverse operations. A unique feature to the vessel is her hybrid propulsion system which can support both the high power needed for icebreaking as well as the silent running for scientific operations. In terms of seakeeping she can handle:

- waves up to sea state 9 (14 m plus significant wave height)
- wind speed up to Beaufort 12 (hurricane)
- air temperatures ranging from −30° C to 45° C, and
- water temperatures ranging from −2° C to 32° C

Table 1 — Key dates and Milestones

Construction contract	28 Apr. 2016
Steel cutting	31 May 2017
Keel-laying	24 Aug.2017
Launching	17 Sep.2018
Harbour Acceptance Tests	May 2019
Classification	17 Aug.2021
Arrival Hobart	16 Oct. 2021

While the construction of the hull and installation of machinery was successfully completed at Damen's Galati shipyard in Romania, by mid-2020 the global outbreak of the COVID-19 pandemic was taking its toll on the progress of this project. At the outfitting stage, given the need to mobilise equipment suppliers and technicians from various parts of the world, to speed up the process it was decided to relocate her to Damen's main shipyard site in Vlissingen the Netherlands. Vlissingen, due to proximity to two major European ports (Rotterdam at 130 km and Antwerp at 86 km), has a strategic and favourable position in this regard (see Figure 1). The 3672 n mile relocation journey, though a justified plan, its achievement was not easy as she had to pass many obstacles through the Black Sea, the Mediterranean and Strait of Gibraltar under tow. During towage through the Sulina channel on the Danube River in August 2020, her body lightly touched the ground. Consequently, on arrival in the Netherlands, she underwent thorough diver inspections followed by dry docking to ensure any scratch to the hull paint was identified and reinstated.



Profile of *Nuyina* showing the arrangement of facilities and equipment
(Drawing courtesy Australian Antarctic Division)

Figure 1 Vlissingen is between two major EU ports

Monday morning 26 November 2020 was the *moment of truth* for her as she set sail for her first technical sea trials in the deep waters of the North Sea. More than 100 people, men and women including a medical doctor, accompanied her during this voyage. One prominent observation which caught the attention of those onboard was her silence and smoothness in various navigation and manoeuvring modes in comparison to other ships which they had experienced previously. Upon completion of three weeks of technical sea trials she headed towards Norwegian waters for the second part of trials to test and calibrate the scientific and environmental equipment capabilities. She returned to the Netherlands right before Christmas to recuperate and undergo further fine-tuning.

The push and need for delivery of *Nuyina* heightened as the news of a debilitating fire onboard MPV *Everest* broke out in April 2021. Such urgency demanded an intensified support and presence of the Australian team in the Netherlands. With the Australian government's COVID lockdown measures in place the supervising team of AAD and SERCO crew visiting the Netherlands had to additionally bear the burden of quarantine on each flight returning home. Accordingly, a word of appreciation to their families and loved ones for their patience and support during this period is genuinely deserved.

Alongside the many players engaged in the battle with COVID restrictions, the Australian Maritime Safety Authority (AMSA) as the flag administration devoted profound remote support to guarantee a timely delivery by holding frequent online meetings and review of progress reports. Finally, by 17 August 2021 *Nuyina* proved to be deserving of registration and the issue of the required certificates. Achieving this goal was an exciting moment of success for all parties including Lloyd's Register (LR) as her classification society and certifying body on AMSA's behalf. "I am sure that when *Nuyina* reaches her home it will be a very exciting and historical moment for the crew and the Australian nation. We wish *Nuyina* and her crew calm seas and decades of safe operation and important research work," read part of LR CEO Nick Brown's letter on this occasion. According to LR ship classification rules, *Nuyina* has earned a number of remarkable notations* as indicated in Table 2 which makes her an outstandingly prestigious ship in her own right.

Table 2 — Class Notations

Classification	ǀ100A1 Research/Supply Ship, Icebreaker(+), Helideck, LA, *IWS, LI, Winterisation H(-40), D(-30), S(B), Ice Class PC3
Environmental	ECO (BIO, BWT, EnMS, GW, IBTS, IHM, NOx-2, OW, P, SEEMP, Sox)
Machinery	ǀLMC, CAC2, UMS, DP(AA), NAV1, IBS, PSMR*
Descriptive notes	ShipRight [ES(anti heeling and anti roll tanks +1 mm for plating and internal stiffening), SCM, SERS]

As an example the PSMR* notation denotes that the main propulsion and steering systems are configured such that, in the event of a single failure in equipment, the ship will retain not less than 50 per cent of the installed prime mover capacity and not less than 50 per cent of the installed propulsion systems and retain steering capability. The propulsion and steering arrangements are installed in separate compartments so that, in the event of the loss of one compartment, the ship will retain availability of propulsion power and manoeuvring capability. *Nuyina's* propulsion system comprises diesel-driven main engines as well as electric motors and combinations thereof, all controlled through a smart Power Management System (PMS) for the various modes of sailing and icebreaking. Figure 2 illustrates the redundancy in her propulsion arrangement — not to mention her steering and dynamic positioning capabilities featuring six thrusters and a pair of controllable pitch propellers.

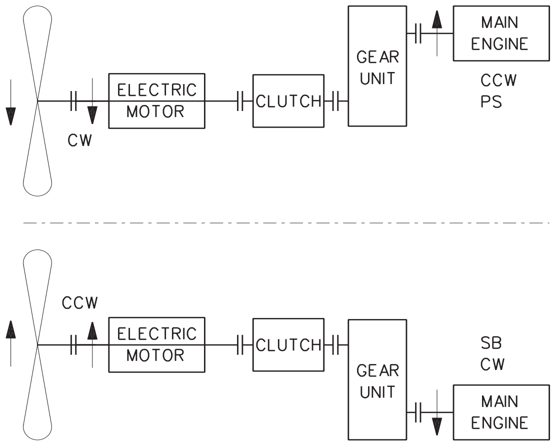
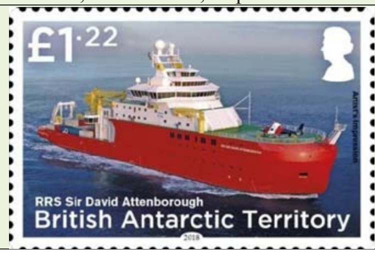


Figure 2 Propulsion layout
(Drawing courtesy DSNS)

If one wants to appreciate such a ship's function and mission, the author recommends reading about Captain Shackleton's crew and their ship *Endurance*. *Nuyina,* as a descendant of *Endurance*, is a unique investment and inspiring ship in many aspects. Her seakeeping, icebreaking, logistical and technical capabilities make her the right platform for future polar scientific explorations in the Antarctic. Assimilating and squeezing such diverse elements all within a 160 m body of steel posed many big challenges to the builder and the owner. For instance, halfway through the design process it was realised that if she is to accommodate all the desired equipment then her mighty steel body needed to be further lengthened by almost 5 m! If one is interested to get a relative idea of *Nuyina* with respect to one of her age-sake relatives such as RRS *Sir David Attenborough* see Table 3.

Table 3 — Main features of RSV *Nuyina* and RRS *Sir David Attenborough* (Wikipedia)

	RSV *Nuyina*	**RRS *Sir David Attenborough***
Owner	DMS Maritime Pty Limited	NERC Research Ship Unit
Builder	Damen Schelde Naval Shipyards	Cammell Laird
Home port/Flag	Hobart/Australia	Stanley, Falkland Islands
IMO Number	9797060	9798222
Cost million	$A528	£GB200
Start Construction	24 August 2017	17 October 2016
Classed/Acquired	17 August 2021	2 December 2020
Length m	160.3	129
Breadth m	25.6	24
Draught m	9.3	7
Tonnage/DWT	25 500	15 000
Ice class	Polar class 3 icebreaker (+)	Polar class 4 (hull) 5 (machinery)
Endurance days	90	60
Propulsion	2 × 9600 kW	2 × 2750 kW
Speed max. knots	16+ (3 knots in ice 1.65 m thickness)	17.5
Crew	32 crew, 116 scientists + 1 doctor	28 crew; 60 scientists; 2 spare berths
Collectible Stamps		

State-of-the-art Scientific Equipment:

Nuyina will be the backbone of Australia's Antarctic program over the next 30 years by providing a wide range of logistical and scientific exploration capabilities. She will serve as the main lifeline to Australia's three Antarctic research stations and its sub-Antarctic station on Macquarie Island. She has a number of flexible modular science laboratories and is the only ship in the world to have a watertight room or 'wet well' to process seawater for krill and other fragile marine organisms, at up to 1800 L per minute. Other scientific equipment includes acoustic instruments to map and visualise the seabed and organisms in the water column, and instruments to measure atmospheric gases, cloud properties, wave heights and ice conditions. An overview of the scientific equipment and sensor suites is presented in Table 4.

Table 4 — Overview of Scientific Equipment and Sensor Suite

Science Equipment	**Sensor Suite**
500 m² science laboratories and offices	Deep water wide-band bathymetric echo-sounder
24 × modular science containers	High resolution multi-beam bathymetric echo-sounder
8 m stern A-frame, Modular deep-sea coring system	Sub-bottom profiler
Towing booms and winches, Trawling system (winches and net drums)	Acoustic Doppler Current Profiler
2 × drop keels	Mammal observation hydrophones
CTD system, Moon pool handling system	Fishery sonar system
Wet well and ultra-pure seawater systems	Weather doppler radar and BOM Sensors
Meteorological and air chemistry labs	Ultra-short Base Line (USBL)
Forward deployment boom	Expendable Bathythermograph (XBT) probe system
	Conductivity Temperature and Depth system (CTD)

Her Arrival and Future

As *Nuyina* emerged on the horizon in Hobart a COVID-lockdown in Tasmania held back her spectators at a distance and she showed her appreciation by blowing the whistle a number of times and making a magnificent 360° turn in the bay.

"We are excited to arrive in Hobart and finish the long

Nuyina arriving in her home port of Hobart
(Photo courtesy Australian Antarctic Division)

voyage. *Nuyina* is a fantastic sea handling ship — very comfortable indeed. The voyage wasn't without its challenges, as I'm sure you can imagine, but we had a brilliant and hardworking team of engineers on board who diligently worked through all the issues as they presented themselves" *Nuyina's* master Captain Gerry O'Doherty wrote on Sunday 17 October.2021.

"To the future crews and expeditioners aboard *Nuyina*, you carry with you the discoveries of the past, the questions of today and the dreams of the future. I wish you calm seas and clear skies," said Scott Morrison, the Prime Minister.

The author, in the capacity of a classification society surveyor who has witnessed *Nuyina's* performance during her sea trials in the North Sea, wishes to comment that "We learnt and continue to learn many great lessons through this journey that the spectacular *Nuyina* is taking us from Romania to the Netherlands and then Australia and soon to the Antarctic polar waters for the many years to come. Such a story of hardship and success could not unfold without the vision of the Australian nation as the investors in the first place and, secondly, the 'borderless' support, innovation and knowledge sharing among the industries from many countries. I feel honoured for myself and LR in being part of this great journey as the scientific findings through *Nuyina* will benefit the inhabitants of this planet in securing a more sustainable future."

Currently due to COVID-19 restrictions public access onboard is limited. *Nuyina* stays in Hobart until December for further commissioning and preparations before taking up her first Antarctic mission. *Nuyina's* many stories and adventures are to be continued.

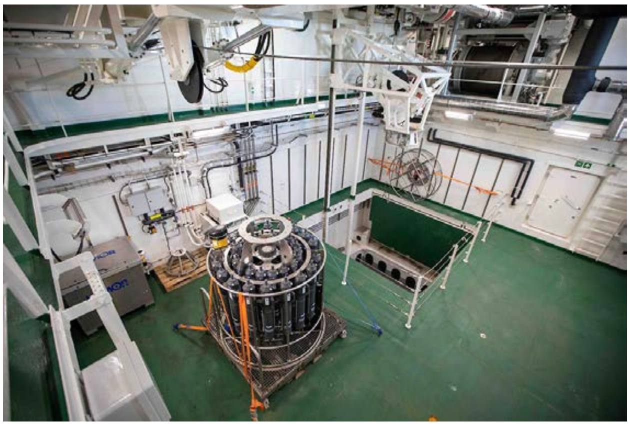
Acknowledgment

The author wishes to thank all those who supported and continue to contribute to *Nuyina* in various capacities. Special appreciation is reserved to Daniel Webster Electrical Engineering Manager, Serco Defence, for sharing and permission to publish pictures and material.

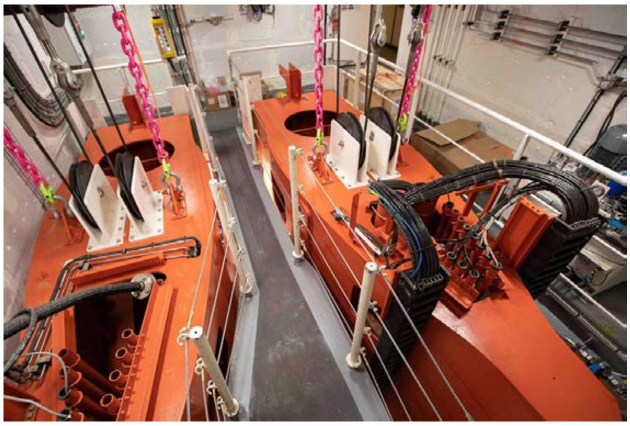
References:

To learn more about the meaning and character of the classification abbreviations reference is made to Lloyds Register rules and regulations Part 1 Section 2 available for download at: https://www.lr.org/en/rules-and-regulations-for-the-classification-of-ships/

Video and article published on 16 October 2021 at: https://www.antarctica.gov.au/nuyina/stories/2021/antarctic-icebreaker-arrives-in-hobart/



The 'moon pool' with the CTD rosette, which samples water at various depths when lowered into the ocean
(Photo Pete Harmsen courtesy AAD)



Two 'drop keels' with acoustic instruments can be lowered below the ship's hull to avoid interference from ice or bubbles
(Photo Pete Harmsen courtesy AAD)

The A-frame for deploying nets and other equipment from the trawl deck
(Photo Pete Harmsen courtesy AAD)

The trawl deck showing A-frame, winch systems, net drums, cranes and one of the personnel tenders
(Photo Pete Harmsen courtesy AAD)

Nuclear Maritime Propulsion Roadmap for Australia

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Captain RAN (retired)

This article is based on a seminar presented by the author to the NSW Section of RINA and the ACT & NSW Branch of the IMarEST on 1 September 2021, and therefore predated the tri-national announcement on 16 September by Australia, the UK and USA of the AUKUS partnership which called for sharing of advanced technology, notably the transfer of nuclear-powered submarine technology to Australia

Introduction

Nuclear propulsion for marine vessels, in particular for submarines, confers extraordinary performance both in power and hence speed, and in endurance. It also obviates the vulnerability to detection for conventional submarines while recharging the submarine battery by snorting at periscope depth.

The adoption of nuclear propulsion for future Australian submarines has been advocated for several years but had been discounted due to a lack of a nuclear power industry for generation of electrical energy. This lack is due to several factors, including legislative bans, which have been reviewed in recent years without producing bipartisan agreement for repeal or revision of these laws.

This article is based on the alternative premise that nuclear maritime propulsion should *lead* the creation of an Australian nuclear power industry, as it is not expressly prohibited by either federal or state laws and is arguably not required for sustainment of nuclear-powered submarines.

The process to implement such a program is proposed through a roadmap comprising ten sections as follows:

Why Nuclear Propulsion for Submarines?

Australia is a continental landmass which sits astride three enormous oceans — the Pacific, Indian and Southern Oceans — adjacent to the archipelagic nation of Indonesia and to several other island countries stretching from Timor Leste, through Papua New-Guinea, Fiji, Vanuatu, the French territory of New Caledonia and other smaller islands, to New Zealand, and with a territorial responsibility for a large part of the Antarctic continent. Australia trades by sea and air with other parts of the world, the largest trading partner being China. More than 90% of Australia's trade is carried in shipping, although almost none of which is Australian owned or flagged. Australia is thus a quintessential maritime nation.

The geopolitical climate in the Indo-Pacific region is becoming more uncertain, with daily confrontations in the Taiwan Strait and continuing militarisation of the South China Sea from artificial islands constructed by China. Submarines are a strategic maritime capability.

History of Nuclear Propulsion Globally

Nuclear propulsion for submarines was the work of renowned US Navy Admiral, Hyman Rickover, the father of the nuclear submarine. USS *Nautilus*, the first submarine underway on nuclear power in 1955, was powered by a nuclear pressurised water reactor (PWR), a technology still the most commonly used not only for submarines and surface ships, but in most of the several hundred nuclear power stations world-wide.

After an initial modest start in 1914, Australia chose to discontinue its submarine force in the 1930s only to rely on US, UK and Dutch submarine forces during World War II. Australia re-established a professional submarine arm of the Royal Australian Navy in 1967 with six Oberon-class diesel-electric submarines, and later replaced them with six Collins-class submarines built in Australia. The Collins class experienced various shortcomings to begin with, but have now attained very high availability and operational effectiveness. However, preparing for their replacement has not been handled well, with a protracted delay in deciding on a replacement program requiring an extension of the life of all six boats for a further decade past their original 30-year design life. This was a daunting prospect in its own right and is now made even more difficult by the cancellation of the SEA 1000 contract with Naval Group to design and build 12 conventionally-powered Attack-class submarines for Australia. This has now also been superseded by a stated intention to build, in Australia, eight or more nuclear-powered attack submarines (SSN) with AUKUS technology transfer.

