Unmanned Aerial Vehicles (drones): an introduction

This note provides an introduction to the use of Unmanned Aerial Vehicles (UAVs) by the UK Armed Forces, more commonly known as drones. These are remotely piloted aircraft that range from simple, hand-operated systems to high altitude, long endurance systems similar in operation to small aircraft.

UAVs are primarily used to gather intelligence and provide a surveillance and reconnaissance function for the armed forces. Only a handful of systems are capable of carrying weapons. The only armed UAV used by the UK Armed Forces is the Reaper and it is only used in Afghanistan.

Remotely piloted aircraft operate on the same rules of engagement as manned aircraft. However the growth in the use of armed UAVs, particularly by the United States, raises a number of moral, ethical and legal issues.

This note explores the strengths and weaknesses of UAVs, the different types of UAVs in use by the UK Armed Forces in Afghanistan, rules of engagement and highlights some of the points raised by those concerned about their development and use.

Contents

1   Summary

There has been a rapid growth globally in the acquisition and development of Unmanned Aerial Vehicles (UAVs). Approximately 80 countries have UAVs, of which fewer than a dozen operate systems that can be armed, according to the Ministry of Defence. The US General Accounting Office estimates the number of countries with UAVs has increased from approximately 41 in 2004 to at least 76 countries in 2012.

Unmanned Aerial Vehicles (UAVs), commonly referred to as drones, are remotely piloted aircraft or systems. They range from simple hand-operated short-range systems to long endurance, high altitude systems that require an airstrip. UAVs have civil and commercial uses but this note looks only at their military role. They may also be referred to as Unmanned Aerial Systems (UAS) and Remotely Piloted Aircraft (RPA).

Their primary role is Intelligence, Surveillance and Reconnaissance (ISR) or Intelligence, Surveillance, Target Acquisition and Reconnaissance (ISTAR). A handful of systems may also be armed. The only armed UAV used by the UK Armed Forces is the Reaper and it is only used in Afghanistan.

The Government pledged in its 2010 Strategic Defence and Security Review (SDSR) to invest in a fleet of UAVs in both combat and reconnaissance roles, in particular for the Royal Air Force.

The growth in usage of armed UAVs, and their use by the United States in Afghanistan, Pakistan and elsewhere, raises a number of moral, ethical and legal issues. Remotely piloted aircraft operate on the same rules of engagement as manned aircraft. There are no fully autonomous UAVs in operation.

2   Strengths and weaknesses

Unmanned Aerial Vehicles (UAVs) or Systems have a number of strengths and weaknesses compared to manned aircraft. UAVs help minimise the risk to aircrew operating in hostile territory and can be used for 'dull, dirty and dangerous' tasks. They can be more cost effective and provide a significant intelligence, surveillance and reconnaissance capability, whether that is 'over the hill' sight for soldiers on the ground or a persistent presence in the air which can help provide a more complex intelligence picture for commanders. This in term can help inhibit an enemy's ability to move in secrecy. They are more expendable than manned aircraft, at least in terms of human life if not in cost.

UAVs also have plenty of weaknesses – they currently lack the flexibility and adaptability of manned aircraft and the more advanced systems require as heavy if not heavier crew requirement than manned aircraft.[1] Depending on their capabilities they may not necessarily be more cost effective. A Ministry of Defence Joint Doctrine Note suggests "If current trends continue, it is likely that the cost of complex unmanned aircraft will increase to converge rapidly with those of manned aircraft."[2] The vast quantity of data provided by UAVs requires similar advances in automated data analysis to ensure the information collected is of use.

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[1]   According to Air Vice-Marshal Jon Lamonte , 39 Squadron, which operates Reaper from Nevada, has a manpower to aircraft ratio greater than that of a traditional fast jet squadron; Air Vice-Marshal Jon Lamonte, Chief of Staff Strategy, Policy & Plans, RAF "The Future of UAVs: Concepts and Considerations", RUSI Air Power conference, 19-20 October 2009

[2]   "Joint Doctrine Note 2/11 The UK Approach to Unmanned Aircraft Systems", *MOD Development, Concepts and Doctrine Centre (DCDC)*, 30 March 2011, 104

They may also be vulnerable to failure and to data link interference. There are also restrictions on where they can operate, particularly in civilian airspace.

Most analysis of the use of UAVs share concerns about the legal, moral and ethical issues they raise. These are more explored more fully below.

For the UK Armed Forces, UAVs are likely to have a greater impact on the Royal Air Force than the other services because they will be used to deliver its core function of air power, according to Air Vice-Marshal Jon Lamonte, Chief of Staff Strategy, Policy & Plans, RAF. He argues the Army and Royal Navy are likely to use UAVs to "better enable them to deliver their Land or Maritime Power." He predicts that while an RAF of entirely unmanned aircraft is not yet here "over time UAVs will progressively become more predominant in the force mix."[3]

The Ministry of Defence published a Joint Doctrine Note in March 2011 exploring the issue of how Unmanned Aircraft Systems might contribute to the UK's future defence and security needs between now and 2030. It does not describe policy but was written to identify the issues arising from the use and potential use of UAS. It concluded:

> UAS have both advantages and disadvantages when compared to manned aircraft. Regardless, it is certain that they will be ubiquitous on the battlefield of the future. Manned aircraft can still provide wide utility and may, in some circumstances, be cheaper, more acceptable or more technologically feasible than an unmanned solution.[4]

A table summarising the strengths, weaknesses, opportunities and threats presented by Unmanned Aircraft Systems, as explored in the Joint Doctrine Note, is provided in the appendix.

3   Capabilities

The UK Armed Forces deploy five types of Unmanned Aerial Vehicles in Afghanistan, of which only one may be armed. The Army is procuring a new capability, Watchkeeper, which will replace the Hermes 450, currently in use. The UK and France agreed in July 2012 to pursue a joint unmanned Future Combat Air System and to also cooperate on Watchkeeper.

3.1   Deployed capabilities

The UK currently operates five types of Unmanned Aerial Systems in Afghanistan[5]:

- The British Army operates four tactical unmanned aircraft in theatre: the Hermes 450, which will be replaced by Watchkeeper when it comes into service; the mini-size Class I Desert Hawk 3; the T-Hawk and the Black Hornet, a nano aerial rotocraft.[6]

- The Royal Air Force uses the Reaper, which is the only armed UAS operated by the armed forces.

