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Learning together: UK–Germany cooperation on military innovation and the future of warfare

Introduction

Technological innovation is once again perceived as a key driver influencing the future of warfare. Emerging, converging and disruptive technologies form the centre of the "Fourth Industrial Revolution",[1] which is transforming how humans live, work, play – and wage war.[2] The United Kingdom and Germany are facing similar challenges in adapting their armed forces to a changing security environment. The digitisation of the battlefield, the proliferation of uninhabited systems and the growing importance of domains like space and cyber are but some examples. However, until now, the two countries have not been particularly close partners in engaging with these topics. While both express a desire for a closer defence partnership, so far cooperation has emanated primarily from convenience and accidental alignment rather than strategic considerations. Renewed political will for cooperation and the inflection point created by technological innovation open up opportunities to jointly assess options for engaging with the challenges of the future.

How armed forces utilise technological change to enhance military capabilities is traditionally shaped by operational and strategic challenges, support from military and political leaders, available resources, and organisational culture.[3] This paper will take a look at British and German preparedness in these areas relevant to military innovation and future warfare. It will analyse their defence innovation ecosystems as potential suppliers and explore possible avenues of cooperation.

Future visions: strategic and operational challenges

The primary strategic challenge for both armed forces is the return of great power competition and the threat of peer-to-peer conflict, as stated in their respective strategic documents.[4] With it, the importance of new domains such as cyber and space increase significantly, as the new state competitors can operate more easily in these domains than insurgents and non-state actors. Some might even have built up military advantages there.[5] At the same time, rapid technological change often coincides with a wealth of

Sophia Becker
Christian Mölling
Torben Schütz

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new ideas about war and warfare.[6] A comparison between the emerging concepts of future warfare in Germany and in the United Kingdom shows that both armed forces share similar visions and expect similar operational challenges, which are also in line with NATO assessments.[7]

The German perspective

Operationally, both the German army[8] and the air force[9] highlight certain meta-trends that will influence their future force composition and warfare. First among them are digitalisation, robotisation, automation and increased networking of assets. Resulting from these megatrends, the German armed forces expect three essential characteristics in future warfare. First, even greater importance of a reconnaissance-fire-complex, meaning that the network is becoming more important than the individual asset.[10] Second, they expect the battlefield to become truly transparent through the further proliferation of sensors and command and control capabilities able to process the plethora of information from those.[11] Third, these trends raise the question of the human role in this kind of warfare. As the battlefield becomes more transparent, more deadly and shaped by an accelerating operational speed, the use of inhabited systems and human operators becomes riskier – to their life as well as to military efficiency. Nevertheless, both services underline that humans will have to retain their function as decision-makers.[12]

For the army, further problems arise from the general lack of mass on the battlefield, while the age-old task of holding territory requires precisely that mass. Dispersion versus concentration of assets becomes a critical question when the army expects battlefields to be transparent.[13] This is especially problematic if adversaries can utilise precision effects – regardless of their origin (eg artillery, uninhabited vehicles) – against a small number of high-value assets. The integration of uninhabited systems, open system architectures, increased networking across domains and enhanced mobility are some of the answers to these challenges as they would enable more rapid concentration or dispersion of forces and add mass to complicate an adversary's target prioritisation.[14]

The British perspective

The British MoD expects a similar development with access and control of all five domains (land, air, sea, space, cyber) to be heavily contested and with growing threats to the information environment.[15] Unsurprisingly, most of its answers are also quite similar: better integration of information and physical activities across all domains, an information instead of platform-centric force, the inclusion of uninhabited systems into the armed forces[16] and a focus on more robust C2 networks.[17]

Information – its generation, distribution and effective use – is the absolute centre of these visions of future warfare. For both armed forces, the cyber domain as the realm of generation and processing information will thus become more important as an operational domain in the future. The development of concepts and capabilities is the first step in this process. Initiatives like the UK's Data Management Strategy[18] and the German creation of the "Cyber and Information Space" as a separate organisational unit in the Bundeswehr's structure[19] reflect the growing importance given to the information and cyber realm by the ministries of defence. Moreover, the electromagnetic spectrum

as the means of transporting information between assets will garner more attention, especially if peer competitors are able to contest the spectrum. One might go so far as to state that both armed forces expect the struggle for information will define the next battle network competition – the combination of reconnaissance, command and control and weapon systems.[20]

What is notably different is a more significant focus on doctrinal changes and technologically advanced training in the UK compared to Germany. The UK expects that it has to further push mission command and the delegation of authority – with cascading effects for processes, force structures, technologies, culture, training and exercises.[21] The UK MoD also seems to funnel serious investment into advanced and digital training possibilities for its forces,[22] while nothing on that scale exists in Germany.

