THE FUTURE SUBMARINE - AUSTRALIA'S SCIENCE, TECHNOLOGY AND ENGINEERING CHALLENGE OF THE 21ST CENTURY

WELCOME TO THE

GOLD SPONSOR babcock

Welcome

Welcome by President of the SIA – Peter Horobin

Welcome to the Inaugural Submarine Science, Technology and Engineering Conference of the SIA. The Conference is being held at a time when these issues are at the forefront of the public discussion about submarines. It is appropriate that this inaugural conference be held in the city which will yet again host the construction of new submarines and we thank the state of South Australia for its support in bringing this conference to you. We also acknowledge the contribution by the Australian Society for Defence Engineers (and its parent, Engineers Australia) in supporting the review and publication of the many technical papers. While this conference started as a germ of an idea in the head of Captain Chris Skinner to hold an informal set of technical discussions of about a half-day in conjunction with the usual off-year SIA Workshop, it has become a significant event and seems likely to feature regularly in the SIA calendar. The high quality of these documents is testament to the efforts of all the authors and the Technical Committee.

The future of submarines in Australia depends not just on the selection of an appropriate design and of its construction. It rests firmly on the shoulders of the engineering community both for design and sustainment. The engineering community itself needs to grow to meet the demands of a burgeoning maritime industry and the Future Submarine truly is the engineering challenge for Australia in the 21st century.

I urge you to listen, learn and contribute to the many discussions that will take place over the next three days.

In support of all these activities the Institute is pleased to acknowledge the generous contributions which our sponsors have provided. The names of our sponsors are prominently displayed in the conference literature and here at this magnificent venue.

Peter Horobin MBE, FAICD

Peter Horobin enjoyed a naval career mainly in submarines. On leaving the service, he established a strategic consulting business. He was the founding president of the Submarine Institute and Chairman of the National Submarine History Task Force which established the submarine Ovens as an exhibit in the Western Australian Maritime Museum. He is the current president of the SIA and is the Director of Underwater Business for James Fisher Defence.

Master of Ceremonies – RADM Peter Clarke RAN Rtd

Since March 2006, Peter has been a non-executive director of Signature Security Group. Appointed by the new owners, Allco Equity Partners (now Oceanic Capital Partners), Peter focused particularly on the development of the leadership team, and defining and reducing corporate risk. During this period, Signature has grown steadily against the sector trend. The signs are now good for the company's future.

Peter has built a successful and profitable consulting business based in Sydney and Canberra. The practice involves executive leadership development of individuals and teams, mentoring systems and executive coaching. Peter's clients include public and private companies, and federal and state government agencies.

Before 2004, Peter served the Australian Defence Force as a Rear Admiral. He set up and headed the division responsible for leading a transformation in Australia's defence philosophy. This involved adopting the new and very different approach of effects based thinking as part of a much broader understanding of the threats to our national security. Other appointments included two pivotal roles in one of Australia's most demanding endeavours: the Collins class submarine program, namely;

commanding the Australian Submarine Group during which he led significant cultural change, bringing the Collins Class into operational service – a technology leap of more than twenty years for the crews – and

managing the submarine building project during its get well program.

Formerly in the British navy, Peter commanded a nuclear submarine in the latter stages of the Cold War and, earlier, a diesel submarine. He worked in a central policy and intelligence areas in London and led cultural reform at the Royal Navy's officer training college, Dartmouth.

Peter has always been at the forefront of change; melding experience and tradition with a desire to do things differently and better. He is enjoying bringing this experience to the corporate environment in which he finds many familiar and some new challenges. His mantra is reducing leadership risk.

Peter is also Chairman of the Canberra based not-for-profit, Menslink.

Peter is married and lives in Canberra. With two young daughters, he has every expectation of working for many years to come.

SIA Corporate Sponsors

Raytheon Australia DCNS JACOBS

DSTO & DASI

SESSION 1

SUBMARINE SCIENCE 1ST SIA TECHNOLOGY CONFERENCE 2011 TECHNOLOGY AND ENGINEERING

TRENDS IN AUTONOMOUS UNDERWATER VEHICLES

Anthony Finn – Research Professor of Autonomous Systems at the Defence And Systems Institute (DASI), University of South Australia.

Anthony Finn is Research Professor of Autonomous Systems at the Defence And Systems Institute (DASI), University of South Australia. He has published two books and authored around eighty book chapters, journal articles, research reports, and refereed conference papers. He has been the recipient of a number of international awards for his research, his work has formed the basis of submissions to a number of governmental and international bodies, and he has been called as an expert witness in a number of criminal trials. Anthony graduated from Cambridge University in 1989 with a PhD in Satellite Navigation. Prior moving to South Australia in 1991 to join the Defence Science & Technology Organisation (where he held a number of different positions of research leadership) he worked in industry and as a research consultant for a number of commercial and government organisations in Europe. His current research interests lie in autonomous and unmanned systems - and multi-vehicle or 'systems of autonomous systems' in particular - but he has a wide-ranging background in technology and systems engineering generally.

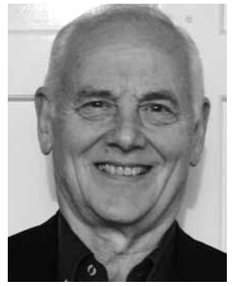
The introduction of unmanned underwater vehicles into military and commercial markets has been a slow and costly process for those involved. This talk will provide an overview of the chronology of the developments and discuss state-of-the-art, emerging technologies, and hurdles that must be overcome as we move into the future. In particular, it will consider key issues relating to the "long pole" technologies associated with these complex systems.

THE REQUIREMENTS FOR DEFENCE S&T IN THE FSM PROGRAM

Dr David Kershaw - Acting Research Leader Submarine Operations Acting SEA 1000 S&T Adviser DSTO

David Kershaw started in Defence as a Cadet Engineer with Navy Material in 1987 and transferred to DSTO in 1989. He holds a B.Sc(Hons) in Physics, a B.E in Electrical and Computer Systems Engineering and a PhD in Tracking Systems. Positions held within DSTO have included Head of Torpedoes & Torpedo Defence Group (1999 through to 2002), Navy Scientific Adviser (2003-04), Air Warfare Destroyer S&T Adviser (2005-06), Acting Research Leader in Surface Ship Operations (Sept 2006- March 07), Head Torpedo Systems Group (2007-2010), and Head Submarine Combat Systems Group (May 2010 – present). As Head of Submarine Combat Systems he was leading the DSTO Combat System program in support of both the Collins Class Submarine and the Future Submarine. He has been the Acting Research Leader Submarine Operations and SEA 1000 S&T Adviser since late July 2011.

A Future Submarine Program is technically challenging undertaking for any country. If the program is to succeed then it will need to be underpinned by an extensive Defence Science and Technology (S&T) program. In this presentation I will discuss the types of Defence S&T required to support the program, both now and into the future, and the strategies that are being employed to deliver the S&T program.



SUBMARINE SUPPORT – LESSONS LEARNT THE HARD WAY

John (Jock) Thornton, FIEAust; MIMechE; MIMarEST. Bio

Born and educated in Scotland, Jock Thornton joined the Royal Navy in 1962 and, after qualifying in marine engineering at the Royal Naval Engineering College Manadon, he specialised in nuclear submarine engineering. He served in HM Submarines REPULSE (SSBN) CHURCHILL AND CONQUEROR (SSNs) and in a number of submarine operational and support appointments, culminating in his appointment as Submarine Flotilla Marine Engineer Officer. Jock joined ASC in 1989 and in his ten years with the company, filled a number of general managerial roles including ILS, Certification & Commissioning and. finally, General Manager Technical. After time in Malaysia with PSC (Naval Dockyard) and Williamstown with Tenix Defence, he joined the Defence and Systems Institute at the University of South Australia as a senior lecturer in military systems integration.

Jock Thornton joined submarines in 1969 when the Royal Navy Submarine Service was undergoing a rapid transition from one which was still heavily influenced by the experiences of the wartime generation to one where the demands of nuclear propulsion and the deterrent were challenging those older traditions. Nowhere was this more apparent than in the engineering specialisations and in how they supported the growing operational requirements of the Cold War. By the time he left the service to join ASC in 1989, the advent of the Collins Class was having a similar impact on the RAN as the nuclear experience had had in UK. In both countries the advent of commercialisation placed further strains on submarine support practices and organisation, often with unintended and undesirable consequences.

Jock will look back over the lessons he has learnt during this time - often the hard way - and offer some suggestions on how those lessons remain as relevant now as they were then.

SYSTEMS ENGINEERING - THE KEY TO SUCCESSFUL SUBMARINE BUILDING

Prof Stephen Clive Cook, BTech, MSc, GradDip, PhD, CEng, FIET, FIEAust, CPEng.
Director, Defence and Systems Institute University of South Australia
Associate Professor and Research Leader: Enterprise Process Capability
Director, Defence and Systems Institute, University of South Australia

Bachelor of Technology in Electronics Engineering, South Australian Institute of Technology, 1977

Master of Science in Programmable Electronics (Computer Science), University of Kent, Canterbury, 1981. Graduate Diploma in Electronic Systems (Communications, Computer Science and Measurement Science), University of South Australia, 1990. Doctor of Philosophy in Measurement and Instrumentation (Measurement Science, systems Engineering & Artificial Intelligence), City University, London, 1991.

Prof Cook brings to the University of South Australia the benefit of a varied career in industry, defence research, and academia. He commenced his career in design engineering in the telecommunications industry and after four years he moved to the defence industry for six years. During his industry period, he worked on the design of 13 projects that produced products and systems that entered production and service. The highlight of this period was his time as the Starlab Project Engineer during which he led a team of engineers in the development of the electronics subsystem of a UV space telescope.

In 1988, Prof Cook joined the Defence Science and Technology Organisation as a Principal Engineer to pursue a research career in defence communications. This research covered modem developments, error-control coding, adaptive link control, network modelling, and systems studies. The success of this work was recognised by the Secretary's Award for Achievement and his promotion to Senior Principal Research Scientist in 1994. In this role, Prof Cook also regularly consulted within the Department of Defence on systems engineering issues associated with large defence communications projects.

In 1997, Prof Cook was seconded to the University of South Australia to head a joint DSTO/UniSA initiative in systems engineering research and education that has grown into the Defence and Systems Institute. The DASI role has enabled him to span a wide variety of professional activities including courseware development, and research and consultancy in system safety modelling, systems engineering tool research, defence systems of systems practices, and the architectural design and acquisition of complex systems.

He has published over 200 articles and reports in a variety of areas including defence communications, systems engineering, and aviation safety modelling.

Prof Cook holds a bachelor's degree in electronics engineering from the South Australian Institute of Technology, an MSc in computer science from the University of Kent, UK; a Graduate Diploma in electronic systems from the University of South Australia; and a PhD in measurement science and systems engineering from the City University, London, UK.

He is a Fellow of the Institution of Electrical Engineers (UK), a Fellow of the Institution of Engineers Australia, Past President of the Systems Engineering Society of Australia, a member of INCOSE, and a Member of the Omega Alpha Association: the international honour society in systems engineering.

The International Council on Systems Engineering proclaim that "Systems Engineering is an interdisciplinary approach and means to enable the realization of successful systems. It focuses on defining customer needs and required functionality early in the development cycle, documenting requirements, then proceeding with design synthesis and system validation while considering the complete problem …". While it has been known for many years that significant expenditure on early project definition and de-risking activities is very strongly correlated with project success, it has only been very recently that new research results have emerged that indicate how best to allocate that effort. This presentation will provide the latest research findings on the return on investment in systems engineering and the findings it provides on when best to undertake certain tasks and how to allocate project effort over time.

THE FUTURE SUBMARINE – AUSTRALIA'S SCIENCE, TECHNOLOGY AND ENGINEERING CHALLENGE OF THE 21ST CENTURY

TEST & EVALUATION AND TRIALS MANAGEMENT – TIMING IS EVERYTHING

Dr Vivian Crouch

Viv is currently a Senior Lecturer and Course Coordinator for the Principles of Test and Evaluation course that is offered by the Defence and Systems Institute (DASI) at the University of South Australia. Prior to this appointment, Viv had 30 years of experience in Research, Development, Test and Evaluation [RDT&E] where he held several appointments within the Australian Department of Defence and the Defence Science and Technology Organisation. This experience incorporated significant exposure to multi-lateral cooperation and collaboration on a variety of Research, Development and Test and Evaluation (RDT&E) programmes.

Viv holds a Bachelor of Technology in Electronic Engineering (Australia, 1977), a Masters Degree in Engineering (Australia, 1997) and a Doctor of Science in Strategic Science (UK, 2005). In 1995 he was awarded the Society of Military Engineering Medal for 'Leadership in T&E' – and he also holds a number of citations from federal agencies in the United States such as NASA and the US DoD.

His current research interests include national RDT&E infrastructure investment planning. This includes the tools to facilitate this – such as bringing connectivity between live, virtual and constructive simulations – along with the strategic facilitators which include national, regional and international critical infrastructure planning.

Preparing for the challenges that will accompany a future submarine capability - all the way from concept genesis through to operational reality - requires an effort that results in a clearly articulated vision and significant strategic insight.

This raises new challenges for all steps in the capability development process so we can tell how well we are doing to enable each step to be successfully passed. And this activity needs to be resourced and 'timed' so that any errors of judgment are detected early enough to be remedied as quickly and cheaply as possible.

The presentation will look at some major lessons we should all learn as a result of similar major capability development programmes – where the need to integrate, as early as possible, the Test and Evaluation (T&E) community into the process itself was made evident.

Given that the needed strategic insight does not reside in one person – but requires a collective wit and wisdom – it also requires insight that goes beyond a national perspective to address the international implications.

It is a given that no one country owns all the test resources it needs and the presentation concludes that 'timing will be everything' for all aspects to be properly considered – from the plausibility testing of the envisaged operational scenarios – to concept development and exploration – to the verification and

validation of the selected concept and its ultimate 'real-world' realization.

SIA 2011 – NETWORKED SUB SEA COMMUNICATIONS

Alessandro Ghiotto

Alessandro Ghiotto has worked in underwater acoustics for L-3 Nautronix for 12 years. As a senior analyst he is focussed on the design and testing of new technology and production systems. He is a key contributor to AUSSNet, which is a Capability Technology Demonstrator of an underwater surveillance network that uses acoustic and satellite communications. Other areas of interest include sonar performance analysis, underwater target tracking, and acoustic signature measurement and susceptibility assessment.

Networked Sub sea communications promise inter-connectivity between multiple underwater platforms, including dived underway submarines, unmanned vehicles and autonomous sensors. These networks may also extend to provide connectivity with the broader terrestrial network through communication gateways. There are however significant and well known challenges which have thus far limited the underwater transfer of information in most circumstances to very simple exchanges. Many of these problems now have Australian technology solutions which provide the basis for viable and practical underwater networks. The solutions include significant advances in acoustic communication technology, and an application of relevant computer networking principles to the underwater environment and its associated constraints.

The concept has been demonstrated with a seabed based autonomous underwater surveillance network, which is accessible through satellite and acoustic communications. This presentation gives an overview of some of the relevant new algorithms and technology, recent trials results, outstanding challenges and future directions.

DESIGNING AND BUILDING AUSTRALIA'S FUTURE SUBMARINE

Mr James (Jim) Duncan

- Weapons Electrical Engineer Royal Australian Navy.
- Engineer and Manager Thorn EMI Electronics Australia and Technology Transfer Manager, resident Honeywell's, Marine Systems Division, U.S.A.
- Director Commercial, South Australian Department of Marine and Harbors
- Director, Major Projects. South Australian Department Of State Development – Cooper Basin, Roxby Downs, Port Bonython, Alice to Darwin Rail, Tasman submarine communications cable.
- Deputy Director Department of State Development and Technology and Director South Australian Government's bid to establish a submarine construction facility for the Collins Class submarines at Osborne.
- CEO Dapoli Corporation - acquisitions, mergers and takeovers - Defence industry related companies.
- Director Development, Baulderstone Hornibrook – Civil and mechanical engineers.
- Managing Director Hornibrook NGI Pty Ltd – structural and mechanical engineers, shipbuilders,
- Founder Fibretech Developments Ltd – bio technology.
- Past Directorships - Australian Design Council S.A, South Australian Tourism Board and the South Australian Government's Defence Industry Advisory Board
- Past advisory engagements - Leighton Holdings, John Holland and, Austal Ships Ltd. South Australian Institute of Technology's Centenary Commission
- Current Directorships include MPC Pty Limited, Global Marketing Australia and ACN Pty Ltd.
- Currently Australian Representative TKMS, Australian Submarine Project

The Request for Tender seeking replacement for Australia's Oberon submarines attracted offers from no less than seven competent submarine design and construction companies. It could be argued that if the same RFT was issued today only two of the companies could still meet all of the original qualifying pre conditions – in particular a company capable of "ab initio" conventional submarine design and with the proposed design in service or about to enter service with the parent navy. As history shows these were wise, albeit unenforced, pre-qualifications. Failure to stick with the pre qualification conditions gave rise, as many would recall, to the "paper boat" argument but more significantly it opened the way for Australia to acquire what was a prototype submarine – a largely untested design with inherent technical risks.

