



Ministry
of Defence

Defence Science

The magazine for Science, Technology and Engineering

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**Defence Growth
Partnership**
Working Together for
Growth and Prosperity – p4

**Support for the UK's
Deterrent System**
Past and Future – p12

**Learning from the
Ebola Crisis**
Training to Save Lives
in West Africa – p25

**Defence Science and
Technology at Porton Down:
Meet the Scientists –p17**

Defence Science (formerly Defence Codex) magazine

The new magazine for anyone
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Star Tech
Into the future with AWE's
Orion high power laser



BLAST
Collaboration increases
understanding of blast injuries



Ministry of Defence

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Supporting innovation for security and growth

The past few years have been dominated by the need to support operations in Afghanistan. Although military engagements have now ceased, the Ministry of Defence (MOD) and the Armed Forces remain fully engaged in world events, and the defence community – industry, academia, small and medium-sized businesses and others – continue to collaborate to help make the world a safer place.

The role of science and technology is broad and multifaceted, from deployed scientists on the front line through to those designing future platforms or supporting policy and capability decisions. To maintain our technological advantage and competitiveness for the future, we must adapt our approach to innovation today, by developing new partnerships in those technology areas where the non-traditional commercial sector is leading. We also need to position the UK for growth by pairing the opportunities of emerging technologies, such as quantum, big data and autonomy and robotics, with the future strategic challenges for Defence.

In my frequent interactions with the United States I am proud to see, at the most senior level, how they use and value our work – including nuclear warhead stewardship, chemical and biological threat reduction and support to Joint Strike Fighter, to highlight a few.

This issue highlights recent innovations in defence science and technology and looks at some of the ways the UK government funds and supports innovation – responding to rapidly evolving threats, improving value for money and supporting growth in the UK economy.

I remain committed to ensuring that we focus on the longer-term and making sure that innovation remains at the heart of Defence science and technology, so that we continue to have the right people, in appropriate partnerships, working at the right pace.

We look forward to continuing to bring you news of the latest developments in defence science and welcome your views and suggestions.

**MOD Chief Scientific Adviser,
Professor Vernon Gibson FRS**



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MOD Science Capability Review

The effectiveness and efficiency of the UK's Armed Forces depends on defence harnessing the most advanced science and technology.

The recent Science Capability Review commissioned by MOD and led by Government Chief Scientific Adviser Sir Mark Walport, confirmed that the work and output of defence science and technology is of 'high quality'.

The widespread review was a comprehensive examination of MOD's broad science and technology needs and its ability to meet them from its own resources, and the national and the global science base. The review used the expertise of independent academics, as well as civilian and military staff from within MOD, to make observations on specific S&T Capability and broad recommendations on possibilities for the future.

The review made a series of high-level recommendations to improve the process of how science and technology is delivered – both now and into the future.

Functions will be established and led by the MOD's Chief Scientific Adviser, to provide improved commissioning and governance.

The day-to-day interface with suppliers will be largely unaffected – there should be no change in existing contracts – and Dstl will continue to run the majority of commercial competitions and place subsequent contracts.

There will be better alignment of the S&T Programme to MOD's future capability needs and decisions on procurement options will be taken more strategically – taking account of the capability and capacity of the S&T supply base across government, industry and academics.

At the heart of this work is the strongly held view that science and technology has, does and will continue to contribute an essential role in the defence and security of the UK.

Any changes will bring an even closer alignment of the work being undertaken by research suppliers and partners with the future direction of UK Defence and Security.

Defence Growth Partnership

Collaboration for growth and success

What is the Defence Growth Partnership?

The Defence Growth Partnership (DGP) was set up by the Prime Minister in 2012 as a forum for the Government, UK's top defence companies, defence trade associations and small and medium-sized enterprises (SMEs) to work together for growth.

"The Defence Growth Partnership sets us and industry a joint challenge to deliver a long-term strategic vision to maintain our position on the leader board – maximising opportunities for British business and further strengthening the economy."

Prime Minister, David Cameron. September 2013.

How will the UK benefit from the DGP?

The long-term partnership between government and industry will maximise new opportunities for exports and inward investment, support new skills and generate new

jobs in companies of all sizes. The DGP highlights the UK's strongest core areas, which offer the greatest opportunity for growth, both at home and overseas.

Who is involved?

The DGP is co-chaired by the Minister for Small Business, Industry and Enterprise, Anna Soubry, and Industry co-chair, Steve Wadey. Minister of State for Defence Procurement, Philip Dunne, sits on the DGP Ministerial committee.

Vision

The Defence Growth Partnership will secure a thriving UK Defence Sector delivering security, growth and prosperity for our nation.

What will the DGP do?

The DGP's core objectives are to grow the UK's global market share through increased exports, by encouraging and supporting greater collaboration and innovation. This will bring products and services to market that

will better meet customer needs and improve competitiveness.

How will the DGP achieve this?

By taking a fresh and ambitious approach! Government and the Defence Industry are committed to working together to develop new opportunities, including building on the UK's strengths in air capabilities and intelligent systems – delivering growth through innovative and tailored solutions for customers around the globe.

How can industry get involved?

As a government-industry partnership, the DGP is an opportunity for companies at all levels to get involved, contributing towards UK growth and prosperity – from Prime Contractors to SMEs, engagement from a broad base of participants is crucial to the DGP strategic vision. ■

■ www.defencegrowthpartnership.co.uk



From vision to reality...

Steve Wadey, Industry Co-Chair of the Defence Growth Partnership reflects on early success and looks forward to the future.

In September 2013, the Defence Growth Partnership (DGP) set out its vision and strategy for the UK Defence Sector – to secure a thriving UK Defence Sector, delivering security, growth and prosperity for the UK.

To achieve this vision, government and industry are working in partnership and last year launched the DGP Implementation Plan at the Farnborough International Airshow. We launched the DGP with a very clear vision, and I am delighted how the measures outlined in our implementation plan have been delivered. There can be no better validation for government and industry working together, than the success achieved so far; it means we are in a strong position to tackle the challenges ahead and build momentum. What has been delivered through the DGP isn't simply the result of a great deal of hard work, but the willingness of many individuals and organisations to work in an exciting way which challenges the norm and extracts as much potential as possible from across the industry.

With a turnover of £22bn annually, the UK's defence industry makes a valuable contribution to the national economy. This financial success plays an integral role in underpinning national security, enabling industry to invest in the innovation and technological development needed by the UK's armed forces and security agencies.

There are few other sectors that make such an important contribution to two such distinct, but vital aspects of British life: security and the economy. This is why sustaining the UK defence sector to provide the equipment and services our forces need, and helping national



prosperity through increasing our share of global market opportunities is so important.

Through the DGP, UK defence industry is in a stronger position to identify new customers, engage with them effectively and meet their requirements with innovative, tailored solutions.

Earlier this year, the UK Defence Solutions Centre (UK DSC) opened in Farnborough – a key DGP initiative which has been developed to bring the best of UK capability to the

international market. This is a major milestone for the DGP, attracting the very best minds from across industry to work collaboratively with customers from around the globe in developing next-generation capabilities and services. It is an innovative and very exciting way to work, and it signals to international customers that the UK is focused on delivering solutions in a wholly innovative way, with a comprehensive oversight of the UK's industrial base.

Photo 1 –
Steve Wadey

Supporting the UK DSC through strategic customer engagement is the strengthened UK Trade and Investment (UKTI) Defence and Security Organisation (DSO). The UKTI DSO is strengthened by taking resources from industry to provide more horizon scanning market intelligence and analysis that will aid decision making on international defence export opportunities and capability development.

Focus on strengths

It means a more collaborative industry and government overview of long-term opportunities for the UK, and that valuable insight will be coordinated through UKTI DSO and the UK Defence Solutions Centre (DSC.)

The Defence Growth Partnership has also delivered other market-led growth projects focused on UK national strengths in intelligent systems and air capabilities. Within air capabilities, the DGP is undertaking studies on growth opportunities in Unmanned Air Systems and Synthetic Operational Training; a programme being transitioned through the UK DSC.

Last November, the DGP officially opened the Centre for Maritime Intelligent Systems (CMIS) in Portsmouth, where world-leading capability in next-generation maritime intelligent systems will be developed. The Centre is also creating an initial programme for a Maritime Autonomous Systems Demonstrator, supported by funding from the Solent Local Enterprise Partnership and the alignment of around £1million of MOD's Science and Technology spending.

Through the DGP we are able to engage the complete value chain. The UK's SMEs are often at the heart of breakthrough innovation; as well as being able to present this vibrant industrial base to international customers, wider industry gains from access to this valuable source of ingenuity. We are keen for organisations – large and small – to identify how they can be part of this.

Competitions and challenges

As part of the opening of the UK DSC, the Minister of State for Defence Procurement, Philip Dunne, announced a £10m 'DGP Innovation Challenge'. Funded by the MOD and run by the UK DSC, the challenge involves a series of competitions, largely aimed at the SMEs, which are focused on identifying next-generation solutions and technology to meet 21st Century global defence needs. The winners of the first competitions will be announced at this year's Defence and Security Equipment International exhibition (DSEI) in London.

The Government has been very clear on its commitment to boosting productivity and it recognises the importance of long-term investment in research and development, skills and exports to improving productivity. The Innovation Challenge is designed to foster the ingenuity that will bring about a step-change in technology, solutions and services, all of which will enable the UK to compete effectively.

Through the DGP, UK industry is better placed than ever to secure its share of international market opportunities. Nowhere else can provide global customers with a coordinated response to identifying their needs and delivering bespoke solutions.

DSEI is an important opportunity for organisations throughout the value chain to engage more effectively with the Defence Growth Partnership; momentum is likely to increase as we head to next year's Farnborough International Airshow. ■

Through the DGP, UK industry is better placed than ever to secure its share of international market opportunities.

Defence Growth Partnership Innovation Challenge

Minister for Defence Procurement Philip Dunne launched a £10 million Innovation Challenge earlier this year.

The competition is managed by the UK Defence Solutions Centre, supported by the Centre for Defence Enterprise.

The Innovation Challenge is looking for next-generation solutions and technology to meet future global defence needs and invites ideas from across the entire value chain and academia.

