

An update for defence decision makers

# INFORM

February 2015

## Driving innovation in Defence



### Inside this issue:

Address from defence minister Philip Dunne MP

Innovation across the partnership: our members' views

Niteworks and Dstl working together

Recent Niteworks activities: case studies



## PROVIDING PRACTICAL, IMPARTIAL RESPONSES TO COMPLEX DEFENCE PROBLEMS

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# Introduction

by Simon Jewell, Managing Director, Niteworks

Welcome to the second edition of *Inform*. As flagged in the October 2014 issue, our focus this time is on innovation. This will not be a surprise as innovation is high on the defence agenda: but what is innovation, how does it come about, what challenges need to be overcome to deliver it, and what role does the Niteworks partnership play in its introduction? We shed light on such questions through the pages that follow.



It is tempting to think of innovation as being a relatively new concept born out of the industrial revolution or digitisation era. Yet it dates back at least to the 16th Century (see p.10 for what William Shakespeare had to say on the subject!).

There is no single accepted definition of what innovation means in practice. No wonder therefore that it remains so elusive for many. My own favoured definition, one advocated by Michael Porter, is to think of innovation as the successful *commercialisation of invention*. This captures its two essential ingredients of generating something new and doing something new with it. Yet for a concept so simple, it is remarkably difficult to achieve in a complex system, and therefore warrants our attention as a problem to address.

I am delighted that in this edition defence minister Philip Dunne MP has kindly agreed to publish his speech prepared for the Niteworks Partnership Day. Reading this you will see how central innovation is to Defence Reform and the vibrancy of the defence sector.

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### INFORM

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# News in Brief



## Members out in force for major event

**Niteworks was delighted to welcome more than 130 people to MOD Main Building in London, for its Partnership Day event.**

The gathering in October attracted senior support from the partnership, with keynote addresses provided by Philip Dunne MP, Minister for Defence Equipment, Support and Technology and Dstl Chief Executive Jonathan Lyle.

The day sought to provide an overview of how Niteworks has supported the MOD over the past year, with a particular focus on fostering innovative solutions within Defence. The MOD's Director of Corporate Strategy, Dr Roger Hutton, gave a stimulating insight into the MOD's approach to innovation, whilst Air Cdre John Philliban from Joint Forces Command talked about some of Niteworks' activities in the Open Source Intelligence domain. These efforts were recognised by the MOD in 2014 with an award under the Chief Scientific Adviser's Commendation Scheme.

The afternoon gave way to more practical sessions on how members can get involved in Niteworks activities and derive maximum benefit from their membership. Niteworks Delivery Director Rick Bounsall signposted some future tasks which are expected to be undertaken by Niteworks, before Finmeccanica UK's Sir Brian Burrridge opened the final session to consider successful models for MOD-industry collaboration. Dick Hemsley, Director of Vedette Consulting, provided an associate member's view of Niteworks.

Samantha Page, Head of Commercial / Partnering at Niteworks, said:

"We were thrilled to see so many delegates, representing around 65 organisations or almost half of our



*Philip Dunne MP attended the event, which was held at MOD Main Building.*

members. It is always difficult to carve out an agenda which satisfies the needs of our very diverse partnership, but we seek to provide an information-rich day at both the strategic and tactical level, providing plenty of opportunity for networking and engagement."

"I would like to thank all those who attended, and express my particular appreciation to those who gave

briefings on the day. The event provides further indication that both MOD and industry commitment to Niteworks remains strong."

Niteworks will be developing the format of future events, to ensure that they remain relevant and of value to the MOD and broader partnership. The next event is being planned provisionally for 2016.



*Dick Hemsley (Vedette Consulting), left, and Sir Brian Burrridge (Finmeccanica UK), right, presented at this year's Partnership Day.*

## Briefing opportunity for partners and associates

In response to feedback from its members, Niteworks has launched a series of monthly 'Coffee Break Briefings' at its offices in Farnborough. The sessions are an opportunity for members to provide an overview of their organisation's capabilities through a short presentation and Q&A session. Attendance is open to all partnership members.

The series kicked off in January, with a presentation from Head of

Bohemia Interactive Simulations (BISim) UK, Jonathan Read. BISim specialises in simulation training software and its 'Virtual Battlespace' [VBS] series has been used to train military forces around the world. At the time of going to press, further briefings from Catalyze and Lockheed Martin UK were in the pipeline.

If your organisation is interested in giving a future briefing, please send an e-mail to [comms@niteworks.net](mailto:comms@niteworks.net).

## White Paper initiative continues

Since the last edition of *Inform*, work has progressed rapidly on two further Niteworks White Papers addressing the themes of *Complex System Interventions* and *Capability Coherence*. Both are currently undergoing peer review before they are issued to the partnership for wider consultation. Coincidentally, a planned fifth White Paper is likely to focus on the theme of *Innovation*, which will once again examine how best practice from Niteworks projects can be used to tackle strategic systemic issues within MOD.

## Driving quality: Project Leads' Top 10

As part of the normal assurance process, a checklist for Niteworks project leads has recently been introduced to support the quality and consistency of the diverse projects undertaken by the partnership. The advice draws on best practice from past Niteworks projects and will act as a reference document for all project managers contracted with Niteworks.

Poster versions of the checklist are now on display in the Niteworks office in Farnborough, and will be distributed to new starters during their induction period.



There are several ideas already under consideration for future topics, but if you have any suggestions that you would like to put forward, please e-mail Mike Wilkinson, Technical Director, at [mike.wilkinson2@niteworks.net](mailto:mike.wilkinson2@niteworks.net).



## New associate members on board

Niteworks is pleased to confirm that ten new associate members have joined the partnership since the last issue of *Inform*.



Niteworks' membership now stands at 150 organisations, comprising the MOD (including Dstl), 12 Partners and 137 Associates. The announcement will ensure we continue to bring innovation and a fresh perspective into the partnership, in support of some of the MOD's most pressing issues.

# Philip Dunne MP addresses the Niteworks partnership

We are grateful to Philip Dunne MP, Minister for Defence Equipment, Support and Technology, for allowing us to publish his speech that was prepared for the Niteworks Partnership Day, held on 20 October 2014. Here is the speech in full:



Defence Minister Philip Dunne MP

## Introduction

It's a pleasure to speak to you all this afternoon. And it's great to see such a full room of influential colleagues across Defence. Which I take as a sign that Niteworks is no longer – as my predecessor, Peter Luff, used to lament – one of the MOD's best kept secrets.

## You have come far

In fact, far from being a secret, you've become a significant player in the world of UK defence capability and even an international talking point.

Using the formidable collective brainpower of the MOD, DSTL and Industry to tackle key challenges, offer innovative solutions and deliver answers. Solutions and answers that give not only the MOD and Industry a better result, but also the British taxpayer and, most crucially, our servicemen and women.

## Three winning qualities of Niteworks

Your success gives me *particular* cause for optimism because it's based upon three key behaviours that *also* lie at the heart of our Defence Reform Programme.

They are: Collaborating; Innovating and Challenging.

And since 2003, Niteworks has been proving that these principles aren't just lofty ideals but that, when put into practice, they are central to creating and sustaining a healthy and thriving UK Defence Machine.

I'd like to touch briefly on each of these three principles this afternoon.

## Collaborating

So let me start with collaborating.

For a sector that has competition woven into its very DNA, buying into

the concept of collaboration could, in itself, have been an insurmountable challenge for the members of Niteworks.

But you've not only bucked the trend. You've set a new one, with more than 140 associates and partners ranging from SMEs to Primes, and more signing up each month.

Whether it's working with DSTL to see how we can improve our Open Source Intelligence Capability or looking into simulation requirements for Merlin Mk 4 training, Niteworks is a unique and highly prized example of what Government, Industry and Academia can achieve by working together. You're proof – if it were needed – that when it comes to dealing with today's complex and interconnected problems, *none* of us is as smart as *all* of us.

