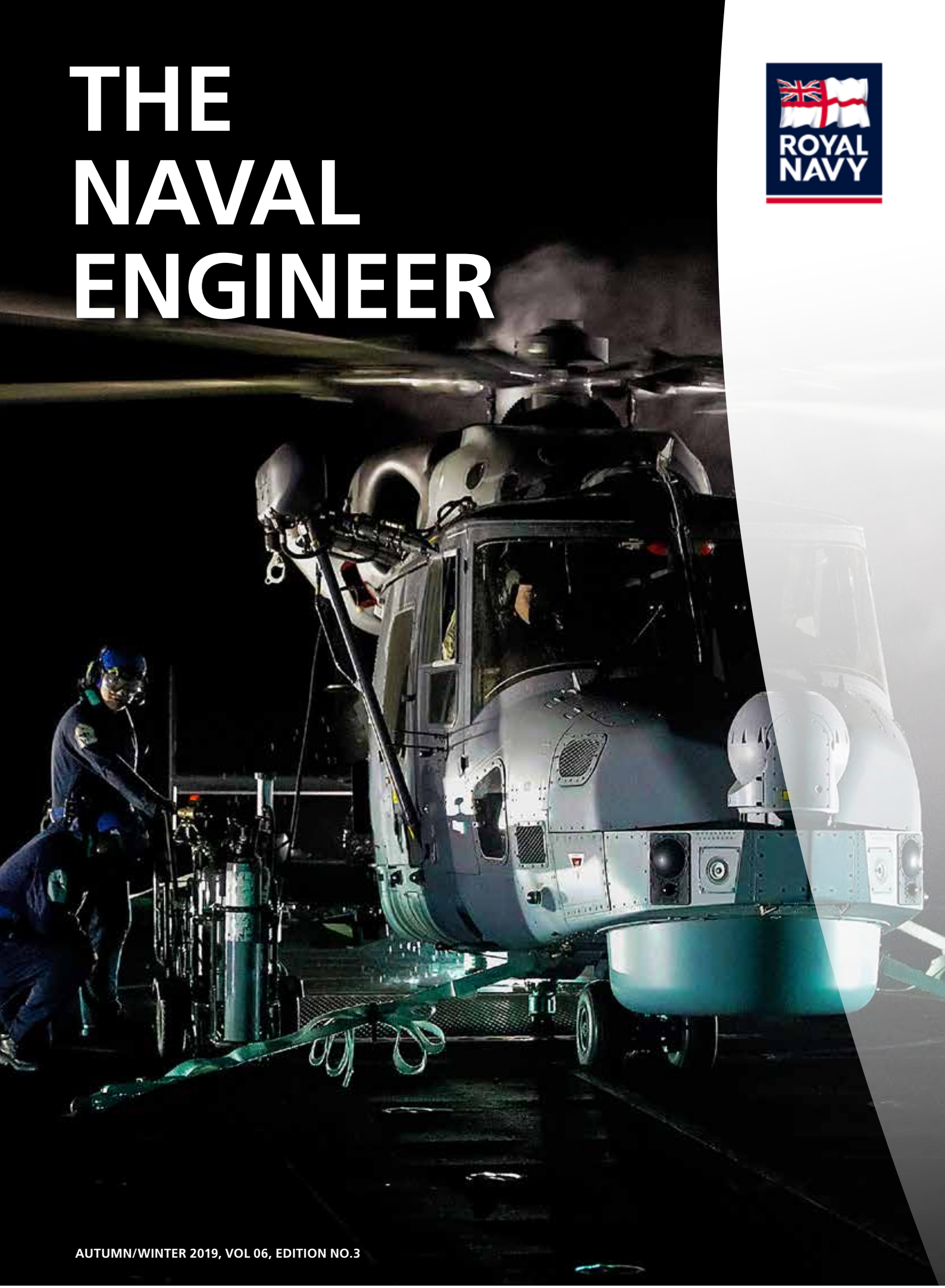
THE NAVAL ENGINEER



AUTUMN/WINTER 2019, VOL 06, EDITION NO.3

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Contributions:
Contributions for the next edition are being sought, and should be submitted by:

31 Jan 2020

Contributions should be submitted electronically via the form found on The Naval Engineer intranet homepage, the RN and UKNEST websites.

All photographs and graphics are to be high resolution wherever possible (300dpi), and supplied separately.

Feedback:
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If you would like to update your contact details, or if you are the representative of a unit or organisation that would like to be added to the distribution, please contact the Editor.

This will be my third and final Edition of TNE as Chair of the Editorial Board and I would like to thank all contributors for making your journal such a resounding success. Feedback has been extremely positive, however this is only possible through the submission of interesting and compelling articles for which I am exceedingly grateful. Please keep them coming, long or short; in such an extensive and technically complex endeavour such as ours there are so many exciting and enlightening stories to be told. Share them!

I would also like to add my personal thanks to your Editor, Clare Niker for all the hard yards, flexibility and tremendous attention to detail, the Navy Graphics team for their professionalism (in particular Jon Field our designer), and the Editorial Board for their guidance, wisdom and advice. As I will be retiring from the Royal Navy in the New Year "time done" my successor, Capt John Bonnar RN, will take on the role of Chair. I very much hope that TNE will be a lasting legacy of the Year of Engineering campaign as a celebration of the breadth, complexity and diversity of engineering across the Naval Service, including our industry partners through our collaboration with UKNEST.

In this edition we cover a lot of ground, from cyber security and the future Commando force, to operations in the Antarctic and Project Lewis – a reminder how engineers can help cut costs. I hope you enjoy it, either way please let us know and don't forget you can always write to the Editor to raise issues and thoughts. As Naval engineers we have much to celebrate and be proud of; and with that, I leave you with the words of Varun Narayanan:

**What is an engineer? Well, look around:
Our monuments are everywhere – we make
and speculate, design, create, and build,
then bridge the continents or search the stars,
bring information into every hand,
shape air and fire, sea and land – each one
an element with which we innovate,
imagining how lives might be improved.
To generate the new, the future now,
ingenious, from backgrounds of all kinds,
inventing at all ages, for all time,
with individual spirit and joined minds,
to tackle any challenge, far or near-
is what it means to be an engineer.**

Capt Matt Bolton RN

THE EDITORIAL BOARD'S TOP PICK!

The Editorial Board found it difficult to highlight only one article form the last edition. However, the choice was made to celebrate 'Accelerating Our Apprentices' by PO Derek Nicholls. Why? Because this article demonstrates the value placed on engineers willing to share knowledge and expertise, this start serves to provide the world envied calibre of expert engineers that the RN enjoys – something of which we should all be proud – **well done PO Nicholls.**

TNE Spring/Summer 2019, Vol 06, Edition No 2

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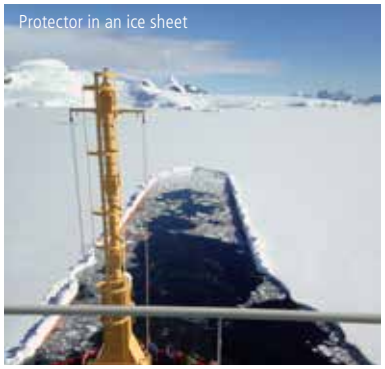
Produced on behalf of Chief Naval Engineer Officer, The Naval Engineer (TNE) is a professional journal for all Engineers across the Naval Enterprise, managed by the Future Support and Engineering Division in NCHQ. TNE celebrates the success of naval engineers, provides opportunity for academic recognition, and generates interest and discussion on topics relevant to the delivery of naval engineering. Articles are welcomed from all ranks and rates of Royal Navy, Royal Marine, Royal Fleet Auxiliary and Royal Corps of Naval Constructors specialisations, and from our civilian partners in industry. TNE is proud to be working with UKNEST and The Royal Corps of Naval Constructors.

ENGINEERING TECHNOLOGY


what is a Cyber Vulnerability Investigation?

OPERATIONAL ENGINEERING


Protector in an ice sheet

ENGINEERING PEOPLE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UKNEST

ENGINEERING
TAKE A CLOSER LOOK


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DCNEO Foreword

Commodore Graeme T Little OBE BEng(Hons) MSc MCGI FIMarEST CMarEng CEng

I'm delighted to once again be able to write the Foreword for what is becoming an increasingly important journal for Engineering across the Naval Enterprise particularly as we allowed our journal to wither on the vine at a point where having a strong and coherent narrative was essential. What makes TNE, and this Edition standout, is that it is relevant to all parts of the Naval Engineering community – written for and by the Naval Enterprise. It is also heartening to see that we have continued to expand our readership across the uniformed civil service and wider industry community. When we set out with the new focus of TNE we were very clear that it was to become the go to journal for the Naval Engineering Community – a celebration of all that is good in Engineering in the Royal Navy, a nod to the past (another good Lesson from History), an emphasis on the USP of delivering Operational Engineering at Reach and some exciting Technology snippets – we should not be surprised that Naval Engineers are so viscerally engaged in shaping the future. I am also pleased that we have devoted quote so much column inch to our people and their recognition – we've lots to shout about and impressively have not only seen Engineers recognised by CNEO but also by Professional Institutes, Industry and various Worshipful Companies. I have also had the great pleasure of recognising Engineers and Engineering Departments; we must be getting something right.

For the eagle eyed amongst you will be aware that I have now almost completed my fifth year as DCNEO, and I thought it worth just reflecting on and what has been a really challenging period for Engineers and Engineering – picking up on my Spring 2016 TNE Article 'Are we there yet?'. There is no doubt that Faraday is well and truly woven into the fabric of many of our engineers both general service and to some extent our submariners and I think all those involved can look back with a degree of satisfaction on having delivered the once in a generation transformational programme that has seen us re-establish a cadre of engineers who are at the forefront of delivering operational engineering. The quality and capability of our engineers has never been in doubt and I'm delighted by the manner in which Faraday has become the accepted standard and a brand that people associate with. It has not all been as positive, we have not made the progress that we had envisaged with the broader agenda of support improvement but of course this is all changing and with a combination of Submarine Availability Improvement and Support Transformation there is an energy and pace in improving support and as CNEO made clear at the 2019 Conference he expects to be held to account by Engineers for some real progress over the coming months. The energy that is being expended to do stuff now is significant and will go a long way to Enabling, Equipping and Empowering Engineers and Engineering with a real commitment in resources and money. We will let the results speak for themselves over the coming months but will use TNE to signpost the successes. We all talk grandly about Innovation, there is lots of ambition in this space but we must do better to harness the ideas from across the Enterprise which are looking at innovation in technology (and its rapid adoption) and the way that we grow and maintain the Enterprise's talent. Of course, the challenge is to make it easy for you all to get involved and you will have seen we have made a start by launching the Engineers' Portal, which can be accessed from both MoDNET and Defence Gateway.

It's really easy to get carried away with the rhetoric but I do feel that we know what good looks like and in the Naval Engineering Board and UKNEST (its Industrial counterpart) we have the wherewithal to deliver on the promise of the Lived Experience and Branch Health. So, as I said in my earlier article, we are not there yet and whilst it is very easy to be overly reflective, there is much good happening across the Enterprise that is true to the words of Capt Binney (HMS Hood) who said of Engineers - 'place in the hands of those who fight the naval battle the most effective weapons that the state of art can achieve and keep them operational as long as they are needed. Mobility is by no means the least though perhaps the oldest of these weapons'.

Commodore Graeme T Little OBE BEng(Hons) MSc MCGI FIMarEST CMarEng CEng

Now, in closing – I'll come clean – I only volunteered to write the Foreword on the basis that I would finally get a Tugg Cartoon back in TNE. Having carefully selected an appropriate one when the final draft of my Foreword left me it did so with an attached cartoon – if it isn't with my article you've the Chairman of the Editorial Board to thank. On the subject of whom, Captain Matt leaves the Service early next year and I want to take the opportunity to thank him for all that he has done to establish TNE as our Journal and for the contribution that he has made to Engineering in the Royal Navy over the last 38 years.

Regards
Commodore Graeme T Little OBE
DCNEO

From the Editor

By Clare Niker

Clare Niker

Welcome to the Autumn/Winter 2019 edition of The Naval Engineer.

This edition has some really good articles submitted from across the ranks of both military and civilian contributors. CPO Ryan and LET Lovibond collaborate on page 34 with 'Buttoning Up the Cardigan', an article all about their experiences as part of the Phalanx team onboard RFA Cardigan Bay, whilst Lt Cdr Chris Cozens explains the issues around operating in cold weather environments in 'Out in the Cold' on page 28. On the civilian side, Chloe Woodger-Smith examines a question posed by Colonel Mike Tanner in 'Future Commando Force – What Does the Future of the Royal Marines Look Like?' on page 12. Chloe is a part of UKNEST, representing our industry partners.

It is fitting therefore, that in this edition we acknowledge the centenary of the Women in Engineering Society which was formed soon after the end of the First World War to promote engineering amongst women; having helped sustain the country's economy and enable the war effort through their engineering aptitude and expertise but then having to relinquish their jobs to men returning home from the front. Their subsequent achievements speak for themselves, see the centre pages; and we also pay homage to the first female Naval Architects: Eily Keary, Blanche Thorneycroft and Rachel Parsons in Cdr Mark Barton's article '100 Years of the First Female Naval Architect'.

This edition has also seen a bumper crop of rewards and recognition. There is so much good work being done by naval engineers – it is a fantastic honour to recognise your achievements. Do please drop me a line to let me know if one of your team receives an award. We really do need to be proud and shout about your achievements!

Now a plea. We have been incredibly fortunate to continue to receive some really high quality articles for this edition. As ever though, we still need your contributions in the shape of articles, reviews, letters and even questions. In addition, good imagery is essential to TNE to keep the look up to date and fresh, representing naval engineers as they are today, so if you have a good photo that you want to share with the community, please send it through. Finally, feedback. Your comments and suggestions help the Editorial Board to shape the journal so please do keep them coming.

As always, I would like to thank all our excellent contributors, who despite their busy day jobs, have taken time and considerable personal effort to write a submission for this edition. The commitment shown by each author in the pursuit of sharing their knowledge and experiences really sums up what TNE is all about. TNE only exists because of you, so thank you. Please keep sending your contributions in.

Finally, thanks has to go to all those who support the production of TNE. In particular, the amazing Navy Graphics team here at NCHQ, and the Editorial Board for their continued sage advice and guidance. Huge thanks must go to Capt Matt Bolton, Chair of the Editorial Board. Capt Bolton is leaving the Navy in the New Year after joining as an apprentice in 1981 (see his note on page 2). He has been a staunch advocate of TNE, and a personal point of support for all TNE related issues for me. His enduring legacy, including the RN Year of Engineering 2018 campaign and TNE, as well as his unwavering support, sums up the inimitable qualities of a naval engineer: always inquisitive, highly skilled, determined and professional.

As always, enjoy the read, and I look forward to hearing from you.

Clare

ENGINEERING TECHNOLOGY

Beyond Ones and Noughts

By Lt Cdr Trevor Bradley MSc CEng MIET RN, JFCyGp CVI Ops Cell Maritime Domain Lead

See: TNE Spring/Summer 2019, Vol 06, Ed. No. 2 Defensive Cyber as an Engineering Discipline

December 2018's Modernising Defence Programme Final Report re-affirmed the importance of understanding the cyber threats to our systems and operations. Traditionally this has been managed through accreditation and in-service assurance to ensure that the conditions for entry were being adhered to. The weaknesses with this approach are that systems are often assessed in isolation and the way that we use the tools at our disposal can undergo significant change. To address this gap, the Cyber Vulnerability Investigation (CVI) Ops Cell was established as part of Joint Forces Cyber Group to take that holistic look through the use of Socio-Technical Investigations to meet the following aim:

> Defence is able to understand and manage cyber vulnerabilities of social-technical systems and their associated pan-DLOD risks cost-effectively through life
>
> **Jt User Desired End State**

Reaching IOC in 2018, the team is a mixture of civil servants, military and external contractors and continue to develop the CVI methodology which blends technological and Human Factors (HF) studies in a way that is increasingly being adopted by industry.

Another Name For More Assurance?

Thankfully no. A CVI examines the people, processes and technologies, the interest is not so much in whether the processes/policies etc are being followed, but how we do our business, use our systems and why we do what we do. At the end of an investigation, the final report phrases the vulnerabilities, associated attack paths and their impact on a mission into risks, so that those that remain, can ultimately be used as part of the mission assurance process when planning an operation.

The CVI Process

CVIs are part of Defensive Cyber Operations and are authorised at the Cyber Programme 2* Exec Board, with prioritisation aligned with contingency planning commitments, the cyber threat and single Service requirements; the latter is essential as each CVI requires a 1* sponsor. In the near future, this prioritisation will place much more emphasis on the threat to current and contingent operations to aid the mission assurance element whilst maintaining capacity for emergent work.

The type of Target of Investigation (ToI) can range from a single equipment or platform to a HQ and once selected for a CVI, there are 4 main stages (Figure 1) during which the delivery team works closely with the sponsor's representatives:

Orientate. This is a scoping and feasibility study to ensure that the scope is understood, achievable and stakeholders and supporting material have been identified. This enables initial high level modelling (Figure 2) and Cyber Threat and Mission Impact Analysis (CT&MIA). Cancellation, change of supplier or re-targeting of a CVI (e.g. due to classification restrictions or assessed lack of cyber risk) is a valid result of this stage and not a failure.

> In a complex rapidly changing environment it is essential we understand our systems and risks

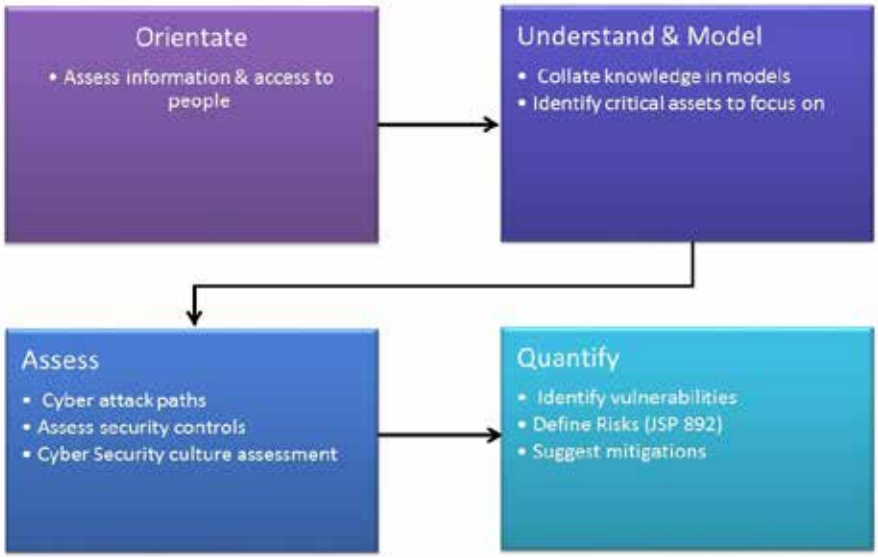


Figure 1: Current CVI Process Overview

Understand. Forming the bulk of the effort it is during this phase that detailed system, behaviour modelling and Mission Impact Analysis takes place. These are achieved through a combination of technical research and the application of Human Factors analysis, therefore for a successful understand phase access to the users as well as the SMEs is essential. The split between the two is CVI dependant e.g. Operational HQ 'or communications equipment, but in all cases, system models derived from HF and technical analysis are utilised to define the operation, responsibilities, dependencies, information exchange this enables the development of the detailed CT&MIA.

