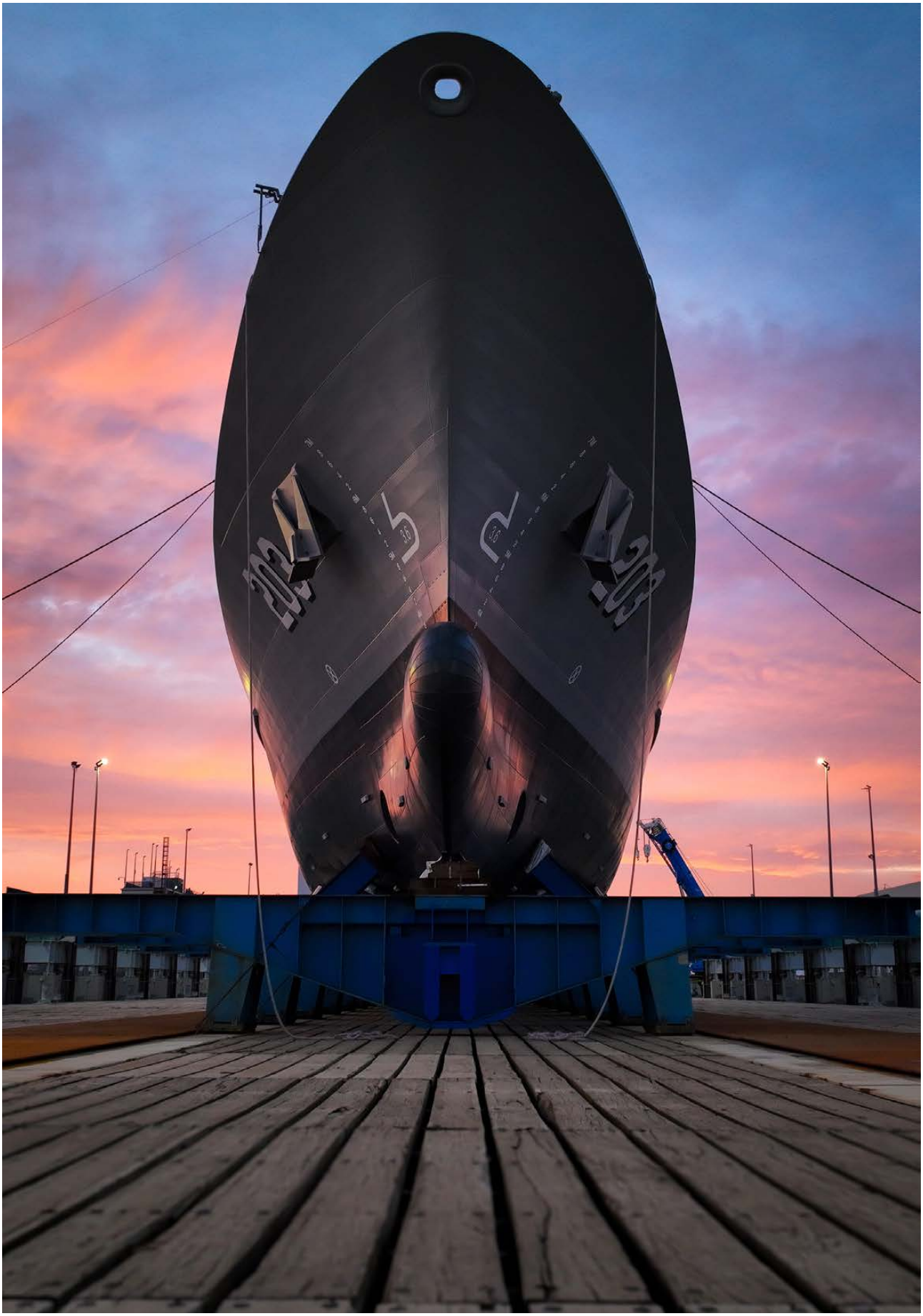
THE AUSTRALIAN NAVAL ARCHITECT

Volume 26 Number 1
February 2022



NUSHIP *Arafura*, the first of the RAN's new offshore patrol vessels, on the shiplift at the Osborne Naval Shipysrd in Adelaide ready for her launching on 16 December 2021
(Photo Department of Defence)

THE AUSTRALIAN NAVAL ARCHITECT

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Cover Photo:

The start of the two-handed division in the Rolex Sydney to Hobart yacht race on Boxing day, 26 December 2021
(Photo John Jeremy)

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The Editor
The Australian Naval Architect
c/o RINA
PO Box No. 462
Jamison Centre, ACT 2614
AUSTRALIA
email: jcjeremy@ozemail.com.au

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on the
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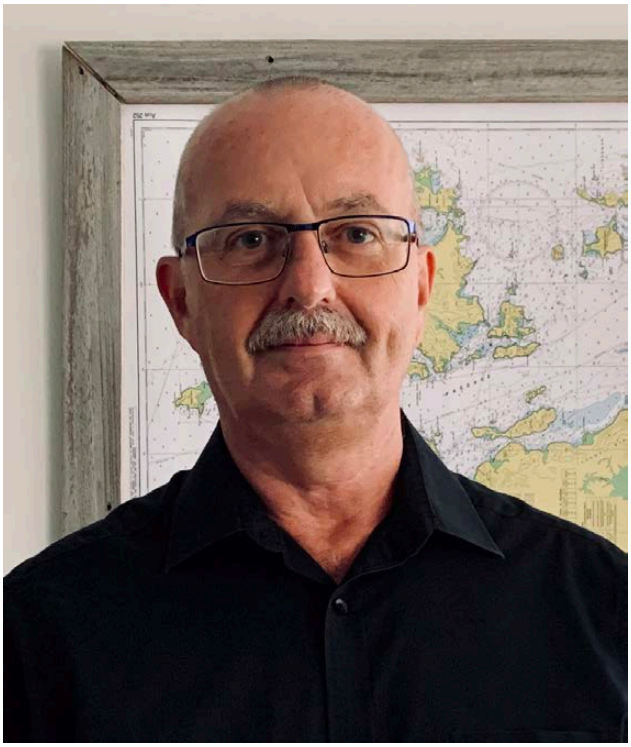
From the Division President



Gordon MacDonald

Welcome to the February edition of *The Australian Naval Architect* — a happy and less eventful New Year to you all. This will be my last column as the President of the Australian Division of RINA as my term in office ends in March 2022. It has been an honour to serve in the role and to work with so many dedicated professionals, all working hard to improve the standing and recognition of the naval architecture community within the Australian maritime industry.

There is an immense amount to be proud of as naval architects and I would ask all our membership to reflect on what makes our calling unique. As naval architects we are responsible for ensuring the safe, efficient and cost-effective design and building of a wide range of marine vessels; military, commercial and recreational. Our field covers whole platform design, specialist engineering, integration, regulatory compliance, project management, construction, commissioning and surveying. There has been a tendency by the wider engineering and project-management disciplines over the past decade or more to try to pigeonhole our profession into its component sub specialisations such as stability, seakeeping, structures, etc.; a direction that, if unchecked, will displace our membership from the roles which the profession was originally created to fulfil. While I have noted this direction, I have also noted pleasingly, that most of the senior project engineering positions naturally revert to naval architects over time. I feel that it is the responsibility of all naval architects, whether members of RINA or not, to continuously advocate for the role of our profession in the industry — it is, after all, your future.

I have also noted that our profession is not well represented in the production field within Australia; this potential failing represents a huge opportunity in light of the National Shipbuilding strategic direction of government. With the government placing such a high priority on the nation's ability to continuously build ships, there will be the need for career paths which specialise in all aspects of construction and commissioning which could be reflected into the curricula of our naval architecture degree and post-graduate courses.

Unfortunately, the key memory of my tenure as president has been the impact of COVID-19, not only on the Australian Division and wider RINA, but also on all the individuals in the Australian maritime industry.

It is with considerable regret that COVID-19 eliminated my ability to attend section meetings around the country, as has been the privilege of my predecessors. However there has been some good coming out of the pandemic; our move to conducting technical and section meetings through videoconferencing has increased the ability of the membership to participate in the activities of the Division. This feature is likely to remain and, no doubt, with experience will progressively improve in quality.

This brings me to our Annual General Meeting for this year, which will be run as a teleconference using the Zoom software platform and is scheduled for Tuesday 22 March 2022 at 2000 hours Australian Eastern Daylight Saving time. I will be standing down as President at the AGM, having completed my two-year term. I have been heartened by all the time and effort that the council members have put in over that two-year period, noting that they are all volunteers. I strongly recommend to our membership to get involved in your sections and aspire to council — that is how we will keep abreast of the needs and expectations of our industry and continue to grow the Institution.

I particularly want to thank our Secretary, Rob Gehling, for (keeping me out of jail) and all the work which he has done to support and guide me through my tenure. I need to pay my sincere respects to John Jeremy AM and Phil Helmore for their relentless effort, as editors of *The Australian Naval Architect*; we are all in their debt. I look forward to continuing to be involved with the Institution and I wish the incoming President the very best for their term in office.

Gordon MacDonald

Editorial

As another new year begins, we are still in the midst of a global pandemic which is changing our lives in many ways. Some of these changes may turn out to worthwhile, like the benefits to our wider membership from the adoption video conferencing for technical meetings, enabling many more people to have access to information and experience otherwise limited to those who could attend a meeting in person. These changes may remain after COVID-19 fades away from our everyday lives.

Many other changes have been necessary to the way we conduct business, with public health restrictions adding a layer of complexity to the task of managing the work we do. With the benefit of high-speed internet connections some can work from home, remote from their usual workplace. However, the construction and maintenance of boats, ships and submarines is something which can only be done by teams of people working in close proximity. The need to adopt testing procedures for employees and visitors and to maintain social distancing must be adding very unwelcome overhead costs and reducing productivity.

Competition for skilled labour throughout Australia has become intense. Our intake of skilled migrants in 2018–19 was just under 110 000 but the skilled immigration stream has been badly affected by the pandemic and the number of skilled immigrants in 2020–21 was much lower at just under 80 000. Add to this the variable and unpredictable access between the states, and the challenges for industry are considerable.

Something else which fell victim to COVID-19 was our International Maritime Conference planned for October 2021. The Indo Pacific Maritime Exposition, with our conference, was deferred to May this year. Indo-Pacific 2022 is almost upon us, and will be held in Sydney on 10–12 May. Indications are that it will be one of the largest events so far.

Planning for the International Maritime Conference, IMC2022, has been proceeding apace and a very interesting and relevant program has emerged with papers addressing a wide range of topics including nuclear propulsion, regulation and safety, life-cycle management, advanced composites, autonomous vessels, reducing carbon emissions from ships, the digital twin, and many more.

Registration for IMC2022 will open in March. Those attending will find that COVID-19 will affect the way we do things at the conference centre, but those restrictions which may remain will be managed to ensure a safe and rewarding exposition and conference for everyone. The IMC2022 organising committee looks forward to welcoming many members to this highlight event.

John Jeremy

The British High Commissioner, Victoria Treadell CMG, MVO, the United States Chargé d'Affaires, Michael Goldman, and the Minister for Defence, the Hon. Peter Dutton MP, at the signing of the Exchange of Naval Nuclear Propulsion Information Agreement at Parliament House in Canberra on 22 November 2021
(Photo Department of Defence)

COMING EVENTS

New South Wales

NSW Section Technical Presentations

Technical presentations are arranged jointly with the IMarEST (ACT & NSW Branch) and held on the first Wednesday of each month, starting at 6:00 pm for 6:30 pm and finishing by 8:00 pm (local times).

Presentations will continue for the foreseeable future as webinars, hosted by RINA. Registration for each presentation is required, and details will be provided in the flyer for each meeting. When pandemic restrictions permit and it is safe to do so, consideration will be given to a return to face-to-face presentations.

The *Coming Events* page on the RINA NSW Section website will be updated with details and changes as soon as they become available.

The program of meetings remaining for 2022 is as follows:

2 Mar	Bernard Dwyer, Chief Executive Officer, TT-Line *Design and Construction of the New Spirit of Tasmania Vessels*
2 Mar	NSW Section Annual General Meeting
6 Apr	Mathieu Courdier, PhD Candidate, Australian Maritime College *Seakeeping of a Surfaced Underwater Vehicle*
4 May	Clare Grandison, Discipline Leader Environmental Signatures, and Richard Piola, Discipline Leader Biofouling Control and Biosecurity, DST Group *Environmental Signatures and Protective Systems*
1 Jun	IMarEST — Damen *TBA*
6 July	Matt Johnston, Manager Maritime Safety and Environmental Policy, Australian Maritime Safety Authority *Australia's Regulatory Framework for Autonomous Vessels and Decarbonisation*
3 Aug	IMarEST — Jotun *TBA*
7 Sep	RINA — Damen *Tug Electric-drive Technology—The Future is Now*
5 Oct	Lachlan Toohey, Senior Technical Officer, Australian Centre for Field Robotics, University of Sydney *Hover-capable Autonomous Underwater Vehicles: Design and Use Cases*
1 Dec	SMIX Bash 2022

NSW Section AGM

The Annual General Meeting of the NSW Section of RINA will be held by video-conference on Wednesday 2 March immediately following the scheduled technical presentation webinar of RINA (NSW Section) and IMarEST (ACT & NSW Branch) at 6:00 for 6:30 pm AEDT. Registration is required as for the technical presentation. The formal notice and agenda have been emailed and reports will be emailed to members prior to the meeting.

Australian Division AGM

The Annual General Meeting of the Australian Division of RINA will be held by video-conference on Tuesday 22 March, commencing at 2000 AEDT, 1930 ACDT and 1700 AWST. The formal notice and agenda for the AGM are included elsewhere in this issue of *The ANA*; reports will be emailed to members prior to the meeting, and registration will be required.

AOG Energy 2022 and 2023

AOG Energy is Australia's premier oil, gas and energy trade event held annually in Perth.

Diversified Communications Australia, organiser of AOG Energy, has announced the cancellation of AOG Energy 2022.

For over 40 years, AOG Energy has been recognised as *the* premier Australasian oil, gas and energy event, bringing together the entire supply chain from across Australia and the globe.

We regularly connect with our community so that AOG Energy can continue to meet the needs of the industry. Recently we surveyed our audience, spoke to key exhibitors and consulted with our industry committees on their objectives for AOG Energy 2022. The results demonstrated that, while there is an appetite for local connection, it is abundantly clear that there is a stronger desire for this to happen at the large global scale to which the industry is accustomed.

We are committed to delivering the event annually; however, we understand that 2022 will continue to present its challenges in connecting the market at scale. We want to do the best by you and reunite the industry at the right time, and have therefore made the difficult decision to cancel AOG Energy for 2022.

We look forward to bringing the industry back for a true celebration of what the Australasian oil, gas and energy market has to offer and to continue to innovate towards a clean energy future. The next edition will next take place on 15–17 March 2023 at the Perth Convention & Exhibition Centre.

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

Indo-Pacific 2022

The Indo-Pacific International Maritime Exposition to be held in May this year will combine an extensive exhibition presence, a comprehensive conference program and a schedule of networking and promotional opportunities. 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 in to the future.

Indo-Pacific is where customers and industry will connect, where commercial maritime and naval defence suppliers will

imc2022

INTERNATIONAL MARITIME CONFERENCE

10-12 MAY 2022

INTERNATIONAL CONVENTION CENTRE
SYDNEY, AUSTRALIA

Registration - Opening Soon

Registration will be opening soon for the IMC2022 International Maritime Conference.

The Conference organised by the Royal Institution of Naval Architects, Institute of Marine Engineering, Science & Technology and Engineers Australia, will coincide with the INDO-PACIFIC 2022 International Maritime Exposition which is organised by AMDA Foundation Ltd.

The Conference Program will be designed to allow all registered delegates to visit the many industry displays at INDO-PACIFIC 2022 International Maritime Exposition and the opportunity to network and hold informal professional discussions with exhibitors and fellow delegates. Registration for IMC2022 International Maritime Conference includes free daily access to the Exposition.

KEYNOTE SPEAKERS

RADM Katherine Richards AM
Head Navy Engineering
Royal Australian Navy

Professor Emily Hilder
Chief Maritime Division
Defence Science & Technology

Jane MacMaster
Chief Engineer
Engineers Australia

Chris Boyd
CEng, CMarEng, FIMarEST, FRINA
Chief Executive Officer
Royal Institution of Naval Architects

Reconnect with eminent leading speakers, decision makers, new technical research and leading-edge maritime technologies at the region's premier maritime technical conference, IMC2022. The Conference Program will be available on the IMC2022 website soon.

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

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

For further information please visit www.indopacificexpo.com.au/IMC2022

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, the organiser of the event, 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.

Main themes of the conference include

- 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 in March, and that the conference program will be posted soon. Keep your eye on the website https://www.indopacificexpo.com.au/IMC2022.

For further information regarding the Indo-Pacific IMC 2022 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 and, to this end, RoboNation awarded a limited number of the WAM-V platforms to teams which committed to participate in this and future Maritime RobotX Challenges and Forums.

NEWS FROM THE SECTIONS

Victoria

Victorian Maritime Industry Annual Social Event

With the easing of restrictions towards the end of last year, the Victorian Section was able to host the Victorian Maritime Industry Annual Social Event on 17 December. Despite all the complications and uncertainty caused by the pandemic, the event was a great success. Thirty-eight people joined us for an enjoyable gathering on the banks of the Yarra, with drinks and a barbeque on a breezy summer Melbourne evening.

Held at The Common Man on South Wharf, the event was a perfect chance to meet new people from the industry, and reconnect with old colleagues and friends in an enjoyable casual environment; a great way to cap off a difficult year. There was a great mix of young and the young-at-heart, with a number of engineers, mariners, surveyors, and others from the industry. Those that attended were from a range of companies and organisations within the maritime industry in Victoria.

A special thanks to our sponsors who helped the event come to fruition:

Gold

- Altair

Silver

- AMT
- Company of Master Mariners of Australia

Bronze

- Maritime Survey Australia
- Thrust Maritime

The support of each of these organisations is greatly appreciated.

Keegan Parker

Western Australia

Wave Interactions with Floating Structures

Dr Wenhua Zhao, Senior Research Fellow at the University of Western Australia, gave a presentation on *Innovative Experiments for Wave Interactions with Floating Structures* in the auditorium at Engineers Australia, West Perth, attended by 12 on 9 December 2021. The presentation was also streamed live via EA's Webex platform and attracted a further 60+ participants.The hydrodynamic performance of floating assets is of great importance, both in operational and extreme conditions. Over the past five years, UWA has led the Offshore Hub, jointly funded by the ARC and industry (including Shell, Woodside, Bureau Veritas and Lloyd's Register) to investigate the hydrodynamics of floating offshore structures. Both physical experiments conducted in a world-class wave basin and supercomputer fluid dynamic simulations have been performed, demonstrating advanced experimental methodologies and innovative analysis. The experiments cover

(i) LNG side-by-side offloading operations in operational sea states — with wave resonance in the gap; and

(ii) Green-water events for FPSOs in extreme sea states — wave on deck, arising from the combination of incoming waves, wave scattering off the hull, ship motions and overtopping.

New, interesting and practically-important phenomena have been captured for both problems. This presentation described how we have unravelled new physics and built efficient prediction models, with practical engineering applications to the fore.

Question time raised some further interesting points.

The Presenter

Dr Wenhua Zhao is a DECRA fellow and Shell-funded Senior Research Fellow at the University of Western Australia. His research focuses on hydrodynamics and wave-structure interactions, which has led to more than 70 publications spanning from the most renowned academic journal in fluid mechanics to most industry-focused conferences. Wenhua has been serving as a Chief Investigator for the Offshore Hub (https://www.offshorehub.edu.au) and the TIDE (https://tide.edu.au). He was elected as a By-Fellow in 2020 at Churchill College of Cambridge University, and he is currently a Deputy Editor for the *Ocean Engineering* journal.

Wenha's presentation was recorded, and is expected to be available soon on the RINA YouTube channel.

Wave Energy

Dr Adi Kurniawan, Research Fellow at the University of Western Australia, gave a presentation on *Wave Energy: History, Fundamentals, and Challenges* in the auditorium at Engineers Australia, West Perth on 9 December 2021. The presentation was also streamed live via EA's Teams platform, and was the second presentation for the evening. There is enough wave energy in the ocean globally to power about 1 billion homes. Not all of it can be practically harnessed, but even a small proportion would mean a lot for the security of our energy supply. The oscillatory nature of waves and, hence, of wave-power machines makes wave energy unique compared to other renewables such as wind or solar. To get the most out of the waves, wave-power machines need to oscillate with both the right amplitude and phase. This would be easy if ocean waves were of constant amplitude and period, but real ocean waves have varying amplitudes and periods, at all time scales.

Adi's presentation began with a brief overview of the history of wave energy, followed by a discussion of some fundamentals of wave energy absorption, highlighting some challenges arising from the oscillatory nature of the problem, and concluded with some examples of wave energy converters which UWA has been investigating recently, including

(i) the flexible bag device; and

(ii) the M4 wave energy converter

as a snapshot of our recent research efforts towards making progress in this fascinating field.

Question time raised some further interesting points.

The Presenter

Dr Adi Kurniawan is a Research Fellow with the Wave Energy Research Centre, UWA. His research covers aspects of wave-energy conversion, wave-structure interactions, and multi-objective optimisation. He has numerically modelled a variety of wave-energy converters. Adi obtained his PhD in Marine Technology from the Norwegian University of Science and Technology. Before joining UWA, he worked at Aalborg University, Denmark, and the University of Plymouth, UK. Adi is the co-author of *Ocean Waves and Oscillating Systems: Linear Interactions Including Wave-Energy Extraction* (2nd edition). He is a member of the Standards Australia Committee EL-066 on Marine Energy.

Adi's presentation was recorded, and is expected to be available soon on the RINA YouTube channel.

End-of-Year Drinks

The two technical presentations on the evening of 9 December 2021were followed by the WA Section's end-of-year drinks at the Mayfair Lane Pub and Dining Room in West Perth.

Nathan Chappell

South Australia & Northern Territory

Development and Operations of the Osborne Naval Shipyard

Paul Bates, General Manager Operations, Australian Naval Infrastructure, gave a presentation on *An Overview of the Development and Operations of the Osborne Naval Shipyard* in Lecture Room S112 on the North Terrace Campus at the University of Adelaide on 17 November 2021 attended by 20.

Paul's presentation provided a brief history of Australian Naval Infrastructure (ANI) and how they are supporting the Government's Naval Shipbuilding Plan, and went on to provide an overview of the operations of the naval shipyard, the Collins-class Sustainment facility and the associated programs in which they are currently involved.

Paul was appointed General Manager Operations for ANI on 1 December 2017. He has substantial maritime operations experience. Prior to his appointment at ANI, Paul was General Manager—Operations for Defence SA, ensuring the successful delivery of the CUF and other contracted

services to the AWD Program since 2009. From 2006, Paul was Project and Bid Manager for DMS Maritime (now Serco Defence). He holds a Master of Business Administration and is a graduate of the Australian Defence Force Academy. He served for 18 years in the Royal Australian Navy, holding a variety of operational roles both at sea and ashore.

Paul's presentation was not recorded.

Christopher Carl

Queensland

December Technical Presentations

The Queensland Section held the final technical presentations of 2021 at a meeting on 9 December at Aus Ships in Rivergate Marina, Murrarie, on the Brisbane River. The meeting was held both in person and streamed live with a good turnout of members and a few new faces.

Tour of Rivergate Marina

Tommy Ericson, Director, Aus Ships Group, led a tour of their manufacturing facility at the Rivergate Marina attended by 20, showing some of their boats under construction. The main interest centred on the fourth of the new-generation CityCats being built for Brisbane City Council. This 27 m aluminium catamaran was built and will be maintained under Lloyd's Register class, and has a top speed of 24 kn. Tommy shared some interesting factors which influenced the design of this vessel, and there have been significant efforts to make the vessel light, environmentally-friendly and with minimal wash in the river. This has resulted in narrow and streamlined demi-hullforms with some shell plates difficult to shape. Another challenge has been the speed limitation of 6 kn in the Brisbane River; e.g. with the vessel's engines at idle, the vessel exceeds this speed! Aus Ships has produced some innovative solutions to optimise and control the vessel power output.

Brisbane City Council is using Rivergate Marina to service their vessels. This provides a great opportunity for Aus Ships to see the life-cycle and maintenance of vessels which they have built. It is not common for naval architects and shipbuilders to continuously observe and receive feedback on their product. It also benefits Brisbane City Council to have the experts located just beside their boat on the hard stand. Another 12 m aluminium utility catamaran was also under construction in the yard. After the tour, Tommy presented the group with more information on their projects, design challenges and solutions.

Tour group inspecting new Brisbane City Cat *Barrambin II*
(Photo courtesy Jalal Rafieshahraki)

LR's Role within the Marine Industry

Dean Biskupovich, Technical Performance Manager Australasia, Lloyd's Register, gave a presentation on *Lloyd's Register's Role within the Marine Industry* at Aus Ships Group at the Rivergate Marina attended by 20. The presentation was also streamed live via the Microsoft Teams platform and attracted a further 10 participants.

Dean began his presentation with an outline of the current status of LR in Australia, including the staff they have, where they are located and an overview of the work they do. Dean also spoke about the effect that the pandemic is having on LR. Some major changes have been made within LR since the pandemic began, including closing their main offices and working from home, renting shared offices for meetings, and conducting remote surveys. LR has conducted a number of surveys remotely using a web-based camera and app. These remote surveys were mostly successful, although a number of issues were encountered in the process. Due to the software being web based, the biggest issue they faced was internet connection. The ships were often at anchor out of the port when the surveys were conducted, and so didn't receive very good internet. As a result, the quality of the video was hard for the surveyors to distinguish what they were looking at. This became especially relevant when inspecting the internal structure of the ship. As a result, LR has deferred a number of surveys until a time where in-person surveys could be conducted.

Dean also discussed the future legislation that is to be introduced into Australia and how this will affect the vessels operating in Australian waters. The majority of this legislation relates to emissions and is due to be introduced within the next five years. He also discussed how LR has recently started conducting surveys on behalf of AMSA. A number of LR surveyors within Australia have had their qualifications recognised by AMSA and are also AMSA-accredited surveyors and are performing surveys on domestic commercial vessels.

Dean's presentation was not recorded.

Dean' Biskupovich's technical presentation
(Photo courtesy Jalal Rafieshahraki)

Thanks

RINA Queensland Section would like to thank Dean, Tommy and the Aus Ships' team for their time in preparing their presentations, the tour, and their great hospitality.

Ashley Weir
Jalal Rafieshahraki

ACT

The Use of Manned Models in Shiphandling Training

Captain Andrew Beazley, General Manager, and Captain Cliff Beazley, Managing Director, Port Ash, gave a presentation on *Port Ash: The use of Manned Models in Shiphandling Training* as a webinar hosted by RINA using the Zoom software platform with the Chair of the ACT Section, Warren Smith, as MC on 23 November. This presentation attracted 26 participating on the evening.

Introduction

Port Ash Australia is a manned ship model training and research centre, located on the east coast of Australia, approximately two hours by road north of Sydney, and 30 minutes north of Newcastle, New South Wales. It is one of seven such facilities in the world; there are two in the USA, one in Panama and three in Europe.