And it's especially gratifying to see this happening at a time when the need for

the MOD and Industry to collaborate is becoming ever greater. A time when threats to our national security abound and when defence budgets are contracting while manpower and capability costs are expanding. A time when the UK must compete with other nations developing their own capabilities and strive to stay one step in front of its adversaries. In short, a time when we must work harder *together* to squeeze every last ounce of value from the taxpayer's pound.

## MOD: becoming fit for collaboration

But, for the MOD, making collaboration with industry the rule, not the exception, was, until recently, something of a chimera. A £38 Billion black hole in the defence budget, an overheated equipment programme, a failed procurement system and an endemic culture of financial short-termism meant we simply weren't worthy or capable partners.

That's why, back in 2010, we started taking radical steps to up our game.

Reforming our structures and practices to become a more professional counterpart to industry - one fit for collaboration.

Our transformation programme has seen defence evolve from an unwieldy, outmoded and financially-troubled apparatus into a leaner and more agile fighting machine. We've filled the £38 Billion black hole and balanced the books. And thanks to our business-like approach we now have a balanced £163 Billion Equipment Plan - giving everyone within Defence greater transparency and greater certainty to plan for the future.

Central to all of this has been the reincarnation of DE&S as a "Bespoke Trading Entity" - with greater freedoms to operate along more commercial lines and with far greater business rigour.

And, crucially, we have devolved capability decision making to the Front Line Commands, ensuring that the men and women at the coalface - who know intimately *what* equipment is needed - take responsibility for spending decisions.

## Redefining the MOD's relationship with industry

So having got our house in order, we're now redefining our relationship with industry, re-establishing it on a more equal footing - one that has *collaboration* at its heart.

We've seen it with the renegotiation of the frankly shocking Carrier Contract, where 90p in every pound of cost overruns was borne by the taxpayer. Working *with* industry, we've established a new mechanism to share pain and gain equally above a realistic threshold.

This collaborative approach represents a new way forward through closely aligning our interests with those of industry. And I want to see industry taking the initiative to adopt this approach more widely.

Not just to identify, understand and manage risk but to *bear* and *share* the risk in a spirit of partnership as we look to develop capabilities for a broader defence (and sometimes adjacent civilian) customer base.



In stark terms that means no longer looking upon the MOD as a benevolent cash cow who will fund R&D and then development cost overruns.

But our ask of industry goes beyond just risk.

In the past the MOD contracted for bespoke products, often at great expense - a story that everyone at Niteworks is very familiar with. We often received gold-plated capability but only thought afterwards how they could meet the requirements of our friends and allies. Their high specification often proved their Achilles heel when it came to selling in a generic market.

So we're determined that defence contractors build exportability into their thinking.

By actively considering it early on in the MOD acquisition cycle.

By making greater use of modularity and open systems.

And by developing and procuring equipment with partners where it makes sense to do so.

## Collaboration through DGP

But, in the spirit of collaboration, we're not just throwing our idea against the wall and seeing if it sticks.



We're creating a mechanism for collaboration through the Defence Growth Partnership (DGP).

This is about industry and government working together to identify and capture new market opportunities. And it's about harnessing the wealth of capability and innovation in the UK defence industry to ensure we can maximise our competitive advantage.

Setting Government and industry a long-term challenge to deliver a long-term strategic vision to maximise opportunities for British business and bolster the UK economy.

In recent months we've made major announcements that strengthen the DGP's hand. We've beefed up the Defence and Security Organisation to focus UK Trade & Investment even more on the needs of global customers. The new UK Defence Solutions Centre will provide the collaborative working environment in which industry can develop the new defence technologies of the future.

It's not going to be easy but Niteworks has proved it can be done.

You have shown time and time again that – despite all the potential hurdles and pitfalls – collaboration is not only *possible*, it pays dividends by:

- promoting mutual understanding between industry and Defence;
- informing good decision making;
- helping us adapt to the ever-changing environment;
- and ensuring we stay ahead of the game.

## Innovation

Which brings me onto the second principle that makes Niteworks such a success.

Innovation.

Innovation - a corollary of collaboration - the lifeblood of a thriving defence

industrial sector and crucial to sustaining World-Class Armed Forces.

It's a term very much in vogue in industry and, increasingly, within MOD.

One that's easy to say yet difficult to deliver. But 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.

From supporting the Chief Information Officer's aim to accelerate IT solutions throughout Defence, to its work on using the gaming industry to deliver simulated air training.

And, under the new defence structure, your potential to innovate is becoming ever greater as you work more closely with the Front Line Commands, helping the MOD stay ahead of the curve in a fiercely competitive world.

But, once again, with the UK's prosperity and security riding on innovation, the MOD and Government can't afford to leave it to chance. And that's why we're doing our utmost to support innovation:

By protecting S&T spend at 1.2 per cent of the Defence Budget, set to rise to 1.3 per cent this year.

By encouraging Primes to open up their supply chains to tap into the niche cutting-edge capability of our SMEs.

And – through our Defence and Security Industrial Engagement Policy – encouraging overseas-based defence and security suppliers to extend opportunities to UK SMEs and give them advice on enhancing their opportunities in the wider market place.



We're also providing financial support for research into novel high-risk, high-potential-benefit innovations through the Centre for Defence Enterprise.

However, I was interested to learn about General Dynamics' EMC<sup>2</sup> system, which can take an innovative idea to contract within 30 days, showing perhaps that there is more we can do to speed up innovation.

And here we would do well to keep our eyes on what is happening in other sectors, benefiting from the development and innovation that has taken place there and saving ourselves time in the process.

I know, for instance, that Lockheed Martin have recently been working with the Motor Sports industry.

## Challenging

But innovation is more than about conjuring up new ideas. It's about challenging perceived wisdoms.

The *third* principle that underpins Nitework's success and one that – it goes without saying – has been the linchpin of our Defence reforms.

This is an area in which Niteworks has really grasped the initiative, using its

11 years of accumulated knowledge, evidence and expertise to identify underlying systemic issues that dog defence.

Things like how to speed up the acquisition of fast-moving technologies and how to improve capability coherence.

Whilst such challenges are often easy to identify, resolving or dissolving them is an order of magnitude more difficult.

I know that Niteworks has started to stimulate a discussion across the partnership on such issues through its White Paper series. And whilst it's too early to draw any conclusions on the recommendations of these White Papers, I commend the enthusiasm shown to tackle these challenges.

It's a mindset that we must inculcate throughout Defence if we're to sustain and progress our reforms, ensuring we can, and will remain, fighting fit, well beyond the next General Election.

## Conclusion

So the Niteworks partnership doesn't only embody the behaviours that underpin defence reform.

It's key to making defence reform work.

Paving the way for closer collaboration between Industry and Defence by promoting mutual understanding. Corraling talents to drive innovation and supporting the inexorable march towards a better way of doing things by honing decision-making and challenging the status quo.

So, I want to thank you for your invaluable work.

I hope you have found today a useful chance to take stock and re-galvanise.

Because, be in no doubt, we need you to keep doing what you are doing.

So that *together*, Government, Industry and Science can

keep the UK prosperous;

keep delivering our battle-winning capabilities;

and ensure our brave Armed Forces can keep our country safe.



# Delivering Defence Innovation

## About the author

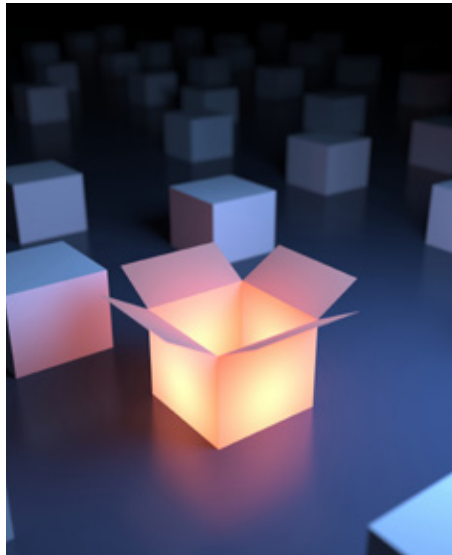
Simon Jewell has a long association with Niteworks and has been its managing director since 2012. A former military officer, he holds a first-class honours degree in Information and Communication Technologies and a Masters in Technology Management. He was previously chair of the Systems Engineering for Autonomous Systems (SEAS) Defence Technology Centre and has for the past eight-years chaired the ASTRAEA steering board that seeks to open the airspace to the routine operation of unmanned aircraft systems. He is presently undertaking doctoral studies in Defence Innovation in association with the University of Roehampton and Royal United Services Institute (RUSI). He is a fellow of the Royal Aeronautical Society.



