THE AUSTRALIAN NAVAL ARCHITECT

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The sail training ship *Young Endeavour*, seen here in company with the Chilean *Esmeralda* in the Atlantic Ocean, arrived in Fremantle on 22 December completing a year-long circumnavigation of the world. Some 208 young Australians joined the 44 m ship for stages of the voyage during which they visited New Zealand, Argentina, Brazil, Spain, Turkey, Greece, Malta, France, Portugal, England, Norway, Denmark, Germany, the Netherlands, Cape Verde, the Canary Islands and South Africa
(RAN photograph)

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Cover Photo:

The future USS *Omaha* (LCS 12) ready for launching at the Austal USA facility in Mobile, Alabama
(Photo courtesy Austal)

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From the Division President

My report to the Australian Division Annual General Meeting in Sydney on 2 March provides a useful summary of the activities of the Division during the past twelve months and is reproduced below. This is my last column as President as I have not sought re-election for the term following the AGM, although I do intend to remain active on Council in the position of Immediate Past President. It has been a demanding position but I am grateful for having had the opportunity to represent the profession. My thanks go to all who contributed to the Division's work during the year, including Council members and officers of the State Sections, and especially to our Treasurer, Craig Boulton, for his financial wisdom. Finally I wish Martin Renilson, my successor, all the best for his time as President.

President's Report to the Australian Division AGM 2016

A highlight of the Division's year was the visit a year ago by RINA President, Bruce Rosenblatt. Through members' efforts, Bruce left with a good understanding and lasting memories of both the Division and the Australian maritime industry, and was able to take a very positive message back to London.

The year's activities started with the expectation of further interaction with the Senate Economics Committee Inquiry into Naval Shipbuilding and ended with a submission to a Senate Foreign Affairs, Defence and Trade References (FADTR) Committee Inquiry into the Capability of Defence's Physical Science and Engineering workforce. Whilst the main purpose of the Australian Division is to support and encourage the development of the Australian Sections, a large number of RINA members is directly and indirectly involved in the manufacture, maintenance and repair of naval craft, and the Division Council is of the opinion that it is vital to the future of the naval craft industry to express our opinions to the Government. RINA members employed by the Government or in the defence industry may have a conflict between their employment and professional responsibilities, but are usually constrained by their conditions of employment from expressing their opinions, whereas RINA is not so constrained and, therefore, we are in a position to provide an opportunity for members to express their opinions through a RINA submission. Council consequently established a committee to manage our involvement in naval shipbuilding and repair, and to consider our approaches to the Government. The Senate Inquiry into Naval Shipbuilding appeared to be overtaken by events and went quiet and, having agreed to a submission to the Senate FADTR, the Committee is now waiting for the promised White Paper on Defence.

There was substantial input from persons in the defence industry to the RINA submission to the FADTR Inquiry. This was not surprising, because this directly and indirectly concerned the employment of many of our members. There was a clear opinion from several sources that the Department of Defence was a poor manager, with systems which were unable to distinguish the difference between senior managers with technical experience and senior administrators. The advantages of having staff knowledgeable in naval architecture was not recognised and, clearly, this was something that RINA could bring to the Government's notice, particularly at a time when there were several major naval projects at the formulation stage. Our written submission expressed views which were also made by other organisations. An oral presentation was also given to the Senate Inquiry by the Secretary and myself.

Our financial position is sound. Our income is similar to that of the previous year, despite a reduction in the interest rates for our deposits. Administration costs are the same as those from last year, but the expenses associated with the production of *The Australian Naval Architect* have been reduced to less than half of that for previous years owing to the move to electronic distribution of the magazine. At the same time, the move to electronic distribution has enabled us to publish in colour, enhancing the visual appeal of our journal. *The ANA* has continued to maintain the high standards exhibited in previous years owing to the hard work of the editors, John Jeremy and Phil Helmore. Many thanks to them for their efforts.

John has also been the primary driver of RINA's involvement in the Pacific 2015 International Maritime Conference and it is pleasing to note his award in the Order of Australia. Adrian Broadbent has also been heavily involved in organising the Pacific 2015 IMC, which by all accounts was better than ever. I imagine that it will be world-class once it returns to its normal Darling Harbour venue.

By the time that you read this, the Western Australian Section will have hosted the naval architectural stream of the Australian Oil and Gas Conference in Perth. Hopefully it will have been successful. I would like to congratulate the WA section, particularly Yuriy Drobyshevski, for the long-running and intensive effort that they have put into this Conference, and to thank the Chief Executive for his support.

The Division has continued to support UNSW and UTas (AMC) with prizes for the various student projects and has again given the Walter Atkinson award for the best Australian technical paper which, this year, went to Dr Roger Neill of DST Group. Some of you will remember Bob Campbell, a past President of the Division and past Chairman of the Pacific IMC Organising Committee who, sadly, passed away last year and kindly bequeathed us a sum of money which will be used to fund an appropriate prize for a paper presented at the biennial Pacific International Maritime Conference, in memory of his involvement in the success of this Conference series.

The Division has maintained a watching brief over the issues surrounding the Single National Jurisdiction, but engagement with AMSA has been disappointing from my perspective. The introduction of regulations for Surveyor Accreditation was done without any input from RINA.

There has been little engagement with Engineers Australia over the past twelve months and the Joint Board has not met at all. There are some outstanding issues that need to be resolved.

In the early part of the year I attempted to develop a list of future activities for the Division. The list was discussed in Council and was subsequently modified into more of a vision statement in the belief that this would make the document more useful to future officers of the Division without listing

specific issues, but the proposal has still to be presented to the Division Council.

The Division Council has met on four occasions since the previous AGM, in accordance with our By-laws, each time with an adequate attendance to allow useful discussion over many different topics. Meetings were generally limited to a duration of about two hours. Thank you to all of the Division Council members who have supported me and have offered their valuable time to promote the values of the Royal Institution of Naval Architects.

Tony Armstrong

Editorial

In an interview published in the December 2015 edition of *Marine News*, Guido Perla, Chairman of the Seattle-based Guido Perla & Associates, Inc., commented on the impact of CAD/CAM on the work of a naval architectural firm as the technology has developed. He comments that, while the excellent modern design software has saved many hours in ship design, production engineering software has some limitations. He said that "They are valuable tools but one has to understand them and make the best use of their capabilities….like the shipyards, we on the engineering side are losing the skilled personnel to provide production engineering. If you hire a person who is proficient on specific software, sometimes that person does not have any idea of how to construct a vessel or install a pipe or detail a structure. You need that because you are building the vessel in all its detail in the computer."

He went on to say "We are also losing our 'seat-of-the-pants' approach and gut feelings or intuitive naval architecture. We are depending too much on the computer for creative tasks. As an engineer, you need that so that you have situational awareness of the project, and so you know what to expect."

Guido Perla was speaking of the situation, as he sees it, in the United States. The problem is likely, however, to be a common one.

Intuitive naval architecture is a skill which may come naturally to some with an innate understanding of the science but, generally, it is a skill born of experience. That experience is gained by being involved in a wide range of projects over many years. When the industry is plagued by stop-start order books, it prevents the development of the long-term careers which produce a wealth of knowledge for the benefit of future projects.

Discontinuity of workload is not the only factor. In Australia there are still many with extensive experience in the industry but retirement age approaches inexorably and organisations are prone, from time to time, to reduce staff levels in a drive for cost reduction or in response to workload fluctuations. It is sometimes those approaching retirement that go. Whilst this opens up opportunities for younger professionals, the benefit of the experience of the older engineers is lost.

The answers to this problem lie in maintaining a healthy industry with a steady workload. In the commercial world, we cannot control the effects of the world economy on the market place but, as has been discussed extensively for decades, the naval shipbuilding industry can benefit from long-term structuring to provide the continuity which is the birth place of experience.

The ideal mix is surely one which combines the enthusiasm of young talent determined to prove that there is a better way to do everything with the experience of the older professionals who, as a yachtie might say, have 'been around that buoy before'.

John Jeremy

The shape of ships to come? The future USS *Zumwalt* during early sea trials
(US Navy photograph)

LETTERS TO THE EDITOR

Dear Sir,

The Need for Structural Continuity in Ship Design — Nothing New under the Sun

A career within the Department of Defence doesn't give a naval architect much opportunity to make their own design mistakes, since overall ship design work on vessels which were subsequently built hasn't been performed here in decades [1]. However there is still more than ample opportunity to learn through the design mistakes of others, and this is the case across the spectrum of matters naval architectural.

One common problem which has been encountered in a range of RAN vessels over the years has been structural cracking. Some of these problems have been 'niggling' in nature and have been dealt with by modest repair work, reinforcement or minor re-design. A case in point would be the now-decommissioned RAN LCHs which served the RAN well for around four decades. More significant have been cases such as the FFGs which were subject to superstructure cracking; however, even this class has served a 'full' life with a number of the younger ships in the class continuing in RAN service. Other classes have proven to be more problematic.

Failures are often apparent in RAN ships and boats with aluminium-alloy construction and, once again, the FFG superstructures are an example of this, given that these ships were constructed with steel hulls and aluminium-alloy superstructures in order to lower the VCG of the design. Consequently, over time, aluminium alloy has attracted a bad reputation as a shipbuilding material within the RAN, perhaps unfairly so, given that cracking has also been experienced in RAN ships and boats of steel construction. [2]

Rather than material being the common factor in these vessels, I suspect that the core problem in many cases of failure has been a lack of attention to detail in the ship design process to achieving good structural continuity, perhaps exacerbated by poor production (alignment and welding quality).

Reviewing both SNAME's 1968 and 1980 editions of *Ship Design and Construction* it is clear that a good understanding and sensible advice concerning structural continuity of ships has been around for a long time. However, when I look through the naval architecture journals, all too often I come across cases where I wonder whether attention has been paid to achieving such continuity. For example, see the images in RINA's *Warship Technology,* January 2016, at the top of Page 17 and Page 20 as recent, and by no means extreme, cases.

Following are some extracts from the 1980 edition of *Ship Design and Construction*:

"4.7 **Importance of Continuity of Structure**. ... The proper order of importance in considering continuity is: First, can discontinuity be avoided? From a structural standpoint, this is obviously the best way of handling the problem, but it cannot always be accomplished. Second, if the discontinuity is unavoidable, what can be done to alleviate its effects?... The common characteristic... is the provision of an area in which... stress levels are kept reasonably constant in spite of necessary changes in geometry"? [3]

"4.9 **Stress Concentrations including Application to Hatch Corner Design**. Openings in structure increase stresses in two distinctly different ways: first, by reducing the amount of material available to support the load and, second, by causing concentrations of stress. These stress concentrations will, in many cases, be more serious than the effect of removal of material. In the classic case of a circular hole in an infinitely wide plate under tension, the change in stress due to lost area is infinitesimal, but the stress at the edge of the opening is three times the nominal value.... Badly designed or constructed... corners are a frequent source of low-cycle fatigue fracture.

"4.11 **Effect of Radii.** The degree of stress concentration is primarily a function of the abruptness of the discontinuity. Thus, the stress concentration factor at the end of a sharp notch, such as a crack, may mathematically approach infinity, and a very low nominal stress will cause local stresses in the plastic range. In some cases the local stress level will cause failure and the crack will advance across the plate.

"4.12 **Avoiding Square-cornered Cuts.** From the foregoing, it is obvious that square-cornered cuts constitute an invitation to failure and should never be permitted....

"4.18 **Causes of Cracking.** The occurrence of cracks is usually associated with stress concentrations, and poor workmanship and materials... Currently, brittle fracture and fatigue are the major causes of cracking. Cracks are generally initiated at points of stress concentration which can be due to:

a) Design Deficiencies
   * cuts in highly stressed areas
   * abrupt changes in continuity

b) Poor workmanship
   * faulty welding
   * rough plate edges
   * misalignment of structure"

It would be good if these design considerations received greater attention at the earliest stages of any future ship designs intended for the RAN service (regardless of whether MOTS/COTS or not) and that good structural design was carried through preliminary design and into detailed design.

Martin Grimm
Principal Naval Architect
Navy Engineering Division

1. Whole-ship design was last performed within the Department of Defence for the mine hunter inshore (MHI) catamaran project. Lessons were certainly learned from this project by Defence naval architects. Defence naval architects were also engaged in a subsequent concept design for an oceanographic/hydrographic ship class, the preliminary design work for the modification of the US LSTs into the training and helicopter support ships (THSS),

later designated LPA, and a number of other broad-brush concept-design studies to support the early stages of various design projects.

2. This may be a topic for a future letter to the editor as attention to fatigue relative to a quasi-static design load approach appears to be far more critical for aluminium alloy construction than for shipbuilding steel.

3. Keeping stress levels relatively constant at geometric discontinuities simply by adopting progressive increases in thickness of insert plates is not an ideal solution. These inserts simply add more welding with associated greater fatigue-crack initiation risk relative to adopting more-uniform plate thicknesses and avoiding such discontinuities to start with.

Dear Sir,

I would just like to thank the Organising Committee for the fabulous evening that was SMIX 2015. I thought it was an excellent get-together for the maritime community who came not just from Sydney but also from Hobart, Launceston and Melbourne, and maybe other locales, to enjoy the night. The catering was first-class and the weather was perfect, for which you also might as well take credit!

Thanks for making it possible.

Jennifer Knox
Lightning Naval Architecture

Dear Sir,

With the environmental impact of shipping in greater focus than ever before and the increasing cost of conventional fossil fuels, the need for alternative means of propulsion for the multitude of large ships around the world has never been greater. This need is something that we, as naval architects, have an obligation to address. There are some who have chosen to explore the possible solutions before it is no longer a choice.

Sails, and their more recently-developed cousins, kites, are one option often explored. Solar panels and wave energy have also provided alternative energy sources for some smaller ships. The challenge facing the naval architects of the 21st century is to apply these solutions to the giants of the oceans, the container ships, bulk carriers and tankers.

One of the most promising attempts to do just this is the 130 m, 8000 t, *Ecoliner* whose design is currently being finalised by Dykstra Naval Architects as part of the SAIL project. The SAIL project is a collaborative effort involving 17 partners, primarily universities and ship operators, from seven North Sea countries whose goal is to "*facilitate the transition process towards a sustainable shipping sector with focus on zero emission freight sailing."* This design meshes an ancient method of propulsion by sails with the cutting edge technologies and manufacturing techniques of the present and future to meet one of the major engineering challenges of the 21st century.

All available modern analysis methods, including a large array of software programs and model tests, such as wind-tunnel tests, have been utilised in the development of this three-masted general design which is theorised to be scalable from 1000 to 100 000 t with modifications. Though still in the early stages of development, this is the type of vessel, and, indeed, these are the types of design values, that we as responsible naval architects have a duty to follow in the coming decades.

Brett Ryall
UNSW Student

Dear Sir,

The Chinese shipbuilding industry has experienced considerable expansion virtually in parallel with China's accelerated economic growth. This economic development, driven by exports, has relied heavily on seaborne transport services. However, unlike other emerging economies which relied heavily on foreign shipping services, China adopted a policy of building up its domestic fleet to meet the growing demands of international trade, and this has greatly increased the commercial output of new vessels. In recent years, the capacity of China's shipbuilding industry has been undergoing rapid growth compared to Japan, Korea and Europe, exploiting its natural advantages in low labour and other costs, attractiveness to direct foreign investment, and the strong foundation of its existing shipbuilding sector.

Moreover, the entry of large, foreign shipbuilding enterprises reflects this opening-up of the market and has resulted in a significant expansion of production capability which, in turn, has strengthened the competitiveness of the Chinese shipbuilding industry.

The great strength of the Chinese shipbuilding industry has been its ability to build competitively-priced basic vessels, especially bulk carriers and tankers. Now its shipbuilding industry is increasingly diversifying into more-complex and technologically-advanced vessels. For example, China has successfully developed an 8000 TEU container vessel and is understood to be able to manufacture container vessels of up to 10 000 TEU. The first large Chinese-built LNG vessel was successfully delivered in April 2008.

In order to accelerate its technical capability, China has been importing advanced production methods and key equipment, including complete production lines, as well as using foreign-sourced hardware and software for computer-aided design and computer-aided manufacture (CAD/CAM). This has enabled Chinese naval architects to become more proficient in the design of ship hulls, compartment layouts, and propeller-rudder combinations which improve speed, efficiency and structural integrity.

With the improvement of technologies, Chinese shipbuilders have been successfully entered into the international shipbuilding market to take advantage of the very buoyant market for new vessels.

For the future, the Economic Plan has set the goal for China to become one of the world's largest ship producers by around 2020, and the Chinese Government has introduced a number of measures to facilitate this development.

Jiong Wang
UNSW Student

NEWS FROM THE SECTIONS

ACT

Since the last edition of *The ANA* the ACT Section has hosted one technical presentation jointly with the South East Australia branch of the Nautical Institute (NI). The section also held a technical presentation combined with a Christmas dinner for RINA ACT members and families.

On Wednesday 18 November 2015, CDRE Steve Tiffen gave a presentation to the ACT section of RINA, Nautical Institute members and other interested parties on *The SEA4000 AWD Program to date, its Foundations, its Successes and its Failures* at the Campbell Park Offices of the Department of Defence.

CDRE Tiffen was the DMO Platform Systems Director for the AWD Program from July 2006 to October 2007 and thereafter managed the AWD Alliance's activities at Navantia's Ferrol facility in Spain. In March 2010 he commenced duties as General Manager Technical with responsibilities for, amongst other things, the establishment of the sustainment arrangements for the future Hobart-class destroyers.

Steve shared his perspectives on the factors which made the project cost more, and take longer, than originally intended and identified how to avoid similar problems in the future. This review extended as far back as consideration of shipbuilder options and the process that led to the selection of the platform system design and designer. The fate of the Gibbs & Cox evolved design option (which was competing in the final stages with the 'existing' F104/F105 option from Navantia) was discussed, with participants sharing their insights into this option. He noted the assessment at the time was that pursuing the 'evolved' option was likely to add several years and several billions to the project cost.

One observation was the desirability for future similar projects to have a 'friend' [party independent of contractors] who works 'above the line' [prior to first pass approval] to ensure that appropriate requirements are defined for such major projects and to provide long-term support for what he considered is a small organisation, namely the Department of Defence. One example of such support was to help identify the size and cost implications of a combination of requirements, such as the original Navy desire to achieve 96 VLS cell combined with 6000 n miles range at 18 kn which he considered would have led to a 10 000 t displacement destroyer [*Such a concept design capability was available in-house at the time and had prepared costed concept options for Capability Development Group for a range of frigate/destroyer options across a span of warfighting capabilities. This capability is still available in-house within the Navy Technical Bureau but has not been consistently utilised to support projects in the early needs and requirements development phases* — M. Grimm and C. Hoey].

Another observation was that a three-ship build was the "wrong thing to do" in that such a limited build program didn't allow for any economies of scale to be achieved [*An option for a fourth AWD was originally a provision of the program but was not finally pursued by Defence/Government* — MG and CH].

Also not originally recognised were the quite different approaches to shipbuilding of Navantia and ASC, which subsequently had implications for ASC when building to design data and drawings provided by Navantia. The perception that a ship class could simply be built to a set of plans supplied by the designer was false. In contrast, CDRE Tiffen indicated that for the Anzac-frigate project, numerous staff from the Australian shipbuilder had been sent to work with Blohm & Voss in Germany for a considerable time to build familiarity with the construction of that frigate type.

He also noted that, unlike the division of work across several yards for the AWD project, which added complexity, Navantia did not do this for the Spanish Alvaro de Bazan-class frigates, building all in their Ferrol facility.

The Alliance Contracting arrangement for the AWD project also received some attention from CDRE Tiffen, as did some of the limitations with the original cost estimation for this project.

A lesson from the AWD project was also that the specification for the lead ship of a selected class should not be the basis for an Australian shipbuilding project. It would be preferable to adopt the specification of a follow-on class of ships which should incorporate lessons learned by the parent navy and shipbuilder. The AWD is based mainly on the F104, but incorporates upgrade features of the F105 — the second variant of the F100 class. This base platform was further modified by an Australian-specific combat system which differs from that of the Spanish ships.

Another lesson is that, in future projects if the alliance approach is adopted, the designer needs to be a part of the alliance rather than being separately contracted. This would help to ensure that the designer's goals are more closely aligned with other alliance partners, including the Commonwealth.

Also learned was that the construction schedule should not be based on the assumption of success at each step of the process, as this allows no provision for extra time required when the inevitable problems emerge.

Comparative costs of man hours were provided for Anzac-class frigate and AWD projects which indicated that, on a manhours per compensated gross ton measurement basis, the AWD was consuming more than twice the resources of the achieved Anzac-class vessel performance. This international benchmarking was performed by First Marine International.

For sustainment of the AWDs, CDRE Tiffen noted that a new Systems Program Office is being formed within the AWD Program, rather than being integrated into one of the existing Maritime Systems Division SPOs.

CDRE Tiffen encouraged audience interaction during his presentation and this certainly prompted lively discussions with various questions and contributions, including different perspectives, from those in attendance who in some cases also had considerable years of exposure and, hence, insights into the AWD project.

On Wednesday 9 December 2015 the ACT Section met at

the Kingston Hotel for a Christmas dinner and a celebration of the year past. The section chair, Tom Dearling, gave a short speech and the section shared a moment in memory of our colleague and friend Bruce McNeice. Captain Iain Kerr provided the "technical presentation" for the evening. His talk on marriages at sea was informative and entertaining for all in attendance. He drew on his experience as a vessel captain and a registered celebrant and discussed some unique factors which can influence ship design.

Martin Grimm
Caitlin Hoey

New South Wales

Committee Meeting

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

- SMIX Bash 2015: Sponsorships mostly in and bookings filling up; raffle prizes of hampers arranged to be delivered to winners' doors, rather than having to cart home on the night; program booklets to be printed.
- TM Program 2016: Presentations arranged for five months, with dates and details to be confirmed for some; IMarEST have a meeting arranged for February, and three more to come.

The next meeting is scheduled for 11 February.

SMIX Bash 2015

The sixteenth SMIX (Sydney Marine Industry Christmas) Bash was held on Thursday 3 December aboard the beautifully-restored *James Craig* alongside Wharf 7, Darling Harbour, from 1730 to 2130. The Bash was organised jointly by RINA (NSW Section) and the IMarEST (Sydney Branch). About 200 guests 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 present students to the elders of the marine community.
It was also great to see intrastate, interstate and international visitors in the throng, including Rob Gehling and Greg Hellessey from Canberra, Anette Hill and Liz Hay from Brisbane,and Gregor Macfarlane, Jonathan Duffy, Max Haase and Dean Cook from Launceston and Christopher Becker from Perth.

James Craig with the registration desk in full swing
(Photo Phil Helmore)

Sydney turned on a beautiful evening and many partners in attendance enjoyed the view of the city lights from the decks of *James Craig*. Drinks and hors d'oeuvres were provided and a delicious buffet dinner was served in the 'tween decks, followed by a selection of Christmas-themed petit fours, tea and coffee, and mini gelati, and many tall tales and true were told.

Some of the crowd enjoying drinks and hors d'oeuvres on board *James Craig*
(Photo courtesy Graham Taylor)

More of the crowd enjoying drinks and hors d'oeuvres on board *James Craig*
(Photo courtesy Graham Taylor)

Adrian Broadbent welcoming guests and thanking sponsors
(Photo Phil Helmore)

Bookings used the Trybooking website again this year, and it worked a treat. All tickets were sold before the event — you really do have to be early!

Formalities were limited to a speech by Adrian Broadbent, who welcomed the guests and thanked the industry sponsors, and a short speech by Major-General Jim Molan, who said that he was here from Canberra, and that it was exhilarating to meet with people who actually build things! Also, that he saw one of Australia's greatest achievements being that we had not actually experienced war for nearly 70 years, but that was also one of our greatest problems! He used to think that he was famous in his own right, but these days he is being known as the father of television presenter and *The Footy Show* host, Erin Molan!