- There are no Royal Navy unmanned aircraft currently in service. The MOD is currently running a competition meet an urgent operational requirement to provide

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[3]   Air Vice-Marshal Jon Lamonte, Chief of Staff Strategy, Policy & Plans, RAF "The Future of UAVs: Concepts and Considerations", RUSI Air Power conference, 19-20 October 2009

[4]   "Joint Doctrine Note 2/11 The UK Approach to Unmanned Aircraft Systems", *MOD Development, Concepts and Doctrine Centre (DCDC)*, 30 March 2011, 320

[5]   HL Deb 30 October 2012 cWA116

[6]   Ministry of Defence, *Miniature surveillance helicopters help protect front line troops*, 4 February 2013

intelligence, surveillance and reconnaissance capability for the Royal Navy and Royal Fleet Auxiliary ships which the MOD says may be met using an unmanned air system.[7] There are no plans to deploy Watchkeeper from Royal Navy or Royal Fleet Auxiliary vessels.[8]

- The Defence Secretary confirmed there are no plans for the use of combat unmanned aerial vehicles in Afghanistan by the UK after combat operations end on 31 December 2014.[9]

The UK currently operates 330 Remotely Piloted Aircraft in Afghanistan[10]:

Remotely Piloted Air System	Number of Remotely Piloted Aircraft
Reaper	5
Hermes 450	9
Desert Hawk III	239
Black Hornet	64
Tarantula Hawk	18
Total	335

The number of hours flown by Reaper, the Hermes 450 and the Desert Hawk 3 has increased considerably since they were introduced in 2007. The Reaper flew over 10,000 hours in 2010, compared to 300 hours in 2007, while the Hermes 450 flew nearly 15,000 hours in 2010, compared to 1,700 in 2007.[11]

Army-operated UAVs

The Hermes 450 provides tactical level imagery to unit and formation commanders on the ground in Afghanistan and requires an airstrip to launch.[12] The Desert Hawk 3 is a hand launched UAV designed to provide ground forces with a live tactical video feed, an 'over the hill' view for commanders. The T-Hawk provides a hover and stare capability and is primarily used by Explosive Ordnance Device operators to examine suspicious vehicles or structures.

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[7] HC Deb 23 October 2012 c812W

[8] HC Deb 4 December 2012 c703W

[9] HC Deb 26 November 2012 c 4

[10] HL Deb 30 October 2012 cWA116

[11] HC Deb 18 July 2011 c586W

[12] Major Claire Button provides a more detailed look at the use of Hermes 450 in Afghanistan in "Unmanned Aerial Vehicles on Operations: Overcoming the Challenges", *RUSI Defence Systems,* June 2009

The Black Hornet is a tiny helicopter (4 inches by 1 inch) with a camera that gives troops video and still images. It used by soldiers in the battlefield to peer around corners or over walls.

RAF-operated UAVs

The General Atomics MQ-9 Reaper is the only armed remotely piloted aircraft system used by the UK and is currently used in Afghanistan. It is a medium to high altitude, long-endurance unmanned aircraft that requires a prepared runway surface for take-off and landing. It is primarily tasked in the Intelligence and Surveillance Awareness role although it can be armed with up to 4 Hellfire and 2 Paveway II weapons. It is not an autonomous system and therefore cannot use its weapons unless it is commanded to do so by the flight crew.

The aircraft is launched from an airfield within Afghanistan by crews deployed in theatre and once airborne is flown by RAF personnel (39 Squadron) based at Creech Air Force Base in Nevada in the United States. Operations will shortly begin from RAF Waddington after the formation of a second Remotely Piloted Aircraft Squadron, 13 Squadron, in October 2012.[13]

At present the UK has five Reaper aircraft deployed in Afghanistan. The Prime Minister announced in December 2010 a £135 million plan to double the number of Reaper aircraft[14] and the new squadron doubles the Reaper capability to ten aircraft.[15] There are currently 31 RAF personnel qualified to pilot the Reaper aircraft with plans to train a further 16 RPA pilots between October 2012 and September 2013.[16]

The total financial approval for delivering and supporting the UK Reaper system from 2007, when it entered service, until the end of combat operations in Afghanistan in 2015, is £506 million.[17]

Royal Navy operated UAVs

There are no Royal Navy operated unmanned aircraft currently in service. The primary requirement for Unmanned Underwater Vehicles for the Royal Navy is for mine countermeasures and beyond the subject of this note.

3.2   Procurement via Urgent Operational Requirements

The Desert Hawk, Hermes 450 and Reaper were all purchased as urgent operational requirements. This means they were brought into service in response to meet an immediate operational need rather than as a planned capability requirement. The MOD says no decision has been taken on whether to retain Reaper once combat operations end in Afghanistan.[18]

Reaper pilots are all RAF and Royal Navy pilots who are qualified in operating other military aircraft. The majority have served on at least one operational tour on a traditional manned platform. 32 RAF personnel are qualified to pilot the Reaper.[19] Operators of the Army's

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[13] "RAF reforms 13 Squadron", *RAF News,* 26 October 2012
[14] "Prime Minister announces boost to Afghan campaign", *MOD News,* 7 December 2010
[15] "Defence in the media 23 October 2012", *MOD News,* 23 October 2012
[16] HL Deb 8 October 2012 cWA400
[17] HC Deb 31 October 2012 c297W
[18] HC Deb 13 November 2012 c172W
[19] HC Deb 31 October 2012 c297W

unmanned UAVs are not required to be qualified pilots because of the greater level of autonomy of their UAVs.[20]

Further information about each capability is available in the annex of Joint Doctrine Note 2/11 *The UK Approach to Unmanned Aircraft Systems*.

As of December 2011, the total financial approval for delivering and supporting the UAVs, including deployment costs on operations is as follows: [21]

UAV type	Approval (£ million)
Desert Hawk	42
Hermes 450	181
Reaper	[1]506
[1] Includes funding to sustain the Reaper capability until 2015	

Altogether 290 personnel are involved in delivering Desert Hawk, Hermes 450 and Reaper. This includes command, aircrew, technicians, intelligence and support staff.[22]

The MOD has separately said the total financial approval for delivering and supporting the UK Reaper system from 2007 until the end of combat operations in Afghanistan in 2015, is £506 million.[23]

One Reaper has been lost since entering service in 2007, because of mechanical failure.[24] There have been 11 Hermes 450 crashes in Afghanistan since its introduction in 2007. A review of army use of unmanned aerial systems at the end of September 2012 resulted in changes to training procedures.[25]

Altogether, the UK's fleet of UAVs have carried out over 100,000 hours of flying in Afghanistan[26] and fired 349 precision-guided weapons (297 Hellfire precision guided missiles and 52 laser guided bombs).[27]