In his book *The Fruits of War*, Michael White describes an invisible thread of military research funding that touches almost all aspects of our day-to-day lives. However, for many decades the tide has been turning, where now there is a strong inflow of commercial technologies into defence from where many first evolved. As a result, over the last three decades, defence has gradually transformed from operating a closed innovation model to a stance of being predominantly Open Innovation, although it is a moot point whether this was a deliberate act or as a consequence of wider Defence Reform. For example the Infographic that directly follows this piece reminds us how commercial information and other technologies are changing the battlespace.

I have to admit to being initially underwhelmed by Henry Chesbrough's concept of Open Innovation. When people spoke about it over a decade ago, they did so using hushed and reverential terms; it had already rapidly acquired cult status. Yet Chesbrough's introductory lines left me flummoxed; they said:

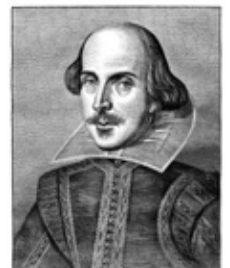
*Open Innovation is a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as the firms look to advance their technology.*



Really, I thought, that's it – *quelle surprise?* It was not until I read on and reflected on my own experience that I realised complexity lay not in the concept, but in its implementation. Pursuing this theme, as part of my own research into Open Innovation conducted in 2013, I surveyed a sample of companies working in the defence sector. In response to the question, "Do you believe open or closed innovation offers better advantage to your company?" virtually all respondents stated that open innovation was the way ahead. In response to the question "Have you implemented an Open Innovation strategy?" the answer was again overwhelmingly yes. Yet when asked, "Has your company successfully adopted an Open Innovation paradigm?" the answer was overwhelmingly no.

There was clearly more to this than meets the eye.

Before moving on it's worth stepping back to define innovation as the world is not short of descriptions for it. A personal favourite, one advocated by Michael Porter, considers innovation as the *commercialisation of invention*. This captures the two essential ingredients of generating something new and doing something new with it. Yet for a concept so simple, it is remarkably difficult to achieve in a complex system such as defence. I have my own belief why this might be the case that is encapsulated within Shakespeare's use of the term *hurly-burly innovation* in Henry IV, Part I, Act 5, Scene 1, written over 400 years ago!



*"To face the garment of rebellion  
With some fine colour that may  
please the eye  
Of fickle changelings and  
poor discontents.  
Which gape and rub the elbow  
at the news  
Of hurly-burly innovation"*

Henry IV, Part 1, Act 5 Scene 1

In the scene, Shakespeare highlights the heretical nature of innovation and challenges the presumption that all innovation is intrinsically better. These are worthy concerns though there is a fine line between worrying about the future and clinging to the past (see Box 1). When considering innovation's potential heretical qualities it is worth recalling Shakespeare's 1597 work pre-dated Francis Bacon's *Novum Organum* (1620), that led to the establishment of the scientific method and the principle of sensory evidence, rather than authoritarian-based beliefs, that had until then largely shaped opinion. And should we rush to dismiss this as pre-enlightenment thinking and rambling from a bygone era, the 20th century economist, Schumpeter, himself building on Kondratieff's earlier work on technology cycles or waves, amplifies the point by challenging established mantras and norms through his concept of Creative Destruction. He argued that economies and companies that fail to mutate are doomed, a point reiterated by Alan Greenspan, speaking in 2008 on the economic downturn. There is clearly a tension that exists between innovation's potential and the desire for stability by incumbents. Where this arises, resistance within the enterprise system elements occurs, inhibiting innovation and causing a failure to commercialise. Niteworks' experience suggests that establishing an Innovation Eco-System that close-couples the key actors, establishing an innovation culture with clarity of vision, empowerment and good communications are all necessary steps to overcome such resistance.

So what is Niteworks doing to help deliver this? Niteworks' Strategic Goal 2 requires: *An organisational culture that encourages entrepreneurial spirit and innovation, underpinned by robust analysis and*

*practical thinking, delivered with a sense of urgency. In so doing making Niteworks the place where people want to work to further develop their understanding of defence issues and where learning is turned into transferable best practice for the MOD in an environment of open collaboration.*

This goal translates into a number of interwoven customer-focused strands. Firstly, the *Continuous Capability Evolution White Paper* (see *Inform Issue 1*) provides an Innovation Blueprint for MOD to establish Innovation Eco-Systems within its acquisition stream. As a result all Niteworks projects are required to explore the opportunity for innovation as part of their challenge function. Secondly, Continuous Improvement, where projects such as OSINT and Brockworks have successfully demonstrated the benefits and advantages of close-coupling the current military capability, innovation environment and acquisition system, helping to overcome the organisational resistance that might otherwise occur. Thirdly, Dissemination, where learning is being incorporated into projects as diverse as Brigade Command and Control, Enterprise Challenge 15, Cyber and beyond.

In closing an observation on asymmetry: given the scale disparity between the activities and Defence as a whole, such initiatives might sceptically be considered as a few scattered seeds, rather than roots, let alone shoots. However, there is no reason why such seeds should not grow fast in fertile soil, tilled through a locus of localisation; thereby leveraging a key feature of the Levene Reforms. Perhaps it will be the ability to deliver localisation that will be the true determinant of Defence Innovation's success or failure?