The facility has a purpose-built lake covering 2 ha of waterways to 1:25 scale, with deep and shallow water areas which have been carefully constructed to re-create the scale depths of water when approaching a typical harbour environment and the water depths within a typical harbour. The lake has approximately one-third of the area dedicated to 2 m deep water (scale 50 m depth), another third is of medium depth (scale 25 m depth) and a third dedicated to shallow water areas of 14 m scale depth, and includes features allowing pilots to experience severe bends, berthing, bank effects and squat in a range of water depths.

They currently have seven ship models, three with re-configurable superstructures to give different vessel types, and some with multiple propulsion configurations (single or twin screw with single or twin rudders), with a further one under construction, and eight tug models, including a manned tug model with azimuth drive.

Operations commenced in 2001 with their first course for a Darwin pilot, and they have been providing manned ship model training in Australia ever since.

Andrew began the presentation by showing a video outlining the facilities. The video is available on the Port Ash website, see https://www.portash.com.au/ and click on the video.

Handymax bulk carrier model *Triton*
(Photo from Port Ash website)

Model of RAN LHDs HMA Ships *Canberra* and *Adelaide*
(Photo courtesy Port Ash)

What *is* Manned Model Training?

Manned model training is simulated shiphandling training using

- accurately scaled ship models;
- an accurately scaled lake facility representing a generic harbour and its approaches;
- accurately scaled channels and shallow-water areas to replicate hydrodynamic effects; and
- accurately scaled model tugs operated by tug masters for ship assists.

Here Andrew showed a chart of the lake facility.

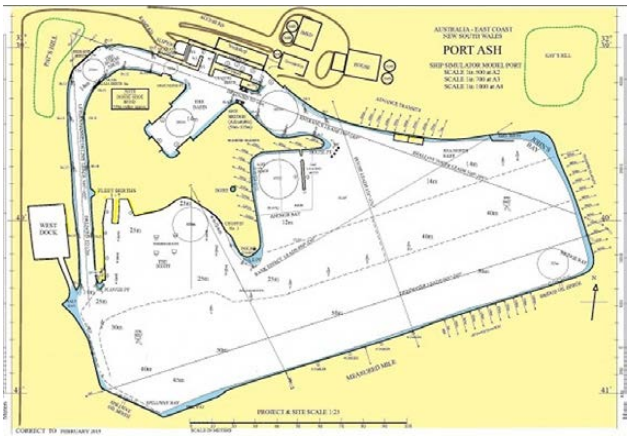


Chart of the lake at Port Ash
(Chart from Port Ash website)

View of the lake at Port Ash
Photo from Port Ash website

Value in Visual Shiphandling Training

Manned models have been used for many decades for shiphandling training in a real-world environment. The focus is on the technical skill of visual shiphandling. Both manned

models and electronic simulation are used for shiphandling training, and these complement one another. Both have their individual strengths and are used to develop and maintain visual shiphandling skills to a high level of proficiency.

Strengths of Manned Models for Shiphandling Training

Manned ship models bring the theory of shiphandling text books to life and demonstrate the physical concepts of shiphandling in a real-world environment very effectively. Shiphandlers physically feel and observe hydrodynamic effects, such as bank suction, vessel interaction, current and wind effects, heavy landings during berthing and other effects. Models operate in a compressed time-frame, so that more shiphandling exercises can be achieved in a given time frame than in real time simulation.

To see the significance of this, the time-frame is compressed by the square root of the scale, i.e. by a factor of $\sqrt{25} = 5$. One hour of exercises in a ship model is therefore the equivalent of five hours on the bridge of a ship in real time! A side benefit of this is that the model shiphandler is forced to make decisions very quickly and act on them.

Bank Suction and Manoeuvring Exercise

Here Andrew showed two videos:

- The first, of the horse-shoe bend with the model of the Panamax bulk carrier *Mentor* transiting; the model feels the effects of the bank suction and sheers from side to side.
- The second, with *Mentor* in the deep section of the lake demonstrating a turning circle, and then moving to the shallower part, where speed dropped by about one-third, handling became sluggish, and the turning circle doubled in diameter.

Manned Model Training for Commercial Shipping and Ports

Port Ash provides general shiphandling training for merchant navy deck officers and masters. This may lead to a candidate moving into a marine pilot trainee role where manned models may also be used for the following:

- evaluation of a potential candidate for entry into a port's marine pilot training program; and
- initial marine pilot training in visual shiphandling skills and knowledge, also as recommended by IMO Res. A960.

Manned Model CPD for Marine Pilots — Emergency and Contingency Training

It is necessary for marine pilots to be trained for emergencies and contingencies. Port Ash provides

- Structured and relevant training for identified shiphandling risks for individual port pilotage.
- Realistic emergencies for the trainee to deal with, and a full debrief following completion of the exercise, with the outcome recorded.
- Documentary evidence of a successful competency.

All of these are as recommended by IMO Res. A960.

Manned Model CPD for Marine Pilots Content

Port Ash provides

- Refresh knowledge of basic shiphandling principles, shallow-water effects, bank effects, and passing-vessel interactions.
- Refresh knowledge on anchoring and heavy vessel handling, the use of anchors during normal operations and during emergencies and contingencies.
- Refresh knowledge of tug operations and the use of tugs in emergency scenarios.

Manned Model Training used for the RAN and RNZN

Port Ash is used by both the Royal Australian Navy and the Royal New Zealand Navy, and half the models in the fleet are grey in colour! Shiphandling training is at three levels for Navigating Officers.

- Intermediate Navigating Warfare Officers Course (INWOC) for minor warfare vessels.
- Surface Combatant Navigator Course (SCNC) for navigators for major fleet units (e.g. Anzac-class frigates and the DDGs)
- Principal Warfare Officers Navigation Plus (PWON+) for deep-draft vessels (e.g. the AORs and LHDs).

Other training includes

- Command Navigation Course (CNC) for Commanding Officers and Executive Officers prior to initial posting to vessels.
- Specific-vessel type training for naval officers in the RAN and RNZN.

Vessels in the Fleet

Ship models at Port Ash include

Lake Teacher, a handysize vessel with a single fixed-pitch propeller and a single rudder, plus bow and stern thrusters.

Triton, a handymax bulk carrier, re-configurable with superstructure as a 185 m LOA pure car carrier.

Mentor, a Panamax bulk carrier.

Centurion, a multi-purpose vessel with the bridge forward; re-configurable with superstructure to have the bridge aft, three propeller shafts and three rudder positions, all fully configurable at trainee's request.

HMA Ships *Canberra* and *Adelaide*, the RAN's LHDs with azimuth-drive propulsion, re-configurable with superstructure to a cruise ship with twin azimuth-drive propulsion and twin bow thrusters.

HMAS *Choules*, the RAN's Bay-class LSD with azimuth-drive propulsion.

A model of the RAN's new AORs, HMA Ships *Supply* and *Stalwart*, is under construction.

The majority of the models, with the exception of the azimuth-drive models, are controlled by touch-screen computer control. Failures of vessel propulsion, steering and thruster systems can be simulated to value add to CPD/ emergency and contingency training exercises.

Conclusion

So, why use manned models for shiphandling training?

Manned models complement electronic simulation, and each has its own unique strengths. Combined with electronic simulation, both training methods cover all aspects of shiphandling training for marine pilot training, bridge teams (both commercial and navy), and ongoing CPD for marine pilots as recommended by IMO. It provides realistic hydrodynamic effects in a real-world environment and

allows the shiphandler to experience the feel of handling a ship in the simulated model environment.

Questions

Question time was lengthy and elicited some further interesting points.

Current at 2 kn can be generated in the channel in either direction. Wind is, naturally, a bit more random; when setting up the facility, Cliff made sure that the site was surrounded by trees to give as much protection as possible. Wind is scaled up by a factor of five, so a 10 kn breeze scales up to a 50 kn gale! However, it is valuable to have actual conditions, as a master or pilot never knows what they are going to be faced with during an actual pilotage.

Two of the facilities worldwide use wave generators. In the early days at Port Ash they did generate swell waves, but not anymore, as they found that they had to filter the effects of waves bouncing off the edges and giving confused wave patterns on the lake. The simulation of swell waves was of limited value during shiphandling training.

The bottom of the lake is a hard-packed rolled-clay base which was graded 20 years ago to the charted depth. Maintenance of the lake facility means that the bottom of the lake requires occasional dredging to maintain the charted depths.

The models are ballasted to change the loading and trim during exercises, e.g. changing the loading of the Panamax vessel from light ballast through to full load. As a matter of interest, a person on board (the shiphandler) scales up to approximately 2500 t, so the effect on trim and stability can be significant.

During the introduction to a new group of trainees, the effect of the time-scale being reduced by a factor of five, and so things happen five times as fast as at full scale, is emphasised. It forces the trainees to make decisions quickly and to act. Port Ash allows a period of time for the trainees to adjust and, by about halfway through their first session on the water, most have adjusted. Visually, they can see what is happening in real life, compared to what the speed log is saying; 5 kn coming in to a berth is probably going to result in a hard landing.

Training courses typically have 4–6 commercial participants, but sometimes as low as 2. Naval teams often number 8–10 but, logistically, they can only run so many ship models at one time. They need an experienced pilot, usually retired, conducting the training in a structured manner, rather than saying "Here's a boat, off you go!"

They occasionally have pilots from the USA attending Port Ash for training courses. The facility is not used as a fast track to a master's certificate; it is a part of the overall training/refreshing regime.

There has been an increase in the number and availability of electronic simulators; as the cost has come down, so the proliferation has increased. One facility in Europe had both manned models and an electronic simulator located on the same site, but they have now moved them apart. They have overlapping functions, but each has specific benefits.

Model building is a whole ballgame in itself, and early models were all designed and built by Cliff and Andrew using their model-building and pilotage skills in concert. A plug was made of the first model *Triton* (Handymax), which was used to create an extendable fibreglass mould of the hullform. The plug was then used to create the hull for the very first model *Triton* itself, and a lengthened version *Mentor* (Panamax) was then constructed from the mould by local Newcastle boatbuilders, who have constructed the remaining models at Port Ash. Timber is subject to rot, so the models are usually fibreglass, 8–10 mm thick, and using stainless-steel fittings. Then comes the electronics—they use an integrated system with stand-alone computers. The radio-controlled tug models have azimuthing thrusters (replicating the tugs themselves), and qualified tugmasters come to Port Ash to drive them for the training exercises.

Two of the other facilities worldwide have azimuth propulsion in their model fleets.

The "thank you" bottles of wine have subsequently been delivered via eGift cards.

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

The Presenters

Andrew commenced his maritime career with Howard Smith Shipping in 1983. Sailing as a Deck Officer in their tankers and bulk carriers, he obtained his Master Class 1 Certificate of Competency in March 1993. In August 1997 he commenced employment as a Marine Pilot with the Newcastle Port Corporation, spending the last 12 years as a Check Pilot, and relieved in the position of Acting Harbour Master for the Port of Newcastle on occasion. Andrew has extensive experience handling ships ranging from tugs to cape size. In July 2014, Andrew commenced employment with Port Ash Australia as General Manager.

Cliff commenced his seagoing career in 1959 as a midshipman with Alfred Holt and Co. Blue Funnel Line, UK. Upon completion of his apprenticeship, he then sailed as Third Officer with MacAndrews Line, before emigrating to Australia in 1964. He then joined Howard Smith as Third Officer, and served for ten years on tankers and bulk carriers, the last three years in command. In 1973 he joined the Newcastle Pilot service which, at that time, was owned by the Maritime Services Board of NSW. He served for 27 years as a Pilot, the last eight years as a Check Pilot for the Port of Newcastle. Cliff has extensive experience handling ships ranging from tugs to VLCC in size. In 2000, Cliff retired as a Check Pilot from the Newcastle Port Corporation, and went on to establish Port Ash.

Phil Helmore

December Drinks

The ACT Section held their annual social event, December Drinks, for members and friends in the enclosed courtyard at the Capital Brewery, Fyshwick, on Tuesday 7 December. After 18 months of virtual presentations, it was great to see each other's faces again, with 15 members attending (great for the ACT's small membership). A number of attendees suggested that it would be good to make this a regular occurrence, especially with the reduced in-person hours of many Canberra offices at the moment. The ACT Section hopes to hold similar events through 2022—so watch this space!

Lily Webster

New South Wales

SMIX Bash

Following the cancellation of SMIX Bash 2020 due to the pandemic, the 21st SMIX (Sydney Marine Industry Christmas) Bash was held on Thursday 2 December 2021 aboard the beautifully-restored *James Craig* alongside the North Wharf, Darling Harbour, from 1730 to 2130. The event was organised jointly by RINA (NSW Section) and the IMarEST (ACT & NSW Branch). About 150 guests (limited by pandemic restrictions) came from the full spectrum of the marine industry, including naval architects, marine engineers, drafters, boatbuilders, machinery and equipment suppliers, regulators, classifiers, surveyors, operators, managers, pilots, navigators, researchers, and educators. Equally importantly, the full spectrum of age groups was represented, from recent graduates to the elders of the marine community. Sydney turned on a beautiful evening, and many partners in attendance enjoyed the view of Darling Harbour and the city lights from the decks of *James Craig*.

James Craig berthed at the North Wharf, Darling Harbour
(Photo Phil Helmore)

Drinks (full-strength and light beers, Australian sparkling, cabernet merlot and cabernet sauvignon wines, orange juice and soft drinks) and canapés (Peking duck pancakes, roast pumpkin and fetta tartlets, Thai-style spring rolls with sweet chilli, parmesan-crusted chicken skewers, and salt-and-pepper prawn cutlets with a chilli glaze) were provided. Formalities were limited to one speech by the Chair of the NSW Section of RINA and Chair of the Organising Committee, Belinda Tayler, who welcomed the guests and thanked the industry sponsors, and then a few words from each of the Platinum Sponsors, Scott Willey for Atlantic and Peninsula, Luke Halliday for Halliday Engineering, and Tony Armstrong for TeeKay.

TeeKay provided the raffle prizes and the winners, drawn by Tony Armstrong and presented by Adrian Broadbent, were:

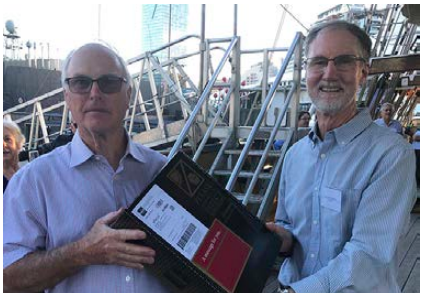
Third	Greg Hellessey	Chandon Celebration Hamper
Second	Felicity Kelleher	Moet with Australian Sweets and Nuts Hamper
First	Jan Arnott	Christmas Bites with Moet Hamper

Belinda Tayler welcoming guests
(Photo Phil Helmore)

Belinda Tayler with Scott Willey
(Photo Phil Helmore)

Belinda Tayler with Luke Halliday
(Photo Phil Helmore)

Belinda Tayler and Tony Armstrong preparing to draw the raffle prizes
(Photo Phil Helmore)



Adrian Broadbent presenting third-place raffle prize to Greg Hellessey (Photo Phil Helmore)

Adrian Broadbent presenting second-place raffle prize to Felicity Kelleher (Photo Phil Helmore)

Adrian Broadbent presenting first-place raffle prize to Jan Arnott (Photo Phil Helmore)

A delicious buffet dinner (roasted beef fillet served with a shiraz jus, seasoned turkey breast roast with cranberry, honey leg ham, roasted seasonal vegetables, herb buttered chat potatoes, penne pasta tossed in pesto, Sydney rock oysters, smoked salmon, BBQ marinated octopus and calamari, and Greek, coleslaw, Caesar, Tabouli, and Vietnamese noodle salads, with brewed coffee and tea selection) was served in the 'tween decks, with afters (individual ice creams, mini mixed tarts and cream, and Australian cheese and crackers) served on deck, and many tall tales and true were told.

Servery in the tween deck (Photo Phil Helmore)

Dinner in the tween deck (Photo Phil Helmore)

This year's event was sponsored by the following organisations:

Platinum

- Atlantic and Peninsula Australia
- Halliday Engineering
- TeeKay

Gold

- Adroita
- AkzoNobel
- Ausbarge Marine Services
- Ausbright Electrical Solutions
- Birdon
- DNV GL
- Electrotech Australia
- Eptec
- Wärtsilä
- NSM
- SDS
- Shadbolt Group
- Sydney City Marine

Silver

- ASO Marine Consultants
- Asena
- Damen
- Maritime Survey Australia
- Thompson Clarke

Bronze

- Lightning Naval Architecture

Our thanks to them for their generosity and support of SMIX Bash 2021, without which it could not happen.

Some of the stayers, who were shown the gangway late in the peace, rocked on to other venues and continued to party until the wee small hours.

Committee Meetings

The NSW Section Committee met on 18 January and, other than routine matters, discussed:

- SMIX Bash 2021: SMIX Bash 2021 was successful; the weather gods smiled and we had close to the allowable number of 150 attendees on board *James Craig*; projections are for a small surplus in funds. SMIX Bash 2022 has been pencilled in for Thursday 1 December with the Sydney Heritage Fleet.
- Technical Meeting Program 2022: Four presentations have been secured for the RINA contribution to the program.
- Finance: Accounts for 2021 to be finalised and audited prior to the NSW Section AGM on 2 March.

The next meeting of the NSW Section Committee is scheduled for Tuesday 15 March.

Wärtsilä Products and Solutions—Powering a Sustainable Maritime Future

Ashar Khan, Manager New Build Projects Australia-Pacific, Wärtsilä, gave a presentation on *Wärtsilä Products and Solutions—Powering a Sustainable Maritime Future* 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 2 February. This presentation attracted 20 participating on the evening.

Introduction

Ashar began his presentation with on overview of Wärtsilä's operations. Founded in 1834, Wärtsilä is a global leader in innovative technologies and lifecycle solutions for the marine and energy markets. The company emphasises innovation in sustainable technology and services to help customers continuously improve their environmental and economic performance. Their dedicated and passionate team of 17 500 professionals in 200 locations in more than 70 countries shape the decarbonisation transformation of their industries across the globe. In 2021 Wärtsilä's net sales totalled EUR 4.8 billion. Wärtsilä is listed on Nasdaq Helsinki

Wärtsilä's operations around the world
(Map courtesy Wärtsilä)

Wärtsilä offers new-build engines, propulsions systems, hybrid technology and integrated powertrain systems. In the services arena they have a global network of maritime expertise, performance-based agreements, planned and unplanned maintenance services, and upgrading and optimising installations.

The marine product portfolio provides upgradable solutions for customers' future challenges, including

- core stand-alone engines and propulsion systems
- key complementary technologies for catalytic NOx reduction, fuel-gas supply systems, and electrical and power-management systems; and
- an upgrade path towards decarbonisation via fuel flexibility, hybrids and IMO target compliance.

They serve most marine segments including passenger vessels (cruise, ferries and yachts), offshore (oil-and-gas and wind), merchant (bulk carriers and tankers, cargo vessels, container vessels, LNG carriers, ro-ro and PCTC vessels), and special-purpose vessels (including fishing, navy and tugs).

Engines and Gensets

Wärtsilä is continuously developing its portfolio of gas and multi-fuel engines to suit different marine applications. As well as medium-speed engines, they now have high-speed engines.

Wärtsilä High Speed

Lighter, smarter, greener, launched in 2018, for main propulsion and genset applications

12V (27 L) and 16V (36 L), mechanical output 749–1340 kW, electrical output 675–1155 kW at 1500–1900 rpm.

Wärtsilä Medium Speed

Main propulsion and genset applications; available in diesel, dual fuel or pure gas.

Propulsion Engines: output 800–19400 kW

Dual fuel output 1110–18320 kW at 600–1200 RPM

Gensets (50 and 60 Hz): electrical output 700–9370 kW at 1200–750 RPM

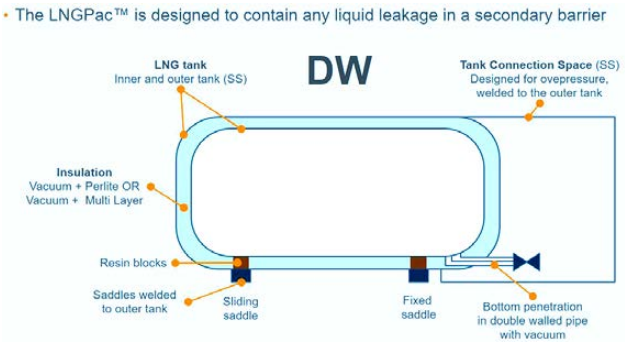
Dual fuel: electrical output 920–9220 kW at 1200–750 RPM

Pure gas: electrical output 4225–8450 kW at 720–750 RPM

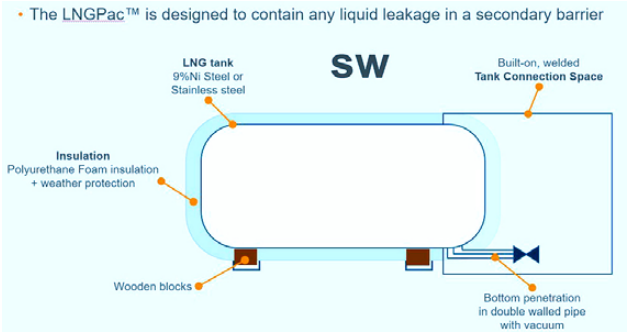
[*The Wärtsilä 31 medium-speed engine was awarded the Guinness World Record title for the most efficient four-stroke diesel engine in the world in 2015*—Ed.]

Fuel Gas System

The Wärtsilä LNGPac™ system is based on an IMO C-type LNG storage tank with either double-walled vacuum or single-walled polyurethane (PUR) insulation. All LNG pipelines, e.g. from the bunker station to the tank, are insulated. All necessary process equipment is installed in a separate unit, which can be either mounted directly to the LNG tank or placed remotely. The LNGPac™ system has been designed in compliance with international safety requirements and operational standards specific to a gas-processing plant.



Wärtsilä's LNGPac™ double-wall tank
(Diagram courtesy Wärtsilä)



Wärtsilä's LNGPac™ single-wall tank
(Diagram courtesy Wärtsilä)

Propulsors and Gears

Wärtsilä Propulsion solutions and services are built on unique experience, technical and engineering expertise, all focused on delivering the highest efficiency, safety and

IMO C-Type LNG-Tank	Double-wall tank	Single-Walk tank	
LNG Volume	25 – 500 cbm	300 – 5000 cbm	500 – 5000 cbm
Dmax (2 < L/D < 7)	6.5 m	10 m	10m
Design pressure	4 – 9 barg	4 – 7 barg	4 – 7 barg
Insulation	Vacuum	PUR	PUR
Tank type	Single-lobe	Single-/Bi-lobe	Multi-lobe
Positioning	Horizontal or Vertical, Top- or Below-deck		
Secondary barrier	Not required		
Bunkering capacity (DN 50-200)	40 – 1000 cbm/h		

Details of Wärtsilä's LNGPac™ tank
(Table courtesy Wärtsilä)

manoeuvrability to enable the future of vessel propulsion. Offerings include gears and transmissions, propellers, thrusters, waterjets, and propulsion control systems.

Controllable-pitch Propellers

Wärtsilä Controllable Pitch (WCP) propeller systems provide excellent performance and manoeuvrability, and are recommended for vessels with frequent sailing routes that involve multiple operating conditions. It is an ideal choice for diesel-mechanical propulsion with both medium-speed and low-speed diesel engines. The WCP comprises a boss, propeller blades, shafting, hydraulics, control system and any further accessories required.

Technical Data

- Power range starting from 500 kW, no upper limit.
- 4- or 5-bladed propellers starting at a diameter of 1200 mm.
- Bronze or stainless-steel propellers.
- Various boss types, depending on the application.
- Compliant with all ice classes.

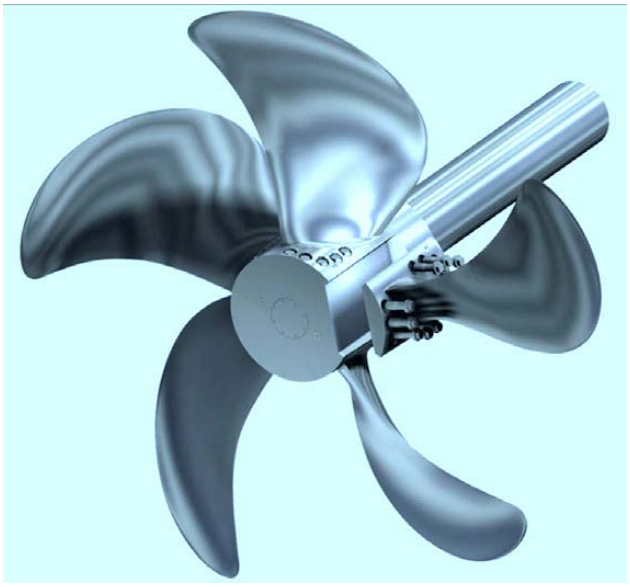
Options/Add-ons

- US EPA Vessel General Permit 2013 compliance.
- Zero-pollution sterntube.
- Underwater replacement of propeller blades.
- Trailing propellers or full blade feathering.
- Navy/research/fishing requirements for low noise signature.
- EnergoPac rudder or EnergoProFin boss cap for increased efficiency.
- Continuous oil monitoring for increased reliability.
- Wärtsilä high-performance (HP) nozzle.
- Shaft withdrawal interval reduction.
- Cruise control and fuel savings with EcoControl functionality.

Fixed-pitch Propellers

Wärtsilä fixed-pitch propellers range from 1 to 12 m in diameter, and up to 95 t mass can be produced.

In addition, the Wärtsilä Built-up Propeller (BUP) is an attractive alternative to a monobloc propeller. The easily (de)mountable blades and the possibility of under water (de)mounting enable the propeller blades to be replaced or repaired with minimum interruption to the normal operating service. The BUPs are supplied in stainless steel or bronze. Connections to the propeller shaft are made using a flange and fit bolts. Most BUPs are delivered with 4- and 5-blade propellers, but 6-bladed propellers can also be delivered on request. There are no propeller diameter or mass limits.



Wärtsilä's Built-up propeller
(Image courtesy Wärtsilä)

Steerable and Transverse Thrusters

Wärtsilä Thrusters are available in different series covering a wide range of customer needs.

Wärtsilä Steerable Thrusters (900–3300 kW)

The Wärtsilä Steerable Thruster (WST) series is intended for tug or offshore/wind-farm support vessel applications, and for river/inland waterway vessels.

Wärtsilä Retractable Thrusters (1000–6500 kW)

Retractable thrusters provide additional manoeuvring and station-keeping capabilities. The thruster can be fully retracted inside the hull for transit or shallow-draught operations. Retractable thrusters up to 4500 kW are available in L- and Z-drive configuration. All WSTRs feature an 8° tilted propeller gearbox design to minimise thruster-hull and thruster-thruster interactions. LMT types are equipped with a 3° tilted nozzle.

Wärtsilä Underwater Mountable Thrusters (2435–6500 kW)

The Wärtsilä WST-U designated underwater mountable thrusters belong to a series with several added features, such as an increased power range, an 8° tilted propeller gearbox, and the Wärtsilä Thruster Nozzle to provide superior and reliable DP performance. The underwater mountable thrusters from the LMT series are available for the lower end of the power range.

Wärtsilä Transverse Thrusters (550–603 kW)

CP and FP options are available.

