National Audit Office

The Ajax programme

Ministry of Defence

REPORT

by the Comptroller and Auditor General

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The Ajax programme

Ministry of Defence

Report by the Comptroller and Auditor General

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Gareth Davies
Comptroller and Auditor General
National Audit Office

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Key facts

£3.167bn

payments to General Dynamics to December 2021 on the Ajax programme out of a firm-priced contract of £5.522 billion

4 years

increase so far to Ajax's expected in-service date. The Ministry of Defence (the Department) missed its latest target date of June 2021

26

Ajax vehicles received by the Army as of December 2021, out of an order of 589 vehicles

Progress on the programme, at December 2021

143	assembled Ajax vehicles at various capability drop standards. Factory acceptance testing has been completed on these. In total, General Dynamics has built 324 of the 589 hulls
21	training systems General Dynamics has delivered, along with training courses and logistic support
7 years 9 months	overlap between the design and manufacture stages, compared with 3 years 4 months that was expected in 2014
1 year	the delay to the programme schedule set in 2019, with production 61 vehicles behind target

Future challenges in delivering the programme

27	limitations of use on Ajax vehicles in September 2021, of which 22 related to safety and 11 were critical to achieving initial operating capability
Late 2022	the Department's estimate of when it will be able to understand and resolve the noise and vibration issues on the Ajax programme
Not yet known	the revised target date for achieving initial operating capability
More than £10 billion	the Department's initial estimate of the whole life cost of the Ajax programme – including the contract cost – although it is still developing its understanding of future support costs

Summary

1 Ajax is an armoured fighting vehicle which should provide the Army with its first fully digitised platform. It will be based on new technologically advanced sensors and communication systems which would transform the Army's surveillance and reconnaissance capability. The vehicles form an integral part of the Ministry of Defence's (the Department's) vision for digital integration across land, air and sea domains, allowing real-time information-sharing and connectivity with other capabilities, such as Lightning II jets.

2 Ajax represents the biggest single order for a UK armoured vehicle in more than 20 years.[1] The Department has a £5.522 billion[2] firm-priced contract with General Dynamics Land Systems UK (GDLS-UK) for the design, manufacture and initial in-service support of 589 vehicles.[3] The programme will deliver six types of vehicle which will perform different roles.[4] At December 2021, the Department had paid GDLS-UK £3.167 billion and, at this point, GDLS-UK had designed the vehicles, built 324 hulls and assembled and completed factory acceptance testing of 143 vehicles. The Department had received 26 Ajax vehicles, as well as associated training systems and support.

3 The programme has encountered significant problems. In 2014, the Department extended its expected in-service date by three years when it set an initial operating capability[5] (IOC) of July 2020.[6] The programme subsequently missed a revised target date of June 2021. In 2021, the Department publicly acknowledged concerns about excessive levels of noise and vibration on the Ajax vehicles, leading the minister for defence procurement to make regular statements to Parliament on the programme's progress and the possible impact on the health of its crews who had been testing the vehicles. These issues remain unresolved, and the Department has not yet set a new target date for IOC.

1 Throughout this report 'Ajax' refers to the Armoured Cavalry programme covering the six types of armoured vehicles. The programme aims to deliver an integrated, multi-role capability (that is, the Ajax family of vehicles) and its training solution into service.
2 All figures in this report include Value Added Tax.
3 This type of contract means that the contractor undertakes the contract for a total, all-inclusive price that will not change irrespective of how long it may take the supplier to deliver, or how much it costs.
4 The six variants are: Ajax (reconnaissance), Athena (command), Ares (protected mobility reconnaissance support), Atlas (recovery), Apollo (repair), and Argus (engineer reconnaissance).
5 Initial operating capability is the minimum level at which the Department can usefully deploy a capability or service and is usually the in-service date. For the Ajax programme, this includes requirements for training and logistics
6 In 2010, the Department's planning assumption was that Ajax would enter service in early 2017. When it awarded the manufacture contract in 2014, this planning assumption was replaced by a formal IOC date of July 2020.

4 The long-running Ajax programme has evolved from previous attempts to replace the Army's reconnaissance vehicles, dating back to 1992. We covered the early stages in our 2011 report, finding that the Department's approach to renewing its core armoured vehicle fleet did not represent value for money.[7] This report assesses the causes of the problems that the Ajax programme has encountered since 2011 and considers the challenges that the Department now faces in delivering the intended capability. We set out:

- an overview of the Ajax programme, including the Army's vision and objectives **(Part One)**;
- our assessment of the underlying causes of difficulties on the Ajax programme **(Part Two)**; and
- the challenges that the Department faces in delivering the programme **(Part Three)**.

Key findings

Programme vision and objectives

5 The Army's vision for its armoured vehicles is now more dependent on Ajax despite the Department reducing the number of vehicles on order in response to affordability pressures. When delivered, Ajax should provide significant technological enhancements and is central to the Department's vision for digitally connected capabilities. However, in 2014, in response to wider affordability pressures, the Department ordered 589 vehicles out of an optional 1,328. This was below the Army's required fleet size at that time of 686 vehicles, which the Army accepted could restrict its ability to train. Despite this, subsequent strategic defence reviews – which set out the government's approach to national security – have resulted in the Army becoming more dependent on Ajax. The 2015 Strategic Defence and Security Review expanded Ajax's number of roles, and the 2021 Integrated Review envisaged a future force centred around Ajax and the Boxer mechanised infantry vehicles. In November 2021, the Army set out new transformation plans, with Ajax playing a significant role in future operations (paragraphs 1.3 to 1.5).[8]

7 Comptroller and Auditor General, *The cost-effective delivery of an armoured vehicle capability*, Session 2010–2012, HC 1029, National Audit Office, May 2011.

8 Army, *Future Soldier Guide*, November 2021. By 2025, the Army plans to use Ajax in its two close combat Armoured Brigade Combat Teams and as part of its Deep Recce Strike Brigade.

6 The Department does not know when Ajax will be operational and has already extended its expected in-service date by more than four years. In 2010, when the Department awarded the demonstration contract to GDLS-UK, its planning assumption was that it would have a deployable capability in 2017. It subsequently replaced its forecast date with an IOC date of July 2020, which it then pushed it back to June 2021 but missed. The Army also redefined the requirements that vehicles must meet at IOC and accepted some technical constraints, most notably on the weapon system and armour. The Department will not set a new target date for IOC until it has agreed with GDLS-UK on how to resolve the noise and vibration issues. It has not yet changed the target for full operating capability (FOC) – April 2025 – even though it has no confidence that this is achievable (paragraphs 1.21 and 2.16).[9]

The causes of the programme's difficulties

Programme set-up

7 The Department's commercial approach to the programme may not protect it from further expenditure. In 2014, the Department and GDLS-UK agreed a firm-priced contract to deliver 589 Ajax vehicles. The Department transferred the contract's financial risks, including the risk of inflationary cost growth caused by any delays, to GDLS-UK. The Department has maintained that it will hold GDLS-UK to deliver the intended Ajax capability within the terms of the firm-priced contract. However, it has not managed schedule and performance risks effectively. Ajax will be delivered late, leaving the Army to operate with ageing armoured vehicles, which are expensive to maintain. There remains a risk that it will need further funding to deliver and maintain the armoured vehicles capabilities that it needs (paragraphs 1.10 and 3.3).

8 The Department's original requirements were highly specified, and its management of design changes has led to disputes and delays. The design of Ajax is based on an existing platform, but the Department's requirements have, in effect, made it a bespoke technology which is more complex than other armoured vehicles. Ajax was highly specified, with around 1,200 capability requirements for each of the six vehicle types. However, the Department and GDLS-UK did not fully understand some components' specifications or how they would be integrated onto the Ajax vehicle. For example, the initial design of some technologies, such as the cannon, was immature when the Department awarded GDLS-UK the manufacture contract.[10] It could not describe the characteristics of some systems in sufficient detail, which subsequently led to consequential changes to the overall design. The extent of these technical changes led to disputes between the Department and GDLS-UK, and the time taken to agree changes contributed to programme delays (paragraphs 2.2 to 2.4).

9 Full operating capability is the level of military capability which is intended for a project.
10 The Department supplied the cannon, and its integration into the turret is managed through a separate contract between GDLS-UK and a subcontractor.

9 The Department and GDLS-UK did not understand the scale of work or technical challenge, resulting in insufficient contingency in the programme schedule. As we have seen many times on other government programmes, the Department and GDLS-UK under-estimated the scale and sequencing of work which meant that the programme schedule was over-optimistic.[11] It took longer than expected for GDLS-UK to undertake design work, complete testing, resolve defects and manage supply chain disputes. GDLS-UK told us that this was because the Department's acceptance criteria and standards were not fully defined and subject to change. The Department disagrees and repeatedly found GDLS-UK's safety documentation insufficient. As a result of all these factors, the programme quickly used up the contingency in the schedule, leading to missed milestones and a four-year slip in the demonstration phase. This meant the overlap between the demonstration and manufacture stages was much greater than originally anticipated, which made addressing design issues more complex and added risk because of the need to manage complex delivery and retrofitting schedules (paragraphs 2.12 to 2.14).

Programme implementation

10 The Department has not managed the programme effectively. It did not establish effective governance arrangements or the necessary resources to manage the programme. There were multiple lines of reporting and complex assurance arrangements; insufficient senior management time; a high turnover of senior staff; an under-resourced programme management team; and an ineffective programme board. We also found that the Department had weak project controls with an over-emphasis on achieving its IOC target date, which meant that it prioritised time and cost over capability. As a result, it pressed ahead with the programme without resolving performance issues. The governance weaknesses also meant that programme risks and results of trials were not escalated in a timely manner or sufficiently visible to senior personnel (paragraphs 2.5 to 2.11).

11 The Department and GDLS-UK reset the contract in 2018, but this did not resolve the programme's underlying problems. By 2017, the Department and GDLS-UK faced disputes over the handling of technical design issues and significant schedule slippage. They therefore negotiated a contract reset, which took 15 months to agree. This led to some positive changes, including the resolution of some technical issues. However, work on the programme slowed during this extended period of renegotiation, compressing the programme's schedule, and the reset added complexity with multiple build standards and vehicles from early capability drops having to be upgraded. The programme continued to encounter technical and safety issues, and the revised schedule was based on over-optimistic assumptions which did not adequately reflect the time needed by GDLS-UK and the Department to complete and sign off safety reviews that met the Department's requirements. Consequently, GDLS-UK missed its first 11 revised milestones, and by December 2021, 18 out of 36 critical milestones were outstanding, 10 of which were six months or more late (paragraphs 2.15 to 2.19).

11 National Audit Office, *Framework to review programmes*, April 2021.

12 The Department knew of noise and vibration issues before soldiers reported injuries but was not aware of the severity of potential problems. Noise and vibration are common problems on armoured vehicles. The Defence Science and Technology Laboratory (DSTL) had been warning Defence Equipment & Support (DE&S) of concerns about Ajax's potential compliance with legislative requirements since 2014. Reporting of issues identified in trials was limited and slow, meaning that safety concerns were not shared or escalated by the Army or DE&S. The Army's trials team began reporting injuries from July 2020 onwards, having raised concerns about vibration since late 2019. But excessive noise and vibration levels – and potential injuries – were not reported to the senior responsible owner (SRO) until September 2020. The Army and DE&S had signed off safety documentation – provided by GDLS-UK – that, with some limitations on use, the vehicles were safe to commence training in August 2020, one month after reported injuries. Briefings for the minister for defence procurement did not mention noise and vibration until November 2020, after he had given evidence to the House of Commons Defence Committee. Quarterly programme reports did not mention noise and vibration problems until March 2021 (paragraphs 2.20 to 2.26).

13 The Department did not create effective mechanisms or incentives to resolve safety issues. The Department's approach to safety testing is complex, with multiple layers of testing and uncertainty around roles and responsibilities. For example, as advisers, DSTL lacked authority to ensure that the Department gave due consideration to the safety issues that it raised. There was a lack of clarity about the level of evidence required for safety cases, which meant GDLS-UK had to provide additional evidence, necessitating additional resources to complete the work. The Department believes that the contract also incentivised GDLS-UK to prioritise production milestones over the quality and performance of the capability. In December 2021, the Department published its own lessons learned review and made 20 recommendations for change (paragraphs 2.25 to 2.27).

14 The Department is taking steps to resolve the noise and vibration issues, but they continue to represent a significant risk to the programme. The Department and GDLS-UK disagreed on whether the levels of noise and vibration in Ajax vehicles breached contractual requirements. As a result, the Department commissioned trials to provide an independent dataset on the scale of the issues. But these trials did not provide evidence on the cause, test the impacts on personnel in an operational scenario nor identify potential solutions. GDLS-UK has undertaken its own analysis and argues that the vehicles are safe to operate with appropriate hearing protection. GDLS-UK claims that noise levels are higher when using the Army's headsets than the headsets used by its own crews.[12] The Army has been aware since at least 2019 of problems with these headsets, which have been used in some operational armoured vehicles. GDLS-UK has identified potential design changes to minimise the impact of vibration on the crew. Further independent trials in early 2022 will test these modifications and will include more vehicle variants. But the effectiveness of these mitigations has not yet been proven or accepted by the Department. As such, there remains a risk that additional work will be needed to resolve issues, including retrofitting solutions for vehicles that have already been built or integrating alternative headsets. The Department and GDLS-UK continue to disagree on the safety of the vehicles, and it is likely to take until late 2022 to agree on solutions, adding further to schedule and cost pressures (paragraphs 2.21 to 2.24).

15 Other safety and technical risks remain unresolved. By December 2021, the Department had imposed 27 limitations of use on the Ajax vehicles, of which 22 related to safety and 11 were critical to achieving IOC. DSTL was also tracking 136 'concerns', only four of which related to noise and vibration. GDLS-UK told us that it was unaware of DSTL's concerns as it progressed work on vehicle design. While a programme of this scale and complexity will inevitably need to resolve design issues, the Department's management of the programme means it still has a high level of unresolved technical issues (paragraph 2.28).

Future risks

16 The programme faces significant challenges, and it is not yet clear whether the issues are resolvable. The pressure on the programme has significantly increased over the past year. It is a year behind the revised schedule, trials involving Army crews have been stopped, noise and vibration issues remain unresolved, and GDLS-UK has continued production without receiving any payment in 2021 – with the Department having paid GDLS-UK £1.1 billion less than scheduled at December 2021. The two parties remain in dispute over unresolved contractual, safety and technical issues. The programme team is exploring how to recover the programme but will not agree a revised target date for IOC until noise and vibration issues are resolved. The Department will need to consider carefully whether the programme can deliver the intended capabilities but does not expect to be in a position to do so until late 2022 (paragraphs 3.2 to 3.4).

