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EMERGING INSIGHTS

Lessons from the Ajax Programme

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EXECUTIVE SUMMARY

The travails of the Ajax programme have been widely publicised in Parliament and the media. This Emerging Insights paper provides an interim analysis of how and why this situation has come about.

It argues that the plight of the programme must be understood in the context of over 15 years of British Army and Ministry of Defence (MoD) failure to follow through on armoured vehicle projects, resulting in a loss of expertise in both the industrial and governmental sectors. It also confirms that the MoD, the Army customer, the procurement body and industry have all contributed to the programme's shortcomings. The paper identifies four preliminary lessons.

First, it underlines the necessity for government to maintain a drumbeat of orders if it wishes to maintain a national industrial capability in a sector.

Second, if government runs down its in-house expertise, it must rely on corporate claims about what is possible in a period of time for a fixed sum of money. Yet, especially in a competitive context, companies can be driven towards excessive optimism in their offers.

Third, when projects involve an extensive development and production effort, a team approach that brings together suppliers, procurement bodies and customers is likely to work better than arms-length relationships.

Fourth, looking for individuals and bodies to blame does not incentivise transparency and effective lesson identification and learning.

The paper recommends that the planned inquiry focuses on holding to account individuals who were involved not only in recent years but also from the start of the programme, requiring them to identify the decisions they took. There is a need to understand the pressures that directed them to behave as they did so future acquisition programmes can be managed differently. The paper includes key questions for all the parties involved.

Many defence budgets overrun their schedules and budgets, and do not fulfil all their requirements. However, it is rare for an order to go into production that is unacceptable to its customer.

INTRODUCTION

In summer 2021, the British Army's Ajax programme appeared to be in considerable difficulty. It faced negative press coverage,[1] and was described as being on 'end-of-life watch' by John Healey, the shadow Secretary of State for Defence, in September.[2] It remains unclear when, if ever, the vehicle will enter service, although MoD material has signalled that Ajax development problems can be resolved and that the vehicle will be a part of the future Army.[3] However, no timescale has been set. Moreover, even if the Ajax vehicles are eventually fixed, the programme raises many questions about the technical and managerial behaviour of all involved parties.

Understandably, the initial focus was on the vehicle's performance issues.[4] Three elements were initially reported: that it generated unacceptable levels of vibration; noise coming through headsets caused physical damage to the crews; and the gun did not fire with reliable accuracy. While the first two elements were confirmed by the MoD, there has been little further mention of the gun's performance. General Dynamics UK (GDUK) and Lockheed Martin UK (LMUK) have not indicated any problems with the gun or the turret in their evidence to Parliament. GDUK told the House of Commons Defence Committee in September 2021 that 'AJAX can fire its CT40mm Cannon on the move against static and moving targets, and has demonstrated this successfully with a high level of accuracy'.[5]

Knowing *how* a system fails to perform does not explain precisely *why,* and, in engineering terms, this remains an Ajax mystery at the time of writing. The thorough independent report on safety issues released by the MoD in December 2021 (henceforth referred to as the Safety Report) revealed

1. Jerome Starkey, 'TANKS NO THANKS: New Tanks Which Cost Army Staggering £5.5 Billion Have Trials Halted After Troops Fall Sick and Damage Hearing', *The Sun*, 31 May 2021; Larisa Brown, 'Minister Backs Noisy Ajax Tank That Can't Fire On the Move', *The Times*, 9 June 2021. See also Harry Adams, 'Ajax: What's Going On With the Army's New Armoured Vehicle?', *Forces News*, 9 June 2021.
2. Richard Wheeler, 'Fears £5.5 Billion Ajax Light Tank Project Put on "End-of-Life" Watch', *Evening Standard*, 9 September 2021.
3. Introducing the Future Soldier document to the House of Commons, the defence secretary stated that 'we are resolving development issues with the troubled and nonetheless technically capable … Ajax armoured reconnaissance vehicle'. See Ministry of Defence (MoD) and Ben Wallace, 'Defence Secretary Announces Future Soldier for the British Army', speech, 25 November 2021.
4. Jack Watling, 'The British Army's Greek Tragedy', *RUSI Commentary*, 22 July 2021.
5. See House of Commons Defence Committee, 'Written Evidence Submitted by General Dynamics', 1 September 2021, p. 2, <https://committees.parliament.uk/writtenevidence/38791/pdf/>, accessed 6 January 2022. See also House of Commons Defence Committee, 'Written Evidence Submitted by Lockheed Martin UK', 14 July 2021, <https://committees.parliament.uk/writtenevidence/37865/pdf/>, accessed 6 January 2022.

an extensive menu of possible causes, including its basic design and poor manufacturing and assembly.[6] The Report found that:

'Noise and vibration in the Ajax family of vehicles have both electrical and mechanical origins from the following broad sources:

- Track, suspension and running gear, in particular the tension and sprocket design/track interface.
- Engine and its mounting into the vehicle.
- Quality issues associated with, but not limited to, inconsistent routing of cabling, lack of bonding and weld quality; all of which can lead to potential electromagnetic compatibility issues with communication equipment. As witnessed during trials, insecure components and bolting within the vehicle can also lead to noise and vibration, and again this was noted by ATDU crews.
- Headset performance and integration (noise only)'.[7]

In March 2022, GDUK and the MoD were working on identifying and testing potential mitigation measures.

This paper seeks to address the wider issues of how and why the programme reached its current condition. Minister for Defence Procurement Jeremy Quin has announced that a legally led inquiry is to be set up to address wider Ajax-related matters. It will look for lessons to be learned and any cases of 'gross misconduct'.[8] This paper, reliant largely on publicly available material, highlights what is known so far and presents specific questions that should be addressed.

