Capability Statement

Supporting Australia's Defence

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The University of Wollongong (UOW) is helping to meet the needs of Australia's Defence through our work in research and development, training and education.

In the past decade, UOW has delivered more than $18 million in defence-related research, with the University being a founding partner of the DMTC (formerly Defence Materials Technology Centre). The supply of high-quality and relevant research has been driven by UOW's strengths in engineering, materials and IT, although defence-related research is undertaken across the University.

UOW works with industry, government, universities and other partners, such as the Australian Nuclear Science and Technology Organisation (ANSTO), to deliver solutions and technology to the challenges faced by Defence.

Research at UOW that has been providing solutions for Australian-built defence equipment is also being adapted to meet the needs of small and medium-sized manufacturing enterprises.

UOW has a number of research capabilities that align with Defence priorities. These include:

- **Materials sciences** (Australian Institute of Innovative Materials, the Intelligent Polymer Research Institute, and the Institute for Superconducting and Electronic Materials)
- **Energy generation and storage** (Australian Institute of Innovative Materials and the Institute for Superconducting and Electronic Materials)
- **Welding, joining and automation** (Facility for Intelligent Fabrication and UOW Industry 4.0 Hub)
- **Information technology and cybersecurity** (Institute of Cybersecurity and Cryptology and the Decision Systems Lab)
- **Robotics and sensors, including trusted autonomous systems** (Facility for Intelligent Fabrication, UOW Industry 4.0 Hub, SMART Infrastructure Facility, and the Decision Systems Lab)
- **Medical countermeasures and chemical threats** - including toxicology, antimicrobial resistance and radiation protection (Centre for Medical Radiation Physics, Molecular Horizons, Centre for Atmospheric Chemistry, and the Centre for Environmental Informatics)
- **Enhanced human performance** (Centre for Medical and Exercise Physiology, and the Intelligent Polymer Research Institute)
- **Integrated intelligence** – including sonar and radar technology, and reconnaissance through artificial vision and crowd-monitoring applications (SMART Infrastructure Facility, Institute for Superconducting and Electronic Materials, and the Centre for Signal and Information Processing)
- **Other areas** including Internet of Things, decision support systems, maritime security and law, and use of drones (SMART Infrastructure Facility, Future Mobility Group, Australian National Centre for Ocean Resources and Security, and the Decision Systems Lab)

UOW is working with Australia's Defence in the priorities of trusted autonomous systems, cybersecurity, enhanced human performance, and material sciences and is part of the Defence Science Partnership Program with the Defence Science and Technology Group (DST Group).

A collaboration between the Decision Systems Lab at UOW and the University of South Australia (UniSA) is focusing on each university's strengths in data analytics and artificial intelligence.

UOW has made significant research and development contributions to major Defence projects, particularly in the fields of welding, robotics, automation and materials.

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UNIVERSITY OF WOLLONGONG AUSTRALIA

UniSA and UOW are working with the DST Group to assess where their combined AI capability can be applied to the newly released STaR (Science Technology and Research) Shots technology areas outlined in the *More, Together 2030* strategy document.

UOW is also a founding member of the new Defence Innovation Network (DIN), which brings together leading scientists and engineers from seven public universities in NSW. The DIN undertakes research focused on Defence priority areas, building on NSW's extensive defence industry capability and bringing to life the next generation of Australian Defence technology.

EXPANDING REGIONAL CAPABILITY

UOW is a founding member of the DMTC (formerly Defence Materials Technology Centre). The DMTC was established in 2008 as a partnership between Defence, industry and universities focused on delivering enhanced Defence and national security capabilities.

Research areas include the core activities of welding and joining, industrial automation and steel design, together with additive manufacturing, corrosion, advanced armour, and piezoelectric sonar. The work undertaken by UOW and DMTC is helping to expand regional defence capability and accelerate local competitiveness.

UOW has made significant research and development contributions to major Defence projects, particularly in the fields of welding, robotics, automation and materials. Projects include the Bushmaster and Hawkei armoured vehicles built by Thales Australia, maritime welding and fabrication for the Collins Class submarines and the Air Warfare Destroyers.

The team at UOW was responsible for the development of innovative automated offline programming systems for robotic welding of the complex hull of the Bushmaster vehicle, which has protected troops in some of the most challenging combat environments.

UOW's welding automation group forms a critical part of the contract awarded to Thales Australia to supply the Australian Defence Force with 1,100 Hawkei four-wheel drive heavily-armoured vehicles.