3.3   Future capabilities

The MOD identified unmanned aerial vehicles as a capability it intends to invest in, along with Typhoon and the Joint Strike Fighter, as part of its £18.5bn planned spend on Combat Air over the next ten years. This was identified in the Defence Equipment Plan 2012 published in January 2013.[28]

Watchkeeper

A new UAV, Watchkeeper, is being procured for the Army to be operated by the Royal Artillery. It will provide Intelligence Surveillance Target Acquisition and Reconnaissance (ISTAR) and will replace the Hermes 450. Its operational deployment has been pushed back

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[20]   HC Deb 31 October 2012 c298W
[21]   HC Deb 1 December 2011 c1063W
[22]   HC Deb 1 December 2011 c1063W
[23]   HC Deb 31 October 2012 c297W
[24]   HC Deb 31 October 2012 c297W
[25]   HC Deb 24 October 2012 c878W
[26]   HC Deb 6 November 2012 c203WH
[27]   HC Deb 12 November 2012 c31W
[28]   Ministry of Defence, *Defence Equipment Plan 2012,* 31 January 2013, p9

repeatedly because of delays in securing the necessary airworthiness certification. Planned for 2010, then Minister for Defence Equipment, Peter Luff, said in March 2012 "it would be speculative to provide a forecast as to when Watchkeeper will achieve release to service or its in-service date."[29] Philip Dunne said in January 2013 that "The release-to-service process, including airworthiness certification, is taking longer than originally expected."[30]

Watchkeeper will cost just under £1 billion and 54 will be built for use by the UK armed forces.[31] It will be delivered through an incremental programme to allow the system to be upgraded. There are no plans to arm Watchkeeper. There are also no plans for it to be operated from Royal Navy or Royal Fleet Auxiliary vessels.[32]

Scavenger

The MOD is also developing the Scavenger programme which is expected to be Class III Medium Altitude Long Endurance (MALE) UAS to provide theatre wide persistent ISR.[33] It is not expected to enter service until the end of the decade. It is part of the Core Equipment Programme and comes under Intelligence, Surveillance, Target Acquisition, and Reconnaissance (ISTAR) capabilities.[34] (Reaper is the only MALE currently in service and the MOD has not made a decision has to whether to retain Reaper once combat operations end in Afghanistan.)[35]

Unmanned Combat aircraft

Then Defence Minister Peter Luff said in July 2011:

> The Ministry of Defence (MOD) is undertaking work on the Taranis[36] technology demonstrator in partnership with a BAE Systems-led industry team comprising Rolls-Royce, QinetiQ and GE Aviation. Initial ground-based testing began in 2010 with flight trials scheduled to take place in either 2011 or 2012.
>
> The Department is also engaged in a further unmanned combat air system (UCAS) concept design and engineering study with a BAE Systems-led team that includes Rolls-Royce and Selex. This will help inform new concept designs for a future operational UCAS.
>
> Discussions have taken place, and will continue, between MOD officials and their French counterparts about the future development of unmanned combat air vehicles, but these are at a very early stage.[37]

The UK and France agreed in July 2012 to pursue a joint unmanned Future Combat Air System. Defence Minister Dr Andrew Murrison said the two countries have agreed the assessment phase and the MOD will have further to report "in the fullness of time."[38]

The MOD confirmed in May 2012 it has held an initial scoping discussion with the US Government about the X-47B unmanned combat air demonstration system.[39] The pan-

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[29]   HC Deb 20 March 2012 c586W

[30]   HC Deb 7 January 2013 c50W

[31]   Ibid

[32]   HC Deb 4 December 2012 c703W

[33]   "Joint Doctrine Note 2/11 The UK Approach to Unmanned Aircraft Systems", *MOD Development, Concepts and Doctrine Centre (DCDC)*, 30 March 2011 p4-4

[34]   HC Deb 17 December 2012 c613W

[35]   HC Deb 13 November 2012 c172W

[36]   "New Taranis combat aircraft thunders into view", MOD news, 12 July 2010

[37]   HC Deb 30 June 2011 c922W

[38]   HC Deb 26 November 2012 c10

European Neuron Unmanned Combat Air vehicle made its first flight on 1 December 2012. It is a joint project involving France, Greece, Italy, Spain, Sweden and Switzerland and Dassault Aviation is the prime contractor.[40]

Maritime uses

The MOD's Joint Doctrine Note notes "operating unmanned aircraft from ships at sea is demanding, but entirely feasible, with most tactical systems being catapult-launched/net-recovered, or vertical take-off and landing."[41]

The MOD is developing a strategy paper considering maritime Unmanned Air Systems and expects this to be completed in first quarter of 2013.

Defence Minister Philip Dunne said the paper "will consider potential future capability needs for unmanned air systems, but it will not consider in detail their use in particular scenarios."[42] Elements of the paper are likely to be classified.[43]

The Ministry of Defence is currently running a competition to meet an urgent operational requirement to provide ISR capability for the Royal Navy which, the MOD says, may be "an unmanned air system."[44] It is expected to reach its main investment decision point in the first quarter of 2013. This is when the in-service date will be confirmed.[45] Defence Minister Philip Dunne has said the capability will be delivered "as soon as is practicable."[46]

Defence Minister Philip Dunne also confirmed details of a possible rotary (rather than fixed) wing UAV for the Royal Navy:

> The Rotary Wing Unmanned Air System Capability Concept Demonstrator is a two-year research project to explore how such a system might be used to fill a range of maritime roles. It is expected to report by mid-2015. An advertisement was placed in the Defence Contracts Bulletin in July and expressions of interest were received from a number of companies. The competitive process is ongoing and the Ministry of Defence expects that a contract will be awarded in mid-2013.[47]

The construction of the Queen Elizabeth class aircraft carrier has raised questions as to whether UAVs may be operated from them in the future.[48] Defence Minister Philip Dunne has said that as UAVs are generally lighter than manned aircraft "it is likely" they could be launched from the new carriers. The UK has previously conducted trials with a Scan Eagle UAV flown from a frigate (HMS Sutherland in 2005 and 2006[49]) although there are no plans to acquire Scan Eagle (it is used by the US Navy and Marine Corps and does not require a runway). Mr Dunne confirmed the MOD is considering another such concept

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[39] HL Deb 1 May 2012 c436WA

[40] N de Larrinaga, "Maiden flight for Europe's Neuron UCAV", *Jane's Defence Weekly,* 3 December 2012

[41] "Joint Doctrine Note 2/11 The UK Approach to Unmanned Aircraft Systems", *MOD Development, Concepts and Doctrine Centre (DCDC)*, 30 March 2011, para 421

