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Weaponising Universities

Research Collaborations between UK Universities and the Military Industrial Complex

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Abstract

Universities in the UK and beyond have allied with the military and the arms industry to form a "military-industrial-academic complex" (MIAC), which collaborates on research and development (R&D) projects with military and dual-use purposes. The MIAC in the UK and elsewhere is currently developing science and technology to prepare for future warfare, which is characterised by the growing application of emerging and disruptive technologies (EDT)s, principally driven by artificial intelligence (AI), and militarised environmental technologies (MET)s, such as electrified vehicles. These technologies are regarded as critical for dominating the battlefield whilst limiting harm to the environment via increasingly "automating" and "electrifying" warfare.

Privatisation and the funding crisis of universities provide critical enabling conditions for the expansion of the MIAC. Privatisation is also contributing to the government performing less R&D and industry and universities performing more R&D across time. This is driving the military sector to expand into these two sectors to develop EDTs and METs. However, this means that the military sector is increasingly militarising civilian industry and academia. In addition, the development of METs in particular, which is often a cause of collaboration between the arms industry and academia, helps the industry to claim that they are meeting Environmental, Social, and Governance (ESG) criteria. Such criteria have often been adopted by investors to limit or exclude investments the arms industry, so such collaborations carry high stakes for arms companies.

However, several concerns have been raised over these technologies. EDTs can adversely impact crisis stability, arms-race stability, and humanitarian principles. METs in turn "greenwashes" the arms industry, and are also premised on the contentious notion of "green" war. Furthermore, EDTs and METs reduce the problem of war to the weapons used, as opposed to the causes of war.

While collaborations on METs helps arms companies address the "environmental" component of ESGs, arms companies also take advantage of their role as major employers in certain regions and communities to address the "social" element of ESGs. Yet the role of arms companies as major employers in these regions and communities undermines the capacity to reverse the expansion of all such dangerous weapons systems.

Ultimately, universities can diminish the control of the MIC over such communities and universities through supporting disarmament, which reduces the control of the MIC over various means of physical and "mental" production, and economic conversion, which develops nonmilitary uses of military facilities and industry.

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Campaign Against Arms Trade (CAAT) is a UK-based organisation working to end the international arms trade.

Demilitarise Education (dED_UCATION/dED) is a community and guide for modern day peacemakers, working to see universities break from the global arms trade and become champions for peace.

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Introduction

Universities becoming involved in military research is not new. Such active and historical collaboration on research and development (R&D) projects with military or dual-use purposes (i.e. military and nonmilitary uses) between universities, government, and industry has gone by names such as a "triple helix,"[1] "golden triangle,"[2] or most notably, the "military-industrial-academic complex". The term military-industrial-academic complex (MIAC) was coined by the late former U.S. Senator William Fulbright to define the interrelationships between universities, the arms industry, and military establishment.[3] This term emerged six years after the term "military-industrial complex" (MIC) was coined by the late former U.S. President Dwight D. Eisenhower to describe and warn of the long-term and perennial alignment of the arms industry and the military establishment.[4]

This report provides an overview and a few case studies of the MIAC in the UK, and aims to investigate the nature and underlying mechanisms of the MIAC and the context of their overall defence and security R&D strategy. This report will therefore investigate how universities collaborate with the military and arms industry, and why these collaborations occur in the contemporary context and across time.

Historical roots of the MIAC in the UK

The historical roots of this nexus in the UK can be traced back to weapons research during the First World War (WWI). Notably, researchers from Imperial College London (ICL) contributed to the war by enabling chemical weapons, and was once a focal point for chemical weapons research.[5] Chemistry research from WWI also resulted in early examples of dual-use research, e.g. Arthur Green, a professor of Tinctorial Chemistry from the University of Leeds, manufactured picric acid, which was used for treating burns and as an antiseptic, as well as for explosives.[6] Researchers from the Universities of Birmingham (UoB) and Manchester (UoM) facilitated the development of aircraft, submarines, and tanks as engineering contributions to the war effort.[7] Besides

1 Taylor, J. 2018. The Impact of the First World War on British Universities. Emerging from the Shadows. (Palgrave Macmillan, United Kingdom) p.302
2 Leslie, S.W. 1993. The Cold War and American Science. The Military-Industrial-Academic Complex at MIT and Stanford (Columbia University Press, New York) p.2
3 Congressional Record 1967. Fulbright Speech. https://bitly.ws/3ctQJ
4 Dunne, J.P. Sköns, E. 2011. The Changing Military Industrial Complex in the UK. Defence Economics 4 (2). pp.1-9. p.1
5 Taylor, J. 2018.The Impact of the First World War on British sities. Emerging from the Shadows (Palgrave Macmillan, United Kingdom) p.289
6 ibid 2018, p.290
7 ibid 2018, p.293

chemistry and engineering, scientific disciplines such as mathematics and physics have also played key roles in developing military weapons. In 1940, two UoB physicists, Rudolf Peierls and Otto Frisch, sent a "Frisch-Peierls" memorandum to the government that contained the first ever calculations for assembling an atomic bomb.[8]

Prior to WWI, academics were wary of commercial interests interfering with their work, businesses felt that academic research was irrelevant to their needs, and the government recoiled from playing "matchmaker" between academia and industry.[9] However, after mutual recognition that combining resources effectively served the needs of the Front, and could serve long-term needs of domestic survival and economic prosperity, a "triple helix" between universities, industry, and government began to form,[10] and a growing number of research projects and centres, and even universities, were launched in collaboration with industry and government.

However, the materialisation of these collaborations raised criticisms by influential figures in universities. Academics such as Arthur Smithells, a chemistry professor at the University of Leeds, expressed concerns over the impact of these collaborations on academic autonomy, and criticised the notion of research institutions being created to service the needs of particular industries,[11] while Sir Oliver Lodge, Vice-Chancellor of UoB, expressed concerns over the limited application of military technologies for civilian purposes.[12] Despite such concerns, universities in the UK have become increasingly militarised and commercialised across time. "Militarisation" has been investigated as the "intensification of land, labour, and material resources allocated to military purposes as well as the shaping of other institutions in line with military goals".[13] Commercialisation refers to "the process by which new or improved technologies, products, processes, and services are brought to market" and a mechanism for applying an idea originating from R&D to an unaddressed need.[14] Applying these definitions, the militarisation of academia can be understood as the allocation of academic labour and resources to military purposes and the shaping of academic institutions in line with military goals. While, the commercialisation of academia refers to academic technologies, products, and services being brought to market to address certain problems and needs. The commercialisation of university research has been institutionalised via spinout companies, which are companies created and owned by universities to commercialise university research.[15] The link between militarisation and commercialisation is reinforced by spinouts which provide products with military applications. Militarisation and commercialisation are also linked by academic resources being allocated to develop military products to be sold on the market to address military needs. This outcome often results from academic collaboration with arms companies on R&D for military and dual-use systems. Arms companies perform the R&D needed to manufacture weapons for their clients either "in house" i.e. under the company's premises, or by subcontracting the R&D to universities.[16] As the following section will show, privatisation and the funding crisis of universities have collectively stimulated the arms industry to subcontract R&D to universities.

8 Hikcks, D. 2015. University of Birmingham's pivotal role in the invention of nuclear weapons. Business Live. https://bitly.ws/3bJMj
9 Taylor, J. 2018. The impact of the First World War on British Universities. Emerging from the Shadows (Palgrave, Macmillan, United Kingdom). p.302
10 ibid 2018, p.303
11 ibid 2018, p.313
12 ibid 2018, p.314
13 Lutz, C. 2018. Militarization. The International Encyclopedia of Anthropology. p.1
14 UKRI. (undated). What is commercialisation?. http://bitly.ws/3bJZM
15 Oxford University (undated) "Spinout Companies: Turning Researh into Impact". http://bitly.ws/3bK9w
16 Beale, M. Street, T. 2007, Study War No More: Military Involvement in UK Universities. Campaign Against the Arms Trade. Fellowship of Reconciliation. p.14

Privatisation and funding crisis

Privatisation manifests as a reduction in government activities and finances in favour of an increase in activities and finances by private actors and systems.[17] During the early 1980s, the UK government perceived universities as too "academic", overfunded, and insufficiently allied with industry, so the government reduced overall government funding of universities, and sought to increasingly emphasise science, engineering, and technology.[18] In addition to this, UK and European governments progressively adopted a "contractual-oriented" vision of the university in which academia "is required to support aims that enhance national economic development and the strengthening of economic competitiveness".[19] Individuals such as the chief executive of the UK trade association for the Aerospace, Defence, Security and Space (ADS) sectors hence defended university-arms company cooperation on the basis of, among other considerations, increasing economic competitiveness.[20] To the extent that the arms industry is perceived as a contributor to economic "prosperity" and competitiveness, then universities contribute to economic prosperity by bolstering the arms industry.

After mutual recognition that combining resources effectively served the needs of the Front...a "triple helix" between universities, industry, and government began to form

The expectation of universities to contribute to economic competitiveness is met by university participation in industry groups linked with the Ministry of Defence (MOD), such as the UK Defence Solutions Centre (UKDSC). The Defence Growth Partnership (DGP), which opened in 2015, aims to grow the scale and competitiveness of the defence industry in the UK.[21] The DGP is a partnership funded by both government and industry, but the UKDSC is a part of the DGP that links industry, government, and academia to respond to "international customers' needs for innovative and tailored world-class defence solutions".[22] Various universities that are confirmed to be a part of the UKDSC include ICL, Queen's University Belfast, Southampton, King's College London, and Cranfield University.[23]

Furthermore, as government funding of universities has been reduced, alternative sources of funding, such as industry, have grown.[24] Industry funding has also become more alluring due to the acute and ongoing funding crisis of universities. From the 1990s onward, the UK has experienced one of the deepest decreases in government funding for education in the EU[25], and this included significant higher education budget cuts from 2010-2016. These developments have further raised the incentives of universities to offer research addressing the needs of the defence industrial base (DIB) and war economy.

The culture of privatisation persisted in 2001 and culminated in the emergence of new academic and industrial suppliers of science and technology for the military. The Defence Evaluation and Research Agency (DERA), which was a government military research laboratory charged with managing military R&D, was split into QinetiQ, an arms company, and the Defence, Science, and Technology Laboratory (Dstl), a laboratory for military-related science and technology for the MOD not easily sourced from academia or industry.[26] Dstl often launches competitive calls for industry and academia to submit research proposals into military-relevant technologies.

17 Walford, G. 1988. The Privatisation of British Higher Education. European Journal of Education. 23 (1-2) pp.47-62. p.50
18 ibid 1988, p.52
19 Geuna, A. 2001. The Changing Rationale for European University Research Funding. Are There Unintended Negative Consequences? Journal of Economic Issues 35 (3) pp.607-632. p.617
20 Doward, J. 2018. Defence contractors hand British universities £40m. The Guardian. https://bitly.ws/3bKbf
21 "About us". Defence Growth Partnership (undated). https://bitly.ws/3bKi8
22 ibid (undated)
23 ibid (undated)
24 Walford, G. 1988. The Privatisation of British Higher Education. European Journal of Education 23 (1-2) pp.47-62. p.53
25 Geuna, A. 2001. The Changing Rationale for European University Research Funding. Are There Unintended Negative Consequences? Journal of Economic Issues 35 (3) pp.607-632. p.614
26 Hartley, K. 2020. The United Kingdom In Hartley, K. Belin, J. (Eds.) The Economics of the Global Defence Industry (Routledge Studies in Defence and Peace Economics). p. 134

Dstl and QinetiQ became the main providers of science and technology for the MOD, but consortia, specifically Towers of Excellence (TOE), Defence Technology Centres (DTCs) and joint grants schemes, supported a policy of broadening the science and technology supplier base to incorporate a wider range of academia and industry.[27] Besides TOEs and DTCs, consortia also include Defence and Aerospace Research Partnerships (DARPs), and together, consortia are MOD-funded or led collaborations between industry, academia, and the MOD for basic and advanced research.[28] These partnerships result in a consistently growing network of research projects that result in innovations with military and dual-use applications.

Privatisation can also disempower faculty from protesting the expansion of the MIAC. Faculty self-determination is secured through tenured employment, since tenure enables faculty to confront the university administration without fear of losing their jobs in response,[29] but the growing privatisation of universities has led to less full-time faculty and more short-term and zero-hour contracts.[30] One study found that tenured faculty were far more likely to sign petitions calling for universities to divest from the fossil fuel sector than non-tenured track faculty.[31] According to anecdotal evidence, tenure-track junior faculty were advised by some tenured faculty not to sign the petition in order to shield their career prospects.[32] To the extent that fossil fuel and military-industrial divestment campaigns similarly address controversies over university financing, non-tenured faculty can be similarly dissuaded from protesting the MIAC despite having concerns over the ethics of such collaborations.

Ethical Concerns

Militarising and commercialising science and universities compromises core scientific values. As previously stated, the autonomy of university departments is threatened by the MIAC. Another (albeit contested) scientific standard of ethical conduct threatened by military-industrial involvement is social responsibility, which obligates scientists to conduct socially valuable research and avoid harm, and to be held responsible for the anticipated consequences of scientific research.[33] Yet, anticipating the consequences of research can be complicated by the dual-use nature and secrecy of many military-industrial projects. The openness of military-industrial research is often constricted by security and commercial considerations. Previous research that employed the Freedom of Information Act (FOIA) to request information of university funding by the MIC was often denied this data on the basis of commercial confidentiality and national security clauses.[34] Therefore, militarising and commercialising science limits the openness of science, which also undermines public trust in science.

Previous research has often employed FOIA to collect large samples of evidence of military-industrial investments and research funding in UK universities. However, there has been less research employing case study data to provide a more in-depth investigation of military-industrial involvement in specific UK universities, and the mechanisms that currently link the military, industry, and academia with each other. This report therefore provides data collected through the FOIA as well as case study data to explore military-industrial involvement in academia. Data was also gathered

27 Kiszely, J. 2004. Defence and the universities in the twenty-first century. The RUSI Journal 149 (3) pp.34-39. p.38
28 Langley, C. 2005. Soldiers in the Laboratory. Scientists for Global Responsibility. p.43
29 Giroux, H.A. 2007. The University in Chains. Confronting the Military-Industrial Academic Complex. (Taylor & Francis Group, London and New York). p.117
30 ibid 2007, p.118
31 Frumhoff, P.C. Stephens, J.C. Yona, L. 2018. The role of college and university faculty in the fossil fuel divestment movement. Elementa Science of the Anthropocene 6 (41) pp.1-12. p4
32 ibid 2018, p.4
33 Resnick, D.B. 1998. The Ethics of Science. An Introduction (Routledge, London). p.53
34 Beale, M. Street, T. 2007 Study War No More: Military Involvement in UK Universities. Campaign Against the Arms Trade, Fellowship for Reconciliation., p.5

from miscellaneous sources such as scientific literature, open sources, press releases, media reports, and official reports.

Structure of the report

- The second chapter begins by providing a brief background of the progression of academic research into military weapons, including nuclear and conventional weapons, and security systems since WWI and WWII, as well as how the military are increasingly prioritising high-tech weapons systems and cyber capabilities.
- The historical context that led to the increased military priority for such high-weapons is then provided. This context traces the evolution of dual-use research, from a primary emphasis on "spin-off" technology to a dominant emphasis on "spin-in" technology. The following section then illustrates how the growth of spin-in technology and industry/academic performance of R&D is being utilised by the military to procure weapons systems perceived as essential for future military and technological dominance, which is reflective of a revolution in military affairs (RMA) by emerging and disruptive technologies (EDT)s, and artificial intelligence (AI) lies at the forefront of this RMA.
- Spin-in and industry/academic dominance in R&D is also being utilised by the military to acquire technology to adapt to climate change. Due to their dual-use nature, when applied for military purposes, environmental technology intended partly or wholly for military purposes are referred to as "militarised environmental technologies" (MET)s. Taken together, EDTs and METs are technologies that are perceived to alter the future character of war, and industry and academia are critical for their attainment by the military.
- For arms companies, METs also contribute to environmental commitments under environmental, social, and governance (ESG) criteria, which have been used to shun investments in the arms industry. However, METs "greens" war and "greenwashes" the arms industry. Despite this, arms companies are collaborating with universities to advance their environmental commitments under ESG. Arms companies are also collaborating with universities to achieve social impact as a contribution to ESG criteria. Social impact however is also a means of securing the future workforce for the arms industry to develop EDTs and other military systems.
- The third chapter provides individual case studies of the MIAC in the UK and investigates the varying issues raised in the previous chapter. The case study of ICL investigates university collaboration with NATO and the U.S. military establishment on EDTs, and a start-up on METs. The case study of Southampton University (Soton) investigates university collaboration with arms companies on METs and autonomous technology. The case study on Lancaster University (LU) primarily investigates the university's collaboration with BAE Systems for social impact. Additionally, the case study also investigates how LU's expertise in cyber is being targeted by both BAE Systems and GCHQ.
- The following chapter explores resistance and alternatives to the MIAC. This chapter investigates how universities can pursue a comprehensive approach to peace. These alternatives include disarmament and economic conversion, and the chapter outlines how these alternatives can be pursued at various levels and means: by providing peace education, student and union activism, and policy entrepreneurship.
- The final chapter provides concluding remarks and recommendations. These include academic and student support for disarmament and economic conversion, the provision and circulation of a disarmament education, and a conversion of research in departments that receive military-industrial funding.

Background and Context

Military Research

As previously shown, UK universities have been involved in military research at least since WWI, such as engagement in chemical weapons research during WWI, and University of Birmingham (UoB) professors developing calculations for atomic bombs during WWII. Unlike WWI, universities do not currently engage in chemical weapons research since these are banned under the Chemical Weapons Convention (CWC),[35] but research enabling nuclear weapons persists in the UK despite the widespread "nuclear taboo" and adoption of the Treaty on Prohibition on Nuclear Weapons (TPNW) by many states.[36] The UK has signed and ratified the CWC, along with the Biological Weapons Convention (BWC), but together with other permanent members of the UN Security Council (p5), is a nuclear-weapons state, and has neither signed nor ratified the TPNW.[37]

One early instance of organised scientific opposition to nuclear weapons research in the UK was the British Society for Social Responsibility in Science (BSSRS), which, during the 1970s, not only opposed research on nuclear weapons and other weapons of mass destruction (WMD) in universities, but also protested landmines and cluster bombs.[38] Landmines and cluster bombs were eventually banned under the Mine Ban Convention in 1997[39] and Convention on Cluster Munitions in 2008 respectively.[40] More recent protests have targeted university investments, not research, into WMD and illegal weapons. In 2016, the Ethics for the University Superannuation Scheme (USS) campaign, petitioned the USS, the largest private pension scheme for universities, to divest from controversial and illegal weapons such as WMD, cluster munitions, and landmines.[41] However, these protests from the BSSRS and the USS campaign targeted university associations with illegal weapons and WMD, not conventional weapons.

Conventional weapons are distinguished from WMD for their legality, and are regarded by many as legitimate tools of national defence and guarantors of sovereignty in the "anarchic" international system, i.e. the absence of a central authority to govern and

35 Duzer N.V. 2019. Schools of Mass Destruction. American Universities in the U.S. Nuclear Weapons Complex. International Campaign to Abolish Nuclear Weapons. p.5
36 ibid 2019, p.5
37 International Campaign to Abolish Nuclear Weapons (undated) United Kingdom. https://bitly.ws/3bKuq
38 British Society for Social Responsibility in Science (undated) Background. http://bitly.ws/3bKCv
39 United Nations Office for Disarmament Affairs (undated). Landmines. https://bitly.ws/3bKJK
40 Human Rights Watch (undated). Cluster Munitions. https://bitly.ws/3bKPv
41 SOS UK 2016. NUS rallies against university fees funding illegal weapons. https://bitly.ws/3bKPJ

protect states.[42] Therefore, conventional weapons research is not as constrained by international law as research into WMD and illegal weapons. Additionally, and similar to other p5 members, the UK is not only a nuclear weapons state, but also one of the largest exporters of conventional arms. According to the Stockholm International Peace Research Institute (SIPRI), which compiles annual statistics on the global arms trade, the UK has the seventh largest share of exports of "major conventional weapons" in the world.[43]

In universities, research enabling nuclear and conventional weapons occurs primarily under the auspices of Science, Technology, Engineering, and Mathematics (STEM) departments. A report titled Study War No More, which investigated military-industrial funding of universities from 2001-2006, found that engineering departments in particular have been the primary beneficiaries of military-industrial funding.[44] The central role of engineering and technology to weapons development was starkly expressed in written evidence submitted by defence professors to a parliamentary inquiry:

> *"The definition, design, and delivery of defence systems are dominated by engineering and technology; hence the future skill-set for the defence sector must have engineering and technology at its core. A defence sector without technology and engineering at its core would be like a legal system without law at its core, or a hospital without medicine at its core".*[45]

STEM disciplines external to engineering have played a prominent role in R&D for nuclear weapons as evidenced by mathematics and physics in UoB during WWII. Evidence has been uncovered many years later of ongoing university research capable of contributing to nuclear weapons. A 2014 report from the Nuclear Information Service and Medact found widespread funding of computer science, mathematics, and physical science departments in the UK by the Atomic Weapons Establishment (AWE), the MOD-serving lab that supports the UK's nuclear weapons system.[46] Similar to chemical and biological research, research undertaken with nuclear material is broadly dual-use, and the AWE has supported research centres in universities such as ICL with research with potential dual-use applications.[47]

Academic collaborations with industry and the military on conventional weapons systems exist, but, like all weapons research, are often shrouded in secrecy. Nevertheless, evidence of some projects and collaborations have been made public. In 2010, BAE Systems, a UK-based arms company that is the largest in Europe, entered into four university partnerships for investment into long-term research projects including the design and support of naval ships.[48] In 2012, research engineers from the University of Surrey entered into a partnership with Lockheed Martin, a US company that is the largest arms company in the world, to augment the 'protection' and 'survivability' of armoured vehicles employed by the UK Army and Special Operations Forces, with potential applications in space systems.[49] The Northern Ireland Advanced Composites and Engineering facility (NIACE), is a partnership between Queen's University Belfast, Ulster University, and Bombardier, an aviation company, to provide advanced engineering R&D for a range of sectors.[50] Defence applications of NIACE were implied by the 2018

42 Grillot, S. Stohl, R. 2009. The International Arms Trade. (Polity Press) p.181
43 Gadon, Wezeman, Wezeman 2023. Trends in International Arms Transfers 2022. SIPRI Fact Sheet. p.2
44 Beale, M. Street, T. 2007. Study War No More. Military Involvement in UK Universities. Campaign Against the Arms Trade. Fellowship of Reconciliation. p.4
45 UK Parliament (undated) Evidence on Defence Growth Partnership. https://bitly.ws/3bKQc
46 Langley, C. 2014 Atoms for Peace: The Atomic Weapons Establishment and UK Universities. Nuclear Information Service Medact. p.18
47 Ibid 2014, p.44
48 BAE Systems 2010. University partnerships engineer future maritime success. https://bitly.ws/3bKWW
49 Army Technology 2012. "Lockheed and University of Surrey partner to enhance armourd vehicle protection" https://bitly.ws/3bL3d
50 Ministry of Defence 2018. Combat Air Strategy: An ambitious vision for the future. p.28

MOD Combat Air Strategy, which promoted NIACE as demonstrating "the benefits of government, academia, and industry working together".[51]

Military research does not only consist of weapons systems such as naval ships, armoured vehicles, or aircraft. Action On Armed Violence (AOAV), an organisation that investigates evidence of civilian victimisation in conflict and beyond, uncovered evidence of research partnerships between arms companies and UK universities, and found that universities such as Edinburgh received more than £500,000 in funding from QinetiQ for the study of ballistics and explosives in the School of Chemistry.[52] As the evidence above shows, unlike chemical weapons, nuclear and conventional weapons have left the most enduring impacts on military research in UK universities since WWI and WWII.