The true capital cost and the opportunity cost resulting from the decision to "Australianise" the (Type 471) Collins Class design becomes apparent as the life of the class progresses. A rule of thumb of the relative cost ratio of 1-Design; 3-Construction; 7- Cost of ownership can tells us a lot about the cost-effectiveness of the Collins Class and the validity of the reasoning behind the original equipment acquisition strategy and its expected outcomes. Looking back at the Collins project it is reasonable to surmise that with the benefit of hindsight Australia would have done many things differently. Will the lessons be heeded in the Future Submarine Program? Decisions taken in the coming months will be critical to Australia laying down a successful blueprint to acquire and deploy an enhanced submarine warfare capability through to the middle of this century and beyond.

Even the most experienced submarine designers sometimes fail to meet critical performance benchmarks. In reality the design of a modern state-of-the-art-submarine should never an exercise from first principles – it is never just a paper boat. A new design is the result of meticulous applied science and incremental engineering evolution and experienced across many designs over many years. Even so the risks, on all submarine programs, are great and even small failures can seriously impair the integrity of the design.

Theoretical capability designed into a submarine to take it beyond the state-of-the-art envelope, a step too far, will have operational consequences. Knowing where the tipping point is between the holy grail of the technological edge and an impaired unreliable submarine design is, in essence, nothing more than experience.

NOW SURFACING:

THE GREATEST CELEBRATION OF AUSTRALIAN SUBMARINES

IN A HUNDRED YEARS.

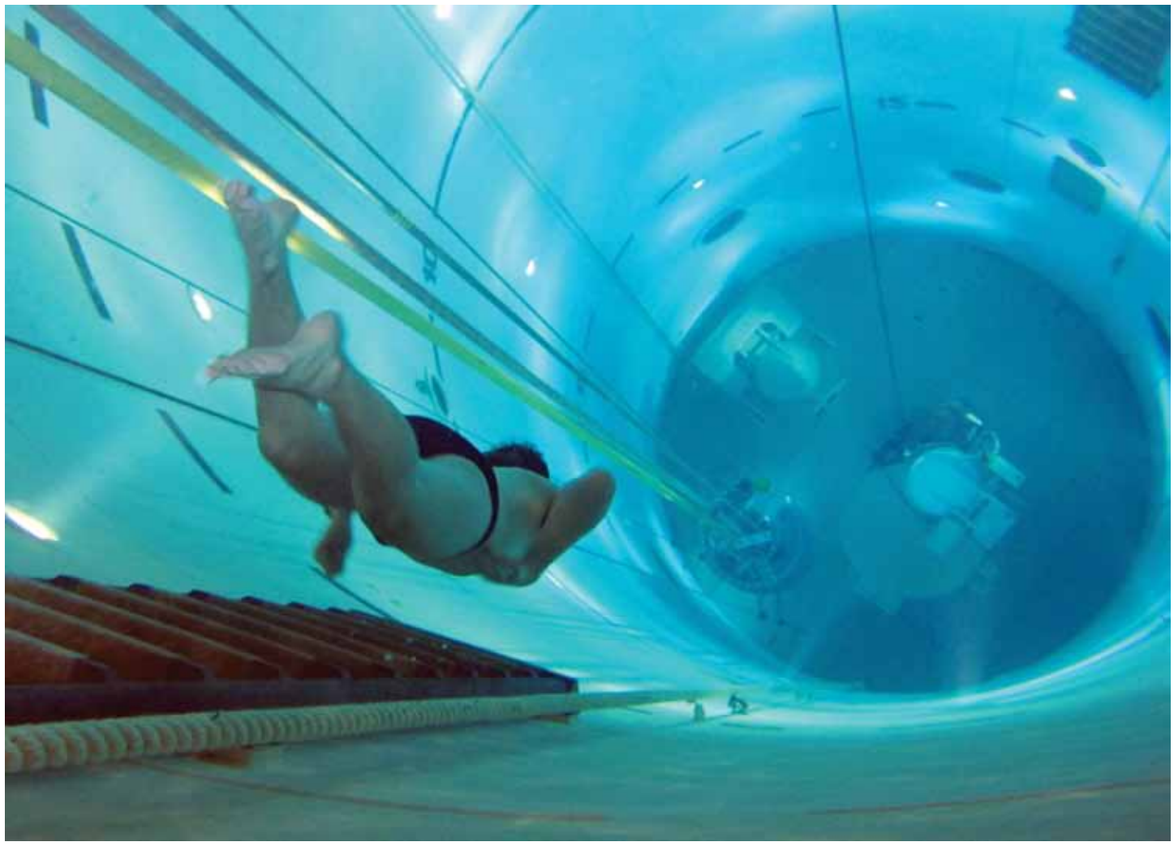
IN A HUNDRED YEARS.

TSP150711

Academia & Industry SESSION 2

SUBMARINE SCIENCE TECHNOLOGY AND ENGINEERING

1ST SIAST TECHNOLOGY CONFERENCE 2011



RECENT DEVELOPMENTS IN SUBMARINE VIBRATION ISOLATION & NOISE CONTROL

Dr Carl Howard - University of Adelaide School of Mechanical Engineering

Dr. Carl Howard works at the University of Adelaide in the School of Mechanical Engineering as a researcher and lecturer and specialises in the fields of acoustics and vibrations. He has developed technologies that can be used to reduce the noise and vibration from machinery inside submarines, and hence reduce their acoustic signature. He has undertaken collaborative research work with DSTO, US Air force, SA Water, and others. Before joining the University of Adelaide he worked at the United Technologies Research Center in Connecticut, USA, in research and development for their business units, and as an acoustic and vibration consultant for Colin Gordon and Associates in San Francisco, California, USA, in the design of low vibration manufacturing facilities for semi-conductors. He has published 70 papers in conferences and journals and has 3 patents in the field of acoustics and vibration.

Vibration isolation and noise control technologies are used in submarines on multiple systems and there are various reasons for employing these technologies. One of the principal reasons is to minimise the acoustic signature of the submarine so that it is difficult to detect. This paper contains descriptions of conventional and emerging noise and vibration isolation technologies that have and could be applied to submarines.

DEVELOPMENTS IN COMPRESSION IGNITION ENGINES

Prof Manfred (Fred) Zockel, School of Mechanical Engineering University of Adelaide

Prof Zockel graduated from The University of Adelaide with first class honours in 1962. This was followed by work on a Vane Type Rotary Engine for the ME degree and in 1963 he joined the then Aeronautical Research Laboratory (ARL) at Fishermans Bend, Melbourne. His responsibilities included small engine analysis and high temperature fuel cell development. At the end of 1964 he received a Department of Supply scholarship to study for his Ph.D. at St John College, Cambridge. The thesis, entitled "Impact of a high Speed Jet on a Surface", dealt with the fuel injection characteristics of diesel engines. On return to ARL in 1967 he worked on the analysis of a Constant Volume Combustion Gas Turbine and the development of a pulsed combustor for such an engine.

In 1973 he joined the staff of the School of Mechanical Engineering at The University of Adelaide where he taught mainly thermodynamics and design, and researched liquid phase LPG injection as well as noise control of machinery. After a stint as Dean he spent a sabbatical at the South Australian Centre for Manufacturing in 1986 and then continued there as a part time consultant until 2000 on product development. Another sabbatical was spent at Robert Bosch in Germany on the development of 1000 bar diesel injectors and pumps with yet another sabbatical at Purdue University in the USA where he helped rank the noise sources of a diesel engine and identified that the additional noise from an accelerating engine is directly proportional to the extra fuel supplied to the engine.

Since his retirement in 1996 he has been active as a consultant on mechanical failures including the engines failure of the Whyalla airline disaster and the mechanical failure of the Spin Dragon at the Adelaide Show.

After a brief history of Diesel engines the characteristics of the diesel engine will be compared to other common power plants. This will be followed by an explanation of the fundamentals of the compression ignition (CI) combustion process and the requirements of the injection system. The traditional mechanical system will then be compared with the latest electronic systems with explanations of how these new injections systems affect the characteristics of the engine. A discussion of the influence of turbo chargers and emission controls on the engine characteristics will conclude the paper.

EXPERIMENTAL AND COMPUTATIONAL INVESTIGATION INTO THE HYDRODYNAMICS OF CONVENTIONAL SUBMARINES

D. Ranmuthugala, Australian Maritime College, University of Tasmania, Australia

Dr Dev Ranmuthugala is the Associate Dean, Teaching & Learning, and Associate Professor in Maritime Engineering at the Australian Maritime College, University of Tasmania. He has also served as Head of Department in Maritime Engineering and Vessel Operations over the past 15 years. Prior to joining AMC, he worked as a marine engineer and in the design and sales of piping systems. His research includes: experimental and computational fluid dynamics to investigate the hydrodynamic characteristics of underwater vehicles, behaviour of submarines operating near the free surface, stability of surfaced submarines, towed underwater vehicle systems, and maritime engineering education.

It is important to understand and optimise the hydrodynamic characteristics of a submarine in order to improve its propulsive efficiency, operational characteristics, and manoeuvring capabilities. In addition, conventional submarines are required to operate in a near surface condition further affecting the behaviour of the vessel. The Australian Maritime College (AMC) in collaboration with industry partners, are carrying out a range of numerical and experimental works aimed at identifying and optimising these hydrodynamic characteristics under various design configurations and operational conditions. Current work includes: investigating the added resistance and adverse vertical forces and moments on submarines operating near the surface, specifically quantifying the effects due to varying depths, speeds, length to diameter ratios, and different sail configurations; developing dynamic simulation models to predict the hydrodynamic characteristics of submarines during prescribed manoeuvres; and investigating the stability of surfaced submarines.

The analytical investigation is carried out using commercial and open source CFD software to develop appropriate simulation models to understand the behaviour of submarines under varying conditions. This enables the prediction of relevant hydrodynamic characteristics, including forces, moments, coefficients and flow profiles under various operational and manoeuvring conditions, thus enabling AMC to develop suitable simulation models to investigate and optimise design and operational aspects. These include modifying software and developing new models to meet the requirements unique to the operation of such vehicles. The numerical modelling is supplemented by experimental work of captive scaled models in AMC's towing tank, model test basin and circulating water channel, including the use of a Horizontal Planar Motion Mechanism (HPMM) for underwater vehicles. The experimental data adds to the information available, whilst enabling the evaluation and validation of the numerical work. The numerical simulation models have shown agreeable correlation with experimental data. The results have provided information to improve design and operational configurations.

SUBMARINE ENERGY & PROPULSION CONSIDERATIONS

David Williams is a Senior Electrical Engineer at Deep Blue Tech (DBT)

David Williams is a Senior Electrical Engineer at Deep Blue Tech (DBT), a wholly owned subsidiary of ASC Pty Ltd. He has over 8 years of experience in submarine design and in-service support.

David has been a part of DBT since its inception in December 2007, undertaking concept design work for the energy related submarine systems. A major focus of his work has been developing the capability of DBT in the battery, air independent propulsion and propulsion motor system areas. He has also developed tools to model and calculate the overall performance of the submarine energy systems.

David also provides technical support to the Collins Class project on a part time basis and is an Engineering Domain Authority for several safety critical systems.

Australia requires its submarines to undertake long transits and lengthy deployments. In addition, a conventional submarine design has severe weight and volume limitations placed on the submarine energy chain. The ability of the Future Submarine to meet transit and endurance requirements within these limitations is a challenging problem space unique to Australia. It will be a key differentiator from other diesel electric submarines.

Deep Blue Tech has developed several tools to model the performance of the submarine energy chain. This paper uses these tools to explore which aspects have the greatest impact on transit and operational area energy performance (Speed of Advance, Indiscretion Ratio, fuel usage etc).

This work shows the importance of optimising the whole submarine system for the entire mission and the need to include operational considerations in the transit requirements. It also highlights the need for clearly defined terms that are understood by all stakeholders e.g. what does Speed of Advance mean?

The potential to use this modelling work to help focus development of new technology in areas which will realise the biggest overall performance gains is also discussed.

PASSIVE TARGET MOTION ANALYSIS FROM BEARINGS AND MULTIPATH TIME DELAY MEASUREMENTS

Laleh Badriasl

Laleh Badriasl received a B.Sc. degree in Biomedical Engineering from Amirkabir University in 2007 and a M.Sc. degree in Communication Engineering from University of Tabriz in 2010. In 2011 she was awarded a University Presidential Scholarship to work toward a Ph.D. degree in Electrical and Information Engineering at the University of South Australia. Currently, she is a PhD student with a research project focussing on "passive target motion analysis from bearings and multipath time delay measurements". Her research interests include statistical signal processing, estimation theory, and telecommunication.

In passive underwater tracking problems the presence of two bounding surfaces (i.e., sea surface and seabed) results in several propagation paths between the receiver and the source. Conventional passive tracking approaches only use the bearing data of direct signal emitted from the target, ignoring the multipath reflections between the target and the receiver. Since time-delays between the received multipath signals are functionally dependent upon the target-receiver geometry and environmental conditions, they can provide additional nonlinear information about the state of the target. This has stimulated the interest in incorporating multipath time-delay measurements in the estimation process. This research will exploit time-delay measurements concurrently with bearing measurements to design and develop improved tracking algorithms for passive sonar applications. The outcomes of this research could result in two tactical advantages for the submarines: no requirement for ownship manoeuvre and good estimation error performance within a shorter time.

Keynote Addresses

SESSION 3

SUBMARINE SCIENCE TECHNOLOGY AND ENGINEERING

SIA 1ST TECHNOLOGY CONFERENCE 2011

MY PERSPECTIVES ABOUT SUBMARINES

Vice Admiral R.J. Griggs AM CSC RAN

Vice Admiral Griggs was born in Homebush NSW in 1961. He joined the Adelaide Port Division of the Royal Australian Navy Reserve in 1978 as a radio operator and entered the Royal Australian Naval College at HMAS Creswell on a short service commission in 1979. In June 2011, Vice Admiral Griggs assumed command of the Royal Australian Navy.

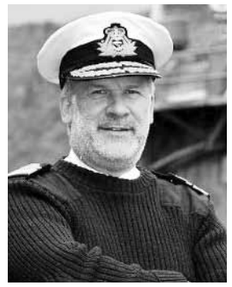
During his seaman officer training Vice Admiral Griggs served in the aircraft carrier HMAS Melbourne and HMA ships Yarra and Advance before spending 12 months loaned to the Royal Navy in HMS Jersey to gain his Bridge Watchkeeping Certificate. In late 1981 he was posted to HMAS Perth as a Bridge Watchkeeper and deployed to the North West Indian Ocean in support of Australia's independent presence in that region following the Soviet invasion of Afghanistan.

From 1983 to 1994 the then Lieutenant Griggs completed a series of postings as Navigating Officer of HMA Ships Cessnock, Torrens, Tobruk, Jervis Bay and Perth. Ashore he has served in variety of roles including as the aide-de-camp to His Excellency the Governor of Tasmania, Sir James Plimsoll, AC, CBE, two postings in the Navy's officer career management directorate, Staff Officer (Navigation) to the Commander Australian Patrol Boat Forces and as Deputy Director Military Strategy and Director Future Warfare in the Australian Defence Headquarters. He completed specialist navigation training and graduated as a Principal Warfare Officer.

Between 1995 and 1997 Vice Admiral Griggs served as commissioning Executive Officer of HMAS Anzac helping to bring the ANZAC class into service. In October 2001 he assumed command of the ANZAC Class frigate HMAS Arunta and was immediately involved in border protection duties as part of Operation RELEX. Arunta then deployed to the Persian Gulf to enforce United Nations sanctions against Iraq and in support of the War on Terror. The ship was recognized for her efforts by being awarded the Duke of Gloucester's Cup for being the most operationally efficient ship in the RAN fleet for 2002.

In 2003 he was posted as the ANZAC class Capability Element Manager in Rockingham, Western Australia. In 2004 he studied at the National War College in Washington D.C. prior to assuming command of the Australian Amphibious Task Group in mid 2005. He was promoted to Commodore in February 2006 and appointed as the Deputy Maritime (Fleet) Commander until assuming the position of Director General Navy Strategic Policy and Futures in Navy Headquarters in September 2007. In February 2008 he was seconded to the Defence White Paper team where he led the development of the Force Structure Review that provided the force structure underpinning the 2009 White Paper. In early 2009 he attended the UK Higher Command and Staff Course and was subsequently promoted to Rear Admiral and appointed as Deputy Head Strategic Reform and Governance. In May 2010 he was posted as Deputy Chief of Joint Operations during a high tempo period of operations abroad and at home.