12 The headsets used by GDLS-UK crews are ear defenders.

17 The Department also recognises that it needs to strengthen its programme management. It is seeking to:

- revise governance arrangements and ensure the programme has appropriate resources. It has made improvements, such as appointing a full-time SRO, and the programme board has started to provide stronger oversight. The Department has recognised that the programme needs strong leadership and decision-making, with clear accountabilities and better management information on progress and issues;
- ensure the commercial arrangements create the right incentives to deliver the required capability, including meeting safety requirements. To date, payments have been driven by achieving production milestones; and
- develop a realistic, agreed schedule to IOC and FOC. The Department and GDLS-UK do not have an agreed timeline. The Department cannot set a new target date for IOC until it has agreed with GDLS-UK how to resolve the noise and vibration issues (paragraphs 3.5 to 3.11).

18 The Department also faces significant challenges in developing the enabling capabilities that will allow it to use Ajax as intended. Delivering the full Ajax capability will depend on the Department delivering supporting programmes, including new communication systems, training facilities and infrastructure projects to store the vehicles. In particular, the Department is planning to enhance Ajax's digital capability through the delivery of the Morpheus programme – also partly supplied by General Dynamics – which will improve communications. However, this programme has had significant cost increases and is running at least three years late. Ajax will not have the full level of enhanced digital capability until new radios are delivered under this programme. The Department has also encountered delays and difficulties on other enabling programmes, including developing infrastructure, designing training courses and providing operational ammunition (paragraphs 3.12 to 3.14).

19 The delays to developing Ajax will have important operational and financial impacts for the Army. The Army's plans rely on delivering a network of digital capabilities by 2030, centred around Ajax, Boxer and Challenger 3 armoured fighting vehicles. But the delays to the Ajax programme mean it is not clear how the Army will achieve its planned restructuring by 2025. The Army accepts it will not deploy Ajax as early as planned, relying instead on the ageing Warrior armoured infantry vehicle and Challenger 2 main battle tank. If Ajax continues to be delayed, the Army may need to keep Warrior in service for longer, or delay upgrades to some Challenger vehicles, so that more are available for operations. The Army will also need to manage the financial consequences of keeping old capabilities in service, which will add to wider affordability pressures (paragraphs 3.10, 3.11 and 3.15 to 3.17).

Conclusion on value for money

20 The Department expects Ajax to improve its armoured vehicle capability significantly. So far, it has insisted that GDLS-UK will deliver 589 Ajax vehicles for the agreed contract price of £5.522 billion. But the in-service date has already increased by four years and the Department does not know when it will be able to start using the vehicles. The programme continues to face significant problems and there is not yet agreement on the causes of critical safety issues or how these will be resolved. There are other technical issues which still need to be addressed and wider problems in developing the enabling capabilities that will allow Ajax to achieve full capability. These problems mean that the Department has not demonstrated value for money on the £3.167 billion it has spent so far through this contract.

21 The Department's and GDLS-UK's approach was flawed from the start as they did not fully understand the scale or complexity of the programme. A series of programme management failures have since led to missed programme milestones and unresolved safety and technical issues. The two parties remain in dispute over unresolved contractual, safety and technical issues. The Department faces a significant challenge and difficult decisions if it is to deliver the programme, with a risk that the problems might prove insurmountable. To deliver value for money from the programme, the Department must introduce the capability that it set out to achieve, without costs escalating or further delays in introducing the capabilities. We have seen similar problems on other defence programmes, and the Department must ensure that it learns lessons to prevent a reoccurrence of failings across its £238 billion equipment programme.

Recommendations

22 Our recommendations are intended to help the Department create the necessary conditions to deliver the programme and, in doing so, apply the lessons across its other armoured vehicle programmes. It should:

Delivery schedule

a **agree a credible delivery plan to IOC and FOC with GDLS-UK**. In doing so, it should consider what contingency it needs to resolve existing issues and manage unknown risks and ensure that the timetable is realistic. It should assess whether the FOC target date is achievable and re-assess this as the programme progresses;

Governance

b **reassess the way the programme is governed and resourced** – focusing on the role of the programme board and interfaces between the Army, DE&S and the bodies involved in trials and managing the interdependencies. Duty holders should have sufficient authority to perform their roles, and the governance structure needs to support clear and timely decision-making to provide the necessary approvals and manage programme risks;

c **improve the management information to provide more real-time visibility on progress, risks, and dependencies**. This should allow all parties to have a single view on progress against milestones and budgets, clarity on risks and when action is needed;

Commercial incentives

d **ensure that the contract incentives are focused on outcomes and align the need to deliver to time with an increased focus on developing the capability**, by ensuring technical issues are addressed in a timely manner; and

Safety issues

e **ensure that there is a clear mechanism and accountability for implementing the recommendations of its safety report**. As part of this, the Department should consider the scope for streamlining the safety trials process and ensure that duty holders have sufficient authority to report and escalate findings. There is a need to ensure that the advice provided by DSTL, or any other advisory body, is given due consideration in a timely manner, and a complete record is kept of actions taken against the advice.

Part One

The Ajax programme

1.1 This part sets out the Ministry of Defence's (the Department's) ambitions for and approach to managing the Ajax programme, summarises the programme history and provides an update on what has been delivered.

What the Department is seeking to achieve

1.2 Ajax is an armoured fighting vehicle which should provide the Army with its first fully digitised platform. The Army expects that new sensors and communications systems will transform its reconnaissance capability. The Department is buying 589 vehicles in six variants, each with a different role: intelligence gathering, battlefield command, protected mobility, support, recovery, and engineer reconnaissance **(Figure 1)**. 245 of the vehicles will be turreted and equipped with a cannon. In this report, we use 'Ajax' to describe the Army's Armoured Cavalry programme, which is introducing all six variants into service, together with training, infrastructure and logistics.

1.3 The Department is purchasing Ajax to replace the Army's ageing fleet of armoured reconnaissance vehicles, which it has used since the 1970s.[13] The Army intends to use Ajax's communication systems to enable digital integration across land, air and sea domains – allowing real-time information-sharing with other capabilities, such as Lightning II jets. Ajax's introduction will help the Army rationalise the number of vehicle types in its fleet from 35 to 15 by 2030, increasing efficiency in support contracts.

13 Ajax will replace the in-service Combat Vehicle Reconnaissance fleet.

Figure 1
Ajax vehicles - planned for 2025

There are six types of Ajax vehicles, each with a different role

Ajax
245 vehicles

Turreted variant for intelligence, surveillance, target acquisition and reconnaissance

Ares
93 vehicles

Armoured personnel carrier, delivering troops

Apollo
50 vehicles

Repair vehicle – towing damaged vehicles and lifting heavy parts

Athena
112 vehicles

Command and control variant

Argus
51 vehicles

Engineer reconnaissance variant

Atlas
38 vehicles

Recovery vehicle

Note
1 Figures show the number of each variant that the Army is scheduled to receive by 2025.

Source: National Audit Office review of Ministry of Defence documentation

1.4 Since the start of the Ajax programme in 2010, affordability pressures have reduced the number of vehicles the Department is purchasing, yet subsequent strategic reviews have broadened Ajax's role and increased the Army's dependence on the programme:

- In 2014, the Department ordered 589 Ajax vehicles out of an optional 1,328, the minimum order quantity in its 2010 contract. This was below the Army's requirement at that time of 686 vehicles and reduced the number in its training and reserve fleets, which the Army accepted could restrict its ability to train.
- Following the 2015 Strategic Defence and Security Review, the Army expanded Ajax's purpose from a specialist reconnaissance vehicle to a medium-weight armoured fighting vehicle, including close combat, mobile action and support roles. But this did not result in further vehicles being purchased or changes to requirements.
- The 2021 Integrated Review announced significant changes to the Army's armoured vehicle capability.[14] The Department will retire rather than upgrade the Warrior infantry fighting vehicle. It will reduce the number of Challenger main battle tanks, only upgrading 148 of 227. The Army's future force will be more centred around Ajax and Boxer mechanised infantry vehicles.

1.5 Following the Integrated Review, the Army has redefined its vision for how Ajax will operate alongside other armoured vehicles. In November 2021, the Army stated that, by 2025, it would use Ajax in its two close-combat Armoured Brigade Combat Teams and as part of its Deep Recce Strike Brigade Combat Team.[15] The Army is considering how this new brigade will be employed, including the range of activities, operations and scenarios in which it will use Ajax alongside other armoured vehicles.

Roles and responsibilities for the programme

1.6 The main bodies involved in managing and delivering the programme are:

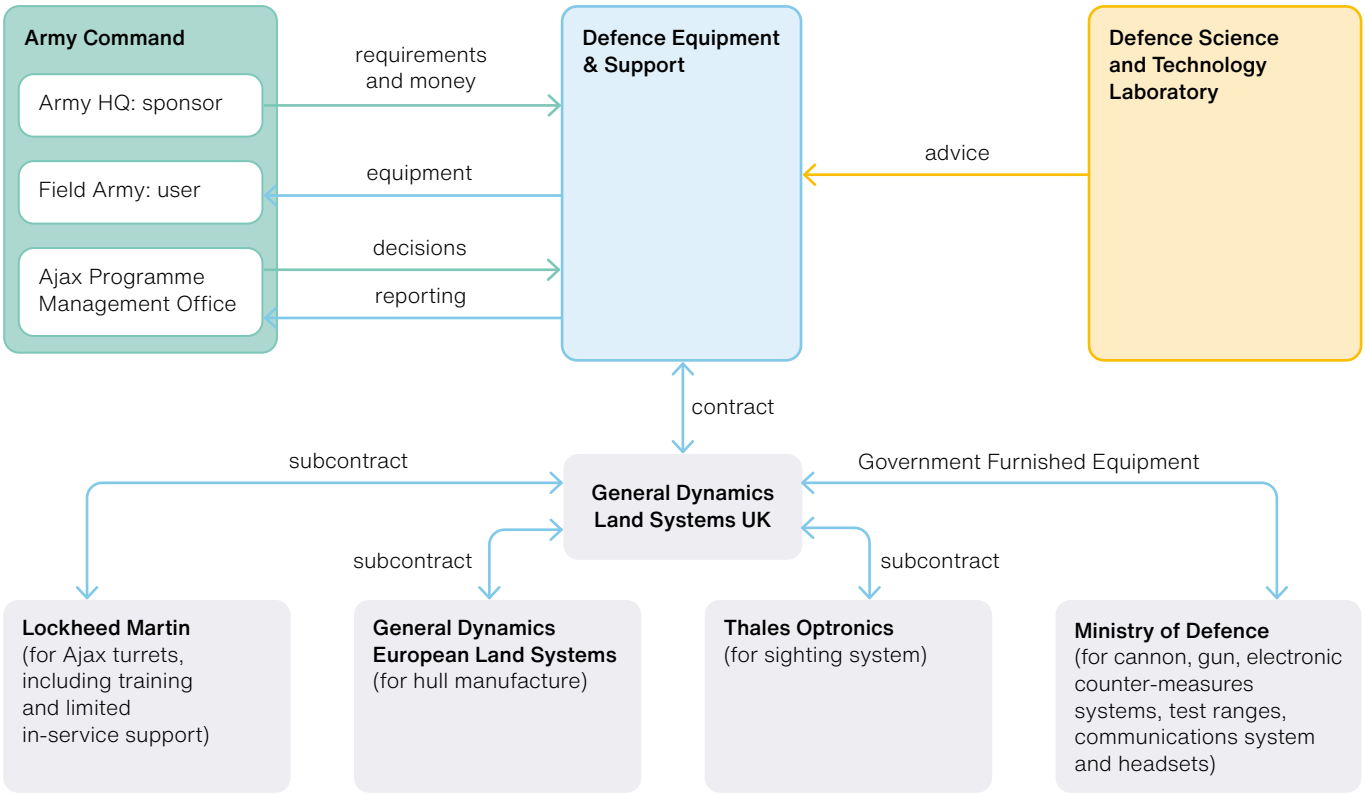
- the Army – sponsor and user of the vehicles;
- Defence Equipment & Support (DE&S) – negotiated and manages the contract with General Dynamics Land Systems UK (GDLS-UK);
- the Defence Science and Technology Laboratory (DSTL) – provides technical advice to DE&S;[16] and
- the supplier, GDLS-UK, and its subcontractors (**Figure 2**).

14 HM Government, *Global Britain in a competitive age: The Integrated Review of Security, Defence, Development and Foreign Policy,* CP 403, March 2021.
15 Army, *Future Soldier Guide*, November 2021. A brigade combat team is the Army's new self-sufficient tactical formation. The Deep Recce Strike brigade combat team is intended to combine reconnaissance with long-range firing capabilities.
16 DE&S also receives advice from other expert bodies such as the Defence Ordnance Safety Group.

Figure 2

Roles and responsibilities in the Ajax programme

Defence Equipment & Support manages the relationship with the prime contractor



Notes

1 The chart shows the main relationships between teams and organisations named in this report. The programme governance is in Figure 7.

2 The Ministry of Defence is responsible for procuring and supplying some components to General Dynamics Land Systems UK, including the cannon, purchased under a contract with CTA International and the communications system, purchased under a contract with General Dynamics Mission Systems.

Source: National Audit Office analysis of Ministry of Defence information

The programme history

1.7 The Department had been considering replacing its reconnaissance vehicles since 1992. After 18 years exploring different options, including a failed attempt to buy 3,700 medium-weight armoured vehicles, it approved the Ajax business case in 2010.[17] Following a competition, in July 2010 the Department awarded GDLS-UK a contract for the demonstration phase and provision of training systems. The Department supplied the cannon and ammunition, and the cannon's integration into the turret is managed through a separate contract between GDLS-UK and its subcontractor.[18] **Figure 3** sets out the key events since 2010.

1.8 The Department encountered delays early in the programme, with milestones missed throughout the demonstration phase, including:

- during 2012, GDLS-UK reported schedule slippage relating to the preliminary design review milestone. It needed an additional six months and other concessions from the Department before this was passed in December 2012;
- the first anchor milestone (a mine blast test) was delayed from November 2012 to July 2013.[19] However, GDLS-UK initially failed the test, resulting in further delay to the milestone; and
- in 2013, GDLS-UK presented a new schedule with further delays, largely due to problems with the technical specification of the cannon and its integration into the turret.