The primary output from this phase is delivered at a 'Pink Team', where the detailed models and Mission Impact Analysis are presented for discussion with the stakeholder community. Crucially the presented CT&MIA should account for checks, balances, training and reversionary modes that allow us to continue to fight (Classic Thursday War Scenarios).

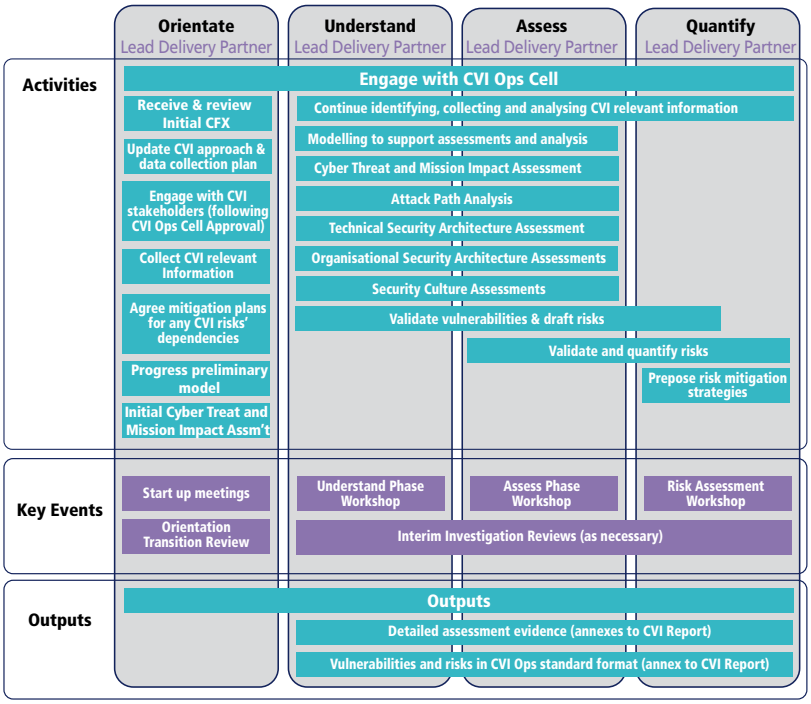


Figure 2: A Simplified High Level Model

The consideration of Human Factors when assessing effective cyber security is a growing field

Assess. This builds on the models from the understand phase and takes an attackers perspective, examining the cyber attack chain; including the attack surface (areas exposed to potential attacks), attack paths (how an attack could be launched against an identified attack surface), known or potential vulnerabilities that could be exploited, the feasibility of conducting that exploit and what the impact would be – including an assessment on response and recovery capability.

In addition to these attack focused actions, examination of the data collected by the HF analysis and relevant external sources e.g. recent audit reports, will be used to form a Cyber Security Maturity Assessment (CSMA), summarising the cultural and technical robustness employed. As with the Assess phase, these are again validated with the stakeholders at a 'Red Team' and where possible, the audience is widened to include relevant SMEs external to the target, that can provide specialist or novel insight into attack paths.

Quantify. After the target has been characterised, essential components identified and viable ways to attack those have been defined, the outstanding element is the quantification of the associated risks and any mitigation. Deliverables within the Quantify phase include the final report; containing all investigation findings, along with recommendations from the risk workshop, where the Stakeholders again validate the findings and the assessed impact. The finalised risks will be presented in JSP 892 format and passed to the sponsors, in addition to Joint User. As the CVI is not an assurance activity, the report does not include a line by line breakdown of every instance of 'bad practice' or transgression of JSP 440, although any major breaches are highlighted to the POC as they are discovered. This is a conscious decision by the CVI team as it ensures maximum disclosure by those interviewed and is also based on the premise that if our people are doing the wrong things, they think it is for the right reason (those familiar with root cause analysis will see this as corporate gain).

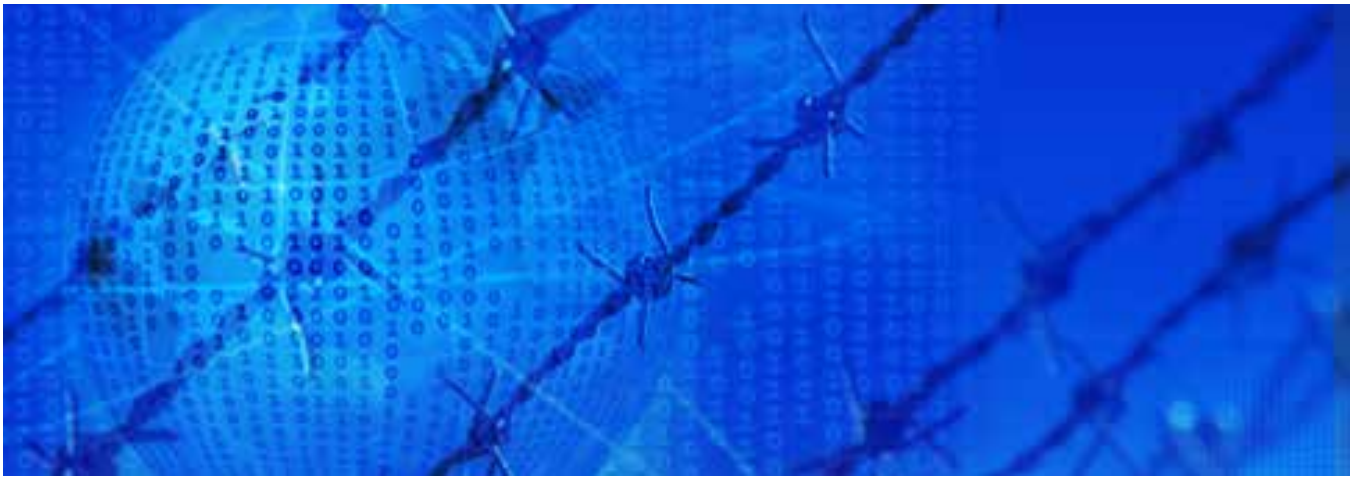
The Human Factor

This is the key differentiator from traditional security accreditation and why CVIs are conducted on in-service equipment. The importance of this is underlined by the presence of a full time HF expert within the team. With a major role to play in the Understand phase and contribution to the Assess and Quantify activities, the HF studies gather data from a variety of methods, including questionnaires, focus groups, interviews and observation of tasks (ideally concealed observation where the user knows they are being observed but doesn't know why, as this reduces any deviation from normal working routines). When investigating the behaviours that may increase the level of vulnerability (Figure 3), there is an observed overlap with the safety field's use of root cause analysis.

Involvement of the HF team does not stop at this phase and continues to input into the risk assessment and in particular the CSMA advising how performance may be approved through a cultural shift, e.g. Physical blocking of USB ports and provision of charging points, makes the presence of a USB device attached to a computer an exceptional event, increasing likelihood of reporting.

What About The Reports?

Unfortunately this is where there is a requirement to balance need to know, OPSEC and not scaring the horses (employing intelligent, pro-active people means that excessive controls often result in workarounds). If you are the owner of an equipment that has had a CVI conducted on it, then the team will have been closely involved and will be issued a copy of the report, providing owners with evidence to drive improvement and change; however, if you are a user, then rather than cascade the routes to attack our systems, what you are more likely to see are improvements and



some revised guidance. At the other end of the spectrum, data from CVIs is mined by the Joint User Cyber Risk Management team for trends with developments underway to encompass the findings of security reports to build that enterprise wide picture, so that we know where our vulnerabilities lie, helping Joint User to address them. The CVI team also works increasingly closely with PSyA, FLCs and other relevant teams to enact rapid change where possible.

Parting Thoughts

As the delivery of CVIs continues to mature, with the MOD ahead of the curve, there are already a number of general observations, many of which are not rocket science but worthy of inclusion:

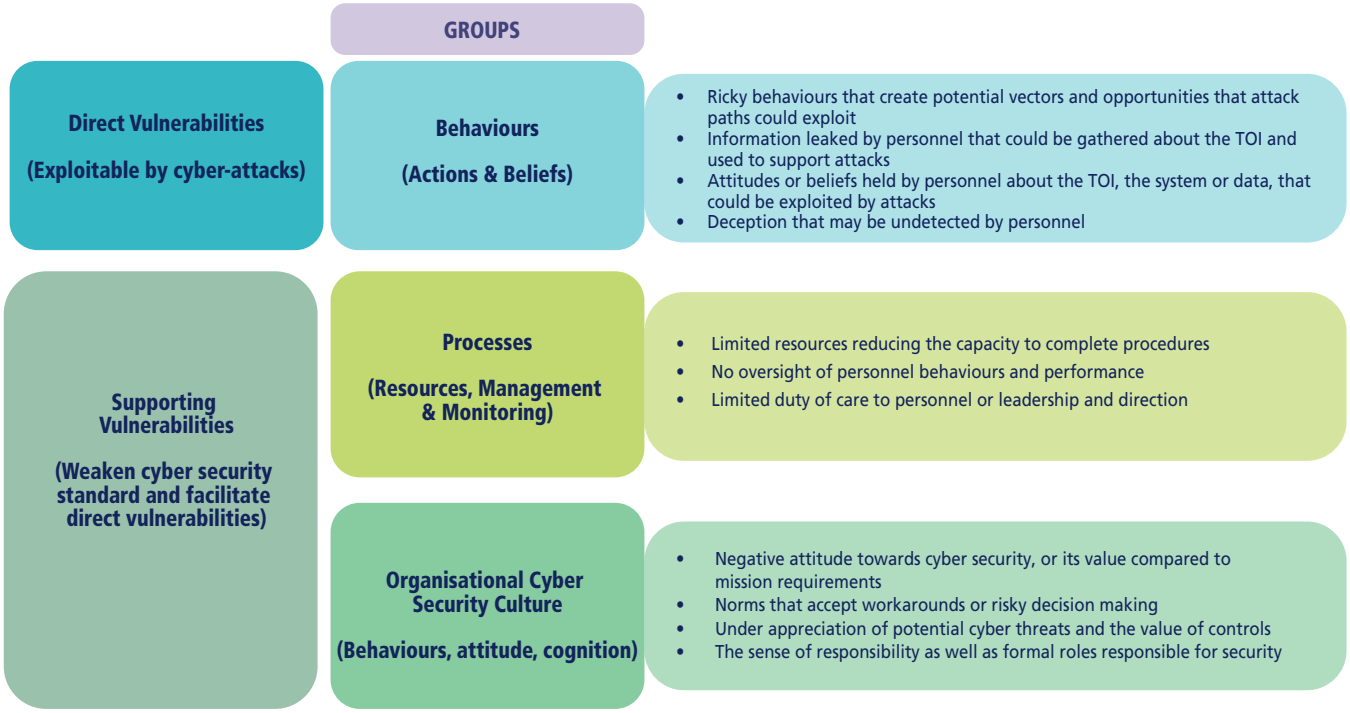
- Generally, our people only do 'bad things' for what they perceive to be good reasons, including getting the job done. Controls deemed by users to be excessive and obstructive, will inevitably be worked around.
- There is much that can be learnt from the realm of safety management when looking at the human element and how we manage/influence behaviour, after all, cyber may be new, but people aren't.
- Knowing what good looks like for both system performance and personnel is difficult but key.
- System security measurements are like an MOT – only valid on the day of the test for the conditions tested but…
- Not all threats are viable and should be treated accordingly.

For more information on the cyber threat and MOD policy, the MOD Cyber Primer (available on the internet), is a recommended read for all or search for 'Defence Cyber Teams'.

Lieutenant Commander Trevor Bradley

Lt Cdr Trevor Bradley joined the RN in 2000 and has enjoyed a varied career including time as a Section Officer on HMS Invincible, WEO on HMS Somerset, loan Service to DSTL, land based OP TELIC tours and a couple of stints at ISS responsible for the development and delivery of a variety of deployed systems to all FLCs including DII-Minerva and LC2. Having recently joined the CVI Ops Cell as part of a small team he is now the lead for Cyber Vulnerability Investigations centred on the maritime domain.

Figure 3: The HF influence on Vulnerabilities



Future Commando Force

UKNEST

By Chloe Woodger-Smith MIET MInstP, Combat Systems Engineer, BMT Defence & Security UK Ltd

What does the future of the Royal Marines look like? It's a big question. The Royal Navy is growing for the first time in recent years and the threats to our country and allies are constantly evolving along with rapid changes in technology. The Royal Marines are moving with these political and technological changes to stay ahead of our adversaries. We have new threats to face, humanitarian concerns to support and our largest ever aircraft carriers to deploy from. The Royal Marines are eager to keep pace with our changing world and are investing widely in their own ongoing transformation.

What does the future of the Royal Marines look like?

The modern age has brought growth in communications, transport and space technologies that have been changing our world at a staggering rate and will continue to do so as experts predict this progress to still be accelerating (take a look at Moore's law). As the world gets to grips with new technologies we each become better at dealing with these changes. Most of us are now adept at downloading a new app and giving it a try without a how-to manual or giving our friend's new drone a flight (successfully or not). In today's world we are well equipped to take full advantage of new innovations in front of us and the defence world is one that can take huge benefit. At our First Sea Lord Admiral Radakin's appointment ceremony he emphasised this saying "We are going to use technology and innovation in a much bigger way than we have been to drive everything that we do".

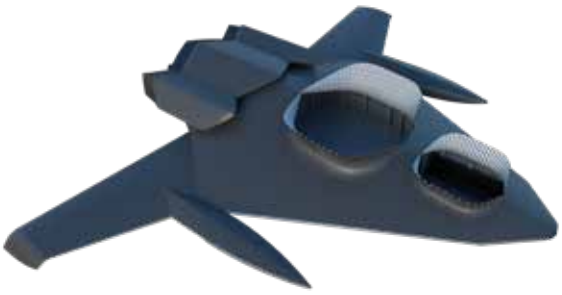
So what does the future of the Royal Marines look like? This big question is one that Colonel Mike Tanner (at the time Commandant of the Commando Training Centre Royal Marines) wants answered. He challenged a group of early career professionals from UKNEST to create some ideas in response to this question, the result was combat skin, escort drones, exoskeletons and battlefield perception helmets. It sounds ridiculous, or does it?

To stay ahead of the curve with warfighting in the next few decades we need to be at the forefront of technology and innovation. We have to aim high with our capabilities, work out what we can achieve and strive for it. Push boundaries to their fullest or even push outside of the box, and that is what we did for this project. The twenty of us from across defence were brought together in Lympstone and joined with serving Royal Marines to put our heads together and create some pioneering concepts.

One of the situations the Royal Marines thought could be improved was the transport from ship to shore. This may be from the Queen Elizabeth aircraft carriers positioned over the horizon, requiring a vehicle to move marines all the way to shore safely and efficiently.

Personal Drone

The group designed a wing-in-ground-effect vehicle, or 'Ekranoplan'. Ekranoplans use the ground effect to travel across the water's surface on a bubble of air, this reduces drag and keeps the craft below the enemies' air defence systems. Our design includes a hybrid drivetrain comprising a compact gas turbine and dual carbon batteries which would create speeds of up to 300knots. It has two separate spaces, one for Royal Marines and one cargo storage bay. The craft is designed to work alongside force protection 'escort' drones which will carry weaponry, sensors and communications to support and protect Royal Marine insertions. The Ekranoplan is autonomously navigated whilst connected to the drones via a neural network.



Here you can see the ekranoplan with its two bays, the wings and tail are designed for speed and stealth.

One of the challenges the Royal Marines face with shore insertion is scaling cliffs and rock faces fast, these are currently surpassed with classic climbing gear which is slow, hard work and adds to already bulky equipment. The Marines would like to scale cliffs quicker and with less effort so that they have more energy left in the tank by the time they get to the top. Out of this came a multi-use suit to assist the wearer in a range of situations. An exo-skeleton was our answer to this, made out of composite materials it would contain a protective skin with adaptive camouflage, load bearing alloy structure and energy harvesting boots. Full situational awareness would be delivered on the visor of a battlefield perception helmet.

The dark grey is the semi-rigid structure of the suit, carrying the load of the backplate and the wearer's own weight. The light grey parts are the muscles which will assist the wearer's muscles and provide protection.

At this point you may be thinking that this is all crazy, you only see technology like this in sci-fi films with big CGI budgets. This may be true today, but lots of the technology to create these inventions is being developed now, we don't know how far away this future really is for the Royal Marines. Some of this technology is in use today: autonomous drones, piezoelectric tiles, high-power batteries, and super strong materials. Some is in its infancy, untrialled and requiring considerable further development, but there are many concepts here that could be brought to fruition with the right investment.

UKNEST workshops Dreadnought 2050, Nautilus-100 and now this Future Commando Force have been used to take a look way into the future at how the world will be working and what the naval landscape will look like. The previous projects have been employed by the Defence Nuclear Organisation to work backwards, creating roadmaps for the near future and investing time and money in the right places to ensure that we can make it to the future we want. A future where the UK has a technology driven world class Navy.

Minister for Defence Procurement, Anne-Marie Trevelyan MP, said: *"Britain's Royal Marines are among the world's most highly trained, elite fighting forces. All the more important that they are looking to the future to ensure they can continue to intervene at short notice anywhere in the world to help restore peace and stability as well as protect Britain's interests.*

"This is a great example of how British industry and the military can come together to create an innovate vision of the future. I would like to pay tribute to the young engineers of UKNEST for their willingness to push the boundaries and challenge convention."

Royal Marines prepare their equipment, drones and Ekranoplans for a raid whilst in the HMS Queen Elizabeth hangar.

What does the future of the Royal Marines look like? I don't know, but I look forward to finding out, and trying on an exo-skeleton suit...

If you would like to learn more about this project or have any questions please go to **www.royalnavy.mod.uk/rm2050**, **www.UKNEST.org.uk** or contact the author.

An Ekranoplan skims across the sea surface to the shoreline, encircled by force protection 'Escort' drones.

Chloe Woodger-Smith

Chloe Woodger-Smith is a Combat Systems Engineer at BMT. She graduated Swansea University with a degree in Theoretical Physics before joining QinetiQ on their magnetic trials and analysis team. Chloe has previously worked on BMT's Venator 110 ship concept and the MoD's Common Support Model, she is currently embedded in the MoD Mine Countermeasure and Hydrographic Capability team working to use unmanned vehicles to clear mines.

The Commandos assault the enemy's anti-aircraft missile battery utilising hologram decoys (bottom right) and specialised drones collaboratively to achieve a successful outcome.

Evolution Of Submarine Common Combat Systems

By Cdr Christian Bamforth RN, FWEO (SM) SM Capability Delivery Team, NCHQ

Common Combat System (CCS) was originally generated as part of the 'Design for Cost Reduction (DfCR)' initiative to reduce the cost of the 2nd phase of the Astute class Build programme (Astute hulls 4-7). The CCS vision was to use Commercial Off the Shelf (COTS) technology to develop a server based 'Common Infrastructure' (CI) hardware that could enable rapid insertion of capability using software applications (apps). Moreover, concentration of previously disparate hardware into one solution would also generate significant (~40%) Through Life Cost (TLC) savings. Fast forward nine years and this vision has been rolled out to multiple submarines deployed on operations and is one of the fundamental building blocks for the future Dreadnought SSBN. This article discusses the experience of delivering the CCS capability and how this has shaped the future submarine Combat System.

