AMC
Australian Maritime College

UNIVERSITY of TASMANIA

Submission by Email

28 November 2019

Senate Standing Committees on Economics
PO Box 6100
Parliament House
CANBERRA ACT 2600

Dear Senate Standing Committee

The Australian Maritime College (AMC) of the University of Tasmania (UTAS) is the National Institute for Maritime Education, Training and Research, and is grateful for the opportunity to provide a submission to the Economics References Committee inquiry into: *Developing and delivering Australia's sovereign naval shipbuilding capability*.

AMC has a long association with the Defence Science and Technology Group (DSTG) in developing Maritime Engineering and Hydrodynamics capabilities to support naval design assurance, and in-service operational test and evaluation processes. This capability, unique in Australia, will be integral to Defence and industry demands for both developmental and operational test and evaluation in support of the continuous sovereign shipbuilding and sustainment programs.

In response to increased demand, a project is underway to enhance the capabilities of the AMC through establishment of a Maritime Defence Innovation and Design Precinct. The Government is providing funding of $30M, through Defence, for Phase 1 of precinct development between 2021 and 2024. The precinct will enable collaborators from Defence, industry and academia to access a broader array of integrated UTAS capabilities in the areas of Naval Platform and Autonomous Systems, Human Performance and Remote Sensing related to Defence innovation and capability development needs. A summary of the precinct's foundation test and experimentation facilities is enclosed.

As a strategic partner of the Naval Shipbuilding College (NSC), AMC is working within its national provider network to provide solutions to shipbuilding workforce demand challenges. AMC's most significant contribution to the generation and sustainment of this workforce is as the premier domestic provider of specialised tertiary study programs in Maritime Engineering, and Maritime Business Management and International Logistics. The Maritime Engineering Program includes the specialisations of Naval Architecture[1], and Marine and Offshore Systems[2], with the student experience and quality of AMC graduates greatly enhanced through applied learning attained through use of Hydrodynamics research facilities and dedicated Training Vessels.

The Maritime Engineering specialisations and skill sets of Naval Architecture and Marine and Offshore Systems Engineering are fundamental inputs to the sovereign industrial capabilities in support of the Continuous Shipbuilding Program; *Collins* Class Submarine Maintenance and Technology Upgrade; and Test, Evaluation, Certification and Systems Assurance.

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[1] *Naval Architects* lead the design and oversight of construction and commissioning of new and upgraded vessels
[2] *Marine and Offshore Engineers* select, integrate and commission vessel propulsion, power generation and auxiliary machinery systems (i.e. they are the Mechanical Engineers of the maritime domain).

However, both the current pipeline of Student Engineers and existing pool of Graduate and Professional Engineers in these specialisations are insufficient to satisfy the demand of the naval shipbuilding enterprise. Neither the capacity nor reputation of AMC are contributing factors here, but rather, the following four causal factors have been identified:

1) the relatively small pool of secondary school students with pre-requisite STEM achievement eligible to enrol;

2) a lack of recognition and awareness of Maritime Engineering specialisations amongst the target student market;

3) attraction of prospective and eligible students to Tasmania and away from alternative courses in other Engineering disciplines nearer home locations; and

4) a greater attraction of Graduate Maritime Engineers to alternative maritime industry sectors, or overseas shipbuilding, to access more mature and structured pathways to Chartered Engineer status.

While AMC is endeavouring to address the workforce supply issue, both independently and collaboratively, resources and reach are finite, and so a more strategic and integrated enterprise approach is essential. The ensuing paragraphs highlight actions and initiatives that are already underway or planned, and some proposed enterprise level initiatives that would require the additional support of Government. These initiatives were also addressed in AMC's response earlier in 2019 to the Department of Defence *Naval Shipbuilding Strategic Workforce Discussion Paper* that highlighted demand and supply challenges.

AMC has re-invigorated and re-developed its interactive, practical and inspirational "Why Study Maths?" program that deploys academic staff to show predominantly Year 8-10 students how mathematics can be applied to maritime engineering. While it is too early to assess the success of enrolment, anecdotally, the program has been successful in supporting past marketing and student recruitment efforts. School coverage is limited by resources, and ideally the program would be expanded in scope to help build the capacity of Secondary School teachers to embrace applied learning for mathematics. Within Tasmania, AMC and UTAS have commenced working with the Education Department to introduce a STEM curriculum for Year 11 and 12 students whereby credits are awarded towards attainment of Undergraduate foundation units; as well as offer supporting vocational work opportunities. AMC is also actively engaged in the generation of ideas for national policy development through participation in events such as the recent National Defence Industry Workforce and Skilling Summit in Perth.