Vice Admiral Griggs was awarded the Conspicuous Service Cross in 1997, a Commendation for Distinguished Service in 2003 for his work in the Persian Gulf and appointed as a Member of the Order of Australia in 2009. He holds a Bachelor of Arts degree from the University of Queensland, a Master of Business Administration from the National Graduate School of Management at the Australian National University and a Master of Science (National Security Strategy) from the National Defense University in Washington D.C. He is married and has a daughter and a son.



EARLY LESSONS FROM THE UK SUCCESSOR SSBN PROGRAMME

RADM Steve Lloyd, MSc, CEng, MIMarEST, RN - Chief, Strategic Systems Executive (UK)

Stephen Lloyd was born in 1957 and joined the Royal Navy in 1976.

After completing engineering training at RNEC Manadon and general naval training in HM Ships BLAKE, BRINTON and COVENTRY, he specialised in submarines, serving in HM/SMs REVENGE, TIRELESS and TRENCHANT. These appointments were interspersed with further studies on an MSc course and staff training and were followed by a period as the senior nuclear engineer on the staff of Captain (SM) Sea Training.

On moving ashore, submarine business remained the focus of attention during several jobs spanning new design issues through to specialist technical support. After an appointment as the Naval Assistant and Secretary to the Chief of Fleet Support, he turned his hand to construction in the role of Project Sponsor both for the redevelopment of the submarine refitting facilities at Devonport and for the decommissioning of the nuclear infrastructure at Rosyth Dockyard. After an appointment as Chief Staff Officer Engineering (Submarines) on the staff of Commander in Chief Fleet, he attended the Royal College of Defence Studies.

On promotion to Commodore in 2006 he led the ASTUTE Programme as Director of Production Submarines prior to taking up his current appointment in 2008 as Chief Strategic Systems Executive in the rank of Rear Admiral, assuming responsibility for assurance of activities that underpin the UK's nuclear deterrent programme. In April 2011 he added Programme Manager for the Successor Deterrent to his CSSE Role. He is married to Elizabeth and they have 2 daughters.

In 2007 the UK Parliament passed a white paper outlining the Government's intention to replace the Vanguard SSBN submarines. The new class would to continue to carry the life extended Trident D5 missile system and would continue to provide the current posture of Continuous At Sea Deterrence, CASD. Following the difficulties experienced during the design and build of Astute, and it being some 25 years since the previous Vanguard design, it was concluded that an Industrial collaborative approach was essential in order to deliver such a demanding programme. Furthermore the full transfer of risk from the MoD to the Industrial companies was neither possible, nor desirable, as the risk premiums would be unaffordable.

This paper will outline the collaborative approach that was adopted for the concept stage between the MoD and the three tier 1 companies Babcock, BAES and Rolls Royce. The approach adopted took account of the changing industrial landscape and the increasingly stringent substantiation necessary to secure government approval.

The progressive industry involvement will be explained, including its scale and commercial basis, in addition the establishment within the project of a 'client' team to test project progress will be also be described.

THE CHALLENGES FOR AUSTRALIA IN UNDERTAKING THE FUTURE SUBMARINES (FSM) PROGRAM

Rear Admiral Rowan Moffitt, AO, RAN

Rear Admiral Rowan Moffitt has been Head of Australia's Future Submarine Program since February 2009.

Born and schooled in Sydney, Admiral Moffitt graduated from the Royal Australian Naval College, Jervis Bay, at the end of 1975. A surface warfare officer and specialist navigator, he has had diverse sea and shore postings in a 37 year naval career including command of the frigate HMAS NEWCASTLE, the destroyer HMAS BRISBANE, the Australian Defence Force Warfare Centre at RAAF Base Williamtown and the Australian Fleet. He has served as the Deputy Chief of Navy and Deputy Chief of Joint Operations.

There does not seem to be many people who could be accused of over-optimisim about Australia's Future Submarines Program. Our experience tells us that it will certainly be a challenging undertaking from many perspectives and we will need to work hard to avoid falling into the "conspiracy of optimism" trap and the avoidable problems that can result; over-promising and under-delivering being a symptom of them. But can we take our concerns over that risk too far? Could we be at risk of a "conspiracy of pessimism" and if so, what's causing it and what do we do about it?

FUTURE SUBMARINE AS A NATION BUILDING ACTIVITY

Steve Ludlam, FREng FIEAust CPEng

Managing Director and Chief Executive Officer, ASC Pty Ltd

Steve holds a Master of Science from Royal Naval College, Greenwich and is a Fellow of the Royal Academy of Engineers, Fellow of Engineers Australia and the Institution of Mechanical Engineers.

Steve was appointed as Managing Director and CEO of ASC and commenced in the role in January 2010. Prior to that he worked for Rolls Royce for 34 years and his last position with that company was President – Submarines, responsible and accountable for Rolls Royce's submarine business.

Other management positions included the Executive Vice President – Naval Marine Europe, Executive Vice President – Naval Marine, Submarines and the General Manager – Reactor Test Establishment.

Steve was also a senior stakeholder in a number of UK Ministry of Defence strategic change programs and has strong relationships with the Ministry of Defence, the Defence Materiel Organisation and major industry not only in the United Kingdom and Australia but also in Europe and the United States.

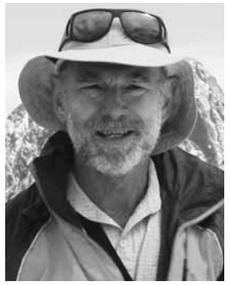
Experience and lessons learned during the construction of the Collins Class submarines and Air Warfare Destroyers have created an indigenous capability in the naval shipbuilding sector a capability able to plan, build and execute the successful construction of submarines that can achieve long range, blue water operations.

Steve Ludlam will outline the national benefits that will flow across Australia from a decision to build the next generation of submarines using local technologies, companies and employees. He will also provide some thoughts on resourcing and skilling such a project. In addition the risks and mitigations required in such a national capability will be outlined. Finally he will pose the challenge to the nation to stand behind the ability to be successful.

Engineering Workforce Planning

SESSION 4

SUBMARINE SCIENCE TECHNOLOGY AND ENGINEERING
1ST SIA TECHNOLOGY CONFERENCE 2011



R&D IMPLICATIONS FOR AUSTRALIA ARISING FROM THE FUTURE SUBMARINE PROGRAMME

Rear Admiral Peter D Briggs AO CSC RAN Rtd

Peter retired from the RAN in 2001 after a 40 year naval career. He specialized as a submarine operator, including two submarine command tours. He spent ten years as a senior Defence executive. Key postings included:

- The Head of Submarine Capability Team.
- Head of the Strategic Command Division at Australian Defence HQ.
- Flag Officer Naval Training Command.
- Naval Officer Commanding Western Australia.
- Director of Submarine Policy, Navy Office.
- Commander, Australian Submarine Squadron.
- Director Submarine Warfare Systems Centre.

He served as President of the Submarine Institute of Australia Inc in 2004-2009 and is currently the Chairman of the AE 2 Commemorative Foundation Ltd and Defence Science Institute Inc.

An overwhelming strategic requirement exists to sustain and develop Australia's underwater warfare capability post Collins.

The submarine's unique capabilities of stealth, long range and endurance allow it access to key areas denied to other platforms and will make it a weapons system of increasing importance for Australia.

Australia's geographic and strategic requirements are particularly demanding.

No "off the shelf" solution is likely.

FSM will be a developmental project, led and executed by Australia.

Noting the difficulty of accessing submarine IP and the timescales, as the parent Navy Australia will require incentives to develop an indigenous R&D capability in key technologies.

University, Industry particularly SME's R&D will made a significant and unique contribution

As a trusted R&D partner, DSTO and the Defence Science Institute it has established will have a critical role in managing the R&D program for FSM.

DEVELOPING AND SUSTAINING ENGINEERING TALENT FOR LARGE NAVAL CAPITAL PROJECTS

Jeff Owen, Director – Capability and Future Business Babcock International Group – Marine & Technology Bristol, UK

With a background in Maritime Technology/Naval Architecture Jeff has been working in the maritime domain for over 25 years. In 1989 he joined Strachan & Henshaw (now part of Babcock), since that time he has played a significant role in the integration of payload systems into a number of platform (surface ship and submarine) programmes, having been involved in 5 different first of class submarine designs. Alongside these platform programmes he has contributed to a large number of R&D projects. In his current role as Director – Capability & Future Business he is involved from the earliest stages of international platform programmes (both from business development and contract execution aspects) and regularly lectures and delivers technical papers to international audiences.

By their very nature the development of new platforms and in particular submarines occurs typically with a cycle of some 15 – 20 years for many nations. This presents a challenge both in terms of maintaining the knowledge between programmes and indeed managing the resource demand associated with development of a first of class submarine design.

With a view to the potential forthcoming submarine programme in Australia, Babcock is able to share its experience and some of the challenges within the UK Naval enterprise, together with the experience of developing a local engineering capability to execute programmes in Australia.

Recognising that the ability to realise a submarine programme is not just a function of the production infrastructure, is a measure of the maturity of a country's approach, even within the most accomplished submarine developing nations, this is a constant challenge, particularly in an era of reduced defence spending leading to longer periods between new design programmes.

Within the UK the recognition of this aspect led to the creation of UKNEST (UK Naval Engineering Science and Technology), which involves a broad spectrum of stakeholders across the enterprise, keeping a focus on developing and sustaining the required skills and experience to maintain the capability.

Benefiting from its involvement in more than six first of class submarines programmes over the last 25 years, this paper will outline some of the approaches and techniques adopted by both the organisation and the enterprise to develop and sustain an appropriate resource capability.

ENGINEERING MASTERS PROGRAMS TO SUPPORT SUBMARINE DESIGN AND MAINTENANCE

Dr Margaret Law, Innovation Manager, ASC, Osborne South Australia 5017

Dr Law graduated from The Flinders University of South Australia in 1995 with a PhD in Physics. She commenced work with Vision Abell, later to become Tenix, Electronics Systems Division. Her initial task was the development of a high powered laser, currently in-service with the LADS MKII Laser Bathymetry system. She has worked on a broad range of tasks with an electro-optics focus, culminating in the management of various R&D projects. Margaret commenced work with ASC in June 2006, taking the role of Innovation Manager. In this capacity she had responsibility for the training and professional development initiatives within the Design and Engineering group, manages R&D programs as well as interactions with academia and R&D partners. Margaret has been involved with DBT, a wholly owned subsidiary of ASC since its inception in 2007. In July 2011, she transferred to DBT, looking to further develop interactions with academia and R&D partners.

Submarines are complex systems of systems. The support, maintenance and enhancement of these complex systems requires a diverse range of engineering capability, with both breadth and depth of specialised subject knowledge required. ASC has had to develop a comprehensive approach to attract, retain and grow capable engineers. We have instigated extensive programs to ensure our Engineers have the knowledge to undertake the tasks required in today's environment, as well as ensuring they are being upskilled to handle future needs.

This paper will present a range of training and professional development initiatives established within ASC to meet the challenging through life engineering needs that modern submarines represent. The discussion will focus on the strategies of the Engineering group and several of the Engineering Masters programs that ASC has helped establish.

DELIVERING A WORLD CLASS SUBMARINE CAPABILITY FOR AUSTRALIA

Wendy Wates, QinetiQ

Wendy Wates is responsible for leading QinetiQ's drive into the Australian Maritime market. As a senior member of the Strategic Business Team, Wendy is working with Industry, Clients and Colleagues in Australia and the UK to identify, shape, win and deliver innovative programmes.

Degree qualified in Physics, Wendy's has 13 years' experience with Defence capability delivery, developed through successful delivery of management consultancy, business operations and operational research tasks for key Defence programs.

Wendy's successful track record is focused around the creation of innovative programs that enable QinetiQ's clients to benefit from ready access to the best industry has to offer, including programs such as FSM Client Advisor, the Haldane Spearman Human Capability Research Consortium and the UK PECOC Program. She has a demonstrable track record in building, leading and motivating teams, including working with partners to develop mutually beneficial relationships and commercial structures.

SEA 1000 can deliver two capabilities for Australia in a modern submarine force and an enduring submarine design capability. Assuring the effective design, acquisition, development, delivery and sustainable operability of Australia's Future and ongoing Submarines Capability will be dependent on the creation of a nation building program that addresses existing industrial capability and capacity shortfalls, current and anticipated technology and engineering skills requirements, mobile and sustainable workforce creation, and innovative commercial contracting mechanisms that encourage and incentivise all stakeholders to work together as part of a single team. In this Paper, QinetiQ and BMT have jointly considered how the Commonwealth can deliver the best submarine capability Australia can afford, and the project structures required to underpin capability delivery; whilst addressing the critical need to create a growing and sustainable national submarines capability. In delivering this paper, we will discuss options available and conclusions that include:

- Development of an indigenous sustainable submarine design capability
- Separating the Design and Production Phases of the program
- Delivering the 12 submarines in batches
- Creation and sustainment of a 21st century Navy workforce
- Commonwealth appetite for and appreciation of risk
- Establishment of a Capability Partner
- Consideration of the creation of an SPV for production.

In delivering this paper it is our intention to challenge current approaches and present new ideas, promote and encourage innovative thinking and proactively engage in an open debate to support and ensure the sustainable, affordable, and cost effective delivery of the SEA1000 Future Submarines program.

MANAGING THE TRANSITION FROM CONSTRUCTION TO SUPPORT

Air Vice-Marshal Chris Deeble

Air Vice-Marshal (AVM) Deeble was born Sydney in 1957 and graduated from Sydney Technical High School in 1975. He graduated from Sydney University in 1978 with a Bachelor of Science in pure and applied maths and subsequently joined the RAAF in 1979 as an aircrew cadet. After completing Navigator training, graduating as dux of the course, he was posted to fly Canberra's. Following a short tour on Canberra's he was posted to fly F-111s and gained experience in the strike, reconnaissance and instructional roles at 1 and 6 Squadrons.

In 1990 AVM Deeble was posted to the Australian Defence Force Academy as a Squadron Commander. Later that year he was seconded to the F-111 Avionics Update Program and was responsible for the oversight of the development of the F-111 operational software and associated support systems. On completion of the four year update program he was posted back to F-111s as the Executive Officer of 1 Squadron and subsequently to the 82 Wing Headquarters in charge of operations. As a result of his project work and operational efforts, he was admitted as a Member of the Order of Australia in the 1999 Australia Day Honours.

Air Vice-Marshal Deeble was posted to Air Force Headquarters in 1999 where his senior appointments have included Deputy Director of Capability Review and Director of Combat Capability Management – Air Force. In 2002, he was subsequently posted to Capability Systems - Aerospace Development as Director of Aerospace Systems Development. In December 2003, Air Vice-Marshal Deeble was promoted to his Air Commodore and assumed the duties of Director General Aerospace Development. In June 2006 he was promoted to Air Vice-Marshal and appointed as Program Manager Airborne Early Warning and Control (now Program Manager Collins and Wedgetail) in the Defence Materiel Organisation.

Air Vice-Marshal Deeble attended the Defence Staff Course at the Australian Defence College. He has accumulated 2500 operational flying hours. Air Vice-Marshal Deeble's hobbies include woodworking and camping, and his interests include project management and military strategy.

FACING THE TECHNICAL CHALLENGES OF THE FUTURE SUBMARINE - THE COALITION'S PERSPECTIVE

Senator the Hon David Johnston - Shadow Minister for Defence

David Albert Lloyd Johnston (born 14 February 1956), Australian politician, has been a Liberal member of the Australian Senate since July 2002, representing the state of Western Australia. Johnston was born in Perth and was educated at University of Western Australia, where he graduated in law. He was a barrister in Kalgoorlie before entering politics.

On 6 March 2006, Johnston was made Minister for Justice and Customs (effective 9 March), following the resignation of Senator Ian Campbell from the Human Services portfolio and Campbell's replacement by former Justice minister Chris Ellison.[1]

Malcolm Turnbull promoted Johnston to the Shadow Cabinet as Shadow Minister for Defence after he defeated Brendan Nelson in a leadership ballot. In September 2010 he was re-appointed to that role by Opposition leader, Tony Abbott, after the 2010 election.