Security Research

The MIAC conducts research in the security domain as well. Previous and current collaborations by the MIAC in the security domain have occurred at the EU-level. Several of these collaborations can be found in CORDIS, which collects information on EU R&D projects. EFFISEC was a project to develop more efficient technological equipment for border authorities for control of passengers and pedestrians in vehicles, land and maritime checkpoints.[53] The University of Reading participated in EFFISEC, along with Thales Electron Devices SA and Thales Six GTS France SAS, which are both part of Thales, a French company involved in not only the arms industry, but also security and electronics.[54] The University of Reading and the UK Home Office are currently partners in another project titled EURMARS, which is developing an advanced surveillance platform for maritime security by integrating technologies such as satellite imagery and unmanned vehicles.[55] A Thales-linked entity, Thales Alenia Space France, is also a participant in this project.[56] Unmanned vehicles are technologies that have been utilised for security purposes as well as military operations. However, as the report will illustrate, unmanned vehicles are part of a group of systems that are predicted to dramatically alter the character of military and security operations in the future.

Military and Security Technology of the Future

The 2021 UK military budget, which raised military spending to levels not seen since the end of the Cold War, reduced the quantity of certain conventional military systems, such as Challenger II Tanks, and Typhoon aircraft, which is primarily manufactured by BAE Systems with engines provided by Rolls Royce, the second largest arms company in the UK.[57] These cuts were in favour of increasing spending on emerging and high-technological acquisitions in fields such as cyber and artificial intelligence (AI).[58] These systems prioritised by the 2021 military budget are seen as essential for achieving and shoring up future military dominance, and also for potentially revolutionising security systems. Cyber specifically is regarded by the UK military as the "fifth dimension" of conventional warfare, in addition to air, land, sea, and space,[59] and is increasingly

51 ibid 2018, p.28
52 Creffield, M. Jones, M. Tacchi, J. 2021 "UK universities funded £190 million from major arms manufacturers since 2013" AOAV. https://bitly.ws/3bLwt
53 CORDIS (undated). Efficient Integrated Security Checkpoints. https://bitly.ws/3cvJv
54 Ibid (undated)
55 CORDIS (undated). An advanced aurveillance platform to improve the European Multi Authority Border Security efficiency and cooperation. https://bitly.ws/3cvJS
56 Ibid (undated)
57 Chuter, A. 2021. Who are the winners and losers in Britain's new defense review? Defense News. https://bitly.ws/3bLr2
58 Ibid 2021
59 Pritchard, S. 2021 "UK armed forces confirm cyber as fifth dimension of warfare". The Daily Swig

deployed in both the security and military domain. Emphasising the growing significance of cyber capabilities in defence, the head of the UK Strategic Command stated that the MOD will need to "place equal value and afford equal status to computer scientists, data engineers, and cyber operators as we do on the traditional warrior elite".[60]

The following sections will uncover the historical context and series of developments that inform the increased military and security priority for such capabilities and high-tech weapons. This context begins by tracing how changes in the nature of dual-use technology led to transformations in the military-industrial complex (MIC), and by extension, interactions between the military, industry, and academia.

Dual-Use Research and Technology

Spin-Off Technology

Many technologies are "dual-use" i.e. having both military and civilian applications. While new weapons systems are often developed in-house within arms companies or the military, dual-use technology is often developed with academic participation and funding by the MIC. Such dual-use applications are often invoked to justify military expenditure and military-industrial involvement in universities. In 2021, a spokesperson for Oxford University defended the university's ties with the MIC by stating that "all research projects with defence sector funding aim to advance general scientific understanding, often with a range of generic, civilian applications".[61] One variant of dual-use development is "spin-off" in which military technology contributes to civilian technology.[62] During the cold war, spin-offs played a significant role in advancing technological discoveries since the military sector generated technological innovations at a faster pace than the civilian sector.[63] One of the most dramatic spin-off contributions from the field of computer science brought about by university-military collaboration was the first advanced computer network (ARPANET) in 1969, which would lay the foundation for the Internet in the future.[64] ARPANET was military technology, but it arose out of the mutual interests of U.S. academic departments and the U.S. military in a decentralised computer network system. Academic departments did not want to be subject to central network control, and the military felt that a decentralised computer network system was the most resistant to a Soviet attack.[65]

Dual use applications are often invoked to justify military expenditure and military-industrial involvement in universities

However, the perceived value of military production has long been removed from such spin-off benefits. This decline of spin-off can be attributed to several factors. Firstly, the long-lead times of military technology, which is the extended period of time it takes for military technology to be completed, meant that military technology was often rendered

60 ibid 2021
61 Rogers, A. 2021 "Revealed. The Nine Elite UK Universities That Still Have Links With Arms Dealers". Huffington Post. https:bitly.ws/3bLMX
62 Dunne, J.P. Sköns, E. 2011. The Changing Military Industrial Complex. Defence Economics 4 (2). pp. 1-9. p.4
63 ibid 2011, p.4
64 Curran, J. Fenton, N. Freedman, D. 2012. Misunderstanding the Internet. (Routledge, London). p.36
65 ibid 2012, p.36

obsolete by the time it entered service.[66] Secondly, the specifications for military products became increasingly complex and detached from those for civilian products, which reduced the likelihood of spin-off.[67] Finally, the growing proliferation of computers in the commercial sector diminished the innovative role of spin-off. Computers were large and expensive when ARPANET was invented in the 1960s, and hence beyond what consumers in the commercial sector could afford, so the Pentagon was the largest (and richest) customer of computer companies.[68] Eventually computers became much smaller and cheaper, which led to the rapid growth of computers as consumer goods, and this contributed to the fulcrum of technological innovation shifting from military technology to consumer technology.[69] Eventually, innovations in the civil and commercial sector began to outpace innovations in the military sector, which in turn led to "spin-in" playing a greater role in technological innovation towards the end of the Cold War, which is the second variant of dual-use technology in which civilian technology contributes to military technology.[70]

Spin-In Technology and the Growth of Civilian R&D

The growth of spin-in innovation has been linked to a dramatic increase in civilian R&D and the strengthening of the role of industry and universities in performing R&D.[71] Whilst the UK is included among the top 10 largest funders of military R&D among countries in the Organization for Economic Cooperation and Development in 2022 (OECD)[72], there has been a significant 60% decrease of said funding between 1989 and 2010.[73] On the other hand, overall funding of civil R&D has increased by nearly 70% over the same time period, which has extensively diminished the role of the military sector in developing cutting-edge scientific innovations.[74] The UK has also witnessed the most marked decline in state activity for the execution of R&D in comparison to the EU and U.S., with state R&D activity falling from 20.6% in 1981 to 6.3% in 2016.[75] From 1981 to 2016, the share of R&D activities by industry has slightly fluctuated but remained relatively stable and accounted for the largest share of R&D activities in the UK at 67.0% by 2016.[76] The shift away from government dominating R&D towards industry dominating R&D was also driven by the privatisation wave since the 1980s.[77]

However, UK universities have seen the biggest proportional increase in shares of R&D activities from 1981 to 2016, not only in comparison to business R&D in the UK, but also in comparison to university R&D activity in France and the U.S., with this share doubling from 13.6% in 1981 to 26.0% in 2011.[78] The 2022 UK Innovation Report from the Cambridge Industrial Innovation Policy also found that universities in the UK not only execute considerably more R&D than the government, but far more than universities in other countries such as France and Germany.[79] These facts and figures indicate that

66 Dunne, J.P.Sköns, E. 2011. The Chaning Military Industrial Complex. Defence Economics 4 (2) pp. 1-9. p.4
67 Renner, M.G. 1988. Conversion to a Peaceful Economy. Criteria, Objectives, and Constituencies. In Thee, M. Dumas, J. (Eds.) Making Peace Possible (Pergamon Press, Great Britain).
68 Chapman, G. 2003, An Introduction to the Revolution in Military Affairs. Presented at the XV Amaldi Conference on Problems in Global Security. p.4
69 ibid 2003, p.4
70 ibid 2003, p.4
71 Belin, J. Guille, M. 2019. Innovation Dynamics in Defence Industries. In Barbaroux, P. (Eds.) Disruptive Technology and Defence Innovation Ecosystems. p.7
72 OECD 2022. Main Science and Technology Indicators. p.67
73 Holden et al 2016. Indefensible: Seven Myths That Sustain the Global Arms Trade (Zed Books, London). p.99
74 ibid 2016, p.100
75 Belin, J. Guille, M. 2019. Innovation Dynamics in Defence Industries. In Barbaroux, P. (Eds.) Disruptive Technology and Defence Innovation Ecosystems, p.7-8
76 ibid 2018, p.8
77 Brzoska, M. 2006. Trends in Global Military and Civilian Research and Development (R&D) and their Changing Interface. p.16
78 Belin, J. Guille, M. 2019. Innovation Dynamics in Defence Industrues. p.9
79 University of Cambridge 2022. UK Innovation Report 2022. Benchamrking the UK's industrial and innovation performance in a global context. Cambridge Industrial Innovation Policy. Institue for Manufacturing. p.9

industry and universities have become leading sites of cutting-edge developments in science and technology. Therefore, while R&D for the arms industry is still mainly funded by the government,[80] the performance of R&D has increasingly drifted away from the government and towards industry and to a lesser but great extent universities in the UK.

The UK Integrated Operating Concept 2025 (IOC), a strategy by the UK military to adapt to the evolving nature of warfare, summarises this shift of dominance from government-run R&D to industry/university-led R&D: "...while we have access to world-class science and technology capabilities, we must recognise that the engine room for innovation lies outside of government. We need to create a systematic programme in which military professionals can air operational challenges within industry, technologists and academia to determine the most appropriate mix of technologies to provide our future competitive edge".[81] The growing intake of R&D activities by industry and academia (along with the growing complexity of research activities) has thus compelled the military to expand into the civilian domain to acquire new technologies and exploit innovative scientific developments.[82]

Therefore, the dominance of spin-in innovation and industry dominance in R&D has led to a growing number of weapon components being "commercial-off-the-shelf" products (COTS), i.e. available to the public,[83] so the arms industry is increasingly appropriating products developed in the civilian sector for military uses. For example, in 2021, Microsoft won a U.S. Army Contract for procurement of modified HoloLens augmented reality (AR) headsets worth $21.88 billion over 10 years.[84] The Army described this technology as enabling soldiers to "fight, rehearse, and train in one system," but several Microsoft employees petitioned Microsoft to cancel the Army contract due to disapproval over military uses of HoloLens.[85] HoloLens are also advertised and sold to the public and for use in business settings such as education, engineering and construction, and healthcare.[86] However, similar to the dynamic of universities and diminished government funding, some companies in the information and communications technology (ICT) sector are drawn to the military market due to the inability to attract spending from the civilian economy. Like computers at the time of ARPANET, sales of AR technology in the commercial sector have underperformed due to perceptions of AR devices as too large and expensive, so the military's high budgets not only make them a promising alternative market for AR devices, but a source of improving deficiencies in AR technology that could improve their sales in the commercial sector.[87]

Such incentives for these companies have led to the growing militarisation of the ICT sector and civilian industry. Given the disproportionately high performance of R&D by industry and universities, the militarisation of the civilian industry has occurred in close tandem with the growing militarisation of universities. Additionally, the availability of COTS goods for military use also shows how the dominance of spin-in innovation created an opportunity for military planners by providing elements for a "Revolution in Military Affairs" (RMA),[88] as the next section will discuss.

80 Brzoska, M. 2006. Trends in Global Military and Civilian Research and Development (R&D) and their Changing Interface. p.16
81 Ministry of Defence 2021. Integated Operating Concept. p.9
82 Belin, J. Guille, M. 2019. Innovation Dynamics in Defence Industries. In Barbaroux, P. (Eds.) Disruptive Technology and Defence Innovation Ecosystems. p.23
83 Dunne, J.P. Sköns, E. 2011.The Changing Military Industrial Complex. Defence Economics 4 (2) pp.1-9. p.4
84 Novet, J. 2021. "Microsoft wins U.S. Amy contract for augmented reality headsets, worth up to $21.9 billion over 10 years. CNBC. https://bitly.ws/3bMdy
85 ibid 2021
86 Microsoft (undated). Microsoft HoloLens. For Precise, efficient hands-free work. https://bitly.ws/34UVs
87 Culpan, T. 2023. Military Technology: Microsoft Has a $22 Billion Case for AR. Bloomberg. https://www.bitly.ws/3bM6j
88 Chapman, G. 2003. An Introduction to the Revolution in Military Affairs. Presented at the XV Amaldi Conference on Problems in Global Security. p.3-4

The Revolution in Military Affairs (RMA)

The phrase "Revolution in Military Affairs" (RMA) broadly refers to revolutionary alterations in military weaponry and strategies.[89] Since the 1990s, there has been much discussion of a new RMA arising from the transformative role of information technology (IT) and digital technologies in warfare.[90] As discussed, the UK's 2021 military budget signalled a shift in priorities from conventional weapons systems such as Challenger II Tanks to high-technological acquisitions in systems such as AI and cyber systems. This shift in priorities has materialised in the development of weapons systems such as the Challenger III Tank, which has been described as a "fully digitalised" battle tank.[91] Moreover, the recognition of cyber as the fifth element of conventional warfare reflects the increasing use of computers and IT for almost all military activities.[92] Therefore, as the engine of technological discoveries shifted to the civilian and commercial sector, the military is exploiting technology from this sector to revolutionise the conduct of war.

The shift in military priorities towards information and digitised warfare has been observed by leading military officials and defence papers in the UK. The Minister for Defence Procurement in the UK stated in the 2025 Defence Equipment and Support (DE&S) Strategy that "a modernised defence will require a shift in thinking away from the traditional platforms of ships, tanks, and aircraft to systems of sensors, effectors and deciders. Solutions must keep pace with rapid technology change – embracing new information-centric technologies, plugging into the digital backbone and being designed for the upgrades of the future".[93] These technologies are among families of technologies that have been singled out by superpowers, emerging powers, and second-tier powers such as the UK as critical for battlefield success in the future. Due to the dominance of industrial and academic contributions to R&D, the development of these technologies for the military depends, to a significant extent, on the active participation of industry and academia.

Emerging and Disruptive Technologies (EDT)s

The RMA is currently driven by "automated warfare" and strategic competition between the U.S., its NATO allies, and China, and, to a lesser degree, Russia, and the convergence of dual-use "emerging and disruptive technologies" (EDT).[94] EDTs are variably defined, but are generally understood as technologies that will yield a revolutionary effect on military and security functions.[95] Due to their dual-use nature, these technologies are capable of not only revolutionising warfare but affecting aspects of daily life such as banking or shopping.[96] However, deriving military applications from EDTs are regarded

89 ibid 2003, p.2
90 Raska, M. 2021. The sixth RMA Wave: Disruption in Military Affairs? Journal of Strategic Studies 44 (4). pp. 456-479. p.458
91 British Army 2023. Challenger 3. For the British Army. https://www.bitly.ws/3bMsT
92 Gray, D.S. Sheldon, J.B. 1999. Space Power and the Revolution in Military Affairs. A Glass Half Full? Airpower Journal. p.33
93 Ministry of Defence 2021. DE&S Strategy 2025. p.3
94 Raska, M. 2021. The sixth RMA Wave: Disruption in Military Affairs? Journal of Strategic Studies 44 (4) pp. 456-479. p.469
95 Clapp, S. 2022. Emerging disruptive technologies in defence. At a Glance. European Parliament
96 NATO 2023. Emerging and Disruptive Technologies. https://bitly.ws/3bMtL

by NATO states, China and Russia as urgent for strategic and operational dominance in future warfare. Similar to the nuclear arms race during the Cold War, EDTs are capable of becoming the prized resources of a new arms race between the U.S. and NATO allies on one end, and the emerging powers of China and Russia on the other end.

Both the EU and NATO have sought to apply a "triple helix" approach for innovation into EDTs due to the civilian or dual-use origin of many EDTs and the importance of academia and industry as partners to both organisations.[97] In the U.S., following recognition by the U.S. Department of Defence (DoD) of the military and strategic value that EDTs could provide over China and Russia, the military has deepened its presence on university campuses and proximity to academics.[98] The military has also expanded cooperation with start-ups, due to the military's perception of universities and start-ups as leaders in technological innovation.[99]

Military expansion into universities in the UK is not only driven by the same recognition of universities as leaders in technological innovation, but also by the strategic significance that the UK government has also attached to EDTs. To great and second-tier powers, EDTs are strategically significant since they can not only augment their military capabilities but also their economic competitiveness, status, and international political influence.[100] Therefore, the UK government and MOD has produced documents identifying the development of EDTs as a research priority, and such documents often promote opportunities for academia to develop EDTs for military or dual-use purposes.

The MOD's Defence Technology Framework (DTF), which provides a strategic assessment of technologies deemed essential by the MOD for military modernisation and battlefield victory, identifies seven "technology families" believed to be "critical to drive innovation and radical transformation across a range of defence activities".[101] A brief outline and description of these technology families, as detailed in the DTF, are provided on page 17.

The DTF stresses the need for the MOD to harness these technologies to keep ahead of geopolitical adversaries.[102] Additionally, the DTF states that the assistance of industry, academia, and international partners is indispensable for adopting and putting these EDTs into front-line service, and also acknowledges, similar to the MOD's IOC, that "fundamental technology developments will largely take place outside the government sector".[103] Since EDTs possess dual-use applications, one of the listed uses of the DTF is to help small & medium enterprises (SMEs) and academia identify potential military applications and users for EDTs.[104] By providing such guidance, the DTF can enable academics to tailor research in EDTs to meet military purposes, and it can also help researchers identify customers for such militarised research.

The Defence Innovation Initiative (DII), launched in 2016 by the UK Secretary of State, similarly drew attention to the influential role of academia and industry in developing EDTs. The document launching the DII mentions how the capacities of academic and industry experts can be leveraged to manufacture "new disruptive capabilities".[105] One of the critical outputs of the DII is the Defence and Security Accelerator (DASA), which became active in 2016, but was heralded by the Strategic Defence and Security Review

97 Calcara, A. 2023. One Step Back, Two Steps Forward: the EU, NATO, and Emerging and Disruptive Technologies. Centre for Seecurity, Diplomacy and Strategy. Brussels School of Governance. p.1
98 Klare, M. 2023. The Pentagon's Quest for Academic Intelligence. The Nation. https://bitly.ws/3bMua
99 ibid 2023
100 Raska, M 2021. The sixth RMA Wave: Disruption in Military Affairs? Journal of Strategic Studies 44 (4) pp. 456-479. p.473
101 Ministry of Defence 2019. Defence Technology Framework. Defence Science and Technology. p.10
102 ibid 2019, p.8-9
103 ibid 2019, p.8-9
104 ibid 2019, p.12
105 Ministry of Defence (undated). Advantage through innovation: the Defence Innovation Intiative. p.1

in 2015.[106] DASA has become a key government initiative sustaining collaborations between academia, government, and industry, and has launched several projects and calls for proposals into EDTs. One of the projects occasionally launched by DASA is an Innovation Focus Area (IFA), which offers innovators the opportunity to submit proposals that address specific needs from defence and security customers.[107] In 2023, DASA launched an IFA into applying AI to defence challenges.[108]

"Algorithmic Warfare"

AI, defined as the "automation of tasks that previously required human intelligence to complete",[109] has been singled out as a particularly influential EDT by the military, and is widely regarded as the principal driver of EDTs in general.[110] Similar to other dual-use EDTs, AI is regarded as holding the potential to revolutionise nonmilitary and military affairs. By compiling large amounts of data to improve predictions and risk analysis, and executing operations at a pace faster than humans are capable of, AI aims to not only streamline operations in civil sectors such as commerce and human resources, but also in security sectors such as border management.[111] However, in addition to concerns over privacy, the deployment of AI towards border management has been criticised for militarising borders.[112] The case study on Southampton University (Soton) in section 3.2 will briefly further investigate how arms companies that collaborate with UK universities have deployed AI towards border management.