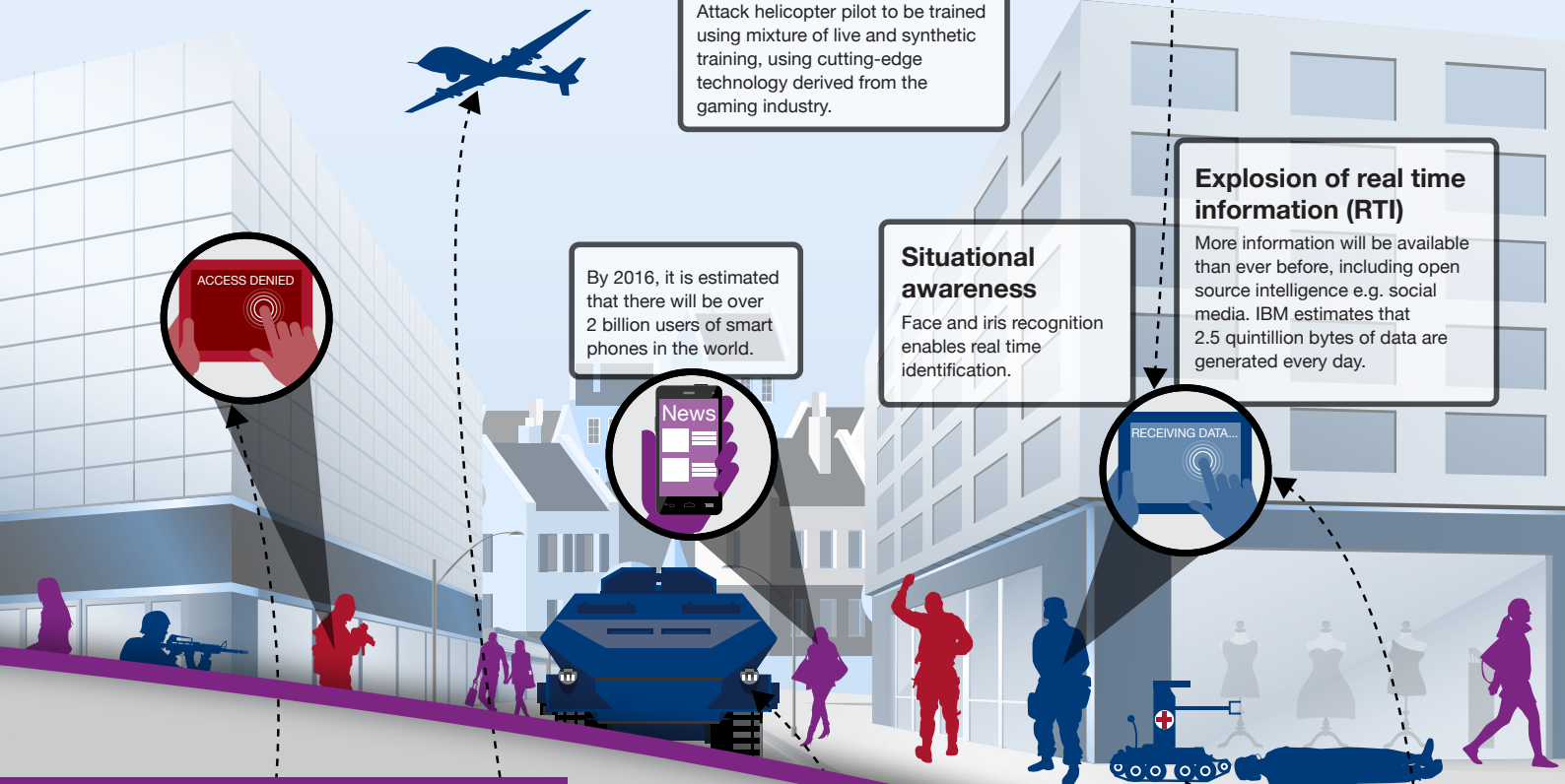
### Box 1

The difficulty of introducing new capability that is disruptive is well documented. Christensen's excellent book *The Innovator's Dilemma* describes how businesses are generally good at spotting disruptive technologies, yet frequently do not progress them. This is because their mainstream customers initially do not desire them, as mature technologies are usually more capable than the fledgling disruptive technologies (at least initially), and even where niche customers do express an interest in the fledgling technologies, the markets are generally small with low risk-reward ratios. However, if you don't act, somebody else may and today's disruptive technologies fast evolve into tomorrow's mature technologies, and a loss of market share may quickly follow.



# Innovation in the 21st century battlespace

## The battlefield...



Approximately 1,100 active satellites orbiting the earth today.

**Use of technology in training**  
 Attack helicopter pilot to be trained using mixture of live and synthetic training, using cutting-edge technology derived from the gaming industry.

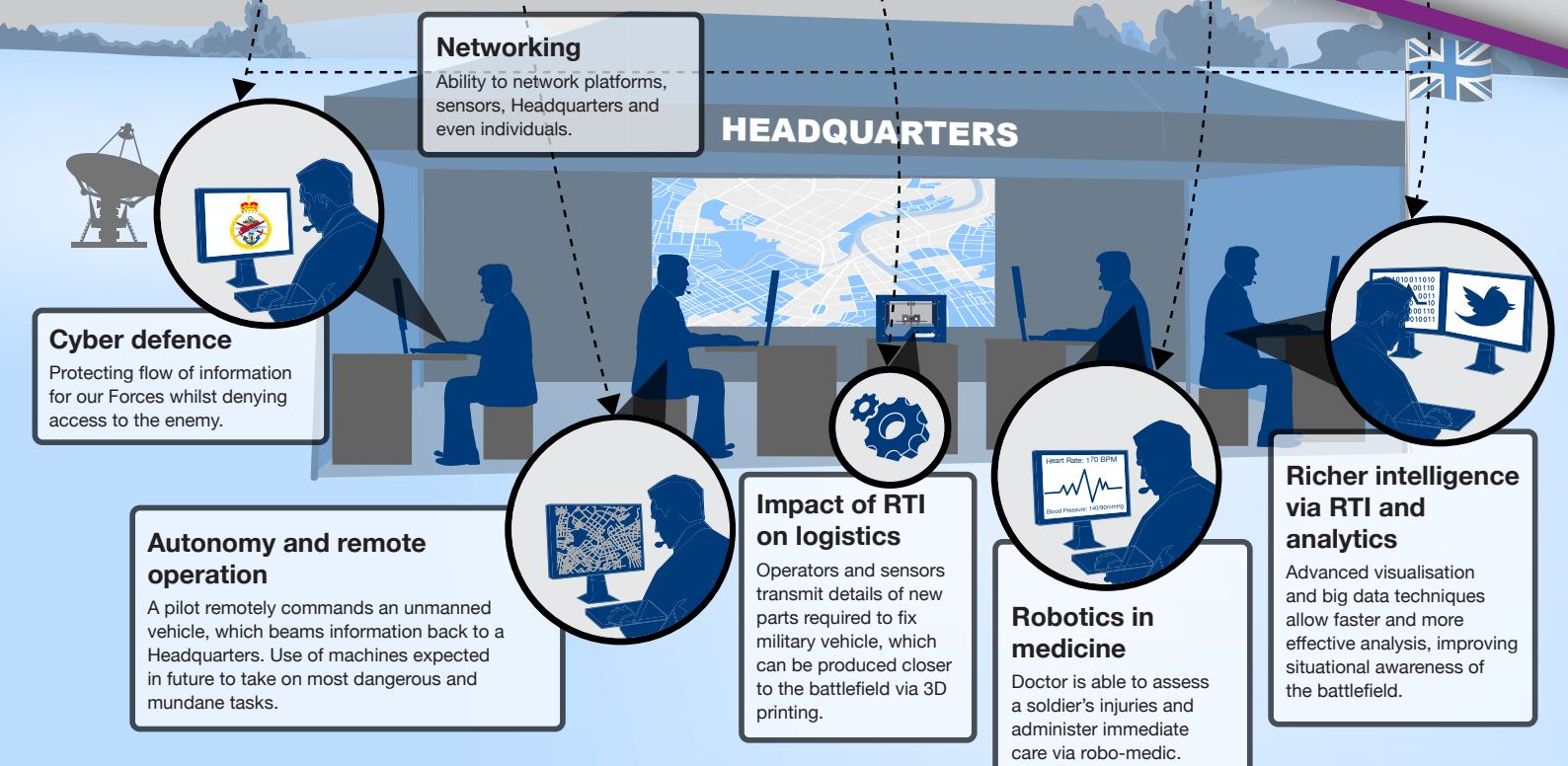
**Explosion of real time information (RTI)**  
 More information will be available than ever before, including open source intelligence e.g. social media. IBM estimates that 2.5 quintillion bytes of data are generated every day.

**Situational awareness**  
 Face and iris recognition enables real time identification.

By 2016, it is estimated that there will be over 2 billion users of smart phones in the world.



## The battlespace...



**Networking**  
 Ability to network platforms, sensors, Headquarters and even individuals.

**HEADQUARTERS**

**Cyber defence**  
 Protecting flow of information for our Forces whilst denying access to the enemy.

**Autonomy and remote operation**  
 A pilot remotely commands an unmanned vehicle, which beams information back to a Headquarters. Use of machines expected in future to take on most dangerous and mundane tasks.

**Impact of RTI on logistics**  
 Operators and sensors transmit details of new parts required to fix military vehicle, which can be produced closer to the battlefield via 3D printing.

**Robotics in medicine**  
 Doctor is able to assess a soldier's injuries and administer immediate care via robo-medic.

**Richer intelligence via RTI and analytics**  
 Advanced visualisation and big data techniques allow faster and more effective analysis, improving situational awareness of the battlefield.

# INNOVATION WITHIN INDUSTRY

We asked our Partner and Associate members about their approaches to innovation. Here's what they told us.

## GENERAL DYNAMICS United Kingdom Limited

### EDGE UK®: delivering innovation

General Dynamics UK works innovatively with Small-and-Medium-sized Enterprises (SMEs) and academia through EDGE UK, its innovation hub based in South Wales. EDGE UK is a unique model in which General Dynamics UK, SMEs and academia come together as partners with government organisations and the user community in an open environment to rapidly deliver new technologies and innovative capabilities to defence customers around the world.