Challenges for Australia in Adoption of Nuclear Propulsion

Australia had been on a trajectory to build nuclear civil power capability from the establishment of the Australian Atomic Energy commission in 1953, but this was terminated in 1987 by the Labor Government which had been elected four years earlier. The Government proceeded to implement a number of nuclear policy matters including fully embracing the Nuclear Non-proliferation Treaty and to enacting explicit prohibitions on future Australian governments engaging in nuclear industrial activity, including the enrichment of uranium ores, operation of nuclear power stations or reprocessing nuclear spent fuel. But the policy did not prohibit nuclear propulsion.

The Australian Nuclear Science and Technology Organisation (ANSTO) was established in 1987 and operates the OPAL reactor at Lucas Heights in NSW and the Synchrotron at Clayton in Victoria.

Nuclear Fuel Cycle for Nuclear Propulsion

The nuclear fuel cycle is of special importance in nuclear propulsion for a number of reasons, some of which apply especially to Australia which has the world's largest known deposits of uranium ores. The steps through the cycle are as follows, noting that some of them are prohibited from being performed in Australia:

- mining uranium ore;
- milling to separate 'yellowcake' uranium oxide U_3O_8 and processing to uranium hexafluoride UF_6 suitable for enrichment;
- enrichment to low-level enriched uranium (LEU) of 3–5% fissile uranium U235 content, or highly-

enriched uranium (HEU) of 20+% U235 as is used in US and UK submarine reactors, thereby avoiding the need to refuel over the life of the submarine;

- manufacturing of fuel assemblies, which are carefully designed holding structures for the specially-clad nuclear fuel pellets fabricated from the enriched fuel material;
- ultimately defueling the spent fuel materials, to be placed in cooling ponds for several years; and
- reprocessing of the spent fuel to recover unused fissile material, leaving residual radioactive waste to be encapsulated and consigned to a permanent geologically-stable repository.

Infrastructure Required for Nuclear Propulsion

Infrastructure requirements for nuclear propulsion include support for the reactor round the clock due to the fission decay heat, which requires the provision of cooling water and high-reliability electricity supply, even when the reactor is shut down, plus the additional infrastructure to undertake fuelling, refuelling if required, and defuelling at the end of service life.

A critical support capability is for dry-docking in either a graving dock, a ship-lift or a floating dock, in each of which redundant cooling water supplies for the reactor must be provided to substitute for the sea-water cooling in its natural environment.

The handling of new fuel is more straightforward than handling spent fuel which is highly radioactive due to the fission products from the fuel which has been consumed and remains hot for several years while the radioactivity of the fission products decays. It is normal to place such spent fuel in a cooling pond or other storage until the radioactivity has decayed to a level making transportation to a reprocessing plant more readily achievable.

Other infrastructure requirements include shielding for workers. All workers in the proximity of an operational nuclear plant even when shut down must be classified radiation workers and their dose while working must be monitored and recorded.

The primary cooling loop will become radioactive also due to irradiation of small quantities of steel as wear product. This is exposed to high neutron flux in an operating reactor and transforms Fe59 to Co60, which circulates in the cooling water and is termed 'crud'. This collects in low water areas and dead legs and may be disturbed by mechanical shock to be collected in a system for that purpose, but which becomes highly radioactive as a consequence. Removal of this collection system necessitates special handling for any such material removed at end-of-life or for repair.

Construction of Nuclear Submarines in Australia

Non-nuclear submarines have been constructed in Australia and subsequently subjected to major full-cycle maintenance programs taking two or more years and entailing separating the pressure hull to regain access to machinery compartments.

There have been precedents in world submarine building practice where sections of the submarine pressure hull have been constructed at different sites and then transported to a final assembly site for welding to adjoining sections. This is currently the situation in the USA for Virginia-class construction by Huntington Ingalls at Newport News and General Dynamics Electric Boat at Groton.

The same approach will apply to the construction and subsequent maintenance of nuclear-powered submarines in Australia. For initial construction, the forward sections of the submarine pressure hull and bow and sail structures will be manufactured locally as in the past. The reactor section will be sourced from an overseas supplier, either the UK or USA, and transported to the Australian final assembly site with nuclear fuel installed but not yet activated. There are precedents in the UK for this process, where a submarine is constructed at one site but the reactor not activated to attain criticality until after relocation to a different site where the necessary infrastructure is available.

The after sections of the submarine containing the steam plant, other auxiliary machinery and main propulsion train could be constructed locally, as it is all located in a separate section of the submarine pressure hull and stern assembly but may, alternatively, also be constructed elsewhere and brought to the final assembly site already attached to the reactor section.

Workforce Development for Australian Nuclear Propulsion

All uniformed and civilian members of the nuclear propulsion workforce must be formally licensed following formal training, education and qualification. This will present a major challenge for Australia to build up such a workforce through recruitment and training, and may become the critical path in acquiring nuclear submarine capability.

Initially there will need to be a major program to attract already trained and qualified personnel from the UK and USA to transfer or temporarily relocate to Australia, as was the case in setting up the Australian Atomic Energy Commission and the building of the HIFAR research reactor at Lucas Heights in the 1950s.

Regulatory Needs for Australian Nuclear Propulsion

A primary determinant of progress on the nuclear propulsion roadmap is the establishment of both a civil arm of the nuclear regulatory authority responsible for ensuring the maintenance of the highest standards of nuclear safety during preparations for and execution of the nuclear submarine construction, operation and sustainment. All the naval activities of plant operation, including submarine building, are monitored and controlled by a navy safety section. This naval regulatory authority which could be entitled Office of Naval Reactors (ONR) for example, would derive its authority from, and be located within, the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA). Relevant information would derive from two sources:

- the source country for the nuclear reactors would have a fully developed regulatory framework which they would require be replicated in Australia; and
- ARPANSA would provide the Australian context for the ONR to function. It is worthy of note that ARPANSA is the authority for visits to Australia by nuclear-powered warships and has published the regulations for such visits to be approved,

including description of a reference nuclear accident to be considered by organisations responsible for managing such visits.

Implications of Nuclear Propulsion for Civil Nuclear Power

The power ratings of submarine nuclear reactors are in the 100 MWt (thermal) range, which is similar to the power levels defined for civil nuclear small modular reactors (SMRs) of 30–300 MWt. The other features of SMRs are their transportability and fabrication in a factory environment, making them similar in many respects to submarine reactors.

SMRs are operating in Russia and China, licensed and under construction in the UK and USA, and under development in Canada and South Korea. The first of the western-world SMRs will be in operation by the end of this decade

SMRs differ from submarine reactors in three main respects:

- Civil nuclear power reactors are typically refuelled every 18 months or so, whereas the only opportunity for submarine reactor refuelling is at the main full-cycle refitting availability which occurs every 10–12 years as in the Marine Nationale naval submarines of France which uses LEU fuel.
- A submarine reactor is required to withstand the shock and vibration experienced by all warships in active service due to ocean wave movements or enemy action.
- Submarine manoeuvres sometimes require dynamic changes in power levels, and this requires that the overall propulsion train is able to withstand such rapid changes of power without tripping the reactor and causing a sudden and total loss of propulsion power.

Another factor in the relationship between a submarine and civil nuclear reactor workforce is that naval reactor qualified staff are readily accepted for civil reactor work, and this relationship is to the benefit of both communities. The US nuclear power industry has many ex-Navy staff.

There is also active consideration for nuclear propulsion of merchant shipping, but possibly with other forms of reactors such as molten salt reactors which have been used in an experimental way in a small number of naval submarines but have not been widely adopted due to some practical difficulties.

Timelines for Implementation of the Nuclear Maritime Propulsion Roadmap

The timeline for execution of the Nuclear Maritime Propulsion Roadmap for Australia has been stated publicly as the first SSN to be built in Australia starting construction around 2030 with delivery around 2040, and with further deliveries at two-to-three-year intervals. However, this timeline does not align well with the end of service life for Australia's current Collins-class submarines which, even after an intended life-of-type-extension (LOTE) of ten additional years' service, would still result in a reduction in submarine numbers.

This mandates an accelerated approach with earlier delivery of the Australian-built SSNs or other measures to fill the gap, such as by the earlier purchase or lease of SSNs built overseas to be in operation in the 2030s.

This drives the timeline for the precursory steps described above, namely:

- Establishment of the submarine nuclear reactor regulatory authority (such as an ONR).
- Education, training, qualification and licensing of the nuclear propulsion workforce, both naval and civilian.
- Building up of the specialised infrastructure to handle nuclear submarine sustainment and for fuelling, defuelling and fuel-cycle management.

These preparatory steps will take several years and need to start just as soon as the Australian Government approves the program based on the USA and UK sharing the technology and management insight to make the program feasible.

Conclusions

- SSN capability provides much greater capability than the current diesel-electric submarines.
- Nuclear small modular reactors (SMRs) are operating in Russia and China, licensed and under construction in the UK and USA, and under development in Canada and South Korea. They may be accepted for Australia, but this requires repeal of legislative bans.
- SMR power levels are comparable with nuclear submarine reactors.
- Workforce education, training and qualification for SMRs and submarine nuclear reactors are similar.
- Regulation, licensing and standardisation of nuclear reactors in Australia will be provided by ARPANSA.
- Some additional requirements for naval submarine reactors and workforce imply the need for an additional Office of Naval Reactors, which must be established at the start of the Nuclear Propulsion Roadmap implementation.
- Specialised infrastructure is essential for re/de-fuelling reactors, and for continuous reactor cooling during general maintenance.
- The entire nuclear fuel cycle must be addressed in setting up the nuclear propulsion program; management of spent nuclear fuel must be assured.

Overall, the requirements of the Nuclear Propulsion Roadmap can be met without the prior creation of a nuclear power industry, but will require a nuclear industrial workforce to maintain the submarines.

The Author

Christopher Skinner served 30 years in the Royal Australian Navy as a weapons electrical engineering officer on six surface warships, including all three of the previous classes of guided-missile destroyers. He is active in several organisations covering geopolitics, technology and maritime warfare. He is a member of the Engineers Australia Sydney Division Nuclear Engineering Panel, the Australian Nuclear Association and the American Nuclear Society.

Disclaimer

Christopher Skinner is neither a naval architect, nuclear engineer nor a submariner. This article is based on his desk research of open-source material alone and has not been endorsed by any other individual or organisation.

Scaling the Wall:
Inclining Experiment Analysis on Vessels with Chines, Hull Discontinuities or Asymmetry

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Introduction

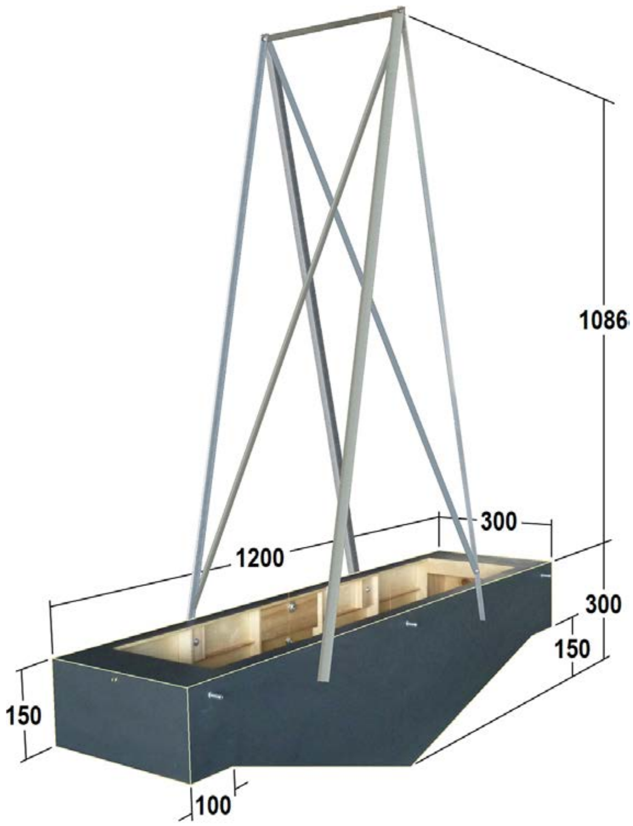
The Australian Army Special Forces are equipped with 11 m air-drop rigid-hull inflatable boats (SF-ADRHIBs). The craft, of about 6 t displacement, are certified for stability in accordance with the requirements of the National Standard for Commercial Vessels (NSCV), with the VCG calculated via GM from an in-water inclining experiment. In 2019, an in-air inclining showed a marked difference in VCG with no significant change to the vessels' arrangement. The (then) Naval Technical Bureau subsequently conducted air and water inclining experiments on a scale model to investigate this issue.

VCG was first measured by suspension and the air inclining gave good agreement with this value. The water inclining experiment, worked up by three typical GM methods, gave widely-varying estimates for VCG; none close to the measured value and two grossly under the measured value. Further investigation was undertaken using numerical models.

The explanation of the error leads to an accurate alternative work-up method, suggesting that it may no longer be appropriate to nominate the use of GM for deriving VCG from inclining experiment results.

Hull Section Model

The model represents a section through the aft region of some of the hard-chine vessels of the Australian Defence Force. These all have little change of form in the run aft from midships; the transverse moment of inertia of the aft portion of the waterplane represents between 70% and 80% of the total. The model is of constant cross-section, and has a low *L/B* ratio of 0.25. The wide chine flats enable the point of contact with the water to be readily observed, and reduced topsides make access easier and help to lower VCG. The model was ballasted with no initial list or trim and to a depth where the chine was just clear above the water when upright, but became immersed at a small angle of heel.



Hull section model
(Diagram courtesy Richard Dunworth)

The centre of gravity was found by direct measurement: suspending the model from three different (pairs of) points with pendulums hung from the same points.

No recording marks could be made on the model: any touch caused the hull and pendulums to swing and, with only air damping, the motion continued for some time. Paper scales were taped to the hull behind the pendulum lines, top and bottom, and photographed once all was still.

With the model back on the workbench, a straightedge was placed through the crossing points, reproducing the pendulum lines by reference to the photographs. On each face, all three lines crossed close to a single point: 134.0 mm below the deck forward; 135.0 mm aft. The baseline through the nominal underside of keel was defined to be 300 mm below the deck, so:

VCG = 300.0 – (134.0 + 135.0)/2
=165.5 mm above the baseline.

Inclining Experiments

The generalised diagram for evaluation of an inclining experiment shows that at move '*i*', when a mass w_i is moved a distance d_i across a vessel, a moment $w_i d_i$ is generated and the shift of the centre of gravity of the system from to G_{i-1} to G_i is:

$$G_{i-1}G_i = w_i d_i / \Delta$$

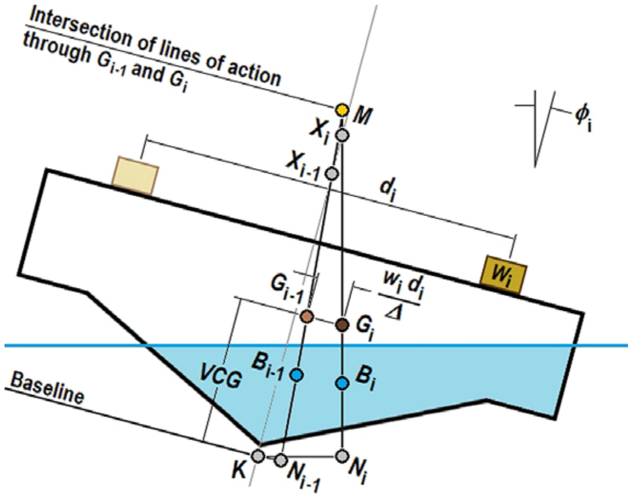
Pendulums were suspended from the top of an aluminium pylon, fore and aft, with the lines crossing scales on the deck. Two consecutive experiments were conducted both in air and in water. An eight-move air inclining was repeated with the same mass moves for both experiments. Results shown are the mean values from the two inclinings. A pair of water inclinings was conducted in a similar manner, but the actual mass move distances differed slightly from the air inclinings.

Air Inclining Experiment

For an air inclining experiment, the intersection of the lines of action through G_{i-1} and G_i is at the pivot point. In this case the system hung from knife edges in the underside of the pylon top bar, 1086 mm above the deck.

With the deck 300 mm above baseline:

$$KM = 1086 + 300 = 1386 \text{ mm}$$



Generalised inclining experiment
(Diagram courtesy Richard Dunworth)

From the slope of the linear trendline of moment vs Δtanϕ, the centre of gravity was 1220.3 mm below the pivot, so:

VCG = 1386.0 – 1220.3
= 165.7 mm above baseline
cf. 165.5 mm measured

Water Inclining Experiment: VGG via GM

Common practice assumes that ships are wall-sided and that, for small angles of heel, the metacentre behaves as a pivot point. The correlation with an air inclining, based on this assumption, is clear: the only difference being that the height of the 'pivot' above the baseline is calculated as KM, rather than being physically measured.