The Defence Technology Framework states that the assistance of industry, academia, and international partners is indispensible for adopting and putting these Emerging and Disrptive Technologies into front-line service

The future military significance of AI has been noted by a UK Defence Command Paper, which states that "future conflicts may be won or lost on the speed and efficacy of the AI solutions employed".[113] Furthermore, in 2021, the UK government released the National Artificial Intelligence Strategy, which is a 10-year strategy to make the UK an "AI superpower".[114] The strategy established collaborative fora for government, industry, and academia to develop AI. One forum was the National Security Technology Innovation Exchange (NSTIx), in which national security stakeholders, industry, and academia collaborated to improve national security capabilities.[115] One government initiative to support the development of AI in defence is the Defence AI Centre (DAIC), and university involvement in the DAIC has been confirmed by the University of Liverpool, which became part of a consortium announced by Dstl to form a Defence Data Research Centre as a part of the DAIC.[116]

Due to the perceived military significance of AI, the MIAC has launched several projects that integrate AI and other EDTs into weapons systems; some of which may realise early predictions of the RMA "replacing wherever possible the man with the machine".[117] "Algorithmic warfare" is commonly used to describe the merger of AI with military capabilities.[118] Nottingham Trent University was one of several applicants that won funding from DASA as part of the Dstl's Intelligent Ship project, which funds

106 HM Government 2015. National Security Strategy and Strategic Defence and Security Review 2015. A Secure and Prosperous United Kingdom. p.75
107 Haque, F. 2023. Innovation in Defence and Security. In Conversation with DASA. Beauhurst. https://www.bitly.ws/3bMuG
108 GOV.UK 2023. DASA seeks AI Innovation to solve defence challenges. Defence and Security Accelerator.
109 Sauer, F. 2021. Lethal autonomous weapons systems. In Anthony Elliot (Eds.) The Routledge Social Science Handbook of AI (Taylor & Francis Group, London & New York). p.237
110 Thomas, M. 2023. "The Future of AI: How AI is Changing the World". Builtin. https://bitly.ws/J4c3
111 Tyler, H. 2022. The Increasing Use of Artifical Intelligence. https://bitly.ws/3bMw9
112 ibid 2022
113 Ministry of Defence 2021. Defence in a Competitive Age. p.42
114 HM Government 2021. National AI Strategy. p.4
115 ibid 2021, p.13
116 University of Liverpool 2022. Teaming up with the Defence Science and Technology Lab to improve AI data. https://bitly.ws/3dbCG
117 Chapma, G. 2003. An Introduction to the Revolution in Military Affairs. Presented at the XV Amaldi Conference on Problems in Global Security. p.2
118 Candlin, A. 2023. A Role of algorithmic warfare is a "game-changer" on the battlefield. https://bitly.ws/3bMwW

proposals to develop, among other functions, an "innovative mission AI prototype" for defence platforms, including the Royal Navy's future fleet.[119] In another example, researchers from Coventry University secured a grant under the MOD's Unmanned Distribution Capability (UDC) for research into unmanned armoured ground vehicles.[120] The researchers utilised AI to develop intelligent control and guidance systems to enable the unmanned ground vehicles to "talk" with each other.[121]

One major UK project integrating AI and digital technologies into combat aircraft is "Team Tempest", a consortium combining the arms companies BAE Systems, MBDA, Leonardo, Rolls-Royce, and military representatives to develop the sixth generation of fighter combat aircraft systems, which will amalgamate manned, unmanned, and optionally-manned operational platforms, and is intended to replace the UK's Typhoon jet by 2035.[122] Undisclosed UK universities have also signed on to Team Tempest,[123] but UoM is collaborating on a Data Science Accelerator for fighter aircraft with BAE Systems that could, according to BAE Systems, "directly feed" into Tempest.[124]

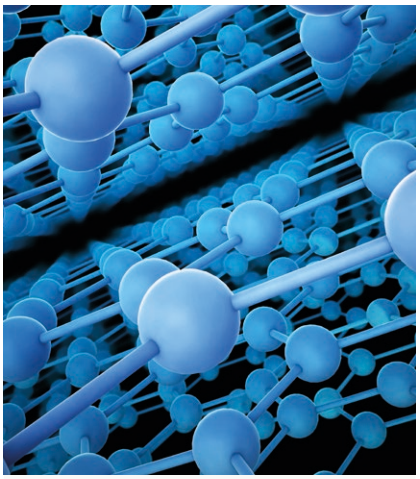
Tempest will employ AI, ML, and autonomous systems technology to provide the manned/unmanned flight capabilities, as well as swarming technology for drone control.[125] The University of Salford has been involved in research that could be exploited to support Tempest's swarming technology and unmanned capabilities. According to FOIs submitted by AOAV, the University of Salford received £36 916 from BAE Systems for a project titled "Autonomous Swarm-Based Mission Planning and Management System" described as part of the Autonomous Systems Underpinning Research (ASUR) Programme.[126] ASUR was a BAE-led consortium aiming to develop science and technology for intelligent unmanned systems for the UK military.[127]

Tempest may also be armed with hypersonic missiles,[128] which are weapon systems that have been singled out by the European Defence Agency as one of six critical EDTs for the military.[129] Hypersonic weapons travel at Mach 5 speed i.e. five times the speed of sound, and are capable of manoeuvring during flight.[130] In 2023, the MOD announced a Team Hypersonics partnership, which plans to collaborate with industry and academia to develop a hypersonic strike capability, but similar to Team Tempest, the academic representatives that are participating in Team Hypersonics have not been disclosed.[131]

A report from the campaign group Drone Wars UK found that universities such as UoM were in partnerships with BAE Systems for research on experimental drone technology.[132] Drones in turn are gateways to lethal autonomous weapons systems (LAWS), which are weapons systems that complete the "targeting cycle", which is "finding, fixing, tracking, selecting, and engaging a target without human intervention or supervision", which has been described as "the most consequential application of AI in a military context".[133] Unmanned drones leave a role for human decision making, since the decision to kill is still taken by human operators, but LAWS delegate the decision

119 Naval Technology 2019. AI and machine learning for the future fleet. Dstl's Intelligent ship https://bitly.ws/3bMxc
120 Coventry University (undated). Ministry of Defence. Unmanned Ground Vehicles. https://bitly.ws/3bMzw
121 ibid (undated)
122 Air Force Technology 2022. Tempest Future Combat Air System (FCAS) Aircraft, UK. https://bitly.ws/3bMzJ
123 Allison, G. 2023. Tempest - Facts on Britain's new fighter jet programme. UK Defence Journal. https://bitly.ws//3bMzP
124 BAE Systems 2023. Accelerating Combat Air System Design and Development. https://bitly.ws/3bMzT
125 Air Force Technology 2022. Tempest Future Combat Air System (FCAS) Aircraft, UK. https://bitly.ws/3bMzJ
126 AOAV 2021
127 Burt 2018. Off The Leash: the development of autonomous military drones in the UK. Drone Wars. p.27
128 Air Force Technology 2022. Tempest Future Combat Air System (FCAS) Aircraft, UK. https:// bitly.ws/3bMzJ
129 Clapp, S. 2022. Emerging disruptive technologies in defence. At a glance. European Parliament
130 Seldin, J. 2022. What are Hypersonic Weapons and Who Has Them? https://bitly.ws/3bMAb
131 Martin, T. 2023 UK Launches Team Hypersonics in bid to eventually develop "hypersonic strike capabilities at pace" Breaking Defense. https://bitly.ws/3bMz
132 Burt, P. 2018. Off The Leash: the development of autonomous military drones in the UK. Drone Wars. p.36
133 Sauer, F. 2021. Lethal Autonomous weapons systems. In Anthony Elliot (Eds.) The Routledge Social Science Handbook of AI (Taylor & Francis Group, London & New York) p.237-239

Emerging and Disruptive Technologies



Advanced Materials

"Materials whose structure and function has been designed to support specific applications... includes the innovative use conventional materials to improve the performance of a product or technology"[134]

Artificial Intelligence (AI), Machine Learning (ML), and Data Science (DS)

AI "the ability of machines to perform tasks normally requiring human intelligence"

ML "the ability of computer systems to learn without being explicitly programmed"

DS "the extraction of useful insights from data"[135]

Autonomous Systems and Robotics

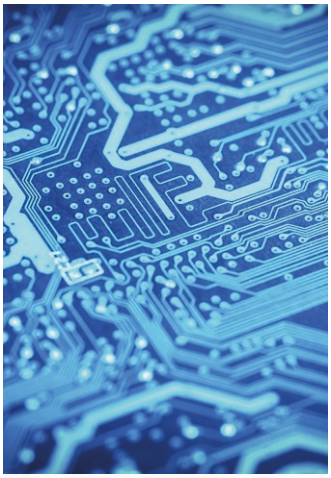
"Exploit sensors and other data sources to gather information on their environment, use advanced algorithms and AI to understand it, and make decisions about how to respond, and perform tasks – whether physical or virtual – to achieve assigned goals"[136]

Power, energy storage, conversion and transmission

"Ways of harnessing technology from one source and in one form, and preserving it for later use or altering it into another form"[137]

Sensors

"Detects a physical phenomenon such as an electric field, vibration, or particle, and generates a response, such as the transmission of digital information or a change in colour to represent a detected chemical"[138]



Advanced electronics and computing

"Concerned with information processing, systems that are programmable, and the technologies that support them"[139]

Effector Technologies

"Technologies that aim to change the properties of a target and, when integrated with other technologies, form weapons systems"[140]

134 Ministry of Defence 2019. Defence Technology Framework. Defence Science and Technology. p.16
135 ibid 2019, p.18
136 ibid 2019, p.20
137 ibid 2019, p.22
138 ibid 2019, p.24
139 ibid 2019, p.26
140 ibid 2019, p.28

to kill to algorithms.[141] Due to this, LAWS eliminates the human element entirely and presents a paradigmatic example of algorithmic warfare. The campaign group Campaign to Stop Killer Robots (CSKR), which formed in 2012 to advocate for an international treaty banning LAWS, released a report in 2022 that identified at least 65 active research projects in UK universities capable of contributing to the development of LAWS.[142] The study employed a novel risk-assessment method to determine the extent that such projects could be developed into LAWS, and 17 of these projects were assessed to be of "high-risk" of this.[143]

Benefits and Criticisms

In addition to their perceived benefits for achieving battlefield dominance, EDTs such as AI have been vaunted for strengthening several humanitarian principles during war. These include incorporating mechanisms for self-neutralisation, increased awareness of civilians and civilian objects in war, such as cultural objects and hospitals, improved assessments of battlefield outcomes, and enhanced target identification.[144] Due to this, one of the main advertised benefits of EDTs are their capacity to reduce collateral damage i.e. death and injury to noncombatants, during war. However, as will be discussed in more detail in the case study on Imperial College London (ICL) in section 3.1, such claimed humanitarian benefits have not been realised, with significant negative impacts on civilian populations.

Additionally, humanitarian principles are only one set of outcomes that could be positively or negatively affected by EDTs. For example, ML can induce "automation bias", which occurs when humans excessively depend on information gathered by autonomous systems and assume that such information is infallible.[145] Negative effects during conflict include raising uncertainty about an adversary's intentions, and inducing decision-makers to act rashly due to reducing their time to make decisions and information overload.[146] The ICL case study will investigate other outcomes, in addition to humanitarian principles, that can be adversely affected by EDTs.

Drones in turn are gateways to lethal autonomous weapons systems (LAWS), which...delegate the decision to kill to algorithms

141 Autonomous Weapons (undated) Slaughterhouses are Here. https://bitly.ws/3bMAk
142 Griffiths et al 2022. An Investigation into the Role of UK Universities in the Development of Autonomous Weapons Systems. Stop Killer Robots in UK Universities. p.10
143 ibid 2022, p.10
144 U.S. Mission Geneva 2019. U.S. Statement on LAWS. Potential Military Applications of Advance Technology. https://bitly.ws/3bMAV
145 Bugos, S. 2023. Arms Control Tomorrow. Strategies to Mitigate the Risks of New and Emerging Technologies. Arms Control Association. p.10
146 ibid 2023, p.7

Climate Change & ESG

Greening the Military

The RMA in EDTs is not the only development that is predicted to alter the future character of war. Climate change, defined as "long-term shifts in temperatures and weather patterns" primarily driven by a burning of fossil fuels and rising greenhouse gas (GHG) emissions, all predominantly caused by human activities,[147] is also informing military modernization in the UK. According to the MOD's 2021 Climate Change and Sustainability Approach, climate change is anticipated to negatively affect the capacities of military operations, equipment, and infrastructure.[148] For example, extreme heat waves have melted runways in bases used by the Royal Air Force (RAF),[149] and rising sea levels and flooding threaten UK coastal military nuclear infrastructure.[150] Due to this, climate change is perceived by the military as posing a direct threat to the integrity of military operations and installations. The MOD has hence pledged to reduce the use of fossil fuels and support the UK's legal commitment to meet "net zero" by 2050,[151] which is cutting GHG emissions as close to "zero" as possible.[152] Curbing MOD emissions is essential for the government to meet the net zero target since half of the government's GHG emissions are accounted for by defence.[153] Separate from this, unlike EDTs, a "green armaments race" between NATO countries and Russia and China has not materialised since the Russian and Chinese militaries have made little effort to reduce their own military GHG emissions.[154] On the other hand, the UK has linked a green transition to lessening energy dependence on Russia, particularly following Russia's invasion of Ukraine.[155] Renewed great power conflict is therefore implicated to a certain extent in the government's climate goals.

The military is increasingly appropriating environmental technology to reduce emissions. Environmental technology, such as electrification, when applied to military systems such as armoured vehicles, becomes militarised and can hence be conceptualised as militarised environmental technology (MET). METs are perceived by the military as instrumental for not only reducing reliance on fossil fuels and supporting net zero, but, crucially, for also enhancing military capabilities and capacities to operate in harsh environmental conditions. For example, technology that reduces military aircraft noise, along with electrified military vehicles, not only reduces GHG emissions but also improves military surveillance and stealth capabilities.[156] As pointed out in the MOD's Climate Change and Sustainability Strategy 2021, "new energy systems could offer the operational edge against adversaries".[157] Making the military more climate resilient can hence be a disguise for securing military advantage, which is similar to the function offered by EDTs. Additionally, beyond the capacity of METs to enhance military capabilities, care has been taken by the MOD to ensure that meeting net zero targets does not erode military capabilities. Therefore, a non-executive director for Climate Change

147 United Nations (undated) What is Climate Change? https://bitly.ws/rrft
148 Ministry of Defence 2021. Ministry of Defence Climate Change and Sustainability Strategic Approach. p.8-9
149 Reuters 2022. UK Royal Air Force halts flights at Brize Norton base due to heatwave. https://bitly.ws/3bMTC
150 Edwards, R. 2021. Nuclear sites "set to flood" due to climate change. The Ferret. https://bitly.ws/3bMTV
151 Ministry of Defence 2021. Ministry of Defence Climate Change and Sustainability Strategic Approach. p.10
152 United Nations (undated). Net Zero Coalition. https://bitly.ws/3bMU9
153 UK Parliament 2023. Defence and Climate Change. Defence Committee
154 Brzoska, M. 2012. Climate change and the military in China, Russia. the United Kingdom, and the United States. Bulletin of the Atomic Scientists 68 (2) pp. 43-54. p.49
155 GOV.UK 2022.UK to phase out Russian oil imports. https://bitly.ws/3bMUj
156 UK Parliament 2023. Defence and Climate Change. Defence Committee
157 Ministry of Defence 2021. Ministry of Defence Climate Change and Sustainability Strategic Approach. p.12

and Sustainability in the MOD declared that the MOD will "reduce emissions where we can".[158] Therefore, ambitions to reduce GHG emissions are subordinated to concerns for maintaining military capabilities and achieving military supremacy.

In another similarity to EDTs, the military often relies on the civilian sector for the development of METs. The military applies the "fast follower" principle for environmental technology, in which the military appropriates low-carbon technologies such as solar and electric-driven technologies from the civilian and commercial sector.[159] For example, in the U.S. GM (General Motors) Defence manufactured an electrified Infantry Squad Vehicle with components that were 90% COTS.[160] The fast follower principle thus follows a similar logic to the military obtaining weapons components from the civilian and commercial sector.

The MOD's Climate Change and Sustainability Approach also encouraged partnerships with industry and academia to meet its net-zero 2050 targets,[161] so the pursuit of METs is also contributing to the militarisation of universities. In 2023, the University of Sheffield signed a Defence Aviation Net Zero strategy with the UK Minister of Defence Procurement and the UK Air-Vice Marshall.[162] Also in 2023, the UK Research and Innovation (UKRI) agency granted £218 131 in funding for a project in Loughborough University with the MOD as a project partner titled NETZMIL, which will assess the actual and potential impact of net zero on UK military operations.[163]

ESG & Greenwashing

Arms companies have intensified efforts to develop METs due to the increased priority accorded to this technology by the military. However, pressure has also been exerted on arms companies themselves by socially responsible investors and finance institutions to diminish GHG emissions and support net zero targets in accordance with environmental, social, and governance (ESG) criteria, which are standards for socially responsible investors to assess the social and environmental impact of a business as well as its accountability and transparency.[164] ESG criteria is intended to dissuade investment in companies that fail to live up to these standards, which are subsequently deemed unsustainable and socially harmful. Pressure on arms companies to fulfil ESG criteria is driven by the same forces that have increasingly commercialised and militarised higher education: privatisation and deregulation. Since privatisation and deregulation weakened corporate regulation by the government, corporate regulation is increasingly privatised and "outsourced" to nonstate actors such as socially oriented consumers and socially responsible investors, who can employ tools such as boycotts and ESG as "civil regulation" of corporate behaviour.[165] Limiting investments into arms companies via ESG is thus an instance of civil regulation by socially responsible investors.

Ambitions to reduce GHG emissions are subordinated to concerns for maintaining military capabilities

Arms companies often form strategic partnerships with universities to meet environmental commitments and address other ESG impacts. The University of Cambridge is in a strategic partnership with Rolls Royce to reduce CO2 emissions through University Technology Centres (UTCs).[166] The University of Nottingham is one of

158 UK Parliament 2023. Defence and Climate Change. Defence Committee
159 ibid 2023
160 Lopez 2021. GM Defense Creates Electric Infantry Squad Vehicle (ISV) Concept. https://bitly.ws/3bMUU
161 Ministry of Defence 2021. Ministry of Defence Climate Change and Sustainability Strategic Approach. p.11
162 University of Sheffield 2023. University of Sheffield contributes to new net-zero aviation strategy for the defence sector.https://bitly.ws/3bMV2
163 UKRI (undated). Net Zero Militaries (NETZMIL): Retaining Operational Effectiveness in a Low Carbon World. https://bitly.ws/3bMV5
164 British Business Bank (undated). What is ESG? A guide for businesses. https://bitly.ws/3bMV8
165 Vogel, D. 2005. The Market for Virtue: The Potential and Limits of Corporate Social Responsibility. (Brookings Institution Press, Washington D.C.) p.46
166 Fell (undated). Strategic partner: Rolls Royce. Reaching for the Skies. University of Cambridge. https://bitly.ws/3bMVH

several strategic partners of BAE Systems conducting research into energy management to help the company meet its net zero target across all operations by 2030.[167] While research projects aimed at reducing GHG emissions appear laudable, given the grave threat posed by climate change, they "greenwash" war and the MIC in light of the current defence and security policies of the UK and activities of the arms industry. "Greenwashing" refers to a company or entity attempting to convince audiences of its environmental responsibility out of a greater concern with image than substance.[168] For example, with the exception of contributing to the legal commitment of net zero by 2050, the UK's Climate Change and Sustainability Approach sets no other reduction targets. which testifies to the limited substance behind the approach.[169]

Critics of greenwashing also draw attention to how companies often aim to redefine "sustainable development" in ways that are consistent with the company's existing practices,[170] which permits companies to qualify as "sustainable" despite making little to no changes in their corporate behaviour. Based on their contributions to Ukraine following the Russian invasion, arms companies have called for "unsustainable" and "socially harmful" investment to be redefined as "investment in companies that manufacture weapons that violate international conventions on the manufacture, use, and deployment of weapons, such as chemical weapons, biological weapons, and cluster bombs".[171] Arms companies such as BAE Systems and Thales have clarified that their current practices meet these revised standards since they are not directly involved in the manufacture of such weapons.[172] Therefore, by narrowing the definition of "unsustainable" investment to investment in such weapons, arms companies can claim to be sustainable despite continued involvement in the manufacture and international trade of conventional weapons, which are environmentally and socially harmful and largely contribute to state violence against civilians worldwide. Furthermore, as the following section will discuss, most universities maintain exclusions under their ethical investment policies that are limited to such controversial and illegal weapons. By limiting investment exclusions to these weapons systems, and subsequently collaborating with arms companies on ESG, universities are furthering this perception of the arms industry as legitimate partners and a source of "sustainable" investment.

"Green" weapon systems can still cause significant human and environmental harm

167 BAE Systems (undated). BAE Systems welcomes University of Nottingham as latest strategic academic partner. https://bitly.ws/3bMVM
168 Clapp, J. Dauvergne, P. 2005. Paths to a Green World: The Political Economy of the Global Environment (The MIT Press, United States). p.178
169 Akkerman et al 2022. Climate Collateral. How Military Spending Accelerates Climate Breakdown. Transnational Institute. p.2
170 Clapp, J. Dauvergne, P. 2005. Paths to a Green World: The Political Economy of the Global Environment (The MIT Press, United States). p.178
171 Hollinger, P. 2022. Ukraine war prompts investor rethink ogf ESG and the defence sector. https://bitly.ws/3bMVZ
172 Jones, D.Templeman, L. 2022. Will Defence and Nuclear Pivot to ESG? dbSustainability. Deutsche Bank Research. p.3

Investment Policies and Exclusions

Investors and finance institutions, as well as universities, have often excluded arms companies for investment on the basis of ESG criteria. ESG criteria and ethical investment has hence been referred to as a major threat to the UK arms industry by the UK Secretary of State for Defence.[173] However, investors and universities often do not exclude the entire category of the arms industry for investment. Demilitarise Education (dED), a community of modern day peacemakers working to end university ties to the global arms trade, has so far uncovered 31 universities with ethical investment policies broadly excluding "armaments". On the other hand, dED's research found that 42 universities limit investment exclusions to companies that manufacture controversial weapons or weapons illegal under international law and treaties. The number of universities that have ethical investment policies that make no exemptions on arms companies are 44. Overall, 73 universities place limits on investments in arms companies, but only 31 out of these 73 universities exclude investments in all arms companies without qualifications based on international law and controversy.

Critics of greenwashing also draw attention to how companies often aim to redefine "sustainable development" in ways that are consistent with the company's existing practices

In contrast, according to People & Planet, the largest grassroots student campaign in the UK for the environment, human rights, and poverty eradication, 102 universities so far have committed to divest from fossil fuels.[174] This discrepancy illustrates how universities, as well as investors, have not linked climate degradation to the highly polluting activities of the arms industry. In addition to this, the arms trade and fossil fuel trade currently sustain each other in the UK. Authoritarian petrostates have often financed arms imports from countries such as the UK from revenues derived from oil exports.[175] Furthermore, following the UK phasing out Russian fossil fuels, fossil fuel imports from authoritarian Gulf petrostates surged[176] (which further greenwashes the UK government's climate ambitions). This surge has occurred alongside a growing dependence by the UK arms industry on these petrostates for arms export revenues following Brexit and the consequent shrinking of EU markets.[177] These outcomes illustrate the current symbiosis of the arms trade and fossil fuel trade in the UK ("oil for guns and guns for oil"), hence investments must be simultaneously decarbonised and demilitarised.