Projects are undertaken in a fully collaborative manner with an integrated project team comprising General Dynamics UK's engineers, SMEs and/or academia working together. All Intellectual Property Rights are fully protected and projects tend to be short in duration, often between 10 days to three months, from start to finish. Removing any formal contracting between the parties streamlines the process and ensures genuine buy-in from all sides.

Should a project be successful, it is demonstrated at a one-to-one meeting or at a variety of trade shows and events to highlight its capabilities

to customers. The intention is to deliver the innovative solution to the end user in rapid time.

Since its inception in 2008, the EDGE UK has had a strong track record of delivering new capabilities, removing risk and helping to shape future customer capability requirements. For example, in collaboration with SMEs and academia, the EDGE UK has delivered Bowman CHAT, an innovative instant messenger

service on the Bowman tactical communication system that is utilised regularly by the British Armed Forces, as well as new flexible radio antennas for dismounted British soldiers.

The EDGE UK is part of a wider EDGE Innovation Network within General Dynamics Mission Systems, with innovation hubs right across North America focusing on different technological challenges.



Photo: General Dynamics UK

# QinetiQ

## The QinetiQ hackathon – focusing innovation on real business challenges

By Jeremy Ward, Chief Technical Officer, QinetiQ Group

Innovation is one of the most reliable and persistent drivers of business growth and technology advancement. For QinetiQ, innovation is the process of turning ideas into profitable business ventures – be they product or service based – that solve customer problems.

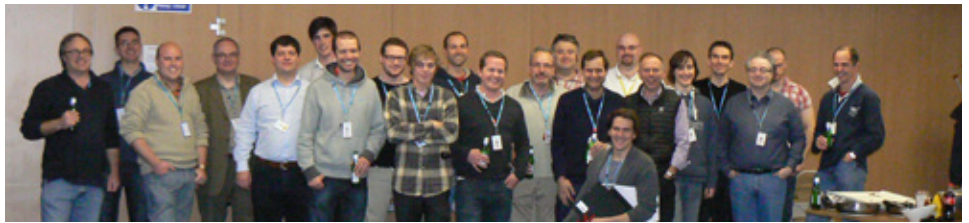


technical challenges. These challenges could come directly from our customers, from our internal employee suggestion system, “My Contribution”, or be raised by one of our operating businesses. The hackathon experience focuses participants on increasing the commercial potential of an idea, and has led to better quality of future ideas as participants quickly learn through collaboration.

Importantly, a hackathon is not a brainstorming event; participants have to produce tangible output to be eligible to receive a prize at the end. As a result, the QinetiQ hackathon format has opened a new channel to trial many different new business opportunities simultaneously, for little cost.

Winners of the “most promising ideas” at previous hackathons have included Open Source Intelligence modelling, Line of Sight Apps for the British Army, a UAV for the fire service, an improved Helmet Cam and Laser Range finder.

Run as a two day event, the QinetiQ hackathon format provides a forum to ‘rapidly prototype’ innovative solutions to real business and



Participants and judging panel from the first QinetiQ Hackathon on 22/23 November 2013.

# CGI

By Dr Robert Morton, Defence Advisory Group, CGI

Innovation means different things to different people. All too often, the first thought is to technical innovation, but this is a limited view that may miss process, organisational, commercial or service improvements that may or may not be enabled by technology. At CGI we define innovation as:



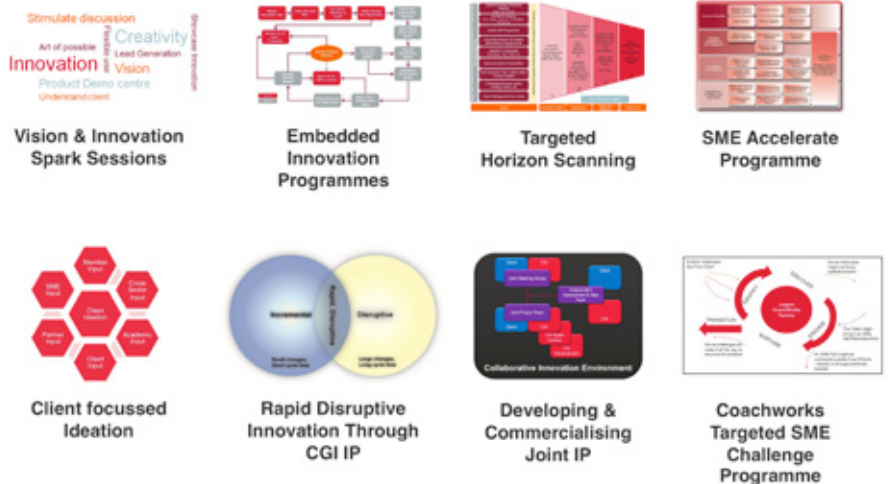
*“The successful exploitation of an idea that is new to you, leading to a positive business benefit.”*

The majority of innovation we see is not the result of brand new thinking, rather, it is the transfer of a successful solution from one context to another where it adds value.

Sometimes innovation can be confused with a “quick-win” culture that identifies and addresses short term and small scale improvements. In our view, for true innovation that delivers game-changing benefits, the opposite approach is needed. The ability to innovate comes from a deep mutual understanding between the client and the innovation partner built on trust developed over time.

We have a number of innovation methods that we use to achieve this, as summarised in the figure below.

An example of this is our work with The Crown Prosecution Service (CPS). We work closely with the CPS to make best use of its investments and to map out how the evolving business can harness technology. We bring ideas to the table, collectively explore their potential and select the best ones to take forward based on delivery of benefits. For example, in recent years we have provided 4000 secure tablet devices to allow electronic presentation directly to the courtroom.





In 1939 a shared passion for innovation brought two friends together in this garage, the birthplace of Silicon Valley. 76 years later this heritage permeates our culture and innovation remains at the heart of Hewlett-Packard (HP).

But innovation at HP is not just about technology. Incremental process innovations may underwhelm the radicals but they vastly outnumber moon landings and tend to stick. What is clear to me, though, is that our ability to help customers innovate demands a deep understanding of their challenges, priorities, culture and, critically, appetite for risk and change.

Compelling events such as wars stimulate innovation by raising risk appetite. With enduring resource pressures, today's most compelling

event could be the maintenance of effective combat power through efficiencies. Vital for national security, with major shifts in focus and capabilities required, but innovation here is against a peacetime risk appetite.

A general recognition of the value of unstructured 'human information' or big data appears to me (and many major corporations) a compelling event.

An enterprise approach to big data will demand innovation in technical,



*The HP Garage is known as the Birthplace of Silicon Valley.*

commercial and operational effort. Making sense of data better/faster than competitors will be essential: as relevant for supermarkets as armed forces – albeit somewhat different stakes. Technology can help. Data analytics will be the enabler for affordable information superiority and 'back-office' information compliance. As a former intelligence officer and manager I want both, now! But such innovation demands curiosity and risk taking. Time perhaps for a drop of courage and some garage spirit?

**The author is Ross Bailey, Intelligence & Analytics Campaign Lead in HP Enterprise Services, and previously an RAF Intelligence Officer.**



## AIRBUS GROUP

Innovation is part of Airbus Group's DNA and, through the promotion of cutting edge technological advances and scientific excellence, it gives us the opportunity to contribute to a better environment, reduce reliance on fossil fuels, ensure mobility for generations and strive to deliver benefits to society as a whole. Through Airbus Group Innovations, the given name for our dedicated team of more than 1,000 scientists and engineers, based at 15 sites worldwide, Airbus Group is at the forefront of research and technology.

Through this network, we foster technological excellence and business orientation through the sharing of competences and means between our three business divisions - Airbus, Airbus Defence and Space and Airbus Helicopters - and our partnerships with world-famous

schools, universities and external research centres.

Airbus Group Innovations R&T budget is 70 percent driven by the requirements of the three Airbus Group business units, and 30 percent by its Chief Technical Officer's vision for potential technological game changers. These types of revolutionary technologies include the E-Fan, the first fully electric training aircraft constructed from composite materials (see image above right), which completed its maiden flight in March 2014. Through projects like the E-Fan and E-Thrust, Airbus Group will provide a long term model for civil aviation, which will reduce fossil fuel usage and carbon emissions, securing mobility for future generations.