The raffle and lucky-door prizes were drawn by Liz Hay, Chief Executive Officer of the Australian Shipbuilding and Repair Group. The winners, who were each delivered a Christmas hamper, were:

Raffle 1 Jennifer Knox, Lightning Naval Architecture
Raffle 2 Graham Taylor, Taylortech
Lucky-door Prize Michael Hickling

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

Platinum

- Damen Shipyards Group
- TeeKay Shipping (Australia)

Gold

- ABS Pacific
- AMC Search
- AusBarge Marine Services
- Australian Commercial marine Group
- BAE Systems Australia
- BMT Design & Technology
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- International Paints
- Lloyd's Register Marine
- Svitzer Australasia
- Rolls-Royce
- Schottel
- Sydney City marine
- Thales Australia

Silver

- AMD Marine Consulting
- ASO Marine Consultants
- Cummins South Pacific
- FP Marine Risks
- Noakes Group
- Thompson Clarke

Bronze

- Edwards Marine Services
- Lightning Naval Architecture
- One2three Naval Architects
- Shearforce Maritime Services

Our thanks to them for their generosity and support of SMIX Bash 2015, without which it could not happen.

Submarine Diesel Engine Development

Geoff Goodwin, Specialist Marine Propulsion and Failure Investigation of AADI Defence, gave a presentation on *Submarine Diesel Engine Development* to a joint meeting with the IMarEST attended by 39 on 2 February in the Harricks Auditorium at Engineers Australia, Chatswood. The vote of thanks was proposed, and the certificate and "thank you" bottle of wine presented, by Greg Hellessey.

It is expected that the write-up of Geoff's presentation will appear in the May issue of *The ANA*.

Phil Helmore

COMING EVENTS

Australian Division AGM

The Annual General Meeting of the Australian Division of RINA will be held on Wednesday 2 March immediately prior to the scheduled technical meeting of RINA (NSW Section) and IMarEST (Sydney Branch) at 6:00 for 6:30 pm at Engineers Australia, 8 Thomas St, Chatswood; see notice sent separately to members. Please note that the AGM will start at 6:15 pm.

NSW Section AGM and Technical Meetings

The Annual General Meeting of the NSW Section of RINA will be held on Wednesday 2 March immediately following the scheduled technical meeting of RINA (NSW Section) and IMarEST (Sydney Branch) at 6:00 for 6:30 pm at Engineers Australia, 8 Thomas St, Chatswood; see notice sent separately to members. The AGM is expected to start at approximately 7:45 pm.

Technical meetings are generally combined with the Sydney Branch of the IMarEST and held on the first Wednesday of each month at Engineers Australia, 8 Thomas St, Chatswood, starting at 6:00 pm for 6:30 pm and finishing by 8:00 pm.

The program of meetings for 2016 (with exceptions noted) is as follows:

3 Feb	Geoff Goodwin, Specialist Marine Propulsion and Failure Investigation, AADI Defence *Submarine Diesel Engine Development*
2Mar	Tim Asome, General Manager, and Marcus Ekstrom, Ship Manager, ASP Ship Management *CSIRO's New Research Vessel,* Investigator
2 Mar	NSW Section Annual General Meeting
6 Apr	IMarEST *TBA*
4 May	Bing Zheng Ho, Student, UNSW Australia *Design and Analysis of Composite–Metal Bonded Joints in Ships*
1 Jun	IMarEST *TBA*
6 Jul	Steve Quigley, Managing Director, One2three Naval Architects *TBA*

3 Aug	IMarEST *TBA*
7 Sep	Drew Shannon, Manager East Coast, London Offshore Consultants Salvage of *Rena* in New Zealand
5 Oct	Nick Browne, Research Supply Icebreaker Project Manager, Australian Antarctic Division *Australia's New Antarctic Vessel*
1 Dec	SMIX Bash

Pacific 2017 IMC

The next Pacific International Maritime Conference, held in conjunction with the Pacific International Maritime Exposition and the Royal Australian Navy's Sea Power Conference, will be held in Sydney on 3–5 October 2017 to coincide with Navy Week, at the brand-new Sydney Exhibition Centre at Darling Harbour.

The change in dates from the previous January–February timeslot is a result of the success of Pacific 2013, which was held in October 2013 to coincide with the Royal Australian Navy's Centenary celebrations and International Fleet Review on 4 October. Pacific 2015 was also successfully held in October. In consultation with the Royal Australian Navy, the biennial Pacific International Maritime Exposition will in future coincide with Navy Week during the first week in October.

Held every two years, the Pacific International Maritime Exposition will continue to host two headline events, the RAN Sea Power Conference and the International Maritime Conference (IMC), as well as an extensive portfolio of specialist maritime business and technical seminars and symposia.

Navy Week provides an opportunity for the Royal Australian Navy to promote the importance of maritime trade and naval power to Australia's physical, environmental and economic well-being and security. Maritime Australia Limited is proud to be able to support these aims by organising a world-class industry exposition, according to its CEO, Mr Ian Honnery. "As a not-for-profit foundation, our purpose is to support the development of Australia's maritime industry capacity, both naval and merchant. This has a direct bearing on Australia's national security as well as our economic prosperity," Mr Honnery said.

In 2011–12 Australia's maritime trade was worth over AUD $400 billion a year, with exports growing at over 6% a year, according to official figures. To help secure Australia's maritime security and trade into the next generation and beyond, the Royal Australian Navy plans to acquire new submarines, frigates, supply ships and patrol boats worth some AUD $70 billion.

"The Pacific International Maritime Exposition is a showcase for the maritime industry, both naval and merchant, in one of the fastest-growing regions in the world. It attracts exhibitors, high-level official delegations and influential trade visitors from around the globe. This exposure to global opportunities is especially important for Australia's innovative marine industry SMEs. In essence, by bringing the world's maritime industry to Australia, we take Australian companies to the world," Mr Honnery added.

"Running Pacific 2015 and its successors during Navy Week in October every two years will benefit everybody involved."

The domain name of www.pacific2017.com.au has been registered and the website is parked.

Put these dates in your diary and, for further details, watch this space!

HPYD6

HPYD is a series of conferences on high-performance yacht design organised by the Royal Institution of Naval Architects (RINA) NZ and the University of Auckland. The first conference was held in December 2002. Since then, the conferences in 2006, 2008, 2012 and 2015 have showcased the latest developments in yacht research from around the globe. The conference enables naval architects, engineers, designers and researchers to present and hear papers on the current state of high performance yacht and power craft technology.

Agreement has been reached between HPYD, SNAME (Chesapeake Section) and Ecole Navale (Innov'Sail) to provide a coordinated rolling three-year program of high-quality yacht technical conferences. As a result, HPYD6 will be held in Auckland, New Zealand, in 2018.

See www.hpyd.org.nz for more details.

CLASSIFICATION SOCIETY NEWS

ABS Classes the World's Largest Offshore Wind Farm Installation Vessel

ABS has announced that the ABS-classed *Seajacks Scylla*, the world's largest and most-advanced wind-farm installation and offshore-construction vessel, has been delivered by the Samsung Heavy Industries Shipyard in Geoje, Republic of Korea.

"Industry growth depends on innovation and new designs," says ABS Chairman, President and CEO, Christopher Wiernicki. "As a technology leader, ABS is pleased to work with Seajacks as it develops and launches vessels with increasingly greater capabilities."

Seajacks CEO, Blair Ainslie, credits the strong working relationship among the project participants for the successful delivery of this unit. "The cooperation among Seajacks, ABS and SHI was vital to the success of this newbuild effort," he said. "As we bring new designs to the market, we rely on partners who are willing to take on projects like this one that break new ground in the industry."

Based on the Gusto MSC NG14000X design, *Seajacks Scylla* has more than 8000 t of available deck load. Equipped with a 1540 t leg-encircling crane and a usable deck space in excess of 5000 m^2, the unit is outfitted with 105-m legs with the ability to install components in water depths to 65 m. The rig is capable of meeting the installation needs of jumbo-monopiles, jackets, and turbines of future wind farms in deeper waters farther from shore.

Seajacks Scylla complies with ABS classification requirements for self-propelled jackup units, including the DPS-2 for dynamic positioning capability; ACCU, which applies to automatic centralized control unmanned units; and CRC for crane register certificate.

Since 2009, Seajacks has invested in five self-propelled jackup units, all of which have been classed by ABS. *Seajacks Scylla* represents a milestone for the company as it is considered to be the most technically-advanced installation vessel in the market.

Craig Hughes

LR Standards for Use of Low-flashpoint Fuels and New Notation

With the development of gas as a marine fuel going beyond LNG, Lloyd's Register (LR) has developed a notation, which came into effect on 1 January 2016, which provides clarity and helps to ensure that technology can be adopted effectively.

LR has developed a new notation for low-flashpoint fuels (LFPF), allowing owners and shipyards to demonstrate that their design and construction meet requirements. The notation came into effect as of 1 January, 2016, as part of LR's Regulations.

In the last 12 months, the industry experienced two major changes in legislation with the revised International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code) and the adoption of the International Code of Safety for Ships using Gases or other Low-flashpoint Fuels (IGF Code). The codes have broadened the horizons for gas applications, encompassing the use of low-flashpoint fuels for gas carriers and non-gas carriers, but it is the classification society's role to ensure

Seajacks Scylla
(Photo courtesy Seajacks UK Ltd)

that clear standards, requirements and methodology are put in place to help ensure that the required levels of safety and reliability are achieved.

The notation LFPF is assigned where the main propelling and/or auxiliary machinery is designed to operate using a low-flashpoint fuel in accordance with the applicable LR Rules and Regulations. LR's approach to this developing market is through Rules and Regulations applicable to all ships using low-flashpoint fuels under an overarching notation which is clearly structured, scalable, and can evolve as the industry's knowledge matures.

Leo Karistios, LR's Global Gas Technology Market Manager, commented "The innovation in gas carriers and non-gas carriers using gas as a marine fuel has been tremendous over the last two years. Our new class notation LFPF is Lloyd's Register's response to the market's evolution. Our rules and regulations are evolving at the same pace so that classification's role maintains its significance in the marine and gas market sectors."

The LFPF notation is to be appended by the associated characters GC or GF:

GC Assigned to gas carriers, indicating that the gas-fuelled machinery has been constructed, arranged, installed and tested in accordance with the relevant requirements of Chapter 16 of LR's Rules for Ships for liquefied gases, or is equivalent thereto.

GF Assigned to ships other than gas carriers, indicating that the low-flashpoint-fuelled machinery has been constructed, arranged, installed and tested in accordance with the LR Rules and Regulations applicable to the fuel(s) used.

The low-flashpoint fuel (or fuels) which the ship is designed to use is indicated in the notation using a two letter identifier:

NG Natural Gas
EG Ethane Gas
PG Liquid Petroleum Gas
ML Methanol

LR to Class Nine Tankers for Maersk to Latest Common Structural Rules

Lloyd's Register (LR) has been awarded the contract for classification of nine medium-range (MR) type product tankers. Owned by Maersk Tankers, the vessels will be built at Samsung's Ningbo yard in China.

These are the first-ever vessels ordered by a Danish ship owner to the latest Common Structural Rules for Bulk Carriers and Oil Tankers, which came into force in July 2015 for tankers and bulk carriers. The new rules provide a consistent approach for all International Association of Class Society (IACS) members to evaluate the structural strength of these ship types.

LR's Copenhagen Marine Client Manager, Morten A. Jensen, commented "I'm very pleased that LR has been chosen for this newbuilding programme and proud that Maersk Tankers has expressed its confidence in LR by classing these ships with us."

LR holds a leading position in the adoption of the latest CSRs and is currently working on a Joint Industry Project to develop software to simplify the application of the CSRs.

Jim Smith, LR's Regional Marine Manager for North Asia, added "These are amongst the first new CSR vessels to be ordered and show the trust placed in LR by the shipyard

and shipowner. Our strong technical capabilities in Korea and China mean that we can meet the demands for support in a timely manner, and help ensure that high-quality and high-performance vessels are delivered by Samsung to Maersk Tankers."

Construction of the first vessels is due to start in the near future, with deliveries due in 2017/18.

Lloyd's Register Approval for GTT Pressurised Membrane Systems

Lloyd's Register (LR) specialists have issued GTT (Gaztransport & Technigaz) an Approval in Principle (AiP) for a membrane cargo containment system (CCS) for bunker ships to allow an increase in vapour pressure of up to 2 bar g.

The AiP follows a joint research and innovation programme between GTT and LR investigating cargo containment behaviour, looking at strength aspects in various applications, sizes and at different pressures. The close collaboration between LR and GTT experts, through workshops using experimental and analytical results and data on internal pressures occurring in LNG tanks, studied the maximum compressive strength of the containment system on LNG carriers.

Using a 4000 m^3 LNG bunker as a reference case, with two Mark III Flex membrane tanks and structural analysis — while considering navigation and operating conditions — in October 2015 LR issued the AiP for a GTT membrane system with an increase in vapour pressure up to 2 bar g for use in bunker ships.

Higher vapour pressures in CCS are relevant for gas-fuelled ships and small-scale LNGs — especially for LNG bunkering — to help manage boil-off gas. Strengthening the hull offers additional safety within the tank to withstand the boil-off gas generated.

The project required a clear engineering understanding of the membrane technology as well as the fundamental principles of applicable rules and regulations in order that the required safety and reliability levels were maintained, when implementation of membrane containment systems goes beyond atmospheric pressure applications.

Dariusz Boryszewski, Senior Specialist, Ship Structures, LR, said "The potential use of such applications in the gas-as-fuel and small-scale LNG market are many. This AiP opens up the route to progress further with GTT towards project-specific applications. This study carried out by our specialists and those of GTT was an effective marriage of our organisations' capabilities. Getting to Approval in Principle with the novel idea of pressurised membrane tanks is a real achievement. Our review identified areas which can be engineered to help ensure that the ship's structure effectively supports the CCS."

David Colson, Commercial Vice-President of GTT, commented "Thanks to our extensive knowledge and experience GTT, together with LR, has been able to demonstrate the feasibility of operating membrane tanks at higher pressures. This is a significant step in increasing the use of membrane tanks in the LNG-as-fuel chain for fuel tanks and bunker vessels."

Lloyd's Register and Additive Manufacturing

[*Additive manufacturing is commonly referred to as 3D printing* — Ed.)

Lloyd's Register in January launched its goal-based additive manufacturing (AM) guidance notes to industry, giving operators and manufacturers in the energy and marine industries confidence in metallic equipment and components produced using AM.

AM is being called the 'next industrial revolution' in the manufacturing mix. The introduction of Lloyd's Register's certification guidelines for metallic AM parts represents a move by the leading integrity, compliance and specialist risk consulting services group, together with engineering research and technology firm TWI, to help industry harness the technology. Once deployed, AM will enable companies to more-efficiently and cost-effectively manufacture complex components and equipment.

Chris Chung, Head of Strategic Research at Lloyd's Register Energy, said "As the Lloyd's Register Energy Technology Radar survey suggests, AM will have a major impact in the oil and gas industry in the next five years. That is why last year, together with TWI and a number of industry partners, we brought together research and development efforts with real-world AM practices. "Our new certification guidelines, launched today to industry, are already being used by companies in this joint industry project to gain early certification of AM components."

The guidance notes are an important step towards AM commercialisation, and have been designed to mitigate the industry scepticism which often meets new technology in its early years. As the technology is complex, dedicated guidelines are essential to ensure the quality and repeatability of AM parts.

Lloyd's Register's certification framework for AM metallic components provides a step-by-step approach to provide the necessary level of confidence and acts as a stabilising force for quality and safety. By enabling widespread adoption of the technology, the guidelines will support the long-term sustainability of the energy and marine industries.

Roger Fairclough, Principal Project Leader at TWI, said "TWI has been involved in the research and development of additive manufacturing for over 15 years. It is increasingly obvious that the technology is now at a stage where its adoption in general engineering is technically possible and commercially viable."

Fairclough highlights "To enable full industrial take-up of the technology, it is essential that the certification and validation procedures used for conventional manufacturing processes are extended and, if necessary, modified to suit additive manufacturing. This joint industry project between Lloyd's Register and TWI will bridge this gap for the project participants and enable them to bring AM parts quickly and safely into the industrial marketplace."

In the oil and gas sector, cost savings and efficiency gains are crucial to restore competitiveness and increase investor confidence. The use of AM components will expedite this, and the introduction of AM certification will qualify competency and improve the safety of components and equipment used to replace worn or decommissioned parts.

In the marine industry too there is a move to assess this new technology. Commenting on the implications of AM, Luis Benito, Marketing Director, Lloyd's Register Marine, said "AM will have implications for global industry, trade and shipping as well as ship operations. It is important that we can help drive best practice as AM is adopted around the world."

From pharmaceuticals to aerospace, several industries have already adopted AM due to its ability to create complex parts with a high level of precision and reduced material usage and weight. Rolls-Royce, for example, has been exploring AM technology for component manufacture and repair for over half a decade. "We believe AM will increasingly have a major part to play in how manufacturers and designers tackle challenging component design, prototyping and manufacture," says Derek Jones from the Research and Technology programme within Rolls-Royce's Nuclear business. "Shortening the manufacturing time by almost one-third gives us more time to design, which is always a benefit. As a leading developer of AM, Rolls-Royce will play an active role in this joint industry project with Lloyd's Register, TWI and other leading industry partners. We recognise that AM has the potential to deliver real benefits across many energy applications in the future, including nuclear. The consistent approach and standards for component certification provided by this project will be a significant step forward in proving to our customer the industrial viability of components made using the latest AM techniques."

Combining a component's various parts into one printed component is achievable and can lead to savings in assembly and maintenance. The industry is also investigating hybrid production that incorporates AM technology with a view to reducing its outlay on high-value material.

Chung states "We believe operators working in offshore and onshore can learn a lot from other industries, particularly in the fast manufacture and replacement of equipment and components used in standard and critical applications."

For these operators, the Lloyd's Register certification framework (www.lr.org/additive-manufacturing) provides confidence in the performance of any certified AM part or component.

Unlike most conventional manufacturing techniques, AM forms objects by building material layer by layer, rather than forming the shape by machining. Paired with computer-aided design (CAD) software, this technique affords the creation of new and improved components to exacting material specifications. The designer is no longer limited by the constraints of conventional machining — new and redesigned components can be manufactured with almost complete freedom.

AM offers faster lead times than traditional manufacturing methods. For example, in Formula One motor racing, engineers use AM to manufacture parts in a highly reactive way. They can now analyse a car's performance while it goes around the circuit and have a new part generated before it finishes the race.

Recently, Maersk and other marine organisations have begun trials with printing replacement parts onboard vessels, thus removing the intermediate steps in the supply chain and ensuring that equipment downtime caused by part failure is dramatically reduced. AM's unique techniques and technologies open up new ground for innovation and offer a range of logistical, economic and technical advantages.

Go to www.lr.org/additive-manufacturing for information on the joint industry project and the AM guidance notes.

Pierre de Chateau Thierry

Eighteenth Century meets Twenty-first Century. The Australian National Maritime Museum's *Endeavour* passing the RAN's latest ship, HMAS *Adelaide*, off Sydney Cove on Australia Day. HMAS *Adelaide* was commissioned in Sydney on 4 December 2015 (Photo John Jeremy)

GENERAL NEWS

Air-warfare Destroyer Project Management Changes

On 8 December 2015 the Minister for Finance, Senator the Hon. Mathias Cormann, and the Minister for Defence, Senator the Hon. Marise Payne, announced that the Government was putting in place long-term arrangements to ensure the future success of the air-warfare destroyer project.

Following a limited tender process, Navantia SA has been selected to bring an experienced shipbuilding management team into ASC Pty Ltd to maximise program performance through to the end of the three ships' construction. Navantia will also locate a design team in the Osborne shipyard.

This latest step is the culmination of a number of reforms which have been made to address budget and schedule overruns and bring the project back on track. These reforms included improvements to the senior management at ASC Shipbuilding and inserted additional shipbuilding and related capability from Navantia, BAE Systems and Raytheon Australia.

These initiatives have seen a marked turnaround in the project's performance. Productivity has improved by around 35 per cent and delivery of the second and third air-warfare destroyers is now expected up to three months earlier than the timeframes estimated by a forensic audit in May this year.

The Ministers stated that the Government recognises the significant value to our nation of a skilled naval shipbuilding workforce, is prepared to invest in the skills and knowledge base of the Australian naval shipbuilding industry, and is prepared to commit to a long-term investment to make sure that this important industry enjoys a future in Australia and that these critical skills are maintained.

Expansion of Cape-class Program

Austal Ltd has announced that it has entered into a shipbuilding contract with the National Australia Bank to construct two further Cape-class patrol boats. The contract value is $63 million.

The two vessels will be delivered to the National Australia Bank in mid-2017 and subsequently chartered to the Commonwealth of Australia (Department of Defence) for a minimum term of three years. Austal has successfully employed a similar off-balance-sheet charter of defence ships through the charter of *Westpac Express* to the US Navy for 13 years.

The vessels will also be sustained by Austal in accordance with the in-service support offering provided to the 8 existing Cape-class patrol boats designed and constructed by Austal and owned by the Australian Border Force.

Austal is providing a residual-value guarantee to the National Australia Bank, which may be exercised at the conclusion of the charter term. In the event that the Department of Defence returns the ships at the end of the charter, and National Australia Bank exercises the residual-value guarantee option, then Austal will purchase the vessels at a pre-agreed price.

Austal CEO, Andrew Bellamy, said that the contract would take the fleet of Cape-class patrol boats to 10 vessels and reflected the quality and performance of the existing fleet of ships which Austal recently delivered on time and on budget.

"It is also a terrific vote of confidence in Austal and the products we design, build and sustain at our Henderson shipyard in Western Australia. As Australia's only ASX-listed prime contractor, we are very well positioned to support the Commonwealth in its future continuous shipbuilding plans," Mr Bellamy said.

Frigates and OPVs on the Way

On 17 December 2015 the Minister for Defence, Senator the Hon. Marise Payne, confirmed that the competitive evaluation processes have now commenced for the future frigates and offshore patrol vessels for the RAN.

"The Turnbull Government is committed to ensuring that Australia has a strong and sustainable shipbuilding industry. We are getting on with the job," Minister Payne said. "Defence is now conducting an analysis of mature ship designs for each project. This approach will enable Government to better understand the options for delivery of these important ADF capabilities."

In August, the Government announced the first programs to be delivered as part of the national shipbuilding strategy would be the future frigates, commencing in 2020, and the offshore patrol vessels, commencing in 2018.

"These vessels will be the first in a continuous local shipbuilding program, with construction of the Future Frigate being centred in Adelaide," Minister Payne said.

Minister Payne visited the Adelaide shipyards on 17 December 2015 to see the work being done on the air-warfare destroyer program and the sustainment program for the Collins-class submarines.

"The Adelaide shipbuilding and submarine sustainment workforce is world class. The announcements we have made on the future frigates will help secure thousands of jobs for the long-term."

Minister Payne has also been engaging with the local defence industry, which will be crucial to the success of shipbuilding in Australia.

"Delivery of a successful and sustainable shipbuilding industry plan requires changes in the way Defence and industry do business."

Austal Delivers Sixth EPF to the US Navy

On 16 January Austal USA delivered the sixth expeditionary fast transport vessel, USNS *Brunswick* (EPF 6), to the US Navy.