Challenges for military innovation: resources and political-military support

In terms of available resources, financial constraints will likely form the background for military innovation in both Germany and the United Kingdom. Both have to tackle key financial challenges: Both armed forces will have to deal with the ongoing challenge to balance legacy programs and capabilities and innovation. This will remain true despite the recent defence spending review announcement by the British government. Germany has to refill its force structure, thus reducing headroom for investment into new domains and technologies.[24] Few available resources must not necessarily be a bad thing for military innovation, as it forces armed forces to tackle tough questions and decisions.[25] Still, it naturally runs the danger of putting too many eggs into too few baskets, creating an unbalanced force structure or creating razor-thin forces without any sustainability.[26]

As for political support for exploration of the future of warfare, political leadership currently does not massively interfere with future force planning, as seen for example in the restructuring of forces for new challenges such as the creation of cyber commands. At the moment the armed forces are largely free to think and publish their visions of future warfare without much outside interference. However, this model might run into problems in the future. Especially with the integration of uninhabited systems and the idea of automation and (a level of) autonomy in weapon systems is a political[27] and societal[28] concern in Germany and the UK. Even though both armed forces stress the importance of human decision-making ("human-in-the-loop"), any autonomy or high degree of automation will likely lead to extensive debate. Hence, a potential misalignment between military visions and means of future warfare and political support for further research into certain aspects of it might arise.

Comparing defence innovation ecosystems and organisational cultures

Both Germany and the United Kingdom have innovative and robust defence industries as well as generally technologically advanced industries and research institutions.[29] The differentiation between defence industries and the general industry and research institutions as non-traditional players in the defence realm is necessary as it reflects one of the meta-trends in technological innovation, which is that private companies and investment is becoming more critical. Spin-in, the military application of commercial

technologies and components, is the new normal, instead of spin-off, the commercial use of initially military products.[30]

The German ecosystem

The German defence budget earmarks €1.5bn for defence-related R&D in 2020.[31] It flows into an innovation ecosystem that is dominated by (partially) state-funded research institutions, especially the Fraunhofer Group for Defence and Security,[32] the technical centres of the armed forces (Wehrtechnische Dienststellen) and private defence companies. Some universities in Germany are also performing defence-related research, foremost the Bundeswehr Universities in Hamburg and Munich.[33] Others are either prevented by state law[34] or by committing themselves to so-called Zivilklauseln, banning defence-related research at the university.[35]

The defence industrial ecosystem in Germany is, except for Airbus, shaped by comparatively small and fragmented companies as well as SME's across the supply chain and even on the system integrator level. This limits the ability of these small actors to independently invest in R&D and inhibits cross-domain technological innovation within companies. The utilisation of technologies from civilian-commercial companies in the armed forces is limited so far.[36] Nevertheless, the armed forces and the government are now trying to address emerging technologies and cyber in a more targeted manner. Three new institutions are signifying this: The Cyber Innovation Hub of the Bundeswehr,[37] the newly founded Centre for Digitisation and Technology Research[38] and SPRIN-D, the Federal Agency For Disruptive Innovation.[39] While the cyber innovation hub focuses on progressing digitalisation in the armed forces, the Centre for Digitisation and Technology Research shall act as a motor for university-based digitisation and technology research in the Bundeswehr and establish a start-up incubator from the outset. This incubator aims to provide founders with an environment that promotes the transfer of research results and business ideas into innovative start-up projects in cooperation with business and industry. While exemplary fields of research reflect those technologies mentioned in the Federal Government's strategy on key technologies (including armoured vehicles and naval shipbuilding), most initial projects lean heavily towards digitalisation instead of other technologies. SPRIN-D, on the other hand, is the government's agency focusing on hardware and software civilian applications that could disrupt commercial business sectors. However, if the agency works according to the political conviction of its director, is does not venture into defence.[40] Hence, there is a particular gap for non-digital emerging technologies such as robotics and their exploration for defence use in Germany. It is so far unclear whether the Centre for Digitisation and Technology Research will be able to address this gap effectively. This shows a certain German reluctance to use all innovation available in the pursuit of military advantages.[41]