With a major equipment acquisition, there are three main groups involved. In crude chronological order, the service branch, in this case the Army, dominates the specification of the requirement (namely, the attributes and capabilities required from the equipment). It includes a specialist Army Trials and Development Unit (ATDU), which receives interim equipment from manufacturers, and operational units, which learn how to use new equipment. The procurement body, Defence Equipment and Support (DE&S), arranges the selection and contracting of a supplier to deliver a product that meets the stated needs of the service customer. It is also responsible for managing the execution of the contract, including the terms for the release of payments and assurances about the safety of any product.[9] It can secure advice and support from the MoD's in-house research body, the Defence Science and

6. See Director Health, Safety and Environmental Protection, 'HS&EP Ajax Noise and Vibration Review', MoD, December 2021.
7. *Ibid.*, p. 16.
8. MoD, 'Defence Ministerial Statement on the AJAX Programme', 15 December 2021, <https://www.gov.uk/government/speeches/defence-ministerial-oral-statement-on-the-ajax-programme>, accessed 6 January 2022.
9. MoD and Defence Equipment and Support (DE&S), 'Defence Acquisition Safety and Environment Management', guidance, last updated 6 February 2020, <https://www.gov.uk/guidance/acquisition-safety-and-environment-group>, accessed 23 December 2021.

Technology Laboratory (Dstl). Finally, it is down to the chosen private sector firm(s) to deliver something that meets the terms of the contract. In this case, delivery involved both development work and production. For the Scout programme, which became the Ajax programme, the prime contractor was GDUK, the UK subsidiary of the US General Dynamics corporation.

For Ajax, the three main players (the Army, DE&S and GDUK) – in addition to some subject matter experts – came together on the Joint Safety and Environmental Panel, which had a broad risk management role but focused on safety.[10]

This paper begins with a brief survey of the Army's failure to follow through with a series of armoured vehicle projects from the mid-1990s, before analysing the procurement activities around the Ajax programme. Finally, the paper points to four early learnings from the Ajax episode and discusses key questions, including:

- Why did the procurement process include provision for concurrent development and production work?
- How were the risks associated with this approach assessed, recorded and managed?
- What has happened to the whole system understanding and the corporate noise and vibration expertise that must have been involved in the development of the original ASCOD vehicle?
- Why was GDUK allowed to proceed with extensive production work (and be paid for its efforts) for products which later inflicted acknowledged damage on the crews using them?
- Why were GDUK and its turret sub-contractor LMUK chosen to undertake work in fields where they had only modest experience?
- Should the MoD opt to cancel the project, and could it demonstrate conclusively that GDUK failed to meet the terms of its contract?

THE ORIGINS AND SCOPE OF AJAX

Examining the origins of the Ajax programme shows the risks taken in the procurement strategy regarding running development alongside manufacturing activities. By 2010, the Army had an urgent need for a replacement reconnaissance vehicle, having failed consistently to pursue that capability for more than 15 years. At the same time, the Army's wider procurement behaviour and failure to push projects through to the production stage had led to a diminution of British industrial interest and capability.

10. Director Health, Safety and Environmental Protection, 'HS&EP Ajax Noise and Vibration Review', p. 9. This report provides a full and deeper description of the Ajax governance arrangements.

The Ajax vehicle is the latest stage of a protracted Army effort to replace the Combat Vehicle Reconnaissance (Tracked) (CVR(T)), which entered service in the early 1960s. The replacement effort began in the mid-1990s when a collaborative project with the US Army called TRACER was pursued. However, in 2002, the US pulled out in favour of an ambition to define and deliver a huge programme of related equipment (the Future Combat System).[11] Separately, the UK had joined a collaborative project with Germany in 1999 for what is today the Boxer family of wheeled vehicles, but it withdrew in 2004[12] as the vehicle was considered too heavy by some senior levels of the Army.

After TRACER, the Army dropped its focus on a reconnaissance system and conceived its own group of platforms (the Future Rapid Effect System – FRES).[13] Following US thinking, it pursued (and abandoned) the notion of an armoured vehicle that could be transported in a C-130. Finally, it prioritised the purchase of an armoured wheeled vehicle. However, that procurement failed when it proved impossible to agree terms with the preferred supplier (MOWAG of Switzerland, which was also owned by General Dynamics) for a version of the Piranha system.[14]

The Army's wider procurement behaviour and failure to push projects through to the production stage had led to a diminution of British industrial interest and capability

During 2009 and 2010, when a competition was actually held for a CVR(T) replacement, the whole of the Army's fighting vehicle fleet was seriously ageing. The Scout programme, as Ajax was then called, by then comprised a family of vehicles using a common core of a chassis and propulsion system.

The Labour government opted to use formal competitive tendering in 2010 for the selection of a single Scout contractor from the Demonstration phase.[15] GDUK offered to develop the ASCOD platform, a product of General Dynamics European Land Systems (GDELS), another subsidiary in the wider GD group. BAE Systems bid a development of the CV90 from its Swedish

11. UK Parliament, 'House of Commons Written Answers for 25 October 2001', <https://publications.parliament.uk/pa/cm200102/cmhansrd/vo011025/text/11025w03.htm>, accessed 23 December 2021; UK Parliament, 'Tracer Programme User Trials', 22 October 2002, <https://api.parliament.uk/historic-hansard/written-answers/2002/oct/22/tracer-programme-user-trials>, accessed 23 December 2021; Think Defence, 'TRACER, MRAV and Project Bushranger', <https://www.thinkdefence.co.uk/british-army-medium-weight-capability/tracer-mrav-and-project-bushranger/>, accessed 23 December 2021.
12. ARTEC, 'The BOXER: Addressing the UK Mechanised Infantry Vehicle (MIV) Requirement', 26 January 2018, <http://www.artec-boxer.com/fileadmin/documents/BOXER_MIV_UK_footprint.pdf>, accessed 23 December 2021.
13. National Audit Office, 'Ministry of Defence: The Major Projects Report 2009: Appendices and Project Summary Sheets', HC 85-II, December 2009, p. 250; *Army Technology*, 'Future Rapid Effects System (FRES)', 30 March 2008, <https://www.army-technology.com/projects/fres/>, accessed 28 April 2022.
14. UK Parliament, 'Written Ministerial Statements', 11 December 2008, Col. 66WS, <https://publications.parliament.uk/pa/cm200809/cmhansrd/cm081211/wmstext/81211m0001.htm>, accessed 23 December 2021.
15. *BBC News*, 'General Dynamics Beats BAE to Win UK Tank-Making Deal', 22 March 2010.