UK Defence Solutions Centre open for business

The Defence Growth Partnership (DGP) appointed Steve Brittan to lead the UK Defence Solutions Centre (UK DSC) earlier this year. He is already settled at their Farnborough base and relishing his role at UK DSC, describing the DSC as ‘unique’ – bringing together highly skilled specialists to develop innovative products and services for defence customers. Wendy Jacob travelled to Farnborough to find out more about the ambition of this new asset for UK defence.



With an impressive background – a degree in Electronics and Electronic Engineering, experience working with MOD and industry, and most recently starting up a cyber security small and medium sized enterprise (SME), Steve Brittan is not only bringing experience, but also energy and determination to the UK Defence Solutions Centre (UK DSC) “At my heart, I am an innovator and committed to promoting innovation” says Brittan.

“The UK Defence Solutions Centre is the first organisation of its kind, enabling UK industry as a whole to be able to respond to customers’ needs. And we are harnessing the skills and talent that will make this work”.

UK DSC is at the heart of the Defence Growth Partnership (DGP) and an industry-first, aiming to provide solutions to defence challenges faced by international customers, by engaging across the entire defence sector – from large multinational primes to SMEs as well as academia and technologists.

“I think the key output of the UK DSC is to promote innovation across the defence industry, as well as the

government. We are in a very competitive environment and our future prosperity and success rests on innovation as the output of everything we do” explains Brittan. “Part of our job is to understand the environment in which we are operating internationally – understanding key drivers and trends across the international arena, as well as understanding what is happening in the international landscape.”

UK DSC brings together experts to work collaboratively to deliver tailored services and products to meet the long-term requirements for international customers. The UK is a world-leader in delivering innovation and is Europe’s largest exporter for defence equipment and services (second only to the United States) contributing £8.2 billion gross value a year to the UK economy, with 87 per cent of companies generating revenue through exports. Brittan believes that there are even more opportunities for future growth. “The UK DSC is an innovation cluster funded partly by the Department of Business Innovation and Skills (BIS), and investment by the DGP

companies and in essence, our job is to operate at a strategic level, taking a longer term view of how the UK defence industry, in partnership with government, needs to evolve, grow and become more competitive and innovative. We take a helicopter view of what the critical success factors will be for us in the markets in which we operate.”

“Our job is to be at a strategic level, taking a longer term view of how the UK defence industry, in partnership with government, needs to evolve, grow, and become more competitive and innovative.”

Steve Brittan

The UK DSC is a partnership between government and industry – BIS providing £5.4 million and industry providing people to support the Centre. It has a permanent central core of staff – around 35 people – operating independently of the partner companies. As a centre for coordinating strategic planning,



Photo 1 –
Defence Minister Philip Dunne, tries a flight simulator at the new centre.

it is working with a wide range of partners, and is developing business cases that will meet the challenges of a changing economic environment.

The UK DSC will be the friend of innovation, harness the entire value-chain and act as Britain's showcase to our international partners and customers.

Minister for Defence, Equipment Support and Technology Philip Dunne

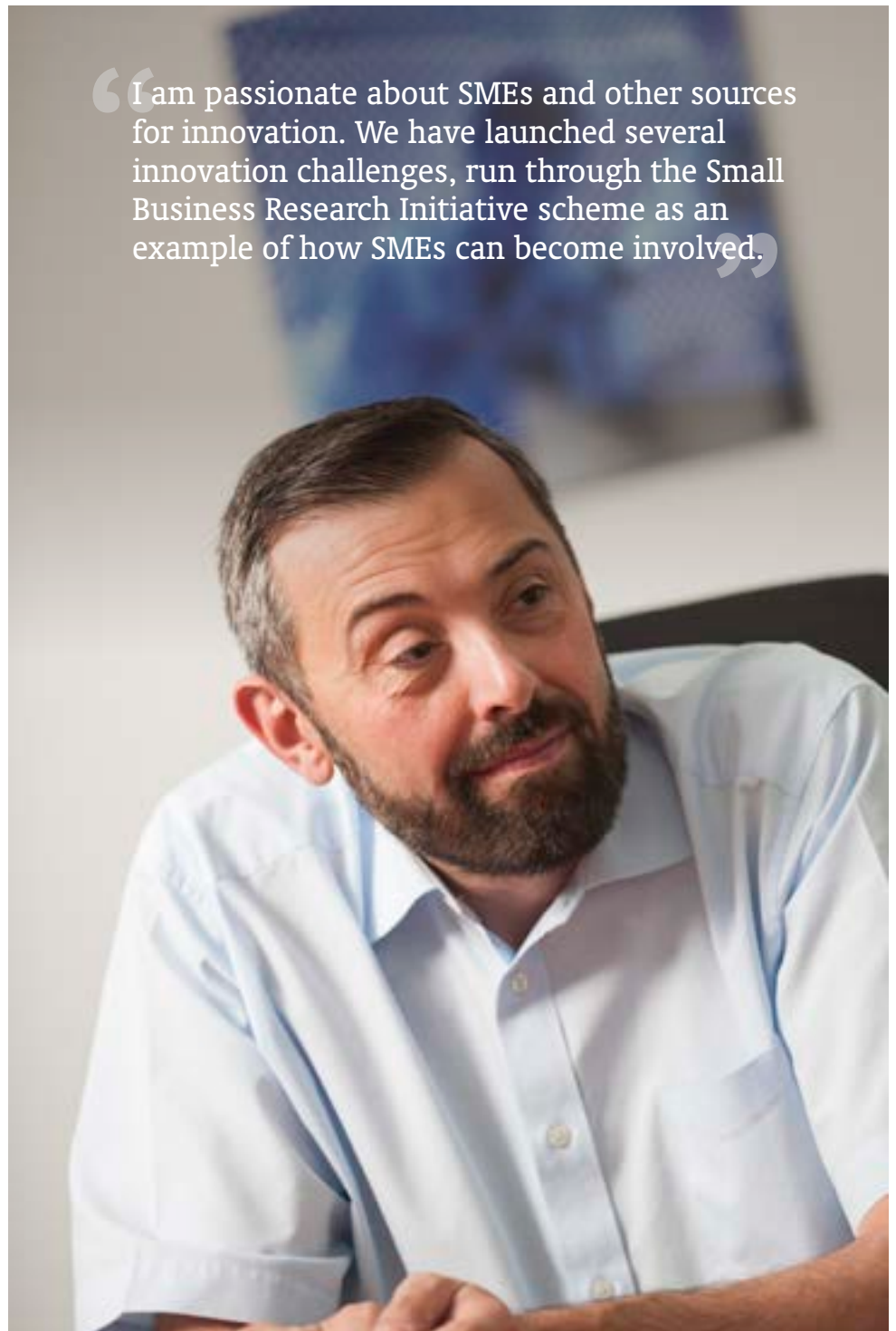
The UK DSC was officially opened in March 2015 by Minister of State for Small Business Industry and Enterprise, Matthew Hancock; and Minister for Defence, Equipment Support and Technology, Philip Dunne; who heralded the event as an important milestone for the DGP, saying "this spearheads a new approach to the way we develop defence capability in the UK. The UK DSC will be the friend of innovation, harness the entire value-chain and act as Britain's showcase to our international partners and customers."

Brittan points to his world-leading team as being the main asset of the Centre, saying that the spirit of co-operation makes it a very exciting place to be at the moment. "We have the experience, ingenuity and insight, and together we will make the UK DSC the place to understand and explore the needs of defence customers, and tailor solutions to meet these needs, both in the UK and abroad".

Open to involvement from organisations across a range of sectors, the UK DSC aims to 'unlock' the UK's wider industrial infrastructure in help maximise research and development opportunities, manufacturing support, expertise and capability. Brittan says that they already have SMEs involved in projects and studies that are underway. "I am passionate about SMEs and other

sources for innovation. We have launched several innovation challenges, run through the Small Business Research Initiative scheme as an example of how SMEs can become involved. These challenges are seeking innovative solutions to a number of defence problems for the future – providing opportunities to take these solutions to international markets." ■

"I am passionate about SMEs and other sources for innovation. We have launched several innovation challenges, run through the Small Business Research Initiative scheme as an example of how SMEs can become involved."



Small Business Research Initiative helps MOD harness innovation and save costs

All government departments face challenges and are looking for new ideas and to engage with suppliers to develop solutions for present and future challenges. Step forward the Small Business Research Initiative (SBRI) – the quick, simple and well-established process that works with innovators to develop innovative products and services for government departments and public sector bodies.

 **The SBRI is helping MOD tap into new ideas and technologies, and adopt new technology.** This is bringing benefits to both sides – finding solutions to challenges and improving efficiency for the department, and in return, helping businesses to grow, by providing finance to develop their innovative ideas.

SBRI competitions create opportunities for innovators to engage with MOD and prove their technology or idea. Successful

applicants gain a new customer for the development of their solutions, whilst still retaining their intellectual property rights. The business receives a contract for the full cost of demonstrating the feasibility of their technology and the opportunity for subsequent funding for prototype development. This provides a reliable source of early-stage funding, a potential route to market and establishes credibility for further investment. Any organisation can submit an application that addresses a challenge.


The structure of the scheme is particularly beneficial to early-stage companies and small and medium-sized enterprises (SMEs). ■

■ www.sbri.innovateuk.org



Cutting carbon in the military

A UK start-up company has developed a wind turbine inspired by traditional sailing technology, which they estimate could save the British Army up to £950,000 in fuel costs over five years. The turbine uses vertically mounted sails to generate power and works in much the same way as sailing a boat in a circle.

 **The first prototype was part-funded by a collaborative initiative with the MOD and the Technology Strategy Board using the SBRI process.**

Tradewind Turbines, based in Devon, responded to a Centre for Defence Enterprise (CDE) call – “The Self Sustaining Forward Operating Base” – seeking new technology that could help the UK’s Armed Forces reduce its use of fossil fuels. The

challenge was to reduce the energy requirements of a military base by providing an alternative to diesel generators without compromising the effectiveness of their operations.

While the use of sails to capture energy is not new, what makes the technology unique is the ability to control the amount of sail area. The Tradewind turbine uses flexible materials and rigging which allows


it to handle strong winds and gusts. It is also exceptionally quiet.