However, there are several limits to divestment as a means of demilitarising universities. Firstly, some universities may still conduct research on weapons excluded for investment. For example, UoM has an ethical investment policy incorporating ESG criteria that aims to minimise and, "ideally", exclude investments in companies that manufacture "cluster munitions, landmines, biological and chemical weapons, nuclear and depleted uranium weapons".[178] This policy tacitly acknowledges nuclear weapons as unethical, but the Atomic Weapons Establishment (AWE) has established a Centre of Excellence in UoM, and researchers from the department of Mathematics in UoM collaborated with material scientists from the AWE to form a Materials Modelling Hub in 2019.[179] While research on nuclear material is inherently dual-use, AWE's collaboration with UoM aims to support the "safety, reliability and performance of nuclear warheads throughout their life cycle".[180] Secondly, as the study on Southampton University in section 3.2 will show, it may be difficult to hold non-transparent universities accountable

173 Corfield, G. 2023. Ethical investing is a threat to Britian's defence industry. The Telegraph. https://bitly.ws/3bMWb
174 People & Planet (undated). Universities Committed to Pursuing Fossil Fuel Divestment. https://bitly.ws/3bMWT
175 Holden et al 2016. Indefensible. Seven Myths That Sustain the Global Arms Trade. (Zed Books, London). p.67
176 Grostern, J. 2023. £19.3bn of fossil fuel imported by UK from authoritarian states in year since Ukraine war. https://bitly.ws/HZI6
177 Shaw, S. 2021. Brexit Boost for Arms Industry and Human Rights Abusers as "Global Britain" Gets Underway. Byline Times. https://bitly.ws/3bMX2
178 University of Manchester 2020. Revised Policy for Responsible Investment. https://bitly.ws/3bMX9
179 AWE 2023. Mathematics and national defence: an unlikely combination. https://bitly.ws/3bMXd
180 ibid 2023

to commitments to divest. Finally, the Lancaster University study in section 3.3 will investigate a case of a university collaborating with an arms company for social impact despite the university announcing a divestment from the arms industry.

Social Impact

The "social" in ESG refers to how a company "impacts wider society and workplace culture".[181] Supporting local communities by generating jobs and cultivating skills are examples that arms companies have held as contributing to social criteria in ESG. For example, the UK defence secretary supported arms investments as ethical investments based, among other factors, on the 200,000+ jobs sustained by the arms industry in the UK,[182] which presumably testifies to the impact of the arms industry on local communities. Universities also partner with arms companies to advance and deepen the social impact of the arms industry. In 2021, Babcock International, a company that plays an essential role in sustaining the UK nuclear submarine fleet, cited its strategic partnership with the University of Strathclyde for innovation projects as an example of the company's social impact as a part of its ESG Strategy.[183] In 2022, Lockheed Martin and Northumbria University announced a collaboration that included a £630,000 investment to support skills, research, and technology in the North East of the UK.[184]

In addition to social impact, such partnerships are also part of a wider effort to support the underlying defence industrial base (DIB). The DIB depends on STEM personnel for the daily support and functioning of the arms industry, so STEM graduates are highly sought after by the arms industry. Furthermore, efforts to recruit STEM graduates are also driven by the perceived "STEM shortage" in the graduate and postgraduate level in the UK, so academic relationships and partnerships have been promoted by the Defence Suppliers Forum, one of the main MOD-industry groups, as a means of reducing the STEM shortage in defence as a part of the 2025 Defence Industry Vision.[185] Such academic relationships, which are found in these collaborations for social impact, often aim to impart skills applicable to EDTs to graduates and prospective employees. Northumbria University's collaboration with Lockheed for example supports the development of space skills and research in the North East, and Northumbria's space and solar physics research is distinguished as an area of excellence.[186] Space technologies in turn is another one of six EDTs singled out by the European Defence Agency as "particularly disruptive".[187]

73 universities place limits on investments in arms companies, but only 31 of these exclude investments in all arms companies

181 British Business Bank (undated). What is ESG? A guide for businesses. https://bitly.ws/3bMV8
182 Corfield, G. 2023. Ethical Investing is a threat to Britain's defence industry. https://bitly.ws/3bMWb
183 Babcock International 2022. Returning to strength. Annual Reports and Financial Statements. p.68
184 Northumbria University 2022. Lockheed Martin and Northumbria University join forces to support the development of space skills, research, and technology. https://bitly.ws/3bMXM
185 Ministry of Defence (undated)b. Defence Suppliers Forum. 2025 - Defence Industry Vision. p.2
186 Northumbria University 2022. Lockheed Martin and Northumbria University join forces to support the developemnt of space skills, research, and technology. https://bitly.ws/3bMXM
187 Clapp, S. 2022. Emerging disruptive technologies in defence. At a Glance. European Parliament

Conclusion

Since the end of the two world wars, the MIAC has sustained research into nuclear and conventional weapons. However, as cutting-edge science and technology is increasingly being developed by the civilian sector, the MIC is increasingly appropriating technology from the civilian sector, with the crucial assistance of R&D from industry and academia, to develop future weapons technology for battlefield dominance and climate change adaptation. METs also contribute to environmental targets for arms companies, which is part of a larger effort by arms companies to fulfil ESG criteria, which arms companies also attempt to meet through academic partnerships for social impact. Taken together, the growing application of spin-in innovation, and dominant intake of R&D activities by industry and universities, is leading to the growing intrusion of the MIC into civilian spaces, which is further blurring the distinction between military and civilian spheres of activity.

Furthermore, the growing intrusion of the MIC into the civilian domain is reinforced by the normalisation of war. The aim of EDTs to minimise civilian harm in conjunction with the aim of METs to minimise environmental harm suggests that the MIC is striving towards "green and clean warfare". Some of the following case studies will call into question the ability of EDTs and METs to deliver such benefits. Yet, the problem of war goes beyond "humane and environmentally friendly weapons", and the rationales for EDTs and METs, such as the quest for military dominance, arms as a means to security, as well as the preparation for war are all taken for granted and treated as a given by these pursuits. The quest for military dominance for instance undermines any supposed humanitarian benefits to be gained from such "green and clean" weapons. The status and military dominance of p5 states such as the UK derives largely, but not wholly, from the maintenance of nuclear weapons, whose deterrent effect derives from threatening mass devastation to combatants and non-combatants alike, as well as long-term harm to the environment. As previously shown, universities are also involved in research that contributes to nuclear weapons. Additionally, the pursuit of military dominance is driven by the desire to preserve the capacity of the UK to launch global military actions, but these have often resulted in devastating humanitarian consequences. Due to this, the MIAC contributes to the normalisation of war and valorisation of military power through these research partnerships. Additionally, as Chapter 4 will further discuss, war is structurally driven by the permanence of the MIC, which militarises universities and other parts of society. Chapter 4 will investigate several examples of how universities have engaged in research and activities critical of the arms trade and MIC.

Case Studies

This chapter consists of brief case studies of three UK universities: Imperial College London (ICL), Lancaster University (LU), and Southampton University (Soton), that exemplify different elements of the MIAC regarding emerging and disruptive Technologies (EDT)s, militarised environmental technologies (MET)s, and environmental, social and governance (ESG) impacts. Whilst each university mentioned has a particularly high level of involvement in the military-industrial complex (MIC), the nature of this involvement varies. For example, some universities have received a much higher value of defence investment than others, but other universities are in communities that rely much more significantly on investment from the arms industry.

ICL, which was once a focal point of chemical weapons research, is increasingly becoming a focal point of research into EDTs. Given the major role of ICL in such research, the broader ethical concerns of several EDTs for military uses will be raised in this case study. The section on ICL will also include an example of a start-up developing METs for the military, so this case study will be used to investigate issues with greening the military. Soton will provide examples of research into METs and autonomous technologies, one of which was weaponized by BAE Systems for military uses, as well as issues with greenwashing arms companies.

While multiple military and industrial partners often appear in each section, certain elements of the MIC figure more prominently than others in the individual case studies. Of the three universities covered, the military establishment is most prominent in ICL, but ICL will primarily focus on the military establishments from NATO and the U.S., and will therefore focus on how interest in EDTs is driving the formation of links with military research offices from abroad. As stated in a previous section, the implementation of EDTs depends heavily on the contributions of international partners, so such international partners are collaborating with ICL for research into EDTs.

The section on Soton will investigate a partnership with BAE Systems, but the section will also spotlight Rolls Royce, the second largest arms company in the UK. Rolls-Royce differs from BAE Systems in the sense that defence makes up a much smaller proportion of Rolls Royce's revenue, so this section will explore and problematise this nature of Rolls-Royce's business. Soton's collaboration with Thales will also be introduced and problematised in the section.

The section on Lancaster University (LU), on the other hand, will spotlight the long-term and extensive partnership the university has held with BAE Systems. Given the significant controversy courted by BAE arms exports, this section will show how the company projects an alternative and "ethical" image through social, rather than environmental, contributions to ESG criteria, namely its role in communities highly dependent on arms employment. The case study on LU will also illustrate how the militarisation of local and regional economies can be linked to the militarisation of universities. Additionally, while the region in which LU is based includes other highly

militarised universities such as the University of Manchester (UoM), LU is selected as the case study due to its contributions to cyber security, perceived as the "fifth dimension" of conventional warfare, and the university's previous announcement to divest from the arms industry, which illustrates how universities sustains collaborations with the arms industry despite such divestment.

Tables below present key facts and figures of the different university case studies, as well as the Demilitarise Education (dED) Universities and Arms Database. The first table summarises the value of research funding in each university collected from previous studies. The following table ranks the top 10 universities according to the value of military/industrial partnerships from the dED database. The third table summarises the key areas of expertise that will be highlighted in each case study, and the main military/industrial relationships within each university that will be investigated.

Tables

Research Funding

University	Study War No More (SWNM) – Minimum Received for Military Projects	Action on Armed Violence (AOAV) - Research Funding
Imperial College London	£24, 642, 446	£15, 609, 286
Southampton University	£43, 251, 201	Undisclosed
Lancaster University	Not included	£1, 408, 434

Value of Military/Industrial Partnerships. Collected from the dED database

University	dED Database - Value of Military/Industrial Partnerships
Imperial College London	£48 609 473, 18
Southampton University	Undisclosed
Lancaster University	£2 235 325

Top 10 Universities from dED Database ranked in value of military/industrial partnerships

University	Value of Military/Industrial Partnerships
University of Edinburgh	£240 225 184
University of Bristol	£92 212 855 56
University of Birmingham	£53 268 544
City University	£49 199 615
Imperial College London	£48 609 473 18
King's College London	£47 496 651
University of Sheffield	£44 098 769
University of Nottingham	£43 431 803 23
Brunel University	£36 150 365 92
University of West London	£35 010 000

Case Studies

University	Areas of Expertise Under Investigation	Key Military/Industrial Partnerships Under Investigation
Imperial College London	Emerging and Disruptive Technologies (EDT), Circular Economy (MET)	NATO; Research Offices from the U.S. Department of Defence (DoD); Uplift360
Southampton University	Noise Reduction (MET), Autonomous Systems (EDT)	Rolls Royce; BAE Systems; Thales
Lancaster University	Skills & Economic Development (Social Impact), Cyber (EDT)	BAE Systems; GCHQ

Imperial College London Overview

Founded in 1907, and "on the basis of strong links with government, business and industry",[188] Imperial College London (ICL) is a Russell Group university, a group of 24 prestigious world-renowned universities in the UK. Most relevant to this report, Russell Group universities account for the majority of university funding by the military-industrial complex (MIC).[189] ICL is distinguished as one of the top recipients among Russell Group universities of military-industrial funding. ICL, along with Cranfield University, was found to be the most extensively involved in military-industrial consortia in a report by Scientists for Global Responsibility (SGR) titled *Soldiers in the Laboratory*.[190] ICL joined the UK Defence Solutions Center (UKDSC) as an associate member to provide expertise in power, materials, and cyber.[191] ICL also houses a spinout with potential military applications, Sensor Coating Ltd, which provides applications in aerospace.[192] Given the entwinement of the aerospace and defence industry in the UK, aerospace applications are likely to meet military purposes.

Despite receipts of significant military-industrial funding, dED's research found that ICL has held no direct or third-party investments in arms companies from the last five financial years.[193] This would appear to conform with the demand of the campaign Divest Imperial, which called for ICL to end investments in industries including fossil fuels and armaments.[194] Yet, dED also uncovered evidence of research funding from arms companies from the last five financial years, with funding from companies such as Rolls-Royce Plc, Rolls-Royce Deutschland Ltd & CoKG, and BAE Systems.[195]

The following sections will investigate ICL's collaborations with military partners on EDTs, and a start-up on METs. ICL has facilities located within its White City Campus that enable the university to share resources and knowledge with industry and the military.

188 Taylor,J.2018.The Impact of the First World War on British Universities. Emerging from the Shadows. (Palgrave Macmillan, United Kingdom) p.302
189 Beale, M. Street,T. 2007.Study War No More: Military Involvement in UK Universities.Campaign Against the Arms Trade, Fellowship of Reconciliation.p.24
190 Langley, C. 2005. Soldiers in the Laboratory. Scientists for Global Responsibility. p.43
191 UKDSC(undated). Imperial College Joins UKDSC as an Associate Member. https://bitly.ws/3bVpx
192 Sensor Coating (undated) Aerospace-High Temperature Mapping application using THT. https://bitly.ws/3bVq7
193 dED 2023. Imperial College London. Response to FOI18/07/2023
194 Imperial College Union (undated).Divest Imperial. https://bitly.ws/3bVqr
195 dED 2021. Imperial College London. Response toFOI10/09/2021

White City Campus

Located in the White City Area in West London, ICL's White City Campus is described as "a hotbed of innovation for security and defence, creating synergy between UK government, industry, and academia".[196] The White City Campus is the nucleus for research activity, partnerships, and centres with military or dual-use purposes. One institute located in White City is the Centre for Defence Communications & Information Technology (DCIT). Areas of research interest under the DCIT include EDTs such as AI and autonomy, machine learning (ML) and optimisation.[197] The Translation & Innovation Hub (I-HUB), is also located in White City.

White City Campus

I-HUB

A part of the Commercial & Investment Activities Group that opened in 2016 on ICL's White City Campus, I-HUB supports "the commercialisation of scientific research by providing a home for businesses from around the globe to work directly alongside Imperial's world-leading academics".[198] I-HUB therefore offers residency and work facilities for various commercial and military-industrial partners. In 2018, the government's Defence and Security Accelerator (DASA) assumed a residency in I-HUB following a signed agreement with ICL to collaborate to bolster UK defence and security.[199] During the same year, the arms and aerospace company Airbus established an office in I-HUB.[200] By the following year, and with leadership from the Institute for Security Science and Technology (ISST), the main hub for security research in ICL, SAAB Aerospace, the largest arms and aerospace company in Sweden, launched a SAAB Innovation Hub for research on Multistatic and Multiple-Input Multiple-Output radars (MIMO).[201] SAAB once came under controversy for supplying radar technology to the United Arab Emirates (UAE) due to the latter's role as a partner in the Saudi-led war in Yemen.[202] Beyond radar technology, SAAB has expressed an interest in electronic warfare (EW) and cybersecurity as future areas of research at ICL.[203] EW employs directed energy weapons (DEWs), which is another EDT, and the integrated deployment of EW and cyber is increasingly becoming vital for technological dominance in the battlefield.[204] SAAB's future involvement in ICL is therefore likely to involve research into future weapons technology.

Beyond offering residency and facilities, I-HUB also supports student recruitment and retention needs for its partners. Access to students is offered through services such as the supply of connections to the College's Career Services, a boost of the company's profile among students, student engagement for projects and placements,

196 Swinscow-Hall 2018. Security and defence innovation in WhiteCity. https://bitly.ws/3bVud
197 I-X Resilience (undated) https://bitly.ws/3bVvi
198 Imperial College London 2017.Transnation &Innovation Hub (I-HUB) p.1
199 Evanson, D.2018. New solutions to defence and security challenges to be explored at White City. https://bitly.ws/3bVyd
200 ibid 2018
201 SAAB 2019. SAAB establishes a UK innovation network with £3.5 million investment. https://bitly.ws/3bVyu
202 Sveriges Radio 2016. Saudi radar deal with UAE criticized. https://bitly.ws/3bVyQ
203 SAAB 2019. SAAB establishes a UK innovation network with £3.5 million investment. https://bitly.ws/3bVyu
204 Global Defence Technology (undated)The new battlefield: the race to integrate cyber and electronic warfare. https://bitly.ws/3bVD3

and the offer of stands for the company at the Careers Fair.[205] Through their affiliation with I-HUB, arms companies can access these services to recruit students from ICL.

In 2022, I-HUB became one of two global headquarters of the Defence Innovator Accelerator for the North Atlantic (DIANA).[206]

Defence Innovator Accelerator for the North Atlantic (DIANA)

Two months after the Russian invasion of Ukraine in February 2022, NATO announced DIANA, which brings together universities, industry, and governments to work with start-ups and other innovators for R&D into dual-use EDTs identified by NATO as high-priority, such as AI, autonomy, big-data processing, biotechnology, energy and propulsion, hypersonics, space, novel materials and manufacturing, and quantum-enabled technologies.[207] In another reference to the dependency on academia and industry for R&D, a contributor to a 2020 report by a NATO Advisory Group on EDTs notes that STEM activities in the civilian and higher education sectors play a significant role in the development of EDTs.[208] Therefore, the cultivation of close ties with the private sector and academia is deemed essential for NATO's engagement with EDTs.[209] The formation of DIANA thus fits with this agenda. The former co-director of the ISST was appointed as the first managing director of DIANA, and described the group as enabling a grouping of the "triple helix" of industry, government and academia.[210]

DIANA's managing director bases the need for DIANA in, among other factors, "developing and implementing disruptive technologies to mitigate the likelihood and impacts of conflict".[211] However, a report from the Institute for Peace Research and Security Policy from the University of Hamburg found that, contrary to this rosy picture from DIANA, some EDTs may actually lower the threshold to conflict rather than reducing its likelihood, while others may worsen the impacts of conflict.[212]

The report consulted experts to assess the impact of 12 EDTs on three dependent variables or outcomes: arms race stability, crisis stability, and humanitarian principles.[213] Arms race stability refers to "the absence of incentives to increase the quantity or quality of a state's nuclear forces", crisis stability refers to "the absence of incentives to use nuclear weapons first in a crisis", and humanitarian principles refers to "the moral and legal expectations of appropriate conduct as regards the use of force.[214] The report also assessed how soon each EDT will reach operational deployability.

Most of the technologies, such as AI for weapons and effects, AI for cyber operations, AI for information warfare, as well as hypersonic weapon systems, weakened all three of these effects.[215] All were expected to be operationally deployable by 2040, with hypersonic weapons and DEWs found likely to deploy at the earliest times.[216] Hypersonic weapons, which were found to lower the threshold to initiating war, were also assessed as capable of reducing collateral damage.[217] AI for weapons and effects was assessed as capable of reducing the risk of injury and death to combatants, so both hypersonic weapons and AI for weapons potentially strengthen humanitarian principles for

205 Imperial College (undated) Services. https://bitly.ws/3bVDk
206 Swinscow-Hall,Wilson 2022. Imperial's White City campus named as location for NATO innovation headquarters. https://bitly.ws/3bVDz
207 NATO 2023. Emerging and Disruptive Technologies.
208 NATO 2020. NATO Advisory Group on Emerging and Disruptive Technologies. Annual Report, p.15
209 ibid 2020, p.16
210 Machi, V. 2023.How industry can partner with NATO on disruptive technologies. https://bitly.ws/3bW7u
211 ibid 2023
212 Favaro, M. Kühn, U. Renic, N.2022. Negative Multiplicity. Forecasting the Future Impact of Emerging Technologies on International Stability and Human Security. Institutue for Peace Research and Security Policy. Research Report 010. p.14
213 ibid 2022, p.14
214 ibid 2022, p.20
215 ibid 2022, p.9
216 ibid2022, p.8
217 ibid 2022, p.94

civilians and combatants respectively,[218] and may therefore support the managing director's claim that EDTs may mitigate the impact of conflict. On the other hand, AI for weapons and effects, and other weapons that strengthen humanitarian principles, potentially weaken crisis stability by lowering the political threshold to resort to the use of conventional weapons,[219] which weakens the managing director's claim that EDTs may lower the likelihood of conflict. Pairing these effects together, EDTs that reduce the impact of conflict may also inadvertently increase the likelihood of conflict.

Moreover, the capacity of AI systems to strengthen humanitarian principles has been questioned. During the war in Gaza in 2023, Israel has deployed an AI-targeting platform called "the Gospel" which generates hundreds of daily targets in contrast to 50 targets a year in previous periods.[220] Yet, despite such enhanced targeting capabilities, Israel's bombing campaign has resulted in historic levels of civilian casualties. Related to this, assuming that civilian victimisation in war can be significantly curbed by advanced weapons systems assumes that civilian protection is purely mediated by technology. Contrary to this assumption, civilian victimisation can be a deliberate strategy adopted by states. For example, civilian victimisation can be driven by a "logic of punishment", in which civilians are targeted in order to drive those civilians to rise up and pressure their government to end the war.[221] According to the report that uncovered Israel's use of AI-targeting platforms, "power targets", such as private residences, and public buildings, have been targeted to lead the civilian population in Gaza to put pressure on Hamas, the militant organisation that governs Gaza.[222]

Also, even if such technology was able to reduce the risk of death and injury, the report from the University of Hamburg found that AI for weapons and effects weakens other humanitarian principles. These effects include diminishing accountability and the loss of meaningful human control in war by delegating key military decisions to AI, and AI for weapons has also exhibited biases against certain ethnicities and/or genders.[223] Therefore, AI-targeting systems may not only worsen the impact of conflict, as shown by the "Gospel", but also possess low accountability for the harm they cause. On a separate note, according to the Hamburg University report, other technologies were assessed as not having similarly positive discriminatory effects as hypersonic weapons and AI for weapons and effects. AI for cyber operations may have difficulties differentiating between military and non-military objects due to the interconnectedness of critical infrastructure and networked systems.[224] AI for Information Warfare was also linked to a difficulty in distinguishing civilians from combatants.[225]

Conclusions from the Hamburg University report can enable scientists to exercise social responsibility for research into EDTs since the report outlines anticipated consequences of these emerging technologies. While these assessments mostly concern the military uses of EDTs, their dual-use nature, and the central role of NATO in DIANA, raises the prospect that knowledge generated in ICL will contribute to military applications.