Across a range of emerging technologies, DMTC's Maritime Program is making a substantial contribution to industrial capability in Australia in support of the SEA 5000 Future Frigate program and the naval shipbuilding program more broadly.

Wollongong has a proud and successful history of providing innovative technology and services to both the Australian Defence Force and the global defence industry. The city is home to many large and established companies that have serviced the Defence industry for decades – many of which work with UOW.

SUPPORTING THE ROYAL AUSTRALIAN NAVY

UOW's engagement with the Royal Australian Navy (RAN) leverages the unique expertise of the Shoalhaven region, including Albatross Aviation Technology Park, HMAS Albatross, and local SMEs involved in advanced manufacturing.

UOW is a joint member of Shoalhaven Defence Industry Group (SDIG). The SDIG is an alliance between the local defence industry, Shoalhaven City Council, the NSW Government and the Shoalhaven Business Chamber.

UOW Industry 4.0 is currently engaging with Sikorsky Australia and Adroita. The strong partnerships between the hub, UOW, SDIG, HMAS Albatross, and Albatross Technology Park also help foster a workforce for the future that can deliver solutions to challenges faced by the Navy. These partnerships are well placed to position the Shoalhaven as a leader in RAN technology development.

There are four research groups across UOW that are actively engaged in naval research. These are the Decision Systems Lab (DSL), DMTC, the Australian National Centre for Ocean Resources and Security (ANCORS), and the Centre for Signal and Information Processing (CSIP).

The work undertaken by UOW is leading the way in providing naval shipbuilding research for new materials and processes. In addition to existing projects, UOW's Centre for Medical Radiation Physics (CMRP) is internationally recognised for the development of semiconductor radiation sensors and

Image supplied by Department of Defence

radiation transport modelling. There is potential for the CMRP's capabilities in radiation detection to be applied in naval technology.

UOW's engagement with the RAN includes:

- Navy funds a full-time academic at UOW to manage three naval research programs that incorporate nine other universities, three government research institutions and over 30 industry partners, both nationally and internationally.
- UOW is the only Australian university that represents the tertiary education sector on the Naval Shipbuilding Industry Representative Committee. This committee sets the national framework for naval shipbuilding skills and training needs.
- UOW has recently completed a six-year partnership with UTas Australian Maritime College and Flinders University for the ARC Industrial Research Training Centre for Naval Design and Manufacturing.
- UOW was commissioned to provide a report in 2018 to Defence and Cabinet for Australian Steel Making Capability for Naval Platforms, which influenced Australia's decision to endorse locally-sourced steel products for future naval shipbuilding projects.
- The Australian Institute for Innovative Materials (AIIM) at UOW and Distinguished Professor Shujun Zhang (recently listed as Australia's top ceramic engineering specialist) is central to a NGTF/DSTg/DMTC Advanced Piezoelectric Materials and Applications Program for next-generation sonar.
- UOW has recently partnered with QUT to collaborate on a NGTF/DSTg/DMTC-funded High Temperature Superconductor program for Mine Countermeasures and naval applications.
- BAE Systems Maritime Australia and ASC Shipbuilding are part of a project with UOW and ANSTO for weld modelling and distortion control for Hunter Class Frigates.
- Naval Group Pacific is collaborating with UOW researchers and CSIRO on additive manufacturing of submarine components.
- UOW recently completed a four-year investigation into Life of Type Extension of Collins steel grades and repair procedures.
- UOW collaborated with BlueScope Steel and DSTG on a DMTC project to enhance the naval shipbuilding steel for the Hunter Classic Frigate and received The Defence Science and Technology Enterprise Collaboration Award at the Australian Defence Science, Technology and Research Summit (ADSTAR).

Research at UOW that has been providing solutions for Australian-built defence equipment is also being adapted to meet the needs of SMEs.

MARITIME LAW AND SECURITY

The Australian National Centre for Ocean Resources and Security (ANCORS) at UOW has been Australia's leading research, education and training institute in ocean affairs and maritime security for over 20 years. It provides advice and training on ocean issues and maritime security to over 50 countries.

ANCORS' maritime security activities fall under the categories of research, education, training and advisory services. Expertise in maritime security involves policy, legal, technological and at-sea enforcement aspects. ANCORS is deeply involved with maritime border protection, the safety and security of shipping and global supply chains, security for offshore industries, and maritime domain awareness (MDA). MDA experience includes collaboration with government, industry and regional organisations to establish the ANCORS Vessel Tracking Initiative (VTI), involving work with both fisheries and merchant shipping sectors.