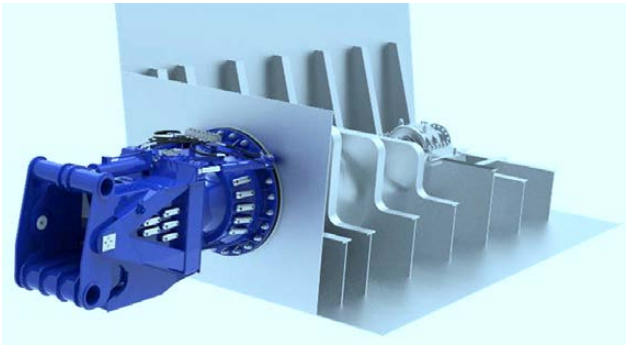
Waterjets

Wärtsilä waterjets have been developed in line with the latest efficiency, performance and operating demands for fast ferries, crew-transfer vessels, patrol vessels, workboats, and luxury yachts. They are available in full duplex stainless steel and aluminium, and range from 500 kW to 50 MW.

Modular WXJ Series

This waterjet series is a modular design, and comes with loose outboard parts, thrust bearing, hydraulic power pack, machinery controls (LMCS) and PTO (gearbox mounted). Options include inboard or outboard hydraulics. Material is duplex stainless steel. Excluding the inlet, design is by

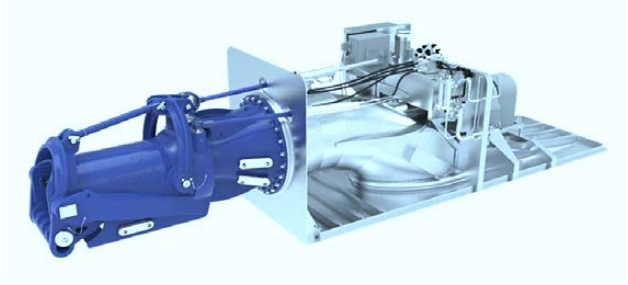
Wärtsilä with fabrication at the building yard and becomes part of hull construction. Sizes range from 450 to 2180 kW.



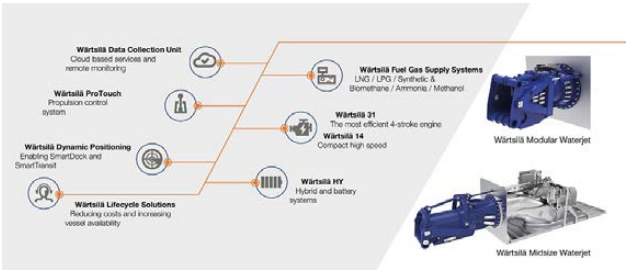
Wärtsilä's modular WXJ series
(Image courtesy Wärtsilä)

Midsize LJX Series

This waterjet series is a package design, with all components mounted on a skid including outboard parts, thrust bearing, hydraulic powerpack, machinery controls (LMCS), and PTO. The hydraulics are always inboard (skid mounted). Materials are aluminium for the inlet and outboard parts (jetavator and reversing plate) and duplex stainless steel for the stator bowl, impeller and shaft. Including the inlet, design and fabrication is by Wärtsilä (the skid is completely mounted in the hull). Sizes are 510, 570, 640, 720, and 810 kW.



Wärtsilä's midsize LJX series
(Image courtesy Wärtsilä)



Wärtsilä's integrated waterjet solutions
(Image courtesy Wärtsilä)

Gearboxes and Transmissions

Wärtsilä gears have been designed to meet the highest standards of operational efficiency, reliability and low noise and vibration.

Gear Configurations

- 1-speed gearboxes, for installations with a single engine and propeller operating at a constant propeller speed. The Wärtsilä SCV designation indicates a vertical offset, while SCH represents a horizontal offset.
- 2-speed gearboxes, for installations with a single engine and propeller able to operate at two selectable propeller speeds. The Wärtsilä SCV/2 designation indicates a vertical offset, while SCH/2 represents a horizontal offset.
- Double gearboxes, for installations with two engines and one propeller operating at a constant rotational speed. "Twin-in single-out" gears have Wärtsilä designation TCH.
- Special gearboxes, e.g. gearboxes with both horizontal and vertical offsets, are available upon request and are customised for the specific application.
- All Wärtsilä gears can be supplied with built-in multi-disc clutches for engaging the propeller.

Decarbonisation and Future Fuels

Shipping contributes 2.6% of the global emissions (based on 2018 figures). CO_2 is the largest of the greenhouse gases (GHGs), while other important ones are methane (CH_4) and nitrous oxide (N_2O).

In 2015 the United Nations signed the Paris Agreement which set an ambition to limit global warming to well below 2°C above pre-industrial levels and pursue efforts to limit it to 1.5°C — in part by pursuing net carbon neutrality by 2050.

Following the Paris Agreement, the International Maritime Organisation (IMO) set mid- and long-term targets for shipping to reduce its total annual GHG emissions by at least 50% by 2050 compared to 2008, whilst pursuing efforts towards phasing them out entirely. It is further preparing short- and mid-term regulations which will step-by-step increase the reduction of carbon emissions. This is covered in Marpol Annex VI.

The Poseidon Principles

The Poseidon Principles are the world's first sector-specific, self-governing climate alignment agreement amongst financial institutions. The principles establish a global framework for assessing and disclosing the climate alignment of ship finance portfolios. They are consistent with the policies and ambitions of the International Maritime Organisation, including its ambition for greenhouse gas emissions to peak as soon as possible and to reduce shipping's total annual GHG emissions by at least 50% by 2050.

The Sea Cargo Charter

The Sea Cargo Charter establishes a framework for assessing and disclosing the climate alignment of ship chartering activities around the globe. It sets a benchmark for what it means to be a responsible charterer in the maritime sector and provides actionable guidance on how to achieve this.

The Sea Cargo Charter is consistent with the policies and ambitions of the International Maritime Organization (IMO), including its ambition for greenhouse gas emissions to peak as soon as possible and to reduce shipping's total annual GHG emissions by at least 50% by 2050.

As a result, the Sea Cargo Charter will enable cargo owners and shipowners to align their chartering activities with responsible environmental behaviour and incentivise international shipping's decarbonisation, to shape a better future for maritime shipping and society.

The Sea Cargo Charter is applicable to bulk ship charterers.

The EU Fit for 55 Package

The European Union's legislative proposals cover a wide

range of policy areas including climate, energy, transport and taxation, setting out the ways in which the Commission will reach its updated 2030 target in real terms.

In the maritime area, as per the updated MEPC 76, ships will be given a rating with respect to their energy efficiency (A, B, C, D or E, where A is the best). Administrations, port authorities and other stakeholders as appropriate, are encouraged to provide incentives to ships rated as A or B, thus sending out a strong signal to the market and the financial sector. A ship rated D or E for three consecutive years is required to submit a corrective action plan, to show how the required index (C or above) would be achieved. Such category shall also be exposed to financial risk, charter risk and regulatory risk.

Developments and Initiatives by Wärtsilä

Wärtsilä expects to launch a ground-breaking two-stroke future fuels conversion solution, and has joined forces with MSC for a technology demonstration in the first quarter of 2022.

Wärtsilä and Simon Møkster Shipping Norway are to study the feasibility of ammonia and LNG dual-fuel operations.

Wärtsilä and SHI South Korea have agreed to collaborate on ammonia-fuelled engines for future newbuilds.

Wärtsilä and Eidesvik Offshore Norway are to cooperate in the world's first ammonia conversion project.

Wärtsilä and Grieg Edge are collaborating to develop a ground-breaking new tanker, MS *Green Ammonia*. The vessel, which will both transport and run on green ammonia, is expected to be in operation as early as 2024. The

development project is part of the Zero Emissions Energy Distribution at Sea (ZEEDS) initiative.

Knutsen OAS Shipping AS and Repsol, with the Sustainable Energy Catapult Centre, will commence the world's first long-term full-scale testing of ammonia as a fuel in a marine four-stroke combustion engine using a NOK20 million grant from the Norwegian Research Council through the DEMO 2000 programme.

Wärtsilä gas engines to burn 100% hydrogen are on the way; engines with blends of up to 60% hydrogen and 40% natural gas have already been successfully tested.

Wärtsilä expects that the first ammonia-fuelled engine would be ready by 2023, and the first hydrogen-fuelled engine by 2025.

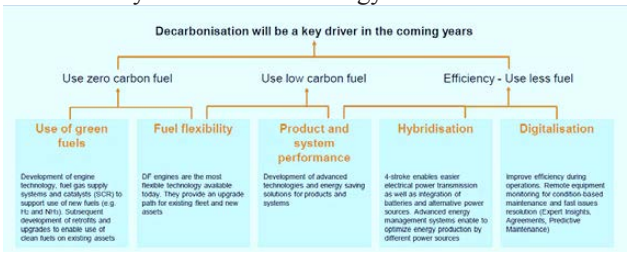
Bio- and Hydrogen-based fuels

Bio- and hydrogen-based fuels are needed to decarbonise the shipping industry. However, there are business risks which must be considered.

- Fuel Availability: Variations due to local regulations and feedstock, production capacities and existing infrastructure.
- Increased CapEx and OpEx: Carbon-neutral fuels typically require existing equipment to be replaced and are likely to be more expensive than fossil fuels, at least initially.
- Impact on Vessel Structure: Many carbon-neutral fuels will have lower volumetric energy density compared to HFO and LNG, and require larger tanks to maintain vessel endurance.
- Increased Complexity: Managing some cryogenic or toxic fuels will require more complex solutions to comply with rules and regulations.
- Shipyard Capacity: There is a mismatch between the number of shipyards capable of handling the fuel conversion work and the size of the international commercial fleet.

Wärtsilä's Technology Developments

Wärtsilä's technology developments are aligned with long-term industry needs and technology trends.



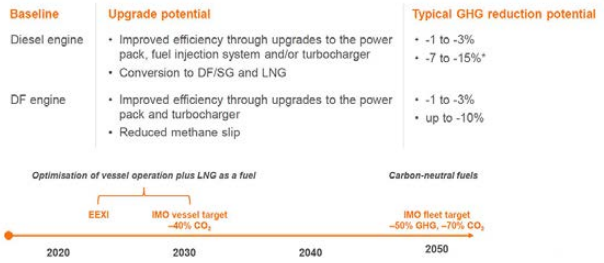
Wärtsilä's technology developments
(Image courtesy Wärtsilä)

Engine Technology Development

The development of engine technology is ongoing. The time schedule and cost impacts for engine performance are as follows:

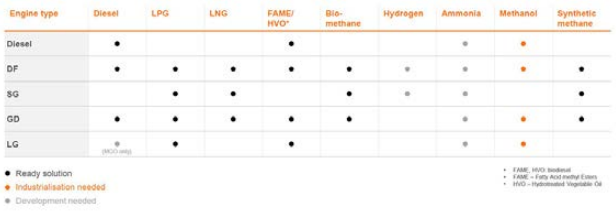
- Bio or synthetic methane (CH_4): Verified in 2003; contains about 99% methane and can readily be used in liquid form with equipment made for LNG.
- Methanol (MeOH): Verified in 2015; A methanol conversion package is available for the ZA40 engine and Wärtsilä has the technology to burn methanol. The next step is to industrialise this technology on the relevant portfolio engines according to market needs.
- Ammonia (NH_3): Expected to be verified in 2023; Wärtsilä has technologies which are capable of using ammonia, and test are ongoing in Stord, Norway.
- The needed combustion concepts to maximise engine performance and related safety technologies are currently being investigated.
- Hydrogen (H_2): Expected to be verified in 2025; Wärtsilä's gas engines are already able to blend LNG with up to 60% hydrogen, and combustion concepts have been made for 100% hydrogen. Future efforts will be directed towards maximising engine performance.

Total greenhouse gas emissions can already be reduced on existing engines.



Reduction potential of GHG emissions on existing engines
(Diagram courtesy Wärtsilä)

We have the knowledge and technologies to burn most of the future fuels; development is on-going for the rest.



Fuel technology for future fuels
(Chart courtesy Wärtsilä)

We will have fuel storage and supply systems for most future fuels.

Fuel storage and supply systems for future fuels
(Chart courtesy Wärtsilä)

The dual-fuel engine is an excellent fuel-flexible choice for the future, operating on diesel and Otto cycles, with three separate fuel-injection systems. As a matter of interest, Wärtsilä DF engines have been chosen for the new Spirit of Tasmania vessels, and for the new SeaRoad ro-ro vessel.

Wärtsilä Solutions and Concepts for Decarbonisation

Wärtsilä solutions and concepts for decarbonisation include energy-saving devices, engine power limitation, fuel conversions, batteries and shore connections.

Energy-saving Technologies

To meet the requirements for 2030 and beyond, Wärtsilä has been proactive in developing existing solutions and innovating and partnering to ensure that there are options available to suit all vessel types and operating profiles.

Solutions include

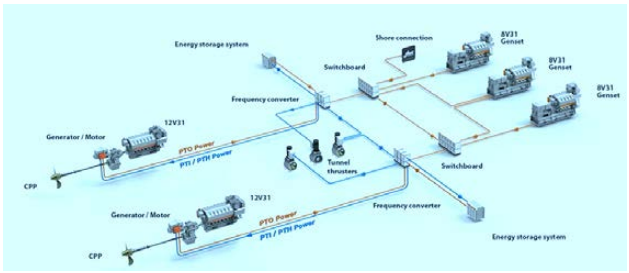
- Air-lubrication systems with microbubbles generated by a compressor blown under the hull; these have been approved by classification societies. This solution has been developed by Silverstream Technologies.
- Gate rudders (with a rudder either side of the propeller) which improves the turning efficiency and manoeuvrability. Wärtsilä, with the consent of all joint Japanese patent holders developing gate-rudder technology, has announced the signing of a licence and co-operation agreement with Kuribayashi Steamship Co. for future development, sales and servicing of gate rudders.
- EnergoProfin, i.e. propeller-boss cap fins, which reduce the propeller boss vortex resulting in fuel savings and a reduction of underwater noise and vibration.
- EnergoFlow, i.e. a pre-swirl stator (consisting of multiple curved fins and a ring) which creates optimal inflow for the propeller by guiding one side of the stern flow in the opposite direction to the propeller rotation, improving fuel efficiency and reducing NOx and CO_2 emissions.
- EnergoPac, i.e. an integrated propeller and rudder design with the aftmost shaft bearing integrated with the rudder, reducing flow separation behind the propeller boss and thus reducing fuel consumption.
- High-performance nozzle to increase thrust and reduce fuel consumption.
- Rotor sails, i.e. using the principle of the Magnus effect whereby useful thrust is created by rotation of a rotor in an air flow, resulting in a difference in pressure on the different sides of the rotor; the thrust depends on the wind angle and speed, with the maximum thrust being created when the wind direction is just aft of the beam. The system has been developed by Anemoi Rotor Sail System and Wärtsilä is an authorised Seller. [*Rotor sails were first developed by the German aviation engineer, Anton Flettner, in the 1920s*—Ed.]
- Wärtsilä's OPTI Design methodology is the result of highly experienced design engineers having access to the very latest and most sophisticated software and analysis tools, and aims to achieve a perfect match between the propeller, engine and hull.

Wärtsilä Propulsion Designs and Concepts

Here Ashar showed diagrams of a number of Wärtsilä solutions for various types of vessels.

Ro-ro Diesel-electric PTO/PTI and Hybrid

The hybrid solution of shaft generators, converters and transformers includes a 5000 kWh energy-storage system, enables zero emissions operation while in port to meet RINa Green Plus class notation, and deliver fuel savings.



Propulsion concept for hybrid diesel-electric ro-ro ferry
(Diagram courtesy Wärtsilä)

Ferry with Zero Emissions

This battery solution enables ferry operations using an all-electric propulsion solution with shore charging at the destination. This offers zero-emissions transportation and faster response time to thrusters, which allows better manoeuvrability and efficiency.

Ferry Diesel-electric and Hybrid

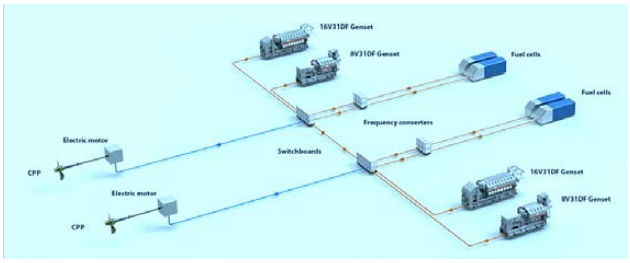
The flexible hybrid solution allows the vessel to operate the engines at their optimal load by providing peak shaving, which removes variable loads and acts as spinning reserve. This reduces fuel consumption and associated emissions, increases engine maintenance intervals and reduces noise levels when needed.

Cruise Vessel Fuel-cell Diesel-electric

The fuel cell supplies 2.5 MW for hotel load and 1.5 MW for propulsion, plus 2 MW peak power for manoeuvring. This offers silent operation in harbour and at very low speed, and fully-electric operation for zero emissions.

Bulk Carrier Hybrid with PTO/PTI and Shore Connection

The fully-integrated Wärtsilä hybrid solution will enable the vessel to sail in and out of port, and to perform cargo

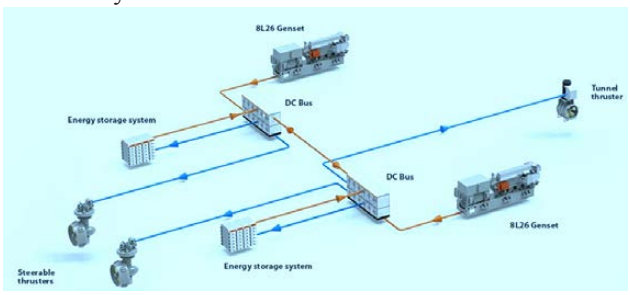


Propulsion concept for fuel-cell diesel-electric cruise vessel
(Diagram courtesy Wärtsilä)

operations, completely emissions-free. In addition, the battery will handle the variable load when sailing, allowing the main engine to work on a stable load. This will meet port regulations where reduced emissions are required.

Tug Hybrid

The variable load needed for tug operations is ideally suited to a hybrid configuration—offering peak shaving and load balancing so that the engines can operate at their optimal level. The hybrid system also allows the tug to run fully electrical in low-load conditions in and out of harbour and when waiting, and power boost when additional power is needed. Hybrid can also allow smokeless start.



Propulsion concept for hybrid tug
(Diagram courtesy Wärtsilä)

Fishing Vessel Hybrid

For a fishing vessel with variable loads, the hybrid system allows the main engine to run at optimal load and the total installed power can be reduced, thus allowing the main engine installation to be smaller to match the power needed. The battery and auxiliary engines supply additional power for propulsion boost in harsh weather conditions and offer peak shaving.

Shore Connection

When a ship docks in a port, it can be connected to an onshore power supply, enabling the engines to be shut down; this reduces harmful emissions, visible smoke, noise pollution and ensures the use of more-efficient/greener energy to meet its power requirements.

The Wärtsilä SAMCon system comprises

- Cable reel
- Cable reel control box
- Monitoring and control cabinet
- Medium voltage switchboard
- Transformer
- 2nd reel for connection to ship.

Container Features

- Up to 7.2 MVA transferable power at 6600 V 60 Hz and 45°C
- Usable on port and starboard sides

Wärtsilä's SAMCon shore-connection container
(Photo courtesy Wärtsilä)

- Container including CSC certificate
- Design according to IEC 80005-1
- Safe operation area
- Electric cable reel drive including tension control
- Shore interface designed for ports of West Coast California (others on request)
- Maintenance-friendly technology.

Summary

Wärtsilä's goal is to be the leading power solution in the smart marine ecosystem.

There is no one single future fuel—there will be a whole variety of fuels in use. Investing in fuel flexibility and the combustion engine will mitigate compliance and business risks introduced by future fuels. Wärtsilä will continue to be a supplier of complete systems and energy-saving solutions, regardless of the fuel. When it comes to engines, Wärtsilä dual-fuel engines are an excellent choice for introducing future fuels. This presentation has shown a major part of what Wärtsilä can offer at the moment, but there is more on the horizon — there are projects under development to increase Wärtsilä's offerings. Customers most probably need to take a step-by-step approach and do different kinds of upgrades over the coming years to comply with CII and EEXI.

Questions

Question time was lengthy, an raised some further interesting points.

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

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

Phil Helmore

CLASSIFICATION SOCIETY NEWS

LR becomes World's First Renewable Energy Certification Body for Marine Energy

Lloyd's Register (LR) has been accepted as the world's first Renewable Energy Certification Body (RECB) for marine energy by the International Electrotechnical Commission's Renewable Energy System, (IECRE), which operates the global conformity assessment system in the three electrically-producing renewable-energy sectors: solar photovoltaic (PV) energy, wind energy, and marine energy.

With IECRE recognition as an RECB for the marine energy market, which refers to the energy harnessed from wave, tidal, river current or ocean thermal gradient sources, and the wind sector, LR is now able to certify complex hybrid renewable-energy projects on behalf of the IECRE which involve multiple technologies, such as wind, wave and tidal.

Through its RECB status, LR can conduct end-to-end certification activities for marine energy converters which seek compliance with the IEC 62600 technical specification and operational documents published by the IECRE. Furthermore, LR can also support marine energy technology developers by providing independent assessment and certification, which uses IEC standards as its basis.

Mark Darley, LR Marine & Offshore Director, said "Lloyd's Register's new status as the world's first IECRE Renewable Energy Certification Body for Marine Energy is a testament to our strong capabilities across a range of technical disciplines and our commitment to safety in the renewable-energy market. We look forward to working with new clients in the future, certifying marine energy or complex hybrid renewable-energy projects in line with the IECRE scheme."

"Given the expected rapid growth of the marine energy industry, we anticipate that the IECRE system will be widely adopted by the industry and become increasingly important in providing the assurance required by project stakeholders, which LR can provide, while ensuring that this process adds value to projects," Darley added.

Alistair Mackinnon, IECRE Chair, said "Marine energy is the newest of our renewable-energy technologies in IECRE and our members have worked exceptionally hard to develop a robust conformity assessment system to meet the needs of this exciting emerging sector. IECRE is delighted to welcome Lloyd's Register as its first renewable-energy certification body for technology qualification (TQ). As the sector develops, IECRE is keen to offer new deliverables to help address the global climate challenge and the marine energy sector has an important role to play in maintaining a sustainable climate for future generations."

Jonathan Colby, Convener for the Marine Energy Sector Working Group (ME-SWG), said "On behalf of the Marine Energy Sector Working Group of the IECRE, I extend my congratulations and excitement for Lloyd's Register to join as the first Renewable Energy Certification Body within the marine energy sector. Certification plays a critical role in the development of the marine energy industry and the third-party verification of compliance with international consensus-based standards, such as the IEC TS 62600-4 on Technology Qualification, is essential to reduce risk and increase market confidence in the innovative technologies used to extract energy from waves, tides and other water currents."

LR News, 29 November 2021

DNV Publishes Competence Standard and Recommended Practice for Remote-control Operations in Shipping

DNV has introduced the shipping industry's first competence standard for vessel remote-control centre operators (RCCO). The standard is supported by a new recommended practice which offers a certification scheme for RCCOs. Together, they provide a framework for training, assessing, and certifying personnel working in remote-control centres which support or manage operations at sea.

Intelligent software systems and enhanced ship-to-shore connectivity have laid the groundwork for the growth of remote solutions and autonomy in shipping. Unmanned vessels are already expected to begin operations in the near future.

Ensuring that these vessels operate at an equivalent level of safety is essential to building confidence and realising the potential of these technologies. However, despite the technical solutions being in place, competence requirements for those monitoring, supporting and/or controlling these ships have not been defined.

The new DNV competence standard for remote-control centre operators (DNV-ST-0324) and the supporting recommended practice (DNV-RP-0323) change this. They were developed in collaboration with Kongsberg Maritime, Wilhelmsen, the University of South-Eastern Norway, and the Norwegian Maritime Authority.

"Making sure that shore-based staff are prepared for autonomous, remote-controlled or remotely-supported operations at sea is a big challenge," said Torsten Schröder, SeaSkill™ Service Manager, Competence & Learning at DNV Maritime. "Because when it comes, the wider application of these technologies, trust in the systems, and the people managing these operations is paramount. This is why we are so pleased to have developed the RP with expert partners from across the industry. Having a wide range of expertise was essential to devising a uniform and controlled approach to the training, assessment and certification of RCCOs."

The recommended practice, DNV-RP-0323, gives guidance to centres conducting examinations of remote-control centre operators and issuing personnel certificates as a certification body. It also covers the competence-building process for candidates before undertaking an RCCO examination, for example learning programmes and practice sessions in the centres themselves.

The DNV SeaSkill™ standard ST-0324 provides a foundation for the entire process. It lists the required competencies for the operation of autonomous or remotely controlled and/or supported ships.

It also covers competency in:

- Emergency handling and resource management within a remote control centre (RCC).

- Communication with third parties on behalf of the ship under remote-control.
- Man-machine interaction.

RCCO certificates can be registered in an existing DNV online database, making it possible for interested parties to verify qualifications and validity of an RCCO certificate.

To ensure transparency in this emerging field and build trust among users and the public, examination centres, certification bodies, as well as the training centres, their RCC simulators and learning programmes for RCCOs can also be certified by DNV.

DNV News, 29 November 2021

LR Supports Drive for Sustainable Finance

Six of the world's leading marine insurers, supported by a drafting committee which includes Lloyd's Register (LR), have launched a ground-breaking initiative to provide transparency on carbon emissions and support the shipping industry's green transition.

The Poseidon Principles for Marine Insurance are a framework to quantitively assess and disclose the climate alignment of marine insurers' underwriting portfolios. This pioneering initiative makes marine insurance the first line of business to establish a sector-specific methodology to support the ambition of the Net-Zero Insurance Alliance (NZIA), where members commit to transitioning their underwriting portfolios to net-zero GHG emissions by 2050, consistent with a maximum temperature rise of 1.5°C above pre-industrial levels by 2100, in order to contribute to the implementation of the COP21 Paris Agreement.

Founding signatories include Swiss Re, Gard, Hellenic Hull Management, SCOR, Victor International, and Norwegian Hull Club. Founding members and the drafting committee supporting the principles include LR, A.P. Moller–Maersk, Cefor, EF Marine, Global Marine and Willis Towers Watson.

Signatories to the Poseidon Principles for Marine Insurance commit to assessing and disclosing the climate alignment of their hull and machinery portfolios, and to benchmarking them against two trajectories: one linked to a 50% reduction of annual CO_2 emissions by 2050 compared to 2008—in line with the International Maritime Organization's Initial GHG Strategy; and one linked to a 100% reduction of emissions by 2050. Furthermore, a third trajectory will be introduced to align the full decarbonisation trajectory with zero-lifecycle GHG emissions in order to meet the ambition of net-zero commitments such as the NZIA, and to support a zero-emissions future for shipping.

Brokers, clubs, and other key stakeholders in marine insurance commit to supporting the principles as affiliate members and align with the goal of decarbonising international shipping by 2050.

Nick Brown, LR CEO, said "Lloyd's Register has been involved with the Poseidon Principles from the very beginning, and we're proud to provide independent expertise and advice to support the development of this new framework for marine insurance. This is a significant milestone for maritime—providing the marine insurance industry with a framework that will effectively support the acceleration of maritime decarbonisation."