CCS was designed to replace multiple obsolete hardware and software solutions through the introduction of a single hardware processing environment hosting multiple apps. The apps are hosted on a set of blade servers with new Multi-Function Consoles providing the Human Computer Interface (HCI). Data storage is centralised and the entire system is connected via a series of network switches. Many hardware components of the system are COTS, however, some elements remain bespoke where COTS products are not available or unsuitable for this specific military application. The apps are hosted in a virtual environment on the blade servers and there are a limited number of Authorised Software Configurations (ASCs). ASCs define what apps can be used at any one-time dependant on the hardware available and thus manage the processing demand on the blade servers. This load balancing is required owing to the intensive sonar processing demand associated with large submarine hull mounted sonar arrays. The challenges of a system with multiple apps hosted and virtualised in the same processing environment has led to the requirement for significant design proving and regression testing to assure the provision of safety critical functions e.g. navigation and collision avoidance. This design proving/testing load has tended to delay software upgrades and patching. However, a set of significant combat system software updates, known as Combat System Releases (CSR), have been delivered to in-service and build submarines.

> This vision...
> ...is one of the Fundamental building blocks for the future Dreadnought SSBN

The rollout of CCS in the Astute build programme was initially aimed at HMS Audacious (4th of class). However, the benefits of CCS and the rapid rate of system development, accelerated using COTS technology, enabled draw forward to HMS Artful (3rd of class) in the final stages of build at Barrow-in-Furness.

The decision to retrofit equipment, especially on the scale of CCS, is not without issues and risks. The interfaces between different legacy systems and new COTS hardware on new and old submarines generated additional complexity that has resulted in a system which is currently 'Common As Possible but Bespoke As Necessary (CAPBAN)'. However, HMS Artful left Barrow in 2015 fitted with CCS Version 3.1 and went on to successfully complete sea trials including the first firings using CCS of Spearfish Mod 0 heavyweight torpedoes. HMS Astute was retro-fitted in 2016 during a long Base Maintenance Period (BMP); she was the first CCS fitted submarine to complete Basic Operational Sea Training (BOST) and take the capability on operations. The rollout has now progressed onto Vanguard class SSBNs, with two platforms currently in the delivery phase, and the final in-service A-class SSN in the near future. Although differences between and within classes drive design change in the CI, the system maintains significant commonality which elicits benefits across Defence Lines of Development (DLoDs) e.g. support, training, and personnel.

The introduction of virtualised apps enables significant capability insertion opportunities through software update. In CCS this is achieved through uplift of the relevant Combat System Releases (CSRs). The first major CSR update was delivered into multiple platforms in 2018 and took two weeks alongside to conduct software installations and assurance testing. This two-week period brought the Astute class up to the Sonar 2076 Stage 5 baseline including major improvements to sonar processing and MMI. In the legacy (non-CCS) fitted Trafalgar class, the equivalent update was completed during Refit or a 1-2 year Revalidation Assisted Maintenance Period (RAMP) owing to the combined hardware/software changes.

CCS introduced high levels of redundancy to the Combat System but also a new virtualised software layer. Providing assurance that the new architecture was resilient to electrical power and chilled water loss required the conduct of additional testing alongside. Moreover, generation of the methodology for operation of the system under Damage Control (DC) conditions required joint working between HMS Artful, Combat Systems Delivery Team (based in MoD Abbeywood), and FOST North staff. Long-standing electrical DC methodologies had to be re-examined considering the integrated nature of CCS and new processes generated to ensure the sustainment of capability to Command. Similar impacts from CCS have emerged across security, network management, and user roles where multi-disciplinary working has been required to generate

CCS Multi-Function Consoles (MFCs)

the necessary policy and processes to manage the significant leap forward that CCS represents. Whilst a number of these issues have been managed at the NCHQ level Capability Integration stage, some have necessarily been resolved by crews during delivery; this has required tight coupling of activity between the Waterfront, Combat System Delivery Team, OEM (BAES), FOST, PCAP and SM Capability Delivery Team (SM CDT).


CCS Shared Computing Environment (SCE)

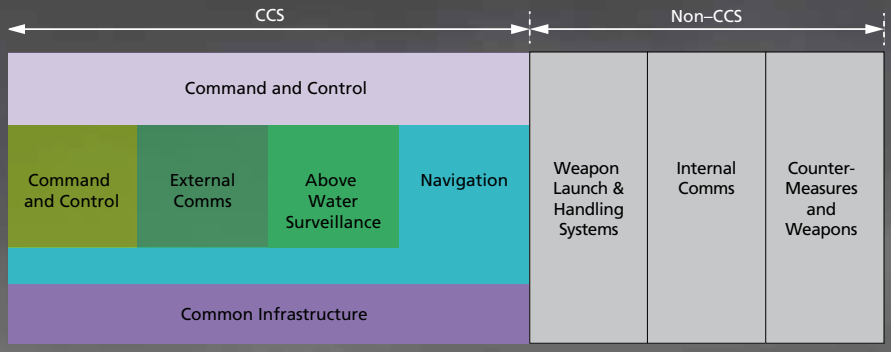
The impact that such a significant change in equipment can have across the DLoDs should not be underestimated. For example, CCS has caused major ripples through both Personnel and Training which have required a complete re-alignment of the WESM(TWS) Branch. CCS combines previously separate Fire Control and Sonar equipment which are currently maintained by two different sub-cadres of the WESM(TWS) specialisation. This opportunity to combine sub-specialisations was recognised early but practical delivery was deferred until actual installation of the equipment. It very quickly became apparent on-board CCS fitted submarines that the WE departmental was not optimised to manage this all-encompassing equipment; CCS was initially the joint responsibility of multiple sections (Fire Control and Sonar) with maintainers from different career pipelines required to maintain and interact with a common system. Moreover, the degree to which CCS required a fundamental shift in career training, owing to the far greater use of COTS hardware and networking, or simply an enhancement to equipment specific Pre-Joining Training (PJTs) was unclear. Resolution of this conundrum was achieved through extensive analysis using a Multi-Disciplinary Team (including Industry) to arrive at a mixed model with enhancement of both Career and PJT based training. CCS also drove a need for change to on-board departmental structures. These changes are currently being rolled-out under the stewardship of a Capability led MDT to ensure synchronisation of equipment delivery, training pipeline changes, cross training of legacy individuals, and update of policy. The tangible benefits of these personnel changes are empowerment of LETs, structural re-balancing across rates/ranks, and reduction in the Branch's overall complexity. These changes are also now included in the personnel model for Dreadnought.

Owing to legacy equipment and the timing of the submarine Build programme, there are multiple minor versions of CCS within the same class and across different classes of submarine. The aspiration is to combine these multiple versions to provide a truly Common Combat System which is targeted at the Dreadnought SSBN. A series of iterative design changes will take place across the SSN and SSBN Force to combine the multiple versions of CCS to provide a truly common variant known as CCS Version 4. Benefits of this iterative approach is that future designs are de-risked, technology is brought forward into in-service (especially important for enabling sonar related enhancements), and in-service obsolescence is mitigated.

Wholesale collapsing of previously separate equipment into one virtualised hardware/software solution, whilst attractive for reducing cost, has its challenges. Very rapid update of software, for example within a 1 year cycle, has been stymied by the need to provide rigorous assurance of safety critical functions. The next stage of CCS is to partition tactical and safety critical functions to enable rapid update of the former without affecting the latter. Moreover, a highly centralised safety critical hardware/software solution is not optimised for conducting software/algorithm testing or experimentation. The future approach is to bolt on a 'sand-box' to CCS that draws information from the network but which is not integrated into the main virtualised environment; this should allow rapid testing of software which can then be integrated into the main system at a future update.

Common Combat System has its origins in the need for reducing the cost of the Astute Build programme. However, as the capability is being rolled out across the whole Submarine Force it is providing an opportunity to implement fundamental change to how the WESM(TWS) Branch is structured, trained, and the raw capability that it provides to Command. The Combat Systems for in-service and future submarines are also now becoming ever more tightly coupled together with benefits for support, training, obsolescence management, and provision of cutting-edge capability.

Capability is being rolled out across the whole Submarine Force



CCS scope

Commander Chris Bamforth

Cdr Chris Bamforth has served as Fleet Weapons Engineer Officer Submarines (FWEO SM) for nearly 3 years in the Submarine Capability Delivery Team based in NCHQ, Portsmouth. Previous roles include two tours in FOST as a sea trainer, employment as a Change Programme/Project Manager, a brief tour as a Career Manager, Flotilla staff, and sea assignments as DWEO on HMS Sovereign and WEO on HMS Tireless. The last 5 years have involved support to capability delivery and integration of Common Combat System working in both FOST North and NCHQ. He is married and in his spare time is an enthusiastic, although firmly novice, mountaineer.

The Pendulum Swings

By Cdr Mark Barton BEng MA CEng MRINA RN, Eng Support SO1 Doctrine & Policy, NCHQ

Lessons from History 3

In a change to the article mentioned in the last edition, and the third in a series of articles looking at what lessons from history can offer, this article considers procurement, and its associated scandals over the years.

Shipbuilding and weapon production have, over the centuries, been a series of pendulum swings, from making heavy use of private firms to largely being in government hands. Both approaches have their advantages and disadvantages; it is usually seen that commercial practices will bring cost savings and more efficient working processes; they also include the additional cost of needing to make company profits.

Therefore, there have been many procurement scandals over the centuries. They are nothing new. A classic was one of the 1880s, when, to keep up with the needed supply of new cavalry swords and other weapons to the Armed Forces, a large contractor was brought in to supplement the government factory at Enfield.

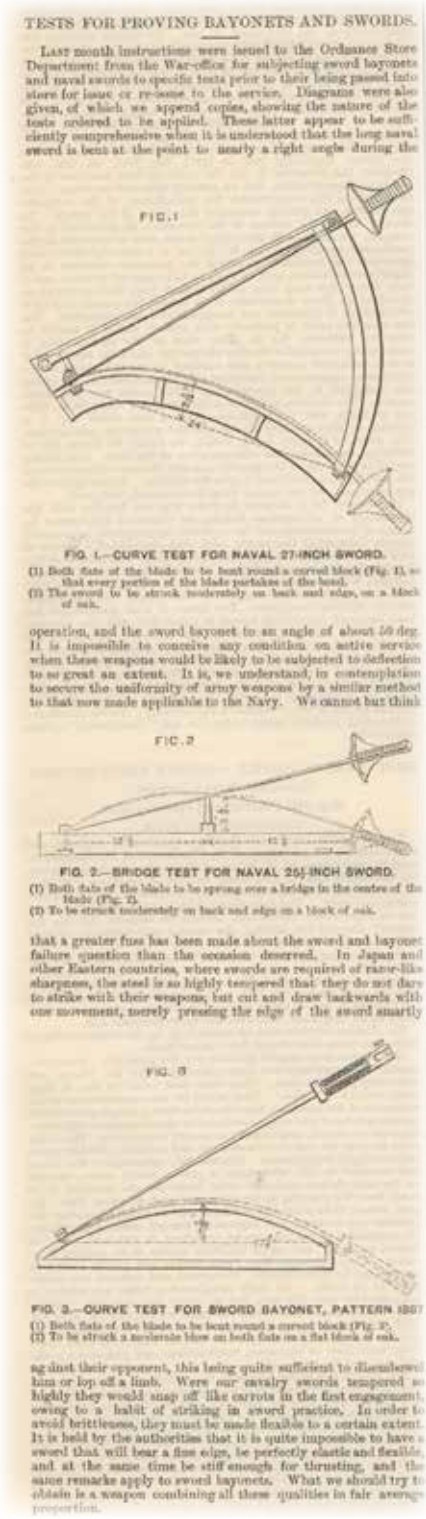
The newspaper headlines then were identical to those at so many other times. One daily national newspaper described the new equipment issued to the Army as "*utterly useless*"[1] and then went on to say: "*somebody must surely be responsible for this disgraceful state of affairs, and no time should be lost in altering a rotten system under which not only mouldy biscuits, uneatable flour and stinking preserved meats are supplied to our gallant troops but even the weapons they fight with are useless.*"

As a result of that article and many others looking at the issue, the Government of the day set up an enquiry, which quickly looked to explain what had happened. The committee found several key factors were to blame. First, rather than use the traditional government supplier, the contract had been passed out to a large English manufacturer,[2] (which is no longer in existence), who had established itself as the only firm capable of fulfilling a contract of that size. The firm was determined to make good profits and did not wish to invest their own company money in infrastructure, so sub contracted out much of the work, including to foreign companies, in this case various German sword manufacturers at Solingen.

To improve efficiency, the firm installed its own QA inspectors at the sub suppliers. The QA process was to strike the blade against a wood block and ensure it survived the blow. The QA inspector was found to be an old man unable to deliver the requisite strength of test of the sword blow.

The blades were delivered from Germany in an unfinished state, over case hardened and oversized. The delivery process was so slow that the equipment was stored under poor conditions for considerable periods. Due to both the storage and arrival condition, the blades then had to be subjected to considerable grinding and polishing to remove the corrosion and make them appear correct. All this left the blades very weak.

The results of this were at the time notorious. At the time the British Army was largely fighting in Africa in campaigns like Sudan. When a retesting regime was introduced for the swords, it was found that for the two regiments about to deploy "*half of the swords…unserviceable*". For the support corps about to deploy with them the situation was even worse with "*most of the weapons being found to be utterly useless*"[3]. This led to some complete disasters in the field, with Lieutenant Wormald of the 7th Hussars having his "sword bent double" when he delivered a blow to a Dervish Warrior[4].



TESTS FOR PROVING BAYONETS AND SWORDS.

Last month instructions were issued to the Ordnance Store Department from the War-office for subjecting sword bayonets and naval swords to specific tests prior to their being passed into store for issue or re-issue to the service. Diagrams were also given, of which we append copies, showing the nature of the tests ordered to be applied. These latter appear to be sufficiently comprehensive when it is understood that the long naval sword is bent at the point to nearly a right angle during the operation, and the sword bayonet to an angle of about 50 deg. It is impossible to conceive any condition on active service when these weapons would be likely to be subjected to deflection to so great an extent. It is, we understand, in contemplation to secure the uniformity of army weapons by a similar method to that now made applicable to the Navy. We cannot but think that a greater fuss has been made about the sword and bayonet failure question than the occasion deserved. In Japan and other Eastern countries, where swords are required of razor-like sharpness, the steel is so highly tempered that they do not dare to strike with their weapons, but cut and draw backwards with one movement, merely pressing the edge of the sword smartly against their opponent, this being quite sufficient to disembowel him or lop off a limb. Were our cavalry swords tempered so highly they would snap off like carrots in the first engagement, owing to a habit of striking in sword practice. In order to avoid brittleness, they must be made flexible to a certain extent. It is held by the authorities that it is quite impossible to have a sword that will bear a fine edge, be perfectly elastic and flexible, and at the same time be stiff enough for thrusting, and the same remarks apply to sword bayonets. What we should try to obtain is a weapon combining all these qualities in fair average proportion.

FIG. 1.

FIG. 1.—CURVE TEST FOR NAVAL 27-INCH SWORD.
(1) Both flats of the blade to be bent round a curved block (Fig. 1), so that every portion of the blade partakes of the bend.
(2) The sword to be struck moderately on back and edge, on a block of oak.

FIG. 2

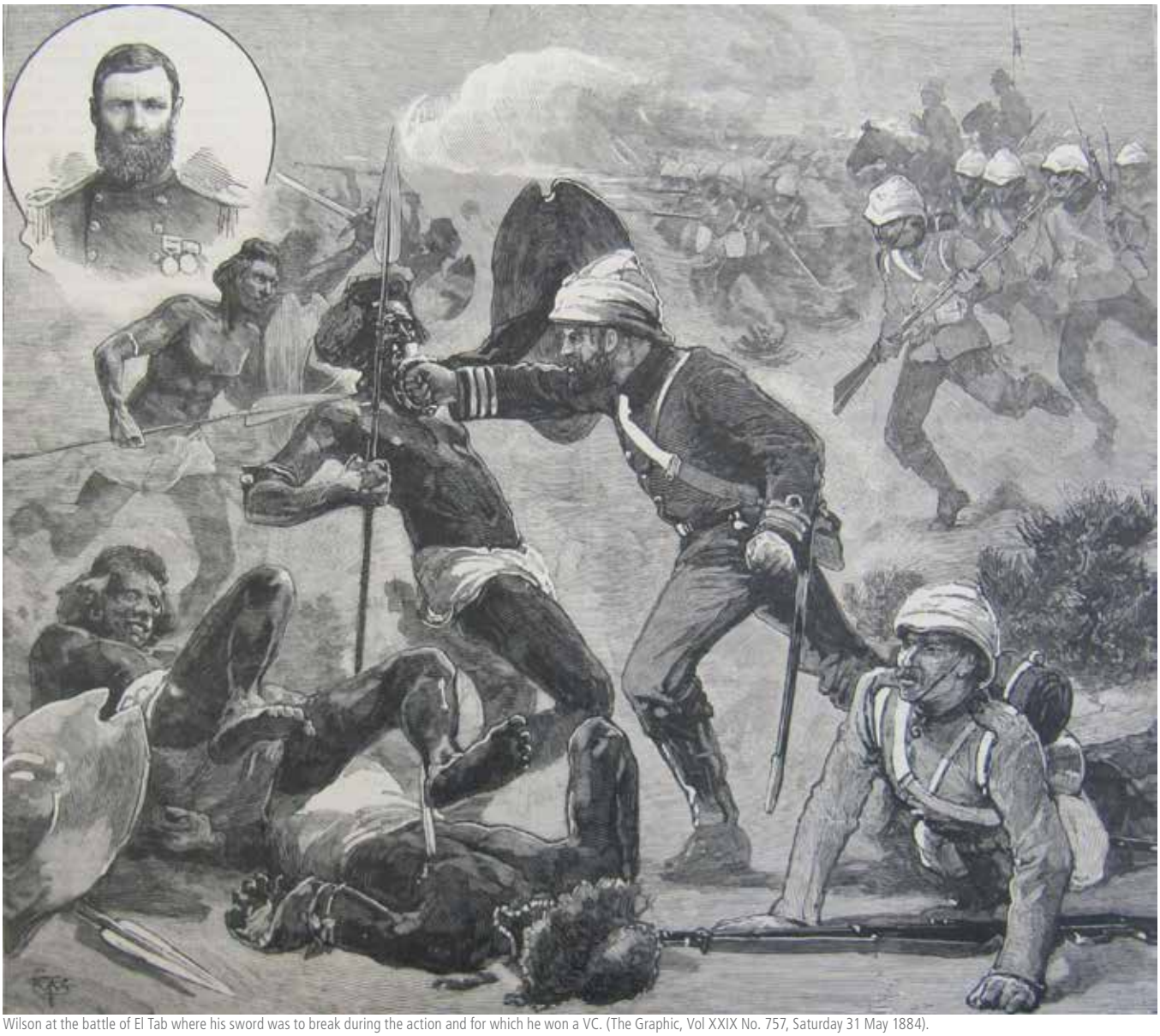
FIG. 2.—BRIDGE TEST FOR NAVAL 25½-INCH SWORD.
(1) Both flats of the blade to be sprung over a bridge in the centre of the block (Fig. 2).
(2) To be struck moderately on back and edge on a block of oak.