From the model's hydrostatics:

KM = 1093.7 mm

Water Inclining Data with VCG by 3 GM Methods

DATA (mm, kg & degrees)				CLASSIC DERIVATIONS via GM			
Move	w.d	Moment	Heel	Δ tanϕ	GM	KM_T	VCG
0	0	0	0.00	0.000		1093.7	
1	310	310	1.07	0.333	931.1	1100.1	169.0
2	930	1240	3.61	1.128	1099.1	1316.4	217.3
3	-465	775	2.38	0.743	1043.0	1430.2	387.2
4	-775	0	0.02	0.005		1093.7	
5	-310	-310	-1.07	-0.333	929.9	1100.1	170.2
6	-930	-1240	-3.60	-1.127	1100.5	1316.8	216.3
7	465	-775	-2.37	-0.740	1047.7	1431.3	383.6
8	775	0	0.00	0.001		1093.7	
	Hull Wt.	17.889		Average:	1025.2		257.2
Slope GM	1074.6		Av. GM	1025.2			
KM_T	1093.7		KM_T	1093.7		(local KMs)	
VCG (a)	**19.1**		**VCG (b)**	**68.5**		**VCG (c)**	**257.2**

(a) GM via Trendline Slope

The slope of moment vs Δtanϕ gives the height from the centre of gravity to the metacentre, GM, as 1074.6 mm, so:

VCG = 1093.7 – 1074.6
=19.1 mm above baseline

(b) Mean GM

At moves 0, 4 and 8 the nominal heel angle is 0° and, since tanϕ is close to zero, GM is indeterminate. With these moves omitted, the mean of the remaining six GM values was 1025.2 mm, giving:

VCG = 1093.7 – 1025.2
= 68.5 mm above baseline

(c) Using Heeled KMs

Rather than using a single upright value of KM, values of heeled KM_i were used in the calculation of VCG at each of the six non-zero moves. The mean VCG was calculated as:

VCG = 257.2 mm above baseline

Summary of VCGs from the Model Inclinings by GM

The result for the air inclining is very good; however, there is a wide range of VCGs from the water inclining. Use of individual heeled KM values (c) gives a very high VCG; the two most-common methods, determining GM by linear trendline (a) and by average over all mass movements (b), give alarmingly low values of VCG.

In view of the effort which went into ensuring that the water inclining was accurate, the results based on the three GM work-up methods are disappointingly erratic.

Numerical Inclining Experiment

To confirm and explain the results, an inclining experiment was simulated by a numerical model with the designed dimensions of the physical model. Matched by freeboard, the displacement and VCG were very similar to the physical model; to differentiate measurements for the numerical model are shown in metres, rather than millimetres.

Back-calculating the inclining experiment using the underwater centroid at each heel to achieve the actual 0.1655 m VCG, the required moments—and hence mass moves—were found.

Calculation of VCG by the same three GM methods as for the physical inclining give:

(a) GM via Trendline Slope

GM = KM – slope ($w_i d_i$ vs $\Delta \tan_i$)
= 0.019 m above baseline

(b) Mean GM

GM = $\Sigma(KM - GM_i)/N$
= 0.068 m above baseline

(c) Using Heeled KMs

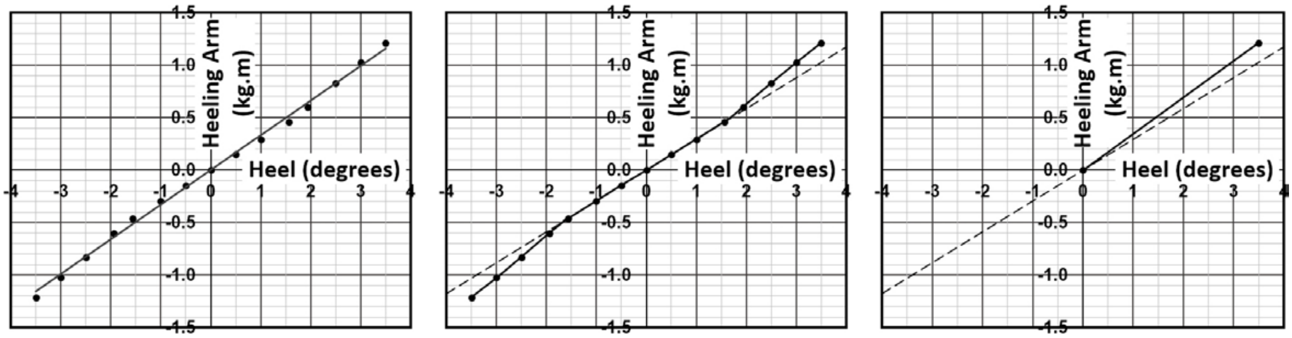
GM = $\Sigma(KM_i - GM_i)/N$
= 0.257 m above baseline

The results follow the same pattern as the physical water inclining experiment: none of the answers are close to the actual VCG of 0.1655 m, with the two most-commonly used methods grossly underestimating VCG.

Graphical Illustration

Graphs of the heeling arm data vs heel angle give an insight into the problem. The outboard tip of the chine touched the waterplane at a heel of 1.51° and the chine flat became fully immersed at 1.87° heel. These were included in a set of heel angles at every half degree from upright to 3.5°, with draft at each adjusted to deliver the chosen volume. Plot (a) shows a small, symmetric scattering of the points and a well-fitting linear trendline ($r^2 = 0.997$). In fact, as can be seen in Plot (b), the locus of the points is divided by knuckles at the angles of chine immersion into three almost straight lines: a plot of this form is often described as indicating excessive free liquids.

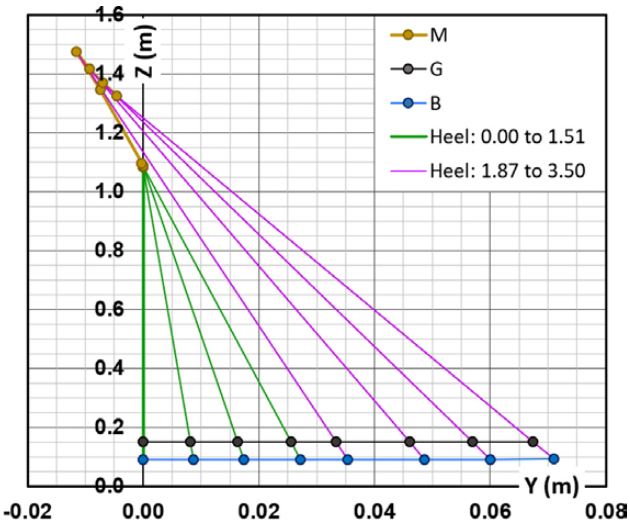
Plot (c) shows the slopes at upright and to the 3.5° point are quite different: a trendline through all points is not necessarily representative of the slope at any point.



Numerical simulation: points (a), locus (b) and slope (c)
(Graphs courtesy Richard Dunworth)

Inclining with a Single Mass Movement?

GM_0 is derived from the slope at upright of the line through the points of heeling moment vs. heel angle (or, more usually, of $w_i d_i$ vs $\Delta\tan\phi_i$); with upright KM_0 obtained from hydrostatics, VCG is then calculated as $KM_0 - GM_0$. There is a problem in determining GM_0 when using a single mass movement: with only the initial point and one other point, a curve of almost any form will pass through the two points. Without more information, a unique slope at upright (and hence GM_0) cannot be identified from a single mass movement.



Behaviour of points M, G and B over the range of heel angles
(Diagram courtesy Richard Dunworth)

Scaling the Wall

It is commonly assumed that the hull is wall-sided, that all points of moment vs heel should lie on a straight line, and that any deviations must be the result of experimental error. However, the validity of a universal straight-line fit is both unjustified and misleading.

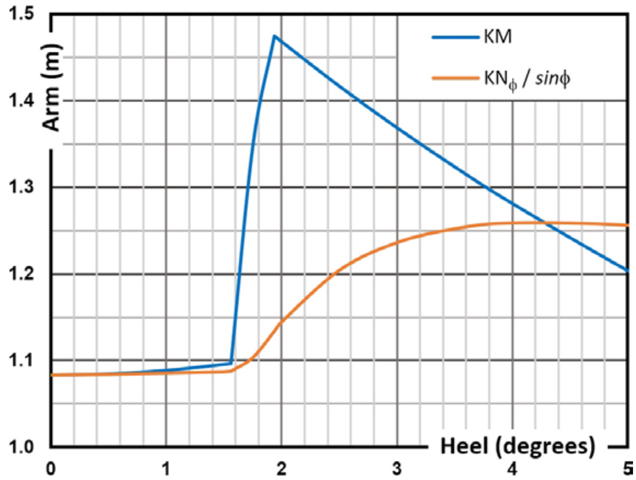
The vessel responds to each inclining mass movement by changing heel so that a state of equilibrium is attained, with B and G aligned vertically; M lies on the same vertical line. Looking at the system in ship coordinates, provided that the inclining masses are not raised or lowered as they are moved, there is no change in VCG; after each mass movement G moves horizontally a distance wd/Δ from the previous position and there is a slight rise of B with increasing heel. For wall-sided ships, it is assumed that the change of waterplane transverse inertia reflects the transverse shift of B. In this case, as the chine becomes fully immersed, there is almost no perceptible change of TCB but the transverse moment of inertia increases considerably due to the greater beam of the waterplane, with corresponding increases in BM and KM. Rather than being fixed, M moves up by almost 0.4 m and shifts off centre.

Centre of Gravity via KN rather than GM

Looking again at the geometry of the generalised inclining experiment, KX_i, can be expressed as $KN_i/\sin\phi_i$. Since at each heel KN_i has a unique value, the ambiguity of KM is removed and an exact value of VCG can be calculated. Reliance on the metacentre can be justified only if KM and $KN_i/\sin\phi_i$ are the same over all heels.

The difference in behaviour between KM and $KN_i/\sin\phi_i$ is pivotal to the accuracy of the method employed to evaluate the inclining experiment data. KM responds immediately to the change in waterplane breadth as the chine touches the water; as the chine becomes immersed, there is a large change in transverse moment of inertia—BM (and hence KM) increase accordingly. During immersion of the chine, there is almost no shift of the centre of buoyancy, so there is only a small change in KN at that event.

With the chine fully immersed, TCB continues to move: on the low side, the vertical hull side becomes increasingly immersed while, on the high side, volume is lost from the V-bottom. The loss of waterplane breadth with increasing heel results in rapid reduction of BM and KM.



KM_T and $KN_\phi/\sin\phi$ vs ϕ
(Diagram courtesy Richard Dunworth)

When evaluating $KN_i/\sin\phi_i$, KM can be substituted at upright where $\sin\phi = 0$ and the expression would otherwise be indeterminate.

Extended Application of the Numerical Model

When the model is at level trim, the chine immerses and emerges throughout its entire length instantaneously, generally representing the worst case for erratic derivation of VCG. As the short length of the model precluded meaningful investigation of trimmed states, the numerical model was extended into a pseudo hull form, of similar waterplane length/beam ratio to the SF-ADRHIB.

The existing model was stretched from 0.3 m to 1.5 m long to form the aft LBP/2 from midships to the transom. Forward, all lines were extended as circular arcs to a common point on the deck centreline, LBP/2 forward of midships.

The resulting 3.0 m LBP hull form is a reasonable scaled approximation of the small Antarctic Survey Vessel (ASV) and similar to, though fuller than, the air-drop RHIB.

10 m ASV (L), Extended Numerical Model (C) and 11 m SF-ADRHIB (R)
(Image courtesy Richard Dunworth)

Results for a Range of Drafts and Trims

With the extended capability, behaviour at an inclining over a range of initial draughts and trims was investigated. Trims of 0°, 1° and 2° by the stern were used.

For each of the three trims, the waterplane was arranged at four increasing depths:

- LIGHTEST: at the lightest displacements, the low chine touches the waterplane aft at 4° heel. Both chines remain above the waterplane throughout the inclining.
- LIGHT: at light displacements, both chines are fully above the waterplane when upright, but the chine on the low side touches the waterplane aft at 1° heel and, if trimmed, progressively immerses as heel increases.
- DEEP: at deep displacements, both chines are below the waterplane aft when upright. If trimmed, the chine on the high side progressively emerges as heel increases; it emerges fully at 2° heel.
- DEEPEST: at the deepest displacements, both chines are below the waterplane at upright. The high chine crosses the waterplane amidships at 4° heel, so remains at least partially immersed aft.

These arrangements aimed to ensure that the most common behaviours at an inclining were all represented. Since the waterplane was set to meet these specific requirements, displacements differed in each case.

The extended numerical model and plots of KM and KN/sinϕ vs ϕ for the model are shown below.

The lightest displacement is probably impracticably low for craft as small as a RHIB, though certainly feasible for a 50 m patrol boat. The deep and deepest states could be encountered by any craft. Introduction of trim cannot necessarily be expected to mitigate for chine immersion or emergence during the experiment.

The diagram for light displacement at level trim is similar in form to that for the hull section model, tending to support the use of a simplified hull section model for preliminary assessment at level trim, if necessary.

None of the three GM methods stands out as consistently better or worse than the other two. A small maximum inclination angle is likely to deliver a relatively good result by GM; however, such angles may be hard to achieve and measure accurately at an in-water inclining experiment on a small craft.

With liquid movement correctly accounted for (preferably by moments of transference) the accuracy by the KN method is unaffected by large heel angles. A change of heel of at least 1° at each mass movement is advantageous.

General Solution with Non-Zero TCG

The scale model inclining experiments were conducted with no initial list or trim for both the air and water inclinings and the numerical working adopted the same initial state. To be of practical use, a more general solution is required in which the vessel may be presented for inclining with a non-zero TCG, resulting in a list to one side or the other.

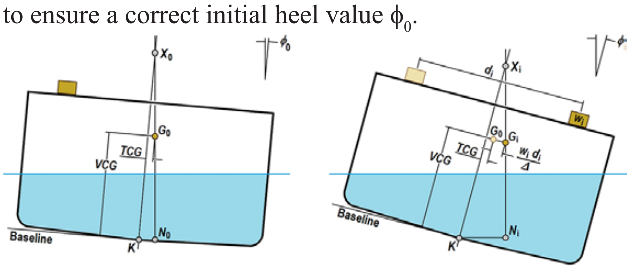
The derivation again relies on the use of the relationship $KN_\phi/\sin\phi$. In the absence of experimental errors, it gives exactly correct values of VCG and TCG.

Mass move *i* results in a change of state from *i-1* to *i*. A value of VCG is calculated for each single move with a trendline solution (A vs B in the table below) used to derive overall VCG.

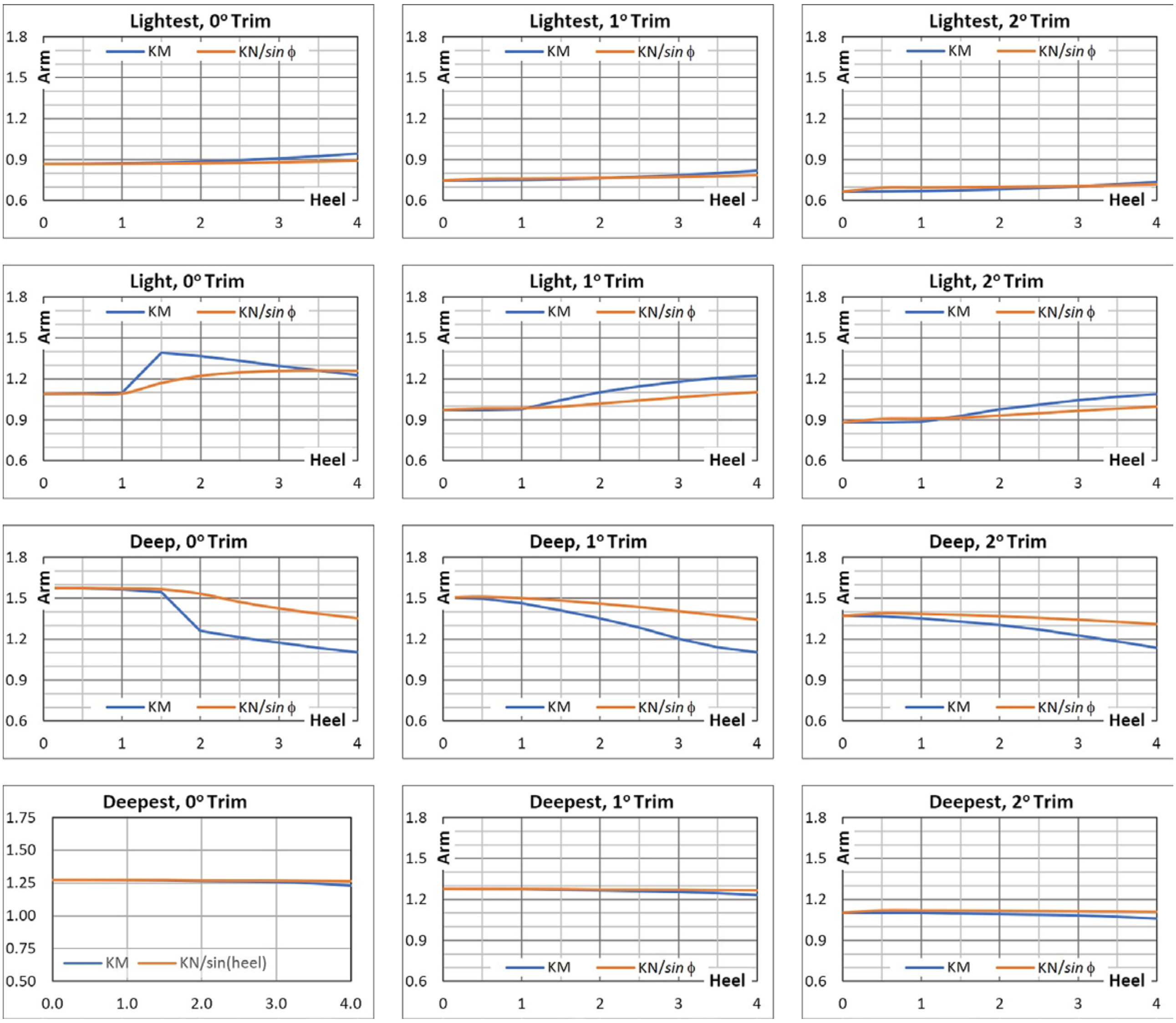
Any pair of states could represent a move, with over 30 possible pairs for an eight-move inclining. Since moves are both cumulative (move 3→5 is the same as 3→4 followed by 4→5) and reversible (move 2→1 is the inverse of 1→2), no information is lost if the calculation uses only the moves which were actually performed.