1.9 In September 2014, six months earlier than planned, the Department awarded GDLS-UK the contract for the manufacture and initial in-service support phase. It brought forward the investment approvals process because it saw an opportunity to exert commercial leverage as GDLS-UK had failed to achieve the anchor milestone in July 2013, which allowed the Department to threaten to invoke the default and termination clause in the contract. The Department believed that committing to manufacture in 2014 – with some overlap of demonstration and manufacture phases – would incentivise GDLS-UK to invest early in producing vehicles and, as a result, reduce the risk of not achieving programme milestones. It also wanted to secure stability for the programme prior to the 2015 Strategic Defence and Security Review.

17 We covered the early stages of the Department's efforts to replace its reconnaissance vehicles in Comptroller and Auditor General, *The cost-effective delivery of an armoured vehicle capability*, Session 2010–2012, HC 1029, National Audit Office, May 2011.

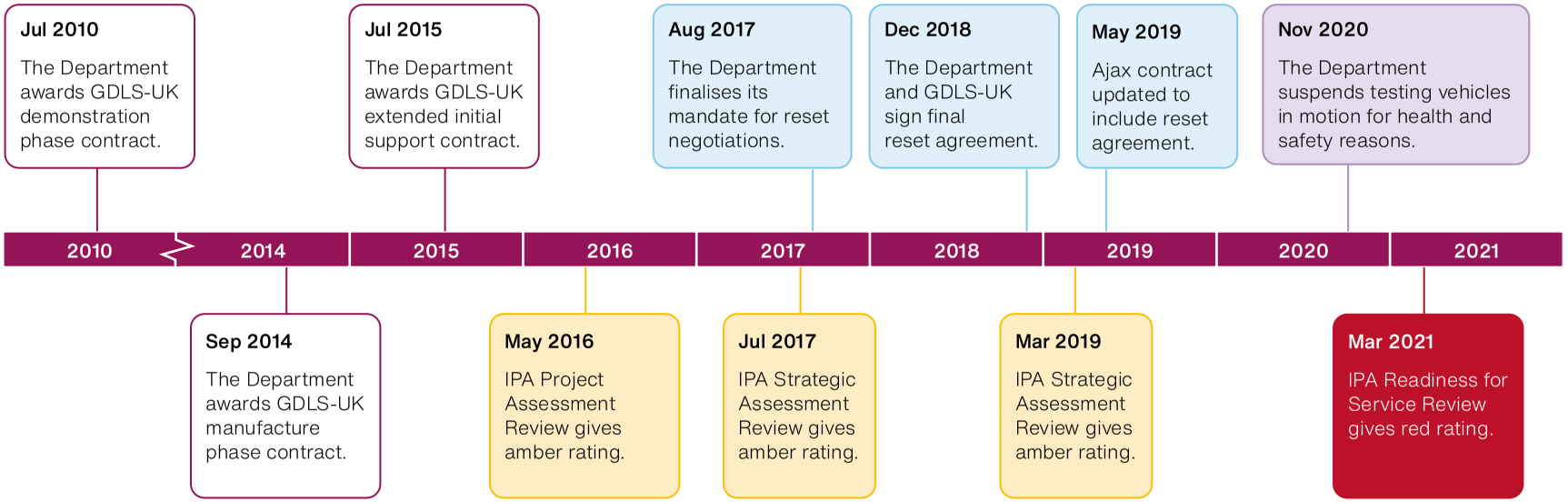
18 The Department planned to use the same cannon and same turret supplier for both the Ajax and Warrior programmes.

19 Anchor milestones are key points in the development of the programme. They are designed to give the Department leverage over its contractors' performance, and give it rights to recover payments or terminate the contract for underperformance. The contract originally included seven anchor milestones.

Figure 3

Key events on the Ajax programme, 2010 to 2021

The Ajax programme has a long history, with the Ministry of Defence (the Department) awarding the demonstration contract to General Dynamics Land Systems UK (GDLS-UK) in 2010



- Contracts for the Ajax programme
- Reset of the Ajax programme
- Infrastructure and Projects Authority (IPA) review amber rating
- IPA review red rating
- Testing suspended

Notes

1 Demonstration phase contract was for GDLS-UK to develop a common base platform for the six variants and training for the initial operating capability.

2 Manufacture phase contract was for GDLS-UK to manufacture 589 vehicles across six variants and provide initial in-service support until December 2016.

3 In 2015 the Department awarded GDLS-UK an extended initial support contract until December 2024.

Source: National Audit Office analysis of Ministry of Defence information

1.10 During negotiations for the 2014 contract, the Department agreed the number of vehicles to be supplied, a new delivery profile and a change to its expected in-service date from the first quarter of 2017 to July 2020, when it set its initial operating capability (IOC) date. In return, GDLS-UK agreed to £600 million of efficiency savings and offered a £125 million discount. GDLS-UK also agreed to convert the contract from a 'fixed' to 'firm' price. This transferred the risk of inflationary cost growth caused by any future delays from the Department to GDLS-UK at 2014 rates. To help achieve the programme's schedule, the Department agreed to a 40-month overlap of the programme's demonstration and manufacture stages.

1.11 In 2015, GDLS-UK submitted an unsolicited proposal to extend its initial in-service support contract by eight years. This proposal included establishing a facility in Merthyr Tydfil to assemble the vehicles and transferring programme knowledge from Spain, where the hulls were being manufactured.[20] The Department awarded this contract in July 2015, with an end date of December 2024.

1.12 Between 2014 and 2017, the programme encountered further delays and missed milestones. There were disputes between GDLS-UK and the Department over the management of commercial arrangements and the lack of progress in resolving design issues that were holding up delivery:

- GDLS-UK had made claims to delay programme milestones, asserting that the Department had caused delays because it had failed to provide enabling equipment in accordance with the contract, engage in contract change procedures and operate the contract in accordance with the technical flexibility built into it.
- The Department had made penalty claims against GDLS-UK, asserting it had delivered vehicles and training equipment late.

1.13 The Department and GDLS-UK therefore agreed to a contract reset to address the programme slippage caused by the difficulties of achieving the vehicles' design requirements. It also sought to address known significant technical issues. The Department's intention was to realign the contract schedule with the required work without increasing the cost of the contract or altering the IOC and full operating capability (FOC) dates.[21] Both parties agreed to release their claims for outstanding disputes when they signed the revised agreement in December 2018.

20 The 2014 contract provided that all 589 vehicles would be manufactured by General Dynamics European Land Systems, based in Spain. The 2015 contract amended this so that only the first 100 vehicles were assembled in Spain, the remainder in Merthyr Tydfil. The hulls continue to be manufactured in Spain, but they are then transported to Merthyr Tydfil where the vehicles are assembled.

21 The reset also sought to ensure GDLS-UK was paid at milestones and had commercial cover to undertake work, including passing that through its supply chain.

1.14 The Armoured Trials Development Unit first reported formally injuries to soldiers during entry qualification trials in July 2020, having raised concerns about vibration since late 2019. In response, DE&S issued a safety notice to reduce the time crews could spend in the vehicle. At that time, DE&S was awaiting a review by the Institute of Naval Medicine to measure noise and vibration levels. Nevertheless, the Army and DE&S signed off the safety case, produced by GDLS-UK working closely with parts of the Department, to allow training on the vehicles to commence (with safety restrictions in place).[22] The Department commissioned additional monitoring and found noise issues were not just limited to prototype vehicles. As a result, in November 2020, it banned any testing which involved the vehicles moving. Testing and trials recommenced under strict controls until June 2021 when the Army escalated concerns, and DE&S issued an urgent safety notice to stop all use of Ajax vehicles.

1.15 By December 2021, the Department had identified 310 personnel who may have suffered harm from being exposed to noise and vibration when testing Ajax vehicles. These individuals have received medical assessments and, where required, specialist outpatient care. Eleven individuals potentially need to limit their military duties because of noise exposure, four of whom did not have pre-existing hearing issues, although no causal link has yet been proven. No individuals have had their duties downgraded or been discharged due to vibration. We cover noise and vibration issues in detail in paragraphs 2.20 to 2.27 and set out a detailed chronology of events in Appendix Three.

Programme expenditure and what has been delivered so far

Funding

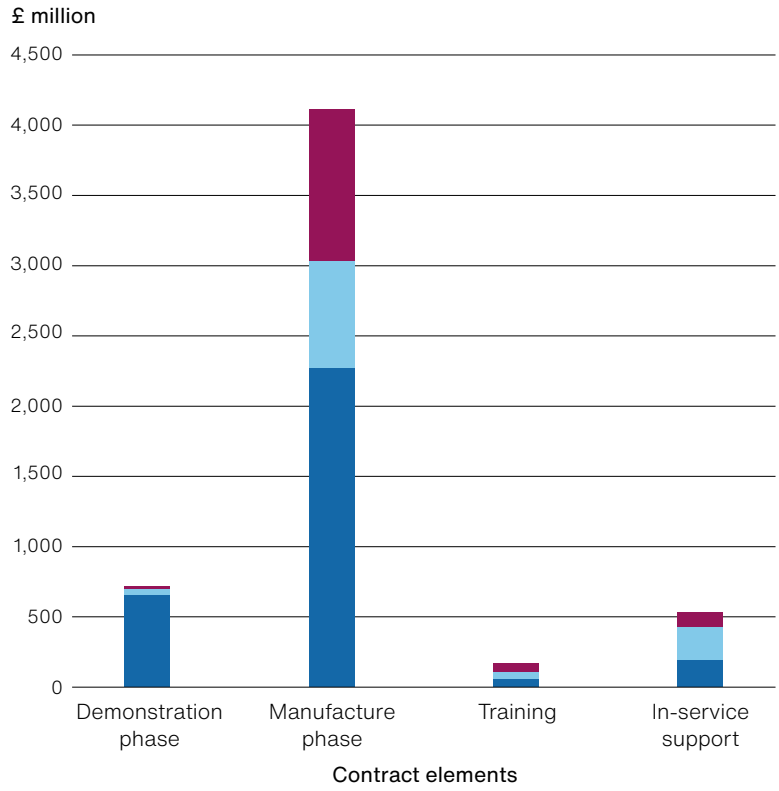
1.16 In 2014 the Department agreed to a £5.522 billion firm-priced contract with GDLS-UK to complete design work and manufacture 589 vehicles and provide training and initial in-service support (**Figure 4** overleaf). By December 2020, the Department had paid GDLS-UK £3.167 billion in accordance with contract milestones. The Department made no payments during 2021 and has said that it will not do so until GLDS-UK can implement a viable solution to remedy the noise and vibration issues. By December 2021, the total payment that would have been made, had GDLS-UK achieved all milestones, was £4.282 billion, £1.114 billion more than it has received.

22 We provide a more detailed description of roles and responsibilities in the Department's safety process in paragraph 2.25 and Figure 9.

Figure 4

Ministry of Defence's payments to General Dynamics on the Ajax programme, December 2021

At December 2021, the Ministry of Defence (the Department) had paid General Dynamics Land Systems UK £3.167 billion out of its £5.522 billion firm-priced contract



	Demonstration phase	Manufacture phase	Training	In-service support
Future payments for work from January 2022	16	1,062	60	102
Forecast spending to December 2021 that is unpaid	43	787	46	239
Paid up to December 2020	655	2,264	60	188

Notes

1 The Department has made no payments under the contract since December 2020 because of the noise and vibration issues which caused it to suspend trials of the vehicles.

2 All figures include Value Added Tax.

Source: National Audit Office analysis of Ministry of Defence data

1.17 By December 2021, GDLS-UK had:

- received £655 million for design and demonstration work;
- built 324 of the 589 hulls;
- assembled and completed factory acceptance testing of 143 vehicles at various capability drop standards (**Figure 5** overleaf explains the manufacturing process and levels of capability);[23] and
- retrofitted six capability drop 0 vehicles to drop 1 standard.

The Army had received 26 Ajax vehicles at drop 1 standard, intended only for training and familiarisation.[24] It was during these trials that reports of injuries from exposure to noise and vibration were first formally recorded. The Department will not accept any vehicles until it is satisfied that they are fit for purpose.

1.18 In addition, GDLS-UK has delivered:

- training courses and materials to the Army;
- 21 training systems for Ajax; and
- logistic support for vehicles, including spares.

1.19 The programme budget to the end of the manufacture phase is £6.354 billion, which includes £802 million for payments to contractors other than GDLS-UK. These costs are not in the main contract and are for goods and services such as weaponry, upgrading digital communications systems and conducting safety trials. By December 2021, the Department had paid £263 million to other contractors.