SIA TECHNOLOGY CONFERENCE 2011

Tuesday 8 November 2011 - Science & Technology

0730-0830	**Registration & Coffee:** Crowne Plaza breakout area (top floor)
0830-0845	**Welcome:** RADM Peter Clarke RAN Rtd Master of Ceremonies; & Mr Peter Horobin MBE FAICD - President, SIA

Session 1: Defence Science & Technology Organisation (DSTO) & Defence & Systems Institute (DASI)

0845-0905	**Trends in Autonomous Underwater Vehicles:** Professor Anthony Finn - DASI
0910-0930	**The Requirements for Defence S&T in the FSM Program:** Dr David Kershaw - Research Leader, Submarines, DSTO
0935-0955	**Submarine Support**: **Lessons Learned the Hard Way** - Mr Jock Thornton - DASI
0955-1015	**Morning Coffee Break:** Sponsored by IMAGINit Technologies Pty Ltd - Crowne Plaza breakout area
1015-1035	**Systems Engineering**: **The Key to Successful Submarine Building** - Professor Stephen Cook - DASI
1040-1100	**Test & Evaluation & Trials Management**: **Timing is Everything** - Dr Vivian Crouch - DASI
1105-1125	**Networked Subsea Communications - MASQ - Developments, Applications, Results** Alessandro Ghiotto - Senior Analyst, L-3 Communications Nautronix Ltd
1130-1150	**Designing & Building Australia's Future Submarine**: Mr Jim Duncan - Representing ThyssenKrupp Marine Systems
1155-1210	**Questions & Answers:** Master of Ceremonies & Speakers from Session 1
1210-1310	**Lunch sponsored by Saab Systems Pty Ltd**: Crowne Plaza breakout area

Session 2: Academia & Industry

1310-1330	**Recent Developments in Submarine Vibration Isolation & Noise Control:** Dr Carl Howard - University of Adelaide School of Mechanical Engineering
1335-1355	**Developments in Compression Ignition Engines:** - Dr Manfred Zockel University of Adelaide School of Mechanical Engineering
1400-1420	**Experimental & Computational Investigation into the Hydrodynamics of Conventional Submarines:** Professor Dev Ranmuthugala - Australian Maritime College (AMC), Launceston, Tas
1425-1445	**Afternoon Coffee Break:** Crowne Plaza breakout area
1445-1505	**Submarine Energy & Propulsion Considerations:** Mr David Williams - Engineer, Deep Blue Tech Pty Ltd
1510-1540	**Passive Target Motion Analysis from Bearings & Multipath Time Delay Measurements:** Ms Laleh Badriasl - PhD Student, School of Electrical & Information Engineering, University of SA
1535-1555	**Questions & Answers**: Master of Ceremonies & Speakers from Session 2
1600-1620	**Expert Panel Discussion:** Eminent Scientists
1620-1625	**Closing Comments:** Day 1 - Mr Peter Horobin - President, Submarine Institute of Australia
1645-1715	**Opportunity to inspect Anechoic Chamber & other related facilities:** University of Adelaide (tbc)
1830-2030	**Opening Cocktail Party:** Sponsored by MacTaggart Scott Australia Pty Ltd - Crowne Plaza breakout area

The Chatham House Rule applies to questions and answers

Participants are free to use the information received, but neither the identity nor the affiliation of the speaker(s), nor that of any other participant, may be revealed

SIA TECHNOLOGY CONFERENCE 2011

Wednesday 9 November 2011 - Plenary Session

0745-0855	**Registration & Coffee:** Crowne Plaza breakout area (top floor)
0855-0905	**Welcome:** RADM Peter Clarke RAN Rtd - Master of Ceremonies; & Mr Peter Horobin MBE FAICD - President, SIA

Session 3: Keynote Addresses

0910-0930	**Welcome to South Australia - the Defence State & Opening Address:** The Hon Jay Weatherill MP, Premier of South Australia
0935-1000	**My perspectives about submarines:** VADM Ray Griggs AM CSC RAN - Chief of Navy
1005-1030	**Lessons Learned from the UK Successor Program:** RADM Steve Lloyd, RN - Programme Manager, UK 'Successor' Programme
1030-1050	**Morning Coffee Break: Sponsored by James Fisher Defence:** Crowne Plaza breakout area
1015-1035	**The Challenges for Australia in undertaking the Future Submarine (FSM) Program:** RADM Rowan Moffitt AO RAN - Head FSM Program
1125-1150	**The Future Submarine as a Nation-Building Activity:** Mr Stephen Ludlam - Chief Executive Officer, ASC Pty Ltd
1155-1205	**Questions & Answers:** Master of Ceremonies & Speakers from Session 3
1205-1215	**Launch of the Submarine Centenary Program & Logo:** Mr Peter Horobin & CDRE Steve Davies, AM RANR
1205-1310	**Lunch sponsored by Pacific Marine Batteries Pty Ltd:** Crowne Plaza breakout area

Session 4: Engineering Workforce Planning

1310-1335	**Workforce Development for the FSM Program:** RADM Peter Briggs AO, CSC, RAN Rtd Chairman, Defence Science Institute Advisory Board of the University of Melbourne
1340-1405	**Developing and Sustaining Engineering Talent for large capital Naval Projects:** Mr Jeff Owen - Director - Future Business - Marine & Technology Division, Babcock International Group
1410-1435	**Engineering Masters Programs to support Submarine Design & Maintenance:** Dr Margaret Law - Innovation Manager, ASC Pty Ltd
1440-1500	**Afternoon Coffee Break:** Crowne Plaza breakout area
1505-1530	**Delivering a World-Class Submarine Capability for Australia:** Ms Wendy Wates - Strategic Business Development, QinetiQ Pty Ltd
1535-1600	**Managing the Transition from Construction to Support:** AVM Chris Deeble - Program Manager, Collins and Wedgetail, DMO
1605-1630	**Facing the Technical Challenges of the Future Submarine - the Coalition's Perspective:** Senator the Hon David Johnston - Shadow Minister for Defence
1630-1645	**Questions & Answers:** Master of Ceremonies and Speakers from Session 4
1830-1900	**Pre-Dinner Drinks sponsored by BAE Systems Pty Ltd:** National Wine Centre - corner Botanic & Hackney Street, Adelaide
1900-2230	**Conference Dinner sponsored by Sonartech Atlas Pty Ltd:** National Wine Centre **Dinner Wines sponsored by Navantia: Dinner Speaker:** H.E. RADM Kevin Scarce AC CSC RANR - Governor of South Australia

The Chatham House Rule applies to questions and answers

Participants are free to use the information received, but neither the identity nor the affiliation of the speaker(s), nor that of any other participant, may be revealed

SIA TECHNOLOGY CONFERENCE 2011

Thursday 10 November 2011 - Technical Papers

0700-0830	**13th Annual General Meeting of the SIA: (Members Only) -** Hindmarsh 1, Crowne Plaza
0800-0840	**Day 3 Registration & Coffee:** Crowne Plaza breakout area (top floor)

Session 5: Technical Papers (in association with the Australian Society for Defence Engineering)

	Stream A: Hull, Mechanical & Electrical Hindmarsh 1	Stream B: Combat Systems, Communications Hindmarsh 2	Stream C: Systems Engineering, Safety, Design & Logistics Support Hindmarsh 3	Stream D: Submarine Energy & Uninhabited Vehicles Hindmarsh 4
0840-0900	**Welcome & Review of the Program for the Day** Chair: TBA	**Welcome & Review of the Program for the Day** Chair: TBA	**Welcome & Review of the Program for the Day** Chair: TBA	**Welcome & Review of the Program for the Day** Chair: TBA
0900-0925	**Electric Actuation of Submarine Equipments** - Niall Skinner, MacTaggart, Scott and Company (presented by Brian Foster)	**The Need for a Systems Engineering/Architectural Approach to the Design of Submarine Mission Systems** - Michael Irrgang, Engineering Director, Raytheon Australia Pty Ltd	**Designing for the Future - Modularity and Transformability in Submarine Design** - Gunnar Öhlund, Senior vice President, Kockums AB	**Air-Independent Propulsion Based on Fuel Cells & Methanol Reforming** - Peter Hauschildt, Director R&D/ Conceptual Design/ German Navy, Howaldtswerke-Deutsche Werft GmbH
0930-0955	**Dynamics of the Swash Plate Mechanism** - Josh Trainor, Chief Engineer, Rix Industries	**Augmenting the Collins AN/ BYG-1:** Supporting In-Country Combat System Capability Evolution - Ted Huber, Managing Director, Acacia Research Pty Ltd and Graham Smith, Technical Operations Manager, Lockheed Martin Australia Electronic Systems	**Achieving the Goal of a Submarine Modular Mission Payload System** - Sean Williams and Tim Whitten, Babcock	**Electrical Platform and Fuel Cell-based AIP Systems for Submarines** - Albert Hammerschmidt, Director PEM Fuel Cells, Siemens
0955-1015	**Morning Coffee Break: Sponsored by Moog Inc.:** Crowne Plaza breakout area			
1015-1040	**Innovative Solutions to reduce the Environmental Impact of Future Submarines** - Eric Fusil, Naval Architect, DCNS	**Developing Proven Submarine Combat System Technology to Future Customer Needs** - Alfred Schulte, Chief Technical Officer, Sonartech Atlas Pty Ltd	**Early Phase Availability Modelling** - Chris Edmonds and Tammy Chau, Babcock	**S-80 AIP System** - Antonio Pérez de Lucas, Director Engineering and Innovation, Navantia
1045-1110	**Electrohydrostatic Actuators for Control of Undersea Vehicles** - Steve Smith, Moog Industries	**The Benefits of Wireless Networking Technology for use in existing and future submarines** - Martin Childs, Platform Systems Manager, ASC Pty Ltd	**Model-based Systems Engineering and its Application to Submarine Design** - Paul Pearce, Lead Systems Engineer, Deep Blue Tech Pty Ltd	**S-80 AIP System Land-Based Test Site** - Amos Fuentes, Managing Director, Shipyard, Navantia
1115-1140	**A search method for localising a noise source on a submarine** - Stewart Kanev, Specialist Signatures Engineer, ASC Pty Ltd	**Networks of Underwater Systems** - Craig Benson, Senior Lecturer, ADFA	**Early Stage Tools for Submarine Design - "Boat-by-Numbers"** - Paul Plant - A/ Concept Team Leader, Deep Blue Tech Pty Ltd	**Naval Architecture Challenges for the Integration of UUVs in Submarines** -Eusebio-Ángel Martinez-Conesa, Navantia
1145-1210	**Submarine Manoeuvring and Appendage Design** - Martin Renilson, Technical Director, Renilson Marine Consulting Pty Ltd	**Virtual Ship Training and Information Systems (ViSTIS) for Submarines** - Tom Reynolds, BD Manager, Maritime KBR Pty Ltd	**The S-80 Submarine Building Program** - Captain Nicolas Monereo, S-80 Head of Program, Spanish Armada	**Design and Development of a Small, Low-Cost UUV for Shallow Water Operations** - Nicholas Gover, Student, ADFA
1210-1310	**Lunch: Sponsored by Siemens Pty Ltd:** Crowne Plaza breakout area			

The Chatham House Rule applies to questions and answers

Participants are free to use the information received, but neither the identity nor the affiliation of the speaker(s), nor that of any other participant, may be revealed

SIA TECHNOLOGY CONFERENCE 2011

Thursday 10 November 2011 - Technical Papers

Session 5: Technical Papers (in association with the Australian Society for Defence Engineering)

	Stream A: Hull, Mechanical & Electrical — Hindmarsh 1	Stream B: Combat Systems, Communications — Hindmarsh 2	Stream C: Systems Engineering, Safety, Design & Logistics Support — Hindmarsh 3	Stream D: Submarine Energy & Uninhabited Vehicles — Hindmarsh 4
1315-1340	**Human Factors and Habitability** - Anders Folbert, Team Leader, Deep Blue Tech Pty Ltd	**High Capacity Underwater Communications** - Craig Benson, Senior Lecturer, ADFA	**An Integrated Data Environment for the Future Submarine in Australia** - Malay Pal, Director, Shipbuilding, Siemens Industry Software, India	**Design and Development of a "6-Inch Submarine"** - Joshua Fearnley, ADFA
1345-1410	**Development of Composite Pressure Vessels for Submarine External Stowage** - Dan Miller, Engineering Services Manager (SA), ASC Pty Ltd	**Periscopes and Optronics - Future Submarine Visual Systems** - Adam Waldie, Business Development Manager (Submarines), Thales Underwater Systems and Alan Stevenson, Optronics Sales Director, Thales Optronics Limited (UK)	**Establishment of a Cost-Effective Submarine Support Capability in Canada** - Michel Bouchard - President, Canadian Submarine Management Group	**6-DOF Particle Filter-based Navigation System for AUV** - Andrew Lammas, PhD Student, Flinders University
1415-1440	**Development of a Capability for Measuring Dewpoints at High Pressure for the Collins Class Submarine** - James Gregor, ASC Pty Ltd	**Submarine Sonar - Outboard Acoustic Array Technologies** - Tim Cain, Thales Australia Pty Ltd	**Infrastructure Considerations of Possible Investment in an SSN Option** - Jock Thornton, University of South Australia	**The Utility of Virtualisation Technologies to Combat Submarine Combat System Obsolescence** - David Culpin, Engineering Manager, Raytheon Australia
1440-1510	**Afternoon Coffee Break:** Sponsored by Hynergreen Technologies, S.A: Crowne Plaza breakout area. Rooms to be reconfigured.			
1515-1545	**Open Forum:** MC and all Authors of Day 3 papers			
1550-1610	**Closing Remarks**: President SIA			

Technology Conference 2011 Sponsors

GOLD Sponsor: babcock

SOUTH AUSTRALIA THE DEFENCE STATE

MacTaggart Scott — Innovators since 1898

ThyssenKrupp

Silver Sponsors: Navantia, Lockheed Martin

ATLAS ELEKTRONIK — A joint company of ThyssenKrupp and EADS

Navantia

BAE SYSTEMS

THALES

SAAB

PMB — Pacific Marine Batteries

SIEMENS

MOOG

IMAGINIT Technologies — A PTC Worldwide Company

James Fisher Defence

HYNERGREEN

The Chatham House Rule applies to questions and answers

Participants are free to use the information received, but neither the identity nor the affiliation of the speaker(s), nor that of any other participant, may be revealed

Technical Papers

(in association with the Australian Society for Defence Engineering)

SESSION 5

ENGINEERS
AUSTRALIA

SUBMARINE SCIENCE
1ST SIA TECHNOLOGY CONFERENCE 2011
TECHNOLOGY AND ENGINEERING

ELECTRIC ACTUATION OF SUBMARINE EQUIPMENTS

Niall Skinner. This paper will be delivered by Brian Foster

Nial is responsible for identifying technology demands in the Marine and Defence sectors and implementing projects to fulfil those demands. MacTaggart Scott has extensive experience in the design, development, supply and support of hydraulic and electrical-drive systems for both surface and subsurface naval vessels. In recent years Mr Skinner has led many electrification projects in MacTaggart Scott and he continues to oversee a wide-range of advanced actuation projects for future submarines.

There is considerable interest in making future submarines 'more electric'. This paper assesses the viability of replacing hydraulic actuation with electrical actuation for outboard submarine equipment. The paper provides a general review of the 'state of the art' with regard to electric actuation of this type of equipment. It then provides a review of certain equipments that may be readily be converted from hydraulic to electrical operation. The paper then quantifies the development work required for systems where mature actuation solutions do not currently exist.

For the purposes of comparison, the requirements of a typical large modern submarine are used as the baseline.

The general conclusions are that electric alternatives to rotary hydraulic drives are obtainable at reasonable cost and risk, whereas electric alternatives to hydraulic cylinders are not universally available. Recent developments in electric linear actuators can provide viable solutions to the majority of applications; however some modification of operating modes and requirements may be necessary.

Session 5: **Stream A - Paper 1**

THE NEED FOR A SYSTEMS ENGINEERING/ARCHITECTURAL APPROACH TO THE DESIGN OF SUBMARINE MISSION SYSTEMS

Michael Irrgang, Engineering Director, Raytheon Australia

Michael Irrgang is an Engineering Director within Raytheon Australia, having responsibility for acquisition programs and Systems and Software Engineering activities across the company. Michael is based in Sydney Australia, and has over 8 years at Raytheon having worked across a number of key projects and bids including the Collins Class Replacement Combat System program and the Air Warfare Destroyer program.

Michael has over 15 years experience in developing complex software based systems in both the Defence and Telecommunications domains and has a Bachelors degree in Electrical Engineering (1st class honours) from Sydney University

The development of a Mission System for a Submarine is a large and complex activity which involves the integration of large numbers of products from multiple vendors, some of which would likely be procured as Foreign Military Sale (FMS) items. In addition the Mission System has an extremely long lifespan and is likely to require progressive upgrades in capability throughout its life both to enhance capability and to replace obsolete items.