This unique installation technology means that the turbine can be used in temporary bases anywhere in the world and could also be a useful tool for aid agencies to provide emergency power quickly and efficiently during disaster relief operations. ■

■ www.tradewindturbines.com

Getting oxygen to the frontline

In October 2009 MOD announced a call for proposals for innovative research into battlefield medical technology, with the aim of providing the best possible care to injured personnel – either retaining them in service, or minimising disability on discharge. Collaboration across government and defence meant that the Centre for Defence Enterprise (CDE) worked jointly with the Surgeon General’s Department to support a competition as part of the Small Business Research Initiative (SBRI) scheme. Proposals for the Battlefield Medical Technology programme were invited from industry and academia, offering a total of up to £400k for research lasting up to 12 months.

 **Cambridge Design Partnership (CDP) designed a lightweight portable oxygen generator that could save lives on the front line.**

Earlier research, undertaken by the Defence Science and Technology Laboratory (Dstl), showed that administering oxygen to soldiers within minutes of injury can dramatically increase their survival rates by ‘buying’ crucial extra time before they can be evacuated. This triggered a CDE call, inviting organisations to identify potential lightweight solutions.

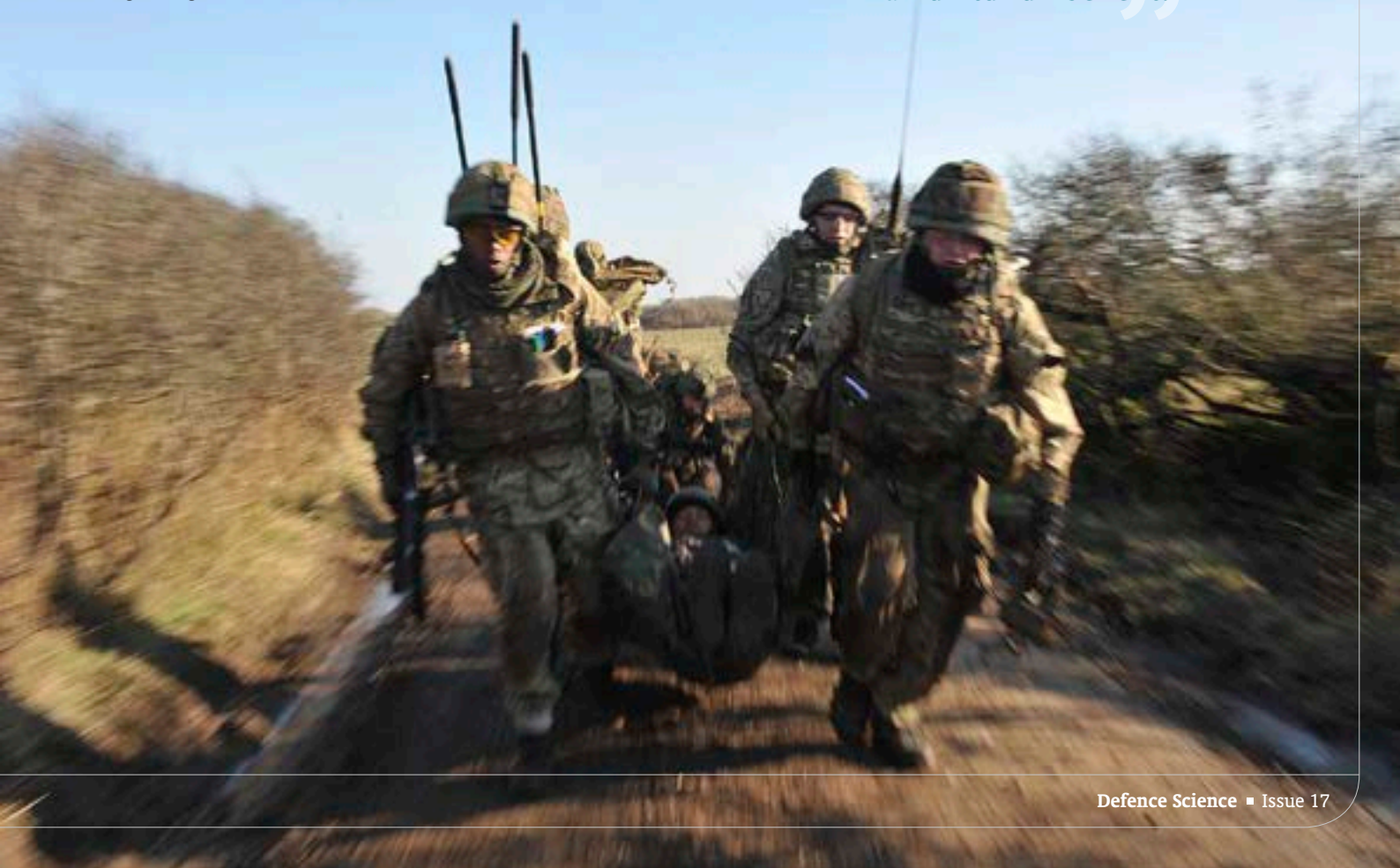
Oxygen delivery to casualties relies on heavy, pressurised cylinders, which are dangerous and bulky to transport. Although portable oxygen generators exist, they need large, heavy batteries and consume a lot of power.

CDP was awarded £70k through CDE to develop the new oxygen generator which weighs just 3kg compared to 9kg for existing battery powered generators – running for five hours compared to one for current models. A key part of the

research included consultations with MOD medical specialists and soldiers, demonstrating a great example of government acting as a lead customer. ■

■ www.cambridge-design.co.uk

“Investment under the SBRI scheme has catalysed an innovation process with considerable military and humanitarian benefit.”





Supporting the UK's Deterrent – past and future

One of the Navy's four strategic submarines is always on patrol, ensuring a continuous at-sea deterrent, carrying the nation's ultimate weapon somewhere in the Seven Seas. The Vanguard-class submarines began their mission in the late 1960s and since April 1969, the Royal Navy's ballistic missile boats have not missed a single day on patrol.

 **The Atomic Weapons Establishment (AWE) has been providing and maintaining Trident's nuclear warheads for more than 60 years, working across the entire life cycle of warheads – everything, from initial concept and design, to manufacture and assembly, in-service support, and finally decommissioning and disposal, ensuring maximum safety and protecting national security at all times.**

It is also AWE's responsibility to maintain the capability to produce a successor system if one is required in the future.

Their nuclear know-how and technical expertise also helps the Government develop and deliver a range of innovative and integrated support services, including national nuclear security and counter-terrorism solutions.

A unique scientific challenge

The UK is a signatory to the Comprehensive Nuclear-Test-Ban Treaty (CTBT), which bans nuclear explosions by everyone, everywhere – on the Earth's surface, in the atmosphere, underwater and underground.

AWE invests in cutting-edge science and computational methodologies to verify the safety and effectiveness of the warhead stockpile. Their unique expertise also supports international arms control treaties, including the Non-Proliferation Treaty (NPT) with the objective of preventing the spread of nuclear weapons and weapons technology, promoting cooperation in the peaceful uses of nuclear energy and furthering the goal of achieving nuclear disarmament.

Keeping the UK safe and secure

AWE supports the Government with specialist national nuclear security, threat reduction and counter-terrorism solutions.

Their nuclear weapons expertise helps to identify worldwide and UK-based nuclear threats – using cutting-edge scientific methods and



instrumentation to assist with threat reduction and counter-terrorism. As part of their enhanced detection programme, they are working on an improved capability to detect special nuclear material at the UK's borders.

AWE experts are on-call 24/7 as part of the Government's national emergency response arrangements – ready to deal with any nuclear accident or incident in the UK. And in the field of nuclear forensics, they identify the origin of materials and recover traditional forensic information from crime scenes where exhibits have been contaminated with radioactive material.

Centres of Excellence

AWE has some of the most advanced research, design and production facilities in the world. Orion, the replacement laser facility, is a world-class facility, able to generate matter several times denser than

solid, at temperatures up to 10 million degrees, employing targets the size of a grain of sugar.

AWE's latest supercomputer is one of the most powerful in the UK, able to perform trillions of calculations per second. This is being used to simulate and understand the science of nuclear explosions,

Another example of AWE's precision engineering capability is the use of 3D simulation to support design into manufacture. This saves time and money in designing products and equipment, and is being used across AWE.

AWE has strategic alliances with leading universities, including Bristol, Cambridge, Cranfield, Heriot-Watt and Imperial College London, to support technical research projects for the benefit of the national defence programme. ■

About AWE

AWE is managed for the MOD through a Government-Owned-Contractor-Operated (GOCO) contract. With AWE Management Limited (AWE ML). AWE ML is a consortium comprising three equal partners: Jacobs Engineering Group, Lockheed Martin Corporation and Serco Group plc. All the sites and facilities are owned by the MOD, but the day-to-day management is contracted to AWE plc. In 2011, MOD announced the decision to outsource elements of the Strategic Weapons Systems support at the Royal Naval Armament Depot, Coulport, to an industrial alliance, composed of AWE plc, Babcock and Lockheed Martin Strategic Systems UK.

Photo 1 – Vanguard submarine carrying Trident nuclear warheads

AWE's role at the Olympic Games 2012

As well as building and maintaining warheads for the UK's deterrent, the Atomic Weapons Establishment (AWE) also plays a vital role in national security. This was evident at the Olympic Games 2012 where AWE scientists and experts contributed to the security and smooth running of the London site.

London 2012 was a global event – watched and scrutinised by billions of people. The Olympic Park in Stratford, East London, was designated a Tier 1 security venue, meaning that the risk of a terrorist-related incident was deemed to be 'High' and 'Catastrophic' respectively. Securing the safety of all participants, spectators and staff was a top priority.

The role of AWE was to provide technical guidance, alarm mitigation and threat assessment to ensuring that capability would meet the stringent requirements of the London Organising Committee for the Olympic Games, the Olympic Development Authority and the UK Government.

The site had to be completely ring-fenced with restricted and controlled access points. At every point of entry, every person and vehicle entering had to be fully checked, verified and screened. At peak times, the rate of entry to the site was estimated to be higher than the flow rate of passengers through Heathrow Airport – but crucially, would have to be faster.

AWE also deployed a comprehensive multi-layered radiation detection screening system, capable of detecting and identifying a range of materials that could pose a threat. This system has set the gold standard for future events.

This screening system was the culmination of a cross-government approach to integrate response planning to mitigate the threat of radiological and nuclear attacks. The Olympic Park was pre-screened for radioactive material during construction and prior to lock down – no threat material was identified during the screening. Some of the components in the system were subjected to technical analysis, which was then followed by a period of installation and final acceptance testing and validation – all of which was overseen by AWE.