Some EDTs may actually lower the threshold to conflict rather than reducing its likelihood, while others may worsen the impacts of conflict

218 ibid 2022, p.12, p.70
219 ibid 2022, p.70
220 Abraham, Y. 2023."A mass assassination factory "Inside Israel's calculated bombing of Gaza. https://bitly.ws/347dY
221 Downes, A.B. 2008. Targeting Civilians in War. (Cornell University Press, Ithaca and London) p.4
222 Abraham, Y. 2023. "A mass assassination factory":Inside Israel's calculated bombing ofGaza. https://bitly.ws/347dY
223 Favaro, M. Kühn,U. Renic,N. 2022. Negative Multiplicity:Forecasting the Future Impact of Emerging Technologies on International Stability. Human Security. Institute for Peace Research and Security Policy. University of Hamburg. Research Report 010. p.69
224 ibid 2022, p.73-74
225 ibid 2022, p.77

NATO is not the only international partner that has expressed an interest in research in EDTs from ICL. The following section will investigate collaborations between ICL and military research offices from the United States. These research offices played a significant and formative role in the development of the MIC in the U.S., so a brief historical background will be provided of these research offices prior to investigating their collaborations with ICL.

US Department of Defence Research Offices

The US Department of Defence (DoD) is linked to several military-serving laboratories. The Office of Naval Research (ONR), was established in 1946, the Army Research Office (ARO) in 1951, the Air Force Office of Scientific Research (AFOSR) in 1952, and finally, the Advanced Research Project Agency (ARPA) in 1958.[226] ARPA was the military research office that developed ARPANET in collaboration with academia, as described in section 2.1. With the addition of "defence", ARPA would later be renamed "DARPA" in 1972.[227] These offices were formed following the issuance of a memorandum by then-Army Chief of Staff Dwight D. Eisenhower which called for a long-term integration of civilian and military resources after WWII.[228] Due to this, and despite his later warning, Eisenhower's memorandum has been described as the "founding act" of the U.S. MIC,[229] and these research offices have supported and sponsored university research with explicit military purposes.

In 2020, ONR, ARO, and AFOSR, jointly secured a residency under I-HUB, with coordination by the ISST, as part of an action calling for stronger collaboration with traditional and non-traditional innovators.[230] The Chief of Staff of AFOSR expressed interest in UK universities "investing heavily in secure hardware design, artificial intelligence and quantum sciences; all of which are of tremendous interest to us".[231] These offices have previously worked with researchers from ICL. In one example, a professor from ICL collaborated with ONR on research that fell under a DEW and High Power Microwave (HPM) Program.[232] HPMs are currently being sought by the Pentagon to defend against swarms of small combat drones, with the larger goal of countering technological advances from China and Russia.[233] In another example, a professor from ICL worked on an AFOSR-sponsored project which had applications for the control of autonomous micro air vehicles (MAVs).[234] MAVs, which resemble small birds in flight, are employed for military operations such as evacuation, intelligence gathering, reconnaissance, and surveillance, although in the most extreme circumstances, they can be deployed as "swarm weapons" against enemy forces.[235]

226 Krinsky, R. 1988. Swords and Sheepskins:Militarization of HigherEducation in the United States and Prospects of its Conversion. InThee, M. Dumas, J. (Eds.) Making Peace Possible. (Pergamon Press, Great Britain). p.88
227 DARPA (undated). ARPA Becomes DARPA. https://bitly.ws/3bWjB
228 Eisenhower, D.D.1946. Scientific and Technological Resources as Military Assets.War Department.
229 Melman, S.1970. Pentagon Capitalism. The Political Economy of War. (McGraw-Hill Book Company) p.88
230 Lachance, M.2020. U.S. Air Force International Division, tri-service partners join technology transition ecosystem at innovative UK university. https://bitly.ws/3bWJW
231 ibid 2020
232 Hoffman 2020. Directed Energy Weapons (DEW) High Power Microwave (HPW) Program. Annual Report for FY20. Office of Naval Research. p.151
233 Sherman, J. 2023 New Microwave Weapons Could Defend against Swarms of Combat Drones. Scientific American. https://bitly.ws/3bWK8
234 BPRL (undated) Visual Insect Sensors -AFOSR.The Relationship Between Visual Sensor Equipment in Flying Insects and their Flight Performance - a "Neurobio-Engineering" approach. https://bitly.ws/3bWNY
235 Abrar, M.Patil, R.2013.MicroAirVehicle - A Pocket Sized Flying Aircraft, Military Asset and a Boon to Mankind-An overview. International Journal of Emerging Technologies in Computational and Applied Sciences 6 (1) pp. 43-51. p.48

DARPA

DARPA is not listed as a partner under I-HUB, but ICL has participated in DARPA-linked research on EDTs. DARPA is the main DoD research office tasked with investing in EDTs.[236] In 2018, DARPA funded a 4-year research project by ICL – under the DARPA Assured Autonomy Project - for the development of formal safety assurances for the operation of intelligent autonomous systems, particularly Cyber Physical Systems.[237] ICL has research links with DARPA that predate the Assured Autonomy Project. In 2015, a lecturer from ICL participated in the now-closed DARPA Robotics Challenge (DRC),[238] which was a project designed by DARPA for competitors to develop human-supervised robots able to execute complex tasks in natural and human-made disaster environments i.e. humanitarian and disaster relief.[239] DRC technology aimed to assist the DoD's strategic plan for the Joint Force to conduct humanitarian and disaster relief operations.[240] Therefore, while the DRC was intended for the development of robotics in disaster response, such disaster response was expected to be executed by the U.S. military.

Uplift360

ICL also houses several start-ups as members of its Innovation Ecosystem under the ISST, and a few of these start-ups provide defence services. One example is ORCA Computing, which provides quantum computing services to various industries including financial services, energy, healthcare & life science, and defence.[241] Uplift360 is a start-up that provides METs for defence. ICL, along with Bristol University, are the two university partners of Uplift360, which is also partners with the Dstl and DASA.[242] Uplift360 aims to be the first company to utilise the circular economy to make militaries more sustainable and resilient.[243] This technology is also promoted beyond defence to sectors such as automotive and construction.[244] By applying low energy technologies to reuse materials for as long as possible, the start-up aims to not only reduce the environmental impact and emissions of military activities, but to also create a more secure supply chain for the military, the vulnerability of which according to the company was shown by Covid-19 and the war in Ukraine.[245]

Furthermore, according to the MOD's Defence Aviation Net Zero Strategy (DAS), growing competitiveness and volatility around resources, and long-term dependence on fossil fuels, threatens supply chains and military operations, so the DAS advocates shifting towards secure energy alternatives to increase operational resilience and reduce the vulnerability of supply chains to disruption.[246] Uplift360's stated aim to make militaries more resilient and create more secure supply chains hence fits with this recommendation from the DAS.

Uplift360 takes note of the significant contribution of military activities to global emissions, which shows sensitivity to how military activities impact climate change. On the other hand, such efforts to improve military sustainability and resiliency are occurring against a backdrop of historic increases in the UK military budget and capabilities since 2021. These include an increased presence of UK troops abroad, an increased cap on British nuclear warheads, and an expansion of conventional military

236 Calhoun, M.P. 2016. DARPA. Emerging technologies. Strategic Studies Quarterly 10 (3) pp. 91-113. p.91
237 VAS Group (undated). SAIL -DARPA Assured Autonomy Project. https://bitly.ws/3bWPe
238 Imperial College 2015. DARPA Robotics Challenge Finals. https://bitly.ws/3bX4D
239 DARPA (undated). DARPA Robotics Challenge. https://bitly.ws/3bWTP
240 ibid (undated)
241 Orca Computing (undated). Applications. https://bitly.ws/3bX65
242 Uplift360 (undated). Uplift360: Defence Sustainability. Availability. https://bitly.ws/3bXaK
243 Cooper, J. 2023 Making militaries more sustainable and resilient. Imperial College London. https://bitly.ws/3bXaZ
244 ibid 2023
245 ibid 2023
246 Ministry of Defence 2023. Defence Aviation Net Zero Strategy. p.4

capabilities.[247] Therefore, despite being promoted as research addressing climate change, such research, when set against the current UK security and defence context, rests on the implicit and tenuous assumption that effective action against climate change is commensurate with an expansion of military spending, capabilities, and activities abroad. These patterns however can be reconciled as preparation for "green war".

Furthermore, the issue of how the "savings" from reduced military emissions will be re-invested is relevant. For example, the former commander of the U.S. Transportation Command suggested that reducing dependence on oil can lead to a reduced military presence in the Gulf region,[248] an area in which the U.S. military, with significant monetary investment, secures oil supplies. However, the former head then suggests that funds released from a reduced presence in the Gulf can be re-invested in other "critical military priorities", such as "cybersecurity and hypersonic weapons".[249] Yet, in a different proposed scenario, a reduced military presence in the Gulf, owing to reduced dependence on oil, can pressure the government to "decrease its military spending and reorient its economy to more economically productive activities".[250] Military planners presiding over a green transition of the military can thus exploit reduced oil consumption to enhance military capabilities, which is consistent with military perceptions of the utility of low-carbon technologies. In conclusion, reducing military GHG emissions could be as easily used to prepare for either "green war" or peace, but given the backdrop in the UK of increased military expenditure, high-priority for acquiring EDTs, and MOD-industry led initiatives such as the Defence Growth Partnership (DGP), which aims to broaden the economic scope of the arms industry, research from Uplift360 is more likely to support the former.

Military Planners presiding over a green transition...can exploit reduced oil consumption to ehance military capabilities

Southampton University Overview

Soton was founded in 1952, but its history dates back to 1862.[251] Similar to other Russell Group universities, Soton is positioned highly in several rankings of military-industrial involvement in universities. In the *Study War No More* report, Soton was found to be one of five universities that received the largest amount of funding for military projects during 2001-2006.[252] The *Soldiers in the Laboratory* report found that Soton was the third-most extensively involved university in consortium partnerships, with the other two universities being ICL and Cranfield University.[253] Defence Aerospace Research Partnerships (DARPs) is an example of a consortium, and Soton participates in research groups with DARP status titled Rotorcraft Aeromechanics, and Modelling and Simulation of Turbulence and Transition for Aerospace, which are part of a research

247 Arneson, B. Edwards, N. 2023. The Challenge of Demilitarizing the Response to Climate Change. World Peace Foundation. Tufts University. https://bitly.ws/3bXbU
248 SAFE 2018. The Military Cost of Defending Global Oil Supplies. https://bitly.ws/3bXh7
249 ibid 2018
250 Crawford, N. 2022. The Pentagon, Climate Change, and War. Charting the Rise and Fall of U.S. Military Emissions (The MIT Press, Cambridge Massachusetts). p.335
251 University of Southampton (undated). Our history. https://bitly.ws/3ctxP
252 Beale, M. Street, T. 2007. Study War No More: Military Involvement in UK Universities. Campaign Against the Arms Trade, Fellowship for Reconciliation. p.4
253 Langley, C. 2005. Soldiers in the Laboratory. Scientists for Global Responsibility. p.43

group designated as the Aerodynamics and Flight Mechanics Group (AFM).[254] DARP projects are industry-led partnerships on research with military objectives,[255] but there is little public information about the project. Requests for information by AOAV about funding for military projects in Soton and their purpose were met with a refusal to disclose such information on the basis of section 43(2) of the FOIA, concerning commercial interests.[256] Despite being a tool for enhancing transparency, the ability to exclude information demanded by the FOIA on the basis of commercial interests illustrates how the commercialisation of education negatively impacts the openness of academia.

Unlike other universities in this report, information concerning investments was also not provided to dED due to section 43(2) of the FOIA.[257] Additionally, unlike ICL, Soton's unique contributions to the UKDSC have not been formally introduced. Soton is hence distinguished from other universities in this report for their restrictive practices, which limit information sharing and transparency of its activities with the MIC. On the other hand, in response to an FOI request for the report by the campaign group Campaign to Stop Killer Robots (CSKR), a spokesperson for Soton claimed that the university is not involved in weapons research,[258] and Soton also claimed to have divested from arms companies in 2016 following student activism against arms company investments.[259] Yet, the limited transparency of military-industrial investments and research in Soton makes it difficult to hold the university accountable to such claims.

Soton has distinguished itself for creating more spinout companies than almost all other universities in the UK, including the largest and most successful university spinout, Southampton Photonics, but later known as SPI Lasers.[260] Soton has two spinout companies with defence applications. AccelerCom delivers technology in wireless communications, and provides services in defence such as ensuring immediate response from autonomous vehicles.[261] Covesion is a spinout that engages in R&D and manufacture of periodically poled lithium niobate (PPLN) solutions, and the company provides services in space and defence.[262]

This case study investigates research collaborations between Soton and a few arms companies into METs, specifically related to noise reduction, and autonomous technologies. Several of these collaborations occur under the Centre for Defence and Security Research (CDSR). Similar to ISST and I-HUB at ICL, the CDSR in Soton is a hub for cross-disciplinary investigations in defence and security research "through directly engaging with government and collaborating with industry partners".[263] An assortment of arms companies are listed as industrial partners of CDSR, such as Airbus, BAE Systems, Leonardo, Thales, and Northrop Grumman.[264] EDTs such as autonomous systems, AI and ML are included among the areas of expertise listed by the CDSR.[265]

Requests for information by AOAV about funding for military projects in Soton and their purpose were met with refusal

254 University of Southampton (undated). Research Group: Southampton Wind Tunnels. https://bitly.ws/3cty7
255 Beale, M. Street, T. 2007. Study War No More: Military Involvement in UK Universities. Campaign Against the Arms Trade, Fellowship for Reconciliation. p.33
256 AOAV 2021. University of Southampton. FOI Response to 12/11/2021
257 dED 2020. University of Southampton. Response to FOI 12/11/2020
258 Griffiths et al 2022. An investigation into the Roleof UK Universities in the Development of Autonomous Weapons Systems. Stop Killer Robots in UK Universities. p.20
259 CAAT 2016. University of Southampton ends its investments in arms companies.
260 University of Southampton (undated). Our history. https://bitly.ws/3ctxP
261 AccelerCom (undated). Industry use cases. https://bitly.ws/3ctyE
262 Covesion (undated). Space & Defence. https://bitly.ws/3ctzg
263 University of Southampton (undated). Centre for Defence and Security Research. https://bitly.ws/3ctzs
264 ibid (undated)
265 ibid (undated)

Noise Reduction Technologies

UTCs and Intelligent Structures for Low Noise Environments

Soton has formed a number of University Technology Centres (UTCs) and research centres in strategic partnerships with leading arms companies under the School of Engineering. University Technology Centres (UTC) provide short and long-term research support for a specific company.[266] Three UTCs are involved in delivering expertise in research on noise: the Airbus Noise Technology Centre (ANTC), Rolls-Royce UTC in Propulsion Systems Noise, and the Rolls-Royce UTC in Gas Turbine Noise.[267] In addition, Soton has a partnership with BAE Systems that aims to reduce underwater noise pollution, not under the framework of a UTC, but under the umbrella of the Intelligent Structures for Low Noise Environments Research Programme, part of the Institute of Sound and Vibration Research and listed as a related research institute of the CDSR.[268] Separate from UTCs applicable to research on noise, Rolls Royce also has a UTC in Computational Engineering,[269] so Rolls Royce is heavily represented in UTCs in Soton.

Rolls Royce

Unlike BAE Systems, which derives 97% of its revenue from arms sales, only 32% of Rolls Royce's revenue is from military business, as it produces engines for both military and civil aircraft and ships, as well as power systems for offshore platforms and other industrial systems.[270] Rolls Royce's more diversified business marks an important distinction between the two companies.

Rolls Royce operates a global network of UTCs that provides research and specialist knowledge for key technologies for the company, such as combustion, materials, noise, and vibration.[271] Soton promotes its UTCs with companies such as Rolls Royce as a gateway for students to training and experience that can enable them to work for such companies in the future.[272] UTCs therefore also steer students into careers with arms companies.

The Rolls-Royce UTCs in Propulsion Systems Noise and Gas Turbine Noise are both oriented to research on noise. Rolls Royce aims to achieve a 65% reduction in perceived aircraft noise by 2050 as a part of the company's commitment for aviation to reach net zero, which is also central to the company's sustainability and ESG approach.[273] Noise reduction research at Soton, in collaboration with Rolls Royce, is also driven by commercial needs to accommodate increases in air travel while reducing noise at airports.[274] However, noise reduction of aircraft can also provide benefits to the military. As stated in section 2.3, defence accounts for half of government GHG emissions, but defence aviation emissions constitute the single largest contributor to defence's total emissions.[275] Furthermore, the MOD's Defence Aviation Net Zero Strategy draws attention to defence's role as a "fast follower" and how defence benefits from close synergies with the civil aviation sector,[276] so noise reduction research in the civil

266 Beale, M. Street, T. 2007. Study War No More: Military Involvement in UK Universiies. Campaign Against the Arms Trade, Fellowship for Reconciliation. p.35
267 University of Southampton (undated). Strategic Relationships. https://bitly.ws/3ctzD
268 University of Southampton (undated). Intelligent Structures for Low Noise Environments. https://bitly.ws/3ctAH
269 University of Southampton (undated). Strategic Relationships. https://bitly.ws/3ctzD
270 da Silva et al 2023. The SIPRI Top 100 Arms-producing and Military Services Companies. Stockholm International Peace Research Institute. p.9
271 Rolls Royce (undated). Research and University Technology Centres.
272 University of Southampton (undated). Autonomous Systems. Industry
273 Rolls Royce (undated). Elephant in the Room. Can aviation meet net zero? News & Insights. https://bitly.ws/3ctBi
274 University of Southampton 2018. Quiet Skies. Reducing the noise of Rolls Royce jet engines. https://bitly.ws/3ctBB
275 Ministry of Defence 2023. Defence Aviation Net Zero Strategy. p.3
276 ibid 2023, p.8

aerospace sector can contribute to noise reduction in the defence aerospace sector. Additionally, as also previously discussed in section 2.3, noise reduction enhances the surveillance capabilities of military aircraft. Noise reduction therefore provides military benefits, but such technology can also be highly profitable for arms companies. Rolls Royce maintains aerospace operations in both the civil sector and defence sector. However, the company's military aerospace operations registered higher underlying operating margins than its civil aerospace operations from, at least, 2016 to 2022.[277] So the higher profit margins from the company's military aerospace operations strongly incentivize the development of METs.

Since defence aviation accounts for a majority of military emissions, reducing noise emissions may provide environmental (and PR) benefit for reducing MOD emissions, but such technology provides limited benefit to reducing the death and injury caused by such technology, which Rolls Royce has been complicit in through supplying the EJ200 engine used for fighter jets committing atrocities in Yemen. The share of Rolls Royce's business that is for military purposes is less relevant than the human impact of its military activities, as these have been linked to atrocities and human rights violations in several countries. Due to this, while companies such as BAE Systems may derive a much larger amount of revenue from arms sales, both Rolls Royce and BAE Systems are arguably equally complicit in exporting violence to countries such as Yemen.

BAE Systems & Intelligent Structures for Low Noise Environments

Soton has also collaborated with BAE Systems for METs. Along with the University of Salford, Soton is collaborating with BAE Systems to improve the energy efficiency of the company's warships.[278] Additionally, Soton has supported BAE Systems with research into sound to reduce environmental harm to marine wildlife. This collaboration is a part of BAE Systems' Strategic Partnership programme, in which BAE partners with select universities for expertise and development into various technologies, such as AI, data fusion, and maritime.[279] This research partnership seemingly addresses BAE System's objectives to protect biodiversity and natural capital, which is a part of the company's sustainability approach under its ESG strategy.[280] Similar to collaborations with Rolls

277 Rolls Royce Annual Reports 2016, 2017, 2018, 2019, 2020, 2021, 2022
278 BAE Systems 2023. Technology Watch: Sustainability Edition. p.3
279 BAE Systems 2017. Collaborating with academia. https://bitly.ws/3ctDx
280 BAE Systems (undated). Electricity, consumption, waste, water, and biodiversity

Royce into noise, Soton's collaboration with BAE Systems in this instance is motivated by the increase in global trade, but contrary to addressing the environmental impacts of the growth in air travel, the increase in naval shipping worldwide motivates this research.[281] Nevertheless, noise reduction from wind turbines and sea vessels is described by BAE Systems as "having clear civilian and military benefits".[282]

Yet, and in another similarity to Rolls Royce, BAE Systems research with Soton exemplifies greenwashing. Companies greenwash themselves by self-advertising as "green" despite several of their actions defying this image.[283] Saudi Arabia's bombing campaign in Yemen has used Tornado and Typhoon combat aircraft supplied by BAE Systems, and these airstrikes, as well as causing huge civilian casualties, have extensively damaged water and food sources.[284] These impacts compounded the food insecurity wrought by the Saudi-led blockade imposed on Yemen. Water scarcity has been described as the most pressing environmental problem in Yemen.[285] Thus, arms companies and militaries boast of the "environmentally-friendly" weapons they are producing as a way to bolster their green credentials, and to give the impression that it is possible to have a "green war", but these weapons still cause immense human and ecological damage when they are used.

Autonomous Systems

Autonomous systems & robotics is one of the seven key technology families listed by the MOD's Defence Technology Framework (DTF). Soton has been distinguished as the leading university in the UK for autonomous systems.[286] Therefore, Soton has played a leading role in the creation of research centres in autonomous technology in the UK. Soton is a founding member of the EPSRC UK Robotics and Autonomous Systems Network (UK-RAS).[287] In 2020, Soton was announced as a leader of a Trustworthy Autonomous Systems (TAS) Hub.[288] According to a press release by Soton, defence and security is one of several domains in which the hub will conduct research.[289] Finally, during a parliamentary hearing into automation in military operations, Soton generated the most interviewees and peer reviewers out of the universities acknowledged in the POSTnotes.[290] The following sections will investigate case examples of research into autonomous systems carried out by Soton in partnership with other universities, industrial partners, and the MIC.