The expeditionary fast transport program, formerly named the joint high-speed vessel (JHSV) program, provides the Navy with a high-speed intra-theatre transport capability. *Brunswick* is a 102.4 m long aluminum catamaran capable of transporting 600 t for 1200 n miles at an average speed of 35 kn, and is designed to operate in austere ports and waterways, providing added flexibility to US forces worldwide. The ship's flight deck can also support flight operations for a wide variety of aircraft, including a CH-53 Super Stallion helicopter.

"We're proud to deliver yet another great ship to the US Navy fleet," Austal USA President, Craig Perciavalle, said. "The five expeditionary fast transport vessels in service today have already proven to be a valuable resource for our nation and we're excited to deliver another ship which will add to that global capability."

USNS *Spearhead* (EPF 1) was delivered in 2012 and has already logged over 100 000 n miles supporting operations from Africa to the Pacific and South America. Her four follow-on sister ships have also been put to use around the globe supporting humanitarian and combat operations.

Upon delivery of USNS *Brunswick*, there will be three Spearhead-class EPFs under construction at Austal's Mobile, AL, shipyard. The future USNS *Carson City* (EPF 7) was christened on 16 January, and was launched the following week. Modules for the future USNS *Yuma* (EPF 8) and USNS *Bismarck* (EPF 9) are under construction in Austal's module manufacturing facility, with the construction of *Burlington* (EPF 10) scheduled to begin in early 2016. EPFs 11 and 12 have been fully funded by Congress in the 2015 and 2016 Omnibus Appropriations Bills. The Navy awarded Austal a $54 million contract in October to fund long lead materials for EPF 11.

Hydrodynamic Research Agreement

Australia and Japan have signed a cooperative research arrangement on marine hydrodynamics, the Chief Defence Scientist, Dr Alex Zelinsky, announced on 1 December 2015. "This is the first joint defence research project to be conducted by our two countries," Dr Zelinsky said.

The collaborative research program will be undertaken by Australia's Defence Science and Technology Group and Japan's Acquisition, Technology and Logistics Agency.

"This is an excellent start to our new relationship in defence science and technology cooperation," Dr Zelinsky said. Understanding hydrodynamics is vital for the future of Australia's maritime defence and this collaboration will greatly benefit our technology development in this area.

"While the research being undertaken is not connected to the competitive evaluation process currently underway to assess Australia's future submarine needs, the results from the research will have broad applicability to Australia's future maritime projects."

The collaborative research program will involve experimental work at facilities in Japan as well as at the DST Group laboratory in Melbourne and the Australian Maritime College at the University of Tasmania.

Dr Zelinsky said that researchers from both countries had already visited each other's facilities and scoped the collaborative work to be undertaken.

"Our defence scientists are very excited at the prospect of working with their Japanese counterparts and look forward to achieving some innovative outcomes for Australia's maritime defence," Dr Zelinsky said.

Twelfth LCS Launched by Austal for USN

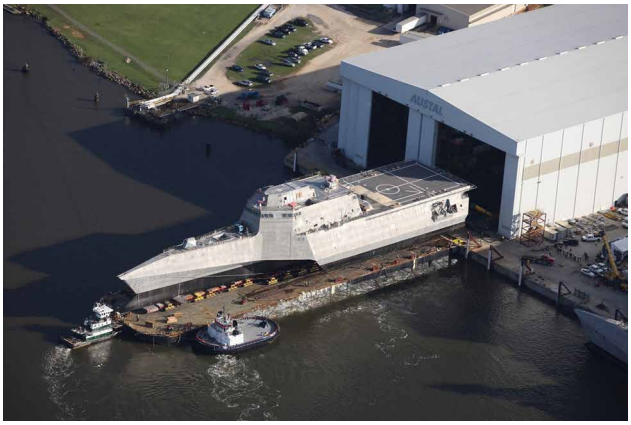
Austal USA has launched the twelfth Independence-class littoral combat ship (LCS), the future USS *Omaha* (LCS 12), at its facility in Mobile, AL, on 20 November 2015.

"It's exciting to successfully launch another LCS, and we are pleased at how well the program is maturing," said Austal USA President, Craig Perciavalle. "Incredible teamwork makes it all happen and the team here is second to none."

LCS 12 will undergo final outfitting and testing before sea trials and delivery to the US Navy. *Omaha,* a 127 m trimaran, is the fourth LCS Austal has launched as part of a $3.5 billion 10-ship block-buy contract.

The Independence-class LCS combines superior seakeeping, endurance and speed with the volume and payload capacity needed to support emerging missions enabling rapid response to ever-evolving missions, technologies and future threats.

Six LCSs along with four expeditionary fast transports (EPF) are currently under construction in Austal's Mobile, AL, facility. Austal has delivered three LCS and five EPF to the US Navy to date. The US Navy took delivery of the future *USS Jackson* (LCS 6) in late July. The future *USS Montgomery* (LCS 8) is preparing for acceptance sea trials in early 2016.



USS *Omaha* (LCS 12) ready for launching at the Austal USA facility (Photo courtesy Austal)

Keel Laid for Third AWD

The week of 19 November 2015 marked significant progress on the air-warfare destroyer (AWD) program, as the keel was laid for the third destroyer, *Sydney,* and initial combat systems activation commenced on the first destroyer, *Hobart.*

Sydney is the last of three AWDs currently under construction on this program, which will deliver the most capable warships ever possessed by the Royal Australian Navy.

AWD Alliance CEO, Rod Equid, said that the keel-laying for the third ship is the latest in a series of important achievements across the project, with the start of the hull consolidation phase for *Sydney,* as well as the progression to the system activation phase for *Hobart* in advance of sea trials in 2016. Mr Equid said the second destroyer, *Brisbane,* is also on track towards meeting the completion of hull consolidation next month.

"We are proud of this further progress. Production is now more than 70 per cent complete across the project and significant productivity improvements are being realised from ship to ship. We have come a long way since our first keel-laying ceremony was held three years ago.

"We recognise the importance of the work being done on the third ship, as this is where we will achieve the highest levels of productivity, based on the lessons from *Sydney's* sister ships," said Mr Equid.

AWD Program Manager, Peter Croser, commended the work accomplished by the AWD Alliance over the course of the last year. "We have achieved a number of critical milestones this year, from launching our first ship *Hobart* in May, to achieving 70 per cent completion on our second ship, *Brisbane*, and now commencing the hull consolidation phase for our third ship, *Sydney*," said Mr Croser.

Chief of Navy, VADM Tim Barrett, and ASC apprentice Billy Hewitt make sure that the keel of the future HMAS *Sydney* is well and truly laid
(Photo courtesy AWD Alliance)

ASC shipbuilders in front of the first modules for NUSHIP *Sydney*
(Photo courtesy AWD Alliance)

Bali Hai Cruises Selects IMC Fremantle for New Passenger Catamaran Design

Bali's largest marine tourism operator, Bali Hai Cruises, has selected International Maritime Consultants (IMC) of Fremantle for the design of its next generation day-cruise catamaran.

Established in 1990, Bali Hai Cruises provides a wide variety of tourism experiences from Benoa Harbour. These include day cruises to a water-activities pontoon off Nusa Lembongan, day-sailing trips, ocean-rafting trips on high-speed rigid inflatables, and evening dinner cruises. The company also operates the Hai Tide Beach Resort.

Working closely with Bali Hai Cruises, IMC has developed a unique design which can successfully support its diverse range of operations. With capacity for 400 passengers in a contemporary tropical interior, IMC's new 40 m aluminium catamaran design is intended to provide a significant step forward from the 36 m, 315 passenger *Bali Hai II* which Bali Hai Cruises has operated successfully for over 20 years.

"A foundation of our success has been bespoke-quality vessels, maintained to the highest standards," said Dick Chandler, Managing Director of Bali Hai Cruises.

"This new project reflects both our confidence in Bali's tourism industry and our intention to consolidate our leading market position through the introduction of another world-class vessel. Bali Hai Cruises is very pleased to be working with IMC towards that goal," he added.

A key feature of the design is the use of a diesel and electric propulsion system, which will provide a 25 kn cruise speed

IMC's proposed catamaran design will enhance Bali Hai Cruises' operations to its water activities pontoon off Nusa Lembongan (Photo courtesy IMC)

to the pontoon and low noise and emissions when operating in an all-electric mode during the evening dinner cruise. To provide these environmental and operational benefits, the Western Australian naval architecture consultancy is leveraging its experience with hybrid propulsion gained through the design of advanced offshore support vessels.

In addition to providing the full functional design for the new vessel, IMC will utilise its expertise and experience in acquisition management to assist Bali Hai Cruises pre-qualify and select a preferred shipyard to undertake the construction.

Commenting on the contract, IMC's Managing Director, Justin McPherson, said "To be entrusted with the design of a new aluminium passenger catamaran by Bali Hai Cruises, which has been operating similar craft so successfully and for so long, is a great honour."

BMT Provides New Design for the River Murray Ferry Services

BMT Design & Technology Pty Ltd (BMT), a subsidiary of BMT Group Ltd, has recently completed a design project for the South Australian Government's Department of Planning, Transport and Infrastructure (DPTI). Working in partnership with the DPTI, BMT has developed a replacement design for ferries which operate on the River Murray, the third longest navigable river in the world, after the Amazon and Nile.

The steel hull, built by local firm Bowhill Engineering, was fitted out by the Department's Morgan dockyard. The first ferry has now gone into service at Lyrup with another three scheduled for completion by July 2016, 2017 and 2018 respectively. These ferries are relied upon heavily by the local communities for safe passage across the River Murray. A source from DPTI commented "BMT has helped us to deliver a robust design, a critical factor for a service which operates 24 hours a day, 365 days a year."

The team at BMT provided structural engineering and naval architecture services to deliver a detailed design which aligned with the customer's requirements. BMT also carried out condition surveys on a further four timber-hulled ferries which were nearing end of life. Following the surveys, the Department applied weight restrictions to help maintain the longevity of these ferries for safe operation until they are replaced. Constructed of steel and 22m long, these cable driven ferries can take two lanes of cars or trucks of up to 50 tonnes, or a maximum of 70 passengers.

Trevor Dove, Maritime Engineering Lead at BMT Design & Technology commented: "We recognise that providing the optimum design in terms of cost, schedule and performance is the key. Our team has been able to demonstrate its expertise and knowledge in all aspects of marine engineering to deliver a design that is fit for purpose for the customer."

The first of the BMT-designed ferries in service (Photo courtesy BMT)

Refit for Retired Patrol Boat HMAS *Townsville*

Decommissioned RAN Fremantle-class patrol boat HMAS *Townsville* has been moved under tow from Ross Creek in Townsville to Cairns for refurbishment works which will be performed by Port of Townsville Limited.

The vessel arrived in Cairns on December 2 and was moved into dry dock for the first stage of renovations.

In a joint project between the Townsville Maritime Museum, Port of Townsville Limited, and the Royal Australian Navy, the vessel will spend approximately four months at the Norship Dockyard in Cairns.

Restoration works will include blasting, sealing underwater openings and a new paint job. The vessel will return to Townsville in 2016 to take up her place as a star attraction at the Townsville Maritime Museum.

Townsville en route to Cairns (Image Port of Townsville Limited)

Townsville Maritime Museum Chair, Brad Webb, said: "The addition of HMAS *Townsville* as a centrepiece attraction for the Maritime Museum will be a huge boost which will attract not only tourists, but locals who are curious to find out more about the vessel that carries their city's name as well."

The movement of *Townsville* was a multi-agency operation with Navy, Army Water Transport, Queensland Water Police, Maritime Safety Queensland, the Port of Townsville and local business Pacific Marine Group all involved.

LCDR Peter Mellick, the Navy Harbour Master and naval pilot who moved the vessel out of Ross Creek in Townsville and into the dock at Norship, said "This vessel was gifted by Navy to the city of Townsville in 2007 when she was decommissioned after 26 years of service. She served her entire career based out of Cairns and many of her former crew are still in uniform,"

Built at NQEA in Cairns, *Townsville* was laid down in 1979 and commissioned into the RAN in 1981.

She was assigned to naval base HMAS *Cairns* during her service and was primarily assigned to fisheries protection and border control operations in northern Australian waters. The vessel was decommissioned in 2007.

Royal New Zealand Navy celebrates 75th anniversary

As part of the Royal New Zealand Navy (RNZN) 75th Anniversary celebrations, a formation entry into Auckland's Waitemata Harbour was held on Monday 8 February 2016.

The formation entry included a 17-gun salute from HMNZS *Canterbury* as she passed Devonport Naval Base at midday, and this was reciprocated with an 11-gun salute fired from HMNZS *Te Mana*, berthed at Devonport Naval Base.

New Zealanders were able to watch the ceremony from ashore, from North Head and other vantage points around the Auckland's harbour.

HMNZS *Wellington* maneuvering in company with HMNZS *Canterbury* during the RNZN 75th Anniversary celebrations (RNZN photograph)

Maritime Museum heritage vessels, the scow *Ted Ashby* and the steam vessel *Breeze*, also accompanied the RNZN ships.

The salute is a naval tradition in which the Maritime Component Commander of the RNZN is formally acknowledging the newly appointed Chief of Navy, Rear Admiral John Martin ONZM.

Following the formation entry, the ships engaged in manoeuvres, including a boarding party deployment from HMNZS *Wellington* via RHIBs to HMNZS *Hawea,* and a winching demonstration using 6 Squadron's Seasprite SH-2G helicopters to conduct a transfer between ships.

Baru Providencia and *Baru Antares* from Incat Crowther

Incat Crowther has announced the launch of two new UT4000 monohull fast supply vessels built by ETP Engenharia Ltda. *Baru Providencia* and *Baru Antares* are the third and fourth in a 12-boat series, following on from *Baru Gorgona* and *Baru Macura*.

The vessel designs have been optimised to comply with the UT4000 Fast Supply Vessel specification. Ships fuels is in excess of 40 000 L, with a cargo fuel load of 90 000 L. There is also capacity for 90 000 L of cargo fresh water.

The vessels are dominated by an expansive aft deck of 225 m^2 of usable area, planked with hardwood and protected by sturdy cargo rails.

An additional 30 m^2 of cargo area is provided inside the main-deck cabin, allowing for the carriage of items out of the elements, such as food and other supplies. Also housed in the main-deck cabin are wet room and laundry facilities.

The upper-deck wheelhouse includes an aft-facing control station allowing for safe and efficient manoeuvring.

Below decks are six cabins accommodating 11 crew, as well as a mess, galley and bathrooms.

The vessels are powered by a quartet of Cummins QSK 50 main engines, each rated at 1342 kW @ 1800 rpm. Propulsion is by way of fixed-pitched propellers, whilst two 112 kW electric tunnel bow thrusters enhance manoeuvrability. The vessel has a service speed of 21 kn.

Incat Crowther's extensive experience in the offshore supply field has led to a respectful design to provide a fleet of class-leading vessels that are rugged, efficient and profitable.

Principal particulars of the new vessels are

Length OA		48.0 m
Length WL		46.1 m
Beam OA		9.50 m
Depth		4.25 m
Draft	(hull)	1.70 m
	(propeller)	2.10 m
Crew		11
Deck area		225 m^2
Deck strength		3.0 t/m^2
Ship's fuel oil		44 600 L
Ship's fresh water		90 000 L
Cargo fuel		90 000 L
Cargo fresh water		91 000 L
Main engines		4×Cummins QSK 50 each 1342kW @ 1800 rpm
Propulsion		4×5-bladed propellers
Generators		2×Cummins QSM 11, 280 kWe
Speed	(service)	21 kn
	(maximum)	25 kn
Construction		Marine-grade aluminum
Flag		Brazil
Notation		✠ 1A1 HSLC (bra) R1 Service 2 E0

Port bow of *Baru Antares*
(Image courtesy Incat Crowther)

Baru Antares under way
(Image courtesy Incat Crowther)

Alya McCall from Incat Crowther

Incat Crowther has announced the delivery of *Alya McCall*, the first vessel in a fleet of a new class of monohull fast support vessels (FSV) for SEACOR Marine. *Alya McCall* is the first in the SEACOR Express Plus class and features striking lines not ordinarily found in traditional monohull FSV designs. Gulf Craft in Franklin, Louisiana, constructed the vessel to their usual high commercial-quality standards. The vessel features seating capacity for 100 personnel and has an impressive top speed of 38 kn. The performance is enabled by a quintet of Cummins QSK 60, EPA Tier-3-compliant diesel engines, each producing 1998 kW. The engines are coupled to Twin Disc MGX 61500 SC reverse reduction gearboxes driving Hamilton HT-810 waterjets. Cardan shafting systems by Driveline Service of Portland connect the gearboxes to the waterjets.

Superior station-keeping capability is provided through the combination of three Thrustmaster 30TT200 electric-mechanical tunnel thrusters working in conjunction with the azimuth-like waterjets, all of which are controlled by a Kongsberg DP-2 dynamic-positioning system.

Electrical power is derived from three Cummins QSM 11 gensets, each producing 290 kWe. Dual FFS fire-fighting pumps and remoted-controlled monitors provide FiFi-1 equivalent firefighting capacity for combatting off-ship fires. A Naiad Dynamics ride-control system is also fitted to improve passenger and crew comfort while underway.

The vessel is certified by the USCG under the provisions of 46 CFR Subchapter T and by the American Bureau of Shipping as a High-Speed Craft with DP-2 and Fire-Fighting Capability notations.

Incat Crowther is proud to have had the opportunity with SEACOR Marine to introduce both monohull and catamaran offshore-support vessels with increased performance and passenger comfort. *Alya McCall* is another testament of the excellent relationship that Incat Crowther has with SEACOR Marine and Gulf Craft. A commitment to service, combined with a shared philosophy of innovation, has led to the development of a yet another new class of vessel to serve its ever-demanding industry.

Principal particulars of *Alya McCAll* are

Length OA	62.8 m
Length WL	58.9 m
Beam OA	9.80 m
Depth	4.60 m
Draft	2.80 m
Passengers	100
Crew	16
Deck size	41.6 m × 8.1 m
Deck area	328 m²
Deck cargo	305 t
Fuel oil	316 000 L
Fresh water	28 000 L
Grey water	2270 L
Black water	2270 L
Lube oil	2650 L
Waste oil	1893 L
Bilge oil	1893 L
Main engines	5×Cummins QSK 60 each 1998 kW @ 1900 rpm
Gearboxes	5×Twin Disc MGX 61500 SC
Propulsion	5×Hamilton HT-810 waterjets
Generators	3×Cummins QSM 11, 290 kWe
Bow Thrusters	3×Thrustmaster 30TT200ML
Speed (maximum)	38 kn
Construction	Marine-grade aluminum
Flag	USA
Class/Survey	USCG Subchapter T, Oceans ABS ✠A1 HSC Crewboat ✠AMS ✠DP2 Fire-fighting capable

Zach Dubois

Port side of *Alya McCall*
(Photo courtesy Incat Crowther)

34m Catamaran Passenger Ferries from Incat Crowther

Incat Crowther has announced the commencement of construction of a further two 34 m catamaran passenger ferries for Fullers Group Ltd. The new vessels will be sister ships to *Te Kotuku* (delivered in 2014), validating the close association between designer, builder and operator in developing that vessel, including its integration into the Auckland transport network. As with *Te Kotuku*, the new vessels are being built by Q-West in Wanganui, New Zealand. The vessels will each carry 401 passengers and include the addition of a sun deck.

The main deck features seats for 174, a large café, luggage racks and wide access doors. Also fitted will be two toilets (one of which is handicap-accessible) and racks for 14 bicycles.

The upper deck features 76 exterior seats and 81 interior seats. An additional bar and pair of toilets are also located on the upper deck.

The wheelhouse retains its successful asymmetric configuration, designed in consideration of the operational requirements. The frequently-used starboard wing control station is enclosed for protection from the elements, whilst the port side is dedicated to crew access via stairs to the foredeck, which houses palletised cargo and a deck crane.

Passenger boarding is by large side gates on the main deck, or via the hydraulic hinging articulated ramps mounted on the transom port and starboard, which integrate with the existing shore-based infrastructure and offer a fast turnaround time.

The new vessels will feature larger engines, carrying the increased deadweight and offering improved performance and efficiency. The vessels feature conventional fixed-pitch propellers and offer an efficient loaded service speed of 26 kn.

The vessel will be fitted with a dry exhaust system which, along with the engine-room air outlets, will exit high above the upper deck. This configuration, which reduces fumes and noise in passenger areas, is typical of vessels in the Fullers fleet.

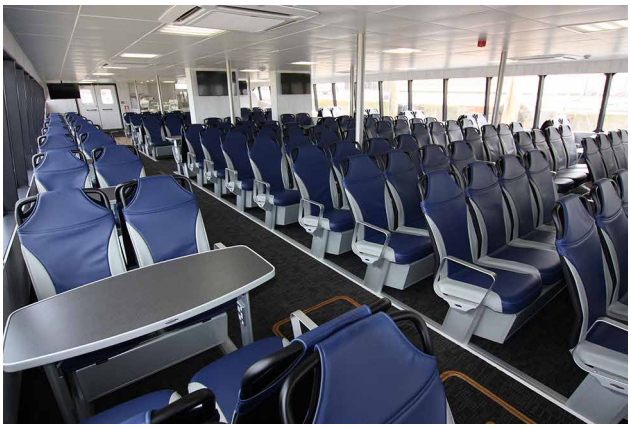
Incat Crowther is pleased to continue its association with Fullers Group Limited, as they expand their fleet.

Principal particulars of the new vessels are

Length OA		34.0 m
Length WL		33.8 m
Beam OA		9.50 m
Depth		3.05 m
Draft	(hull)	1.20 m
	(propeller)	1.80 m
Passengers		401
Crew		5
Fuel oil		8000 L
Fresh water		3000 L
Sullage		3000 L
Main engines		2×Cummins QSK50-M each 1342 kW @ 1975rpm
Propulsion		2×fixed-pitch propellers
Generators		2×100 kVA Cummins 6B-CP
Speed	(service)	26 kn
	(maximum)	30 kn
Construction		Marine-grade aluminium
Flag		New Zealand
Class/Survey		Maritime New Zealand

Port side of *Te Kotuku*
(Photo courtesy Incat Crowther)

Port quarter of *Te Kotuku*
(Photo courtesy Incat Crowther)



Main-deck cabin on *Te Kotuku*
(Photo courtesy Incat Crowther)

Utila Dream from Incat Crowther

Incat Crowther has announced the delivery of *Utila Dream*, a 244 passenger 30 m catamaran passenger ferry, built by Midship Marine in Louisiana, USA. *Utila Dream* was recently delivered on its own bottom to Honduras where she has commenced operation between the island of Utila and the mainland city of La Ceiba, a journey of approximately 21 n miles.

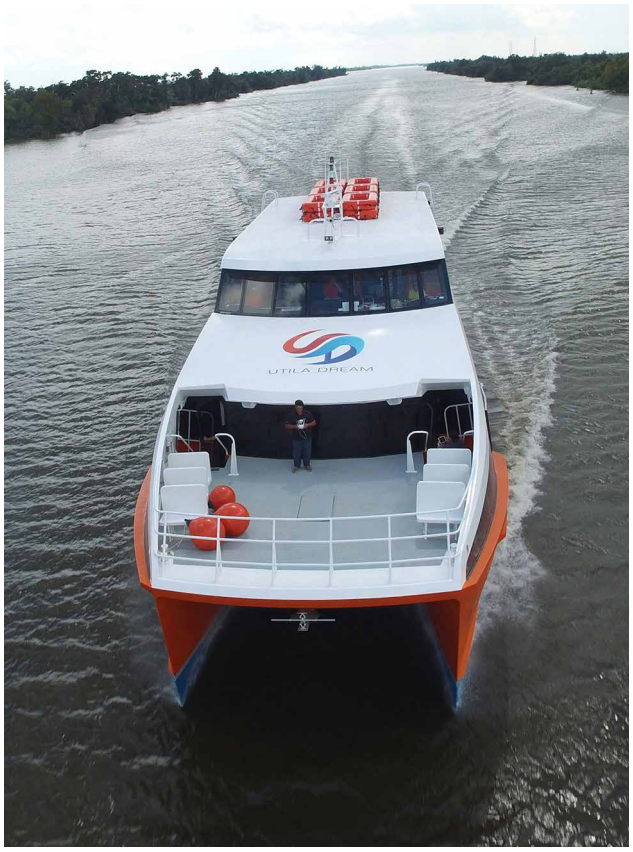
Designed specifically for rough-water operation, *Utila Dream* heralds a new era of ferry service for the island, being larger, faster and far more capable than previous operations. Providing a lifeline to the mainland, reliability is addressed with Incat Crowther's robust engineering, the selection of a main engine delivering the service speed at low MCR, and a simple machinery and drive-train package.