Naval Architecture is an internationally recognised specialist Engineering discipline related to shipbuilding; however, despite the overt ambition for continuous naval shipbuilding in Australia there is little recognition and awareness of it in the current national dialogue and lexicon. While the Marine and Offshore Systems Engineer may not be part of the international lexicon, the Course has been specifically developed to complement Naval Architecture for the shipbuilding and the repair sector. The increasing demand for Maritime Engineering graduates has become clear through AMC's close relationship with industry, particularly Naval Architects, however, marketing and recruitment is challenged by the absence of Naval Architecture from the promotional lexicon; directly impacting on workforce supply. By way of example, Naval Architecture does not explicitly feature alongside other engineering disciplines like Mechanical and Electrical in the *Defence Industry Skilling and STEM Strategy*

despite the document re-enforcing the importance of design professionals in complex naval shipbuilding projects.

Through its "Why Study Maths?" program, AMC is endeavouring to provide a snapshot to secondary school students of what a Maritime Engineering career pathway might look like. Efforts are also underway in collaboration with Engineers Australia (EA), the Royal Institution of Naval Architects (RINA) and NSC to raise career profiles, and to partner with industry in the marketing of careers as part of the student recruitment process.

AMC has traditionally enrolled students in its Maritime Engineering program from across all states and territories, attracting a relatively small cohort with a pre-existing awareness and passion for the maritime industry, and willingness to re-locate to Launceston. Most students originate from the more populous and nearby regions of the eastern seaboard and so to broaden the recruitment area, in 2011, AMC partnered with Flinders University in South Australia and Edith Cowan University in Western Australia, to create a '2+2' Collaborative Bachelor of Engineering Degree with maritime specialisations completed at AMC. More recently, AMC has also partnered with TAFE organisations in South Australia, New South Wales and Western Australia to provide formal articulated pathways from Diploma, Advanced Diploma and Associate Degree levels of attainment into the Maritime Engineering program.

While the '2+2' programs were successful in earlier years there has been a steady decline in conversion that is consistent with market research suggesting a growing disinclination of prospective students to re-locate from home to interstate Universities. AMC is reviewing the structure of its Maritime Engineering program with the aim of reducing the amount of time required to study on campus; however, the 'hands-on' applied learning environment is what produces the quality and job readiness of graduates sought by industry. Therefore, to enhance the attractiveness of its programs of study for interstate students, the scope of scholarships and bursaries available[3], including the '2+2' Bachelor of Engineering Course, is also being reviewed. This includes AMC's Women in Maritime Engineering Scholarship designed to encourage more women to make this career choice. It is unlikely though, that the finite resources available from UTAS and its benefactors will be sufficient to overcome the 'gravitational pull' of home.

Design Engineering and Systems Engineering are identified in the *Defence Industry Skilling and STEM Strategy* as two of eight skill sets most affected by workforce shortages[4]. It is therefore proposed that a national enterprise approach to funding scholarships and bursaries be adopted to stimulate attraction to study programs aligned to shipbuilding skill sets in short supply, and assist with student re-location. Naval Architecture and Marine and Offshore Systems Engineering sub-disciplines align with Design Engineering and Systems Engineering, respectively. As a national endeavour espoused in the Naval Shipbuilding Plan, any cost outlay to stimulate student mobility would be substantially less than duplication of existing programs of study and associated infrastructure elsewhere, particularly national centres of expertise and excellence, unless a capacity issue exists.

Despite the demand signal for Maritime Engineers created by the Naval Shipbuilding Plan in 2017, there has only been a modest increase in interest amongst Undergraduates. While Defence industry has supported AMC's annual Careers Expo, it has become apparent that earlier engagement is necessary to ultimately attract Graduate Engineers. This will enable the naval shipbuilding enterprise to compete with other industry sectors and the perception

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[3] http://www.amc.edu.au/study/scholarships

[4] *Defence Industry Skilling and STEM Strategy* (2019) P.14 - the top eight skill sets identified as most identified by shortages, in descending order, are: Design Engineering; Planning and Production; Project Management; System Engineering; Integrated Logistics; Cyber Security; Software Design; and Electrical Engineering.

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Of greater opportunities for career advancement in the overseas shipbuilding sector owing to more established and structured graduate programs. AMC suggests that the attraction to shipbuilding careers would be enhanced by creating a continuum of industry engagement with Undergraduates, including linkages with the critical skills scholarship and bursary initiative previously described. This might include greater industry support for mentoring; project activities and mandatory industry work placements for undergraduates; and an enterprise approach to graduate programs, including opportunities for secondments in overseas shipyards and design offices.