The British ecosystem

The UK is spending about €2.1bn on defence-related R&D in 2020.[42] The Defence Science and Technology Laboratory (DSTL) and QinetiQ are the essential players in the UK's defence innovation ecosystem, the latter with a market share of 30 per cent in UK defence RDT&E.[43] Universities are actively contributing to defence-related research efforts. The UK defence industrial landscape is characterised by large system

integrators, especially BAE Systems, enabling intensive cross-domain innovation, complemented by a range of SME's in the supply chain.

A range of initiatives launched since 2015 aims to exploit technological progress across diverse technologies. First, the jHub[44] "aims to create direct links between military end-users and providers of technology, especially start-ups that have never worked with the Ministry of Defence before."[45] jHub has interacted with 200 start-ups that are active in technological areas like blockchain, artificial intelligence and robotics. It can test and trial adaptations of commercial products for military uses.[46] Second, the Defence and Security Accelerator (DASA)[47] aims to encourage new entrants into the defence business and thus wants to change the interaction between the MoD and traditional and non-traditional suppliers. It also funds projects with large defence companies, SMEs and universities, thus overall addressing rather traditional actor groups, but aiming to enlarge the target audience for cooperation with the MoD.[48] Third, the Defence Innovation Initiative, modelled on the US Defense Innovation Initiative, provides funds for research projects from inside and outside the MoD. It features an Innovation Research Insights (IRIS) unit "to identify and anticipate future challenges and make recommendations on defence investment priorities."[49] Lastly, as demonstrated by the "Autonomous Warrior Experiment" and the introduction of "Prototype Warfare",[50] the UK armed forces show the intention to establish a more user-centric innovation model in cooperation with the industry. Such an innovation system is generally seen as necessary to address future challenges with technological innovations.[51]

In comparison, the UK's defence innovation ecosystem is more open (civilian/commercial versus defence and user-centric versus organisation-centric) and more comprehensive in addressing various avenues of technological change. At the same time, the current German approach leaves some technological areas untapped for military use. What is more, the UK MoD seems to offer better guidance concerning those technologies, which require a closer look, as formulated in the Defence Technology Framework (DTF),[52] for which there is no German equivalent. Prioritisation and identification of the needed capability base become especially crucial in resource-constrained environments, and the DTF provides that focus with the goal to identify the sources of the most significant technological challenges and opportunities.[53]

Conclusion, cooperation opportunities and recommendations

Germany and the United Kingdom show a mixed and slightly diverging picture in their preparedness for military innovation in the factors of operational and strategic challenges, support from military and political leaders, available resources, the defence innovation ecosystem, and organisational culture. They both share broadly the same outlook on the strategic and operational challenges of the future, as recognised at the political level in strategic documents and as signified by visions of future warfare, especially against peer-competitors on the operational level.

Both armed forces are likely to face limited resources due to the economic situation. Apart from allocating resources, political-military support for military innovation seems to persist so far. Leadership in armed forces and ministries addresses topics of innovation, especially technological innovation, and promotes it through various, partially newly introduced, instruments. However, political support might wane if

military innovation becomes too radical in its thinking, eg demanding aggressive development and deployment of technologies like automation and autonomy, which are societally controversial. Another possible avenue for such debates would be demands for the re-introduction of banned technologies to better address the peer-to-peer military challenge, eg the of cluster munitions.[54] Here, trade-offs and displacement movements between past and future technologies best suited to address the changing operational and strategic challenges will come into play.

While both countries indeed maintain capable defence industrial ecosystems, the UK and its more open system are better positioned to take full advantage of traditional and non-traditional suppliers to defence innovation. Its instruments are better designed to capture technological innovation across the whole spectrum, while current German defence instruments focus too narrowly on digitalisation. Its focus on digital and cyber innovation might achieve digitalisation and networking of assets as central requirements of future forces. Still, robotics and automation are not covered or at best entrusted to traditional defence actors such as large defence companies. The German defence ecosystem has culturally-induced blind spots in emerging technologies that are not software (eg robotics), but so far also does not seem keen on doctrine[55] and training reform. Visions of operational challenges and industrial efforts seem more aligned in the United Kingdom, with a broader scope on potentially useful technologies and potential collaboration actors. Moreover, it concentrates more effort into user-centric approaches like prototype warfare.