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ANCORS has collaborated with the Australian Border Force (ABF) and Maritime Border Command (MBC) for many years, supporting the Australian Government to enhance national maritime security through improved border protection measures. Every year, ANCORS undertakes capacity-building activities in maritime security on behalf of the Department of Foreign Affairs and Trade and ABF in Malaysia, Indonesia, Papua New Guinea, Vietnam and the Philippines.

Maritime security capacity-building programs at ANCORS have a global reach, but focus mainly on three maritime regions: Southeast Asia, the Indian Ocean, and the South West Pacific. In Southeast Asia, ANCORS facilitates the Maritime Security Desktop Exercise (MSDE) in Indonesia on behalf of the ABF and MBC to promote maritime security understanding and cooperation among the representatives of 22 Indo-Pacific region countries and territories. It has tested various scenarios related to combating piracy and armed robbery at sea, maritime terrorism and people smuggling.

For more than 20 years, ANCORS has partnered with the Defence Cooperation Program to deliver professional short courses. For example, ANCORS has partnered with the RAN to deliver a Maritime and Strategic Studies Period (MSSP) to the Indonesian Naval Command and Staff College (SeskoAL) annually since 1999 and to the Philippines since 2012. This is the longest continuously operating Defence Cooperation activity Australia has with Indonesia.

ANCORS has educated naval and coast guard officers from more than 12 nations in its Master of Maritime Policy degree under the Defence Cooperation Scholarship Program, which is focused on South and Southeast Asia and the South West Pacific. Naval and coast guard officers from 23 countries have completed UOW award courses with ANCORS at Masters or Graduate Certificate levels.

ANCORS has also undertaken substantial advisory work in the context of better inter-agency cooperation in maritime enforcement, as part of a large ongoing project for the Department of Foreign Affairs. This has included the delivery of desktop exercises and law of the sea training.

EDUCATION AND TRAINING

The Australian National Centre for Ocean Resources and Security (ANCORS) at UOW is Australia's only multidisciplinary university-based centre dedicated to research, education and training in ocean law, maritime security and natural marine resource management.

ANCORS was established as a joint venture between the Royal Australian Navy (RAN) and UOW in 1994. The centre has collaborated with the Australian Border Force and Maritime Border Command for many years, supporting the Australian Government to enhance national maritime security through improved border protection measures.

For more than 20 years, ANCORS has partnered with the Defence Cooperation Program to deliver professional short courses. ANCORS continues its close relationship with the RAN, particularly via its Sea Power Centre, and the Department of Defence.

Post-graduate training for Defence personnel is provided at ANCORS. The Department of Defence provides a number of scholarships each year for Navy and Coastguard officers from Asia-Pacific nations to undertake the Master of Maritime Policy degree at ANCORS.

UOW is a member of the Research Training Centre for Naval Design and Manufacture. This centre was established in 2015 specifically to provide training for future Defence personnel in the maritime sector. This is a collaborative centre funded by the Australian Research Council and comprises three academic institutions, industry and the DST Group.

UOW's Faculty of Business delivers defence-related programs including decision-making in complex environments, risk management, and technology implementation. The faculty's research areas and centres are also working with military personnel and contractors in the commercial and research space, particularly in the area of sustainability.

FACILITY FOR INTELLIGENT FABRICATION

The Facility for Intelligent Fabrication (FIF) was launched by UOW, TAFE NSW and Weld Australia in March 2018. The FIF has been established to help Australian businesses skill up to participate in manufacturing to support Defence.

The FIF offers a unique "one-stop shop" resource to help small and medium enterprises (SMEs) adopt technology to improve their competitiveness. The collaboration assists businesses identify and implement welding and automation-related technology, backed up with technical, education, training and certification support.

UOW INDUSTRY 4.0 HUB

UOW established the Industry 4.0 Hub in the Shoalhaven to specifically provide access to information, training, technology demonstrations and a link to UOW expertise and capabilities. This ecosystem provides a setting to learn about, workshop and implement Industry 4.0 principles such as (but not limited to) robotics, digital twins, smart systems, augmented and virtual reality.

The UOW Industry 4.0 Hub is strategically located in the Shoalhaven, as many SMEs in the region have the capabilities to contribute to the defence sector or are already involved. The Shoalhaven is also home to HMAS Albatross - the largest operational naval establishment and the RAN's only air station.