FIG. 3

FIG. 3.—CURVE TEST FOR SWORD BAYONET, PATTERN 1887
(1) Both flats of the blade to be bent round a curved block (Fig. 3).
(2) To be struck a moderate blow on both flats on a flat block of oak.

Testing of naval edged weapons, article from The Engineer, 8 March 1889. (Cdr Barton)

1 Lloyds Weekly dated 11 Apr 1885
2 The Broad Arrow dated 20 February 1886
3 Lloyds Weekly dated 11 Apr 1885
4 Cable from Daily Mail Omdurman Correspondent September 1898



Wilson at the battle of El Tab where his sword was to break during the action and for which he won a VC. (The Graphic, Vol XXIX No. 757, Saturday 31 May 1884).

The RN was not immune from such awful experiences. In a letter home, Captain AK Wilson RN (later to become Admiral of the Fleet Sir Arthur Knyvet Wilson VC) reported that whilst fighting with the Naval Brigade at El Teb that his "sword broke against his ribs"[5].

This sword is held by the National Museum of the Royal Navy at Portsmouth, and it shows a clean brittle fracture horizontally across the blade, indicative of incorrect tempering of the steel after it had been quenched.

As the Daily Telegraph reported in Jul 1885:

'I have seen a blue-jacket's cutlass sword-bayonet at Tamai, as well as some of the battles up the Nile, bend into a semicircle, and remain in that shape, unfitting it for a second 'point'. The use it was put to did not justify the giving way of the weapon. The fact that it did not regain its form further proved the quality of the blade was of the poorest. What I have said of the bad quality of the cutlass applies equally to the sword-bayonet. Many a soldier at Abu Klea saw with dismay his bayonet rendered useless at the moment when there was no chance to load his rifle, and when he most stood in need of its services. There also I saw sword-bayonets bend and twist with the facility of soft iron rather than steel.

After that fight you might have noticed brawny foot-guardsmen, herculean life-guardsmen, and the deft fighters of the mounted infantry, all of whom had stood shoulder to shoulder in the square, straightening their bayonets across their knee or under foot. Others there were who discarded their distorted weapons and picked up some dead comrade's from the field'[6].

It was known that this led to the deaths of several servicemen as 'thus disarmed the seaman was killed by another Arab'[7].

These scandals were not just limited to swords as poor recognition of likely areas of conflict mean that the rifles issued for the Sudan campaign struggled as well: 'the lives of our men [were] imperiled by the jamming of the cartridges in the rifles' and by 'defects… from the accidental fouling of the breaches of the rifles by the all pervading dust of the Sudanese desert'[8].

5 British Military Swords from 1800 to the present day, John Wilkinson Latham, (London, Hutchinson, 1966) pp 43-52
6 Te Aroha News, dated 18 Jul 1885.
7 Commander W E May RN and P GW Annis, Swords for Sea Service 2 vols (London: HMSO, 1970), Vol 1, p 88.
8 Lloyd's Weekly dated 11 Apr 1885.

Commander Wyatt Rawson leading the combined Army/Navy operation at Tel-el-Kebir in 1882. (MOD Art Collection)

In response to these failures of cutlasses in service, improved tests were introduced to ensure that weapons taken into store were fit for purpose.

See: TNE Spring/Summer 2019, Vol 06, Ed. No. 2 For Lessons from History Part 2

So while at the moment, the drive to remain within available manpower and a belief that industry is cheaper, means that the pendulum is currently at the contractor end of the spectrum; at some point in the future the pendulum will swing the other way as one of the factors, such as a need for surety of supply, guarantee of quality or an inability of industry to produce suitably qualified personnel due to the Armed Forces no longer training in that area, means that there will be a need for the State to once again take on more in a specific area. In response to these failures of cutlasses in service, improved tests were introduced to ensure that weapons taken into store were fit for purpose.

Commander Mark Barton

Commander Mark Barton has had a career that has tended to alternate between naval architecture roles and operational support, having completed five sea appointments and three Op Tours. His 5th sea appointment was as Commander E of HMS Bulwark. He is currently employed as the SO1 Doctrine and Policy in the Engineering Support Division at NCHQ and has been responsible for authoring Volume 2.9 of Fighting Instructions which is Maritime Engineering. He is now writing the Naval Engineering Policy BR. Tied in with this he supports various engineering aspects of operational planning and provides input to support aspects for strategic planning. With an interest in Naval history, he has several publications including the book British Naval Swords and Swordsmanship, writes regularly for The Naval Review and is currently endeavouring to complete a PhD in Napoleonic naval history. As part of his contribution to Year of Engineering he researched and authored the history of The Engineering Branch of the Royal Navy.

OPERATIONAL ENGINEERING

Down Birds

By CPO Thomas Hone Eng Tech IMechE RN, 1710 NAS Senior Repair Coordinator

1710 NAS (Naval Air Squadron) Repair Department has worked on 9 different air system types and 17 marks including Merlin, Apache, Chinook, Gazelle, Watchkeeper and Wildcat across 15 different worldwide locations, all within the last 12 months. Our customer feedback confirms that we are a valued and highly effective resource used throughout the military air environment (MAE). This article will demonstrate that even now, with the lack of enduring Operations, a fundamental change to our day to day business and the new more modern aircraft, the appetite for our specialisation has not diminished. We are a sought-after resource that is used to its fullest capability within the MAE.

1710 Naval Air Squadron

For the uninitiated, 1710 NAS is a unique unit compared with other Naval Air Squadrons. Based within the historic home of the Surface Fleet in HMNB Portsmouth, it provides specialist aviation support activity in a variety of different areas. The Modification Department provides an in-house, end-to-end assured solution for the assessment, prototyping, design, manufacture, trial installation and even production for aircraft modifications across all three Services. It is one of the only MoD organisations with this capability and has the advantage of understanding the environment and challenges from both a Delivery Team and Operator perspective.

Repairer carrying out damage removal on Sea King MK 4, ZD626

The Materials and Monitoring Departments cover many different disciplines such as aviation forensics, non-destructive testing, vibration & health usage monitoring, wear debris analysis, structural materials investigation, corrosion control & husbandry and chemical investigations. These sections are integral to the sustainment of military aviation Force Elements at Readiness (FE@R). The work is predominantly related to aviation assets but increasingly ships and submarines are becoming part of their repertoire. The team also performs forensic investigations following equipment failures which have included vehicle incidents that involve metal fatigue and failures of machetes used by the Royal Marines, to name just a few examples.

The Repair Department recovers structural integrity of military registered tri-service rotary wing and specified Unmanned Air Systems. The Department has teams permanently at Very High Readiness and has the capability to deploy at short notice anywhere in the world within any environment. In 2017, the Department delivered approximately 125 repairs, ranging in complexity from extensive structural rebuilds that require specialist jigs and support equipment, to the replacement of windscreens and canopies. 1710 NAS is the only organisation within the Royal Navy and one of only 3 within the MOD that holds a Design Approved Organization Scheme (DAOS) approval. DAOS provides an independent assessment by the military aviation regulator (the MAA) of the competence of organisations involved in the design of aircraft systems, products, components and appliances. 1710 NAS is a highly effective enabler to UK military aviation assets that are deployed around the world.

Down Bird – a military term for a military aircraft incapacitated in an operational environment, necessitating the undertaking of emergency repair

Merlin MK3 ZH826 windscreen change

Belly panel damage on Chinook MK4

Extensive repair task on a Chinock MK 4

Operation Herrick

1710 NAS Repair supported Op Herrick (Afghanistan) over a ten-year period with individual tours broken down into 3 – 4 month time scales, operating over the two main operating bases of Kandahar and Camp Bastion. The typical teams deployed on these tours consisted of one Repair Officer (designer and detachment commander Lt) one Senior Repair Coordinator (CPO or SSgt) and three repairers (PO or Sgt). Due to the operating and operational environment, the aircraft sustained regular and sometimes extensive damage. The deployed Repair Teams had their own bespoke workshop, with easy access to tooling and equipment needed for such tasks, it was perfectly suited for this work and was constantly improved on by the teams throughout the operation. This allowed us to complete numerous concurrent tasks. The bulk of the work was recovering damage to the aircraft caused by small arms fire and stone punctures, followed closely by undercarriage damage sustained during heavy landings in "brown out" conditions. As aircraft come into land, sand and dust created from the downwash of the rotor blades creates a thick brown cloud, reducing the aircrew's visibility to zero. Maintaining structural airworthiness was top priority and at no stage through the entire Operation was there an Expedient Repair (ER) regime invoked. ER is designed to restore operational capability by providing rapid repair solutions for military aircraft. The fundamental principle of ER is that the repair solution must always aim to achieve the greatest degree of restoration within the constraints of time and available resources. Formal recovery action must be carried out in the form of a fully restorative and permanent repair after an ER. However, all repairs implemented by 1710NAS were permanent, requiring no subsequent restoration work.

Sea King lift frame

Sea King repair

1710 NAS Output:

35,000 man hours

135 Tasks

9 types of aircraft

Post Op HERRICK

Statistics compiled, and personnel accounts show that 2014 was arguably our busiest period during the conflict, providing more than 30,000 man hours, for all repair tasking in the UK and on operations. To support Op Herrick, 1710 NAS was provided with additional manpower to the tune of 2 Repair Teams (6 people); this was removed post withdrawal. We must be able to deploy multiple teams at varying readiness states from R2 upwards R8 (5 days to 90 days).

There was a large reduction in repair requests post the withdrawal from Afghanistan. The transition from Sea King to Merlin and from Lynx to Wildcat for the Fleet Air Arm during this period had a large influence on these figures. The later parts of 2015 and 2016 showed a steady increase again, with 2017 being a particularly busy period for the department. The type of repairs that we were carrying out has altered too, due to the changeover. The structural makeup of the modern airframes is markedly different to the traditional airframes. In particular, there is a greater use of composite materials meaning we have had to change the way we do our business. Due to the complexity and the implications if conducted incorrectly, all Merlin windscreen and canopy replacement and repairs have become 1710 NAS core business. The skill set of our repairers has expanded to cover composite repair and adhesive bonding in addition to the traditional sheet metal and fasteners. The more mature aircraft that are still in service, they are now showing signs of fatigue related damage on a larger scale. This manifests into protracted repair task that are encompassing for the teams. All this combined with a much more stringent regulatory requirement has contributed to an increase in our workload.

As a direct comparison from information gathering, in 2014 we delivered 30,000-man hours and well in excess of 250 tasks on 8 types of aircraft, with 35% of those repairs being carried out on operations where the aircraft were easily accessible and, in most cases, immediately available to the repair team. Due to the nature of the tasks we were undertaking, protracted depth repair projects. In 2017, we covered 35,000 man hours but only 135 tasks on 9 types of aircraft, with only 8% of those repairs being carried out overseas and on operations. So, with less manpower and generally longer travel times and reduced aircraft availability, 1710 NAS repair output is greater than ever before.

Summary

1710 NAS is the only service repair organisation able to recover the structural integrity of UK Military registered rotary wing and UAS assets in a range of operating environments. We now have more experience across a range of different structures, from sheet metal to advanced composites and sandwich panel structures. Our business is booming. We cover more types and marks of aircraft than ever before. Our operating model and capability generation procedures allow us to support our customers, predominately Navy Command and Joint Helicopter Command, to maintain their OC wherever they may be operating. With several new aircraft types and marks introduced since our withdrawal from Op Herrick in 2014 and the proliferation in use of UAS, this high tempo is expected to continue.

When it comes to value for money, a recent study concluded that 1710 NAS repair would cost double the amount if our primary capabilities were provided by industry. The figures within the study don't consider the secondary capabilities that 1710 NAS can provide: the list is extensive and varied but all benefit the FAA, RN and wider MoD providing even greater economy, efficiency and effectiveness.

In conclusion, although the nature of 1710 NAS Repair tasking has changed. The tempo of activity, the value for money and the ability to deliver military effect by keeping aircraft in the air all remain as high as ever. With continued support from our REME brethren, by investing in our capabilities and with our extensive experience we can, at short notice, turn our hand to enduring operations if required.

Chief Petty Officer AET Thomas Hone

Chief Hone joined the Royal Navy in Jan 1999 as a Aircraft engineering mechanic, on completion of his basic training at HMS Raleigh, he proceeded on to carryout his basic aircraft engineering training at HMS Sultan becoming AEM2. He completed his training with the CHF "Junglies" at 848NAS at RNAS Yeovilton and then continued within the CHF community by completing a further tour of 848NAS and 3 front line tours of 845NAS. Within this time he has covered the Mediterranean and spent the bulk of his front line duty within Iraq and Afghanistan on multiple deployments.

Promoted to Chief in 2015 he has become an SRC (senior repair co-ordinator) on 1710NAS where he continues today recovering rotary wing assets within the Military Aviation Environment throughout the three services.

Out In The Cold

By Lt Cdr Chris Cozens MEng CEng MIMechE RN, MEO HMS Westminster

Operating in cold weather environments provides challenges to the most seasoned engineers, with some of the most basic routines becoming disproportionately significant if not completed appropriately. It is imperative to plan ahead, train your people and respect the conditions in which you sail. Different ships offer different demands, as a vessel designed to operate in cold climates is inherently better suited to the environment such as heated boat davits and boat engine bay heating connections. Checking documentation early, considering stability impacts and using appropriate fuel are all vital for a successful period of engineering, with Defence Lessons Identified Management System (DLIMS) useful post-operations.

As an anecdote, in early 2018 off the northern tip of Norway, HMS Westminster was gliding along smooth seas during a break from the usual deep, low pressure systems which hasten across the Northern Atlantic. This was a chance to see what the previous storm had done to the sea boats, which had been plagued with engine start issues due to the cold. We inspected the adhoc engine bay heating rig we had set up to deal with the freezing conditions, scraping back the ice and frost. All looked well and thankfully the engines, with a little patience, started. Looking over our shoulders, we could see the clouds drawing in and the ripples of wind on the sea, the next squall was due through. Experience has taught me a number of key lessons, where understanding the limitations of our people and equipment is essential in the maintenance of Operational Capability (OC).

Operating in cold weather environments provides challenges to the most seasoned engineers

Having seen operational engineering in Extreme Cold Weather (ECW[1]) from the Antarctic to the Arctic, there is no more challenging environment. Hampered with bulky cold weather clothing and gloves, working on fiddly issues in sub zero conditions, where taking off your gloves will immediately glue hands to the item being worked on, is not only frustrating but dangerous. Conducting upper deck maintenance requires more than the usual planning, much of it is in preparation before starting the task, taking a closer look at personal safety and clothing. Winterisation of equipment used to be second nature during the Arctic convoys in WW2 through to the Cold War when the RN majored in the Atlantic during Anti Submarine operations, however this altered to the other extreme in the Gulf. Other than the regular cold weather operations of HM ships Endurance and Protector, the last recorded extreme cold weather voyage of a major warship was HMS London in the 1990s. This meant that the RN's corporate knowledge was low and reliant on out of date equipment documentation and old operational reports, coupled with technological improvements which had not been implemented fully.

The preparations start at home in base port; clothing, upperdeck fluid connections, boats and most importantly, learning the limitations of the equipment and people. When dealing with a ship which is designed to operate in ECW, the planning is relatively easy. Protector had heated tanks and decks as well as steam lance connections on the upper deck to remove ice build up; so it was primarily a case of ensuring the systems work. The preparations are more involved for a Type 23 (T23) Frigate, where greater precautions are required; for example, a T23 doesn't have suitable electrical connections for engine bay heaters in the boats. My initial approach was to review old documentation. Starting points included knowing the temperature limitations of the equipment itself as well as the fuels and lubricants, switching to different greases and adding AVCAT (aviation fuel) to NATO F76 Marine Dieso for the boats (due to AVCAT's anti icing additive Fuel System Icing Inhibitor (FSII)).

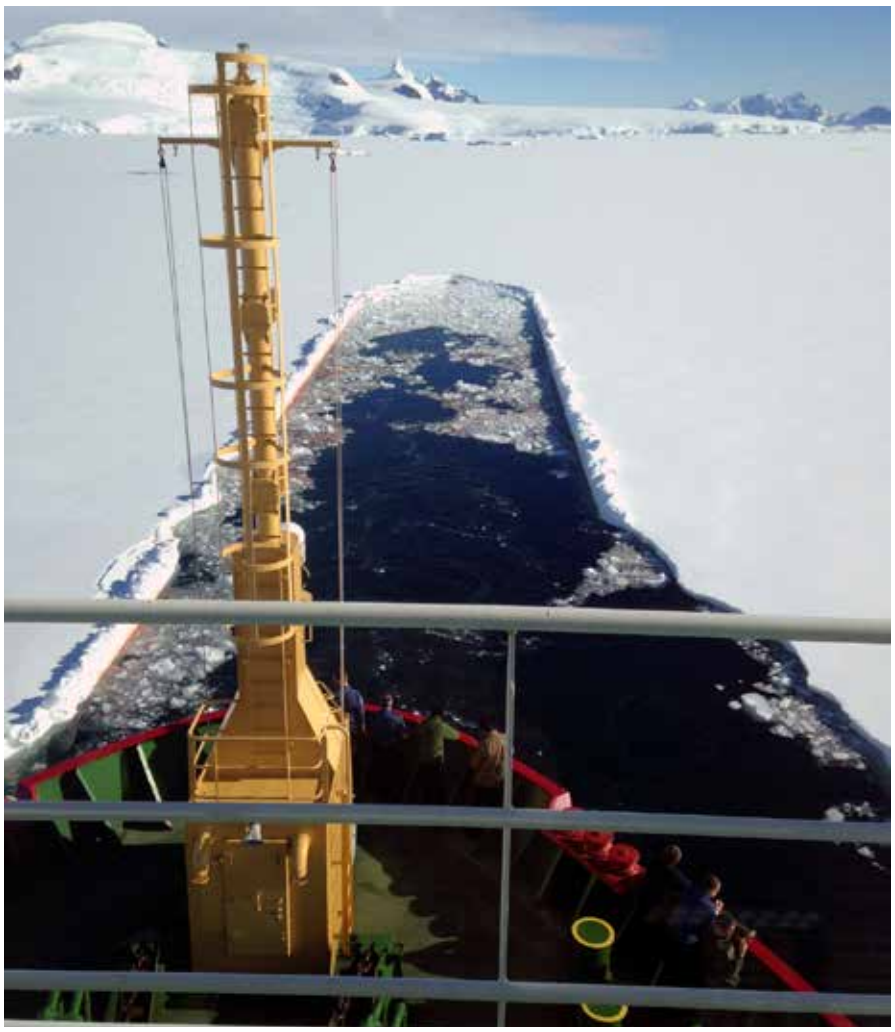
1 JSP 911 (Survival, Evasion, Resistance and Extraction), Ch 24: 'An ECW environment can be defined as being one which experiences mean temperatures of -10°C. For survival purposes it can be described as any region where temperatures are below 0°C throughout the day, usually accompanied by snow.