A small set of interacting cooperation initiatives could help both countries to mitigate resource scarcity and help, especially Germany, to overcome culturally-induced blind spots:

- **Embrace reciprocal conceptual and organisational learning**: prototype warfare,[56] as embraced by the British Army, is a prime example of an open and user-centric innovation approach. The Bundeswehr, both the ministry as well as the services, could certainly learn from the British experience with this bottom-up innovation process while identifying structural and organisation hurdles that it needs to overcome.

- **Encourage radical thinking, but benchmark continually**: open and bottom-up innovation approaches, based on experimentation and rapid adaptation, need to be benchmarked continuously against both existing military capabilities as well as different innovative approaches (if not directed against particular problems). Experiments like the British army exercise "Autonomous Warrior"[57] are crucial for that. Germany and the UK have a long history and experience in joint exercises and the necessary infrastructure (eg the Sennelager Training Area). A dedicated joint training centre or a joint experimental unit especially for uninhabited systems and their integration could provide an opportunity to test and learn together in Germany or at Salisbury Plains in the UK.

- **Seek political and equipment cooperation in uninhabited systems**: as both armed forces identify uninhabited systems as a core element of future warfare, they could be a starting point for joint research, development and procurement cooperation. Depending on the political will, maritime and aerial cooperation could be less

controversial, while cooperation in the land area certainly would be very promising due to the potential capability gains. In any case, the ongoing debate in Europe about the role of uninhabited systems in future warfare, their regulation as well as the societally acceptable degree of autonomy for such systems, will benefit from mutual cooperation. Without societal and political buy-in, this vision of future warfare cannot be realised.

- **Strengthen standardisation**: digitalisation and interoperability are key to information-centric warfare, which in turn increases the effectiveness of its capabilities. However, going beyond the national frame requires intensive standardisation, which is most feasible for military uses on a NATO level.[58] Germany and the UK, still in the process of digitalising their national armed forces, would benefit from pushing this topic early on in NATO while modelling national development efforts accordingly. Building interoperability into the front end of next-generation military capabilities is essential, even if that's below the threshold of joint development. In doing so, Germany and the UK should also track differing views on the role of autonomy in warfare and how that may affect future coalition operations. Since civilian-commercial technological developments set a growing number of standards, the allies would also benefit from earlier upstream cooperation in shaping industrial standards via collaboration between the EU and UK and in international organisations active in this field.

References

1. Schwab, K., 2016. The Fourth Industrial Revolution: what it means, how to respond. [online] World Economic Forum. Available at: https://www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond/ [Accessed 7 September 2020].
2. Reding, D.F., Eaton, J., 2020. Science & Technology Trends 2020-2040 Exploring the S&T. Brussels: NATO Science & Technology Organization, p.7.
3. Mahnken, T.G., 2018. Innovation in the Interwar Years. SITC Research Briefs, Series 10 (2018-11), p.4.
4. Becker,S., Mölling, C., Schütz, T., 2020. Bridging the Capability Gaps – Towards a more strategic German-British defence cooperation. London: King's College London, forthcoming.
5. Schütz, T., 2019. Der Vernetzte Krieg - Warum Moderne Streitkräfte Von Elektronischer Kampfführung Abhängen. DGAP, p.2f. Available at: https://dgap.org/system/files/article_pdfs/2019-17-DGAPkompakt.pdf [Accessed 9 September 2020].
6. See e.g. Freedman, L., 2019. The Future of War – A History. Penguin Random House UK, London. p.14f.
7. NATO, 2018. Framework for Future Alliance Operations. p.20ff. Available at : https://www.act.nato.int/images/stories/media/doclibrary/180514_ffao18-txt.pdf [Accessed 9 September 2020]. and NATO, 2018. Framework for Future Alliance Operations. p.21ff. Available at: https://www.act.nato.int/images/stories/media/doclibrary/180514_ffao18.pdf [Accessed 9 September 2020].
8. Autorenteam Kdo H II 1 (2), n.d. Thesenpapier I: Wie kämpfen Landstreitkräfte künftig? Kommando Heer, p.8.
9. Deutsche Luftwaffe, n.d. Luftmacht 2030 - Die Luftwaffe im Dienste Deutschlands. p.11.
10. Ibid, p.12.
11. Autorenteam Kdo H II 1 (2), n.d. Thesenpapier I - Wie kämpfen Landstreitkräfte künftig? Kommando Heer, p.15.