subsidiary Hägglunds. GD were deemed to have won and were awarded a £500-million contract to develop seven prototypes in the Demonstration phase of the programme.[16] By then, the Conservative–Liberal Democrat coalition had taken power and the contract was signed by the new Minister for Defence Procurement, Peter Luff.[17]

Four years later, but with development not complete, GDUK was awarded a firm price £3.5-billion contract to produce the Scout fleet.[18] The GDUK announcement began:

> General Dynamics UK has been awarded a contract by the UK Ministry of Defence (MoD) to deliver 589 SCOUT Specialist Vehicle (SV) platforms to the British Army to provide essential capability to the Armoured Cavalry within Army 2020. The platforms, consisting of six variants, will be delivered to the British Army between 2017 and 2024, alongside the provision of initial in-service support and training, and will serve at the heart of the Armoured Infantry Brigade structure. This contract directly safeguards or creates up to 1,300 jobs across the programme's UK supply chain, with 300 of these at General Dynamics UK's Oakdale site. SCOUT SV represents the future of Armoured Fighting Vehicles (AFV) for the British Army, providing best-in-class protection and survivability, reliability and mobility and all-weather intelligence, surveillance, target acquisition and recognition (ISTAR) capabilities.
>
> Its range of variants will allow the British Army to conduct sustained, expeditionary, full-spectrum and network-enabled operations with a reduced logistics footprint.[19]

There were two government-mandated sub-systems (Government Furnished Equipment) to be fitted to the vehicle. This included, most prominently, a 40mm cannon jointly developed by BAE Systems and Nexter of France, which fired novel caseless ammunition. As has been officially explained, the reason for choosing this powerful weapon was its enhanced lethality in a more demanding battlefield: it could fire one shot to get the effect (or better) of three rounds fired from a 30mm cannon.[20] The second was the Combat

16. 'Demonstration' is the third phase of the UK acquisition cycle under the Smart Procurement changes of 1998–99. It is preceded by the 'Concept' and 'Assessment' phase, and followed by the 'Manufacture', 'In-Service' and 'Disposal' phases.
17. MoD, 'MOD Signs Contract for New Armoured Vehicle', 1 July 2010, <https://www.gov.uk/government/news/mod-signs-contract-for-new-armoured-vehicle?msclkid=4b7fce04c25f11eca64d326692be2c35>, accessed 28 April 2022.
18. MoD, DE&S and Michael Fallon, 'UK Jobs Secured by £3.5 Billion Contract for New Fighting Vehicle', 3 September 2014, <https://www.gov.uk/government/news/uk-jobs-secured-by-35-billion-contract-for-new-fighting-vehicle>, accessed 9 May 2022.
19. General Dynamics, 'General Dynamics UK Awarded £3.5 Billion to Deliver 589 SCOUT SV Platforms to the British Army', 3 September 2014, <https://www.gd.com/Articles/2014/09/03/eneral-dynamics-uk-awarded-335-billion-deliver-589-scout-sv-platforms>, accessed 23 December 2021.
20. In his address to the House of Commons on 9 September 2021, Minister for Defence Procurement Jeremy Quin cited the earlier findings from the Defence

Mk II headset supplied by Defence Digital, the acquisition body owned by Strategic Command.[21] These are the headsets associated with the Bowman tactical communications system.

This was followed by a period of adjustment and, understandably, delay. The then CEO of GDUK, Sandy Wilson, had said in 2010 that the Scout programme would mean 10,600 UK jobs,[22] a far cry from the 1,300 announced four years later. GDUK came under political pressure, especially from Procurement Minister Philip Dunn, to increase the UK content of the vehicle. Particularly once it was awarded an extended £390-million support contract in 2015, it responded positively without changing the agreed price.[23] A factory to build the vehicles was established and fitted out, a workforce recruited and trained in a disadvantaged part of Wales outside Merthyr Tydfil, and a test track was built adjacent to the factory. Ajax was a clear example of defence contributing to what is today called the 'levelling up' agenda. A range of over 200 new UK suppliers were also qualified and given contracts so that the number of jobs supported by the programme rose to over 4,300.[24]

This all took time and, along with unspecified development problems, GDUK proved unable to meet the contracted schedule. Negotiations with the DE&S took place and the contract was 'recast' in 2019 for deliveries to the Army to begin in 2020. Again, there was no change to the contract price. Even in January 2020, GDUK was publicly upbeat about progress.[25]

Then, in summer 2021, Ajax's problems became public, attracting extended attention from the Defence Committee, the media and the MoD itself.

Science and Technology Laboratory. See UK Parliament, 'Ajax Armoured Vehicle Procurement', *Hansard*, 9 September 2021, <https://hansard.parliament.uk/commons/2021-09-09/debates/39A1428C-A08C-4803-9406-5BD54AA62A41/AjaxArmouredVehicleProcurement>, accessed 23 December 2021.

21. Director Health, Safety and Environmental Protection, 'HS&EP Ajax Noise and Vibration Review', p. 8.
22. Julian Nettlefold, 'Ajax – "Send Again, Over"', *Battlespace*, 21 July 2021, <https://battle-updates.com/ajax-send-again-over-by-julian-nettlefold/>, accessed 23 December 2021; *BBC News*, 'General Dynamics Beats BAE to Win UK Tank-Making Deal'.
23. MarketScreener, 'General Dynamics : UK : Awarded 390 Million Pounds Sterling SCOUT SV Support Contract and Invests in New UK Industrial Capability', 23 July 2015, <https://www.marketscreener.com/quote/stock/GENERAL-DYNAMICS-CORPORAT-12723/news/General-Dynamics-UK-awarded-390-million-pounds-Sterling-SCOUT-SV-support-contract-and-invests-in-20737356/>, accessed 23 December 2021.
24. Srivari Aishwarya, 'British Army's Ajax Armoured Fighting Vehicles to Be Built in Spain', *Army Technology*, 11 May 2016.
25. Julian Nettlefold, 'GDLS Gives Ajax Update at IAV', *Battlespace*, 22 January 2020 <https://battle-updates.com/gdls-gives-ajax-update-at-iav-by-julian-nettlefold/>, accessed 23 December 2021.