LR, the sole classification society to be part of the framework, supported the development and initial launch of the Poseidon Principles in 2019.

The Poseidon Principles for Marine Insurance are founded on the methodology used in the Poseidon Principles for Financial Institutions and were developed in an effort spearheaded by leading marine insurers and industry stakeholders with expert support provided by the Global Maritime Forum, Swiss Re Institute, and UMAS. The International Union of Marine Insurers (IUMI) is a supporting partner.

For further information visit https://www.poseidonprinciples.org/insurance/

LR News, 15 December 2021

FROM THE CROWS NEST

SailGP Returns to Sydney

Following a hugely successful first season in 2020, won by the Australia SailGP Team led by Australia's home-grown Olympic gold medallist, Tom Slingsby, SailGP returned to Sydney Harbour on 17 and 18 December 2021 for the seventh event of SailGP Season 2.

SailGP is sailed in the cutting-edge one-design F50 foiling catamarans, leaving performances and results directly in the hands of the world-class athletes who sail them. The design is based on the AC50 catamarans which raced in the 2017 America's Cup, but the F50 shares few similarities with its predecessor. Yes, it still foils using rudders with elevators and two daggerboards, but nearly the entire design was reworked to create faster, flatter and more stable flight. The F50 was the first boat to hit 50 kn during racing, and has a predicted top speed of over 52 kn.

The SailGP F50 catamaran fleet on Race Day 1 of the Australia Sail Grand Prix presented by KPMG, 17 December 2021 (Photo by David Gray courtesy SailGP)

Season 2 kicked off in Bermuda on 25–26 April 2021, with subsequent races in Italy, Great Britain, Denmark, France and Spain. The boats arrived in Sydney with Tom Slingsby's Australia SailGP Team on top of the overall leaderboard with 45 points, one point in front of the USA and Japan, followed by Great Britain, New Zealand, Spain, Denmark and France.

After the six races on Sydney Harbour (five fleet races plus the final between the top three on the Sydney leaderboard), Tom Slingsby's Australia SailGP Team was still on top of the overall leaderboard with 55 points, two points in front of the USA, two points in front of Japan, followed by Spain, New Zealand, Great Britain, Denmark and France.

From Sydney, the boats move to San Francisco on 26 and 27 March for the final events of Season 2 and the championship-deciding Grand Final.

For all the details of the boats, teams, the course, scoring system, penalties, calendar, Season 3, etc., visit the SailGP website at https://sailgp.com/general/sailgp-overview/

SailGP website

Wave Swell Energy wins Energy Globe Award

At an official awards ceremony in Glasgow on 8 November 2021, coinciding with COP26, Wave Swell Energy (WSE) was announced as the winner of the Energy Globe Awards in the Fire (Energy Generation) category. The Energy Globe Awards, conducted annually since 2000, are considered to be one of the world's most prestigious awards for sustainability, with three other categories being Air, Water, and Earth.

WSE was adjudged the winner by an international jury which included the Jury Chair, Maneka Gandhi (member of the Gandhi family and former Indian Government minister), and Prof. Edward Ayensu (former Chairman of the World Bank, Africa). WSE was presented as the winner of the Fire category by Tareq Emtairah, Director of Energy, UNIDO. Former presenters of the Energy Globe awards include Kofi Annan, Mikhail Gorbachev, Justin Trudeau, Martin Sheen, and Alanis Morrisette.

WSE was pleased to receive such notable recognition on a global scale, particularly in light of its successful King Island project and the independent assessment of the potential of its UniWave technology by Australia's national science agency, the CSIRO.

WSE post on LinkedIn

World's First Zero-emissions Autonomous Boxship Readies to Enter Service

Wave Swell Energy's UniWave 200 installation at King Island
(Photo from Wave Swell Energy website)

The world's first fully emission-free autonomous container vessel, *Yara Birkeland*, has completed its maiden voyage in the Oslo Fjord, following its delivery to Norwegian ammonia and fertilizer manufacturer, Yara International.

Yara Birkeland is 80 m long, with a beam of 14.8 m, a depth of 12 m and a draft of 6 m. The vessel will be propelled by electric motors driving two azimuth pods and two tunnel thrusters. Batteries rated at 7–9 MWh will power the electric motors, giving an energy-optimal speed of 6 kn and a maximum speed of 10 kn. The vessel will have a capacity of 120 TEU.

Yara Birkeland has been developed in collaboration with Kongsberg and built by Vard in Ålesund, Norway, with NOK133.5M ($15.2M) support from the Norwegian government through Enova. The vessel will sail between Herøya and Brevik (approximately 7 n miles) carrying chemicals and fertiliser. Remote operation is expected to start in late 2021, operated from Massterlys' monitoring and operations centre in Horten, a joint venture between Kongsberg and Wilhelmsen.

"We are proud to be able to showcase the world's first fully-electric and self-propelled container ship. It will cut 1000 t of CO_2 and replace 40 000 trips by diesel-powered trucks a year," said Svein Tore Holsether, CEO of Yara International. "This is an excellent example of green transition in practice, and we hope this ship will be the start of a new type of emission-free container ship. There are a lot of places in the world with congested roads that will benefit from a high-tech solution like this," added Holsether.

Splash247.com, 19 November 2021
Wikipedia

WWSR Spirit 2

Yara Birkeland
(Photo from Vard website)

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*.

During the pandemic lockdown restrictions which prevented

any running of the vessel, the Warby Motorsport team used the time productively to improve the boat's handling and setup at 250+ mph with the assistance of the University of Newcastle, matching the practical feedback of tests with the tailplane now on the boat with the theoretical side of things

After months of lockdown restrictions, *Spirit of Australia 2* returned to the Manning River at Taree on 23 January, and managed to get in three good runs. The team were very pleased with the boat, and Dave feels that the small modifications made to the trim of the tailplane are in the right direction, improving the handling. The Manning River isn't long enough for *Spirit 2* to stretch her legs, but speeds of 180–190 mph (km/h) were comfortably achieved.

The team is now planning to head back to Blowering Dam in March.

Phil Helmore

WWSR Longbow

Spirit of Australia 2 at speed on the Manning River on 23 January
(Photo from Warby Motorsport Facebook page)

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

As with *Spirit of Australia 2,* progress has been slow during the pandemic restrictions on the other side of the world. However, the paint coats (three coats of primer, four coats of undercoat and four coats of topcoat, with sanding down between each coat) have now been applied to the underside of the hull prior to turning over for fit-out.

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

First coat of topcoat on *Longbow*'s underside
(Photo from Longbow website)

GENERAL NEWS

Australia signs Naval Nuclear Propulsion Information Sharing Agreement

On 22 November 2021 the Exchange of Naval Nuclear Propulsion Information Agreement was signed by Australia and the AUKUS partners, the United Kingdom and the United States.

The Minister for Defence, the Hon. Peter Dutton MP, said that the Agreement will further advance consultations by permitting the United Kingdom and the United States to exchange sensitive and classified naval nuclear propulsion information with a third country for the first time.

"This Agreement will support Australia in completing the 18 months of intensive and comprehensive examination of the requirements underpinning the delivery of nuclear-powered submarines," Minister Dutton said.

"The United Kingdom and the United States will be able to share naval nuclear propulsion information with Australia, which they cannot with any other country, in the determination of the optimal pathway to acquire nuclear-powered submarines for operation by the Royal Australian Navy.

"With access to the information this Agreement delivers, coupled with the decades of naval nuclear-powered experience which our UK and US partners have, Australia will also be positioned to be responsible and reliable stewards of this technology."

The Agreement will also provide a mechanism for Australian personnel to access invaluable training and education from their UK and US counterparts, necessary for learning how to safely and effectively build, operate and support nuclear-powered submarines.

Importantly, the Agreement is consistent with Australia's international obligations, including under the Treaty on the Non-Proliferation of Nuclear Weapons. The Agreement only allows for the sharing of naval nuclear propulsion information. No nuclear equipment can be transferred under this agreement.

Minister Dutton also highlighted the importance of the Agreement for Australia's regulatory framework.

"This Agreement will assist Australia to develop the necessary skills and knowledge to create a world-class regulatory and safety regime required for the safe operation of naval nuclear propulsion," Minister Dutton said.

"I thank our AUKUS partners for their commitment to bringing this pivotal agreement together quickly, which assures continued progress for our nuclear-powered submarine ambitions and our collective efforts to ensure that the Indo-Pacific remains stable, secure and prosperous, and free from coercion."

The Agreement has been tabled in the Australian Parliament for consideration by the Joint Standing Committee on Treaties. The Agreement is also subject to the domestic processes of the United States and the United Kingdom.

Incat Tasmania High-speed Catamaran for South Korea

On 17 January Incat Tasmania announced a contract to build a fast ferry for Daezer Construction of South Korea.

Work on the new 76 m craft has already commenced with delivery scheduled for the first quarter of 2023.

The high-speed ferry will operate for Daezer on the line between Pohang and Ulleung, an island 117 n miles off the eastern coast of South Korea where the main economic activity is tourism.

Incat Tasmania Chairman, Robert Clifford, said that Incat is no stranger to South Korean waters, having delivered its first vessel to the region in 1995, the still-highly-regarded, Incat Hull 037, *Sunflower*. "*Sunflower* served Ulleung Island for 25 years and was only recently retired by Daezer in compliance with South Korean ship age limits.

"This new craft will benefit from Incat's evolved tried-and-proven hullform, with its new bow arrangement, and will lead the local market in terms of seakeeping for vessels of its size" he said.

An impression of the 76 m catamaran which Incat tasmania is building for South Korea
(Image courtesy Incat Tasmania)

Hunter-class Frigate Data Transferred to Australia

More than two million digital artefacts and 90 000 documents have been transferred from the UK's Type 26 frigate program in Scotland to Adelaide's Osborne Naval Shipyard for the construction of the Hunter-class frigates.

BAE Systems Maritime Australia is building nine Hunter-class frigates based on the Global Combat Ship (GCS) baseline design and the Type 26 reference ship currently under construction in Glasgow for the UK's Royal Navy. In a massive undertaking, teams in the company's UK operations are now transferring design information, drawings, data, videos, diagrams and tools to a team of engineers at Osborne to establish a new sovereign design capability for complex warships in Australia.

Known as "Design Separation", this process enables the local design and development of the Hunter-class frigate as plans of the ship are progressively transferred to the Australian shipyard and locally-mandated changes to the combat system are incorporated. A mature ship design will then be translated into production drawings ahead of the construction of each frigate.

Collaboration will also continue with Global Combat Ship partners in the UK and Canada. A variant of the Type 26 reference ship is also in the design phase for the Royal Canadian Navy, and the three programs are sharing common data.

The digital design of the Hunter class frigates enables BAE Systems Maritime Australia to invest in the development of new technologies and solutions which will transform continuous naval shipbuilding in Australia.

Teams of engineers are utilising technology including a state-of-the-art 4 m wide × 2.5 m high LED wall which provides full 2D and 3D views of the Hunter-class frigate and is updated continuously from the reference ship design. This "vis suite" tool also synthesises data from across the Hunter-class program and the design is updated every 24 hours.

Future USS *Canberra* Delivered by Austal USA

The Independence-class Littoral Combat Ship (LCS) is the second LCS which Austal USA has delivered to the US Navy in 2021 and the fifteenth delivered since 2010.

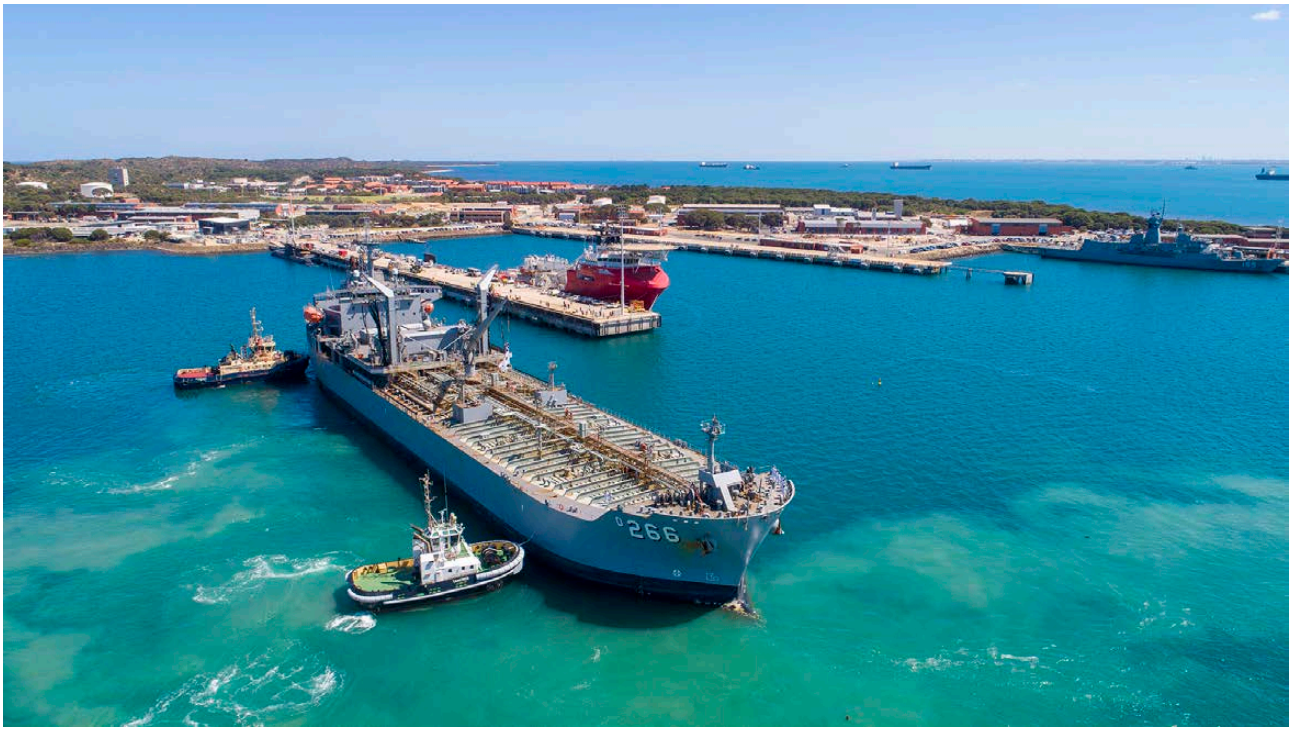
Austal Limited Chief Executive Officer, Paddy Gregg, said that the latest LCS delivery was of great interest and significance as the vessel was named after Australia's national capital, Canberra, and was sponsored by Australia's Foreign Minister, Senator the Hon. Marise Payne.

Four more LCSs are currently under construction at Austal USA, including the recently-launched future USS *Santa Barbara* (LCS 32) and future USS *Augusta* (LCS 34). Modules are under construction for the future USS *Kingsville* (LCS 36) and the future USS *Pierre* (LCS 38). Two Expeditionary Fast Transport vessels (EPF 13 and 14) are also under construction at the shipyard.

In October 2021, Austal USA was awarded a contract for the detailed design and construction of two US Navy Towing, Salvage, and Rescue (T-ATS) ships, the first contract for Austal's new steel construction facility. Austal has recently been awarded several post-delivery service-related contracts for the LCS program including Sustainment Execution Contracts (SEC) for both classes of LCS, on the east and west coasts of the United States, and a further contract to support LCSs deployed to the Western Pacific and Indian Oceans.

Austal USA also recently announced that the company had completed the purchase of a lease on waterfront property to establish a permanent ship repair facility in the Port of San Diego — a 6 ha site enabling ship repairs and maintenance on US Navy, US Coast Guard and Military Sealift Command ships. The facilities will include a new dry dock, designed specifically to service small surface combatants and other small-to-medium size ships.

The future USS *Canberra* (LCS 30)
(Photo courtesy Austal)



HMAS *Sirius* approaching the wharf at Fleet Base West when the ship returned to her home port for the final time on 9 December 2021.

HMAS *Sirius* was decommissioned on 18 December after 15 years of service during which she steamed about 540 000 n miles and conducted moore than 770 replenishments at sea.

In 2013 *Sirius* broke the previous Navy record for the biggest fuel replenishment at sea, passing almost 10,000 m^3 of fuel to the US Naval Ship *Yukon* over 13½ hours
(RAN Photograph)

NUSHIP *Arafura* was launched on 16 December 2021 at the Osborne Naval Shipyard in South Australia. Built by Luerssen Australia, *Arafura* is the first of 12 new OPVs being built for the Royal Australian Navy to replace the Armidale- and Cape-class patrol boats. The first two OPVs are being built in South Australia; the remainder of the class will be built in Western Australia where Civmec has several under construction
(Photo Department of Defence)

Electric Ferry from Incat Crowther

Incat Crowther has announced a contract to design an Incat Crowther 32 electric ferry for Fullers360 of Auckland, New Zealand. To be built by Q-West in Whanganui, New Zealand, the ferry will be the designer's sixth from the builder and will join ten other Incat Crowther ferries in the Fullers360 fleet.

Fullers360 announced that it has reached this milestone in its decarbonisation journey with Auckland's first electric hybrid fast ferry for their Auckland ferry fleet. This critical first step will reduce carbon emissions by 750 000 kg per year on the Devonport route alone.

The new electric ferry gives the operator an excellent combination of efficiency and flexibility. Designed specifically for the route, the vessel will provide an efficient low-emission quiet service between Auckland and Devonport. The vessel cabin is modular, with the main deck configured for metro operations and overflow capacity to the upper deck.

Flexibility is provided by an enhanced capability to operate on other routes on the network. The drivetrain features the ability to employ a pair of range-extending generators which can be used in conjunction with the battery bank. This technology supports the electrification transition whilst the charging network is expanded to allow all-electric operation on longer trips. The design is also compatible with retrofit for hydrogen fuel for increased range as the fuel becomes more widely available in the future.

The passenger experience is centred around large midship boarding doors which are designed to mimic existing vessels and integrate with existing infrastructure. The vessel has also been designed to be fully compatible with Auckland's newly-developed Downtown Ferry Basin terminal.

Once aboard, a large vestibule adjoins an open area with fold-up seats which accommodate up to 28 bicycles, facilitating fast, smooth passenger flow. A café is located amidships whilst toilets are located aft.

Starboard quarter cutaway view of 32 m electric ferry for Fullers360
(Image courtesy Incat Crowther)

The vessel's drivetrain consists of four Danfoss EM-PMI540-T4000 electric motors directly mounted to Hamilton HTX42 waterjets, with a battery arsenal of 1944 kWh to achieve maximum speeds over 28 kn.

An advanced energy-management system controls the deployment of the system over a range of usage profiles. As well as the primary electric-only profile, the vessel can extend its range by a mode directly feeding the propulsion motors from the generators, a mode which charges the batteries from the generators, and a hybrid boost mode which combines both sources.

The new vessel is Fullers360's first step towards building a fleet which eliminates the use of fossils fuels on Auckland Harbour. New Zealand is a leading force in renewable energy, with over 80% of their energy usage coming from renewable sources such as hydro, wind and geothermal. As such, the use of electric propulsion in the city's public transport represents an immediate reduction of emissions over diesel propulsion.

Sharing Fuller360's drive to achieve this reduction, Incat Crowther is proud to have developed a real, workable transitional platform. The design not only equips Fullers360 to realise their dream of introducing green ferry technology into its fleet and operations, but with the functional flexibility

offered by the hybrid modes, enhances and protects the operator's investment.

Principal particulars of the new Incat Crowther 32 electric ferry are

Length OA		34.6 m
Length WL		32.2 m
Beam OA		9.50 m
Depth		3.15 m
Draft (hull)		1.50 m
Passengers		299
Crew		3
Batteries		1944 kWh
Fuel oil		5140 L
Fresh water		1000 L
Sullage		1000 L
Propulsion motors		4×Danfoss EM-PMI540-T4000
Propulsion		4×Hamilton HTX42 water jets
Generators		2×Scania DI16 070M with Danfoss EM-PMI540-T3000
Speed	(service)	12 kn
	(maximum)	28 kn
Construction		Marine-grade aluminium
Flag		New Zealand

Stewart Marler

Duyfken Replica comes to the ANMM

In March 1606, under the command of Willem Janszoon, the 60 t vessel *Duyfken* sailed from Banda (now in the eastern Indonesian province of Maluku) to explore unknown territory in the south for potential trade opportunities. The vessel reached the north of Australia and charted 300 km of the west coast of Cape York, unaware that they were the first Europeans to visit the continent. Not only is this voyage the first documented European contact with the Australian mainland, but it is also the first recorded meeting on Australian soil between the Indigenous people of Australia and Europeans.

Janszoon's voyage was the first in a succession of Dutch voyages during the 17th century which would culminate in the charting of almost two-thirds of the Australian coastline. It predates James Cook's voyage on *Endeavour* by 164 years, but is often a forgotten aspect of our history.

The *Duyfken* replica was built by the Duyfken 1606 Replica Foundation, jointly with the Maritime Museum of Western Australia, with the keel being laid on 11 January 1997 and the vessel launched on 24 January 1999. Your scribe was in Fremantle soon after the keel was laid and saw the start of construction at the MMWA.

Since her launch, the *Duyfken* replica has embarked on many voyages and adventures in her quest to share with communities, both within Australia and internationally, the story of the Dutch maritime connection to the evolving history of Australia. The Western Australian Government saw value in this work and took on the role of supporting the Foundation with a grant agreement. However, in 2020, that grant agreement came to an end.

The Australian National Maritime Museum recognised the significance of this replica ship in telling the Dutch maritime story, opened negotiations with the Board of the Duyfken 1606 Replica Foundation, and came to an agreement which saw the *Duyfken* replica gifted to the ANMM, securing the ship's future for the rest of its useful life.

The vessel has arrived in Sydney, and was berthed at the ANMM on the evening of SMIX Bash 2021.

Phil Helmore

Duyfken competing in the Tall Ships Race on Sydney Harbour on Australia Day 2022
(Photo John Jeremy)

John Oxley Restoration

The restoration of *John Oxley* by the Sydney Heritage Fleet has been severely hampered by the pandemic restrictions over the last two years. However, the team was back on the job for the last quarter of 2021, there has subsequently been significant progress, and the volunteer team is enjoying the challenge of preparing the vessel for re-launching in 2022.

Garry Burns (Chief Engineer), Ian Bird and their engineering team have continued to install the fire and bilge pump systems including the installation of the essential and non-essential systems. The emergency electrical bilge pump has been installed in the stokehold and the Alpha Laval water separator has been installed in the main hold for transferring diesel fuel from the main fuel bunker to the diesel-powered generators' day fuel tanks. These pumps are now ready for the electrical contractors to connect the electrical cabling and control panels.

The electrical contractors have been working on the electrical installation at their off-site workshop, but the new isolation transformer, essential and non-essential switchboards, cabling, bulkhead penetrations and shore power connections have now been craned on board ready for wiring.

All hull plating has now been completed, and the draft marks have been lined off.

It is expected that the Sea Heritage Dock will be towed to the Captain Cook graving dock at Garden Island for the re-floating of *John Oxley* in early April, and the subsequent docking of *Kanangra* for her restoration.

For further details and lots of photographs of all the work, see the *Latest News* on the *John Oxley* website.

Phil Helmore

Nuclear Submarines for Australia: When Would You Like Them?

Jock Thornton

Introduction

Ten years ago, I authored a paper which addressed the then hypothetical question of whether Australia should procure a nuclear submarine force. One of my conclusions was that "A nuclear submarine force would be so expensive and potentially have such a de-stabilising effect on the rest of the Australian Defence Force, that its selection as the Collins-class successor would need to be justified on the grounds of the highest-possible strategic need."

In early 2021 I came to the conclusion that the rapid rise of Chinese naval power had reached the point of satisfying that condition. Now, fast forward to 16 September 2021, when came the announcement of the AUKUS agreement which included a collaborative endeavour between the UK, US and Australia to provide nuclear submarines.

Much has been written in the months since then. Warm, tepid and cold water has been poured on the deal. Consequently, I have revisited my original paper to explore some of the challenges that will face us.

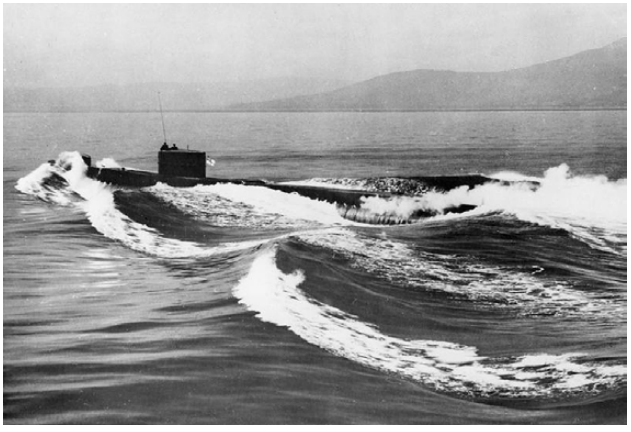
Firstly, why did Australia make the switch? A look back to a similar dilemma facing the Royal Navy in the 1950s when it faced a similar fork in the road would be useful.

Some History

The rapidly-intensifying Cold War of the 1950s was a scary time; the Soviet Union seemed to be advancing on all fronts and the West was, to a certain extent, running to keep standing still. Nowhere was this more true than in the development of submarine warfare. The Soviet Union was rapidly building up its force of conventional submarines while the West looked for the circuit breaker that would turn the tide and overcome the intrinsic flaws of the conventional submarine — the absence of an air-independent propulsion system. This issue had been highlighted in the final phases of the Battle of the Atlantic where, after some critical setbacks in early 1943, the battle finally tilted the Allies' way aided by the closing of the mid-Atlantic gap by air cover which really did force the U-boats to keep their heads well and truly down. Air-independent propulsion (AIP) was therefore the holy grail for which all submarine operators searched.

Britain opted for high test peroxide (HTP) in its search for AIP. A German HTP powered U-boat, U-1407, which had been scuttled following the German collapse at the end of the Second World War, was salvaged and eventually commissioned into the Royal Navy as HMS *Meteorite*. HTP engines were essentially steam turbines, with the steam being generated by the interaction of HTP with diesel oil and a catalyst.

This provided the impetus for a British research programme which resulted in the construction of two experimental submarines, HMS *Explorer* and HMS *Excalibur*. Built for speed trials, they were unarmed.



HMS *Explorer*
(Photo courtesy Imperial War Museum)

They turned out to be impressively fast, achieving submerged speeds of 25 kn, and the two boats served a useful purpose as high-speed targets for the Royal Navy's anti-submarine forces. Their main use, however, was to finally prove that HTP was impracticable as an air-independent propulsion system for submarine use. The HTP was carried in special bags outside the inner pressure hull, which were prone to exploding unexpectedly. Additionally, the engine room (which was not occupied while under way) would often be the scene of flames appearing on the top of the combustion chamber and, on at least one occasion, the crew were forced to evacuate the pressure hull and stand on the upper casing to avoid fumes which had suddenly filled the boat. The HTP fuel proved to be so troublesome that the boats quickly became known as *Exploder* and *Excruciator*.

However, everything changed with the signal from USS *Nautilus* on 17 January 1955, "Underway on nuclear power".