12. Deutsche Luftwaffe, n.d. Luftmacht 2030 - Die Luftwaffe im Dienste Deutschlands. p.13. and Bundeswehr, 2019. Artificial Intelligence in Land Forces. Army Concepts and Capabilities Development Centre, p.9.
13. Autorenteam Kdo H II 1, n.d. Thesenpapier II - Digitalisierung von Landoperationen. Kommando Heer, p.6.
14. Autorenteam Kdo H II 1 (2), n.d. Thesenpapier I - Wie kämpfen Landstreitkräfte künftig? Kommando Heer, p.7.
15. Defence Innovation Directorate, 2019. Defence Innovation Priorities - Accelerating commercial opportunities to solve Defence's most pressing challenges. UK Ministry of Defence, p.20.
16. Global Defence Technology, n.d. Exercise Autonomous Warrior 2018 and the Future of Battlefield Robots. Available at: https://defence.nridigital.com/global_defence_technology_feb19/exercise_autonomous_warrior_2018_and_the_future_of_battlefield_robots [Accessed 10 September 2020].
17. Defence Innovation Directorate, 2019. Defence Innovation Priorities - Accelerating commercial opportunities to solve Defence's most pressing challenges. UK Ministry of Defence, p.11.
18. Ministry of Defence, n.d. Data Management Strategy. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/877705/Defence_Data_Management_Strategy_2020_FINAL_FINAL.pdf [Accessed 10 September 2020].
19. Bundesministerium der Verteidigung, n.d. Entwicklung des Organisationsbereichs bei der Bundeswehr. [online] bmvg.de. Available at: https://www.bmvg.de/de/themen/cybersicherheit/cyber-verteidigung/entwicklung-des-org-bereich-bei-der-bw [Accessed 14 September 2020].
20. "Fundamentally, a battle network is a combination of target acquisition sensors, target localization sensors, command and control (C2) elements, weapons, weapon platforms, and the electronic communications linking them together." Stillion, J., Clark, B., 2015. What it Takes to Win - Succeeding in 21st Century Battle Network Competitions. Center for Strategic and Budgetary Assessments, p.1 and 3.
21. Defence Innovation Directorate, 2019. Defence Innovation Priorities - Accelerating commercial opportunities to solve Defence's most pressing challenges. UK Ministry of Defence, p.18.
22. Chuter, A., 2019. The UK is ready to kick off an effort to revamp military training. [online] Defense News. Available at: https://www.defensenews.com/global/europe/2019/10/16/the-uk-is-ready-to-kick-off-an-effort-to-revamp-military-training/ [Accessed 15 September 2020].
23. Becker, S., Moelling, C. and Schuetz, T., 2020. Deterrence and Defense in Times of Covid-19 – Europe's Political Choices, German Council on Foreign Relations, Policy Brief No. 9, p.2. Available at: https://dgap.org/sites/default/files/article_pdfs/dgap-policybrief-2020-09-en.pdf [Accessed 15 September 2020].
24. Roberts, p., 2020. The UK's Integrated Review Has Restarted: Are Key Questions and Assumptions Still Valid? [online] RUSI.org. Available at: https://rusi.org/commentary/uk-integrated-review-has-restarted-are-key-questions-and-assumptions-still-valid [Accessed 16 September 2020].
25. One Example is the Wehrmacht, which largely completed doctrinal innovation before large-scale re-armament after 1934. For equipment projects see: Ricks. T. E., 2017. You want military innovation? OK, let's start by cutting the defense budget. [online] foreignpolicy.com. Available at: https://foreignpolicy.com/2017/06/27/you-want-military-innovation-ok-lets-start-by-cutting-the-defense-budget/ [Accessed 17 September 2020].
26. Depending on political preferences as seen in the "Breite vor Tiefe" Debate in Germany after 2011. See: Dickow, M., Linnenkamp, H., 2016. Breite vor Tiefe: eine Fessel deutscher Verteidigungs- und Kooperationsplanung. SWP- Aktuell 38, p.2f. Available at: https://