Utila Dream is fitted with wet and dry cargo rooms aft, loaded via three lifting ramps on each side of the vessel. The aft ramps serve the cargo rooms, whilst the remaining ramps serve passenger spaces with all passenger movement being segregated from freight movement.

The main-deck cabin features seats for 112 passengers. A pair of forward doors leads past the forward boarding ramps to the foredeck, where an additional 32 outdoor seats are located.

The upper deck is served by stairs port and starboard, adjacent to the aft passenger ramps. A total of 82 exterior passengers are seated on this deck, with a bar located forward. Forward of this is a VIP cabin with 18 large executive-style seats.

Port side of *Utila Dream*
(Photo courtesy Incat Crowther)



Bow of *Utila Dream*
(Photo courtesy Incat Crowther)

Utila Dream is fitted with a pair of Cummins KTA38 main engines rated to 1007 kW and operates at a service speed of 28 kn at 75% MCR.

Principal particulars of *Utila Dream* are

Length OA		30.3 m
Length WL		29.2 m
Beam OA		8.00 m
Depth		3.10 m
Draft	(hull)	1.00 m
	(propeller)	1.27 m
Passengers		244
Crew		5
Fuel oil		8900 L
Fresh water		570 L
Sullage		570 L
Main engines		2×Cummins KTA38 each 1007 kW @ 1900 rpm
Propulsion		2five-bladed propellers
Generators		2×30 kVA
Speed	(service)	28 kn
	(maximum)	31 kn
Construction		Marine-grade aluminium
Flag		Honduras
Class/Survey		USCG Subchapter T

Thapdaorai from Incat Crowther

Incat Crowther has announced the delivery of *Thapdaorai*, the seventh catamaran passenger ferry for Lomprayah High Speed Ferries. Constructed by BP Marine, the 34 m vessel is an extended version of Lomprayah's previous delivery, *Maehaad*.

The improvements over the previous vessel reflect feedback from the operation, as well as responding to increased patronage for the operation. The vessel has been lengthened in the mid-body which, in conjunction with the addition of aft pods, allows for increased deadweight that includes increased baggage and cargo loads. The vessel's windows have been enlarged to increase passenger outlook, whilst the boarding gates have been increased to aid passenger flow.

The main-deck cabin seats 233 passengers, with increased luggage storage. The kiosk is located at the aft end of the cabin, adjoining the crew mess and recreation room. The upper deck accommodates 20 passengers in the executive cabin, 50 in the VIP cabin, and 58 passengers on the exterior aft deck. The roof deck seats 120. Total passenger capacity is 481.

Thapdaorai is powered by a pair of Yanmar 12AYM-WGT main engines, each producing 1340 kW, and is capable of speeds in excess of 31.5 kn.

Incat Crowther yet again offered an extensive package of deliverables, including 3D structural design in addition to a full kit of aluminium structure and major components. *Thapdaorai* is built to capitalise on the success of *Maehaad*. Her ruggedness and efficiency commend her to the demanding operation.

Principal particulars of *Thapdaorai* are

Length OA		33.5 m
Length WL		33.0 m
Beam OA		9.00 m
Depth		3.20 m
Draft	(hull)	1.40 m
	(propeller)	2.10 m
Passengers		481
Crew		8
Fuel oil		6000 L
Fresh water		2000 L
Main engines		2×Yanmar 12AYM-WGT each 1340 kW @ 1940 rpm
Propulsion		2×Propellers
Generators		2×Yanmar 6HAL2-WT each 136 kW @ 50 Hz
Speed	(service)	25 kn
	(maximum)	31.5 kn
Construction		Marine-grade aluminium
Survey		Thai Government Marine Department

Stewart Marler

Port side of *Thapdaorai*
(Photo courtesy Incat Crowther)

Main-deck cabin on *Thapdaorai*
(Photo courtesy Incat Crowther)

Cruising

The summer cruise season has moved into high gear, with visits to Sydney in late November by *Carnival Spirit, Voyager of the Seas, Pacific Pearl, Pacific Jewel, Carnival Legend, Volendam, Noordam, Diamond Princess, Dawn Princess, Pacific Dawn, Celebrity Solstice, and Explorer of the Seas.*

Carnival Australia turned on the taps on 25 November 2015 when, for the first time ever, they sailed five cruise ships into Sydney Harbour on the one day for the naming of their two latest vessels, *Pacific Aria* and *Pacific Eden*. The two new vessels were joined off Sydney Heads by their big sisters, *Pacific Dawn, Pacific Jewel* and *Pacific Pearl*, and they steamed towards the heads in V-formation, then into the harbour in single file at 0615. Up the harbour, the naming ceremony was performed with the vessels sailing either side of Fort Denison at 0830 by singer Jessica Mauboy (*Pacific Aria*) and actress Kate Ritchie (*Pacific Eden*), who cracked bottles of champagne over the bows and, in a decidedly modern twist on the traditional ceremony, tweeted to their thousands of followers as it happened. The five ships then docked at various points around the Harbour in preparation for the afternoon and evening events. From 1600 to 2000, 20 live music acts and 10 DJs performed live concerts for passengers, Jessica Mauboy on board *Pacific Aria* docked at the Overseas Passenger Terminal; The Veronicas on *Pacific Eden* anchored at Neutral Bay, Justice Crew on *Pacific Jewel* anchored at Athol Bay, Stan Walker on *Pacific Dawn* anchored east of Garden Island, and Samantha Jade on *Pacific Pearl*, anchored off Point Piper. A spectacular fireworks display lit up the sky at 2045 and the ships cruised out of the Harbour at 2200, taking their partying passengers to ports in NSW, Queensland and the Pacific Islands.

The following months saw return visits by most of these vessels, and December added visits by *Astor, Radiance of the Seas, Celebrity Solstice* and *Superstar Virgo*. January added visits by *Silver Shadow* and *Azamara Quest, and* early February added visits by *Europa, Pacific Venue, Seabourn Odyssey* and *Silver Whisper.*

Cruise vessels operating out of Sydney have continued to call at Eden, NSW, with passengers going ashore. *Volendam, Pacific Dawn, Pacific Jewel* (twice)*, Pacific Eden* (twice)*, Marinara,* and *Noordam* all visited between mid-November and mid-February.

Phil Helmore

Pacific Eden at anchor in Twofold Bay, Eden,
on her inaugural visit on 10 January
(Photo courtesy Robert Whiter)

Daytime fireworks welcoming *Pacific Eden* and *Pacific Aria* to Sydney on 25 November
(Photo John Jeremy)

FROM THE CROWS NEST

Guide for Air Inclinings

SNAME has recently published Technical and Research (T&R) Bulletin 9-1 *Standard Guide for Conducting Small Boat Air-Inclining Stability Test (Lightweight Survey and Air Inclining Test to Determine Lightweight and Centers Of Gravity)* by Todd Hillier.

While working for the US Coast Guard, Chris Barry and Todd Hiller initiated what would later become SNAME's new T&R Bulletin 9-1. The idea of developing a standard guide for conducting air-inclining stability tests came about as the Coast Guard widened its operational performance requirements in their fleet of small boats. Consequently, since there were no current guidelines for military and commercial small boats, it later inspired a standard and explanation for all small boat operators, builders, buyers, accident investigators, and others who may be required to determine an accurate boat weight and centre of gravity for their boat in order to apply stability criteria or perform other analyses. This T&R Bulletin is considered a guide to provide the marine industry with an understanding of an air-incline stability test for small boats. It contains procedures to ensure that valid results are obtained with precision at a minimal cost to owners, shipyards, and the government. The guide is not intended to direct anyone in the actual calculations of the boat weight and centres of gravity, but to serve as a guide to the recommended procedures required to gather accurate data for use in the calculation of the boat characteristics. A complete understanding and documentation of proper procedures to conduct a stability test is paramount to confirm that the results gathered during the test can be examined for accuracy, especially by third parties subsequently reviewing the data.

After the initial draft, the guide went out to industry for their input and recommendations. Mr Hillier then went to work incorporating the suggestions from notable maritime industry professionals, researchers, technicians, and engineers from the Surface Forces Logistics Centre, the Marine Safety Centre (Small Vessel Branch) of the US Coast Guard and the Naval Sea Systems Command C235 Test and Evaluation of the Combatant Craft Division of the Carderock Naval Surface Warfare Centre. Todd Hiller credits Chris Barry for encouraging him into accepting the assignment and in the development of a methodology for the benefit of all small-boat maritime industry professions.

The new publication may be ordered for $US40 ($US20 for SNAME members) through the SNAME website (www.sname.org) or by contacting Kristin Walker at kwalker@sname.org.

SS *United States* to Sail Again

Crystal Cruises has come to the rescue of historic luxury liner SS *United States*, announcing in February an exclusive purchase option agreement to begin work on returning America's flagship to service as the world's fastest cruise ship. Once the world's fastest, safest and largest passenger liner, the historic ship still holds the Blue Riband for passenger liner crossing the Atlantic Ocean westbound in regular service with the highest speed. [*The rules differ for the Hales Trophy which can be won by any type of commercial passenger vessel for a crossing in either direction and, after SS* United States*, has been held by Incat Tasmania-built vessels* Hoverspeed Great Britain, Catalonia, *and* Fjord Cat *ex* Cat Link V — Ed.]

SS *United States* in service
(Photo worldshipwrecks.wordpress.com)

SS *United States* has spent years mothballed at dock holding off a looming trip to the scrapyard, having last sailed under her own power more than 40 years ago. Following a number of attempts by developers to save SS *United States* through the years, Crystal, together with the SS *United States* Conservancy, the group which owns the vessel and has led the efforts for its preservation, will now work toward bringing the ship into compliance with the latest standards in order to return the Big U to oceangoing service.

SS *United States* was designed by William Gibbs and launched in 1952, capturing the transatlantic speed record on her maiden voyage. Still the largest passenger ship ever designed and built in America, the Big U was designed as part of a secret Pentagon program during the Cold War, which stipulated that she could be quickly converted from a luxury liner into a naval troopship in the event of a war, carrying 15 000 troops with a 240 000 hp (178 968 kW) shaft power propulsion plant capable of traveling 10 000 n miles — almost halfway around the globe — without refuelling.

Before her retirement in 1969, SS *United States* was regarded not only as a technological marvel, but also as the world's most glamorous and elegant ship, having transported more than one million passengers, including four U.S. presidents, international royalty and many of Hollywood's "golden era" celebrities.

For more information, see www.marinelink.com/news/united-states-again404653.aspx.

Phil Helmore

HMS *Protector* Completes Antarctic Patrol

The UK Royal Navy's Ice Patrol ship HMS *Protector* has recently completed an historic five week patrol to the East Antarctic and Ross Sea. She is the first Royal Navy, or UK Government, vessel to have visited the region in 80 years or to have traveled so far south having dipped below 77° south latitude.

Her mission has been to support the work of the Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR) in protecting the unique Antarctic eco-system through close co-operation with Australia and New Zealand.

HMS *Protector* alongside in Hobart in December on the way to the Antarctic
(Photo John Jeremy)

During her patrol *Protector* inspected a number of fishing vessels to ensure that they adhere to the strict licensing regulations in the area.

In addition, the ship also paid a visit to the Italian Antarctic research station, Mario Zucchelli, while members of the ship's company paid homage to the legendary British Antarctic explorers Captain Robert Scott RN, and Sir Ernest Shackleton.

Within 24 hours of arriving in the Ross Sea, *Protector* had carried out the first of several CCAMLR inspections with six embarked Australian and New Zealand specialists in support.

During summer, the Ross Sea can lose most of its ice and it is possible for ships to push further south than anywhere else on the continent. It was from this region that the great Antarctic explorers mounted their expeditions to reach the South Pole. The legendary Norwegian explorer, Roald Amundsen started the journey that led him to being the first person to reach the South Pole from the Ross Ice Shelf.

Similarly, the British explorers, Captain Robert Scott and Sir Ernest Shackleton commenced their epic journeys from the Ross Sea, including Scott's fateful final expedition in 1911–12.

In honour of Scott, Shackleton, and the men they led, many of *Protector's* ship's company visited the huts they used as their base stations. *Protector's* ship's company was granted permission to visit Scott's hut at Cape Evans by the New Zealand Antarctic Heritage Trust. The embarked New Zealand Defence Force liaison officer, LCDR Hickey, acted as guide for the visit and the sailors got to witness a scene that had been untouched in years. Fur boots and skis lay where they had been left, the wooden bunks still have their sleeping bags, and clothes were hung over stoves, as if drying in the warmth.

After the visit to Scott's hut the ship went on to pay respect to Sir Ernest Shackleton and his team — fifteen miles to the north, another visit facilitated by the New Zealand Antarctic Heritage Trust.

HMS *Protector* achieved a latitude of 77 degrees 56 minutes south — the very edge of the vast Ross Ice Shelf, named for James Clark Ross who led the exploration of the area.

HMS *Protector* in Antarctica
(Photo UK MOD(N))

THE PROFESSION

Status of the Ballast Water Management Convention

The International Maritime Organisation (IMO) has completed its calculations of the shipping tonnage of the states which have ratified the Ballast Water Management Convention, and concluded that the conditions for initiating entry into force have not been met. An additional 0.44% of global tonnage is needed to meet the required 35% threshold.

This means that the Ballast Water Management Convention will not enter into force on 24 November, 2016, as predicted.

Lloyd's Register, *Class News* No. 03/2016

Towards the Implementation of a Generalised Inclining Method for the Determination of the Centre of Gravity

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ABSTRACT

The stability of a ship at sea is often limited by its centre of gravity and, throughout the life of a ship, this point is constantly changing. It is, therefore, necessary to accurately manage its position. Since the late 17th century, the traditional 'inclining experiment' has been near-universally adopted by the maritime industry, whereby known moments and measured angular deflections are analysed to yield the location of the centre of gravity in a reference condition. This traditional method draws upon wall-sided approximations, which assume constant waterplane area and a fixed metacentre throughout the range of experimental heels.

In the modern maritime industry, there are few truly wall-sided vessels (especially small vessels) in operation, and a more-accurate method of determining their centre of gravity is desirable. A new method has recently been proposed by Dunworth [1–3], which utilises advanced computational hull models to independently determine the particulars of the underwater volume at any combination of heel, trim and displacement — doing away with the limitations of wall-sided approximations.

The work reported herein, undertaken as part of an undergraduate thesis, sets out to confirm the validity of the newly-proposed method through the parallel work-up of results by both methods for the inclining of ex-navy tug *Bronzewing*, and explore to the potential issues of implementation and broader utility in future application.

NOMENCLATURE

a	=	measured heel angle deflection
d	=	distance of inclining mass shift
l	=	separation of heel angle measurements/pendulum length
w	=	inclining mass
x	=	heel measurement from datum
α	=	waterline flare angle
Δ	=	displacement
ϕ'	=	relative heel angle
ϕ	=	absolute heel angle
ϕ_{list}	=	list angle
ρ	=	density
B	=	centre of buoyancy
BM	=	height of transverse metacentre above the centre of buoyancy
G	=	centre of gravity
GM	=	metacentric height
GZ	=	righting arm
HZ	=	heeling arm
KG	=	height of vertical centre of gravity above keel
KM	=	height of metacentre above keel
KN	=	buoyant righting arm about the keel
LCB	=	longitudinal centre of buoyancy
LCG	=	longitudinal centre of gravity
M	=	metacentre
TCB	=	transverse centre of buoyancy
TCG	=	transverse centre of gravity

INTRODUCTION

The centres of buoyancy (B) and gravity (G), of a vessel are the critical parameters in the determination of its stability. A vessel is considered to have positive, negative, or neutral stability depending on their relative positions, as illustrated in Figure 1.

Throughout the life of a vessel, the location of the centre of gravity shifts as a result of loading, consumption of fuel and stores throughout a voyage, and changes in outfit or configuration. In order to ensure the positive stability of a vessel throughout its operations, conservative margins are necessarily placed on the loading conditions which generally result in reduced capability of the vessel. Therefore, it is beneficial to determine the centre of gravity accurately, allowing the conservative margins to be safely reduced, and hence capabilities increased.

The centre of buoyancy is defined as the centroid of the underwater volume displaced by the vessel. This may be determined for any combination of displacement, heel and trim from the lines and offsets or computational models of the hullform.

The centre of gravity is defined as the centre of mass of the vessel and its cargo. The value is typically determined systematically through the summation of moments applied by individual loads. However, due to the inherent compounding of errors in measured mass and position of individual items, it is desirable to accurately establish a 'lightship' condition which acts as a reference figure to which relatively small

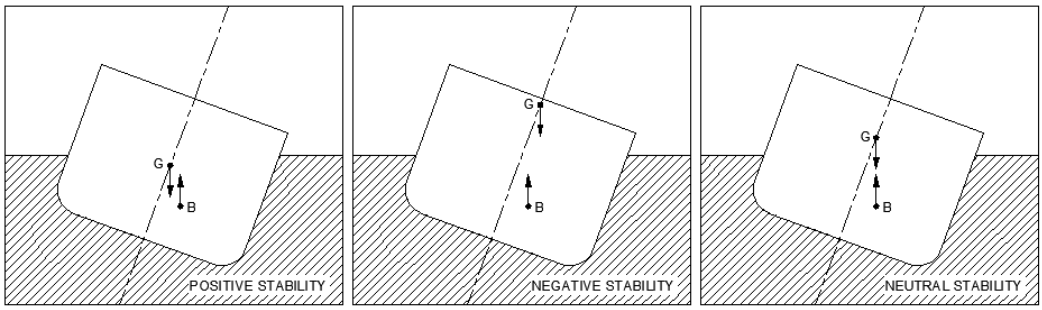

Figure 1 - Positive, negative and neutral stability

'deadweight' adjustments can be made for particular load conditions to determine corresponding 'displacement' and centre of gravity. The inclining experiment is utilised as a method for determining the lightship condition.

Traditional Inclining Method

The traditional method is built upon the wall-sided theory, whereby the immersed and emerged wedges of a heeled vessel are equal. The lateral shift of the centre of gravity from *G* to *G'* is determined from the moment balance due to the shifted inclining mass resulting in Equation 1. The vertical centre of gravity *VCG* or *KG* is determined using the upright height of the metacentre, KM_0, as shown in Equation 2.

$$GG' = \frac{wd}{\Delta} = GM \tan\phi \;\rightarrow\; GM = \frac{wd}{\Delta \tan\phi} \tag{1}$$

$$KG = KM_0 - GM = KM_0 - \frac{wd}{\Delta \tan\phi} \tag{2}$$

Whilst the fundamental reliance upon the wall-sided approximations tend to introduce only small errors for many standard hullforms, they are known to be responsible for large deviations in others, particularly small craft and those with chines near the waterplane.

In addition to the wall-sided assumption, the traditional method also assumes that the height of the upright metacentre applies to all experimentally-induced heel angles. However, the metacentre has been shown to shift with the heel angle [4]. The locus of the metacentre is known as the metacentric evolute, and an extreme illustrative case is shown for a wall-sided square prism floating at its half-depth draft in Figure 2.

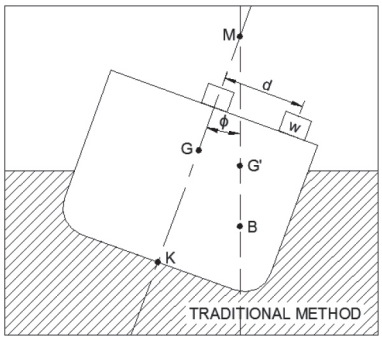

Figure 2 – Traditional method Geometry

Whilst a number of attempts have been made to study the behaviour of the metacentre and generalise its movement, it remains a quantity which must be found directly from the hull geometry, and the moment of inertia of the waterplane area as given in Equation 3.

$$KM = KB + BM = KB + \frac{I_{WP}}{\nabla} \tag{3}$$

As a result of these wall-sided and constant waterplane assumptions, the validity of the traditional method is limited to standard near-wall-sided vessels, which are inclined to small heel angles during the experiment.

Alternative Inclining Methods

In order to address special conditions or novel vessels, some alternative means of determining the position of the centre of gravity have been developed. However, these have typically been work-around methods for narrow-scope issues and minor deviations to the standard assumptions. Such alternative methods have been unable to demonstrate improved accuracy over the traditional method across a full spectrum of vessels in operation.

A 1926 paper by Hovgaard [5] provided a collection of corrections and adjustments to be used in conjunction with the traditional inclining method for vessels of small (or negative) initial stability, as well as those with an initial list due either to instability or unsymmetric loading.

After a 1983 paper titled "Rethinking the Inclining Experiment" by Cornell [6], a number of attempts were made to propose alternative methods for unconventional vessels. In their 1995 paper, Wilczynski and Diehl [7] proposed an alternative inclining method which was based on the centre of buoyancy rather than the metacentre, in an attempt to remove the fixed metacentre constraint of the wall-sided assumption.

Proposed Method

Over the course of three recent publications, Dunworth has laid the foundations for a new method of determining the position of the centre of gravity using established experimental procedures, but with the increased utilisation of computational hull models in the determination of hydrostatic data. The method was originally proposed in a paper titled *Up Against the Wall* [1], where the need for an alternate method was discussed. Dunworth then published a more thorough treatment of his proposed method as *Back Against the Wall* [2]. In light of preliminary experimental model validation, *Beyond the Wall* was presented to the 12th International Conference on the Stability of Ships and Ocean Vehicles [3].