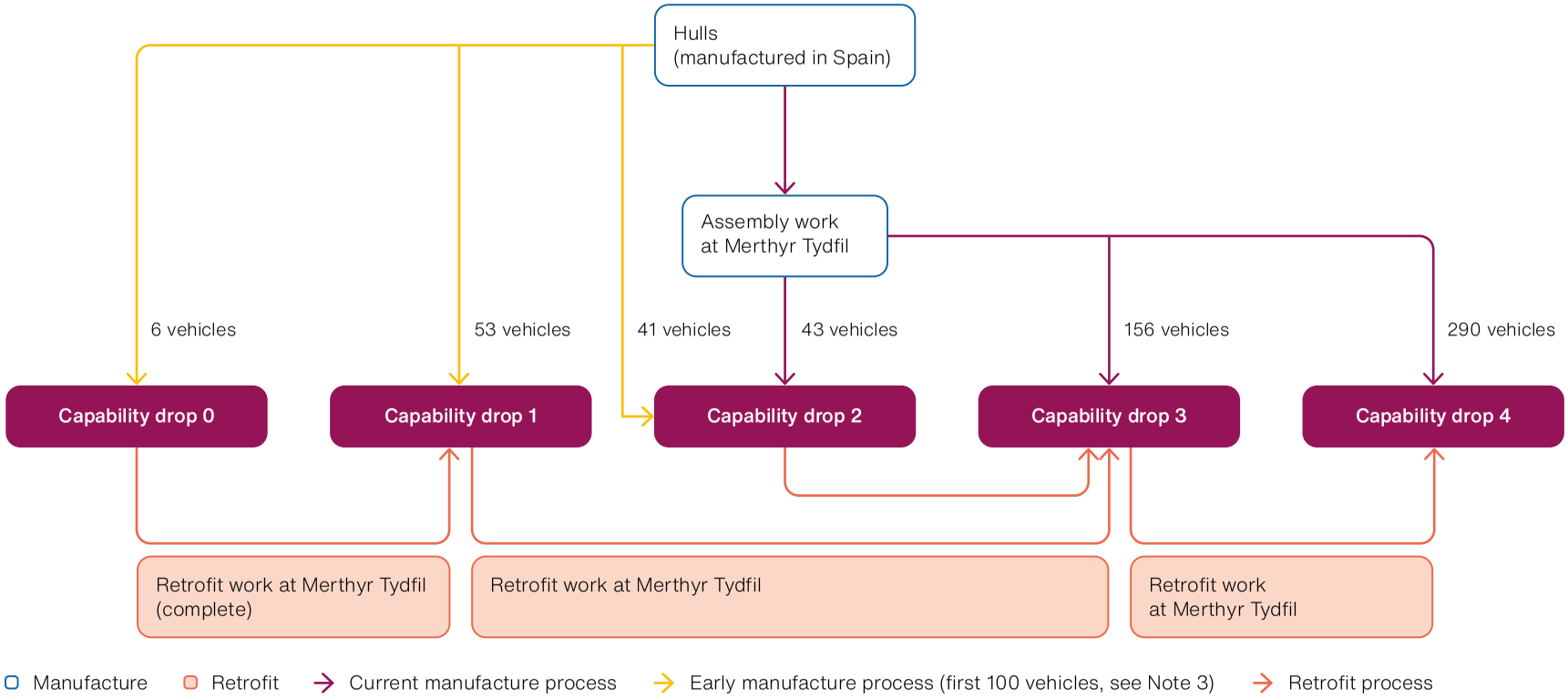
1.20 The whole-life cost of developing and using Ajax will include longer-term support, operating and enhancement costs. In 2020 the Army estimated that Ajax will cost more than £10 billion over its whole life cycle, including the £5.522 billion contract. However, future costs remain uncertain as the Army is still developing its understanding of future support costs, including the cost of spare parts.

23 This comprises six vehicles at drop 0 standard, 53 at drop 1 standard and 84 at drop 2 standard. Factory acceptance testing is completed by GDLS-UK before a vehicle is delivered to the Department. Once the Department has received a delivery, it undertakes general acceptance testing of each vehicle to confirm GDLS-UK's factory acceptance testing. The Department then randomly selects vehicles from a capability drop and undertakes batch testing against its capability requirements. The Department only accepts the vehicles once the batch testing has been successfully completed. The Department has not yet begun batch testing. If the results of the general acceptance or batch testing are unsatisfactory, the Department can request that GDLS-UK conducts all necessary analysis, modification and retesting required to successfully complete the test, at no additional cost to the Department.

24 The contract specifies that the Department owns all materials and components in the pipeline. However, it does not accept completed vehicles until they have passed the acceptance testing required under the contract (as outlined above), so that liability for correcting faults remains with GDLS-UK. GDLS-UK will need to retrofit those vehicles the Army has received to meet the final capability drop 4 standard.

Figure 5
How Ajax vehicles are manufactured

General Dynamics Land Systems UK manufactures the Ajax vehicles in stages, known as 'capability drops'



Notes

1 The main principle is to provide increasing compliance with system requirements and add new capabilities to the vehicle through successive capability drops and a retrofit programme. The definition of each capability drop is: Drop 0 – Trials vehicles used for early training design; Drop 1 – Initial production vehicles used for UK-based training; Drop 2 – Increment to maintain production; Drop 3 – Full compliance with contractual system requirements (except for reliability requirements); and Drop 4 – Full production standard incorporating final fixes identified by reliability trials.

2 Early production vehicles (Drop 0 – Drop 2) are not fully compliant with requirements or approved for operations but allow the Army to undertake training and experimentation. They will be retrofitted to bring them up to the final manufacture standard, "Capability drop 4".

3 The first 100 vehicles were manufactured and assembled in Spain. For subsequent vehicles, the hulls are made in Spain, but assembly work is undertaken in Merthyr Tydfil.

4 The figure shows the number of vehicles manufactured to each capability level, the first six to Capability Drop 0, the next 53 to Capability Drop 1. Subsequently 41 vehicles were manufactured to Capability Drop 2 in Spain, but the rest of the Capability Drop 2 vehicles were assembled at Merthyr Tydfil.

Source: National Audit Office analysis of Ministry of Defence data

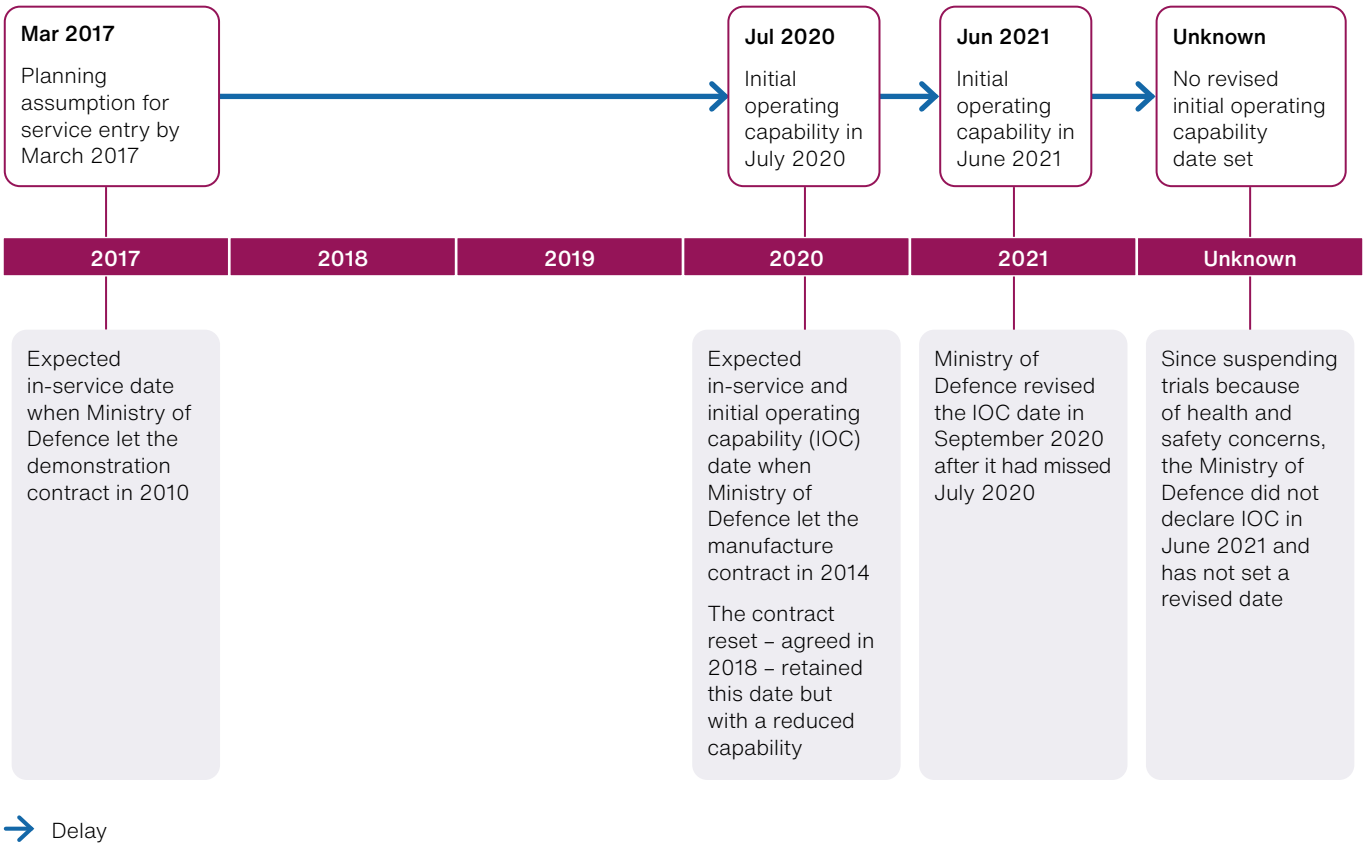
Schedule

1.21 The Department has already increased the expected in-service date by more than four years (**Figure 6**). The Department's initial planning assumption was that Ajax would enter service in the first quarter of 2017. In 2014, it replaced this assumption with a formal IOC date of July 2020. When that date was missed, the Department set June 2021 as its target but missed that because the trials were suspended. As of December 2021, the Department had not set a new IOC date. The FOC date remains April 2025, despite the Department having no confidence that it can achieve this.

Figure 6

Changes to the Department's expected in-service date for Ajax since 2010

The initial expected in-service date was 2017 but this has been pushed back repeatedly



Source: National Audit Office analysis of Ministry of Defence data

Part Two

Underlying causes of programme difficulties

2.1 This part sets out our analysis of why the Ministry of Defence (the Department) has encountered problems delivering the Ajax programme.

Requirements were highly specified

2.2 Rather than develop a new platform or upgrade an old one, following a competition in 2010, the Department decided to contract with General Dynamics Land Systems UK (GDLS-UK) to buy a modified version of an existing armoured vehicle. It expected this would provide value for money by reducing the risks associated with new designs and legacy vehicles. Our 2011 report highlighted that one of the reasons why previous programmes to purchase armoured vehicles have failed was the Department's unwillingness to compromise on demanding and unachievable sets of requirements.[25] Yet the Army set around 1,200 requirements for the Ajax programme, making it a bespoke design which was more complex than other armoured vehicles. GDLS-UK accepted the specification – including these requirements – when it agreed the contract.

2.3 The Department and GDLS-UK agreed the initial programme schedule without fully understanding Ajax's design requirements, including some components' specifications or how they would be integrated into the Ajax platform. For example:

- there were evolving technologies, such as the cannon which the Department procured separately. The cannon's design was technically immature when the Department awarded the Ajax manufacture contract in 2014. Its performance characteristics were not fully documented and the initial build standard was a prototype, leading to the need for subsequent design modifications;[26]
- the Department could not describe the characteristics of some systems until design work was completed, which led to revisions;

25 The Family of Light Armoured Vehicles programme in the 1980s, the Tactical Reconnaissance Armoured Combat Equipment Requirement programme (TRACER) from 1992-2001, the Multi-Role Armoured Vehicle programme (MRAV) from 1998-2003, the Future Rapid Effect System – Utility Vehicle from 2004-2008.

26 This meant that the Department was customer for the whole vehicle and supplier of the cannon to GDLS-UK's subcontractor Lockheed Martin.

- GDLS-UK stated that some requirements were contradictory when considered at system level, and trade-offs were needed to achieve a balanced design. This challenge is common to the development of many complex systems and was envisaged in the contract. However, the programme encountered delays while the Department approved design changes to integrate technologies into the overall vehicle design; and
- there were disagreements between the Department and GDLS-UK on the interpretation of scope definitions, dependencies and acceptance criteria set out in the contract.

2.4 As requirements were not sufficiently understood, there was a high volume of changes to the design specification. GDLS-UK told us that acceptance criteria and standards were not fully defined and subject to change, leading to subjective interpretation. This led to disputes, with GDLS-UK claiming that the Department had not engaged with contract change procedures or operated the contract in accordance with the technical flexibility built into it. The length of time involved in agreeing design changes and resolving disputes resulted in programme delays. For example, the Department supplied the cannon later than planned and at a different configuration to the contract documents, resulting in substantial redesign and delays of around 18 months. By 2017, several disputes remained unresolved and led to the Department and GDLS-UK resetting the contract (paragraphs 2.15 to 2.19).

Inadequate programme resources

2.5 The Army's policy of regularly rotating posts means that the programme has had a high turnover of senior personnel, with five senior responsible owners (SROs) since November 2011, and four programme directors and six project managers since September 2013. Defence Equipment & Support (DE&S) replaced the programme manager who had negotiated the reset immediately after the contract was updated in May 2019, affecting the programme's corporate knowledge. It also replaced other senior programme personnel after the new director general was appointed in December 2019.

2.6 Some senior roles were not full-time before 2021:[27]

- The SRO was initially allocated to the programme for 10% of his time, which increased to 30% in 2018. Previous SROs were also SRO for the Boxer and Challenger programmes at the same time as Ajax. The SRO appointed in October 2021 was the first to be full-time on the programme.
- The programme director role was made full-time in April 2021. Until then, the time allocation had been between 10% and 80%.

2.7 The programme management office, which supports the SRO, has remained small for a programme of this scale and complexity. In 2016, six of the eight posts were vacant, and the Department rated the programme's skills and capabilities as Amber/Red. By April 2019, it had filled these vacancies to manage the contract renegotiation in 2018, but then reduced resources – at a time when the programme was missing milestones. In July 2020, the programme management office had dropped to four posts and the SRO amended the programme's capabilities rating from Amber/Green to Amber/Red. The Infrastructure and Projects Authority (IPA) raised concerns about the small size of programme team in both 2017 and 2021.

2.8 The Department and GDLS-UK faced considerable challenges in building their programme teams. Ajax was the first major procurement of an armoured vehicle for 20 years. The Department did not have a land industrial strategy – in contrast to shipbuilding, combat air and complex weapons – which it acknowledges has presented both itself and industry with a variety of investment, affordability and delivery challenges. Since 2014, GDLS-UK has built up production sites in Merthyr Tydfil and Oakdale, where it now employs 800 personnel engaged in design, testing and manufacture. It has also developed a supply chain of more than 230 UK-based suppliers.[28] Both the Department and GDLS-UK found it difficult to recruit personnel with the required technical and programme management skills, which impacted on the experience of programme personnel. In particular, in 2019, DE&S did not have enough qualified staff to sign off safety cases and clearance processes for Army crews to operate the vehicles.

27 The programme manager role has been full-time since April 2016.

28 The Department announced it had placed the contract for 589 vehicles, saying it would secure engineering jobs across the UK, on the eve of a NATO summit held in Newport, Wales, in September 2014. UK-based suppliers also provide around 3,300 jobs. Ministry of Defence, *UK jobs secured by £3.5 billion contract for new fighting vehicle*, press release, 3 September 2014. Available at: www.gov.uk/government/news/uk-jobs-secured-by-35-billion-contract-for-new-fighting-vehicle.