Rogue moves can usually be detected by the discrepancy between the local VCG and overall mean: if the same state occurs in more than one suspect move, then that state is likely to be the cause of the problem; e.g. if VCG at mass moves 3→4 and 4→5 both deviate from the mean, it follows that the likely error occurred at state 4 which may, if appropriate, be omitted and results re-calculated.

TCG is best calculated from the initial set of readings. The positions of draft marks must be known and read accurately to ensure a correct initial heel value ϕ_0.



Vessel inclined with list: Initial State (L) and After Move ***i*** (R)
(Diagram courtesy Richard Dunworth)



KM and KN_ϕ/sinϕ vs. ϕ for a range of drafts and trims
(Graphs courtesy Richard Dunworth)

Derivation of VCG and TCG via KN for a vessel inclined with an initial list

From the Initial State:	After Move i:
$TCG = (KX_0 - VCG)\tan\phi_0$ $KX_0 = KN_0/\sin\phi_0$ $TCG = KN_0/\cos\phi_0 - VCG\tan\phi_0$	$TCG = (KX_i - VCG)\tan\phi_i - mom_i/\Delta$ $KX_i = KN_i/\sin\phi_i$ $TCG = KN_i/\cos\phi_i - VCG\tan\phi_i - mom_i/\Delta$
Initial TCG is a constant, so values before and after move i can be equated as: $KN_{i-1}/\cos\phi_{i-1} - VCG\tan\phi_{i-1} - mom_{i-1}/\Delta = KN_i/\cos\phi_i - VCG\tan\phi_i - mom_i/\Delta$	
which can be rearranged as:	$VCG = \dfrac{KN_i/\cos\phi_i - KN_{i-1}/\cos\phi_{i-1} - w_i d_i/\Delta}{\tan\phi_i - \tan\phi_{i-1}}$
or, for evaluation by trendline slope: where: and:	$\mathbf{VCG = \dfrac{A_i}{B_i}}$ $\mathbf{A_i = KN_i/\cos\phi_i - KN_{i-1}/\cos\phi_{i-1} - w_i d_i/\Delta}$ $\mathbf{B_i = \tan\phi_i - \tan\phi_{i-1}}$
From the Initial State:	$\mathbf{TCG = \dfrac{KN_0 - VCG\sin\phi_0}{\cos\phi_0}}$

Water Inclining Data and VCG by KN Method

Move	w.d	Moment	Heel	KN	VCG = A/B		
0	0	0	0.00	0.00	A	B	VCG
1	310	310	1.07	20.39	3.061	0.019	164.4
2	930	1240	3.61	79.64	7.424	0.044	167.0
3	-465	775	2.38	50.20	-3.559	-0.022	165.3
5	-1085	-310	-1.07	-20.42	-10.024	-0.060	166.6
6	-930	-1240	-3.60	-79.53	-7.270	-0.044	163.9
7	465	-775	-2.37	-49.95	3.694	0.022	170.8
8	775	0	0.00	0.06	6.732	0.041	162.6
Hull Weight: 17.889			r^2 0.9999		Slope: 165.6		165.8
			Slope VCG 165.6			TCG 0.0	

In-Water Inclining Resolved by use of KN

Potentially, all weight moves contribute to the result: two more than by GM, where the 'zero' moment moves are not used. In this case, move 4 has been omitted due to a suspect pendulum deflection. Using the remaining readings, with *wd* for moves 4 and 5 combined, VCG is found from the slope of the linear trendline of A vs. B defined above:

VCG = 165.6 mm above baseline
cf. 165.5 mm measured

This accurate KN method is more straightforward than the author's earlier versions.

Re-working the data, it gives a good VCG result, indicating that the water inclining was (with the exception of move 4) an accurate experiment — as intended.

Conclusion in favour of KN over GM

For this simple chine hull form, there is a wide span of error in VCG, both over- and under-estimating the true value, when using the common GM-based work-up methods.

The disparity between KM and $KN/\sin\phi$ implies that the same will be true for vessels with hull discontinuities or asymmetry and, to a lesser extent, to conventional hull forms. There is a real risk of these errors going undetected.

Since the KN method will deliver a correct VCG for any hull form at any angle, it has much to commend it over one which depends on impracticably-small angles of inclination applied to an improbably wall-sided vessel to deliver an approximately-correct result.

Reference to GM: an Ethical Problem?

Guidance on the calculation of the VCG of a vessel from a set of inclining experiment results is varied. The IMO *International Code on Intact Stability, 2008* describes the conduct of the test in detail but, for the work-up, merely suggests that VCG be determined "by applying basic naval architecture principles". Where specific requirements do exist, these often depend on the relationship:

$$KG = KM - GM$$

This will generally result in an incorrect VCG, as discussed above. The magnitude of the error is best determined by comparison with a method known to be accurate—in which case it would seem logical to have used that method at the outset.

Recognising that there will be some error in using a GM method, while being aware that an alternate accurate method exists, may be a problem. By contracting to undertake an inclining experiment (and derive lightship particulars) to the requirements of an authority which nominates a GM-based work-up method, does a naval architect invite conflict with the *Code of Professional Conduct*?

The issue can be readily resolved—and the associated risk mitigated—by regulatory bodies removing any reference to GM in this context and requiring that a consistently correct work-up method be used to derive the centre of gravity from inclining experiment results.

Postscript

Both air and water inclining experiments have subsequently been performed by John Butler Design on a SF-ADRHIB; and were reported in the May 2021 issue of *The Australian Naval Architect*.

Acknowledgements

The author would like to thank Peter Hayes, Lily Webster and Suzanne Sigalas, Naval Architects with the Naval Technical Bureau. Lily and Suzanne:

- prepared, measured and weighed the model;
- developed a 3D as-built model in the Rhinoceros software;
- set up and conducted the measurement of VCG by suspension: photographed and reproduced all pendulum lines to find the crossing points and VCG;
- set up and conducted the air and water inclining experiments, with documentation and photographic records of all measurements, mass movements and pendulum deflections; and
- worked up the results for inclusion in the inclining experiment report.

Peter Hayes has followed and encouraged this body of work over the many years it has been under development. His valuable comments and suggestions have always been welcome, as has his ability to secure the model to overhead fittings without recourse to a stepladder.

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Hydrodynamics of Transom-stern Flaps for Planing Boats

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Background

Most practising naval architects are familiar with the work of Savitsky (1964) and Savitsky and Brown (1976), who developed a set of very simple formulas for estimating the hydrodynamic lift and moment acting on a prismatic-hull planing boat. Savitsky demonstrated that, in a practical design situation, one should first assume a running trim angle, τ.

Next, his formula for the lift force is to be inverted in order to find the mean wetted planing length. Then the moment acting on the boat can be computed directly. In general, the moment generated by the weight acting at the longitudinal center of gravity will not match that of the hydrodynamic formula. Thus, it is necessary to adjust the trim angle by means of iteration.

The analysis properly includes the moment generated by the action of the propeller or the waterjet. We will here discuss a second major advancement, by Brown (1971), in which the forces and moments created by transom-stern flaps can also be included in the analysis.

Transom Flaps

Transom flaps are usually rectangular in shape and are attached to the trailing edge of the planing stern. It is common practice to use either one or two flaps. A single flap could span the beam either fully or partially. In the latter case of two flaps, these would be more suitable where the vessel possesses a deadrise angle.

In their simplest configuration, the angle of the flaps could be adjustable when the boat is at rest, in order to optimise the hydrodynamics of the vessel at the operating speed or, alternatively, over a suitable range of speeds. A more sophisticated installation would allow the operator to set the optimal flap angle during the operation of the craft.

The seminal research work on flaps is that of Brown (1971), in which a series of tests was conducted on a model planing boat at the Stevens Institute of Technology. Different flap chord-to-span ratios were tested. Consequently, four formulas were developed. These formulas are for the additional flap-induced lift, drag, moment and flap-hinge moment.

Experimental Work

In his experimental work, Brown (1971) showed that the lift force was linear (proportional) to the flap angle and to the flap area. The drag force is a more complicated function, because it is necessarily affected by the trim angle of the boat. However, the induced moment and the hinge moment were shown, like the lift force, to be proportional to the flap angle.

Firstly, the formula developed by Brown (1971) for the flap-lift coefficient is

$$\Delta C_L = \frac{\Delta L}{\frac{1}{2}\rho U^2 S_f} = 0.046\delta_f \qquad (1)$$

where ΔL is the flap lift, ρ is the water density, U is the speed of the boat, S_f is the total flap area and δ_f is the flap angle in degrees relative to the hull surface. The flap aspect ratio is excluded from the analysis but, assumedly, the aspect ratio is considered to be high.

Secondly, the formula for the induced additional flap-drag coefficient is

$$\Delta C_D = \frac{\Delta D}{\frac{1}{2}\rho U^2 S_f} = 2\times 0.00024(\tau + \delta_f)\delta_f \qquad (2)$$

where ΔD is the flap-induced drag and τ is the vessel trim angle in degrees. As indicated, a factor 2 has been included on the right-hand side of this formula. It is a required correction to the original published equation and will be discussed below.

Thirdly, the induced flap-moment coefficient (about the stern) is

$$\Delta C_M = \frac{\Delta M}{\frac{1}{2}\rho U^2 S_f c_f} = 0.0276(B/c_f)\delta_f \qquad (3)$$

where B is the vessel beam and c_f is the flap chord.

Fourthly, the flap hinge-moment coefficient is

$$\Delta C_H = \frac{\Delta H}{\frac{1}{2}\rho U^2 S_f c_f} = 0.0064\delta_f \qquad (4)$$

where ΔH is the moment at the hinge on the flap.

The research of Brown showed that the formulas could be applied to partial-span flaps, it being assumed that the forces and moments are simply proportional to the span flap.

These formulas have been rearranged for this presentation. They were also published by Savitsky and Brown (1976).

Theory

Doctors (2020) has applied traditional lifting-surface theory to the hydrodynamic analysis of the planing-boat problem. He used specially-devised and computationally-efficient pressure elements to represent the planing surface, applicable to the high-speed cases usually of interest to naval architects. The interested reader will find the mathematical details in that paper.

The theoretical computations were tested against the remarkable analytic work of Hauptman and Miloh (1986a and 1986b), in which the exact mathematical formulas were developed for the case of elliptic lifting surfaces.

Testing Analysis of Raw Towing-tank Data

We first consider the experimental data published by Brown (1971) in the four parts of Figure 1, for each of the four hydrodynamic quantities of interest. All four parts apply to the case of a flap chord-length-to-beam ratio λ_f of 0.2.

Thus Figure 1(a) shows the flap lift as a function of the flap angle. In his work, Brown averaged his data over a range of high speeds (at each flap angle), weighting the data with the factor F_B^2, where F_B is the beam Froude number. This process has been repeated here and the experimental results are plotted as the circular symbols. The data have also been analysed using an invariant weighting factor. These are shown as the square symbols. The Brown data are plotted

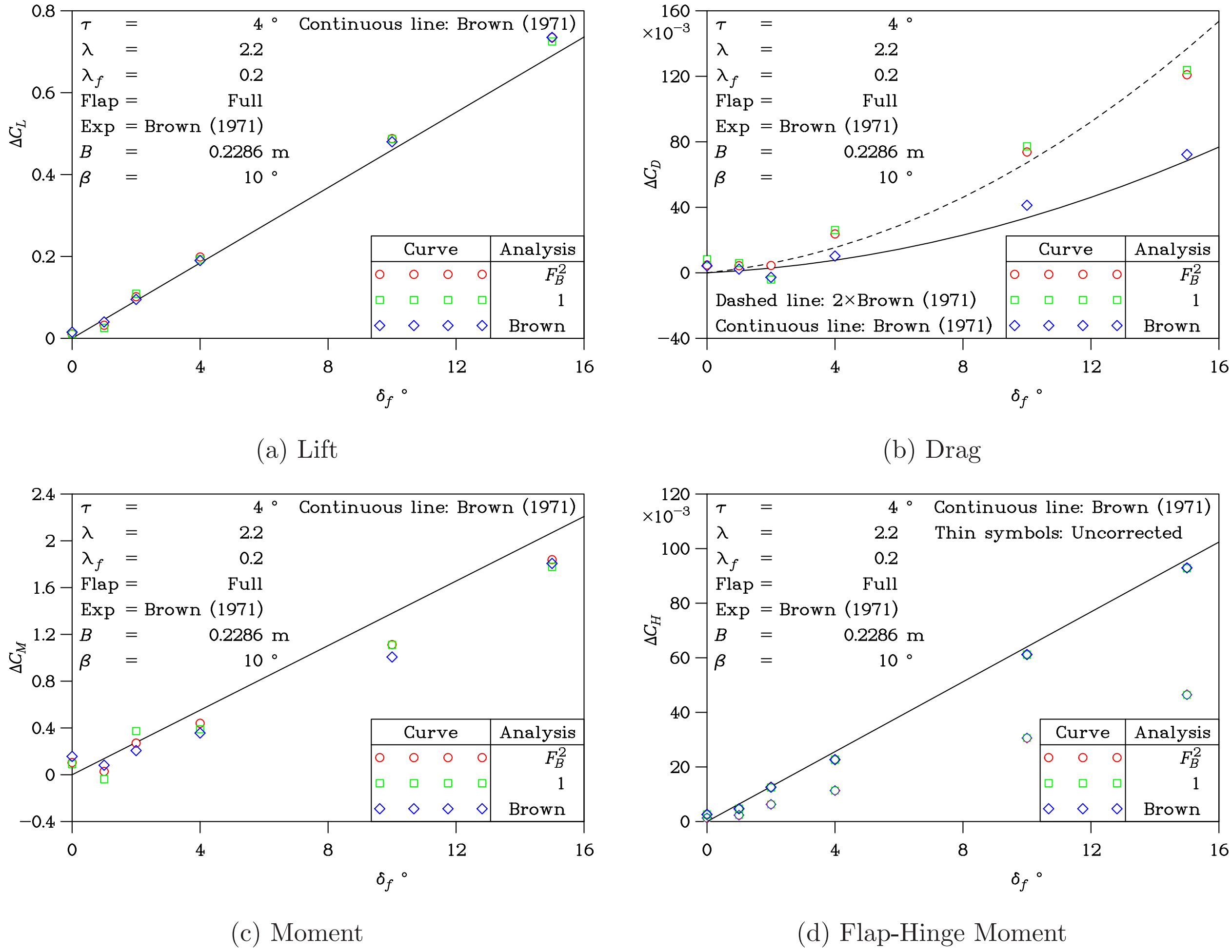


Figure 1 Experimental data and formulas of Brown (1971)
(Graphs courtesy Lawrence Doctors)

using the diamond symbols. There is excellent correlation between the three analyses. There is also good agreement with Equation 1.

The corresponding data for the drag are plotted in Figure 1(b). Unfortunately, there appears to be an error of a factor of 2 in the Brown analysis; both his data and his formula (Equation 2) need to be multiplied by the factor 2.

The data for the flap-induced hydrodynamic moment on the boat are shown in Figure 1(c). There is good agreement between the analysis of the raw experimental data by Brown (1971) and that of Doctors (2020). Equation 3 slightly overpredicts the data in this example for a dimensionless flap chord $\lambda_f = 0.2$.

The flap-hinge moment is the subject of Figure 1(d). This time, there is some scatter in the experimental data, possibly suggesting that the experiment was difficult to conduct with precision.