This means that the architecture for the Mission System needs to ensure it meets the desired quality attributes for modifiability, flexibility and scalability as well as meeting the functional and performance requirements.

In addition, for such a complex development, there is a need to use many different engineering disciplines. These would include naval architects, software, safety, mechanical and electrical engineering, as well as Integrated Logistics Support and a wide variety of specialty engineering areas. This means that there is a clear need for a Systems Engineering approach to be employed in order to provide overarching integration of all of these disparate disciplines into a cohesive project outcome.

This presentation will examines how using a Systems Engineering approach with a strong architectural flavour can help to minimise the risks involved in developing a submarine Mission System.

Session 5: **Stream B - Paper 1**

DESIGNING FOR THE FUTURE - MODULARITY AND TRANSFORMABILITY IN SUBMARINE DESIGNGUNNAR

Öhlund, Kockums AB, Sweden SVP Market, R&D and Business Development

Mr Gunnar Öhlund joined Kockums AB, Sweden, in 1982 and has been engaged in national Swedish and international submarine development projects for more almost 30 years. Between 1990 and 1992 he was Kockums project manager for the design of the Collins Class submarine. In 1993 he was seconded to the Australian Submarine Corporation as General Manager Design Engineering for a period of three years. In recent years he has held positions as divisional manager and technical director at Kockums. He is currently working as Senior Vice President Market, R&D and Business Development. Mr Öhlund is 55 years old and holds a masters degree in mechanical engineering from the University of Lund, Sweden.

Kockums has a long tradition of using a modular design and production technique. Since several submarine generations Kockums has used platform design, distributed production and the Stirling AIP modules.

A key benefit in the design of the next generation AIP submarine for the Swedish Navy, the Kockums A26 submarine, is its modularity, which provides a high degree of operational flexibility, future proofs the vessel and contributes significantly to cost-effective construction and assembly.

This paper elaborates on how Kockums is further developing the modularity and future proofing in designing future submarines.

The modularity of the general arrangement of the submarine will be further developed with all equipment installed on resilient platforms, facilitating well defined construction packages and distributed production. This, in conjunction with inherent design margins for e.g. weight, stability and power, caters for future upgrades and extension of the submarine.

Introducing the flexible payload concept, designed to launch and retrieve diverse mission payloads, will allow for modularity and future proofing also for sensors, weapons and effectors.

On system level, development is ongoing with further modularisation of e.g. the energy system such as the AIP system and diesel generator-set modules. The Combat System and Ship Control and Monitoring System are designed using modular philosophy, both in hardware and in software. Introducing the General Management Services System allows for modular and easily upgradeable systems using open architecture and well defined and standardized interfaces.

Session 5: **Stream C - Paper 1**

AIR INDEPENDENT PROPULSION BASED ON FUEL CELLS AND METHANOL REFORMING

Peter Hauschildt, Mechanical Engineer Director Research and Development, Conceptual Design, Projects German Navy ThyssenKrupp Marine Systems, Howaldtswerke Deutsche Werft GmbH, Kiel

Peter Hauschildt started his professional career with an apprenticeship as Industrial Mechanic for Machine and System Engineering at the company Barthels und Lüders GmbH in 1988, which was in Ship Repair.

In 1992 he started his studies on Naval Mechanical Engineering at the Technical University Hamburg-Harburg and finished in 1998 with a Master degree.

In 1998 Peter started working on submarines as an R&D specialist working on AIP systems in Ingenieurkontor Lübeck.

The Ingenieurkontor Lübeck became part of Howaldtswerke-Deutsche Werft (HDW) in Kiel in 2000.

Peter was promoted to be head of Group "Research and Development Naval Ships" in 2002.

Peter entered his current profession, being "Director Research and Development, Conceptual Design, Projects German Navy", in 2004.

For today's modern non nuclear Submarines Air Independent Propulsion (AIP) is a key factor for combat effectiveness, stealth and survivability.

Today's most successful AIP system is the Fuel Cell (FC) System based on PEM Fuel Cells, jointly developed by Howaldtswerke Deutsche Werft and Siemens.

The FC-AIP produces no exhaust gases, is absolutely silent, and the very high efficiency results in the fact that almost no heat has to be discharged into the surrounding seawater. These aspects did not only convince numerous navies worldwide, already resulting in several re-orders since the first commissioning of a FC-equipped submarine in the year 2005, but also other players in the non-nuclear submarine business, which have meanwhile started the development of FC based AIP systems, even though delayed by 20 years.

Despite this benefits today's FC system based on hydrogen storage in metal hydrides are not very well suited for very large submarines: Due to the high specific weight of the hydrogen storage, the system reaches technical limitations. To overcome this limitation, a methanol reformer has been developed to generate the hydrogen for the fuel cell from a simple liquid fuel – methanol.

The paper will describe the major steps of the development of the FC and the reformer. The decision to use methanol will be explained and the actual technical readiness level will be assessed.

Furthermore an outlook on the remaining development steps will be given.

Session 5: **Stream D - Paper 1**

DYNAMICS OF THE SWASH PLATE MECHANISM

David Trainor

B.S. Mechanical Engineering, UC Berkeley 1980

Staff Engineer, Space Systems Division, Lockheed Missiles and Space Company 1980/81

R & D Engineer, Project Engineer, RIX Industries, Emeryville, CA, 15 years

Project Engineer, Powis Parker, Berkeley, CA, 4 years

Engineering Manager, Parker Hannifin Veriflo Division, Richmond CA, Carson City NV 5 years

Director of Engineering, LSP Products Group, Carson City, NV, 2 years

Director of Manufacturing, Plant/Engineering Manager, RIX Industries, Sparks, NV, 5 years

David spent many years as an R&D engineer at Rix industries, during which time he had design responsibility for a range of compressors, including the swash plate model analysed in "Dynamics of the Swash Plate Mechanism." David obtained his P.E. certification and went on to work as an engineering authority in many industries before returning to RIX Industries in the role of Plant Manager. David first presented his paper at the International Compressor Conference at Purdue in 2004.

Several mechanisms have been used to convert the motion of a rotating shaft to the reciprocating motion needed to drive the pistons of a conventional compressor.

The most common mechanism is the crankshaft in which pistons are driven up and down in a direction normal to the drive shaft centerline. The dynamics of the crankshaft are well developed and readily available in design handbooks. The swash plate, another mechanism, produces reciprocating motion in a direction parallel to the centerline of the rotating driveshaft. Compressors of this type are called axial piston compressors.

This paper investigates the dynamics of the swash plate and develops the mathematical relationships necessary for evaluating stresses, bearing loads, and for sizing and locating counterweights for a proper running balance.

Session 5: **Stream A - Paper 2**

AUGMENTING THE COLLINS AN-BYG 1 - SUPPORTING IN-COUNTRY COMBAT SYSTEM CAPABILITY EVOLUTION

Ted Huber is the MD and Chief Design Engineer at Acacia Research.

Acacia Research is a development company operating primarily in the area of Tactical Data, Surveillance and Mission Systems. The company employs a team of specialist engineers, scientists and domain experts specializing in design and development of advanced systems.

Acacia has delivered deployed systems, technology demonstrators and high fidelity simulators to ADF and DSTO. The company has carried out a number of performance analysis and design studies on high profile systems. Teaming with Australian and overseas primes is intended to deliver Acacia Mission and Surveillance systems to a broader market.

Ted Huber has had significant involvement with developments in the Collins Class Combat System, FA18 Radar Upgrade, ASSTASS, Airborne Navigation Trainer, Network Enabled Undersea Warfare, Imaging laser Radar, Coastwatch CMS04 Mission System and various classified programs. Most recently Acacia has built, designed and integrated a Mission Information Management System into the AN/BYG-1 environment on a Collins submarine.

Ted Huber's earlier career includes R&D and development in the Bio-medical area and later defence sensor applications at Vision Systems.

Ted has a BSC Hons from Flinders and a BEE from Adelaide Universities.

The presentation addresses recent in-country integration of 3rd party applications into the AN/BYG-1 Combat Control System open system (OS) architecture.

A recently completed Mission Information System integration using existing Commonwealth facilities is presented as a case study.

We also introduce a new Combat System integration and evaluation capability and present examples of integrating 3rd party Simulation, Target Motion Analysis and Tactical Support Tool applications into the AN/BYG-1 Submarine Warfare Federated Tactical System (SWFTS) using open architecture concepts.

Session 5: **Stream B - Paper 2**

ACHIEVING THE GOAL OF A SUBMARINE MODULAR MISSION PAYLOAD SYSTEM

Sean Williams

Sean is a Chartered Engineer with significant experience in the submarine and maritime defence industry in both Australia and the UK. This is complimented by involvement in the surface ship, superyacht, transport, aerospace, nuclear and bulk material handling industries. He has experience across all phases of the product lifecycle, from theoretical concept design studies to in-service support of range of systems and equipment, and has participated in the early design phases of a number of submarine concept studies. He has worked in, and lead several teams of engineers, including being responsible for their personal and professional development. His most recent role is Head of Engineering Strategy with Babcock Pty Ltd, where he is focussing on the future needs of the business as it seeks to expand its professional engineering function.

Tim Whitten

Tim is a Principal Engineer in the Future Products team at Babcock International Group, Marine and Technology Division. He has experience of a number of design, development and manufacturing projects for both submarine and surface ship applications. His background includes development of Babcock's trajectory modelling tool as well as a number of other multi- physics simulations and systems models.

The benefits of having modular mission packages is becoming a reality within surface ship platforms, however the adoption of such an approach within a submarine remains a challenging aspect for the platform design, despite demand increasing due to the availability of effective payload devices and the desire to have more flexible platforms.

Whilst some systems have been adopted within larger SSN platforms, the challenges are even greater within a relatively small SSK submarine design, where the implementation of a modular approach has a profound effect on the platform design, requiring the total integration of payload system and platform design to ensure that feasible and optimum solutions are developed.

An ideal modular package would be fully external, thereby posing no risk to the integrity of the pressure hull. However such a system(s) would lead to a significant impact on the whole-boat design and operation.

Due to the potentially wide range of devices to be deployed (and in some instances recovered), and in order to meet the demand for modularity, Babcock is constantly developing a range of systems and techniques to meet this need. These include systems compatible with SSK platforms able for example, to launch missiles, Unmanned Underwater Vehicles (UUVs), Unmanned Aerial Vehicles (UAVs), mines and Special Forces deployment.

This paper discusses the risks and design challenges associated with developing such system(s) for use on a SSK design. In particular it will focus on the naval architecture aspects of incorporating such systems within a SSK platform, such as structural implications, powering, stability/trim, and compensation consequences.

Session 5: **Stream C - Paper 2**

ELECTRICAL PLATFORM AND FUEL CELL-BASED AIP SYSTEMS FOR SUBMARINES

Dr. Albert Hammerschmidt + Dipl. Ing. Dieter Scholz, Marine Solutions Siemens AG, Erlangen, Germany

Design philosophy has changed a lot from the single electrical component solutions of the past to the highly integrated and optimized Electrical Propulsion / Distribution and Electrical Platform Management systems of today's most modern conventional submarines.

Fuel Cell based AIP systems are state-of-the-art, but what is next?

Future technological development trends and future requirements for submarine deployments draw the guidelines for the characteristics and the peculiarities of the Electrical Platform Systems (incl. AIP systems) of the future and all this will need to occur within an innovative network of businesses and within an international engineering / manufacturing work sharing context.

The presentation highlights the topic from different perspectives:

- Historical and state-of-the-art Electrical Platform technologies for submarines
- Fuel Cell technology for a submarine AIP system
- Innovations / Developments – solutions for future challenges, including lessons learnt
- Potentials / Possibilities and limitations / Restrictions of an Electrical Systems Subcontractor to act in an international context

An outlook about further enhancement possibilities of features and performance of Electrical Platform Systems will be given.

For more than 100 years Siemens AG has been an established supplier of electrical and electronic equipment for submarines and, in the last 50 years, has equipped more than 150 submarines with Siemens electrical propulsion and electrical generation / distribution systems. With 30 submarines delivered or contracted with fuel cell based AIP systems.

SIEMENS has (for many decades) and is a major supplier for shipyards for development, design, construction, testing and commissioning of Electrical Equipment for submarines and has significant experience in working in an international context.

Session 5: **Stream D - Paper 2**

INNOVATIVE SOLUTIONS TO REDUCE THE ENVIRONMENTAL IMPACT OF FUTURE SUBMARINES

Eric Fusil, naval architect DCNS, France

Eric FUSIL was born in 1972, in Burgundy (France).

He graduated at ENSIETA, in Brest, after completing a naval architecture course in 1995.

He first worked in DCNS Cherbourg submarine shipyard, on SSBN Le Triomphant class, during ship completion and sea trials, for signature management.

He then worked on the sea trials management of Agosta90B for the Pakistan Navy, spending quite a time underwater with fellow shipmates of the depths and acquiring live field experience.

In 1999, he joined the design team for Barracuda class SSN for the French Navy, in Lorient, Brittany.

Since 2006, he works on the preliminary design projects of submarines of the future, and aims to innovate in architectures and technologies, with a special dedication to eco-conception (reduced environmental impact). He is a RINA member and a chartered engineer as naval architect.

For the first time in the world, DCNS performed the life cycle environment impact of a modern submarine according to present standards.

The life cycle assessment took into account a submarine's life from cradle to grave:

- Shipbuilding in a yard,
- Active duty,
- Shipbreaking after withdrawal from active duty.

The analysis quantified the environmental impact on three families:

- Damage on human health,
- Damage on ecosystems,
- Natural resources depletion.

That first analysis revealed the systems to be improved:

- The propulsion system to limit diesel-oil consumption and the exhausts of SOx and NOx to be reduced,
- The electrical energy storage to increase the capacity, and lower the indiscretion ratio,
- The onboard systems to reduce the electrical consumption,
- The treatment of sewage and bilge waters, as well as solid waste,
- The choice of some materials to be less impacting on the environment.

Based on this analysis, the design team challenged new architectures and technologies with high technological readiness levels. It means the study was lead with technologies existing at the stage at least of prototype, to guarantee the realistic approach and avoid science-fiction.

Based on these issues, DCNS engineers, as testified by its ISO14001:

- Have identified some interesting mature solutions, fitted for future submarines or potential retrofits,
- Have gained knowledge to perform an integrated environment friendly approach in the design for submarines,
- Confirmed that design with high environmental constraints resulted in more efficient submarines on the operational point of view.

Session 5: Stream A - Paper 3

DEVELOPING PROVEN SUBMARINE COMBAT SYSTEM TECHNOLOGY TO FUTURE CUSTOMER NEEDS

Alfred Schulte, Chief Technical Officer (CTO) Sonartech ATLAS Pty Ltd

Alfred Schulte graduated as a "Dipl. Ing. Nachrichtentechnik" from Gesamthochschule Siegen and joined KRUPP ATLAS as a SONAR design engineer in 1979.Till mid of the 90's he has directed the design of Submarine Sonar Systems in various positions. He led the development of the ISUS 90 Sonar, the basis for the successful ATLAS submarine products till today. In 2003 Alfred was appointed "Executive Director" for the Submarine Sonars and Systems at ATLAS ELEKTRONIK. In 2010 Alfred Schulte has become the "Chief Technical Officer" at Sonartech ATLAS, a wholly owned ATLAS subsidiary in Sydney, Australia.

The requirements on a modern submarine combat system are very manifold. It has to be suitable for new build programs as well as for refit projects, where the submarine size can vary from a few hundred to a few thousand tons.

Today's submarine combat systems contain advanced-technology from different vendors and countries. The cost-effective integration of third party sub-systems avoids significant additional development effort and has to be performed with a minimal technical risk. Furthermore the combat system must be flexible enough to allow an easy implementation of upgrades over time to cope with the changing needs of users.

The ISUS Combat System is an advanced, sea proven fully integrated sensor, command & control and weapon engagement system, which in order to satisfy the above mentioned requirements, has had a "product approach" applied to its development. This approach allows ATLAS ELEKTRONIK to use the same technology basis for various system configurations as a low risk solution for submarines of all sizes and all mission types.

An example of the users developing needs is the evolution of complex active pulses used in modern undersea warfare platforms. Intercept, recording and analysis of these pulses are required to allow tactical use of the intercepted signals. Sonartech ATLAS research in this area will provide guidance to the future combat system development.

The paper provides an overview and highlights the latest development approach used by ATLAS ELEKTRONIK in its ISUS Combat System and an introduction into the research of complex active pulse analysis.