Scientific Liaison Officers

AWE also provided Scientific Liaison Officers (SLOs) to man the system at the Park for the duration of the Games. They monitored performance, carried out fault diagnosis and rectified any problems. In addition, they analysed all the data generated by the system, distinguishing between non-threat radiological material, such as a person bearing a medically used isotope and other materials that would pose a threat.

The SLOs used their judgment and scientific expertise to analyse all the incoming data, often in very short time periods. They also liaised with on-site security and military teams, making decisions on what was a threat or not.

AWE technical adviser, Chris Ryden is proud of AWE's contribution: "By day 17 of the Games, more than 2.6 million people had been screened by the system, generating a vast amount of data. Up to 1,000 vehicles per day drove through the fixed vehicle portals. The system performed as expected, detecting many instances of people bearing a medical issue, or vehicles carrying naturally occurring radioactive material. There were no instances of illicit material entering the Park ensuring we could all enjoy the Games without a hitch. ■

Olympic stats:

- More than 2.6 million people screened
- Up to 1,000 vehicles per day drove through the security portals
- Over 150 alarms deployed
- No threat materials detected

Photo 2 –
Pedestrian screening
at the Olympic site





Exploring the frontiers of materials science

Materials science and metallurgy are key areas of research at the Atomic Weapons Establishment (AWE) and are fundamental to understanding the performance, reliability and characteristics of a nuclear warhead. This became increasingly important following the UK's ratification of the Comprehensive Nuclear Test Ban Treaty (CTBT) in April 1998, which means that data can no longer be collected from nuclear tests.

As part of understanding how materials behave in the warhead over time in the CTBT era, AWE commissioned the Inorganic Surface Science Capability (ISSC), a uniquely constructed and sophisticated instrument primarily designed to investigate the chemical and corrosive characteristics and behaviour of materials.

The ISSC is a state-of-the-art ultra-high-vacuum (lower than one millionth of a millionth of atmospheric pressure) surface-science instrument that provides data on the surface properties of materials. It enables AWE scientists to use a model-based approach to predict the lifetime of a warhead – safely and reliably.

AWE scientists can quantify the mechanisms of ageing and surface corrosion of materials such as

inorganic hydrides, metals and composites through an understanding of the chemical degradation processes. These materials can be oxidised by water or gases such as oxygen, carbon dioxide, or even hydrogen. Predicting the material corrosion and its effect on existing systems is essential to the maintenance of warheads for the UK's deterrent.

One of the techniques that are now available to scientists is the capability to yield chemical information of a material surface from approximately 0.1 to 5 nanometres thicknesses (as thin as approximately one millionth the diameter of a human hair). This detects even the slightest reaction on a material's surface.

AWE scientists are also able to conduct experiments using a supersonic, highly-focused beam of

gas directed at a material's surface. This means that the system and its operators can investigate the interaction of the gas beam as it impacts the material's surface using a rotatable mass spectrometer (a device that measures the quantity and mass of atoms and molecules), which can determine the likelihood of a 'sticking' or 'corrosive' event (between the gas beam and the surface).

AWE Head of Materials Science, Dr Tony Skinner, explains the impact of these advances: "Through the novel techniques available, the ISSC will enhance AWE's capability to conduct research on warhead materials. It is also expected to open up many opportunities for AWE to collaborate with universities and the US labs to further develop expertise and knowledge for mutual benefit."

Photo – Orion laser facility based at AWE Aldermaston

Orion laser's academic access programme takes off

The world-leading Orion laser is one of the biggest capital science projects in the UK in the last 25 years. The high energy density physics experimental facility enables AWE scientists and physicists to improve their understanding of nuclear warhead science, using a model-based approach in place of live testing. This is essential to the safety, reliability and performance of the warhead as part of the UK's commitment to the nuclear deterrent.

Orion is a national asset and although its main purpose is to support the deterrent programme, the MOD has made some of Orion's time available (up to 15% per year) to external users for cutting-edge collaborative academic research. Following the first two calls for proposals, four academic experiments were scheduled on Orion; two for the University of Oxford, one for the University of York and the fourth for Imperial College London.

The first international experimental team was led by University of Oxford academic, Professor Gianluca Gregori. The experiment studied supersonic plasma interactions such as those found between binary stars.

The first experiment was heralded a great success by all parties, with Professor Gianluca anticipating further collaboration: "I would be delighted to see the Orion laser grow as a point of reference for laboratory astrophysics experiments in the UK. We would definitely hope to use the Orion laser again."

The second Orion academic campaign, led by Oxford's Dr Andy Higginbotham (now at the University of York), used x-ray diffraction techniques to study matter at extreme pressures.

Following the experiment he spoke about the research: "The quality of the data we obtained at Orion is unprecedented. This has allowed us to gain deep insight into the response of silicon to rapid compression; a topic which has puzzled the scientific community for around two decades."

Orion is currently in the middle of conducting a further series of academic campaigns with Professor Nigel Woolsey, from the University of York, working on magnetic reconnection and its relevance to Inertial Confinement Fusion; and Dr Francisco Suzuki-Vidal, from Imperial College London, studying the formation of radiative shocks and their counter-streaming interaction, which is pertinent to astrophysics phenomena. ■

Orion fascinating facts:

- The Orion laser facility is housed in a building the size of a football stadium
- Orion allows scientists to study conditions similar to those in stars and inside giant planets like Jupiter
- The energy created by Orion is directed at a tiny sub-millimetre scale target, components of which are typically a fraction of the width of a human hair
- Orion can recreate the temperatures close to the centre of the Sun – up to 10 million degrees centigrade
- Orion conducts experiments by researchers from all over the world

Photo 2 –
Orion laser facility



Battle winning science and technology from MOD's Defence Science and Technology Laboratory

The Defence Science and Technology Laboratory (Dstl), as part of the Ministry of Defence, has been bringing together the defence and security science and technology (S&T) community – including industry, academia, wider government and international partners – to provide sensitive and specialist S&T services to MOD and wider government for many years.

Defence Science and Technology Laboratory (Dstl) supplies sensitive and specialist science and technology services for MOD and wider Government, providing and facilitating expert advice, analysis and assurance to aid decision-making. It leads the delivery of MOD's S&T Programme and in managing and exploiting knowledge across the wider defence and security community.

By understanding S&T risks and opportunities through horizon-scanning, it acts as a trusted interface between MOD, wider Government, the private sector, academia and allies to provide S&T support to military capability delivery and cooperation. It also facilitates the development of S&T skills across MOD.

Dstl has a range of customers across MOD, but the most significant is MOD's Chief Scientific Adviser and the MOD S&T Programme. It also works for other Government departments to help meet their objectives. Dstl ensures that external suppliers in industry or academia undertake all the research work unless this needs to be done or led by Dstl, for reasons of national security or political sensitivity.

Developing solutions that deliver impact and save lives

The Defence Science and Technology Laboratory (Dstl) focuses on meeting the needs of the users of science and technology – Maritime, Land, Air Joint Forces, MOD Head Office and wider Government across Whitehall. The delivery of this work (mainly MOD’s Science and Technology (S&T) Programme) has been through a number of programmes and is mainly contracted out to industry. Defence Science speaks to the people involved and highlights some future developments.

AIR



Helen Sherwood focuses on the needs of the Air user. Although, based at Dstl Porton Down, she is more likely to be found on the move: “In reality, I work where I need to – anywhere across Porton, Portsdown West, High Wycombe, Andover and Abbey Wood,” she says.

Her responsibilities cover Air Command, Joint Helicopter Command and the Combat Air, Air Support and Helicopter Operating Centres in Defence Equipment and Support. “The aim of the role is to provide a clear point of engagement and focus for our senior S&T users and stakeholders.”

Joining the Admiralty Research Establishment straight from school, she explains: “This was intended as a year out, before doing a materials science degree. However, plans changed and I’ve been with Dstl ever since, working in a range of different areas.

Her present role focuses on S&T developments in air. “We work closely with our customers and stakeholders to ensure that we are focusing on the highest impact problems, helping their decision making and developing solutions to address capability and operating risks,” she explains. “Users for Air S&T are united by two common themes – managing the delivery and operation of in-service capability, and planning ‘what comes next’ – the platform, sensors and effectors – how the capability is generated as part of the wider force package and all the enabling elements that are essential to deliver the necessary effect.”

The Combat Air programme provides Typhoon in-service support and upgrades, and the introduction of Lightning II into service. It also covers unmanned air systems, conventional and novel weapons, and the future force mix.

Air Command leads on a number of high priority areas including air platform protection. Joint Helicopter Command is heavily focused on

future capabilities – looking into mid-life updates on in-service platforms and how these will dovetail into the future fleet.

Helen explains the challenges: “Across all areas, we need to be agile to exploit new technology, not forgetting the necessary certification requirements, getting more out of the current and future platforms and delivering all of this within an affordable programme.”

“There is a big drive currently for innovation across the full breadth of S&T, not just new technologies. For example if we can fuse real-time the myriad of data that is available, (from either commercial or military sources), this will benefit the aircrew in rapid and improved decision making – a game-changing advance.”

“Quantum technology is interesting because there are significant market drivers in the commercial sector and we are reflecting this in our strategy. Advances here could radically improve precision and timing, Bio (UAS) is looking at nature and trying to replicate the amazing things that birds and insects do, such as ‘perch and stare’, into man-made systems.

“Space is an emergent area of interest, it could offer significant opportunities to do things differently and do different things, however, it poses some challenges to us as well.”

JOINT FORCES COMMAND – INFORMATION SUPERIORITY



Looking at the S&T Information Superiority needs of Joint Forces Command Emma Squire is based at Portsmouth West where she identifies, develops and oversees relationships with users and works closely with other providers to meet their technology needs.

“Joint Force Command is placing a great emphasis on understanding the potential impact of emerging information and communications technology (ICT) on the way we provide capability and conduct operations,” she explains. “The information age is characterised by an unrelenting pace of change, fuelled by growing civil investment in Information and Communications Technology. To maintain competitive advantage, Defence must select and adopt technology from the civilian arena more rapidly than its adversaries. The continuing exponential growth in data and computer processing power provides Defence with an opportunity to harness Big Data tools and techniques to help it operate more effectively.

“Other exciting areas of Dstl research include researching ways of developing ways of developing affordable space-based military capabilities, exploiting ongoing miniaturisation of electronics and recent rapid growth in non-military use of smaller, cheaper and more easily deployable satellites.