Engaging with Sikorsky Australia and Adroita, the hub is aimed at benefitting defence, manufacturing and agribusiness industries, which are key drivers of the Shoalhaven economy.

ROBOTICS AND AUTONOMOUS SYSTEMS

Research at UOW's Decision Systems Lab (DSL) includes the areas of autonomous vehicles, complex systems and decision making, and operations research.

The DSL has had significant engagement with a variety of Defence entities such as the DST Group, BAE Systems and Lockheed Martin Australia in the area of AI applications in Defence. A NSW Defence Innovation Network pilot project that DSL researchers are working on investigates autonomous systems and systems engineering in conjunction with BAE Systems.

Other focus areas include applied artificial intelligence, software analytics, oncology informatics, business process analytics, business process automation, and resilient system design. This work significantly supports UOW's collaboration with the University of South Australia (UniSA) in boosting defence industry research.

DSL researchers work closely with some of the largest IT companies in the world, including IBM Research, Xerox Research, Infosys Labs and Samsung. DSL has also collaborated in the past with Telstra, SunCorp, BlueScope Steel, Actenum Corp as well as government agencies such as the NSW State Emergency Service.

CYBERSECURITY AND CRYPTOLOGY

UOW's Institute of Cybersecurity and Cryptology (iC2) is well known worldwide for the training it provides in addition to initiating and implementing innovations in cybersecurity and this work helps to enhance the cyber capabilities of the Australian Defence Force.

Research areas of the Institute include: information security, cybersecurity; computer and network security; digital signature; encryption; anonymity; cloud and edge security; wireless and mobile security; cryptographic algorithms and protocols; blockchain; multimedia security; quantum cryptography; and post-quantum cryptography.

iC2 research results are widely cited and applied in practice, with continuous funding received from the Australian Research Council, the US National Institute of Standards and Technology (NIST) and industry partners such as DSD, DST Group, Microsoft, and the Department of the Prime Minister and Cabinet.

Researchers from UOW's Decision Systems Lab are collaborating across seven research projects to inform Defence of the potential benefits and practical limitations of cyber technologies.

INTELLIGENT POLYMER RESEARCH

The Intelligent Polymer Research Institute (IPRI) at UOW's Innovation Campus is renowned for expertise in the electrochemistry of organic conductors in applications such as artificial muscles, wearable and implantable energy sources, and biomedical applications.

Researchers are collaborating with the Australian Department of Defence (Land Division) and the DST Group to develop a new type of soft body armour using smart materials. The research has the potential to create flexible, high-performance body armour that meets various mounting requirements and field climatic conditions for combat personnel.

SUPERCONDUCTING AND ELECTRONIC MATERIALS

UOW's Institute for Superconducting and Electronic Materials (ISEM) works to advance technologies including batteries for electric vehicles and energy storage; applied superconductivity for electrical and medical devices; energy conversion and transmission; spintronic and electronic materials for applications; terahertz science; and nanostructured materials.

ISEM researchers are also working with the DST Group to provide knowledge and technology of relaxor-ferroelectric crystal growth, enabling advanced ultrasound transducers for ultrasound medical imaging and underwater acoustic imaging.

UOW's engagement with the Royal Australian Navy leverages the unique expertise of the Shoalhaven region.

LEARNING AND ARTIFICIAL INTELLIGENCE

Researchers from UOW's Centre for Signal and Information Processing (CSIP) within the School of Electrical, Computer, and Telecommunications Engineering are developing machine learning tools for maritime vessel surveillance using satellite imagery. This research has been funded by the Australian Geospatial-Intelligence Organisation and the NSW Space Research Network. Its outcomes have been applied to detect and identify sea vessels from synthetic-aperture radar and electro-optical images.

CSIP researchers are also developing AI algorithms for biometric applications, including age prediction from facial images, and post-mortem identification from iris images. This research has been funded by the Office of National Intelligence and Defence Science and Technology Group.

CSIP researchers have also developed AI tools for drone imaging to detect targets, especially agricultural threats. This research has attracted funding from the Department of Foreign Affairs and Trade, the NSW Government Tech Voucher Program, and a regional start-up company.

Through several real-world and Defence-initiated projects, the CSIP also trains the next generation of researchers with skills in artificial intelligence and machine learning.

