THE ROYAL SOCIETY

Response to the inquiry on the Strategic Defence and Security review

Summary

- Rapid and unpredictable technological change is increasingly important to defence and security so research and innovation should be at the heart of the next Strategic Defence and Security Review (SDSR).
- Government defence and security R&D forms part of a wider research and innovation ecosystem that also includes industry and academia. Government should further pursue open innovation; engaging with other sectors, disciplines and countries.
- Government investment in defence and security R&D offers considerable direct and indirect benefits in areas such as industry, criminal justice and communications.
- The Government should increase investment in defence and security R&D, ensure that it is protected from short-term pressures and forms part of a wider UK long-term flexible framework for research and innovation. Priorities include disruptive technologies and areas where the UK has or can develop niche strengths.
- The current scientific advisory system within the MoD is strong but the role of MoD CSA should sit on the MoD Board and should be given greater seniority.

Introduction

1. The Royal Society welcomes the opportunity to respond to the House of Commons Defence Committee's call for evidence on the SDSR. As the UK's national academy of science, the Society is concerned with the health of the UK's research and innovation system as a whole. Defence and security R&D is undertaken in many different sectors, is a key component of the national research and innovation system, and accounted for 7% of R&D expenditure in the UK in 2013.[1]

The benefits of investment in defence and security R&D

2. Technological capability is increasingly important to defence and security, particularly to address unforeseen threats, so R&D should be at the heart of the next SDSR. Disruptive technologies (drones being a recent example) can substantially alter the defence and security landscape and should be a priority for government investment. One field of particularly rapid recent progress is cybersecurity. The terms of reference of this inquiry classify cyberspace as a "credible threat" and there is a case for cyberspace to be described as a "domain", alongside land, sea and air.

3. The UK's defence and security R&D plays an important role in keeping the UK safe. For example, it provides the capability to handle "dirty bombs" and provided expertise that was important in the investigation of the poisoning of Alexander Litvinenko using polonium 210.[2] The UK's investment and strengths in R&D have resulted in information sharing and participation in cutting edge joint programmes with other countries such as the US Multidisciplinary University Research Initiative (MURI).[3]

[1] ONS (2015). *UK Gross Domestic Expenditure on Research and Development, 2013* http://www.ons.gov.uk/ons/dcp171778_398876.pdf
[2] Further information about detecting nuclear and radiological materials can be found in a summary of a Royal Society workshop on that topic: https://royalsociety.org/~/media/Royal_Society_Content/policy/publications/2008/7957.pdf
[3] For further information see: Malakoff, D. (2015). *Pentagon funding program opens door to UK collaboration.* http://news.sciencemag.org/education/2015/03/pentagon-funding-program-opens-door-u-k-collaboration

4. Defence and security R&D also bring significant indirect benefits. The UK defence industry offers substantial economic rewards, directly employing 162,400 people and in 2013 returning approximately £8.2 billion in gross added value to the UK economy.[4] With over a fifth of employees involved in R&D, science plays an important role in this sector. The research staff needed to undertake government funded defence and security R&D are also valuable to the wider economy through initiatives like the establishment of the analytics company Ripjar, which was founded by government engineers from the Government Communications Headquarters (GCHQ) and has proved useful to the Foreign and Commonwealth Office.[5]

5. R&D in quantum technology, led by the Defence Science and Technology Laboratory (DSTL) in close partnership with the UK civil research base, has been involved in new GPS and sensor technology with civilian applications such as the detection of buried infrastructure.[6] The USA provides a good example of where investment in defence and security R&D has provided benefits for the civilian sector. For example, initiatives such as the Defence Advanced Research and Procurement Agency (DARPA) have pioneered technologies such as GPS and the semiconductor gallium arsenide.[7]

6. Investment in R&D by the MoD has experienced a long-term decline, although this has tapered off more recently.[8] Declining investment and staff numbers can result in the neglect of important fields and lack of in-house expertise within government. One example is metallurgy that is useful for armour - an area where the UK once held a leading position. Metallurgy is an area of concern throughout Europe as demonstrated by the establishment of "Metallurgy Europe" - an attempt by a consortium of several countries, including the UK, to resurrect industrial research in this field. Linking investment strategy to appropriate horizon scanning (see below) by groups that include external scientific experts could enhance the opportunities and reduce the challenges posed by disruptive technologies, and could help identify areas of neglect that may need reviving.