Other exciting areas of Dstl research include researching ways of developing affordable space-based military capabilities, exploiting ongoing miniaturisation of electronics and recent rapid growth in non-military use of smaller, cheaper and more easily deployable satellites.

“And over the last year the first battery-powered, high performance thermal imaging camera has been developed by UK industry, supported by Dstl. High operating temperature (HOT) technology has the potential to have a huge impact on night vision capability from very compact systems for micro-UAVs through to persistent wide-area surveillance systems for airborne and maritime users.

MARITIME



David Sherburn describes his role as ‘outward facing’ which means you will find him out and about meeting maritime users, identifying and meeting their needs.

“I try to understand the context in which science and technology will be exploited and spot opportunities where it can impact and make a difference,” he explains. “It is also important to maintain two way communication – externally and across the lab.”

Based at Porton Down, Sherburn has over 20 years’ experience with Dstl. Sponsored through university by MOD, he has worked at a number of

centres – working in areas including maritime, explosive systems, intelligence and he also leads the UK/US/Aus maritime research collaboration.

He has been in his present role for three years now and says that the variety of the work keeps him excited and engaged: “I deal with a wide range of people – from world experts to Admirals – across a wide range of technical topics. We are currently working with the 30 programmes that conduct maritime science and technology, with their broad range of external stakeholders.”

The users include Navy Command HQ, Defence Equipment and Support Ships and Submarines Operating Centres and Nuclear Capability.

There are a number of exciting new technologies being developed, including maritime autonomous systems and exploring the application in a range of maritime capabilities. “We are looking at directed energy weapons (lasers) and maritime autonomous systems, and how they may transform how the navy does business. We are also looking at quantum sensing and navigation, additive manufacture, synthetic biology and how these can revolutionise the production and maintenance of future maritime platforms.

“We have the Maritime Collaborative Enterprise consortia, which primarily contributes to the delivery of two Dstl research programmes – Ship Systems and Integrated Survivability, and Maritime Freedom of Manoeuvre. We now have a range of industry and academic frameworks, which allow us to engage with the external community. This allows us to access

a much broader 'brain pool' and engage some of the best minds, at home and abroad with maritime problems."

This is an exciting time for maritime science and technology and Sherburn is enthusiastic about the future. "We have a real appetite to pull through and exploit innovation and technology. The Navy are uniquely placed to be the first adopters of a range of emerging technologies. They have the platforms with available power and space providing that unique opportunity for the science and technology community to develop and demonstrate in areas such as maritime autonomous systems."

LAND



Dstl Account Manager for Land, Jim Eckworth has over 20 years' experience in science and technology, joining Dstl straight from university. With a background in Operational Analysis supporting all the single services as well as MOD Head Office and the Permanent Joint Headquarters, he is now based at Portsmouth West.

"I manage and orchestrate Dstl's relationship with the Army, ensuring we understand their science and technology requirements and supporting them with their priorities," he explains.

Eckworth leads the design and delivery of Dstl's Science and Technology Programme for the Army. "I am proud of what we have achieved during the last five years", he says, "Our support for troops in Afghanistan, has helped improve their equipment and ultimately saved lives."

The breadth of the Army's military capabilities is vast, which means the Land Environment covers a wide range of areas including; integrated survivability, decision support, human systems, command and control, cyber, surveillance and weapons.

This makes for an exciting mix of interests, but Eckworth says the human aspect is, for him, the most rewarding part of his work: "Working with the military is a two-way partnership, helping the Army understand and engage with S&T. Given the pace of technology change, we need to continually push the boundaries of science to give the Army the technology edge."

"The Land team are now focusing on looking beyond the next 15 years. We are helping the Army to think about how it could operate differently and take advantage of emerging new disruptive technologies. It is very much a chance to take a 'revolutionary' change in the way the Army operates rather than an 'evolutionary' one'.

"We are testing the boundaries of science – looking beyond what is achievable now and in the next few years, increasing in speed and knowledge and trying reach the next generation in science. To exploit these opportunities the future has to be based on partnerships, ensuring government has access to world class in-house S&T, and the best S&T on offer from industry and academia. It benefits us all to be able to talk openly and work together on challenges the Army face now and in the future."

HEAD OFFICE



Keith Goodman is always on the go: "I spend a lot of my time at Portsmouth West, but I also spend a significant amount of time at Dstl's site in Porton Down and, of course, up to two days per week working in Main Building in London."

Goodman's role is to ensure that the S&T undertaken to help Head Office users is of maximum benefit. "At a strategic level, this means ensuring that Dstl understands the current and future needs of those who use S&T in Head Office. At the operational level, I work with both Dstl colleagues and those who use their output to better understand how our products and services are used, and how well they align to defence's priorities," says Goodman.

"In my role I get to help people solve problems using science and technology solutions, by linking the right people within Dstl with the customers. It's great to see how S&T can make a real difference, whether that be on improving armour for our soldiers, tackling the ebola crisis in Africa, or on a wide variety of issues."

Goodman deals day to day with MOD colleagues in departments that include: Security Policy and Operations; Finance and Military Capability; Defence S&T; Chief of Defence Personnel; Head Office and Commissioning Services; and

elements of DE&S. “Some of the most pressing challenges in Defence are the priorities for the portfolio of defence S&T in these areas these include the Strategic Defence and Security Review, continuing to assess and improve efficiency in MOD, and defence personnel.”

Dstl’s programmes are looking at a range of new and emerging technologies, including some world leading, cutting edge technologies. “But it’s not just technology that’s exciting; we’ve launched a large programme looking for new concepts, innovative approaches and world-leading science that can support change to ensure we deliver a fit-for-purpose defence workforce for 2040.

“The majority of the requirements placed on the S&T community are military requirements, whether that’s about force planning or force protection. The contribution made by the military to my work is indispensable. Our embedded military advisers bring an invaluable sense of focus to our work.”

JOINT FORCES COMMAND – SPECIALIST USER



Dr Deborah Fish OBE is based at Porton Down, near Salisbury, acting as the specialist user in. Joint Forces Commands’ representative within Dstl Fish ensures that their current and future S&T requirements are understood: “It’s a broad-ranging portfolio, spanning organisations as diverse as Surgeon General,

Assistant Chief of Defence Staff (Logistic Operations), Permanent Joint Headquarters (PJHQ), Development Concepts and Doctrine Centre, the Defence Academy, Special Forces, several capability branches and the supporting teams in Defence Equipment and Support.

After a Ph.D. studying the ozone hole, Fish spent five years’ lecturing before moving into technical consulting. Her knowledge of atmospheric dispersion brought her into Chemical Biological Radiological and Nuclear defence and since then she has had a varied career within Dstl, including working as a Scientific Adviser in Iraq and Afghanistan.

The challenges of the role are numerous, but Fish says there are many opportunities to make a difference: “On operations, PJHQ face the challenge of succeeding on numerous small, but important operations around the globe – each with their own force protection challenges and opportunities for analysis. In the longer term, we are helping Director General Joint Force Development understand what warfare should look like in the ‘information age’, where social media allows organisations like ISIS to influence a global audience in seconds,” she says. “Our medics face the challenge of maintaining the skills developed in Afghanistan and providing that care in more austere environments, perhaps using technologies such as telemedicine. We are also looking at how to provide reliable logistic support at lower cost, through a Defence Support Network, which relies increasingly on industry.

“We are working with the University of Michigan, who have designed some cutting edge ultra-miniature sensors – around 1 mm in size – with a range of possible applications for Defence. At the other end of the spectrum, we have worked with industry to mature the solar powered Zephyr unmanned high altitude pseudo satellite aircraft, which currently holds the world record for the longest duration

unmanned flight, and offers new opportunities as a low-cost, persistent ISTAR platform. In the Chemical Biological and Radiological area, we are working with universities to develop improved medical countermeasures and biological detection technologies.”

The diversity of the work is enormous and Fish explains that areas, such as Dstl’s counter-terrorism work on improvised explosive devices (IEDs), spans a wide range of disciplines; including electronics, energetics and explosives. “We have a vet, who leads our work on military working animals, helping devise training programmes for dogs to detect IEDs, and return safely to their handler. Our microbiologists develop medical counter measures against hazardous chemical and biological threats, which gave them the skills to support the UK’s effort to counter Ebola in Sierra Leone. While our medical researchers have helped develop new methods of treatment that led to unprecedented survival rates for severely injured service personnel.” ■

We are working with the University of Michigan, who have designed some cutting edge ultra-miniature sensors – around 1mm in size – with a range of possible applications for Defence.

Land Case Studies

Title: Active Integrated Protection System

Programme: Land Integrated Survivability

Traditional vehicle protection options are not able to keep pace with proliferating, highly lethal threats such as Anti-Tank Guided Weapons. A holistic view of survivability is required, drawing upon a flexible set of options using active, reactive and passive protection technologies. Active Protection defeats threats before they strike a vehicle, by sensing them and providing a 'hard' or 'soft' response to counter the lethal effects.

The Active Integrated Protection System (AIPS) research project aims to derisk the development and introduction to service of an AIPS capability compatible with UK requirements through a combination of commercial-off-the-shelf-systems (COTS) system appraisals and technology research and development. Following the completion of the User Requirements and initial research, the project will enter three parallel streams of activity.

The Medusa Technical Assessment Programme will evaluate a high maturity system. It will prove technical system performance (including live fire threat defeat), evaluate the benefits of threat warning capability and also focus on non-equipment issues, including integration and the development of Tactics, Techniques and Procedures. The Icarus Technology Demonstrator Programme will develop the architecture to support modular Active Integrated Protection Systems (AIPS), suitable for application across fleet and built for through-life support and development. These packages will be complemented by an underpinning research and simulation package.

Title: Future Soldier Vision

Programme: Dismounted Soldier systems

An evolutionary approach to upgrading equipment for the dismounted soldier, driven by urgent operational requirements, has led to UK soldiers carrying as much as 58kg of highly capable but poorly integrated equipment. In 2015 the Capability Directorate Combat stated that the lack of the soldier system integration is the greatest risk to capability development for the dismounted soldier.

Funded from MOD's S&T Programme, Dstl partnered with an industry consortium led by SEA Ltd and developed the Future Soldier Vision (FSV). The FSV is a physical concept for the soldier in 2024, exploiting current and emerging commercial technology – thus offering a deliverable revolutionary step change in the dismounted soldier capability.