Session 5: Stream B - Paper 3

EARLY PHASE AVAILABILITY MODELLING

Dr Chris Edmonds, Director Future Programs, Babcock Pty Ltd

Dr Chris Edmonds is New Platform Director with Babcock Pty Ltd. He has over 30 years experience in defence design and analysis. A major focus of the last twenty years has been the early stages of major UK warship and submarine programmes including Daring, HMS Scott, Astute, Queen Elizabeth and Successor. A Naval Architect with a keen involvement in concept design and design economics his interest in availability is in being able to predict the real benefit of a new platform.

Tammy Chau is a Mechanical Engineer with Babcock Pty Ltd who graduated from the University of Adelaide with a Bachelor Degree in Mechatronics Engineering and Computer Science. Since joining Babcock she has worked in various departments including Design and Build, Production and Test Engineering, with two years spent in the Babcock Bristol Systems and Equipment office. She has worked in teams focusing on design and stress analysis relating to the weapons handling and launch equipment of new and existing submarine projects. Recently she has been involved in enterprise economic and submarine availability modelling, supporting the development of corporate strategy.

In all submarine programmes the issue of the expected availability of the platforms is of vital interest. Many of the programme's key parameters and design strategies are set during the concept phase that will determine the availability in service. However at this stage of a programme there is a major dearth of design data which is the prerequisite of conventional system availability modelling. At this stage the manufacturers have not been selected, the numbers of major equipments may even be undecided, let alone the details of operational configurations and dependencies.

However it is just at this time that critical questions of capability must be answered, for instance:

- How many boats are needed to provide 'n' boats on station?
- Can I trade a more redundant platform for fewer boats in the fleet?
- What should be the shape of the support solution?
- How many "docks" do I need?
- How many diesel generators must I have to be reliable?

This paper will describe a range of approaches that have been developed to analyse the expected availability of a submarine fleet at the earliest stages of a programme based on historic data of the events which stop boats being on patrol. It will discuss how the results can guide design strategy decisions. It will show how the techniques can be used to answer such questions and how it can help set expectations for the readiness that can be achieved.

Session 5: Stream C - Paper 3

S-80 AIP SYSTEM

Antonio Pérez de Lucas - Engineering and Innovation Director, Navantia

Antonio Pérez de Lucas has a MSc in Naval Architecture and MSc in Advanced Materials by the Polytechnic University of Madrid as well as BSc in Business Management by the IESE.

He has developed his professional career in Navantia, and has more than 30 years of experience in Naval Design.

Antonio started in 1979 as Structural Engineer in the Ferrol Shipyard and continued in the Madrid Headquarters Engineer Department from 1985, having responsibilities in Naval Architecture and Project Management of Spanish Navy and Export Programmes.

In 1996, he created the R+D Department in Navantia, been involved in cooperative Research Programmes with the European Maritime Community. He has also been the Head of the Structural Team in two Spanish Challenges to the America's Cup.

Antonio is presently the Corporate Engineering and Innovation Director of Navantia.

Antonio today will present this paper on behalf of Donato Martínez Pérez de Rojas.

Presentation of the S80 AIP System. The System is presently starting integration trials and we will have interesting results to show by November.

The S-80 submarines AIP System concept design was born in the early 2000. At that time there were few technologies compatible with the stringent requirements for the submarine mission needs, mainly in terms of stealth and large endurances. A sound decision methodology was established and pilot plants and scale models were built and operated as part of the technology development and validation strategy. The results of those tests confirmed the basic design options and allowed to fine tune the process basis prior to full scale design.

Once the basic technologies were established and well sustained, the S80 AIP programme started with the objective of integrating the selected technologies inside a submarine subject to the most stringent requirements in acoustic, shock, vibration, EMC,...

This engineering process being developed over the basis of the System Engineering and main milestones have been successfully completed (PDR and CDR). The engineering work for main components has been a challenge for the AIP partners.

Manufacturing of main components started followed by an EQT and FQT process. The main partners will describe the development programme and challenges faced.

Finally, once the components are delivered, integration activities start and the strategy will be described.

Session 5: Stream D - Paper 3

ELECTROHYDROSTATIC ACTUATORS FOR CONTROL OF UNDERSEA VEHICLES

Mr. Stephen Smith, Staff Design Engineer

Mr. Smith received a Bachelor of Science Degree in Mechanical Engineering from Virginia Polytechnic Institute and State University in 1982. He received his Professional Engineers License in 1986. Mr. Smith has worked in the Aerospace and Defense Market for most of his career.

Mr. Smith joined the Moog's Space and Defense Group in 2002 as an Engineering Section Head via acquisition by Moog Inc. of the Tecstar Space Products Line. He was the site manager for a 5 person Moog Inc. design services group specializing in electric motor and electromagnetic design. His current position is Navy Business Unit Engineering Manager. His expertise includes mechanical machine design and electric motor design.

This presentation will offer an alternative actuation scheme for undersea vehicles, particularly submarines. This actuation scheme will facilitate conversion to an all "more electric ship". Currently, submarine control surfaces are actuated hydraulically. The US Navy is in the early stages of converting all the ship's hydraulic actuation to electric. While advantages accrue to each eliminated hydraulic actuator, the full benefits of this conversion are only realized when the hydraulic plant is eliminated. However, electro-mechanical actuation may not be capable of replacing the large control surface actuators. In these cases, electro-hydrostatic actuation (EHA) may be the correct technology. EHA technology could give the submarine fighter aircraft like control. Moog's EHA technology is currently baselined for various military aircraft applications and the technology could be transferred to submarine applications.

Topics covered in this paper include the following:

- Principles of Operation
- Advantages
- Disadvantages
- State of Technology Development
- Future Development Needs

Session 5: **Stream A - Paper 4**

THE BENEFITS OF WIRELESS NETWORKING TECHNOLOGY FOR USE IN EXISTING & FUTURE SUBMARINES

Martin Childs MIEAust CPEng

Martin Childs is a former UK Royal Navy Weapons Engineer Officer, having served for 13 years before joining Defence Industry in 1996 and migrating to Australia that year. He has significant engineering experience ranging from design, test & trials and in-service support gained through many roles undertaking whilst working for Thales Australia and more recently ASC Pty Ltd.

Martin currently works for ASC in a dual role as the Platform Systems Manager within the Engineering Department and as the Transition Program Manager for the Collins Class Submarine arm of the ASC business. His transition role deals with a number of significant projects that will assist ASC in achieving performance expectations under the new In Service Support Contract between ASC and the DMO.

Martin is a Chartered Professional Engineer with Engineers Australia and was awarded a Masters of Engineering in Military Systems Integration in 2010.

This presentation discusses R&D work conducted on the Collins Class Submarine (CCSM), which demonstrated the feasibility of video to the bunk, music, email and web access quality of life capability on the platform. The R&D effort addressed important issues such as minimising the equipment installation footprint whilst ensuring effective coverage and cognisant of RADHAZ, HERO, HERF, EMC and EMI to ensure safety, technical and operational integrity of the CCSM was maintained. The potential benefits of a wireless system for use in a future submarine platform will be discussed both at a quality of life and a tactical level.

Session 5: **Stream B - Paper 4**

MODEL BASED SYSTEMS ENGINEERING AND ITS APPLICATION TO SUBMARINE DESIGN

Paul Pearce MIEAust CPEng MEng (MilitarySysInteg), Lead Systems Engineer, Deep Blue Tech Pty Ltd, Adelaide, South Australia

Paul Pearce graduated from the University of Adelaide in 2004, having successfully completed a Bachelor of Engineering (Mechatronics) with first class honours and a Bachelor of Mathematics and Computer Science. In the same year, he completed a 3-month student internship working on the A380 passenger jet at EADS Airbus in Hamburg, Germany.

Paul gained employment with ASC Pty Ltd in January 2005. In August 2009 he completed a Master of Engineering (Military Systems Integration) at the University of South Australia. Paul is currently employed as a lead systems engineer for Deep Blue Tech Pty Ltd – a wholly owned subsidiary of ASC that was established to conduct research and develop concepts for Australia's SEA 1000 Future Submarine project.

For many large projects across a wide range of sectors, the relentless increase in systems complexity presents a significant engineering challenge. Recognising this problem, a body of systems knowledge and practice has matured in the last two decades to a level where a model-centric approach to engineering is a sound and feasible alternative to traditional document-centric practices of the recent past. The term Model-Based Systems Engineering (MBSE) was originally coined in 1993 by Wymore as a formal mathematical approach to systems engineering. MBSE has since broadened in scope and matured in recent years in tandem with a growing recognition that systems engineering is a discipline in its own right.

This paper presents an approach to submarine design that leverages the strengths of MBSE, namely traceability, consistency, greater precision of the system specification and the ability to reuse and evolve the design. A centralised submarine architectural model is being developed in Deep Blue Tech Pty. Ltd. (DBT) to support the formulation of submarine concept designs. This paper will also discuss the substantial through-life opportunities of this approach and offer some recommendations for further consideration.

Session 5: **Stream C - Paper 4**

PRESENTATION OF THE S80 AIP SYSTEM LAND BASED TEST SITE (LBTS)

Amós Fuentes Degree - Navantia

Amos Fuentes Mellinas is Mechanical Engineer graduated from Polytechnic University of Cartagena and has collaborated in the S-80 Submarine Program since 2006. From 2007 to 2010 Amos Fuentes role was AIP System Fuel Cell Power Module development team leader, working as Navantia's resident engineer at UTC Power facilities in South Windsor, Connecticut (US). His current role is as AIP System integration and verification team leader at Navantia's AIP System Testing Facilities (IPS3) in Cartagena.

The integration of an Air Independent Propulsion system for the Spanish Navy new Submarine, the S-80, has signified by itself a complex development. The validation & verification processes have also been a big challenge for Navantia that has built a LBTS to provide sufficient warranties at the time of installing it at the S-80 Submarine.

At early phases of the program, one of the main issues was how to verify and validate the most stringent requirements of unique equipment, subsystems and the complete AIP system. The solution to the problem came with the help of the Systems Engineering, i.e.:

- Requirements identification
- Verification matrix which establishes the verification and validation methodology (test, demonstration, analysis or inspection). The methodology has been defined in order to be:

– Time effective,

– Cost effective, and

– Increase the maturity level (TRL) as fast as possible.

Once the Methodology has been defined the next topic was: Does the infrastructure to perform these tests exist? The answer was different for each equipment/subsystem/system, but it is mostly answered by the development of a LBTS, that is composed of:

- 4 Test Benches (Boxes) to perform the FAT of: Fuel Processor System (FPS), Power Conditioning System (PCS), CO2 Disposal System (CO2DS), and the O2 safety line (O2SL)
- 1 Test Bench to integrate the AIP Control System with the Equipment controllers
- 1 Test Bench (Box) for the AIP Plant (subsystem) to integrate the Fuel Cell Power Module (FCPM) with the Fuel Processor System (FPS) at first instance and the Fuel Cell Power Module (FCPM), the Fuel Processor System (FPS), the Power Conditioning System (PCS), and the AIP Control System (AIPCS)
- 1 Test Bench (Box) to integrate the AIP System inside the submarine section

This paper will describe the S-80 AIP system LBTS r and why it meets the AIP requirements.

Session 5: **Stream D - Paper 4**

A SEARCH METHOD FOR LOCALISING A NOISE SOURCE ON A SUBMARINE HULL

Stewart Kanev

Stewart is a Specialist Signatures Engineer and has worked at ASC for over 15 years in many areas of acoustics. He is a member of the Australian Acoustics Society and a Chartered Member of the Engineers Australia.

In the underwater world, noise is the 'sense' by which submarines feel their world and stalk their prey, and the emission of noise can turn a submarine from the hunter into the hunted. An onboard search technique is described that uses accelerometers and a portable analyser as a fast method for localising the source of acoustic energy into a submarine hull. The method uses a portable array of between two and five accelerometers to identify the direction of the passing structural bending wave and localise the source. This test method has been proven using a 'blind test' with a randomly placed vibration shaker on a docked submarine hull, and was successful in identifying the location of the hidden source.

Session 5: **Stream A - Paper 5**

NETWORKS OF UNDERWATER SYSTEMS

Craig Benson

Craig Benson is a senior lecturer at UNSW@ADFA where he teaches surveillance, navigation technology, electronic warfare, weapon engineering and test and evaluation. He is a former RAAF engineering officer and consultant whose research interest is in underwater communications.

We are currently in the age of non-networked wireless underwater communication. Underwater wireless (acoustic, optical and radio) communications currently tend to offer only point to point communication. This is a function of the physical solutions chosen for contemporary underwater communication systems. The few networks that do exist are normally just forwarding data to and from a gateway node or 'sink'. We should anticipate an age where the constraints implied by these communication system are removed, and where underwater systems are linked in a true network. Such a network would include the forwarding of data by network nodes, and communication through the network from peer to peer.

Applications supported by underwater networks would include cooperative mine clearance by multiple AUVs, near real-time environmental assessment, and sensor networks for monitoring of outfall plumes from sewerage and desalination plants.

In this paper we review currently available networking techniques, and present our own work which improves on existing networking protocols in underwater acoustic networks. The work is currently limited to simulations, based on performance characteristics of our high-data-rate modem, but will soon extend to a test network of ten instrumented spar buoys.

Session 5: **Stream B - Paper 5**

EARLY STAGE TOOLS FOR SUBMARINE DESIGN – "BOAT-BY-NUMBERS"

Paul Plant BEng (Hons) MIMechE CEng Engineer, Deep Blue Tech Pty Ltd

Paul is a senior engineer in Deep Blue Tech and joined the company in 2007. He leads the concept design team, which conducts the key functions of naval architecture in the submarine system. He previously worked for BAE Systems, in the UK, and worked on a succession of warship projects including Astute and the Vanguard successor, having joined the company as a graduate engineer in 1998. He has a BEng (Hons) degree from The University of Manchester, has completed foundation studies in Naval Architecture at Southampton University, and is currently studying for an MSc in Marine Engineering.

A key aspect of submarine concept design involves translating functional design requirements into physical products – a physical design solution. This can range from satisfying requirements by defining a set of key dimensions, through to developing a fully engineered solution that is balanced hydromechanically, in arrangement with its payloads and subsystems, and with the requirements.

There are several recognised approaches for developing concept designs including an 'evolved' approach using similar vessel(s), 'parametric' using large data sets of parameterised vessels, and graphical methods including using 'building blocks' where known blocks are assembled to develop the submarine. DBT has developed an approach that uses algorithms to calculate realistic demands from requirements and input data, and thereby create a conceptual submarine model – a 'boat-by-numbers'. This paper presents some aspects of this approach and outlines some of the tools used and how it is coupled with other techniques to develop an engineered concept design. A key feature involves the use of computational geometry to develop the hull form and the pressure hull. This enables the geometry to be accurately described in an iteration loop and increases the accuracy of the hydromechanical calculations. It also allows for efficient generation of a faired geometry model in CAD, promoting efficient layout design.

This approach creates the ability to both size submarines and to illuminate the impact of changes in the requirements and the demand from payloads and subsystems.

Session 5: **Stream C - Paper 5**

NAVAL ARCHITECTURE CHALLENGES FOR INTEGRATION OF UNDERWATER UNINHABITED VEHICLES IN SUBMARINES NAVANTIA EXPERIENCE IN THE INTEGRATION OF UUV THROUGH THE SOWEC (R&D) PROGRAM

Eusebio-Angel Martinez-Conesa, Navantia S.A.

Eusebio-Angel Martinez-Conesa has Mining Engineering and Industrial Organization degrees from the Cartagena Polytechnic University of (Spain) and has completed a doctorate in Business Management in the same University. He has 22 years of industrial experience in the Navantia Naval organization in a variety of engineering design, manufacturing, and business development roles. He is currently responsible for weapons system and masts integration in the S-80 submarines and is leading the Special Operations and Weapons Enhanced Capability (SOWEC) research and development (R&D) project.

Naval architecture challenges for integration of underwater uninhabited vehicles in submarines

Navantia experience in the integration of UUV through the SOWEC (R&D) program

There is a general consensus that the Submarine is the most promising naval platform for the use of UUV, when applied to surveillance, intelligence gathering, offensive mining and countermining or special operations support. No other platform can provide comparable stealthiness if it is involved in a low intensity conflict or first strike possibilities in global warfare.

Navantia is currently involved on an internal Research and Development study, named Special Operations and Weapons Enhanced Capability (SOWEC), the object of which is to provide the sufficient knowledge to ensure the most cost effective way to incorporate this capability on the Navantia designs, including future Submarines.