7. The government's recent commitment to invest 2% of national income on defence every year of this decade offers an opportunity to strengthen defence and security R&D.[9] A particular priority is maintaining the pipeline of researchers to ensure national capability in crucial areas such as cybersecurity. Increased investment in defence and security R&D should form part of a wider research and innovation framework that also includes the private sector and academia (see below).

8. Many of the benefits of investment in defence and security R&D are long-term and uncertain, though often substantial.[10] This means that the R&D budget in the MoD is at particular risk of raids from other areas to tackle short-term issues. The Society believes such raids are short sighted and hopes this can be addressed by the Government's commitment to consider controls to ensure that valuable departmental R&D is not deprioritised in favour of short-term pressures.[11]

9. Another challenge is "gapping" whereby government invests to solve a problem then lays off staff once the goal is achieved. This means that capability needs to be rebuilt when a similar problem arises in the future. Lurching from high capability to low capability and back again

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[4] Dorman, A., Uttley, M. and Wilkinson B. (2015). *A benefit not a burden. The security, economic and strategic value of the defence industry.* http://www.kcl.ac.uk/sspp/policy-institute/publications/A-benefit-not-a-burden.pdf
[5] FCO (2015). *Digital evaluation: crunching the numbers with ripjar*. http://blogs.fco.gov.uk/stevenlinzell/2015/06/23/digital-evaluation-crunching-the-numbers-with-ripjar/
[6] See for example: https://www.epsrc.ac.uk/research/ourportfolio/themes/**quantum**tech/ or https://www.epsrc.ac.uk/newsevents/news/quantumrevolution/
[7] Graham-Rowe, D. (2008). *Fifty years of DARPA, hits, misses and ones to watch.* https://www.newscientist.com/article/dn13907-fifty-years-of-darpa-hits-misses-and-ones-to-watch/
[8] ONS (2015). *UK Government Expenditure on Science, Engineering and Technology*. http://www.ons.gov.uk/ons/dcp171778_409986.pdf
[9] HM Treasury (2015). *Summer budget 2015: key announcements*. https://www.gov.uk/government/news/summer-budget-2015-key-announcements
[10] See for example: Brown S and Gebicke S (2010). *From R&D investment to fighting power, 25 years later.* http://www.technology-futures.co.uk/MoG5_DefenseR&D_VF.pdf
[11] BIS (2014). *Our plan for growth: science and innovation.* https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/387780/PU1719_HMT_Science_.pdf

destabilises the research base and weakens links with the wider scientific, academic and industrial communities as there is less time for people to build valuable relationships (see below).[12]

10. A combination of the SDSR and the Spending Review heralds a time of considerable change in defence and security so government should ensure these changes do not overly perturb the R&D function.

Scientific advice and horizon scanning

11. The overriding challenge for scientific advice and horizon scanning within the MoD is to be able to mount a high quality and nimble technical response at short notice. The Society therefore supports the continuation of the roles of MoD CSA and National Security CSA that play a crucial role in achieving this goal.

12. The MoD's decision to downgrade the status of the post of MoD CSA before the most recent incumbent was appointed is inconsistent with the growing need for rapid responses to swift technological changes. This is also important as defence and security decision making tends to be hierarchical and the CSA role no longer sits on the departmental board that often makes decisions in which science and technology play a big part.

13. Another valuable part of the science advice system within the MoD is the Defence Science Advisory Council (DSAC).[13] Rapid technological change implies the opportunity for an enhanced role for this body in the future. DSAC is important because it is independent and directly reports to the Minister. It also offers the MoD access to critical friends from outside government who can supplement in-house expertise, particularly as the CSA role involves investment decisions as well as advice. A recent step forward has been to increase the security clearance of those on DSAC as previously some members, particularly those from industry or academia, could not access important information needed in order to provide helpful advice.

14. A strength of DSAC is its Independent Science and Technology Advice (ISTA) register that provides access to experts in key capability areas. DSAC recently agreed to widen access to this list to the Government Office for Science, the Home Office and the AWE. Further widening may be useful, but this would entail higher management costs than can be currently resourced. The recent establishment of a "cyber reserve", analogous to service reservists or police special constables, of skilled personnel to supplement full time staff has added to sovereign capability and could well be adopted more widely in the defence and security area. The Committee may wish to consider ways to mobilise broader science and engineering expertise of the kind provided by the defence research establishments before they were privatised.