Protector in a snow storm

Protector stopped in an ice sheet

Prior to entering cold waters, every member of the Ship's Company should be given a clear understanding of the risks of operating in the extreme cold

Prior to entering cold waters, every member of the Ship's Company should be given a clear understanding of the risks of operating in the extreme cold and the protective and preventative measures necessary for safety. An untrained or poorly trained crew can quickly endanger themselves and the ship. It is also essential that the operation of the various emergency safety systems in these conditions are fully understood and practised. It does not matter how experienced a mariner is, man overboard and fire fighting equipment require different operation. These drills should be conducted wearing the full complement of cold weather gear so they can become familiar with how this protective clothing can affect their mobility, dexterity and reaction time. Many systems and components will be operating at or near their design limits, this is also true for people who may be nearing their physical limits. Performance may degrade quickly with a comparably rapid increase in the risks to personnel, equipment and the ship itself.



Stability calculations need to take into account the risk of ice accretion. A less known effect on the ship is 'Cold Soak', which is where exposed metal structures such as the hull and upperdeck retains the cold once subjected to freezing temperatures for a prolonged period of time, even when the air temperature increases. This greatly intensifies the danger of ice accretion and subsequent stability problems. The stability calculations for a T23 have concluded that no more than 150mm of ice should be allowed to build up on all horizontal surfaces before significant issues arise. Tools such as snow shovels and wooden baseball bats are useful for removing large quantities of snow and ice without damaging the deck and causing a husbandry issue.
On the subject of husbandry, like a terracotta plant pot at home in a frost, water will penetrate gaps and once expanded when frozen it will act to delaminate surfaces.
A good survey of the upper deck is essential to ensure no subtle damage is caused. Draining down all exposed water connections, such as fire hydrants, will also stop expansion damage.

Something else for consideration is the type and quality of fuel that should be used; cloud point is the main factor to pay close attention to. Anything below minus 3°C will 'wax' and potentially solidify, rendering it unusable. There have been occasional cases, which a T23 found to their cost on a visit to South Georgia a few years ago, where the water temperature dropped below freezing. Heading South could mean a stop in a warm country such as South America or Africa, where this is not normally a consideration. The Arctic and Baltic regions are different where 'winter fuel' is more prevalent and cloud points of minus 20°C is common place.

The preparations for engineering in cold weather operations are as much physical as they are mental

The preparations for engineering in cold weather operations are as much physical as they are mental; knowing how the equipment and people are going to behave in this environment is essential. The vista is stunning but can easily lure us into a sense of complacency. Conditions can deteriorate quickly and catch out the unprepared.
The DLIMS process is vital to build up the experience, knowing what kit and how to use it will improve comfort and survivability; ask a Royal Marine about Norway! The RN is set to operate more and more in cold climates especially in the Northern Atlantic Joint Operating Area (JOA) alongside its Joint Expeditionary Force (Maritime) (JEF(M)) and Northern Group partners, and as this area becomes more contested with the opening of new passes due to climate change. Corporate experience must be developed and shared including more interoperability with those nations closer to the problem; such as Norway and Canada, which in turn will inform ship and equipment design when considering operating in these areas.

Lieutenant Commander Chris Cozens

Lt Cdr Chris Cozens joined the RN as a Marine Engineer Officer in September 2006 after reading a Masters in Mechanical Engineering, serving in HM Ships Manchester, Illustrious, Campbeltown, Engineer Officer to Protector and now Marine Engineer Officer to Westminster. He was the Fleet Gas Turbine Allocation Authority during a time of low Spey GT availability and the Group Marine Engineer Officer to 1 Assault Group Royal Marines managing circa 250 craft from SF boats to Landing Craft. Operating in Antarctica on 7 separate occasions and the Arctic for 6, he has developed a wealth of experience for extreme cold weather engineering.

Action Salvage

By Cameron Beesley BSc (Hons), Project Professional Graduate, Salvage & Marine Operations

Salvage and Marine Operations (SALMO), part of Defence Equipment and Support (DE&S), has the tri-service lead for the provision of marine salvage, aircraft recovery and maritime emergency response for all areas of the MOD. The organisation includes two Marine Salvage Units (MSUs) located in Devonport and Faslane, comprising sponsored reservists who are multiskilled, operationally-deployable MOD civilians.

Battle Damage Repair (BDR) is among the myriad of support SALMO provides to the RN. During peacetime periods, exercises are conducted to ensure the call-out process is known, and the team can form up equipped to deploy as a unit. In April this year, SALMO took part in Exercise Sustained Warrior 2019 (SW).

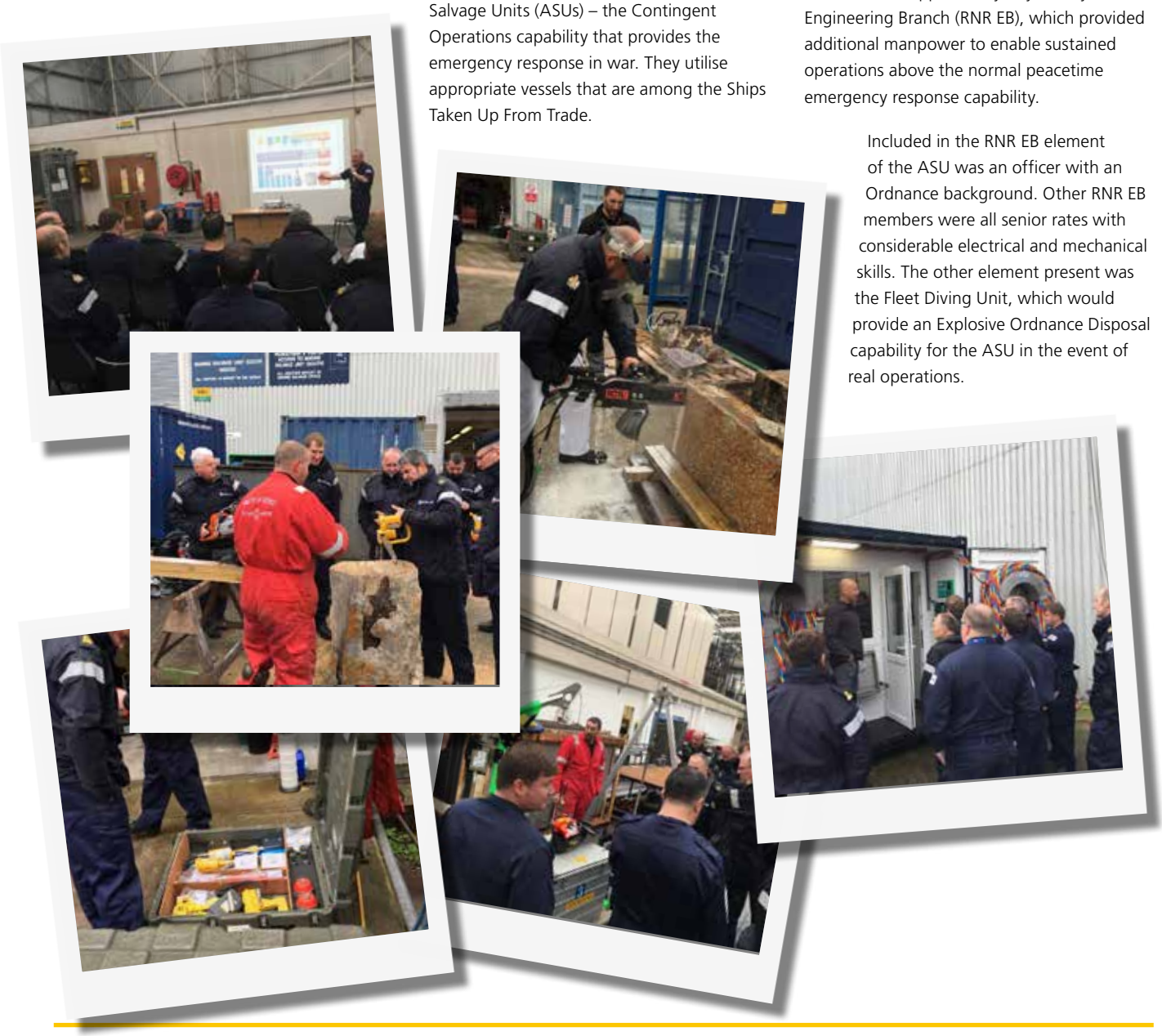
Exercise Sustained Warrior

SW forms part of Exercise Joint Warrior 191 (JW 191). One element of this was a standalone exercise designed to test Action Salvage Units (ASUs) – the Contingent Operations capability that provides the emergency response in war. They utilise appropriate vessels that are among the Ships Taken Up From Trade.

Although the SALMO team often conducts the practical elements of underwater repair, finding sunken objects and raising and towing ships through routine peacetime operations. SW was the first time since 2003 that the capability had been tested under wartime processes. The simulation took place on the ground as if the unit was about to embark, with an area set out to simulate the deck of the embarkation vessel.

The aim of the exercise was to simulate the generation of an ASU at MSU South. The exercise was supported by Royal Navy Reserve Engineering Branch (RNR EB), which provided additional manpower to enable sustained operations above the normal peacetime emergency response capability.

Included in the RNR EB element of the ASU was an officer with an Ordnance background. Other RNR EB members were all senior rates with considerable electrical and mechanical skills. The other element present was the Fleet Diving Unit, which would provide an Explosive Ordnance Disposal capability for the ASU in the event of real operations.



The Exercise

On 3 April, a Task Order was sent instructing activation of an ASU, Martin Watts (SALMO Principle Salvage and Mooring Officer) reported to the Force Repair Coordinator in the JW191 Battle Staff, led by the Joint Tactical Exercise Planning Staff (JTEPS).

Dave Price (MSU South Officer in Charge) was nominated ASU Officer in Charge. This utilisation of tasking required effective communication between SALMO, JTEPS, RNR and DE&S. On completion of the exercise, Dave Price reported back up the chain of command that the ASU had been stood up. SALMO and RNR EB were mobilised and ready for tasking, at which point it became a paper asset for the remainder of JW191.

On Friday 5 April, SALMO and RNR EB undertook an exercise consisting of integration and familiarisation training. There was a practical demonstration and the use of SALMO equipment, including hydraulic and pneumatic power tools. Presentations were also given on current doctrine and how the ASU would fit into the operation. This included how it was part of the Joint Warrior Plan – to support a raid on enemy territory that would occur in the exercise the following week. A brief history of SALMO and the unit's capabilities were also presented. Lastly, there was a show and tell of the 2003 Operation Telic Sea King mid-air collision and recovery. Laying out the capabilities required for the task including detection of the beacons, sea-bed survey, side scan sonar, and diver recovery.

The exercise was a great success and enabled the diverse mix of teams to assemble and improve the skills and knowledge of an operational ASU. In the future, simulations will be both in terms of how it is deployed exercising the battle-staff and additionally conducting further practice mobilisations eventually to a vessel to fully prove the capability.

Cameron Beesley

Cameron joined the DE&S in April last year after working for Mercedes-Benz in a Supply Chain Management role. He graduated from the University of Leeds in 2016 with a degree in Geological Sciences. He is currently on the DE&S Project Professional Graduate Scheme working as an Assistant Project Manager in SALMO. In addition to his placement, Cameron is currently studying for the Associates of Project Management Qualification.

ENGINEERING PEOPLE

Buttoning Up The Cardigan

By CPOET (WE) Sean Ryan IEng RN and LET (WE) Jason Lovibond RN

RFA Cardigan Bay – Alongside Duqm, Oman, July 19

RFA Cardigan Bay is a Bay-Class Landing Ship Dock (Auxiliary) that is currently deployed on OP KIPION. She delivers a multitude of roles for the Ministry of Defence in support of Joint and Combined Operations.

She is designed to offload troops and their equipment at the same time (up to 400 personnel, plus 150 trucks or 24 tanks). She acts as the Mine Counter Measure Vessel (MCMV) Command Vessel, simultaneously hosting deployed Battle Staff. Bay-Class Ships contain a hospital and a contingent of medical staff, who deliver primary care to Ship's company and embarked units wherever it is required, in support of their tasking.

The Ship stores a significant amount of ammunition, along with a deployed Roll On Roll Off (RORO) vessel. She also refuels Frigates, Destroyers and MCMV's as required. These capabilities result in a vessel that is highly adaptable, often delivering multiple roles simultaneously, with a professional crew that consistently delivers to the highest of standards.

Designed to offload up to 400 personnel, plus 150 trucks or 24 tanks

Phalanx 1B Weapon System

Phalanx 1B Weapon System

The Phalanx 1B is a Close In Weapon System (CIWS) for defence against airborne and surface threats, such as anti-ship missiles, aircraft and Fast Incoming Attack Crafts (FIAC).

The system consists of a 20mm Vulcan cannon guided by a Ku band fire control radar system for acquiring and tracking targets. The surface capability utilises both the radar system and a Forward-looking Infrared (FLIR) camera to identify and track targets.

The Phalanx 1B is a stand-alone system, requiring a 440v 3ph supply, and either sea water or chilled water cooling for the heat exchanger unit. Due to its self-contained nature, it is ideal for use on support vessels that lack integrated Command and Targeting systems, or that have limited sensors.

Phalanx Team

RFA units that are tasked East of the Suez (EOS), or as directed will deploy with two Phalanx 1B weapon systems. The phalanx team will provide the ship with a last line of defence capability, greatly reducing damage to the ship from incoming missiles or FIAC. RFA units will often operate as a singleton unit in these high threat areas, making this capability a mission critical system.

These systems are fitted during the ship's generation period in the UK and the installation involves extensive testing and trials prior to acceptance. The phalanx team will embark on the ship when installation commences and will remain on board until the systems are removed from the ship.

For each unit fitted with Phalanx there are two teams, each conducting roulemont periods. Each team consists of:

- 1x CPOET(WE) (Chief Petty Officer Engineering Technician (Weapons Engineering))
- 2x LET(WE) (Leading Engineering Technician (Weapons Engineering))
- 2x ET(WE) (Engineering Technician (Weapons Engineering))

The CPO is the Team Leader and acts as the focal point for the team and liaison to the Ship's Hierarchy. They are responsible for delivering Operational Capability, and achieve this by empowering their team to conduct daily maintenance activities and first line defect diagnosis on the Phalanx System.

Each LET(WE) has the responsibility of one Phalanx 1B mounting. This includes daily maintenance and husbandry, and also its operation during firing. They will also act as the Temporary Ammunition Custodian (TAC). The ET(WE) will assist the LET(WE) with their activities, with a focus on developing their skillset for future promotion.

The Royal Fleet Auxiliary

The first few days when joining a ship are normally dedicated to learning the layout of the Ship and who the key personnel onboard are. This process can be difficult for the RN as there are different titles for similar roles in the RN, roles differ, and there is a mixture of RFA and tri-service military staff onboard.

The Phalanx team is a sub-department of the Systems Engineering (SE) department, who sit under the Chief Engineer. The System's Engineering Officer (SEO) acts as the Line Manager for the Phalanx Team and has oversight of the maintenance activities and will release Operational Deficiency (OPDEF) signals as required. As a rule, the SEO will permit the Phalanx Team to function independently, liaising weekly to ensure Operational Capability.

The Chief Engineer is the focal point for safety onboard the vessel. The Phalanx team require Permits to Work (PTW) daily, in order to ascend the weapon system and conduct maintenance activities. Potential hazards onboard the Ship are controlled by the Ship's Communications Officer (SCO).

The Point Defence Officer (PDO) is responsible for the Warfare elements onboard. Liaison between the CPO(ET) and PDO occurs daily in order to plan test firings, ascertaining live rounds requirements or planning for choke point transits such as the Straits of Hormuz.

The Officer of Quarter (OOQ) onboard is usually a junior Officer of the Watch. They will not have an engineering background and will have only conducted the three-day OOQ accounting course. Providing guidance and assistance as required to the OOQ will aid in ensuring accurate accounting when de-ammunitioning occurs, or when assurance visits take place.

> There is a mixture of RFA and tri-service military staff onboard

Daily Routines

Starting at 0800, the team will gather in the office to discuss what maintenance activities are to be conducted that day. Prior to the commencement of any work, a PTW is generated via the Chief Engineer, and Safety Harnesses are issued by the Chief Bosun's Mate. The approach to PTW and potential hazards on-board a RFA Ship differ in some areas in comparison to the RN, however there is no difference in safety standards.

During the forenoon, daily system tasks are conducted. These are non-invasive and feature the radar, electronic and servo systems. Additional maintenance activities for that day will also be conducted.

Meticulous planning is required, as when the vessel is at sea the weapon system will be loaded with ammunition which prevents the completion of certain activities.

The routine during the afternoon focuses on general husbandry, whole ship training and career development journal tasks. There is also enough time for all personnel to visit the gym, with the facilities onboard generally being superior to those on board a RN vessel.

Each day one of the Junior Ratings (ET and LET'S) will act as the Duty Phalanx Rating. At sea, this requires conducting End of Working Day rounds on the equipment and acting as the first point of contact should a defect arise. While alongside, there is an additional responsibility of being a member of the Harbour Emergency Organisation (HEO), assisting during emergencies and as required by the Officer of the Day.

General Routines

Outside of the primary maintenance and system activities there are a number of administrative and Whole Ship tasks to be conducted by the team.

Entering and leaving port requires the completion and return of the souls on board document to 1700 NAS HQ (Squadron Headquarters). This is completed independently of the ship and is required to ensure accurate recording for leave, Longer Separation Allowance (LSA), Local Overseas Allowance (LOA) and Separated Service (SS) totals. A weekly update brief will be sent back to the Commanding Officer, Weapons Engineering Officer (Head of Department) and other parties at 1700 NAS HQ. This document will outline activities from the past week and is useful for discussing any achievements or concerns that may arise onboard.

Removing debris from the Salt Water Heat Exchanger.

Fridays are a big day on board as this is when the Captain or Executive Officer of the Ship will conduct cleanliness inspection rounds of the accommodation and shared areas. These inspections require no formal reporting, and normally involve the inspecting personnel having a chat with the crew. The weekly planning meeting with the departmental Senior Ratings will also take place on a Friday. This will de-conflict any issues between the Midcast and Shortcast (Short and Long-term Planning documents) and is useful for the Phalanx Team Leader to discuss ammunition transfer requirements.

One of the most important activities onboard an RFA vessel is Smoke-O, known as Stand Easy to RN personnel (a break with a tea or coffee!). These periods are key, as it is important to engage with the RFA crew to ensure effective information exchange, and there is potential for solely focusing your interactions with the military personnel onboard. Often these informal chats are more useful than the weekly planning meetings.

Defect Investigation

Rectifying defects on board a vessel that is deployed on Op KIPION requires a disciplined approach, balancing the desired time required to discover the root cause of a defect against the required availability of the system when in high threat areas.

The fault diagnosis capabilities of the system enable extensive tests of all sub-systems, providing the maintainer with the ability to narrow down the defective unit with a certain degree of confidence. In some cases, liaison with engineering support in the UK is sought for advice. Their support, and ability to provide insights 24/7, 365 days a year is often pivotal when restoring capability to Command.