EXPLAINING AJAX

In 2021, the scale and nature of Ajax's problems became clearer and the project emerged as a potential defence and industrial disaster. As with most complex projects that go seriously wrong, clearly identifying the causes is difficult.[26]

RISK

From 2014, the MoD – and DE&S, in particular – must have known that there was risk in the programme. Applying concurrency after 2014 (namely, conducting significant development[27] activity at the same time as launching production) is widely understood in defence as a hazardous approach. This has since been acknowledged by Jeremy Quin, who told Parliament in September 2021 that 'the overlapping of demonstration and manufacturing phases added complexity, technical risk and safety risk into the programme'.[28] In the UK acquisition cycle, Demonstration and Manufacture are separate stages, with the former aiming to 'eliminate progressively the development risk'.[29] The reported hope at the time was that it would save money and even speed production.[30] Concurrency is also quite counter to the knowledge-based, staged approach to acquisition long advocated by the US General Accounting Office and accepted in principle by the US Department of Defense.[31] Significantly, the US had accepted a lot of concurrency in its F-35 programme, which was also marked by delays.[32]

Among the recommendations of the Safety Report on Ajax was direction that concurrent development and production should not be used in future, but a key issue is how the concurrency risk was viewed by the DE&S and its higher approving authorities in the MoD and the evidence basis they relied on for accepting it as tolerable.

26. Charles Haddon-Cave, *The Nimrod Review* (London: The Stationery Office, 2009).
27. Also referred to as 'Demonstration' in UK terms.
28. Jeremy Quin, 'Armoured Cavalry Programme: Ajax', *Hansard*, 6 September 2021, <https://hansard.parliament.uk/commons/2021-09-06/debates/21090616000011/ArmouredCavalryProgrammeAjax>, accessed 11 April 2022.
29. MoD, 'The Acquisition Handbook', 6th edition, October 2005, p. 15.
30. Director Health, Safety and Environmental Protection, 'HS&EP Ajax Noise and Vibration Review', p. 11.
31. US General Accounting Office, 'Best Practices: Using a Knowledge-Based Approach to Improve Weapon Acquisition', January 2004, <https://www.gao.gov/assets/gao-04-386sp.pdf>, accessed 23 December 2021.
32. A US Government Accountability Office (GAO) 2020 report on the F-35 provides a summary and a list of its many previous inquiries. See GAO, 'F-35 Joint Strike Fighter: Actions Needed to Address Manufacturing and Modernization Risks', May 2020, Appendix 1, p. 44.

The MoD is looking at how this could be put into practice while still allowing incremental and spiral acquisition procedures to take place.[33] A capacity for regular updates and improvements is of much value in an era where software-based systems are central to capability. The Army's record of exploring and abandoning projects back into the late 1990s presented urgency that likely increased the MoD's appetite for concurrency risk.

The MoD's treatment of the financial risk was to transfer it, in order to get the contractor to accept a firm price contract. This was a contrast with the F-35 programme across the Atlantic, where Lockheed Martin negotiated annual price increases with the Pentagon for at least seven years after production began. The MoD also ensured that, while its contract was with GDUK, ultimate responsibility for delivery lay with its US owner. The GD parent, the fifth-largest defence business in the world, could be relied on to have available finance to cover any extra costs.

The obvious next question is why would GDUK take on such a hazardous venture? While company records on the decision are not available, some surmising is feasible. After the loss of the 2010 competition, the unsuccessful bidder, BAE Systems, ran down its UK armoured vehicle capability, eventually closing its Newcastle factory. With little potential alternative work on the horizon for BAE Systems, GD could reasonably have seen the Ajax work as the route to establishing itself as the UK's champion supplier of armoured vehicles – a move which would also gain GDUK responsibility for the eventual Challenger II replacement. Building a network of UK suppliers would not damage the chances of this.

The acquisition approach for the Scout family was further to develop surveillance, protection and firepower on to an apparently established vehicle in terms of its chassis and drive system. There was no acknowledgement of risk in the MoD's 2010 announcement: 'The design is derived from modifying the ASCOD SV vehicle, which is already in service with some NATO nations, is well-proven and is suitable for export sales'.[34] With the benefit of hindsight, it can also be seen that what the MoD and the contractor saw as a cost and risk reduction measure (using an established platform) appears in practice to have enhanced risk. The basic approach was to integrate a new turret with a new gun system, compared with that developed by Nexter in France, a multitude of sensors and enhanced protection on to the Spanish ASCOD/ Pizaro platform.[35]

33. Jeremy Quin, 'Defence Ministerial Oral Statement on the AJAX Programme', speech, 15 December 2021.
34. MoD, 'MOD Signs Contract for New Armoured Vehicle', 1 July 2010, <https://www.gov.uk/government/news/mod-signs-contract-for-new-armoured-vehicle>, accessed 6 January 2022.
35. 'ASCOD is a modular tracked based vehicle designed to be customised according to the designs of the end-user'. It was jointly developed by the Austrian and Spanish subsidiaries of General Dynamics. Spain named its family of vehicles 'Pizaro'. See Samuel Cranny-Evans and Jon Hawkes, *Janes Land Warfare*

The original Spanish Pizarro armoured fighting vehicle, based on the ASCOD, weighed 26 tons, although with the ASCOD 2 it rose to between 31 and 42 tons, depending on the configuration.[36] A new turret, gun and sensors – and additional armour – meant that by 2020 the UK Ajax was rated to 42 tons. Its actual weight varies depending on the particular fit of modular armour selected for a mission. This meant that only the C-17 in the UK's air transport fleet could easily carry one. With significant weight stripped off and loaded on a second aircraft, it can also be fitted into an A400M. The increased weight also took it out of the Medium Weight Capability category associated with the Army's 2005 plan for its Future Army Structure, and rendered it impractical for the Army's Strike concept.[37]

The Mk II headsets have been reported as particularly problematic,[38] but these were not those used by GD in the development processes.