Comparison of Theory and Experiment

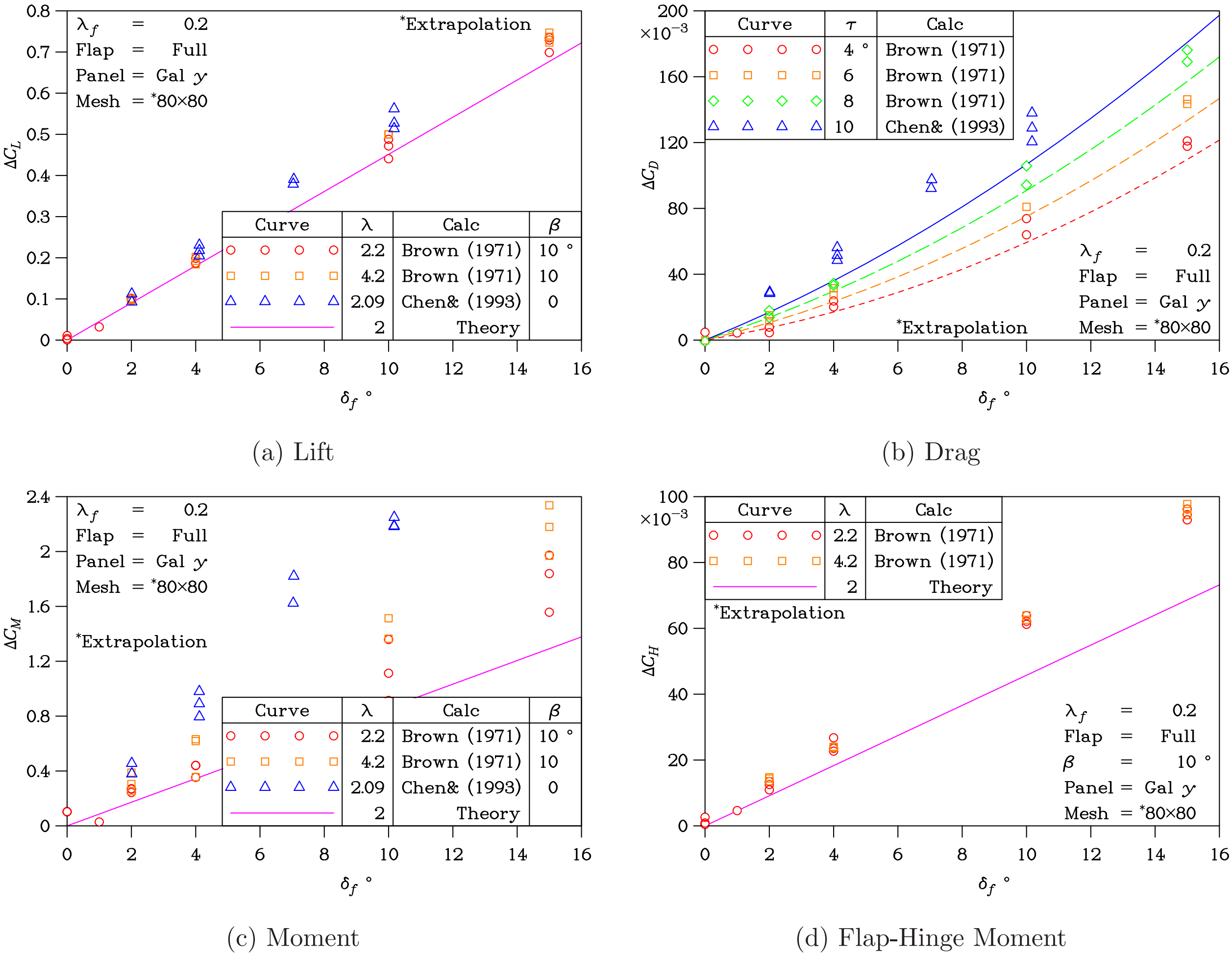
The four parts of Figure 2 are employed to compare the experimental data of Brown (1971) and the lifting-surface theory of Doctors (2020). Again, we will concentrate only on the case λ_f of 0.2.

The lift is shown in Figure 2(a). Two sets of data from Brown (1971) are shown, corresponding to two values of the planing length-to-beam ratio λ, of 2.2 and 4.2. Also plotted are the data of Chen, Hsueh, and Fwu (1993). It is encouraging to see the good correlation between all the experimental data and the computations of Doctors (2020). The annotation on the plot includes the symbol β, the deadrise angle.

The drag is presented in Figure 2(b). By definition, the data cannot all collapse together, because of its nonlinear nature, as suggested by Equation 2. So there are four curves of drag against flap angle, with a separate curve for each of four trim angles. There is good agreement between the towing-tank data from the two sources of experimental data. As anticipated, there is greater drag from the flaps when either the flap angle or the vessel trim angle is increased.

The moment is considered in Figure 2(c). The theory is seen to somewhat underpredict the moment acting on the planing boat. This disappointing outcome is difficult to explain. The calculation of the moment is identical to the calculation of the lift force — but with the single exception, of course, that the lever arm must be included in the former computation. So one would strongly expect a good prediction for the moment if there is a good prediction for the lift. One can note that there is a very large scatter in the experimental data of Brown (1971), as well as a substantial difference between the data of Brown (1971) and the data of Chen, Hsueh and Fwu (1993). One can only wonder if, perhaps, there is a question about the accuracy of these data.

Lastly, we consider the hinge moment in Figure 2(d). The theory is seen to underpredict the available data to some degree.



(a) Lift (b) Drag

(c) Moment (d) Flap-Hinge Moment

Figure 2 Theory and experiment for flap hydrodynamic coefficients
(Graphs courtesy Lawrence Doctors)

Conclusions

This work has shown that, apart from the simple factor-of-two correction to the Brown (1971) formula for the drag, his formulas are a good representation of the towing-tank data. There appears to be a problem with the moment as well. The inviscid small-angle theory is shown to be a fair predictor of the data, although it tends to be a little low.

There is a relatively large scatter in much of the data. So it would be prudent to repeat these experiments. Such experiments would be simple to repeat using modern electronic instrumentation and monitoring. Such research would constitute an excellent project for an engineering student to undertake.

Further considerations of this matter were published by MacPherson (2012), who demonstrated that the flap performance depends to some degree on the flap aspect ratio, analogous to the corresponding behaviour of a traditional aerodynamic wing. This point was also confirmed closely by Doctors (2020, Figure 2(f)).

Acknowledgement

I would like to thank Dr Raju Datla of the Davidson Laboratory, Stevens Institute of Technology, who kindly checked my reanalysis of the original towing-tank data and confirmed my understanding of the relevant institutional report, written by Brown (1971).

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Training Naval Architects at HMA Naval Dockyard, Garden Island

Hugh Hyland

Prior to 1990 Garden Island in Sydney was a Naval Dockyard, which could undertake almost every type of repair and which offered excellent training and experience. The following are some examples of the training and development of naval architects.

Naval architects at the Dockyard filled the following specific positions:

Naval Architect Design (NAD):
Four Class 1, two Class 2, one Class 3;

Naval Architect Quality (NAQ):
One Class 2, one Class 3;

Project Superintendent Support Craft (PJS(SC)):
One Class 2;

Naval Architect Dock (NADK):
One Class 3;

Naval Architect Ship Production (NASP):
One Class 3 until 1977, thereafter a Class 4;

Superintending Naval Architect (SNA):
One Class 4;

Assistant Manager Projects Docks and Services (AMPDS):
One Class 4.

(Manager Production (MPR) and Manager Technical Services (MTS) were multi-discipline.)

Graduates who had worked and, indeed, had qualified as draughtsmen while studying part time were eligible for promotion from Class 1 to Class 2 after three years, otherwise those who studied full time were eligible after four years. To be promoted to Class 3 included a period of time outside the dockyard such as with the General Overseer and Superintendent of Inspection (GOSI) at Cockatoo Dockyard (Codock), in Navy Office, or overseas. GOSI had one Class 3 plus a training billet, and juniors rotated through were trained in hull surveying and naval overseeing, as well as receiving submarine familiarisation. Promotions were based on "Senior Efficient", so gaining a Class 2 was fairly routine, however beyond that there was a "Death List" with dates/ages between ages 60 and 65 for all the seniors indicating when they were required to retire — the younger staff would recognise the most senior efficient amongst them for any forthcoming vacancy and would tend to let them be the successful applicant, and the resulting vacancies would cascade down the levels.

Class 1 and 2 officers were routinely rotated through all the above applicable positions, firstly on higher duties and eventually on promotion. As available, other positions were also included such as Superintendent Job Planning (SJP) and Senior Project Superintendent (SPJP) which supervised refits on major ships.

The seniors had started their careers during World War II and much excellent mentoring was given to juniors in the 1960s and 1970s. Also the Vietnam War was in progress, with busy times for the dockyard and regular 12 hours per week overtime for many of the staff in NAD and NAQ, which further developed the learning curve of younger staff. Opportunities were also taken to visit Codock to inspect new construction, and to observe the launching of ships there and at the State Dockyard in Newcastle. Inspections of notable visiting RN and USN ships were also conducted.

For a small number of Class 2 and 3 personnel there were postings to the UK and USA for two to three years.

Sea time was also part of the training for Class 1 and 2 personnel, anything from one day to nine days, and was in addition to sea time to undertake trials, investigations or other work. Overall this time covered patrol boats, frigates, destroyers, replenishment ships, an aircraft carrier, minehunters, *Kimbla* and the survey ship *Moresby*. Duties included standing watch on the bridge and in the machinery spaces (steam, diesel, electric, gas turbine), and accompanying ship's staff on routine rounds. Observations of gunnery trials were often included, wearing anti-flash, and witnessing the 5-inch, 4.5-inch, 50 cal. rifle, Mk 10 anti-submarine mortar, and even joining the pistol shoots off the transom. Dress in the wardroom was white shirt, dark trousers and cummerbund. For example, during trials of the newly-designed high-speed surface-gunnery target, we were given the use of HMAS *Vampire* and an Attack-class patrol boat, (you can see these today at the Australian National Maritime Museum in Sydney) off Jervis Bay, including a small-boat transfer in a sea state 3 to 4 when the bilge keels of *Vampire* were coming out of the water.

Furthermore the Class 1 and 2 personnel would also undertake the damage control training activities at HMAS *Countersunk* and observe training at the fireground at Jervis Bay.

NAD covered every possible design aspect of repair and maintenance, as well as inclining experiments, heeling trials, RAS trials, turning trials and even heavy commercial lifts using the 250 ton crane.

NAQ was involved in tests and trials and set-to-work, including cool and cold rooms, tropical habitability, air conditioning, theodolite alignments, weapons alignments, and tilt tests, as well as hull surveying of all commissioned surface vessels plus local support craft.

PJS(SC) supervised the repair and trials of all types of support craft from dinghies up to torpedo recovery vessels, covering hull, mechanical, electrical and slipping work. Craft would be taken on the measured distance down harbour to check everything was according to specification, fuel consumption, etc., (sometimes with a stop for lunch at Watsons Bay). Some examples — one time we rounded Clark Island at 26 kn in a sea-air rescue craft and our bow wave severely disturbed a Captain Cook Tour coming the other way. Another time in that craft, a flying boat from Lord Howe Island passed very close overhead and landed just ahead — apparently their chase boat couldn't catch us to warn us to keep clear. Once we were near Watsons Bay on a TRV when the centre engine caught fire, so we hastily returned to GID and assistance. In my time, boats were prepared to transport the Queen during her visits.

NADK was in charge of the graving dock and the floating dock, dry docking everything from minesweepers to aircraft carriers, and managing all underwater work including painting, plating, welding, riveting, rudders, shafts and propellers.

NASP covered around 500 tradesmen including boilermakers, sheet metal workers, coppersmiths, blacksmiths, shipwrights, painters, riggers, etc.

SPJS covered all trades working on refits of major ships. One time my duties included overseeing repairs on board the Royal Yacht *Britannia*.

While in the Production Division, PJS(SC), SPJS, NADK and NASP, there was a Duty Roster for one Sunday every two months. Manuals covering SUBMISS and SUBSUNK were issued along with a pager, and directions to keep within one hour from GID during the 24 hour period. The status of available rescue ships and recompression chambers were to be ascertained. Early on Monday mornings a report was to be submitted to AMPDS, including what overtime was worked by what trades and its status. For example, on one of my duty days there was a fire in the machinery spaces of a Tribal-class destroyer, another time there was water in the fuel of a donkey boiler.

Thus the theoretical, practical and installation aspects were all well developed in those naval architects. Similar programs were there for the mechanical and electrical engineers. As an example, this all was put to good use in 1990, a year after the Naval Dockyard transitioned to ADI, with the first-of-class fit of two CIWS to the Charles F. Adams-class DDG, HMAS *Brisbane*, when the design, production and set-to-work was completed in just six weeks prior to her deployment to the Gulf War.

Times have changed. One wonders how the training and practical experience of young naval architects compares today.

HMA Naval Dockyard, Sydney, about 1970
(RAN Historical Collection)

EDUCATION NEWS

UNSW Canberra

We continue to draw nearer to opening the doors and welcoming the first cohort of Naval Architecture students into our program in Semester 1 next year. It is an exciting time but there is not a lot else to report which will not be included in the paper to be published in the February 2022 edition of *The ANA: The New Naval Architecture Degree Program at UNSW Canberra*.

One key positive worth mentioning is that our programs have been provisionally accredited by Engineers Australia with representation from RINA on the review panel. Full accreditation is only possible when some students have graduated from the program. This should follow in the next cycle of the accreditation process.

My hope to announce the successful candidate from our academic recruitment activities is unfulfilled, but the astute may have noticed our retesting of the market again recently. An announcement of our "full team" may be possible in the next edition.

Please do not hesitate to contact me via email at <w.smith@unsw.edu.au> or <navarch@adfa.edu.au>, or by other means, if you have any questions or would like to contribute to our enterprise.

A/Prof. Warren Smith
Naval Architecture Program Coordinator
School of Engineering and IT

Tyree Foundation Donation for UNSW

The Sir William Tyree Foundation has made a $1 million donation to support UNSW's expanding nuclear engineering program and foster the skills in Australia for using future technology.

The nuclear engineering program prepares students for careers in high-tech industries including nuclear science, nuclear medicine, mining and resources, energy, manufacturing, aerospace, space exploration and defence.

The funding aims to support scholarships for approximately 20 domestic students to obtain a master's degree in Nuclear Engineering from UNSW's School of Mechanical and Manufacturing Engineering, along with top-up scholarships and research expenses for research students. Funding will also support work placements with industry partners and other professional development opportunities for the Tyree Scholars.

The Tyree Foundation has generously made the donation to UNSW to continue its support of the University's nuclear engineering program which began in 2014.

This gift builds on the foundations laid down to develop a high-tech nuclear industry in Australia, which will be essential if we choose to adopt nuclear energy as one of the options available to our country as it deals with climate change according to Robyn Fennell, Sir William Tyree's daughter and chair of the Tyree Foundation Board.

"My father believed strongly in the benefits of nuclear energy as a safe, clean power source for Australia and our gift continues to support that vision," Fennell added.

"To make this a reality, nuclear engineering programs like UNSW's are critical in ensuring Australia has the home-grown skills to support that choice."

Pathway to Defence Industry Popular

The Defence Industry Pathways Program has been a hit in Western Australia, as people of all ages take up the chance to get a taste of life in the state's defence industry.

The program aims to give school leavers and others an initial experience in the defence industry through placements with relevant employers.

It also provides participants with a Certificate III in Defence Industry Pathways from Western Australia's South Metropolitan TAFE.

Running over 12 months, with up to 120 trainees taking part through to 2023, the goal is to build the nation's future defence industry workforce by showing school leavers and those looking for a career change what defence industry options are available, as well as introducing them to its workplace culture.

The program was developed with input from South Metropolitan TAFE and the Western Australian maritime defence industry.

To date, 50 employers have applied to train and mentor the applicants, including L3 Harris Technologies, Austal, BAE Systems, BRE Engineering, and Nihar Consultants.

It is hoped that the wide range of businesses taking part in the program will give the successful applicants exposure to a variety of sectors within defence industry, providing them as many options as possible as they decide on the best path to take in the sector.

However, it is not just employers in Western Australia who are enthusiastic about the program. Within 90 minutes of its launch in June, the program had more than 100 applications.

According to data from the first two intakes, they were a diverse group. While more than half of those accepted into the program were aged 18–21, almost a third were aged over 30, and about a third of the group were female.

Head Maritime Systems, RADM Wendy Malcolm, said that the popularity of the program across all age groups showed the strong interest in working in Defence industry.

"There are so many opportunities over future years in this industry, and the Defence Industry Pathways Program is a great way to attract people to the sector, whether it is school-leavers, people looking for a career change, or those who are just exploring opportunities," RADM Malcolm said.

"Ultimately, we all benefit from this program, since we will be able to grow the size of our defence industry workforce to meet the challenges of the future."