> It was obvious that this vessel and its crew were in an operational theatre

Straits of Hormuz

Transiting choke points such as the Straits of Hormuz is where the Phalanx team come in to their element as they are in control of the armed weapon, ready to fire the Weapon System should the ship come under attack. They act as the primary layer of defence to the ship and its crew.

The most recent transit involved sailing from the Central Arabian Gulf to the Gulf of Oman in unison with HMS Montrose, acting as the Task Group Commander in the event of interaction with Iranian vessels.

Summary

For a member of the Phalanx team, the role on board an RFA vessel offers you the opportunity to dedicate your efforts on a single objective – providing the primary defence capability to the ship. You have the ability to dedicate your focus on delivering that goal and commit the time and resources to rectifying defects when they arise.

The other RN/RM teams attached to the vessel, Battle Staff and Force Protection, operate in a similar singular fashion. Building relationships with these teams, as well as with the RFA crew, is important to maintain morale within the team and ensure that the roulemont ticks by at a steady pace.

The job offers you the ability to operate largely independently in order to achieve your goals. This coupled with the high living standards on board makes it a fulfilling role to undertake.

CPOET (WE) Sean Ryan

Chief Petty Officer Sean Ryan joined the Royal Navy in February 2005 as a Weapon Engineering Artificer Apprentice. On completion of Artificer's course he was assigned to HMS Montrose as the Close Range maintainer. Drafts as Air Weapons and 4.5" Mk8 MOD 1 maintainer on board T23s followed. Promoted to Chief Petty Officer in April 2012. Recent assignments include Flag Officer Sea Training (FOST), within the Weapons Team. Currently assigned to 1700 Naval Air Squadron as a Phalanx Team Leader, deployed on board RFA Cardigan Bay.

LET (WE) Jason Lovibond

LET Jason Lovibond joined the Royal Navy in January 2001 as an Operator Mechanic Communications. After completing basic training he was drafted to HMS Edinburgh where he worked in the Main Communications Office and the Internal Communications section. Drafts followed to NCHQ, FOST NWD (JTEPS) as a Communicator and then HMS Southampton, HMS Mersey and HMS Clyde after transferring to ET WE. LET Lovibond was selected for LET in 2015 and is currently assigned to 1700 NAS as a Phalanx Controller/Maintainer.

100th Anniversary of the First Female Naval Architect

By Cdr Mark Barton BEng MA CEng MRINA RN, Eng Support SO1 Doctrine & Policy, NCHQ

The IMarEST and IMechE may be the most familiar of the Professional Engineering Institutes (PEIs) in the Royal Navy, but there is a third smaller PEI that is appropriate for many of the marine engineering specialisation – the Royal Institution of Naval Architects (RINA). This has at its core "the design, construction, maintenance and operation of marine vessels[1]" and is a natural home for personnel in roles that historically were considered shipwrights' billets, or involved in the structural, docking or stability aspects of naval business.

The 1919 AGM of the Institution of Naval Architects was chaired by Engineer Vice-Admiral Sir Henry Oram, who had been the most senior Royal Navy engineer during the preparations for and first half of World War 1. At the AGM, it was agreed unanimously, following an institution referendum, that women would be eligible to become members of what is now the Royal Institution of Naval Architects[2], on the same terms as men. The first three women were Eily Keary, Blanche Thornycroft and Rachel Parsons. Eily was considered to be first, mainly on alphabetical grounds, but helped by the fact that she had graduated from Cambridge with a degree in Mechanical Sciences[3]. She was indeed the first woman to move from being an Associate to an Associate Member in 1923 and first to full member in 1956, Blanche and Rachel having retired from business by then. In supporting the motion to allow women membership, Sir Alfred Yarrow stated: "*The last destroyer we tried attained during four hours a speed of 39.6 knots, fully equipped. I think that is the best speed that has ever been attained. The lines of that ship were determined partly by a young lady, Miss Keary.*"[4]

While the Thornycroft and Parsons names are probably more familiar to naval engineers, the lives of all three women give fascinating insights into the variety of roles undertaken by naval architects and their contribution to the Royal Navy.

Eily Keary was the first woman to have a paper published in the RINA Transactions and had already presented a paper to RINA prior to this election[5]. The shipping company owner, Sir William Smith, described the significance of the paper stating: "*It broke new ground, and gave us very great information as to the variation in the transverse stability of a vessel when proceeding under way, in comparison with her stability when at rest in still water.*"[6]

Eily worked at the 'National Experiment Tank' at the National Physical Laboratory in Teddington. This 549-foot-long tank, now often forgotten, was presented to the nation in 1911 by Sir Alfred Yarrow. Eily was an assistant to the tank supervisor George Baker. Having trained as a shipwright at Portsmouth Dockyard, and then gone through the Royal Corps of Naval Constructors training, and rising to be Director of Naval Construction, Baker was then sent to be assistant to Robert Froude, at the Admiralty's Haslar tank. Her work was partly on the hydrodynamic properties of seaplane hulls as well as the testing of other naval hulls.

> It was obvious that this vessel and its crew were in an operational theatre

Following the departure of the pre-war assistant to the tank supervisor, a naval architect called GH Miller (first name unknown), to serve in the Naval Division, and JL Kent moved up from Junior Assistant to replace him. Eily, after leaving Cambridge in June 1915, became the Junior Assistant, in effect the third of the researchers, as opposed to those operating the tank and making the models. She was initially brought to work on improvements to seaplane floats[7].
Miller had a series of Boys' Own style adventures that deserve an article in their right – he was captured near Antwerp, then escaped and became involved in the early attempts to land aircraft on ships, unfortunately dying in a crash in 1918.

The work at the Teddington tank during World War 1 forms the basis of many systems that we now take for granted. The researchers developed mines with increased reserves of buoyancy so they stayed in situ in tidal currents; anti-submarine nets; the ability to fire torpedoes from a deck on higher speed craft, and indeed how to improve the speed of craft in particular the high speed destroyers used to hunt submarines. The impact on transverse stability (GM) of speed was discovered at Teddington during this period. The tank itself was renamed as Tank No 1 when a second was added on the same site during WW1 and, in 1959, the facility was moved to Feltham and a larger tank.

Eily did not vacate her employment after WW1, nor did she decamp to the new seaplane testing tank at Farnborough where the porpoising characteristics of seaplanes were to be studied. Her post-war work involved research and design work for Thornycroft, but also she was noted for her work on the interactions between barges when several were being towed by a single vessel. Eily continued at the Tank until 1929,

1 RINA Statement of purpose on RINA website.
2 The Institution was granted the Royal in 1960, the only one of the three Marine Engineering PEIs to have that privilege.
3 Alice Perry in 1906 was the first engineering graduate but Enabled by Sir Charles Parsons, Rachel Parsons and Elsie Keary went to Newnham College, Cambridge to study mathematics and mechanical sciences. Rachel was there from April 1910 to 1912. Elsie for Autumn 1910 until 1913. They were the first women ever to do so. At that stage Cambridge would not allow them to sit the final exams and so they did not graduate. Eily arrived in 1912-15 and was allowed to graduate.
4 RINA Annual Transactions 1919 pg 122–3.
5 The paper presented in 1917 and published in 1918 jointly by Mr. G. Baker and Miss E. M.L. Keary was entitled "The Effect of the Longitudinal Motion of a ship on its tactical Transverse stability."
6 RINA Annual Transactions 1919 pg 121–2
7 D Bailey, Ships in the Making: History of Ship Model Testing at Teddington and Feltham 1910-1994 (Lloyds of London Press, London, 1995).

Eily Keary. Image courtesy of author

when she married another naval architect Frederick Smith and became Mrs Smith-Keary. She continued to be involved with the testing and wrote further research papers until the couple moved out to the Antipodes in 1940.

The shipbuilding company Thornycroft was established on the River Thames at Chiswick in 1866. In the latter years of the 19th century the size of vessels required by the Navy grew to the point at which, if they were launched at Chiswick, parts of the superstructure had to be removed in order to allow them to pass under the relatively low bridges on the Thames to sail on trials, a similar problem to that found for the QEC building in Rosyth. For Thornycroft the solution was to move the bulk of their operations to Woolston, Southampton, in 1904.

8 Although he is recorded as having built steam launches in the same yard as early as 1864.

40 foot Coastal Motor Boat. Image courtesy of the Classic Boat Centre Trust, Cowes, Isle of Wight

55 foot Coastal Motor Boat. Image courtesy of the Classic Boat Centre Trust, Cowes, Isle of Wight

As part of this move, Sir John I Thornycroft relocated the family home to Bembridge on the Isle of Wight, and it was here that he developed facilities to explore the design of ships. The garden had a lily pond in which Sir John hid sophisticated measuring equipment behind a pump-driven decorative waterfall. Once the waterfall was turned off and the waves died down, the pond became a testing tank. This enabled the construction of scale models which were then tested by being towed in the water[9]. This was later replaced by a larger purpose-built testing tank elsewhere on the estate.

Thornycroft was very much a family business and this extended to one of Sir John's daughters, Blanche. She appears to have been heavily involved in the work of the test tank, if not the key person conducting the experiments[10], from at least 1907 until the end of World War 2. Vessels tested on the estate included racing motor boats, which developed into Coastal Motor Boats, Acasta and Acheron Class Destroyers for the Royal Navy, motor torpedo boats, Royal Air Force Rescue Launches, and RNLI Lifeboats.

Blanche continued working at the testing tank until the mid 1930s, being involved in the early work on an RAF rescue launch at that time. She resigned her membership of RINA in 1948 and died in 1950, and alongside Rachel Parsons was a founder member of the Women's Engineering Society.

Rachel was the daughter of Sir Charles Parsons, who was one of the key developers of the steam turbine, which at this time was dominating propulsion in the Royal Navy. Rachel along with her brother Tommy and mother Katharine participated in her father's experiments at home. This also involved models on the pond at the family home. It was the experimental Parson-designed Turbinia that demonstrated the importance of this propulsion change when she raced past the RN ships at the 1897 Spithead Review. This meant that Parson steam turbines were adopted as the propulsion system for HMS Dreadnought.

It was the experimental Parson-designed Turbinia that demonstrated the importance of this propulsion change when she raced past the RN ships at the 1897 Spithead Review

9 K Harcourt and R Edwards, Engineering and the family in business: Blanche Coules Thornycroft, naval architecture and engineering design, Science Museum Group Journal Issue 10 Autumn 2018.
10 The Classic Boat Museum on the Isle of Wight holds her note books from the tests and the curves and calculations of 'Velocity and Weight per BHP' for various vessels which appears to be Blanche's handwriting.
11 The name at that time for what is now Zimbabwe.

Rachel was one of the first three women to study Mechanical Sciences at Cambridge. Her brother worked in the family firm Parsons Marine Steam Turbine Company in Newcastle-upon-Tyne. However, he enlisted during World War 1 and was killed in 1918. While he was away, Rachel was appointed an interim director but after the war her father refused to let her continue, causing a family rift. Rachel resigned but was determined to continue in engineering. With the support of her mother, she founded the Women's Engineering Society and in 1920 she was one of a group of eight women who founded Atalanta Ltd, an all-female engineering company, which included further technical education for its employees for its eight years of operation. After this her interest in engineering waned as she pursed politics and racehorses before being killed in 1956 by one of her former stablehands.

These women, as professional engineers, were not only pioneers for their gender but were also innovators in ship design, which is why they found their professional home in RINA. Then as now, it was steps forward in the "design, construction, maintenance and operation of marine vessels" that is so critical to develop a world leading and highly capable navy.

Blanche Thorneycroft testing by the 1884 lily pond. Image courtesy of the Classic Boat Centre Trust, Cowes, Isle of Wight

Commander Mark Barton

Commander Mark Barton has had a career that has tended to alternate between naval architecture roles and operational support, having completed five sea appointments and three Op Tours. His 5th sea appointment was as Commander E of HMS Bulwark. He is currently employed as the SO1 Doctrine and Policy in the Engineering Support Division at NCHQ and has been responsible for authoring Volume 2.9 of Fighting Instructions which is Maritime Engineering. He is now writing the Naval Engineering Policy BR. Tied in with this he supports various engineering aspects of operational planning and provides input to support aspects for strategic planning. With an interest in Naval history, he has several publications including the book British Naval Swords and Swordsmanship, writes regularly for The Naval Review and is currently endeavouring to complete a PhD in Napoleonic naval history. As part of his contribution to Year of Engineering he researched and authored the history of The Engineering Branch of the Royal Navy.

Engineering the Future Generation

By Lt Cdr (SCC) George Wilson IEng IMarEng MIMarEST RNR

Sea Cadets is not messing about on the water. We aim to inspire the next generation to realise their potential and seize a better future through a structured programme of engaging activities based on the customs and traditions of the Royal Navy. By blended teaching of key maritime skills and leadership development, the Sea Cadet Training programme helps Cadets grow into confident, resilient and self-reliant young people and prepare them for the modern world.

Sea Cadets is part of the Marine Society and Sea Cadets (MSSC), a charity with a long history of youth development with approximately 15,000 cadets in 400 units across the UK. Activity is delivered by 9000 committed volunteers who freely give their time to train our Cadets. The Royal Navy is the charity's biggest supporter, providing in the region of 50% of our funding, the remainder is raised through donation from individuals and organisations who share the Charity's ideals of training young people, providing life skills and support that leads to meaningful and rewarding careers.

Over the past few years we have been reinforcing our already strong engineering delivery (indeed marine engineering has always been one of our most popular topics). Today we take a tiered approach and this paper sets out where we are.

Inspiring young people towards an engineering career through Sea Cadets

Sowing the Seed

- **Outreach** The MSSC Marine Engineering outreach project aims to target young people who are not Sea Cadets by delivering marine engineering workshops to Key Stage 3 (S1-S3 in Scotland) 11–14 year old school pupils. Through the use of specially built mobile marine engineering pods some 18,000 young people have already taken part and we expect to reach a further 37,500 pupils over the next 3 years. The Pods contain a range of Marine Engineering equipment, including both running and sectioned engines, to deliver a range of 2-hour workshops. Each workshop is a fun, hands-on session, aimed at teaching pupils about the principles of engineering through use of Marine based real-life scenarios. Pupils are required to work in small teams to design and develop engineering solutions. These sessions are focussed at KS3 to help young people make an informed decision when choosing their GCSEs subjects. Seafarer UK reports that "*The evidence from teachers and students is that the project has made a real difference in inspiring young people about Marine Engineering and their GCSE choices.*"
- **Internal** The Junior Sea Cadet Programme targets young people aged 10-12 who are looking for something more than other youth groups offer. It aims to give them a good taster of wider Sea Cadet activity but with the emphasis on practical and fun activity. In Sep 19 we introduced a new STEM module developed in association with the British Science Association. This will let cadets get hands on with experiments. It offers a wide range of activities based around Science, Technology, Engineering and Maths, all with a nautical theme. For example: Cadets will learn about gravity with the help of eggs, forces and motions by building catapults, and buoyancy by constructing boats. Cadets who successful completion all the activities will gain a nationally recognised CREST[1] qualification and of course a STEM badge. Interest during development has been incredibly strong and we expect this to take off rapidly.

1 CREST is a nationally recognised scheme for student-led project work in the STEM subjects supported and recognised by employers in the STEM sector.

Developing an interest

Whilst STEM is embedded in many topics, Sea Cadets delivers subjects from meteorology and navigation to practical seamanship, for example the use of block and tackle. However, it is the practical hands on approach that makes the Sea Cadet marine engineering so attractive to many young people; we awarded almost 1000 qualifications last year. A number of units have developed their own engineering classrooms and facilities. Interest and involvement is also developed and encouraged through regional competitions which maintain interest and develop problem solving and engineering skills. Units are also encouraged to participate in wider activity such as the annual QinetiQ powerboat challenge, whcih was won in 2018 by Warsash Sea Cadets, TS Tormentor.

We awarded almost **1000 qualifications** last year

I suppose the "Marine" of Marine Engineering is a bit of a misnomer. Our combined 70+ years' experience of Engineering has led us to conclude that much of what we teach our cadets is not unique to that particular branch of engineering. What is does give however, are the broad building blocks on which to develop a young person's engineering knowledge and to whet their appetite for something on a much grander scale.

Capt Bolton with the Sea Cadets

The Sea Cadets Marine Engineering syllabus is broken down into three levels, each following on from and building up the knowledge learned at the previous level. Within each of these there is some guidance on engineering careers in the Royal Navy, Merchant Navy and ashore in industry:

- Basic (minimum age 13 years): is exactly that, the aim being to give the Cadet an appreciation of the basics of why things go round and round and up and down! They learn the component parts of a small internal combustion engine along with basic electrical knowledge (Ohms Law for example) and how to use basic tools correctly.
- Intermediate (minimum age 14 years): This course is based on some of the elements of the MEM(M) qualifying course of 1990's vintage and covers a fairly in-depth training on basic engine ancillary systems (fuel, cooling, lubrication etc.) and gives some instruction on the working of AC and DC electrical motors and generators.
- Advanced (Mechanical) (minimum age 15 years): This is a very "hands on" course with Cadets removing cylinder heads from small diesel engines, stripping these down, calibrating wearing parts and rebuilding the engine. It also gives instruction on small boat bilge pumping systems, petrol engines and an introduction to vessel stability, construction and propulsion.
- Advanced (Electrical) (minimum age 15 years): Power generation and electrical distribution systems, including discrimination and protective devices (RCD; over current etc). Connecting and disconnecting of shore supplies and electrolytic corrosion is also covered along with a small section on electronics, rectifiers, inverters and smoothing circuits.

While these courses provide a good grounding in basic engineering principles and can lead to a career in any engineering discipline, it is generally through the commitment of instructors who bring the subject to life and who are frequently professional practising engineers at the "coal face with dirty hands" that the Cadets are inspired to want more!

Feeding the Appetite

Some years ago, we were able to offer a BTEC Level 2 qualification in maintenance engineering to our cadets which was very popular and led to many Cadets embarking on their engineering careers, mostly with the Royal Navy although some did enter the Merchant Navy and other engineering disciplines. Over time, the criteria for awarding the BTEC changed, which took away the ability of The Sea Cadets to deliver. We were conscious that we had many Cadets within Sea Cadets who wanted to satisfy their craving for engineering knowledge, but we could not, until recently, find a suitable course to satisfy their appetites. That is until we became aware of the Open Awards organisation who had a course we were sure would, to some extent, fill the gap left by the BTEC. This course is an Open Awards Level 1 Certificate in Exploring Maritime Skills (Vessel Engineering).

A working group of several Sea Cadet Marine Engineering Instructors was formed to discuss what we could do within the Open Awards framework with the facilities available to us and always remembering the skill sets of our Marine Engineering instructing staff. After much drafting and discussion within the working group and in consultation with the Open Awards organisation, and having capitalised on the Year of Engineering to open the doors at HMS Sultan, a task book was developed and used for the first time on the course held in HMS Sultan at the end of July this year.

The course, hosted by the Defence School of Marine Engineering within Sultan, exposes the cadets to modern real Royal Navy engineering, mixing theory with practical hands on sessions in Marine and Air Engineering combined with visits to ships in repair in the Dockyard. The facilities provided by HMS Sultan and QinetiQ Haslar are an excellent teaching ground for the fertile minds of young budding engineers who required little motivation to enquire and glean as much information as possible when on their course. We had 19 cadets on the course, all of whom satisfactorily completed their task books which are currently in the final stages of internal verification before being sent to Open Awards for consideration of an award being granted. I am fully confident that all Cadets will be successful in gaining the qualification.