A related key challenge identified in the *Naval Shipbuilding Strategic Workforce Discussion Paper* is that of attracting experienced Engineers. In the case of Maritime Engineers, those who were originally attracted overseas by career advancement opportunity have an outstanding HECS-HELP debt as a possible disincentive for returning to Australia to work in the naval shipbuilding sector. Subject to validation, perhaps some form of HECS-HELP concession arrangement linked to the critical skills shortages for naval shipbuilding may be worthy of policy consideration, e.g. previous HECS-HELP Benefit program for graduates of Early Childhood Education, Nursing and Midwifery courses were created to provide an incentive to pursue industry relevant roles. Such a benefit program may also complement the critical skills scholarship initiative for attraction of undergraduates.

In closing, this submission seeks to highlight the critical issue of the shortfall in supply of Maritime Engineering specialists, both Naval Architects and Marine and Offshore Engineers, for the naval shipbuilding enterprise. It also advises of the four perceived key contributing factors; and the actions and initiatives already underway by the AMC to address them. The submission suggests that disparate or disconnected small scale efforts are not enough to overcome the challenge, and that a coordinated, enterprise approach led by government policy initiatives is needed. AMC, supported by UTAS, continues to work hard within the enterprise on the initiatives proposed herein, as well as on other adaptive and innovative solutions.

Yours sincerely

Michael van Balen AO
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Enclosure: *Foundation Test and Experimentation Facilities of the Maritime Defence Innovation and Design Precinct*

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Enclosure to
ERC Submission by AMC

FOUNDATION TEST AND EXPERIMENTATION FACILITIES OF THE MARITIME DEFENCE INNOVATION AND DESIGN PRECINCT

Maritime Hydrodynamics Research Laboratory (MHRL). Co-developed with DSTG since the 1980s, the MHRL comprises a Towing Tank and Model Test Basin, both incorporating wave and motion generation complemented by a suite of numerical prediction tools for undertaking both physical and mathematical modelling and analysis. This enables calm water resistance tests, powering predictions, vessel manoeuvring characteristics predictions, flow visualisation, seakeeping tests, hydrodynamic analysis and advice, physical modelling of shallow water environments, measurement of ship-generated waves (wave wake), simulation of ship manoeuvring within restricted waterways, and vessel-vessel, vessel-seabed and vessel-bank interactions. Models are fabricated and instrumented on site at AMC. Data obtained from these facilities is also used for developing digital models at the Centre for Maritime Simulations.

Cavitation Research Laboratory (CRL). The CRL hosts the most sophisticated medium-sized variable-pressure (4-400 kPa) water tunnel in the world. Co-developed with DSTG, it is used for the study of cavitating and bubbly viscous flows around hulls and protrusions (e.g. shafts, propellers, rudders, fins and sensors), and the characteristics of resultant cavitation and wake. Results of such studies inform vessel design and operation to mitigate against the creation of unwanted vibration and water flow effects, i.e. reduction of susceptibility to internal equipment failure, and detection and targeting by an adversary.

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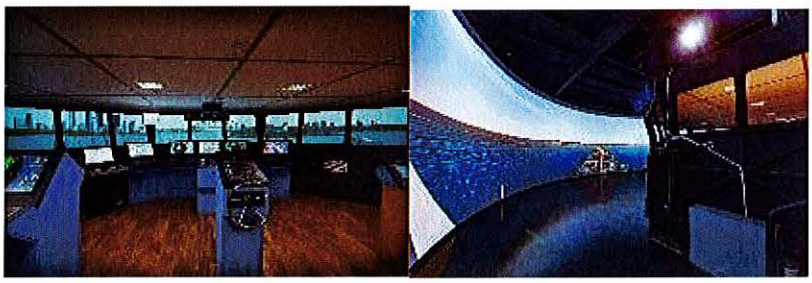
Underwater Collision Research Facility (UCRF). The UCRF is a newly commissioned facility (2019) co-developed with DSTG, used for structural research, and the investigation of crashworthiness of submarines and underwater vehicles. This unique capability provides new knowledge for understanding the structural survivability of submarines and underwater vehicles, and sub-surface structures. It interfaces with hydrodynamic research capability and progresses frontiers in the design and operation of Submarines and AUV's. This facility has the potential to expand its scope of structural research.