This innovative way in which we can now demonstrate the art of the possible has also helped focus the future research for the dismounted soldier. Researchers within Dstl and its industry partners are now working towards closing the technology gaps, with a particular interest in power and data-enabled weapon technology, which will bring the concept of the FSV to life.

Title: Manual Wargaming

Programme: Land Environment Decision Support

This year has seen a resurgence in interest for manual wargaming for education and training of junior officers, force development and policy and planning guidance.

One of Dstl's manual wargaming tools, the Rapid Campaign Assessment Toolset (RCAT), was successfully used to support 3 DIV during their annual training event known as IRON RESOLVE. RCAT facilitated the range of training activities, i.e. course of action planning, execution of the plan within a scenario that dynamically develops according to responses and action from the players and after action review.

Dstl and Cranfield University have also completed a successful Operational Commanders' Test for RCAT validation. The 1982 Falklands War was wargamed using RCAT and compared with the historical outcomes and command experience. Variances were identified and examined in order to improve the validity of the RCAT system.

Dstl are continuing to bring together and work with professional wargaming practitioners as a means to respond to the increase in interest in manual wargaming. The development of a manual wargaming capability hub to act as this focal point and as a means by which to develop the necessary tools and skills is a key aim for the next year. ■





Joint Forces Command

Joint Force Command – Information Superiority

Great things in small packages

Dstl and the Gioconda consortium, led by Roke Manor Research, part of Chemring Technology Solutions have invented a novel compact radio frequency antenna for use on small spacecraft – a crucial step towards achieving an affordable space-based military capability.

Technological advances in the civil domain have seen a rapid growth in smaller and cheaper satellites; however, these advances are limited by the required size of antennas. This novel antenna has arms made of coiled carbon fibre composite, which can extend to more than three metres long – all from a package measuring no more than five centimetres high. This enables much smaller satellites to be used, and makes the associated launch costs far cheaper.

In addition, the consortium's technology can be applied to the deployment of large structures in space, such as solar panels and de-orbit devices, which help to ensure a satellite's harmless destruction at the end of its life. The technology is also being tested for its potential for deploying large high resolution sensors in space from extremely compact devices.

Top of the Queen Elizabeth class

Dstl has worked with Systems Engineering & Assessment (SEA) Ltd to support a training programme for the Queen Elizabeth Class Carrier (QEC). It is vital that the crew on an aircraft carrier can simultaneously manage the aircraft on deck and the aircraft in the air approaching the carrier; any disruption to these time sensitive activities can be severe. Consequently, the ability to make complex decisions and take remedial action fast and effectively following a disruption is critical. Dstl and SEA

hosted a simulation training day to show the value of an integrated approach between several key roles: the flying command team, flight deck, hangar operations, bridge, operations room, and fast jet and helicopter pilots.

On a deck as large as the QEC's, operating multiple helicopters and jets concurrently and safely requires competent integrated planning and sequencing, and places a premium on the expertise of every individual involved. However, live training on the QEC is complex and challenging. The ability to simulate the training will be invaluable in developing the crew's skills and experience. The simulation was a great success, demonstrating clearly the value to be secured through adoption of an integrated approach, and showed how this approach can be taken forward and embedded as standard operating procedure.

The future's bright – the future's HOT

Dstl has supported Selex ES Ltd in developing the first battery-powered, high performance thermal imaging camera, which can be used for night vision. Traditional high-performance thermal cameras operate at a very cold temperature, necessary to capture infra-red (IR) wavelengths and processing them into an image. These cooled cameras are usually very bulky and power hungry compared to uncooled IR technology; however, they do produce a much superior image. Dstl and Selex's new high operating temperature (HOT) technology has pushed up the temperature at which a camera can operate, significantly reducing its size, weight and power, while retaining the quality of cooled cameras.

With a unique manufacturing technique, the UK now leads the world in HOT thermal imaging capability. This technological advantage is opening new applications and displacing traditional approaches to night vision. A new technology demonstration programme began this financial year to provide specialist dismounted soldiers with the ability to operate at night at four times their current stand-off range. Preliminary outdoor assessment, facilitated by Dstl to capture requirements, has provided important user feedback, which will improve the prototype now under development.

Through continued investment, HOT technology has the potential to have a huge impact on night vision capability from very compact systems for micro-unmanned air vehicles, through to persistent wide-area surveillance systems for airborne and maritime domains. ■

Catalysing Defence Innovation through Science and Technology

The Defence Science and Technology community are working with partners from across the whole Defence enterprise and the wider UK innovation network to consider options for how defence can:

- improve value for money through partnership
- sustain operational advantage despite reducing budgets
- improve the affordability of defence capabilities
- ensure timely response to rapidly evolving threats

Dstl's facilities

Dstl's specialist facilities include:

- An indoor ballistics range, with a small-arms ballistics and fragment firing capability to assess the ballistic effects of weapon performance
- The UK Home Made Explosives (HME) Facility and Centre of Excellence, a purpose-built facility dedicated to meeting the Government's research requirements on HME.

Flexible medical training prepares soldiers during Ebola crisis

In August 2014 Army Medical Services Training Centre (AMSTC), Strensall, was tasked to design, construct and assure training for what has been described as the ‘most dangerous medical mission ever undertaken by Defence Medical Services’ – the Ebola outbreak in West Africa. Capt Neil Weddell describes how innovative training supported the Army and scientists working in West Africa to counter the disease, which was moving into crisis.



1 Op GRITROCK saw the British Army provide medical, planning and engineering capabilities to the Sierra Leonean Government; building and running Ebola treatment centres and training their healthcare workers, police and civilians.

That AMSTC were able to deploy medical personnel with the appropriate knowledge and training, straight to an unknown theatre of operation at such short notice, which was no mean feat. So, how did they set about arming them with the correct training materials to enable them to deploy safely to such a hazardous environment?

AMSTC was responsible for developing and delivering an affordable and flexible training system to ensure each soldier was prepared and sustained to the required standard for operating in that environment.

Aware that getting this training correct would keep our personnel safe from this most virulent of viruses, AMSTC enlisted the support of the Education and Training Services (ETS) branch of the Adjutant General's Corps (AGC). Traditionally perceived as academics who prepare soldiers and officers for promotion, the ETS are also Masters level specialists in training theory and innovation.

ETS from the Directorate of Training (Trg Dev) identified early on that the application of learning technology underpinned with sound academic theory was the most suitable way forward. This stemmed from the international nature of the crisis, the remote areas of operations, the varying educational levels of personnel, the mix of regular and reserve and the fact treatment practices were evolving on a near daily basis. Consequently all training material needed to be accurate, timely, compliant to Defence Training standards (DSAT) and be easily accessed by various organisations through multiple channels 24/7.

Guided by the academic principles of Adult Learning Theory (Andragogy) and the versatility of e-learning devices, the challenge was met with unstinting drive, enthusiasm and passion.

Through forensic attention to detail, the cap badge partnership contributed to operational capability through the design of numerous innovative processes which have brought acclaim, acumen and requests for access. However, more importantly, they brought confidence to those deploying that the new skills were fit for purpose and would

Photo 1 –
Ebola virus disease is a severe, often fatal illness in humans



Photo 2 –
Army HQ Medic
Training Op
GRITROCK
Photo 3 –
Op GRITROCK
microsite design

allow them to treat patients to UK standards in the rigor of a West African jungle without the threat of becoming a casualty themselves.

One example of innovation was the creation and deployment of the GRITROCK online e-learning portal. Up and running within two weeks of the contractor CDS receiving the brief it was fully deployed within a month. The successful execution of the project included five strands offering a combination of learning material from videos to interactive training presentations. Examples included:

ETS specialists managed the creation of bespoke video tutorials, developed at the training field hospital facility in the UK, a replica of the field hospital deployed in Sierra Leone, to ensure they captured important new information as it was relayed from the Army on the ground and scientists working to combat Ebola. 100 per cent accuracy of the training material was an absolute requirement given the number of lives at stake, so high definition video with commentary in multiple languages was the only choice.

This approach also allowed for flexibility in training content, if feedback from Africa identified a change on how personal protection clothing should be donned, the video crew (on standby in York) would record the change that same day. This enabled the updated version to be sent electronically to

Sierra Leone overnight ensuring the very next morning medical personnel preparing to enter the red zone could watch the latest procedure before they started that day. With traditional posters and medical leaflets this would not be possible.

3



A tailor made internet microsite was designed to host training videos and enhanced PPTs, ensuring material was accessible using smartphones, laptops and tablets. Foreign armed forces and Non-Government Organisations (NGOs) preparing for training at AMSTC could watch the videos before arriving, enabling familiarisation and learning to begin earlier. This approach, known as Flipped Learning Theory, leads to students having greater mastery of skills by the end of training compared to traditional 'chalk and talk' due to the longer exposure and out of classroom access to the learning materials.

E-learning intranet portal

A Learning Management System (LMS) underpinned the micro site enabling the tracking of student access and time spent viewing materials. The use of this e-learning technology means training is richer, more engaging and of higher quality and allows training staff to know which students have accessed what and for how long (training assurance).

There are currently 387 users registered on the GRITROCK portal, with nearly 400 hours of training delivered. Implementing this kind of web-based learning has solved the problem of having to train staff in a traditional classroom environment, which could have required 20 training sessions with two to three trainers used to demo per session.

The impact of this training project is huge, not only in lives saved, but also money and time saved to deliver appropriate sustainable training. The five strands provide a lasting legacy and ongoing e-learning resource, with the materials available and ready for any future outbreak.

This methodology soon became not only the defence solution but that also of the Department for International Development and then quickly moved to be the international centre for NGO's, with now over 1,000 personnel undergoing training at AMSTC.

At the peak of the epidemic 600 people lost their lives to Ebola every day. With effective medical intervention from Op GRITROCK, this figure dropped to one per day. The learning technology solution combined with AMSTC's medical training provided staff on the ground with the knowledge, skills and confidence to work in an extremely dangerous environment. In turn this enabled them to provide critical support to local and NGOs on the Ebola front line. ■



Photo 4–
Medic training
at Army HQ

Independent advice and a moderating voice in defence

Professor David Delpy took up the post of Chair of MOD's Defence Scientific Advisory Council last year. Wendy Jacob met Professor Delpy in Whitehall to find out more about his role and the work of this non-departmental public body.