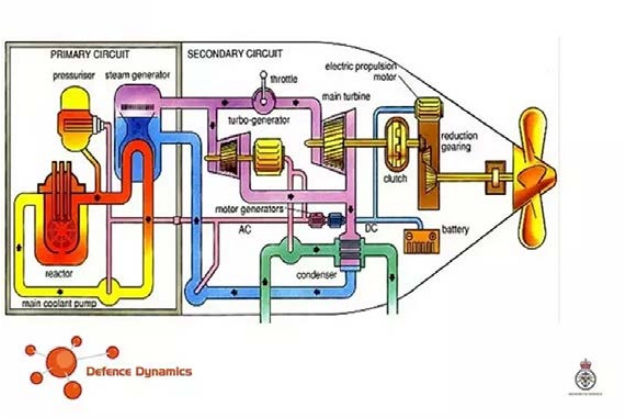
The impact on the Royal Navy of the October 1957 visit to the UK of USS *Nautilus* was profound. In Operation Rum Tub, an exercise which matched *Nautilus* against the Royal Navy, *Nautilus* comprehensively outperformed the Royal Navy and prompted the First Sea Lord, Louis Mountbatten, to write, "We now appreciate that we are in the presence of a revolution in naval warfare; in some ways more far-reaching than the transition from sail to steam".

The Admiralty Board declared "If the Royal Navy did not acquire these submarines, then it would cease to count as a naval force in world affairs".

One could now transpose a few words to read "If the Royal Australian Navy does not acquire these submarines, it will cease to count as a naval force in world affairs".

The power source which gave *Nautilus* such an advantage was a pressurised water reactor (PWR), and it remains the reactor plant of choice to this day. So why is it such a game changer?

A typical submarine nuclear power plant is shown below and it can quickly be seen that the PWR is merely the source of heat which generates steam for power generation and propulsion in ways that have been in use since James Watt was a lad!



Typical submarine nuclear power plant
(Diagram from Quora website)

The advantages of a PWR are

- The coolant and moderator are both light water and thus readily available by distilling sea water.
- Using the same medium for moderator and coolant gives the plant a self-regulating/load-following characteristic and makes it very responsive to power changes; this is explained below since it is a key element of PWR operation.
- The plant has a very high power density — it uses highly-enriched uranium; without enrichment you could not have a core that is little bigger than a large dustbin and lasting the life of the submarine.
- Advanced core design now means that cores can be tailored either for high power or long life or a combination of the two.
- It now has a long and detailed safety case, which has been refined over 50 years.
- The secondary cycle is relatively low technology, ideally suited for long periods of independent operation and for maintainer intervention in the event of defects.

Self Regulation and Load Following

A moderator's role is to slow down the fast neutrons emitted from nuclear fission so that they have the right energy to effect further fission and maintain a chain reaction.

Light water's effectiveness as a moderator increases with its density — as the temperature drops, its density and hence its moderation effectiveness, increases and vice versa. Lower temperature = more moderation = more fission.

The load-following cycle is as follows:

- Opening the throttles increases the steam take-off from the steam generators.
- The increased heat transfer reduces the temperature of the primary coolant leaving the steam generator and returning to the reactor pressure vessel (RPV).
- The cooler water increases the degree of moderation and, hence, the number of thermal neutrons available for fission.
- Reactor power increases and the coolant leaving the RPV and returning to the steam generators increases in temperature, which reduces the amount of moderation.
- Heat transfer to the secondary circuit increases until the system achieves equilibrium at the new power level, at which point coolant temperatures stabilise at their new levels.
- The control rods do not control reactor power when the plant is operating in the power range — the secondary steam demand (the throttle jockey) does that — control rods are merely adjusted to maintain the average primary coolant temperature constant during the transient.

The inherent simplicity of using water both as coolant and moderator is what makes a PWR so attractive for propulsion. Its high power output enables it to counter the very low efficiency of a steam plant. It enabled submarines for the first time to become true submarines rather than the submersibles that they had been up to that point.

To grasp the scale of this revolution it is worth looking in a bit more detail at the benefits which nuclear propulsion provides:

Overcoming the Tyranny of Distance

Getting to the action has always been the Achilles heel of conventional submarines. Transit speeds of only 10 kn are possible either on the surface or snorting (running diesels while dived) at periscope depth. Clearly the ability to transit to an operational area at dived speeds continuously in excess of 25 kn is a unique attribute of the nuclear submarine. Two excellent examples of this were the Falklands crises of 1977 and 1982 when nuclear submarines went non-stop to the Falklands at high power virtually all the way. HMS *Dreadnought*'s deployment to the Falklands in 1977 was a classic example of successful power projection in an operation short of actual conflict. Clearly this is important in an Australian environment, given the long transit distances between support bases and likely operating areas.

Indiscretion or the Lack of It

Indiscretion is the term given to the requirement for a conventional submarine to operate at periscope depth to run its diesel generators, either to recharge its batteries or to transit dived while floating the battery load. Think back to the Battle of the Atlantic to understand how vulnerable that makes a submarine. Total independence of the surface except for command-initiated activities ensures that the properties of a true submarine can be used to maximum benefit. This is most clearly demonstrated by the strategic missile submarine's primary patrol aim of remaining undetected, an aim that is only made possible by nuclear power disengaging its dependence on the surface.

Unlimited Electrical Power

Not unlimited but, as far as what is required, this is virtually so. A nuclear submarine can generate about 4 MW of AC power and, while a substantial amount of that is required for reactor and propulsion auxiliaries such as main coolant pumps, it still leaves a lot for ship and combat systems. It also enables power to be allocated to other traditionally under-resourced systems, such as ventilation and cooling systems. When I joined the Collins New Submarine Project from a nuclear programme, the need for tight management of power budgets had to be re-learned!

Space

The additional space available in an SSN (nuclear-powered conventionally-armed submarine) is invaluable in respect of weapons load. HMS *Astute* can carry up to 38 weapons. USS *Virginia* has 12 vertical-launch missile tubes for Tomahawk

SLCMs and four 533 mm torpedo tubes. There is capacity for up to 26 Mk 48 ADCAP heavyweight torpedoes and Sub Harpoon anti-ship missiles to be fired from the tubes. Mk 60 CAPTOR mines may also be carried. Space for people has not, however, increased proportionately!

Back to Our Tale

It was then accepted by the UK that investing in HTP was taking the RN down a blind alley and those submarines were scrapped as the RN switched to a nuclear solution. However, they were well behind the eight-ball and looked to the US for assistance

The outcome of these negotiations was the 1958 US–UK Mutual Defence Agreement, part of which involved the sale to the UK of one complete nuclear submarine propulsion plant, as well as ten years' supply of enriched uranium to fuel it. That submarine plant was installed in HMS *Dreadnought*.

The Father of the US Navy's Nuclear Programme, Admiral Hyman Rickover, was initially virulently opposed to sharing the USN's nuclear secrets with anyone, but was smooth talked by Lord Mountbatten, the British First Sea Lord. When they were discussing how best to accelerate the UK programme, Rickover asked Mountbatten whether the British Admiralty wanted to satisfy its pride or whether it wanted to get a nuclear submarine as soon as possible. Mountbatten answered that he wanted to get a submarine as soon as possible.

The rubber really hit the road then. *Dreadnought* was laid down in June 1959, launched in October 1960 and commissioned in April 1963. So *Dreadnought* was completed in under four years.

As a midshipman in September 1963, I had the chance to spend a day at sea in *Dreadnought* and it is safe to say that it completely changed my life.

During *Dreadnought*'s construction, Rolls-Royce, in collaboration with the United Kingdom's Atomic Energy Authority at the Admiralty Research Station, HMS *Vulcan*, at Dounreay, developed a completely new British nuclear propulsion system. On 31 August 1960, the UK's second nuclear-powered submarine was ordered from Vickers Armstrong and, fitted with Rolls-Royce's PWR1 nuclear plant, *Valiant* was the first all-British nuclear submarine. She was laid down in January 1962, launched in December 1963 and commissioned in July 1966, less than six years after being ordered.

HMS *Dreadnought*
(Photo from Wikimapia website)

HMS *Valiant*
(Photo from National Archives and Records website)

So, by 1966, the Royal Navy had two SSNs in commission just eight years after the US/UK agreement.

More remarkably, by the end of the decade the RN had four SSNs and four SSBNs (nuclear-powered ballistic-missile-armed submarines) in service, following the Nassau agreement in 1962 to buy the Polaris weapon system in place of the cancelled Skybolt airborne nuclear missile system. I shall return to how this was achieved later.

So why, I ask myself are we, or rather the media, talking about it taking decades before an Australian SSN can enter service. If that is really the case, then we as a nation have not yet convinced ourselves that the growth of Chinese naval strength really is an existential threat to our security which demands the same urgency as was displayed by the UK in the face of the rise of Soviet power in the 1950s and 60s. I am bound to say that an eighteen-month study period does not inspire confidence that we have done so, although recent more sensible timescales are now being bandied around which gives me reason for hope.

So, if we are to move faster, how do we achieve it? For any sensible discussion, several assumptions need to be made:

- All three countries (Australia, the UK and the USA) and their defence organisations share the belief that it is in their joint interests for Australia to procure nuclear-powered submarines as soon as possible.
- The submarines selected will either be an Astute-class from the UK or the Virginia-class from the USA.
- The Australian Government and the Department of Defence accept that the strategic imperative is for these submarines to be procured in the shortest time possible.
- Australia accepts that the first submarines may best be built overseas and will not be subjected to Australianisation unless it can be achieved without impacting on the build programme.
- The parent navy of whichever submarine is selected accepts that supporting an Australian project will require sacrifices within its own programme.
- The Royal Australian Navy accepts that this will create significant personnel challenges

Crewing

Where do the people to crew the submarines come from? Without a doubt this is the elephant in the room. When looking at this, the best way is to consider the three functions of any warship: Float, Move, Fight.

Float and *Fight*

The personnel are much the same type of people in an SSN as in any submarine. The ship's systems, sensors and weapon systems are still fundamentally unchanged. The details of the systems may be different, but their basic functions remain very much the same. The numbers involved will not be hugely different in an SSN and retraining will be more akin to conversion training rather than starting from scratch.

Move

This really changes the scene. Nuclear propulsion plants require a lot of people to operate them. A typical watch will consist of an Engineer Officer of the Watch, a Nuclear Chief of the Watch, four senior sailors and three juniors. There will be three watches of qualified personnel plus a watch of trainees who cannot stand a watch unsupervised until qualified.

Thus, the scheme of complement of the propulsion department might typically consist of:

- Three or four officers
- Three Nuclear Chiefs of the Watch
- Three reactor-panel operators
- Three electrical-panel operators
- Three roving senior personnel
- Three engineer room senior personnel
- Nine junior sailors
- Plus a complete watch of trainees and, possibly, an augment watch

The breadth and depth of training of each watchkeeper is mandated by his or her role. Moving from junior to more senior roles will often involve additional specialised training while the engineer officers will have undergone extensive theoretical courses as well as practical training. All training and qualification is subject to regulatory control. No one who has not qualified for a watchkeeping position can stand a watch unsupervised.

Finding so many people will not be easy, and keeping them will be even harder. The RN had to introduce a bounty to retain those senior sailors with very marketable skills in the navy.

Starting up a programme of this size and scale is likely to be the most demanding of any the RAN has attempted. It makes sense, therefore, to start by closely integrating the RAN's training with that of the RN or USN. Watchkeeping personnel will undergo identical training to their RN or USN counterparts and will go to sea for training and qualification as part of an RN or USN crew. When required for crewing RAN SSN 01, personnel will move to the Australian submarine in the roles for which they have been qualified.

Regulation

A word here about regulation. Initially the UK's Ministry of Defence (MoD) regulated itself, as it was exempt from the provisions of the Nuclear Installations acts. Its standard statement declared that the MoD operated to standards at least as high as those mandated by the act. This arrangement became less straightforward when the Royal Dockyards were commercialised and, as a result, a more structured approach was adopted across defence to encapsulate all elements of nuclear reactor and weapon safety as the Director of Nuclear Safety Regulator. It is this body which will have approved the new submarine's design and will approve the training and qualification of Australian nuclear propulsion operators and of shore-based personnel who work on nuclear submarines or the equivalent system within the US Office of Naval Reactors. A shadow Australian organisation will need to be set up but, undoubtedly, this will be one of the most complex aspects of the project.

Now let us consider some other suggested ways of moving the programme along.

To Lease or not to Lease, that is the Question

The idea of leasing a *Virginia*- or *Astute*-class submarine is very seductive. After all that's how the Indian Navy did it when they leased a Russian SSN. However, it poses a few difficult questions:

- Who is responsible for the nuclear safety regulation of the leased submarine, Australia or the parent navy?
- Who will manage the maintenance of the submarines and ensure that nuclear integrity is maintained?
- Who will control the training and qualification of the crew, particularly that of naval nuclear powerplant operators and of the shore-based personnel who will work on the submarine?
- What facilities will be required to support the submarine, and how will they be qualified from a nuclear safety perspective?

Base-porting

Another half-way house being kicked around is the idea of base-porting an SSN at HMAS *Stirling* to enable Australian submariners to familiarise themselves with nuclear submarine operation and support while not having the burden of ownership. Again, this sounds a very seductive concept, and I am sure that many RN submariners would be happy to recreate the glory days of the Royal Navy's 4th Submarine Flotilla which was based in Sydney between 1949 and 1969.

Again, one must consider how that would work, even assuming that that the RN or the USN would be prepared to have one of their precious assets tied down a long way from home. HMAS *Stirling* has hosted numerous visits by nuclear submarines, most recently by HMS *Astute* early last year. Such visits are termed operational visits and rely on the visiting navy guaranteeing that the submarine will not carry our any activities which could impact on the integrity of the reactor plant. The services required to support the submarine on such a visit are therefore modest, including a 450 V AC shore supply to enable the reactor to be shut down, fresh water, sullage and communication links.

However, base-porting a submarine assumes that it will carry out more extensive maintenance while in harbour. Any such activities which have nuclear-safety implications may only be carried out by an approved repair authority and any repair procedures must be approved in advance by personnel who are authorised to confirm that the proposed procedure is safe. Again, who would have ultimate responsibility for nuclear safety?

One such procedure might be docking the submarine. It is not unusual for a submarine to require an unscheduled docking, so such a capability would need to be available at the operating base. Now we head into uncharted waters.

Docking a nuclear submarine with a core installed in such a way as to ensure continued core cooling at all times takes one into the complex world of site safety justifications. One of the major issues facing the safety justification of the shiplift at the Clyde Naval base used to dock Trident-class SSBNs was to confirm its ability to withstand an earthquake of an intensity with a probability of one in a million. Now the west of Scotland is not noted for its seismic activity, but the same cannot be said for parts of Australia and memories of Fukushima are fresh. So, one could argue that the use of a floating dock would get round that, but what about the integrity of the electrical shore supplies and other essential services required to maintain core cooling? Without doubt, the scale and cost of the infrastructure required to provide safe and efficient management of nuclear-powered submarine operation and support will be one of the major costs of this programme.

Los Angeles-class USS *Dallas* (SSN 700) in floating dry dock USS *Shippingport* (ARDM 4) in 2001
(Photo from Wikimedia Commons website)

Los Angeles-class USS *Helena* (SSN 725) entering floating dry dock USS *Arco* (ARDM 5) in 2005
(Photo from Alamy website)

None of these issues are insurmountable but need to be worked through. Having said that, many such decisions can and should be taken in parallel so that they are not on the critical path. That remains the provision of a nuclear submarine and the people to crew it.

Polaris

Polaris takes me back to the situation facing the UK in December 1962, when the Nassau agreement was signed in which the US agreed to supply the UK with the Polaris weapons system for the UK deterrent to replace the cancelled Skybolt missile programme.

So, just as *Dreadnought* was nearing completion, the Polaris programme burst on the Royal Navy with the need to build four SSBNs by the end of the decade. There was insufficient capacity in the Vickers (now BAE Systems) submarine building yard at Barrow-in–Furness to meet the demand as well as maintaining the SSN programme. A second build yard had to be opened up and this was Cammell Laird's at Birkenhead which would build *Renown* and *Revenge*, the second and fourth SSBNs. Like the other Resolution-class submarines, they were ordered on 8 May 1963 and laid down on 25 June 1964, with drawings provided by the lead yard. Construction was slower than planned, with poor performance by Cammell Laird and its workforce, resulting in both *Renown* and *Revenge* being delayed by six months. However, *Renown* was still launched on 25 February 1967 and was formally commissioned on 15 November 1968. So, even with the teething problems, it still was five years from go to whoa. By the end of the SSBN build programme, Cammell Laird had hit its straps with the last boat it built before the MoD returned to a single stream programme — HMS *Conqueror* was a great boat, but I admit to being biased as she was my last boat.

HMS *Resolution* deployed on its first deterrent patrol in June 1968.

So is every pundit talking about a programme running into the 2040s?

We seem to have a built-in defeatist attitude here, in that we do not believe anything in defence procurement can happen quickly. This brings me back to my original change of heart on nuclear submarines — only if the strategic situation demands it; well, just like 1958 in the UK, the current situation we face definitely demands it.

I Have a Cunning Plan

Here's my plan. I shall use the Astute class as my model simply because I know more about the British way of doing things. However, a solution based on the Virginia class would not differ fundamentally.

- RAN SSN 01 will be built by BAE Systems at Barrow-in-Furness. It will be an extension to the current seven-boat Astute-class programme.
- Changes to the combat system suite or any other system will only be contemplated provided that it does not impact significantly on the overall build schedule.
- BAE Systems will concurrently build a nuclear steam-raising plant (NSRP) for shipping to Australia for RAN SSN 02.
- The complete reactor compartment will be built in the UK with as much initial testing of reactor systems as possible done there. Reactor systems outside the reactor compartment would be fabricated in the UK for installation in the appropriate hull section in Australia.
- The secondary propulsion plant would be assembled and tested in a land-based test site.
- RAN SSN 02 will be assembled by ASC in Adelaide. It will be identical in form, fit and function to RAN SSN01 and will be built to drawings and data provided by BAE Systems. The NSRP will be supplied to Adelaide as a

complete unit with core installed for consolidation into the submarine. As it is a once-in-ship lifetime, the details of the core load out are not essential in-country skills for Australia. Other sections might also be fabricated in the UK, depending on schedule. Future NSRP builds would continue to be conducted in the UK.

- The submarine would then be launched on the Osborne shiplift. Nuclear safety issues on the use of a shiplift might be less stringent with a clean core that has not been taken critical and therefore has no fission fragment inventory.
- Propulsion and primary plant testing would then take place at Osborne (subject to the site receiving a licence for critical operations, see below).
- Local suppliers will be utilised wherever possible, provided that they can be adequately qualified.
- The Australian Department of Defence will establish a nuclear safety regulatory system mirrored on the MoD's Directorate of Nuclear Safety Regulation.
- The RAN will establish a training programme working in parallel with the RN and using the same training system as the Royal Navy.
- The development of the infrastructure required to operate and support nuclear-powered submarines should start now.

I do not for a moment underestimate the scale of the challenge. Getting it done will require a visionary figure, or several of them. As Rickover said to Mountbatten in 1958 "What you want to run a show like this is a real son-of-a-bitch". Mountbatten's reply is said to have delighted Rickover: "That is where you Americans have the edge on us; you have the only real son-of-a-bitch in the business".

The UK did have one in Admiral Sir Hugh Mackenzie who, as Chief Polaris Executive, drove the Polaris Project through against all opposition. He established his office and that of his immediate staff in London, which he considered was necessary in order to be in immediate contact with the Admiralty, the Ministers and the key departments. He was initially given two rooms and a closet at the Admiralty! The Polaris project was completed on time, with the first successful firing of a Polaris missile conducted off Cape Canaveral on 15 February 1968, and within budget.

So, the challenge is there for all of us to see. The question is do we have the bottle?

Jock Thornton served in the Royal Navy for 27 years. He was marine engineer officer of two nuclear-powered submarines and filled several shore appointments in submarine training, operations and support, ultimately as Submarine Flotilla Marine Engineer Officer.

The third Royal Navy Astute-class submarine, HMS *Artful*, on the shiplift at Barrow in Furness, UK. Could the Astute-class be the reference design for Australia's nuclear submarines? (BAE Systems photo courtesy MoD(N) UK)

The New Naval Architecture Degree Program at UNSW Canberra

Warren Smith, Associate Professor
David Lyons, Senior Lecturer
School of Engineering and IT
UNSW Canberra

We are open for business with the new Naval Architecture degree program of UNSW Canberra at the Australian Defence Force Academy. We are excited about the future and look forward to welcoming the first cohort of undergraduate students who will engage with us in 2022. Through this paper we will provide insight into our planning and aspirations for our activities in teaching and research. Given the history of naval architecture at UNSW Sydney, this might be seen as a transfer geographically of the discipline from Sydney to Canberra, but it also represents a conscious effort to tailor the program for Navy in support of the current Defence White Paper, the continuous naval shipbuilding policy, and the requisite foundational skills development in the discipline. The Australian Defence Force Academy is a unique institution in the context of the Australian higher education landscape and positioning the program here provides opportunities for it to thrive.

Terminology

In the context of this paper the current usage of UNSW is adopted:

University Program	A defined plan of study comprising a range of core and elective courses which lead to the award of a degree. A standard engineering degree is planned to span a four-year period of full-time study and requires the accrual of 192 units of credit.
University Course	A discrete block of study in which students enrol, are assessed and are given a grade. A standard engineering program comprises 32 courses (core and elective). A full-time load is nominally eight courses per year and four courses per semester, in a two-semester system (as at UNSW Canberra in contrast to UNSW Sydney's three-term system).
Units of Credit	Each standard course carries 6 Units of Credit (UoC) where each UoC represents approximately 25–30 hours of student engagement (including all related activities such as lectures, tutorials, assignments and exam preparation). 192 units of credit are required for a standard engineering degree.

INTRODUCTION

As announced in various places in August 2020 (including a joint media release from the Minister for Defence, Senator the Hon. Linda Reynolds CSC, and the Minister for Defence Industry, the Hon. Melissa Price MP [1], and a UNSW Canberra Media Release [2], both of 18 August 2020) a new Naval Architecture (NA) discipline has been established by UNSW Canberra at the Australian Defence Force Academy (ADFA). The priority will be delivering an undergraduate degree program, but it is expected that postgraduate coursework programs will follow. In parallel to the teaching activities, appropriate maritime-related research activities will grow. In authoring this paper, we represent the core academic team that will be responsible for the naval architectural and marine engineering content and we are excited to have this opportunity.

In structuring this paper, our aims are to provide an overview, both historical and contemporary, of our unique environment at ADFA and of the naval architecture discipline. This is defined based on the foundations laid for naval architecture education in Australia, principally by UNSW and the Australian Maritime College, and by the unique relationship between UNSW and Defence in providing education and training of future leaders of the ADF at the Australian Defence Force Academy. From this perspective and with a recognition of our stakeholders, we will then provide some insights into our academic planning and our underpinning resources. With formal teaching of courses commencing in 2022, we have been building and forming the program—it is a work in progress with preparations having begun in 2020.

Fundamentally, we want to be known for providing a quality education which develops the relevant and requisite understanding and discipline skills through a strong theoretical framework and practical application.

NAVAL ARCHITECTURE UNIVERSITY EDUCATION IN AUSTRALIA

It is always appropriate to acknowledge, in reaching some new state, on whose shoulders you stand. This is no different when describing our vision for our new program, one that represents best practice and one that is tailored consciously for Navy with a "grey ship" focus in support of the current Defence White Paper, the continuous naval shipbuilding policy, and the requisite foundational skills development in the discipline. Please note that our discussion is constrained to university education, and no attempt is being made to account for the contributions of the vocational training institutions across the country, past and present, which deliver trade certificates and engineering diplomas in naval architecture and related areas.

While we would be the first to acknowledge that our discipline is not large compared to mechanical, civil, or electrical engineering, there is a rich history of naval architecture university education in Australia beginning in the 1950s. The vision of UNSW led to a program being established, and its first graduate, Brian Robson, was awarded his degree in 1963. With the new program came nearly 60 years of UNSW Sydney's direct contributions to the capabilities of the Australian shipbuilding and naval sectors through its highly-regarded NA program.

With a wider lens, the history of UNSW points to its contribution to national capabilities in many ways since its inception in 1949 as the New South Wales University of Technology, growing out of the Sydney Mechanics'

School of Arts (1833) and the Sydney Technical College (1878). These contributions, amongst other things, were the spawning of new universities such as the University of Wollongong (which grew from a UNSW division established in 1951, transitioning to Wollongong College of UNSW in 1962 and the University of Wollongong's independence in 1975), and the University of Newcastle (UoN) (which grew from UNSW's Newcastle University College established in 1951, to University independence in 1965). As UoN looked to its 'big brother' in Sydney but with the State Dockyard in its own backyard, it launched its own Naval Architecture program in 1970. However, it was not long-lived, taking in its last first-year cohort in 1974. Having phased out the program, no UoN naval architecture course was listed in the handbooks post 1978, as all enrolled students were assumed to have completed or exited by then. Students wishing to enrol in the UoN Naval Architecture program for the first time in 1975 or later at UoN were directed to transfer to UNSW Sydney after completing the first two years of their BE program in Mechanical Engineering. This highlights the use of the "2 + 2" model of the UNSW Sydney degree.

At UNSW Sydney historically and, as will also be shown true for UNSW Canberra in the future, the Naval Architecture program ran/will run in parallel with Mechanical Engineering for the first two years. This led/leads to an arrangement where students who satisfy the requirements of the first two years of an accredited Mechanical Engineering four-year degree program at any Australasian tertiary institution may be admitted into the third and fourth years of the program, leading to the award of a Bachelor of Engineering degree in Naval Architecture. The proviso was/is that the Head of the School be satisfied that the courses studied at the other institution were/are equivalent, and that their recommendation was/is given.

After the closure of the UoN program, it was then not until the 1980s with the creation of the Australian Maritime College (AMC) (absorbed into the University of Tasmania system in January 2008), that another university option for naval architecture education became available to students in Australasia. The first graduates in NA from the AMC were Michael Hunn and Gregor McFarlane in 1992. For a period, until the closure of the UNSW Sydney program at the end of 2017 (last course taught in 2018), which was primarily for budgetary reasons (all courses with less than 25 students were cut across the University), both the UNSW and AMC programs co-existed cooperatively and enduringly in the NA space. As highlighted in Figure 1 against key milestones in the life of UNSW and AMC, AMC from 2018–21 alone delivered NA graduates to the discipline and the nation. While Edith Cowan University (ECU), Flinders University and Auckland University of Technology (AUT) each currently advertise NA programs, it is through agreement with AMC and an application of the "2 + 2" model that this is achieved. Their students, like those of UoN in the 1970s, do two years with them and then transfer to AMC.