The course could not have been held without the commitment and support of HMS Sultan command and the various instructors of the Defence School of Marine Engineering within Sultan. Without their time, advice and organisation, all freely given, the course could not have been the success it was. It was a great pleasure for the Sea Cadets to be welcomed back to Sultan and we are hopeful that the Open Awards course will become a permanent fixture in HMS Sultan annual programme.

Capt Bolton presenting Able Cadet Polly Ward with the Level 1 Certificate in Exploring Maritime Skills (Vessel Engineering)

Looking ahead, we are already planning for the 2020 course and it is also hoped, that within a few years, we can progress to offering a Diploma in this subject. Furthermore, if we can find suitable volunteers from within the Sea Cadets we would like to develop a CIS and Sensors course. There is clearly an appetite from our cadets.

Sea Cadets would be nothing without the support of our amazing volunteers who deliver the Sea Cadet experience at over 400 units

Assessing the Impact

From what we know about the career choices of former Sea Cadets, statistically, a large proportion of the readers of this article will be former cadets. The MSSC in association with Durham University and University of London has just embarked on a historic impact study to evidence how Sea Cadets influenced cadets' upbringing, and later life. So, if you were a former cadet your feedback would be invaluable; please visit https://www.sea-cadets.org/my-legasea.

Finally, a bit of a plug. Sea Cadets would be nothing without the support of our amazing volunteers who deliver the Sea Cadet experience at over 400 units across the UK. Any subject brought to life is much more appealing to cadets. Instructors who are practitioners of their trade can easily do this. Seafarers of either naval service who have come ashore, or who are still involved with the sea, make excellent instructors; such volunteers are always welcome within The Sea Cadets, training tomorrow's seafarers today! We are always on the lookout for more volunteers. Therefore, whether you are heading ashore towards retirement and wishing to keep your hand in, or just returning home for leave, I would encourage you to drop into your local Sea Cadet unit and lend a hand. I can assure you the feeling of giving something back to the next generation is extremely gratifying and will be well worth it.

Lieutenant Commander (SCC) George Wilson

Lt Cdr (SCC) George Wilson is currently Headquarters Staff Officer (Marine Engineering) within the Sea Cadet organisation having held that post for the past 12 years. He has enjoyed a career spanning over 40 years in the shipping industry. George sailed in ranks up to First Engineer Officer, gaining his First Class Certificate of Competancy for Steam and Motor Ships, and held several senior positions ashore in vessel engineering management. His current position is with a major international insurance company where he is a Consultant Marine Engineer.

George joined the Sea Cadets over 25 years ago and continues to specalisie in Marine Engineering. For almost 20 years he was significantly involved in the operation of a TON Class minehunter used as a teaching base for a local Sea Cadet unit. Focused on enhancing cadet training, all of the Sea Cadet Marine Engineering task books currently in use have been authored by George.

George is currently in the final stages of achieving Chartered Engineer status and becoming a Fellow of the Institute of Marine Engineering, Science and Technology.

Engineer Officer Development Strategy

By Cdr Fiona Haynes MBE MA MEng RN, SO1 Keyham, NCHQ

Since the last edition of TNE, the Keyham Implementation Team has focused on new entry sponsorship schemes and the introduction of an Engineer Officer (EO) Development Strategy. We have also been working with Flotilla and NCHQ to see if any of the seagoing EO administration can be removed. Finally, we are reviewing the training provided for non-seagoing roles to ensure that EOs are fully prepared for employment across the Career Fields.

At the core of the EO Development Strategy is the introduction of new policy on Professional Registration: by 2029, Incorporated Engineer (IEng) will be the minimum expected requirement for transfer to a Full Career Stage (FCS). Accreditation can be with any of the Engineering Council's (EC) recognised Professional Engineer Institutes (PEI). This is an internationally recognised standard, demonstrating individual knowledge, competence and commitment against a global benchmark, which not only professionalises individuals but the Engineer Branch as a whole.

Gaining professional accreditation improves credibility, demonstrates motivation, instils a professional attitude, provides evidence of expertise and allows greater influence within the organisation. It also facilitates networking with Professional Engineers out with of Defence. Demands within the Service for IEng and Chartered Engineer (CEng) accreditation are increasing, particularly with respect to safety critical and professional command roles; therefore, individuals will expand their career choices through professional accreditation. They will also be rewarded with the Engineer Professional Recognition Award (EPRA).

The accreditation process in most cases has been simplified to reduce the administration burden on individuals via Defined Routes (DR) with the PEIs, where evidence is based on the EO training pipeline, assignments completed and CPD. Most of the PEIs have information on defined routes on their web pages; in the e-version of this article the logos below are linked. For those individuals who find the DR is not an option owing to a lack of recognised engineer qualifications, an experiential route is available through PEI individual professional and academic review. Continuing professional commitment is measured through ongoing CPD, an auditable requirement of the PEIs for individuals to maintain registration status.

To support the accreditation policy and CPD, we will introduce online mechanisms. A Professional Development page will be created within the newly launched Royal Navy Engineering Portal, accessible via the Intranet and Defence Gateway. This page will provide a one-stop-shop for all EO development requirements, including links into the EC/PEIs, CPD guidance, mentoring advice, career pathways, including explanations of first and second stage careers (1SC/2SC) and Career Fields as well as a general reference portal. It will also link to the new Engineers' Career and Accreditation Logbook (ECAL), encompassing the Engineer Officer Competence Framework, a web-based application linked to JPA.

The ECAL, owned by individuals, enables recording and evaluation of experiences through the 1SC and into a 2SC, supporting reviews with reporting officers, mentors and career managers. The tool will assist EOs in career planning and allow easy retrieval of evidence for accreditation and, when the time comes, for resettlement.

ECAL Vision:

'Informative, intuitive, accessible professional EO development tool and repository for evidence to inform career progression and support accreditation and further development'.

A prototype ECAL has been submitted for development and we will be looking for more volunteers for user-testing. It is hoped to be able to roll out the app in Q1 20, starting with Engineering Officers undergoing Systems Engineering and Management training and then subsequently to the rest of the Branch.

Commander Fiona Haynes

Cdr Fiona Haynes joined the Royal Navy in 1999 as a UCE Marine Engineer. On completion of University and SEMC she joined HMS Ocean in 2006 as the Ships Services Engineer Officer (SSEO). Other roles have included IC of a Student Presentation Team, T23 COM Platform Manager and project manager and eventually business manager for UTC Portsmouth. Cdr Haynes joined Keyham in July 2018.

Reward and Recognition

Congratulations to all those who have won the awards featured.

Every effort has been made to ensure as many awards were included as possible, and any errors or omissions are entirely unintentional.

We want to celebrate your achievements! If you would like to have an award included in the next edition, please send details to the Editor at: **NAVYSPT-ENGTNEMAILBOX@mod.gov.uk**

A revised and updated RNTM on reward and recognition for engineers was published in March **– RNTM 09-006/19 Reward & Recognition within the Royal Navy Engineering Branch**. It seeks to act as a 'one stop shop' for information and guidance on awards and will be revised annually.

Thank you to the all of the sponsors of the awards:

OFFICER OF THE MOST EXCELLENT ORDER OF THE BRITISH EMPIRE (OBE)

Cdr M J Freeman

MEMBER OF THE MOST EXCELLENT ORDER OF THE BRITISH EMPIRE (MBE)

Cdr A G Clarke

CPOAET (Avionics) T M Eland

AEM (Mechanical) M K Gallimore

CPOET (CIS) H G Heady

MERITORIOUS SERVICE MEDAL

CPO(SET) S Annison

CPO Annison is presented the MSM by Rear Admiral Mike Bath

WO1MEM(M) P Bell

WO1 Bell is awarded the MSM by Rear Admiral Marshall

CPOWEM(O) R A Johnson

CPO Johnson is awarded the MSM by Rear Admiral Marshall

WO1ET(ME) B W Lloyd

WO1 Lloyd is awarded the MSM by Rear Admiral Marshall

WO1(AET) J G Morris

WO1(WESM) R Morrison

CPOAEA(M) P E Roberts

CPO Roberts is awarded the MSM by Rear Admiral Marshall

CNEO COMMENDATION

LET Laurence Foley

Rear Admiral Higham presents the CNEO Commendation to LET Foley

WO1 Paul Dixon

Rear Admiral Higham presents the CNEO Commendation to WO1 Dixon

POET Thomas Hinchcliffe

Rear Admiral Higham presents the CNEO Commendation to POET Hinchcliffe

Lt Sam Leahy

Rear Admiral Higham presents the CNEO Commendation to Lt Leahy

FLEET COMMANDER'S COMMENDATIONS

POET(WE) R K Emerson

PO Emerson is awarded the Fleet Commander's Commendation by Vice Admiral Jerry Kyd CBE

Lt S Hawthorn

Lt Hawthorn is awarded the Fleet Commander's Commendation by Vice Admiral Jerry Kyd CBE

Lt D M Hughes

Lt Hughes is awarded the Fleet Commander's Commendation by Vice Admiral Jerry Kyd CBE

POET(MESM) C M Jones

Lt Cdr H R Magill

Lt Cdr Magill is awarded theFleet Commander's Commendation by Vice Admiral Jerry Kyd CBE

LET(CIS) I B J Mayle

LET Mayle is awarded the Fleet Commander's Commendation by Vice Admiral Jerry Kyd CBE

CPOET(ME) A J Mitchell

Lt Cdr A J A Searle

POET(ME) K A Silk

PO Silk is awarded the Fleet Commander's Commendation by Vice Admiral Jerry Kyd CBE

POET(MESM) C B Warren

PO Warren is awarded the Fleet Commander's Commendation by Vice Admiral Jerry Kyd CBE

FLEET COMMANDER'S TEAM COMMENDATIONS

Marine Engineering Department, HMS Sutherland

JOINT COMMANDER'S COMMENDATIONS

WO1ET(ME) S M Ashmore

DEPUTY COMMANDER COMMANDO HELICOPTER FORCE SPECIAL COMMENDATION

CPO(AE) Michael Hart

CPO Hart with his commendation from Col Brown MBE

CPO(AE) Hart has had involvement in all that the engineering team have achieved in 847 NAS; determined, focused and driven, he is an ambassador for excellence within his field.

ROYAL NAVAL ENGINEERS' BENEVOLENT SOCIETY (RNEBS) ANNUAL PRIZE 2018

ET(ME) Joseph Wright

Rear Admiral Warrander presents ET(ME) Wright with the RNEBS Prize

Awarded to the top trainee who has achieved the highest academic results on ETICC over the course of the calendar year.

POAET(AV) Steele

Royal Naval Engineers' Benevolent Society Award (RNEBS) presented to POAET(AV) Steele by Mr Cliff Fiander

Awarded annually to the students completing POAET(AV) & (M) QC achieving the highest grades

POAET(M) Dunn

Royal Naval Engineers' Benevolent Society Award (RNEBS) presented to POAET(M) Dunn by Mr Cliff Fiander

Awarded annually to the students completing POAET(AV) & (M) QC achieving the highest grades

POAET(M) Wright (2017 Prize winner)

Royal Naval Engineers' Benevolent Society Award (RNEBS) presented to POAET(M) Wright by Mr Cliff Fiander

Awarded annually to the students completing POAET(AV) & (M) QC achieving the highest grades

INSTITUTE OF MECHANICAL ENGINEERING (IMECHE) ANNUAL PRIZE 2018

POET Maxey

Rear Admiral Warrander presents POET Maxey with the IMechE Annual Prize for 2018

Awarded annually to the trainee on POETQC (SM) and (GS) who has achieved academic excellence and demonstrated outstanding practical skills.

HENRY LEIGH CARSLAKE AWARD

HERBERT LOTT

Lt Cdr A Vance*
Lt Cdr M Howe
Awarded to any FAA RN and RNR personnel for the best article on the subject of the work and development of the FAA written between 1 Apr – 31 Mar. For 2018/19 this award is shared between 2 recipients owing to the distinct diversity and strength of both articles.

(*TNE Spring/Summer 2019, Vol 06, Edition No 2, The Cost of Human Factors)

ROLLS ROYCE EFFICIENCY TROPHY

845 NAS

Awarded annually to the NAS, flight or unit judged to have achieved the best overall standards of engineering efficiency and effectiveness.

COLLINGWOOD OFFICER'S ASSOCIATION SWORD

Lt Dave Haw

Lt Haw is presented the award by First Sea Lord Vice Admiral Tony Radakin CB, ADC

Collingwood Officer's Association Sword is presented to an Officer, below the rank of Commander, who has displayed the greatest Leadership potential during the preceding year. The sword is usually a refurbished sword belonging to a member of the Officers' Association. The 2019 award was donated by Capt Charles Crawford RN (Rtd).

THE ADMIRAL RUTHERFORD MEMORIAL TROPHY

HERBERT LOTT

POET(WE) Mark Lavery

POET(WE) Lavery is presented the award by Mr Sam Rutherford

Awarded to the rating who, during their POET(WE) Qualifying Course, has made the most significant progress during training in regards to developing leadership qualities, for unselfishness and contribution to the common good and for overcoming adversity in order to achieve success. The prize was presented by Admiral Rutherford's son, Sam, who travelled from Belgium to make the presentation.

THE ARMOURY PRIZE

WORSHIPFUL COMPANY OF ARMOURERS AND BRAZIERS

POET(WE) Baker

POET(WE) Baker is presented the award by Upper Warden Nicky Davis

The Armoury Prize is gifted by the Worshipful Company of Armourers and Braziers and is awarded to a trainee who has demonstrated outstanding leadership and/or has made a significant contribution to the benefit of the class, Training Group or MWS whilst on POET(WE) course. The prize consists of a £250 cheque, a medal and a certificate.

LET Cooke

LET Cooke is presented the award by Upper Warden Nicky Davis

The Armourer Prize is gifted by the Worshipful Company of Armourers and Braziers and is Awarded to a trainee who has demonstrated outstanding leadership and/or has made a significant contribution to the benefit of the class, Training Group or MWS whilst on LET(WE) course. The prize consists of a £250 cheque, a medal and a certificate.

THE LT CDR MICHAEL JAMES COLLINS SWORD PRIZE

SLt Simon Marr

The Lt Cdr Michael James Collins Sword Prize presented to SLt Marr by Rear Admiral Martin Connell

This is presented to the best Air Engineering Officer (Academically and Holistically) of all courses in the previous year inclusive of SEMC and Certificate of Competence Training.

THE LEONARDO SWORD PRIZE

LEONARDO HELICOPTERS

Lt Hana Rabuzin

The Leonardo sword prize presented to Lt Rabuzin, with Rear Admiral Martin Connell and Mr Steve Allen

This is awarded to the SEMC (AE) Graduate who on completion of Certificate of Competence has achieved the best overall results from both initial and professional training.

FLEET AIR ARM ASSOCIATION AWARD (FAAA)

LAET(AV) Helmore

Fleet Air Arm Association Award (FAAA) presented to LAET(AV) Helmore by Mr Brian Bingham

LAET(M) Barrett

Fleet Air Arm Association Award (FAAA) presented to LAET(M) Barrett by Mr Brian Bingham

For the best all round LAET(AV) & (M) through the academic year

INSTITUTE OF MECHANICAL ENGINEERS ANNUAL PRIZE (IMECHE)

POAET(M) Dunn

Institute of Mechanical Engineers Annual Prize presented to POAET(M) Dunn by Mrs Jill Dwyer

For the highest overall course mark on POAETQC

ROYAL NAVY CHARTERED ENGINEER OF THE YEAR

WORSHIPFUL COMPANY OF ENGINEERS

Lt Cdr Lee Packer

Lt Cdr Packer conceived the Duncan Den. This is a concept where successful ideas obtain funding and/or support. Entirely because of his drive, the number of ideas submitted grew from zero to 49. Lt Cdr Packer's achievements within his department and across HMS Duncan to nurture innovation and talent make him a worthy recipient of the RN CEng Award.

BARONESS PLATT OF WRITTLE AWARD

WORSHIPFUL COMPANY OF ENGINEERS

Lt Timothy Ward

Rear Admiral Jim Higham OBE, presents the Baroness Platt of Writtle Award to Lt Ward, pictured with the Master Engineer, Commodore (Retd) Barry Brooks RN. Photo courtesy of Mark Whitter Photography.

Lt Ward's work within his field is far reaching and he has proven management skills. He is involved in the local engineering community and encourages others to persue their engineering careers. This award was refocussed to recognise engineering excellence to those who achieve registration as Incorporated Engineer in the preceeding calendar year. Named for the Late Honorary Liveryman and Court Assistant Emeritus, The Baroness Platt of Writtle CBE FREng in recognition of her work in support of the Engineering profession in general and Incorporated Engineers in particular, the Award was first made in 2002. The Engineers' Company acknowledges the assistance of the Engineering Council and its partner Professional Engineering Institutions in selecting the winner.

THE VICE ADMIRAL WILDISH MEMORIAL PRIZE FOR ENGINEERING

LET(ME) Louis Martin

Dr Andrew Tyler CBE FREng, President IMarEST, presents the VAdm Wildish Memorial Prize to LET(ME) Martin, pictured with Rear Admiral Higham OBE and the Master Engineer, Commodore (Retd) Barry Brooks RN. Photo courtesy of Mark Whitter Photography.

Awarded to the member of any engineering department onboard HMS Prince of Wales (Air, Marine or Weapons) who has either created a new piece of equipment or technique to deal with a unique problem, solved a known problem in a more efficient way or used existing equipment or techniques in a new fashion to achieve a better result, demonstrating innovation in the face of adversity. In his first position as a leading hand LET(ME) Martin has displayed tremendous ingenuity and initiative.

THE COMMANDER MARINE ENGINEERING AWARD FOR OPERATIONAL ENGINEERING

WORSHIPFUL COMPANY OF ENGINEERS

CPO Richard Dover

Dr Andrew Tyler CBE FREng, President IMarEST, presents the Commander ME Award to CPO Dover, pictured with Rear Admiral Higham OBE and the Master Engineer, Commodore (Retd) Barry Brooks RN. Photo courtesy of Mark Whitter Photography

Awarded to the member of the Marine Engineering department onboard HMS Prince of Wales who has delivered an exceptional result against either significant operational or time pressure, and/or arduous conditions

The coordination of significant training has been concurrent to the daily activities that CPO Dover has had to support.

WEAPONS ENGINEER TRAINING GROUP OC'S COMMENDATION

Mr Philip Bull (BMT)

WEAPONS ENGINEER TRAINING GROUP OC'S EFFICIENCY PRIZE

PO Dave Turner

PO Turner is presented the award by Commander Jonathan Pearce, Officer Commanding the Weapon Engineering Training Group

FIRST FEMALE SUBMARINER ON FAST TRACK STREAM

ET(MESM) Jade Fraser

The first female submariner to be selected for fast-track Leading Engineering Technician Marine Engineering Submariner training, Jade completed 33 weeks of intensive training on the Engineering Technician Initial Career Course (ETICC) within the Defence College of Technical Training's Defence School of Marine Engineering at HMS Sultan.