Ineffective governance arrangements

2.9 The governance arrangements, introduced in 2016, mean that the programme has no single point of authority and control **(Figure 7** overleaf):

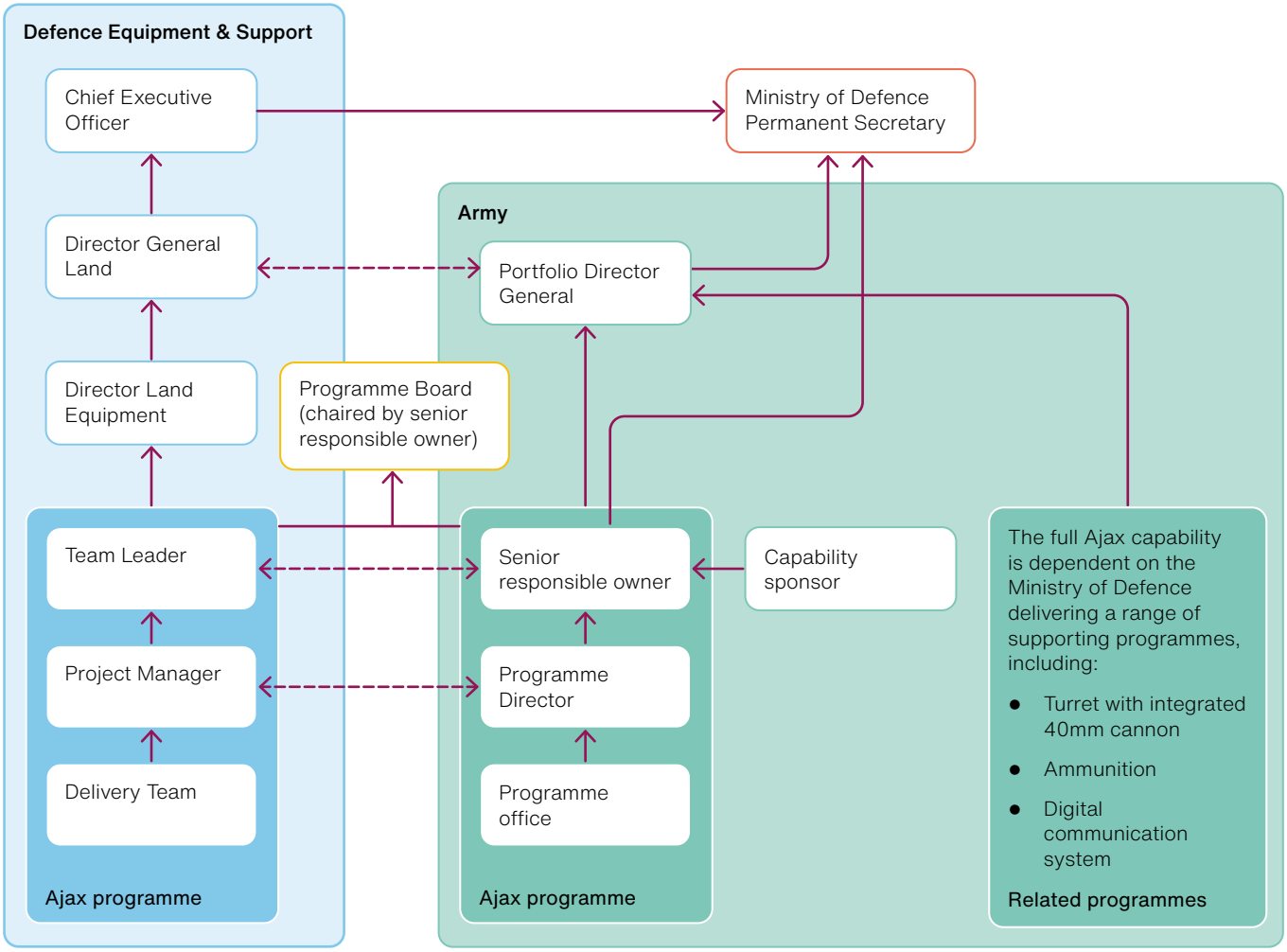
- Despite being accountable for delivering the capability requirements, the SRO and programme director do not direct and oversee all delivery activities across the programme, as happens in other departments.
- The Army is the programme sponsor and manages the board, but is not involved in some decisions, including authorisation to make payments and changes to the DE&S programme team once the contract had been reset. DE&S liaises with the Army regarding this programme, but it reports directly to the Department's head office.
- Complex assurance and approval processes created delays. Initially, the programme had insufficient formal mechanisms to request support from other parts of the Department or establish accountability for the delivery of requests.

2.10 Until recently, the programme board has not played its proper role in overseeing and directing the programme. In 2016, the IPA concluded that the board was an "information share and update forum". We found that before 2021, board papers were basic and minutes of meetings cursory. For example, reset negotiations concluded in December 2018 but the programme board did not meet between September 2018 and February 2019. Actions from meetings were not followed up, nor progress updated. In September 2020 – when DE&S had already commissioned the Institute of Naval Medicine to investigate concerns about noise and vibration issues – the board did not discuss this issue and was told that the programme was at an "exciting stage", at which safety cases for two variants had been approved, with vehicles expected to be fielded by the Army within eight months.

2.11 Programme risks were not managed effectively or escalated in a timely manner, if at all. In October 2020, DE&S identified there was collective optimism bias and denial across the programme. Board papers typically included around five high-level risks, with little evidence of the board discussing or managing these. In addition, risk management did not remain up to date during the reset due to the demand on resources within the programme management office.

Figure 7
Ajax programme governance since 2016

The programme's governance arrangements have multiple components



Source: National Audit Office analysis of Ministry of Defence data

Over-optimism in the programme schedule

2.12 The Department and GDLS-UK under-estimated the scale of work and technical complexity of the Ajax programme at the outset. Under the contract, GDLS-UK was responsible for assessing what was achievable by when and agreed these milestones with the Department. However, the Department and GDLS-UK signed the manufacture contract in 2014 before the critical design review was conducted, meaning that they did not fully understand the scope, interdependencies and sequencing of work. The critical design review failed in March 2015, then passed in July 2015 with more than 60 technical issues outstanding, of which 15 were critical. Many of these issues were unresolved when the Department and GDLS-UK reset the programme in 2018. We have previously found that the Department declares key project milestones as achieved without the intended capability always being met at that point.[29]

2.13 Under the contract, GDLS-UK must present the Department with evidence on the vehicles' compliance with 1,200 capability requirements. The scale of this work and the challenges involved in generating the technical documentation and safety evidence required to operate the vehicles was greater than GDLS-UK initially expected, due to disagreements with the Department on the definition of acceptance criteria:

- GDLS-UK provides technical documentation prior to the Army training on the vehicles. The Army has reported inconsistencies between the documents and the vehicles, leading to uncertainty on maintenance requirements. Delays to the availability of accurate documentation restricted users' ability to train on the vehicles.
- Safety evidence took longer than anticipated to sign off. The Department repeatedly found GDLS-UK's safety documentation insufficient, which required additional work to demonstrate it was meeting safety standards. The Department told us that this was because GDLS-UK did not understand the volume and quality of safety documentation it expected to meet its standards, and that GDLS-UK did not allow enough time to generate sufficient evidence. GDLS-UK disagrees, saying it understood the requirements but that the Department wanted additional evidence and that repeated changes to its safety staff resulted in inconsistency and delays signing off documentation.

29 Comptroller and Auditor General, *Defence capabilities – delivering what was promised*, Session 2019–2021, HC 106, National Audit Office, March 2020.

2.14 GDLS-UK also encountered technical problems during testing, which required additional time to resolve. GDLS-UK told us that the problems were exacerbated by the Department's use of expert advisers leading to changes in the level of evidence it was required to provide to meet acceptance criteria. The programme schedule did not contain sufficient contingency to address these issues and undertake the necessary re-work. Despite undertaking activities in parallel, the programme schedule was over-optimistic, and the delays resulted in a four-year slip in the demonstration phase.

The contract reset did not address underlying programme problems

2.15 The Department expected to conclude negotiations to reset the contract in October 2017, but these took 15 months instead of two, with the legally binding agreement signed in December 2018. The Department then took until May 2019 to amend the contract because it underestimated the scale of translating the agreement's high-level principles into it. Many of the difficult issues were 'parked' to maintain momentum and business-as-usual activity became increasingly difficult.

2.16 The Department achieved its main objective from the reset as there was no change to the requirement to deliver 589 vehicles for the agreed contract price. It agreed new programme milestones and a revised technical baseline which reflected changes in the requirement, most notably an updated build standard for the cannon and integration of a newer battlefield communication system.[30] However, the reset involved compromises as the Army chose to prioritise time and cost over performance:

- The Army agreed 28 change requirements to redefine initial operating capability (IOC) based on what could be achieved by July 2020. This meant the vehicles would have some technical constraints, most notably on their weapon system and armour, compared with the original requirements set in 2014.[31]
- The Department agreed to offset costs of up to £48 million by GDLS-UK providing service credits to be used for other work on the programme.
- Under a 50:50 gainshare arrangement – up to £72 million – GDLS-UK could use its share to offset its costs whereas the Department's share would generate an equivalent amount of additional service credits.

30 The latest version of Bowman (BCIP 5.6).
31 After the reset, the Department did not expect to achieve all the original IOC requirements until September 2021.

2.17 The changes made during the contract reset increased the programme's delivery risks. The Department agreed that GDLS-UK would deliver the vehicles in 'capability drops', with each drop adding capabilities.[32] It agreed this to allow the Army to begin to understand the new capability and develop tactics and procedures, as well as maintain the target dates for IOC and full operating capability by enabling the demonstration and manufacture phases to proceed in tandem. However, the introduction of four capability drops across six variants increased the interface, dependencies and hand-offs between DE&S and GDLS-UK. It also made the programme schedule more complex, with vehicles from early capability drops having to be upgraded. The multiple build standards introduced by this approach also made achieving safety cases more complex. For example, the contract required GDLS-UK to provide completely new safety cases for each drop and, as a result, safety cases took longer than GDLS-UK had planned. The level of evidence provided by GDLS-UK was significantly less than that required by the Department.

2.18 The Department and GDLS-UK continued to underestimate the complexity of work after reset and progress was slower than expected. By January 2020, GDLS-UK had missed all its first 11 revised milestones. In December 2021, of the 36 critical milestones that were due, 18 were outstanding, 10 of which were more than six months late. We found that the problems that existed prior to reset had continued:

- Schedule assumptions were still over-optimistic. Shortly after reset GDLS-UK was working with multiple incoherent schedules: it had yet to agree a combined plan with DE&S and the scale of uncertainty and complexity associated with safety cases was not fully understood.
- The Department still had inadequate resources to deal with safety cases, with no contingency in the schedule to accommodate delays.
- Technical issues remained. Additional recovery work was needed to resolve the technical issues which had been outstanding going into reset (paragraph 2.12).
- Issues with the cannon's fire control panel delayed delivery of the turreted variant. GDLS-UK has designed an interim measure, which will be used until a permanent solution is available.

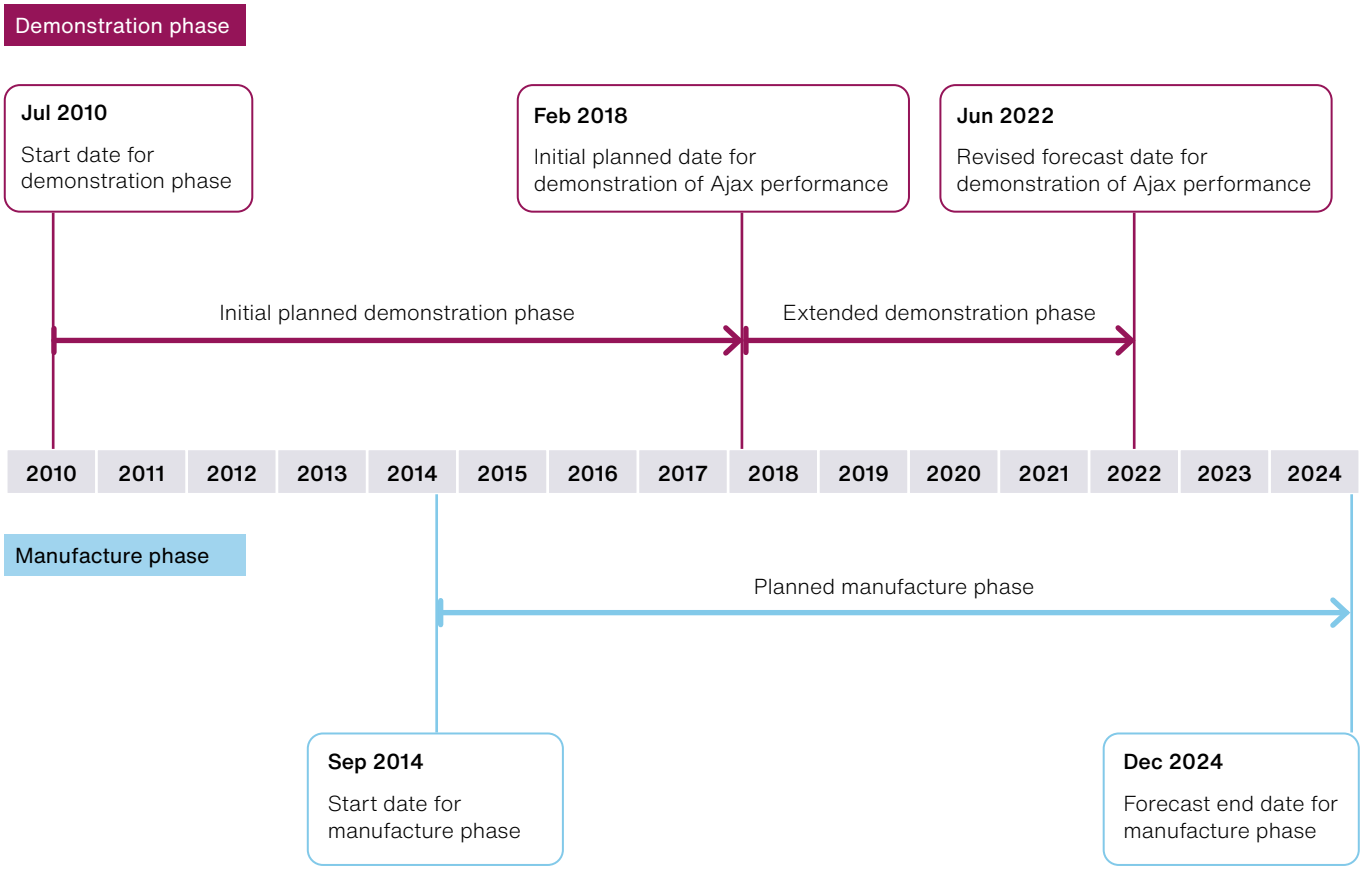
2.19 The problems led to the overlap in demonstration and manufacture phases increasing by more than four years, with the 'demonstration of performance' milestone now forecast for June 2022 instead of February 2018 (**Figure 8** overleaf). This made addressing design issues more complex and added risk because of the need to manage complex delivery and retrofitting schedules. It also increased demands on teams in DE&S, where technical experts were stretched across different stages of the design and production phases at the same time.