So, with UNSW now building a NA degree program in Canberra, we are standing on the shoulders of those who, for many years, delivered in Sydney on the Kensington campus. A list of these staff members is provided in Appendix A. However, it is also worth emphasising that, given the history of naval architecture at UNSW Sydney, while our endeavour

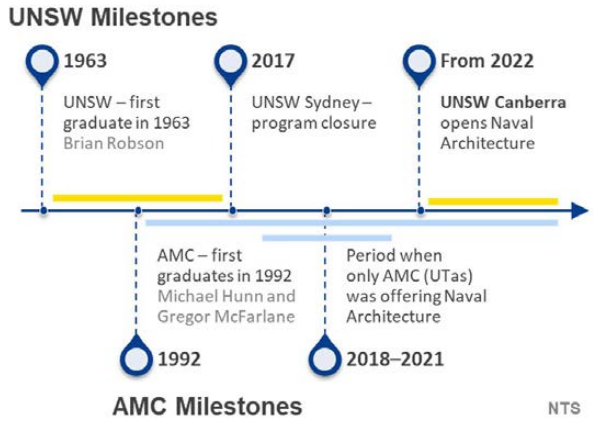


Figure 1 The primary providers and milestones of university Naval Architecture education in Australasia UNSW (firstly UNSW Sydney, then UNSW Canberra) and AMC (UTas) (Diagram courtesy Warren Smith)

might be seen as a transfer geographically of the discipline from Sydney to Canberra, it does represent a conscious effort to tailor the program for Navy while building on that tradition. It also reflects upon the very different environment within which UNSW Canberra operates, which is the Australian Defence Force Academy.

UNSW AT A GLANCE

Before turning to consider the Defence connection, and having briefly described the NA discipline's roots and the role which UNSW has played and is playing nationally, what does UNSW look like today? It is defined as being one of Australia's and the world's best universities. It is one of the "Group of 8", the leading research-intensive universities in Australia. It is active on three major campuses known as "Sydney" (Kensington), "Art and Design" (Paddington) and "Canberra" (ADFA). It comprises six faculties: Arts, Design & Architecture; Business; Engineering; Law & Justice; Medicine & Health; Science: and one college (faculty equivalent), UNSW Canberra. In total, there are 47 schools and 125 centres and institutes.

The reputation of the University as a whole is reflected in it being ranked:

- 43rd in the 2022 QS World University Rankings (4th in Australia behind ANU (=27), U of Melbourne (37), U of Sydney (38)) across a field of 1300 + institutions;
- 70th in the 2022 Times Higher Education World University Rankings (6th in Australia behind U of Melbourne (33), ANU (=54), U of Queensland (=54), Monash (57), U of Sydney (=58) across a field of 2100 + institutions; and
- 65th in the 2021 Academic Ranking of World Universities (Shanghai) (3rd in Australia behind Melbourne (33), U of Queensland (51) across a field of 1800 + institutions.

While the rankings do not provide sufficient fidelity to drill down and search on NA, the reputation of the University in engineering is reflected in it being number one in Australasia across all three ranking systems in engineering:

- 54th in the 2021 QS World University Rankings by subject in Oceania: Mechanical, Aeronautical and Manufacturing Engineering (1st in Australasia ahead

of U of Melbourne (60) and U of Sydney (=65));

- = 46th in the 2022 Times Higher Education World University Rankings by subject: Engineering (1st in Australasia ahead of Monash (55) and U of Melbourne (57)); and
- 36th in the 2021 Global Ranking of Academic Subjects—Mechanical Engineering (Shanghai) (1st in Australasia ahead of U of Wollongong (47) and Monash and U of Sydney (both in the 51-75 band)).

UNSW AND DEFENCE

We assume that it is this stellar reputation of UNSW, and UNSW Engineering, that has been a significant factor underpinning the long-term relationship between UNSW and Defence in educating ADF personnel, first Army and Navy in the 1960s, and then all three services from the mid 1980s at ADFA. The vision for such an institution as ADFA has its roots in the 1950s. The first significant steps towards its realisation were the military services recognising the value of university education alongside officer training. In the 1960s, each of the three services independently moved to incorporate university degrees in their training and education frameworks. The Royal Australian Air Force (RAAF) in 1960, using Point Cook in Melbourne as their RAAF College, built a relationship with the University of Melbourne to incorporate a degree program. In the process, the RAAF College became the RAAF Academy. It followed that Army operating from the Royal Military College (RMC), Duntroon, and the Navy, using HMAS *Creswell* at Jervis Bay, both negotiated with UNSW Sydney to provide academic input to their respective officer training and education processes. In 1968, UNSW established the Faculty of Military Studies at RMC, offering degrees alongside military training over a four-year (arts and science) or five-year (engineering) period. A different model, also introduced in 1968, by the Royal Australian Navy College required Midshipmen to study at HMAS *Creswell* for one year and then complete their degrees by attending the UNSW Sydney campus for the remainder of their study.

In 1976, under the Fraser Government, approval-in-principle was ultimately given for the establishment of a Tri-Service Academy. However, it was not until 1980 that the Bill establishing ADFA passed through the House of Representatives. In 1981, an agreement between UNSW and Defence was signed and construction began on the site adjacent to RMC. It was a natural choice for UNSW as the university provider in the new Academy and the UNSW Faculty of Military Studies staff moved "over the hill" to form UNSW Canberra's nucleus. The Academy opened its doors in 1986. This sequence of milestone events is laid out in tabular form in Table 1.

UNSW CANBERRA AT THE AUSTRALIAN DEFENCE FORCE ACADEMY

Since ADFA is a military base, UNSW exists on the site as a contractor and tenant of Commonwealth buildings. However, UNSW Canberra represents the academic heart of ADFA. It has been there for a long time and expects, as contracts are renegotiated, to remain for a long time into the future. Fundamentally, UNSW Canberra is committed to providing a high-quality university education for both military and civilian students in a military environment that:

- enhances the intellectual edge of the Australia's Defence Force;
- supports the ADF Joint Professional Military Education program; and
- develops future global leaders.

Table 1 Milestones in the relationship between Defence and the University of NSW

University education was recognised as valuable in Officer education and training in 1950s	*1960 RAAF College / Academy, Point Cook, built relationship with the University of Melbourne to incorporate degree*
Army and Navy both negotiate with UNSW to provide academic input to their respective officer education processes	1967 UNSW established Faculty of Military Studies at Royal Military College (RMC) – arts, science and engineering degrees
	1967 RAN College Midshipmen to study at HMAS Creswell for 1 year and then complete their degrees at UNSW Sydney
Creation of Australian Defence Force Academy (ADFA)	1976 Approval in principle for Tri Service Academy given under Fraser Government
	1980 The Bill establishing ADFA passed through the House of Representatives
	1981 Agreement signed between UNSW and Defence for education services at ADFA
ADFA Opens UNSW Canberra commences	1986 UNSW Faculty of Military Studies staff moved "over the hill" from Duntroon to form the nucleus of "University College"
Ongoing Relationship	Periodically contracts renegotiated for continuous delivery of UNSW education in a Defence Environment at ADFA

Referred to at times as "University College" it is, in the context of the University's structure, the seventh "Faculty". It wears the label "College" to signify its multidisciplinary nature and, by similar argument, it is headed by a "Rector" rather than a "Dean". It currently comprises four schools, the:

- School of Engineering and IT (SEIT) — one of the largest Schools within UNSW;
- School of Science;
- School of Humanities and Social Science; and
- School of Business.

As a tri-service officer-training institution, ADFA opened its doors to Midshipmen and Officer Cadets in 1986, as previously highlighted. While world-class research was being undertaken, in the early days it was predominantly operating as an undergraduate teaching institution. However, 36 years on, it is now a well-rounded faculty of the University where the number of postgraduate students outnumber the undergraduates, and research income and research output is significant.

At the post-graduate level, UNSW Canberra operates as a normal civilian university with no mandatory connection to Defence, but a strong connection to Defence naturally exists. This leads to many people being surprised to discover that they can study at UNSW Canberra at the postgraduate level without Defence connections, given the common association with ADFA. A successful effort over the last 20 years has been made to grow these activities and positively change these perceptions. We deliver highly-successful postgraduate coursework programs in areas such as systems engineering and cyber security, and we have significant numbers of higher-degree research students, largely international. A further and exciting initiative in this space will be the creation of a new precinct, UNSW Canberra City, in the Canberra CBD.

Returning to a discussion of undergraduates, until 2011 all undergraduate students were in uniform, being either a Training Officer (TO — Officer Cadet or Midshipmen) in the Australian Defence Force, a mature-age student serving in the ADF (belonging to the Advanced Student Squadron with a variety of ranks), or a member of a foreign military force gaining training and education at ADFA. While this collective military cohort remains dominant, two civilian

cohorts are now also in the mix. There are those which are Defence sponsored under the DCUS scheme (Defence Civilian Undergraduate Scholarship) which provides full tuition fee coverage, a $2000 per annum bursary, and paid work-experience placements. There are also those who are regular fee-paying non-defence students. The University has negotiated with Defence to allow a quota of up to 40 civilian fee-paying non-defence students per year cohort in SEIT. This is partially in recognition that no other University in the ACT region offers traditional engineering degrees. It should be noted that the new naval architecture program is open to all three student cohorts, military, Defence-sponsored civilians, and regular fee-paying civilians.

The number of uniformed military undergraduate students is 1100–1200 across the College, and the flavour of the Academy and the classrooms will remain a tri-service military one. With these students wearing uniforms to classes and being paid to attend, their being managed and pastorally cared for by their divisional officers, in comparison to civilian universities, ADFA is unique (see Figure 2). To arrive at ADFA, school leavers aspiring to join the ADF must apply:

- through Defence Force Recruiting (DFR) for ADF positions (culminating in Service-based Officer Selection Boards); and
- to UNSW Canberra via the Universities Admission Centre (UAC).

Civilian students seeking a DCUS scholarship would have a similar two-step process of application where fee-paying students would only need to apply via UAC (noting the quota).

Figure 2 ADFA and UNSW Canberra: fundamentally, a tri-service institution at the undergraduate Level
(Photo courtesy UNSW Canberra)

The pathway for trainee officers pursuing an engineering degree over a five-year period varies depending on the service (Army, Navy or Air Force). Over that period, but in different patterns, they all graduate from ADFA (military training over a three-year period), graduate from UNSW (with a four-year degree education), and they experience a year embedded in their service:

- Army
  - Years 1–3 at ADFA, ADFA Graduate, complete first three years of degree
  - Year 4 at Duntroon (Army), further Officer Training, Duntroon Graduate
  - Year 5 complete fourth year of degree, UNSW Graduate
- Navy
  - Year 1 in NOYO Scheme (RAN), Navy Officer Year 1 scheme to test aptitude for Navy and life at sea
  - Years 2–4 at ADFA, ADFA Graduate, complete first three years of degree,
  - Year 5 complete fourth year of degree, UNSW Graduate
- Air Force
  - Years 1-3 at ADFA, ADFA Graduate, complete first three years of degree
  - Year 4 complete fourth year of degree, UNSW Graduate
  - Year 5 with RAAF Unit/Training

So, in the context of graduation, Figure 3 is an aerial view of ADFA taken during a graduation parade (circa 2005). The axis, that could be defined vertically through the photo bisecting the parade ground, effectively also delineates the division between the military buildings to the left (or south), and the University, to the right (or north). Cut by the axis is the main Administration building which overlooks the parade ground and the Officers' Mess and Staff Club further to the west. On campus, the military side is run by the ADFA Commandant, and the University, as noted previously, by the Rector. Both organisations work towards a common goal of shepherding TOs to develop appropriate competencies and capabilities through education and training, within a cooperative and collaborative framework. However, the cycle of military postings places the military staff on a different time scale of rotation compared to academia. The majority of TOs live in the accommodation 'lines', eat in the Cadets' Mess and are organised in Divisions and Squadrons. They have a short walk to classes on the University side, regularly passing the "Tree of Knowledge" (shown in Figure 4) adjacent to the Auditorium, the Administration Building and the Library.

Figure 3 Aerial View of the ADFA campus (looking to the west) Graduation Parade circa 2005
(Photo courtesy UNSW Canberra)

Figure 4 The Tree of Knowledge on the campus' axis (circa 2020)
(Photo courtesy UNSW Canberra)

It is noted that the campus is continually evolving, and the photo in Figure 3 does not capture the redevelopment of the site which took place in the 2010s. Missing is the new gymnasium, the new accommodation blocks, the new Adams Auditorium (captured in Figure 4), and the new teaching spaces. Figure 5 is a contemporary photo from around the campus of buildings and common study areas, the latter of particular importance with growing numbers of civilian students

Figure 5 Around the UNSW Canberra campus (circa 2020) (Photo courtesy UNSW Canberra)

MORE ACADEMIC MATTERS

Turning to more-specific academic matters, the School of Engineering and IT (SEIT) from 2022 will cover five engineering disciplines, namely civil, electrical, mechanical, aeronautical engineering and naval architecture. Each discipline offers two Bachelor of Engineering (BE) degree programs, the "standard", and the Chief of Defence Force (CDF) variant. The CDF program is an elite research-focused degree offered to students entering the program with an Australian Tertiary Admission Rank (ATAR) greater than 98 (top 2% of students). The CDF scholars then also need to maintain a high level of performance in their studies to remain in the program.

From an accreditation perspective, the five-yearly Engineers Australia accreditation visit to UNSW Canberra and SEIT was conducted in August 2021, with representation on the panel from the Royal Institution of Naval Architects (RINA). The panel's recommendations were to re-accredit all existing SEIT engineering programs and to provisionally accredit the naval architecture programs (standard and CDF), conditional upon the submission of a progress report in September 2022. This outcome for SEIT was as expected, since full accreditation is only possible when graduates have been produced from a program, expected for us at the end of 2023. It follows that full accreditation of the naval architecture programs will be anticipated no later than the 2026 review cycle (and perhaps sooner if based on out-of-round consideration).

The historical record of UNSW Sydney shows that 414 Naval Architecture graduates have been produced with a long-term average of 8 graduates per year. While UNSW Canberra anticipates ramping up to an average of 10–15 graduates per year, this will take a few years to achieve, as the knowledge of our program increases, and success is demonstrated. Perhaps they will only number 3–5 in the initial years. It is to be noted that the different conditions of the ADFA environment do not threaten small class sizes such as these, as they would and *did* in Sydney. The cohorts will comprise both uniform and civilian students: TOs and Advanced, and DCUS and fee-paying. For all involved, staff and students, it represents a fantastic staff-to-student ratio.

From Navy's perspective, the midshipmen studying mechanical engineering, in the past and into the future at UNSW Canberra, are on a path to becoming Marine Engineering Officers. The new naval architecture program offers an alternate academic route to the same MEO career at sea for these midshipmen, though subsequent postings ashore may vary, drawing on their naval architectural education.

As mentioned previously, the required ATAR for the CDF program is 98. The currently-advertised indicative ATAR required for entry into the standard program for civilians is 92. From this, it would be fair to interpret that we are looking for highly-performing students who are keen to contribute to the maritime sector; to the Navy, to ship design, to shipbuilding, and to ship maintenance and repair. The use of the term "ship" here is inclusive of vessels both big and small, manned and unmanned, surface and subsurface.

PROGRAMS AND COURSES

To begin this discussion, the terms "program" and "course" carry specific connotations as described in the terminology section at the head of the paper. The two naval architecture programs have already been introduced, the standard and the CDF. Also, as indicated previously in the discussion of the 2 + 2 model, the naval architecture program is built on a common foundation with mechanical engineering, covering courses such as engineering mathematics, physics, mechanics, thermodynamics, fluid mechanics, materials and mechanics of solids. This leads to the inclusion in the third and fourth years of eight specialist naval architectural courses, namely:

- ZEIT3750 Naval Architecture Practice, Ship Hydrostatics and Stability
- ZHSS3750 Building the Fleet
- ZEIT3751 Hydrodynamics of Ships and High Speed Craft
- ZEIT3752 Ship Structures
- ZEIT3753 Design of Ships and High-Speed Craft
- ZEIT4750 Ship Design Project A
- ZEIT4752 Ship Propulsion and Marine Engineering
- ZEIT4751 Ship Design Project B

The courses comprising the naval architecture degrees are laid out in tabular form in Appendix B. The first year is common with the Mechanical and Aeronautical Engineering programs. There is only one course different in the second year: the mechanical engineers do ZEIT2700 Mechanics of Machines, the aeronautical engineers do ZEIT2502 Fundamentals of Flight, while the naval architects pick up a general studies elective (ZGENxxxx). The handbook descriptions of the eight specialist naval architecture courses are provided in Appendix C. The capacity to provide greater description of the depth of our planning for each course is outside the scope for this paper. Our courseware development is also a work in progress, as some courses will not be taught for the first time until 2023. What can be

said, though, is that we will be responsive to the needs of the discipline while acknowledging that we are engaged in the process of imparting foundational knowledge, building application confidence, and developing experience in our students to underpin their future productive careers, hoped to be characterised by lifelong learning and application.

What is unique to our program is the inclusion of a compulsory contextual course in Semester 1 of the third year, titled ZHSS3750 Building the Fleet. It is presented by the School of Humanities and Social Science, and aims to provide students with a historical, political, strategic, tactical, and cultural perspective of why the Navy looks the way it does. The other seven courses provide for a contemporary technical education in things naval architectural, with a structure similar to the former program at UNSW Sydney.

It is worth noting that another four courses in fourth year also provide an opportunity for students to explicitly engage in naval architectural studies through their elective choices (two in number) and the thesis topic chosen (followed in ZEIT4500 Engineering Project A and ZEIT4501 Engineering Project B). The CDF students in fourth year pursue a 24 UoC thesis, in contrast to the standard 12 UoC thesis but, because of it being a zero-sum game, lose the electives. Any student could, of course, take extra elective courses above the minimum requirements of the degree to expand their knowledge and capability. It follows that, when considering the eight core naval architecture courses, the mandatory explicit naval architecture content represents 25% of the program. However, in considering electives and thesis to be naval architecture related, the naval architecture content could be viewed as12 of 32 courses or 37.5% of the program. This does not consider the exposure to discussions and examples which might be ship and boat related in foundational courses, such as in materials, mechanics, structures and thermo-fluids. For example, all thermo-fluids students (mechanical, aeronautical, and naval architecture) are exposed to concepts of buoyancy, metacentre, boundary layer, and frictional resistance. So, in extending this argument, all courses and 100% of the degree will shape our naval architecture graduates, albeit with 75% in common with our mechanical and aeronautical engineering graduates.

The elective choice is reasonably wide within the School, but naval architecture students will be encouraged to take courses which complement their thesis project and/or their broader capability development as naval architects. The published list of electives for the program currently includes: ZEIT3502 Vibration and Control Engineering, ZEIT3701 Heat Transfer and Refrigeration, ZEIT4003 Computational Fluid Dynamics, ZEIT4006 Structural Integrity Analysis, ZEIT4014 Impact Dynamics, ZEIT4503 Applied Thermodynamics and Propulsion, ZEIT4504 Electrical and Mechanical Plant, ZEIT4603 Finite Element Methods, and ZEIT4702 Microcontroller-based Instrumentation. None of these is unique to naval architecture but they all have obvious naval architectural relevance.

STAKEHOLDER ENGAGEMENT

Noting that a bachelor's degree represents the start of a career within the discipline, and what is hoped to be a life-long learning journey, we explicitly engaged with potential stakeholders through a survey in early 2021. Beyond some questions which described the organisations that respondents represented (primary areas of relevant practice, number of naval architects employed, percentage of naval architects educated in Australia, propensity to employ graduates with minimal experience), doors were opened regarding willingness to be classified a "stakeholder" and openness to actively support students through work experience or the program as a guest lecturer, design review panellist, thesis project sponsor, or industry visit host (in person or virtually).

A positive set of responses was submitted, with organisations identifying as stakeholders in our program including: Navy, classification societies, Government, and industry. Explicitly, the list comprises:

- Head Navy Engineering, HNE, (as the Program Sponsor);
- Naval Construction Branch (Navy/CASG);
- Navy Education, Navy People Branch;
- Lloyd's Register;
- DNV;
- Transport for NSW, Maritime;
- Austal;
- Australian Maritime Technologies;
- International Maritime Consultants; and
- Thales Australia.

The invitation remains open to experts and organisations, not listed, which would like to contribute to the quality of the naval architecture program at UNSW Canberra.

As we shape our program in the knowledge of the aforementioned support, the key encouraging outcomes from the survey are reflected in the alignment of expectations. Asked "What are the key characteristics expected in a graduate?", the common general themes from respondents align well with our academic aspirations, namely that future graduates would:

- possess well-rounded relevant engineering skills: analytic, mathematical and scientific;
- have foundational knowledge in the domain principles and working knowledge of the technology used (e.g. CAD, CFD, FEA);
- understand the practical application of ship design and construction: the how and why;
- have basic understanding of rules and standards, Federal and state requirements, class and sustainment;
- have broad understanding across the NA field, with enough depth to be productive soon after graduation;
- can demonstrate sound core technical knowledge, have some practical experience and good communication skills;
- exhibit ability and skill in report writing, project management and administration;
- maintain an appropriate professional attitude; and
- achieve all Engineers Australia (EA) Stage 1 Competencies.

These views are paralleled in the Naval Architecture Program Learning Outcomes as documented in the Handbook [3] and reproduced in Table 2. In general, across all programs, UNSW aspires to develop globally-focussed graduates who are rigorous scholars, capable of leadership and professional practice in an international community.

Table 2 Naval Architecture (Honours) Program Learning Outcomes (Program 4484)

PLO1	Relate a quantitative, theory-based understanding of the sciences and rationally apply comprehensive knowledge of the fundamental principles underpinning maritime engineering, with advanced knowledge of both Naval and Ocean vehicle design, hydrodynamics, ship structures, and/or on-board systems and equipment specific to the naval architecture discipline, using critical thinking and judgement
PLO2	Appropriately select and apply the mathematical, statistical, programming and computational tools and techniques which underpin naval architecture
PLO3	Demonstrate a comprehensive understanding of ship design, construction, performance, maritime systems and sub-systems aboard surface ships and submarines, and articulate directions of research and knowledge development in naval architecture
PLO4	Synthesise ship design practice, contextual factors, norms and accountabilities in and the limitations on naval architecture
PLO5	Define, conduct experiments on and apply problem solving, design and decision-making methodologies to identify complex problems in both the ship design and construction industries and the wider maritime sector whilst concurrently considering the implications of the solution in a global and sustainable context using appropriate engineering methods and tools
PLO6	Demonstrate proficiency in applying systematic engineering synthesis and design processes, and critically evaluating and effectively communicating the results and implications to all audiences
PLO7	Operate in collaborative environments, as leader or member of interdisciplinary teams
PLO8	Review personal performance, demonstrate independent initiatives and leadership as a means of managing continuing professional development and lifelong learning

STAFFING AND RESOURCES

Underpinning the ability for achievement of learning outcomes are the staff and resources available. From a staffing perspective there are currently two full-time academics with relevant industrial experience working in SEIT, and the School is in the process of recruiting another two. A further member of staff has naval architecture qualifications although he currently contributes more broadly in foundational and mechanical design courses. We also have our colleague in the School of Humanities and Social Science who will deliver the course ZHSS3750 Building the Fleet: History, Politics and Naval Technology. Necessary too are students. As a significant employer, Navy is taking the lead here and working amongst their midshipmen to build understanding of their new NA educational option, but we are open to civilians too, and would welcome and encourage any enquiry.

Before talking about hardware and software resources, the program owes its existence to the support and sponsorship of Head Navy Engineering (HNE), previously RADM Colin Lawrence and presently RADM Katherine Richards. It is anticipated that, through HNE, the program will receive coordinated access to RAN establishments and assets, clearly underpinning and emphasising our grey-ship distinction.

Another human resource to be utilised will be that of our stakeholders as described previously. We anticipate contributions from a range of guest lecturers, from Navy, industry, government and subject-matter experts. We look forward to their hosting visits and offering students work experience opportunities.

While not desiring to duplicate the facilities of other places, we will be leveraging those of SEIT, UNSW Canberra, ADFA, UNSW more broadly, AMC and the Navy. Locally, we will grow a collection of models for use in stability demonstrations (intact and damaged) and for use in our flumes, of which we have two from 2022. The flumes will be utilised by both civil engineering and naval architecture disciplines for teaching and research. A wavemaker and carriage will be added to the flume(s) providing a capability for resistance and seakeeping demonstrations and related student projects. The School has a number of Armfield hydraulic and flow benches, and we are acquiring the Armfield ship stability rig to complement current ship stability assets. Figure 6 shows the set up for a model inclining experiment with an Armfield hydraulics bench in the background. All other SEIT facilities including wind tunnels, material testing laboratories, student workshops, and College computer laboratories are available to the NA programs and students.

Figure 6 Set up for a model inclining experiment with an Armfield hydraulics bench at back left (Photo courtesy Warren Smith)

A wide range of software is available through the University and key general packages students will be exposed to in first year include Dassault 3D Experience (CATIA), and MATLAB. Specifically, for naval architecture, the Bentley Suite including Maxsurf will be foundational. The Autodesk Suite is also available and will likely be employed to produce general arrangement drawings. Packages such as Rhino, Navcad Hydrocomp and the Wolfson Unit's Marine Design Software are under evaluation. More generally amongst others, ANSYS for FEA and Star CCM+ for CFD simulations are available.

Beyond the School and College boundaries, the ADFA and Duntroon pools offer other potential model test facilities. Both have been used for experiments in the past and some portable rigs for towing models in these environments are being developed. The pools would also enable self-propelled models to be operated, enabling such things as the demonstration of ship manoeuvring. Another available asset of ADFA is the Boat Shed on Yarralumla Bay, Lake Burley Griffin, which has the potential to support the development of an open-water lake test facility.

AMC COOPERATION

With the desire to foster and strengthen existing collaborative, cooperative and collegial relationships with AMC, it is not in our interest to duplicate the facilities of Australia's premier maritime experimental organisation. Rather, we plan to visit and utilise and expose students to AMC's facilities, through a cooperative agreement that has been negotiated in principle. The precedent for this exists in that UNSW Sydney naval architecture students have similarly visited and experienced AMC's facilities each year. We certainly look forward to visiting AMC with our first cohort in Semester 1, 2023.

What is planned specifically for the AMC-centred trip is a mandatory 15 day "Work Experience Block", which is in addition to any specific course. It will be built around a one-week period at AMC early in fourth year and may facilitate the gathering of data for thesis or design-project work. It will be planned to run experiments in the towing tank and seakeeping basin, gain exposure to all other AMC facilities and conduct a "training cruise" on AMC's *Bluefin*. The rest of the "work experience" time accounts for time spent working up data and reports once back in Canberra.

FIELD TRIPS

While the work experience described stemming from the

AMC collaboration occurs in fourth year, all students are expected to participate in a minimum of three significant naval architecture field trips:

- Semester 1, Year 3 To Sydney, including visits to Garden Island Dockyard, a naval architecture consultancy, a classification society, and the conduct of an inclining experiment (courtesy of a Sydney Heritage Fleet vessel);
- Semester 1, Year 4 To Tasmania, including field trip to AMC, Hobart (e.g. Incat) and training cruise (it is possible that visits to relevant sites in Melbourne (e.g. DST Group), and a passage on a *Spirit of Tasmania* vessel can be incorporated in the trip); and
- Biennially To Sydney, with Year 3 and Year 4 cohorts to attend the Indo-Pacific International Maritime Conference and Exhibition.

It is possible that the Semester 1, Year 4 training cruise may be conducted on one of Navy's assets (possibly MV *Sycamore*) rather than on *Bluefin*. Also, as opportunities arise, other visits and experiences will be targeted. These may cover:

- Shipyards and organisations in Adelaide (e.g. ASC, Naval Shipbuilding College);
- Shipyards and organisations in Perth/Fremantle (e.g. Austal and HMAS *Stirling*)
- RAN ship visits, e.g. at Fleet Base East (Garden Island) or HMAS *Creswell*; and
- RAN ship (and other vessel) sea-time experiences.