The smaller scale demands for innovation from our business units also have the potential to make a significant impact, through incremental advances and efficiency



improvements. Our research covers a broad range of disciplines and materials from composites, metal and surface technology to mechatronics and IT topics. It is the work on these projects which can bring more immediate advances to our production and development processes, our products and potentially our daily lives.

All of the developments that Airbus Group Innovations have worked on, and are still working on, are only possible thanks to our pioneering teams of people with curiosity, vision and a desire to make the technologically impossible, possible.

## PROJECT SPOTLIGHT

### Innovation in action at Niteworks

# Exploiting Open Source Intelligence through innovation

## Project summary

Niteworks has been assisting the MOD in its search for an enhanced Open Source Intelligence (OSINT) capability, whereby the plethora of non-classified and publically available information can be best utilised by the MOD and the UK intelligence community to ensure the security of the United Kingdom.

## How did Niteworks approach the task?

This task has sought to develop an approach that fuses together a range of problem solving approaches and techniques to offer an agile, iterative solution to the issue of OSINT, in order to determine increasingly detailed patterns and trends in human activity.

In 2012, the MOD asked Niteworks to develop a Concept Capability Demonstrator (CCD) that would examine its Key User Requirements for an OSINT capability and recommend solutions that could be applied across the intelligence community. Niteworks responded by pulling together a multi-disciplinary team of information specialists from across the partnership, who conducted a series of experiments to examine the range of technologies available. Through these experiments, the CCD was able to consider the functionality of various software tools to exploit the rich sources of commercially provided insight that are now available.

As a result of this initial phase of work, Niteworks recommended that the MOD adopt an “innovation



environment” which could be transitioned out to key MOD sites. This consisted of a new approach to generating and exploiting new ideas, underpinned with appropriate technology, tools and test environments. By the end of 2013, the second phase of the Niteworks CCD had proven the concept of an Innovation Hub as an enabler for activities across MOD and industry. The Niteworks team then looked at the high level architecture options and some of the challenges that these generated, including security. Finally, as the MOD is taking a service-based approach to the CCD, whereby it has decided to acquire this capability through a number of services provided by industry, the Niteworks team visited a number of partners to look at how MOD might define the service they require.

Under the third phase of work, Niteworks is now supporting the MOD in its move to acquire an OSINT capability in 2015. Niteworks is also helping the acquisition process by supporting the development of robust

requirements and drafting a range of key documents such as a Concept of Use (CONUSE) and Concept of Employment (CONEMP).

## What was the outcome?

Innovation lies at the very heart of the Niteworks OSINT programme. As a result of its support, the MOD is now taking a new approach to procuring this key capability. This will ensure that the solution that it delivers incorporates the latest technology and avoids the risk of being rapidly obsolete given the pace of technology change. Through demonstrating what the innovation process looks like, Niteworks is supporting the MOD to procure OSINT capability in an incrementally evolving way, drawing on the very best practice from across the partnership.

## Benefits

- MOD and the Intelligence Community will be able to safely exploit a vast and untapped information resource, in real-time
- Industry participation in the OSINT CCD via Niteworks has significantly contributed to its success and has driven the establishment of MOD’s future engagement strategy on OSINT
- The Innovation process that has been developed under the Niteworks OSINT programme is now being explored by the MOD’s Chief Information Officer for applicability to wider Information, Services and Systems transformation



# An Associate's View of Niteworks

Niteworks currently has 150 members, of which around 42% are small and medium-sized enterprises (SMEs)<sup>1</sup>. With this edition's theme of innovation in mind, we spoke to John Barrass, Director of Montvieux, one of the SMEs involved in the cutting-edge Niteworks Open Source Intelligence (OSINT) programme profiled on page 16.

## How did you find out about Niteworks?

Several of us had worked on Niteworks-led technology demonstrator projects in the past and we were providing technical and project leads for several programmes through Niteworks associates. It seemed a natural next step to become an Associate company ourselves.

## How long have you been an Associate?

Since August 2013.

## How have you been involved so far?

Our involvement so far has been to provide technical leadership and project management for cyber and related programmes, and we are now delivering the Social Media Intelligence Predictive Analysis and Exploitation Service (SPAES) under the OSINT Concept Capability Demonstrator project.

## What value do you think Niteworks provides to you and your company?

As a Niteworks Associate we get an insight into the longer term direction of Defence. That enables us to look ahead and develop capabilities that we need to meet future challenges. The contracting mechanism is great for SMEs such as ourselves and we have developed a good working relationship with the Niteworks technical and commercial team.

## What expertise do you bring to the partnership?

Our expertise in Internet facing systems, complex data, machine learning and analytics, is widely recognised and we have a growing portfolio of Big Data projects and capabilities. We are also conducting next-generation research building our expertise in machine intelligence.

## How important is innovation at Montvieux?

Innovation is fundamental to our company identity. We operate at the leading-edge of turning science into engineering and recognise that this wouldn't be possible without highly capable and creative staff. Our people are our most important asset.

## How do you encourage it within your organisation?

From the very beginning we have reinvested 20% of our effort in to internal research. This approach has resulted in an enduring staff-led research programme looking at the novel, innovative and unusual. This enables our team to continue to develop their technical skills, and explore the latest concepts and technology. The benefit this brings the company is a really diverse range of experience and knowledge, which we are able to apply to create cutting-edge solutions to our customers' problems.



*John Barrass,  
Director of Montvieux*

## How do you ensure that innovative ideas are put into practice within your organisation?

Practical exploitation of our work is critically important to us; this shapes our culture and focuses us on providing practical, useful outputs to our customers. Knowing that our work has been exploited provides us with the valuable real-world feedback that is essential for us to continually improve.

## How can Montvieux help Defence to exploit the latest innovations?

The pace of technological change means that solutions need to be flexible and able to exploit new technologies as they appear. We have many years' experience of delivering research, services and solutions, and we understand the importance of open architectures that are able to adapt and evolve to exploit the latest innovations.

1. Figures based on members who identified themselves as SMEs at the point of joining Niteworks.

# Dstl ■ its involvement in Niteworks ■ and approach to innovation

**Niteworks' Chief Scientist is seconded from Dstl. Here he discusses the various ways in which Dstl plays a role in the partnership and provides an insight into Dstl's innovation activity, including potential future synergies with the Niteworks approach.**

Dstl plays a role in Niteworks in several different ways; via its permanent staff embedded in the core team, other staff embedded in temporary roles in Niteworks project teams, and sometimes also as a customer for Niteworks tasks.

As one of the MOD organisations involved in the delivery of Niteworks, Dstl provides three permanent full-time staff into the Niteworks Technical Team, of which I am one. All three of us have a primary role providing Technical Assurance of Niteworks projects. Our main responsibilities are to provide technical guidance and advice to Niteworks projects in their early stages, and to conduct technical scrutiny and review in their later stages. This means ensuring that the project outputs meet the original aims of the customer, and that the evidence presented supports the

conclusions and recommendations they make.

We also have a secondary role providing a liaison role between Niteworks project teams and Dstl teams working in related areas, to ensure that the wider Science and Technology (S&T) context is understood. In addition to the permanent staff, where there is a requirement for specific key skills or knowledge (e.g. architecting or training and simulation), Dstl provides additional staff embedded on a temporary basis into Niteworks projects.

As Chief Scientist, I lead on the strategic relationship between Niteworks and Dstl. In particular, this means seeking to ensure the collaborative nature of the relationship is maintained and strengthened



and improving the coherence of the Niteworks programme with the wider MOD S&T programme, which is mainly delivered through Dstl. Recently I have fostered a more open relationship between the Dstl team that runs the Synthetic Environments Tower of Excellence and the Niteworks team working on the delivery of the Defence Operational Training Capability (Air) project, and conducted awareness briefings to Dstl forums explaining how Dstl can best use Niteworks as a unique way of engaging collaboratively with industry.