The proposed method is derived from the balance of the heeling and righting levers in equilibrium after each mass movement. The hydrostatic geometry is illustrated in Figure 4. The heeling lever, *HZ*, is produced by the shift of the inclining mass, and the righting lever, *GZ*, is given by the separation of positive buoyancy and negative gravity levers. The resulting governing equation is Equation 4.

$$HZ = GZ$$

$$\frac{wd\cos\phi}{\Delta} = KN - KG\sin\phi - TCG\cos\phi \tag{4}$$

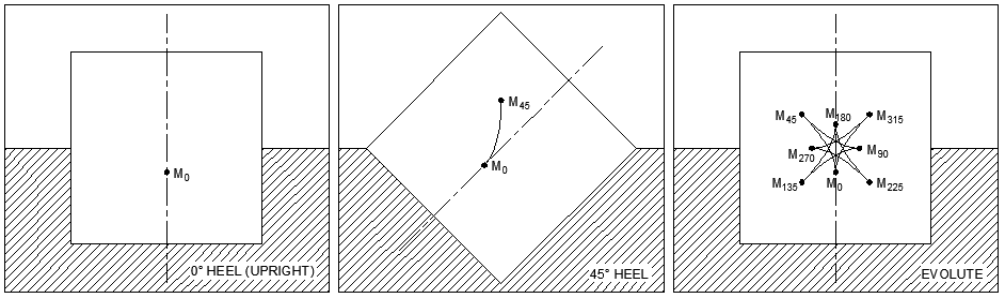

Figure 3 – Metacentrique for a square prism at half-depth draft [2]

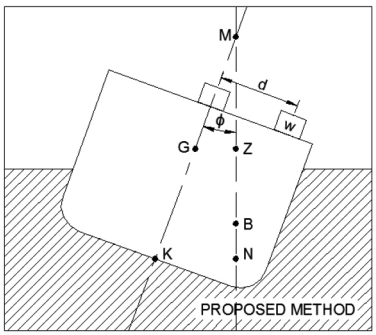

Figure 4 – Proposed Method Geometry

Where the vessel is presented with a list angle, the solution for the transverse centre of gravity is determined for the condition where ϕ is zero, and Equation 4 simplifies to Equation 5. For a symmetric hullform where KN_0 is zero, the solution for *TCG* is determined by the y-intercept of the plot of heeling lever, *HZ*, against heel angle, ϕ.

$$TCG = KN_0 - HZ_0 \quad (5)$$

The vertical centre of gravity *VCG* or *KG* is determined by rearrangement of Equation 4 to yield Equation 6. *KN* values are determined for each equilibrium position, and are used together with the heeling lever and *TCG* component to evaluate *KG* sin ϕ for each equilibrium position. They are then plotted against sin ϕ, yielding the solution for *KG* as the gradient of the trendline.

$$KG \sin\phi = \left(KN - \frac{wd\cos\phi}{\Delta} - TCG\cos\phi\right) \quad (6)$$

The fundamental distinction of the proposed method over the traditional method is its generalised approach, which is independent of the aforementioned wall-sided and constant waterplane assumptions. The method utilises computational hull models in order to determine exact hydrostatics for each equilibrium position rather than applying approximations based on upright hydrostatics.

VALIDATION

A wider study which forms the basis of an undergraduate thesis project by Smith at UNSW Australia, involves the assessment of the proposed method through elements of numerical, model, and full-scale validation, as well as error sensitivity analysis and discussions of issues of implementation.

Previous work by Dunworth [1–3] has provided preliminary numerical and model validation. The method has also been internally verified within Defence through parallel propagation of results by both methods for inclining experiments on current Navy vessels. However, due to the sensitivity of information, these results have been withheld from the public domain.

In order to establish a validation case at full-scale, ex-Navy Tug *Bronzewing* was inclined and analysed using both the traditional and proposed methods. *Bronzewing* is of a reasonably standard form, and its inclining by the traditional method is considered valid. Therefore, the inclining of *Bronzewing* by both methods sought to supplement numerical and model validation, ensure universal validity of the proposed method, and provide a platform to discuss practical considerations of implementation.

BRONZEWING INCLINING

The inclining experiment of *Bronzewing* took place alongside at Sydney Heritage Fleet, Rozelle Bay on 6 May 2015, and was conducted by UNSW Australia staff and students in conjunction with the experiential learning component of the third-year NAVL3610 course, Ship Hydrostatics and Practice course.

As per standard inclining practice, the shift positions were marked with chalk on the deck, and mass groups were placed in their initial positions. Cross connections between tanks were closed, and tanks were sounded. The bilges were inspected to confirm level of suction as per the lightship condition.

Mass Groups

Four mass groups were formed on the main deck using sets of 25 kg and 50 and 56 lb masses. The measured masses, initial positions and shift distances are given in Table 1.

Table 1 – Mass groups

Group	Mass	LCG	TCG	Shift	Moment
	t	m	m	m	t-m
A	0.1750	-2.69	-1.90	3.80	0.665
B	0.2004	-1.61	-1.90	3.80	0.762
C	0.1754	-0.52	1.90	-3.80	-0.667
D	0.2004	0.74	1.90	-3.80	-0.762

Heel Angle Measurement

Although the pendulum is a well-established method of measuring the heel angle and angular deflection during an inclining experiment, there is a number of alternative methods available including u-tubes, optical devices, and digital inclinometers.

In addition to the standard pendulum hung from an overhead pipe in the engine room, a simple u-tube was constructed using a length of 6 mm vinyl tubing with its ends fastened against amidships bollards, and a Bosch 'Quigo II' self-levelling laser was mounted below deck projecting vertical and horizontal laser sheets onto the forward house bulkhead.

The difference between u-tube and laser measurements from fixed datum points gave an effective deflection over a measured distance for each mass movement. The resulting measurements and calculated deflections by each of the four methods are shown in Table 2.

Draft Marks and Freeboard Measurement

The draft marks and freeboard measurements were taken for the central equilibrium positions. These readings were taken from a small boat using a draft gauge (clear plastic tube to dampen surface effects). The imperial measurements were converted to metric and manipulated to determine amidships draft and trim between perpendiculars to be 2.103 m and 0.033 m respectively, as shown in Table 3.

Water Density

Using a hydrometer, the water was found to have a density of 1.021 t/m^3. The calculation of the water density is given in Table 4. This density was significantly lower than normal due to run-off from heavy rain during the prior week.

A side-by-side comparative calibration of the hydrometer was performed in April 2015 against DNPS calibrated hydrometers, and a systematic error correction of +0.001 t/m^3

Table 2 – Heel angle measurement

	Pendulum	U-tube	Vertical Laser	Horizontal Laser
l (m)	2.097	4.1	1.205	1.417

	Pendulum	U-tube			Vertical Laser			Horizontal Laser		
Move	a (m)	x_P (m)	x_S (m)	a (m)	x_L (m)	x_U (m)	a (m)	x_P (m)	x_S (m)	a (m)
0	0.000	0.496	0.550	0.054	0.111	0.104	-0.007	0.659	0.665	0.006
1	0.045	0.452	0.584	0.132	0.093	0.111	0.018	0.634	0.671	0.037
2	0.092	0.405	0.632	0.227	0.087	0.133	0.046	0.608	0.679	0.071
3	-0.001	0.496	0.544	0.048	0.110	0.105	-0.005	0.658	0.667	0.009
4	-0.048	0.536	0.500	-0.036	0.115	0.084	-0.031	0.684	0.658	-0.026
5	-0.100	0.584	0.455	-0.129	0.127	0.068	-0.059	0.709	0.650	-0.059
6	-0.001	0.496	0.539	0.043	0.115	0.110	-0.005	0.661	0.663	0.002

Table 3 – Draft marks and freeboard measurements

		Fwd	Aft	
			Port	Stbd
Measured freeboard	m	1.105	0.597	0.533
Measured draft	m	1.461	2.089	2.134
Draft datum	m	0.625	0.000	0.000
Draft	m	2.086	2.111	
Position of marks	m	7.16	-3.55	

Length between marks	L_M	10.71	m
Trim between marks	t_M	0.025	m
Draft amidships	T_M	2.103	m
Length between perpendiculars	L_{BP}	14.22	m
Trim between perpendiculars	t_{BP}	0.033	m

Table 4 – Water density

Hydrometer type	Draft Survey	
Make and model	Zeal T/13628	
Last calibration	April 2015*	
Apparent density	*1.0200*	t/m^3
Temperature	*19.0*	°C
Total correction	0.0019	t/m^3
Relative density	1.0219	t/m^3
FW density at 15.0°C	0.9991	t/m^3
Water density at 19.0°C	1.0210	t/m^3

was determined for the Zeal T/13628 instrument. Original calibration was performed in 1996.

Items On and Off

No dry items to be added for lightship were noted. The mass and moments of dry items to be removed are given in Table 5.

The mass and moments of liquid items to be removed are given in Table 6.

Table 5 – Dry items off

Group	Item	Mass t	VCG m	M_V t-m	LCG m	M_L t-m	TCG m	M_T t-m
Inclining masses	A	0.175	3.02	0.53	-2.69	-0.47	-1.90	-0.33
	B	0.200	3.02	0.61	-1.61	-0.32	-1.90	-0.38
	C	0.175	3.02	0.53	-0.52	-0.09	1.90	0.33
	D	0.200	3.02	0.61	0.74	0.15	1.90	0.38
Inclining crew	Helmore	0.072	3.86	0.28	3.29	0.24	-1.90	-0.14
	Lyons	0.080	2.25	0.18	-2.08	-0.17	0.00	0.00
	Smith	0.076	3.32	0.25	1.92	0.15	-1.00	-0.08
	Bessone	0.076	1.70	0.13	0.02	0.00	0.00	0.00
	Johnston	0.080	3.31	0.26	0.62	0.05	2.00	0.16
	Ryall	0.092	3.32	0.31	4.99	0.46	0.00	0.00
	Wong	0.075	3.51	0.26	-5.63	-0.42	-1.50	-0.11
	McCarey	0.070	3.51	0.25	-5.63	-0.39	1.50	0.11
	Lobato	0.069	3.41	0.24	0.62	0.04	-2.00	-0.14
Inclining gear	Pendulum	0.020	3.05	0.06	0.47	0.01	0.20	0.00
	Misc. gear	0.020	3.56	0.07	-0.78	-0.02	0.00	0.00
Other	Box of filters	0.010	2.84	0.03	3.58	0.04	0.50	0.01
	Oil drums (×2)	0.040	3.05	0.12	0.80	0.03	0.00	0.00
	Oil drums (×3)	0.070	1.65	0.12	-2.67	-0.19	0.25	0.02
	Tow rope	0.200	2.59	0.52	-3.65	-0.73	0.00	0.00
	Ropes	0.200	3.66	0.73	-5.20	-1.04	-0.80	-0.16
Total		2.00	3.03	6.07	-1.34	-2.68	-0.17	-0.33

Table 6 - Liquid items off

Tank	Contents	Density t/m^3	Sounding m	Mass t	VCG m	M_V t-m	LCG m	M_L t-m	TCG m	M_T t-m	FSM t-m	Comments
FW Ballast (aft)	FW	1.000	Pressed	2.66	1.62	4.31	-3.54	-9.42	0.00	0.00	0.00	
FO (P)	FO	0.820	0.962	1.64	1.01	1.66	2.06	3.38	-0.80	-1.31	0.79	
FO (S)	FO	0.820	0.978	1.68	1.02	1.71	2.06	3.46	0.80	1.34	0.79	
FW (fwd)	FW	1.000	M.T.	-	-	-	-	-	-	-	-	
Sullage bladder	FW	1.000	-	-	-	-	-	-	-	-	-	not yet fitted
Bilgewater	SW	1.025	Suction	-	-	-	-	-	-	-	-	part of lightship
Total				5.98	1.28	7.68	-0.43	-2.58	0.01	0.03	1.58	

RESULTS BY TRADITIONAL METHOD

Determination of Δ and KM_0

Under the Australian National Standard for Commercial Vessels, a maximum trim of $L_{BP}/50$ is nominated in order to use level-trim hydrostatics [8]. For *Bronzewing*, the maximum allowable trim is 0.284 m, which is significantly greater than the observed trim of 0.033 m. However, for best accuracy the trimmed hydrostatic data for the amidships draft of 2.103 m was used. The displacement was calculated to be 50.82 t after correction for water density, and KM_0 was found as 2.857 m.

Solution for

The *LCB* and *MT1cm* were determined from level trim hydrostatics to be -0.164 m and 0.58 t.m respectively. Hence, the *LCG* was calculated to be -0.202 m using Equation 7.

$$LCG = LCB - \frac{100 t_{BP} MT1cm}{\Delta} \quad (7)$$

Determination of G_FM_0

For each method of measurement, the heel angle deflections were made relative to the mean deflection, *a,* observed from the central equilibrium positions corresponding to mass movements 0, 3, and 6. These relative deflections *a'* and their respective length or separation *l* was used to determine tan ϕ' terms by each method of measurement according to Equation 8. The average tan ϕ' term was then found, as shown in Table 7. On the basis of Equation 1, G_FM_0 was found to be 0.628 m from the gradient of wd/Δ plotted against tan ϕ as shown in Figure 5.

$$\tan\phi = \frac{a}{l} \quad (8)$$

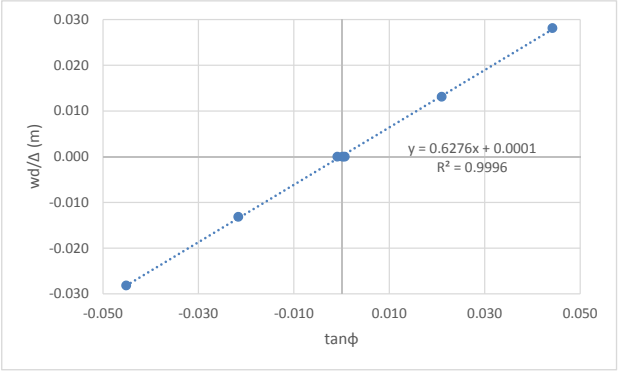

Figure 5 – wd/Δ vs tan φ

Determination of *FSC*

The free-surface moment is the transverse moment of inertia of any tankage free-surface, and was taken to be 1.58 t.m from the tank calibration tables provided in the *Bronzewing* Stability Book [9]. The free-surface moment was then divided by the displacement to produce the free-surface correction *FSC* of 0.031 m.

Solution for *VCG*

By definition, the solid metacentric height and *VCG* were found to be 0.659 m and 2.199 m respectively from Equations 9 and 10.

$$GM_0 = G_FM_0 + FSC \quad (9)$$

$$VCG = KG = KM_0 - GM_0 \quad (10)$$

Table 7 - Data for determination of G_FM_0

	Pendulum	U-tube	Vertical Laser	Horizontal Laser
l (m)	2.097	4.1	1.205	1.417

Δ (t)	50.7		Pendulum			U-tube			Vertical Laser			Horizontal Laser			Average
Move	wd (t-m)	wd/Δ (m)	a (m)	a' (m)	tanφ'	a (m)	a' (m)	tanφ'	a (m)	a' (m)	tanφ'	a (m)	a' (m)	tanφ'	tanφ'
0	0.000	0.000	0.000	0.001	0.000	0.054	0.006	0.001	-0.007	-0.001	-0.001	0.006	0.000	0.000	0.000
1	0.665	0.013	0.045	0.046	0.022	0.132	0.084	0.020	0.018	0.024	0.020	0.037	0.031	0.022	0.021
2	1.427	0.028	0.092	0.093	0.044	0.227	0.179	0.044	0.046	0.052	0.043	0.071	0.065	0.046	0.044
3	0.000	0.000	-0.001	0.000	0.000	0.048	0.000	0.000	-0.005	0.001	0.001	0.009	0.003	0.002	0.001
4	-0.667	-0.013	-0.048	-0.047	-0.023	-0.036	-0.084	-0.021	-0.031	-0.025	-0.021	-0.026	-0.032	-0.022	-0.022
5	-1.428	-0.028	-0.100	-0.099	-0.047	-0.129	-0.177	-0.043	-0.059	-0.053	-0.044	-0.059	-0.065	-0.046	-0.045
6	0.000	0.000	-0.001	0.000	0.000	0.043	-0.005	-0.001	-0.005	0.001	0.001	0.002	-0.004	-0.003	-0.001
		ā (m)	-0.001			0.048			-0.006			0.006			

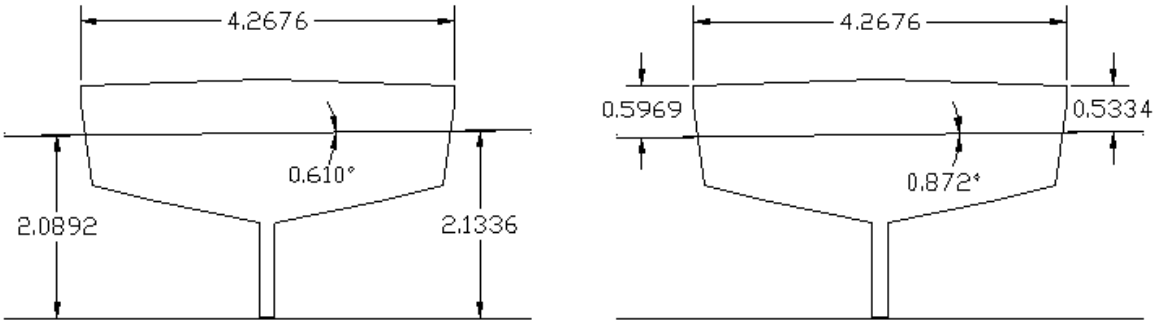

Figure 6 – ϕ_{list} from draft and freeboard measurements

RESULTS BY PROPOSED METHOD

Determination of ϕ_{list}

The angle of list is an important consideration for the proposed method, and is determined at the central equilibrium position by the reading of drafts, measurement of freeboards, or u-tube measurements. Using the section geometry at the location of the aft draft marks (Frame 26), list angles of 0.610° and 0.872° were found by marking the measured drafts and freeboards respectively, as illustrated in Figure 6.

However, due to the high order of uncertainty in the reading of drafts and freeboards, the u-tube measurements were consulted on the assumption of comparable height of deck used as the datum for their comparison. The average difference in readings at the central equilibriums corresponding to mass movements 0, 3, and 6 over the measured 4.1 m separation produced an angle of list ϕ_{list} of 0.675°.

Determination of Δ

Using the draft amidships, trim and angle of list, the hydrostatic data was generated from the computational hull model, yielding displacement of 50.82 t when corrected for density of water at the inclining.

Determination of *KN* Values

The observed relative deflection angle for each mass movement was augmented by the initial list angle to give the absolute heel angle for each equilibrium position. The *KN* values for these specific angles of heel were then calculated, and are shown in Table 8.

Solution for *TCG*

KN_0 is zero for a symmetric hullform, and is given by the y-intercept of the plot of heeling arm against the heel angle as shown in Figure 7. From Equation 5, the *TCG* was found to be 0.007 m to starboard of the centreline.

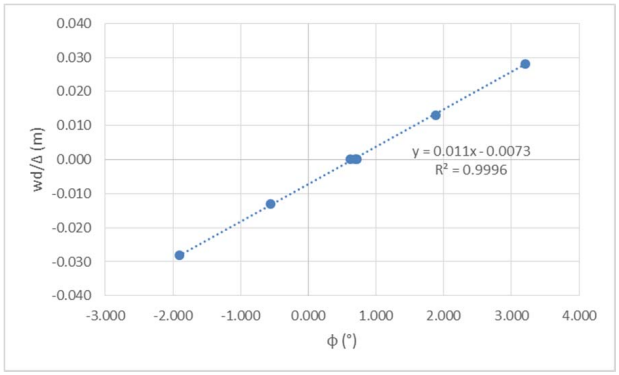

Figure 7 - *wd/Δ* vs *φ*

Determination of *FSC*

Although advisable to determine free-surface transfer moments individually for each angle of heel under the proposed method, the maximum free-surface correction was taken uniformly as 0.031 m, as for the traditional method.

Solution for *VCG*

Expressions for $KG \sin\phi$ were produced according to Equation 6 for each equilibrium position. The solution for *VCG* of 2.232 m was found from the gradient of the trendline of the plot of $KG \sin\phi$ against $\sin\phi$ as shown in Figure 8.

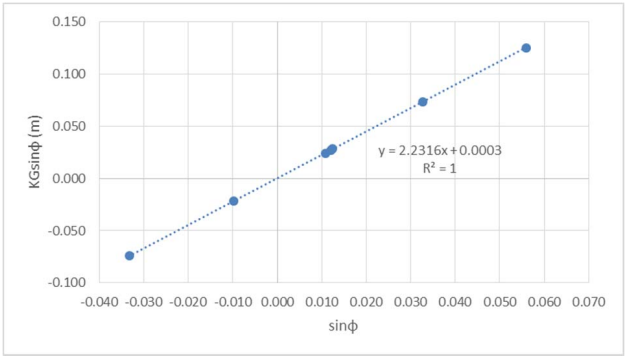

Figure 8 - *KG sin φ* vs *sin φ*

Table 8 – *KN* Values

	Pendulum		U-tube		Vertical Laser		Horizontal Laser		Average		
Move	tanφ'	φ' (°)	tanφ'	φ' (°)	tanφ'	φ' (°)	tanφ'	φ' (°)	φ' (°)	φ (°)	KN (m)
0	0.000	0.018	0.001	0.079	-0.001	-0.063	0.000	0.013	0.012	0.687	0.034
1	0.022	1.248	0.020	1.169	0.020	1.125	0.022	1.267	1.202	1.877	0.094
2	0.044	2.530	0.044	2.495	0.043	2.455	0.046	2.640	2.530	3.205	0.160
3	0.000	-0.009	0.000	-0.005	0.001	0.032	0.002	0.135	0.038	0.713	0.036
4	-0.023	-1.293	-0.021	-1.178	-0.021	-1.204	-0.022	-1.280	-1.239	-0.564	-0.028
5	-0.047	-2.712	-0.043	-2.477	-0.044	-2.534	-0.046	-2.613	-2.584	-1.909	-0.095
6	0.000	-0.009	-0.001	-0.075	0.001	0.032	-0.003	-0.148	-0.050	0.625	0.031
									φ_{list} (°)	0.675	

The measure of *VCG* determined by this method is in global coordinates and is corrected to ship coordinates using the trim measurement. However, for the small trim observed for the inclining of *Bronzewing*, the *VCG* remains as 2.232 m. Finally, applying the free-surface correction of 0.031 m yielded a solid *VCG* of 2.201 m.

DISCUSSION AND CONCLUSIONS

The traditional and proposed methods produce as-inclined *VCG* estimates of 2.199 and 2.201 m respectively, giving an absolute difference of 2 mm or percentage difference of around 0.1%. The lightship conditions resulting from the mass and moment correction for items on and off give *VCG* values of 2.288 m and 2.290 m, which maintain the 2 mm difference between methods. The similarity of the results demonstrate high-level compatibility of the proposed method in place of the traditional method.

A distinct advantage of the proposed method is its ability to determine *TCG* independently where, due to its theoretical limitations, the traditional method was forced to assume its nullity. Furthermore, the method lends utility in situations where a vessel is presented with an initial angle of list. For the same situation, users of the traditional method are required to undertake additional work in order to present the vessel for inclining with an upright central equilibrium position. Therefore, it is evident that a significant practical benefit is offered by the proposed method.

The determination of the initial list angle is an additional step introduced by the method, and requires additional or altered measurement procedures. On the other hand, if the list angle is unobtainable, or an upright central equilibrium position is assumed, then the proposed method incurs no more disadvantage than by the traditional method.

Given that the traditional method was forged in the absence of modern computational power, it is evident that a modernisation of methods is now possible and somewhat inevitable. While the traditional method has been adapted in recent times, it remains fundamentally limited by the wall-sided and constant waterplane area assumptions. However, the generalised reworking of the theory underpinning the proposed method removes these assumptions and extends the scope of application to a universal domain.

A potential stumbling block for the proposed method arises from the accuracy of the hull model used for the generation of hydrostatic and *KN* data. The impact of geometric deviation from the as-built vessel, as well as the fidelity of the mesh itself, is a consideration that should be addressed due to the intimate dependence of the method on accurate data for any defined underwater volume. This sensitivity is not wholly unique to the proposed method, as the hydrostatics used by the traditional method are also derived from a hullform definition subject to the same dangers of misrepresentation.

In addition to its advantageous application to the inclining experiment itself, the generalised approach also offers potential for broader systematic change in the management of the centre of gravity. In the light of current and projected technology, it is possible that the discrete periodic nature of inclining experiments may be able to give way to continuous calibration throughout the life of a vessel. For example, a vessel with automated means of measuring its draft, trim and heel (e.g. sensors on waterline) and hence displacement, coupled to a computational model of the hullform, would allow for 'real-time' evaluation of the underwater volume and associated hydrostatics. Then, if a measurable moment were applied to the vessel (e.g. liquid transfer between ballast tanks), an algorithm framework based on the generalised theory could provide a dynamic physical measure of the centre of gravity. Naturally, care would need to be preserved as per the standard inclining procedure during the application of these measureable moments to mitigate effects of external moments on the vessel (e.g. wind, waves, tides, crew movements, etc.). Furthermore, the implementation of such continuous calibration methodology could also reduce the extent of compounded measurement errors which arise from numerical mass and moment corrections by the 'lightship' plus 'deadweight' approach.