15. The horizon scanning provided by government defence and security R&D offers a useful strategic tool, although making forecasts about disruptive technologies is difficult. The development of a more unified horizon scanning activity drawing together the work of MoD, the Government Office of Science and the Cabinet Office could enhance the UK's preparedness for coping with disruptive change. The Society welcomes the renewed interest in robust horizon scanning across government following the Day Review, particularly efforts to better integrate civil and defence horizon scanning. One successful example of defence and security horizon scanning is provided by the "Centre of Excellence for Technology Innovation: Knowledge, Innovation and Futures Enterprise".

16. Staff at DSTL carry out a range of activities that include horizon scanning, identification of external capability and in-house research, which is undertaken where there is a need for a critical mass of expertise in very sensitive areas. However, there is a risk that within

[12] House of Commons Defence Committee (2006). *The future of the UK's Strategic Nuclear Deterrent: the manufacturing and skills base.* http://www.publications.parliament.uk/pa/cm200607/cmselect/cmdfence/59/59.pdf
[13] Further details of DSAC can be found here: https://www.gov.uk/government/organisations/defence-scientific-advisory-council

government there are insufficient numbers of people who are capable of undertaking science themselves and can perform these functions.

17. The national academies can play an important role in providing government with independent scientific advice and assisting with horizon scanning.

The wider research and innovation policy environment

18. The scale of the defence and security challenges facing the UK means that increasingly government is recognising that it has to look outward for ideas. This model of open innovation involves engaging with other sectors, disciplines, companies and countries. For example, much cutting edge work is now taking place in Small and Medium sized Enterprises (SMEs) and spinouts. This offers diverse new sources of ideas but presents challenges to government given the classified nature of some of this work and because it is harder to identify and work with many smaller partners than a few larger ones, as in the past.

19. One successful example of engagement with SME's for proof of concept work comes from the Centre for Defence Enterprise[14] and the new technologies from such initiatives should receive greater pull through by government. Other examples of successful partnership between government and other sectors include the Heilbronn Institute for Mathematical Research[15] and the Institute for Security Science and Technology[16] at Imperial College London.

20. Since much defence R&D is conducted outside of government, the wider policy environment is increasingly important for government defence and security R&D. For example, the "eight great plus 2 technologies" have provided a helpful focus for action, although blue skies research is also important.

21. As well as engaging other sectors there are also opportunities to work with new disciplines. One successful example of this is the Economic and Social Research Council funded Centre for Research and Evidence on Security Threats (CREST)[17] at the University of Lancaster that partners social scientists with government and industry. Interdisciplinary and multidisciplinary research is increasingly important for defence and security. For example, some of the biggest challenges in the recent Ebola outbreak in West Africa, an apparently medical issue, were cultural and behavioural practices that increased risk of infection, which might be approached using the social sciences.[18]

22. The UK needs to be able to bring clear strengths and leadership to the table when working with international allies and partners. Limited resources mean that the UK cannot simply mirror the USA so should instead focus on niche areas where there is strength. These should be identified by robust peer-review; for example using DSAC and other appropriate Science Advisory Councils in the defence and security areas working with the MoD and National Security CSAs. An example of UK-US cooperation in disruptive technology in an area where the UK can contribute much is quantum technology that has applications in precise navigation and timing, as well as novel sensors.

23. The Society is currently conducting a report focusing on the challenges and opportunities for UK in cybersecurity research, many of the findings of which will be of interest to the committee, including the issues of partnership. We will share a copy of the report with the committee on publication.

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[14] Further details are available from: https://www.gov.uk/government/organisations/centre-for-defence-enterprise
[15] Further details are available from: http://www.bristol.ac.uk/maths/research/heilbronn/
[16] Further details are available from: http://www.imperial.ac.uk/security-institute/
[17] Further details are available from: http://www.lancaster.ac.uk/psychology/news-and-events/news/2015/national-centre-for-research-and-evidence-on-security-threats/
[18] WHO (2015). *Factors that contributed to the undetected spread of the ebola virus and impeded rapid containment.* http://www.who.int/csr/disease/ebola/one-year-report/factors/en/