**In addition to its role in the delivery of Niteworks, when Dstl has a requirement for conducting work in close collaboration with a broad spectrum of Industry, Dstl also directly tasks some Niteworks projects. There are several reasons why Dstl might use Niteworks to engage collaboratively with Industry:**

To provide an impartial second opinion from an industry perspective on an issue

To give advice to enable more deliverable requirements

To advise on industrial or commercial best practice

To propose new ideas that challenge the perceived wisdom in MOD

To help understand what is technically feasible or commercially viable

To offer a pan-DLOD appreciation of potential delivery solutions

To facilitate collaborative engagement across the enterprise

## Innovation at Dstl

As you would expect, Dstl is very focused on the discovery and use of novel technologies as well as testing the latest scientific theories for Defence applications.

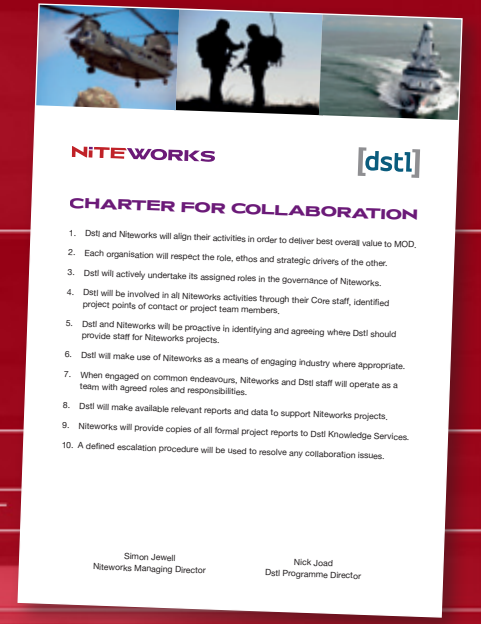
There is an active 'Knowledge, Innovation and Futures Enterprise' strand (KnIFE) within the Dstl S&T programme that is aimed at exploring these ideas (e.g. via Horizon Scanning for emerging technologies with potentially game-changing applications for Defence), and developing collaborative tools and techniques for fostering greater innovation. In addition Dstl manages the well-established Centre for Defence Enterprise (CDE), which has been active for a number of years, successfully stimulating and harnessing innovative ideas from SMEs to some particularly intractable MOD problems.

More recently, under direction from the MOD Chief Scientific Adviser

(CSA), Dstl has sought to increase the proportion of the CSA funded S&T programme devoted to exploring where some key emerging technologies may have the potential to have a disruptive effect on future Defence capability.

Harnessing innovation is definitely an area in which Dstl and Niteworks could work together to achieve more in the future, potentially by combining elements of Dstl's innovation activities with the Niteworks approach of fostering innovation via collaborative models. By being involved in the Niteworks innovation model, Dstl can contribute its key insights and ideas on novel technologies whilst gaining the benefit of exposure to wider innovation from across the Defence enterprise. This includes the innovative business models and processes and organisational constructs or services that are required if those novel technology applications are to become an exploited reality.

**The Niteworks-Dstl Charter for Collaboration sets out the principles for how these two organisations work together. The Charter has been updated to reflect the more collaborative nature of the Dstl-Niteworks relationship and different types of engagement between the two organisations.**



# Innovation: A view from academia



Keith Goffin is Professor of Innovation and New Product Development (NPD) at Cranfield School of Management. He worked for 14 years in marketing and NPD at Hewlett-Packard and has published extensively on the subject of innovation management. Dr Arnoud Franken is a Lecturer in Change Management at Cranfield School of Management. He has researched and published with the Royal Marines on their rapid adaptability to disruptive change, and has worked for many years with DE&S and Front line Commands to realise benefits from investments in new military capabilities. Here, Keith and Arnoud provide an academic perspective on the role of innovation management within business. Cranfield University is an Associate member of Niteworks.



Professor  
Keith Goffin



Dr Arnoud  
Franken

We are often asked why we think that innovation tends to fail within many organisations. Our view is that it usually due to a misunderstanding of innovation itself and the absence of good innovation management. Innovation is not simply about the big breakthrough products (radical innovation) and it is not just about technology. It is also about the modification of existing ideas (incremental innovation) and it applies to processes and services as well as technology.

Different approaches are required to deal with the different types of innovation. Incremental innovations – improvements to existing products in existing markets – are important but there is a danger that companies focus exclusively on such projects, as they feel more comfortable approving projects for markets they understand fully.

We know that there are potentially very high rewards for successful radical innovations, but they also come with much higher risk. This means that organisations need to have a plan for some projects failing and they must be prepared to make ruthless decisions early on if a concept or idea is not looking viable. Even top companies such as

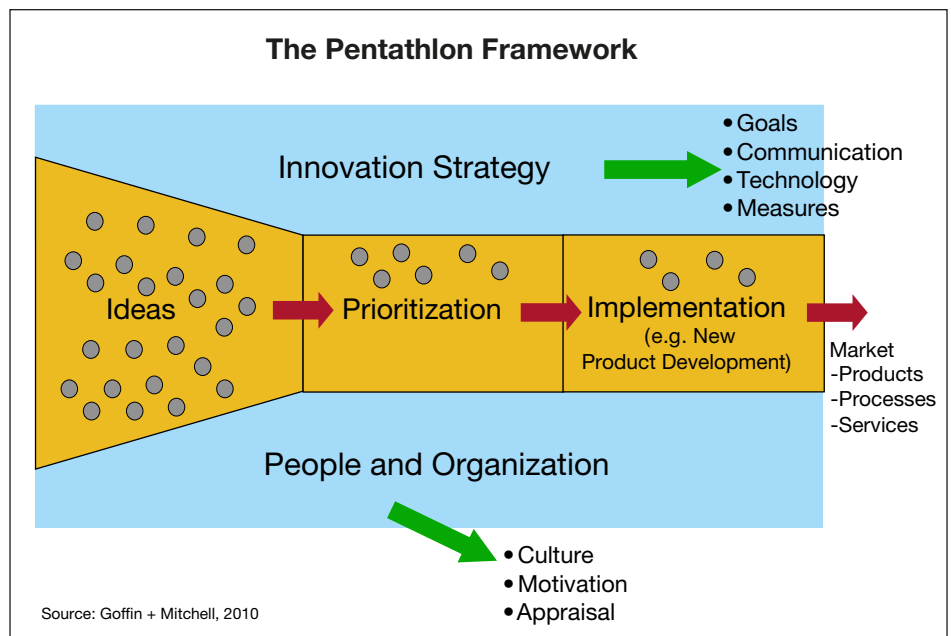
Apple have some innovations that fail. However, a company without any radical projects in its portfolio is not going to become a leader.

Organisations also need to recognise that innovation is cross-functional by its nature. It is not only found in the R&D department – it also cuts across operations, finance, human resources and external resources (e.g. using open innovation through contact with experts and suppliers).

The vast majority of companies have cross-functional teams but few of them are really effective at eliminating

silos in their new product or service development. In public, senior managers state that they have effective cross-functional teams but in private, they admit that silo mentality persists and teams lose momentum because each function is primarily interested in its own goals, rather than those of the project.

To illustrate the five main areas required for successful innovation management, Cranfield School of Management uses the Innovation Pentathlon Framework (see figure below).



The Pentathlon analogy is a useful one because it reminds us that managing innovation needs good performance in five disciplines rather than just one. These areas are:

**Innovation strategy:** the first step for senior management is to ensure that there is a clear, well communicated innovation strategy with the resources in place to support it. It is also essential to evaluate innovation performance through the use of appropriate measures.

**Ideas:** these are the raw material for innovation so managers need to create a supportive environment at the individual and team level, using creativity techniques and advanced techniques for identifying customers' hidden needs to draw them out. A large number of ideas need to be generated, the most successful of which will blend technical, user and market requirements. The scope needs to be kept wide and should involve external sources.

**Prioritisation:** an efficient process is required to ensure that the best ideas are chosen for development into new products, services and process innovations. This requires suitable tools to analyse the risk and return of individual projects. Managers need to collate the information across the range of projects to check that the portfolio of innovation projects is balanced and matched to the organisation's innovation strategy. Retaining information on portfolio decisions is also useful to enable future management teams to review and learn from previous decisions.