281 University of Southampton (undated). Intelligent Structures for Low Noise Environments. https://bitly.ws/3ctAH
282 BAE Systems (undated). (Don't feel the noise). Working with universities on active sound control. https://bitly.ws/3ctDN
283 Clapp, S. Dauvergne, P. 2005. Paths to a Green World: The Political Economy of the Global Environment (The MIT Press, United States). p.178
284 Jafarnia, N. 2022. Risking the Future: Climate Change, Environmental Destruction, and Conflict in Yemen. center for Civilians in Conflict p.17
285 Lackner, H. Eryani, A. 2020. Yemen's Environmental Crisis is the Biggest Risk for its Future. The Century Foundation
286 Fawley Online 2015. Southampton to provide major boost to UK robotics and autonomous sytems capability. https://bitly.ws/3ctDV
287 ibid 2015
288 University of Southampton2020. Southampton Based Hub to Lead UK Research on Trustworthy Autonomous Systems. https://bitly.ws/3ctE4
289 ibid 2020
290 UK Parliament 2022. Automation in Military Operations. https://bitly.ws/3ctEm

ALADDIN

The Autonomous Learning Agents for Decentralised Data and Information Networks (ALADDIN) project, which also includes university researchers from Bristol, ICL, and Oxford, is a £5 million project from 2005 funded by BAE Systems and the EPSRC to find solutions for disaster management.[291] The ALADDIN disaster management system is executed by multiple autonomous agents using the best available information to make individual and collective decisions in dynamic environments while retaining flexibility over their decision making.[292] Software demonstrations of the use of the project in environmental disasters include raising situational awareness, evacuation from a building fire, and robocop rescue, building on a model for the 1995 Kobe Earthquake in Japan.[293]

Contrary to ALADDIN's application to disaster management, BAE Systems declared its intention to use the ALADDIN system "to improve logistics, communications and combat systems", and create new systems to enable the cooperative control of UAVs and the detection of terrorism threats using data from social media".[294] As stated in one article on the project, "what works for disaster relief should therefore also work for conflict".[295] However, Dr Nick Jennings, a professor from Soton who was one of the leaders of the project, explained that future research would look into integrating "flexible autonomy" into ALADDIN to limit the autonomy of the "agents" by handing several decisions to human operators,[296] which would presumably reduce the likelihood of ALADDIN being used to develop Lethal Autonomous Weapons Systems (LAWS).

Despite this, ALADDIN foreshadows how other research conducted in Soton could contribute to LAWS. The report from CSKR assessed that a project affiliated with Soton and the Alan Turing Institute, with applications to disaster response, titled "Flexible Autonomy for Swarm Robotics", was at high risk of contributing to LAWS due to integrating technologies relevant for LAWS and the participation of the French arms company, Thales.[297] ALADDIN followed a similar trajectory by being developed for disaster management and eventually being appropriated by an arms company for military purposes including cooperative control of UAVs.

Arms companies and militaries boast of "environmentally-friendly" weapons to bolster their green credentials...but these weapons still cause immense human and ecological damage when they are used

291 Adams et al 2008. The ALADDIN Project. Intelligent Agents for Disaster Management. International Workshop on Robotics afor Risky Interventions and Surveiillance of the Environment. International Advanced Robotics Programme. ESP. p.2
292 ibid 2008, p.2
293 ibid 2008, p.2-3
294 BAE Systems 2010. ALADDIN in use for operational projects. https://bitly.ws/3ctEE
295 The Economist 2010. No Command, and control. https://bitly.ws/3ctEH
296 ibid 2010
297 Griffiths et al 2022. An Investigation into the Role of UK Universities in the Development of Autonomous Weapons Systems. Stop Killer Robots in Universities. p.14

Marine Autonomous Systems & Thales

Another project from Soton deploying expertise in autonomous systems is the Marine Autonomous Systems Testing Service (MASTS), which will be the first UK service dedicated to testing autonomous systems such as unmanned air vehicles, boats, and sensors in a controlled and realistic environment.[298] In collaboration with the EPSRC and Department for Transport, the Solent Local Enterprise Partnership (LEP) invested £457 000 in BAE Systems for delivery and design of MASTS, so Soton will work alongside BAE Systems as well as other industry partners to support its production.[299] As suggested by the preceding discussion of ALADDIN, BAE Systems' involvement is likely to militarise the project, so the Combat Systems Head of Technology from BAE Systems commented positively on the project and organisations that may benefit from it:

Autonomous and unmanned systems are widely regarded as vital technology for the future, but there is a great deal of work to be done if we are to unlock their true potential and understand how they are best integrated into wider systems...a wide range of organisations from the defence and commercial sectors, along with academia, have ambitions for this technology, and this unique service will allow them to find valuable ways to use it whilst furthering its development".[300]

In addition to developing testing services for marine autonomous systems, Soton is also involved in developing marine autonomous systems with arms companies. In 2019, Thales signed an agreement to collaborate with Soton over five years to develop autonomous marine systems for use by the Royal Navy.[301] A year later, Soton deepened its strategic partnership with Thales in autonomous systems through collaboration in the Integrated Mission Management System (IMMS), which sought to enable humans to be "supervisors" as opposed to being "controllers" of autonomous vessels.[302] As a part of this strategic partnership, Soton and Thales will also support student careers and recruitment.[303]

As previously discussed in Chapter 2, Thales and various Thales-linked entities are linked to research in surveillance systems. Thales in general plays a pivotal role in developing technologies for surveillance and border control. Thales has developed biometric technologies for use by the US Department of Homeland Security (DHS) to collect biometric profiles of at least 268 million people.[304] This technology was instrumental to a program which enabled automated fingerprint sharing between local law enforcement and Immigration and Customs Enforcement (ICE), which led to a sharp increase in deportations in the U.S.[305] Automated biometric surveillance was identified in a report by the European Commission as an area in which AI could be deployed for border control, migration, and security.[306] Thales technology thus plays a strong role in militarising borders. Given Soton's expertise in autonomy, which is passed down to students, students could contribute to the further militarisation of borders through Soton's support for recruitment and careers in Thales.

298 University of Southampton 2017. University will be part of UK's first maritime autonomous systems testing service. https://bitly.ws/3ctEP
299 ibid 2017.
300 ibid 2017.
301 Naval Technology 2019. Thales to develop autonomous marine systems with University of Southampton. https://bitly.ws/3ctEZ
302 University of Southampton 2020. Thales relationship makes big autonomous strides. https://bitly.ws/3ctF7
303 ibid 2020
304 AFCS Investigate (undated). Thales. https://bitly.ws/3ctF
305 ibid n.d.
306 Jones et al 2023. Europe's Techno Borders. EuroMed Rights. Statewatch. p.29

Lancaster University Overview

LU was founded in 1964.[307] The colours of the university, red and quaker grey, are described as reflecting the historical regional and local presence of the Quakers,[308] a Christian society founded by George Fox, who all practised pacifism and supported the abolitionist and women's rights movements.[309] Despite this regional history, LU is located in Lancashire in the North West, and Lancashire is one of the top four centres in the world for aerospace production for defence.[310] The arms industry's vast presence in the region has been felt by LU. The "George Fox Six", whose name was adopted by the press, were six LU students who interrupted and protested a corporate event held in the George Fox building in LU with the participation of BAE Systems and fossil fuel companies, but were later convicted and fined for trespassing in a case that sparked a heated debate about free speech and the right to protest on campus.[311] Eventually, in 2021 LU announced that the university would be divesting from the fossil fuel, tobacco, and arms industries.[312] In contrast to Soton, dED was able to confirm this commitment to a certain extent by discovering, through an FOI request, that LU held no investments in the arms companies that were listed under the request in the last five financial years, which included some of the largest arms companies in the UK, such as BAE Systems and Rolls Royce.[313] However, LU's geographic location provides a rationale for sustained collaborations with arms companies. Nationally, the arms industry makes up a relatively small share of total manufacturing, and thus declines in military expenditure would not cause calamitous effects for the national economy.[314] However, the effects of reduced military expenditure on some local and regional economies may be of a greater magnitude, since the arms industry is highly concentrated in certain regions and local communities. The North West, in particular parts of Lancashire and Cumbria, is one such region.

As a major local employer, the arms industry plays a strong role in dictating skills requirements in the North West, and universities are pressured to provide a workforce equipped with these skills in order to support the industry and economy. For example, The Engineer, a London-based monthly of the engineering sector, outlined key themes and technologies that will shape the aerospace and defence industry in the North West in the future, and these include sustainability and digitalisation, which consists of AI, automation, robotics, and autonomous systems.[315] The Engineer advocates for the aerospace and defence industry to leverage educational institutions and training programs in the North West to develop a workforce skilled in these technologies to address the industry's changing needs.[316] LU is one educational institution in the North West that has been utilised by arms companies for expertise in these areas. Based in LU, the Lancaster Intelligent, Robotic, and Autonomous Systems Centre (LIRA) has developed

307 Lancaster University (undated). Origins and Growth. https://bitly.ws/3ctGv
308 ibid (undated)
309 History 2023. Quakers. https://bitly.ws/3ctGE
310 Invest Lancashire (undated). #1 in UK for Aerospace Employment. https://bitly.ws/3ctGT
311 Smith, A. 2006. "Lancaster Six" lose appeal. The Guardian https://bitly.ws/3ctGM
312 Cunnington, P. 2021. Lancaster University moves to end investment in fossil fuels following long-running campaign by students and staff. Lancashire Post. https://bitly.ws/3ctH6
313 dED 2023. University of Lancaster. Response to FOI 13/09/2023
314 Holden et al 2016. Indefensible: Seven Myths That Sustain the Global Arms Trade (Zed Books, London). p.84
315 The Engineer 2023. Analysis: How aerospace &defence is driving skills requirements in the North West. https://bitly.ws/3ctHc
316 ibid 2023

and completed projects funded by the MOD and arms companies such as BAE Systems, Thales, and QinetiQ.[317] This case study will investigate how LU is developing additional skills required from the arms industry,

LU is also linked to the nuclear enterprise through its spin-out Hybrid Instruments, which formed in 2003 and has "designed, manufactured, and supplied nuclear instruments" of a certain type to public and private sector organisations around the world.[318] LU maintains another spinout called Lancaster Helium, which is also linked to nuclear technology by providing, among other functions, coolant gas in nuclear reactors.[319]

The following sections will investigate the role LU plays with the University of Cumbria in deepening the economic and social impact of BAE Systems in the Lancashire and Barrow-in-Furness communities. Additionally, this section will also investigate how LU's cyber security expertise has been targeted by BAE Systems and the UK's leading intelligence agency, Government Communications Headquarters (GCHQ).

Barrow Learning Quarter

BAE Systems measures social impact by three indicators: firstly, supporting active service personnel, veterans, and their families; secondly, inspiring young people to consider STEM subjects and careers; and working to support the communities in which the company operates.[320] BAE's presence in the North West and partnership with LU reflects the second and third indicators of social impact. BAE Systems economic support for local communities in the North West is vividly illustrated in a recent case in which BAE Systems purchased a number of vacant retail units in the shopping centre of Barrow-in-Furness, Cumbria, the location of major BAE naval production.[321]

LU is also deepening BAE Systems' social impact through the Barrow Learning Quarter (BLQ) . Announced in 2021, the BLQ, developed by the University of Cumbria in partnership with Furness College, LU, and industry partners including BAE Systems, "aims to create more opportunities for people in Barrow and the surrounding areas to access further and higher education".[322] The BLQ also aims to improve the employment prospects of the local population and the competitiveness of local businesses while in close alignment with the needs of local employers.[323] In an insight into the future employment needs of BAE Systems in Barrow, BAE announced in October 2022 that the company was seeking to hire around 1,200 people, mostly based in Barrow, for work to begin on the Barrow Shipyard for the third phase of Dreadnought nuclear submarines.[324] The BAE Systems facility in Barrow-in-Furness, which is the site of development of Dreadnought nuclear submarines, is the largest BAE Systems facility in the UK and employs the largest number of workers of all BAE facilities, followed by, in order, Warton, Samlesbury in Lancashire, and Portsmouth.[325] BAE Systems employs 26% of the working population in Barrow-in-Furness.[326] As one of the largest sites for aerospace and defence, Lancashire is also the site in which Typhoon aircraft, which have been used for previous bombing raids in Yemen, are manufactured.[327] Tempest, which is set to replace Typhoon

The arms industry plays a strong role in dictating skills requirements in the North West, and universities are pressured to provide a workforce equipped with these skills

317 Lancaster University (undated). Security and Defence.
318 Lancaster University (undated). Hybrid Instruments.
319 Lancaster Helium (undated). About Us.
320 BAE Systems (undated). Supporting our communities. https://bitly.ws/3ctJ2
321 BBC 2023. BAE Systems buys empty Barrow shopping centre units. https://bitly.ws/3ctJa
322 Brilliant Barrow (undated). The Learning Quarter. https://bitly.ws/3ctJg
323 ibid (undated)
324 BBC 2022. BAE Systems to recruit 1,200 workers for MOD submarine plans. https://bitly.ws/3ctHE
325 BAE Systems 2022. BAE System's Contribution to the UK Economy. Oxford Economics. p.19
326 ibid 2022, p.2
327 Harrigan, J. 2021. BAE Systems:Lancashire engineering firm hopes new Typhoon jet order will drive growth. The Bolton News. https:/bitly.ws/3ctLk

Barrow Learning Quarter (Design)

aircraft, will be manufactured in the Samlesbury and Warton sites in Lancashire.[328] Samlesbury is also the site in which BAE Systems manufactures the rear fuselage for F-35 aircraft, which are used by Israel in bombing Gaza.[329]

At the core of the BLQ is a university campus, announced in February 2021 and set to open in 2024, with land provided by BAE Systems, providing degree-level programmes in areas of expertise such as cybersecurity and project management.[330] In March 2021, staff at LU created and circulated a petition calling for an end to the campus and the university's collaboration with BAE Systems.[331] The staff drew attention to BAE System's role in atrocities in Yemen, and how the university should instead focus on developing "skills, knowledge, and technologies and jobs to tackle the climate emergency and promote global justice, as advocated by the Green New Deal campaign".[332] In response to staff protest, a spokesperson from LU cited the contribution of LU's relationship with BAE to local economic development, and justified LU aiding BAE Systems to recruit high-skilled individuals on the basis of BAE being the largest employer in Barrow.[333]

Supporting BAE Systems' recruitment efforts in the North West, however, not only leads STEM students into military careers, but into careers with an arms company whose production facilities in the region manufacture some of the UK's most controversial and harmful arms exports. However, given the depth of the arms industry in the region, alternative civilian employment would have to be generated in order to offer insurance to workers in the event of plant closures. Absent such alternatives, arms company divestment from the region would risk severely disrupting the local community and region due to the community's economic dependence on the war economy. However, maintaining employment and military orders in regions such as the North West is also largely driven by the need by the UK government to preserve the knowledge and capability to design weapon systems.[334] According to this logic, the UK builds nuclear submarines and fighter aircraft in order to preserve the knowledge and capacity to build more nuclear submarines and fighter aircraft in the future.[335]

328 BBC 2023. BAE Systems awarded more than £600 for fighter jet project. https://bitly.ws/3ctLA
329 Horgan 2023. UK factories help build the fighter jets used by the Israeli military. They should be stopped. https://bitly.ws/3cLI
330 Brilliant Barrow (undated). The Lerning Quarter. https://bitly.ws/3ctJg
331 Rouncivell, G. 2021. Lancaster universities urged to break ties with arms industry. Lancaster Guardian. https://bitly.ws/3ctLU
332 ibid 2021
333 ibid 2021
334 Lister, K. 2014. The Vortex of Violence: And Why We Are Losing the War on Climate Change. (Createspace Independent Publishing Platform) p.89
335 ibid 2014, p.89

The BLQ also shows how arms companies varnish their reputations by presenting themselves as job-creators and saviours of British industry who elevate the country's skills base and stimulate young people's interest in STEM subjects.[336] Yet, BAE Systems has invested large sums in outreach to boost student interest in STEM subjects in order to support the future "pipeline" of available skills for the company.[337] Therefore, such university partnerships with LU for economic development are less philanthropic but more lucrative, since they provide BAE Systems with employable and high-skilled recruits for the future. Furthermore, as previously stated, the arms industry is struggling to recruit STEM talent. Therefore, under the cover of delivering "social impact", the BLQ addresses the arms industry's acute need to boost STEM recruitment. Cyber, as previously described, is also one of several emerging capabilities increasingly prioritised by the security and defence sector. Therefore, LU's contribution in the form of its cybersecurity expertise to the Barrow Campus is central to fulfilling the BLQ's aim to "provide some of the emerging skills required for our future workforce".[338] Finally, boosting recruitment into the arms industry diverts students away from more ethical industries such as renewable energy. Far more public R&D spending is devoted to defence than the environment,[339] so the green sector, which is already relatively deprived of capital resources, is additionally deprived of human capital by such diversion.

In 2022, BAE Systems and LU formalised their long-term partnership with a Memorandum of Understanding (MoU) for a Strategic Agreement for skills development and technology R&D to further enhance "prosperity" in the region.[340] The agreement also furthers cooperation between BAE Systems and LU into sustainable technologies and cyber expertise.[341] Partnership with BAE Systems is also framed as enabling LU to meet net zero targets.[342] As the next section will show, LU has continued to deepen its collaboration with BAE Systems in terms of the provision of cybersecurity expertise.

Given the depth of the arms industry in the region, alternative civilian employment would have to be generated...in the event of plant closures

Lancashire Cyber Partnership

In 2023, Lancashire announced LU as a part of a Lancashire Cyber Partnership (LCP) to "implement initiatives and strategies which will facilitate and boost cyber-led economic growth across the County's digital industries, technology supply chains, and broader disciplines.[343] Other LCP members include the University of Central Lancashire, the National Cyber Force, defined as a "partnership between defence and intelligence", and BAE Systems.[344] BAE Systems is described as bringing a "world-leading advanced aerospace and defence technology perspective" to the LCP.[345] The LCP therefore bears similarity to the BLQ in the sense that both are community development programmes with the participation of BAE Systems, and the growth of cybersecurity talent are anticipated outcomes of these programmes. These partnerships show how LU's expertise in cybersecurity is targeted by not only BAE Systems, but as the following section will show, GCHQ, in a way that Northumbria's expertise in space technologies was targeted by Lockheed Martin, as previously shown in section 2.3.

336 Stavrianakis, A. 2015. In Arms' Way: Arms Company and Military Involvement in Education in the UK. Acme: An international Journal for Critical Geographries 8 (3) pp. 505-520. p.514
337 BAE Systems 2022. BAE System's Contribution to the UK Economy. Oxford Economics. p.28
338 University of Cumbria 2021. University of Cumbria and Lancaster University sign partnership to develop HE in Barrow. https://bitly.ws/3ctNv
339 Panjwani, A. 2023. Research & Development Spending. House of Commons Library. p.23
340 Lancaster University 2022. Strategic Agreement with BAE Systems drives further business innovation and sustainable technology research in Lancashire. https://bitly.ws/3ctNM
341 ibid 2022
342 ibid 2022
343 Lancaster University 2023. Lancashire announces new strategic partnership to maximise country's "once in a generation" cyber opportunity. https://bitly.ws/3ctNX
344 ibid 2023
345 ibid 2023

Security and Trust Partnership & the GCHQ

In 2021, the GCHQ launched the "North West Partnership for Security and Trust", in partnership with four universities including LU, UoM, Manchester Metropolitan University, and the University of Salford, which, in a first for the GCHQ, "will see GCHQ publish its own research jointly with the universities".[346] The partnership also aims to contribute to the development of the North West region's "cyber corridor", which includes the National Cyber Force's new HQ in Samlesbury, Lancashire, which draws together personnel from GCHQ, the MoD, the Secret Intelligence Service (MI6), and the Dstl, under one unified command for the first time to conduct cyber operations.[347]

The partnership not only fosters closer collaborations between GCHQ and universities but also aims to "attract a new, more diverse workforce by encouraging students from courses involving subjects like computer science, maths, behavioural science, criminology and linguistics to consider careers with the UK intelligence community".[348] Similar to the BLQ, the partnership between GCHQ and LU aims to boost student recruitment, but in this case, into intelligence agencies. While this partnership foregrounds business needs, it also promotes careers in the GCHQ, which also offers roles linked to defence. Furthermore, the GCHQ is aiming to recruit students from a broader range of disciplines than those recruited into the arms industry.

346 Lancaster University 2021. GCHQ announces new academic partnership with universities. https://bitly.ws/3ctPd
347 ibid 2021
348 ibid 2021

Resistance and Alternatives

As shown by the report, civilian industries and universities have become increasingly militarised under the contemporary developments of the RMA in EDTs and development of METs. The growing encroachment of the military sector into the civilian domain is leading to the fruition of what has been termed a "garrison state", which is "a nation in which the line of demarcation between military and civilian activity is difficult to define", which results from an increasingly pervasive military-industrial complex (MIC).[349] According to Fulbright, who coined the term "MIAC", the MIC is a powerful force "for the introduction and expansion of expensive weapons systems, and as a result, for the militarisation of large segments of our national life".[350] Fulbright also spoke of how several individuals and groups have a vested interest in the MIC and military expenditure, but as Fulbright emphasises:

> *"This is not…because anyone favours war but because every one of us has a natural and proper desire to preserve the sources of his livelihood. For the defence worker this means preserving or obtaining some local factory or installation and obtaining new defence orders, for the labour union leader it means jobs for his members at abnormally high wages, for the politician it means preserving the good will of his constituents by helping them to get what they want… Every time a new program…is introduced, a powerful new constituency is created".*[351]

Upon the formation of a government program, or, in Fulbright's formulation, production of a military system, the constituencies or interests that benefit from the program develop a significant interest in its protection and growth.[352] The formulation adopted by Fulbright can be applied to illustrate the benefits or what the MIC and military expenditure can "mean" for universities, academics, and university students. For universities, military investment can confer status and prestige. Prestigious universities in the U.S., such as Carnegie Mellon, Massachusetts Institute of Technology (MIT), Stanford University, and Georgia Institute of Technology, ascended to "elite" status due in large part to investment from the MIC.[353] The status that accords to countries from their military systems extends to the universities that generate R&D into those systems.

349 Melman, S. 1970. Pentagon Capitalism: The Political Economy of War (McGraw-Hill Book Company). p.217
350 Congressional Record 1967. Fulbright Speech. https://bitly.ws/3ctQJ p.4
351 Ibid 1967, p.3-4
352 Kingdon, J. 2014. Agendas, Alternatives, and Public Policies. 2nd Edition. (Pearson Education Limited, United States). p.152
353 Leslie, S.W.1993. The Cold War and American Science. The Military-Industrial-Academic Complex at MIT and Stanford. (Columbia University Press, New York) p.255

Academics and experts in nonmilitary issues can increase their chances of gaining funding for their projects if they can "securitise" nonmilitary phenomena - that is, frame certain issues as "security issues", which often demand "extraordinary" and militarised responses.[354] Since the voices of academics and experts can carry powerful weight in such matters, such academic declarations can help advance the militarisation of nonmilitary phenomena, in turn benefiting these same academics.

