Summary of UoN / DIN / Pacific-ESI PHD PROJECT

PROJECT TITLE:	Naval vessel response under adverse conditions
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The central objective of the project is to ascertain the feasibility and the economics of applying a meshless numerical technique, the so-called Finite Pointset Method, based on Lagrangian principles, to generate (numerical) sea states for application to finite element models of naval vessels.

A critical part of the project is the comparison of the capabilities of FPM to generate extreme sea states (wave heights and the like typical of severe sea storms and wave conditions) against the technique currently being employed in an Australian Research Council (ARC) Linkage project (LP 190101283) in which the so-called Smoothed Particle Hydrodynamics (SPH) technique is being used. SPH was the technique of choice at the time this Linkage project commenced. But since then, some evidence has been forthcoming that FPM may be faster, more accurate and hence more practically useful then SPH. This evidence needs to be critically evaluated.

At present there are no known efforts anywhere using FPM for the modelling of sea states and wave actions, and integrating these with the response of a vessel such as a ship. There is no doubt that this work will be highly original and without competitors.

Methodology for the project is straight-forward. The PhD candidate will carry out a survey of FPM and how it works, supported by and in conjunction with, the Pacific-ESI team members and more importantly with the expert advice from ESI team in Europe, the last of these largely by Zoom/Teams meetings.

Using existing FPM software to be made available by Pacific-ESI, the project will develop the capability to simulate sea states of various intensity and have wave actions and forces interact with a 'flexible' ship, this work being done in parallel with the existing approach used for SPH but within a different numerical and modelling setting.

Partners and Facilities

UoN has an exemplary track record in research and development, particularly in marine corrosion, as demonstrated by successive research grants, both from the ARC and industry, extensive relevant publications and many PhD graduates and consulting projects.

UNSW has extremely good computing and experimental facilities used for concentrated research in coordinated critical masses and in the area of infrastructure and safety. In these areas it has a group of researchers with very strong track records. The Faculty of Engineering at UNSW has a computational cluster currently consisting of 2,944 compute cores and 5.8 TB memory, available free of charge to the project team.

Pacific-ESI is an Australian engineering consulting house with an enviable reputation for delivering leading edge technology to industry, government and academia. It engages principally in scientific software development and enhancement. The skills that will support the present project build on a recognised track record in industry-oriented research and development, including to high profile local and overseas organizations including Defence Science and Technology (DST), Boeing, Airbus, Nissan, Ford, Honda, Downer Rail and others. Further, Pacific-ESI has participated in large local research programs, including 17 years in the CRC for Advanced Composite Structures (CRC-ACS) and 12 years with the (similarly structured) Defence Materials Technology Centre (DMTC). Both have included working with DST. Pacific-ESI also has collaborated with major R&D organizations such as CSIRO in Australia, DLR in Germany and NASA in the US.

The contributions from Pacific ESI will exploit, through their contacts, the very significant, long-term, experience ESI staff have in Europe in application of FPM to scenarios such as (motor) vehicle impact and collisions and aeroplane and defence aircraft on-land and on-water crashlanding scenarios. The ESI experts in Europe have indicated their interest in the project and their 'in-kind' assistance, funnelled through Pacific-ESI staff in Australia. Taken together such contributions have been estimated, conservatively, to be worth about $10,00 per annum.

Pacific-ESI will support the project through the use of its 156-core computer system. In addition, the High Speed computational facilities at DST Group may be available for the project.

DST Group is part of the Department of Defence and is the national leader in safeguarding Australia by delivering valued scientific advice and innovative technology solutions for Defence and national security. It is the second largest public R&D organization in Australia and has a long history of ground-breaking advances in science and technology.

Investigators

Prof Robert E Melchers (UoN) will take overall responsibility for the project, and work closely with Prof Chongmin Song and the staff at Pacific ESI to ensure the project is borne to fruition, He has a strong background in development of mathematical models, has a long-standing association with DST Group and has strong industry links. He holds a 100% research position at Newcastle, holds 2 ARC Discovery grants in related areas, as well as ARC LP and other research grants with, for example, the National Decommissioning Research Institute. He has been an expert advisor for a number of projects and was part of the team investigating weld issues with the Collins Class submarine. He has supervised more than 25 PhD research students.

Prof Chongmin Song (UNSW) has a strong background on computational mechanics and structural engineering. He holds several research grants including 2 ARC Discovery grants, and the on-going ARC LP project. He has published 2 research books and more than 140 refereed journal papers and given more than 12 keynote addresses. He has supervised more than 20 PhD research students during his academic career.

Damian McGuckin (industry partner Pacific-ESI) has over two decades of collaboration experience with domestic and international researchers across a diverse range research projects

The importance of the project to Defence and to industry generally is reflected in the comments by Rear-Admiral Wendy Malcolm, Head of Maritime Systems, RAN: '*shipbuilding is sexy, but sustainment pays the bills*', and further: '*... it is critical we make the right acquisition decisions, but ... it is equally important that we invest in ... the infrastructure ... to sustain and maintain the Royal Australian Navy's fleet and capabilities*'. These comments also reflect assessments by the Department of Defence in 2017.