GDUK was – and is – insistent that its vehicles were within the limits set by its contract and the control of noise and the control of vibration legislation. It also insists that there had been no problems in securing noise, vibration and harshness expertise from GDELS and the whole GD company.[39] Jane's reported that 'for Ajax the ASCOD 2 suspension has been upgraded with a new dual-rate suspension system that combines torsion bars and hydraulic dampers to provide an improved rise of the crew and a more stable firing platform over rough terrain'.[40]

Carew Wilks from GDUK told the House of Commons Defence Committee in October 2020:

> … the risky element of adding systems on to a platform is around the digital integration and the digital architecture. That is resolved on Ajax and these other

Platforms: Armoured Fighting Vehicles: 2021–2022: Tracked (London: Janes, 2021), pp. 429–30.

36. Cranny-Evans and Hawkes, *Jane's Land Warfare Platforms*, pp. 429–30; Military Today, 'Pizarro', <http://www.military-today.com/apc/pizarro_ifv.htm>, accessed 23 December 2021; Military Today, 'ASCOD 2', <http://www.military-today.com/apc/ascod_2.htm>, accessed 23 December 2021.
37. MoD, *Defence Industrial Strategy*, Cm 6697 (London: The Stationery Office, 2005), p. 78; *Wavell Room*, 'The British Army's Strike Concept', 12 October 2017.
38. *Overt Defense*, 'British Army Vehicle Headsets Under Investigation for Hearing Risks', 26 October 2021, <https://www.overtdefense.com/2021/10/26/british-army-vehicle-headsets-under-investigation-for-hearing-risks/>, accessed 6 January 2022.
39. Noise, vibration and harshness (NVH) are a fundamental aspect of the development of all vehicles and there are engineers who specialise in their control as development proceeds.
40. Cranny-Evans and Hawkes, *Jane's Land Warfare Platforms,* p. 409.

> platforms by having this open, generic vehicle architecture into which that can happen. The mechanical interfaces tend to be more straightforward.[41]

GDUK's letter to the Defence Committee of 1 September 2021, along with assurances about the performance of the turret and its gun, said that 'GDLS-UK employees have reported no injuries regarding excessive noise and vibration on the production-standard Ajax vehicles during trials'.[42]

DELIVERY OF FLAWED SYSTEMS

It is now clear that Ajax was known at least in Dstl to have major vibration issues long before they emerged in the press. Jeremy Quin has confirmed that 'in December 2018 a specific army safety notice introduced restrictions on use in relation to vibration on this vehicle and identified that, in the longer term, a design upgrade was needed to reduce vibration'.[43] Also, the Safety Report of December 2021 highlighted that both the Dstl and the ATDU had raised vibration and noise issues from 2018 which were not acted on by the DE&S or higher levels of the Army. It argued that these bodies had been disinclined to take soldiers' concerns seriously and had prioritised delivery over safety, but that the further inquiry announced by the minister should generate more granular results.[44] According to GDUK, 'noise and vibration injuries were not raised with GDLS-UK prior to autumn 2020'.[45] Clearly, the announced inquiry should examine all communication linking the ATDU, the Dstl, the DE&S and GDUK.

The MoD was in little doubt that the systems were not acceptable, and halted its trials twice in the first part of 2021.[46] At the end of the year Jeremy Quin told the House of Commons:

> We are ensuring that we protect our commercial position under the contract and will not accept a vehicle that is not fit for purpose. It remains impossible to share with the House 100% confidence that the programme will succeed or, if it does, the timing of achieving full operating capability.[47]

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41. House of Commons Defence Committee, 'Oral Evidence: Progress in Delivering the British Army's Armoured Vehicle Capability', HC 659, 6 October 2020, Q60, <https://committees.parliament.uk/oralevidence/1005/pdf/>, accessed 23 December 2021.
42. Letter from Carew Wilks and further information from GDLS-UK to the Chair of the House of Commons Defence Committee, Tobias Ellwood, 1 September 2021, p. 2.
43. Quin, 'Armoured Cavalry Programme'.
44. Director Health, Safety and Environmental Protection, 'HS&EP Ajax Noise and Vibration Review'.
45. Letter from Carew Wilks and further information from GDLS-UK to the Chair of the House of Commons Defence Committee, Tobias Ellwood, 1 September 2021, p. 2. See also *Ibid.*, p. 9.
46. *BBC News*, 'Trials of Army's New Armoured Vehicles Halted Again', 29 June 2021.
47. Jeremy Quin, 'Ajax: Noise and Vibration Review', *Hansard*, Col. 1080, 15 December 2021.

PAYMENTS AND ACCEPTANCE

As the MoD has acknowledged, GDUK has been paid £3.2 billion for the work it has done to date.[48] The MoD is contracted to pay a maximum of £5.5 billion.[49] The difference between the original £3.5-billion 2014 contract price and the figure today is accounted for by some requirement changes[50] and the addition of VAT. The unresolved nature of the vibration issues raises questions about the criteria for the release of monies. In particular, how could it have been that the DE&S paid for, and approved release to the Army for testing, the 25 problematic vehicles?[51] Since procurement problems in the 1980s with the AEW Nimrod and the Phoenix unmanned air surveillance system, the government has been charged with issuing payments against progress made rather than hours of effort put in by a supplier. There may have been defensible reasons why the DE&S paid what it did and allowed the delivery of vehicles to the Army, but these remain unknown. GD's total deliverables by the end of 2021 comprised a further 111 completed vehicles, training systems, logistics support and technical publications.[52] Clearly, these will only be of value once the vehicles can go into service.