The MIC can even create supportive constituencies from university students. An example of this is provided by a commentary which defends the arms industry's presence in Soton on the basis of, among other arguments, arms company sponsorship of many engineering student societies.[355] Finally, high levels of military expenditure generate a profitable market for R&D for the military, and this large and profitable market incentivises the militarisation of academia and civilian industry.

However, this is not to suggest that the MIC itself is intrinsically driven by the need to secure the livelihoods of these groups. The unceasing development of weapons systems assures a steady stream of contracts and taxpayer subsidies to the arms industry. These subsidies provide "corporate welfare" for the arms industry, since the taxpayer funding of a large proportion of the arms industry's R&D and capital expenditures rewards shareholders with billions of pounds.[356] However, the considerable influence that the MIC wields over so many livelihoods bestows it with powerful leverage to secure such self-serving benefits from the government. Despite this, universities legitimise the perception of the MIC as benevolent job creators and community developers through partnerships with arms companies for "social impact".

Recent Opposition to the MIAC

As this report has shown, however, the expansion of the MIAC has also been met with resistance. Students in universities in the UK and around the world have mounted opposition to the militarisation of education. A multitude of student protests broke out in 2022 and 2023 in the UK against university participation in the arms trade, with students from Bristol, Cambridge, Glasgow, Lancaster, Manchester, Nottingham, and Sheffield universities staging protests on college campuses.[357] In the University of Sydney in Australia, students protested the university's partnership with Thales.[358] In the U.S., students from Boston University's College of Engineering[359], and social justice groups from the University of Massachusetts,[360] protested Raytheon's presence on their respective campuses.

The issue that hence confronts peace campaigns is how best to support protests and activism against the MIAC. A plan to demilitarise universities and social life must diminish the power of the underlying source of the MIAC, which is the MIC, by reducing its scope and control over various parts of society. Disarmament as a peace strategy entails starkly reducing the military budget, as well as the people, resources, and capital under military-industrial control following international agreements on arms reduction.[361] The disarmament process is fundamentally about "reducing their control

The "military industrial complex" is a powerful force "for the introduction and expansion of expensive weapons systems, and as a result, for the militarisation of large segments of our national life"
(Sen. J. William Fulbright)

354 Eriksson 1999, J. Agendas, threats, and politics. securitization in Sweden. Aberdeen Studies in Politics. p.17
355 Steadman, T. 2013. Southampton and the Military: A Critical Relationship. The Southampton Tab. https://bitly.ws/3ctRD
356 Kersley, A. 2023. UK "wastes billions" on defence firms that give investors rich returns. The Guardian. https://bitly.ws/KTyH
357 Autonomy News 2022. Warwick Students shut down careers fair in protest against the arms trade. https://bitly.ws/3ctRR
358 Modaro, E. 2023. Sydney Students Protest University Links to Weapons Manufacturer Thales. CityHub. https://bitly.ws/3ctSd
359 Macdougall, A. 2022. "Student group demand UMASS cut ties with Raytheon. Daily Hampshire Gazette. https://bitly.ws/3ctSp
360 Avery, J. 2020. Students protest Raytheon's presence at ENG career fair. The Daily Free Press. https://bitly.ws/3ctSw
361 Melman, S. 1988. The Demilitarized Society: Disarmament and Conversion (Harvest House, Montreal) p.58

over means of production of every kind - factories, laboratories, schools".[362] Given that a holistic international agreement on arms reductions is a critical precondition for reversing the power of the MIC, the issue for peace groups is what such a holistic international agreement on arms reductions ought to be.

General and Complete Disarmament (GCD)

The Strategic Concept for Removal of Arms and Proliferation – or SCRAP Weapons – a research project based in the School of Oriental and African Studies (SOAS) University of London, has drawn on and developed such a comprehensive approach to disarmament at the international level. SCRAP Weapons aims to establish a set of controls of major conventional weapons as well as eliminating WMD through a framework that sets out objectives to achieve the legal obligation of all nations under Article VI of the Nuclear Proliferation Treaty (NPT) to negotiate general and complete disarmament (GCD).[363]

As previously shown, ethical investment policies and constraints on weapons research are often informed by international legislation on weapons systems. However, given the absence of comprehensive international legislation on conventional weapons, and the UK's status as a non-signatory to the TPNW, most university ethical investment policies and weapons research policies don't place limits on conventional weapons and nuclear weapons. Yet, students and staff that protest military-industrial involvement in universities often target conventional weapons systems such as F-35 fighter aircraft and the UK's nuclear weapons system.[364] Conventional weapons are thus highly controversial despite their legality among states, and nuclear weapons are similarly controversial despite their permissibility in the UK.

However, as discussed in the section on LU, promoting disarmament without offering alternative economic opportunities can severely dislocate arms-dependent regions and communities, so disarmament must be paired with economic conversion for a comprehensive approach to peace.

Economic Conversion

Economic conversion is converting technology, companies, and human skills involved in military production to nonmilitary uses.[365] Coupled with an economic transition away from fossil fuels, economic conversion can not only decarbonise the economy, but also demilitarise the economy. One of the most ambitious attempts at economic conversion in the UK was the Lucas Aerospace Combine Shop Stewards' Committee. In 1976, the Lucas Aerospace Company, which depended on military contracts for half of its output, announced layoffs.[366] In response, a Combine Committee composed of workers from Lucas Aerospace designed an Alternative Corporate Plan for 150 socially useful products, which fell into sixe categories: energy conservation, improved braking systems, oceanics, medical equipment, telechiric machines, and transport vehicles, but the Plan was rejected by the management of Lucas Aerospace.[367]

The School of Peace Studies in the UK-based Bradford University, which celebrated its 50th anniversary of its founding in 2023, not only provided a model for a university promoting economic conversion, but also directly engaged with communities similar to the Lucas Plan while doing so. The Arms Conversion Group (ACG) was an umbrella

362 Ibid 1988, p.58
363 SCRAP Weapons (undated). Aboutus. SOAS University of London. https://bitly.ws/3ctSX
364 Autonomy News 2022. Warwick Students shut down careers fair in protest against the arms trade. https://bitly.ws/3ctRR
365 Peattie, L. 1988. Economic Conversion as a Set of Organizing Ideas. In Thee, M. Dumas, J. (Eds.) Making Peace Possible. (Pergamon Press, Great Britain)
366 Lucas Plan (undated). Story of the Lucas Plan. https://bitly.ws/3ctTk
367 Ibid (undated)

The Lucas Aerospace Combine Shop Stewards' Committee

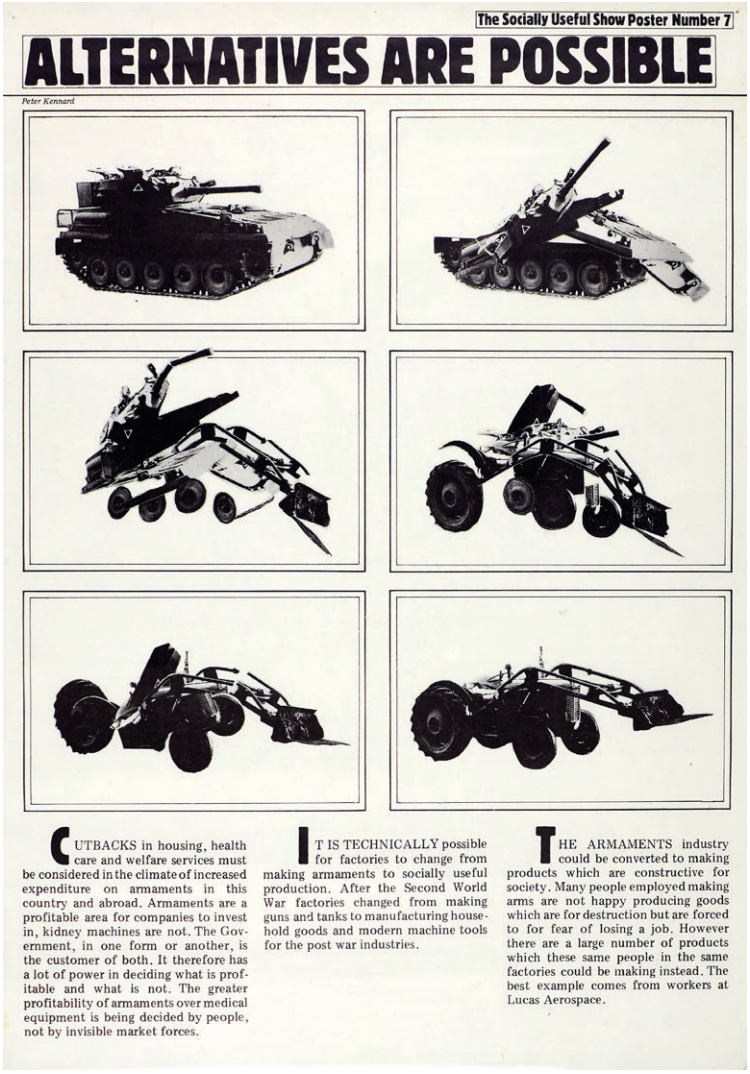
organisation based in the School of Peace Studies for various conversion projects in the UK.[368] The Barrow Alternative Employment Committee (BAEC), based in the North West, which, as described in the case study on LU, is one of the most arms-dependent regions in the UK, was an example of such industry and trade union-led conversion projects.[369]

Academics and students that wish to demilitarise their own departments stand to benefit from campaigns for economic conversion in several ways. A converted economy is less likely to lead to instances in which civilian technology is exploited for military purposes since the demand for military R&D will significantly diminish in such an economy.[370] Therefore, the militarisation of research such as ALADDIN as described in section 3.2 would be far less likely to occur following economic conversion. Also, as shown in section 3.3 on LU, a militarised economy militarised employment, which pressures universities to support the recruitment of high-skilled individuals by the arms industry. Therefore, a converted economy will expand the markets supporting civilian research,[371] which can increase opportunities for civilian employment.

Meanwhile, universities, like arms companies, can themselves be demilitarised by conversion planning. Alternative-use committees to design peaceful and socially-useful research can be organised to convert university departments dependent on military-industrial funding.[372] Such a committee is modelled after initiatives such as the Lucas Aerospace Plan, which was itself an alternative-use planning project.[373] Alternative-use committees in the university can design and develop scientific programs in fields such as renewable energy sources and other environmentally and socially useful goods.[374] Conversion at the regional level and conversion at the university level can be mutually reinforcing. A converted economy can expand markets supporting civilian research, and civilian research can contribute to planning for economic conversion. The Lucas Plan initially looked to 180 external bodies for suggestions of socially useful products, but only received three responses before seeking suggestions from the workforce.[375] Contrary to providing products for the MIC, academics can devote their talents to investigating such socially useful products for economic conversion planning.

368 Schofield, S. Southwood, P. Woodhouse, T. 1988. Arms Conversion and the Defence Industry in the United Kingdom: A Review of Recent Developments. In Thee, M., Dumas, J. (Eds.) Making Peace Possible. (Pergamon Press, Great Britain). p.175
369 Ibid 1988, p.170
370 Feldman, J.M. 2003. Economic Conversion: An Alternative to Military Dependency in the University. National Commission for Economic Conversion and Disarmament. p.238
371 Ibid 2003, p.238
372 Ibid 2003, p.237
373 Peattie, L. 1988. Economic Conversion as a Srt of Organizing Ideas. In Thee, M., Dumas, J. (Eds.) Making Peace Possible. (Pergamon Press, Great Britain)
374 Feldman, J.M. 2003. Economic Conversion: An Alternative to Military Dependency in the University. National Commission for Economic Conversion and Disarmament, p.237
375 Lucas Plan (undated) Story of the Lucas Plan. https://bitly.ws/3ctTk

Therefore, a comprehensive approach to peace is embodied by pairing efforts such as SCRAP in SOAS with initiatives such as ACG from Bradford University. The following sections show how advocacy for disarmament and conversion can occur. First, through peace education at the international, classroom, and campus level. Secondly, activism by students and student unions, and finally, by policy entrepreneurship by academia.


The Socially Useful Show Poster Number 7

ALTERNATIVES ARE POSSIBLE

Peter Kennard

CUTBACKS in housing, health care and welfare services must be considered in the climate of increased expenditure on armaments in this country and abroad. Armaments are a profitable area for companies to invest in, kidney machines are not. The Government, in one form or another, is the customer of both. It therefore has a lot of power in deciding what is profitable and what is not. The greater profitability of armaments over medical equipment is being decided by people, not by invisible market forces.

IT IS TECHNICALLY possible for factories to change from making armaments to socially useful production. After the Second World War factories changed from making guns and tanks to manufacturing household goods and modern machine tools for the post war industries.

THE ARMAMENTS industry could be converted to making products which are constructive for society. Many people employed making arms are not happy producing goods which are for destruction but are forced to for fear of losing a job. However there are a large number of products which these same people in the same factories could be making instead. The best example comes from workers at Lucas Aerospace.

Peace Education

Agenda for Disarmament

The UN Secretary General (UNSG) put forward a new "Agenda for Disarmament" in 2018. Contrary to applying EDTs to reduce the likelihood and impact of conflict, as problematised by the case study of ICL in section 3.1, this agenda promotes disarmament as a tool to prevent the occurrence and impact of conflict.[376] Drawing heavily on a SCRAP Weapons publication developed with the UN on disarmament,[377] a set of actions to address disarmament towards the entire range of weapons systems are provided.[378] The first set of actions address WMD, which fall under the category "Disarmament to Save Humanity", the second set of actions address conventional weapons, under the category "Disarmament That Saves Lives", and a third set of actions addresses future weapons technologies, under the category "Disarmament For Future Generations".[379]

In contrast to emerging and disruptive technologies, the Agenda for Disarmament promotes disarmament as a tool to prevent the occurence and impact of conflict

Action 28 under "Disarmament for Future Generations", states that the UNSG will collaborate with scientists, engineers, and industry to encourage responsible innovation and application of new technologies.[380] Action 28 addresses concerns over the weaponization of new technologies but supports the use of these technologies for peaceful purposes.[381] Action 28.3 calls for "work with research institutes and universities to develop and disseminate a model curriculum for undergraduate and graduate students on responsible innovation".[382] Similar to this, Action 28.4 calls for the UNSG and senior UN officials to "utilise targeted opportunities, such as speeches and engagements with industry and the research community, to promote responsible innovation".[383] An example given is of students from the University of Tokyo holding two days of virtual workshops on AI governance with the United Nations Office of Disarmament Affairs (UNODA), which also addressed issues with AI raised in the ICL study.[384] In another

376 United Nations Office for Disarmament Affairs 2018. Securing Our Common Future: An Agenda for Disarmament. (United Nations Publication, New York). p.ix
377 SCRAP Weapons (undated) UNSG's Agenda. https://bitly.ws/3ctTV
378 United Nations Office for Disarmament Affairs 2018 Securing Our Common Future: An Agenda for Disarmament (United Nations Publication, New York). p.x
379 Ibid 2018, p.ix
380 United Nations (undated). Encouraging Responsible Innovation and Application of New Technologies. https://bitly.ws/3ctUg
381 Ibid (undated)
382 ibid (undated)
383 Ibid (undated)
384 United Nations Office for Disarmament Affairs 2021. Students discuss how to innovate responsibly with artificial intelligence. https://bitly.ws/CTuZ

example, over 100 university students and peace advocates from civil society, academia, and international organisations from India participated in a 4-day online course which provided a "Disarmament Toolkit", with a different day covering each weapon system ranging from WMD to conventional weapons and EDTs.[385] Similar virtual workshops can be held linking individual universities in the UK with UNODA to educate about responsible innovation, the weaponization of EDTs, and disarmament. Therefore, the Agenda for Disarmament offers several activities that can be taken by university students and staff to obtain education on disarmament issues.

Classroom Engagement

The engagements described in the previous section exemplify the dissemination of peace education at the international level, but university staff can introduce disarmament and peace education directly into the classroom. Peace Studies programs and curricula can incorporate teaching on disarmament and investigations of the role of the arms race and MIC in perpetuating war and various social ills.[386] These studies can also investigate the nature, prospects, and barriers to disarmament and economic conversion. One research institute that provides a model for such peace studies is the Costs of War Project, based in the Watson Institute for International and Public Affairs in Brown University in the U.S., which researches and stimulates debate on various costs of war, including the material and social costs of the global war on terror, the U.S. global military footprint, and the political, economic, and social effects of military spending.[387] Topics investigated by the Costs of War project can also be incorporated into teaching courses for students. A peace curriculum can also be promoted under STEM premises. Teaching and research in engineering ethics have often focused more on relationships between engineers and their employers, as well as the daily practice of the profession.[388] However, there has been less teaching concerning the social responsibility of the engineering profession, and the ethics of otherwise legal activities,[389] such as research into conventional and high-tech weapons. Drawing attention to the wider issues of the arms trade, as a "macro-ethical" approach to engineering ethics, can impel engineers to direct their talents into addressing the underlying causes of armed conflict, such as competition over scarce resources and socioeconomic alienation.[390] These educational structures can provide a basis for sustaining and transmitting knowledge of disarmament, economic conversion, and macro-ethics to successive generations of students, and inspiring each new generation to sustain and improve upon the knowledge of previous generations.

The Teach-In

The Nation, one of the oldest and most prestigious progressive magazines in the U.S., issued a call in 2023 for faculty, students, and staff to demand transparency and vigorous debate over the growing MIAC.[391] The "Teach-In" can be a forum for debating the MIAC in a way that directly links faculty, staff, and students with each other. Teach-ins are public events in which scholars discuss issues in which they hold expertise in relation to certain political or social justice concerns, which bears some similarities

385 United Nations Office for Disarmament Affairs 2022. University students and peace advocates conclude Disarmament toolkit online course. https://bitly.ws/3ctUN
386 Feldman, J.M. 1999. Universities in the Business of Repression. The Academic-Military-Industrial Complex in Central America (South End Press). p.241
387 Brown University (undated). Costs of War Project. https://watson.brown.edu/costsofwar/about
388 Seedhouse, D. 1988 In Hersh, M.A. 2017. Professional Ethics and Social Responsibility: Military Work and Peacebuilding. pp. 10592-10602. p.10593
389 Hersh, M.A. 2017. Professional Ethics and Social Responsibility: Military Work and Peacebuilding. pp. 10592-10602. p. 10593
390 Ibid 2017, p. 10593
391 Klare, M. 2023. The Pentagon's Quest for Academic Intelligence. The Nation. https://bitly.ws/3cMua

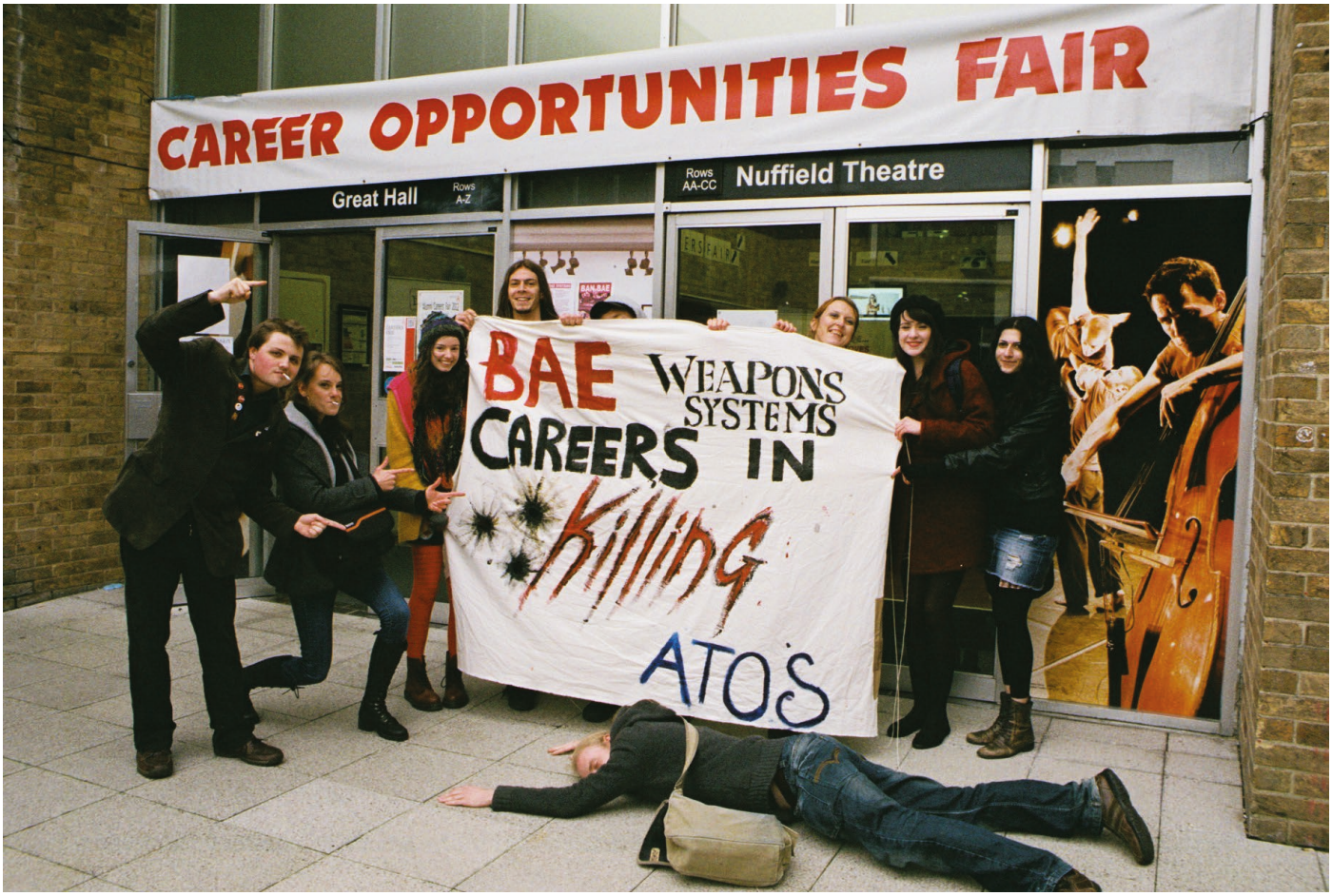
to classroom discussions, but unlike classroom discussions, teach-ins do not conform to a narrow scope for discussion and permit extensive participation and discussion from the audience, which includes students.[392] The Yale Endowment Justice Coalition (EJC), from the University of Yale in the U.S., hosted a teach-in for students that explored Yale University's investments in the fossil fuel sector along with other investments in unethical sectors such as private prisons, arms companies, and immigration detention centres.[393] Several of the student attendees expressed a lack of awareness of Yale University investments in fossil fuels,[394] so teach-ins can play a critical role in educating the wider student body about the MIAC. One of several activities held with the students as a part of the teach-in were the organisers asking the audience to consider and discuss with other participants about how the university's endowment could be alternatively spent.[395] Therefore, a teach-In provides a more informal, participatory, and less hierarchical forum of discussion than that found in the classroom.