32 Early drops provide vehicles to the Army suitable for training and experimentation and then new capabilities are added to vehicles through a retrofit programme. Drop 4 will be the final build standard after trials. To ensure vehicles from Drop 0 through to Drop 3 are brought up to the same capability, particularly the earlier drops, the programme includes a schedule of retrofitting to bring each vehicle within each drop up to the same, final capability, that of Drop 4. The management of this programme of work will require significant configuration management and close attention to ensure the correct vehicle is upgraded to the correct specification at the right time, that it is available to be upgraded and that each vehicle is managed until all retrofits have been completed.

Figure 8

Overlap between the demonstration and manufacture phases

The demonstration phase has slipped by four years, increasing the overlap with the manufacture stage to seven years and nine months



Notes

1 Demonstration phase contract was for General Dynamics Land Systems UK (GDLS-UK) to develop a common base platform for the six variants and training for the initial operating capability.

2 Manufacture phase contract was for GDLS-UK to manufacture 589 vehicles across six variants and provide initial in-service support.

Source: National Audit Office analysis of Ministry of Defence data

Technical and safety issues remain unresolved

Noise and vibration

2.20 Managing noise and vibration is a fundamental element of armoured vehicle design. The Department set the contractual requirements, which were accepted by GDLS-UK, and has long been aware of the risks.[33] In September 2014, the Defence Science and Technology Laboratory (DSTL) warned of potential non-compliance with health and safety regulations. It raised issues with noise and vibration, along with other risks, on several occasions during testing of the vehicles' design. In December 2018, DE&S issued a safety notice, following reports of crew motion sickness during trials of prototype vehicles. This limited the length of time the crew could spend in the vehicles, stating that a longer-term design solution was needed for vibration. In January 2020, DSTL again warned that crew members could be exposed to excessive levels of noise and vibration on early production vehicles. In March 2020, the Department placed restrictions on how Ajax vehicles could be used during trials before they were paused that month due to the COVID-19 pandemic (Appendix Three).

2.21 The Department resumed trials in June 2020 but banned the use of Ajax vehicles in motion from November 2020, when DE&S also required crews to use ear defenders rather than headsets when moving Ajax vehicles. GDLS-UK crews use ear defenders, and it states that they have not reported comparable noise injuries.[34] GDLS-UK asserts that noise levels in Ajax are similar to other in-service armoured fighting vehicles, hearing protection provided by the Army is insufficient and Army crews did not follow correct safety procedures during trials. The Department disagrees.

2.22 The Army has known about problems with its headsets when used in some operational armoured vehicles since at least 2019. A review then, which excluded Ajax crews and was based on responses from 46 personnel, found that two-thirds of soldiers reported headaches and half reported tinnitus after using them on firing operations. The review recommended that future headsets should be individually issued, fit-tested, well-maintained and regularly checked. Army crews continued to use these headsets, including on Ajax vehicles, from October 2019.[35] In May 2021, DSTL advised the Army to further limit use of its headsets. The Army subsequently issued safety notices restricting the time that soldiers could spend on any operational armoured vehicle while wearing these headsets. These restrictions are regularly reviewed and have since been eased, but not totally removed.

33 The requirements were: acceptable levels of acoustic detection from outside the vehicles (as Ajax will be used for reconnaissance); health and safety at work regulations for safe levels of noise and vibration inside the vehicles; the level of vibration transmitted to the crew should not detrimentally affect their ability to complete their tasks; and suspension to ensure the driver's position does not move excessively.

34 In 2014, GDLS-UK issued safety notices that referred to noise and vibration and required all users to have adequate personal protective equipment, including hearing protection.

35 The Army requires crew members to wear headsets for hearing protection and communication. It issued safety notices to ensure only serviceable headsets were used.

2.23 The Department and GDLS-UK have disputed whether the data on noise and vibration levels have breached contractual requirements, with GDLS-UK claiming that the vehicles were safe to operate with appropriate protective equipment. In March 2021, the Department, therefore, commissioned independent testing to benchmark the crew's exposure to noise and vibration against the safe levels, as determined by health and safety legislation. However, the testing has not yet considered:

- variability of vehicles: there will be at least 19 different build standards, before variability in the build quality of individual vehicles is considered.[36] At December 2021, only the two variants the Army had received were tested (two vehicles for each variant);
- operational scenarios: testing was undertaken in the 'head out' position partly because the Department did not know the extent to which the communications system and headsets contribute to noise issues;[37] and
- root cause of the issues, nor potential solutions: GDLS-UK still needs to verify the data, determine the causes and agree potential design changes with the Department. While waiting for the results, GDLS-UK commissioned its own independent testing.

2.24 The Army, DE&S and GDLS-UK have set up a joint team to identify the root cause and find a technical solution. They identified that noise and vibration issues are caused by the track, suspension and running gear; the engine and its mounting in the vehicle; quality issues;[38] and the performance and integration of headsets used by crews. GDLS-UK has been developing engineering solutions, but it is not yet clear whether its proposed mitigations – such as additional vibration damping and hearing protection – will be acceptable to the Department. DE&S has commissioned further independent testing to check the efficacy of proposed modifications, with results expected in April 2022. These will compare the performance of four vehicle variants against the baseline established by the first tests. In the meantime, the Army has paused training, and the Department does not expect to agree solutions and begin to implement changes until late 2022.

36 This includes one variant at Capability drop 0, and six variants at Capability drops 1, 3 and 4. Capability drop 2 vehicles are no longer planned for release to the Army.
37 Head out means operating with hatches open.
38 These include including bolting, cable routing and welding.

The Department's safety process

2.25 Responsibility for safety is shared across the Department and contractors. The Army has three 'duty holders' on the Ajax programme, who are responsible for mitigating safety risks to as low a level as is reasonably practicable, with the Chief of the General Staff having ultimate responsibility.[39] GDLS-UK must ensure, verify and demonstrate that the equipment it provides is safe by design, including meeting contractual requirements. It prepares safety cases for each variant, working closely with DE&S and the Joint Safety and Environmental Panel.[40] DE&S is responsible for assuring the Army's duty holders that the equipment is safe to use, signing safety cases once it is satisfied with the evidence provided by GDLS-UK (**Figure 9** on page 39).

2.26 We found weaknesses in the Department's management of its safety process:

- **Unclear responsibility and limited authority to fulfil safety roles.** The Army and DE&S were responsible for different elements of the safety process but were not able to illustrate how they worked effectively together or with DSTL. DSTL advises DE&S on safety and technical issues but has no authority to ensure its recommendations are followed. There was also a high turnover of safety officers, with three people in DE&S holding responsibility for Ajax safety since 2018. The lack of clarity for managing safety risks, and a lack of resources, meant the Department was slow to identify and respond to concerns identified during trials and to assess the impact on crew members.

- **Failures to escalate safety concerns.** The Army did not escalate the warnings from safety trials, including the risk to crews, via the formal safety reporting process. The officer responsible for safety and the SRO were first told of the issues in September 2020, after soldiers had begun formally reporting injuries. Similarly, DE&S did not pass on to the Army the concerns raised by DSTL. The minister for defence procurement received updates on the Ajax programme throughout 2020 but these did not mention noise and vibration issues until November 2020, after his appearance at the House of Commons Defence Committee. Soon afterwards, the Army suspended testing of Ajax vehicles. Quarterly reporting by the SRO first mentioned a "technical issue" in January 2021 and did not set out the noise and vibration problems until March 2021.

39 The Chief of General Staff delegates safety management to his deputy, who holds the role of safety champion.
40 A safety case is a structured argument, supported by a body of evidence, that provides a compelling, comprehensible and valid case that a system is safe for a given application in a given operating environment.

- **Reliance on estimates of noise and vibration levels.** The Department relied on a noise and vibration calculator provided by GDLS-UK to predict the level of exposure by different crew members in Ajax vehicles. In January 2020, DSTL raised concerns that the calculator underestimated the levels of noise and vibration.[41] DSTL identified that safety limits had been exceeded during trials and recommended that instruments be fitted on the vehicles to measure actual noise and vibration levels. The trials continued in March 2020 but the national lockdown due to the COVID-19 pandemic affected the ability to run trials and GDLS-UK still had not fitted instruments by the end of May. The Army was aware of the uncertainty over noise levels and the potential impact on crews, and imposed limitations of use designed to protect crews and enable trials to be conducted. The first instance of soldiers reporting vibration symptoms was in July 2020 and noise-induced hearing loss symptoms in August 2020. In September 2020, DSTL discovered an error in GDLS-UK's measurements which meant vehicle crews may have been over-exposed to noise and vibration and that previous trials may need to be re-evaluated. The Department and GDLS-UK disagree on the suitability and completeness of the underlying data.[42]

- **Complex arrangements for safety cases.** The Department's process for confirming Ajax vehicles are safe to operate is complex (Figure 9). The introduction of capability drops (paragraph 2.17) meant that the Department was performing multiple safety cases on vehicles at different stages of maturity. This led to safety cases being signed off before noise and vibration issues were resolved and training was undertaken while the vehicles were still undergoing trials. For example, a Part 3 safety case – determining that vehicles were 'safe to operate' with some limitations of use – was signed off by the Department in August 2020 to allow soldiers to train on the vehicles, despite reports of injuries from July 2020 onwards.

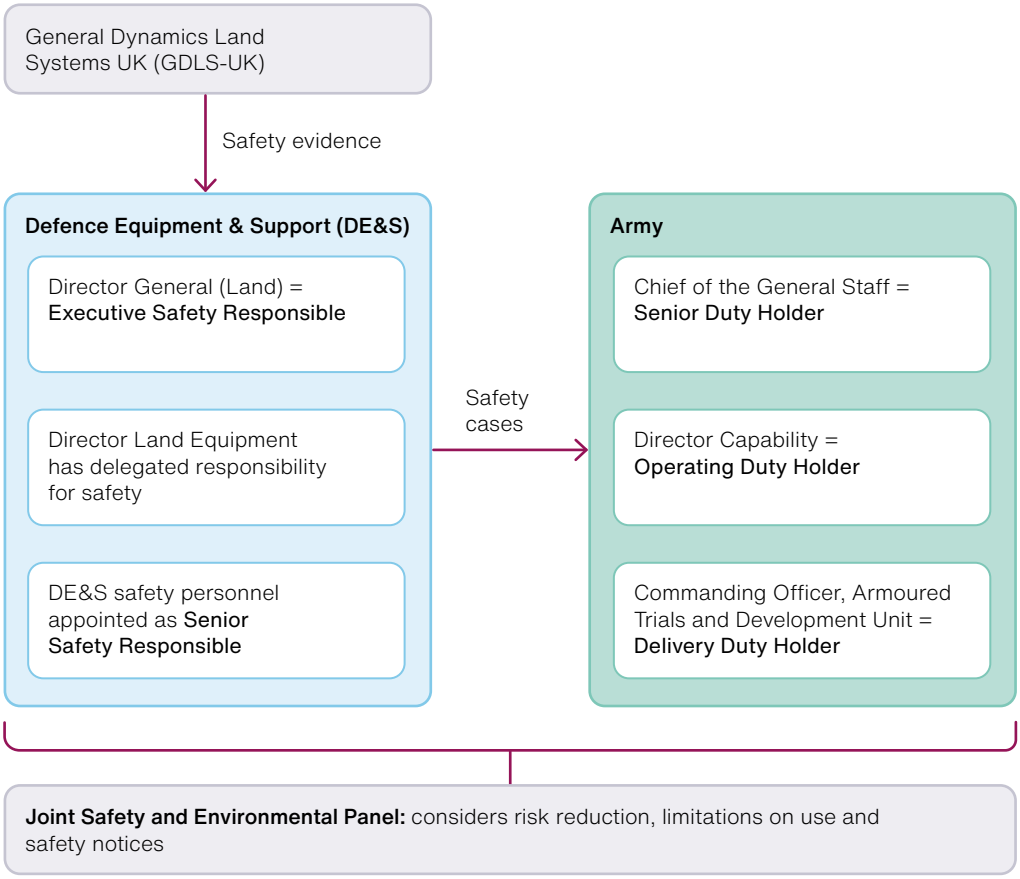
- **Insufficient focus on ensuring safety standards are met**. The Army's focus was on progressing the programme. Where possible, it imposed limitations of use to allow trials to continue, based on technical evidence from GDLS-UK. The Department has since found that these limitations were insufficient and that trials should have been stopped earlier. The contract incentivised GDLS-UK to achieve production milestones resulting in it continuing to manufacture vehicles while technical issues remained unresolved.

41 The calculator was used to estimate the maximum safe exposure time on Ajax vehicles for given conditions, such as speed and terrain. GDLS-UK developed this calculator based on its own measurements from early trials. The risks of exposure were initially managed using the calculator.

42 The Department questions the accuracy of the underlying data in the calculator, while GLDS-UK claims it is because the Army's headsets do not provide the level of attenuation assumed by the calculator.

Figure 9
Safety governance for Ajax programme

Responsibility for safety is shared between the Ministry of Defence and its contractors



Notes

1 General Dynamics Land Systems UK (GDLS-UK) is responsible for providing and demonstrating that Ajax equipment is safe by design. It prepares the safety cases for each variant, working closely with DE&S and the Joint Safety and Environmental Panel. DE&S signs a safety case once it is satisfied with the documentation.

2 DE&S must assure Army that the equipment is safe, providing evidence in safety cases. For each variant and capability drop, there are three safety cases:

- **Part 1:** safety capability requirements.
- **Part 2:** 'safe by design', signed by GDLS-UK and DE&S, to allow trials to take place, supported by safety advice for each individual activity.
- **Part 3:** 'safe to operate', signed by DE&S to confirm the equipment is safe by design and by the Army to confirm they will operate it safely.

3 The Joint Safety and Environmental Panel considers whether risks have been reduced to as low as reasonably practicable. It also decides on limitations of use and safety notices for Ajax.