www.swp-berlin.org/fileadmin/contents/products/aktuell/2016A38_dkw_lnk.pdf [Accessed 18 September 2020].
27. Federal Foreign Office, 2019. "Doing nothing isn't an option." Rethinking arms control. Available at: https://www.auswaertiges-amt.de/en/aussenpolitik/themen/abruestung/uebersicht-konvalles-node/rethinking-arms-control/2199924 [Accessed 18 September 2020].
28. See e.g. "Campaign to stop killer robots", n.d. Available at: https://www.stopkillerrobots.org/ [Accessed 18 September 2020].
29. See e.g. Giegerich, B., Mölling, C., 2018. The United Kingdom's contribution to European security and defence. IISS/DGAP, p.8f. Available at: https://dgap.org/system/files/article_pdfs/the_united_kingdoms_contribution_to_european_security_and_defence.pdf [Accessed 21 September 2020].
30. EDA, 2016. The next industrial (r)evolution: What implications for the security and defence sector?. European Defence Agency. Available at: https://www.eda.europa.eu/info-hub/press-centre/latest-news/2016/05/03/the-next-industrial-(r)evolution-what-implications-for-the-security-and-defence-sector [Accessed 21 September 2020].
31. Bundesministerium der Finanzen, n.d. Wehrforschung, Entwicklung und Erprobung. Available at: https://www.bundeshaushalt.de/#/2020/soll/ausgaben/einzelplan/1404.html [Accessed 22 September 2020].
32. Nelson, A.J., 2020. Innovation and Its Discontents: National Models of Military Innovation and the Dual-Use Conundrum. The Center for International and Security Studies at Maryland, p.18.
33. See e.g. Forschungsinstitut Cyber Defence, n.d. Laufende Projekte. Universität der Bundeswehr München. Available at: https://www.unibw.de/code/laufende-projekte [Accessed 22 September 2020].
34. Bontrup, H., Götzke, M., 2019. Geplante Änderung des NRW-Hochschulrahmengesetzes: Kein Verständnis für ein Ende der „Zivilklausel". [online] Deutschlandfunk. Available at: https://www.deutschlandfunk.de/geplante-aenderung-des-nrw-hochschulrahmengesetzes-kein.680.de.html?dram:article_id=449095 [Accessed 23 September 2020].
35. Klein, S., 2019. Die Friedenspflicht fällt. [online] Süddeutsche Zeitung. Available at: https://www.sueddeutsche.de/bildung/zivilklausel-nrw-pentagon-1.4494891 [Accessed 23 September 2020].
36. Nelson, A.J., 2020. Innovation and Its Discontents: National Models of Military Innovation and the Dual-Use Conundrum. The Center for International and Security Studies at Maryland, p.19.
37. Bundeswehr, n.d. Empowering Innovation in Defence. [online] Cyber Innovation Hub. Available at: https://www.cyberinnovationhub.de/en/ [Accessed 24 September 2020].
38. Wiegold, T., 2020. Die Bundeswehr und das Corona-Paket: Etwas mehr Klarheit – aber noch nicht bei Rüstungsprojekten. [online] Augengeradeaus.net. Available at: https://augengeradeaus.net/2020/06/die-bundeswehr-und-das-corona-paket-etwas-mehr-klarheit-aber-noch-nicht-bei-ruestungsprojekten/comment-page-1/ [Accessed 24 September 2020].
39. Federal Agency for Disruptive Innovation, n.d. SPRIN-D. Available at: https://www.sprind.org/en/ [Accessed 28 September 2020].
40. Bauchmüller, M., 2019. Wie Deutschland technologisch wieder an die Spitze will. [online] Süddeutsche Zeitung. Available at: https://www.sueddeutsche.de/wirtschaft/agentur-fuer-sprunginnovationen-1.4528404 [Accessed 28 September 2020].
41. Nelson, A.J., 2020. Innovation and Its Discontents: National Models of Military Innovation and the Dual-Use Conundrum. The Center for International and Security Studies at Maryland, p.19.
42. Rhodes, C., Ward, M., 2020. Research & Development spending. House od Commons Library. Briefing Paper Number SN04223, p.16. Available at: https://researchbriefings.files.parliament.uk/documents/SN04223/SN04223.pdf [Accessed 29 September 2020].
43. QinetiQ Group plc, 2020. Annual Report & Accounts 2020. p.16. Available at: https://