Environmental, Energy and Safety Laboratory (EESL). This facility, incorporating a **Diesel Spray Test Facility (DSTF),** support research into *Asset Integrity Management of Naval Vessels and Maritime Structures*. EESL Instruments in service or planned include gas analysers, corrosion measurement devices, fuel cells, magnetic stirrer, chemicals, glass ware, spectrophotometer, ion and gas chromatographers as well as total organic and carbon measurement devices. Equipment at the DSTF measures fuel spray geometry, droplet velocities and droplet sizes used to enhance the understanding of spray dynamics and to calibrate the complex computer models used to design engine combustion systems for reduced emissions of oxides of nitrogen, particulate matter and greenhouse gases. The research area focusses on gaining knowledge of asset integrity, operational life expectancy, reliability, inspection regimes and maintenance requirements to optimize the through-life management of maritime assets in challenging environmental conditions and associated uncertainty of degradation mechanisms and integrity. It aims to: develop and install sensors for continuous full-scale asset monitoring; investigate failure mechanisms based on different material properties; undertake advanced structural analysis including fluid-structure interactions by coupling Finite Element Analysis (FEA) and Computational Fluid Dynamics (CFD); develop Machine Learning Algorithms (MLA) for prediction purposes; develop risk-based asset integrity models to predict the future health of assets; and develop mitigation strategies to improve the current and future conditions of assets.

Centre for Maritime Simulations (CMS). The suite of simulators at the CMS serve the dual purpose of seafarer training and research. The Full Mission Bridge Simulator integrated with two Azimuth Stern Drive (or Azimuth Tractor Drive) Tug Simulators are used extensively for research and investigation into port development and operation, ship manoeuvring, marine incidents, human performance of individuals and teams, and safety and efficiency of ships and ports. Kongsberg Maritime Polaris software (version 7.4.4) and hardware (DNV Class A certification) will be upgraded in 2020 to the next generation K-SIM NAV and will bring unprecedented facility integration with the ability to link together multiple Bridge, Offshore, Tug, Engine, Cargo/Ballast and Vessel Traffic Services (VTS) simulators. The upgrade will offer a

range of improvements, including: advanced hydrodynamic vessel modelling for realistic vessel interactions; six degrees of motion for enhanced vessel motion accuracy; an improved physics engine which supports full interaction with shore and maritime based objects and vessels to provide realistic behaviour of lines and cables for tug and mooring exercises, and; improved degree of realism in details, depth perception and motions. The CMS advanced modelling incorporates features that aren't available in other ship handling simulators, achieved utilising in-house simulation and hydrodynamics expertise that include propeller and thruster wash, environment shadowing for ships and terrestrial features, and forces of interaction (including ship-ship, squat and canal effect).



Autonomous Maritime Systems Laboratory (AMSL). This facility was developed for enabling AUV engineering research and development and staging of AUV deployments by road, sea and air to operating areas for testing, evaluation and marine science missions. AMSL includes a purpose-designed *ISE* Explorer AUV, a *Hydroid* (*Konsberg Maritime*) REMUS 100 AUV, the *Mullaya* AUV model for hydrodynamic testing, other small remotely operated vehicles (ROV) and AUV mission simulator. The Explorer, named *Nupiri Muka*, is a deep-water survey grade AUV acquired and customised primarily for under-ice polar research as part of the Antarctic Gateway Partnership (AGP), involving the Australian Antarctic Division (AAD), Commonwealth Scientific and Industrial Research Organisation (CSIRO), the Institute for Marine and Antarctic Studies (IMAS), and AMC. *Nupiri Muka* or 'Eye of the Sea' (8 metres length, 2000 kg deadweight) is dynamically ballasted with a maximum endurance of 40 hours, maximum range of 250 kilometres and maximum operating depth of 5000 metres, with modular on-board sensors including bathymetric and side-scan sonar, sub-bottom profiler, magnetometer, oceanographic sonde (sonic profile for depth measurement), and acoustic doppler current profiler. The REMUS 100 is a low-logistics, man-portable, AUV with side-scan and bathymetric sonars and a high-grade navigation system. A substantial body of research into AUV technology and their operation applicable to a range of defence related maritime missions, including hydrographic survey and mine countermeasures, has also been undertaken in conjunction with DSTG, including development of a suite of mission planning tools and operator training packages utilised by the RAN's Deployable Geospatial Team at HMAS *Waterhen*. A longer-term goal of the facility is to incorporate autonomous shipping into its R&D program.

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High Performance Computing Facility (HPCF). Test and Experimentation facilities at AMC are supported by extensive expertise in the field of numerical research and simulation of (advanced) hydrodynamic flow problems. The simulations are supported by necessary and accompanying hardware and software resources. The current hardware consists of 106 nodes with 4 cores each at Launceston and 256 nodes with 28 cores each located at Hobart. An expansion of capacity at Launceston is planned for early 2020. The most important software packages support Computational Fluid Dynamics (CFD) simulations, providing the ability to investigate full-scale flow and force behaviour, perform (non-intrusive) measurements and quantification of the entire flow field (while experimental work only conducts point measurements in time and/or space), set-up experiments that are impossible in an experimental setting (e.g. launch-and-recovery operations), and research potential adjustments and improvements to be implemented in the experimental facilities.