[42] HC Deb 20 December 2012 c908W

[43] HC Deb 3 December 2012 c615W

[44] HC Deb 23 October 2012 c812W

[45] HC Deb 28 November 2012 c354W

[46] HC Deb 6 November 2012 c524W

[47] HC Deb 4 December 2012 c703W; see also "UK looks again at rotary-wing UAS demonstration", *Jane's Defence Weekly,* 26 July 2012

[48] See for example I. Shields and J. Spencer "An unmanned future for naval aviation", *RUSI Journal,* December 2012 vol 156 no 6 pp48-54

[49] HC Deb 2 November 2012 c428W

demonstration.[50] Northrop Grumman has developed the X-47B for the U.S. Navy's Unmanned Combat Air System Carrier Demonstration (UCAS-D) programme. It completed its first at sea tests aboard the USS Harry S. Truman in December 2012. As a demonstration aircraft it will not be put into production.[51] The US Navy is running an Unmanned Carrier-Launched Airborne Surveillance and Strike (UCLASS) programme that is expected to achieve initial operating capability in 2020.[52]

3.4 Cooperation with France

The UK and France agreed in July 2012 to pursue a joint unmanned Future Combat Air System. Two Memoranda of Understanding were signed:

- One MoU represents the first phase of a demonstration programme for a Future Combat Air System (FCAS);

- The other was signed to enable cooperation on the Watchkeeper Tactical UAS. In this field of UAS the Ministers also discussed the potential for military cooperation between specialised units of the two armies using the same systems.[53]

4 Restrictions on airspace

All military remotely piloted aircraft (UAVs) are treated as UK military aircraft and subject to the same regulations as military aircraft. Full guidance on the use of UAVs is contained in the Civil Aviation Authority's (CAA) publication *CAP 722-Unmanned Aircraft System Operations in UK Airspace*.

Within the UK, Unmanned aerial vehicles (UAVS) are only permitted to fly in segregated airspace, specifically restricted airspace (temporary) and in danger areas.[54] This is because none of the UAVs currently in service are equipped with an approved 'sense and avoid capability' to allow them to operate in civilian airspace.

The Civil Aviation Authority provides the following definitions:

> **Sense-and-Avoid** is a generic term used to describe a system involving one or more sensors, which has the capability to see, sense or detect conflicting traffic or other hazards and take the appropriate action to comply with the applicable rules. In this way, the system acts as a substitute for See-and-Avoid in manned aircraft.

> **Segregated Airspace**, as the name suggests, is a block of airspace specifically allocated for an unmanned aircraft's flight. Collision risks are eliminated by either preventing or strictly controlling entry to this airspace by other aircraft.[55]

A Danger Area is defined as "airspace which has been notified as such within which activities dangerous to the flight of aircraft may take place or exist at such times as may be notified."[56]

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[50] HC Deb 26 November 2012 c29-30W

[51] US Navy News,*X-47B Unmanned Combat Air System Completes First At-Sea Tests*, 18 December 2012

[52] G. Jean, "X-47B completes at-sea flight deck trials on board USN aircraft carrier", *Jane's Defence Weekly,* 19 December 2012

[53] "French Secretary of State for Defence Jean-Yves Le Drian and his British counterpart Philip Hammond Joint Communique", FBC Defence, 24 July 2012

[54] HC Deb 12 July 2012 c381W; The only unmanned aerial vehicles (UAVs) licensed by the Civil Aviation Authority (CAA) for civil use in UK airspace are those weighing less than 20 kilograms. These may be used only within the line of sight and within 500 metres of the operator at altitudes up to 400 feet (HL Deb 14 March 2012 c78WA), & HC Deb 28 February 2011 c84W;

[55] Civil Aviation Authority website, accessed 5 December 2012

Watchkeeper will be the first UK military unmanned aircraft "to secure all the necessary airworthiness certification to fly in both a civil and a military environment"[57] but at the time of writing it has yet to receive its release-to-service certification. The MOD said there is no current requirement for military UAVs to operate in the UK in non-segregated airspace.[58][59]

A facility for research and development of Unmanned Aircraft Systems has been set up at Parc Aberporth in West Wales. The MOD has said there are no plans to use it in the further development of UAVs following the completion of flight trials of all the Watchkeeper aircraft in 2015.[60]

5 Rules of engagement

The rules of engagement for the use of weapons are the same as those that apply to manned combat aircraft. Then Armed Forces Minister Nick Harvey detailed the legal use of Reaper in Afghanistan in July 2012:

> In Afghanistan, the policy governing the use of Reaper is identical to that for conventionally piloted combat aircraft. UK forces in Afghanistan come under the command of the NATO International Security and Assistance Forces (ISAF) and operate in accordance with international humanitarian law (also known as the law of armed conflict) and UK rules of engagement. Military lawyers based in Afghanistan advise on all aspects of operations including the selection and prosecution of all ISAF targets, which is the subject of a rigorous process that is compliant with international humanitarian law. Every effort is made to minimise the risk of collateral damage, particularly civilian casualties, which includes in some circumstances deciding not to engage the target.[61]

The MOD does not publish the Rules of Engagement as "disclosure would, or would be likely to prejudice the capability, effectiveness or security of our armed forces." [62]

The MOD has separately said "strikes should not be directed against non-combatants, including any individuals assisting the wounded or deceased, or individuals who are "hors de combat."[63]

5.1 Where are armed UAVs used by the UK?

Reaper is the only armed remotely piloted aircraft system used by the UK. It is only deployed in Afghanistan.

Defence Minister Andrew Robathan has confirmed the UK does not use armed UAVs against terrorist suspects outside Afghanistan.[64] Defence Minister Philip Dunne has confirmed it has

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[56] HC Deb 10 July 2012 c141W

[57] HC Deb 20 March 2012 c587W

[58] Ibid

[59] A Congressional Research Service report *Pilotless Drones: Background and Considerations for Congress Regarding Unmanned Aircraft Operations in the National Airspace System (R42718),* 10 September 2012, examines the issues raised by and use of UAVs in US national airspace; Eurocontrol provides information about military Unmanned Aerial Systems in European airspace

[60] HC Deb 12 September 2012 c230W

[61] HC Deb 12 July 2012 c381W

[62] HC Deb 13 September 2011 c1153W

[63] HC Deb 6 November 2012 c524W

[64] HC Deb 26 November 2012 c29W

not been used in Pakistan or Somalia.[65] The MOD has not made a decision has to whether to retain Reaper once combat operations end in Afghanistan.[66]

As of 1 November 2012, 297 Hellfire precision guided missiles and 52 laser guided bombs have been employed by Reaper since operations began in Afghanistan.[67] Reaper deployed to Afghanistan in 2007 but only had the capability to deploy air-to-ground weapons since May 2008. The following table shows the number of weapons used during each time period:[68]