POTENTIAL RESEARCH AND GROWTH AREAS

As we look to building our UNSW Canberra naval architecture enterprise, our current and primary focus has been, and will continue to be, preparing to teach and deliver the new undergraduate courses. Five will be taught for the first time in 2022 and the remaining three in 2023. This represents our new discipline's foundation. Other courses at undergraduate and postgraduate levels are expected to follow in future years. Of course, in parallel, we will be building research capability as it will underpin the teaching, provide avenues for projects, and build reputation and esteem. We will always welcome higher-degree research (HDR) students, i.e. those studying for PhDs and Masters degrees. Examples of recent and current HDR students working in the domain include (Ayob, 2011; Drohan, 2015; Hayes, 2014; and Shama, expected completion 2023). We have also had a post-doctoral fellow working with us in Alaa Osman (Osman, 2019).

Related undergraduate projects have included (Anastasio, 2017; Bell, 2019; Buckland, 2019; Carrol, 2021; Cavanagh, 2018; Champ, 2021; Fortescue, 2016; Harper, 2019; Hazenberg, 2020; Hunter, 2020; Jewson, 2021; Patel, 2021; Shpak, 2021; Smith, 2020; Ukmar, 2020; Von-Limont, 2019; and Wotherspoon, 2019). Thesis projects being undertaken in 2022 relate to developing our flume, pool, and open-water testing capabilities, and the continuation of work with the hybrid submersible UAV through design optimisation.

In general, due to the existing multidisciplinary nature of the College, there is opportunity for us to align with the existing research strengths of SEIT, bringing a maritime flavour to them. For example, strengths in the following can be leveraged:

- optimisation and design, as related to ships, boats, submarines and systems;
- fluid and fluid-structure iInteraction, as related to numerical (CFD) simulations, model tests and full-scale trials;
- trusted autonomy, as related to surface and sub-surface vessels; and
- advanced materials and impact dynamics, as related to ship survivability and vulnerability issues.

Each of us has interest and history, the union of which covers these areas of existing strength. We also look forward to developing relationships with stakeholders which would shape UNSW Canberra research efforts, helping to solve relevant problems and pushing the boundaries of knowledge and application in useful directions.

While the preceding comments on research directions has focussed on technical issues, we are also interested in educational research with a specific question — How do we best educate the naval architect of the 21st century? A secondary and related topic of interest is bound up in professional practice and ethics — summarised by the intersections of engineering, business, and the law.

SUMMARY OF KEY TAKEAWAYS

To conclude, we look forward to 2022 unfolding and the years beyond, when we expect naval architecture at UNSW Canberra to be found to be flourishing. We imagine our teaching spaces, like that shown in Figure 7, filled with junior engineers in a simulated workplace. They are connected to online design tools and learning management systems. They are applying naval architecture theory to practice and they are defending their design decisions to staff, peers, and representatives of industry. Their learning is seen to mature from understanding of concepts and the development of skills, to the application of deeper knowledge in self-directed project work.

Figure 7 Imagine a Naval Architecture class here! Junior engineers in a simulated workplace (Photo courtesy UNSW Canberra)

So, in summary:

- We are excited to be creating a high-quality undergrad naval architecture program which is grey ship focussed — standing up this program is our priority, and it is a work in progress.
- We will welcome our first students formally in 2022. We anticipate producing our first graduates in 2023.
- We look forward to subsequently growing relevant research and post-graduate coursework opportunities.

- We reside within a strong multi-disciplinary College which has a unique relationship to Defence.
- We appreciate and acknowledge Navy's support and, particularly, that of HNEs (past and present).
- We appreciate the cooperation of AMC in support of our planned field trip to visit and use their facilities.
- We appreciate the engagement of our stakeholders, and we invite all interested to come aboard.
- We are keen to answer any questions arising — now and in the future! — from stakeholders and prospective students.

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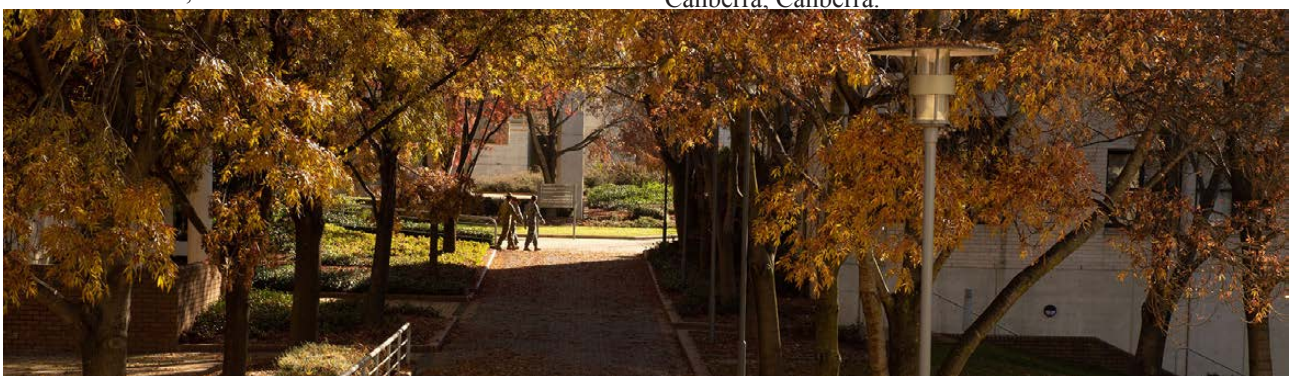


APPENDIX A

UNSW Sydney Naval Architecture Academics Honour Roll

UNSW BE(Nav Arch) Program: First Course 1959, Last Course 2018

Given Name	Family Name	From	To
FULL TIME STAFF			
John	Tuft	1959	1976
Owen	Hughes	1963	1988
Tom	Fink	1968	1978
Lawrence	Doctors	1970	2007
Farrokh	Mistree	1974	1980
Frank	Bartlett	1978	1979
Prabhat	Pal	1981	2001
Mac	Chowdhury	1990	2018
Phil	Helmore	1993	2018
Tracie	Barber	2005	2008
David	Lyons	2014	2018
PART TIME STAFF			
Cecil	Boden	1980	1981
Noel	Riley	1980	2004
Don	Gillies	1981	1993
Phil	Helmore	1991	1992
Richard	Sproge	1994	2016
David	Lyons	2000	2013
Craig	Boulton	2000	2018
Graham	Taylor	2002	2007
Michael	Andrewartha	2005	2006
Craig	Singleton	2007	2007
Rozetta	Payne	2008	2018
Mel	Atack	2016	2018

Compiled with the assistance of Phil Helmore, and UNSW sources: the UNSW Faculty Handbooks (1962–2001) [4], UNSW Calendars (1950–1962) [5], the Engineering Faculty History 1949–2009 [6] and the School of Mechanical and Manufacturing Engineering History 1949–2009 [7].

APPENDIX B

UNSW Canberra Naval Architecture Programs — Standard and CDF (as at February 2022)

BE (Nav Arch) (Honours)	
ZPEM 1303	Engineering Mathematics 1A
ZPEM1307	Computational Problem Solving
ZPEM1503	Engineering Physics 1A
ZEIT1504	Introduction to Mechanical, Aeronautical and Naval Architecture Engineering
ZPEM1304	Engineering Mathematics 1B
ZEIT1102	Introduction to Programming
ZEIT1501	Engineering Practice and Design
ZEIT1503	Engineering Mechanics
ZPEM2309	Engineering Mathematics 2A
ZEIT2500	Thermofluids
ZEIT2501	Mechanical and Electronic Design
ZINT2501	Engineering Materials and Chemistry
ZPEM2310	Engineering Mathematics 2B
ZEIT2503	Fluid Mechanics
ZEIT2504	Mechanics of Solids
ZGEN	
ZEIT3501	Engineering Materials
ZGEN	
ZEIT3750	**Naval Architecture Practice, Ship Hydrostatics and Stability**
ZHSS3750	**Building the Fleet: History, Politics and Naval Technology**
ZEIT3506	Managing the Development of Engineered Systems
ZEIT3751	**Hydrodynamics of Ships and High Speed Craft**
ZEIT3752	**Ship Structures**
ZEIT3753	**Design of Ships and High Speed Craft**
ZEIT4500	Engineering Project A
ZEIT4750	**Ship Design Project A**
ZEIT4752	**Ship Propulsion and Marine Engineering**
	Technical Elective
ZEIT4501	Engineering Project B
ZINT 2100	Introduction to Cyber-Security: Policy and Operations
ZEIT4751	**Ship Design Project B**
	Technical Elective

BE (Nav Arch) (Honours) (CDF)	
ZPEM 1303	Engineering Mathematics 1A
ZPEM1307	Computational Problem Solving
ZPEM1503	Engineering Physics 1A
ZEIT1504	Introduction to Mechanical, Aeronautical and Naval Architecture Engineering
ZPEM1304	Engineering Mathematics 1B
ZEIT1102	Introduction to Programming
ZEIT1501	Engineering Practice and Design
ZEIT1503	Engineering Mechanics
ZPEM2309	Engineering Mathematics 2A
ZEIT2500	Thermofluids
ZEIT2501	Mechanical and Electronic Design
ZEIT2901	Engineering Research 2A
ZPEM2310	Engineering Mathematics 2B
ZEIT2503	Fluid Mechanics
ZEIT2504	Mechanics of Solids
ZGEN	
ZEIT3501	Engineering Materials
ZGEN	
ZEIT3750	**Naval Architecture Practice, Ship Hydrostatics and Stability**
ZEIT3901	Engineering Research 3A (include aspects of ZHSS3750)
ZEIT3506	Managing the Development of Engineered Systems
ZEIT3751	**Hydrodynamics of Ships and High Speed Craft**
ZEIT3752	**Ship Structures**
ZEIT3902	Engineering Research 3B (include aspects of ZEIT3753)
ZEIT4901	**Engineering Research 4A (12 UoC)**
ZEIT4750	**Ship Design Project A**
ZEIT4752	**Ship Propulsion and Marine Engineering**
ZEIT4902	**Engineering Research 4B (12 UoC)**
ZINT 2100	Introduction to Cyber-Security: Policy and Operations
ZEIT4751	**Ship Design Project B**

APPENDIX C

UNSW Canberra Naval Architecture Course Descriptions

(as per the 2022 University Handbook)

ZEIT3750 Naval Architecture Practice, Hydrostatics and Stability

The Practice component of this course introduces ship terminology and the role of international and Australian independent and statutory authorities concerned with ship classification, naval and commercial standards, vessel registration, safety and survey; vessel stability measurement and assessment, and the professional practice of the naval architect. Excursions may include visits to drydock and harbour facilities, consultancies and the conduct of an inclining experiment. The Hydrostatics and Stability component covers ship geometry, hydrostatic particulars, intact and damaged stability, subdivision, launching and grounding. A practice-based introduction to relevant software is provided.

ZHSS3750 Building the Fleet: History, Politics and Naval Technology

This course examines the technological, political and strategic factors that have shaped the development of warships and ship design and continue to do so today. It will survey the key developments in naval and maritime technologies over the past 200 years, setting them into their broader contexts. This will provide a grounding for a more focused exploration of the historical, political, strategic, tactical, and cultural factors that frame decision making regarding Australian naval construction. The course aims to develop the students' understanding of the contexts which shape the decisions over the design and construction of warships.

ZEIT3751 Hydrodynamics of Ships and High Speed Craft

Introduction to ship and high speed craft hydrodynamics, resistance, seakeeping and model testing, followed by the study of ship motions, powering and manoeuvrability/steering.

ZEIT3752 Ship Structures

Methods for the first-principles analysis of global and local loading and response are treated alongside rules-based ship structural design and scantling determination with the aid of naval codes and classification society software. Familiarisation with material properties, welding and composite processing precede a more detailed investigation of fatigue and fracture, particularly of structural connections.

ZEIT3753 Design of Ships and High Speed Craft

This course introduces the preliminary ship design and construction process with emphasis on naval ship types and requirements. Methods for the initial estimation of vessel performance, dimensions, weights/centres and volumetric capacity are practised before undertaking ship geometry definition using software tools to generate preliminary hull lines and general arrangement drawings. Requirements for load lines, freeboard and commercial vessel tonnage admeasurement are presented, followed by ocean environment and seakeeping considerations. The case of IMO High Speed Craft design, regulation and operation is specifically considered. A typical ship specification document is presented as an exemplar.

ZEIT4750 Ship Design Project A

In response to a nominated design brief, all essential ship design tasks are individually completed to a preliminary stage in Ship Design Project A: Principal particulars; hull lines; general arrangement; estimate of weights and centres; resistance calculation; machinery selection; performance prediction and structural design, culminating in a presentation. To assist with the design project, advanced structural design considerations are addressed, namely optimisation, vibration, noise, shock, slamming, whipping, risk and drawing practices.

ZEIT4751 Ship Design Project B

In response to a nominated design brief, all final ship design tasks are individually completed in Ship Design Project B: Principal particulars; hull lines; general arrangement; estimate of weights and centres; stability; resistance; machinery; performance prediction and structural design, culminating in the production of a consolidated final design report, presented and defended in class at the end of semester.

ZEIT4752 Ship Propulsion and Marine Engineering

This fourth-year course equips students with knowledge and skills required to analyse and design marine thermo-fluid engineering equipment used on board a variety of ship types. This knowledge can then be applied to obtaining effective engineering design solutions for these systems, so that they can meet their functional purposes within international statutory and regulatory frameworks.

[*This paper was originally presented by Warren Smith, David Lyons and Ahmed Swidan via the RINA/IMarEST webinar on 6 October, but has been updated here with the latest developments. The recording of the October presentation is available on the RINA YouTube Channel*—Ed.]

Collaboration to Advance Naval Shipbuilding Technology

DMTC Limited is working with BAE Systems Maritime Australia, ANSTO and the University of Wollongong to develop advanced welding technologies for use on naval shipbuilding programs such as the Hunter-class Frigate Program. Collaboration between the industry, research and academic organisations will take place over two years and is expected to result in production efficiencies in the construction of complex warships by incorporating artificial intelligence to reduce weld rejection rates, increase throughput and improve workforce skills in shipbuilding. BAE Systems Maritime Australia is designing and building nine of the world's most advanced anti-submarine warfare frigates for the Royal Australian Navy. Investment and technology development across the highly-automated Osborne Naval Shipyard is driving digital transformation in shipbuilding through advanced robotics, additive manufacturing and Industry 4.0 utilisation. While Osborne's production facilities incorporate state-of-the-art robotic welding, the organisations believe that this phase of research and development could identify opportunities to further automate and optimise weld sequencing, which is critical in ensuring the stability and life of welded structures such as steel bulkheads and panels.

Weld sequencing for ship construction is considered a complex, manual and time-consuming process, and the research will focus on an optimal model which improves structural analysis to reduce distortion in the welding of units and the 22 blocks which make up each frigate. Initial work will take place at ANSTO and the University of Wollongong before moving into trials at Osborne. To optimise the weld sequencing in panel/unit/block fabrication and consolidation, a streamlined process will be developed to ensure the accuracy of weld modelling inputs, robotic programming outputs and weld control programming. The project will establish a sovereign capability in optimising weld sequencing and builds on DMTC's long history in working on industrial projects to reduce weld-induced distortion on various defence platforms. The research forms part of broader work to deliver Australian Industry Capability outcomes under DMTC's Naval Shipbuilding and Sustainment Program, an industrial innovation partnership with Defence's Capability Acquisition and Sustainment Group.

PMB Battery Contract

Australian company PMB Defence (PMB) has been awarded a contract to supply main battery modules for Royal Navy submarines.

The contract has been awarded for Submarine Main Battery TDP Phase 3a – Final Module Design. Under the contract, the firm will develop and improve an existing submarine main battery module design. Furthermore, the deal includes the initial production standard module build, shock testing, and electromagnetic interference pre-qualification.

The contract's value is £22 million ($29 million). The duration of the contract, as well as the delivery dates, have not been disclosed.

PMB was first established in South Australia as the logical site for the delivery of battery systems to Australia's Collins-class submarine program, given the location of the submarine construction facility at Osborne. PMB began as a local manufacturer to a licensed design sourced from offshore.

The firm has continued supporting the Collins-class battery, cooling and agitation units, battery monitoring probes, and battery analysis tools. It now owns equipment and designs for submarines in the UK, Canada, Sweden and Australia.

The Royal Navy Submarine Service operates a fleet of six submarines of the Trafalgar and Astute classes and four ballistic-missile submarines (SSBN) of the Vanguard class.

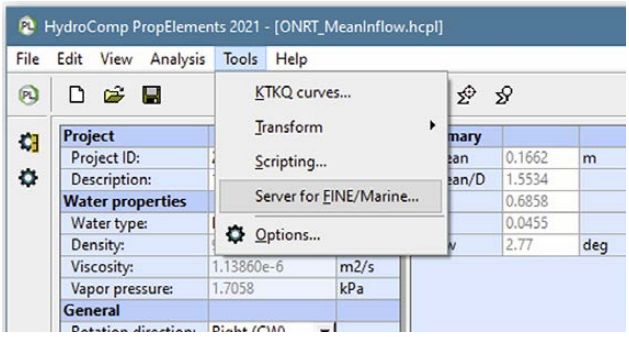
As the current Vanguard-class submarines reach the end of their lifecycle, they will be replaced by a new class of nuclear submarines: the Dreadnought class, the first of which is now under construction at Barrow in Furness.

HydroComp PropElements® 2021 Update

Development in 2021 for HydroComp's PropElements software offers new features across the range of applications.

PropElements + FINE/Marine Coupling

User testing is underway for the new coupling of HydroComp's PropElements with NUMECA's FINE/Marine CFD software. One of the challenges of full self-propulsion analysis with CFD is the computational load required to model the propeller within the 3D space. When coupled with FINE/Marine as a higher-order actuator disk replacement, PropElements calculates velocity fields and propeller body forces for the wake field, offering a significantly improved model of propeller performance for self-propulsion simulation at a fraction of the computational cost of full "sliding grid" 3D analysis.



Screen shot showing link to FINE/Marine

Updates to the prediction of nozzle contribution

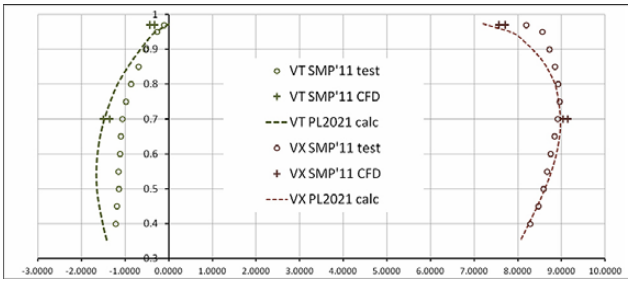
A number of updates have been added to the modelling of nozzle contribution for the design and analysis of ducted propellers in PropElements. New features for 2021 include:

- Updated model for 19A and high efficiency nozzles.
- New scale correction for nozzles to better predict large nozzles.
- Addition of nozzle style 30 as a minimum-drag non-contributing nozzle, and style 38 for symmetric fore-aft performance.
- Indicator for the potential inception of critical nozzle cavitation.

Prediction of streamline parameters

A new script-based module has been developed for the prediction of streamline axial and tangential velocities at positions some axial distance from the propeller's design reference origin (both upstream and downstream), as well as corresponding jet compression (contraction) and twist angle. Results of total axial and tangential velocities for the PPTC benchmark from SMP'11 are shown below for a reference plane 20% diameter aft of the propeller plane. Markers are for test data, with dashed lines the PropElements prediction. The report also includes CFD predictions from multiple participants for the 0.70 and 0.97 radii, with results(for the mean 90%) shown by the error band markers in the plot. You can note that PropElements very closely matches the CFD predictions.

This is a foundational piece of the upcoming contra-rotating propeller analysis module under development for 2022.



Results of total axial and tangential velocities

Preliminary Prediction of Properties for Noise and Vibration Assessment

New for 2021 are predictions of various properties for follow-on noise and vibration analysis. These properties are included in the Performance and Strength calculations, and can be generated for output using simple scripts. Parameters that are calculated include:

- Key frequencies, including shaft and blade pass.
- Entrained water properties, including wetted added mass and moment of inertia.
- Tip vortex parameters, including inception cavitation number, resonance frequency, and core diameter.
- Singing parameters, including estimation of the blade natural frequency and the radial exciting "vortex street" frequencies.

Miscellaneous updates and enhancements

HydroComp also found opportunity for a number of miscellaneous enhancements,including:

- Automatic estimation of ideal angle for imported geometric data.
- Improved influence of the hub's effect on induced velocities.

For additional information visit: www.hydrocompinc.com/solutions/propelements

ABS Approval for Alfa Laval for Firing Boilers with Methanol

The American Bureau of Shipping (ABS) has granted Alfa Laval the first marine approval for operating boilers on methanol. Alfa Laval received an approval in principle (AIP) on 4 November 2021, based on extensive solution testing at the Alfa Laval Test & Training Centre in Aalburg, Denmark.

Taking methanol beyond the main engines

Methanol, which is liquid at ambient temperatures and carbon-neutral if produced from green sources, is the next likely fuel step in decarbonising the marine industry. While methanol can be found on a handful of vessels and is planned for many more, its use has so far been limited to main engines. In the future, methanol operations will need to extend to boilers. Alfa Laval has been testing boiler operations with methanol since early 2021 at the Alfa Laval Test & Training Centre, where engine combustion tests with methanol are also underway. Tests have been conducted using a pressure-atomising MultiFlame burner on an Alfa Laval Aalborg OS-TCi boiler, as well as a methanol valve unit designed by Alfa Laval to meet the class requirements from ABS.

EDUCATION NEWS

UNSW Canberra

By the time this edition is published and you are reading these words, we will have passed an historic day with the first classes of our inaugural courses in the new Naval Architecture program having been taught. COVID-19 permitting, this will have been face-to-face with the students on Tuesday 22 February and have included some acknowledgement of the occasion. I am sure that David Lyons and I will be delighted. A photo or two documenting the making of history may be included in the next issue.

Included in this issue is our paper *The New Naval Architecture Degree Program at UNSW Canberra*, which consolidates much of the background and information relating to our endeavour. I commend it to you to understand our purpose and aspiration.

In previous issues of *The ANA* we have flagged in this column our active recruitment activities, with the hope of announcing in this issue who will be joining our team. Unfortunately, there is no announcement to make in the positive yet, but we have lost a member of the team in Dr Ahmed Swidan, who has returned to Egypt. He has chosen a path involving an appointment as Vice Dean Maritime Research at the Arab Academy for Science, Technology and Maritime Transport in Alexandria. We wish him well and thank him for his contributions in Canberra. While he is now geographically dislocated from us, he has accepted an Adjunct Senior Lectureship from UNSW, so he remains in the family and able to continue working with and mentoring our students.

In parallel with our courses starting, we have four midshipmen undertaking final-year thesis projects with us, building our capability for experimentation and demonstration in our flumes, pools and open-water facilities (including the ADFA boatshed on Lake Burley Griffin). Watch this space for updates on their achievements.

Please do not hesitate to contact me via email <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

Nuclear Science and Engineering Scholarships

On 19 December the Minister for Defence, the Hon. Peter Dutton MP announced the creation of more than 300 scholarships over the next five years to grow Australia's nuclear science and engineering workforce.

"The delivery of at least eight nuclear-powered submarines will see thousands of jobs created across the country over the next few decades," Minister Dutton said.

"We must ensure that our people have the right skills and qualifications to support and deliver this once-in-a-generation endeavour which will bolster our national security and defence."

The Defence Nuclear Science and Engineering Scholarships build on the existing National Naval Shipbuilding education pipeline.

Minister Dutton said that the Government will also identify opportunities to increase the number of Australians undertaking Vocational Education and Training Courses, providing additional entry points for Australians interested in nuclear-related careers.

On graduation, scholarship recipients will be qualified to work across a range of organisations contributing to the nuclear-powered submarine program, including Defence, nuclear stewardship and environmental agencies, research and training, and the broader shipbuilding industry.

Vale Neil Otway

One of the Australian Maritime College's former Principals, Neil Otway (1996–2005) died in Adelaide on 8 January 2022.

During his time at AMC, Neil made significant contributions to academia, research and leadership. In response to the need to underpin our education programmes with solid research, there was a growth in postgraduate degrees and research through to doctoral level, the first doctoral degree being awarded by AMC in 1998.

One of Neil's strengths was his financial management and integrity and he steered AMC through this challenging period — a time of financial difficulty for all universities, as well as for the Australian shipping industry. There was increasing accountability, not only financially but also with respect to equal opportunity, quality and educational standards. Neil was proactive in responding to areas of possible development and improvement. His active involvement in various initiatives (e.g. equity meetings, student welfare committee, staff induction and indigenous cultural awareness sessions) demonstrated to the staff the priority which he placed on these aspects. There were numerous reports and reviews by Government and industry bodies, but feedback was always positive.

In 1999, the International Association of Maritime Universities (IAMU) was established with AMC as one of the founding members and representing the Oceania region. The Association had its roots in collaborative meetings initiated by the United Nations in 1979 in response to the needs for global standards of safety management at sea. Australia, and especially the Maritime College, was seen as pivotal to the development of appropriate standards of seafaring training in the Asian area and beyond. Neil was a member of the IAMU International Executive Board from 1999 to 2005, and was appointed as Chair of the Association in 2004–2005. In 2014, he was made an Honorary Fellow of IAMU in recognition of his significant contribution to its establishment and development in its formative years.

Neil's significant contribution to the Australian Maritime College was most recently acknowledged on 11 December 2020 by the College of Science and Engineering awarding Neil the Executive Dean's Medal for Service in recognition of "*Exceptional sustained contributions to the achievement of the mission of the University that have significantly exceeded the scope and commitment of usual expectations."*

Michael van Balen

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 December 2021 e-Newsletter included:

- Recent surveyor audit findings
- What is corrective action?
- Condition of tailshaft, survey recommended by Surveyor
- Stability audits – common findings
- Maintaining professional competence
- Marine Safety Incident – POB
- Harmonisation of shaft surveys with renewal surveys
- Initial survey of sister vessels
- Weld defects and NDT examination
- NSCV C6B review project commencing

The articles on *Stability Audits – Common Findings* and *NSCV C6B Review Project Commencing* are reproduced below.

Phil Helmore

Stability Audits — Common Findings

AMSA audits accredited marine surveyors to ensure that the correct procedures and protocols set out in the National Law – Marine Surveyors Accreditation Guidance Manual (SAGM) and the Marine Safety (Domestic Commercial Vessel) National Law Regulation 2013 (the regulations) are being implemented.

AMSA has performed over 300 audits related to stability approvals from accredited marine surveyors (AMS), with the assistance of Transport for New South Wales. Most of the submissions from accredited surveyors were found to be compliant and several positive observations noted. However, some of the audits identified several serious findings and the vessels failed to meet criteria. Some of the most common non-conformances identified are:

1. Maximum allowable angle of static heel.
2. Allowable loss of freeboard calculation using. alternate simplified criteria.
3. Wind pressures in the bare poles condition for sailing yachts.