The purpose of this paper is to present the main conclusions of this study, where several feasibility analyses have been performed in order to incorporate this essential technology in a Conventional Submarine Platform. The analysis includes different concepts/locations which were developed for incorporating UUV Launch & Recovery on the Conventional Submarine architecture, including a launch platform in the Forward Free Flood Zone, a Special Launch Tube (SLT), a separate system located behind the sail, and the use of current TLTs as a UUV dry shelter. At the same time, a number of UUV securing methods were investigated, including, stowage rack with retracting straps, different latch system interfaces, and the use of a ROV to latch into a stowage rack. In parallel, a new concept on pulsating control system is being developed to provide hovering for the covert UUV recovery. Finally, the possibilities for communication between an UUV and the Submarine, in at short/long ranges, is discussed.

Session 5: **Stream D - Paper 5**

SUBMARINE MANOEUVRING AND APPENDAGE DESIGN

Professor Martin Renilson - Technical Director, Renilson Marine Consulting Pty Ltd

Martin Renilson first moved to Tasmania to set up the hydrodynamics facilities at the Australian Maritime College (AMC) in 1983, and was the inaugural Director of the Ship Hydrodynamics Centre there. He subsequently ran the Australian Maritime Engineering CRC Ltd for a year, and then established the Department of Naval Architecture and Ocean Engineering at AMC.

Professor Renilson moved to DERA in the UK to take the role of Technical Manager, Hydrodynamics, in 2001. This was subsequently privatised to become QinetiQ. He left QinetiQ in 2007 to return to Tasmania, where he now runs his own hydrodynamics consultancy. He also holds a part time chair in Hydrodynamics at AMC.

In order to control manoeuvring motion in both the vertical and horizontal planes submarines are fitted with controllable appendages. The traditional approach to this for modern submarines is a rudder to control motion in the horizontal plane, together with forward and aft planes to control motion in the vertical plane.

The differences in manoeuvring in the horizontal plane and the vertical plane are outlined, and the need for forward planes demonstrated. There are various options for the location of the forward planes, and the pros and cons of these for a modern SSK are discussed.

Many SSKs are being fitted with X planes instead of the traditional cruciform configuration of rudder and aft planes. For some submarines X planes are likely to be better options, whereas for others the traditional cruciform arrangement is preferable. The hydrodynamic differences in the way these provide the required forces to control manoeuvring in both planes are explained, and the advantages and disadvantages of the different arrangements are discussed.

Session 5: **Stream A - Paper 6**

VIRTUAL SHIP TRAINING AND INFORMATION SYSTEM FOR SUBMARINES

Noel Thomas (Tom) Reynolds, Business Development, Defence & Government Services, Asia Pacific Kellogg, Brown and Root Pty Ltd

Tom Reynolds currently manages the Maritime Business Development portfolio for the KBR Defence and Government Services business, responsible for training, engineering and integrated logistic support opportunities in the Defence and civil maritime domains.

Tom's previous appointments with KBR have included the Program Director (PD) role for the Through Life Support Armed Reconnaissance Helicopter (ARH) Tiger Training Contract and the ARH Tiger Training Acquisition Contract.

Prior to employment with KBR, Tom spent 22 years in the Australian Army in a variety of appointments.

These included the Senior Logistics Manager for the army's aviation organisation, responsible for ensuring compliance with Australian Defence Force airworthiness regulations, aviation logistics and training policy, contract management and oversight of army aviation aerospace engineers. Prior to that, he completed an appointment as the Commanding Officer of the Army's Aviation Support Group Workshop, responsible for the leadership and management of 320 engineering, training and logistics personnel and the airworthiness integrity and logistic support for 26 rotary wing aircraft.

Other appointments have included Director of Integrated Logistic Support (Army) based in Melbourne, Commander of the first Australian Defence Force contingent deployed into Bosnia-Hercegovina in support of NATO led forces and Officer Commanding the 5th Aviation Regiment Workshop in Townsville.

He has completed Command and Staff College at Queenscliff, Victoria; the Material Acquisition Project Management course at the United States Logistic Management College, Fort Lee, Virginia; the Officers Long Aeronautical Engineering course at Middle Wallop in the United Kingdom and is a Graduate of the Royal Militar

The virtual submarine training capability has been developed by the Virtual Ship Training and Information System (ViSTIS®) Alliance partners, Blohm+Voss Naval (BVN), Kellogg Brown & Root (KBR) and Crytek. ViSTIS® is an advanced training system that enables flexible single and multi-trainee scenario based learning in a photorealistic, immersive 3D environment.

Technically accurate to the submarine specifications with integrated simulations and context sensitive training information, ViSTIS® scales to meet customer requirements and securely delivers training to any platform in a distributed or classroom learning framework. It organizes and monitors the full learning process using integrated learning and content management, while motivating and rewarding students with the latest, future-proof serious gaming technology.

Our virtual submarine training capability offers knowledge management and intuitive authoring capabilities allowing instructors and trainees to adapt scenarios and share their experiences. It reduces the cost and time dedicated to training on board the actual submarine, which directly leads to improved operational availability.

Session 5: **Stream B - Paper 6**

THE S-80 SHIPBUILDING PROGRAM

Captain Nicolás Monereo - S-80 Head of Program, Spanish Armada

Captain Nicolás Monereo was born in Madrid in 1957. Graduating from the Spanish Naval Academy in 1982 he was designated as engineering assistant and Damage Control Officer in the Corvette "Vencedora". In 1984 he served as Chief Engineer in the Patrol Boat "Bonifaz" and in 1995 in the Corvette "Infanta Elena".

He earned a Masters Degree in Naval Engineering Science from the Madrid Polytechnic University and a Master of Naval Architecture from the ENSTA (École Nationale Superiéure de Techniques Avancées) in Paris.

His engineering duty officer tours include F-100 Shipbuilding Program, Spanish Naval Program at NAVSEA (Washington DC), and Platform Leader in S-80 Program. Since 2010, he has been the Head of S-80 Program for the Spanish Armada.

Other skills:

Computer System Analyst

Quality Assurance Representative

Program Manager

The S-80 Submarine, together with other programs such as the F-100 Frigates and LHD multipurpose ships, is one of the most ambitious shipbuilding programs that the Spanish Navy has recently undertaken.

Due to the long tradition of the Spanish Navy in the operation of SSKs and the maturity of the Spanish Shipbuilding Industry, in the 1990s it was decided that the time had come to design and build our own submarines, the S-80 Class. This program is very important for both the Spanish Navy and the Spanish Naval Defence Industry. This paper will describe the main reasons behind this decision, the consequences and the situation of the program.

This submarine program is a challenge not only because of the important technological advances that it encompasses, but also because it is the starting point of a new way of thinking for the Spanish Naval Defence Industry and of course, for the Spanish Navy. The definition of requirements, the maturity of the project before commencing construction, the restraining of changes during construction, and the maintenance of a very strict engineering methodology are obvious, but always difficult to realise in such a complex program. Other issues that strongly affect the program are related with the use of commercial standards, the integration of new and advance submarine technologies into a new platform, the reliability studies considering the ship as a unique system, and the application of a very strict Safety Plan. After some intense years in which the Spanish Navy and Navantia worked side by side, we are confident that we will have a very good submarine that will satisfy requirements and will provide to the Spanish Navy a significant increase in their current capabilities.

Session 5: **Stream C - Paper 6**

DESIGN AND DEVELOPMENT OF A SMALL, LOW COST UNMANNED UNDERWATER VEHICLE FOR SHALLOW WATER OPERATIONS

Nicholas Gover, School of Engineering and Information Technology

University of New South Wales, Australian Defence Force Academy

Nicholas Gover is an undergraduate student at the University of New South Wales at the Australian Defence Force Academy in Canberra. He is currently in his final year of his Bachelor of Engineering (Aeronautical) where the paper presented here is a part of his final-year thesis. Nicholas has nine years' experience in the Australian Defence Force with a background in mobile terrestrial communications and tri-service communications integration. Nicholas is also a remote area fire fighter and an avid musician.

Last decade has seen a significant increase in the use of Unmanned Underwater Vehicles (UUVs) for various purposes such as mine reconnaissance, oceanographic surveys, pipeline and underwater infrastructure monitoring etc. While most of such UUV's have been designed for deep water applications, there seems to be fewer papers on design of low cost UUVs for shallow water operations. Typically such UUV's are important research platforms which allow experimentation of allied technologies such as underwater communications, collective and collaborative intelligence etc. This paper outlines the design and development of a small, low cost UUV prototype platform capable of supporting underwater communications research at shallow water depths. The design requirements, options and the underlying rationale for several choices made throughout the design process are discussed in depth along with its quantitative performance estimates. The UUV design described in the paper relies heavily on the use of off-the-shelf components in an attempt to contain cost, while maintaining a modular configuration is adopted for future enhancements. The design has since then been built and is currently undergoing trials.

Session 5: **Stream D - Paper 6**

HUMAN FACTORS AND HABITABILITY

Mr Anders Folbert, Deep Blue Tech Pty Ltd

Anders Folbert joined the Royal Swedish Navy 1986 and served in the 1st Submarine Flotilla for 22 years including basic submarine training, Naval Academy, Naval War College and Swedish National Defence College. He has more than 20 years of submarine experience including service on seven submarines of four different classes 1986-2007, Commanding Officer of three submarines 2003-2007 and Commanding Officer SWENARAPSUB 2006-2007

He has experience from Singaporean and Danish submarine training projects as OOW and XO providing operational training and staff experience as Head of Training and Education at the Swedish Submarine Flotilla, Head of Submarine Inspection Group and Crew Tactical Training.

His last assignment in the Swedish Navy 2007-08 was as Head of Underwater Warfare School at the Swedish Naval Warfare Centre.

Anders joined ASC in 2008 as Submarine Specialist and is seconded to Deep Blue Tech. He has been lead in several different projects such as Mission Analysis, Crewing, Human Factors and Habitability. His current role is Team Leader – Combat Systems, Modelling & Simulation and Signatures.

A submarine is a whole society comprised of equipment and people living in a small and unique environment. "A soldier can put up with anything" might have been an adage that could be applied previously, but today, and even more so in the future, this will not be an acceptable way of expressing the requirements for accommodation and habitability.

The submarine accommodation solution needs to be progressed to an acceptable level at an early stage due to the impact it will have, not only on the overall ship design, but also in terms of attracting and retaining new sailors. We do not know exactly how technology will develop, but we know that we will still need a crew consisting of people with higher requirements than ever before and an acuter awareness of what they believe is acceptable.

As submarine engineers, it is easy to revert back to existing designs and simply develop uninspiring solutions rather than be innovative in this area. This may be acceptable from a purely functional perspective, but looking beyond the functionality and towards the actual expectations of the wider submarine community, it should be realised that the boundaries have to move. Exploration of new ideas and directions need to be undertaken to be more competitive in terms of attracting personnel, not only to join but to stay.

This paper will present the background and work conducted in Deep Blue Tech, the interior design projects undertaken, the resultant outcomes and the lessons learned.

Session 5: **Stream A - Paper 7**

HIGH CAPACITY UNDERWATER COMMUNICATIONS

Craig Benson, Senior Lecturer, ADFA

Craig Benson is a senior lecturer at UNSW@ADFA where he teaches surveillance, navigation technology, electronic warfare, weapon engineering and test and evaluation. He is a former RAAF engineering officer and consultant whose research interest is in underwater communications.

Current underwater communication system suffer from low data capacity. The data rates barely support telemetry of basic sensor data, very few systems can transmit of modest images in a timely fashion, and dreams of video transmission remain just that.

The main reason for this is the low frequencies at which underwater acoustic systems operate. These low frequencies are selected so that long-ranges can be achieved, higher frequencies suffering from absorption. By adopting a relaying communication scheme, long communication ranges can be achieved in spite of short wireless link ranges. Therefore high carrier frequencies can be used allowing a massive increase in data rates. A side benefit of this scheme is that such transmissions are covert, since detection from even modest ranges is not possible because the signal is rapidly absorbed by the water. This paper outlines our high-frequency, high-data-rate underwater acoustic modem, including results from open water testing.

Applications supported by high-data-rate communications include tetherless download of sensor data after AUV missions, intra-vehicle communications between swarms of small AUVs, and wireless video transmission from reconnaissance or mine clearance AUVs and divers.

Session 5: **Stream B - Paper 7**

AN INTEGRATED DATA ENVIRONMENT FOR THE FUTURE SUBMARINE PROJECT IN AUSTRALIA

Malay Pal, Director, Shipbuilding, Siemens Industry Software, India

Malay Pal is responsible for managing all activities of Siemens Industry Software in the shipbuilding, marine and offshore industry in Asia Pacific, and is a member of the dedicated global team in Siemens Industry Software for the marine industry. Siemens Industry Software has more than ten years experience in supporting constructors and navies in the United States and Europe.

Malay's previous experience included 12 years working with IBM in a variety of roles including leading IBM's activities in the marine industry in India and Asia Pacific. He has over 22 years experience in working with the shipbuilding industry, both naval (warships, submarines) and commercial, in the areas of design, construction and data management.

The design, construction and life-cycle support of warships and submarines is an extremely challenging, technically complex endeavor which can span 30 to 40 years. The design and construction of a class of ships can itself span a decade. The information required to support this effort is voluminous and constantly changing.

While CAD/CAM systems are used for design and construction of ships, an Integrated CAD/PLM/DM suite of software can provide the backbone of an Integrated Data Environment (IDE) which houses the product model data, and enables people to work in concert towards common business goals throughout the life-cycle of the ship. Designing and maintaining a ship using such an IDE can add significant efficiencies to the process, and enables highly efficient collaboration between all involved agencies.

This paper discusses the requirements that an IDE must support in order to enable efficient naval ship design, construction and service life support. Several naval projects in the world have historically used a variety of tools in their design, construction and operational phases, and have faced various challenges like issues with data transfer and inter-operability, lack of integration, etc., which have prevented the realization of setting up an efficient and effective IDE. With the availability of integrated CAD/PLM/DM solutions which are already proven in large and complex defense projects including naval, it is possible to set up a highly effective IDE for the Future Submarine Project in Australia. The paper will also discuss issues like Long Term Data Retention which is critical for such projects.

(DM : Digital Manufacturing)

Session 5: **Stream C - Paper 7**

DESIGN AND DEVELOPMENT OF A "SIX INCH SUB"

Joshua Fearnley, School of Engineering and Information Technology University of New South Wales Australian Defence Force Academy Canberra, ACT 2610, Australia.

Joshua Fearnley is a fourth year undergraduate student studying a Bachelor of Mechanical Engineering at UNSW@ADFA. He joined the RAN in 2007 where he completed the RAN's New Entry Officer Course before commencing his studies at ADFA in 2008. Joshua will re-join the waterfront in early 2012 to begin his Marine Engineer Officer training with the RAN.

Joshua joined the Multidisciplinary design Optimisation group at UNSW@ADFA in the beginning of 2011 where he inaugurated research into the design and development of a "six-inch sub" for his final year engineering project.

While Uninhabited Underwater Vehicles (UUVs) have received significant research attention in the last two decades, limited studies (around 4.1% of all published literature on UUV's) have focussed on the design and development of mini/micro(smaller (less than 1 feet in length) underwater vehicles. Such vehicles are particularly attractive for deployment in extraordinarily confined spaces such as inspection of intricate underwater structures or extreme hazardous areas. This paper outlines the approach undertaken by the MDO Group at UNSW@ADFA to design and build a low cost, six-inch remote control submarine with image capturing capability. The concept demonstrator UUV has a torpedo shaped body with an overall length of 152 mm and an external diameter of 42mm. It utilises one main propeller for surge control, while two small paddle wheels are used for yaw control. A hydrostatic vertical displacement system is deployed for heave and pitch control. The design is optimized for minimum drag while considering clash free assembly of internal components. Design considerations for improved manoeuvrability and adequate dynamic stability are discussed in the context of imaging requirements. Further research is underway to improve its controllability and in future an autonomy, whereby multiple mini vehicles can be deployed by a larger submersible to perform a task in collaboration.

Session 5: **Stream D - Paper 7**

DEVELOPMENT OF COMPOSITE PRESSURE VESSELS FOR SUBMARINE EXTERNAL STOWAGE

Dan Miller, Engineering Services Manager (SA), ASC Pty Ltd

Daniel Miller holds the current position of Engineering Services Manager – SA at ASC Pty. Ltd., where he manages the Engineering Services Group including the Materials Engineering Section. He is responsible for the engineering direction of in-service support and major dockings and holds technical authority delegation in structural and material domains on the Collins Class Submarines. Prior to this he was a Specialist Structural Engineer, at ASC, supporting initially the build and then the through life support of the Collins Class Submarines for the Royal Australian Navy.