The prospect of increased utility by the proposed method without reduced validity, together with an opportunity for universal implementation and improved logistics makes for a compelling argument.

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This paper was presented at the Pacific 2015 International Maritime Conference in Sydney, October 2015

EDUCATION NEWS

Auatralian Maritime College

Reducing Noise Key to Ensuring Stealthy Ships

Researchers at the Australian Maritime College are working with national and international collaborators on three key projects investigating different elements of noise reduction for naval vessels.

A/Prof. Paul Brandner said on 12 January that the objective of the research is to understand how to make ships and submarines as quiet, and therefore undetectable, as possible.

Physical experiments and numerical modelling will take place at AMC's world-class $10 million Cavitation Research Laboratory in Launceston, Tasmania.

The first project, funded by a $1 million grant from the Australian Defence Science and Technology Group, will study the effect of microbubble populations and turbulent flow on tip-vortex cavitation inception. It is part of a greater collaborative program with the Acquisition, Technology & Logistics Agency (ATLA) of the Japanese Ministry of Defence.

"An understanding of the physics and the ability to predict when cavitation starts is vital to improving the operation of ships and submarines and reducing radiated noise," A/Prof. Brandner said.

"Lifting surfaces, such as propeller blades and hydrofoils, generate swirling flows at their tips, known as tip vortices, in which there are low pressures. For this reason, tip-vortex cavitation is often the first type of cavitation to occur on propellers and hydrofoils."

The second project will study the complex bubbly wake ships leave behind which makes them vulnerable to detection.

The cavitation tunnel will be used to create test flows with varying bubble sizes to study the effects of turbulence and cavitation created by propellers and hydrofoils on passing bubble populations.

This $1 million project is funded by the United States Office of Naval Research and the Australian Defence Science and Technology Group, and involves collaboration with the University of Michigan on the experimental program and the Universities of Minnesota and Iowa for complementary computational work.

The third project looks at the role which marine propellers play in noise production and will explore whether composite propellers offer a solution for reduced sound radiation.

"Marine propellers are a harmful source of noise in the marine environment, disturbing animal behaviour, revealing the location of naval vessels and interfering with sonar operation," A/Prof. Brandner said.

"Adaptive composite propellers are potentially quieter than metal propellers, as well as offering improvements in

efficiency and fuel consumption. We are aiming to provide advanced numerical capabilities which will enable quieter marine propeller designs."

AMC is collaborating with UNSW Australia to acquire experimental data sets to develop and validate computational models for noise prediction. The project is funded through a $1 million Australian Research Council Linkage Project grant and supported by Pacific Engineering Systems International, Bundeswehr University Munich, Germany, and RK Acoustics, UK.

AMC Autonomous Underwater Vehicle Research Facility

Building plans for a new $750 000 state-of-the-art facility, set to position Tasmania as a world leader in underwater robotic technologies, were revealed on 10 February 2016.

The autonomous underwater vehicle (AUV) facility, located at the University of Tasmania's Australian Maritime College, will be home to a fleet of robots used to survey the ocean's depths and collect scientific data on research missions.

AMC Principal, Prof. Neil Bose, said that the development would bring a range of social and economic benefits to the Launceston region.

"This is an exciting new development for AMC, the University and the state of Tasmania. It will be unique within Australia and one of just a handful of comparable facilities globally, allowing us to be on the cutting-edge of research in this field," Prof. Bose said.

"Building our underwater robotic research capabilities not only enhances our reputation on the international stage, it also helps stimulate the local economy through the recruitment of specialist personnel and the use of a local architectural firm and other related industries."

Five new staff members have been recruited to help run the facility, including facility coordinator Peter King, lab manager Alfian Marzuki, and engineers Isak Bowden-Floyd, Nathan Kemp and Konrad Zurcher.

"This facility will be a hub for world-class AUV research and technology. Through local and international collaborations, we aim to develop new data-collection capabilities, improve reliability and increase autonomy of underwater vehicles," AUV Facility Coordinator, Peter King, said.

"One of these projects, the Antarctic Gateway Partnership, will see us acquire and develop an AUV which tackles the great engineering challenge of venturing far beneath ice-covered waters to further our understanding of the Antarctic's role in the world's climate."

The facility's fleet of autonomous robots includes UBC-Gavia, Mullaya and the soon-to-be-procured Antarctic Gateway PartnershipAUV.

The $24 million Antarctic Gateway Partnership is a Special Research Initiative of the Australian Research Council bringing together the University of Tasmania, CSIRO and the Australian Antarctic Division to build further polar research

An artist's impression of the new AUV Facility
(Image courtesy Artas Architects)

Artas Architects Principal, Heath Clayton, and AMC AUV Facility Coordinator, Peter King, with the autonomous underwater vehicle UBC-Gavia and an artist's impression of the new facility
(Photo courtesy AMC)

capability in Tasmania as a gateway for Antarctic research, education, innovation and logistics. The Antarctic Gateway Partnership has contributed $3.6 million in funding for the new AUV and four of the new staff positions, with a further $3.75 million and one staff position contributed by AMC.

Launceston firm Artas Architects was tasked with designing a facility big enough to accommodate the Antarctic Gateway Partnership AUV, which will measure up to 8 m long, have a mass of 3 t and be capable of transiting more than 100 km while collecting data from the sea floor at depths of about 4000–5000 m, and beneath ice shelves and sea ice.

Artas Principal, Heath Clayton, said that the project provided an opportunity to highlight how thoughtful design could transform existing building structures into functional, modern spaces.

"We've been able to take a simple storage area that was largely unused and convert it into a contemporary research facility utilising modern building products. The design of the building, its colour and materials, complements the other structures in the area while still maintaining its own identity," Mr Clayton said. Building works are expected to be completed in late 2016.

Uncovering the Secrets of Lake St Clair

A research project mapping the floor of Australia's deepest glacial lake hopes to shine a light on the underwater environment and uncover clues as to how it was formed.

Australian Maritime College naval architecture student Sam Hunnibell used the autonomous underwater vehicle (AUV) UBC-Gavia to map the significant lake-bed features of Lake St Clair in the Tasmanian Highlands as part of his final-year thesis.

The survey revealed underwater rocky cliffs and channels, slump features and exposed bedrock which tell a story about the geological and glaciological history of the region.

Dr Vanessa Lucieer and Sam Hunnibell with the autonomous underwater vehicle UBC-Gavia at Lake St Clair
(Photo courtesy AMC)

"This research shows how AUV-mounted acoustics can be used to accurately identify glacial features which occurred during the last Tasmanian glacial maximum 20 000 years ago. It provides the foundation for improving lake surveys, which could potentially impact future limnology research and geological surveys," Mr Hunnibell said.

While AUVs are commonly used to map the ocean floor there hasn't been as much work done with lake bed mapping. The main research question was to discover how to successfully apply this technology to mapping lake beds, particularly for other lakes where access is impossible for small vessels.

The project was co-supervised by Dr Vanessa Lucieer from the Institute for Marine and Antarctic Studies and Dr Alex Forrest from AMC. The results will feed in to Bare Earth Tasmania — a project, run by University of Tasmania's Prof. Matt King, which aims to create a digital elevation model of

Tasmania, including the lake bottoms, in order to reconstruct past glacier environments.

"Refining acoustic methods for different mapping applications such as lake environments is an important step in challenging our ability to adapt our skills and technology to answer relevant questions for all sorts of disciplines. It is exciting to be able to deploy our equipment in different environments and reveal features which have never been seen before," Dr Lucieer said.

For Mr Hunnibell, the final-year research experience has armed him with invaluable project management skills as he graduates from university to embark upon an engineering career.

"A key challenge which I had to overcome was developing an awareness of AUV mapping processes, from minimal knowledge about how they work to doing an extensive investigation into potential ways of improving the survey methods. I also had to learn a number of new programs to analyse the data that we collected," he said.

As well as developing technical knowledge, the project helped build effective communication and collaboration skills as he liaised with a number of different parties to progress each stage.

"Seeing results from a lot of hard work and effort is what inspires me and drives me to work on projects such as these, as the end result is very rewarding," Mr Hunnibell said.

The project team would like to acknowledge the support of the Tasmanian Parks and Wildlife Service, the staff at Lake St Clair National Park, and Mineral Resources Tasmania in this research endeavour.

Tank Testing Milestone for Brisbane Boat Builder

A significant milestone has been quietly achieved at the Australian Maritime College towing tank, when the facility's longest and most regular client completed experiments on their 28th new vessel in 28 years.

Bill Wright, Managing Director of Brisbane boat builders Norman R Wright and Sons, ran through a series of tests studying the effects of length-to-beam ratios on pilot boats.

"If we can find the exact length-to-beam ratio for certain boats we can offer superior seakeeping and better fuel consumption which leads to greater efficiency," he explained.

Norman R Wright and Sons Managing Director Bill Wright at the AMC towing tank
(Photo courtesy AMC)

The 107-year-old, third-generation family business originally tested all its models at Sydney University before the tank closed in 1988, coinciding with the opening of the AMC facility.

"From then on we've always tested here — it's very professional, competitively priced, and we get treated extremely well when we're here," Mr Wright said.

"If I have unknowns, I can go and talk to Towing Tank Manager Gregor Macfarlane or his team and they'll go out of their way to help me. When I'm back in Brisbane, if I have a question that I know they can answer, I'll give them a call and they're always extremely helpful — and that high level of client service goes a long way."

The towing tank is the largest and only commercially-operating facility of its type in Australasia. It has been used to test more than 500 models of ships, submarines, offshore oil rigs and other ocean structures since being commissioned.

For boat builders such as Norman R Wright and Sons, being able to conduct physical model experiments in such a facility is an essential step in the design process.

"It gives me the best security that I can possibly have, other than having a real boat in front of me, to make sure that what I'm guaranteeing will actually happen," Mr Wright said.

The luxury motor yachts *Lionheart* and *Whistler*, built by Norman R Wright and Sons, were tank tested at AMC
(Photo courtesy AMC)

Tuart, a pilot boat, tank tested at AMC and built by Norman R Wright and Sons (Photo courtesy AMC)

"So it's a matter of confidence in what we're predicting, but it's the ability to pretty much guarantee that what you're presenting will work."

Mr Wright said that the business builds both commercial vessels and pleasure craft and has tested police and pilot boats, pleasure craft and ferries in the towing tank. Some tests have proven more rewarding than others.

"All the projects are different and satisfying in their own ways, and can be totally frustrating in their own ways. There has been one occasion where I stopped the test, took the boat up to the rubbish bin and threw it in and started all over again. This is opposed to another test I did about a year ago which fulfilled all my optimistic desires, but I'm just happy if they do what I've calculated them to do," he said.

Curtin University

Centre for Marine Science and Technology

CMST is thirty years old, and in their newsletter, CMST News*, Christine Erbe and John Penrose record the history of the Centre, as we reproduce below.*

CMST was established in 1985, as part of the Western Australian Institute of Technology (WAIT) which, a year later, became Curtin University. We are Curtin's oldest research centre.

CMST creates marine-related research programs which are both innovative and applied. Australia has substantial offshore energy resources, a large fishing industry, a strong maritime defence sector, booming coastal and marine tourism — all overlapping with rich and often still-pristine marine ecosystems. CMST is committed to the development of technologies and methodologies, as well as environmental-monitoring programmes, for the sustainable development of our marine resources. Curtin University has significant capability and infrastructure in the field of marine research. CMST works closely with other centres and departments at Curtin, other Australian and international universities, and a wide variety of industry and government bodies, both here and overseas.

CMST's research is very much interdisciplinary. The Centre melds the skills of physicists, acousticians, biologists, ecologists, and engineers. CMST currently has 12 academic research staff, four technical and administrative support staff, and 20 PhD students. We also have a large and very dear community of true and trusted casual staff, on whose brains and hands we rely at busy times.

CMST is involved in many large, multi-year, collaborative and, last but not least, fun projects. CMST built, and since 2009 has been maintaining, the Acoustic Observatories of Australia's Integrated Marine Observing System (IMOS; http:// imos.org.au). In addition, industry and government have funded CMST to listen to the underwater soundscape on-and-off at over a hundred sites around our continent, accruing almost 5000 datasets in over 20 years. This data provides a record of the marine soundscape at these locations, and lets us monitor great whales on migration, observe seasonal fishes chorusing, study ocean weather, track anthropogenic activities and identify any long-term changes in the soundscape.

CMST staff are co-investigators in four Western Australian Marine Science Institute (WAMSI) projects within the Kimberley Science Node, studying marine mammals visually and acoustically, under water. As the Australian marine acoustic environment is unique due to its acoustically-dense calcareous seabed, CMST has had a continuous stream of sound propagation projects for industry and government, including several PhD theses.

CMST staff were key contributors to the *Sydney–Kormoran* Project, which conducted a detailed 3D imaging survey of the two World War II shipwrecks, HMAS *Sydney* and HSK *Kormoran*, which sank each other and are now located at a depth of 2500 m, 200 km off the WA coast. Several spin-off research projects on deep-sea marine biology and corrosion have resulted from this trip. A 3D exhibition is planned at the WA Museum and partner institutions.

CMST further specialises in modelling and measuring ship under-keel clearance, ship motions in waves and stability of offshore structures. CMST has developed guidelines for under-keel clearance in several ports and led an international benchmarking study on the accuracy of ship motion codes in shallow water which confirmed our ship clearance modelling as world's-best practice.

There are many attests to the quality of our research. Several members of staff act as the Australian representatives on international committees to standardise underwater acoustic measurement, modelling and reporting. Some staff have won fellowships. Many students are supported by domestic and international, industry and government scholarships. The relevance of our research is manifested in the number of media interviews and reports — sometimes exceeding 100 per year.

We're living in interesting and challenging times, currently with our economy slowing and government cutting funds. As a result, the academic sector has recently undergone great changes reshaping its academic staff portfolio as well as support services.

For a self-funded research centre like CMST, such changes are unsettling and challenging — at least temporarily until "the system regains homeostasis". CMST has sailed through turmoil in the past and always managed to arrive back in port — safe and sound with dry feet, ready to set sail again. What makes CMST special are its people and our unparalleled

team spirit. I am both proud and humbled to be leading this exceptional team of staff and students.

Christine Erbe
Director CMST

A Short History of CMST

CMST originated with a fire and a group of staff at the then Western Australian Institute of Technology (WAIT). In the 1970s, staff members from Physics, Biology, Chemistry, Geology and Electrical Engineering formed a Marine Studies Group which carried out some small projects and ran a first-year elective unit in marine science.

The fire was important because, just before it took place, John Penrose of Physics was working with John de Laeter, then Physics Head, on a project in mass spectrometry. One evening, the Mass Spec. lab was gutted in a fire that put it out of action for two years. John set about building an ultrasonic diver communicator during this period, reflecting a long interest in sub-sea activities. This project, in turn, led to a substantial focus on marine acoustics. Shortly after, John led a group of six WAIT staff and students in an expedition to the site of the 17th century wreck of *Batavia* in the Abrolhos Islands, beginning a long period of engagement with the Western Australia Maritime Museum.

The mid-1980s saw a dramatic escalation of marine activity, in Physics in particular. Kevin Parry, of the then Parry Corporation, and the then WAIT Director Don Watts, approached John Penrose with a proposal to create a Centre for Marine Science and Technology. This was formed in 1985 and was charged, in the first instance, with supporting the then defence of the America's Cup and a triple circumnavigation of the world to be undertaken by noted yachtsman Jon Sanders. Parry Corp. provided five graduate scholarships, of which one was taken up by Kim Klaka. Kim went on to become Director of CMST for many years and brought teaching and research in naval architecture to CMST. Jon Sanders succeeded in his triple, solo, non-stop circumnavigation during which, amongst other achievements, he made echo sounder records of a seamount in the South Pacific, predicted from satellite altimeter plots. His vessel, *Parry Endeavour*, is on display in the Fremantle Maritime Museum.

This too involved centres in other states. CMST was particularly involved in acoustic assessment of seabed characteristics. Rob McCauley brought a strong program of bio-acoustics to CMST, a focus which has continued to expand now for some years.

The arrival of Christine Erbe as our latest Director has brought many new contacts, both for projects and graduate students, to the Centre. Christine is leading CMST at a time of great change within Curtin University and CMST is enmeshed with many of the changes emerging. Over the years, staff and students have been the brains of the Centre and it is difficult to name all who have contributed!

John Penrose
CMST News, No 21, November 2015

University of New South Wales

Undergraduate News

Thesis Conference

As reported in the November 2015 issue of *The ANA*, at the School's annual undergraduate thesis conference on 28–30 October the following presentations on naval architecture student projects were made:

Alvin Lim	*Automated Drawing of Ka Series Marine Screw Propellers using AutoCAD*
Nazrin Fauzi	*Methods of Estimation of the Overall Life-cycle Costs of Tankers*
Molly McManus	*Energy Efficiency and Emissions Prediction Methods for Tugs and Cruise Ships*
Alistair Smith	*Validity, Accuracy and Implementation of Inclining Methods*
Dov Sobel	*Design Methodologies for Newbuilding and Conversion of FPSO Vessels*
Mitchell Stubbs	*CFD Analysis of the Freestyle Swimming Stroke*
Elisa Taniputra	*Investigation of Submerged Hydrofoils: Improving Vessel Efficiency and Performance*
Alexander Walter	*Development and Validation of a Crash-Stop Prediction Program*
Bryce Waters	*Investigation and Comparison of VPPs with Recorded Yacht Data*

RINA–DST Group Award

RINA and the Defence Science and Technology Group jointly offered an award of $125 and a certificate for the best presentation at the conference by a student member on a naval architectural project. Assessment was made on the basis of marks awarded by School staff. The award went to Alistair Smith for his presentation on *Validity, Accuracy and Implementation of Inclining Methods*. The certificate has arrived from London and has been presented. As a sign of the times, the award funds were transferred directly to Alistair's bank account. Congratulations, Alistair!

Thesis Projects

Among the interesting undergraduate thesis projects recently completed are the following:

CFD Analysis of the Freestyle Swimming Stroke

For many years, swimming research has pondered the mechanisms which produce propulsion in the freestyle swimming stroke. Swimmers have been noted to use diagonal patterns in their stroke to enhance propulsion, with many coaches having the view that the lift forces generated as a result of this motion are significant in their contribution to overall propulsion.

Mitchell Stubbs has conducted an investigation involving moving a swimmer's hand and arm through a variety of orientations to gain an improved understanding of the mechanisms which improve forward propulsion. Using ANSYS CFX and the shear-stress transport turbulence model, the CFD simulation was able to physically reproduce the separation of flow expected off the swimmer's hand, something which the literature has not yet touched on.

Presentation of the RINA–DST Group Award to Alistair Smith by Phil Helmore
(Photo courtesy Lawry Doctors)

The maximum forces were shown to be generated as the swimmer's hand and arm move through an orientation perpendicular to the flow direction. These forces were closely related to the corresponding increase in velocity of the hand moving through the water. The heavily-separated flow reinforced why Bernoulli's equation should not be used by coaches to explain the generation of lift forces.

Crash-stop Prediction Program

The prediction of vessel stopping times and distances during emergency-stopping manoeuvres has been covered by a number of prediction methods over the last 60 years. However, these methods rely on principal particulars of the vessel only. While some of these methods achieve reasonable results for some large vessels, a more-accurate method of determining the crash-stop performance of vessels using fixed- or controllable-pitch propellers is required.

Alexander Walter took a prediction program written in Basic code and converted it to Fortran code, added a number of refinements for different types of propellers, including thrust and power control and the implementation of RPM and pitch controls for controllable-pitch propellers, increasing the complexity and performance of the predictions. The methodology has been validated and an effective method of prediction crash-stop time and distance created. Further work resulted in successful modification of the program to predict the acceleration time and distance.

Naval Architects' Annual Dinner

With the passing into history of the Thesis Conference Dinner, the fourth Naval Architects' Annual Dinner was held on 19 November at Giovanna Italian Restaurant in Kingsford, and was attended by most of the final-year naval architects along with staff Lawry Doctors and Phil Helmore.

Phil Helmore

Post-graduate and Other News

Doctoral Dissertations Submitted

Ship Resistance Reduction using Super-hydrophobic Surfaces

Andrew Baglin has submitted his PhD dissertation, supervised by A/Prof Tracie Barber, on *Ship Resistance Reduction using Super-hydrophobic Surfaces*, has received and incorporated examiners' comments, and it has been approved.

Superhydrophobic surfaces have been shown reduce drag in laminar flows; however, in turbulent flows, the literature is divided with drag reductions between 0% and 70% being achieved. With frictional drag accounting for over half of the resistance of most ships, a method of decreasing drag would result in both significant fuel savings and a

Naval architects enjoying their Annual Dinner
(L to R) Bryce Waters, Phil Helmore, Elisa Taniputra, Mitchell Stubbs, James Phillips, Alvin Lim, Sammy Free, Lawry Doctors and Alex Walter
(Photo courtesy Giovanna Italian Restaurant)

reduction in carbon dioxide emissions. In order to ascertain whether these surfaces can provide a reduction in drag in turbulent flows, experimental and detailed computational fluid dynamics studies have been undertaken. In addition to determining whether turbulent flow drag reduction is achievable, this work investigated both the mechanics and conditions under which the drag reduction occurs, and quantified the interaction between the hydrophobic surface and the turbulent multiphase flow.

The experimental program aimed to determine whether drag reduction in high Reynolds number flows were achievable. As part of the research, a test rig was designed and constructed which allowed measurement of skin friction drag whilst minimising the effects of pressure drag. A hydrophobic surface was compared to a smooth plate across a range of turbulent flow Reynolds numbers with no noticeable drag reductions shown. Further investigations into the reasons for the lack of drag reduction were then achieved using computational fluid dynamics.

The lattice Boltzmann method was used to accurately simulate the interactions between air and water at a scale where surface tension dominates. A code featuring methods which include fractional propagation, a novel technique of mesh refinement, a multi-phase model and pseudo direct numerical simulation of turbulence has been devised and implemented. Validation across a range of benchmark tests was performed and the code proven to produce accurate results. An optimisation process was also undertaken to maximise efficiency.

This code was then used to simulate laminar, transitional and turbulent flows through a smooth-walled channel, and over a series of roughened and hydrophobic surfaces.

The results of this research have confirmed that drag reductions in laminar and transitional flows are achievable; however, at Reynolds numbers greater than Re_tau = 390, minimal benefit was found because the air layer against the surface was removed. The drag reduction effect has been shown to be dependent on the location of the free-surface, and the way in which it insulates the ridges and posts on the hydrophobic surface from the water. The geometry of the surface has also been shown to have an effect on both the overall drag and the ability of the surface to maintain the insulating air layer.

Andrew Baglin

Optimisation of Composite Marine Propeller Blades and Hydrofoils,

Manudha (Thinu) Herath has submitted his PhD dissertation, supervised by Prof. Ganga Prusty, on *Optimisation of Composite Marine Propeller Blades and Hydrofoils*, has received examiners' comments, and is awaiting final approval.

Traditional marine propellers which are manufactured using alloys have a fixed shape. These propellers are designed to achieve the highest propulsion efficiency at the cruise condition of the vessel. However, if the flow conditions change from the vessel's cruise condition, the propulsion efficiency reduces significantly. The objective of this thesis is to develop flexible shape-adaptive (self-morphing) blades using high-performance composite materials, with particular focus on carbon fibre reinforced polymer. By careful selection of fibre angle of composite layers, composite laminates can be catered to optimally change their twist under various lateral loading conditions. This special characteristic is proposed to be used for optimal change of pitch of the propeller blade based on incoming flow conditions.