MERCHANT NAVY MEDAL FOR MERITORIOUS SERVICE

Cdre(E) David Smith RFA

This is a State Award within the British Honours System. A maximum of 20 are awarded annually with recipients having to have spent a minimum of 20 years at sea and demonstrated exemplary service and devotion to duty, rewarding those who have set an outstanding example to others.

FIRST SEA LORD'S GREENWICH HOSPITAL PRIZE – JUNE 19

Cdr Adrian Coulthard

Cdr Coulthard received the award from Vice Admiral Tony Radakin

Over the past 26 years Commander Coulthard has played a vital part in the delivery of training at the Defence School of Marine Engineering at HMS Sultan, particularly in his role as Training Commander of the Gosport engineering school.

Lt Cdr K L Mehta

Lt Cdr Kim Mehta received the award from Vice Admiral Tony Radakin

Having nurtured thousands of Royal Navy engineers in Lt Cdr Mehta's 23 years as a Training Officer, she is commended for her tireless efforts to champion the cause of women in engineering. In her citation, it said her contribution "should not be underestimated" and her improved training regime delivered more effective marine engineers to the fleet.

HERBERT LOTT ENGINEERING TECHNICIAN PRIZE

HERBERT LOTT

ET Stephen McInerney

ET McInerney is presented the award by Commander Jonathan Pearce, Officer Commanding the Weapon Engineering Training Group

ROYAL ENGINEERING BENEVOLENT SOCIETY (RNEBS) SEMC PRIZE

SLt Gary Threapleton

SLt Threapleton is presented the award by Mr Mark Stevens of the Royal Engineering Benevolent Society (RNEBS)

ROYAL ENGINEERING BENEVOLENT SOCIETY (RNEBS) POET PRIZE

SPO James Dickens

SPO Dickens is presented the award by Mr Mark Stevens of the Royal Engineering Benevolent Society (RNEBS)

SYSTEM ENGINEERING AND MANAGEMENT COURSE (SEMC) PRIZE

ARMED FORCES COMMUNICATIONS AND ELECTRONICS ASSOCIATION (AFCEA)

SLt Victoria Cox

SLt Cox is presented the award by Mr Andrew Stewart of the Armed Forces Communications and Electronics Association (AFCEA)

REAR ADMIRAL BATESON AWARD FOR WEAPON ENGINEERING EXCELLENCE

THE INSTITUTION OF ENGINEERING AND TECHNOLOGY (IET)

PO Green

PO Green is presented the award by HRH Prince Edward, Duke of Kent, KG GCMG GCVO CD ADC

Due to an error in the previous edition the following three awards have been corrected and republished.

MERITORIOUS SERVICE MEDAL

WO1 Nicholas Ullett

WO1 Ullett is awarded the MSM by Vice Admiral Tony Radakin

CPOAET(AV) J M Nourse

CPOAET(AV) Nourse is awarded her MSM by Vice Admiral Tony Radakin

SECOND SEA LORD'S COMMENDATIONS

Lt Cdr L E Cairney

Lt Cdr Cairney is presented her award by Vice Admiral Tony Radakin

Engineering the Supply Chain

By Lt Cdr Jerome Pethrick BEng (Hons) BA MSc CEng MIMechE FIKE GCGI RN, MARCAP DARE Team

There is a perception, that operation of Unmanned Systems is a new activity for the Royal Navy. However, UAVs have been operating from Royal Navy warships for almost as long as manned aviation. In 1933, a UAV was launched from HMS Valiant[1] and operated for the purpose of training her anti-aircraft gunners in how to account for aircraft movement and train their weapons. The aircraft was a Fairey IIIF light bomber which was converted for radio control. The name given to the aircraft post modification was the Fairey Queen, which started the process by which British target UAVs were pre or post ceded by the word Queen.

Further drone aircraft were generated and proved very useful for the calibration of the then nascent radio detection and ranging[2] being developed by Watson-Watt as part of the home chain system used by Fighter Command in the 1940s. Most of the aircraft types were converted trainer aircraft such as the ubiquitous Tiger Moth which was named Queen Bee. The use of Queen Bee thereby generated the term 'Drone,' which has persisted ever since. The utility of UAVs to simulate threats has a long history which, with the DARE team, is now continuing.

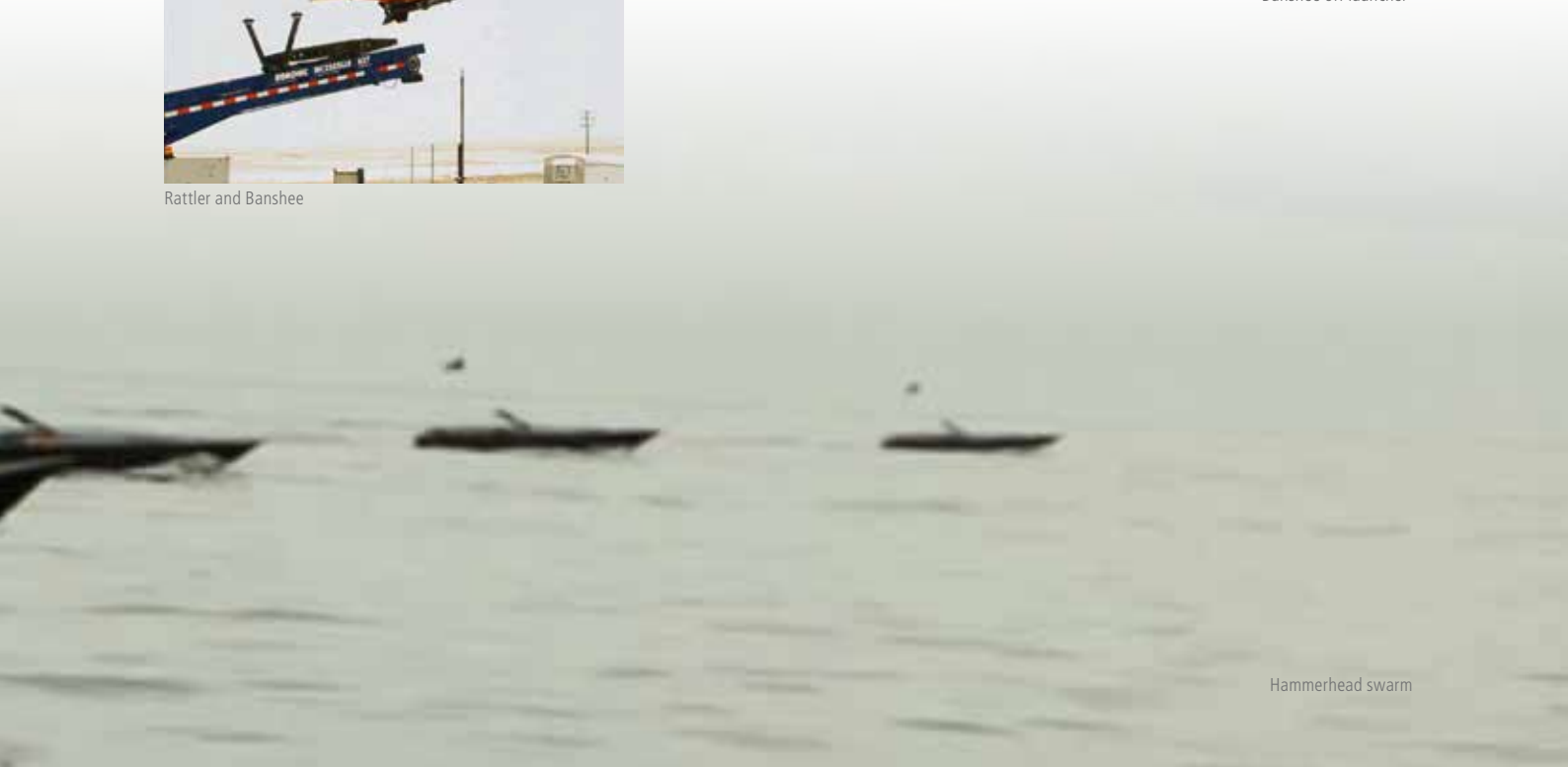
The Royal Navy has taken a significant step forward in this area, working with QinetiQ to integrate the Banshee jet powered UAV[3] and the Rattler missile system onto weapons ranges used by HM Ships. Current threat simulation missiles are land launched and have a limited profile, providing a fast-moving threat from a known threat direction and along a predictable profile. This combination of the Banshee UAV and the Rattler missile opens significant possibilities for increasing the degree of realism provided for ships training in these ranges. A potential profile would be the launch of a Banshee UAV wave of up to four systems. These can then approach a task group from various points in the compass at high and low level.
The Banshee has a radar altimeter allowing a sea skimming approach to be made to present a challenging target. On command, the Banshees pull up and launch their Rattler missiles which can be setup to simulate the attack profile and radar cross section of several representative hostile missiles.
These missiles are GPS guided to a point in the safety trace. The profile will allow a Mach 2+ approach to the target area from various altitudes and on different directions. This will provide realistic training for air defence and point defence system operators by providing a variable and evolving threat set. The use of the Banshee UAV allows the launch system to be reusable and to be re-task able up until the simulation round is fired. This is a far more cost-effective way of providing an air to surface simulation rather than using more powerful and thus more expensive land launched systems or air launched systems with the associated manned aircraft launch costs. The Banshee has an endurance of over an 1hr 30 mins.

Whilst the air battle is developing overhead with Rattler missiles being launched towards the task group, the surface battle is also subject to drone attack, with up to eight Hammerhead Unmanned Surface Vessels conducting swarm attack. This can be setup to reflect tactics used by hostile nations in locations such as maritime choke points. Four USVs can be controlled from a single ground control unit, however two is more common, in order to fully utilise the acceleration, speed and agility of the system. The Hammerheads can make 35 kts, in sea state 3, whilst manoeuvring. The Hammerheads are disposable assets that can be engaged and destroyed allowing a full end to end engagement. However, they can also be equipped with towed inflatable targets, allowing these to be engaged, thus significantly reducing the cost of engagement.

1 HMS Valiant was a Queen Elizabeth Class Battleship with 15" guns.
2 RADAR development relied heavily on Gyroscopes and UAVs as a method of producing predictable flights paths to tune receivers and to train operators.
3 The Banshee variant used is the Jet 80 variant powered by twin 40Kg thrust gas turbines.

Banshee off launcher

Rattler and Banshee



Hammerhead swarm

The Hammerheads themselves can be used to simulate heavy machine gun fire, missile launches, and decoy launches. The radar cross section can also be enhanced allowing much larger ships to be simulated, Thereby, significantly increasing the number of scenarios that can be put together for training purposes.

The upper deck crew served weapons teams are however, more able to handle these fast-moving threats as the DARE demonstrated POINTER, upper deck weapons system trainer, has been now funded by FOST and taken into core. This system provides a holographic display for the operator and feedback from the weapons mount location to provide command with the bearing of all upper deck weapons allowing better co-ordination of a ship's fire power. This system can be integrated quickly onto ships undertaking gunnery evolutions during FOST.

DARE: Discovery, Assessment and Rapid Exploitation

Hammerhead being shot

Rattler

DARE has also assisted in work to assess the performance of the 4.5" gun by using two radars to very accurately track the fall of shot. This work remains ongoing.

DARE continues to work with 700X NAS on a number of UAVs from small tactical systems designed to look around the next corner, to larger area survey that looks into the next village and then beyond to the next valley. These now include both free flying and now tethered systems. In the above examples autonomy is being used to enhance the effectiveness of existing systems. The RN continues to push forward with autonomy and DARE is at the forefront of delivering and developing these for the frontline.

The DARE Team is situated within the MarCap division of Navy Command, responsible for the development of future naval capability. DARE's mission is, *"to energise and accelerate innovation throughout the Naval Service in order to support operational capability."*

Lieutenant Commander Jerome Pethrick

Lt Cdr Jerome Pethrick read Aerospace Engineering at Glasgow University and Aerospace vehicle design at Cranfield University and went on to be a stress engineer, working on most of the Airbus narrow and wide-bodied fleet including the A380 airliner type certification. He joined the Navy in 2005 and completed tours on Harrier, 1710 NAS, Merlin PT, Unmanned Air Systems Team and was AEO of 820 NAS. He is currently in the MARCAP DARE team.

By Keri Watson, Comms Cost C2, NCHQ

Project Lewis – The Naval Service Cost Consciousness Initiative

What is Project Lewis?

Project Lewis was created from the Consumables Cost Consciousness idea submitted to the RN Dragon's Den. The aim of the Project is to raise awareness of the RN's spend on consumables, engage the Naval Service in challenging prices and wasteful behaviours and adopt a cultural change in reducing waste. Changing behaviours is a difficult task in an organisation as large as ours and it will take time. This project over time has grown and now covers 43 lines of development and 9 individual programmes covering Policy, Consumption, Returns, Controls, Consolidated Allowance List, Training, Communications and Resources and Governance.

The RN currently spends approximately £112M each year on consumable items. It is estimated that millions of pounds of this is wasted because of poor management of demands and unnecessary wastage. The Royal Navy is a growing organisation and with the introduction of the carriers and the T26s and T31s following closely behind, these figures will only continue to rise if we do nothing about it.

How can you as engineers help?

- The Project Lewis team have been sharing data with you regarding your consumables spend and asking questions regarding large cost or large quantity items. Be sure to engage with the team to weed out anything that might have been unnecessary.
- A1 consumables (items in their original packaging) can be put into the chacons found around the base at HMNB Devonport, where the Naval Base Storekeeper will return these items via the Reverse Supply Chain process for you. You are not required to complete any paperwork. HMNB Portsmouth and HMNB Clyde will also have this facility in the near future. In the first year of this returns programme being run in HMNB Devonport £1.5M of A1 stock was returned onto the system.

- Are you ordering "just in case" stock? Stop! We need to adopt better demand behaviours and reduce our unnecessary consumption costs.
- Be cost conscious. Do you think a consumable item is worth what we're paying for it? Challenge this. You know what these items do and what they're used for. This is an ideal opportunity for Engineers to actively make a difference. We need more involvement by Engineers to challenge items which we are not receiving value for money for.
- Don't say "it's not my money" – it is. Every penny we spend is funded by the UK tax payer (ie you) and is money we cannot spend on other areas of support in the RN.

If you have any innovative ideas for saving money or would like to challenge prices, your first points of contact are:
keri.watson546@mod.gov.uk or
charlotte.kingman100@mod.gov.uk
You can also contact the Fleet Logs Officer team via their **DefNet page**.

"Today's wastage is tomorrow's shortage"

Keri Watson

Keri Watson has a 20 year career in the MOD. Starting her career as a Storekeeper (Logistics), Keri then changed direction into Finance Two years ago, she returned to her first love of Logistics. Project Lewis was borne from an idea pitched in the Navy's 'Dragon's Den', with the idea of saving money spent on consumables. Keri was recruited to take this forward. Keri relished the challenge of trying to find ideas and ways of encouraging others to save money. Making people more aware of the cost of items by sharing data and changing peoples behaviours has been a challenge, but she continues to carry the momentum forward. Now making good progress with Logistics, Keri is keen to engage and carry the good work forward with Engineers engagement.

wes

TRANSFORM THE FUTURE,
CELEBRATE THE PRESENT,
REMEMBER THE PAST

WOMEN'S ENGINEERING SOCIETY
CELEBRATING 100 YEARS

www.wes.org.uk

WES was founded on 23 June 1919 by a small committee drawn from the National Council of Women, which was created during the 1914-18 war to get women into work to release men for the armed forces. This group of influential women had government backing to support women engineers who, although welcomed into the profession during World War 1, were under pressure at the end of the war to leave the workforce to release jobs for men returning from the forces. These women founded WES, not only to resist this pressure, but also to promote engineering as a rewarding job for women as well as men.

Founding members included wives of eminent engineers for example Lady Katharine Parsons, wife of Sir Charles. Famous members since then have included Amy Johnson, Dame Caroline Haslett, and Professor Daphne Jackson.

Dame Caroline Haslett

First WES Secretary, 1919

Amy Johnson CBE

The pioneering English female pilot who was the **first** woman to fly solo from London to Australia born 1 July 1903, disappeared 5 January 1941
WES President 1935–1937

Beatrice 'Tilly' Shilling

invented an adaption to Spitfire and Merlin engines (nicknamed Miss Shilling's Orifice by the RAF) which stopped the engines flooding during manoeuvres, preventing the aircrafts from crashing

Blanche Thorneycroft

One of the **first** three woman to become a member of the Royal Institution of Naval Architects in 1919

Laura Annie Wilson

One of the founding members of the Women's Engineering Society and was the **first** female member of the Federation of House Builders

Verena Winifred Holmes

The **first** Woman Member elected to the Institution of Mechnical Engineers. An Early Member of WES and its president in 1931

Founded on 23 June 1919

Women's Engineering Society

Dr Elizabeth Laverick OBE

the **first** woman to receive a PhD in a scientific curriculum

Diversity matters:

Companies are **15%** more likely to perform better if they are gender diverse*

Over 7% of Engineering
apprentices are Female

Engineering students are second only to medics in securing full-time jobs & earning good salaries*

Naomi Climer CBE FREng FIET
The **first** female President of the Institution of Engineering and Technology (IET)

79.8% of Female

engineering students get a First or Upper Second, compared to 74.6% of male students*

60.7% of Female
engineering graduates enter full-time work*

Dame Ann Dowling
The **first** female President of the Royal Academy of Engineering from 2014–2019. She is a Patron of the Women's Engineering Society

Dawn Childs
CEng FICE FIMechE FRAeS FWES RAF (rtd.)
Current and 54th WES President

TRANSFORM THE FUTURE, CELEBRATE THE PRESENT, REMEMBER THE PAST

2019 is The Women's Engineering Society Centenary year. Throughout 2019 there will be events, projects and campaigns linked to their three themes: celebrating the present, remembering the past, transform the future.

To get involved email: **info@wes.org.uk**

www.wes.org.uk

100 YEARS OF THE WOMEN'S ENGINEERING SOCIETY

1919 WES Formed

1924 Electrical Association for Women (EAW)

1942 Amy Johnson Memorial Fund

1955 British Women Pilots Association

1969 Women in Engineering Year (WES 50th anniversary)

1969 Verena Holmes Trust and Lecture Series

1984 WISE Set up (Women in Science and Engineering)

1985 Daphne Jackson Trust Returners Fellowships Pilot

1991 Lady Finniston Awards

1991 ICWES 9 in UK

1998 Karen Burt Award

2000 WES Prize Established for Young Woman Engineer

2001 INWES founded with WES as founder members

2002 MentorSET mentoring scheme

2006 Doris Gray Award

2014 National Women in Engineering Day

2017 International Women in Engineering Day launched

2019 WES Centenary!

100 years after the WES' foundation was formed, an interactive Centenary Trail Map has been created at wes.org/centenary-map celebrating the people and places that have played a key part in the organisation's history.

12.37%
of all engineers are women in the UK*

23 June 2014
National Women in Engineering Day celebrated for the first time – now International Women in Engineering Day (INWED)

*All quotes sourced from https://www.wes.org.uk/content/wesstatistics. PHOTOS: Courtesy of IET Archives, WES and RN Photo Library