The Defence Scientific Advisory Council (DSAC) is the main source of independent advice on non-nuclear science, technology, engineering, analysis and mathematics, providing advice on these issues to ministers and senior MOD officials. The Council consists of world-renowned scientists and engineers from UK industry and academia and as Chair, Professor Delpy brings a wealth of academic and scientific experience to the role.

Familiar with chairing high-level scientific committees, Professor Delpy is one of only a handful of UK researchers to be appointed as a Fellow to the Royal Society, the Royal Academy of Engineering and the Academy of Medical Sciences. He spent most of his academic career at University College, London where he was Head of the Department of Medical Physics and Bioengineering and Vice-Provost for Research. He was Chief Executive of the Engineering and Physical Sciences Research Council, the UK's main agency for funding research in engineering and the physical sciences from 2007–14.

DSAC is the most long-standing of all the Government's Science Advisory Councils and has been MOD's main source of independent advice on non-nuclear science, technology, engineering, analysis and mathematics issues since 1969. It advises the Secretary of State for Defence on defence science, technology, engineering, analysis and mathematics (STEAM). As a non-departmental public body, it is

not part of any government department and operates at arm's length from ministers. DSAC's interests also embrace research and development and science intelligence and capability.

After over a year in the role, his initial excitement has been tempered by an awareness of the responsibility of the role and the satisfaction of the value of the committee's work, providing independent, objective advice, based

on their own knowledge and experience. This wealth of experience is combined with information provided by other experts and officials, bringing knowledge and clarity to the issues being addressed.

"Science and engineering play key roles in defence and DSAC has undergone significant restructuring to better align with a transformed MOD and provided advice on a number of topics," he explains. "The





committee currently has 10 independent members, plus the Chair. There is a considerable amount of knowledge – from academics, industry and lay members – but all have an interest in defence.”

Science and engineering play key roles in defence and DSAC has undergone significant restructuring to better align with a transformed MOD and provided advice on a number of topics.

Last year, a review of the Committee’s work emphasised the need to be clear about their role and what can be achieved from the contribution of science and technology in MOD. This includes support for policy development, which requires affordable strategy, which in turn delivers effective capability to Commands – for example, a range of tasks from operational support to procurement. Recognising that the demands are often for the immediate and short term, Delpy says that it is important to prioritise research and training to shape capability. “For example, with IT and digital technology, six months is a long time and is unlikely to last beyond three years. We need to look at how MOD engages with new technologies and work closely with

Photo 1–
Professor
David Delpy

DSAC will support the Secretary of State for Defence and senior MOD officials by providing authoritative, independent, informed, impartial and timely advice and recommendations on matters of importance to the Department relating to the effective development and application of science, technology, engineering, analysis and mathematics. In doing so, DSAC will be recognised as the leading standard for independent advice to Government.

industry, academia and SMEs who are at the forefront of these developments.”

Ways of working

DSAC reports to the Secretary of State for Defence through an Annual Report and through ad hoc reports and advice, supporting a wide range of customers throughout MOD. Areas of interest are partly generated from DSAC or through requests from customers. Activities may include providing reports and advice on areas including science intelligence, horizon scanning and longer-term quality assurance.

Professor Delpy has a particularly important relationship with MOD Chief Scientific Adviser, Professor Vernon Gibson, which he describes as ‘invaluable’ as the interests of DSAC broadly overlap with those of CSA. DSAC is also able to call on the knowledge and experience of a large number of security-cleared scientists – from both academia and industry – listed on the MOD’s Independent

Science and Technology Advisers Register which gives access to independent expertise which is crucial when involved in a number of diverse areas.

With the requirement to build capabilities to meet and prepare for anticipated future threats and develop new technologies, Professor Delpy is aware of the need to harness information and innovation from outside the traditional defence industry. “With budgets challenged, it is important to fund areas where the UK is leading internationally. This means prioritising research and ‘shaping’ capability. The UK is in a very good position and we want to ensure that we continue to provide the right advice, by asking the right questions – how and why – that provide the best answers.” ■

DSAC areas of involvement

- All aspects of the MOD research and development programme, including direction, content, exploitation, balance and changes, and value for money
- The use of resources within MOD
- Ways of achieving cross-cutting capabilities, from conception to disposal and across all defence lines of development; operational issues
- Ad-hoc issues, including broad strategic issues, priorities and policies internal to MOD and those that are external to, but will impact upon, MOD
- Emerging external developments, innovation, opportunities and threats to MOD, both national and international.

Niteworks – a unique partnership for Defence

Since the Niteworks partnership began in 2003, membership has grown to over 150 organisations comprising MOD, Dstl, large defence primes, broader suppliers, research establishments and specialists – of which approximately 40% are small to medium enterprises.

Nearly 50 organisations have joined Niteworks since the start of the most recent contract in April 2013 and recently MOD reaffirmed the contribution of the Niteworks partnership with the announcement of a two-year extension to the current service – extending the contract to March 2018.

The philosophy behind the partnership remains the same – committed to remain open and inclusive, allowing new companies to join – ensuring it continues to encourage innovation from a constantly evolving community, bringing diverse and fresh perspectives to defence.

The enthusiasm of current and potential members shows that many organisations recognise the value that the Niteworks partnership provides to the MOD, industry and academia alike. For industry members there is the opportunity to gain insight and develop skills through submitting project team members, attending industry workshops, taking part in industry consultations or review panels, or simply accessing information made available through the partnership.



For the MOD, the partnership provides access to an impartial, pan-industry view on how to address cross-cutting problems, which is motivated by what is ‘best for Defence’. Through bringing together the MOD, industry and academia, Niteworks helps MOD to maximise capability for the Armed Forces within available budgets and with minimum risk. In addition, by tapping into the business minds and intellectual property available from the wider partnership, MOD can de-risk requirements and gain access to information about new technology types or innovative services from industry and academia, helping to improve Defence acquisition.

Niteworks’ success relies on the commitment and active participation of the whole partnership and a survey undertaken in 2014 revealed some very encouraging results. Ninety-six per cent of respondents valued their participation in Niteworks, with over 90% believing that it improved their understanding of MOD processes and capability, enabling them to ensure they are best positioned to support MOD in the future. This is demonstrated by over

58 projects initiated in support of the MOD in 2014 – giving industry exposure to some of MOD’s most challenging issues.

At the helm of this unique partnership is Simon Jewell, who took over as Managing Director of Niteworks in 2011 following nine years’ military service and 30 years in industry. Jewell believes that accelerating the introduction of new military capabilities through injecting greater innovation and agility into the acquisition system remains one of the greatest challenges for the MOD- and that Niteworks is well-placed to support this process: “For me, ‘accelerate and innovate’ captures the spirit of the time and what MOD is seeking to achieve. For a long time it’s been recognised that our adversaries are capable of rapidly bringing through innovations in threats, such as IEDs. The challenge is to have an acquisition system, which is at least as agile, if not more agile, than our foe, but still follows clear boundaries, rules and procedures. This means that when systems are introduced or modified, they are supportable and fully integrated into the mainstream training and logistic support environments. It’s about

how we evolve the system, ensuring it is less bureaucratic and more capable.”

“I think that most people would agree that innovation requires collaboration”, says Jewell. “In order to get good collaboration you need to have the mechanisms, procedures and the trust to allow people to come together and to want to work together.”

According to Jewell, the drive to inject greater innovation into the process is fundamental to Niteworks and is enabled through its unique partnership structure, which allows MOD, industry and academia to work together in badge less, mixed project teams in support of the MOD project sponsor.



Photo 1–
Simon Jewell

2



“I think that most people would agree that innovation requires collaboration”, says Jewell. “In order to get good collaboration you need to have the mechanisms, procedures and the trust to allow people to come together and to want to work together. Niteworks effectively creates that permission through the MOD asking for its support in a project area. The challenge then is to flush out the psychological barriers, enabling the team to focus on the task in hand with a fresh mindset.”

Jewell believes that another, perhaps less obvious, advantage of the partnership is the way that it brings together different elements of the MOD. These, he explains, fall into three main categories: the warfighters, those responsible for planning new capabilities and those whose job it is to procure them: “A good Niteworks project brings together an understanding of all of the elements necessary to address the problem in hand. If you want to develop ways of working this is best done by combining experience and practice. Our experience is that as often as not the MOD already has a range of processes available to it to

get things done. The challenge is not to develop a new process, but to make better use of and synchronise the ones that already exist through better planning, information flows and trust.”

A route to achieving a new, more agile approach to defence acquisition was outlined in the Continuous Capability Evolution ‘White Paper’ published by Niteworks last year. Already informing MOD thinking, the paper is part of a series of papers drawing on best practice from a variety of Niteworks projects to address some of the root causes of major Defence issues. Other themes include Styles of Architecting and Holistic Complex Systems Interventions; further papers are due to be published on Capability Coherence and Innovation.

Another strength of the Niteworks partnership is its commercial construct, which protects the intellectual property of the partnership whilst allowing them to share knowledge, helping MOD make better decisions about military capability. Jewell firmly believes that

facilitating the knowledge exchange in this way is ‘an absolute necessity’ for achieving a more innovative, agile acquisition system. “The Niteworks partnership is a recognised, mature construct for accessing and protecting knowledge from academia, industry and MOD,” explains Jewell. “Over time it has established trust in those mechanisms, such that people are confident in using them to bring knowledge forward.”

In a typical year around 600 people get involved in Niteworks projects and a further 800 will attend pro bono workshops, bringing their collective expertise to bear in support of MOD projects. The commitment to the principal of partnering is acknowledged by Jewell as a big commitment by the partnership and places a considerable responsibility on everyone involved to use the time productively.

In many ways, Jewell regards greater knowledge sharing as an obvious, though challenging, consequence of squeezed budgets across Defence – within government, industry or academia. “Gone are the days when we can afford to be wholly vertically integrated and to see knowledge as being wholly derived from inside our organisation. We now recognise the need to be horizontally integrated to a large extent and reliant upon the knowledge of our collaborators.”

“It’s pointless reinventing what somebody already knows, and if you wish to accelerate and innovate then it’s a prerequisite that you have to be drawing upon the existing knowledge to the largest extent possible,” he concludes.