An in-house optimisation algorithm has been developed to search for the optimum fibre angle of each carbon fibre layer which can enable the required shape change. The optimisation algorithm uses the Genetic Algorithm (GA) coupled with state-of-the-art Finite Element techniques such as Cell-Based Smoothed Finite Element Method (CS-FEM) and Iso-Geometric FEM. The CS-FEM uses a stable triangular element scheme, while the Iso-geometric FEM has the capability of representing the complex geometry without any mesh-based approximations. The finite element techniques also take into account ply terminations of the blade and hygrothermal effects which may be present in the composite. An iterative procedure to search for the initial shape of the blades was also developed.

The developed techniques were used to optimise a hydrofoil using experimental data from cavitation tunnel tests of a non-optimised hydrofoil. The optimised hydrofoil was then manufactured and was subjected to rigorous structural testing in order to ensure the strength and safety of the hydrofoil and to validate the reliability of the manufacturing technique. Afterwards, hydrodynamic tests were conducted in the cavitation tunnel facility in order to characterise the performance of the optimised hydrofoil and compare against previously-tested identical non-optimised hydrofoils. The optimised hydrofoil indeed showed more favourable results in terms of L/D ratio of the hydrofoil and hydrodynamic fluctuations and uncertainties due to turbulence. The cavitation tunnel results were then validated against Fluid-Structure Interaction simulations conducted using FEM and were found to have good agreement with FE predictions.

Automated Fibre Placement Robot Cell

UNSW Australia has commissioned a new coordinated facility for composites research, through investment in automation infrastructure. The cornerstone of the new facility in the School of Mechanical and Manufacturing Engineering is Australasia's first turnkey Automated Fibre Placement (AFP) robot cell. The automated facility was purchased from Automated Dynamics Corporation, USA, through active financial support from the Australian Research Council and UNSW Australia as well as several partner universities (ANU, University of Sydney, University of Tasmania, Western Sydney University, Flinders University and University of Auckland), DST Group and industries (ACS-A and CST Composites).

The AFP facility features a coordinated multi-axis robot and spindle system for maximum control over fibre trajectories and part geometry. The facility includes a head for laying 4 parallel 0.25" thermosetting composite tows as well as a specialist thermoplastic processing head for in-situ melding (melting + welding) for one-shot part fabrication.

For further details, contact Ganga Prusty at g.prusty@unsw.edu.au.

Ganga Prusty

The Equadorian sail training ship *Guayas* visited Sydney in January, joining *James Craig* and *Endeavour* in Darling Harbour. She arrived in Australia at Fremantle on 21 December 2015 after seven months away from home. *Guayas* last visited Sydney in 1988
(Photo John Jeremy)

Rambler, *Wild Oats XI*, *Loyal* and *Ragamuffin 100* shortly after the start of the SOLAS Big Boat race on Sydney Harbour on 15 December 2015
(Photo John Jeremy)

Civmec buys Forgacs

On 2 February 2016 Civmec announced that the company had completed the acquisition of Australia's largest privately-owned engineering and shipbuilding company, Forgacs.

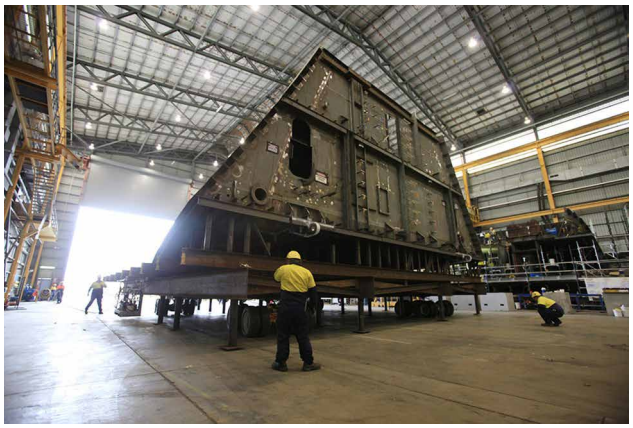
Following the due diligence process and subsequent negotiations, the company decided that the acquisition will include the Forgacs name, the shipyard facilities, and the assets located at Tomago, New South Wales.

The purpose-built shipyard at Tomago is situated on the Hunter River, just 14 km from the Port of Newcastle. The 22.7 ha site includes 535 m of river frontage with two ship basins.

Civmec will develop the Tomago site to operate as a multi-disciplinary facility which will, in future, replicate Civmec's flagship operations at Henderson, Western Australia.

Civmec CEO, Pat Tallon, said "This acquisition gives us a strong presence on the East Coast of Australia, enabling us to establish a more substantial East Coast office to provide national and regional clients with a range of services in line with those we currently provide on the West Coast of Australia. It also ensures that we are well positioned immediately to capitalise on the significant ongoing infrastructure expenditure on the East Coast."

"Our initial focus will be on steel fabrication and precast concrete manufacture and, over time, we intend to combine the credibility of both the Tomago purpose-built shipbuilding facilities and Civmec's heavy engineering expertise to further strengthen our defence service offering."



AWD modules under construction by Forgacs at Tomago
(Photo courtesy Civmec)

ThyssenKrupp and Civmec target Australian Submarine Construction

On 14 December 2015, Civmec, in collaboration with ThyssenKrupp Marine Systems (TKMS), unveiled a newly-built submarine hull section constructed by Civmec at their Henderson facility in Western Australia. This construction is a self-funded initiative, used by the companies to prove that they have the expertise and capabilities to play a part in the construction of Australia's future submarine fleet.

Civmec Executive Chairman, Jim Fitzgerald, said that the work shows that Civmec has the appropriate skills and can meet the fine tolerances required for building submarines.

"We've never done anything like this before, so to get into the business if we build a section of the submarine at our cost, we can demonstrate to everybody that we have the ability," he said.

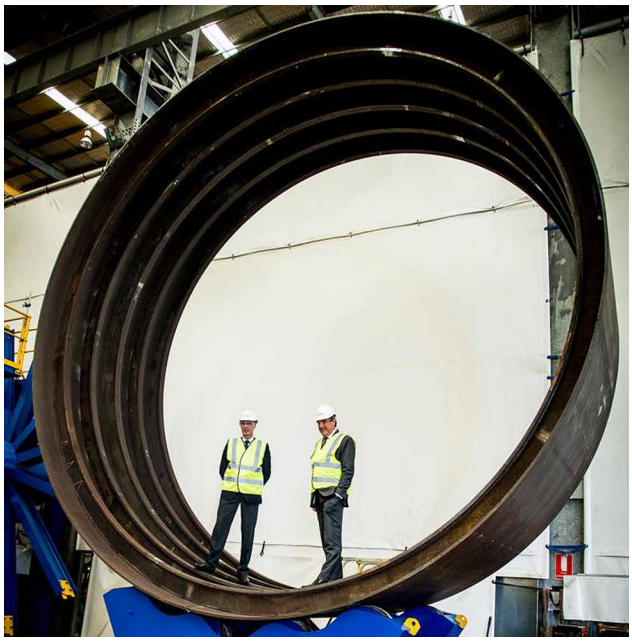
The hull section was designed in Germany by TKMS before the plans were digitally transmitted to Civmec for the construction phase.

ThyssenKrupp Marine Systems is participating in the Federal Government's Competitive Evaluation Process to select the international partner to build Australia's next generation of submarines and sees advanced manufacturing, using digital design, construction techniques and data management, as a key part of its approach.

Chairman of ThyssenKrupp Marine Systems Australia, Dr John White, said that ThyssenKrupp was able to design the hull section at its Kiel, Germany, shipyard for the Western Australian shipbuilding and engineering company Civmec to use the latest technology to complete the build.

Dr White said "Importantly, it means that, having agreed on the final design of the new submarine fleet in accordance with the Department of Defence's specific requirements, the process of building the fleet can be completed in Australia using local companies like Civmec, Austal and ASC among others. They will effectively have TKMS as a partner in their workshops and drawing offices, 24/7, as part of a seamless digital data link — effectively an industrial internet."

Dr White also said that ThyssenKrupp has already engaged with approximately 500 companies around Australia who could take part in a local submarine build.



The submarine test section built by Civmec at their Henderson, WA, facility
(Photo courtesy Civmec)

Change to Armidale-class Support Contract

The Australian Government and Serco Group have reached an agreement to amend the terms of the company's contract to provide in-service support to the Navy's fleet of Armidale-class Patrol Boats (ACPB).

The company has negotiated to shorten the onerous contract which previously ran to 2022. According to the company's statement the contract will now end in 2017. Under the terms of the Settlement and Amendment Deed, both parties have agreed to a mutual release of claims they may have had against each other prior to the point of contract amendment.

Serco will provide maintenance and remediation work on an agreed cost-recovery basis, but under improved standards, as the agreement states.

The ACPB contract was subject to an onerous contract provision (OCP) which had Serco pay about $290 million at the end of 2014, reflecting anticipated future losses through to 2022, together with a further charge of $140 million relating principally to the impairment of receivables.

Although a detailed assessment of Serco's contracts subject to OCPs was to be carried out at the year end, the company expected that the ACPB contract amendment will result in a significant decrease in the overall level of the Group's provisions against future contract losses.

Rupert Soames, Group Chief Executive Officer, said "These amendments represent an equitable solution for both parties. We remain absolutely focused on delivering the highest standard of operational performance on this challenging contract and continuing to support the Australian Defence Force as we have for nearly twenty years."

The provisions against the ACPB contract represented approximately 30 percent of the Group's OCPs charged at the end of 2014 and ACPB was the single largest OCP. The Group utilised $34 million of the ACPB provision in the first half of 2015.

Rapid Design Space Optimisation with NavCad Premium

HydroComp NavCad® is internationally-recognised as the gold-standard for resistance and propulsion prediction for naval architects. With the recent introduction of the Premium Edition, NavCad is now able to provide integrated support for design optimisation.

To ensure that process efficiency and cost-effectiveness of resource-intensive CFD calculations are as high as possible, it is necessary to make use of Rapid Design Space Optimization (RDSO). Coupled with third-party software for management and optimisation, NavCad Premium is the ideal simulation solver for RDSO.

What is RDSO?

The ship-design process often follows a path from a starting "parent" toward an optimised solution which meets certain design objectives. The set of all possible solutions is the design space. Design space optimisation is simply the analytical narrowing of this limitless scope to the superior solutions. NavCad Premium allows researchers and designers to rapidly evaluate many design variants, and to focus time and resources on regions of the design space worthy of study with CFD simulations.

Why is RDSO important?

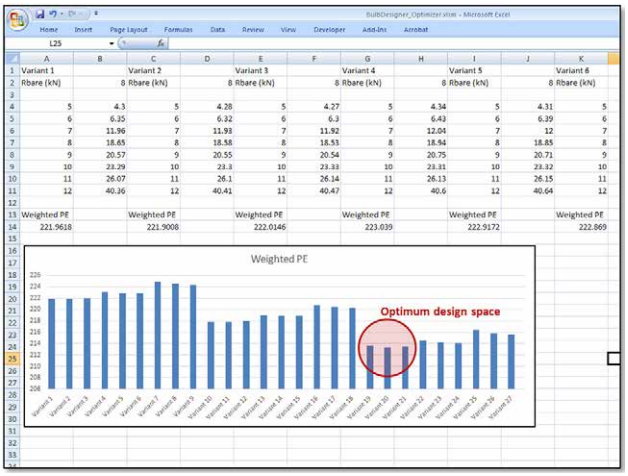
- it is critical to establish and confirm the big design decisions early in the design spiral; and
- detailed-design optimisation by CFD or model testing is made more efficient and effective when predicated by knowledge from an initial RDSO study.

The advent of more-affordable and accessible CFD offers exciting possibilities for design space optimisation in naval architectural offices — and one can make the optimisation and analysis from CFD more effective by using NavCad Premium to "set the table" for it. A preparatory RDSO study establishes a starting geometry and condition for CFD that is substantially closer to the final outcome, greatly increasing the success of CFD-analysed designs.

In addition to quickly narrowing the design space, NavCad Premium can also be used to provide a quantitative benchmark for establishing confidence in CFD results. NavCad predictions are well-behaved, accurate and robust, allowing CFD prediction studies — for both hull and propulsor performance — to be judged against the results generated by NavCad Premium during its RDSO investigation.

To ensure that overall process efficiency and cost-effectiveness of a design solution is as high as possible, it is necessary to make use of rapid design space optimisation. A NavCad Premium RDSO solution ensures that a company's potent CFD resources start with the best initial "parent" and can therefore focus on detailed optimisation and validation of results.

More information about NavCad Premium can be found at www.navcad-premium.com.



A screenshot of a NavCad Premium RDSO study using Microsoft Excel as the administrative host. NavCad Premium was run in silent mode with data, commands and process control managed by Excel. A Design-of-Experiments optimisation for 27 variants is illustrated. The resistance prediction was by HydroComp's "Prismatic Wave Drag" distributed volume wave-theory method. Total calculation time was less than three minutes, including development of the variant geometry in Excel, calculation via NavCad Premium, and reporting and graphing of results back in Excel
(Image courtesy HydroComp)

New Premium Option for HydroComp PropCad

HydroComp PropCad is the global source for the geometric modeling of marine propellers and is now offering PropCad Premium, a collection of major new capabilities for PropCad. These features supplement existing capabilities of PropCad with additional capabilities for the manufacture and inspection of marine propellers. A new Premium licensing option has been created for access to these new features.

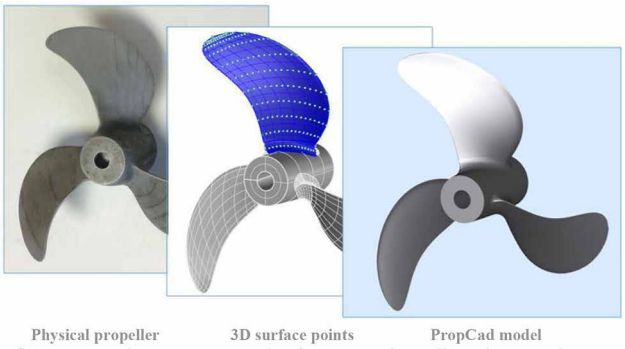
More information can be found at www.hydrocompinc.com/propcad-premium.

Features

PropCad will be available in Standard and Premium editions. The Premium license will include these new capabilities and upgrades:

Floating network license — All Premium licenses will include (or will be upgraded to) a one concurrent user floating license (i.e., a one-seat workgroup license).

Scan Converter — This utility allows for the entry of scanned blade surface data (in XYZ or polar format) and conversion into a PropCad design file. This information typically comes from a "scanning" measurement device, but it can be obtained by interrogation of a 3D CAD file. Users with the separate Scan Converter add-on license will receive full credit upgrading to the Premium Edition.

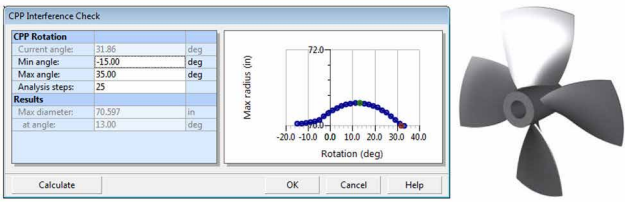


Scan Converter can take 3D measurement data from an actual propeller and recreate the 2D profiles and blade parameters. This allows the propeller to be rebuilt as a parametric PropCad model (Image courtesy HydroComp)

Geometry Transforms — These allow for repositioning of the blade about the shaft axis, along the reference helix, or even about a spindle axis. Some of these are useful in conjunction with Scan Converter for smoothing and positioning. The spindle axis transformation can be used to check off-design geometry of CPP blades.

Pattern Corrections — This utility helps to build pattern geometry from a PropCad design. It provides the means to create new pattern geometry with additional offset stock for machining and finishing, as well as user-defined scaling factors to account for distortion and shape changes during the casting process.

CPP Interference Check — This calculates the maximum extents of the propeller blade through a range of spindle axis rotation. It is useful for calculating clearance between CPP blades, as well as tip extent changes (when in nozzles, for example).



Interference Check is used to calculate the maximum extents of the blade as it rotates through different angles, allowing designers to quickly calculate nozzle diameters (Image courtesy HydroComp)

Creating Patterns with PropCad Premium

HydroComp's Pattern Corrections tool reduces manipulation of a propeller design within a 3D CAD tool. Pattern Corrections allows users to directly specify machine stock and shrinkage to create machining models, casting patterns, and mould geometries. A major advantage is that these corrections are applied directly to the propeller parameters, allowing calculation and visualisation of sections, blade parameters, and radial distributions. The Pattern Corrections utility also allows users to document these corrections and saves them to the original design file. Consequently, adjustments to the pattern can be made rapidly and easily.

Geometry Models

When using the Pattern Corrections utility, it is important that the user has an understanding of the manufacturing operation. There are three geometry models which are commonly used to produce a propeller:

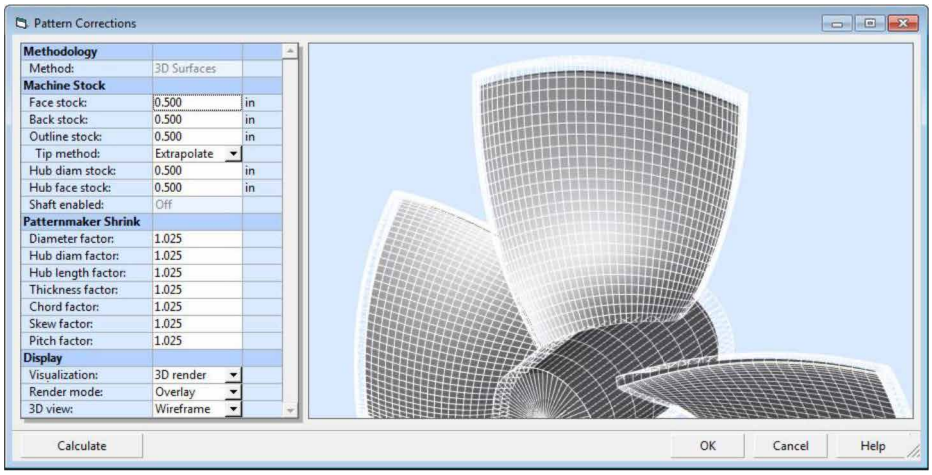
- **Design geometry** — This is the geometry of the final, finished propeller. This model can be used to produce the "drive surfaces" for CNC machining.
- **Machining geometry** — This is the geometry of the propeller which includes extra material for machining via milling or grinding operations. This model is often used as the "stock model" for CNC machining operations performed on propeller castings.
- **Pattern geometry** — This geometry (also known as a casting geometry) is used to create the propeller mould. It includes the extra material for machining, and also includes "shrinkage factors" which relate to the reduction in size which occurs when the molten material used to pour the propeller cools and solidifies.

The user is required to specify all machining and shrinkage values for the Pattern Corrections utility. This should be done in consultation with the foundry or machining centre which is manufacturing the propeller.

Pattern Corrections

The Pattern Corrections utility provides a clear, easy-to-use interface. The machine stock and patternmakers shrink corrections have individual control of the different blade parameters to provide the necessary flexibility. The visualisation below shows a sample of a Kaplan-style blade, with the corrected geometry as a (wireframe) over the design geometry (solid).

Once the corrections have been specified, the derived geometry is displayed in PropCad where the user has full control over the distributions, offsets, and parameters. Additionally, 3D models, 2D drawings, and offset reports can be generated for the new geometries.



Pattern Corrections is used to expand and thicken propeller designs to create machining models and casting patterns.
Individual control is provided for separate blade parameters

(Image courtesy HydroComp)

Wärtsilä to Upgrade Largest Residential Ship in the World

The World, the largest private residential ship on the seas, will be retrofitted with a Wärtsilä Advanced Wastewater treatment system and a Wärtsilä Nacos Platinum system for navigation and external communication purposes. The Wärtsilä Advanced Wastewater solution will replace an existing system and keep the vessel in full compliance with the International Maritime Organisation's (IMO) requirements concerning the prevention of pollution from ships. The ship is owned by its residents and is managed by ROW Management Ltd based in Fort Lauderdale, Florida, USA. The contract with Wärtsilä was signed in November. The equipment is scheduled for delivery in April, 2016.

Wärtsilä Hamworthy Membrane BioReactor (MBR) solutions are designed to facilitate the management and treatment of both 'grey' and 'black' wastewater, and to monitor discharges to the sea. The Wärtsilä system treats black and grey water so that the effluent can meet the most stringent marine discharge standards across the globe, including the latest nutrient-removal requirements in the Baltic Sea.

The navigation retrofit to *The World* will replace an earlier system. The new installation will ensure that the vessel has the latest and most technically advanced system available. The Wärtsilä Nacos Platinum system's unique combination of integrated voyage planning, monitoring, and track control significantly reduces the workload for ship navigators, while improving navigational safety. The system to be supplied as part of this order includes the unique integration of an ice radar. *The World* is powered by Wärtsilä main and auxiliary engines, namely two 12-cylinder and three 8-cylinder Wärtsilä 32 engines.

"We at Wärtsilä are committed to assisting marine industry operators to reduce their environmental impact and to increase their operational efficiency. These goals are being met with this contract. The MBR system being supplied for this very special vessel will enable it to comply with the very stringent regulations relating to wastewater discharge. Being a retrofit project, we had to design the system to fit the existing space. This created something of a design challenge, but our experience and know-how allowed us to meet the customer's needs and provide an optimal solution. Similarly, the navigational system represents the very latest technology," said Juha Kytölä, Vice President, Environmental Solutions, Wärtsilä.

The World in Hong Kong
(Photo courtesy Wärtsilä)

The World is a 196.35 m long vessel which features a concept combining a private yacht and a luxury vacation home. The ship comprises 165 individual 'homes' which are owned by the residents, who together own the ship. It sails the globe and caters to the highest standards of convenience and lifestyle. The onboard systems, including that for wastewater treatment, are required to be of the highest possible quality.

Wärtsilä Hamworthy Membrane BioReactor Systems

Wärtsilä's innovative MBR system is an evolution of the company's proven sewage-treatment technology for handling grey- and black-water waste. The company has over 30 years of experience in wastewater treatment and in meeting the waste handling needs of the marine industry. The technology is an advanced wastewater treatment process based on biological degradation and membrane separation. It delivers the highest quality discharge without requiring any addition or generation of chemicals hazardous to the maritime or shipboard environments. The Wärtsilä Hamworthy MBR is capable of meeting both current and anticipated effluent quality standards.

The Wärtsilä Nacos Platinum Integrated Automation Navigation Control System

This fully integrated system provides outstanding features in terms of usability, scalability and network by means of a single common hardware and software platform. It is based on a common software platform for navigation and automation applications, including dynamic positioning, and is designed in accordance with the latest standards. These cost-efficient systems are easy to install and require minimal operator training. The Platinum series offers the entire scope of ship control systems, hosted on a shared set of work stations using a common network.

Wärtsilä to Supply Waterjets for *KatExpress 3*

The Incat Tasmania shipyard in Hobart has again specified Wärtsilä waterjets and controls for a new fast ferry, *KatExpress 3*, being built for Danish operator Mols-Linien. The yard has previously specified Wärtsilä waterjets for a number of fast ferry projects. This latest order was placed in November 2015.

The scope of supply includes four Wärtsilä LJX 1500 SRI waterjets and a Wärtsilä Lipstronic control system. The equipment is scheduled for delivery to the yard in September 2016.

"The strong relationship between Wärtsilä and the Incat yard continues, and this latest order confirms the good cooperation that the two companies enjoy. It also underlines Wärtsilä's commitment to the Australian market. We are pleased to once again be supplying Wärtsilä waterjets, which provide reliable and efficient propulsion for fast ferry applications," said Hans Laheij, Sales Director, Wärtsilä Marine Solutions.