www.qinetiq.com/-/media/80b11b897ab9446c9ac024665a77e434.ashx [Accessed 1 October 2020].
44. Government UK, n.d. JHUB - Advantage through Innovation. [online] GOV.UK. Available at: https://www.gov.uk/government/organisations/jhub-defence-innovation [Accessed 1 October 2020].
45. Merindol, V., Versailles, D.W., 2020, July. The (R)evolution of Defence Innovation Models: Rationales and Consequences. Armament Industry Research Group, Policy Paper #60, p.17.
46. Ibid.
47. Government UK, n.d. Defence and Security Accelerator. [online] GOV.UK. Available at: https://www.gov.uk/government/organisations/defence-and-security-accelerator [Accessed 1 October 2020].
48. Merindol, V., Versailles, D.W., 2020. The (R)evolution of Defence Innovation Models: Rationales and Consequences. Armament Industry Research Group, Policy Paper #60, p.17f.
49. Marino, T., 2017. Maintaining NATO's Technological Edge: Strategic Adaptation and Defence Research and Development, General Report. NATO Parliamentary Assembly, p.11.
50. David, A.P., Buckley, J., Whitmarsh, T., 2019. Prototype Warfare: Inculcating a Culture of Adaptation in the British Army. [online] Wavell Room. Available at: https://wavellroom.com/2019/06/04/prototype-warfare-inculcating-a-culture-of-adaptation-in-the-british-army/ [Accessed 2 October 2020].
51. Merindol, V., Versailles, D.W., 2020. The (R)evolution of Defence Innovation Models: Rationales and Consequences. Armament Industry Research Group, Policy Paper #60, p.5.
52. Defence Science and Technology, 2019, September. Defence Technology Framework. UK Ministry of Defence. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/830139/20190829-DTF_FINAL.pdf [Accessed 5 October 2020].
53. Defence Science and Technology, 2019. Defence Technology Framework. UK Ministry of Defence, p.8. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/830139/20190829-DTF_FINAL.pdf [Accessed 5 October 2020].
54. See e.g. Watling, J., 2019. The Future of Fires - Maximising The UK'S Tactical and Operational Firepower. RUSI Occasional Paper, p.34. Available at: https://rusi.org/sites/default/files/op_201911_future_of_fires_watling_web_0.pdf [Accessed 5 October 2020].
55. "Leading by mission, winning and keeping the initiative, trust in well-trained military leaders and subordinates and thus the possibility of delegating responsibility, will remain constant key factors for military success. Under the framework conditions of the information age, new capabilities will be obtained through horizontal communication, but also increasingly exposed to old threats (micro-management through information permeability)." Hence, at least the Germany Army simply continues its existing doctrinal orientation, assuming it will be equally valuable in the changing battlefield. Autorenteam Kdo H II 1 (2), n.d. Thesenpapier I - Wie kämpfen Landstreitkräfte künftig? Kommando Heer, p.7.
56. "Simply put, Prototype Warfare is a new mindset that the British Army wishes to inculcate to encourage innovation down to the lowest levels. It will enable the rapid integration of new ideas and technology into training and deployed environments where units can fail early and fail small, to scale fast and learn fast — to obtain asymmetric advantages well into the future." David, A., Buckley, J., Whitmarsh, T., 2019. Prototype Warfare: Inculcating a Culture of Adaptation in the British Army. Wavell Room. Available at: https://wavellroom.com/2019/06/04/prototype-warfare-inculcating-a-culture-of-adaptation-in-the-british-army/ [Accessed) October 2020].
57. UK Government, 2018. Army start biggest military robot exercise in British history, Defence Secretary announces. UK Government. Available at: https://www.gov.uk/government/news/army-start-biggest-military-robot-exercise-in-british-history-defence-

secretary-announces [Accessed 9 October 2020].
58. Beckley, P., 2020. Revitalizing NATO's once robust standardization programme. Rome: NATO Defense College. Available at: http://www.ndc.nato.int/download/downloads.php?icode=655 [Accessed 8 October 2020].

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About the authors

Sophia Becker is a Research Fellow for US Security & Defense Policy at the German Council on Foreign Relations (DGAP), Berlin.

Christian Mölling is Research Director at the German Council on Foreign Relations (DGAP), Berlin.

Torben Schütz is a Research Fellow for Armament Policy at the German Council on Foreign Relations (DGAP), Berlin.

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