CAPT Angela Bond RAN

Key Naval Projects Confirmed for South Australia

The Commonwealth Government has confirmed a number of naval projects for South Australia, following the announcement of the new enhanced security partnership between Australia, the United Kingdom and the United States (AUKUS).

In addition to the acquisition of nuclear-powered submarines for the RAN, the Government has approved a Life-of-Type Extension for the Collins-class submarine fleet from 2026 in South Australia, and confirmed that the Full-Cycle Docking of the Collins class will continue to be conducted at Osborne. Up to $6.4 billion will be invested in these works, and around 1300 jobs supported in South Australia.

The Government will also invest up to $5.1 billion in upgrades to the Hobart-class destroyer combat-management system upgrades at Osborne from 2024, creating 300 jobs in the state.

On 16 September the Prime Minister, the Hon. Scott Morrison MP, said that the investments reinforced the Government's commitment to South Australia's shipbuilding industry.

"This expansion of Australia's naval capabilities will strengthen national security, boost our sovereign workforce and support thousands of jobs in the South Australian industry," the Prime Minister said.

"South Australia is home to some of the most skilled shipbuilding workers in the world, they have the know-how, ingenuity, industrial knowledge and determination that is required to provide our Defence Force with the very best capability."

The Minister for Defence, the Hon. Peter Dutton MP, said that the Government's investments would ensure that Australia maintained a strong and agile submarine capability for decades.

"The Collins-class submarine to this day remains one of the most capable conventional submarines in the world," Minister Dutton said.

"The planned Life-of-Type Extension, through the replacement of key systems, will help deliver Defence's strategic objectives.

"The upgrade to the Aegis combat-management system will ensure that our fleet of Hobart-class air-warfare destroyers maintain their capability-edge into the future.

"Both of these projects announced today are vital for Defence's ability to act with greater independence in an increasingly contested strategic environment."

The Minister for Finance and Senator for South Australia, the Hon. Simon Birmingham, said that the state would continue to benefit from the Government's sovereign and continuous naval shipbuilding program.

"South Australia is the engine room of naval shipbuilding in this country," Minister Birmingham said.

"Full-Cycle Docking and Life-of-Type Extension at Osborne will ensure that we retain our skilled shipbuilding workforce, and will continue to create opportunities for local businesses to engage with the defence industry.

"In addition, the up to $5.1 billion investment in upgrading the Hobart-class combat-management system will create extra economic activity as well as around 300 jobs in the state.

"Conducting these sustainment projects in Osborne, on top of the building of frigates and submarines will ensure that South Australia continues to be the epicentre of naval shipbuilding in this country."

The Collins-class submarine HMAS *Farncomb* will be the first to undergo a Life-of-Type Extension when it enters its next Full-Cycle Docking in 2026.

Frigate Equipment Contracts

BAE Systems Maritime Australia has announced that businesses in New South Wales, Victoria and South Australia will deliver products into the prototyping phase of the Hunter-class frigate program.

The three companies selected will supply a range of manufactured parts for prototyping blocks now under construction at the Osborne Naval Shipyard in Adelaide.

Work underway on prototyping blocks is enabling systems, tools, plant, workforce and supplier products to be tested, evaluated and refined, providing a solid operational foundation prior to the commencement of production on the first Hunter-class frigate.

The companies awarded contracts are:

Defence Seals & Spares (NSW) — supply manhole and access panel gaskets from its Warriewood operations, north of Sydney;

ABECK Group (Vic) — manufacture and supply of flowforge gratings from its Dandenong facility; and

PRP Manufacturing (SA) — to supply/cut gaskets at its Dudley Park plant in Adelaide.

Craig Lockhart, Managing Director, BAE Systems Maritime Australia, said "Establishing a competitive, sustainable and resilient supply chain in Australia is critical to the overall success of the Hunter-class frigate program.

"Each of these three companies brings a unique and important skillset to the construction of frigates in Australia, helping to deliver the best capability to the Navy.

"We look forward to placing more contracts with suppliers across Australia as the program progresses."

Approval-in-Principle for GEV's Pilot Hydrogen Vessel

Wärtsilä's cooperation with the Australian energy transportation company Global Energy Ventures (GEV) has resulted in GEV successfully obtaining Approval-in-Principle (AiP) for its pilot-scale 430 t C-H2 carrier vessel. The AiP was awarded by the American Bureau of Shipping in early October 2021.

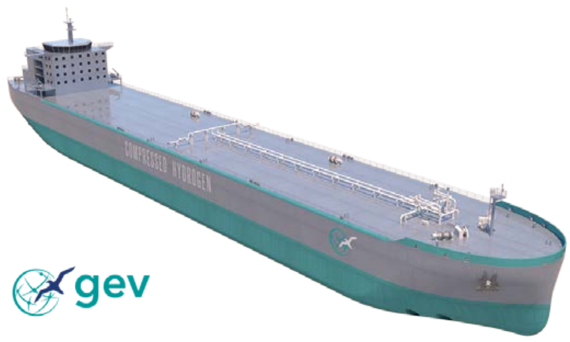
The pilot compressed hydrogen vessel is a highly-functional Handymax-sized gas carrier designed to advance the commercialisation of green hydrogen projects.

Wärtsilä has worked in close cooperation with GEV's ship designer to develop the optimal propulsion solution using highly efficient Wärtsilä dual-fuel engines powering two electric drive fixed-pitch propellers. The work was carried out under a Memorandum of Understanding signed by the two companies earlier this year.

"Marine storage and transport solutions are required for hydrogen to contribute to global decarbonisation ambitions. GEV views the compressed hydrogen ship as a means to provide efficient, safe, and cost-competitive regional marine transportation for hydrogen, and we thank Wärtsilä for its valuable support in making this project a success," said Martin Carolan, GEV's Managing Director and CEO.

"The AiP represents an important milestone in bringing this concept to realisation. Our involvement allows us to further leverage our technology and experience in the development of future fuels to decarbonise ship operations. This is fully in line with our commitment and strategy to support our customers in achieving a sustainable and carbon-free future," said Petteri Saares, Sales Director, Wärtsilä Marine Power.

Compression delivers a proven, simple, and efficient method for transporting green hydrogen. Both GEV and Wärtsilä believe that the compressed hydrogen vessel project will eliminate technical barriers to marine hydrogen transport, and deliver a solution which is superior to currently available alternatives.



GEV's pilot compressed hydrogen vessel features an efficient Wärtsilä propulsion solution, The ship will advance the commercialisation of green hydrogen and support the industry's decarbonisation efforts.
(Image courtesy Global Energy Ventures (GEV)

WinGD Hybrid-energy System-integration Debut

WinGD (Winterthur Gas & Diesel) has won a contract to integrate hybrid energy systems on four newbuild car carriers for Japanese owner NYK Line, further expanding the engine developer's portfolio of future-ready power solutions for companies navigating shipping's energy transition.

The four pure car and truck carriers (PCTC) will run on LNG, with WinGD's 7X62DF-2.1 two-stroke engines coupled with shaft generators, DC-links and battery systems. Based on its in-depth knowledge of the main engine's performance WinGD has optimized spinning reserves, peak shaving, and energy flow to run the main engine constantly at its sweet spot while avoiding inefficient generator loads. WinGD will be responsible for the system integration and system-level energy management, through WinGD's new Hybrid Control System.

Combined with other ship design enhancements, the LNG-battery configuration is expected to cut overall CO_2-equivalent emissions by around 40% compared to conventionally-powered vessels operating on heavy fuel oil, taking them beyond IMO's 2030 target for cutting greenhouse gas (GHG) emissions.

"Battery hybrid technology improves fuel efficiency and emissions by mitigating main engine and electrical generator load fluctuations," said Keita Fukunaga, Deputy Manager/Ship Design Team/Technical Group at NYK Line. "This project is an important step in our plan to replace current vessels to newly-built LNG-fuelled PCTCs, reducing the fleet's carbon intensity by 50% by 2050. We are delighted to contract with WinGD to integrate this innovative power and propulsion arrangement."

WinGD Program Portfolio Manager Digital & Hybrid, Stefan Goranov, added: "An appropriately controlled hybrid energy system is emerging as one of the most cost-effective solutions for deep-sea vessels to meet future environmental targets, combining the high efficiency of low-speed two-stroke engines with optimally-sized electric drives, machines, and energy-storage units. This important landmark showcases WinGD's core engine development expertise and the extensive investments we have been making to understanding how to optimise the operational characteristics of integrated hybrid systems."

WinGD believes that the low-speed two-stroke engine must remain at the heart of any hybrid energy configuration for deep-sea merchant vessels. With its step into system integration, the company brings its expertise to the holistic design of power arrangements which can incorporate batteries, shore power interfaces, solar or wind power generation, fuel cells, frequency converters and energy management systems.

Peak shaving is just one example of the operating modes that hybrid power systems can deploy to make deep-sea shipping more efficient. As low-speed two-stroke engines are inherently more efficient than four-stroke engines, the carefully managed use of the main engine and electrical energy management aided by batteries can optimise the loading of auxiliary engines. Other modes include efficient port manoeuvers and bow thruster operation, and the use of batteries rather than auxiliaries to provide spinning reserve in case of the need for emergency power.

This project marks another significant step forward in WinGD's commitment to the energy transition within shipping. The expertise gained within the well-established X-DF fleet, paired with customers dedicated to improving the sustainability of their assets, is ensuring progress towards this goal.

The vessels will be built by China Merchants JinLing Shipyard (Nanjing) for delivery in 2023. They are expected to be assigned to transport vehicles mainly between Europe and the Middle East.

Wärtsilä to Support Development of IMO2050 CII-ready LNG Carrier

Wärtsilä will collaborate with ABS and Hudong-Zhonghua Shipbuilding (HZS) to develop a flexible, future-proof, and modular LNG Carrier (LNGC) vessel concept. The pioneering design approach for the multi-fuel electric vessel is intended to deliver immediate CO_2 savings, and to be ready for the adoption of future decarbonisation technologies to support the marine industry's ambitions towards zero-emission shipping.

Wärtsilä's Integrated Systems and Solutions experts are working alongside specialists from ABS Global Simulation Centre and Global Sustainability Centres in Singapore, Houston and Athens and HZS' R&D and LNGC design team in Shanghai to evaluate the vessel's performance against the IMO's Carbon Intensity Indicator (CII) up to at least 2050. This involves the use of advanced multi-physics modelling and simulation, and the application of various decarbonisation technologies and solutions to the vessel's design and operational modes.

The LNGC will be highly flexible and the entire vessel design will be optimised around a compact, electrified, integrated, and efficient propulsion power solution which will lead to a significant reduction in CO_2 emissions immediately. The design will also be ready to efficiently integrate new technologies in the future in order to stay ahead of the requirements of CII.

"The evolving demands of the CII mean vessels will need to be ready to continuously adapt to improve their rating and remain viable for the duration of their operational life. Advanced multi-physics modelling and simulation techniques enable the development of a vessel with a strong CII profile at launch that is also equipped to take advantage of future decarbonisation technologies as they mature," said Patrick Ryan, ABS Senior Vice President, Global Engineering and Technology. "ABS is a leader in the application of multi-physics modelling and simulation at sea, and we are excited about the potential of this technology to drive shipping's decarbonisation ambitions and meet IMO 2050 objectives."

"We are very glad to closely work together with Wärtsilä and ABS to develop the new generation of LNG carriers offering a low-carbon footprint and low OPEX cost," said Song Wei, R&D Deputy Director of Hudong-Zhonghua Shipbuilding. "This state-of-the-art hybrid solution will be developed to power the future LNG carrier, enabling dual-fuel engines to run always at their best efficiency and provide flexible power supply modes to adapt to various load demands."

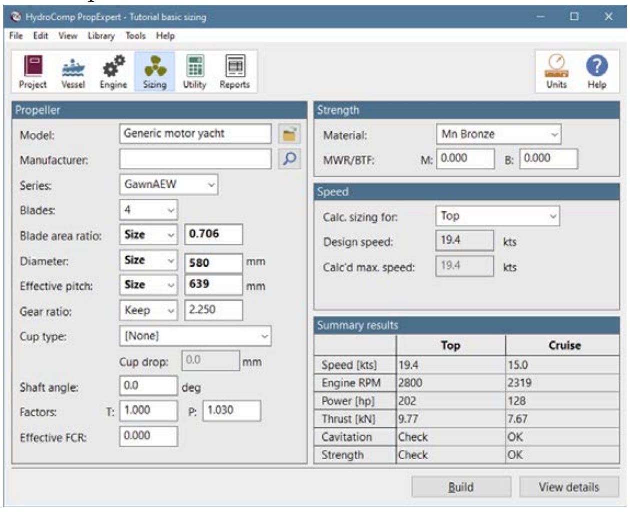
"Ship owners are currently faced with unprecedented challenges and uncertainties as they attempt to plan for their fleets to meet the IMO's CII trajectory of -70% by 2050. What is certain is that this planning must start now in order to safeguard a future-proof newbuild vessel design. By optimising the vessel design around a compact, electrified and hybridised propulsion system, remarkably high efficiency will be maintained across a broad range of vessel speeds and power nodes — making it highly suitable to accommodate all needed vessel speed and voyage optimisations in the future," said Stefan Nysjö, Vice President, Power Supply, Wärtsilä Marine Power.

Nysjö continued: "The modular and hybrid smart propulsion system also provides the correct foundation for the introduction of new and potentially highly-intermittent low carbon energy sources and propulsion energy-saving devices, both in the newbuild phase and also later as potential retrofit solutions. We are honoured that ABS and Hudong-Zhonghua have invited us to contribute to the development of this new LNGC design that will leverage on ABS' long experience in LNGC development and simulation expertise as well as Hudong-Zhonghua´s rich design and construction experience of large LNGCs."

Wärtsilä's integrated systems and solutions will be an integral part of the future-proof LNG Carrier design (Image courtesy Wärtsilä)

HydroComp PropExpert® 2021 Released

During 2021 HydroComp has undertaken a significant in-house initiative to enhance product "look-and-feel" for contemporary themes available in Windows 10 and 11. The overall workflow process remains unchanged and will be familiar to users, but new controls and graphs now support Windows "visual style". This is available as a "Flat UX" theme option.



A screen-shot from HydroComp PropExpert
(Image courtesy HydroComp)

New performance model for 4-bladed Kaplan19A

Prior versions of PropExpert used a performance model developed from limited Expanded Area Ratio (EAR) test data. This restricted its application to the 0.55 to 0.70 EAR range. A new model was developed by HydroComp that provides a smooth distribution of the influence of EAR on performance, greatly improving predictions at higher values of EAR. The new model is recommended for EAR values as high as 0.85 (but is indicated to be substantially improved for values as high as 1.00 EAR).

Wärtsilä Awarded Marine Sector Commercial Certification for EU Stage V Compliance

Wärtsilä has received marine sector commercial certification for compliance with the EU's Stage V standards. The Stage V legislation, which came into force in 2020, tightens restrictions on non-road engines and equipment, and sets stricter limits on emissions, especially particulate matter (PM) and nitrogen oxide (NOx) emissions. The certification applies to the total solution, including the Wärtsilä 14 engine and exhaust after-treatment system, and was received by Wärtsilä in September 2021.

Stage V certification is required for engines powering the European inland waterways vessels, which together comprise a fleet of approximately 17 500 ships. The first deliveries of the certified Wärtsilä 14 engine will be for two new passenger ferries being built for the Swiss company General Navigation Company (CGN) by Shiptec AG. The ferries will operate between Switzerland and France across Lake Geneva, with the first vessel expected to commence operations in December 2022.

Patrol Boat Office Moves to Cairns

The Department of Defence's Pacific Patrol Boat Systems Program Office (PPB SPO) has relocated to Cairns from Canberra so that it can better support the Pacific Maritime Security Program (PMSP).

Under the PMSP, Australia has committed $2.1 billion to deliver and support 21 Guardian-class patrol boats to 12 Pacific Island nations and Timor-Lesté between 2018 and 2023.

The PPB SPO oversees the delivery and management of the Guardian-class patrol boat program.

Assistant Secretary Specialist Ships, John Toohey, said that the move was made after a recommendation by a review of the Pacific Patrol Boat Enterprise in September 2020 by CDRE Steve Woodall.

"The review made several recommendations which we are implementing," Mr Toohey said.

"The recommendations are aimed at evolving Defence's training, maintenance, material and sustainment support to the Pacific region in keeping with the new Guardian-class patrol boat capability.

"The relocation of the PPB SPO to Cairns means that vessel maintenance, crew training and program management all occur in the same location allowing for greater collaboration and efficiency."

As part of the move, the PPB SPO will be integrated with other support teams in north-east Australia in accordance with Plan Galileo, Defence's national approach to sustaining the Royal Australian Navy's existing and future capabilities.

"Being located in Cairns, closer to other specialist ship program offices and Defence's Regional Maintenance Centre North East, will enable us to further develop and improve our sustainment model to support local industry capability and align with Plan Galileo," Mr Toohey said.

Head Maritime Systems, RADM Wendy Malcolm, said that Plan Galileo was part of the Australian Government's investment of more than $170 billion in naval shipbuilding announced in the *2020 Force Structure Plan*.