Robert Clifford, Incat Chairman, said "Incat, and our client Mols Linien, have continued to be satisfied with the performance of the Wärtsilä waterjets on *KatExpress 1* and *KatExpress 2* so it was a logical decision to select the Wärtsilä LJX 1500 SRI jets for *KatExpress 3*."

KatExpress 3 is a 109 m long catamaran capable of carrying around 1000 passengers and with capacity for 411 cars or a mix of trucks, vans and cars. The vessel has a deadweight of 1000 t. She is expected to be delivered to the owners in March 2017. The newbuilding's near-sisterships *KatExpress 1* and *KatExpress 2* are both currently in service for Mols-Linien and were also built by Incat.

Ocean Wave, one of two 24 m catamaran ferries recently completed by Incat Tasmania for Manly Fast Ferries, in service on Sydney Harbour
(Photo John Jeremy)

ROLEX SYDNEY TO HOBART YACHT RACE 2015

Pre-start manoeuvres — *Unicef*, one of the competitors in the Clipper Round the World Race before the start on Starting Line 2. *Unicef* finished ninth in her division
(Photo John Jeremy)

They're off! The pin-end committee boat's view of the start on Line 3, the southern of the three starting lines for the 2015 Rolex Sydney to Hobart Yacht Race
(Photo John Jeremy)

VALE

Bruce McNeice

It is with sadness that *The ANA* records the passing of Bruce McNeice on 18 November 2015.

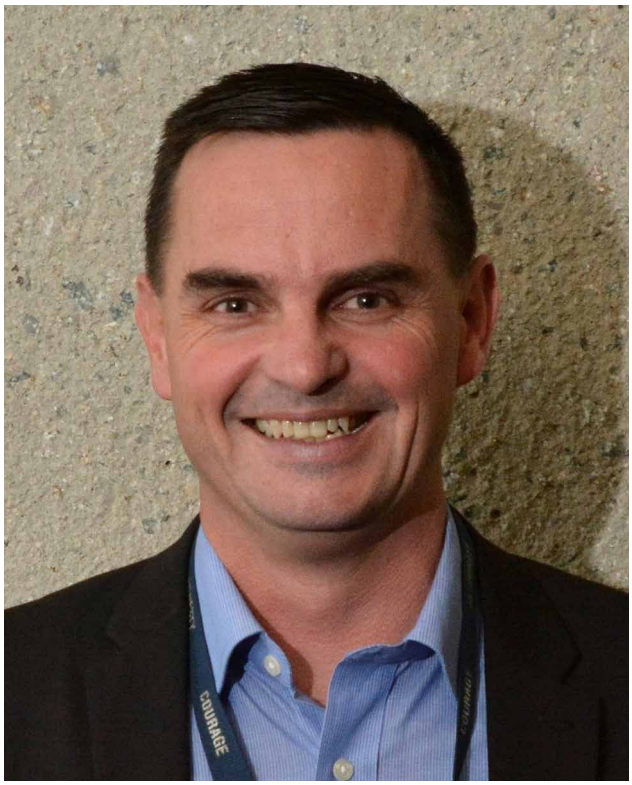
Bruce Warren McNeice was born on 25th February 1975 in Wollongong and grew up and completed his initial education in that city. Following graduation from the University of New South Wales with a Bachelor of Engineering degree in naval architecture with Honours Class 2 Division 1, Bruce commenced his Australian Public Service (APS) career as a naval architect within Naval Materiel Requirements Division (now known as Naval Engineering Division) of the Department of Defence in Canberra in 1997, completing several rotations within naval architecture areas of the group.

In 1998, having come through a life-threatening illness not long beforehand, Bruce married the love of his life, Felicity. Two years later, Hamish was born into a loving and caring family.

From 1998 to 1999, Bruce was fortunate to complete a secondment to Australian Defence Industries (now Thales Australia) during the Minehunter Coastal (MHC) acquisition project, including a significant role in the organisation and completion of the shock trial on then Nuship *Hawkesbury*. Returning to Canberra, Bruce was involved in concept design and costing for future projects and a brief period as MHC Configuration Manager within the then Defence Acquisition Organisation (DAO), being able to draw on his earlier experience with that class. Thereafter he returned to Naval Materiel Requirements Branch, which evolved into Navy Systems Branch, where he took on a range of positions of increasing seniority, predominantly related to structural and hydrodynamic evaluations and definition of RAN requirements in these areas. As Hydrodynamics Technology Manager, Bruce represented the Department and the Royal Australian Navy (RAN) in a range of co-operative naval and ship research programs with NATO navies and European research institutes and maritime industries. From 2003, Bruce took on the role of Project Liaison Officer for Amphibious and Afloat Support Ships, serving as the Navy Engineering liaison with the capability development group and the Defence Materiel Organisation on projects in this sphere. From the 1990s onward, Bruce was involved in the engineering contribution to a number of tender evaluations for RAN ship acquisition projects.

In 2005, Bruce was selected to fill the Australian Naval Liaison Officer (ANLO) position in Bath, UK. This APS engineering position forms an important link between the Department of Defence/RAN and our counterparts, not only in the UK, but across NATO nations in the maritime engineering field. Bruce undertook this role with his usual enthusiasm and vigour, including taking on responsibilities within the group developing the NATO Navy Ship Code and serving as Australian project officer for multilateral groups concerned with Naval Ship Combat Survivability. Naturally, Felicity and their then young son Hamish joined Bruce on this three-year adventure.

Following his return to Canberra in 2008, Bruce was appointed as the Assistant Director Total Ship Survivability



Bruce McNeice
(Photo courtesy Mark Doughton)

within the Navy Platform Systems section of Navy Systems Branch and, later, Navy Engineering Division, gaining this position permanently as Director Total Ship Survivability in 2009. This position provided management and oversight of ship structures, stability, hydrodynamics and ship vulnerability and recoverability specialist engineers responsible for defining RAN requirements and undertaking assessments in these fields. Bruce also served as Design Acceptance Representative for a range of upgrade projects across a spectrum of RAN ship classes in this period.

For a brief period from 2015, Bruce served in the role of Director General Navy Platform Systems; however, with the progressive transition of Navy Platform Systems into the Naval Technical Bureau (NTB) within Naval Engineering Division, Bruce was a natural successor for the relatively newly-established role of Executive Director, Naval Technical Bureau, and was appointed to this position in August 2015. Bruce was focussing his energy on the multitude of aspects required to bring together the various elements of the NTB at the time of his sudden death in the early morning of 18 November. Bruce was at work the previous day and had a busy day of interstate travel ahead of him.

Bruce took an active interest in the operation of the ACT Section of RINA, serving as Secretary of the section from 2000 to 2002 and Chair from 2013 to 2015, and as a member of the Section Committee for a considerable period spanning those roles. He also served as a representative on the Australian Division Council between 2000 and 2002.

Bruce was committed to the Australian Scouting movement, joining in 1983 and remaining with the movement to become

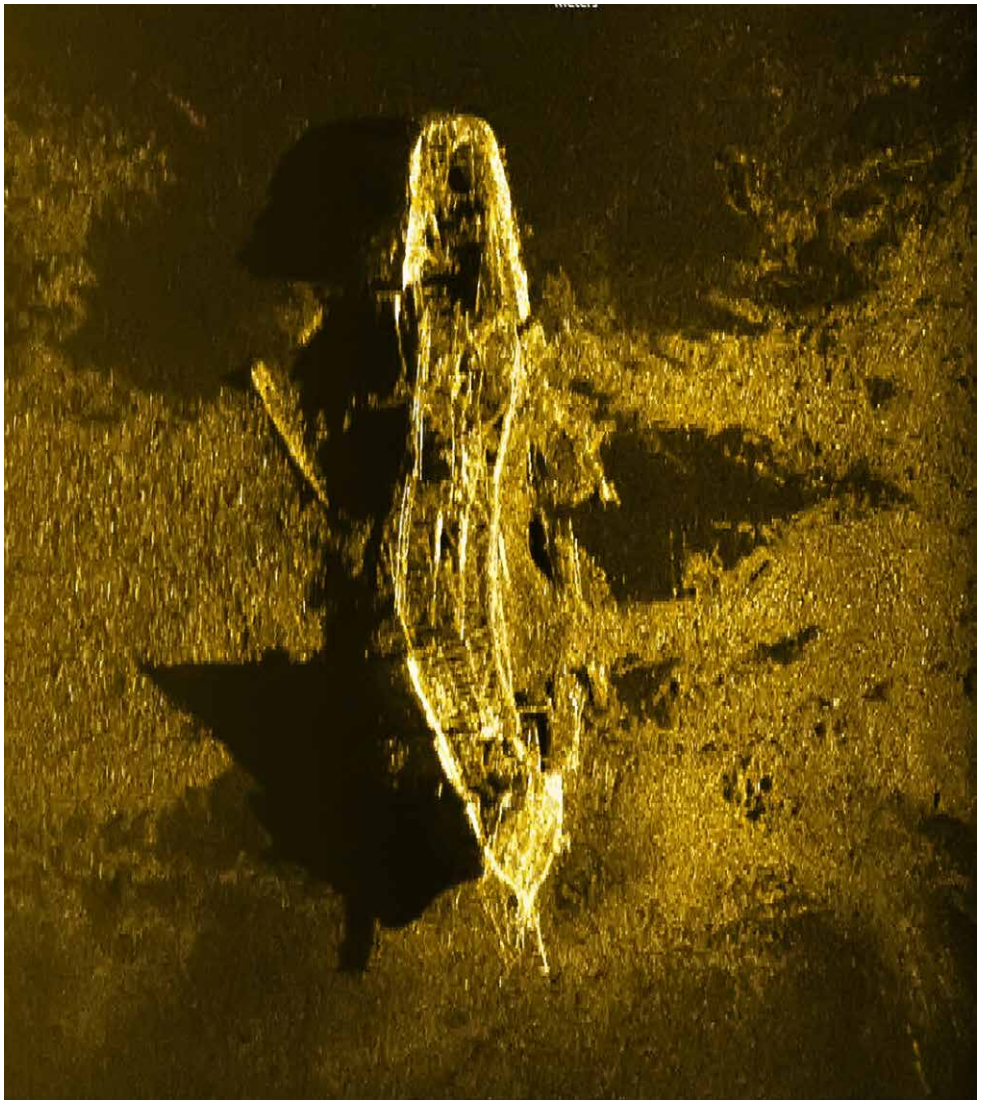
Venturer Leader by 2010. Bruce took great joy in being so actively engaged in the lives of his family, with scouting providing one of these opportunities.

Bruce can rest knowing that he has achieved many successes in life and in his work; however, we include one naval architecture example: While it can be a challenge influencing the technical direction of RAN ship acquisition projects within a large bureaucracy, Bruce was instrumental in helping to drive seakeeping as an important evaluation criterion for the RAN's then *Replacement Patrol Boat* project, now known as the Armidale-class Patrol Boat (ACPB). He was able to influence the Project Director for the ACPB acquisition to consider this important aspect seriously during the evaluation, amongst a multitude of other considerations beyond cost and schedule. Bruce submitted an article to *The ANA* (*Seakeeping Characteristics of Patrol Boats*, v.5 n.4, November 2001) with the objective of helping to shape industry thinking related to the seakeeping features to be included in this project. The goals and constraints of this project are well summarised in the Editorial by John Jeremy in the same issue. Bruce also completed a comprehensive seakeeping operability evaluation of the RAN's then Fremantle-class Patrol Boats to serve as a benchmark from which improved design offers could be assessed. This evaluation was made available to industry as part of the tendering process.

The successful bidder for this project, DMS, working with Austal and its then subsidiary, Seastate, clearly recognised the importance of seakeeping to the RAN for this project, as did a number of other bidders. While the ACPB design was ultimately Austal's creation, RAN patrol boat crews can, in part, thank Bruce for the energy he put into ensuring that seakeeping was given a high profile for this project, both within Defence and within industry. In the interim, we can add to the list of seakeeping and seaworthiness features identified by Bruce.

All of Bruce's colleagues in the Naval Technical Bureau and the wider Defence maritime community have been shocked by the sudden death of their dedicated, passionate and talented leader. Our condolences are extended to Felicity and Hamish and their extended family as they come to terms with their loss. Bruce has left an indelible impression on so many people within Navy Engineering and the broader community through his caring nature, commitment to family and friends, dedication to work and enthusiasm for life. Bruce has left us all far too early and still with so much more to offer.

Martin Grimm



The ongoing hunt for missing Malaysia Airlines jet MH370 has found another shipwreck in the southern Indian Ocean, the second since the search began almost two years ago. Sonar imaging from one of the search vessels, *Havila Harmony*, turned up an object resting on the ocean floor off Australia's west coast. An autonomous underwater vehicle was used to further examine the find and capture high-resolution images. The object was confirmed as a shipwreck, with an iron or steel structure, and most likely from the turn of the 19th Century
(Image courtesy ATSB)

MEMBERSHIP

Australian Division Council

The Council of the Australian Division of RINA met on Thursday 3 December 2015 by teleconference based in Perth.

Some of the more significant matters raised or discussed during the meeting are outlined as follows:

Possible Future Division Activities

Further to the discussion at the previous two meetings, Council considered the President's assessment of the priorities as a vision statement and agreed to discuss this matter further.

Election of President and Vice President for 2016–2018

Council unanimously elected Dr Martin Renilson and Mr Jesse Millar respectively to these positions.

Appearance before Senate Inquiry

Council noted that the President and the Secretary appeared before the Senate Foreign Affairs Defence and Trade References Committee on 17 November 2015 in support of the Division's submission to its inquiry into the Capability of Defence's Physical Sciences and Engineering Workforce. The Hansard record of this appearance is available from the Committee's page on aph.gov.au.

PACIFIC 2015 IMC

Council noted the report of the Chairman of the Organising Committee of this highly-successful Conference on 6–8 October 2015, which appeared as the editorial in the November edition of this journal.

National System Recognition of AS4132

Council considered the Queensland Section's request to approach AMSA with regard to obtaining some relaxation of the conditions applying to its acceptance of this group of withdrawn standards. It decided that further information would be needed to substantiate such an approach.

Division's Budget for 2016

The draft budget was presented and adopted.

Bruce McNeice MRINA

Council acknowledged the untimely passing of Bruce McNeice, immediate past Chairman of the ACT Section and Director of Defence's Naval Technical Bureau on November 2015 at the age of 40.

Next Meeting of Council

The next meeting of the Australian Division Council will be held on Wednesday 2 March 2016 based in Sydney, at 1400 Eastern Summer Time (1100 Western) in preparation for the Division's Annual General Meeting later that day.

Rob Gehling
Secretary
rina.austdiv@optusnet.com.au
(0403) 221 631

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 Pacific International Maritime Conferences in Sydney.

The procedure for obtaining a free student place is to email your request to the Chief Executive, Trevor Blakeley, at tblakeley@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 Division		rina.austdiv@optusnet.com.au
Section	ACT	rinaact@gmail.com
	NSW	rinansw@gmail.com
	Qld	m-dever@hotmail.com
	SA/NT	danielle.hodge@defence.gov.au
	Tas	mfsymes@amc.edu.au
	Vic	siobhan.giles@dsto.defence.gov.au
	WA	rina.westaus@gmail.com

Phil Helmore

NAVAL ARCHITECTS ON THE MOVE

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

Greg Carmody (ex Laanemaa) has moved on from Azure Naval Architects in the Netherlands and has taken up the position of Technical Manager with Australian Superyachts in Sydney.

Goran Dubljevic has moved on from Wood Group Kenny and has started his own consultancy, Rubicon Associates, in Melbourne.

Zijian Gao, a recent graduate of UNSW Australia, has taken up a position as a surveyor with China Classification Society in Guangzhou, China.

Lucy Gilligan, a recent graduate of the Australian Maritime College, has taken up a position as a naval architect with Fred Barrett Yacht Design in Hobart.

LEUT Geordie Grant has moved on from the Capability Acquisition Sustainment Group of the Department of Defence and has taken up the position of Deputy Marine Engineer Officer on board HMAS *Canberra.*

Greg Hampson has moved on and has taken up the position of Subsea Installation Engineer at Chevron in Perth.

Steve Harler has moved on from Helix Well Ops and has taken up the position of Business Acquisition Manager with SapuraKencana Well Services in Perth.

Matthew Harman continues as Senior Naval Architect at BAE Systems in Williamstown.

Dougal Harris continues as Senior Software Engineer/ Naval Architect with Bentley Systems, telecommuting from Tasmania.

Tristan Harris has moved on from semi-concurrent directorships at Trilo-G International, DiConf Management and PMA (Australia and New Zealand) and, since 2006, has been co-CEO and Director of Buying and Marketing with Harris Farm Markets in Sydney.

Sasha Harrison has moved on from Hart Marine and, in 2011, took up a position as a naval architect with Oceanic Design and Survey in Coomera, Qld.

Annette Hill has moved on within Lloyd's Register and has taken up the position of Surveyor in Brisbane.

Brad Hillman continues as Newbuilding Manager with Interorient Marine Services in Limassol, Cyprus.

Peter Hinds moved on from Austal Ships in 2005 and, after some time at Clough, Saipem UK, SWG Offshore, DOF Subsea Australia and Fugro TSmarine, has now taken up the position of Senior Installation Engineer with Technip in Perth.

Caitlin Hoey has moved on within the Department of Defence and has taken up a position as a naval architect with the Hydromechanics Cell in the Naval Technical Bureau in Canberra.

Nazmul Hossain has moved on from Class NK and has started his own consultancy, Executive Marine Services, in Sydney.

Chris Hutchison has completed his PhD degree at the Australian Maritime College and, in 2004, took up a position as a naval architect with Marintek in Trondheim, Norway.

Jun Ikeda moved on from DOF Subsea in 2013 and, after some time at Fugro-TSM, has taken up the position of Subsea Senior Installation Engineer with Technip in Kuala Lumpur, Malaysia.

Sean Ilbery has moved on from Ocean Independence and has taken up the position of Director with Sterling Yacht Management in Maidstone, UK.

Joel Ireland moved on from Subsea7 in 2011 and moved to Ocean Installer where he has now taken up the position of Regional Engineering Manager (Asia Pacific and Oceania) in Perth.

Peter Ivanac continues at Veem Engineering, where he is now the Commercial Manager in Perth.

Nikolai Ivanovic moved on from Austal Ships in 2008 and, after some time at BAE Systems, in 2015 took up the position of Director Ship Construction with Seaspan in Vancouver, BC, Canada.

Zoran Jaksic has moved on within the Thales Group and has taken up the position of Manager Naval Architecture and Project Engineer (Project Manager HMAS *Success*) at Garden Island in Sydney.

Bryan Kent has moved on from London Marine Consultants Asia Pacific in Singapore, and has taken up a position as a sales representative with the AWB Group in Sydney, providing capital equipment sales, service and parts support to the Australian and New Zealand markets.

Alvin Lim, a graduand of UNSW Australia, has taken up the position of Mould Loft Engineer with Jurong Integrated Structure, a Division of Sembcorp Marine, in Singapore.

Molly McManus, a graduand of UNSW Australia, has moved on from Spear Green Design and has taken up a position as a naval architect with One2three Naval Architects in Sydney.

Neil Pollock has moved on from GL Noble Denton and has taken up the position of Head Marine Assurance and Advisory with DNV GL in Brisbane.

Martin Renilson has retired from his position as Dean, Maritime Programs at the Higher Colleges of Technology in Abu Dhabi, UAE, and returned to his home in Launceston.

Alex Robbins has moved on from DMS Maritime and has taken up the position of Multi-Role Aviation Training Vessel (MATV) Project Engineering Manager with CapDA in Sydney.

Umberta Salvarani has moved on from One2three Naval Architects and has taken up a position as a naval architect with Spear Green Design in Sydney.

Peter Samarzia has moved on from ASC and has taken up a position as Project Manager on the re-development of a heritage building in Adelaide.

Alistair Smith, a graduand of UNSW Australia, has moved on from One2three Naval Architects and has taken up a position as a naval architect with the Marine Acquisitions Branch of the Capability Acquisition and Sustainment Group in the Department of Defence in Canberra.

Carl Vlazny has moved on from Linch-pin Offshore Management Services and has taken up the position of Offshore Project Manager with Contract Resources in Perth.

LEUT Alex Walter, a graduand of UNSW Australia, has moved on within the Royal Australian Navy and has converted his part-time position as Assistant Afloat Support Capability Element Manager to full-time in Sydney.

Bryce Waters, a graduand of UNSW Australia, has taken up a position as a naval architect with One2three Naval Architects in Sydney.

Cameron Whitten has moved on from Sea Transport Solutions and has taken up a position as a naval architect with Oceanic Design and Survey in Runaway Bay, Qld.

Glenn Whybro has moved on from the Department of Planning, Transport and Infrastructure and has taken up the position of Marine Surveyor with London Offshore Consultants 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 INTERNET

Webcasts of NSW Section Technical Presentations

Engineers Australia records selected technical presentations made to RINA (NSW Section) and IMarEST (Sydney Branch) for webcasting. The recordings are placed on the Engineers Australia website, usually within a few days of the presentation.

All of the recorded webcasts up to 30 September 2014, together with hotlinks to each one, are listed at

www.rina.org.uk/NSWwebcasts.html.

On 1 October 2014, Engineers Australia started using a new system for recording presentations, using three cameras and a hand-held microphone, with an audio technician in attendance. Webcasts are placed on the Engineering on Line (EoL) website at www.engineeringonline.com. The first presentation to be recorded with this new system was Graham Taylor's presentation on *LNG — The New Marine Fuel?* on 1 October, and the presentation is up on the EoL website at www.engineeringonline.com/video/xjkrsdrf/lng-the-new-marine-fuel. Details of how to access this recording were given in the February 2015 issue of *The Australian Naval Architect*.

However, Engineers Australia has now discontinued using the new recording method and the EoL website for regular monthly presentations, and have resumed using Mediavisionz while considering options for future recordings.

In 2015, only one recording was made, and the link to the webcast made on 1 April 2015 is shown on the NSWwebcasts website.

For future recordings, watch this space!

Phil Helmore

Naval Engineering and Maintenance Bulletin

The Naval Engineering Division of the Department of Defence is in the process of scanning back issues of *Fleet Maintenance Bulletin* and *Naval Engineering Bulletin* so that they can be added to the more recent collection of electronic issues of what is now called *Naval Engineering and Maintenance Bulletin*. These can be downloaded or viewed at: www.navy.gov.au/media-room/publications/naval-engineering-and-maintenance-bulletin.

Hard-copy issues back to March 1972 are held by Defence, however there are still some gaps in the collection. If you have very old copies of the *Fleet Maintenance Bulletin*, in particular issues 1, 4, 9, 10 and 11 which are missing from the Defence collection, they would be very much appreciated for this scanning activity which is now underway. They should be sent to:

Martin Grimm
Principal Naval Architect
Directorate of Navy Platform Systems
CP4-5-151
Department of Defence
Canberra ACT 2600
(02) 6266 2862
martin.grimm@defence.gov.au

There are some great articles in these old bulletins, and any help locating the missing five issues and making them available for scanning would be greatly appreciated.

Martin Grimm

FROM THE ARCHIVES

The Fremantle-class patrol boat *Townsville* crossing Cook Street in Cairns in preparation for her launching in May 1981. The second of fourteen of the class built in Cairns by NQEA, she was commissioned on 18 July 1981 and was one of the last two to be decommissioned, on 11 May 2007. Two of the class survive as museum ships, *Townsville* and *Gladstone*
(Photo J C Jeremy Collection)

HMAS *Townsville* entering the water for the first time on the evening of 17 May 1981, in the rain. It was a very wet night
(Photo J C Jeremy Collection)

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