Daniel graduated from Monash University in 1996, having successfully completed a Bachelor of Engineering (Civil) specialising in Structural Engineering. In the same year, he started a 2 year graduate rotation under the employment of the then Australian Submarine Corporation (now ASC Pty. Ltd.). During this time, Daniel completed a post graduate diploma in Materials, Welding and Joining at the University of Adelaide.

Designers of modern conventional submarines are constantly striving to improve the platform's capabilities in a time of diverse missions. The inherent space and weight restrictions imposed on submarine design dictate a high level of optimisation and the implementation of advanced technologies to combat these often conflicting requirements.

The design of external stowages is an area where this design paradigm is especially evident. In order to provide the RAN with additional mission flexibility and meet stringent submarine requirements, a novel approach was adopted to develop a composite pressure proof stowage. The environment that these items are exposed is highly aggressive and requires a number of issues to be addressed in relation to ship safety. The design explores the use of composite laminate construction with the aim of minimising weight and cost, maintaining buoyancy and maintaining impact resistance using glass/carbon reinforced plastic for the prototype stowage.

Session 5: **Stream A - Paper 8**

PERISCOPES AND OPTRONICS – FUTURE SUBMARINE VISUAL SYSTEMS

Adam Waldie

Adam Waldie is a former Naval Officer and the current Business Development Manager – Submarines for Thales Australia. Adam served on Collins Class submarines from 1997-2004 as a Navigator / Sonar Officer. Since that time, Adam has worked within the Australian Defence Industry as a consultant on various submarine projects. Regrettably, Adam is perhaps best remembered within the Submarine Force as the 'one' who let his wife pack for HMAS Collins deployment to Alaska – as such he had one pair of overalls for the entire six month voyage.

The final decision on what sensor package will be part of the Future Submarine is closer than we think. Modern and indeed future submarine systems by their very nature play a significant role in effecting the baseline design of any submarine. Periscopes and Optronics are no exception. The 'hull penetrating' design of the current periscopes fitted to the Collins Class and the Oberon's before them have provided excellent performance and a mode of confident operation at periscope depth that Australian Submariners have gained renown for internationally.

Seemingly overnight however, our United States and Royal Navy allies have swept over 100 years of tradition aside by fitting their frontline SSN's, the Virgina and Astute Class with not one but two 'non hull penetrating' Optronics masts. Suddenly there is no reason to bolt the Control Room under the fin of the submarine and it is free to roam to an alternate location granting platform designers amazing freedom in their architecture philosophy. No more is the visual tactical picture resident only in the eye of the beholder staring through the optical path – it's on open console display for the entire command team to assess and process - but what have we lost in heading down this road?

This paper will address the significant lessons learned by the Royal Navy in developing the roadmap from periscopes to optronics and how Australia can benefit. Where do we start in gaining confidence with the technology and the mode of operations that an optronics system grants us? Is it already too late to do so?

Point of Contact (POC) in relation to further interest on behalf of the SIA in Thales presenting this paper during the SIA Technology conference is Adam Waldie, contact details are listed below:

Session 5: **Stream B - Paper 8**

ESTABLISHMENT OF A NEW, COST EFFECTIVE SUBMARINE SUPPORT CAPABILITY IN CANADA

Michel Bouchard - President, Canadian Submarine Management Group

Michel Bouchard joined the Royal Canadian Navy in 1976 and secured first and second degrees in Mechanical Engineering from the Royal Military College of Canada. Over 25 years as a Naval officer (Marine Systems Engineering) he held numerous posts with responsibility for platform and combat systems, human resource management and international diplomacy, the last nine years in the senior rank of Commander.

In 2001 he joined Weir Canada as General Manager for a multidisciplined engineering operation specialising in marine systems test and evaluation. In 2004 he was promoted to VP and General Manager of a division of Weir Canada specialising in turnkey refurbishment in the hydro power, oil and gas and mining sector.

In 2006, on formation of CSMG, he was nominated as the VISSC project leader. He has been responsible for bid preparation, contract negotiation and subsequent project delivery.

Canada's support contract for Victoria class submarines (the Victoria class In-Service Support Contract, or VISSC) awarded in 2008 to Babcock's Canadian Submarine Management Group (CSMG), represents a significant change from traditional warship support contracting, seeking to transform the delivery of submarine maintenance, technical support and post-design activity to Canada's Department of National Defence (DND). The contract is also an illustration of how to successfully 'export' extensive experience and expertise, in this instance in through-life submarine support and long-term class management.

CSMG's scope of work under VISSC can be broken down into a number of key areas. These include project management (planning, risk management, safety, quality, financial and commercial services), and engineering support involving delivering services to fulfil the design agent role, such as systems engineering, systems integration, integrated logistics support, engineering changes, and so on. Data management, including configuration management and responsibility for all submarine technical documentation, is a further area covered. Material and logistics support is also provided, encompassing repair and overhaul management, material definition, procurement and supply, warehousing, and so on, as well as maintenance support covering all activities for Level 3 maintenance (Extended Docking Work Periods, or EDWPs), plus definition of and support to Levels 1 (running maintenance) and 2 (base maintenance).

Under the VISSC contract (in which all core services and customer delivery dates have been successfully achieved to date, with the first EDWP taking place this year), Babcock is applying its expertise to deliver both the improved submarine availability that the Canadian Navy seeks, plus through-life support cost savings year on year, while keeping safety and quality at the heart of all CSMG activities. The establishment of this support regime will provide the foundation of an approach that can subsequently be applied to other maritime assets.

Session 5: **Stream C - Paper 8**

6-DOF PARTICLE FILTER BASED NAVIGATION SYSTEM FOR AUTONOMOUS UNDERWATER VEHICLES

Andrew Lammas, School of Computer Science, Engineering & Mathematics, Flinders University

Andrew Lammas received his Bachelor of Engineering (Computer Systems) from Flinders University, Adelaide, Australia in 2004. Currently he is completing his Ph.D. in Engineering also at Flinders University. His research interests include design and implementation of model based robust nonlinear filtering methods for navigation and awareness systems within autonomous underwater vehicles (AUVs). For last 2 years he has worked as a research assistant, funded by CSIRO's Wealth from the Oceans Flagship Program, with the Intelligent Systems Research Group (ISRG) within the School of Computer Science, Engineering & Mathematics (CSEM) at Flinders University. In this role he has assisted in the design and development of various electronic components and algorithms within processing platforms of an AUV being designed and built within the ISRG.

Navigation accuracy is one of the most critical factors in determining the operational suitability of any autonomous underwater vehicle (AUV) for its designated environment. This paper describes a new algorithm, namely the Measurement Assisted Partial Re-sampling (MAPR) particle filter, for improving navigational accuracy in autonomous AUVs. A comparison of the performance of the MAPR filter against those of the industry standard Extended Kalman Filter (EKF) and the current state-of-the-art Unscented Kalman Filter (UKF) estimation algorithms is presented to determine their relative merits.

The MAPR, UKF and EKF algorithms are assessed in a purpose-built AUV simulator in the context of a highly dynamic non-linear and non-gaussian environment such as an underwater vehicle operating under turbulent conditions. The vehicle motion is determined by a full 6-DoF hydrodynamic model driven by a fully-coupled control system performing coupled manoeuvres dictated by a guidance system. Models of the IMU, DVL and GPS sensors have been incorporated into the simulation system to closely mimic real sensors and thus generate realistic raw sensor data.

The three estimation algorithms are evaluated using a common observer design. The state vector containing the three linear and three rotational velocities, three position coordinates, four orientation coordinates and three current velocity coordinates, is chosen such that the observer can estimate the non-continuously measurable states that are used in the 6-DoF control of the vehicle. These sixteen states enable the system model to incorporate a kinetic model as well as the traditional kinematic model used in most systems. The defined state vector and model enable the system to estimate water current parameters purely from the motion of the vehicle, rather than any direct observation.

The results demonstrate the improved accuracy and robustness of the MAPR particle filter and the UKF, in the context of a more complex state vector and model, than the EKF. Though similar, unlike the UKF, the MAPR filter has additional scope for improvement due to particle filters being able to linearly increase the computation effort to reduce error.

Session 5: **Stream D - Paper 8**

DEVELOPMENT OF A CAPABILITY FOR MEASURING DEWPOINTS AT HIGH PRESSURE FOR THE COLLINS CLASS SUBMARINE

James Gregor, Certification Technical Officer Manager - SA, ASC Pty Ltd

James Gregor holds the current position of Certification Technical Officer Manager – SA at ASC Pty. Ltd., where he manages the Certification Technical Officers. He is responsible for providing all the manpower resources ensuring, all SUBSAFE witnessing activities, Installation Inspections, Harbour Acceptance Trials and Sea Acceptance Trials are met for Full Cycle Dockings and in-service submarines here in S.A and W.A. James has spent the last seven years at ASC in the Test and Trials environment.

Prior to working in the Test and Trials environment James spent twenty two years in the Royal Australian Navy serving on Ships, Oberon and Collins Class Submarines. The last three of those years was as the Deputy Marine Engineering officer of HMAS Sheean and HMAS Rankin.

The measurement of dew point at pressure can lead to incorrect values of the water vapor content at atmosphere if these dew points are not corrected for real gas behavior, water vapour polarity and the vapour depositing on walls.

If these values are not corrected when measuring at pressure there is a risk that the water vapour content will be underestimated.

Incorrect establishment of the appropriate high pressure air dew point has the potential to cause a loss in a platforms ability to recover in an emergency situation (i.e. loss or deterioration of the Emergency Blow system). The failure of the emergency air system, due to incorrect dew point (excessive moisture in high-pressure air bottles froze and plugged its own flow path), was a major contributor in the loss of USS Thresher in 1963 (129 officers, crewmen, and military and civilian technicians aboard died).

ASC established contacts with NPL laboratories in the UK and attended workshops at Michell in the UK who are recognised world leaders in dew point measuring technology. These institutions have been engaged throughout the development of the new test methodology, as they did not have any test methodology at the pressures needed for the Collins Class Submarines. Most other Navies establish dew point at atmosphere or near atmosphere which has the potential to introduce several fault sources.

ASC has developed suitable equipment and measurement methodology for use onboard the Collins Class, to establish dew point at pressure. This involves establishing correction factors for environmental factors, appropriate settling criteria and a method of detecting the correct function of sensors.

Session 5: **Stream A - Paper 9**

SUBMARINE SONAR - OUTBOARD ACOUSTIC ARRAY TECHNOLOGIES

Tim Cain, BE, MSc (Acoustics), Dip. Proj. Mgt, MIEAust - Technical Manager, Undersea Warfare Systems, Thales Pty Ltd

Tim is the Technical Manager at Thales Australia Naval Under Water Systems. He has worked in underwater sonar systems for the last 19 years. Tim has been involved in a number of major sonar programs during that time - the integration, test and sea trials of the sonar and combat system onboard the first four COLLINS Class submarines, delivery of underwater warfare system electronics cabinets into the Australian FFG Upgrade program and developmental programs such as the Fibre Laser Sensor Capability Technology Demonstrator (CTD).

Tim is responsible for ensuring the integrity of all technical and engineering activities within the Thales UWS organisation in Australia. This includes providing direction and co-ordination of self-funded research and development effort.

Tim heads a multi-disciplinary technical and engineering group of 70 staff, comprising sonar system architects, mechanical and electrical engineers, acoustic transducer designers, signal processing specialists and software developers.

When the Collins Sonar suite was originally conceived, the inboard processing technology represented a major challenge. Bespoke hardware and software was developed to achieve what were then ambitious processing goals. This led to major challenges throughout the development, integration, and verification phases.

Today these challenges are a thing of the past. Dedicated processing hardware designs are no longer necessary, and the infrastructure software required to develop large multiprocessing applications is now mature and proven. Sonar signal processing is easily achieved with COTS processing hardware, and it's through life refresh has been demonstrated on submarines at sea.

Increased processing ability has led to ever larger outboard arrays which have grown in performance and sophistication. Today high performance outboard arrays are the major investment decision for a new sonar.

Large arrays require careful consideration of cabling, space, weight, structural and stability factors. It is also necessary to ensure that their performance improvement is not lost through platform self noise interference.

New technologies such as outboard digitisation, high speed digital interfaces and fibre optics can reduce the interconnection complexity. Modular panels containing many sensors provide increased reliability and robustness to environmental factors.

It is now more than every crucially important to determine the sonar sensor configuration early in the submarine design process, to ensure that there is time and opportunity to select the most appropriate technologies, to balance the trade offs of cost, risk and performance, and to select a sensor configuration that will meet the through life requirements of the new submarine.

Session 5: **Stream B - Paper 9**

INFRASTRUCTURE CONSIDERATIONS OF POSSIBLE INVESTMENT IN AN SSN OPTION

John (Jock) Thornton, FIEAust; MIMechE; MIMarEST. Bio

Born and educated in Scotland, Jock Thornton joined the Royal Navy in 1962 and, after qualifying in marine engineering at the Royal Naval Engineering College Manadon, he specialised in nuclear submarine engineering. He served in HM Submarines REPULSE (SSBN) CHURCHILL AND CONQUEROR (SSNs) and in a number of submarine operational and support appointments, culminating in his appointment as Submarine Flotilla Marine Engineer Officer. Jock joined ASC in 1989 and in his ten years with the company, filled a number of general managerial roles including ILS, Certification & Commissioning and. finally, General Manager Technical. After time in Malaysia with PSC (Naval Dockyard) and Williamstown with Tenix Defence, he joined the Defence and Systems Institute at the University of South Australia as a senior lecturer in military systems integration.

- The Australian Government has stated that the successor submarine would not be nuclear propelled.
- However the debate continues albeit mainly in submarine–centric communities

Session 5: **Stream C - Paper 9**

THE UTILITY OF VIRTUALISATION TECHNOLOGIES TO COMBAT SUBMARINE COMBAT SYSTEM OBSOLESCENCE

David Culpin, Raytheon Australia

A successful manager with a strong professional services background, Eric Gaschk is Raytheon Australia's WA Deputy Site Executive. In this role he works with and supports the WA Site Executive on matters that relate to the successful execution of all WA programs, and the management of the WA Site comprising 67 staff.

He is also the program manager for the multi-Million dollar Submarine Replacement Combat System (RCS) Systems Integration Agency (SIA) program. Working in an Integrated Product Team environment with the Defence customer, the program provides systems integration, testing and full program support (including Systems Engineering, ILS, Configuration Management and Quality Assurance) services. This program is viewed by senior management as one of the most challenging projects in the corporate portfolio and critical to the future success of the company.

Prior to joining Raytheon, he successfully led the WA operations of a leading Defence sector consultancy for three years where he significantly grew revenue through recruiting and leading a team that shared his focus on quality and had a passion for exceeding client expectations. He gained his core management skills and leadership experience during his military career, the highlight of which was preparing and leading aircrew officers in fast-jet aircraft operations. In parallel with earning tertiary level business qualifications, he subsequently broadened his expertise through project management, business, and systems engineering consulting work to Government clients across Australia.

Eric has been a member of the WA branch of the Australian Institute of Management since 2001, is a graduate of the Australian Institute of Company Directors, and is a registered Master Project Director with the Australian Institute of Project Management.

A Western Australian native, Eric enjoys cycling, travel, reading, and recreational computing. He is married, with two primary school aged children.

The Collins Class Submarine Combat System (CCSCS) is characterised by a number of discrete sub-systems that are largely assembled as individual capabilities; Tactical, Sonar, Navigation and so forth. There exists a myriad of processing hardware inherent within these subsystems that are experiencing various levels of obsolescence. Considering that this issue is shared with all complex Defence systems, there are a number of remediation options; ranging from 'rebuild from scratch' to 'retention of software'. It is the latter that offers the most significant performance benefits (including cost, schedule, size, weight and power) to Navy. The production of new software represents the greatest risk to the sustainment of any complex system. In order to retain any investment in software a strategy that emulates or virtualises the legacy hardware environment is required. The concept of 'Virtual Machines (VM)' has been widely adopted in the Commercial domain but has yet to be accepted as a low-risk approach within Defence. This paper explores the utility of VM technologies for the CCSCS and endeavours to present viable options for a more holistic view on through-life management. In addition, this paper explores opportunities to enhance capability through data fusion and alternative architectural approaches through processor consolidation, in preparation for Future Submarine.

Session 5: **Stream D - Paper 9**

Submarine Institute of Australia

The Submarine Institute of Australia supports or promotes informed discussion and research in the fields of submarine operations, engineering, history and commercial sub-sea engineering – otherwise known as submarine matters.

www.submarineinstitute.com

SUBMARINE SCIENCE TECHNOLOGY AND ENGINEERING

1ST SIA TECHNOLOGY CONFERENCE 2011

Crowne Plaza Hotel, Adelaide, South Australia

This Handbook made possible with the kind support of

LOCKHEED MARTIN

Navantia