IoT AND INTELLIGENT SENSORS

The SMART Infrastructure Facility at UOW has proven expertise in Agent Based Modelling (ABM) and in Model Based Systems Engineering (MBSE) which are used in defence and infrastructure applications.

The facility's dedicated researchers have experience working on Defence projects with the DST Group and US Defence organisations.

SMART research in the areas of social media data analysis, intelligent sensors and the Internet of Things (IoT) have enormous potential in Defence applications, from monitoring suspicious social events for terrorism threats to tracking and managing Defence assets.

REMOTE UNDERSEA SURVEILLANCE

Researchers within UOW's School of Electrical, Computer and Telecommunications Engineering continue to work on enhancing technology to automatically detect underwater mines.

The focus is on enhancing existing advanced machine learning within SonarDetect software, which was developed by DST Group. Sonar-equipped uninhabited underwater vehicles (UUVs) have been developed to not only provide images of the seabed, but to alert people to look at certain objects and make a decision.

This work is a collaboration between UOW, DST Group, Macquarie University, Western Sydney University, and Solutions from Silicon Pty Ltd.

NON-GPS NAVIGATION AND POSITIONING

UOW's School of Electrical, Computer and Telecommunications Engineering has led a project funded through the NSW Defence Innovation Network (DIN) on non-GPS Based Positioning, Navigation and Timing (PNT) Solution for Reconnaissance Missions.

Researchers investigated approaches to using existing Radio Frequency (RF) signals (including WiFi, LTE, television or radio broadcasting, and ultrasonic signals) as RF beacons for non-GPS navigation and positioning. The objective was to discover the potential for these RF solutions for PNT that can be quickly and securely deployed in areas that are less susceptible to jamming where GPS is not available.

RADIATION IN SPACE TRAVEL

UOW's Centre for Medical Radiation Physics (CMRP) is a world leader in the development of semiconductor sensors for radiation dosimetry and microdosimetry.

This research has developed detectors that can measure the background of galactic cosmic rays (GCRs) in aviation and space applications – how much radiation pilots and astronauts are exposed to during long-term space missions and high-altitude flights.

The CMRP works closely with many international institutes, including the National Space Biomedical Research Institute in the United States.

ENHANCED HUMAN PERFORMANCE

UOW's Centre for Medical and Exercise Physiology first partnered with the Department of Defence in 2000 and in subsequent years the Defence Science and Technology Group.

The extensive research relationship has extended in excess of two decades and $8 million in Defence funding. In that time, the Centre has applied its expertise to assist all three arms of the Australian Defence Force across a wide range of human physiology contributing to an individual's lifespan health.

This includes: assessing the impacts of body armour and specialist clothing on thermoregulation in hot and cold environments; establishing effective physical training and monitoring practices to optimise physical fitness gains while reducing musculoskeletal injury in recruits; assessing the physiological demands, human performance and soldier capacities in critical military tasks; and establishing the effects of basic military training on the omega-3 status of recruits.

UOW's translation to practice in Australian Defence has been recognised with invitations to provide keynote presentations and position statements with international collaborators, to the global Defence audience.

AUTOMATED MOBILITY

Partnered with UQ, QUT, RACQ and LICENSYS, UOW's SMART Infrastructure Facility is contributing to a project investigating dynamic mixed reality environment development for future mobility. In collaboration with Hover UAV and NSW Defence Innovation Network (DIN), SMART is exploring flexible and dynamic solutions for cooperative operation of ground vehicles and UAVs for emergency and disaster management.

CUTTING-EDGE STEEL AT PORT KEMBLA

Specialist steel for armoured vehicles, navy vessels and renewable energy installations is to be manufactured at Port Kembla with the involvement of UOW researchers.

In March 2022, it was announced that a new Advanced Steel Manufacturing Precinct around BlueScope's Port Kembla Steelworks is being funded under the Australian Government's Modern Manufacturing Initiative. The precinct includes a new facility that will be able to produce plate steel for armoured vehicles and ocean vessels. This will reduce the need for overseas imports and secure our sovereign capability in steel fabrication.

"BlueScope wants to ensure that it takes full advantage of the modern Industry 4.0 manufacturing principles, which is where UOW's expertise comes in," says Facility for Intelligent Fabrication Acting Director Dr Phil Commins.

UOW WELCOMES THE OPPORTUNITY TO WORK WITH GOVERNMENT AND INDUSTRY PARTNERS TO DELIVER EXCEPTIONAL OUTCOMES

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