**Implementation:** this phase focuses on the quick and efficient development of new products, services or processes (or a combination of these). Faster development times can be achieved

through effective cross-functional teams, prototyping and testing. This process is an area where organisations can learn from each project in order to improve future performance.

**People and organisation:** underlying innovation are many issues related to the management of human resources. These include hiring and training policies, job design and creating effective organisational structures, which will increase innovation outputs. Creating a culture of innovation in which employees are motivated to be constantly innovative is fundamental. Effective reward and recognition programmes play a key part in making this happen.

There are two key points to note about the Pentathlon framework.

- (1) Each of the five elements is, in itself, a complex area and so it is not surprising that innovation management is hugely challenging.

- (2) Top performance in one element alone will not lead to long term competitiveness. Many organisations focus on generating more ideas without considering how the best ideas can be selected, resources allocated and implementation quickly achieved.

Finally, we wanted to end on a reference to the defence sector. Having worked with our colleagues at Cranfield Defence and Security, we think that there are two main areas that defence must focus on in order to improve innovation pull through. Firstly, there is a requirement to focus more on the user, identifying hidden and longer-term needs rather than today's obvious ones. Secondly, there is a need for faster and more flexible development. Both of these points are critically important considering the long service lifetimes of military equipment, where changing requirements demand flexible capability.

## Example of innovation working within the defence environment

The US Army's Rapid Equipping Force (REF) was initially set up in 2002 following the successful, rapid introduction of a new robotic capability to reduce the casualties on operations in Afghanistan. The REF has evolved over time through its constant focus on looking for new ways to speed up processes and to develop innovative solutions for soldiers on the ground based on the latest operational requirements.

One of the REF's most significant developments is the Expeditionary Lab (Ex Lab) - an easily-deployable engineering hub, which contains

state of the art equipment such as 3D printers, Computer Numerical Control Machines and fabrication tools. Two Ex Labs were sent directly to remote areas of Afghanistan in 2012, providing soldiers with immediate access to scientists and engineers who could design custom-made solutions on site to meet the latest operational needs.

The Ex Lab can be deployed to support US Forces wherever it is required around the world and has also helped solve equipment issues for British Forces.

# NITENETWORKS PROFILE



## Major Mike Baxter, Niteworks Military Advisor (Land)

I'm currently working as the Military Advisor (MA) to Niteworks. The partnership provides the MOD with quick access to expertise for military capability decision support and as such, the job is pretty unique and certainly varied!

As an infantryman, I've had the usual roles at Regimental Duty in the Mercian Regiment, but count myself lucky to have also had some more unusual jobs, which have given me the varied background and experience that help me to "add value" to the various project teams working at Niteworks.

For example, I was the "Digitization Officer" for HQ 12 Mechanized Brigade when they became one of the first units to convert to Bowman in 2004, which involved a considerable amount of "tech". I was also a Ground Liaison Officer for an RAF Chinook Squadron, which has given me more "tri-service" experience. Finally, my last job was as the Chief of Operations & Training at the Afghan Consolidated Fielding Centre in Kabul; a lone Brit working for a NATO organisation responsible for manning, equipping, training and deploying newly-formed Afghan units.

I now work in an office at the Farnborough Aerospace Centre, which is the "headquarters" of Niteworks, alongside a joint team of around 30 MOD (DE&S Civil Servants), Dstl and industry personnel who provide the Niteworks Core Team. In addition, we can have up to 250 individuals on secondment



*Maj Mike Baxter (pictured whilst deployed in 2012-13 as Chief of Operations & Training at the Afghan Consolidated Fielding Centre in Kabul)*

from member organisations of the Niteworks partnership working on various projects. My job is to liaise with the project teams, provide advice and "liaison" about their tasks (from the "military user" perspective) and also to brief the wider MOD on the role of Niteworks. Although I work, primarily, in the "land environment", I also get involved in wider Defence projects and travel to a variety of locations to brief MOD organisations and industry.

As well as the "liaison" role, I've also been involved in some of the Niteworks projects as a member of Military Judgement Panels, workshops and as a Data Gatherer for experiments into Dismounted Situational Awareness (on Exercise ASKARI STORM in Kenya) and Brigade HQ Command & Control (on

Exercise COMBINED ENDEAVOUR in Germany). I was also fortunate to be part of a UK delegation that attended the Light Armoured Vehicle User Nations Group in the United States, looking at the use of "medium capability" platforms by other armies. I've thoroughly enjoyed the opportunity to get involved in a wide range of projects that really could improve the way that the MOD works and also enhance Defence capability.

There is really no such thing as a "typical day" in Niteworks, but the common theme is the way that it can bring together people from MOD, Dstl, industry and academia to help solve some of the problems that challenge the MOD today. Hopefully, my experience and background contribute to that.

# Project in depth

## Brockworks: driving a more effective approach to the procurement of commercial off the shelf (COTS) services

### Background

Since the start of 2013, Niteworks has been supporting the MOD's Programme in investigating innovative approaches to the future acquisition of information services, through a project named *Brockworks*.

The MOD Programme was designed to create a new model for defining, acquiring and managing core Information and Communications Technology (ICT) networked services. A primary purpose of the Programme was to support the MOD's Information Systems and Services (ISS) organisation in its aspiration to move away from a small number of long term and inflexible infrastructure supply contracts, towards a more flexible service orientated approach.

Identity and Access Management (IdAM) is the act of controlling who gains access to which information and which actions they are able to perform. ISS has a key requirement for a new IdAM solution – including an integrated set of policies, processes, standards and technologies – for the creation and management of digital identities and associated privileges. This requirement formed the focus for the *Brockworks 4* phase of Niteworks activity.

### How did Niteworks approach the task?

Niteworks was selected to deliver this role because of its ability to quickly pull together a small, focussed team of industry and defence experts and to deliver a solution with no commercial agenda. Niteworks was able to provide an approach where it was possible to quickly determine if a solution was viable through the integration of COTS-based technology.

It is recognised within MOD that there are considerable barriers and challenges to the delivery of a coherent IdAM solution across the MOD, Other Government Departments, partners and industry. This has resulted in the identification of current IdAM capabilities and gaps and the formulation of the MOD's IdAM roadmap for IT infrastructure architecture at the OFFICIAL security level.

The aim of Brockworks 4 was to help MOD's development of a future IdAM solution focused on the OFFICIAL tier, through the practical demonstration of key concepts and relevant technologies. The project built on and refined the Brockworks approach to service prototyping, demonstration and development, in the pursuit of cost avoidance and agility benefits to ISS.

### What was the outcome?

Niteworks conducted a series of demonstrations, documented a progressive design and associated findings, and provided a report detailing the overall feedback and conclusions. These included:

- A documented IdAM design compatible with the MOD's Target Architecture and addressing its current IdAM capability and gaps.
- An IdAM architecture capable of being built from Commercial Off the Shelf (COTS) components.
- The enabling of the MOD's CYOD (choose your own device) approach to mobile working.

- Additional evidence that building end-to-end services from pre-identified commercial offerings is a viable tactic.

Capt (RN) P J Hill, Head, Customer Relationship Management, JFC ISS Design Directorate said: "The flexibility and agility of the organisation, and the quality of the people who were placed on the projects, again demonstrated the value of Niteworks being able to deliver impartial and rapid innovation support to ISS."

The focus of Brockworks 4 was on an IdAM concept for the fixed environment. However IdAM requirements for the deployed environments will need to be considered including options for in-theatre federations with coalition partners. This will provide the focus for the next phase of work, *Brockworks 5*.

### Key facts

Brockworks 4 has identified areas for consideration, potential opportunities and key themes associated with successfully delivering an integrated MOD IdAM solution including:

- An IdAM architecture which has been shown to build a federated IdAM solution for the MOD in a fast and safe way
- Reduced costs and quicker time to market via COTS solutions
- Reduced costs by supporting flexible working through the use of CYOD devices

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