All Niteworks partners and associates (apart from those joining recently) will have either worked on projects, attended workshops or been involved through other engagement mechanisms. And with more than 30 organisations presently interested in joining, the Niteworks partnership is set to continue to support MOD with present and future challenges. ■

Photo 2 –
Sea Viper naval air
defence system

● Niteworks facts:

- More than 150 organisations – of which around 40% are SMEs (estimate based on information received when joining the partnership)
- All of the Niteworks partners and associates (apart from those that have joined most recently) have either worked on projects, attended workshops or been involved through other engagement mechanisms
- 120 projects delivered under Niteworks III (10 Maritime, 39 Land, 17 Air, 47 Joint, 7 Centre)
- £1bn+ cost avoidance identified since the start of the Niteworks II contract (November 2007)
- 97% project sponsors very satisfied or satisfied with the outcome and quality of Niteworks tasks
- 97% MOD project sponsors very satisfied or satisfied with the value for money received from Niteworks (projects delivered between 1 Jan 2010 and 31 Mar 2015, based on 58% response rate)

* Statistics cover the period from the start of the Niteworks III contract (1 April 2013) to 1 July 2015 unless otherwise stated

● Niteworks provides:

Operations support

Applying knowledge, methods and expertise to help understand the risks and impact of operational options with the aim of improving capability.

Capability planning

Providing information on current capability need and demonstrating the impact and outcomes of the different options.

Capability delivery

Informing MOD decision makers in acquisition and delivery on how to reduce risk before commitment and provide better value for money.

Niteworks – industry partners

Niteworks' industry partners provide substantial background intellectual property to support and are able to fully exploit all Niteworks outputs.

Industry partners and key MOD and Dstl stakeholders have representatives on the Niteworks Partnership Board, a non-executive board comprising senior executives from the individual organisations. This meets quarterly providing strategic direction.

- Airbus Defence & Space
- BAE Systems
- CGI
- Finmeccanica UK
- General Dynamics UK
- HP Enterprise Services
- Lockheed Martin UK
- MBDA UK
- Northrop Grumman UK
- QinetiQ
- Raytheon
- Thales UK

Niteworks – associates

Niteworks' associate members range from SMEs, specialists and research establishments to larger companies from both the defence and broader commercial sectors. Associate companies provide expertise and capability to Niteworks activities through people, technical support and innovative solutions.

Niteworks' associates are represented on the Niteworks Partnership Board by ADS, the trade organisation advancing the UK Aerospace, Defence, Security and Space industries.

What they say about Niteworks

“Thanks to its unique ethos, in which all voices are equal, from the smallest SME to the largest prime, Niteworks has created an environment in which old assumptions can be challenged, new ideas can take root and innovation can flourish.”

Philip Dunne MP, Minister of State for Defence Procurement

“Over the years I have been a consistent supporter of Niteworks and look to it to help overcome the boundaries that exist between and within MOD and industry. A successful Niteworks should help MOD and industry adapt within the changing defence environment – it should help us to evolve more rapidly – it should help us provide clarity to the decider on the decisions that need to be taken. In doing this it must challenge the default assumptions and drive innovation: as it does so it must support

Defence in the taking of impartial and informed decisions in a timely manner.”

Air Chief Marshal Sir Stuart Peach, Vice Chief of the Defence Staff

“I have been closely associated with Niteworks for over a decade. Over this time I have seen it evolve under the direction of MOD from a centrally-funded warfighting experimentation centre into a highly flexible organisation providing evidence-based decision support on a wide range of MOD topics, using a much more customer-focused and flexible funding model. As it has done so, it has adapted its ways of working to provide the agility needed to help inform MOD decision making as our operational and operating environments change.”

Dr Dai Morris, Head of Weapons, Evaluation and Capability Assurance, MOD

Working with Centre for Defence Enterprise to fund growth

Plextek Consulting is one of the largest independent electronics design consultancies in Europe providing design services to the communications, defence, automotive, industrial, scientific and medical markets. Established in 1989, the Cambridge design consultancy now has over 100 staff and is one of the leading consultancies in their field. Their work in developing novel technology for defence and security applications has been supported by MOD's Centre for Defence Enterprise – funding innovation projects in diverse technologies, such as secure messaging, optical processing, jamming, compressive sensing, energy harvesting, signature analysis, acoustic shot detection and precise navigation and timing. Plextek Consulting's Defence and Security Group Business Development Consultant Peter Doig shares first hand experience of working with CDE to develop ground-breaking technology for defence.

The Centre for Defence Enterprise (CDE) is a unique government initiative that appreciates the true value small companies bring to fostering innovation in the defence market. CDE offers a level of support that brings significant benefits for design and manufacturing consultancies, such as Plextek Consulting.

During nine years' engaging with CDE, I have witnessed it evolve from a small team to the established, proactive organisation it is now. Since I started working with CDE, I have experienced the emergence of beneficial new initiatives, such as the allocated Phase Two budget, which has been recently introduced to potentially take successful projects to the next stage. This provides a clear exploitation route for successful Phase One projects, allowing us to look strategically, both technically and commercially, at funding calls – improving our team's ability to generate disruptive innovation and to focus on projects

that have the potential to provide real benefits to end users.

Environment of innovators

In addition to supporting select businesses, CDE provides the opportunity to connect with other members across the defence

industry. I have attended multiple successful networking events, ranging from dedicated one-to-one sessions, where I am able to discuss and develop ideas, to CDE Launch events that have helped Plextek Consulting gain an insight into



project call requirements and network with stakeholders, including the Defence Science and Technology Laboratory (Dstl), industry primes and SMEs. This level of integration within the industry is hugely important for facilitating innovation, as partnerships and agreements are easily made, driving research and fuelling growth.

CDE Marketplace

Having access to the CDE marketplace is highly important for creating new business opportunities. I have exhibited with Plextek Consulting at the MOD Research and Development Showcase and the annual CDE Marketplace – showcasing our recent projects and engaging with potential partners and MOD stakeholders. Being involved with these events provides an environment to communicate with like-minded SMEs and industry partners keen to exploit relevant research.

Our collaboration with CDE has enabled Plextek Consulting to become a recognised science and technology supplier, cementing our reputation within Dstl, wider MOD, other government agencies, and industry as a leading provider of innovative engineering technology. The support from CDE staff has also helped promote Phase one research within Dstl core research programmes, leading to an increased footprint and recognition of Plextek Consulting.

By building such a profile, I have experienced the business see an increase in direct recommendations and the creation of important new relationships, emphasising the significance of CDE to defence consultancies in the UK. ■

Having access to the CDE marketplace is highly important for creating new business opportunities.

Centre for Defence Enterprise

The Centre for Defence Enterprise (CDE) funds innovative research that could lead to a cost-effective capability advantage for UK armed forces and national security.

CDE actively seeks applications for funding from small companies, academia and anyone with an innovative idea that has a potential defence application.

CDE is part of the Defence Science and Technology Laboratory (Dstl) and funds only novel, high risk research that has high potential benefit.

With 11 members of staff based at Harwell campus in South Oxfordshire, CDE is aligned with the Government's Small Business Research Initiative, managed by Innovate UK but we has their own submission and assessment process.

Responsibilities

CDE is responsible for:

- funding proof-of-concept research that offers a high potential benefit to defence and security

- opening up defence and security challenges to the widest possible audience of providers, including those new to defence and small and medium-sized enterprises (SMEs)
- helping to take CDE-funded projects to market

Priorities

CDE's current priorities are to:

- extend its reach to new SMEs with innovative ideas
- hold regular themed competitions to address specific defence and security challenges
- promote the monthly enduring challenge competition to address the most important problems in defence
- improve routes to commercialisation following initial CDE proof-of-concept funding
- introduce a new, improved online portal for proposal submission

Photo 1–
Peter Doig (left)
meets Minister
for Defence
Procurement Philip
Dunne (right)

Government support for innovation and growth

Defence Growth Partnership

The DGP is a partnership between Government and the Defence Industry aiming to deliver a competitive, sustainable and globally successful UK Defence Sector.

www.defencegrowthpartnership.co.uk

Small Business Research Initiative

The SBRI is an established process that connects MOD challenges with industry – helping small businesses by providing finance to develop innovative ideas.

www.sbri.innovateuk.org/

UK Defence Solutions Centre

The UK-DSC is a new, independent national body formed to promote growth in defence exports. It part of the Defence Growth Partnership.

<http://defencegrowthpartnership.co.uk/>

Innovate UK

Innovate is the UK's innovation agency, working with people, companies and partner organisations to find and drive UK science and technology innovations.

www.gov.uk/government/organisations/innovate-uk

Knowledge Transfer Network

The Defence and Security Community is a part of the KTN, which explores new links and opportunities for improving knowledge transfer across all technology areas.

www.ktn-uk.co.uk/interest/defence-security/

Defence Science and Technology Laboratory

Dstl ensures that innovative science and technology contribute to the defence and

security of the UK by supplying specialist services to the Ministry of Defence and wider government.

www.gov.uk/government/organisations/defence-science-and-technology-laboratory

Centre for Defence Enterprise

CDE funds innovative research that could lead to a cost-effective capability advantage for UK armed forces and national security.

CDE is part of the Defence Science and Technology Laboratory.

www.gov.uk/government/organisations/centre-for-defence-enterprise

Niteworks

Niteworks is a partnership between the MOD, including Dstl, and industry, providing decision support to enhance current and future capability.

www.niteworks.net/

MOD Defence Science Blog

The blog features news on defence science, technology and innovation and welcomes contributions from industry, SME's and innovators.

<https://defencescience.blog.gov.uk/>

UK Trade & Investment Defence & Security Organisation

UKTI DSO helps UK defence and security industries export their products by providing specialist support to sell their goods, with a dedicated Small Business Unit.

www.gov.uk/government/organisations/uk-trade-and-investment-defence-and-security-organisation

Read the blog: <https://defencescience.blog.gov.uk/>

Future events

23 September 2015:
CDE face-to-face meetings
Fermi Avenue, Harwell, Oxford,
Oxfordshire, OX11 0QX
WED, 23 SEP 09:00

CDE how to submit an effective proposal
webinar – September 2015
FRI, 25 SEP 10:30

CDE Innovation Network, featuring 'security
for the internet of things'
61-63 Great Queen St, London, WC2B 5DA,
THU, 1 OCT 09:30

CDE themed competition webinar: security
for the internet of things
THU, 8 OCT 12:30

Find out more:

www.science.mod.uk/events_listing.aspx
cde@dstl.gov.uk
030 67704236 / 030 67704237
www.gov.uk/dstl/cde