CONTRACT TERMS

As the DE&S seemingly paid GDUK until the halting of the programme in summer 2021, it presumably judged that the company was meeting the terms of its contract. The Safety Report threw some light on this issue by noting that 'it was a contractual requirement that GDUK design and build vehicles that complied with the Control of Noise at Work Regulations 2005 and the Control of Vibration at Work Regulations 2005 and could be operated safely'.[53] However, it continued:

> There is no separate MOD standard or regulation for noise and vibration levels in new land equipment and the requirements in the Control of Noise at Work Regulations 2005 and the Control of Vibration at Work Regulations 2005 did not provide sufficient detailed definition for the design of a complex military capability.[54]

48. House of Commons Defence Committee, 'Written Evidence Submitted by the Ministry of Defence', 21 September 2021, p. 18, <https://committees.parliament.uk/writtenevidence/39481/pdf/>, accessed 5 May 2022.
49. UK Parliament, 'Ajax Programme', *Hansard*, 8 June 2021, Column 829.
50. House of Commons Defence Committee, 'Oral Evidence: Ajax: Recent Developments', 20 July 2021, Q18, <https://committees.parliament.uk/oralevidence/2589/pdf/>, accessed 23 December 2021.
51. *Ibid.*, p. 20.
52. GDUK supplied information, 8 March 2022.
53. Director Health, Safety and Environmental Protection, 'HS&EP Ajax Noise and Vibration Review', p. 16.
54. *Ibid.*, p. 17.

The Safety Report found that:

> Programme staff in DE&S and Army did not have the necessary experience and knowledge to deeply understand the management of noise and vibration.
>
> DE&S was overly reliant on underestimated calculated data from the GDUK noise and vibration calculator rather than using instrumentation to measure actual values.[55]

To summarise, it appeared at the end of 2021, and remained the case in March 2022, that GDUK believed they had delivered according to their contract, something that the MoD did not accept. Also, while ideas had been put forward to reduce the impact of vibration on crews and perhaps vibration itself, it was not known whether they would work, how much they would cost or how long they would take to implement. The government had confirmed that 'design modification(s)' would be necessary, but their nature, and the cost of implementing them on fully and partially completed platforms, remains unknown.[56]

WHY GDUK AND LMUK?

It is inescapable that two UK firms – GDUK and, to a lesser extent, LMUK – made contractual commitments on which they have been unable to deliver on time. But why were they selected in the first place?

The superficial answer is that they had made credible commitments centred on their exploitation of the ASCOD. However, it is also relevant that GDUK had never before developed or made a tracked armoured vehicle and LMUK, built on its acquisition of Insys which had in turn been a management buyout from Hunting Engineering, had not developed a turret. GDUK was also separate organisationally from GDELS, which, at least in terms of the 2014 bid and contract, would actually have delivered much of the work.

A deeper answer is that, even by 2010, the MoD had very little choice if it wanted a UK company. In light of the Army not having placed an order for a UK combat vehicle since 1994,[57] the firms that previously supplied armoured vehicles, and particularly tracked systems, had given up on the defence sector and sold up where they could.

As briefly noted above, the Army launched the TRACER project in 1994, but abandoned it in 2002 when the US lost interest.[58] It also joined what became

55. *Ibid.*, pp. 17–18.
56. Jeremy Quin, 'Ajax Armoured Vehicle Procurement', *Hansard*, 9 September 2021, Col. 485.
57. Army Technology, 'Challenger 2 Main Battle Tank', 20 March 2020, <https://www.army-technology.com/projects/challenger2/>, accessed 23 December 2021.
58. Think Defence, 'TRACER, MRAV and Project Bushranger'.

the Boxer programme, but cancelled it because some senior elements in the Army thought it was too large and heavy for operations such as that in Kosovo in 1999.[59] Additionally, it did not follow through on the Piranha 5 element of FRES because it could not secure the transfer of intellectual property that would have enabled the UK to develop and modify the system. Then Secretary of Defence John Hutton told the House of Commons in December 2008:

> In May 2008 we announced the provisional selection of Piranha V, offered by General Dynamics (UK) Ltd, as the preferred design for the FRES utility vehicle. Following a period of intensive negotiations with General Dynamics to address a number of commercial issues, it became clear to both parties that it would not be possible to reach agreement on the commercial conditions required to enable further progress on the basis of the current procurement strategy. I have therefore decided that we should withdraw General Dynamics (UK)'s provisional preferred bidder status. Our examination of the equipment programme has, separately, considered the balance of investment and priority in the army's armoured vehicle programme. We have concluded that, in the context of current operations, and bearing in mind the considerable recent investment in protected mobility, the highest priority should now be accorded to delivering the Warrior capability sustainment programme and the FRES scout vehicle as quickly as possible.[60]

GDUK had never before developed or made a tracked armoured vehicle

No armoured vehicle company could be expected to maintain, let alone enhance, its development capability for such a period without orders. GKN Defence, Alvis and Vickers Defence Systems had given up on defence by 2005 and were bought by BAE Systems (which had bought Royal Ordnance from the government in the late 1980s).

The Army's lack of consistent commitment to a programme has to be seen in light of the industrial capabilities deemed necessary in the UK in the 2005 Defence Industrial Strategy and its warning in the land systems section that:

> Analysis of the forward programme and the sharp decline in design work in our programme make it difficult to see how industry can retain the skill base required for the key capabilities identified if we were to continue with our current approach.[61]

After 2003, the Army focused most of its attention on the Iraq and Afghanistan counterinsurgency campaigns, which involved buying a range of wheeled vehicles from the US as Urgent Operational Requirements. The Army did not appear concerned with its onshore supply base – a situation it is seeking to remedy in a Land Industrial Strategy which should appear in 2022.