"The work created through enterprises like the Pacific Patrol Boat Enterprise and through sustainment activities at our regional maintenance centres will contribute to the maintenance of existing and future naval capabilities and build resilient local and regional supply chains," RADM Malcolm said.

Eight positions in the PPB SPO have moved to Cairns in the past five months.

"I acknowledge that this has been a challenging time for the PPB SPO personnel and I am grateful for their continued support in making this move a success," Mr Toohey said.

"I am thankful to the PPB SPO team for their commitment and dedication in managing the program over many years, and for embracing this change in support of our Pacific Island partners."

Wärtsilä to Install Air-lubrication System on Trial Basis

Wärtsilä, in cooperation with Silverstream Technologies, will install Silverstream's proprietary Air Lubrication System, the Silverstream® System, on a trial basis on a large container vessel owned by A.P. Moller–Maersk, the world's largest container vessel operator. The trial will examine possible improvements to the ship's overall efficiency, focusing on the reduction of fuel consumption and associated emission levels.

The programme will have a special emphasis on the potential application of the system for methanol-fuelled Maersk vessels. The ultimate aim of all three companies is to support efforts to decarbonise shipping operations. The order was placed by Maersk in May 2021.

Silverstream's Air Lubrication System creates a carpet of microbubbles which coat the entire flat bottom of the vessel. This carpet effectively reduces frictional resistance between the hull and the water. The technology works in all maritime conditions, is not weather dependent, and does not constrain or negatively impact the normal operational profile of the vessel.

"We are delighted that A.P. Moller–Maersk is backing our market leading technology, which is proven to significantly improve operational efficiency and reduce associated greenhouse gas emissions. We also wish to thank Wärtsilä for their collaboration in the delivery of this integrated solution," said Noah Silberschmidt, Founder and CEO, Silverstream Technologies.

The Silverstream System creates microbubbles to reduce frictional resistance, thereby lowering fuel consumption. Wärtsilä is an authorised global sales and service partner (Image courtesy Silverstream Technologies)

"Everything that we do today inevitably sets the future for coming generations, so we need to act in a positive way to ensure that decarbonising vessel propulsion is an effective priority for the industry. This is a view shared by Maersk, a company with whom we have worked closely for many years. Silverstream's Air Lubrication System is an important stepping stone along this path," said Bernd Bertram, Vice President, Propulsion, Wärtsilä Marine Power.

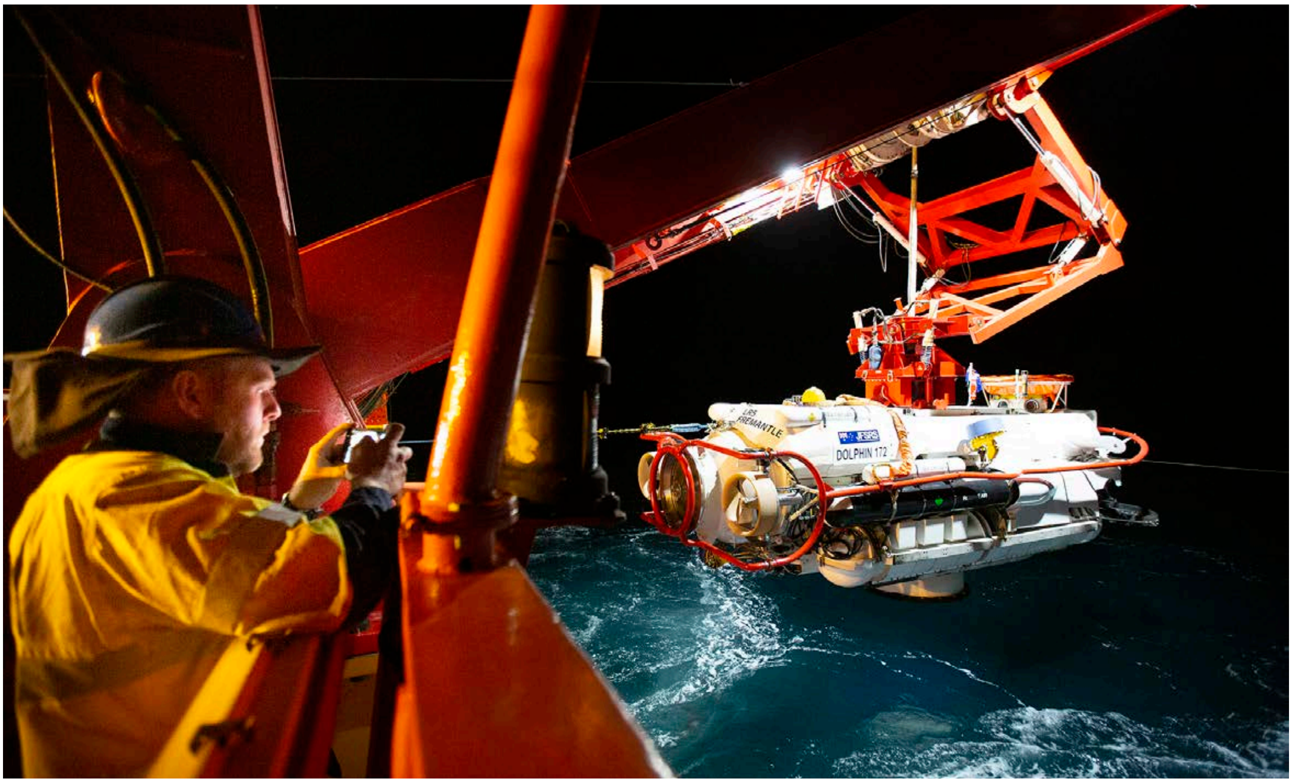
The Wärtsilä/Silverstream equipment will be delivered during the second quarter of 2022.

The crew of HMAS *Stalwart* line the ship's upper decks during her commissioning ceremony at Fleet Base West on Saturday 13 November 2021. HMAS *Stalwart* is the second of two new Spanish-built replenishment ships for the RAN. She replaces HMAS *Sirius* which will be decommissioned (RAN photograph)

A new crane has appeared on Sydney's skyline — a permanent addition to the assets of the Garden Island Defence Precinct. As a final part of Phase One of the Garden Island (East) Critical Infrastructure Recovery Program a new 100 t lift portal crane has been erected on the new wharf constructed as part of this project, now designated as FBE 11, 12 and 13. The new crane, seen here towering over HMAS *Hobart*, can travel the length of the new wharf and has height and outreach to enable it to reach over HMA Ships *Canberra* and *Adelaide*.

Supplied by Favelle Favco, the new crane can lift 100 t at a radius of 6.5 to 17.5 m, 64 t at 34.1 m and 27.5 t at 49.8 m. It will be a significant asset for the dockyard, reducing the need to hire expensive mobile cranes which take up valuable space and have outreach limitations

(Photo John Jeremy)



An LR5 submersible is launched from MV *Stoker* during night operations off the coast of Rottnest Island in Western Australia as part of Exercise Black Carillon 21. Exercise Black Carillon 21 is Navy's annual exercise that tests and evaluates the RAN's Submarine Abandonment, Escape and Rescue system's capabilities

(RAN photograph)

Survey Matters

Survey Matters is AMSA's e-Newsletter relating to domestic commercial vessel (DCV) survey and is published approximately six times per year. You can request placement on the mailing list by emailing DCV Survey <dcvsurvey@amsa.gov.au>. The e-Newsletters are now also available online at https://www.amsa.gov.au/news-community/newsletters#collapseArea612

Items included in the September 2021 e-Newsletter included:

- Audits and application assessments
- Submission of survey reports
- Structural fire protection
- Out of water survey requirements
- Navigation light requirements
- Lines plans/Hull model requirements
- Autonomous vessels in Australia
- Nitrogen oxide (NOx) emission requirements for marine diesel engines on DCVs
- The AMSA National Compliance Plan 2021–22 is now available

The article on *Lines plans/Hull model requirements* is reproduced below.

Phil Helmore

Lines Plans/Hull Model Requirements

The Surveyor Manual Part 2 Table 2 requires that a lines plan (or electronic 3D hull file) be provided when comprehensive stability criteria are used. This is expanded in NSCV C6C, Clause A8.8.4 as part of the information supporting the inclining experiment.

This may elicit concern, as it is a valuable piece of intellectual property. AMSA appreciates that a lines plan represents sensitive proprietary hull design information often built up over many years. It can also represent a significant investment of time to model an existing vessel, providing a competitive advantage.

We understand and appreciate these concerns. AMSA has a comprehensive privacy policy on our website; see https://www.amsa.gov.au/about/who-we-are/privacy.

The rationale behind the requirement for lines plan data (either in the form of a drawing or a 3D hull model) is to permit audit in accordance with Section 45 of the regulations.

Another reason for requiring a lines plan is to aid investigation in the event of an incident linked to the vessel's stability. Should stability need to be assessed the provision of hull data allows for this to be undertaken.

Hence, when comprehensive stability is used on a vessel, either a lines plan containing the data listed in Table 2 of SAGM Part 2, or an electronic hull file, such as a Maxsurf hull file or *.iges, is required in support of a recommendation for stability approval.

Survey Matters, September 2021

AMSA Survey Reports to go Online

From 1 December 2021, AMSA will no longer receive survey reports by email. This means that accredited marine surveyors and Recognised Organisation surveyors will need to submit their reports and recommendations directly into our MARS online system.

This change will mean that certificates can be processed faster and vessel owners and operators will receive their certification sooner.

There are some exceptions to the rule. AMSA will accept emailed submissions when:

- A licensed electrical contractor, who isn't an accredited marine surveyor, conducts an electrical survey.
- A surveyor provides a recommendation in support of an EX02 application or as part of an engine change notification.
- An accredited marine surveyor who doesn't hold the required category to claim a code asks for the survey activity to be marked 'not required' (with sufficient justification).

To prepare for this change, accredited marine surveyors and Recognised Organisation surveyors will have to make sure that their MARS login details are current and get the free VIP Access app. If surveyors need help setting up, then they can email mars.support@amsa.gov.au or call AMSA Connect on 1800 627 484 for assistance.

AMSA Update, October 2021

Advice and Support for Designers of Autonomous Vessels

New guidance is available on the AMSA website for designers, builders, owners and operators of small unmanned autonomous vessels under 12 m in length. It provides information on the scope of items to be considered and suitable standards to use when applying for a specific exemption.

See https://www.amsa.gov.au/guidance-notice-small-unmanned-autonomous-vessels?utm_source=amsa-update&utm_medium=website&utm_campaign=AMSA_Update

AMSA Update, September 2021

Some Thoughts on Climate Change Effects for the Pacific Region Following COP 26

Pacific island countries have for many years been bringing attention to the need to take urgent action in response to climate change in light of the effects observed in their backyard.

The emerging near-unanimous alignment of climate change science and the recent COP 26 conference in Glasgow, together with the announcement by the Prime Minister of Australia of a 2050 no net emissions goal for Australia make it timely to make a dispassionate assessment of the technologies available to achieve that goal. I should say at the outset that I have not generally been an advocate for environmental measures unless the need for those measures has been demonstrated to be essential; I believe that we have reached that point with climate change but that the "plan" adopted by the Australian Government appears to me nothing more than a wish-list whereby the 2050 goal might be met.

What is clear is that we have to stop burning fossil fuels by 2050 unless the resulting emissions are carbon-free. In terms of the lifespan of energy-related equipment, energy decisions made now will result in acquisition of equipment that will still be in service in 2050.

It is our role as naval architects to draw upon existing and emerging technologies and engineer them into a workable solution which meets the specified requirements. This article attempts to do so in relation to Australia meeting the zero net carbon by 2050 goal, without any special scientific or economic expertise but providing a framework that might be applied to other Pacific nations. Particular technologies selected to be implemented will be largely a matter of economics, but also of balancing energy needs and availability. I will then attempt to relate this information to ships and shipping.

Existing Technologies

Generation of electric power by solar photo-voltaics and wind is well established, with power from these sources being stated to be cheaper than that from conventional fossil fuel generation.

The viability of solar in particular is demonstrated by the Sun Cable project to supply 15% of Singapore's power from a solar farm in Australia using a 5000 km under-sea cable. Since large parts of Australia's interior are arid lands with relatively low productivity and plenty of sun, there would appear no technical impediment to supplying all of Australia's power requirements from say 40 or more of such solar farms without necessarily encroaching on productive land.

Noting that the Australian mainland is less than 5000 km across, such solar farms should be formed into a national grid, which would enable power to be transmitted to where the sun is not shining and take advantage of the solar time difference between the east and west coasts.

In this situation of abundant solar power it seems to me that wind-generated power is relatively under-utilised in Australia. For example, many wind generators in Europe are located offshore, but the availability of land in Australia has generally not necessitated offshore installation.

Hydro-electric power is a well-developed source which should not be overlooked. A relatively recent development of it is energy storage through pumped-hydro, which proposals by the Gupta companies for South Australia indicate do not require particularly large altitude changes to be effective. Pumped-hydro requires cheap electricity to enable the water to be pumped uphill to cover periods of high demand, so should be regarded as a means of evening-out supply when the sun isn't shining and the wind isn't blowing.

Nuclear power has for many years been controversial, being subject to some scaremongering with regard to nuclear accidents such as Chernobyl, Fukushima and the Russian submarine *Kursk*. But in my view, the number of nuclear reactors in operation in numerous countries indicate that nuclear power is as safe as any other emission-free power source provided that it is suitably located relative to all hazards including tsunamis, properly regulated and operated by highly-skilled personnel. This option is made more economically attractive by the recent availability of small modular reactors (SMRs). I therefore support lifting of the current legislative ban on nuclear power to enable utilisation of this source for base-load power.

Of course, we have battery power available as another means of filling the troughs in power supply.

The carbon content of biofuels and natural gas (methane) excludes them from this discussion other than as transition fuels to be phased-out before 2050.

Emerging Technologies

Although it is seen by some as an emerging power source, I regard "green hydrogen" as an emerging technology for energy storage, as it has not yet been proven at large-scale and requires renewable electricity to generate the hydrogen by electrolysis.

On the other hand, "blue hydrogen" is made from hydrocarbons and therefore can only be renewable if the carbon emissions resulting from its production are securely captured and stored (secure CCS). Although a number of oil and gas companies in Australia have commissioned CCS installations, I am yet to be convinced that they are either secure or should be regarded as renewable as the underground cavities in which the CO_2 is stored are by definition finite. For the same reason this article ignores CCS in relation to burning of fossil fuels.

Hydrogen is used to fuel some cars, but the cost of generating green hydrogen would seem to put it at a cost disadvantage to other forms of portable stored power such as batteries. As such, pressurised or liquefied green hydrogen would appear to provide a replacement for diesel fuel. But to my knowledge, it has not been proven as being able to be safely transported by sea.

The cost of producing green hydrogen is about double that of blue hydrogen

Ammonia is another form of hydrogen, which can be used as a fuel or as a much more convenient and energy-dense method of storing or transporting hydrogen. As a fuel, it has been demonstrated by MAN Energy Solutions in a test ship's engine and is also proposed for use in fuel cells. As a naval architect I am not familiar with the hazards of by-products that may result from its combustion or with the carbon compounds that may be generated from some forms of its production, but it obviously has some potential in a carbon-free environment.

In Short

Technologies that are available today can, and should, be implemented to meet the net-zero by 2050 goal. Just how economically feasible the implementation of these technologies are needs to be demonstrated. But any investment decisions taken from now on with regard to carbon discharging facilities and equipment need to take account of the need for the facilities to be out of service no later than 2050.

We cannot afford to wait for the emergence of new technologies to reduce carbon emissions, but any new technologies need to be compared with the cost and effectiveness of existing technologies.

What does this mean for Naval Architects?

While maritime emissions into the Southern Pacific air account for a miniscule proportion of global emissions, we cannot be out of step with the rest of the world and have to look beyond fossil fuels to power the ships of the future.

In this regard, the above survey of current and emerging technologies shows renewable electric to be the most likely source of power for vessels operating on relatively short voyages, while hydrogen or possibly ammonia might be used for more prolonged voyages. Any safety issues related to the stowage and use of hydrogen need to be satisfactorily addressed.

In this context, the selection by Australia of nuclear-propulsion for its future submarines appears to be the most environmentally friendly, if not only, option.

We need to be ready for vessels carrying hydrogen, in liquefied/pressurised form or as ammonia, to become as common, replacing oil tankers to the extent that energy needs to be shipped by sea.

That said, I note that in 2018 the IMO adopted resolution MEPC.304(72) *Initial IMO Strategy on Reduction of GHG Emissions from Ships*, in which it aimed to "to reduce CO_2 emissions per transport work, as an average across international shipping, by at least 40% by 2030, pursuing efforts towards 70% by 2050, compared to 2008". This goal clearly falls short of net zero by 2050 and perhaps needs to be reviewed if shipping is to play its part in prevention of climate change.

Rob Gehling
Vice-President (Pacific Region) RINA

THE INTERNET

RINA Webcasts

RINA has set up a YouTube channel and RINA webcasts can be viewed there. The RINA YouTube channel is at https://www.youtube.com/channel/UChb1sfHbWfQmG-iwpp_QGJg/videos

Bookmark this website and keep your eye on it!