May 2008 to December 2008	29
January 2009 to December 2009	46
January 2010 to December 2010	73
January 2011 to 4 July 2011	30

Mr Robathan confirmed in December that no UK unmanned aerial vehicles have been used in Pakistan for surveillance or reconnaissance purposes.[69]

UK operated armed UAVs were not deployed in Libya.[70] However UK personnel flew American UAVs during Operation Ellamy in Libya in 2011.[71]

5.2   Civilian casualties

Then Defence Minister Nick Harvey said in June 2012 that he is aware of only one incident which in individuals not classified as insurgents were killed by a UK Reaper. This occurred on 25 March 2011 when a Reaper fired on two pick-up trucks. Two insurgents and four civilians were killed and two civilians were injured. Mr Harvey said an International Security Assistance Force (ISAF) investigation was carried out and concluded that the actions of the Reaper crew had been in accordance with extant procedures and ISAF rules of engagement.[72] The report is being withheld. A more recent question, answered on 6 November 2012, referred back to that incident.

There is a claims officer located in Lashkar Gah for Afghan civilians to lodge a claim for compensation against the Ministry of Defence. He travels throughout Helmand Province.[73]

Lord Hylton asked the Government how it distinguishes civilians from insurgents:

> What criteria they use to distinguish civilians from insurgents in Afghanistan when assessing deaths and injuries caused by United Kingdom forces; and whether the same criteria apply to casualties caused by drone aircraft.

> The Parliamentary Under-Secretary of State, Ministry of Defence (Lord Astor of Hever): Within the context of the operational environment in Afghanistan, we report the number

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[65]   HC Deb 6 November 2012 c203WH
[66]   HC Deb 13 November 2012 c172W
[67]   HC Deb 12 November 2012 c31W
[68]   HC Deb 18 July 2011 c586W
[69]   HC Deb 4 December 2012 c702W
[70]   HC Deb 6 November 2012 c204WH
[71]   HC Deb 26 November 2012 c29W & HC Deb 29 November 2012 c461W
[72]   HC Deb 26 June 2012 c187W
[73]   HC Deb 26 November 2012 c28W

of casualties that are caused by UK forces' actions, whether these are civilian or insurgent casualties, as accurately as practicable.

The Ministry of Defence does not, as a matter of course, monitor overall insurgent or civilian casualty figures.

However, in all circumstances where a possible civilian casualty is reported, UK forces will investigate the circumstances. The presumption of that investigation will be that any casualty is a civilian unless it can be established that the individual was directly involved in immediate attempts or plans to threaten the lives of International Security Assistance Force personnel.[74]

The Foreign and Commonwealth Office says it does not keep detailed records of deaths of British nationals overseas "who may have been killed by unmanned aerial vehicle (UAV) strikes" and says it cannot comment on specific cases.[75]

5.3   Loss of UAVs

Almost 450 drones have crashed, broken down or been lost in action during operations in Afghanistan and Iraq in the last five years, the Guardian reported in February 2013. Quoting a Freedom of Information request, the Guardian said the figures show the military has lost one Reaper drone since 2007 and nine losses of the Hermes 450, of which 8 were lost in Afghanistan. 412 Desert Hawk 3 have crashed or been lost and 25 T-Hawk's and Black Hornets have also been lost/crashed/destroyed on operations.[76] The figures for the Hermes 450 were previously provided in a PQ (HC Deb 24 January 2013 c2MC)

6   Criticism of drones

There has been much international criticism of the use of armed UAVs, particularly by America in Afghanistan, Pakistan and elsewhere. A report by Stanford University examining US drone attacks in Pakistan, *Living Under Drones*, argued drone strikes are damaging and counterproductive. Based on figures collated by the Bureau of Investigative Journalism, it estimated between 2,562 and 3,325 people were killed in drone strikes in Pakistan between June 2004 and mid-September 2012, of whom 474 to 881 were civilians. It argued US drone strike policies "cause considerable and under-accounted for harm to the daily lives of ordinary civilians, beyond death and physical injury."[77]

The MOD says that no drones operated by UK forces have been used in Pakistani airspace.[78] Nor were they used in Libya in 2011, although the MOD has confirmed UK personnel embedded within a US unit flew remotely piloted air systems in Libya in 2011.[79]

The MOD says it is only aware of one incident in which civilians were killed by weapons deployed from a UK Reaper, on the 25 March 2011. According to the MOD a report concluded the actions of the Reaper crew were "in accordance with extant procedures and UK rules of engagement."[80]

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[74]   HL Deb 13 November 2012 c261WA
[75]   HC Deb 19 November 2012 c278W
[76]   "Nearly 450 British military drones lost in Iraq and Afghanistan", *The Guardian,* 12 February 2013
[77]   "Living Under Drones", *Stanford Law School and NYU School of Law,* September 2012 , introduction
[78]   HC Deb 11 July 2011 c51WS
[79]   HL Deb 24 July 2012 cWA140
[80]   HC Deb 6 November 2012 c204WH

There are a number of organisations who question the development and use of drones and who provide further resources and analysis of their use and implications, including:

- Drone Wars UK

- Living Under Drones

- International Committee for Robot Arms Control

6.1 Ethical and legal issues

Defence Minister Philip Dunne argued in a Westminster Hall debate on drones in November 2012 that "the moral, ethical and legal issues associated with the operation and use of weapons from UAVs are the same as those for manned aircraft." He argued UAVs "are saving the lives" of British and ISAF personnel in Afghanistan and are "vital" to the success of the mission.[81] Members further discussed the moral, ethical and legal issues surrounding UAVs in an adjournment debate on 11 December 2012.[82]

The MOD's *Joint Doctrine Note 2/11 The UK Approach to Unmanned Aircraft Systems* explores the moral, legal and ethical issues. It notes that analogies can be drawn with those presented by manned aircraft where activities mirror each other. However it also raises the prospect that future systems may have characteristics or capabilities that do not easily correlate to manned aircraft activity and hence require new thinking.[83]

Analysts question whether UAVs "lower the bar to war".[84] The argument being that it is easier to send an unmanned asset into hostile territory than it is to deploy a manned asset, which has the associated implications of a pilot being killed or taken hostage, and also requires the deployment of a Search and Rescue capability. Medea Benjamin, author of *Drone Warfare: killing by remote control,* argues "The biggest ethical problem with drones is that it makes killing too easy".[85]

The Joint Doctrine Note raised this question too, asking "if we remove the risk of loss from the decision-makers' calculations when considering crisis management options, do we make the use of armed force more attractive? Will decision-makers resort to war as a policy option far sooner than previously?" It argued it is essential that by removing some of the horror of war "we do not risk losing our controlling humanity and make war more likely."[86] David Cortright looks at more of these issues in his article *License to Kill*[87] which cites a number of other studies exploring these issues in greater depth.