Student and Union Activism

As briefly mentioned in section 3.2, in 2016, a successful student-led campaign in Soton resulted in the university appointing an endowment fund manager to screen out investments in arms companies. However, as also shown in that section, Soton still maintains research partnerships with arms companies. Divestment campaigns must therefore be supplemented with activism against research partnerships with the MIAC. Kent Union from the University of Kent illustrates how Demilitarise campaigns can merge divestment campaigns with campaigns against military research. In 2023, after the release of the CSKR report and a policy proposal submitted by UKC Amnesty International, the Kent Union released a policy in favour of a ban on the development of LAWS.[396] The policy also pledged to support efforts from UKC Amnesty to lobby the university to increase the transparency of dual-use research and make assurances that research will only be used for peaceful purposes[397] (which aligns with Action 28 of the UNSG's Agenda for Disarmament).

These outcomes illustrate how efforts such as those in Soton can be paired with the sort of activism from Kent University to campaign for divestment and research for peaceful purposes. Following Soton's example, students can launch a campaign for the university to divest from the MIC, after employing FOIA to uncover evidence of such investments. In conjunction with this, the FOIA can also be used to uncover evidence of research partnerships, as exemplified by the CSKR, AOAV, Study War No More reports, and this report. Occasionally, such evidence may also be publicly available but if such evidence is withheld on commercial or security grounds, students can campaign for better transparency of such relationships. If such evidence exists, students can follow the example from Kent University and launch an additional or complementary campaign for a union policy supporting a ban on weapons research and voicing support for peaceful research. Students can also lobby for researchers to report dual-use dangers arising from research proposals to committees that review these proposals.[398]

392 Teaching Pals 2018. How to Organise a Teach-in. https://bitly.ws/3ctVH
393 Talbert 2023. Yale Endowment Justice Coalition holds teach-in, pushes for Yale to divest from fossil fuels. https://bitly.ws/3ctVU
394 Ibid 2023
395 Ibid 2023
396 Kent Union 2023. Kent Union Supports a Ban on the development of Lethal Autonomous Weapons. https://bitly.ws/3ctXE
397 Ibid 2023
398 Selgelid, M.J. 2019. Dual-Use Research Codes of Conduct: Lessons from the Life Sciences. Nanoethics. 3. pp. 175-183. p.181



Lancaster Uni students protest against their university's links with the arms industry.

Policy Entrepreneurship

The current political atmosphere may militate against an environment for peace. The war in Ukraine has contributed to increased levels of military spending in the UK that began prior to the war, and, as encapsulated in the recent RMA in EDTs, is fuelling renewed greater power competition. Furthermore, following the invasion of Ukraine, influential figures such as the head of the International Monetary Fund declared the end of the "peace dividend", which is when savings from reduced military expenditure are used to finance social and domestic programs.[399] Due to this, universities and peace campaigners may be tempted to "postpone" efforts for disarmament and economic conversion until the environment for these proposals is more accommodating in the future. However, such fortuitous circumstances prevailed by the end of the Cold War, as the cessation of great power conflict led to dramatic reductions in military expenditure in the U.S. and across many European states, including the UK, which raised hopes for a peace dividend that ultimately never took shape since much of the savings from reduced military expenditure were instead absorbed in the UK to limit taxation.[400] In addition to this, initiatives such as disarmament and economic conversion failed to materialise since the arms industry adopted several adaptive mechanisms to declining military expenditure. One mechanism adopted by the industry to compensate for the decline in weapons arsenals was the development of new capabilities through integrating weapons technology with information technology,[401] which, as previously

399 Alderman, L.Cohen, P. 2023. The "Peace Dividend" is Over in Europe. Now Come the Hard Tradeoffs. The New York Times. https://bitly.ws/3ctXQ
400 Lovering, J. 1998. Labour and the Defence Industry. Allies in "Globalisation". Capital & Class 22 (2) pp. 9-20. p.9
401 Bolton, M. 2016. Time for a discursive rehabilitation. A brief history of general and complete disarmament. In (Eds.) United Nations Office for Disarmament Affairs . Rethinking General and Complete Disarmament in the Twenty-First Century. United Nations p.10

discussed, was a hallmark of the RMA from the early 1990s. Due to the pivotal role of the ICT sector in facilitating the RMA, the militarisation of this sector was instrumental to staving off disarmament. These disparate outcomes show that universities and peace campaigners can't afford to merely "wait" for such favourable circumstances for peace to occur. Universities and peace movements must be prepared to exploit such favourable circumstances to ensure that resources released from reduced military expenditures and disarmament are redirected to peaceful purposes. Additionally, universities and peace movements can actively foster conditions amenable to these proposals. Insights from agenda-setting in the policy process can be used to provide these solutions.

In order to effectively exploit favourable circumstances for disarmament and economic conversion that may arise in the future, academics, in coalition with campaign groups, can be policy entrepreneurs. Policy entrepreneurs are actors who develop ideas, expertise, and proposals "well in advance" of favourable opportunities that arise that can be exploited to draw attention to their preferred solution to a given problem.[402] Academia is well positioned for policy entrepreneurship, since universities have historically incubated revolutionary ideas and movements.[403] In addition to this, academic work is regarded as significantly affecting the "general climate of ideas" that affects policymakers' long-term thinking.[404] The deregulation of the transportation industry in the U.S., for example, was preceded by long-term scholarly literature and political engagement on economic deregulation.[405] Similar academic engagement on disarmament and conversion can create a fertile foundation for the eventual adoption of these solutions for war and the arms industry.

Divestment campaigns must therefore be supplemented with activism against research partnerships with the Military-Industrial-Academic-Complex

Defining Problems

Policy entrepreneurs do not only develop and incubate solutions, but can also play a critical role in the policy agenda by promoting certain "problem definitions" over others.[406] As previously described, the implicit assumption behind EDTs and METs is that the "problem" of war resides in the weapons employed to wage and execute war. This implicit assumption also lies behind investment exclusions being limited to "illegal and controversial" weapons. By redefining the problem of war to the problem of the MIC, as researched and investigated by institutes such as the Costs of War project in Brown University, policy entrepreneurs can increase the prospects of disarmament and economic conversion being adopted as proposals to the problem of war. Such problem formation also shows how policy entrepreneurs can play an active role in creating favourable conditions for these solutions, contrary to waiting for such circumstances to appear. Related to this, policy entrepreneurs can effectively problematise phenomena such as the MIC by drawing comparisons between nations with varying levels of spending on the military,[407] which embodies a comparative approach to militarism. For example, one study compared the effects of military expenditure on health care spending in 116 countries, and found a "significant crowding out effect of military expenditure on domestic government health spending", and this "crowding out effect" was most pronounced in low and middle-income countries.[408] As concluded by the authors, such studies can make a significant case for redirecting resources away

402 Kingdon, J. 2014 Agendas, Alternatives, and Public Policies. 2nd Edition. (Pearson Education Limited, United States) p.181
403 Gready, P. Jackson, E. 2023. Universities as sites of activism and protection. Human Rights Defender Hub, Working Paper Series. Working Paper No. 14. p.14
404 Kingdon, J. 2014. Agendas, Alternatives, and Public Policies. 2nd Edition. (Pearson Education Limited, United States). p.55
405 ibid 2014, p.54
406 ibid 2014, p.115
407 Ibid 2014, p.111
408 Ikegami, M. Wang, Z. 2022. Does Military Expenditure Crowd Out Health Care Spending? Cross-Country Empirics. Quality & Quantity. 57 (2) pp. 1657-1672. p.1669

from the military and towards social goods such as healthcare.[409] Given the regional imbalance in the distribution of the arms industry in the UK, as briefly described in section 3.3., a comparison of the effects of military investment on outcomes in different regions can also be made.

Softening Up Proposals

In addition to problem definition, policy entrepreneurs play a critical role in "softening up" proposals that may take time to be accepted within policy networks. Absent such "softening up", "a proposal sprung even at a propitious time is likely to fall on deaf years".[410] Given the long-term absence of economic conversion from the official agenda in the UK,[411] and the equally long-term absence of disarmament and GCD from the international agenda,[412] these strategies would need to be "softened up" to policy networks before they can be readily accepted. Beyond SCRAP Weapons, there are several examples of academic coalitions that can advocate for disarmament and economic conversion to policy communities. The Physicists Coalition for Nuclear Threat Reduction (PCNTR), was launched at the Program on Science and Global Security at Princeton University in the U.S. in 2020, to inform the scientific community "about the dangers of nuclear arms and build a national network of scientist-advocates for nuclear arms control and disarmament policies".[413] PCNTR have organised visits to national laboratories and physics departments in U.S. universities, and given talks in many states.[414] In recognition of the influence that such experts carry in policy debates, the coalition is also aiming to yield policy impact by organising meetings with House officers and Senators, and advocating for the extension of the START Agreements, which sets caps on the number of strategic nuclear weapons held by the U.S. and Russia.[415] A similar coalition of scientists can expand the remit of their opposition to conventional weapons, including future weapons technologies such as drones and LAWS, as well as appeal to lawmakers for support for disarmament and economic conversion, and the UNSG's Agenda for Disarmament.

Coupling Solutions

In contrast to promoting certain problem definitions, once solutions are developed by policy entrepreneurs, solutions can "search for problems to become attached or political events that increase the likelihood of their adoption".[416] Contrary to confronting a problem and searching for a solution, policy entrepreneurs can develop solutions and search for a problem to couple them to. Disarmament and economic conversion can be coupled as solutions to a myriad of problems, such as climate change, given the outsized contribution of military activities to GHG emissions, and attaching disarmament and economic conversion as solutions to this problem can ensure that the problem of military emissions is not coupled to solutions that are undergirded by "green war", as described in sections 2.3 and 3.1. Disarmament and economic conversion can also be coupled

409 Ibid 202, p.1669
410 Kingdon, J. 2014. Agendas, Alternatives, and Public Policies. 2nd Edition. (Pearson Education Limited, United States) p.128
411 Schofield, S. Southwood, P. Woodhouse, T. 1988. Arms Conversion and the Defence Industry in the United Kingdom: A Review of Recent Developments. In Thee, M., Dumas, J. (Eds.) Making Peace Possible. (Pergamon Press, Great Britain) p.169
412 Bolton, M. 2016,. Time for a discursive rehabilitation. A brief history of general and complete disarmament In (Eds.) United Nations Office for Disarmament Affairs. Rethinking General and Complete Disarmament in the Twenty-First Century. United Nations. p.9
413 Mian, Prager, Selton 2022. Mobilizing Physicists for Nuclear Arms Advocacy. Physics and Society 51 (4). p.8
414 ibid 2022, p.8
415 Ibid 2022, p.8
416 Kingdon, J. 2014. Agendas, Alternatives, and Public Policies. 2nd Edition. (Pearson Education Limited, United States). p.172

as solutions to several problems at once. A shift in spending from the military to clean energy has been shown to create 6-9% additional jobs.[417] In this sense, the solutions of disarmament and economic conversion can simultaneously address the problems of the environment, energy, and employment. Disarmament and economic conversion can therefore more meaningfully contribute to environmental and social impact than current university-arms company collaborations. Therefore, contrary to exclusively attaching disarmament and economic conversion to the problem of military spending or MIC, policy entrepreneurs advocating for disarmament and economic conversion can also couple these solutions to problems caused or aggravated by the diversion of spending and R&D to military purposes. Furthermore, the groups harmed by this diversion of resources to the MIC can be constituencies for disarmament and economic conversion.

Disarmament and economic conversion can be coupled as solutions to a myriad of problems, such as climate change, given the outsized contributions of military activities to GHG emissions

417 Peltier, H. 2023. The Myth Behind Increased Military Spending. Inkstick Media. https://bitly.ws/3ctYg

Concluding Remarks

This report investigated past and ongoing partnerships between UK universities and the military-industrial complex (MIC), which has been conceptualised as a military-industrial academic complex (MIAC). This nexus is a manifestation of the militarisation and commercialisation of universities. As described in this report, the commercialisation of academia is described as academic technologies, products, and services being brought to market to address certain problems and needs. Universities such as Imperial College London (ICL) offer facilities for corporate partners, including those from the arms industry, to commercialise research. Commercialisation in the form of spinouts, which are companies created by universities to commercialise research, is most pronounced in the University of Southampton (Soton), which boasts the largest number of spinouts of all UK universities. Soton, along with other universities, also have spinouts that offer services for defence.

Militarisation refers to the allocation of academic labour and resources to military purposes and the shaping of academic institutions in line with military goals. Current topical military goals, as outlined in this report, consist of adapting to climate change through militarised environmental technologies (MET) while simultaneously acquiring emerging and disruptive technologies (EDT) to achieve technological and military dominance amidst a resurgence in great power conflict. Academic labour and resources, particularly in the form of research and development (R&D) performed with industry, is essential for the military and arms industry to acquire these technologies since most R&D activities are undertaken by industry and universities. However, the high-intake of R&D activities by industry and universities has also led to the growing encroachment of the MIC into these sectors. Industry and academia have hence been frequently identified as key partners for the military development of EDTs and METs. The military acquisition of METs in particular also contributes to environmental commitments made by the arms industry, which is part of a larger effort by the arms industry to improve its brand and secure investment by meeting environmental, social, and governance (ESG) criteria. To support this larger effort, arms companies are also collaborating with universities to meet social criteria under ESG, which also satisfies the arms industry's aim to boost recruitment.

Larger socioeconomic and geopolitical factors are also shaping these developments. Privatisation, which accelerated the militarisation and commercialisation of universities since the 1980s, has not only contributed to the growing use of tools such as ESG to regulate corporate behaviour, including that of the arms industry, but also contributed to industry assuming a growing intake of R&D activities, which is driving the military-

industrial sector to expand into industry and academia to acquire EDTs and METs. Two connected geopolitical factors shaping these developments are the war in Ukraine and renewed great power conflict. These factors are not only driving the race for EDTs, but also relaxing standards of corporate "sustainability" of the arms industry, which enables the arms industry to self-promote as sustainable despite making little or no changes in their manufacturing and export practices. Despite this, the interest in arms companies in acquiring METs is not only sustained by the arms industry's particular self-serving interests in ESG, but also by the priority bestowed to these technologies by the military for future warfare and climate change adaptation. Additionally, delivering social impact is a valuable route for recruiting the workforce for the arms industry. Ultimately, such revised standards of "sustainability" shield the international trade in conventional arms, which accounts for a significant proportion of the arms trade, from investment exclusions. Universities are legitimising this perception of the arms industry by permitting investments in arms companies that manufacture and trade conventional weapons.

Collaborations between universities, the military, and arms companies have been structurally sustained by the underlying MIC, and the contemporary development of the RMA by EDTs and METs is enabling the MIC to expand its domain of influence over the civilian sector and academia. Due to this, disarmament and economic conversion offers a path forward to reverse this expansion of the MIC and re-invest resources in peace and urgent issues such as climate change and unemployment. Universities have contributed to disarmament and economic conversion through unique research projects, including in collaboration with worker-led groups. Furthermore, by addressing the problem of war on a structural basis through disarmament and economic conversion, universities can more meaningfully contribute to peace contrary to preparing for future wars and offering the false sense of security supposedly granted by "humane and environmentally-friendly" weapons which integrate EDTs and METs.

The false hope of "green and clean" warfare, and the urgency of demilitarisation, is attested by the direct and structural violence of the arms trade. This trade manifests as direct arms-related violence in various forms, such as death and injury to civilians, destruction of health and educational systems, disruption in food aid deliveries, and devastation of critical civilian infrastructure.[418] However, the profligate military spending that sustains the arms trade manifests as structural violence in various ways, such as by diverting material resources that could be used to raise teachers' salaries, raise the productivity of industry, reduce unemployment, reduce national and world hunger, and repair crumbling civilian infrastructure.[419] The arms trade thus causes considerable harm and insecurity even "without a single shot being fired". Insofar as the redress of these issues continues to be undermined by the diversion of spending and academic resources to military purposes, activism against the MIAC and unbridled military expenditure will always be highly relevant.

By addressing the problem of war on a structural basis through disarmament and economic conversion, universities can more meaningfully contribute to peace contrary to preparing for future war...

418 Grillot, S. Stohl, R. 2009. The International Arms Trade. (Polity Press). p.120-125
419 Melman, S. 1988. The Demilitarized Society: Disarmament and Conversion (Harvest House, Montreal) p.62

Recommendations

The following recommendations aim to engage governments, intergovernmental organisations, civil society, and universities to address the ethical, environmental, economic, and social implications of the MIAC.

Recommendations for Governments, Intergovernmental Organisations, and Civil Society

- Governments and civil societies around the world should support the UN Secretary General's Agenda for Disarmament and the initiative of general and complete disarmament (GCD).
- The United Nations Office for Disarmament Affairs should disseminate a disarmament education toolkit to university students in the UK and around the world through the framework of the Agenda for Disarmament.

Recommendations for Universities

- University administrations should be transparent about their funding and research partnerships with military-industrial partners, publishing and disclosing as much detail as possible about the companies involved, the amount of funding, the role of the companies in the project, and the broad nature of the research and its potential military applications.
- Require academics to report potential dual-use issues that may emerge from research proposals submitted to the ethics committee that reviews research proposals.

Recommendations for Faculty

- Academic departments focused on peace studies should implement teachings of disarmament and economic conversion into peace studies curricula, and STEM departments should emphasise the macro-ethics of military work as a part of teachings in scientific ethics.
- Concerned academics should form special research groups to investigate and document the effects of military expenditure and militarism on society in the UK, including on domestic and social programs, research agendas, the economy and employment, the climate, and other social, environmental, and economic outcomes. Research should also be carried out on the comparative effects of militarism between nations and regions.
- Concerned groups of academics should assemble as a national coalition to inform about the dangers of all weapons systems, ranging from WMD, conventional, and future weapons technologies, and educate the scientific and policy community about disarmament and economic conversion.
- Concerned academics should create alternative-use planning committees to explore and design peaceful and sustainable uses for research currently geared towards military or dual-use purposes.
- Concerned academics should raise these issues and present findings from the above to their trade union and relevant university governance in order to bring critical awareness and negotiation regarding financial, research and academic partnerships with the MIC.

Recommendations for Students

- University students should organise teach-ins to facilitate discussion, debate and awareness of the MIAC among the wider student body, academics, and civil society.
- University students should submit policy motions to student unions calling for a ban on direct and indirect investments in the MIC, and a ban on research that could contribute to weapons development.
- University students should employ Demilitarise Education's (dED) tools and resources to contribute to the creation of the largest and most extensive database on university partnerships with the MIC, and the use of the dED Treaty as a framework for implementing ethical change.

List of Abbreviations

ADS – Aerospace, Defence, and Security
AOAV – Action on Armed Violence
AI – Artificial Intelligence
AFOSR – Air Force Office of Scientific Research
ALADDIN – Autonomous Learning Agents for Decentralised Data and Information Networks
ANTC – Airbus Noise Technology Centre
ARO – Army Research Office
ARIA – Advanced Research and Invention Agency
AWE – Atomic Weapons Establishment
BAEC – Barrow Alternative Employment Committee
BLQ - Barrow Learning Quarter
BSSRS – British Society for Social Responsibility in Science
BWC – Biological Weapons Convention
COTS – Commercial off the Shelf
CDSR – Centre for Defence and Security Research
CWC – Chemical Weapons Convention
DAIC – Defence AI Centre
DARP - Defence and Aerospace Research Partnership
DARPA – Defense Advanced Research Projects Agency
DAS – Defence Aviation Strategy
DASA – Defence and Security Accelerator
DCIT – Defence Communications & Information Technology
DERA - Defence Evaluation Research Agency
DE&S – Defence Equipment & Support
DEW – Directed Energy Weapons
DGP – Defence Growth Partnership
DIANA – Defence Innovator Accelerator for the North Atlantic
DIB – Defence Industrial Base
DII – Defence Innovation Initiative
DoD – U.S. Department of Defense
DTC – Defence Technology Centre
DTF – Defence Technology Framework
Dstl – Defence, Science, and Technology Laboratory

EDT – Emerging and Disruptive Technology
ESG – Environmental, Social, and Governance
FOIA – Freedom of Information Act
GCD – General and Complete Disarmament
GCHQ – Government Communications Headquarters
GHG – Greenhouse Gas Emissions
ICL – Imperial College London
IFA – Innovation Focus Area
I-HUB – Translation & Innovation Hub
IMMS – Integrated Mission Management Systems
IOC – Integrated Operating Concept
ISST – Institute for Security Science and Technology
LAWS – Lethal Autonomous Weapons Systems
LEP – Local Enterprise Partnership
LIRA – Lancaster Intelligent, Robotic, and Autonomous Systems Centre
LU – Lancaster University
MIAC – Military Industrial Academic Complex
MET – Militarised Environmental Technology
ML – Machine Learning
MASTS – Marine Autonomous Systems Testing Service
MIMO – Multiple Input Multiple Out
MOD – Ministry of Defence
MoU – Memorandum of Understanding
NIACE – Northern Ireland Advanced Composites and Engineering
NSTIx – National Security Technology Innovation Exchange
ONR – Office of Naval Research
RMA – Revolution in Military Affairs
Soton – University of Southampton
SGR – Scientists for Global Responsibility
SHI – Strategic Health Initiative
CSKR – Campaign to Stop Killer Robots
STEM – Science, Technology, Engineering, and Mathematics
TOE – Towers of Excellence
TPNW – Treaty on Prohibition of Nuclear Weapons
UAS – Unmanned Air Systems
UDC – Unmanned Distribution Capability
UKDSC – UK Defence Solutions Centre
UoB – University of Birmingham
UoM – University of Manchester
UTC – University Technology Centre
WMD – Weapons of Mass Destruction

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