59. Author's off-the-record interview with a former Boxer Integrated Project Team member.
60. UK Parliament, 'Written Ministerial Statements'.
61. MoD, *Defence Industrial Strategy*, p. 82.

The 2010 Scout choice was between GDUK and BAE Systems, which both made offers based on platforms developed by their overseas subsidiaries. In the UK, BAE Systems had experience with the Challenger tank and had built the tracked Trojan and Terrier combat engineering vehicles, which entered service in 2007 and 2013, respectively. However, had BAE Systems won the 2010 competition for the Scout programme, it would have given it dominance over the land sector in addition to its pre-eminent place in complex naval vessels, submarines and fixed-wing aircraft. There is anecdotal evidence that this was not an appealing prospect to some in the MoD. Thus, the MoD's readiness to allocate the project to inexperienced suppliers, albeit with well-endowed parent companies, becomes easier to understand.

CONCLUSION: WHAT NEXT?

The situation in December 2021 was that GD had been given time but not money to discover remedies for the symptoms demonstrated by Ajax. This raises questions about the amount of time that will be granted or needed, and the potential consequences of any MoD choice to abandon the project. Leaving aside the operational implications and the feasibility of running-on CVR(T) and using different versions of Boxer for reconnaissance roles, there is also the possibility of a protracted legal battle between an MoD seeking to recover wasted funds and a defence company claiming that cancellation was not justified because GDUK had not breached the terms of the contract.

Moreover, in the Defence & Security Industrial Strategy of May 2021, the government committed to the development of an industrial strategy for the land sector. How GDUK and LMUK can be accommodated within this, given Ajax and, in the case of LMUK, the cancellation of the Warrior upgrade, is a delicate matter. Whatever the performance of Ajax, the location and activity of the GD factory in Wales is a tangible contribution to the 'levelling up' agenda.

There is no doubt about the troubled nature of the Ajax programme. In 2021, the government's Infrastructure and Projects Authority (IPA) classified the Armoured Cavalry 2025 project (which has Ajax at its core) as 'red', meaning:

> Successful delivery of the project appears to be unachievable. There are major issues with project definition, schedule, budget, quality and/or benefits delivery, which at this stage do not appear to be manageable or resolvable. The project may need re-scoping and/or its overall viability reassessed.[62]

However, the fact that the 2020 IPA report had classified Ajax as 'amber',[63] despite persistent vibration problems, raises questions about how much the DE&S staff knew and what was communicated to the IPA.

62. Infrastructure and Projects Authority (IPA), 'Annual Report on Major Projects 2020-21', 2021, p. 35.
63. IPA, 'Annual Report on Major Projects 2019-20', 2020, p. 38.

Defence is sadly but understandably familiar with late and over-budget projects whose initial performance falls somewhat short of that specified in a contract, although this author knows of no other government developing its own equipment that has escaped such problems. However, a British project whose output is simply not fit for basic purpose because of threats to its operators is a rare occurrence.

If the Ajax vehicle were to be cancelled, it would be an even bigger financial disaster than the AEW Nimrod, on which over £1 billion had been spent at cancellation point (around £3.2 billion at today's prices).[64] So far, the MoD has paid GDUK £3.2 billion against the 2014 contract worth £5.5 billion. Given the four areas that are currently seen as potential sources of vibration and noise, their re-engineering remedies – if they exist – will certainly involve GD in major expense and losses. If they cannot be fixed, GD could pursue the MoD for damages if the company could show it had not legally breached the terms of the contract. However, the MoD could claim at least some of its money back and pursue liquidated damages. Only lawyers will smile at these possibilities.

This raises some significant questions that the future inquiry should address. They partially supplement the issues raised in the Safety Report.

- Can the Army and the MoD demonstrate that they took note of the technical risks of changes to the ASCOD that increased its weight from 32 to 42 tons? Did they rely only on the contractor's calculation that the drive and transmission system could power a system of that weight?
- What has happened to the human resources providing the NVH expertise in GDELS that must have gone into the development of the original ASCOD vehicles, and precisely how was that expertise transferred to GDUK after 2010?
- Can the MoD and GDUK demonstrate their awareness of the technical risks associated with sub-contracting the turret to a separate company?
- Why were vibration issues not escalated by GDUK and its DE&S monitors when they were first apparent? If they suddenly appeared around 2018, what changes to the system could have prompted them? If, as is suspected, they were of longer standing, how were they viewed by GDUK and the DE&S?
- Why did the DE&S allow the release of vehicles to a user/customer that the latter quickly found to be inadequate? How were tests approved by the DE&S different from the tests used by the Army? What were the precise contractual obligations on GDUK regarding the integration of MoD-supplied headsets? There have been hints from both GDUK and the MoD about possible flaws in this equipment.[65]

64. *Global Security*, 'Nimrod AEW3', <https://www.globalsecurity.org/military/world/europe/nimrod_aew3.htm>, accessed 23 December 2021.
65. House of Commons Defence Committee, 'Written Evidence Submitted by General Dynamics', section 6, p. 3. In 2021, Jeremy Quin announced that, as a precautionary measure, the use of the in-service headsets is being time-limited

- Did the DE&S payments to GDUK include monies for the completion of the 25 vehicles handed to the Army for testing?

Even without reliable responses to these matters, lessons can be derived from the Ajax experience.

First, if a government wishes to maintain the industrial capability to design, develop, sustain and modify key systems, it needs to provide an adequate drumbeat of orders so that the companies involved can pay for and develop the skills and knowledge needed. The modification element is important even for land platforms which tend to be in-service for multiple years and so need periodic updates. They are often also adjusted for specific operations. Reconstituting neglected industrial capability is expensive and difficult, and it is up to the government (and the Army in this case) to provide the work needed.