Deep Lakes Research Facility (DLRF). AMC has a formal partnership with Thales Australia to exploit the unique environmental characteristics and isolation of Tasmanian lakes for hydrodynamic and acoustic research, and the calibration and testing of sonar arrays.

Training and Research Vessel MV *Bluefin*. *Bluefin* is a 35-metre Domestic Commercial Vessel certified for offshore operations and carriage of passengers, operated and supported from a Fleet Base near the mouth of the River Tamar at Beauty Point (40km by road from Launceston). Designed and built in 1981 originally as a dual-purpose Coastal Seafaring and Fishing Training Vessel, *Bluefin* has continually proven her flexibility and adaptability for embarkation of modular mission systems for supporting marine science research, hydrographic surveys and mine countermeasures systems trials; and as an applied learning and teaching platform for maritime engineers to conduct ship performance trials and design studies.

UTAS Capabilities integrated with AMC:

Ship Structures and Dynamics. Through its long association with the shipbuilder INCAT, the UTAS School of Engineering (Hobart) has the capacity and equipment to assess the fatigue life of the block joints of ship structures for design optimization, while its Ship Dynamics program focuses on the dynamics of high-speed ships using model scale, full scale or numerical computations. The Ship Dynamics program covers research topics on ship motions, structure loads, wave slamming, whipping vibration, motion control and ride control systems, ship propulsion and resistance, shaft power measurement and prediction of propulsive power, and friction stir welding of aluminium structures.

Electrical Power. The School of Engineering (Hobart) has an Electrical Power program focussed on technical problems associated with the integration of distributed and

renewable generation into existing power networks, hybrid remote area power supply systems, network operation and security control, load modelling, smart grids, and intelligent systems applications to power systems. Its Centre for Renewable Energy and Power Systems (CREPS) includes a purpose-built renewable energy laboratory and software for simulation, modelling and analysis in energy and power systems applications, focussed on optimizing the efficiency and overcoming challenges relating to energy transfer and conversion. CREPS has collaborated with the US Office of Naval Research to explore the low load capabilities of modern diesel engines and how the maximum amount of renewable energy could be integrated into a hybrid remote power system. Based on the success of various projects, CREPS has also collaborated with the US Navy to improve the efficiency of variable diesel generators with completely new technology, potentially saving twice as much fuel.

Oceanography. The Institute for Marine and Antarctic Studies (IMAS) (Hobart) undertakes observational oceanography, ocean modelling, and cryosphere research, and is the lead agency of the national Integrated Marine Observing System (IMOS) which operates a wide range of observing equipment throughout Australia's coastal and open oceans. The *TerraLuma* research project is developing innovative tools and processes for environmental remote sensing applications and aerial surveys in support of IMAS, using unmanned aircraft systems and a range of visible, multispectral, hyperspectral, thermal and Light Detection and Ranging (LIDAR) sensors.

Health Sciences. The Tasmanian Cognition Laboratory within the School of Medicine (Hobart) leads in the experimental investigation, and mathematical and computational modelling of cognitive processes that underpin decision-making, language, attention, memory, and learning where it contributes to the development of human capability and enhances cognitive and physical performance and survivability. This research is also contributing to the understanding of team processes and the optimisation of collective performance and organisational behaviour. The School of Health Sciences (Launceston) has an interest in enhancing health and human performance through nutritional modulation and supplementation, and via manipulation of training. Research in this area includes the assessment of energy expenditure, body composition and health and wellbeing in various populations from sedentary to elite and operating in a range of settings.

Food Science and Nutrition. The Centre for Food Innovation (CFI) at Scottsdale near Launceston is a joint UTAS and DSTG facility that is developing key processing and packaging technologies to make and test fresh-like, shelf-stable foods, and the development, testing and evaluation of specialised foods for high performance activities.

Computing Science. UTAS has considerable capability in collecting, managing, interpreting and visualising data. Sense-T is a partnership with CSIRO and the Tasmanian Government and was a first mover in the Internet of Things and big data. It allows acquisition, storage, processing, bundling, analysis and visualisation of near real-time data related to the physical world, and overlayed with a dynamic spatiotemporal component. The Human Interface Technology_Laboratory (HITL) co-located with AMC explores the configuration and application of advanced human-computer interface (HCI) technologies, incorporating virtual and mixed reality technologies with a focus on design, visualisation, simulation and gamification.