The UN's then Special Rapporteur on extrajudicial, summary or arbitrary executions, Philip Alston, produced a report in May 2010. He made the point that a missile fired from a drone is no different from any other weapon and "critical legal question is the same for each weapon: whether its specific use complies with International Humanitarian Law."[88] Former Defence

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[81] HC Deb 6 November 2012 c202WH
[82] HC Deb 11 January 2012 c27WH
[83] "Joint Doctrine Note 2/11 The UK Approach to Unmanned Aircraft Systems", *MOD Development, Concepts and Doctrine Centre (DCDC)*, 30 March 2011, Chapter 5
[84] E. Quintana, "Unmanned systems: confusing ethics", *RUSI commentary*, April 2011
[85] "Drones revolutionise US warfare", *Defencetalk,* 18 June 2012
[86] "Joint Doctrine Note 2/11 The UK Approach to Unmanned Aircraft Systems", *MOD Development, Concepts and Doctrine Centre (DCDC)*, 30 March 2011, p5.9
[87] D. Cortright, "License to Kill", *CATO unbound website,* 9 January 2012
[88] "Report of the Special Rapporteur on extrajudicial, summary or arbitrary executions, Philip Alston", *UN General Assembly Human Right s Council*, 28 May 2010, GE-10 13753, Para 79

Minister Sir Nick Harvey echoed this point during a Westminster Hall debate on UAVs, saying there is "nothing inherently wicked or virtuous" about a UAV but the moral questions raised "hinge entirely on what is done with them."[89]

Mr Alston expressed a concern raised by others about the development of a "play station mentality" to killing because operators are based thousands of miles away and far-removed from theatre. He called on States who operate drones to ensure adequate safeguards for compliance with international humanitarian law.[90]

An Air Force official counters the 'play station' view:

> You are 18 inches away from 32-inch, high-definition combat, where you are in contact [by headset with] the guys on the ground... You are there. You are there. You fly with them, you support them and a person you are tasked with supporting gets engaged, hurt, possibly killed, it's a deeply, deeply emotional event. It's not detached. It's not a video game. And it's certainly not 8,000 miles away.[91]

A similar article for *Stars and Stripes* magazine examines the stresses encountered by the UAV pilots and operators, including the impact of watching US soldiers died in battle. It notes the dangers of exhaustion and burnout among UAV operators. [92]

Lord Wallace of Saltaire, the Spokesperson for Foreign and Commonwealth Affairs in the Lords, has argued that because drones can loiter over a site "not only is target acquisition more carefully attended to than if you are in a fast aircraft but you are asked to look at what happened afterwards." He added "I am told that this means that those who are controlling these aircraft have a thorough sense of responsibility for what has been done."[93]

The Joint Doctrine Note also explores the implications of greater autonomy. It observes the words autonomy and autonomous are used interchangeably but while some UAVs may have a degree of autonomy, they are not fully autonomous – they are not self-aware and are not capable of deciding a course of action without depending on human oversight and control. Fully autonomous systems do not yet exist.

The UK Armed Forces do not use fully autonomous systems – all the UK operated UAVs require a human pilot. According to the Joint Doctrine Note "It is an over-arching principle that, whatever the degree of automation, an unmanned aircraft should provide at least the same, or better, safety standard as a manned platform carrying out the same task."[94] RUSI analyst Elizabeth Quintana points out "there is little or no military appetite at present for fully autonomous systems - not least because a malfunctioning system would be a strategic disaster."[95] Human Rights Watch published a report in November 2012 outlining its case against fully autonomous UAVs entitled *Losing Humanity: the case against killer robots*.

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[89]   HC Deb 6 November 2012 c201WH
[90]   Para 84
[91]   "Demand grows for UAV pilots, sensor operators", *Air Force Times,* 21 April 2012; see also "Meet the pilots who fly America's drones", *Global Post,* 16 December 2011
[92]   "The war room: Daily transition between battle, home takes a toll on drone operators", *Stars and Stripes,* 27 October 2009
[93]   HL Deb 7 February 2013 c351
[94]   "Joint Doctrine Note 2/11 The UK Approach to Unmanned Aircraft Systems", *MOD Development, Concepts and Doctrine Centre (DCDC)*, 30 March 2011, p2.4
[95]   E. Quintana, "Unmanned systems: confusing ethics", *RUSI commentary,* April 2011

Library Standard Note *Drone attacks and the killing of Anwar al-Awlaqi: legal issues* examines some of the legal issues raised by the use of armed UAVs.[96]

The Defence Select Committee is to examine "the effect of changes in the interpretation of the law on the prosecution of operations, and the use of remotely piloted aircraft (RPAs, commonly known as "drones")" as part of its work for the remainder of the Parliament.[97]

7   Global use of UAVs

There has been a rapid growth globally in UAV acquisition, development and military applications, according to a survey by the US General Accounting Office. The GAO notes the number of countries that have acquired a UAV has increased from approximately 41 in 2004 to at least 76 countries in 2012.[98] It suggests over 50 countries are developing more than 900 different UAV systems.[99] The majority are considered tactical UAVs which are primarily used for intelligence, surveillance and reconnaissance missions and have a limited operational range. The GAO notes that demand for UAVs is high but export control restrictions limit the export of sophisticated UAV technology. Israel is one of the predominant global exporters of UAV technology.[100]

The GAO estimates the following countries have acquired UAVs by December 2011[101]:

Algeria	Chile	Greece	Libya	Poland	Syria
Angola	China	Hungary	Lithuania	Republic of Korea	Taiwan
Argentina	Colombia	India	Malaysia	Romania	Thailand
Australia	Croatia	Indonesia	Mexico	Russia	Trinidad and Tobago
Austria	Czech Republic	Iran[102]	Morocco	Serbia	
Azerbaijan	Denmark	Israel	Netherlands	Singapore	Tunisia
Belarus	Egypt	Italy	New Zealand	Slovakia	Turkey
Belgium	Estonia	Ivory Coast	Nigeria	Slovenia	Uganda
Botswana	Ethiopia	Japan	Norway	South Africa	Ukraine
Brazil	Finland	Jordan	Pakistan	Spain	United Arab Emirates
Bulgaria	France	Kazakhstan	Panama	Sri Lanka	
Burundi	Georgia	Latvia	Peru	Sweden	UK
Canada	Germany	Lebanon	Philippines	Switzerland	US