4 Prior to acceptance into service, GDLS-UK and DE&S test each Ajax vehicle, with support from the Defence Science and Technology Laboratory (DSTL). The Army's specialist trials unit undertakes further trials on a small number of vehicles to check they meet the Army's requirements, to qualify them for entry into service and test their reliability.

Source: National Audit Office review of Ministry of Defence information

2.27 In June 2021, the Department's Permanent Under Secretary commissioned a safety review to understand the timeline of events and assess whether health and safety procedures were followed. The report, published in December 2021, concluded that collective failings enabled activity to continue when it should have been stopped or paused until stronger controls were in place. The report made 20 recommendations to improve the approach to safety. A further review, led by a senior legal figure, will examine the "significant cultural failings" and whether there is any evidence of gross misconduct. GDLS-UK has written to the Department as it disputes the report's findings. It told us it had little input into the review and was not given the opportunity to comment on the report prior to publication.

Other technical issues

2.28 On a programme of this size and complexity, resolving design issues is a core part of programme management. The Department is managing a range of issues identified during trials and testing, for example:

- by December 2021, Ajax vehicles were restricted by 27 'limitations of use', of which 22 related to safety and 11 were critical to achieving IOC. It is normal for the Department to impose limitations of use as it develops new capabilities and address these as the programme proceeds. Limitations included no 'enclosed' operation of the vehicle, no night driving, no heavy items to be stored on the roof, no discharging of weapon systems other than the cannon and no stowage or carriage of munitions.[43] DE&S expects to gradually remove these limitations of use for subsequent capability drops, but the delays to trials have prevented planned progress in addressing these limitations; and
- in October 2021, the Department was tracking 136 open concerns raised by DSTL, only four of which related to noise and vibration. These vary from component weaknesses to variability between vehicles and software problems. GDLS-UK told us that it was unaware of DSTL's concerns as it progressed work on vehicle design.

43 Enclosed means operating with the vehicles' hatches down.

Part Three

Challenges facing the Department

3.1 This part sets out the main challenges facing the Ministry of Defence (the Department) on the programme and how it is addressing these, drawing on good practice identified from our wider work.[44]

The programme schedule

3.2 By December 2021, General Dynamics Land Systems UK (GDLS-UK) had built 143 Ajax vehicles at 'production standard' and delivered 26 vehicles to the Army. However, the programme was a year behind the schedule set in 2019 and 61 vehicles behind the production target. While the Department adjusted the schedule by 10 weeks to allow for the impact of the COVID-19 pandemic, it has continued to encounter significant delays, which are impacting the programme's critical path:

- the noise and vibration problems have resulted in the Army stopping reliability trials, which are critical to future progress;
- the Army is not taking delivery of any more Ajax vehicles until it can confirm that the vehicles are safe to operate;
- the Department has withheld payments until a viable remedy to the noise and vibration issues has been agreed; and
- there is no time to validate the design of Capability Drops 3 and 4 before manufacture, increasing the likelihood of any further technical issues having a disproportionate impact.

3.3 The Department and GDLS-UK recognise that they face significant challenges in delivering the programme as planned. In July 2021, the Department noted that GDLS-UK's schedule to full operating capability (FOC) was "very optimistic". The Department is assessing how the programme can be recovered through mechanisms agreed in the contract. In doing so, the Department will need to agree any changes with GDLS-UK. The programme team does not expect to be able to seek internal approval for any changes, such as a revised programme schedule, until late 2022, when it will have a better understanding of the steps needed to resolve noise and vibration issues. It will not set a revised initial operating capability (IOC) date until these issues are resolved.

44 National Audit Office, *Framework to review programmes*, April 2021.

3.4 Lessons from our wider work have highlighted that resetting a programme does not automatically mean issues will be solved, as was illustrated with the 2018 reset of this programme. We have seen how organisations need to be clear on the underlying issues that they are seeking to address and have the right information and insights to understand what went wrong. Our work also highlights the importance of establishing a realistic programme schedule which identifies the critical path, ensuring senior executive capacity and an understanding of the revised costs.

Appropriate governance and resources

3.5 We have previously highlighted that government programmes need governance structures which provide effective oversight, challenge and direction. Programmes also require leadership with the necessary authority and influence.[45] We found that the Department has sought to address governance shortcomings:

- Following contract reset, a joint programme office was established at GDLS-UK's Merthyr Tydfil site.[46] In April 2021, the Department sought to reinvigorate this by co-locating the teams and establishing routine engagement up to 3* level. However, it subsequently assessed there was a lack of commitment to this office because of limited trust and understanding within respective teams.

- The Department sought to improve collaboration with GDLS-UK. Since February 2020, Defence Equipment & Support (DE&S) has engaged monthly with senior US executives and held formal programme reviews every two months. Since June 2021, a working group comprising representatives from the Army, DE&S and GDLS-UK has met weekly to collaborate on noise and vibration issues.

- The programme board has met more often, meeting seven times in 2020 compared with four times in 2018 and 2019. The board met five times in 2021, with minutes of recent meetings indicating more rigorous scrutiny of the programme.[47] In November 2020, the then senior responsible owner (SRO) also set up a board sub-group to focus on noise and vibration issues.

- The Department appointed a new full-time SRO in October 2021. The programme director role was also made full-time.

- A working group with representatives from the Army, DE&S and GDLS-UK has met weekly since 2021 to coordinate the resolution of the noise and vibration issues.

- The minister for defence procurement chairs a weekly ministerial oversight group which receives briefings on the programme and supports its recovery.

45 See footnote 44.
46 The creation of the team was delayed by the COVID-19 pandemic and it was initially established as a virtual team.
47 Meetings in March, July and September 2021.

3.6 In March 2021, the Infrastructure and Projects Authority (IPA) again highlighted the programme's need for sufficient qualified and experienced resources within the Department and GDLS-UK. The Department rated the programme's skills and capabilities as red in September 2021 despite allocating additional resources and increasing the size of the programme management office.[48] The limited number of engineering safety personnel has remained a concern, resulting in safety issues being progressed sequentially rather than in parallel. The Department is seeking to fill these gaps. DE&S made the senior safety officer post full-time in September 2021 and the Army temporarily reinforced its safety monitoring of the programme, although this arrangement ended in October 2021 and it has not decided on a permanent alternative.

3.7 The Department has also sought to improve its programme management. It developed an action plan to review and update programme risks, with a particular focus on information management and scheduling. However, it remains to be proven whether the Department's revised arrangements will meet the criteria that are crucial to delivering successful programmes, such as:[49]

- identifying key programme risks, enabling timely interventions. To date, effective management, reporting and escalation of safety and technical risks has been inhibited because responsibility for these tasks is fragmented. The programme board did not have a consistent or complete view of programme risks;
- oversight that provides strong and effective challenge and direction. The IPA has concluded that programme assurance arrangements needed to support the SRO and senior staff in DE&S and the Army were below the standard found in other departments and on other major programmes; and
- strong programme leadership which is based on timely and accurate management information. A lack of clarity over accountabilities meant responsibility for actions – for example in addressing programme risks – was unclear and updates were often inconsistent or limited.

48 The Department increased the size of the programme management office to 8.5 full-time equivalent posts.
49 See footnote 44.

The right commercial incentives

3.8 In December 2021, GDLS-UK had missed 10 critical contract milestones by six months or more, all of which it must complete before it can invoice again. The parties remain in dispute, with GDLS-UK asserting that the Department has prevented it from completing critical milestones. The Department does not accept this, arguing that the noise and vibration issues have caused the delays and led it to issue safety notices. In December 2021, the Department began to consult GDLS-UK about whether it was in "contractor default". The Department has a range of potential options for dealing with these issues, including applying penalties if GDLS-UK does not deliver vehicles to the contract schedule and, in extremis, the right to terminate the contract. It has rejected requests from GDLS-UK to split, delink or amend payment milestones.

3.9 Our guidance highlights the importance of contracts having appropriate incentives for all parties to deliver.[50] However, the Department believes that the payment schedule in the Ajax contract has incentivised the achievement of production milestones over the quality and performance of the capability. GDLS-UK has continued to manufacture vehicles in line with the contract, even though the potential changes needed to resolve the safety issues have not been determined. In April 2021, the Department commissioned a commercial review to understand its contractual obligations.

Wider issues that need to be managed to deliver the capability

Financial pressures

3.10 To date, the Department has held GDLS-UK to account against a firm-priced contract. However, the problems on the programme have created financial pressure. In December 2021:

- the Department had accepted that just 32% of 1,153 system requirements are compliant with the contract specification but had committed 94% of the demonstration phase funding. GDLS-UK claims greater compliance, but the Department will not accept this until it has proven these requirements **(Figure 10)**;
- there was £40.7 million left on the demonstration phase – 6% of the budget of £713.6 million – leaving limited headroom to deal with outstanding safety issues and technical risks;

50 See footnote 44.

- of the £4.113 billion manufacture budget, 33% (£1.345 billion) remains uncommitted. The scale of works to resolve noise and vibration issues is not known, and the Department is aware of other unresolved issues (see paragraph 2.28); and
- there are additional requirements that were not included in the budget, including around £22.5 million for training simulators and additional armour packs and storage. The programme team will need to make choices within the programme budget, or find efficiencies, to remain within the approval limit.

3.11 The Department has not made cash payments since December 2020 due to the noise and vibration issues. While this has helped the Army's – and Department's – cashflow, it will need to pay the liability when these issues are resolved. The Department had planned to spend £787 million with GDLS-UK on the programme in 2021-22, but because of the slow progress it has accrued less than it had budgeted for. This means that it has had to reprofile its budget, which could add to the financial pressure in future years, shown in our recent report on the Department's latest Equipment Plan.[51]

Figure 10

Ministry of Defence's progress in reviewing compliance of system requirements, December 2021

The Ministry of Defence (the Department) has agreed that General Dynamics Land Systems UK (GDLS-UK) has met 32% of the 1,153 system requirements

Status	Number of requirements	Percentage of total requirements
		(%)
System requirement agreed by the Department	369	32
Evidence available for Department to agree requirement	173	15
Arbitration required/may be required	34	3
Requirement verified by GDLS-UK	537	47
Additional evidence needed	40	3

Source: National Audit Office analysis of Ministry of Defence data

51 Comptroller and Auditor General, *The Equipment Plan 2021 to 2031*, Session 2021-22, HC 1105, National Audit Office, February 2022.

Programme interdependencies

3.12 The full Ajax capability depends on several other enabling programmes (**Figure 11**). The Army reports on these interdependencies on a quarterly basis. Our review identified:

- operational ammunition will not be available until 2023 and the Army will use a short-term alternative until then;
- infrastructure builds for simulators at Bovington were delayed by between three to six months when the preferred bidder withdrew;
- the Department will complete its upgrade of ranges at Kirkcudbright in 2022, later than initially planned; and
- training is on the critical path to Ajax's operational deployment, but courses have been paused and the Army has a limited number of qualified personnel to complete the design of the Ajax training courses.

3.13 The Army's vision for its armoured vehicles – including Ajax – depends on enhanced digital capabilities. Under the contract with GDLS-UK, the vehicles will be fitted with the latest version of the Bowman tactical communications system to provide better data transmission, improved situational awareness and enhanced usability. However, the Army does not have enough Bowman equipment and full accreditation of its installation in Ajax will not be before November 2022. The fitting of Bowman is on the programme's critical path, and there is a risk that delays will affect the delivery of operationally capable vehicles.

3.14 Once Ajax is in service, the Department plans to upgrade its Bowman system with the new Morpheus system, part of which is being developed by another General Dynamics subsidiary through a separate contract.[52] However, the timing of this replacement is uncertain as the Morpheus programme has been delayed by at least three years and has had significant cost increases. This delay means that Ajax's full digital capability will not be available as early as originally anticipated as, for example, the ability to exchange information will be limited until new radios are delivered under the Morpheus programme. The Army plans to adapt how it will operate the vehicles until full digital capabilities are available.

Transition to business as usual

3.15 The Department has begun to develop a schedule to FOC. In September 2021, the Army appointed a scheduler to develop a programme schedule and critical path. The Department has not yet established longer-term plans for the support of Ajax vehicles. GDLS-UK told us that it had reached a provisional agreement with the Department to revise the support contract, but the Department refutes there had been an agreement.

52 The MORPHEUS/LE TacCIS programme consists of multiple sub-projects to deliver the next generation of tactical military communications.

Figure 11
The Ajax programme – supporting enablers

The full Ajax capability is dependent on the Ministry of Defence (the Department) delivering a range of supporting programmes

Enabler	Current situation
Turret with integrated 40mm cannon	• Before recast the integration immaturity of the 40mm cannon into the turret was an area of concern. By 2019, the development of the turret component had matured, and cannons were incorporated in line with the reset agreement. • By December 2021, 79 out of 245 turrets had been completed. • General Dynamics Land Systems UK has completed testing of the French in-service thermal sleeve with data passed to Defence Equipment & Support (DE&S) to consider fleet-wide fitting. • New airburst rounds which are being developed will now be integrated with Ajax after it has achieved full operating capability. • Cancellation of the programme to upgrade the Warrior armoured infantry vehicle removed some opportunities for the Department to fully share costs between the two programmes. DE&S and Army are assessing what remaining activity will now fall to Ajax alone and what this will cost.
Ammunition	• The Department is considering alternatives to tungsten composites for armour-piercing ammunition because of toxicity risks. • Operational ammunition will be available from 2023, and the Army will use surplus armour piercing rounds as a short-term contingency.
Digital communication system	• Capability drop 3 vehicles will be fitted with the latest version of Bowman (BCIP 5.6). This is on the critical path, and the Department is making progress towards its full accreditation, but this will not be before November 2022. • Full benefits of the vehicle's capabilities, such as the enhanced ability to transfer data and information, will be delivered by Bowman's replacement, Morpheus. • This upgrade is not covered within the contract, and Morpheus installation will be part of the Ajax through life capability management plan.
Infrastructure	• The upgrade to Kirkcudbright ranges - to enable the assurance of the 40mm cannon armour piercing operational capability – is projected for summer 2022. • Provision made to provide storage for modular armour packs.
Training facilities	• Delay of three to six months to building housing for training simulators at Bovington was confirmed in September 2021 because building cost increases made the preferred bidder's bid untenable. Contingency plans established at Bovington and Upavon to mitigate the delay.
Training	• First instructor training courses started in June 2019. • Army has accepted into service the desk top trainer, driver training simulators, crew turret trainer and small arms drills trainer, which it has used during pauses in training on actual vehicles. • The Ajax turreted pilot course paused in June 2021; 12 Armour Centre Schools and Household Cavalry Regiment instructors had completed the gunner and commander courses by this point. • Driver and maintenance instructor courses are being designed but cannot be completed until access to vehicles is possible. • Significant time needed to recover the training to its situation when trials of the vehicles were suspended. • Army will have a capability gap in the future training of Ajax equipped units and needs to find £22.5 million from within the Ajax programme to fund this. The Army is working on the assumption that the programme will not have a solution and will need an alternative way to validate its training.