NSCV C6B Review Project Commencing

AMSA has commenced a review of NSCV C6B *Stability and Buoyancy After Flooding*. The project seeks to make amendments to NSCV C6B based on issues and feedback supplied by accredited marine surveyors.

Specifically, the project will:

- review and validate the flotation and foam requirements of Annexes C, D and F;
- develop a new alternative simplified level flotation annex for low complexity vessels;
- review and validate the raking damaged requirements for inflated collar vessels;
- review the number of watertight doors per hull and the type of door; and
- develop guidance to assist with implementation and compliance.

AMSA will be developing a Technical Advisory Panel (TAP) for this project. Interested industry stakeholders should complete the TAP nomination form available on the AMSA website.

Survey Matters, December 2021

Australia Re-elected to Category B of the IMO Council

On 11 December 2011 Australia was successfully re-elected to Category B of the International Maritime Organization (IMO) Council for the 2022–23 biennium. The IMO is a specialised United Nations agency responsible for the safety, efficiency and security of international shipping and the prevention of pollution by ships. The IMO Council is responsible for supervising the work of the Organisation. Category B represents countries with the largest interest in international seaborne trade and is made up of only 10 IMO Member States.

Chief Executive Officer of the Australian Maritime Safety Authority (AMSA), Mick Kinley, said Australia is committed to ensuring that IMO can meet the new challenges arising from emerging technology, global trade expansion, and environmental developments and we are proud to have successfully championed a range of reforms to make the Organisation more open, fair, transparent and accessible to all.

"Australia's re-election to Category B reflects our nation's status as a significant maritime nation and ensures that our interests will continue to be represented at the highest level of international maritime policy making", said Mr Kinley.

Australia has substantial maritime claims as the world's largest bulk commodities exporter, a search-and-rescue area covering ten per cent of the world's surface, and the world's third-largest exclusive economic zone.

Shipping is critical to Australia's economic prosperity, environmental protection and standard of living, transporting 98 per cent (by volume) of Australia's international mercantile trade.

"We would like to thank the international community who supported us in the re-election to the IMO Council. We are committed to advocating for a sustainable shipping industry well into the future", said Mr Kinley.

Australia is a founding member of the IMO since 1959 and has been represented on the IMO Council for many years.

AMSA led Australia's campaign for re-election to Category B of the IMO Council, supported by the Australian Government Departments of Foreign Affairs and Trade and the Department of Infrastructure, Transport, Regional Development and Communications.

AMSA Media Hub, 11 December 2021

VALE

John McKillop

It is with sadness that *The ANA* records the passing of John Andrew McKillop on 11 December 2021, just short of his 59th birthday. John had been in his element, sea kayaking with fellow members of the Tasmanian Sea Canoeing Club off Betsey Island in Storm Bay off Hobart, when he suffered a heart attack and capsized. While assistance was close at hand and quick, he was not able to be revived.

John was born on 14 December 1962 in Hobart and lived there until moving to Sydney for tertiary studies in 1991. He attended Clarence High School to Year 10 before joining Gutteridge, Haskins and Davey (GH&D) in December 1978 as a Trainee Draftsman. During his time there he studied for a Certificate in Civil Engineering from the Hobart Technical College with his certificate being awarded in April 1983. He joined the Civil Engineering Branch of the Hydro-Electric Commission, Tasmania, in September 1982 as a Structural Draftsman Class 1. Aside from study and work, John was a competitive yachtsman, sailing the Fireball class among other dinghy types.

Having met Linda in Hobart, they married in Perth in January 1990 and, together, they raised their children Nicole, Nathan and Alexander while moving around the country in pursuit of further education and work.

John completed his career with the 'Hydro' in November 1990 after gaining a cadetship with the Department of Defence to study naval architecture at the University of NSW from 1991. He graduated with a Bachelor of Engineering degree in Naval Architecture with Honours Class 2 Division 1 in May 1995. He was also awarded the RINA (Australian Division) Prize for the best ship design by a final year student of the Bachelor of Engineering in Naval Architecture Course for his design of an Offshore Supply Vessel/Crewboat.

Following graduation, John joined the Naval Architecture section within the Naval Engineering Division of the Department of Defence in Canberra in 1995 as a Professional Officer Class 1 (Naval Architect). There he initially worked in the fields of ship hydrodynamics and stability, but also with a stint of industrial training sponsored by Defence at NQEA Australia in Cairns between 1996 and 1997.

In 1998 John chose to pursue a naval architecture career in the private sector, initially with Burness Corlett Australia in Sydney and, subsequently, with Commercial Marine Design, also in Sydney. Later in 1998, John and his family moved to Perth to take up a position as a Naval Architect with WaveMaster International in Henderson, working on their early IMO HSC monohull ferries. He mover to a position as a Project Design Coordinator with Austal Ships (Oceanfast) in September 2000 to work on the rebuild of the 57 m luxury monohull motor yacht *Sagitta*, with the original build having caught fire in the Oceanfast construction shed just prior to completion. This project was finished in July of 2001 and from October John took on a role as Project Naval Architect with Austal Ships (Image Marine), also at Henderson.

A few years after North West Bay Ships was established in Margate, Tasmania, John and his family once again

John McKillop
(Photo courtesy Linda McKillop)

relocated in 2005 and settled in Margate where he took up a position as on-site Naval Architect with NWBS. Following the successful completion of the world's first trimaran superyacht *White Rabbit – Echo* in 2005, NWBS embarked on an even more ambitious project to design and construct a 90 m high-speed trimaran superyacht, where John was instrumental in the technical development. Unfortunately, this superyacht project was terminated in 2007 during the early stages of construction when the yacht owner died and so the vessel was never completed. The NWBS shipyard was subsequently sold to Austal ships, and John again joined the Austal team. John remained employed with them until a downturn in fast-ferry construction resulted in Austal consolidating its business and closing the Margate yard in 2010.

Having settled in Margate with his family, John didn't want to relocate for employment yet again, so he established a private naval architecture practice, AllCraft Naval Architecture, supporting local vessel owners and industry with naval architectural advice and analysis.

John began a second stint with the Naval Engineering Division of the Department of Defence on a contract basis in September 2010 while working remotely from Defence facilities in Hobart. During that time, John was primarily engaged in stability and hydrodynamics tasks, such as preparation of stability books, ship motions analysis, and resistance and propulsion analysis and testing. When the Federal Government sought to reduce Australian Public Service staff numbers in 2012, a blanket termination of non-ongoing employment contracts resulted in a premature end to John's employment with Defence through no fault of his own. Consequently, he resumed his private practice which included contract work with Crisp Bros & Haywards in Margate. He became an employee of this company from late 2015 to provide in-house naval architecture support

including structural design, docking plans, inclining experiments, stability books, production support and various tests and trials.

In August 2019 John took up a position as a Naval Architect with BAE Systems Australia at Williamstown in Melbourne to support Anzac-class frigate sustainment on a FIFO basis from Hobart. The pandemic led to him working from home from February 2020 onwards on a wide range of projects, including docking/undocking calculations, conducting inclining experiments and thereafter preparing inclining experiment reports for the class. He was promoted to Senior Naval Architect with BAE Systems Australia in January 2021 and was providing naval architectural input for future developments of the Anzac class with a particular focus on stability analysis of the impacts of engineering change proposals.

John's family, friends and colleagues were shocked by the news of his sudden death. He demonstrated a passion for his chosen profession which extended into a recreational interest in wooden boat building and kayaking. There were many admirable traits to John's character. He was invariably cheerful and kind hearted, and those who were fortunate to have known him saw a true gentleman. He was very unassuming, and never judgmental of people. He was one of those people who, when life threw a challenge, got on with the job, and it just polished him up and made him a better person. He was meticulous with his work, it invariably being well documented. As examples, he wouldn't hesitate to include data to make docking reports easier for the dockmaster and ship staff to use and was always open to suggestions and developments arising from reviews of inclining experiment reports which, for frigates, are invariably major tasks. He will be sorely missed by many.

John is survived by his wife Linda, children Nicole, Nathan and Alexander, mother Eileen and brothers Peter and Brent.

The celebration of John's life was held at the Hobart Baptist Church on 20 December 2021, including a Zoom video link for far-flung family and friends.

Martin Grimm
Jon Emonson
Peter Gawan-Taylor
Geoff Leggatt
Kalevi Savolainen
Nigel Winter
Linda McKillop
Phil Helmore

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 *Playlist*s 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.

ACT Section Webcasts

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

- *Port Ash: The use of Manned Models in Shiphandling Training,* presented by Captain Andrew Beazley, General Manager, and Captain Cliff Beazley, Managing Director, Port Ash, as a webinar hosted by RINA on the Zoom software platform on 23 November 2021.

Lily Webster

NSW Section Webcasts

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

- *Wärtsilä Products and Solutions—Powering a Sustainable Maritime Future*, presented by Ashar Khan, Manager New Build Projects Australia-Pacific, Wärtsilä, as a webinar hosted by RINA on the Zoom software platform on 2 February.

Phil Helmore

Further recordings will be added to the RINA YouTube channel as they occur.

Decarbonising Shipping

A presentation also of interest on the RINA YouTube channel is the RINA President's Invitation Lecture 2021, effectively saying that decarbonisation is happening, and the perfect should not be allowed to get in the way of the good:

- *How a Large Diversified Shipowner is Managing Decarbonisation Challenges*, presented by Budd Darr of MSC Group, as a webinar hosted by RINA on the Zoom software platform on 1 December 2021.

To find the presentation, click on *Playlists/Institution/View full Playlist*, and it is currently at the bottom of the list (No. 18)

Rob Gehling

MEMBERSHIP

Australian Division Council

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

Among the items discussed were:

Election of Division President for 2022–24

Council unanimously elected Vice President Violeta Gabrovska to the Presidency for the coming term. However, as we go to print Violeta has advised that changes to her personal circumstances have just arisen which prevent her from assuming the position, so Council will give this matter further consideration prior to its March meeting.

ACNC Registration and Declaration of Conflicts

Council has for some time been attempting to secure registration under Australian law with the Australian Charities and Not-for-profit Commission. Council adopted a resolution regarding declaration of conflicts of interest by members of Council and Section Committees to remove a potential obstacle to registration, which has subsequently been granted with back-dating to 2 December 2019.

Naval Shipbuilding Plan Policy

Further to the work undertaken by Council working groups on this subject in the past year, Council formed an Improvement Committee to further develop proposals regarding:

- value for members and industry relevant to the Australian context; and
- engagement with EA, NSC and other Government and industry bodies.

Domestic Commercial Vessels Safety Framework Review

Noting that the Government had announced an independent review of the DCV legislative framework, Council agreed to arrangements for development of a submission to the review by the Division.

Division Council Vacancy

In response to a recent resignation, Council agreed to a process to fill the vacancy. As we go to press that process had led to John Butler of NSW Section being appointed to the position.

Sponsorship and Advertising

Recognising the need for improvement in Division funding, Council agreed to advertise for advertisers/sponsors in future issues of *The ANA*.

Next Meeting

Council provisionally agreed to hold its next meeting on Tuesday 15 March 2022 and for the Division's Annual General Meeting to follow a week later on 22 March.

The draft minutes of the meeting have been circulated to Council members and are available to other members by request.

Rob Gehling
Secretary
ausdiv@rina.org.uk

Free Papers for Members

Members should be aware that they are entitled to four free copies of RINA papers each year. This includes papers from previous transactions, conferences, etc., and is especially useful if you are interested in just one or two papers from a particular conference as you don't then need to buy a copy of the entire proceedings.

Papers published by RINA are searchable on the RINA website www.rina.org.uk; click on

Publications>Search Publications and Order.

The procedure for obtaining a free copy is to email your request to publications@rina.org.uk, with the subject line "Member's Free Paper", and specify the author(s) and year, the title of the paper, where the paper appeared (transaction year/volume, conference name and year, etc.) and, finally, your name and RINA membership number.

Free Places for Student Members at RINA Conferences

RINA also makes available two free places for Student Members of RINA at conferences organised by the Institution, including the Indo-Pacific International Maritime Conferences in Sydney.

The procedure for obtaining a free student place is to email your request to the Chief Executive, Chris Boyd, at cboyd@rina.org.uk, and specify the conference, your name and membership number.

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
Australian Div.	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.u
Vic	vicsec@rina.org.uk
WA	wa@rina.org.uk

Phil Helmore

RINA AUSTRALIAN DIVISION

NOTICE OF ANNUAL GENERAL MEETING

TUESDAY 22 MARCH 2022

Notice is hereby given that the Annual General Meeting of the Australian Division of the Royal Institution of Naval Architects will be as a virtual meeting by Zoom at 2000 Australian Eastern Daylight Time on Tuesday 22 March 2022.

Please notify the Secretary no later than Friday 17 March 2022 if you wish to attend, to enable Zoom attendance details to be sent to you before the meeting.

Apologies should be received by the Secretary no later than Sunday 20 March 2022.

AGENDA

1. Opening
2. Apologies
3. To confirm the Minutes of the AGM held on 17 March 2021 [1]
4. To receive the President's Report
5. To receive, consider, and adopt the Financial Statements and Auditor's Report for the year ending 31 December 2021
6. Announcement of appointments to the Australian Division Council
7. Other Business

Relevant documents will be made available to registrants as they become available.

R C Gehling
Secretary
Email: rinaaustraliandivision@iinet.net.au or ausdiv@rina.org.uk; Phone: 0403 221 631

9 February 2022

[1] Refer draft on Australian Division Forum: https://www.rina.org.au/cgi-bin/showpage.fcgi

NAVAL ARCHITECTS ON THE MOVE

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

Ryan Aberle has moved on from the FFG Systems Program Office and has taken up the position of Deputy Engineer Officer on HMAS *Stalwart*.

Angus Bratter has moved on from Thales Australia and has taken up the position of Platform Engineer–Naval Architect with Navantia Australia in Sydney.

Christopher Carl has taken up a position as a Naval Architect with ASC in Adelaide.

Greg Cox completed a Doctor of Philosophy degree in vessel wave wake and shoreline erosion at the Australian Maritime College/UTas in 2020 and has now taken up a position as a naval architect with Doen Waterjets in Melbourne.

Kristian Fet has moved on from Evoy and has taken up the position of Senior Project Engineer with Ulmatec Handling Systems in Hareid, Norway.

Sue-Ellen Jahshan has moved on from Naval Group Australia and has taken up the position of Domain Engineering Manager—Maritime with Babcock Australia & New Zealand in Adelaide.

Claire Johnson has moved on from the Department of Defence and has taken up the position of Senior Naval Architect with Gibbs & Cox (Australia) in Canberra.

Chia How Khee moved on from Consort Bunkers in 2020 and, after some time at Fratelli Consulich Bunkers (S), has taken up the position of Technical and Assurance Manager at Trafigura in Singapore.

Antony Krokowski has moved on from consulting and has taken up the position of Superintendent–Terminals & Ferries with SeaLink Travel Group in Brisbane.

Iain Lund has moved on from ASC and has taken up the position of Engineer Officer on HMAS *Stalwart*.

Warwick Malinowski has moved on from Rolls-Royce/KBR and is taking some time off and travelling overseas before evaluating new opportunities.

Rini Nishanth has moved on from MMI Thornton Thomasetti and has taken up the position of Naval Architect with Kent in Perth.

Dudley Simpson moved on from Bosch Rexroth Korea in 2003 and, after completing a master's degree in computer systems, took up a position with automation company Sensor-Technik Wiedemann in Kaufbeuren, Germany, where he has taken up the position of System Architect.

Robert Skerman has moved on from KPMG and has taken up the position of Platform Systems Engineering Manager with Nova Systems in Canberra.

Karl Slater has moved on within DST Group and has taken up the position of Program Manager—Submarine Naval Architecture in Melbourne.

Alistair Smith has moved on from the Capability Acquisition and Sustainment Group within the Department of Defence and has commenced a two-year full-time master's degree in Nuclear Science at the Australian National University in Canberra.

A/Prof. Warren Smith has moved on with the University of Canberra at ADFA, and has taken up the position of Naval Architecture Program Coordinator in the School of Engineering and IT in Canberra.

James Smithers moved on within the acquisition of Parsons Brinckerhof by WSP in 2014, and has now taken up the position of National Executive, Infrastructure Investment Decisions, with WSP in Sydney.

Adam Solomons has moved on from London Offshore Consultants (Australia) and has taken up the position of Managing Director Australasia with AqualisBraemar LOC Group in Sydney.

Tim Speer has moved on with Austal and has taken up the position of Market Development and Design Manager in Fremantle.

Colin Spence has moved on from DOF Subsea and has taken up the position of Senior Naval Architect with Floating Solutions Consulting in Perth.

Sri Srinivas has moved on within the Department of Infrastucture, Planning and Logistics of the Northern Territory and has taken up the position of Manager Marine Safety and Logistics in Darwin.

Jude Stanislaus has moved on within DNV and has taken up the position of Project Manager and Principal Surveyor in Perth.

David Steed has moved on within Crondall Energy and has taken up the position of General Manager Buoyant Production Technologies in Winchester, UK.

Alex Walter has moved on from BMT and has taken up the position of Capture Manager—Maritime with Saab Australia in Adelaide.

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 Robin 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

HMAS HOBART (I)

Service Cut Short

John Jeremy

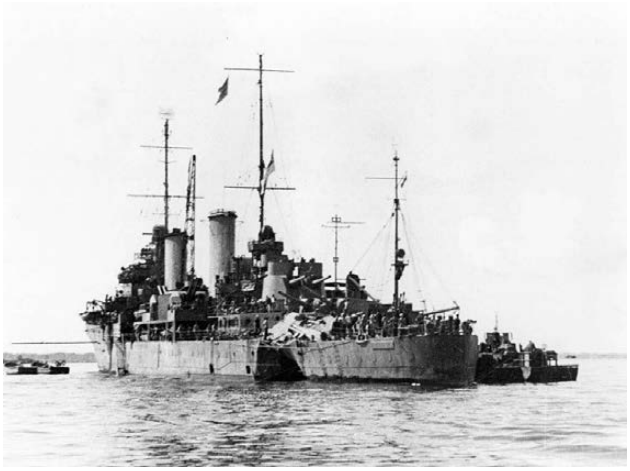
The first HMAS *Hobart* was a modified Leander-class cruiser acquired by the Royal Australian Navy from Britain in the 1930s. Three ships of the class were ordered for the Royal Navy as HM Ships *Phaeton*, *Apollo* and *Amphion*. All three were taken over by the RAN, *Phaeton* becoming HMAS *Sydney* whilst under construction; the other two were commissioned into the Royal Navy before transfer to Australia shortly before the outbreak of World War II, becoming HMAS *Hobart* and HMAS *Perth*. *Sydney* was lost on 19 November 1941 in her famous engagement with the German raider *Kormoran* and *Perth* was lost in the Battle of the Sunda Strait on 1 March 1942. HMAS *Hobart* survived the war.

HMAS *Hobart* was a light cruiser with a standard displacement of about 7 127 t and had a primary armament of eight 6-inch (152 mm) guns in four twin turrets supplemented by four twin 4-inch (102 mm) anti-aircraft gun mountings, a number of smaller calibre weapons and eight torpedo tubes. She could also carry a Walrus seaplane. Her designed complement was about 550 men and, with that number, accommodation was cramped even by the standards of the day.

HMAS *Hobart* in Sydney shortly before the outbreak of World War II
(RAN Historical Collection)

HMAS *Hobart* arrived in Australia at the end of 1938 and, after the outbreak of war in September 1939, she was busy in the Bay of Bengal, the Arabian Sea and the Red Sea before returning to Australia in early 1941. A short spell in the Mediterranean followed before she returned to Australia when war broke out in the Pacific. In May 1942 she took part in the Battle of the Coral Sea and later supported landings in the Solomon Islands. On 20 July 1943 *Hobart* was hit by a torpedo fired by the Japanese submarine IG001 at a range of about 10 n miles. *Hobart* was severely damaged and her stern was nearly severed. Damage control measure included passing a 3½ inch (89 mm) wire rope around her stern to stop it 'waving in the breeze'. Temporary repairs were carried out at Espirito Santo and *Hobart* was able to steam home at 14 kn arriving in Sydney on 26 August for permanent repairs. She was docked in the Sutherland Dock at Cockatoo Island on 6 September 1943.

As the repairs to *Hobart* were clearly going to take many months, the RAN decided that the opportunity should be taken to modernise the ship whilst the repairs were being carried out, with the work being shared between Cockatoo Dockyard and Garden Island Dockyard as far as practicable to minimise any effect on the new construction programme.



HMAS *Hobart* at Espirito Santo in July 1943 showing the torpedo damage to her stern
(RAN Historical Collection)

HMAS *Hobart* in the Sutherland Dock at Cockatoo Island for repair. Y turret has been removed and the stern of the ship completey separated from the rest of the hull for realignment
(RAN Historical Collection)

HMAS *Hobart* in Sydney Harbour in early 1945 after the completion of her repair and modernisation (RAN Historical Collection)

The work planned was extensive and included the fitting of modern radar, additional high-angle fire control, relocation of two of her 4-inch (102 mm) gun mountings, the fitting of additional anti-aircraft guns, a new tactical plotting office and the installation of two emergency diesel generators. A large number of other modifications were included as a result of war experience.

The modernisation increased the complement of the ship which had already exceeded 800 men during the early war years and reduced the accommodation space available in an already overcrowded ship.

The War Cabinet approved the modernisation on 5 January 1944 at an estimated cost of £510 000 (equivalent to about $38 million today), about half of which was required for the damage repairs. The repairs took over five months in dock and required the stern of the ship to be separated from the rest of the hull for realignment and the hull rebuilt over a length of about 33 m on the port side and 21 m on the starboard side. The refit and modernisation was a major task which had to compete for resources with other more urgent work. *Hobart* was recommissioned on 7 December 1944 and the dockyard work was formally completed on 4 February 1945.

HMAS *Hobart* took part in the final stages of the Pacific war and was present in Tokyo Bay for the Japanese surrender on 2 September 1945. She then became part of the occupation forces. *Hobart* had a further refit in Sydney in 1946 when her X turret was removed to reduce top weight. After a further spell in Japan she was decommissioned in Sydney on 19 August 1947 and placed in reserve.

Post-war plans for the RAN included the modernisation of *Hobart* generally to the same standard as adopted by the RN for the Colony-class cruisers. Work began at Garden Island Dockyard in 1950. The plans for the modernisation included the retention of the main armament (but with improved fire control radar), retention of the 4-inch (102 mm)mountings with two new Mk VI HACS directors (MRS 6) and retention of the torpedo tubes. The smaller calibre anti-aircraft armament was changed to comprise six twin 40 mm Stabilised Tachymetric Anti-aircraft Mountings (STAAG) Mk II and four single 40 mm Mk VII guns. Radar and communications were to be updated.

New construction and modernisation plans in the post-war period were greatly delayed for a number of reasons, including shortage of labour in the dockyards and shortage of funds, particularly as a considerable amount of money was devoted to the acquisition of the aircraft carriers HMAS *Sydney* and HMAS *Melbourne* and the establishment of the Fleet Air Arm. By June 1951 the modernisation of HMAS *Hobart* was already assessed as being two years behind schedule. At that time her role was seen as an aircraft carrier escort until the long-delayed Daring-class destroyers were completed.

In 1952, *Hobart's* role was reviewed and changed for her to replace the training cruiser HMAS *Australia* as the fleet's training ship. In view of the financial restrictions of the time, the scope of work was also considerably reduced. The radar installation was simplified and the Mk VI directors deleted. The torpedo tubes and two of the 4-inch mountings were to be removed and she was to be fitted for, but not with, the STAAG mountings. In August 1952 the refit was transferred to the State Dockyard in Newcastle where it proceeded at a leisurely pace. In 1953–54 it was decided that the RAN should have only one operational aircraft carrier with the training role assumed by HMAS *Sydney*. The primary role for *Hobart* had vanished. Consideration was briefly given to converting her into a guided-missile ship or modifying her as a convoy escort, but her refit at Newcastle was stopped and in 1955 she was returned to Sydney and placed in reserve.

By the time the modernisation was cancelled some £1.3 million (about $73 million today) had been spent on the ship. To complete her as a convoy escort was estimated to cost an additional £1 million (about $56 million). Instead,

HMAS *Hobart* alongside Garden Island Naval Dockyard during th early stages of her post-war modernisation. The destroyer alongside is possibly HMAS *Quality*. *Hobart's* planned conversion to a Type 15 frigate was cancelled in 1953 and she was transferred to the State Dockyard in Newcastle in August 1952
(RAN Historical Collection)

she was placed in reserve at a cost of £150 000 (about $8 million in today's money). *Hobart* remained in reserve, a familiar sight moored in Athol Bight under Bradleys Head opposite Taronga Zoo, for some six years. In 1962 she was sold for £170 000 ($340 000) to Mitsui Company of Japan and left Sydney under tow on 3 March 1962 for breaking up in Japan.

Had the modernisation of HMAS *Hobart* been completed it is doubtful that the RAN would have got realised value from the cost of conversion and the cost of running an out-of-date and very labour-intensive ship. Completed for service in the RN in January 1936, in 26 years of naval service she saw only nine years in commission in the RAN. Nevertheless, those years of service were memorable and distinguished.

HMAS *Hobart* in the floating dock in Newcastle in 1955 shortly before her modernisation was cancelled
(Archives of Prof. Cyril Renwick, University of Newcastle)

HMAS Hobart departing Newcastle in December 1955 for lay-up in Sydney
(Archives of Prof. Cyril Renwick, University of Newcastle)

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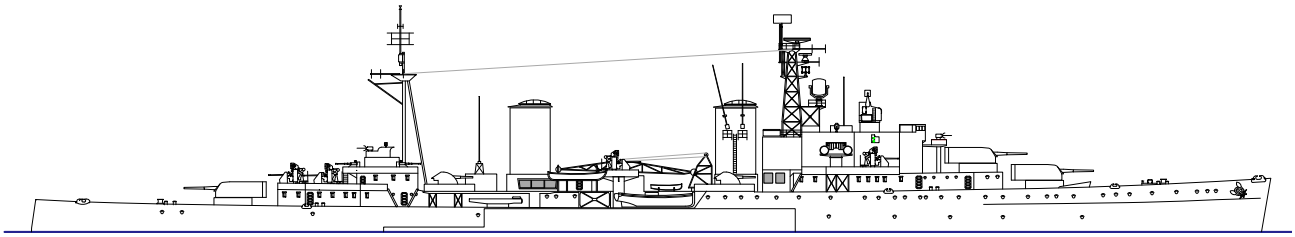

HMAS *Hobart* as she might have appeared had her modernisation as planned in 1952 been completed
(Drawn by J C Jeremy based on Garden Island drawing 415/7/1 dated 22 August 1952 — NAA:MP551/1, 137A/321 [1])

Hobart, with a Japanese tug alongside, about to depart from Garden Island Naval Dockyard on 3 March 1962
for the shipbreakers in Japan
(RAN Historical Collection)

Demolition of *Hobart* well underway at the shipbreakers in Osaka. The cruiser alongside on her port side
is the Dido-class cruiser ex-HMNZS *Black Prince*
(RAN Historical Collection)

The Australia SailGP Team helmed by Tom Slingsby cross the finish line to win the final race on Race Day 2 of the Australia Sail Grand Prix presented by KPMG on 18 December 2021
(Photo by Brett Costello courtesy SailGP)