The MOD assesses that there are approximately 80 states whose armed forces have an unmanned air vehicle capability. Of these, less than a dozen operate systems that can be armed with missiles or other munitions.[103]

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[96]   A. Thorp, *Drone attacks and the killing of Anwar al-Awlaqi: legal issues,* House of Commons Library Standard Note SN06165, 20 December 2011

[97]   Defence Select Committee, *Defence Committee Future Programme,* 10 December 2012

[98]   "Non-proliferation: Agencies Could Improve Information Sharing and End-Use Monitoring on Unmanned Aerial Vehicle Exports", US Government Accountability Office, July 2012, GAO-12-536, p9

[99]   Ibid p13

[100]   Ibid p11

[101]   "Non-proliferation: Agencies Could Improve Information Sharing and End-Use Monitoring on Unmanned Aerial Vehicle Exports", US Government Accountability Office, July 2012, GAO-12-536, p10

[102]   Jane's Defence Weekly undertook a detailed study of Iran's UAV's in its 16 November 2012 edition, entitled "Rise of the Pahphad: Iran's unmanned aerial vehicles"

[103]   HC Deb 29 October 2012 c31W

7.1   Use of drones by the United States

The United States military possess a wide-range of Unmanned Aerial Vehicles and Systems in considerable numbers – over 7,000 vehicles, including 161 MQ-1A/B Predator and 54 MQ-9 Reaper, operated by the US Air Force, and 364 Shadow and 25 Hunter, operated by the US Army. They also possess over 5,000 Raven, a lightweight, hand-launched UAV.[104] Predator B and Reaper are equipped with a strike capability, and many Predator As have been modified to carry weapons.

Their use has increased significantly – from 10,000 UAV flight hours in 2005 to more than 550,000 in 2010.[105] The US also uses and is developing a number of other UAVs of various sizes and roles. More information about US capabilities and their use can be found in *Unmanned Aerial Systems* written by the Congressional Research Service in January 2012.

President Obama's counter-terrorism adviser gave what was described as the most detailed explanation so far of America's use of drones in a speech in April 2012. He argued the strikes are legal, ethical and wise.[106] The Stanford University study, *Living under Drones*, argued "current US targeted killings and drone strike practices undermine respect for the rule of law and international legal protections and may set dangerous precedents."[107] When asked what advice they have sought and received on the legality of the United States' use of drones in Pakistan, the Foreign Office said:

> Drone strikes are a matter for the United States and Pakistan, which are facing a shared and dangerous threat from terrorists. Naturally, we expect all concerned to act in accordance with international law.[108]

Library Standard Note *Drone attacks and the killing of Anwar al-Awlaqi: legal issues* examines some of the legal issues raised by the killing of Anwar al-Awlaqi, a dual US-Yemeni citizen described as the "leader of external operations for Al-Qaeda in the Arabian Peninsula", in a drone strike in Yemen in September 2011.[109]

7.2   NATO

NATO has identified Intelligence, Surveillance and Reconnaissance as one of capabilities it is lacking and, therefore, needs to develop.[110]

The Alliance has agreed to pursue development and deployment of the Alliance Ground Surveillance (AGC) System. 13 members will acquire five unmanned aerial vehicles and make them available to the Alliance. They will be NATO owned and operated. They will be Global Hawk Block 40 high-altitude, long-endurance UAVs.

They are expected to be fully operational by 2017 and the main operating base will be located at Sigonella Air Base in Italy, which will serve a dual purpose as a NATO Joint

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[104] Congressional Research Service, *Unmanned Aerial Systems*, R42136, 3 January 2012, table 1, p7
[105] "Non-proliferation: Agencies Could Improve Information Sharing and End-Use Monitoring on Unmanned Aerial Vehicle Exports", US Government Accountability Office, July 2012, GAO-12-536, p14
[106] J. Brennan, ""The Ethics and Efficacy of the President's Counterterrorism Strategy", *Woodrow Wilson International Centre for Scholars,* 30 April 2012
[107] "Living Under Drones", *Stanford Law School and NYU School of Law,* September 2012 , introduction
[108] HL Deb 25 June 2012 cWA35
[109] A. Thorp, *Drone attacks and the killing of Anwar al-Awlaqi: legal issues,* House of Commons Library Standard Note SN06165, 20 December 2011
[110] For example, see the Speech by Admiral Giampaolo Di Paola, Chairman of the NATO Military Committee, 8 October 2011 & the press conference by Secretary-General Anders Fogh Rasmussen, 5 October 2011

Intelligence, Surveillance & Reconnaissance (JISR) deployment base and data exploitation and training centre.

The 13 countries (Bulgaria, Czech Republic, Estonia, Germany, Italy, Latvia, Lithuania, Luxembourg, Norway, Romania, Slovakia, Slovenia and the United States) signed the procurement contract at the Chicago summit in May 2012. It was cited in the *Summit Declaration on Defence Capabilities: Toward NATO forces 2020*. The UK is not one of the allies but NATO says "contributions-in-kind provided by France and the United Kingdom will complement the AGS with additional surveillance systems."[111]

Then Defence Minister Sir Nick Harvey says the UK did not join the consortium acquiring AGS because the UK's requirements for airborne surveillance are met mainly by the Sentinel system. He said Sentinel "has been accepted by NATO as a contribution in kind to its wider surveillance requirements."[112]

A study by the NATO Parliamentary Assembly into UAVs, *Unmanned Aerial Vehicles: Opportunities and challenges for the Alliance,* provides a summary of use of UAVs in NATO-led operations and missions, including the Balkans, Afghanistan and Libya. It also explores in greater detail the issue of UAVs in a NATO context and raises issues for NATO members to address.[113]

7.3   Terrorist threat

There are concerns about the possible acquisition and use of UAVs by terrorist groups.

Ted Harshberger, an air force analyst at RAND, notes that it is "very difficult" to build the long-endurance, highly automated, multi-role unmanned systems" like Reaper and Global Hawk, arguing only a few companies can produce them and only a few countries can afford them.[114] However he also argues it is "*extremely easy* to produce modest-endurance, partially automated, single-purpose unmanned systems."[115]

The US GAO study observes that while only a limited number of countries have fielded lethal or weaponised UAVs "the threat is anticipated to grow".[116] It notes "no terrorist organisation has successfully carried out an attack with a UAV to date."[117] However it also notes that "if terrorists were able to equip UAVs with even a small quantity of chemical or biological weapons an attack could potentially produce lethal results."[118]

Zac Goldsmith MP asked the Government the following question about the threat assessment of the use of drones by governments and non-state actors:

> To ask the Secretary of State for Defence what recent assessment he has made of the potential threat to national security of the *(a)* acquisition and *(b)* use of drones by (i) governments and (ii) non-state actors.