Notes

1 The manufacture of the turret, including the integration of the 40mm cannon into it, is undertaken by Lockheed Martin UK as a subcontractor to General Dynamics Land Systems UK.

2 Ajax has a modular armour system consisting of three different armour packs for Major Combat Operations, Peace Support Operations, and training.

Source: National Audit Office analysis of Ministry of Defence data

The consequences of programme delays

3.16 The Army's plans for a modern warfighting division by 2030, announced in November 2021, are centred around Ajax, Boxer and Challenger 3 armoured vehicles. But delays to the Ajax programme mean it is not clear how the Army will achieve its planned restructuring vision by 2025. The Army has said it can tolerate a delay to ensure that the programme delivers the required capability.

3.17 The Army accepts that programme delays will mean it cannot deploy Ajax as planned. Instead, the Army intends to meet its NATO commitments using Challenger 2 tanks and ageing Warrior armoured infantry vehicles, which the Department plans to withdraw from service shortly. There is a risk that further delays to the Ajax programme will mean extending out-of-service dates for existing armoured vehicles. Ajax is replacing the Combat Vehicle Reconnaissance fleet, which is more than 40 years old and has already extended its out-of-service date from 2014 to 2023. Delays will also have wider capability impacts which the Department will have to consider when planning future operations. This will create different maintenance and operating challenges, given the existing fleet of reconnaissance vehicles has long been considered outdated by the Army and suffers capability and obsolescence issues. For example, Warrior is 20 years older than equivalents operated by other allies. Further use of Challenger 2 tanks to replace Ajax on operations could also have knock-on consequences for its planned upgrade.

Appendix One

Our audit approach

1 In March 2021, the House of Commons Defence Committee asked the Comptroller & Auditor General to provide independent scrutiny on the Ministry of Defence's (the Department's) armoured vehicles programmes. Following subsequent media reports, both that Committee and the Committee of Public Accounts became particularly concerned about progress with the Ajax programme. This study, therefore, examines the Department's performance in managing the Ajax programme by assessing the:

- history of the Ajax programme, including its governance and what the Army is trying to achieve;
- underlying causes of difficulties on the Ajax programme since 2011; and
- risks that the Department faces in delivering the programme.

2 Our audit approach is summarised in **Figure 12** overleaf. Our evidence base is described in Appendix Two.

Figure 12
Our audit approach

The objective of government

The Ajax programme is central to the Ministry of Defence's (the Department) objective of developing a digitised, transformed Army. Ajax will deliver improved firepower, protection, multi-domain integration of information, and situational awareness, and will be instrumental to the Army's delivery of the Deep Recce Strike and Armoured Brigade Combat Teams.

How this will be achieved

The Ajax programme will deliver into service an integrated multi-role capability comprising 589 vehicles in six variants designed to cover roles ranging from troop carrying to recovery and command and control, and training to bring these into service.

Our study

Assesses the Department's performance in managing the Ajax programme, providing an update on progress against cost, time and performance milestones.

Our evaluative criteria

Whether the Department has established appropriate arrangements to ensure its Ajax programme meets its objectives.	Whether the Ajax programme has made the progress since 2011 that the Department expected.	Whether the Department is now better placed to deliver its Ajax programme.

Our evidence (see Appendix Two for details)

We: • conducted semi-structured interviews with senior officials in the Department; • reviewed departmental documents; and • mapped governance arrangements.	We: • conducted semi-structured interviews with senior officials in the Department and its prime contractor; • reviewed departmental documents; and • analysed financial data.	We: • conducted semi-structured interviews with senior officials in the Department and its prime contractor; • reviewed departmental documents, including the contract; and • assessed arrangements using National Audit Office frameworks.

Our conclusions

The Department expects Ajax to improve its armoured vehicle capability significantly. So far, it has insisted that GDLS-UK will deliver 589 Ajax vehicles for the agreed contract price of £5.522 billion. But the in-service date has already increased by four years and the Department does not know when it will be able to start using the vehicles. The programme continues to face significant problems and there is not yet agreement on the causes of critical safety issues or how these will be resolved. There are other technical issues which still need to be addressed and wider problems in developing the enabling capabilities that will allow Ajax to achieve full capability. These problems mean that the Department has not demonstrated value for money on the £3.167 billion it has spent so far through this contract.

The Department's and GDLS-UK's approach was flawed from the start as they did not fully understand the scale or complexity of the programme. A series of programme management failures have since led to missed programme milestones and unresolved safety and technical issues. The two parties remain in dispute over unresolved contractual, safety and technical issues. The Department faces a significant challenge and difficult decisions if it is to deliver the programme, with a risk that the problems might prove insurmountable. To deliver value for money from the programme, the Department must introduce the capability that it set out to achieve, without costs escalating or further delays in introducing the capabilities. We have seen similar problems on other defence programmes, and the Department must ensure that it learns lessons to prevent a reoccurrence of failings across its £238 billion equipment programme.

Source: National Audit Office

Appendix Two

Our evidence base

1 We reached our conclusions on the Ministry of Defence's (the Department's) progress with the Ajax programme and whether it is delivering value for money, based on our analysis of evidence collected primarily between September 2021 and January 2022. We were able to complete our fieldwork with minimal disruption or restrictions imposed in response to the COVID-19 pandemic.

2 Our audit approach is outlined in Appendix One. We applied an analytical framework with evaluative criteria addressing whether: the Department has established appropriate arrangements to ensure its Ajax programme meets its objectives; the Ajax programme has made the progress since 2011 that the Department expected; and the Department is now better placed to deliver its Ajax programme. Our analytical framework drew upon the National Audit Office's (NAO's) good-practice guidance on managing the commercial lifecycle and its framework to review programmes.[53]

3 To assess whether the Department has established appropriate arrangements to ensure its Ajax programme meets its objectives, we:

- reviewed documents, including the 2010, 2015 and 2021 defence reviews, to understand the Department's objectives and strategy for delivering the programme and how these have evolved;
- reviewed central arrangements for monitoring progress and escalating issues, including programme board papers and ministerial submissions, to assess their adequacy and effectiveness;
- mapped roles and responsibilities for delivering the programme and governance arrangements, including safety governance, based on document review and semi-structured interviews; and
- undertook semi-structured interviews with senior personnel including at Army Headquarters, Defence Equipment & Support (DE&S) and the current senior responsible owner, which covered the Department's objectives for the programme and the arrangements in place to achieve these.

53 National Audit Office, *Framework to review programmes*, April 2021. National Audit Office, *Good-practice guidance: Managing the commercial lifecycle*, July 2021.

4 To assess whether the Ajax programme has made the progress since 2010 that the Department expected, we:

- reviewed documents to develop a detailed understanding of how the Ajax programme has progressed since 2010 and the issues it has faced. These included: business cases and updates submitted to the Department's Investment Approvals Committee; programme board minutes and papers; quarterly reports lodged on the Department's Portfolio Management Reporting System; papers relating to the reset in 2018; and submissions made to ministers and senior officials in the Department;
- reviewed the contract between the Department and General Dynamics Land Systems UK (GDLS-UK) and commercial correspondence between the parties to understand their commercial relationship;
- analysed financial data to establish the amount paid by the Department to GDLS-UK and the timing of these payments;
- analysed monthly progress reports submitted by GDLS-UK to the Department to understand the flow of information between the parties;
- analysed papers concerning the arrangements for trials to assess the performance and safety of the vehicles, including from DE&S, the Defence Science and Technology Laboratory (DSTL) and the Armoured Trials and Development Unit. We triangulated this with semi-structured interviews with senior personnel from each organisation;
- reviewed Infrastructure and Projects Authority (IPA) reports on the Ajax programme, which we triangulated with evidence gathered from the Department regarding the structure and progress of the programme;
- visited GDLS-UK's facility at Merthyr Tydfil, where we held detailed discussions with senior staff, toured the facility and observed a demonstration of an Ajax vehicle; and
- visited the Millbrook proving grounds to observe the independent trials that the Department has commissioned of Ajax vehicles.

5 To assess whether the Department is now better placed to deliver its Ajax programme, we:

- reviewed documents produced by the Department following the suspension of the Ajax trials because of health and safety concerns to understand its assessment of what had gone wrong, what lessons it should learn, and how it intended to try to salvage the Ajax programme;
- reviewed documents to assess whether the Ajax programme now displayed the criteria for a successful programme, as set out in the NAO's *Framework to review programmes*. This included governance, staff resource and financial arrangements;
- reviewed documents to assess whether the Ajax programme has suitable commercial incentives in place, as set out in the NAO's *Good practice guidance: Managing the commercial lifecycle*;
- undertook semi-structured interviews with the current senior responsible owner to understand his assessment of the Ajax programme and how it can be taken forward; and
- reviewed documents relating to enabling programmes on which the Ajax programme is reliant to achieve its full capability, to assess whether they are on track.

Appendix Three

Noise and vibration – overview of main events

Figure 13
Noise and vibration – overview of main events since March 2014

Defence Science and Technology Laboratory (DSTL) warned about noise and vibration concerns during the development of the vehicle

Date	Team	Issue	Impact
February 2014	General Dynamics Land Systems UK (GDLS-UK)	GDLS-UK safety notice referring to vibration levels on test vehicle.	Existing risk controls adequately mitigate residual risk.
March 2014	DSTL	Noise and vibration combine with other technical risks resulting in significant number of failures on test vehicle.	Technical risk being carried forward. Potentially insufficient mobility and poor reliability. Delays to trials programme.
September 2014	DSTL	Potentially serious issue with the intended vibration testing during trials.	Compliance with the health and safety regulations.
December 2014	GDLS-UK	GDLS-UK safety notices referring to vibration and to internal noise to ensure all users have adequate personal protective equipment, including hearing protection.	Existing risk controls adequately mitigate residual risk.
December 2017	DSTL	New track fitted to production vehicles no longer includes rubber track face to dampen noise and vibration. Track connection issues contribute to increased noise and vibration.	Noise and vibration measurements previously taken no longer representative and need to be retaken.
December 2018 (and updated April 2019)	Ministry of Defence (MOD) Safety Notice	Limitations on length of time personnel can operate the vehicle due to vibration.	Potential health concerns of long-term exposure to vibration.
June 2019	DSTL	Initial trial results on noise levels are significantly high.	The vehicles would not meet the health and safety regulations without significant work to attenuate the noise level or enhanced hearing protection.
September 2019	Defence Equipment & Support (DE&S)	Agree to use GDLS-UK's proposed vibration calculator to manage the risk of noise and vibration.	
September 2019 (and again in January 2020)	DSTL	Concerns about validity of GDLS-UK vibration calculator.	Risk of excessive exposure to noise and vibration.
November 2019	Armoured Trials Development Unit (ATDU)	Raises concerns to DE&S about vibration.	Request vibration monitoring equipment on Ajax platforms and urgent engineering solution to vibration.
February 2020	DE&S	Request additional monitoring of noise and vibration by GDLS-UK on Ajax vehicles.	By May 2020, the Department finds GDLS-UK has not yet improved noise and vibration monitoring, so MOD commissions an investigation by the Institute of Naval Medicine.

Figure 13 *continued*
Noise and vibration – overview of main events since March 2014

Date	Team	Issue	Impact
March –July 2020	MOD Safety Notices	Further restrictions on use.	Ajax testing limited by time in vehicle, time on road and speed limits.
May 2020	Defence Safety Authority	Produces report entitled "Serious safety concerns with Ajax".	Retracts report three days later due to concerns over evidence quality and lack of consultation. GDLS-UK told us it never received this report.
July 2020	ATDU	Soldiers begin formally recording symptoms of vibration issues.	Symptoms include pain, pins and needles, swelling.
August 2020	ATDU	Soldiers begin formally reporting symptoms of noise-induced hearing loss.	
September 2020	GDLS-UK	Reports vehicle rejected by Army due to vibration.	GDLS-UK provides letter to demonstrate compliance.
September 2020	DSTL	Identifies an error in the GDLS-UK noise and vibration calculator that means it under-estimates the noise exposure of crews. MOD asks GDLS-UK to review.	Vehicle crews may have been over-exposed to noise and vibration legislation limits. Previous trials need to be re-evaluated. MOD asks GDLS-UK to assess DSTL's observations.
November 2020	Institute of Naval Medicine (INM)	INM finds that hearing protection must be worn inside the vehicle and exposure to whole-body vibration is of particular concern.	
November 2020	ATDU	Comparative noise trials find that noise issues are present on production model vehicles.	
November 2020	MOD Safety Notices	No activity with engine running or intercom headsets. Only essential maintenance permitted.	
November 2020	GDLS-UK	Commissions independent sound and vibration experts to look at trials data. GDLS-UK's report identifies high levels of noise at certain speeds and when using the communications system, and lower than expected performance of headsets.	
January 2021 – May 2021	MOD Safety Notices	Further changing restrictions on use, including hearing protection.	
May 2021	DE&S	Independent testing of headsets.	
May 2021	DSTL	Advises limiting use of Combat MkII headset.	
May 2021 – June 2021	ATDU	Multiple reports of vibration symptoms during trials.	Army Delivery Duty Holder formally escalates risk to Operational Duty Holder, no longer satisfied that the MOD has a safe and assured system for operating Ajax.
June 2021	MOD Safety Notice	Stop all use of Ajax vehicles, including trials.	
November 2021	MOD Safety Notice	Temporary limit to amount of time personnel can operate using Combat MkII headsets in other armoured fighting vehicles.	At this stage, acoustic testing appears to show that alternative headsets perform significantly better than the Combat MkII headsets

Notes

1 GDLS-UK told us that prior to May 2020, all incidents of noise and vibration were a routine part of the development of the design.

2 The Department told us that while it agreed to use the GDLS-UK calculator to manage the risk of noise and vibration it did not agree to the data used within the calculator.

Source: National Audit Office analysis of Ministry of Defence data

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