Click on Playlists in the menu bar. Branch and Section presentations are shown second from the right in the top line. Click on *View full Playlist* to see the list (best for a recent presentation), or click on the search function to the right of About in the menu bar (for an older presentation), type the title of the presentation you are looking for (or at least the first few words thereof) and press Enter.

NSW Section Webcasts

The NSW Section webcasts recorded and uploaded within the last three months are:

- *Nuclear Maritime Propulsion Roadmap for Australia,* presented by Christopher Skinner, Editor *Nuclear Propulsion Roadmap for Australia*, as a webinar hosted by RINA on the Zoom software platform on 1 September 2021.
- *The New Naval Architecture Degree Program at UNSW Canberra,* presented by Warren Smith, Associate Professor, Ahmed Swidan, Senior Lecturer, and David Lyons, Lecturer, UNSW Canberra, as a webinar hosted by RINA on the Zoom software platform on 6 October 2021.

Phil Helmore

Tasmanian Section Webcasts

The Tasmanian Section webcasts recorded and uploaded within the last three months are:

- *Controlling Marine Engine Emissions,* presented by Lachlan Colquhoun, Marine Engine Sales Manager Australia and New Zealand, MAN Energy Solutions, as a face-to-face meeting and as a webinar hosted by RINA on the Zoom software platform on 21 July 2021.

Gregor Macfarlane

VALE

Bryan Chapman

It is with sadness that *The ANA* records the passing of Bryan Vivian Chapman on 29 July 2021, someone who has had a profound influence in making the Australian Division of RINA what it is today.

Bryan was born on 10 January 1943, the first of four children for Vivian and Dulcie Chapman, in Adelaide. Bryan was followed by sister Barbara and brothers Philip and Andrew. The children grew up in in suburban Norwood.

On completing his secondary education at Findon High School, he was first employed by the PMG but then, aged 20, won a traineeship in naval architecture at BHP's Whyalla Shipbuilding and Engineering Works. This involved part-time study under Noel Riley and Ross Stacey at the Whyalla campus of the South Australian Institute of Technology while working full time at the shipyard. As it happened, the decision was made to close the naval architecture program before Bryan and others could complete their studies.

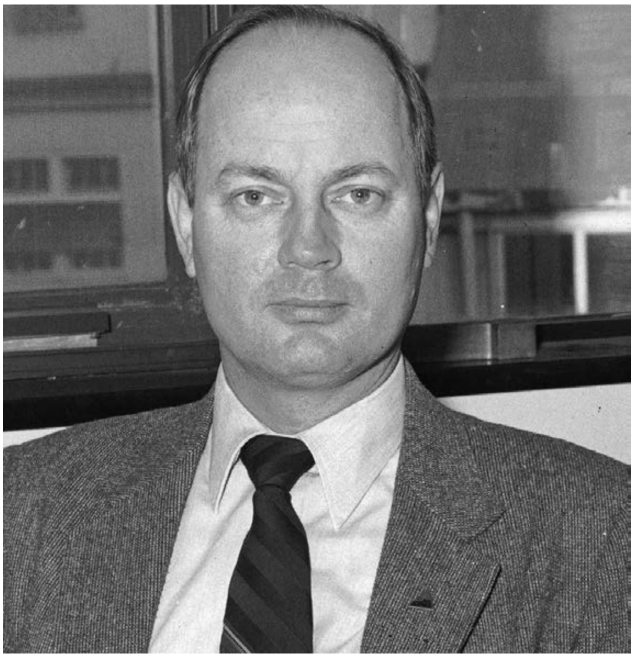
Meanwhile, Frances McLaren's grandfather and father had been involved in shipbuilding in Glasgow, and her father was offered a job at the BHP shipyard on the other side of the world, so the family moved to Whyalla. Bryan met Frances, daughter of the Construction Manager of the shipyard, at a friend's party, and they married on 30 January 1965.

Following the closure of naval architecture at the SAIT, Bryan elected to take a BHP scholarship and moved with Frances to Sydney to complete his studies as a full-time student at UNSW, a program which at that time followed a "sandwich" (full-time/part-time) format. The shipyard had arranged for him to complete the industry experience element of his degree through a secondment to the Australian Shipbuilding Board under the legendary Bob Campbell FRINA. His thesis project, under the supervision of Prof. Tom Fink, was on the state of the Australian shipbuilding industry at the time. Bryan was awarded his BE degree in naval architecture with Honours Class 1 in May 1970. With studies completed, he and Frances returned to Whyalla in 1970, the same year in which he joined RINA.

Following graduation, his work at Whyalla was largely in the management team of the production planning department. Family life evolved, with children Margaret being born in 1970 and Edward in 1973. Away from work, Bryan ran with the Whyalla Harriers.

With the closure of the shipyard, the family left Whyalla in 1978 for Bryan to work at the Williamstown Naval Dockyard, before moving to the USA in 1979 to join the team overseeing the construction of the four Adelaide-class FFGs at Todd Pacific Shipyards in Seattle.

Upon return to Australia in 1982, the family lived in Williamstown before settling in North Balwyn, Melbourne, in 1983. He established his own consultancy, Bryan Chapman & Associates, designing various specialised ships and working on a number of jobs for BHP Shipping with Bob Herd FRINA, a Past President of the Division. Significant jobs which he undertook included designing cargo cradles for use on *Iron Monarch* when converted for carrying rolled steel out of Westernport, and designing and



Bryan Chapman
(Photo courtesy Frances Chapman)

overseeing adaptation of the bulk zinc carrier *Iron Sturt* to carry sulphuric acid, a project carried out in conjunction with another ex-Whyalla-ite, David Baron of Baron & Dunworth. Another large job was supervising the construction of a series of tankers for George Quine, Fleet Superintendent of Botany Bay Tankers, for which Bryan relocated to China for about seven months in 1999–2000. Other work took him to Spain and the Cook Islands, and consultancy work included numerous jobs on domestic commercial vessels.

Bryan was into public speaking and a long-time member of Rostrum Victoria, serving as President in 1991 and 1992. His son Edward has spoken of his continued interest in running in Melbourne, prodding Edward to improve his fitness by joining him on runs.

Bryan was first elected to the Australian Division Council of RINA early in 1995. He was subsequently elected Division President, commencing in September 1998 when the Division was re-constituted to the current national structure in place of the previous Council when Noel Riley was President, which had largely developed from the NSW Section. His presidency was interrupted by the abovementioned relocation to China from mid-1999 until March 2000, during which time he exchanged positions with the Vice President, John Colquhoun. Bryan was re-elected as President in 2001 and continued in the position until he completed his maximum term in March 2003. His presidency was marked by a number of initiatives including the formation of Queensland Section, moves towards the formation of other sections and finalisation of an initial formal agreement with Engineers Australia, together with increased public activity and visibility of the Division.

As Division President, Bryan was very active in the associated role of ex-officio member of the Institution's (London) Council. He and his presidential predecessor, Noel Riley, who was elected as the first Australian RINA (London) Council member following Bryan's appeal in the February

1999 issue of this journal, represented a formidable presence in the governance of RINA. This was evident to Rob Gehling when he succeeded Bryan as Division President, with both Bryan and Noel still on RINA (London) Council. The effect of this Australian presence has continued to this day, as represented by the recent changes to the composition of the RINA Council by election on a regional basis, being similar to the changes reflected in the national composition of the Division Council in the Division's re-constitution led by Noel and Bryan in 1998.

Following his retirement from the Division presidency, Bryan took on the role of Editor of the Institution's annual *Significant Ships* publication until he had to discontinue any further work due to a stroke in 2010 which left him with serious debility and becoming wheelchair-bound. By caring for him at home, Frances' valiant efforts not only kept up his spirits, his dry sense of humour and insistence upon things being done in a well-considered manner, but avoided him being dependent upon institutional care.

In recent years Bryan's health has been problematic, but this did not reduce his interest in the Institution, as reflected by his attendance at the Australian Division's Annual General Meeting by video-conference earlier this year.

Bryan is survived by his wife Frances, children Margaret and Edward, grandchildren Jasmine and Ethan, sister Barbara and brother Andrew.

Rob Gehling
Noel Riley
Phil Helmore

MEMBERSHIP

Australian Division Council

The Council of the Australian Division of RINA met on the afternoon of Tuesday 14 September 2021 by Zoom video conference under the chairmanship of our President, Gordon MacDonald, in Airlie Beach with links to Cairns, Gold Coast, Sydney, Canberra, Melbourne, Launceston, Adelaide and Perth.

Among the items discussed were:

Registration as Not-for-profit

The Secretary reported that he had obtained all the necessary information and lodged the application for registration on 27 August. (Subsequent to the meeting the Secretary was informed in November that the application has been successful.)

RINA and the Naval Shipbuilding Program

Council considered the comprehensive report of the working group, led by Past President Jim Black, which evaluated responses to its report to the previous Council meeting and condensed it into a "to do list". After a wide-ranging discussion on the various related subjects, Council formed a further Working Group to consolidate the "to do list" into actions and individuals responsible for carrying them out.

Walter Atkinson Award for 2021

Council considered and endorsed the advice from the Assessment Panel that no eligible papers had been nominated for the year, so no Award would be made.

Annual Membership Summary

Council noted that membership numbers had enjoyed a healthy increase in the past year. The improvement was across all Sections and membership categories but particularly reflected increased efforts to encourage membership of AMC-UTas students.

Migration Issues

In response to a proposal from a Council member, Council decided to approach Home Affairs with a view to having the Division listed as an assessment body for the qualifications of naval architects migrating to Australia.

Indo-Pacific 2022 International Maritime Conference

Council noted that preparations for the Conference were underway and that the Call for Abstracts was open, closing in October.

Section Funding

Following consideration of this matter at its June meeting, Council agreed to amendments to the relevant guidelines to take account of the circumstances arising during the pandemic period.

Payment of Subscriptions

The Secretary reported that discussions had commenced with RINA HQ with a view to subscriptions being payable into an Australian account, but that these arrangements would not be in place for payment of subscriptions for the coming year.

Next Meeting of Division Council

The next meeting has been tentatively scheduled for the afternoon of Tuesday 14 December 2021.

The draft minutes of the meeting are available to Council members on the Council forum and are available to other members by request to the Secretary.

Rob Gehling
Secretary
ausdiv@rina.org.uk
0403 221 631

Changed Contact Details?

Have you changed your contact details within the last three months? If so, then now would be a good time to advise RINA of the change, so that you don't miss out on any of the Head Office publications, *The Australian Naval Architect*, or Section notices.

Please advise RINA London, *and* the Australian Division, *and* your local section:

RINA London		hq@rina.org.uk
Aust. Division		rinaaustraliandivision@iinet.net.au
Section		
	ACT	rinaact@gmail.com
	NSW	rinansw@gmail.com
	Qld	rinaqlddiv@gmail.com
	SA/NT	rinasantdiv@gmail.com
	Tas	tassec@rina.org.uk
	Vic	vicsec@rina.org.uk
	WA	wa@rina.org.uk

Phil Helmore

NAVAL ARCHITECTS ON THE MOVE

The recent moves of which we are aware are as follows:

Dan Curtis continues consulting as DRJ Consulting, and has recently taken up the position of Principal Engineer Delegate for the Hydrographic Systems Program Office via Downer Professional Services, working in Cairns on a FIFO basis.

Glen Davis has moved on and has taken up the position of Senior Naval Architect/Design Manager with Yamba Welding and Engineering, one of the companies in The Whiskey Project Group, in Yamba.

Billy Gosper has moved on from McConaghy Boats and has taken up the position of Assistant Project Manager with Sydney City Marine in Sydney.

Jamie Howden has moved on from KBR Inc. and has taken up the position of Head of Technical Operations with The Whiskey Project Group in Sydney.

Jun Ikeda has moved on within TechnipFMC and has taken up the position of Senior Installation Engineer in Lombok, West Nusa Tenggara, Indonesia.

Bryan Kent has moved on from KBR Inc. and has taken up the position of Project Manager with the East Coast Services Division of Baker & Provan in Sydney.

Frank Ryan has moved on within the Directorate of Navy Engineering and has taken up the position of Ship Structures Cell Lead in Canberra.

Prasanta Sahoo continues as Associate Professor in the Department of Ocean Engineering and Marine Sciences at Florida Institute of Technology in Melbourne, FL, USA.

Umberta Salvarani continues freelance consulting as Umberta Salvarani Interior Design, but has also taken up the position of Interior Designer with Thomas Hamel & Associates in Sydney.

Kalevi Savolainen continues as Stability Manager with BAE Systems in Fremantle.

Anton Schmieman has moved on within Austal USA and has recently taken up the position of Director Strategy and Business Development in Mobile, AL, USA.

Thor Schoenhoff has moved on from ONA Group and has taken up the position of On-water Sailing and Events Manager with the Fremantle Sailing Club in Fremantle.

Dr Tony Sammell completed his vascular medicine fellowship at St Vincent's Hospital in 2017 and then undertook a clinical observership with the rheumatology vasculitis service at the Mayo Clinic in Rochester, USA. He is now a consultant specialising in rheumatology and vasculitis with public hospital appointments at Prince of Wales and Sydney Eye Hospitals in Sydney.

Jonathan Schultz moved on from Australian Marine and Offshore Group in 2006 and, after some time at SEMF, has taken up the position of Senior Structural Engineer with MMH Engineering in Melbourne.

Adam Schwetz continues as Director at Schwetz Design in Fremantle.

Ethan Seah continues as Managing Director with Ingeliance Singapore in Singapore.

Greg Seil continues contracting through AVT Services in the area of computational fluid dynamics modelling in Sydney.

Greg Shannon has moved on within Jowa AB and has taken up the position of Sales Director in Gamlestaden, Sweden.

Gayle Shapcott, UNSW's first female graduate in naval architecture in 1979, moved on from Canturi Jewels in 2011 and, after some time at Prime Creative Media, has taken up the position of Director and Chief Financial Officer with Fat Lizard Enterprises in Melbourne.

Joanna Shea has moved on from Pout-a-licious and has taken up the position of Customer Service Officer with Murrumbidgee Irrigation in Griffith, NSW.

David Shelton moved on from VicRoads in 2018 and, after some time at Safe System Solutions and Lösingar, has taken up the position of Senior Transport Specialist (Road Safety) with the Asian Development Bank in Melbourne.

Anne Simpson has moved on from Rolls-Royce KBR and has taken up the position of Safety Engineering and Assurance Specialist with Thales Australia in Sydney.

Mitchell Stubbs has moved on within Coras Solutions and has taken up the position of Manager in Canberra.

Gianluca Viluce Correa has moved on from Lightning Naval Architecture and has taken up the position of Project Naval Architect with the Birdon Group in Port Macquarie.

Joon Chee Yew moved on from Larsen & Toubro in 2014 and, after some time at Aqualis Offshore and AqualisBraemar, has recently taken up the position of Vice President (Projects) with SeaTech Solutions International (S) in Singapore.

Renjie Zhou has moved on from the Birdon Group and has taken up a position as a naval architect with Incat Crowther in Sydney.

This column is intended to keep everyone (and, in particular, the friends you only see occasionally) updated on where you have moved to. It consequently relies on input from everyone. Please advise the editors when you up-anchor and move on to bigger, better or brighter things, or if you know of a move anyone else has made in the last three months. It would also help if you would advise Rob Gehling when your mailing address changes to reduce the number of copies of *The Australian Naval Architect* emulating boomerangs.

Phil Helmore

THE AUSTRALIAN NAVAL ARCHITECT

Contributions from RINA members for
The Australian Naval Architect
are most welcome

Material can be sent by email or hard copy. Contributions sent by email can be in any common word-processor format, but please use a minimum of formatting — it all has to be removed or simplified before layout.

Photographs and figures should be sent as separate files (not embedded) with a minimum resolution of 200 dpi. A resolution of 300 dpi is preferred.

FROM THE ARCHIVES

The replenishment ship HMAS *Stalwart*, commissioned on 13 November 2021, is the third ship of the name to serve in the RAN. The first was a destroyer (1920–25) and the second was an Australian-designed and built escort maintenance ship (later classed as destroyer tender). The 15 500 t ship was built at Cockatoo Island in Sydney — seen here on No. 1 slipway shortly before her launching on 7 October 1966. The destroyer escort HMAS *Torrens* is at an early stage of erection on the adjacent No. 2 slipway
(RAN Historical Collection)

Stalwart, guided by the tug *Himma*, passing Snails Bay outbound for her first day of contractor's sea trials in November 1967. She was commissioned on 9 February 1968 and served until 9 March 1990. She was sold in May 1990 to Sea Royal Ferries of Nicosia for conversion to a passenger ship. The new role never eventuated and she was broken up for scrap at Alang in India in February 2003
(RAN Historical Collection)

HMAS *Sirius* refuelling the Royal Navy Type 45 destroyer HMS *Diamond* on 7 October during the last deployment of HMAS *Sirius* before her decommissioning in December. HMAS *Sirius* is being replaced by the second of two new replensihment ships built in Spain the RAN, HMAS *Stalwart*
(RAN photograph)