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[111] More detailed information about AGS is available on the NATO website

[112] HC Deb 11 June 2012 c106W

[113] NATO Parliamentary Assembly Science and Technology Committee, *Unmanned Aerial Vehicles: Opportunities and challenges for the Alliance,* 157 STC 12 E rev.1, November 2012

[114] T. Harshberger, "Expect More Drone Use Like Recent Israeli Episode", *RAND Commentary,* 11 October 2012

[115] Ibid

[116] "Non-proliferation: Agencies Could Improve Information Sharing and End-Use Monitoring on Unmanned Aerial Vehicle Exports", US Government Accountability Office, July 2012, GAO-12-536, p18

[117] Ibid

[118] "Non-proliferation: Agencies Could Improve Information Sharing and End-Use Monitoring on Unmanned Aerial Vehicle Exports", US Government Accountability Office, July 2012, GAO-12-536, p19

Miss Chloe Smith: I have been asked to reply on behalf of the Cabinet Office.

The 2010 National Security Strategy was informed by a National Security Risk Assessment (NSRA) which provides a comprehensive assessment and prioritisation of all major extant and emerging risks which seriously threaten the UK's national security interests. Due to the NSRA's strategic focus it does not include a specific risk of drone acquisition or their use but does include a range of more generic state-led and non-state led threats to our national security interests. The employment of an array of offensive technologies, including drones, was considered when assessing these generic threat scenarios.[119]

7.4   International regulation

There are two principle multilateral regimes that address exports of UAVs – the Missile Technology Control Regime (MTCR) and the Wassenaar Arrangement. Both are voluntary, nonbinding arrangements among like-minded supplier countries. The UK belongs to both.

The MTCR is a voluntary association of 34 countries and focuses on limiting the spread of ballistic and cruise missiles and UAVs capable of delivering weapons of mass destruction.[120] The MOD has said the UK discusses the developments of unmanned aerial vehicles/systems with MTCR partners but notes it works on a consensus basis and therefore each member must be in agreement before any changes to guidelines can be implemented.[121] The UK was a founding partner of the MTCR when it was established in 1987.

The Wassenaar Arrangement (Wassenaar Arrangement on Export Controls for Conventional Arms and Dual-Use Goods and Technologies) is a voluntary association of 41 countries which want to limit the spread of certain conventional weapons.[122] More about UK Arms Exports can be found Library Standard Note *UK Arms Export Control Policy*.[123]

Human Rights Watch, in its report *Losing Humanity: the case against killer robots,* called on Governments to pre-emptively ban fully autonomous weapons because of the danger they pose to civilians in armed conflict. They are calling for an international treaty to prohibit the development, production, and use of fully autonomous weapons.

When asked whether the Government plans to seek international agreement to regulate the use of UAVs, Foreign Office Minister Alistair Burt replied: The use of unmanned aerial vehicles is a matter for the states involved. We expect all concerned to act in accordance with international law."[124]

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[119] HC Deb 4 December 2012 c703W

[120] "Non-proliferation: Agencies Could Improve Information Sharing and End-Use Monitoring on Unmanned Aerial Vehicle Exports", US Government Accountability Office, July 2012, GAO-12-536, p4

[121] HC Deb 16 April 2012 c75W

[122] "Non-proliferation: Agencies Could Improve Information Sharing and End-Use Monitoring on Unmanned Aerial Vehicle Exports", US Government Accountability Office, July 2012, GAO-12-536, p4

[123] J. Lunn, *UK Arms Export Control Policy,* House of Commons Library Standard Note SN02729, 10 January 2012

[124] HC Deb 26 November 2012 c103W

Appendix 1: Strengths and weaknesses of UAVs[125]

The following table is taken from the MOD's *Joint Doctrine Note 2/11 The UK Approach to Unmanned Aircraft Systems*:

Strengths	Weaknesses
Good for dull, dirty dangerous tasks	Lack of small, tailored weapons
Operations can be conducted without risk to aircrew	Lack of long air carriage life weapons
Can be cheaper (caution – through life costs need to be considered)	Vulnerable to cyber and communications link attack
Availability - unmanned aircraft can support tactical activity where manned assets would not be available	Legal, ethical, moral thinking needs further development
Small/medium scale can provide immediate, tactical situational awareness (in uncontested airspace)	Law of Armed Conflict may constrain high levels of automation/autonomy
Reduced manpower footprint in theatre	Current systems are not built to airworthy standards – costs will rise as these are enforced
Very good at intelligence, surveillance and reconnaissance and attack missions (in uncontested airspace)	Integration into non-segregated airspace is problematic, potentially costly and there is uncertainty over when it will happen
Removal of human limitations can allow different performance factors to be developed and exploited	No experience of non-urgent operational requirement procurement
Persistence	Public perception issues (killer drones)
Can help reduce harmony issues by operation from rear base	Limited UK experience in the operation of unmanned aircraft across all Classes
	Key technologies remain immature
	Very good at niche roles but lacks overall flexibility and adaptability compared to manned aircraft
	Poor penetration
Opportunities	Threats
Focused UAS research and procurement could underpin national industrial sustainment in key areas	Threat to operational sovereignty through declining national
Ideal platform to rapidly exploit new and advanced technologies	industrial capability
Directed energy weapon/electromagnetic weapon employment	• Seen by some as policy/financial panacea without
Novel approach to operations.	appropriate understanding of relative strength and
Opportunity to develop new acquisition processes	weaknesses of current systems
Expand into control of the air and mobility air power roles	• Entrenched views skew arguments both for/against
	Requires new thinking
	Funding new systems difficult in financial climate
Export potential (but International Traffic in Arms Regulations and Missile Technology Control Regime	Current defence industrial strategy and procurement

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[125] "Joint Doctrine Note 2/11 The UK Approach to Unmanned Aircraft Systems", *MOD Development, Concepts and Doctrine Centre (DCDC)*, 30 March 2011, Concl-4

issues) Civil markets, interoperability Cross governmental cooperation Quicker, cheaper into service UAS pipeline to provide coordinated research and technology programme Swarming/networks new ways of working	system is not agile enough, may not be able to sustain full range of capabilities (particularly the high end) Research funding under pressure Technology may promise too much and fail to deliver Technology may provide effective counter UAS systems Pressures to increase develop high end systems may starve simpler more affordable systems of funding/development High accident/loss rates Bandwidth requirements and spectrum management Uncertainty over when certain technologies will deliver makes planning of manned/unmanned mix difficult and transition planning problematic