Second, reliance on company confidence to reach conclusions about what is possible in a specific period for a sum of money is risky when the government has only limited sources of in-house expertise. In principle, the engineering function in DE&S is supposed to be useful, with its role of assessing the technical risks in bids and its ability to call on expertise in Dstl and QinetiQ. But, in this case, the MoD seems to have underestimated the risks, or perhaps relied on GD's overall global expertise (and finances) to fix problems. Yet, in competitions for scarce and important contracts, companies can be tempted towards excessive optimism. It should not be overlooked that, when a project underperforms, it may be that it was poorly managed by the delivery agent, but it may also be that the requirement, timetable and budget combination was unrealistic in the first place. Who can be confident that any company could have successfully added armour, multiple sensors and a big gun to an ASCOD without increasing its weight by more than 10 tons?

Third, for a complex project that involves extensive development and production work, there are risks involved in relying on a process that specifies a user, procurement agent and delivery agent as relatively separate players with a fixed price contract for a specified requirement. The Scout project proceeded just as the DE&S was being revamped as a body at 'arms' length' from its military customer, and indeed suppliers, under the reforms brought in by Bernard Gray. Ajax was managed quite differently from the later stages of the Army Basing Programme, which the IPA credits as having been turned around in part because 'the programme's fully integrated team (Army, Defence Infrastructure Organisation and industry) enabled true collaborative working under a single leadership model'.[66] For the *Queen Elizabeth*-class, a team approach that brought all relevant players together in the Carrier Alliance was also adopted. Something similar is being used for the current Tempest

on other armoured vehicles. See Quin, 'Ajax'. See also *Overt Defense*, 'British Army Vehicle Headsets Under Investigation for Hearing Risks'.

66. IPA, 'Annual Report on Major Projects 2020-21', p. 17.

arrangement. In the case of Ajax, it appears the users got significantly involved only just before delivery.

In 2021, the MoD appeared to have accepted the value of all parties working more closely together on Ajax. This was indicated by its belated employment of a specific Senior Responsible Owner, the civil servant David Marsh, to coordinate and perhaps direct the integration of all elements of capability associated with the Ajax family.[67]

Fourth, when projects get into difficulty, opposition politicians and the media naturally look for a target to blame, as the interrogation of GDUK by members of the House of Commons Defence Committee on 20 July 2021 illustrated.[68] The secretary of state has apparently joined this group, telling the House of Commons at the end of November 2021, 'I will leave no stone unturned in relation to how we apportion blame'.[69]

However, as seen, the Ajax project was shaped by many groups and decision-makers, and its problems arise from a range of factors and players. While President John F Kennedy famously observed that 'victory has a hundred fathers and defeat is an orphan', the Ajax reality, as with many serious accidents, is that many factors and elements have contributed to its problems.

- Even the briefest analysis of the motivations and drivers of the parties would stress that the Army, after multiple acquisition U-turns and having seen its historical UK supply base abandon the sector, was desperate for a new fleet of vehicles. It was thus disinclined to take much notice of the ATDU reports and the complaints of its own soldiers. Its intellectual capacity to assess the feasibility of what it was asking for was a function of its own (modest) technical expertise.[70]
- The DE&S, measured on delivery to cost and as near to timetable as possible, could have been expected to be tempted to relegate performance shortfalls to something that could be fixed later. It had

67. See UK Parliament, 'Armoured Cavalry Programme (Ajax) Programme', 6 September 2021, <https://questions-statements.parliament.uk/written-statements/detail/2021-09-06/hcws260>, accessed 23 December 2021; George Allison, 'Ajax Gets "Dedicated" Senior Responsible Person to Oversee Project', *UK Defence Journal*, 19 October 2021.
68. House of Commons Defence Committee, 'Oral Evidence: Ajax: Recent Developments'.
69. Larisa Brown, 'Officers to "Carry the Can" for Tank Fiasco', *The Times*, 26 November 2021.
70. MoD, 'Ajax Noise and Vibration Review', para. 72. The author would offer as a proposition that the British Army possesses limited institutional recognition of the importance of armoured vehicle technology. It thus does little to develop, recognise and reward its own expertise in this field. Indicators of this are its closure of the Defence Technical Officers Scheme for potential officers, its abandonment of support for Master's degrees in military vehicle technology at the Defence Academy, and the rarity of the selection of Royal Electrical and Mechanical Engineers officers for three-star roles.

satisfied itself through a competition and a firm price contract that the MoD would have a ceiling on its expenditure.

- GDUK and LMUK were striving to establish themselves in fields where they lacked experience and had made offers perhaps in the expectation of receiving work and benefits on other projects. They were expected to rely on others, especially GDELS, for the hulls, chassis and power systems that were so central to noise and vibration control.

Seeking and specifying individuals to blame also implies that, if only different (and 'better') people had been involved, an improved outcome would have been reached. This suggests, in turn, that those appointing those individuals carry significant responsibility, since they clearly exercised poor judgement. Moreover, when a strong blame culture permeates, participants are incentivised to hide unwelcome but significant information, which makes the identification and learning of lessons more difficult. Even in July 2021, GDUK appeared to be in a state of denial:

> As of July 1 production and deliveries has seen the build of 271 armored hulls and 60 turrets. All six variants are in full production and 116 vehicles have been fully built and are delivered, or in the handover process. … All the 25 vehicles to meet IOC fleet have already been delivered and been accepted by the British Army, including 12 Ajax variants equipped with the 40mm cannon, which were successfully live fired by the British Army as part of the acceptance process.[71]

While any investigation into Ajax must assess whether the individuals concerned acted carelessly (or even criminally), hunting for scapegoats incentivises the concealment of information and enhances the problems of learning appropriate lessons. The investigation's key role should be to hold all relevant actors – going back at least to 2010 – to account, and require them to articulate the choices they made and the grounds on which they made them. Thus, the extent to which the wider system and organisations in which they were required to act incentivised individuals to behave in certain ways could also be examined.

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71. Andrew Chuter, 'British Committee Wants to Shake Out Ajax's Vibration Problems', *Defense News*, 19 July 2021.

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